3GPP TSG RAN WG1 Meeting #98bis **R1-1910409**
Chongqing, China, 14-20 October 2019

Agenda Item:	7.2.4.1
Source:	TCL Communication
Title:	Physical Layer Structure for Sidelink
Document for:	Discussion and Decision

1 Introduction

Based on the results of the V2X SI [1], the corresponding WI [2] has been approved in RAN Plenary #83. In the following we discuss the physical layer aspects and solutions to enable sidelink unicast, groupcast and broadcast transmission for V2X services.

2 Resource Pool

The following agreements have been reached:

Agreements: **RAN1 AH1901**

- For time domain resources of a resource pool for PSSCH,
  - Support the case where the resource pool consists of non-contiguous time resources
    - FFS details including granularity
- For frequency domain resources of a resource pool for PSSCH,
  - Down select following options:
    - Option 1: The resource pool always consists of contiguous PRBs
    - Option 2: The resource pool can consist of non-contiguous PRBs

Agreements: **RAN1 #97**

- Transmission of PSSCH is mapped onto contiguous PRBs only

2.1 Time-domain Granularity of Resource Pool Configuration

If SL is deployed on a dedicated carrier it is sufficient to configure resource pools on a slot-based granularity.

Proposal 1: On a dedicated sidelink carrier the resource pool time-domain granularity is slot-level.

In a shared carrier, only uplink symbols may be used for sidelink transmissions. If a slot is configured to contain only partially UL symbols it is desirable to utilize the UL symbols for sidelink transmission. In that case the slot can still be indicated as SL and it is understood from the slot format that only UL symbols are used for SL. Thus, we prefer slot-level granularity for shared carriers.

Proposal 2: On a shared sidelink carrier the resource pool time-domain granularity is slot-level.

2.2 Resource Pool Based on Zone

RAN1 received an LS from RAN2 [3] which asks about the support of zoning-based resource pool configuration and selection:

Incoming LS: **R1-1908004**

In addition, RAN2 would like to consult with RAN1 on the following questions about resource pool configuration and selection:

- Whether resource pool configuration based on zone is considered beneficial to support in NR V2X ?
- Whether resource pool configuration based on different cast types should be supported by taking into account the configuration of PSFCH resource ?
- Whether an NR V2X mode 2 UE can select multiple resource pools on single carrier from RAN1 perspective ?

Although some e-mail discussion was conducted, no decision nor precise conclusion

emerged. We support the use of a location indication for resource selection, at least in Mode 2, and in order to reduce standardization efforts and possibly allow some interoperability with LTE, we recommended to use Zone ID in a similar manner as in LTE. The zoning allows resources to be used in a certain area only, e.g. areas with different requirements like highways and cities, areas where Mode-2 is deployed exclusively or other areas where multiple SL resource allocation mechanisms co-exist e.g. NR Mode-1, LTE V2X, etc. For the same resources, the resource pool configuration can be adapted to the specific use case of the particular zone. It is understood that excessive location-based resource sharing can lead to performance degradation in saturation cases, and zoning-based resource pool configurations do not prevent a network to configure a resource pool for all zones (or all zones in a given area). The zoning can also be used to indicate the position of the TX-UE, which can be used to reduce position signaling overhead (e.g. in groupcast), or to provide an approximation of some distance measure. The current LTE Zone ID is however quite limited in resolution and it may however be necessary to increase the resolution of the Zone ID. We propose that the Zone ID is extended to 10-16 bits.

Proposal 3: NR Sidelink supports that resource pool configurations are based on zoning, e.g. similar to LTE Zone ID.

Proposal 4: In order to support better distance and position accuracy, Zone ID resolution should be extended to [10 to 16] bits. Exact value is FFS.

3 Physical Sidelink Shared Channel (PSSCH)

In this section we discuss the design of the SL data channel.

3.1 DMRS Design

The following agreement on reference symbol design for PSSCH has been reached in the last meeting:

Agreements: **RAN1 #98**

- (Pre-)configuration of one or more PSSCH DMRS pattern(s) in time domain per a resource pool is supported.
- Exact DMRS pattern is indicated by SCI

- FFS details, including whether or not to have the indication bit in case of one (pre)configured DMRS pattern

- For Mode 2, DMRS pattern is chosen by the transmitter UE from the (pre)configured patterns for the resource pool.
  - FFS: case for Mode 1
  - FFS: whether/how to use restrictions for choice of DMRS pattern
- FFS on details on time-domain pattern
- FFS the number of possible DMRS patterns
- Note: it is not intended to specify DM-RS based resource pool selection

In the last meeting RAN1#98 it has been agreed to support multiple DMRS patterns in time-domain per resource pool and that the exact DMRS pattern is signaled in the SCI. If only a single DMRS pattern is configured no signaling in the SCI is necessary. Moreover, the indication in the SCI should be limited to 2 bits.

Proposal 5: The signaling of the DMRS pattern in time-domain should not exceed 2 bits. If there is no ambiguity, no signaling is required.

In our view, the transmitter UE chooses the DMRS pattern from a set of (pre)configured patterns for both Mode 1 and Mode 2 since it has always better knowledge of the channel conditions than the gNB. Restricting the choice of DMRS patterns at the UE is certainly useful if there is a large number of different DMRS patterns configured. However, it is unclear why there would be a large number of DMRS time-domain patterns, in NR UL there are at most 4 DMRS symbols in a slot, regardless of the MCS.

Proposal 6: The TX-UE chooses the DMRS pattern, from the (pre)configured patterns for the resource pool, for both Mode 1 and Mode 2.

3.1.1 Time-domain DMRS pattern

A similar approach as in Uu can be utilized, where front-loaded DMRS are present and the number of additional DMRS symbols is configured semi-statically or dynamically. Due to high mobility environments more than 3 additional DMRS symbols can be considered. The PDSCH single-symbol DMRS positions can serve as a starting point. The exact placement of the additional DMRS symbols depends on the slot structure, in particular AGC and Tx-Rx switching symbols.

3.1.2 Frequency-domain DMRS pattern

The WI [2] considers that *multi-rank PSSCH transmission is supported with up to two antenna ports*. Therefore, single-symbol DMRS type 1 is sufficient to support spatial multiplexing for sidelink of up to 2 layers. Adapting the frequency density to increase resource efficiency requires accurate sidelink channel information at the transmitter which, given the dynamic propagation environment and aperiodic traffic, seems difficult to obtain and exploit. Moreover, a single pattern in frequency domain reduces the signaling overhead, which is particularly important if the DMRS pattern is signaled dynamically in the SCI.

Proposal 7: Only support PDSCH single-symbol DMRS type 1 for PSSCH.

3.2 Channel Coding and Modulation

Working Assumption: **RAN1 #96b**

- Transmission of 1 TB with up to 2 layers in a PSSCH is supported.

In our view, it is better to transmit 1 TB with up to two layers. This is in line with Uu and will avoid signaling overhead in both control and feedback channel.

Proposal 8: Confirm working assumption to support 1 TB per PSSCH.

The same modulation and coding schemes as in NR UL/DL can be adopted for NR SL, including 256QAM at least for unicast.

Proposal 9: Support NR Uu modulation and coding schemes for PSSCH.

3.3 Transmission schemes

For unicast transmission it is desirable to use multiple antenna ports for spatial multiplexing. However, short-term channel feedback is likely unreliable because of the aperiodic feedback and dynamic propagation environment. Therefore, transmission schemes that are robust to errors in the channel state information at the transmitter should be

considered in a first instance, e.g. transmit diversity schemes or open-loop spatial multiplexing schemes. Specific scenarios, e.g. platooning, may allow for closed-loop spatial multiplexing since channel conditions are more stable.

Proposal 10: For PSSCH, consider transmission schemes that are robust to errors in channel state information at the transmitter.

4 Physical Sidelink Control Channel (PSCCH)

This section discusses the design of the sidelink control channel.

Conclusion: **RAN1 #97**

- If two-stage SCI is supported, the following details are used.
  - Information related to channel sensing is carried on 1st-stage.
  - 2nd-stage is decoded by using PSSCH DMRS.
  - Polar coding used for PDCCH is applied to 2nd-stage
  - Payload size for 1st-stage in two-stage SCI case is the same for unicast, groupcast, and broadcast in a resource pool.
  - After decoding the 1st-stage, the receiver does not need to perform blind decoding of 2nd-stage.
  - FFS other details

Agreements: **RAN1 #98**

- Support 2-stage SCI
  - 1st SCI is carried in PSCCH.
  - FFS: other details

Last meeting it has been agreed to support 2-stage SCI leaving the details FFS. The first-stage SCI should be of a small, fixed size and transmitted with a (pre-)configured suitable aggregation level to minimize the number of blind decoding attempts.

Proposal 11: The first-stage SCI is transmitted with a (pre-)configured aggregation level per resource pool.

4.1 Transmission schemes

Broadcast transmission requires that all UEs are capable of decoding the PSCCH. To keep the number of blind decoding attempts low, only receiver-transparent single-antenna port transmission should be considered.

Proposal 12: Only consider receiver transparent single-antenna port transmission schemes for PSCCH.

5 Physical Sidelink Feedback Channel (PSFCH)

This section discussed the sidelink feedback channel.

Agreements: **RAN1 #95**

- Physical sidelink feedback channel (PSFCH) is defined and it is supported to convey SFCI for unicast and groupcast via PSFCH.

Agreements: **RAN1 #96**

- At least for sidelink HARQ feedback, NR sidelink supports at least a PSFCH format which uses last symbol(s) available for sidelink in a slot.

Work Item Description: **[2]**

- In sidelink, CSI is delivered using PSSCH (including PSSCH containing CSI only) using the resource allocation procedure for data transmission.

Agreements: **RAN1 #97**

- A sequence-based PSFCH format with one symbol (not including AGC training period) is supported.
  - This is applicable for unicast and groupcast including options 1/2.
  - Sequence of PUCCH format 0 is the starting point.
  - FFS: 1 PRB or multiple PRBs is/are used for this PSFCH format
  - FFS: feasible number of HARQ-ACK bits, mapping of HARQ-ACK bit
- FFS whether to support the following formats
  - X-symbol PSFCH format with a repetition of the one-symbol PSFCH format (not including AGC training period).
    - E.g. $X = 2$
  - A PSFCH format based on PUCCH format 2
  - A PSFCH format spanning all available symbols for sidelink in a slot

It has been agreed to adopt a sequence-based PSFCH format and to consider PUCCH format 0 as a starting point. PUCCH format 0 carries at most 2 bits and spans one PRB in frequency domain and one or two symbols in time domain. In accordance with the guidelines, we propose to reuse PUCCH format 0 as much as possible.

The PSFCH resources per resource pool consist of a certain number of consecutive symbols in a slot and PSFCH needs to be transmitted on *all* of those symbols to maintain an approximately constant PSD. Thus, if a X-symbol ($X > 1$) PSFCH format is supported it applies to all feedback in the resource pool even if some transmissions only require 1-symbol PSFCH transmission for successful detection. However, we believe that multi-symbol PSFCH format are necessary to ensure a reliable feedback link.

Proposal 13: Support a 2-symbol PSFCH format, e.g. PUCCH format 0 with payload repetition.

In frequency domain one PRB should be the base line, although it can be considered to repeat the sequence in frequency domain to improve the convergence of the AGC.

With regards to the payload, we think that two bits should be adopted as in PUCCH format 0, which allows a UE to acknowledge two transport blocks and increases PSFCH resource utilization. However, we think it is beneficial if the PSFCH payload size is

(pre-)configured per resource pool or per configured PSFCH resources.

Proposal 14: Support a configurable PSFCH payload size of up to 2 HARQ-ACK bits, i.e. same as PUCCH format 0.

6 Conclusion

In this contribution the following proposals and observations have been made:

Proposal 1: On a dedicated sidelink carrier the resource pool time-domain granularity is slot-level.

Proposal 2: On a shared sidelink carrier the resource pool time-domain granularity is slot-level.

Proposal 3: NR Sidelink supports that resource pool configurations are based on zoning, e.g. similar to LTE Zone ID.

Proposal 4: In order to support better distance and position accuracy, Zone ID resolution should be extended to [10 to 16] bits. Exact value is FFS.

Proposal 5: The signaling of the DMRS pattern in time-domain should not exceed 2 bits. If there is no ambiguity, no signaling is required.

Proposal 6: The TX-UE chooses the DMRS pattern, from the (pre)configured patterns for the resource pool, for both Mode 1 and Mode 2.

Proposal 7: Only support PDSCH single-symbol DMRS type 1 for PSSCH.

Proposal 8: Confirm working assumption to support 1 TB per PSSCH.

Proposal 9: Support NR Uu modulation and coding schemes for PSSCH.

Proposal 10: For PSSCH, consider transmission schemes that are robust to errors in channel state information at the transmitter.

Proposal 11: The first-stage SCI is transmitted with a (pre-)configured aggregation level per resource pool.

Proposal 12: Only consider receiver transparent single-antenna port transmission schemes for PSCCH.

Proposal 13: Support a 2-symbol PSFCH format, e.g. PUCCH format 0 with payload repetition.

Proposal 14: Support a configurable PSFCH payload size of up to 2 HARQ-ACK bits, i.e. same as PUCCH format 0.

References

[1] TSG RAN, "Study on NR Vehicle-to-Everything (V2X)," 3GPP TR 38.885 V2.0.0, Tech. Rep., Mar. 2019.

[2] ——, "Revised WID on 5G V2X with NR sidelink," 3GPP RP-190984, Tech. Rep., Jun. 2019.

[3] TSG RAN1, "LS on NR V2X resource pool configuration and selection," 3GPP R1-1908004, Tech. Rep., Sep. 2019.