**3GPP TSG-RAN WG4 Meeting # 99-e R4-21xxxxx**

**Electronic Meeting, 19th – 27th May 2021**

**Agenda item:** 6.2.4.1, 6.2.4.2

**Source:** Moderator (LG Electronics)

**Title:** Email discussion summary for [99-e][323] V2X\_Demod\_Part1

**Document for:** Information

# Introduction

This email discussion is for Rel-16 NR V2X demodulation performance for single link in Agenda 6.2.4.1 and 6.2.4.2. For the information, in this meeting, email discussion will focus on finalizing performance requirements and closing all issues.

List of email discussion for 1st round is as follows:

* 1st round:
  + Topic#1: Performance requirements and draft CRs
* 2nd round: TBA
  + Issues: PSBCH performance requirement

# Topic #1: Performance requirements and draft CRs

This section will treat the performance requirements based on companies’ simulation results. For draft CRs, please add comments directly in sub-section 1.3.2.

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2109569 | Qualcomm, Inc. | Proposal: Use the following guidelines to align PSBCH alignment results:  (1) Under the same propagation condition, code rate difference contributes to most of the performance difference between PSCCH and PSBCH.  (2) Higher speed (Doppler spread) yields better performance for PSBCH.  If the average alignment result has large deviation to the suggested value from the above guidelines, larger margin should be added to the final SNR requirement. |
| R4-2109192 | Intel Corporation | In this paper we provided alignment and impairment results for V2X demodulation PSSCH single link requirements. |
| R4-2109720 | LG Electronics Inc. | Draft CR for PSSCH demodulation requirements for NR V2X |
| R4-2110211 | MediaTek inc. | Proposal 1: The required SNR targeted 10% BLER for PSSCH test case with TDLA30ns-180Hz is about 13.1dB.  Proposal 2: The required SNR targeted 10% BLER for PSSCH test case with TDLA30ns-1400Hz is about 7.7dB.  Proposal 3: The required SNR targeted 10% BLER for PSSCH test case with TDLA30ns-2700Hz is about 2.9dB. |
| R4-2110516 | Huawei, HiSilicon | In this contribution, we provide our simulation results for PSSCH test. |
| R4-2109193 | Intel Corporation | Draft CR on NR V2X single link PSCCH requirements |
| R4-2110203 | MediaTek inc. | Proposal 1: The required SNR targeted 1% BLER for PSCCH test case is about 3.8dB. |
| R4-2110517 | Huawei, HiSilicon | In this contribution, we provide our simulation results on PSCCH test. |
| R4-2109048 | CATT, GOHIGH | CR for 38.101-4, Remove square bracket for PSBCH SNR value |
| R4-2109049 | CATT, GOHIGH | CR for 38.101-4, Introduce PSBCH performance requirements |
| R4-2109194 | Intel Corporation | In this paper we provided alignment and impairment results for NR V2X Single link PSBCH requirements. |
| R4-2110204 | MediaTek inc. | Proposal 1: The required SNR targeted 1% BLER for PSBCH test case is about -2.9dB |
| R4-2110518 | Huawei, HiSilicon | In this contribution, we provide our simulation results for PSBCH test |
| R4-2110519 | Huawei, HiSilicon | In this paper, we provide our simulation results for PSFCH performance test. |
| R4-2109047 | CATT, GOHIGH | In this contribution, the updated simulation results of single link test cases are provided based on the simulation assuptions. |

## Open issues summary

### Sub-topic 1-1

**Issue 1-1: PSBCH performance requirement**

* Proposals
  + Use the following guidelines to align PSBCH alignment results:
    - Under the same propagation condition, code rate difference contributes to most of the performance difference between PSCCH and PSBCH.
    - Higher speed (Doppler spread) yields better performance for PSBCH.
  + If the average alignment result has large deviation to the suggested value from the above guidelines, larger margin should be added to the final SNR requirement.
* Recommended WF
  + Need further discussion based on simulation results in Table 1

**Issue 1-2: Requirements for single link test cases**

* Moderator’s proposal based on updated companies’ simulation results
  + Simulation results in Table 1 are baseline to define performance requirements for single link test cases
    - The span for each test case is less than 2.5dB
  + Companies are encouraged to provide impairment results for test cases in 1st round.

Table 1 Simulation results w/o impairment for single link test case

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Test cases** | **LG** | **Intel** | **Huawei** | **QC** | **CATT, GOHIGH** | **MTK** | **STD** | **SPAN** | **AVE** |
| **PSSCH\_Test1  (QPSK\_TDLA30-2700)** | 1.23 | 1.40 | 1.47 | 1.63 | 1.28 | 1.42 | 0.14 | 0.40 | 1.41 |
| **PSSCH\_Test2  (16QAM\_TDLA30-1400)** | 5.77 | 5.90 | 7.41 | 7.66 | 6.95 | 6.12 | 0.81 | 1.89 | 6.64 |
| **PSSCH\_Test3 (64QAM\_TDLA30-180)** | 12.03 | 12.20 | 13.49 | 12.86 | 11.60 | 11.34 | 0.80 | 2.15 | 12.26 |
| **PSCCH** | 3.03 | 3.51 | 3.16 | 2.84 | 2.34 | 2.00 | 0.55 | 1.51 | 2.81 |
| **PSBCH** | -3.32 | -2.10 | -2.49 | -1.50 | -1.70 | -4.00 | 0.97 | 2.50 | -2.52 |
| **PSFCH** | 5.98 | 7.17 | 7.86 |  | 8.00 |  | 0.92 | 2.02 | 7.25 |

* Recommended WF
  + Accept the proposals if there are no any update of simulation results.

**Issue 1-3: FRC for PSBCH defined in drat big CR**

* Proposals
  + Option 1: Change Note 1” The first symbol is used for AGC and the last symbol shall be punctured as per TS 38.211.” to ” The first symbol is used for AGC and the last symbol is gap and shall not be used for PSBCH transmission as per TS 38.211.” (Huawei)

## Companies views’ collection for 1st round

### Open issues

**PSBCH performance requirement**

|  |  |
| --- | --- |
| **Company** | **Comments** |
| LG | Based on the companies’ results, the PSBCH performance seems to be quite aligned, so no larger margin is needed for final SNR requirement. |
| Intel | Same view as LG |
| CATT | The deviation is within 2.5dB so prefer no larger margin. |
| Huawei | Share the similar view with LG. The results is aligned as per the submitted results for this meeting, so no further discussion is needed.  Anyway thanks for providing the method to help align the simulation results. |
| MTK | In our Tdoc, the simulation results are with impairment, the simulation w/o impairment results are updated Table 2as above. Based on the newest simulation results comparison, the span of PSBCH result is about 2.5dB, which may be acceptable based on last meeting’s agreements as copied followings.   |  | | --- | | **Agreements in RAN4#98bis meeting:**  **The acceptable largest span among the companies’ simulation results to derive performance requirement is 2.5dB** | |
| QC | We understand that this is acceptable span, hence we are not asking to redo the simulations. But it already hits the threshold. Moreover, there are many results with PSCCH and PSBCH SNR different >= 6dB. Without additional results as we suggested, we are not sure whether the results combination make sense from analytical perspective. We understand that running additional simulations increase workload, instead, we would like to propose slightly increasing the margin from 0.5 to 1dB, at least to address the issue we observed based on the analytical results. |
| LG | We don’t have strong view to increase the margin. |
| CATT | We can accept to increase margin from 0.5dB to 1dB |
| Intel | The reason to increase margin for PSBCH requirements is not clear for us now. Anyway we will not have conformance testing of PSBCH and these requirements are used just for information on operation region of PSBCH. Probably we can spend some time in the 2nd round to understand more the proposal from QC. |
| QC | We provided the argument of why SNR difference between PSCCH test requirement and PSBCH test requirement should be a few dBs smaller than 6dB in our contribution. Summarized below:   * Code rate comparison shows that with the same propagation condition, PSBCH requirement should be about 6dB lower than PSCCH. Impact of different coding scheme is negligible since the coding rate is very low. * Higher Doppler spread in PSBCH propagation condition provides performance gain of several dBs as we shown in our contribution. Since DMS is on every symbols, higher Doppler provide diversity gain in fading channel, and the gain is large when bandwidth is small (10RB only)   With the results collected so far, the difference between the PSCCH and PSBCH doesn’t align to our analysis. We suggest that companies provide results of PSBCH and PSCCH with the same propagation condition to resolve this misalignment between the averaged results and theoretical analysis. However, we understand that this increases the simulation workload. Since the span is still quite large (meeting the threshold of 2.5dB), and we do observe the misalignment with theoretical analysis, we suggest adding slightly larger margin to account for both span and the misalignment. |

**Issue 1-2: Requirements for single link test cases**

|  |  |
| --- | --- |
| **Company** | **Comments** |
| LG | Support recommended WF |
| Intel | Fine with recommended WF |
| CATT | Support the recommended WF. |
| Huawei | Support the recommended WF |
| MTK | Support the recommended WF |

**Issue 1-3: FRC for PSBCH defined in drat big CR**

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Huawei | Support option 1. According to the rules of PSBCH mapping, the last symbol of slot is not used for PSBCH mapping. However, as per draft big CR R4-2106161, it is explained as “The last symbol shall be punctured as per TS 38.211.” which means the last symbol has been used for PSBCH transmission but the corresponding LLR is set to 0 at receiving side.  Table A.6.4.2-1: PSBCH Reference Channel   |  |  |  | | --- | --- | --- | | Parameter | Unit | Value | | Reference channel |  | R.PSBCH.2-1 | | Channel bandwidth | MHz | 20 | | Allocated resource blocks |  | 11 | | CP-OFDM Symbols per slot (see Note 1) |  | 8 | | Modulation |  | QPSK | | Transport Block Size (without CRC) | Bits | 32 | | Transport block CRC | Bits | 24 | | Binary Channel Bits | Bits | 1782 | | Note 1: PSBCH transmissions are rate-matched for 9 CP-OFDM symbols per slot. The first symbol is used for AGC and the last symbol ~~shall be punctured~~ is gap and shall not be used for PSBCH transmission as per TS 38.211. | | | |
| LG | Note1 is for OFDM symbol per slot for PSBCH, so maybe we don’t need the sentence “and the last symbol shall be punctured is gap and shall not be used for PSBCH transmission as per TS 38.211.”  Based on TS38.211, OFDM symbol for PSBCH is 0,5,6,..., . for normal cyclic prefix and for extended cyclic prefix.    We suggest “PSBCH transmissions are rate-matched for 9 CP-OFDM symbols per slot, and the first symbol is used for AGC.” |
| Huawei | We prefer to keep that sentence to make the clarification for whole slot within PSBCH transmission is clear. The suggestion from LG only clarified part of information for that slot. |
| LG | We are fine with the option 1 in terms of considering whole slot within PSBCH transmission. |
| CATT | Agree with option 1 to indicate the last PSBCH symbol shall not be used for transmission. |
| Intel | Option 1 is fine for us. |

### CRs/TPs comments collection

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

|  |  |
| --- | --- |
| **CR/TP number** | **Comments collection** |
| R4-2109720 (PSSCH) | LG : the final performance requirements for PSSCH will be updated based on conclusion of Issue 1-2. |
| Intel: Suggest editorial changes similar to R4-2109193: add unit for time offset and align wording for Note 2 and 3. |
| Huawei: Share the same views as Intel |
| R4-2109193 (PSCCH) | LG : the final performance requirements for PSCCH should be updated based on conclusion of Issue 1-2. |
| Intel: SNR point will be updated in the second round once we receive confirmation from all companies that existing results are the final results. |
|  |
| R4-2109048 (PSBCH) | LG : According to Big CR approach, no formal CR for each test case is needed. |
| Intel:   1. What is the difference between this CR and R4-2109049? 2. Editorial changes: change value for “Active cell(s)” to “None” to align with other tests align with other requirements and align wording for Note 1 and 2 |
| CATT:  To LGE: Correct. A new tdoc number for draft CR for PSBCH will be needed.  To Intel: (1) This CR is to remove square bracket for SNR value.  (2) The revision will be captured in the updated draft CR as follows:  “Active cell(s)” to “None”  Note 1: Time offset of Sidelink UE receive signal with respect to GNSS reference timing.  Note 2: Frequency offset of Sidelink UE receive signal with respect to GNSS reference frequency. |
| Huawei: Share the same views as Intel. Maybe one CR is enough. |
| R4-2109049 (PSBCH) | LG : the final performance requirements for PSBCH should be updated based on conclusion of Issue 1-2. |
| Company B |
|  |
| R4-21XXXX  (Draft CR PSFCH) | Company A |
| Company B |

## Summary for 1st round

### 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** |
| **Issue 1-1: PSBCH performance requirement** | *Tentative agreements: further discussion is needed*  *Candidate options: margin for PSBCH performance requirement*   * *Option 1: 0.5dB (previous agreement)* * *Option 2: 1dB*   *Recommendations for 2nd round: select one option and capture final PBSCH performance requirement.* |
| **Issue 1-2: Requirements for single link test cases** | *Tentative agreements: Table 1 is baseline to define performance requirements.*  *Candidate options:*  *Recommendations for 2nd round: Please capture following requirements except PSBCH in your draft CRs, and PSBCH performance requirement will be updated based on conclusion of Issue 1-1.*  *<impairment results>*   |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | **Test cases** | **LG** | **Intel** | **Huawei** | **QC** | **CATT, GOHIGH** | **MTK** | **AVE** | **Margin** | **Requirement** | | **PSSCH\_Test1  (QPSK\_TDLA30-2700)** | 2.73 | 2.90 | 2.97 | 3.30 | 2.78 | 2.92 | 2.93 | 0.5 | **3.4** | | **PSSCH\_Test2  (16QAM\_TDLA30-1400)** | 7.27 | 7.90 | 8.90 | 9.50 | 8.45 | 7.62 | 8.27 | 0.5 | **8.8** | | **PSSCH\_Test3 (64QAM\_TDLA30-180)** | 14.03 | 14.70 | 15.00 | 14.40 | 13.10 | 12.84 | 14.01 | 0.8 | **14.8** | | **PSCCH** | 4.53 | 5.00 | 4.66 | 3.60 | 3.84 | 3.50 | 4.19 | 0.5 | **4.7** | | **PSBCH** | -1.82 | -0.60 | -1.00 | 0.50 | -0.20 | -2.50 | -0.94 | [0.5] | **[-0.4]** | | **PSFCH** | 7.48 | 9.70 | 9.36 | 9.20 | 9.50 |  | 9.05 | 0.5 | **9.5** | |
| **Issue 1-3: FRC for PSBCH defined in drat big CR** | *Tentative agreements: Change Note 1” The first symbol is used for AGC and the last symbol shall be punctured as per TS 38.211.” to ” The first symbol is used for AGC and the last symbol is gap and shall not be used for PSBCH transmission as per TS 38.211.”*  *Candidate options:*  *Recommendations for 2nd round: Please capture the tentative agreement in the draft CR for PSBCH test case* |

### CRs/TPs

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

*Note: The tdoc decisions shall be provided in Section 3 and this table is optional in case moderators would like to provide additional information.*

|  |  |
| --- | --- |
| **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”* |

## Discussion on 2nd round (if applicable)

In 2nd round, we will focus on finalizing draft CR including final performance requirements (Table 3) without square bracket. For PSBCH performance requirement will be finalized according to the conclusion of Issue 1-1.

Table 3 Final performance requirements for V2X single link demodulation

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Test cases** | **PSSCH\_Test1  (QPSK)** | **PSSCH\_Test2  (16QAM)** | **PSSCH\_Test3 (64QAM)** | **PSCCH** | **PSBCH** | **PSFCH** |
| **Requirements [dB]** | **3.4** | **8.8** | **14.8** | **4.7** | **[-0.4]** | **9.5** |

**Issue 1-1: PSBCH performance requirement**

* Proposals
  + Option 1: Keep 0.5dB margin for final performance requirement
  + Option 2: Change the margin from 0.5dB to 1dB for final performance requirement
* Recommended WF
  + 1dB margin is applied for PSBCH performance requirement.
  + Final performance requirements for V2X single link demodulation are as below

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Test cases** | **PSSCH\_Test1  (QPSK)** | **PSSCH\_Test2  (16QAM)** | **PSSCH\_Test3 (64QAM)** | **PSCCH** | **PSBCH** | **PSFCH** |
| **Requirements [dB]** | **3.4** | **8.8** | **14.8** | **4.7** | **0.1** | **9.5** |

|  |  |
| --- | --- |
| **Company** | **Comments** |
| LG | We don’t have strong view on this. 1dB margin is fine for us. |
| QC | We paste the last comment from first round to address Intel’s concern for option 2 below:  We provided the argument of why SNR difference between PSCCH test requirement and PSBCH test requirement should be a few dBs smaller than 6dB in our contribution. Summarized below:   * Code rate comparison shows that with the same propagation condition, PSBCH requirement should be about 6dB lower than PSCCH. Impact of different coding scheme is negligible since the coding rate is very low. * Higher Doppler spread in PSBCH propagation condition provides performance gain of several dBs as we shown in our contribution. Since DMS is on every symbols, higher Doppler provide diversity gain in fading channel, and the gain is large when bandwidth is small (10RB only)   With the results collected so far, the difference between the PSCCH and PSBCH doesn’t align to our analysis. We suggest that companies provide results of PSBCH and PSCCH with the same propagation condition to resolve this misalignment between the averaged results and theoretical analysis. However, we understand that this increases the simulation workload. Since the span is still quite large (meeting the threshold of 2.5dB), and we do observe the misalignment with theoretical analysis, we suggest adding slightly larger margin to account for both span and the misalignment. |
| Intel | It is still not clear why we need to ensure certain SNR difference for different Phy channels with different resource allocation. Based on our understanding, it is rather hard to predict this SNR difference due to the following factors:  1)     Impact of propogation conditions. Diversity gain for PBCH channel in comparison to PDCCH channel due to increasing of speed is not so obvious and we need to simulate multiple propagation conditions to see the trend.  2)     Different RX processing. Demodulation processing (propogation parameters (delay spread, evarage CFO and TO) estimation, channel estimation and interference-plus-noise covariance matrix estimation) can be also different for different channels.  In case one of the main concern is that the span for PBCH results is 2.5 dB (which is rather close to the span limit) than we can accept such motivation to increase the margin. |
| QC | We believe our opinion is similar to Intel’s opinion. The analysis is to support the increase of margin based on the large span observed, not the main motivation and reason to get a larger margin. In fact, if the span is small, we don’t believe this analysis itself can justify the increase of the margin. As Intel pointed out, the qualitative ananlysis may not lead to exact SNR point. Therefore, the increase in margin is mainly due to the large span, and the analysis is to help us to understand why this large span needs to be addressed with a larger margin. |
| MTK | Since we have an agreements that 2.5dB span can be accepted, we prefer to keep the current margin value. However, considering the costant concern about the SNR difference b/w PSBCH and PSCCH and meeting progroess and there will not have conformance testing of PSBCH, 1.0dB margin can be accpted for us. |

# Recommendations for Tdocs

## 1st round

**New tdocs**

|  |  |  |
| --- | --- | --- |
| **Title** | **Source** | **Comments** |
| Draft CR for 38.101-4, Introduce PSBCH performance requirements | CATT, GOHIGH | Release: Rel-16  Work item code: 5G\_V2X\_NRSL-Perf |
| Draft CR on NR V2X PSFCH demodulation requirements | MediaTek Inc. | Release: Rel-16  Work item code: 5G\_V2X\_NRSL-Perf |

**Existing tdocs**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Tdoc number** | **Title** | **Source** | **Recommendation** | **Comments** |
| R4-2109727 | Big CR: Introduction of Rel-16 NR V2X demodulation performance requirements | *LG Electronics Inc.* | For Email approval | *Cat: B (Rel-16)* |
| R4-2109728 | Big CR: Introduction of Rel-16 NR V2X demodulation performance requirements | *LG Electronics Inc.* | For Email approval | *Cat: A (Rel-17)* |
| R4-2109569 | On NR V2X Single Link Demod Requirement | *Qualcomm, Inc.* | Noted |  |
| R4-2109718 | Summary of simulation results for V2X demodulation requirements | *LG Electronics Inc.* | Return to | *Collection of companies’ simulation results* |
| R4-2109047 | Simulation results of NR V2X single link demodulation test | *CATT, GOHIGH* | Noted | *This Tdoc was submitted in wrong agenda 6.2.4.3.1* |
| R4-2109192 | Simulation results for NR V2X single link PSSCH requirements | *Intel Corporation* | Noted |  |
| R4-2109720 | Draft CR for PSSCH demodulation requirements for NR V2X | *LG Electronics Inc.* | Revised | *Revised Tdoc number is required to capture agreements* |
| R4-2110211 | Simulation results for NR V2X PSSCH test case | *MediaTek inc.* | Noted |  |
| R4-2110516 | Simulation results for PSSCH performance requirements | *Huawei, HiSilicon* | Noted |  |
| R4-2109193 | Draft CR on NR V2X single link PSCCH requirements | *Intel Corporation* | Revised | *Revised Tdoc number is required to capture agreements* |
| R4-2110203 | Simulation results for NR V2X PSCCH test case | *MediaTek inc.* | Noted |  |
| R4-2110517 | Simulation results for PSCCH performance requirements | *Huawei, HiSilicon* | Noted |  |
| R4-2109048 | CR for 38.101-4, Remove square bracket for PSBCH SNR value | *CATT, GOHIGH* | Not Pursued |  |
| R4-2109049 | CR for 38.101-4, Introduce PSBCH performance requirements | *CATT, GOHIGH* | Not Pursued |  |
| R4-2109194 | Simulation results for NR V2X single link PSBCH requirements | *Intel Corporation* | Noted |  |
| R4-2110204 | Simulation results for NR V2X PSBCH test case | *MediaTek inc.* | Noted |  |
| R4-2110518 | Simulation results for PSBCH performance requirements | *Huawei, HiSilicon* | Noted |  |
| R4-2110519 | Simulation results for PSFCH performance requirements | *Huawei, HiSilicon* | Noted |  |

Notes:

1. Please include the summary of recommendations for all tdocs across all sub-topics incl. existing and new tdocs.
2. For the Recommendation column please include one of the following:
   1. CRs/TPs: Agreeable, Revised, Merged, Postponed, Not Pursued
   2. Other documents: Agreeable, Revised, Noted
3. For new LS documents, please include information on To/Cc WGs in the comments column
4. Do not include hyper-links in the documents

## 2nd round

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Tdoc number** | **Title** | **Source** | **Recommendation** | **Comments** |
| R4-210xxxx | CR on … | XXX | Agreeable, Revised, Merged, Postponed, Not Pursued |  |
| R4-210xxxx | WF on … | YYY | Agreeable, Revised, Noted |  |
| R4-210xxxx | LS on … | ZZZ | Agreeable, Revised, Noted |  |
|  |  |  |  |  |

Notes:

1. Please include the summary of recommendations for all tdocs across all sub-topics.
2. For the Recommendation column please include one of the following:
   1. CRs/TPs: Agreeable, Revised, Merged, Postponed, Not Pursued
   2. Other documents: Agreeable, Revised, Noted
3. Do not include hyper-links in the documents