**3GPP TSG-RAN WG4 Meeting #94-e R4-2002687**

**Electronic Meeting, Feb.24th – Mar.6th 2020**

**Agenda item:** 8.4.4.2

**Source:** Moderator (CATT)

**Title:** Email discussion summary for RAN4#94e\_#14\_5G\_V2X\_NRSL\_UE\_RX

**Document for:** Information

# Introduction

During the previous RAN4 meetings, a great progress has been achieved on Rx RF requirements for NR V2X and most of Rx RF requirements have been agreed in principle. However, there are still some remaining issues on Rx RF requirements for NR V2X that need to be further discussed. This summary is to provide the associated observations and proposals from different companies for the upcoming email discussion. The agenda item involved is as follows:

8.4 5G V2X with NR sidelink [5G\_V2X\_NRSL]

8.4.4 UE RF requirements [5G\_V2X\_NRSL-Core]

8.4.4.2 Receiver characteristics

Indeed, companies are encouraged to bring arguments on your proposals and comments on other companies’ proposals based on this summary.

# Topic #1: Rx RF requirements

The remaining Rx RF requirements for NR V2X, including REFSENS, maximum input level and ACS, will be discussed in the following parts.

## 2.1 Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| [R4-2000599](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_94_e/Docs/R4-2000599.zip) | CATT | Introduce Rx requirements for NR V2X to TS 38.101-1 based on agreed TR38.886 v0.5.0.  Following Rx requirements for NR V2X are introduced to TS 38.101-1:  7.3E Reference sensitivity for NR V2X  7.4E Maximum input level for NR V2X  7.5E Adjacent channel selectivity for NR V2X  7.6E Blocking characteristics for NR V2X  7.7E Spurious response for NR V2X  7.8E Intermodulation characteristics for NR V2X |
| [R4-2000600](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_94_e/Docs/R4-2000600.zip) | CATT | Specifying Rx requirements for NR V2X inter band concurrent operation with NR license band in TS 38.101-3. |
| [R4-2000607](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_94_e/Docs/R4-2000607.zip) | CATT | **Proposal 2: The target SNR level should be derived from simulation results after the definition of reference measurement channel.**  **Proposal 3: The maximum input level for NR V2X should be -25dBm.** |
| [R4-2000966](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_94_e/Docs/R4-2000966.zip) | LGE | **Proposal 1:**Revise the REFSENS equation for NR V2X sidelink including diversity gain [3]dB  REFSENSV2X=*kTB* + SNRV2X +10log10(LCRB/NRB) +( NFV2X+ IM) - Diversity gain  **Proposal 2:** Define the REFSENS levels and Tx configurations for NR V2X UE as shown in Table 2-1 and Table 2-2.  Table 2‑1 Proposed RESENS for NR V2X (PC5)   |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | | **NR Operating band / SCS / Channel bandwidth / Duplex-mode** | | | | | | | | **NR V2X Band** | **SCS**  **kHz** | **10MHz**  **(dBm)** | **20MHz**  **(dBm)** | **30MHz**  **(dBm)** | **40MHz**  **(dBm)** | **Duplex Mode** | | n38 | 15 | -96.7 | -93.5 | -91.7 | -90.6 | TDD | | 30 | -97.3 | -93.6 | -91.9 | -90.5 | | 60 | -96.9 | -94.3 | -92.7 | -90.6 | | n47 | 15 | -92.7 | -89.5 | -87.7 | -86.6 | TDD | | 30 | -93.3 | -89.6 | -87.9 | -86.5 | | 60 | -92.9 | -90.3 | -88.7 | -86.6 |   Table 2-2: Sidelink TX configuration for reference sensitivity of NR V2X Bands (PC5)   |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | | NR operating Band / SCS/ Channel bandwidth / NRB / Duplex mode | | | | | | | | NR V2X Band | SCS (kHz) | 10 MHz (dBm) | 20 MHz (dBm) | 30 MHz (dBm) | 40 MHz (dBm) | Duplex Mode | | n38 | 15 | 50 | 105 | 160 | 210 | TDD | | 30 | 20 | 50 | 75 | 105 | | 60 | 10 | 20 | 30 | 50 | | n47 | 15 | 50 | 105 | 160 | 210 | TDD | | 30 | 20 | 50 | 75 | 105 | | 60 | 10 | 20 | 30 | 50 | |
| R4-2001224 | LG Electronics France | – Add suffix E for EN-V2X operation in 4.3 and include EN-V2X operating bands and channel bandwidths  – Specified EN-V2X UE Tx/Rx requirements  Add for Rx requirements for inter-band con-current operation between n38 and NR Uu.  Note: Only Rx part will be treated in this summary. |
| [R4-2002029](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_94_e/Docs/R4-2002029.zip) | Huawei, HiSilicon | **Proposal 2: It is proposed to define the REFSENS as in Table 1.**   | Operating band / SCS / Channel bandwidth / Duplex-mode | | | | | | | | | --- | --- | --- | --- | --- | --- | --- | --- | | Operating Band | SCS kHz | 10  MHz (dBm) | 20  MHz (dBm) | 30 MHz (dBm) | 40  MHz (dBm) | 50  MHz (dBm) | Duplex Mode | | n47 | 15 | -92.8 | -89.7 | -87.9 | -86.6 |  | HD | | 30 | -93.1 | -89.9 | -88.0 | -86.7 |  | | 60 | -93.5 | -90.1 | -88.1 | -86.9 |  |   **Proposal 3: It is proposed to define the maximum input level as -25dBm for NR-V.**  **Proposal 4: It is proposed to accept the changes for NR-V ACS requirement.**  Table 2.2.3-1: Adjacent channel selectivity for V2X   |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | |  |  | Channel bandwidth | | | | | | | | Rx Parameter | Units |  |  |  | 10 MHz |  | 20 MHz | 40 MHz | | ACS | dB |  |  |  | 33.0 |  | 27.0 | 24.0 |   Table 2.2.3-2: Test parameters for Adjacent channel selectivity for V2X, Case 1   |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | | Rx Parameter | Units | Channel bandwidth | | | | | | | |  |  |  | 10 MHz |  | 20 MHz | 40 MHz | | Power in Transmission Bandwidth Configuration | dBm | PREFSENS\_V2X + 14 dB | | | | | | | | PInterferer | dBm |  |  |  | REFSENS +45.5dB |  | REFSENS +39.5dB | REFSENS +36.5dB | | BWInterferer | MHz |  |  |  | 10 |  | 10 | 10 | | FInterferer (offset) | MHz |  |  |  | 10  /  -10 |  | 15  /  -15 | 25  /  -25 | | NOTE 1: The interferer is QPSK modulated PUSCH containing data and reference symbols. Normal cyclic prefix is used.  NOTE 2: The absolute value of the interferer offset Finterferer (offset) shall be further adjusted to MHz with SCS the sub-carrier spacing of the wanted signal in MHz. The interferer is an NR V2X signal with 15 kHz SCS. | | | | | | | | |   Table 2.2.3-3: Test parameters for Adjacent channel selectivity for V2X, Case 2   |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | | Rx Parameter | Units | Channel bandwidth | | | | | | | |  |  |  | 10 MHz |  | 20 MHz | 40 MHz | | Power in Transmission Bandwidth Configuration | dBm |  |  |  | -56.5 |  | -50.5 | -47.5 | | PInterferer | dBm | -25 | | | | | | | | BWInterferer | MHz |  |  |  | 10 |  | 10 | 10 | | FInterferer (offset) | MHz |  |  |  | 10  /  -10 |  | 15  /  -15 | 25  /  -25 | | NOTE 1: The interferer is QPSK modulated PUSCH containing data and reference symbols. Normal cyclic prefix is used.  NOTE 2: The absolute value of the interferer offset Finterferer (offset) shall be further adjusted to MHz with SCS the sub-carrier spacing of the wanted signal in MHz. The interferer is an NR V2X signal with 15 kHz SCS. | | | | | | | | |   **Proposal 5: It is proposed to similar changes for other Rx requirements as those for ACS.** |
| R4-2001218 | LG Electronics | TP on revised MPR simulation assumptions and update NR requirements to cover open issues  Note: Only Rx part will be treated in this summary. |
| R4-2002030 | Huawei | Requirements specified for NR V2X con-current operation in FR1 for band combinations of NR Uu in licensed band + NR SL in band n47.  Note: Only Rx part will be treated in this summary. |
| R4-2002031 | Huawei | Requirements specified for NR V2X con-current operation in FR1 for band combinations of LTE Uu in licensed band + NR SL in band n47.  Note: Only Rx part will be treated in this summary. |

## 2.2 Open issues summary

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

### Sub topic 2-1: REFSENS

*Sub-topic description:*

*Open issues and candidate options before e-meeting:*

**Issue 2-1-1: LCRB value**

* Proposals
  + Option 1: L**CRB** = NRB (CATT)
  + Option 2: L**CRB** = 50; NRB = 52 for 10MHz (LGE, Qualcomm)
  + Option 3: Decide between Option 1 and Option 2 after RAN1 decision (Intel)
* Recommended WF
  + Need to check the RAN1 progress and decide L**CRB** value following RAN1 agreements.

**Issue 2-1-2: Diversity gain**

* Proposals
  + Option 1: 3dB (LGE)
  + Option 2: no need to consider diversity gain. The calculation should be the same as for LTE V2V which is documented in section7, TR36785-e00, v14.0.0. (Qualcomm)
  + Option 3: Introduce diversity gain but the value needs further evaluation. (CATT)
* Recommended WF
  + More comments on diversity gain are needed for decision. It is recommended to introduce diversity gain but the value of diversity gain needs further discussion.

### 2.2.2 Sub topic 2-2: Maximun input level

*Sub-topic description*

*Open issues and candidate options before e-meeting:*

**Issue 2-2-1: Maximum input level**

* Proposals
  + Option 1: [-22~-25] dBm. Need to consider high order modulation with 64QAM or 256QAM. The Maximum input level will be defined separately. (LGE)
  + Option 2: -25 dBm (CATT, Huawei)
  + Option 3: -22 dBm (Qualcomm)
* Recommended WF
  + Agree option 2

### 2.2.3 Sub topic 2-3: ACS

*Sub-topic description:*

*Open issues and candidate options before e-meeting:*

**Issue 2-3-1: Power in Transmission Bandwidth Configuration**

* Proposals
  + Option 1: The power of wanted signal in case 2 shall be reduced by 3dB. (Huawei)
  + Option 2: 3dB is not necessary. (Qualcomm)
  + Option 3: whether 3dB is necessary or not depends on the maximum input level. 3dB should be considered if the maximum input level is defined as -25dBm. (CATT, LGE)
* Recommended WF
  + Make decision based on option 3.

## 2.3 Companies views’ collection for 1st round

### 2.3.1 Open issues

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| --- | --- |
| **Company** | **Comments** |
| LG Electronics | Sub topic 2-1-1: LCRB value will be restricted by RAN1 agreements as following  the allowed LCRB is [10, 15, 20, 25, 30, 40, 45, 50, 60, 70, 75, 80, 90, 100, 105, 110, 120, 130, 135, 140, 150, 160, 165, 170, 175, 180, 190, 195,200, 210] in NR V2X.  Sub topic 2-1-2: Need to consider diversity gain as [3]dB which was already assumed in NR Uu to derive REFSENS with target SNR[-1] dB. In Huawei paper, they derived almost similar REFSENS requirements considering with diversity gain.  Sub topic 2-2: Need to consider high order modulation with 64QAM or 256QAM. The Max. input level will be defined as seperatly.  Sub topic 2-3: LGE also think that the 3dB reduction of wanted signal will be depend on Max. input level according to modulation order. |
| Qualcomm | Sub topic 2-1:  **Issue 2-1-1: LCRB value**   * Option 2: LCRB has to be a factor of 5 or 10 for PUSCH/PUCCH in NR V2X. Permissible LCRB values**are:** Allowed LCRB allocations=[10,15,20,25,30,40,45,50,60,70,75,80,90,100,105,110,120, 130, 135,140,150,160,165,170,175,180,190,195,200,210]   **Issue 2-1-2: Diversity gain**   * Option 2: no need to consider diversity gain. The calculation should be the same as for LTE V2V which is documented in section7, TR36785-e00, v14.0.0. * Huawei proposes not using the diversity gain (R4-2002029). However, for a SCS=15K, BW=10M reference sensitivity = -104 -1 -10log(50/52)-13-2.5= -89.7dBm. The value in table 1 of R4-2002029 is -92.8dBm. It seems that there is another factor that is being used in this reference sensitivity calculation which is not captured in the Tdoc.   Sub topic 2-2:  **Issue 2-2-1: Maximum input level**   * In sect 7.4 of 38.101-1 the maximum input level is given as -22dBm for 64QAM. It has always been assumed that SL should have similar specs to the NR Uu link so we should keep -22dBm as the maximum input level.   Sub topic 2-3:  **Issue 2-3-1: Power in Transmission Bandwidth Configuration**   * In sect 7.4 of 38.101-1 the maximum input level is given as -22dBm for 64QAM. It has always been assumed that SL should have similar specs to the NR Uu link so we should keep -22dBm as the maximum input level. So, ACS for V2X, case 2 we believe that the Pinterfer = -22dBm and the power of the wanted signal can remain as given in table 9.1.3-3 of TR38.886 V0.5.0. |
| Huawei: | It seems that the allowed LCRB could also be changed due to the discussion in RAN1. Further discussion and consideration on RAN1 progress are needed. |
| CATT | **Issue 2-1-1: LCRB value**  LCRB value should follow the RAN1 agreements given that the agreements have been achieved by RAN1.  **Issue 2-1-2: Diversity gain**  It is reasonable to consider the diversity gain for 2Rx. Nevertheless, whether the diversity gain is defined as 3dB needs further evaluation. The diversity gain can be included in the SNR level. To be more reasonable and accurate, the SNR level should be derived by simulation results after the definition of reference measurement channel.  **Issue 2-2-1: Maximum input level**  Considering the waveform difference between NR V2X and LTE V2X, the maximum input level should be defined as -25dBm.  **Issue 2-3-1: Power in Transmission Bandwidth Configuration**  It is up to the decision on the maximum input level. 3dB reduction should be considered if the maximum input level is defined as -25dBm. |
| LG Electronics | To Huawei, Could you clarify how to derive REFSENS requirements for n47 according to SCS?  To Qualcomm, Do you have specific reason not to consider diversity gain to derive REFSENS for NR V2X UE. In NR, the diversity gain is considered to derive target SNR point -1dB. So I don’t know why QC do not want the change of REFSENS equation. |
| Intel | **Sub topic 2-1: REFSENS**  **Issue 2-1-1: LCRB value**  Based on our understanding, it is still under discussion in RAN1 whether to use PRBs which are remained after CBW are divided in sub-channels. Therefore, we suggest to wait the outcome of RAN1 discussion.  **Issue 2-1-2: Diversity gain**  Diversity gain depends on how SNR value for REFSENS equation is derived. SNR = -1 dB for NR Uu is derived based on 1 Rx results (WF R4-1709951). Same time, SNR for LTE V2V is derived based on 2 Rx results (WF R4-164849). Therefore, we suggest to discuss simulation assumptions for SNR definition, first. Our preference is using of 1 Rx results to derive SNR value for REFSENS. |
| CATT | **Issue 2-1-1: LCRB value**  To all: Could you agree that the decision on LCRB value needs to wait for RAN1 agreements?  **Issue 2-1-2: Diversity gain**  To Huawei: Could you clarify whether the diversity gain is introduced in your REFENS calculation?  **Issue 2-2-1: Maximum input level**  To LG: Could you clarify how to define the maximum input level separately for 64QAM and 256QAM? |

### 2.3.2 CRs/TPs comments collection

*Major close-to-finalize WIs and Rel-15 maintenance, comments collections can be arranged for TPs and CRs. For Rel-16 on-going WIs, suggest to focus on open issues discussion on 1st round.*

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| --- | --- |
| **CR/TP number** | **Comments collection** |
| [R4-2000599](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_94_e/Docs/R4-2000599.zip) | LG Electronics: Need to consider multiple SCS to derive REFSENS and need to define the SL transmission configurations. It will be revised based on company’s 1st round email discussion results. |
| Qualcomm:   * Cannot approve * In table 7.5E-3 ACS for V2X case 2 the Pinterferer level should be -22dBm |
| Huawei: Agree with LGE that REFSENS for 30k and 60k should also be defined. For UL MIMO, some Tx configuration shall be considered for Rx requirements. |
|  |
| [R4-2000600](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_94_e/Docs/R4-2000600.zip) | LG Electronics: Need to derive exact REFSENS requirements based on single carrier REFSENS requirements and need to define the SL transmission and UL configurations for both inter-band combinations. It will be revised based on company’s 1st round email discussion results. |
| Huawei: Scenarios that Uu is in NR licensed band or E-UTRA band should be considered in different specs. |
| CATT: CATT agree to consider NR licensed band and E-UTRA band in different specs. It is suggested that this CR ([R4-2000600](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_94_e/Docs/R4-2000600.zip)) can be revised for E-UTRA band and NR V2X concurrent operation in TS38.101-3.  To LGE, Huawei and all: could you agree that CATT provides the CR for E-UTRA and NR V2X concurrent operation in TS38.101-3 based on R4-2000600 and Huawei provides the CR for NR Uu and NR V2X concurrent operation in TS38.101-1 based on R4-2002030? If agreed, the revised CRs will be uploaded for further check. |
| R4-2001224 | Huawei: Multi-CCs are not supported for NR SL in RAN1, so the requirements should be defined for single carrier. |
| Qualcomm:   * Cannot approve * In section 6.3E.1 we believe the NR to LTE transition time should be 210us for both contiguous and non-contiguous spectral allocations as outlined in R4-2000471. |
| CATT: the current release needs to focus on TDM operation between LTE V2X and NR V2X. The scenario that NR V2X and LTE V2X operate at the same time should be studied in the next release.  To Qualcomm: as LGE comments, the switching period is treated in #11\_5G\_V2X\_NRSL\_UE\_TX moderated by LGE. Only Rx RF part will be treated here. |
| LGE: In draft CR, LGE propose to specify EN\_V2X 47\_n47 with TDM operation between NR SL and LTE SL. It is not multi-carrier operation in ITS spectrum. This is support for intra-band contiguous EN\_V2X\_(n)47AA or intra-band non-contiguous EN\_V2X\_47A\_n47A. You should be read carefully.  To Qualcomm, the switched period will be further discussed and it will be treat in #11 e-mail discussion item not here. Anyway RAN4 specify the the switched period in 6.3E.1 based on RAN4 consensus. |
| R4-2002030 |  |
|  |
|  |
| R4-2002031 | CATT: suggest to remove the Rx RF part and keep the Tx RF part. |
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|  |

## 2.4 Summary for 1st round

### 2.4.1 Open issues

*Moderator tries to summarize discussion status for 1st round, list all the identified open issues and tentative agreements or candidate options and suggestion for 2nd round i.e. WF assignment.*

|  |  |
| --- | --- |
|  | **Status summary** |
| **Sub-topic#1** | *Tentative agreements:*  *Candidate options:*  *Recommendations for 2nd round:* |

*Recommendations on WF/LS assignment*

|  |  |  |
| --- | --- | --- |
|  | **WF/LS t-doc Title** | **Assigned Company,**  **WF or LS lead** |
| #1 |  |  |

### 2.4.2 CRs/TPs

*Moderator tries to summarize discussion status for 1st round and provides recommendation on CRs/TPs Status update*

|  |  |
| --- | --- |
| **CR/TP number** | **CRs/TPs Status update recommendation** |
| XXX | *Based on 1st round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |

## 2.5 Discussion on 2nd round (if applicable)

## 2.6 Summary on 2nd round (if applicable)

*Moderator tries to summarize discussion status for 2nd round and provided recommendation on CRs/TPs/WFs/LSs Status update suggestion*

|  |  |
| --- | --- |
| **CR/TP/LS/WF number** | **T-doc Status update recommendation** |
| XXX | *Based on 2nd round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |

# 3 Topic #1: Title

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

## 3.1 Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-20xxxxx | Company A | Proposal 1:  Observation 1: |

## 3.2 Open issues summary

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

### 3.2.1 Sub-topic 1-1

*Sub-topic description:*

*Open issues and candidate options before e-meeting:*

**Issue 1-1: TBA**

* Proposals
  + Option 1: TBA
  + Option 2: TBA
* Recommended WF
  + TBA

### 3.2.2 Sub-topic 1-2

*Sub-topic description*

*Open issues and candidate options before e-meeting:*

**Issue 1-2: TBA**

* Proposals
  + Option 1: TBA
  + Option 2: TBA
* Recommended WF
  + TBA

## 3.3 Companies views’ collection for 1st round

### 3.3.1 Open issues

|  |  |
| --- | --- |
| **Company** | **Comments** |
| XXX | Sub topic 1-1:  Sub topic 1-2:  ….  Others: |

### 3.3.2 CRs/TPs comments collection

*Major close to finalize WIs and Rel-15 maintenance, comments collections can be arranged for TPs and CRs. For Rel-16 on-going WIs, suggest to focus on open issues discussion on 1st round.*

|  |  |
| --- | --- |
| **CR/TP number** | **Comments collection** |
| XXX | Company A |
| Company B |
|  |
| YYY | Company A |
| Company B |
|  |

## 3.4 Summary for 1st round

### 3.4.1 Open issues

*Moderator tries to summarize discussion status for 1st round, list all the identified open issues and tentative agreements or candidate options and suggestion for 2nd round i.e. WF assignment.*

|  |  |
| --- | --- |
|  | **Status summary** |
| **Sub-topic#1** | *Tentative agreements:*  *Candidate options:*  *Recommendations for 2nd round:* |

*Suggestion on WF/LS assignment*

|  |  |  |
| --- | --- | --- |
|  | **WF/LS t-doc Title** | **Assigned Company,**  **WF or LS lead** |
| #1 |  |  |

### 3.4.2 CRs/TPs

*Moderator tries to summarize discussion status for 1st round and provided recommendation on CRs/TPs Status update suggestion*

|  |  |
| --- | --- |
| **CR/TP number** | **CRs/TPs Status update recommendation** |
| XXX | *Based on 1st round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |

## 3.5 Discussion on 2nd round (if applicable)

## 3.6 Summary on 2nd round (if applicable)

*Moderator tries to summarize discussion status for 2nd round and provided recommendation on CRs/TPs/WFs/LSs Status update suggestion*

|  |  |
| --- | --- |
| **CR/TP/LS/WF number** | **T-doc Status update recommendation** |
| XXX | *Based on 2nd round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |