**3GPP TSG-RAN WG4 Meeting # 109 R4-23XXXXX**

**Chicago, USA, November 13 – November 17, 2023**

**Agenda item:** 8.30.6

**Source:** Moderator (LG Electronics)

**Title:** Topic summary for [109][328] NR\_SL\_enh2\_demod

**Document for:** Information

# Introduction

*This document lists the open issues for demodulation performance of NR\_SL\_enh2. The open issues are summarized as follows:*

* Topic1: UE demodulation performance requirements
  + Sub-topic1-1: NR sidelink CA scenario
  + Sub-topic1-2: NR sidelink unlicensed band scenario

# Topic #1: UE demodulation performance requirements

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2318938 | Qualcomm | **Proposal 1: Introduce demod requirements with different bandwidths for SL-CA, at least for PSSCH and PSCCH decoding capability tests.**  **Proposal 2: Given that the SL-U devices already have to pass legacy PSCCH and PSSCH performance tests, do not introduce new requirement for PSCCH and PSSCH in SL-U.**  **Proposal 3: Consider to introduce requirement for PSFCH in SL-U if significant algorithm difference is identified, or enhancement is required, w.r.t. the legacy PSFCH processing.** |
| R4-2319266 | LGE | ***Proposal 1***: RAN4 to define following tests for sidelink CA   * HARQ buffer test * PSCCH decoding capability test * PSFCH decoding capability test   ***Proposal 2***: SL-U demodulation performance can reuse the existing SL test parameters as much as possible considering interlacing RB mapping and two candidate starting point.   * For transmission model, reuse the existing NR-U transmission model as specified in TS38.101-4 B.5 as much as possible.   ***Proposal 3***: RAN4 need to evaluate the SL-U demodulation performance with the interlacing RB mapping and the two candidate starting point in slot.  ***Proposal 4***: LBT should be modeled in SL-U test. If LBT is agreed, NR-U test parameters can be used as reference.   * Test parameters for LBT have LBT failure probability (PLBT) and if LBT failure occurred SL does not transmit for SL transmission period. * The length of first slot of the SL Tx burst can be from 6 to 12 OFDM symbols except AGC and TxRx switching symbols. Which can be pre-configured by test case scenario. * COT duration can be randomly selected from a set. E.g. {2, 4, 6, 7} slots.   ***Proposal 5***: It is necessary to define PSSCH demodulation performance requirements for SL-U.  ***Proposal 6***: Support option2. RAN4 to define SL-U PSFCH requirements. |
| R4-2320195 | HW | Proposal 1: Use test parameters listed in Table 2-1 and Table 2-2 for SL CA performance test as starting part.  Proposal 2: Keep number of allocated RBs for each CC open until the RAN1’s discussions on capability of “maximum number of non-overlapping RBs UE attempts to decode” is finalized.  **Proposal 3: RAN4 to keep tracking on the RAN1 progress on following CA capability discussion and start the discussion once it is finalized by RAN1**   * Maximum number of receiving PSCCHs in a slot * Maximum number of receiving PSFCHs in a slot   Proposal 4: RAN4 to introduce performance requirements for PSSCH, PSCCH and PSFCH with interlaced RB allocation.  Proposal 5: Consider following test setup for SL-U test:   * Carrier center frequency: 6.5GHz * **Operation mode: Mode2(Standalone)** * **Synchronization source: GNSS based** * **Carrier frequency offset with respect to GNSS: 650Hz** * **Carrier frequency offset for simulation assumption: 1300Hz** * **Time offset with respect to GNSS: CP/2-12\*64\*Tc** * **Time offset for simulation assumption: 24\*64\*Tc** * **SCS: 30kHz** * **Antenna configuration: 1T2R Low** * **Channel bandwidth: 20MHz** * **Propagation conditions: Select one from {TDLA30-2900, TDLA30-1500, TDLA30-195}** * **Channel estimation: MMSE based interpolation in frequency domain and linear interpolation in time domain** * **Only consider 1 interlace (1 sub-channel) with RB index 0,5,10,15,…50**   Proposal 6: RAN4 to consider following principle for LBT model:   * Due to the utilization of HARQ-ACK feedback, LBT failure probability shall be set to 1 (*pLBT*=0) to guarantee that HARQ-ACK feedback is not impacted by the LBT failure. * It's typical to configure gap between two consecutive COTs to give TE more time to perform LBT, one potential way is to set the start position of PSSCH transmission in the first slot of each COT to #7 * CPE extension should be configured for the first AGC symbol of each SL slot within the COT to make the gap between two consecutive slots smaller than 16us * The COT duration should be designed to guarantee that PSFCH is always transmitted in the slot with 14 symbol allocation. * 35 SCI2 information bits are assumed during Rel-16 V2X test. However, to convey the COT information, SCI2 information bits is expected to be more which should be re-discussed.   Proposal 7: RAN4 to consider following LBT model as starting point:   * TE performs LBT to initial a COT with LBT failure probability equaling to 0 (pLBT=1) and share this COT with tested UE * The start symbol of first slot in each COT is #7 * The COT duration is randomly selected from {2,4,8} slots * COT information is conveyed in SCI stage 2. * CPE extension is configured for the first AGC symbol of each SL slot within the COT * Tested UE uses the sharing COT to transmit PSFCH by via type 2 channel access   Proposal 8: RAN4 to consider following test configuration for PSSCH requirements definition:   * Configure 1 PSSCH occasion for each PSSCH * MCS:16QAM, 0.37 * Propagation: TDLA30-1500 * PSFCH resource period: 4 * MinTimeGap: 3 * PSSCH DMRS pattern: 3 symbols for slot without PSFCH transmission and 2 symbols for slot with PSFCH transmission.   Proposal 9: RAN4 to consider the parameters in Table 2-3 and 2-4 for PSCCH requirements definition  **Observation 1: Legacy PSFCH test procedure specifies that tested UE transmits PSSCH to TE firstly, then TE transmits PSFCH to UE and TE counts the number of retransmission to derive the NACK miss detection probability, resulting that tested UE is responsible for initialling COT, which may mix the functional and performance test. It also causes the risk that COT duration is unpredictable, which may bring the challenge for designing the test setup.**  **Proposal 10: RAN4 to further discuss how to design the LBT model and test setup for PSFCH performance test.** |
| R4-2320584 | Nokia | [**Observation 1:** When CA is introduced in a feature, there will be new demodulation requirements for the physical data shared channel for the corresponding feature with CA.](#_Toc149939869)  [**Observation 2:** In LTE sidelink CA, the performance requirement used on soft buffer test (CA) is on PSSCH with 5% BLER metric.](#_Toc149939870)  [Proposal 1: For NR sidelink CA, RAN4 to consider defining requirements by prioritizing on PSSCH demodulation performance requirements. Furthermore, RAN4 to discuss whether similar soft buffer test (CA) and PSCCH/PSSCH decoding capability test (CA) as in LTE can be adopted.](#_Toc149939871)  [**Observation 3:** Referring to 38.786, there are two CA configurations for NR SL CA which are not stated under square brackets, namely, 10 MHz + 10 MHz and 30 MHz + 40 MHz.](#_Toc149939872)  [**Observation 4:** In general, for CA requirements, it is a common practice in RAN4 to have single carrier requirements for each of the carrier components to be aggregated.](#_Toc149939873)  [Proposal 2: RAN4 to define single carrier requirements for 10 MHz, 30 MHz and 40 MHz to be used for NR sidelink CA requirements. RAN4 may consider reducing the workload by selecting the following for the requirements: a). 30 MHz and 40 MHz bandwidth only, for a consideration of widest CA bandwidth sizes, or b). 10 MHz only, for the least possible aggregated combination.](#_Toc149939874)  [**Observation 5:** Test scenario and test configurations will impact the performance gap between interlaced RBs and contiguous RBs.](#_Toc149939875)  [Proposal 3: If RAN4 decide to define requirements for SL-U, it should be on the interlaced RBs mapping. A suitable test scenario should be first discussed by considering aspects that may affect the performance of interlaced RBs mapping, for example, frequency selectivity of the channels.](#_Toc149939876)  [Proposal 4: Existing test parameters and transmission mode from NR-U can be reused.](#_Toc149939877)  [Proposal 5: RAN4 to discuss whether LBT should be considered for defining SL-U demodulation performance requirements. And if so, whether the model in sub-clause B.5.1 in the specification can be reused.](#_Toc149939878)  [Proposal 6: RAN4 to prioritize on PSSCH and may consider PSFCH if there is sufficient performance gap in PSFCH between interlaced RBs and non-interlaced RB.](#_Toc149939879) |

## Open issues summary

### Sub-topic 1-1: NR sidelink CA scenario

*This sub-topic is for NR sidelink CA scenario*

*Open issues and candidate options before meeting:*

**Issue 1-1-1: NR sidelink CA scenario**

* Proposals
  + Option 1: Define following tests for sidelink CA: (Nokia)
    - PSSCH performance requirements
    - HARQ buffer test
    - PSCCH decoding capability test
    - PSFCH decoding capability test
  + Option 2: Define following tests for sidelink CA: (LGE)
    - HARQ buffer test
    - PSCCH decoding capability test
    - PSFCH decoding capability test
  + Option 3: Introduce demod requirements with different bandwidths for SL-CA, at least for PSSCH and PSCCH decoding capability tests. (Qualcomm)
  + Option 4: Define following tests for sidelink CA: (HW)
    - PSSCH performance requirements
    - PSCCH decoding capability test
    - PSFCH decoding capability test
* Recommended WF
  + Moderator’s view: Can be discuss about the scope for NR sidelink CA scenario.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | HW | Nokia | LGE | Qualcomm |
| PSSCH performance requirements | OK | OK | - | - |
| HARQ buffer test | Open to discuss | OK | OK | - |
| PSCCH decoding capability test | OK | OK | OK | OK |
| PSFCH decoding capability test | OK | OK | OK | - |

**Issue 1-1-2: Test parameters for NR sidelink CA**

* Proposals
  + Option 1:  [Use test parameters listed in Table 2-1 and Table 2-2 for SL CA performance test as starting part.](#_Toc149939874) (HW)
* Recommended WF
  + Moderator’s view: If decided to define the PSSCH performance requirement at issue 1-1-1, the issue 1-1-2 need to discuss as starting point for test parameters.
* Table 2-1: Proposed common test parameters for CA

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Parameter | | | | Unit | Value |
| Carrier configuration | | Offset between Point A and the lowest usable subcarrier on this carrier (Note 1) | | RBs | 0 |
| Subcarrier spacing | | kHz | 30 |
| SL BWP configuration #1 | | Cyclic prefix | |  | Normal |
| RB offset | | RBs | 0 |
| Number of contiguous PRB | | PRBs | Maximum transmission bandwidth configuration as specified in clause 5.3.2 of TS 38.101-1 [6] for tested channel bandwidth and subcarrier spacing |
| PT-RS configuration | | | |  | PT-RS is not configured |
| 2nd stage SCI format 2-A configuraion | | | Payloads | Bits | 35 |
| *α* |  | 1 |
| *βoffset* |  | 5 |
| Resource pool configuration | PSCCH Time resource | | | Symbols | 2 |
| PSCCH Frequency resource | | | PRBs | 10 |
| PSFCH number of cyclic shift pairs | | |  | n1 |
| PSFCH hopping ID | | |  | 0 |
| PSFCH candidate resource type | | |  | allocSubCH |
| Set of PRBs for PSFCH transmission | | |  | ones(1,100) for 40 MHz  ones(1,70) for 30 MHz  ones(1,20) for 10 MHz |
| PSSCH RSRP threshold | | |  | 66 (infinity dBm) |
| Synchronization reference | | |  | GNSS |
| Subchannel size | | | PRBs | 10 |
| Number of sub-channels | | |  | 2 for 10MHz, 7 for 30MHz and 10 for 40 MHz |
| Start PRB for first sub-channel | | |  | 0 |
| Time resource bitmap | | |  | ones(1, 160) |
| Note 1: Point A coincides with minimum guard band as specified in Table 5.3.3-1 from TS 38.101-1 [6] for tested channel bandwidth and subcarrier spacing. | | | | | |

* Table 2-2: Proposed test parameters for SL CA

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Test num. | Reference channel | Bandwidth (MHz)/ Subcarrier spacing(kHz) | Modulation format and code rate | Propagation condition | Reference value | |
| PSSCH BLER (%) | SNR(dB) of PSSCH |
| 1 | TBD | 20 / 30 | 16QAM, 0.37 | TDLA30-1400 | 10% | TBD |

**Issue 1-1-3: NR sidelink CA Bandwidth combination**

* Proposals
  + Option 1: [RAN4 to define single carrier requirements for 10 MHz, 30 MHz and 40 MHz to be used for NR sidelink CA requirements. RAN4 may consider reducing the workload by selecting the following for the requirements: a). 30 MHz and 40 MHz bandwidth only, for a consideration of widest CA bandwidth sizes, or b). 10 MHz only, for the least possible aggregated combination.](#_Toc149939874) (Nokia)
* Recommended WF
  + Moderator’s view: If agreed to support NR sidelink CA scenario at issue 1-1-1, then RAN4 can discuss the bandwidth combination. And reducing the workload can be considered as well. So, option 1 is agreeable. Additionally RAN4 have to discuss which combination should be selected.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Sidelink CA configuration / Bandwidth combination set | | | | | | | |
| Sidelink CA configuration | Sidelink CA configuration for TX | Component carriers in order of increasing carrier frequency | | | | Maximum aggregated  bandwidth [MHz] | Bandwidth combination set |
| Channel bandwidths for carrier [MHz] | Channel bandwidths for carrier [MHz] | Channel bandwidths for carrier [MHz] | **Channel bandwidths for carrier [MHz]** |
| SL\_n47B | SL\_n47B | 10 | 10, [20,30] |  |  | 70 | 0 |
| [20] | [20,30] |  |  |
| 30 | [30],40 |  |  |

**Issue 1-1-4: NR sidelink CA capability**

* Proposals
  + Option 1:
    - Keep number of allocated RBs for each CC for PSSCH CA performance requirements open until the RAN1’s discussions on capability of “maximum number of non-overlapping RBs UE attempts to decode” is finalized. (HW)
    - RAN4 to keep tracking on the RAN1 progress on following CA capability discussion and start the discussion once it is finalized by RAN1. (HW)
      * Maximum number of receiving PSCCHs in a slot
      * Maximum number of receiving PSFCHs in a slot
* Recommended WF
  + Moderator’s view: Need further check whether option 1 is agreeable.

### Sub-topic 1-2: NR sidelink unlicensed band scenario

*This sub-topic is for NR sidelink unlicensed band scenario*

*Open issues and candidate options before meeting:*

**Issue 1-2-1: Whether to introduce new requirement for PSSCH/PSCCH in SL-U**

* Proposals
  + Option 1: Do not introduce new requirement for PSCCH and PSSCH in SL-U. (Qualcomm)
  + Option 2: Define PSSCH demodulation performance requirements for SL-U. (LGE, Nokia)
  + Option 3: RAN4 to introduce performance requirements for PSSCH and PSCCH with interlaced RB allocation. (HW)
* Recommended WF
  + Moderator’s view: Can be discuss with issue 1-2-2

**Issue 1-2-2: Whether to introduce new requirement for PSFCH in SL-U**

* Proposals
  + Option 1: Consider to introduce requirement for PSFCH in SL-U if significant algorithm difference is identified, or enhancement is required, w.r.t. the legacy PSFCH processing. (Qualcomm)
  + Option 2: RAN4 to introduce performance requirements for PSFCH with interlaced RB allocation. (HW, LGE)
  + Option 3: RAN4 may consider PSFCH if there is sufficient performance gap in PSFCH between interlaced RBs and non-interlaced RB. (Nokia)
* Recommended WF
  + Moderator’s view: Need further discussion

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | HW | Nokia | LGE | Qualcomm |
| PSSCH in SL-U | OK | OK | OK | NOK |
| PSCCH in SL-U | OK | - | - | NOK |
| PSFCH in SL-U | OK | Conditional OK | OK | Conditional OK |

**Issue 1-2-3: Features of SL-U to be evaluated for performance Test**

* Proposals
  + Option 1: Consider interlacing RB mapping and the two candidate starting point in slot. (LGE)
  + Option 2: Consider interlacing RB mapping only. (Nokia)
  + Option 3: RAN4 shall focus on interlace RB allocation. Starting point depends on discussion of LBT model design (Huawei)
* Recommended WF
  + Moderator’s view: If decided to support SL-U performance, every company have same view that the interlacing RB mapping should be evaluated. But regarding two candidate starting point in slot, need further discussion.

**Issue 1-2-4: Test set-up for SL-U physical channel performance test**

* Proposals
  + Option 1: Consider following test setup for SL-U test: (HW)
    - Carrier center frequency: 6.5 GHz
    - Operation mode: Mode2 (Standalone)
    - Synchronization source: GNSS based
    - Carrier frequency offset with respect to GNSS: 650Hz
    - Carrier frequency offset for simulation assumption: 1300Hz
    - Time offset with respect to GNSS: CP/2-12\*64\*Tc
    - Time offset for simulation assumption: 24\*64\*Tc
    - SCS: 30kHz
    - Antenna configuration: 1T2R Low
    - Channel bandwidth: 20MHz
    - Propagation conditions: Select from {TDLA30-2900, TDLA30-1500, TDLA30-195}
    - Channel estimation: MMSE based interpolation in frequency domain and linear interpolation in time domain
    - Only consider 1 interlace (1 sub-channel) with RB index 0,5,10,15,…50
  + Option 2: Can reuse the existing SL test parameters as much as possible considering interlacing RB mapping and two candidate starting point. (LGE)
    - For transmission mode, reuse the existing NR-U transmission model as specified in TS38.101-4 B.5 as much as possible.
  + Option 3: If RAN4 decide to define requirements for SL-U, it should be on the interlaced RBs mapping. A suitable test scenario should be first discussed by considering aspects that may affect the performance of interlaced RBs mapping, for example, frequency selectivity of the channels.(Nokia)
* Recommended WF
  + Moderator’s view: It would be fine to combine each options and make suitable test scenarios for initial simulation environments. The initial test scenario can be adjusted if necessary later.

**Issue 1-2-5: Necessary principles to consider for LBT model**

* Proposals
  + Option 1: RAN4 to consider following principle for LBT model: (HW)
    - Due to the utilization of HARQ-ACK feedback, LBT failure probability shall be set to 1 (pLBT=0) to guarantee that HARQ-ACK feedback is not impacted by the LBT failure.
    - It's typical to configure gap between two consecutive COTs to give TE more time to perform LBT, one potential way is to set the start position of PSSCH transmission in the first slot of each COT to #7
    - CPE extension should be configured for the first AGC symbol of each SL slot within the COT to make the gap between two consecutive slots smaller than 16us
    - The COT duration should be designed to guarantee that PSFCH is always transmitted in the slot with 14 symbol allocation.
    - 35 SCI2 information bits are assumed during Rel-16 V2X test. However, to convey the COT information, SCI2 information bits is expected to be more which should be re-discussed.
  + Option 2: [RAN4 to discuss whether LBT should be considered for defining SL-U demodulation performance requirements. And if so, whether the model in sub-clause B.5.1 in the specification can be reused.](#_Toc149939878) (Nokia)
* Recommended WF
  + Moderator’s view: Need to discuss

**Issue 1-2-6: Starting point for LBT model**

* Proposals
  + Option 1: RAN4 to consider following LBT model as starting point. (HW)
    - TE performs LBT to initial a COT with LBT failure probability equaling to 0 (pLBT=1) and share this COT with tested UE
    - The start symbol of first slot in each COT is #7
    - The COT duration is randomly selected from {2,4,8} slots
    - COT information is conveyed in SCI stage 2.
    - CPE extension is configured for the first AGC symbol of each SL slot within the COT
    - Tested UE uses the sharing COT to transmit PSFCH by via type 2 channel access
  + Option 2: LBT should be modeled in SL-U test. If LBT is agreed, NR-U test parameters can be used as reference. (LGE)
    - Test parameters for LBT have LBT failure probability (PLBT) and if LBT failure occurred SL does not transmit for SL transmission period.
    - The length of first slot of the SL Tx burst can be from 6 to 12 OFDM symbols except AGC and TxRx switching symbols. Which can be pre-configured by test case scenario.
    - COT duration can be randomly selected from a set. E.g. {2, 4, 6, 7} slots.
  + Option 3: RAN4 to discuss whether LBT should be considered for defining SL-U demodulation performance requirements. And if so, whether the model in sub-clause B.5.1 in the specification can be reused. (Nokia)
* Recommended WF
  + Moderator’s view: Need to discuss

**Issue 1-2-7: Test configurations for PSSCH of SL-U**

* Proposals
  + Option 1: RAN4 to consider following test configuration for PSSCH requirements definition: (HW)
    - Configure 1 PSSCH occasion for each PSSCH
    - MCS:16QAM, 0.37
    - Propagation: TDLA30-1500
    - PSFCH resource period: 4
    - MinTimeGap: 3
    - PSSCH DMRS pattern: 3 symbols for slot without PSFCH transmission and 2 symbols for slot with PSFCH transmission.
  + Option 2: SL-U demodulation performance can reuse the existing SL test parameters as much as possible. (LGE)
    - For transmission mode, reuse the existing NR-U transmission model as specified in TS38.101-4 B.5 as much as possible.
  + Option 3: Existing test parameters and transmission mode from NR-U can be reused. (Nokia)
* Recommended WF
  + Moderator’s view: Need to discuss

**Issue 1-2-8: Test configurations for PSCCH of SL-U**

* Proposals
  + Option 1: RAN4 to consider the parameters in Table 2-3 and 2-4 for PSCCH requirements definition. (HW)
* Table 2-3: Common Parameters

|  |  |  |  |
| --- | --- | --- | --- |
| Parameter | | Unit | Test 1 |
| Active cell(s) | |  | None |
| PSCCH payloads | | bit | 26 |
| Sidelink UE 1 | Sidelink Transmissions |  | PSCCH+PSSCH |
| Timing offset (Note 1) | μs | CP/2-12\*64\*Tc |
| Frequency offset (Note 2) | Hz | +600 |
| Synchronization |  | GNSS or GNSS-equivalent |
| Antenna configuration |  | 1x2 Low |
| PSSCH RMC |  | TBD |
| NOTE 1: Time offset of transmitted Sidelink UE signal with respect to GNSS reference timing.  NOTE 2: Frequency offset of transmitted Sidelink UE signal with respect to GNSS reference frequency.  NOTE 3: OCC index i for PSCCH DMRS is randomly selected from {0, 1, 2} for each PSCCH transmission. | | | |

* Table 2-4: Test parameters

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Test number | PSCCH Reference channel | Bandwidth (MHz) / Subcarrier spacing (kHz) | Propagation condition | Reference value | |
| Probability of missed PSCCH (%) | SNR (dB) of PSCCH |
| 1 | TBD | 20 / 30 | TDLA30-1500 | 1 | TBD |

* Recommended WF
  + Moderator’s view: Need to discuss

**Issue 1-2-9; Test configurations for PSFCH of SL-U**

* Proposals
  + Option 1: RAN4 to further discuss how to design the LBT model and test setup for PSFCH performance test. (HW)
* Recommended WF
  + Moderator’s view: Need to discuss