**3GPP TSG-RAN WG4 Meeting #110 R4-2401063**

**Athens, GR, 26 Feb – 01 Mar, 2024**

**Agenda item:** 6.4

**Source:** Moderator (Apple)

**Title:** Topic summary for [110][104] NR\_2Rx\_XR

**Document for:** Information

# Introduction

This email thread is focused on 2Rx non-REDCAP XR devices under AI 6.3.1.

# Topic #1: 2Rx non-REDCAP XR devices

*Main technical topic overview. The structure can be done based on sub-agenda basis.*

## Companies’ contributions summary

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| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2400157 | Apple | Observation 1: Considering the extensive history of assumptions on NF and IM made by RAN4 when deriving REFSENS and some preliminary RF front end considerations of the new XR wearable form factor, there does not seem to be a strong technical justification to tighten the 2Rx REFSENS value for 2Rx wearable devices.  Observation 2: Based on further guidance by RAN, it is feasible for RAN4 to begin the effort to define the test methodology aspects for the radiated testing of XR wearable devices. Because RAN4 develops OTA performance requirements based on measured data of commercially available devices, this effort should be postponed until a later release. To alleviate operator concerns with the coverage of 2Rx XR wearable devices, RAN4 should discuss whether a single OTA requirement for XR wearables can be defined, regardless of the number of Rx antennas used in the device.  Proposal 1: A CR to 38.101-1 is needed to include the definition of the “2Rx non-REDCAP XR” UE and to update NOTE 1 to Tables 7.3.2-1a and 7.3.2-1b should be updated to include applicability to the “2Rx non-REDCAP XR.”  Proposal 2: Based on the OTA considerations provided, RAN4 can initiate the work to define test methodology aspects for 2Rx non-REDCAP XR UEs in Rel-19. The effort to specify OTA performance requirements should be postponed until a later release. To accommodate operator concerns with the coverage of 2Rx, it is recommended to include the following objective to the future OTA performance requirements WID: “RAN4 should discuss whether a single OTA requirement for XR wearables can be defined, regardless of the number of Rx antennas used in the device.” |
| R4-2400552 | Meta Ireland | **Proposal 1: In TS38.101-1, RAN4 defines 2Rx non-RedCap XR devices, following RP-232657, as:**  **2Rx Non-RedCap XR UE: A UE that is not (e)RedCap and supports only two Rx antennas in frequency bands where 4Rx is mandated. The XR device is intended to be worn on the human head. When in use, it is intended to be supported only by or behind the ears and by a nose-bridge resulting in a constrained form factor with limited volume available for Rx chains.**  **Proposal 2*: RAN4 reuses the existing REFSENS requirement for 2Rx non-RedCap XR UEs.***  **Proposal 3*: RAN4 update Note 1 in Table 7.3.2-1a and Table 7.3.2-1b of in TS38.101-1 to allow 2Rx relaxation and apply the existing REFSENS for XR device.*** |
| R4-2400553 | Meta Ireland | **Proposal 1**: The several key advantages of antenna design and properties of the XR glasses compared to smartphone antennas provide natural mitigation to performance impact of 2Rx vs 4Rx. The performance of XR glasses can be expected to be on-par or outperform compared with a pair of antennas of 4Rx smartphones. The antenna advantages of XR glasses include lower antenna correlation, less uplink SAR backoff, and no impact from antenna loss due to hand-held usage.  **Proposal 2**: In order to overcome the challenges of OTA tests, RAN4 develops and utilises a theoretical model to evaluate the performance of XR devices for OTA considerations. |
| R4-2400555 | Meta Ireland | CR TS38.101-1 on XR device definition and REFSENS requirements for 2Rx non-Redcap XR device [2Rx\_XR\_UE] |
| R4-2400620 | Nokia, | CR 38.101-1 addition of 2Rx XR exception for REFSENS |
| R4-2400707 | Qualcomm Incorporated | **Observation 1: The scope of the feasibility discussion for the conducted REFSENS tightening is limited to bands n7,n38, n41, n48, n77, n78, n79 and n104 for XR device which implements two RX ports for these bands**  **Observation 2: Receiver noise figure can be improved by using more expensive solutions or more power or area.**  **Observation 3: XR devices have some characteristics that have potential for better radiated performance than handheld devices**  How to close the RAN task and draft CRs for RAN#103, will need discussion. There maybe a need for WF for OTA part that may include some draft for new WI objectives for XR device radiated performance.  For conducted part, to assist proper transparency of the agreements, we provided a proposal:  **Proposal: RAN4 shall not conclude on conducted refsens tightening without concluding proper specification language** |
| R4-2400822 | CMCC | **Observation 1: Compared with 4Rx for handheld UE, 2Rx for non-REDCAP XR devices naturally have advantages of antenna performance, e.g. better antenna correlation and antenna efficiency.**  **Observation 2: for dense urban scenario, UL coverage is worse than DL but the coverage difference is little. DL coverage is also very essential.**  **Proposal 1: for 2Rx non-REDCAP XR device, it’s better to define better REFSENSE requirements than that of 2Rx handheld UE.**  **Proposal 2: it’s better to reuse the same OTA requirements as handheld UE for 2Rx non-REDCAP XR device.** |
| R4-2401526 | vivo | How to reflect the new definition and corresponding requirements into 38.101-1  **Proposal 1: Consider the following definition and the note in 2Rx REFSENS and exception in 38.101-1.**  **Wearable 2Rx UE**: a UE intended to be worn on the human head, and intended to be supported only by/behind the ears and by a nose-bridge resulting in a constrained form factor with limited volume available for Rx chains.  *NOTE 1: Four Rx antenna ports shall be the baseline for this operating band except for two Rx vehicular UE and wearable 2Rx UE. Four Rx antenna ports for RedCap UE is not supported for this operating band.*  *NOTE 11: For wearable 2Rx UE, -TBD dB is added to the REFSENS.*  *The UE is required to be equipped with a minimum of two Rx antenna ports in all operating bands except for the bands n7, n38, n41, n48, n77, n78, n79, n104 where the UE is required to be equipped with a minimum of four Rx antenna ports except for wearable 2Rx UE.*  What should be the conduct requirements value should be  **Proposal 2:** Consider a value between 0 and 1 dB for the tightening, since the implementation margin is limited and UL performance is bottleneck.  How to consider OTA requirements  **Observation 1:** The Free-space test method defined in TRP TRS WI is general for different UE types, which can cover XR free space testing. However, the phantom-based XR test method is not specified yet.  **Observation 2:** RAN4 is working on the TRP TRS requirements for smartphone with phantom-based usage scenario.  **Proposal 3:** RAN4 should develop phantom-based XR test method.  **Proposal 4:** To study the OTA performance gap between XR and smartphone, the corresponding work should be well organized and proceed, which can be considered as part of Rel-19 scope in TRP TRS WI. |
| R4-2401527 | vivo | draft CR to 38.101-1 on Addition of requirements for non-Redcap XR |
| R4-2401796 | OPPO | **Observation 1: To reduce the DL performance impacts, the improvement of conducted REFSENS and OTA requirements can be considered.**  **Observation 2: There is no much difference between XR device and other UE types in RFFE which makes no much improvement can be done for conducted REFSENS. In contrast, the OTA requirements probably can be improved by proper antenna design and the missing of hand blocking effects in XR devices.**  **Proposal 1: Keep the conducted REFSENS with 2Rx unchanged in bands where 4Rx is mandatory. Study the improvement of OTA requirements for XR devices in future releases.**   |  | | --- | | **3.1 Definitions**  For the purposes of the present document, the terms and definitions given in 3GPP TR 21.905 [1] and the following apply. A term defined in the present document takes precedence over the definition of the same term, if any, in 3GPP TR 21.905 [1].  [Unchanged sections omitted]  **Vehicular UE:** A UE embedded in a vehicle, permanently connected to an embedded antenna system that radiates externally for NR operating bands.  NOTE: Vehicular UE does not refer to other UE form factors placed inside the vehicle.  **Wideband operation:** For a UE that supports shared spectrum channel access, wideband operation refers to operation within a channel larger than 20 MHz in which intra-cell guard bands may be configured to distinguish individual RB-sets  **2Rx non-REDCAP XR UE:** A UE supporting XR feature and is intended to be worn on the human head and when in use is intended to be supported only by/behind the ears and by a nose-bridge resulting in a constrained form factor with limited volume available for Rx chains. |   For the REFSENS requirement definition, the changes are as below.   |  | | --- | | **7.2 Diversity characteristics**  The UE is required to be equipped with a minimum of two Rx antenna ports in all operating bands except for the bands n7, n38, n41, n48, n77, n78, n79, n104. For the bands n7, n38, n41, n48, n77, n78, n79 and n104, UEs other than “2Rx non-REDCAP XR UE” are required to be equipped with a minimum of four Rx antenna ports, and for “2Rx non-REDCAP XR UE”, it can be equipped with two antenna ports. This requirement applies when the band is used as a standalone band or as part of a band combination. |   **Proposal 2: The changes as above are proposed.** |
| R4-2402421 | Huawei, HiSilicon, Telecom Italia, Telia Company, T-Mobile USA, Telefonica, BT plc, CMCC, Orange, Spark (NZ) | ***Proposal 1: It is proposed to define the REFSENS of 2Rx non-RedCap XR in a relative manner similar to that for 4Rx, i.e. introduce ΔRXR,2R and add it on top of 2Rx REFSENS for handheld UE.***  ***Proposal 2: The introduced ΔRXR,2R should be distinguished with different values for the bands which are mandatorily supporting 4Rx.***  ***Observation 1:*** *OTA TRS requirement is specified in RAN4 band by band with relatively high thresholds that number of commercially available devices should be sufficient with different models from different vendors.*  ***Observation 2:*** *For the bands which are mandatorily supporting 4Rx, RAN4 only develop the OTA requirements based on measurement of 4Rx devices.*  ***Observation 3:*** *Mass commercial 2R/4R XR devices are not available yet to comply with the measurement campaign required by the RAN4 procedure for specifying the OTA requirements*  ***Proposal 3: It is proposed to specify one set of OTA TRS requirement for both 4Rx XR and 2Rx XR for the NR bands which are mandatorily to support 4Rx***  ***Proposal 4: It is proposed to adopt the existing 4Rx TRS requirement, specified for handheld UE, for 2Rx non-RedCap XR device*** |
| R4-2402422 | Huawei, HiSilicon, Telecom Italia, Telia Company, T-Mobile USA, Telefonica, BT plc, CMCC, Orange, Spark (NZ) | CR on Introduction of 2Rx relaxation for XR devices |
| R4-2402452 | T-Mobile USA, Deutsche Telekom, Vodafone, AT&T, Orange, Spark, Telstra, TELUS | **Observation 1: All the 7 devices studied have at least one antenna port that can meet the 4Rx REFSENS requirement with a single antenna port for n41.**  **Observation 2: All the antenna ports in the 7 devices studied when adjusted from 1Rx to 2Rx can meet the 4Rx REFSENS requirement for n41.**  **Observation 3: All but one of the 28 antenna ports studied, when adjusted from 1Rx to 2Rx have at least 1 dB of margin relative to the 4Rx REFSENS requirement for n41.**  **Observation 4: For the two devices studied, all antenna ports can meet the 4Rx REFSENS requirement with a single antenna port for n77.**  **Proposal: XR UEs that utilize the 2Rx antenna allowance shall meet the 4Rx conducted REFSENS requirements for bands where 4Rx is mandatory.** |
| R4-2402609 | MediaTek Inc. | **Proposal 1: Capture the definition of 2Rx non-REDCAP XR Wearable UE into TS 38.101-1 as the following:**  **“A 2Rx non-REDCAP XR Wearable UE refers to a non-handheld device intended to be worn on the human head, supported only by/behind the ears and by a nose-bridge and, due to constrained form factor/volume, equipped with only two Rx antenna ports in all supported FR1 frequency bands.”**  **Proposal 2: Clause 7 requirements for four Rx antenna ports do not apply to a 2Rx non-REDCAP XR Wearable UE.**  **Proposal 3: Agree not to improve conducted Rx sensitivity requirements for 2Rx non-REDCAP XR Wearable UE compared with existing nominal 2Rx assumption.** |
| R4-2402635 | MediaTek Inc. | CR to TS 38.101-1 for 2Rx non-REDCAP XR devices |

*The moderator can suggest a limited number of papers which could be presented.*

## Open issues summary

*Before f2f meeting, moderators shall summarize list of open issues, candidate options and possible WF (if applicable) based on companies’ contributions..*

### Sub-topic 1-1: Definition of 2RX XR devices

* Proposals
  + Option 1: 2Rx non-Redcap XR UE: A UE that is not (e)RedCap and supports only two Rx antennas in frequency bands where 4Rx is mandated. The XR device is intended to be worn on human head. When in use, is intended to be supported only by/behind the ears and by a nose-bridge resulting in a constrained form factor with limited volume available for Rx chains.
  + Option 2: Two antenna port XR UEs: Intended to be worn on the human head. When in use, is intended to be supported only by/behind the ears and by a nose-bridge resulting in a constrained form factor with limited volume available for Rx chains.
  + Option 3: Wearable 2Rx UE: a UE intended to be worn on the human head, and intended to be supported only by/behind the ears and by a nose-bridge resulting in a constrained form factor with limited volume available for Rx chains.
  + Option 4: 2Rx non-REDCAP XR UE: A UE supporting XR feature and is intended to be worn on the human head and when in use is intended to be supported only by/behind the ears and by a nose-bridge resulting in a constrained form factor with limited volume available for Rx chains.
  + Option 5: 2Rx non-RedCap XR UE: A non-RedCap XR-wearable UE with only 2 Rx branches in the bands where 4Rx is specified as mandatory. A non-RedCap XR-wearable UE is intended to be worn on the human head; when in use, the UE is intended to be supported only by/behind the ears and by a nose-bridge resulting in a constrained form factor with limited volume available for Rx chains.
  + Option 6: 2Rx non-REDCAP XR Wearable UE: A non-handheld device intended to be worn on the human head, supported only by/behind the ears and by a nose-bridge and, due to constrained form factor/volume, equipped with only two Rx antenna ports in all supported FR1 frequency bands.
* Recommended WF
  + TBD

### Sub-topic 1-2: Definition of XR

* Proposals
  + Option 1: XR (eXtended Reality): XR is a term for different types of realities and refers to all real-and-virtual combined environments and human-machine interactions generated by computer technology and wearables. It included following representative forms and the areas interpolated among them AR, MR and VR.
  + Option 2: XR: Extended Reality
  + Option 3: XR eXtended Reality
* Recommended WF
  + TBD

### Sub-topic 1-3: Conducted receiver sensitivity tightening

* Proposals
  + Option 1: No tightening
  + Option 2: a value between 0 and 1 dB for the tightening
  + Option 3:

Table 1: Two antenna port reference sensitivity allowance ΔRXR,2R

|  |  |
| --- | --- |
| Operating band | ΔRXR,2R (dB) |
| n7, n38, n41 | -1.5 |
| n48, n77, n78, n79, n104 | -1.0 |

* Recommended WF
  + TBD

### Sub-topic 1-4: OTA aspects

* Proposals
  + Option 1: Based on the OTA considerations provided, RAN4 can initiate the work to define test methodology aspects for 2Rx non-REDCAP XR UEs in Rel-19. The effort to specify OTA performance requirements should be postponed until a later release. To accommodate operator concerns with the coverage of 2Rx, it is recommended to include the following objective to the future OTA performance requirements WID: “RAN4 should discuss whether a single OTA requirement for XR wearables can be defined, regardless of the number of Rx antennas used in the device.”
  + Option 2: In order to overcome the challenges of OTA tests, RAN4 develops and utilises a theoretical model to evaluate the performance of XR devices for OTA considerations.
  + Option 3: WF for OTA part that may include some draft for new WI objectives for XR device radiated performance.
  + Option 4: it’s better to reuse the same OTA requirements as handheld UE for 2Rx non-REDCAP XR device.
  + Option 5: RAN4 should develop phantom-based XR test method. To study the OTA performance gap between XR and smartphone, the corresponding work should be well organized and proceed, which can be considered as part of Rel-19 scope in TRP TRS WI.
  + Option 6: It is proposed to specify one set of OTA TRS requirement for both 4Rx XR and 2Rx XR for the NR bands which are mandatorily to support 4Rx. It is proposed to adopt the existing 4Rx TRS requirement, specified for handheld UE, for 2Rx non-RedCap XR device
* Recommended WF
  + TBD