3GPP TSG RAN WG1 Meeting #110-bis-e **R1-2209083**
eMeeting, October 10th – 19th, 2022

Source: Johns Hopkins University APL

Title: Discussion on Physical Channel Design Framework

Agenda item: 9.4.1.2

Document for: Discussion and Decision

1. Background

The Objective 2 of the Work Item Description (WID) on NR sidelink evolution [1] is to study and specify support for sidelink operation in the unlicensed bands with focus on the FR1 unlicensed bands, n46 and n96/n102. The relevant agreement that was reached on this objective at the 3GPP TSG RAN WG1 #110 meeting is listed below [2].

Agreement
If RAN1 decides that LBT is performed for S-SSB transmission, in addition to the S-SSB occasions in R16/R17 NR SL design, support additional candidate S-SSB occasions
- FFS the number and locations of additional candidate S-SSB occasions
- FFS when a UE transmits S-SSB on such additional candidate S-SSB occasions, and the related Rx UE's behavior

The relevant agreement that was reached on this objective at the 3GPP TSG RAN WG1 #109-e meeting is listed below [3].

Agreement
For S-SSB and synchronization in SL-U:
- FFS the time domain locations of S-SSB resources, e.g., whether/how to introduce more candidate occasions compared with R16/R17 NR SL design, etc.
- Down-selection at least one of the following solutions to meet OCB and PSD requirement for S-SSB transmission
  - Option 1: Using interlaced RB transmission
  - Option 2: S-SSB multiplexing with other SL transmissions in the same slot
  - Option 3: Repetition of S-PSS/S-SSS/PSBCH in frequency domain
  - Option 4: S-PSS/S-SSS/PSBCH with wider bandwidth
- FFS: whether to support 4 symbols S-SSB
  - Note: 4 symbols S-SSB can be considered with options 1/2/3/4 above
- FFS whether the temporary exemption of OCB requirement is applicable for S-SSB transmission
- FFS whether any changes to R16/R17 NR SL synchronization procedure

2. Discussion

2.1 Additional S-SSB Transmissions

In comparison to the channel sensing time in the NR-U (9 us), the time slot sizes used by the sidelink are very large. This large time slot sizes will severely disadvantage sidelink's ability to access the channel during the LBT contention

process. This disadvantage can be somewhat mitigated by supporting multiple starting symbol positions and using the smallest time slot case for the sidelink; however, this problem persists when there are only two starting symbol positions and for larger time slot sizes. In these cases, a short S-SSB transmission can be used to provide enhance access to the channel as well as to improve the synchronization process.

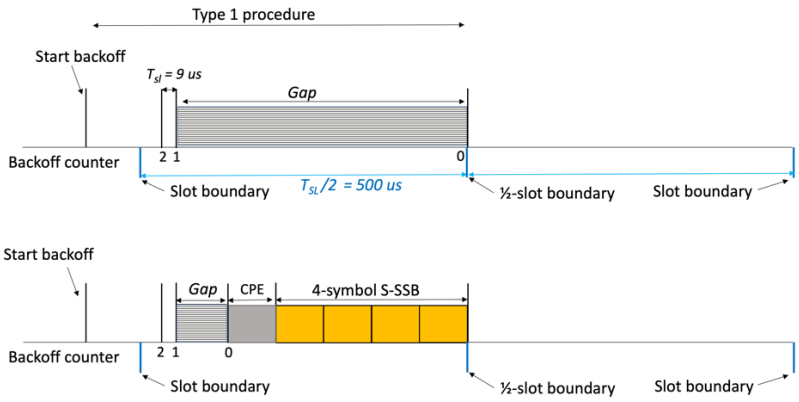

Figure 1. Type 1 LBT process with (bottom figure) and without (top figure) a 4-symbol SSB.

Figure 1 (top figure) shows the Type 1 LBT process for 1 ms slot size sidelink with 2 starting symbol positions where the second starting symbol position is located at the middle of slot. Because the sidelink starts its transmissions at the slot (½-slot) boundaries, in this figure a gap duration is introduced until the end of the ½-slot boundary. The total number of sensing slots in 500 us is approximately 55, so this gap duration can be high most of the time. Because of this channel access can be severely limited when contending with other systems.

In the unlicensed bands, unlike in the case of licensed bands, the S-SSB transmissions have to contend for channel access. This requires realizing more transmission opportunities for S-SSB signals. The bottom figure of Figure 1 shows a scenario of using a 4-symbol S-SSB transmission to minimize the gap duration while serving the synchronization needs.

In this design the PSS signal can be used at the slot boundary to reduce the complexity of the synchronization process. Also, PSBCH signals can be supported at regular intervals from the PSS. Figure 2 shows an example design for such a 4-symbol S-SSB that occupies 10 MHz out of the 20 MHz channel. The first symbol is an AGC symbol which is a repeat of the PSBCH signal, which consist of approximately 48 RBs. The last two symbols contain the S-SSS and S-PSS signals, respectively.

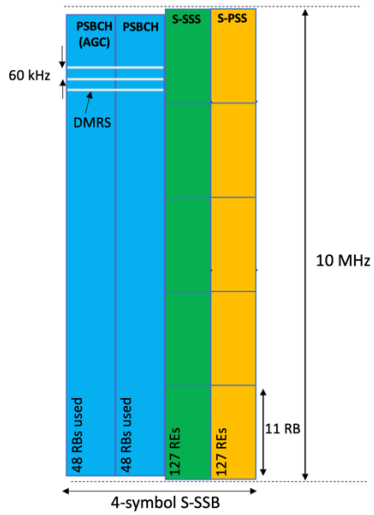

Figure 2. Example design of a 4-symbol S-SSB for 15 kHz SCS.

Observation 1: Channel access for SL-U nodes can be severely limited even with 2 symbol starting positions when the sidelink slot sizes are 500 us and 1 ms.

Observation 2: LBT blocks will degrade the synchronization performance of SL-U.

Proposal 1: Support using 4-symbol S-SSB.

Proposal 2: Study the possibility of using short S-SSB signals to enhance the synchronization process while improving access to the channel.

Proposal 3: For OCB and PSD requirements, support Option 2: S-SSB multiplexing with other SL transmissions in the same slot.

2.2 Synchronization Enhancement for Out-of-Network and Out-of-GNSS Coverage Areas

Relevant proposal from the FL summary at the TSG RAN1#110 meeting [4]:

Proposal 5-3c: For S-SSB and synchronization in SL-U:

- *Compared with R16/R17 NR SL synchronization procedure, FFS whether or not to introduce additional enhancements to handle the case when GNSS and network are not available*

Sidelink mode 2 is expected to operate in areas where GNSS or network coverage is not available. Many such use cases are given in [5]: buildings, basement areas, underground parking lots, mines, underground infrastructure, etc. Under these conditions it may be necessary to provide more frequent S-SSB transmissions than when used in the presence of GNSS or network coverage scenarios.

Observation 3: Sidelink mode 2 is expected to operate in areas where network or GNSS coverage is not available.

Proposal 4: Study whether enhancements to the synchronization process are necessary for SL-U operations in out-of-network and out-of-GNSS coverage areas.

3. Summary of Proposals

Proposal 1: Support using 4-symbol S-SSB.

Proposal 2: Study the possibility of using short S-SSB signals to enhance the synchronization process while improving access to the channel.

Proposal 3: For OCB and PSD requirements, support Option 2: S-SSB multiplexing with other SL transmissions in the same slot.

Proposal 4: Study whether enhancements to the synchronization process are necessary for SL-U operations in out-of-network and out-of-GNSS coverage areas.

4. References

[1] 3GPP RP-220300: "NR sidelink evolution".

[2] OPPO, "Status Report to TSG," RP-221937, 3GPP TSG RAN meeting #97-e. Electronic Meeting. September 12-16, 2022.

[3] OPPO, "Status Report to TSG," RP-221064, 3GPP TSG RAN meeting #96. Budapest, Hungary. June 06-09, 2022.

[4] Huawei, "FL summary#3 for AI 9.4.1.2 SL-U physical channel design framework," R1-2207797 TSG RAN1 meeting #110. Toulouse, France. August 22 – 26, 2022.

[5] 3GPP TR 22.839: "Study on Vehicle-Mounted Relays."