**3GPP TSG RAN WG1 Meeting #112bis-e R1-2303963**

**e-Meeting, April 17th – April 26th, 2023**

**Source: Moderator (Intel Corporation)**

**Title: FL summary #1 on SL positioning reference signal**

**Agenda item: 9.5.1.1**

**Document for:** **Discussion and Decision**

1. Introduction

This document presents a summary of submitted contributions to AI 9.5.1.1 (“SL positioning reference signal”) and the discussions and decisions during RAN1 #112bis-e meeting.

[112bis-e-R18-Pos-01] Email discussion on SL positioning reference signal by April 26 – Debdeep (Intel)

* Check points: April 21, April 26

As part of the Rel-18 WI on expanded and improved NR positioning [1], the following objectives towards support of SL positioning are discussed under this agenda item.

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| * **Specify solutions for support of sidelink positioning (including ranging) in NR systems, including the following [RAN1, RAN2, RAN3, RAN4]:**   + **Specify SL PRS for support of sidelink positioning such that the SL PRS uses a comb-based (full RE mapping pattern is not precluded) frequency domain structure and a pseudorandom-based sequence where the existing sequence of DL-PRS is used as a starting point [RAN1].**     - **Specify support for SL PRS bandwidths of up to 100 MHz in FR1 spectrum.**     - **NOTE: SL PRS transmission in FR2 is not precluded but no FR2 specific aspects will be specified.**   + Specify measurements to support RTT-type solutions using SL, SL-AoA, and SL-TDOA [RAN1, RAN2].   + Specify support of resource allocation for SL PRS:     - Including resource allocation Scheme 1 and Scheme 2, where Scheme 1 corresponds to a network-centric SL PRS resource allocation and Scheme 2 corresponds to UE autonomous SL PRS resource allocation [RAN1].       * For resource allocation mechanism for SL PRS in Scheme 2:         + Study and specify support of sensing-based resource allocation, and/or a random resource selection [RAN1].         + Study and specify solutions for congestion control for SL PRS and/or inter-UE coordination for SL-PRS [RAN1].     - Support resource allocation for shared resource pool with Rel-16/17/18 sidelink communication and dedicated resource pool for SL PRS [RAN1].       * NOTE: For SL positioning resource (pre-)configuration in a shared resource pool with Rel-16/17/18 sidelink communication, backward compatibility with legacy Rel-16/17 UEs should be ensured.   + **Specify procedures for transmit power control for SL PRS transmissions at least based on open loop power control (OLPC) [RAN1].**   + Specify signalling and associated UE behavior for support of unicast, groupcast (not including many to one) and broadcast of SL PRS transmissions [RAN1, RAN2].   + Specify reporting signalling and procedures to facilitate support of SL positioning in all coverage scenarios and for PC5-only and joint PC5-Uu scenarios [RAN2, RAN3]:     - Specify the protocol and procedures for SL positioning between UEs (Protocol for Sidelink positioning procedures (SLPP)).     - Specify the protocol and procedures for SL positioning between UEs and LMF.   + Specify signalling to NG-RAN for sidelink positioning and ranging service authorizations as needed. [RAN3, RAN2]   + Specify corresponding new core requirements, as well as identifying and specify the impact on the existing RAN4 specification, including RRM measurements and procedures [RAN4]. |

Based on the submitted contributions to RAN1 #112bis-e meeting, the discussion points are categorized into the following topics:

* SL PRS design
  + SL PRS resources and resource sets
  + Sequence design for SL PRS
  + Mapping SL PRS to physical resources
  + Multiplexing of different SL PRS resources
    - *NOTE: PSCCH and control information associated with SL PRS are expected to be discussed in AI 9.5.1.3*
  + Other issues
* Transmit power control for SL PRS
  + General considerations
  + Open loop PC (OLPC) for SL PRS transmissions

Please follow the naming convention in this example:

* *SLPRS\_FLS -v000.docx*
* *SLPRS\_FLS -v001-CompanyA.docx*
* *SLPRS\_FLS -v002-CompanyA-CompanyB.docx*
* *SLPRS\_FLS -v003-CompanyB-CompanyC.docx*

If needed, you may “lock” a spreadsheet file for 30 minutes by creating a checkout file, as in this example:

* Assume CompanyC wants to update *SLPRS\_FLS-v002-CompanyA-CompanyB.docx*.
* CompanyC uploads an empty file named *SLPRS\_FLS-v003-CompanyB-CompanyC.checkout*
* CompanyC checks that no one else has created a checkout file simultaneously, and if there is a collision, CompanyC tries to coordinate with the company who made the other checkout (see, e.g., contact list below).
* CompanyC then has 30 minutes to upload *SLPRS\_FLS-v003-CompanyB-CompanyC.docx*
* If no update is uploaded in 30 minutes, other companies can ignore the checkout file.
* Note that the file timestamps on the server are in UTC time.

To avoid excessive email load on the RAN1 email reflector, please note that there is NO need to send an info email to the reflector just to inform that you have uploaded a new version of this document. Companies are invited to enter the contact info in the table below.

## [High] FL1 Question 1-1

* *Please consider entering contact info below for the points of contact for this agenda item:*

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| **Company** | **Point of contact** | **Email address** |
| CATT | Xiaotao Ren | [renxiaotao@catt.cn](mailto:renxiaotao@catt.cn) |
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1. SL PRS Design
   1. SL PRS resources and resource sets

**Background:** For DL PRS, a hierarchical structure is defined starting with DL Positioning Frequency Layer (DL PFL), DL PRS resource sets, and DL PRS resources.

During RAN1 #112 meeting, the following agreements were made:

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| **Agreement**  A SL PFL is not defined. SL positioning RS are defined directly with respect to and contained within a single SL BWP and carrier.  **Agreement**  Support SCS values for SL PRS include:   * + 15 kHz, 30 kHz, 60 kHz for FR1, and 60 kHz, 120 kHz for FR2     - Which SCS values are required, and which ones are optional follow Rel-16 UE capabilities. |

There were also limited discussions regarding definitions for SL PRS resources and SL PRS resource sets and it is expected that the group would make further progress on this during the present meeting.

Inputs from submitted contributions to RAN1 #112bis-e.

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| **Reference** | **Views** |
| HW-HiSi [6] | *Proposal 9: Do not support to introduce the SL-PRS resource set concept.* |
| Spreadtrum [11] | *Proposal 8: The definition of DL PRS resources or resource sets in existing specification can be reused for SL-PRS resource allocation.* |
| Panasonic [15] | *Proposal 8: SL-PRS periodicity could be just same as or multiple times of S-SSB for simplicity.* |
| LGE [16] | *Proposal 11: SL PRS resource is defined as a set of SL resources, which is used for the measurement of a single sample/instance of SL PRS.* |
| Sharp [19] | *Proposal 2: A SL-PRS resource corresponds to one RE offset of the first SL-PRS symbol within a comb-based SL-PRS pattern.*  *Proposal 3: “SL-PRS resource set” is not supported.*  *Proposal 4: For periodic reservation of SL-PRS resources, the periodicity values supported in legacy SL communications are considered as a baseline.* |
| Samsung [20] | *Proposal 1: SL PRS resources and SL PRS resource sets are defined for SL positioning.*   * *SL PRS resource set can be configured with periodic reservation or without periodic reservation.* * *FFS: Other details on configuration parameters in SL PRS resources and SL PRS resource sets.* |
| CMCC [21] | *Proposal 3: At least support to define SL PRS resources similar to the definitions for DL PRS resources.*  *Proposal 4: Parameters of SL-PRS, e.g., SL PRS pattern (incl. number of symbols, comb size), and bandwidth, should be (pre-)configured in a resource pool level.* |
| Lenovo [22] | *Proposal 2: RAN1 to define the SL PRS resource hierarchy in terms of SL Carrier🡪 SL BWP🡪SL Resource Pool🡪SL PRS Resource Set🡪SL PRS Resources. Further consider the definition of a SL PRS resource with respect to one or more sub-channels.* |
| ZTE [23] | *Proposal 1: The concept of SL PRS resource set can be introduced considering forward compatibility where each consists one or more SL PRS resource(s).*   * *The maximum number of SL PRS resource set shall be set as 1 in Rel-18* * *At least the following parameters can be configured per resource set: SL PRS resource set ID, a list of SL PRS resources, power control related parameters (maximum transmission power, alpha, p0)* * *At least the following parameters can be configured per resource:* *SL PRS resource ID, SL PRS comb offset, SL PRS sequence ID if it is a higher layer configured parameter* |
| Apple [27] | *Proposal 1: The design of the sidelink reference signals for positioning should specify the following: numerology, supportable bandwidth, sequence design, frequency domain aspects (including comb-design, staggering pattern, granularity), time domain aspects and SL-PRS multiplexing.* |
| Ericsson [28] | *Proposal 1 For SL PRS, only SL PRS resources are used to configure the SL PRS in a resource pools, without SL PRS resource sets or SL PRS PFL.* |
| LGE [33] | *Proposal 4: SL PRS resource is defined as a set of SL resources, which is used for the measurement of a single sample/instance of SL PRS.*  *Proposal 5: SL PRS resource configuration includes at least the followings.*   * *SL PRS resource ID* * *Comb size of SL PRS resource* * *Number of symbols of SL PRS resource* |
| Qualcomm [29] | *Proposal 13: Higher layers signal SL-PRS comb size, number of symbols, periodicity, frequency-domain allocation, and scrambling seed.* |

***Summary of key observations based on submitted contributions:***

* *On SL PRS resource sets*
  + *Multiple companies propose or assume definition of SL PRS resource sets wherein a SL PRS resource set comprises of a number of SL PRS resources. However, in light of the option of referring to SL PRS resource pools, a clear need to define SL PRS resource sets remain unclear.*
    - *Thus, a primary motivation of defining SL PRS resource sets can be seen from perspective of forward compatibility, e.g., for assigning different SL PRS resources within a SL PRS resource set with different spatial beams. Thus, at least one company proposes that in Rel-18, the max number of SL PRS resource set is limited to one.*
    - *However, it should be noted that, if needed, SL PRS resource sets may be defined in future in a backward compatible manner.*
  + *At least three companies explicitly propose not to introduce SL PRS resource sets.*
* *On SL PRS resources* 
  + *As a starting point, SL PRS resources can be defined using similar approach as for DL PRS resources, with possible exception of periodicity.*
    - *Thus, a SL PRS resource may be defined by reference to a combination of:*
      * *SL PRS resource ID,*
      * *SL PRS comb offset and associated SL PRS comb size (N),*
      * *SL PRS starting symbol and number of SL PRS symbols (M)*
      * *SL PRS frequency domain allocation – e.g., starting PRB and number of PRBs,*
      * *SL PRS periodicity for periodic and semi-persistent SL PRS,*
      * *SL PRS sequence ID if it is based on a higher layer-configured parameter.*
  + *For time domain representation of a SL PRS resource, companies either include or exclude AGC or AGC and Guard Symbols within a SL PRS resource or not. In this regard, given that the details of multiplexing of SL PRS with other SL channels/signals is still under discussion, it would be cleaner and simpler to define SL PRS resource and AGC and guard symbols separately.*
    - ***See FL1 Proposal 2.3.5-1***
    - *NOTE: Certainly, an AGC symbol may be generated by transmission of a symbol containing REs with SL PRS. This can be discussed in the context of Section 2.3.5.*
  + *NOTE: Details of configuration of SL PRS resource as part of SL PRS resource pool configuration can be discussed once there is further progress on SL PRS multiplexing options and need further coordination with AI 9.5.1.3.*
* *On SL PRS periodicity*
  + *There are some limited views expressed regarding supported periodicity values for periodic and/or semi-persistent SL PRS. More inputs and further progress in AI 9.5.1.3 may be necessary prior to addressing this point.*

### [High] FL1 Proposal 2.1-1

* *SL PRS resource sets are not defined in Rel-18.*

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| **Company** | **Comments** |
| CATT | We prefer to define SL PRS resource set in order to align with the DL-PRS/SRS-pos resource set definition in Rel-16.  If the majority support not to define the SL PRS resource set, we can live with the proposal. |
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### [High] FL1 Proposal 2.1-2

* *A SL PRS resource is identified by a combination of:* 
  + *SL PRS resource ID,*
  + *SL PRS comb offset and associated SL PRS comb size (N),*
  + *SL PRS starting symbol and number of SL PRS symbols (M)*
  + *SL PRS frequency domain allocation – e.g., at least information on starting PRB and number of PRBs,*
  + *SL PRS periodicity for periodic and semi-persistent SL PRS,*
  + *SL PRS sequence ID if it is based on a higher layer-configured parameter.*
* *NOTE 1: The above does not imply signalling/(pre-)configuration of these parameters but only serves to define a SL PRS resource.*
* *NOTE 2: SL PRS resource configuration that may be provided as part of SL PRS resource pool configuration may only include some of the above.*

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| **Company** | **Comments** |
| CATT | For the last bullet (SL PRS sequence ID), how to determine the SL PRS sequence ID is still on the discussion, so we prefer to remove the SL PRS sequence ID at this stage. |
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* 1. Sequence design for SL PRS

**Background:**

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| Sequence for DL PRS is defined using Gold sequence:  .  For DL PRS, the generator of the pseudo-random sequence *c(i)* is initialized as:  .  Sequence for SL-CSI-RS is defined using Gold sequence:  .  For SL CSI-RS, the generator of the pseudo-random sequence *c(i)* is initialized as:  . |

During RAN1 #112 meeting, the following agreements were made:

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| **Agreement**  SL PRS sequence is generated based on Gold sequence:  where c(i) is a pseudo-random sequence as defined in Clause 5.2.1 of TS 38.211.  **Agreement**   * For SL PRS sequence generation, the pseudo-random sequence c(i) initialization equation is defined as a function of at least: slot number, symbol number, and a parameter . * The pseudo-random sequence c(i) initialization equation is based on initialization equation as for DL PRS   **Agreement**  For SL PRS sequence generation, consider at least the following options to define the parameter , and select one option:   * + Option 1: is a higher layer configured parameter   + Option 2: is based on 12 bits CRC of PSCCH associated with the SL PRS transmission   + Option 3: based on a combination of higher layer configured parameter from a configured ID list and 12 bits of CRC of PSCCH associated with the SL PRS transmission   + Option 5: is based on 12bits LSB of destination ID   + Option 6: is based on 8 bits of source ID + 4 zero bits   + Option 7: is based on the CRC field of the 2nd SCI associated with SL PRS transmission, if there is a 2nd SCI defined.   **Agreement**  Range of the parameter is: |

Three key opens on this topic are on: (1) determination of the parameter ; (2) SL PRS sequence generation - dependence on parameters other than slot number, symbol number, and a parameter ; and (3) the resulting equation for the sequence generation.

Inputs from submitted contributions to RAN1 #112bis-e.

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| **Reference** | **Views** |
| Nokia [4] | *Proposal 1: The SL PRS sequence initialization parameter is a parameter provided by higher layer (Option 1).* |
| Futurewei [5] | *Proposal 1: For the definition of , down select Options 1-3 for further discussion. Clarify the intent of Option 1.* |
| HW-HiSi [6] | *Proposal 5: For SL-PRS sequence generation, support the following Option 3:*   * *Option 3: based on a combination of higher layer configured parameter from a configured ID list and 12 bits of CRC of PSCCH associated with the SL PRS transmission* |
| vivo [8] | * *The of SL PRS is a higher layer configured parameter (i.e., Option 1 should be supported).* |
| OPPO [9] | *Proposal 1: For SL PRS sequence generation, is based on 12 bits CRC of PSCCH associated with the SL PRS transmission.* |
| Spreadtrum [11] | *Proposal 1: is based on 8 bits of source ID + 4 zero bits.* |
| CATT, GOHIGH [12] | *Proposal 1: The pseudo-random sequence generator shall be initialized with:*  *- where is the slot number, the SL-PRS sequence ID , and is the OFDM symbol within the slot to which the sequence is mapped.*  *Proposal 2: SL-PRS sequence ID is calculated from the CRC for the sidelink control information mapped to the PSCCH associated with the SL-PRS.*  *- where the quantity equals the decimal representation of CRC for the sidelink control information mapped to the PSCCH associated with the SL-PRS according to with and given by clause 7.3.2 in TS 38.212 [3].* |
| Intel [13] | *Proposal 1*   * *For SL PRS sequence generation, at least Option 1 is supported:* * *Sequence ID can be (pre-)configured per UE as part of SL PRS resource configuration.* * *FFS: Option 2.* |
| SONY [14] | *Proposal 3: Support the generation is based on bits of source ID and 4 zero bits (also known as option 6).* |
| Panasonic [15] | [*Proposal 3: The SL-PRS sequence ID needs to be separately allocated for Scheme 1 and Scheme 2*](#_Toc131521783)  [*Proposal 4: is either a higher layer configured parameter or based on a combination of higher layer configured parameter from a configured ID list and 12 bits of CRC of PSCCH associated with the SL PRS transmission*](#_Toc131521784) |
| LGE [16] | *Proposal 1: SL PRS sequence ID used for SL PRS sequence initialization is determined based on the CRC field of the 2nd SCI associated with SL PRS transmission.* |
| Xiaomi [17] | *Proposal 1: is based on 12 bits CRC of PSCCH associated with the SL PRS transmission* |
| China Telecom [18] | *Proposal 1: For the definition of the parameter , we support either option 1 (higher layer configured) or option 2 (12 bits CRC of PSCCH based).* |
| Sharp [19] | *Proposal 1: In addition to the agreed slot number, symbol number, and , RE offset is used as a parameter for SL-PRS sequence initialization.* |
| Samsung [20] | ***Proposal 2:*** *For SL PRS sequence generation,*  is based on 12 bits CRC of PSCCH associated with the SL PRS transmission. |
| CMCC [21] | *Proposal 1: For SL PRS generation, down-select between the following two options, and Option 1 is slightly preferred:*   * + *Option 1: is a higher layer configured parameter*   + *Option 3: based on a combination of higher layer configured parameter from a configured ID list and 12 bits of CRC of PSCCH associated with the SL PRS transmission*   *Proposal 2: The sequence ID of SL PRS should be higher layer configured per UE.* |
| Lenovo [22] | *Proposal 1: RAN1 to further discuss and down-select among one of the following Options to generate the 12-bit SL-PRS sequence ID ():*   * *Option 1: Higher-layer configured parameter* * *Option 5: Based on 12 LSBs of destination ID.* |
| ZTE [23] | ***Proposal 2:*** *For pseudorandom-based SL PRS:*   * *Select one of the following options regarding SL PRS sequence configuration:*   + *Option1: SL PRS sequence ID is configured via high layer signaling*   + *Option 5+6: SL PRS sequence ID is based on both source ID and destination ID, e.g.* * *Reuse the formula of DL-PRS sequence generation* |
| CEWiT [24] | ***Proposal 1:*** *For initialization one of the following options can be supported:*   * *Option 1: is based on 12 bits CRC of PSCCH associated with the SL PRS transmission.* * *Option 2: is based on a combination of higher layer configured parameter from a configured.* |
| IDCC [26] | *Proposal 1: For SL PRS sequence generation, Option 1 in RAN1#112 agreement is selected, i.e., the parameter is a higher layer configured parameter.* |
| Apple [27] | *Proposal 2: For PRS sequence generation,: is a higher layer configured parameter* |
| Ericsson [28] | [*Proposal 2 For SL PRS sequence generation, is a higher layer configured parameter*](#_Toc131753060)  [*a. The listening UE receives the SL PRS sequence initialization as part of the assistance data via the transmitting UE higher layers or the LMF (LPP, SLPP).*](#_Toc131753061)  [*b. For resources in Scheme 1, the transmitting UE receives the SL PRS sequence initialization ID from the network higher layers, i.e., via RRC signalling.*](#_Toc131753062)  [*c. For resources in Scheme 2, the transmitting UE may receive a default SL PRS sequence initialization ID as part of the PRS resource configuration, or choose a specific sequence initialization provided by its own higher layers, if it is not provided by the network.*](#_Toc131753063) |
| Qualcomm [29] | *Proposal 6: n"ID,seqSL-PRS" is a higher layer configured (i.e. SLPP) parameter (Option 1)* |
| ASUSTeK [31] | *Proposal 1: For defining parameter , support one of option 2, 5, 6.* |
| MTK [32] | *Proposal 5-1: For the sequence ID value generation for SL-PRS, option 2 that is based on the CRC of PSCCH associated with the transmission is considered* |

***Summary of observations based on submitted contributions:***

* *Defining the parameter*
  + *Options for defining the parameter:*
    - *Option 1 (higher layer parameter): Nokia, Futurewei (Options 1 – 3), vivo, Intel, Panasonic (for Scheme 1 RA), China Telecom, CMCC, Lenovo, ZTE, IDCC, Apple, Ericsson, Qualcomm* ***(13)***
    - *Option 2 (based on 12 bits CRC of PSCCH associated with the SL PRS transmission): OPPO, CATT, Futurewei (Options 1 – 3), [Intel], Xiaomi, China Telecom, Samsung, CEWiT, ASUSTeK, MTK* ***(9)***
    - *Option 3 (based on a combination of higher layer configured parameter from a configured ID list and 12 bits of CRC of PSCCH associated with the SL PRS transmission): HW-HiSi, Futurewei (Options 1 – 3), Panasonic (Scheme 2 RA), CMCC, CEWiT* ***(5)***
    - *Option 5 (based on 12bits LSB of destination ID): Lenovo, ASUSTeK* ***(2)***
    - *Option 6 (based on 8 bits of source ID + 4 zero bits): Spreadtrum, SONY, ASUSTeK* ***(3)***
    - *Option 7 (based on the CRC field of the 2nd SCI associated with SL PRS transmission, if there is a 2nd SCI defined): LGE* ***(1)***
    - *(New) Option 8 (based on both source ID and destination ID, e.g. ): ZTE* ***(1)***
  + *Options 1, 2, and 3 have the most support with Option 1 being favored by the majority.* 
    - *For Option 2, the main motivation cited is that such an approach is used for some existing SL signals like SL CSI-RS. Sequence generation latency is cited as another reason but the practical significance of this is unclear.*
    - *A concern raised relates to privacy concerns since PSCCH is expected to be decodable by any receiving UE, which can be addressed by Option 1.*
    - *Option 3 aims to combine Options 1 and 2, but it is not clear of the benefits compared to Option 1 as long as the higher layer parameter is UE-specific (see next point).*
* *Clarification on Option 1: whether the higher layer parameter is UE-specific or resource pool-specific.*
  + *One company proposes to clarify this point while several indicate that it should be a (transmitting) UE-specific higher layer parameter.*
* *Whether to include any parameter other than slot number, symbol number, and a parameter .*
  + *One company proposes to include SL PRS RE offset as an additional parameter*.
  + *It is cited that it would be desirable to have additional scrambling according to RE-offsets for SL PRS multiplexed via comb. However, with UE-specific nID value for SL PRS sequence generation, it is not clear if additional scrambling based on RE-offsets would be necessary. Further, benefits of additional scrambling for sequences multiplexed on different comb offsets may not be significant.*
* *Equation for SL PRS sequence generation.*
  + *Several companies propose use of the equation based on the DL PRS equation. It can be decided once use of input parameters to the equation is finalized.*

### [High] FL1 Proposal 2.2-1

* *For SL PRS sequence generation, one of the following options is down-selected to define the parameter :*
  + *Option 1 (with clarification): is a higher layer configured parameter that is (pre-)configured in a UE-specific manner for a transmitting UE.*
  + *Option 2: is based on 12 bits CRC of PSCCH.*
  + *Option 3: based on a combination of higher layer configured parameter from a configured ID list and 12 bits of CRC of PSCCH.*

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| **Company** | **Comments** |
| CATT | Support.  We prefer Option 2. |
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### [Medium] FL1 Proposal 2.2-2

* *For SL PRS sequence generation, no additional parameters other than the following input parameters are used: slot number, symbol number, and the parameter .*

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| **Company** | **Comments** |
| CATT | Support. |
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* 1. Mapping SL PRS to physical resources

**Background:** Related decisions from SI phase [2]:

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| **Agreement**  With regards to the frequency and time a slot has the following characteristics:   * With regards to the value N (comb size) and the number M of SL-PRS symbols within a slot *excluding* the symbol(s) used for AGC training / RxTx Turnaround:   + At least the following values are considered as potential candidate values: N = {1,2,4,6,8,12}   + FFS: the values considered as potential candidate values for M   + FFS1: Whether to consider N>12 as a potential candidate value(s) * The symbols of a SL-PRS resource within a slot are consecutive symbols   + FFS: consecutive and/or non-consecutive symbols for shared resource pool (if supported) * FFS: RE-Offset sequence within a SL-PRS resource, including whether to have in the end of the SL-PRS pattern a symbol with the same RE-offset as the first symbol, for phase-tracking purpose |

The key opens include:

* Comb sizes and offsets for SL PRS
  + Supported comb sizes (values of N) in dedicated and shared resource pools
  + RE offset sequence as function of SL PRS symbols
* Frequency domain characteristics of SL PRS
  + SL PRS bandwidth in dedicated and shared resource pools
  + Granularity of SL PRS allocation in frequency domain
* Time domain characteristics of SL PRS, including AGC and gap symbols
  + Supported values of number of symbols (values of M) for SL PRS in dedicated and shared resource pools
  + SL PRS mapping to consecutive/non-consecutive symbols in time in shared resource pools
* SL PRS patterns
  + Supported (M, N) values in dedicated and shared resource pools
  + Fully staggered patterns
  + Support of partial staggering and effective comb sizes
  + Support of (M, N) patterns with M > N
  + Support of SL PRS repetitions
  + Repetition of first symbol of SL PRS as the last symbol of a SL PRS resource
* AGC and gap symbols

The following were agreed during RAN1 #112 meeting:

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| **Agreement**  For RE-offset sequence for SL PRS, the RE-offset sequences specified for DL PRS are considered as a starting point.   * FFS: Exact RE-offset sequences   **Agreement**  For SL PRS in shared or dedicated resource pools,   * at least comb sizes (N) 2, 4 are supported. * Comb size 6 is supported at least in dedicated resource pool   + FFS: comb size 6 in shared resource pool * Comb size 1 is supported at least in shared resource pool   + FFS: comb size 1 in dedicated resource pool * comb sizes (N) > 12 are not supported. * FFS: support of comb sizes (N) of 8, 12.   **Agreement**  For SL PRS in shared and dedicated resource pools,   * SL PRS patterns with full staggering are supported.   + FFS: whether (M,N)=(6,6) is supported * SL PRS patterns with partial staggering are supported at least for the following (M,N) pairs:   + (M, 2) with M = {1}   + (M, 4) with M = {2}   + FFS: constraints on maximum effective comb size   + FFS: support of partial staggering for other comb sizes * FFS: Support of SL PRS patterns with M > N at least with full staggering. |

Inputs from submitted contributions to RAN1 #112bis-e.

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| **Reference** | **Views** |
| Nokia [4] | |  | | --- | | *Proposal 2: Support the following parameters of SL-PRS structures:*   * *Comb size (N) 1 in dedicated resource pool* * *Comb size (N) 2, 4, 6, 8 for flexibility.* * *Don’t support N = 12.* * *The number of symbols (M) of SL-PRS: 1, 2, 4, 6, 8. Other values of M (1~8) can also be considered depending on resource allocation and SL-PRS multiplexing to be agreed.* |   *Proposal 3: Consider that a subset of N and M from the whole set specified is (pre-)configured by network for each resource pool.* |
| Futurewei [5] | *Proposal 2: Consider increasing the range of M and N values and supporting the duplication of first SL-PRS symbol into the last SL-PRS symbol for large M values.*  *Proposal 3: Support multiple dedicated positioning resource pools within one SL BWP. In each of the dedicated RP SL-PRS occupies the entire BW.*  *Observation 1: In the shared resource pools SL-PRS BW may be less than the BW of the RP.* |
| HW-HiSi [6] | *Observation 1: For sidelink positioning, equivalent comb-3 is sufficient to resolve the sidelobe issue considering the communication range and synchronization condition between two UEs involved in the sidelink positioning.*  *Observation 2: The maximum number of SL-PRS resources within a slot for the dedicated resource pool should be more than 20 to match the maximum subchannels in a RP used for PSCCH transmission.*  *Proposal 1: Support the comb size of 12 with partial staggering mapping with (M,N)=(5,12).*   * *The RE offset sequence takes the first 4 entries and the fifth symbol repeats the first symbol.*   *Proposal 2: Support flexible number of SL-PRS symbols, i.e., M could be the value within {1, 2, …, 9}.*  *Proposal 3: For partial staggering, support to introduce repetition pattern to improve Doppler frequency shift estimation and compensation performance.*  *Proposal 4: For full staggering, support the pattern M > N, where M is the number of SL-PRS symbols and N is the comb size.*  *Proposal 6: Support full RB frequency domain pattern of SL-PRS within the dedicated resource pool.*  *Proposal 7: Support flexible bandwidth of SL-PRS within the share resource pool.* |
| Continental Automotive [7] | *Observation 1: With comb-based multiplexing of SL PRS, UEs in the same RP may transmit SL PRSs using the same comb size and RE-offset values, leading to potential interference in SL PRS transmissions and performance degradation. This necessitates some form of coordination between UEs on selection of these parameters.* |
| vivo [8] | *Observation 1:*   * *The backward compatibility cannot be guaranteed if comb-based multiplexing for SL-PRS is supported in the shared resource pool.* * *For the comb size of SL-PRS in the shared or dedicated resource pool*    + *Support comb size 6 in the shared resource pool with partial staggering;*   + *Comb size 12 can be supported with partial staggering.* * *With regards to AGC training*   + *One symbol preceding a SL-PRS resourcecan be used* * *With regards to Rx/Tx turnaround*   + *At least, one GP symbol is required at the end of slot*   + *FFS one GP symbol after an SL-PRS resource* * *For a dedicated resource pool, the bandwidth of SL-PRS can be the same or smaller than that of the resource pool* * *For a shared resource pool, the bandwidth of SL-PRS should be the same as the indicated bandwidth of SL PSSCH.* |
| OPPO [9] | [*Observation 1: As single BWP may be used for both SL communication and SL positioning, it is necessary to support flexible slot length for SL positioning as current SL communication to enable flexible co-existence between SL and Uu in licensed carrier.*](#_Toc131693933)  [*Proposal 2: For SL PRS in shared or dedicated resource pools comb sizes {1,6,8,12} are supported.*](#_Toc131693935)  [*Proposal 3: For SL PRS in shared or dedicated resource pools M>N is supported.*](#_Toc131693936)  [*Proposal 4: Whether to have in the end of the SL PRS pattern a symbol with the same RE-offset as the first symbol is up to (pre-)configuration.*](#_Toc131693937)  [*Proposal 5: In shared resource pool, the symbols of a SL PRS resource within a slot are consecutive symbols or non-consecutive symbols.*](#_Toc131693938)  [*Proposal 6: RE-Offset sequence defined for Uu DL-PRS/SRS-Pos should be reused for SL PRS, with the exception that and should be interpreted as the index of a symbol/starting symbol within the SL PRS resource.*](#_Toc131693939)  [*Proposal 9: With regards to the bandwidth of SL-PRS transmission, the bandwidth of SL-PRS shall be the same as that of the resource pool, and the minimum bandwidth of SL PRS is 20MHz.*](#_Toc131693942)  [*Proposal 13: The first symbol of a SL PRS time resource is used for AGC.*](#_Toc131693946)  [*Proposal 14: The granularity of a SL PRS time resource should be equal to or larger than 3 OFDM symbols.*](#_Toc131693947)  [*Proposal 15: The last symbol of a SL PRS time resource can be used for Rx/Tx turnaround (if needed), FFS under which condition the symbol for Rx/Tx turnaround is needed.*](#_Toc131693948) |
| Spreadtrum [11] | *Observation 1: AGC training and Rx-Tx turnaround time are always needed for SL-PRS transmission.*  *Proposal 2: Comb size 6 should be supported in shared resource pool.*  *Proposal 3: Comb size 1 should be supported in dedicated resource pool.*  *Proposal 4: (M,N)=(6,6) should be supported in both shared resource pool and dedicated resource pool.*  *Proposal 10: For AGC training, one symbol preceding the set of SL-PRS symbols can be used*  *Proposal 11: For Rx/Tx turnaround, one symbol after the set of SL-PRS symbols can be used.* |
| CATT, GOHIGH [12] | *Proposal 5: For SL-PRS in shared or dedicated resource pools, symbol numbers of SL-PRS within a slot M={1, 2, 4, 6} should be supported.*  *Proposal 6: For SL-PRS in shared resource pools, comb size 6 should be supported.*  *Proposal 7: For SL-PRS in dedicated resource pools, comb size 1 should be supported.*  *Proposal 8: For SL-PRS in shared or dedicated resource pools, comb sizes of 8, 12 are not supported.*  *Proposal 9: For SL-PRS in shared or dedicated resource pools, comb sizes N={1, 2, 4, 6} should be supported.*  *Proposal 10: For SL-PRS in shared and dedicated resource pools, SL-PRS pattern with full staggering of (M,N)=(6,6) should be supported.*  *Proposal 11: For SL-PRS in shared and dedicated resource pools, there is no need to support other SL-PRS patterns with partial staggering, except for (M,N)=(1,2) and (2,4).*  *Proposal 12: For SL PRS in shared and dedicated resource pools, RE-Offset sequence within a SL-PRS resource across the symbols should follow the table below:*   |  |  |  |  |  | | --- | --- | --- | --- | --- | |  |  | | | | |  |  |  |  | | *1* | *0* | *0, 0* | *-* | *-* | | *2* | *0* | *0, 1* | *0, 1, 0, 1* | *0, 1, 0, 1, 0, 1* | | *4* | *-* | *0, 2* | *0, 2, 1, 3* | *-* | | *6* | *-* | *-* | *-* | *0, 3, 1, 4, 2, 5* |   *Proposal 13: The symbols of a SL-PRS resource within a slot should be consecutive symbols for shared resource pool, in order to keep the unified design of SL-PRS resource pattern for both dedicated resource pool and shared resource pool.*  *Proposal 14: For the SL-PRS in dedicated resource pool, one AGC symbol is needed before the SL-PRS transmission/reception, and one GP symbol is needed after the SL-PRS transmission/reception.*  *Proposal 16: For dedicated resource pool, one AGC symbol should be always allocated before every SL-PRS transmission/reception or SCI+SL-PRS transmission/reception. And one GP symbol should be always allocated after every SL-PRS transmission/reception or SCI+SL-PRS transmission/reception.*  *Proposal 19: For a SL-PRS transmission, the first symbol is used for AGC handling. The duplication mechanism of first symbol is left to UE implementation.* |
| Intel [13] | ***Proposal 2***   * *For dedicated resource pool, the bandwidth of SL PRS is the same as that of the resource pool.* * *For shared resource pool, SL PRS transmission is associated with PSSCH and occupies same BW as the PSSCH.*   ***Proposal 3***   * *For dedicated resource pool* * *Comb size N with {2, 4, 6, 8, 12} is supported.* * *M > N is supported for SL PRS with fully staggered pattern, where M = N and is a positive integer.* * *Maximum effective comb size is 2 for SL PRS with partially staggered pattern.* * *For shared resource pool* * *(M, N) pairs with (1, 1), (1, 2), (2, 4), (2, 2) are supported.* * *FFS: maximum value of M as 4.*   ***Proposal 4***   * *Granularity of time-domain resource allocation for SL PRS transmission is based on SL PRS resource.* * *Only consecutive symbols for a SL PRS transmission are supported for both dedicated and shared resource pools.*   ***Proposal 7***   * *Support AGC and guard symbol for Tx-Rx turnaround time for a SL PRS transmission in a dedicated SL PRS resource pool.* * *The first symbol of SL PRS transmission is repeated to generate AGC symbol* * *In case of TDM based multiplexing of SL PRS transmission from different UEs, AGC and guard symbols are inserted between SL PRS transmissions.* |
| SONY [14] | *Proposal 1: Support SL-PRS frequency domain with comb structure. The legacy comb-N structure in legacy NR positioning can be used as the baseline.*  *Proposal 2: Support the time-gap prior to and after the SL-PRS transmission. The first and second gap are used for AGC and Rx/Tx retuning.*  *Proposal 4: SL-PRS bandwidth within a resource pool is reconfigurable up-to the maximum resource pool bandwidth.*  *Proposal 5: For TDM-based multiplexing, the SL-PRSs can be configured using comb-1 structure with comb size N= 1, M≥1.* |
| Panasonic [15] | *Proposal 9: SL-PRS repetition (if >2) may be either to reuse the DL fixed time-gap concept for simplicity, or to design a one-to-one or one-to-many chain reservation by using SCI.*  *Proposal 10: AGC symbol is necessary for SL-PRS.* |
| LGE [16] | ***Proposal 3:*** *For a dedicated resource pool, the comb sizes N={1, 8, 10} are additionally supported.*  ***Proposal 4:*** *For a dedicated resource pool, the fully staggered patterns (M,N)=(1,1), (6,6,), (8,8), (10,10) are additionally supported.*  ***Proposal 5:*** *For a dedicated resource pool, there is no constraints on the maximum effective comb size for partially staggered pattern. Any even numbers M less than N are supported, including:*   * *(M,6) with M={2,4}* * *(M,8) with M={2,4,6}* * *(M,10) with M={2,4,6,8}*   ***Proposal 6:*** *For a shared resource pool, the comb sizes N={6, 8} are additionally supported.*  ***Proposal 7:*** *For a shared resource pool, the fully staggered patterns (M,N)=(1,1), (6,6), (8,8) are additionally supported.*  ***Proposal 8:*** *For a shared resource pool, there is no constraints on the maximum effective comb size for partially staggered pattern. Any even numbers M less than N are supported, including:*   * *(M,6) with M={2,4}* * *(M,8) with M={2,4,6}*   ***Proposal 9:*** *For the fully staggered comb pattern, it is supported that SL PRS symbols can be repeated to fill a slot or a TDM duration, with the same order of the comb RE offset of the original SL PRS symbols.*  ***Proposal 10:*** *For the partially staggered comb pattern, it is supported that SL PRS symbols can be repeated to fill a slot or a TDM duration, with the following ways.*   * *Opt 1. Simple repetition of the partially staggered SL PRS* * *Opt 2. Expansion toward the fully staggered SL PRS and its repetition*   ***Proposal 12:*** *One AGC symbol is located before every SL PRS resource.*  ***Proposal 13:*** *One TX/RX turnaround symbol is located after every SL PRS resource.*  ***Proposal 14:*** *AGC symbol is filled with:*   * *Opt 1. the copy of the last SL PRS symbol* * *Opt 2. the last symbol of the fully-staggered comb pattern corresponding the comb size* |
| Xiaomi [17] | *Proposal 2: SL PRS transmission with number of OFDM symbols from 2 to 9 shall be supported.*  *Proposal 3: SL PRS transmission with flexible bandwidth is supported in both dedicated resource pool and shared resource pool*  *-- PRS subchannel is defined as the frequency domain resource allocation granularity*  *Proposal 4: For shared SL resource pool, SL PRS are not transmitted in the OFDM symbol(s) of PSSCH DMRS symbol.* |
| China Telecom [18] | *Proposal 2: Support both comb size 8 and 12 in a dedicated resource pool to accommodate more comb-based multiplexing of SL-PRS.*  *Proposal 3: Support repetition of the RE-offset in the SL-PRS pattern, e.g., the time domain consecutive symbol number M is larger than the frequency comb size N.* |
| Sharp [19] | **Proposal 5:** The SL-PRS pattern with (M,N)=(6,6) is supported.  **Proposal 7:** Regarding AGC training and TX/RX turnaround, one symbol is used for AGC training, and one symbol is used for RX/TX turnaround.  **Proposal 10:** With regards to the bandwidth of SL-PRS transmission, at least for a dedicated resource pool, adopt Alt. 1 (i.e. the bandwidth of SL-PRS can be same or smaller than that of the resource pool). |
| Samsung [20] | ***Proposal 3:*** *For SL PRS in shared and dedicated resource pools,*   * *SL PRS comb sizes N = {1,2,4,6,8,12} are supported.* * *SL PRS symbol lengths M = {1,2,4,6,8,12} are supported.* * *(M, N) pair can be configured flexibly from supported N and M values.*   ***Proposal 4:*** *The first sub-carrier location of SL PRS in each symbol becomes (X mod N = 0) where*   * *X=(reference sub-carrier location + value for comb offset + value for staggered pattern in symbol)* * *N=SL PRS comb size*   ***Proposal 5:*** *The bandwidth of SL PRS can be same or smaller than that of the resource pool.*  ***Proposal 6:*** *For shared resource pool(s) with SL communication, SL PRS is transmitted in the existing slot structure with the following principle as*   * *SL PRS can be transmitted in symbols for PSSCH.* * *SL PRS is not transmitted in symbols for 2nd SCI.* * *SL PRS is not transmitted in symbols for PSCCH* * *SL PRS is transmitted in consecutive symbols*   ***Proposal 7:*** *For dedicated resource pool(s) for SL-PRS, new PHY structure is considered for SL PRS transmission including at least*   * *One AGC symbol before first symbol, One GAP symbol after last symbol* * *PSCCH (contain the 1st stage SCI)* * *SL PRS symbols* * *PSSCH (only contain the 2nd stage SCI)* |
| CMCC [21] | *Proposal 9: A SL-PRS slot should at least consist of SL PRS and its associated PSCCH, and it includes:*   * *PSCCH occupies 2 or 3 symbols.* * *The 1st symbol of SL-PRS should be used as the AGC symbol, which is the duplication of the 2nd symbol of SL-PRS.* * *A GAP symbol for Rx-Tx turnaround is also required immediately after the last symbol of SL-PRS.*   *Proposal 10: For SL-PRS in shared and dedicated resource pools:*   * *Comb size 6 is supported in shared resource pool.* * *Comb size 1 is supported in dedicated resource pool.* * *Comb size 8 is supported.*   *Proposal 11: For SL PRS in shared and dedicated resource pools:*   * *At least a maximum effective comb size [6] can be supported.* * *SL PRS patterns with partial staggering are further supported for the following (M,N) pairs:*   + - *(M, 6) with M = {1, 2}*     - *(M, 4) with M = {1}*     - *(M, 8) with M = {2}*   *Proposal 12: RAN1 does not consider non-consecutive symbols SL-PRS for shared resource pool.* |
| Lenovo [22] | *Proposal 6: Support the following options of SL-PRS comb sizes (N) in the following cases:*   * *For a dedicated resource pool, support N = {1,8,12}* * *For a shared resource pool, support N= {6} and do not support N= {8,12}*   *Proposal 7: At least for a dedicated resource pool, support at least M=6 for a fully staggered SL-PRS, i.e. (M, N) = (6, 6). Additional M=8 may also be supported pending support of N=8 for a dedicated resource pool.*  *Proposal 8: RAN1 to further consider M>N SL-PRS fully staggered patterns, e.g., M= {10,11,12} depending on the maximum supported comb size, start symbol in a slot and slot structure configuration, e.g., number of AGC, PSCCH and Tx-Rx turnaround symbols.*  *Proposal 11: Mini-slot of various symbol length of SL-PRS e.g., 2, 4, and 6 can be further studied at least for dedicated resource pools. FFS the applicability to shared resource pools.*  *Proposal 12: In the case of a dedicated resource pool, the bandwidth of SL-PRS shall be the same as that of the resource pool.* |
| ZTE [23] | ***Proposal 3:*** *For SL PRS in shared or dedicated resource pools, with regards to the value N (comb size) and the number M of SL PRS symbols of a SL PRS resource within a slot excluding the symbol(s) used for AGC training / Rx-Tx Turnaround,*   * *Comb sizes (N) {1, 2, 4, 6, 8 ,12} are supported* * *The number of SL PRS symbols can be {1, 2, 3, 4, 6, 8, 12}*   + *One symbol SL PRS excluding the AGC-symbol and Gap symbol should be supported* * *SL PRS pattern with full staggering are supported*   + *(M, N) = (1, 1), (2, 2), (4, 4), (6, 6), (8, 8), FFS: (12, 12)* * *SL PRS pattern with partial staggering are supported*   + *(1, 2), (1, 4), (2, 4), (1, 6), (2, 6), (1, 8), (2, 8), (4, 8), (1, 12), (2, 12), (4, 12)* * *The detailed RE offset sequence for SL PRS can be:*  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | | **N:comb size** | **M: Number of symbols for SL PRS** | | | | | | | | 1 | 2 | 3 | 4 | 6 | 8 | 12 | | 1 | 0 | 0,0 | 0,0,0 | 0,0,0,0 | 0,0,0,0,0,0 | 0,0,0,0,0,0,0,0 | 0,0,0,0,0,0,0,0,0,0,0,0 | | 2 | 0 | 0,1 | - | 0,1,0,1 | 0,1,0,1,0,1 | 0,1,0,1,0,1,0,1 | 0,1,0,1,0,1,0,1,0,1,0,1 | | 4 | 0 | 0,2 | - | 0,2,1,3 | - | 0,2,1,3,0,2,1,3 | 0,2,1,3,0,2,1,3,0,2,1,3 | | 6 | 0 | 0,3 | - | - | 0,3,1,4,2,5 | - | 0,3,1,4,2,5,0,3,1,4,2,5 | | 8 | 0 | - | - | 0,4,2,6 | - | 0,4,2,6,1,5,3,7 | 0,4,2,6,1,5,3,7,0,4,2,6 | | 12 | 0 | 0,6 | - | 0,6,3,9 | - | - | 0,6,3,9,1,7,4,10,2,8,5,11 |   ***Proposal 4:*** *At least for the dedicated SL PRS resource pool, and assuming a SL PRS resource with contiguous symbols,*   * *With regards to AGC training*   + *One symbol preceding a SL PRS resource can be used*   + *AGC symbol is a duplication of the expected symbol next to the final symbol of fully/partially staggered SL PRS* * *With regards to Rx/Tx turnaround (gap symbol)*   + *One symbol after a SL PRS resource can be used*   ***Proposal 5:*** *For shared resource pool, with regards to SL PRS bandwidth configuration, down-select between the following two options:*   * *Option 1: SL PRS bandwidth is indicated in SCI;* * *Option 2: SL PRS bandwidth is up to higher layer configuration in a resource pool.* |
| CEWiT [24] | ***Proposal 2:*** *In shared resource pool, SL PRS with Comb size 6 should be supported.*  ***Proposal 3:*** *In dedicated resource pool, SL PRS with Comb size 1 should be supported.*  ***Proposal 4:*** *For SL PRS in shared and dedicated resource pools Full staggering with (M, N) = (6,6) is supported. The effective comb size for the SL PRS with partial staggering should be restricted to 4.*  ***Proposal 5:*** *For SL-PRS in shared and dedicated resource pool full staggering with M>N is supported for the following combination {2,1}, {4,1}, {4,2}, {6,1}, {6,2}, {8,2}, {8,4}.*  ***Proposal 6:*** *SL-PRS Frequency offsets are given in the following table.*   |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | | *SL-PRS symbols (M)*  *k-comb (N)* | *0* | *1* | *2* | *3* | *4* | *5* | *6* | *7* | | *1* | *0* | *0* | *0* | *0* | *0* | *0* | *0* | *0* | | *2* | *0* | *1* | *0* | *1* | *0* | *1* | *0* | *1* | | *4* | *0* | *2* | *1* | *3* | *0* | *2* | *1* | *3* | | *6* | *0* | *3* | *1* | *4* | *2* | *5* | *0* | *3* | |
| Fraunhofer [25] | *Observation 2: Splitting the SL-PRS into two parts with a gap between the two parts (fragmented spectrum) may allow a SL-PRS allocation also, if a contiguous set of sub-channels is not available and causes only a minor degradation of the performance.*  *Proposal 3: Consider non-contiguous frequency allocation of the SL-PRS according to the sub-channel structure of the SL resource pool.* |
| IDCC [26] | *Proposal 3: In a dedicated resource pool for SL-PRS, support one AGC symbol at the beginning of each sub-slot.*  *Proposal 4: In a dedicated resource pool for SL-PRS, support one GAP symbol at the end of each slot.*  *Proposal 5: One GAP symbol between two sub-slots in a slot is configurable in a dedicated resource pool for SL-PRS.* |
| Apple [27] | *Proposal 3: For supportable bandwidths, lower the minimum number of PRBs from 24 (as specified for DL-PRS) to enable support for UEs with smaller bandwidths.*  *Proposal 4: Based on the agreements made in RAN1 #112, the following comb sizes should be considered:*   * *For shared resource pools, given the limited # of slots with transmission of other channels, comb size 6 should not be supported.* * *For a dedicated resource pools, comb size 1 can be supported.* * *For a dedicated resource pool Comb size N = 8 and 12 can be supported. These sizes are not supported for the shared resource pool.*   *Proposal 5: Based on the agreements made in RAN1 #112, the following staggering patterns should be considered:*   * *For SL pattern with full staggering, (M,N) = (6,6) is supported* * *For SL PRS patterns with M>N should be supported with full staggering*   *Proposal 6: For shared resource pools, non-consecutive symbols should be allowed to enable the PRS avoid resources with higher priority signals e.g. DMRS.*  *Proposal 7: The end of the SL-PRS pattern should be a symbol with the same RE-offset as the first symbol, for phase-tracking purposes.*  *Proposal 8: A new AGC symbol should be placed in front of the SL-PRS symbol to allow for AGC training and for RxTx Turnaround.* |
| Ericsson [28] | [*Observation 1 Partially staggered comb patterns have a TOA range of at least 200m for comb 12, up to 1.5km for comb 2 with the largest SCS, which is well in range for the use cases in sidelink positioning.*](#_Toc131686646)  [*Observation 2 Large comb sizes with partial staggering are compatible with the use cases for sidelink PRS.*](#_Toc131686647)  [*Proposal 3 The existing comb sizes (e.g., 1,2,4,6,12) for DL PRS are supported for SL PRS.*](#_Toc131753064)  [*Proposal 4 Support partial staggering in SL-PRS with the following combinations (M,N) of M-symbols for comb N:*](#_Toc131753065)  [*a. 1 symbol SL PRS: {1,2}, {1,4}, {1,6}, {1,12},*](#_Toc131753066)  [*b. 2 symbols SL PRS: {2,2}, {2,4}, {2,6}, {2,12},*](#_Toc131753067)  [*c. 4 symbols SL PRS: {4,4}, {4,12},*](#_Toc131753068)  [*d. 6 symbols SL PRS: {6,6}*](#_Toc131753069)  [*e. 12 symbols SL PRS: {6,12}, {12,12},*](#_Toc131753070)  [*Proposal 5 For SL PRS patterns, reuse the SL PRS mapping equation, with the offset table updated as follow:*](#_Toc131753071)   |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | |  | *Symbol number within the downlink PRS resource* | | | | | | | | | | | | | *0* | *1* | *2* | *3* | *4* | *5* | *6* | *7* | *8* | *9* | *10* | *11* | | *2* | *0* | *1* | *0* | *1* | *0* | *1* | *0* | *1* | *0* | *1* | *0* | *1* | | *4* | *0* | *2* | *1* | *3* | *0* | *2* | *1* | *3* | *0* | *2* | *1* | *3* | | *6* | *0* | *3* | *~~1~~ 2* | *4* | *1 ~~2~~* | *5* | *0* | *3* | *~~1~~ 2* | *4* | *1 ~~2~~* | *5* | | *12* | *0* | *6* | *3* | *9* | *~~1~~ 2* | *7* | *4* | *10* | *1 ~~2~~* | *8* | *5* | *11* |   [*Proposal 6 Doppler or tracking is handled with multiple SL PRS resource instances, i.e., do not specify repeating patterns for SL PRS resources.*](#_Toc131753072)  [*Proposal 14 For the case of SL PRS TDMed in a SL slot, each SL PRS is assigned a separate AGC symbol.*](#_Toc131753087)  [*Proposal 16 The AGC symbol for SL PRS is placed in the first available symbol not occupied by PSCCH, before the SL PRS, and is a duplicate of the SL PRS first symbol.*](#_Toc131753089)  [*Proposal 17 Send an LS to RAN4 asking to study suitable guard time values to enable SL RTT within and across SL slots*](#_Toc131753090) |
| Qualcomm [29] | *Proposal 2: In the shared resource, the existing slot structure is reused for transmission with SL-PRS, including the AGC symbol, PSCCH, PSSCH, and the gap symbol.*  *Proposal 5: SL-PRS is mapped on contiguous symbols only and is not mapped on symbols with PSSCH DMRS, i.e. SL-PRS can only be mapped on one set of contiguous symbol either before, between, or after PSSCH DMRS.*  *Proposal 7: Comb-6 is not supported in the shared resource pool.*  *Proposal 8: Support SL-PRS transmission on 2, 4, 6, 9, and 10 symbols.*  *Proposal 9: Support SL PRS patterns with M > N with full staggering.*  *Proposal 10: SL-PRS reuses existing RE offset sequences from DL-PRS.*  *Proposal 11: A symbol for AGC training and a gap duration are included before and after transmissions containing SL-PRS, respectively.* |
| NEC [30] | *Proposal 1: At least for dedicated resource pool, the bandwidth of SL-PRS can be same or smaller than that of the resource pool.*  *Proposal 2: With respect to the number of SL-PRS symbols within a slot excluding the AGC and GP symbol(s), the candidate values M={1, 2, 4, 6, 8, 12} should be supported.*  *Proposal 5: An AGC/switching symbol before/after each separate SL-PRS in a slot should be supported, namely each separate SL-PRS should has corresponding AGC symbol and switching symbol respectively.* |
| MTK [32] | *Proposal 2-1: M (symbol number) > N (comb size) is not supported*  *Proposal 2-2: (M,N) = (6,6) is not supported*  *Proposal 2-3: Comb size 1 in dedicated resource pool is not supported*  *Proposal 2-7: Prefer to also support comb size 8, since SRS for positioning supports this comb size, and also comb size 2, 4 and 8 form the hierarchy*  *Proposal 2-8: Support comb-6 with 2 symbols to obtain an equivalent comb-3 structure*  *Proposal 2-9: SL-PRS is also applied with the RE offset sequence for the DL-PRS, and the SL-PRS has the own symbol number set different from that for DL-PRS*  *Proposal 4-1: If AGC symbol for SL-PRS is configured in the dedicated resource pool, the AGC symbol also transmits SL-PRS, and the corresponding RE offset is the same as that in the last symbol in a SL-PRS resource* |

***Summary of observations based on submitted contributions:***

* + 1. Comb sizes and offsets for SL PRS

***Summary of observations based on submitted contributions:***

* ***Supported comb sizes (values of N) in dedicated resource pools (2, 4, 6 already agreed; FFS: 1, 8, 12)***
  + *1:* 
    - *Yes: Nokia, OPPO, Spreadtrum, CATT, LGE, Samsung, CMCC, Lenovo, ZTE, CEWiT, Apple, Ericsson*
    - *No: MTK*
  + *8:*
    - *Yes: Nokia, OPPO, Intel, LGE, China Telecom, Samsung, CMCC, Lenovo, ZTE, Apple, MTK*
    - *No: CATT*
  + *10:* 
    - *Yes: LGE*
  + *12:*
    - *Yes: HW-HiSi (w/ partial staggering), vivo (w/ partial staggering), OPPO, Intel, China Telecom, Samsung, Lenovo, ZTE, Apple, Ericsson*
    - *No: Nokia, CATT*
* ***Supported comb sizes (values of N) in shared resource pools (1, 2, 4 already agreed; FFS: 6, 8, 12)***
  + *6:* 
    - *Yes: Nokia, vivo (w/ partial staggering), OPPO, Spreadtrum, CATT, LGE, Samsung, CMCC, Lenovo, ZTE,* *CEWiT, Ericsson*
    - *No: Apple, Qualcomm*
  + *8:*
    - *Yes: Nokia, OPPO, LGE, Samsung, CMCC, ZTE, MTK*
    - *No: CATT, Lenovo, Apple*
  + *12:*
    - *Yes: HW-HiSi (w/ partial staggering), vivo (w/ partial staggering), OPPO, Samsung, ZTE, Ericsson*
    - *No: Nokia, CATT, Lenovo, Apple*
  + *The primary concern expressed regarding the support of larger comb sizes, especially for shared resource pools, relate to potential challenges for Tx UE implementation of large power boosting values, e.g., relative to a symbol with PSSCH. Current PUSCH DMRS specifications expect a power boosting amount of 4.77 dB. For N = 6 and above, the power boosting amount may increase to 7.78 dB and beyond. In such a case, additional transient time may also be necessary for a Tx UE – this may require further inputs and confirmation from RAN4.*
    - *Alternatively, instead of aligning Tx power per symbol, Tx PSD may be aligned between a PSSCH and SL PRS transmission in shared resource pool, in which case, additional AGC symbol may be necessary, thereby reducing overall efficiency considering limited time domain resources in a slot for shared resource pools.*
* ***On RE offset sequence***
  + *Several companies indicate that for SL PRS, RE offset sequence should be defined as a function of SL PRS symbol index within a resource and not symbol index with respect to slot boundary. Accordingly, such a proposal is made below. Further details of RE offset sequence may be discussed once details of time domain mapping of SL PRS are clearer.*

### [High] FL1 Proposal 2.3.1-1

* *For SL PRS in dedicated resource pools, in addition to the already-agreed comb sizes (N) of 2, 4, 6, the following values are also supported:*
  + *N = 1, 8, 12*
  + *FFS: for one or both of N = 8, 12, whether they are limited to partially staggered patterns only.*

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| **Company** | **Comments** |
| CATT | We support N=1 and are OK with N=8, but we don’t think N=12 is really needed. If the majority want N=12, we can live with the proposal. |
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### [High] FL1 Proposal 2.3.1-2

* *For SL PRS in shared resource pools, in addition to the already-agreed comb sizes (N) of 1, 2, 4, larger values of N are NOT introduced.*

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| **Company** | **Comments** |
| CATT | Do not support.  We prefer to keep the same candidate values of N for dedicated RP and shared RP. |
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* + 1. Frequency domain characteristics of SL PRS

***Summary of observations based on submitted contributions:***

* ***SL PRS bandwidth in dedicated resource pools***
  + *Multiple companies propose that SL PRS bandwidth is same as resource pool bandwidth for dedicated resource pools. This is primarily motivated by performance considerations. Given a dedicated SL PRS resource pool, using the max available SL PRS bandwidth can be seen as critical to achieve good localization/ranging accuracy.*
    - *Supported by: HW-HiSi, OPPO, Intel, Lenovo,*
  + *On the other hand, several companies also propose consideration of flexible bandwidth allocation that may be smaller than resource pool bandwidth in dedicated resource pools.*
    - *Supported by: vivo, SONY, Xiaomi, Sharp, Samsung, NEC,*
  + *Given the limited number of clear preferences expressed in tdocs, further inputs and discussions would be necessary to resolve this issue.*
* ***SL PRS bandwidth in shared resource pools***
  + *Many companies propose that SL PRS BW can be smaller than resource pool BW.*
    - *Supported by: HW-HiSi, SONY, Xiaomi, Sharp, Samsung, ZTE, Futurewei*
  + *Some companies further propose that SL PRS BW is same as the BW indicated for PSSCH if/when PSSCH is present in a shared resource pool.*
    - *Supported by: vivo, CATT, Intel*
  + *Given the limited number of clear preferences in tdocs, further inputs and discussions would be necessary to resolve this issue.*
* ***Granularity of SL PRS allocation in frequency domain***
  + *One company (OPPO) proposes that minimum BW of SL PRS should be 20 MHz.*
  + *One company (Xiaomi) proposes that subchannels defined for a resource pool are used to define granularity of SL PRS resource allocation in frequency domain*
    - *Note: For R16 SL, subchannelSize can be {10,12,15,20,25,50, 75,100} PRBs*
  + *One company (Apple) proposes that SL PRS BW with smaller than 24 PRBs minimum BW and granularity smaller than 4 PRBs should be considered.*
    - *Note: For DL PRS, 24 PRBs is the minimum BW with granularity of 4 PRBs*
  + *In addition, one company (Fraunhofer) proposes to consider non-contiguous frequency allocation for SL PRS according to the subchannel structure of the SL resource pool in case of fragmented bandwidth.*
  + *This issue may be visited once further progress once the resource allocation aspects for SL PRS become clearer.*

### [High] FL1 Proposal 2.3.2-1

* *For dedicated resource pools, RAN1 to down-select between:*
  + *Alt 1: SL PRS bandwidth is same as resource pool bandwidth.*
  + *Alt 2: SL PRS bandwidth can be same as or smaller than resource pool bandwidth.*

*Please provide clear justifications in defense of your preference.*

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| **Company** | **Alt 1/Alt 2** | **Comments** |
| CATT | Alt 2. | This issue is also discussed in AI 9.5.1.3. We prefer to discuss this issue only in one AI. |
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### [High] FL1 Proposal 2.3.2-2

* *For shared resource pools, SL PRS bandwidth can be smaller than resource pool bandwidth and is same as the bandwidth indicated for PSSCH if/when PSSCH is present in a shared resource pool.*

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| **Company** | **Comments** | |
| CATT | Support.  This issue is also discussed in AI 9.5.1.3. We prefer to discuss this issue only in one AI. |
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* + 1. Time domain characteristics of SL PRS

***Summary of observations based on submitted contributions:***

* ***On supported values of number of symbols (values of M) for SL PRS in dedicated and shared resource pools****,* 
  + *Views are divergent and summarized as below (From RAN1 #112, already-agreed values of M include: {1, 2, 4}):*
    - *M can be flexibly set from one of {1, 2, 4, 6, 8}, and additional values of M from within {1, …, 8} may also be supported depending on further progress on resource allocation and SL-PRS multiplexing: Nokia*
    - *M can be flexibly set from one of {1, 2, …, 9}: HW-HiSi*
    - *M can be flexibly set from one of {1,2,4,6,8,12}: Samsung*
    - *M can be flexibly set from one of {1, 2, 3, 4, 6, 8, 12}: ZTE*
    - *M can be flexibly set from one of {2, 4, 6, 9, 10}: Qualcomm*
    - *M can be flexibly set from one of {1, 2, 4, 6, 8, 12}: NEC*
    - *For partially staggered patterns, M can be flexibly set as even-number less than N: LGE*
    - *It should be noted that there are couplings between supported values of M with the decisions on support of M > N for fully staggered patterns and on support of fully staggered patterns like (6,6), etc.*
    - *Considering the above, it is suggested that the group aims to progress on those aspects first before revisiting supported values of ‘M’.*
* ***On SL PRS mapping to contiguous/non-contiguous-in-time symbols in shared resource pools***
  + *SL PRS may be mapped to contiguous-in-time symbols only: CATT, Intel, Samsung, CMCC, Qualcomm.*
  + *SL PRS may be mapped to non-contiguous-in-time symbols: OPPO, Apple.*
  + *Given the limited number of clear preferences in tdocs, further inputs and discussions would be necessary to resolve this issue. Accordingly, the following proposal is made.*

### [High] FL1 Proposal 2.3.3-1

* *For shared resource pools, RAN1 to down-select between:*
  + *Alt 1: SL PRS may be mapped to contiguous-in-time symbols only.*
  + *Alt 2: SL PRS may be mapped to non-contiguous-in-time symbols.*

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| **Company** | **Alt 1/Alt 2** | **Comments** |
| CATT | Alt 1 |  |
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* + 1. SL PRS patterns

***Summary of observations based on submitted contributions:***

* ***On support of fully staggered patterns (already-agreed (M, N) = (1,1), (2, 2), (4, 4))***
  + *Support of (M, N) = (6, 6)*
    - *Yes: Nokia, Spreadtrum, CATT, LGE, Lenovo (at least for dedicated resource pool), Sharp, Apple, Samsung, Ericsson*
    - *No: MTK*
  + *Support of (M, N) = (8, 8)*
    - *Yes: Nokia, LGE, Lenovo (at least for dedicated resource pool), ZTE, Samsung*
  + *Support of (M, N) = (10, 10)*
    - *Yes: LGE, Lenovo (FFS)*
  + *Support of (M, N) = (12, 12)*
    - *Although some companies have proposed this option, it may be better to revisit this once further clarity is achieved on multiplexing of SL PRS with other signals/channels in a slot.*
* ***Support of partial staggering and effective comb sizes***
  + *Multiple companies have expressed their preferences on particular choices of (M, N) pairs for partially staggered patterns. However, it is suggested to first address the question of whether there should be a limit on the effective comb size (post-de-staggering) and if so, the corresponding value.*
  + *Companies’ views on max effective comb size for partially staggered patterns are rather divergent and further discussions would be needed.*
    - *Max effective comb size = 2*
      * *Supported by: Intel*
    - *Max effective comb size = 3*
      * *Supported by: HW-HiSi, MTK*
    - *Max effective comb size = 4*
      * *Supported by: CEWiT*
    - *Max effective comb size = 6*
      * *Supported by: CMCC*
    - *No explicit limit*
      * *Supported by: LGE, Ericsson*
    - *Given the limited number of clear preferences in tdocs, further inputs and discussions would be necessary to resolve this issue.*
* ***On support of (M, N) patterns with M > N***
  + *Support of (M, N) patterns with M > N with full staggering*
    - *Supported by: HW-HiSi, China Telecom, OPPO, Intel (with M = N and is a positive integer), LGE, [Lenovo], Qualcomm,*
    - *Not supported by: Ericsson, MTK*
  + *Support of (M, N) patterns with M > N with partial staggering*
    - *Options to extend beyond N symbols include:*
      * *(1) Simple repetition of the partially staggered SL PRS*
      * *(2) Expansion toward the fully staggered SL PRS and its repetition*
    - *Supported by: LGE*
    - *Not supported by: Ericsson, MTK*
* ***On support of SL PRS repetitions*** 
  + *Depending on the design of patterns with M>N with full and partial staggering and on decision regarding mapping of a SL PRS resource of M symbols to contiguous vs. non-contiguous symbols, the design of SL PRS repetitions may either be supplementary or redundant.*
  + *Thus, it is recommended to visit potential options for SL PRS repetitions once progress is made on support of (M, N) with M > N.*
* ***Repetition of first symbol of SL PRS as the last symbol of a SL PRS resource***
  + *Supported by: HW-HiSi, Futurewei, Apple*
  + *May be realized by M>N patterns per (pre-)configuration: OPPO*
  + *Not supported by: Ericsson (“Doppler or tracking is handled with multiple SL PRS resource instances”)*

### [High] FL1 Proposal 2.3.4-1

* *At least for dedicated SL PRS resource pools, in addition to already-agreed (M, N) = (1,1), (2, 2), (4, 4), fully staggered patterns with (M, N) = (6, 6) are supported.* 
  + *FFS: (M, N) = (8, 8), (10, 10), (12, 12).*
  + *FFS: Applicability to shared resource pools.*

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| **Company** | **Comments** |
| CATT | Support.  We think this issue is related to the candidate values of M and N.  We had better firstly to determine the candidate values of M and N, then to discuss the fully staggered patterns. |
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### [High] FL1 Proposal 2.3.4-2

* *For partially staggered patterns, the max effective comb size is determined based on down-selection from the following alternatives:*
  + *Alt 1: Max effective comb size = 2*
  + *Alt 2: Max effective comb size = 3*
  + *Alt 3: Max effective comb size = 4*
  + *Alt 4: Max effective comb size = 6*
  + *Alt 5: No explicit limit*

*Please provide clear justification for your preference considering detection accuracy for target positioning ranges and other factors.*

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| **Company** | **Alt 1/Alt 2** | **Comments** |
| CATT | Alt 5 | There is no need to set such limitation. |
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### [Medium] FL1 Proposal 2.3.4-3

* *(M, N) patterns with M > N with full staggering are supported.* 
  + *FFS: Any additional constraints (e.g., M = k\*N, with k a positive integer).*

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| **Company** | **Comments** |
| CATT | Support. |
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### [Medium] FL1 Proposal 2.3.4-4

* *Regarding (M, N) patterns with M > N with partial staggering, the following options are considered further:* 
  + *Option 1: (M, N) patterns with M > N with partial staggering is realized by repetition of the partially staggered SL PRS*
  + *Option 2: (M, N) patterns with M > N with partial staggering is realized by expansion toward the fully staggered SL PRS and its repetition*
  + *Option 3: (M, N) patterns with M > N with partial staggering is not supported*

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| **Company** | **Option 1/2/3** | **Comments** |
| CATT | Option 1 | It is the UE implementation issue. UE can realize it by repetition of the partially staggered SL PRS. |
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**[Low] FL1 Proposal 2.3.4-5**

* *Repetition of the RE-offset of the first SL-PRS symbol in the last SL-PRS symbol to further facilitate phase-tracking/Doppler estimation (to be down-selected from amongst the following):*
  + *Alt A: is explicitly supported for all (M, N) SL PRS patterns*
  + *Alt B: may be realized based on proper SL PRS resource configuration (e.g., with proper choice of M>N) and/or may be realized using repetitions of SL PRS resources (if supported)*
  + *Alt C: is not supported.*

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| **Company** | **Option 1/2/3** | **Comments** |
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* + 1. AGC and gap symbols

***Summary of observations based on submitted contributions:***

* *Most companies acknowledge the need for an AGC symbol prior to a SL PRS and a gap symbol for Tx-Rx switching following a SL PRS.*
* *However, depending on details of slot configuration and multiplexing with other SL channels/signals, there may be cases when each SL PRS resource (comprising of M symbols) is not followed by a gap symbol.*
* *For the generation of AGC symbol, the following options have been proposed:*
  + *The first symbol of SL PRS is repeated to realize an AGC symbol*
    - *Majority preference*
  + *Copy of last symbol of a SL PRS resource is used to realize an AGC symbol. This is motivated by the observation that if a Rx UE is able to settle its AGC within a fraction of the AGC symbol (ideally within CP), it can be used for phase-tracking/Doppler estimation.*
    - *Supported by: LGE, MTK*
  + *Last symbol of corresponding fully-staggered pattern (in case of partially staggered SL PRS resource) is used to realize an AGC symbol. This is motivated by the observation that if a Rx UE is able to settle its AGC within a fraction of the AGC symbol (ideally within CP), it can be used for better estimation of the channel post-de-staggering.*
    - *Supported by: LGE*
  + *AGC symbol is a duplication of the expected symbol next to the final symbol of fully/partially staggered SL PRS. This can be seen as a generalization of the above option that may be applicable to both partial and full staggering.*
    - *Supported by: ZTE*

In the following, the case of dedicated resource pool is suggested for consideration first. However, it is acknowledged that there may be exceptions to the presence of AGC and gap symbols and such cases can be discussed as a next step.

The case involving shared resource pools may require further considerations on details of multiplexing with other signals/channels.

### [High] FL1 Proposal 2.3.5-1

* *An AGC symbol preceding a SL PRS resource is not considered as part of the SL PRS resource itself.*

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| **Company** | **Comments** | |
| CATT | Support. | |
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### [High] FL1 Proposal 2.3.5-2

* *At least in a dedicated resource pool, a SL PRS resource is preceded by an AGC symbol at least when the SL PRS resource is not preceded by another SL PRS resource within the same slot.*
  + *FFS: How the AGC symbol is created*
  + *FFS: Cases involving TDM-ed SL PRS resources within a slot*
  + *FFS: Other exceptions, if any*
* *FFS: for SL PRS resource in a shared resource pool.*

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| **Company** | **Comments** |
| CATT | Do not support.  If a SL PRS resource is not preceded by another SL PRS resource but is preceded by a PSCCH , and the PSCCH is preceded by an AGC symbol within the same slot, maybe the SL PRS resource is not needed to be preceded by another AGC symbol. |
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### [High] FL1 Proposal 2.3.5-3

* *At least in a dedicated resource pool, a SL PRS resource is followed by a gap symbol at least when the SL PRS resource is not followed by another SL PRS resource within the same slot.*
  + *FFS: Cases involving TDM-ed SL PRS resources within a slot*
  + *FFS: Other exceptions, if any*
* *FFS: for SL PRS resource in a shared resource pool.*

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| **Company** | **Comments** |
| CATT | Do not support.  If a SL PRS resource is not followed by another SL PRS resource but is followed by a PSFCH(maybe will be introduced due to IUC for SL-PRS) , and the PSFCH is followed by an gap symbol within the same slot, maybe the SL PRS resource is not needed to be followed by another gap symbol. |
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* 1. Multiplexing of different SL PRS resources

**Background:**

The following was agreed during RAN1 #112 meeting.

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| **Agreement**   * Comb-based multiplexing of SL PRS from different UEs in a slot is supported at least for dedicated resource pools.   + FFS: Comb-based multiplexing of SL PRS from different UEs in a slot for shared resource pools. * For comb-based multiplexing of SL PRS from different UEs, support at least the case wherein a single (M,N) value is possible .   + FFS: Whether to support comb-based multiplexing of SL PRS from different UEs in a slot using multiple (M,N) values. * FFS: additional restrictions (if any) due to e.g. the impact of synchronization and IBE interference between UEs   **Agreement**  TDM-based multiplexing of SL PRS from different UEs in a slot is supported at least for dedicated resource pools.   * FFS: TDM-based multiplexing of SL PRS from different UEs in a slot for shared resource pools. * FFS: Details, including resource granularity and relationship to SCI/PSCCH associated with the SL PRS resources, additional AGC symbols. * FFS: restrictions for the configuration of TDM-based multiplexing of SL PRS from different UEs in a slot, if any * FFS: which resource allocation schemes are applicable * FFS: whether or not this is a separate UE capability |

Some key aspects to aim for progress during RAN1 #112bis-e meeting include:

* Support of comb-based multiplexing of different SL PRS resources in a shared resource pool
* Support of TDM-based multiplexing of different SL PRS resources within a slot in a shared resource pool
* Support of TDM-ed SL PRS resources within a slot from a single UE in a dedicated/shared resource pool
* Support of comb-based multiplexing of SL PRS from different UEs in a slot using multiple (M,N) values
* Support of FDM-based multiplexing of different SL PRS resources in a dedicated or shared resource pool
* For TDM-ed SL PRS resources within a slot in a dedicated resource pool, details, including resource granularity and relationship to SCI/PSCCH associated with the SL PRS resources, additional AGC symbols

Inputs from submitted contributions.

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| **Reference** | **Views** |
| Nokia [4] | *Proposal 4: To enable backward compatibility in terms of slot design for a shared resource pool, SL PRS can be transmitted via one or more of the following:*   * *In PSSCH, e.g., if accompanying positioning meta-data will be sent in the same slot* * *In PSFCH symbol, using remaining resources from legacy SL transmissions, depending on the size of SL PRS* * *In a new “mini-slot” occupying the last symbols of a legacy slot, which contains dedicated symbol(s) for SL PRS, accompanied with AGC and guard symbols.*   *Proposal 9: Support code-domain multiplexing of SL PRS transmissions.* |
| Continental Automotive [7] | *Observation 1: With comb-based multiplexing of SL PRS, UEs in the same RP may transmit SL PRSs using the same comb size and RE-offset values, leading to potential interference in SL PRS transmissions and performance degradation. This necessitates some form of coordination between UEs on selection of these parameters.* |
| vivo [8] | * *Not support comb-based multiplexing of SL PRS from different UEs in a slot for shared resource pools.* * *Not support TDM-based multiplexing of SL PRS from different UEs in a slot for shared resource pool.* |
| OPPO [9] | [*Proposal 12: TDM-based multiplexing of SL PRS from different UEs in a slot is NOT supported for shared resource pools.*](#_Toc131693945)  [*Proposal 16: When TDM-based multiplexing of SL PRS from different UEs in a slot is supported, both Scheme 1 and Scheme 2 are applicable, but one UE can only use/reserve one and the same one SL PRS time resource in a slot.*](#_Toc131693949)  [*Proposal 17: TDM-based multiplexing of SL PRS from different UEs in a slot is NOT a separate UE capability.*](#_Toc131693950)  [*Proposal 18: For comb-based multiplexing of SL PRS from different UEs, different DMRS OCC is used for PSCCH associated with different SL PRS.*](#_Toc131693951) |
| Toyota [10] | *Observation 1: Comb-based multiplexing of SL-PRS from different UEs create a near-far problem due to IBE interference among UEs transmitting SL-PRS in the same slot.*  *Observation 2: Comb-based multiplexing of SL-PRS from different UEs in SPS or periodic scheduling create persistent IBE interference issues.*  *Observation 3: Although the comb size 1 mitigates the IBE issue as there is only one UE involved, it reduces the number of multiplexed UEs.*  *Proposal 1: RAN1 to design the comb-based SL-PRS multiplexing solution so that it mitigates the associated short-term IBE interference within the slot.*  *Proposal 2: RAN1 to design the comb-based SL-PRS multiplexing solution for periodic/semi-persistent SL-PRS transmissions so that it mitigates the associated persistent IBE interference in multiple consecutive SL PRS transmissions.*  *Proposal 3: To mitigate the short-term and persistent IBE interference issues, the Tx UE applies a frequency RE separation for the SL-PRS resource sets. This frequency RE separation can be provided by (pre-)configuration.*  *Proposal 4: To mitigate the persistent IBE interference issue, the Tx UE changes SL-PRS resource set every SL-PRS transmission in SPS or periodic scheduling, where a frequency RE separation is applied to SL-PRS resource sets. Collision of SL-PRS resource sets among different Tx UEs can be avoided based on resource reservation and resource (re-)selection with the granularity of the SL-PRS resource set and slot.* |
| Spreadtrum [11] | *Proposal 5: TDM-based multiplexing and Comb-based multiplexing of SL PRS from different UEs in a slot for shared resource pools cannot be supported.*  *Proposal 6: Comb-based multiplexing of SL PRS from different UEs in a slot using multiple (M,N) values can be considered.* |
| CATT, GOHIGH [12] | *Proposal 3: Comb-based multiplexing of SL-PRS from different UEs in a slot is not supported for shared resource pools.*  *Proposal 4: For comb-based multiplexing of SL-PRS from different UEs in a slot, support using multiple (M,N) values for dedicated resource pools.*  *Proposal 18: To reduce resource fragmentation, TDM-based multiplexing of SL PRS from different UEs in a slot should have the same bandwidth and frequency resource location.* |
| Intel [13] | *Proposal 5*   * *For shared resource pool* * *Comb and TDM based multiplexing of SL PRS transmission from different UEs in a slot are not supported.*   *Proposal 6*   * *For dedicated resource pool* * *FDM based multiplexing of SL PRS transmission from different UEs in a slot is not supported.* * *In case of comb-based multiplexing, only a single (M, N) pair is supported.* * *In case of TDM based multiplexing, more than one (M, N) pair can be supported.* |
| SONY [14] | [*Proposal 6: Support a separate UE’s capability on processing TDM SL-PRS and FDM SL-PRS.*](#_Toc131689093) |
| Panasonic [15] | [*Proposal 5: Proper multiplexing with different frequency offset or time offset should be designed to avoid potential over-the-air collisions from different SL UEs*](#_Toc131521785) |
| LGE [16] | *Proposal 15: The candidate positions of SL PRS resource in a slot are determined based on the number of symbols of SL PRS resource.*  *Proposal 16: The start positions of SL PRS resources that are TDMed within a slot are aligned between UEs.* |
| Xiaomi [17] | *Proposal 5: The comb size, starting symbol(s) in a slot and number of symbols for a SL PRS transmission is (pre)configured in a SL PRS dedicated resource pool.*  *- The number of starting symbol(s) is (pre)configured in a SL PRS dedicated resource pool.* |
| China Telecom [18] | *Proposal 4: For shared resource pool, TDM multiplexing in slots where PSSCH exist is not supported.*  *Proposal 5: At least scheme 1 (Network-centric operation SL-PRS resource allocation) can be supported for TDMed SL PRS allocation of different UEs for dedicated resource pools.* |
| Samsung [20] | *Proposal 8: For comb-based multiplexing of SL PRS from different UEs,*   * *Supported only in dedicated resource pool.* * *Only single (M,N) value is supported .* |
| CMCC [21] | *Observation 5: For TDM-based multiplexing of SL PRS resources from different UEs within a slot, introducing AGC symbols at the beginning of each SL PRS resource to solve the reception power variation on different symbols and corresponding UE capability to perform sub-slot level AGC has been supported in NR sidelink.*  *Observation 6: For TDM-based multiplexing of SL PRS resources from different UEs within a slot, the solution to locate PSCCH and its associated SL PRS resource from a UE together within a slot to solve the reception power variation on different symbols and corresponding UE capability to perform sub-slot level PSCCH blind detection has not been supported in NR sidelink.*  *Proposal 13: For comb-based multiplexing of SL PRS from different UEs in a slot, only support a single (M,N) value.*  *Proposal 14: For the TDM-based multiplexing of SL PRS resources from different UEs within a slot, the following two alternatives should be considered to solve the potential reception power variation on different symbols:*   * *Alt. 1: The PSCCH of associated SL PRS resources from different UEs are located at the first 2 or 3 symbols within the SL PRS slot. For each SL PRS resource, the 1st symbol is used as the AGC symbol which is the duplication of the 2nd symbol.* * *Alt. 2: The PSCCH of its own associated SL PRS resource are located together within the SL PRS slot.*    + - *FFS details on PSCCH power control to maintain same Tx power of symbols carrying PSCCH and that carrying its associated SL PRS resource.*     - *UE capability of sub-slot level PSCCH blind detection should be further enhanced.*   *Proposal 15: Considering TDM-based multiplexing of SL PRS from different UEs for resource allocation Scheme 1 as 1st priority and for resource allocation Scheme 2 as 2nd priority.* |
| Lenovo [22] | *Proposal 9: Restrict comb-based UE multiplexing to only the dedicated SL-PRS resource pool.*  *Proposal 10: Support different (multiple) SL-PRS comb (M, N) pairs for comb-based UE multiplexing in a slot together with any associated restrictions, e.g., avoid overlapping SL-PRS REs, where applicable.* |
| ZTE [23] | *Proposal 6: Comb-based multiplexing of SL PRS from different UEs in a slot for shared resource pools is not supported.*  *Proposal 7: For comb-based multiplexing of SL PRS from different UEs in a slot, with regards to the (M, N) value:*   * *Support using the same M value and flexibly configured N values.*   *Proposal 8: For TDM-based multiplexing of SL PRS from different UEs in a slot,*   * *Only supported in dedicated resource pool, not supported in shared resource from resource utilization perspective* * *Additional AGC symbol is needed preceding each SL PRS resource* |
| Fraunhofer [25] | *Proposal 2: Support multiplexing of SL PRS from different UEs over the same OFDM symbols in a slot with a cyclic shift configuration for the SL-PRS.* |
| Apple [27] | *Proposal 9: For SL-PRS multiplexing,*   * *For shared resource pools, TDM and comb-based multiplexing of SL PRS from different UEs in a slot should not be supported due to the need for addressing separate multiple UE pairs.* * *Comb-based multiplexing of SL PRS from different UEs in a slot using multiple (M,N) values can be supported if there are no synchronization and IBE interference issues.* |
| Ericsson [28] | [*Proposal 8 Configuration of comb based multiplexing in the shared pool is supported.*](#_Toc131753075)  [*a. The listening UE expect identical SCIs from each transmitting UE, in the same subchannel.*](#_Toc131753076)  [*b. SL PRS resource information is carried in higher layers, not in SCI*](#_Toc131753077)  [*c. FFS: Impact on power control*](#_Toc131753078)  [*Proposal 14 For the case of SL PRS TDMed in a SL slot, each SL PRS is assigned a separate AGC symbol.*](#_Toc131753087)  [*Proposal 15 Study further the location of PSCCH in the slot for multiple TDMed SL PRS*](#_Toc131753088)  [*Proposal 16 The AGC symbol for SL PRS is placed in the first available symbol not occupied by PSCCH, before the SL PRS, and is a duplicate of the SL PRS first symbol.*](#_Toc131753089)  [*Proposal 17 Send an LS to RAN4 asking to study suitable guard time values to enable SL RTT within and across SL slots*](#_Toc131753090) |
| Qualcomm [29] | *Proposal 3: In a shared resource pool, different UEs are not allowed to multiplex SL-PRS on different comb offsets in the same OFDM symbol.*  *Proposal 4: In a shared resource pool, TDM-based multiplexing of SL-PRS in a slot is not supported.* |
| NEC [30] | *Proposal 3: TDM-based multiplexing of SL PRS from different UEs in a slot should be supported for shared resource pool.*  *Proposal 4: Whether one or multiple SL PRS and associated SCI in a slot can be transmitted without SL data in shared resource pool should be studied.* |
| MTK [32] | *Proposal 2-4: It could be feasible within a slot under TDM based multiplexing that, a single (M,N) value is used for a set of symbols, and another (M,N) value could be used for another set of symbols. The two sets of symbols don't overlap with each other*  *Proposal 2-5: It is also feasible within a slot that a single (M,N) value applies*  *Proposal 2-6: For SL-PRS transmission within the shared resource pool, both the comb based and TDM based multiplexing are not supported* |

***Summary of observations based on submitted contributions:***

**On multiplexing of different SL PRS resources**

* *Support of comb-based multiplexing of different SL PRS resources in a shared resource pool*
  + *Yes: Ericsson* ***(1)***
  + *No: vivo, OPPO, Spreadtrum, CATT, Intel, Samsung, ZTE, Apple, Qualcomm, MTK* ***(10)***
* *Support of TDM-based multiplexing of different SL PRS resources within a slot in a shared resource pool*
  + *Yes:*
  + *No: vivo, Spreadtrum, Intel, China Telecom, ZTE, Apple, Qualcomm, MTK, CATT* ***(9)***
* *Support of TDM-ed SL PRS resources within a slot from a single UE in a dedicated/shared resource pool is proposed by one company (LGE).*
* *Support of comb-based multiplexing of SL PRS from different UEs in a slot using multiple (M,N) values within a slot in a dedicated resource pool (note: for shared resource pool, it can be discussed if comb-based multiplexing in shared resource pool is agreed)*
  + *Yes: CATT, Spreadtrum, Lenovo, ZTE, Intel, MTK*
    - *Only for same M and different N values: ZTE*
    - *Only when the different (M, N) pairs are TDM-ed within a slot: Intel, MTK*
  + *No: Samsung, CMCC*
* *One company (SONY) proposes separate UE capability for FDM-based multiplexing of SL PRS from different UEs within a slot while another (Intel) proposes to preclude FDM-based multiplexing of SL PRS from different UEs.*
* *In addition, code-domain multiplexing is proposed by two companies (Nokia, Fraunhofer).*
* *For TDM-ed SL PRS resources within a slot in a dedicated resource pool, details, including resource granularity and relationship to SCI/PSCCH associated with the SL PRS resources, additional AGC symbols*
  + *Resource granularity:* 
    - *For efficient multiplexing of multiple SL PRS from different UEs within a slot without complicating issues with AGC, two companies (Intel, LGE) proposed that, for TDM-based multiplexing within a slot, the granularity of time domain resource allocation for SL PRS is based on SL PRS resource, which is equivalent to the candidate positions of SL PRS resource in a slot are determined based on the number of symbols of SL PRS resource.*
    - *Two companies (LGE, Xiaomi) proposed that starting symbols for SL PRS resources that may be TDM-ed within a slot are aligned across UEs/at the resource pool-level to better align AGC and gap symbols.*
  + *Additional AGC symbols:*
    - *Some companies have shared their views on AGC symbols for TDM-ed SL PRS resources within a slot, some of which are included in Section 2.3.5. It may be better to take up on this once progress is made on AGC and gap symbols for single SL PRS resource case (in Section 2.3.5).*
  + *Relationship to SCI/PSCCH associated with SL PRS resources*
    - *Some companies have shared their views on potential restrictions and multiplexing options for PSCCH associated with SL PRS that are multiplexed via TDM within a slot in a dedicated resource pool. It may be more efficient to discuss these during latter half of this meeting, with likely some progress in AI 9.5.1.3 on multiplexing of PSCCH and SL PRS in the meantime.*

### [High] FL1 Proposal 2.4-1

* *Comb-based multiplexing of SL PRS resources from different UEs in a slot is NOT supported for shared resource pools.*
* *For comb-based multiplexing of SL PRS from different UEs in a dedicated resource pool, at least the case wherein a single (M, N) value is configured in a resource pool is supported.*

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| **Company** | **Comments** |
| CATT | Support the first bullet.  For the second bullet, it seems that the majority support the comb-based multiplexing of SL PRS from different UEs in a slot **using multiple (M,N) values** within a slot in a dedicated resource pool, so we prefer the following revision for the second bullet:   * *For comb-based multiplexing of SL PRS from different UEs in a dedicated resource pool, ~~at least the case wherein~~ multiple~~a single~~ (M, N) values are~~is~~ configured in a resource pool is supported.* |
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### [High] FL1 Proposal 2.4-2

* *TDM-based multiplexing of SL PRS from different UEs in a slot is NOT supported for shared resource pools.*

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| **Company** | **Comments** |
| CATT | Support. |
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### [Medium] FL1 Question 2.4-3

* *TDM-ed SL PRS resources within a slot from a single UE in a dedicated/shared resource pool is:*
  + *Alt A: Supported*
  + *Alt B: Not supported*

*Please share your views with justification.*

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| **Company** | **Alt A/B** | **Comments** |
| CATT | Alt A |  |
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### [Medium] FL1 Proposal 2.4-4

* *On comb-based multiplexing of SL PRS from different UEs in a slot using multiple (M,N) values within a slot in a dedicated resource pool, down-select between:*
  + *Alt A1: Supported without any restrictions*
  + *Alt A2: Supported for same M values and different N values. For different M values, only when the different (M, N) pairs are multiplexed via TDM within a slot.* 
    - *FFS: Potential restrictions on possible N values for a given M.*
  + *Alt B: Not supported*

*Please share your views with justification.*

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| **Company** | **Alt A/B** | **Comments** |
| CATT | Alt A2 |  |
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### [Medium] FL1 Proposal 2.4-5

* *FDM-based multiplexing of SL PRS from different UEs in a slot is NOT supported for dedicated/shared resource pools.*

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| **Company** | **Comments** |
| CATT | Do not support.  If the two SL PRS resources occupy different sub-channels in the same resource pool, it is possible to FDMed multiplexing them and they are indicated with different SCIs, for both the dedicated RP and shared RP. |
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### [Medium] FL1 Proposal 2.4-6

* *For TDM-ed SL PRS resources within a slot in a dedicated resource pool,* 
  + *the granularity of time domain resource allocation for SL PRS is based on the number of symbols of SL PRS resource, and*
  + *starting symbols for SL PRS resources that may be TDM-ed within a slot are aligned across UEs at the resource pool-level*

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| **Company** | **Comments** |
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1. Transmit power control for SL PRS

**Background:** The following decisions were made during the SI phase.

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| **Agreement**  Study power control mechanisms for SL-PRS transmission, including whether it is necessary.  **Agreement**  With regards to the power control for SL-PRS at least Open Loop PC should be introduced. |

Subsequently, as quoted in the Introduction section, it was agreed to specify procedures for transmit power control for SL PRS transmissions at least based on open loop power control (OLPC).

During RAN1 #112 meeting, the following was agreed.

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| **Agreement**  The OLPC framework defined for PSSCH/PSCCH is considered as a starting point for OLPC for SL PRS. |

Some key aspects to aim for progress during RAN1 #112bis-e meeting include:

* Consideration of DL and/or SL pathloss for SL PRS TPC determination
* Pathloss reference for SL pathloss determination
* Relationship between TPC for SL PRS and PSSCH in shared resource pool
* Relationship between TPC for SL PRS and PSCCH in dedicated resource pool
* Reporting of L3 filtered RSRP for SL OLPC.

Inputs from submitted contributions to RAN1 #112bis-e.

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| **Reference** | **Views** |
| Nokia [4] | *Proposal 10: Discuss whether power control for the purpose of congestion control should be applied to SL-PRS.*  *Proposal 11: Study closed loop power control for SL-PRS in unicast.*  *Proposal 12: For OLPC introduce at least S-SSB and SL PRS as pathloss reference signal. FFS: DL PRS for in-coverage or partial coverage.*  *Proposal 13: For OLPC, support transmitting UE indicating the power difference of SL PRS transmissions across SL PRS resource or SL PRS resource sets (if introduced).* |
| Futurewei [5] | *Proposal 10: Support the received power measurements SL-PRS RSRP for the estimation of the UE-to-UE pathloss.* |
| HW-HiSi [6] | *Proposal 13: Support to use SL-PRS as the pathloss reference signal for the power control mechanism based on SL for both dedicated resource pool and shared resource pool of Option 2 (SL-PRS without SL-SCH).*  *Proposal 14: For the power control of PSCCH and SL-PRS, two power control mechanisms can be considered:*   * *independent power control for PSCCH and SL-PRS with one AGC symbol ahead of PSCCH and one AGC symbol ahead of SL-PRS from the same transmitting UE,*   + *Consulting RAN4 on the impact of AGC performances for PSCCH and for SL-PRS.* * *keeping the same transmission power for the PSCCH symbol and for the SL-PRS symbol to avoid the potential transient period.* |
| vivo [8] | * *The minimum of SL pathloss and the DL pathloss should be applied in the power control of the SL-PRS.* * *The power of PSCCH should be equal to the power of the SL PRS when PSCCH and SL PRS are TDMed in a slot.* |
| OPPO [9] | [*Proposal 23: In SL positioning, SL PRS is at least subject to DL pathloss based power control.*](#_Toc131693956)  [*Proposal 24: For the proactively transmitted SL PRS, the transmission power should be upper bounded by the target coverage, and for the reactively transmitted SL PRS, SL pathloss based power control should also be applied.*](#_Toc131693957) |
| CATT, GOHIGH [12] | *Proposal 24: For SL-PRS open-loop power control in Rel-18:*   * *Both DL pathloss and SL pathloss should be considered as the compensated pathloss for the SL-PRS open-loop power control.*   *Proposal 25: A UE determines a power for a SL-PRS transmission on a resource pool in symbols where a corresponding PSCCH is not transmitted in PSCCH-SL-PRS transmission occasion on active SL BWP of carrier as:*  *[dBm]*  *where*  *- is defined in [TS 38.101-1];*  *- is determined based on measured CBR of SL-PRS, the details are FFS;*  *- if a new higher layer parameter dl-P0-SL-PRS -PSCCH is provided*  *- [dBm],*  *where, and are the parameters of SL-PRS fractional power control according to DL pathloss , is a number of resource blocks for PSCCH-SL-PRS transmission occasion and is a SCS configuration, the details are FFS;*  *- else*  *- [dBm]*  *- if a new higher layer parameter sl-P0-SL-PRS-PSCCH is provided and if a SCI format scheduling the SL-PRS transmission includes a cast type indicator field indicating unicast*  *- [dBm]*  *where, and are the parameters of SL-PRS fractional power control according to SL pathloss , is a number of resource blocks for PSCCH-SL-PRS transmission occasion and is a SCS configuration, the details are FFS;*  *- else*  *- [dBm]*  *Proposal 26: A UE determines a power for a PSCCH associated with the SL PRS transmission on a resource pool in PSCCH-PSSCH transmission occasion as*  *[dBm]*  *where*  *- is described in section 5.1.*  *- is a number of resource blocks for the PSCCH transmission associated with SL-PRS transmission in PSCCH-SL-PRS transmission occasion .*  *- is a number of resource blocks for PSCCH-SL-PRS transmission occasion i.* |
| Intel [13] | *Proposal 8*   * *For SL PRS transmissions in a dedicated resource pool, transmit power control mechanism follows the same open loop power control mechanism as defined for PSSCH.* * *For SL pathloss, higher layer filtered RSRP can be obtained based on SL PRS or PSCCH DMRS.*   *Proposal 9*   * *For SL PRS transmissions in a shared resource pool, SL PRS transmit power is determined based on that for PSSCH.* |
| LGE [16] | *Proposal 17: The following OLPC options for SL PRS transmission can be considered.*   * *OLPC based on DL pathloss* * *OLPC based on SL pathloss* * *OLPC based on both DL and SL pathloss*   *Proposal 18: SL PRS RSRP can be used for SL pathloss estimation.*  *Proposal 19: Both PSCCH and PSSCH DMRS RSRP can be used for SL pathloss estimation.*  *Proposal 20: Further study is needed for SL PRS power control when multiple SL PRS resources are transmitted simultaneously.*  *Proposal 21: Further study is needed whether EPRE or the total symbol power is same between PSCCH/PSSCH and SL PRS, if they are transmitted in a same slot.*  *Proposal 22: SL PRS power control for coexistence with SL communication in a shared resource pool needs to be investigated.* |
| Xiaomi [17] | *Proposal 7: For SL PRS transmission in a dedicated resource pool, both DL based and SL based open loop power control for SL PRS transmission are supported*  *- For SL based open loop power control, only unicast of SL PRS is supported*  *Proposal 8: the RSRP report used in SL based open loop power control is measurement obtained from SL PRS reception.*  *Proposal 9: For SL transmission in a shared resource pool, the transmission power of SL PRS follows the transmission power of the PSSCH to keep constant TX power in all the OFDM symbols.* |
| Samsung [20] | *Proposal 10: With regards to SL PRS power control, we propose the following characteristics:*   * *SL PRS and other SL channels/signals is not FDMed with each other.* * *Within a slot, a symbols have the same power, including symbols that carry SL PRS* * *Only OLPC is supported.* * *Both DL pathloss and SL pathloss are applied.* * *is based on PSSCH and/or SL PRS depending on whether SL PRS is multiplexed with PSSCH or not.* |
| CMCC [21] | *Proposal 16: Both DL pathloss-based and SL pathloss-based OLPC should be supported for SL-PRS.*  *Proposal 17: The transmit power of the PSCCH is determined based on its associated SL PRS. FFS details.* |
| Lenovo [22] | *Proposal 13: Support SL PRS open loop power control mechanisms based on SL and DL pathloss references and SL PRS or other RS RSRP reporting.*  *Proposal 14: Support power control parameter(s) sharing, e.g., SL RS/PRS transmit among UEs performing SL positioning.* |
| ZTE [23] | *Proposal 9: For SL PRS power control, a UE determines the SL PRS transmission power in SL PRS transmission occasion as:*  *[dBm]*  *Proposal 10: For a dedicated resource pool or a shared resource pool*   * *Dedicated resource pool: SL PRS is used as pathloss reference for OLPC.* * *Shared resource pool: SL PRS transmit power is the same as that for PSSCH if those two are transmitted in the same slot*   + *PSSCH DMRS is used as pathloss reference if PSSCH and SL PRS are transmitted in the same slot*   + *SL PRS can be used as pathloss reference only if PSSCH and SL PRS are not transmitted in the same slot*   *Proposal 11: Transmission power control for PSCCH which associated with SL PRS in dedicated resource pool is associated with SL PRS, support one of the following options:*   * *Option 1: PSCCH which associated with SL PRS applies the same Tx PSD as SL PRS* * *Option 2: Tx PSD of PSCCH which associated with SL PRS is equal to the sum of Tx PSD of SL PRS and an offset for more robust PSCCH transmission, i.e.* |
| Fraunhofer [25] | *Observation 3: For positioning application “many-to-many” scenarios requires a different power control strategy compared with one-to-many or many-to-one scenarios.*  *Proposal 5: Support enabling multiple SL reference signals from multiple UEs, to be used for determining the minimum transmit power for the SL-PRS transmissions to the multiple UEs and the maximum transmit power avoiding overload of nearby UEs.* |
| IDCC [26] | *Proposal 20: For OLPC, support Downlink pathloss for all cast types of SL-PRS.*  *Proposal 21: For OLPC, study whether sidelink pathloss is used for groupcast SL-PRS.*  *Proposal 22: For OLPC, support sidelink pathloss for unicast SL-PRS.*  *Proposal 23: For OLPC, study how to derive sidelink pathloss for unicast.*  *Proposal 24: Study power control of SL-PRS based on the feedback from the receiver UE.*  *Proposal 25: Study benefits of independent power control between PSCCH and PRS.* |
| Apple [27] | *Observation 1: SL PRS power control is necessary especially in in-coverage scenarios to prevent unnecessary co-channel interference in the network.*  *Proposal 10: OLPC for SL-PRS transmission can be designed based on the similar principles with the following options:*   * *Option 1: If the SL-PRS is transmitted in the same slot as the SL communication signals (shared resource pool), the OLPC parameters will depend ultimately on the shared resource pool design*   + *Option (1-a): If SL-PRS is time multiplexed with PSSCH/PSCCH in the PSSCH/PSCCH region of the slot, the OLPC parameters are the same in the symbols used for PSCCH/PSSCH transmissions in a slot*   + *Option (1-b): If SL-PRS is multiplexed with PSFCH (in the PSFCH region of the slot), the OLPC parameters are the same in the symbols used for PSFCH transmissions in a slot.* * *Option 2: If SL-PRS is in its own dedicated slot (or TDMed with other signals with its own independent AGC, similar to the PSFCH), the OLPC parameters are SL-PRS specific.* |
| Ericsson [28] | [*Proposal 18 Regarding power control:*](#_Toc131753091)  [*a. For in-coverage scenarios DL pathloss is supported for defining OLPC for SL PRS for all cast types supported for positioning purpose.*](#_Toc131753092)  [*b. For in-coverage and out of coverage scenarios SL pathloss, SL pathloss and DL path loss, SL pathloss or DL pathloss are the options supported for defining OLPC for SL PRS at least for SL unicast.*](#_Toc131753093)  [*i. FFS: Group cast*](#_Toc131753094)  [*Proposal 19 For a dedicated resource pool or a shared resource pool, if PSSCH (including PSSCH DMRS) are not present in a slot with SL PRS, SL PRS is selected as pathloss reference for OLPC*](#_Toc131753095)  [*Proposal 20 For a shared resource pool, SL PRS transmit power is same as that for PSSCH if/when PSSCH is transmitted in the same slot.*](#_Toc131753096) |
| Qualcomm [29] | *Proposal 14: In the shared resource pool, the existing OLPC procedure is used for SL-PRS power control.*  *Proposal 15: DL pathloss-based OLPC from sidelink communications can be used for DL pathloss-based OLPC in the SL-PRS dedicated resource pool.*  *Proposal 16: L3-filtered RSRP measurement on PSCCH DMRS is used for SL pathloss-based OLPC for unicast SL-PRS transmissions in the dedicated resource pool. FFS additional changes to procedure.* |
| MTK [32] | *Proposal 3-1: Consider to support both DL path loss and SL path loss for SL-PRS power control*  *Proposal 3-2: Consider to support the report of the filtered RSRP to the UE from a UE receiving SL-PRS*  *Proposal 3-3: Consider to support providing the transmission power from the UE to a UE receiving SL-PRS, at least it is feasible for groupcast type* |

Based on the discussions in submitted contributions, the issues quoted above are classified in the following two sub-sections.

* 1. Open loop PC (OLPC) for SL PRS transmissions

***Summary of observations based on submitted contributions:***

* *Majority of companies consider both DL and SL pathloss for defining OLPC for SL PRS transmissions (when in network coverage)*
* *Some companies point out that consideration of SL pathloss may be limited to unicast cases and in this regard, consider at least DL pathloss based OLPC when in network coverage for dedicated SL PRS resource pools.*
  + *Supported by: OPPO, Qualcomm*
* *At least for a dedicated SL PRS resource pool, and at least when PSSCH (including PSSCH DMRS) are not present, three options are considered by companies for SL pathloss reference:*
  + *Option 1: SL PRS as pathloss reference for OLPC*
    - *Supported by: Nokia, Futurewei, HW-HiSi, Intel, LGE, Xiaomi, Lenovo, ZTE, IDCC, Ericsson, MTK*
  + *Option 2: PSCCH DMRS as pathloss reference for OLPC*
    - *Supported by: Intel, Qualcomm*
  + *Option 3: S-SSB as pathloss reference*
    - *Supported by: Nokia*
  + *Note: The above solutions may apply also for the case of shared resource pools if SL PRS is transmitted without PSSCH. For the case when PSSCH and SL PRS are transmitted in the same slot in a shared resource pool, most companies assume use of PSSCH DMRS as the SL pathloss reference as for the case of PSSCH TPC to realize same Tx power as that for PSSCH.*
* *For a shared resource pool, many companies propose that SL PRS transmit power is same as that for PSSCH (if/when PSSCH is transmitted in the same slot).*
  + *Supported by: Intel, Xiaomi, Samsung (Within a slot, a symbols have the same power, including symbols that carry SL PRS), ZTE, Apple (same OLPC parameters as that of PSSCH/PSCCH or same OLPC parameters as that of PSFCH depending on multiplexing of SL PRS with PSSCH/PSCCH region vs. PSFCH region of a slot), Ericsson, Qualcomm*
* *Companies expressed their views on TPC for PSCCH associated with SL PRS if/when PSCCH is present in dedicated resource pools. In general, three options can be identified:*
  + *Option A: Same Tx power between PSCCH and SL PRS (no need for AGC but transient gap may still be needed due to PSD change if BW of PSCCH and SL PRS are different).*
  + *Option B: Same Tx PSD between PSCCH and SL PRS (AGC symbol may be needed between PSCCH and SL PRS if BW are different)*
  + *Option C: Independent power control between PSCCH and SL PRS (AGC symbol or AGC symbol and transient gap may be needed between PSCCH and SL PRS)*
* *For OLPC for SL PRS, while it can be considered that filtered RSRP is reported by Rx UE (as for SL communications), one company (MTK) proposes to additionally consider reporting of Tx power from Tx to Rx UEs for groupcast(/broadcast) cases.*

Based on the above, the following proposals are made.

### [High] FL1 Proposal 3.1-1

* *For in-coverage Tx UE and for unicast SL PRS, both DL and SL pathloss are considered as pathloss reference for defining OLPC for SL PRS.*
* *For in-coverage Tx UE and for groupcast/broadcast SL PRS, at least DL pathloss is considered as pathloss reference for defining OLPC for SL PRS.*
* *For out-of-coverage Tx UE and for unicast SL PRS, at least SL pathloss is considered as pathloss reference for defining OLPC for SL PRS.*
* *FFS: Use of SL pathloss as pathloss reference for groupcast/broadcast SL PRS.*

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| **Company** | **Comments** |
| CATT | Support. |
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### [High] FL1 Proposal 3.1-2

* *For a dedicated SL PRS resource pool, and at least when PSSCH (including PSSCH DMRS) are not mapped in a dedicated SL PRS resource pool, options for SL pathloss reference for OLPC for SL PRS are:* 
  + *Option 1: SL PRS as pathloss reference*
  + *Option 2: PSCCH DMRS as pathloss reference*
  + *Option 3: S-SSB as pathloss reference*

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| **Company** | **Comments** |
| CATT | Support the Option 1 and Option 2.  For S-SSB, since the SL PRS and S-SSB may come from different UEs, the S-SSB is not suitable for the pathloss reference. |
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### [Medium] FL1 Proposal 3.1-3

* *For a shared resource pool, SL PRS transmit power is same as that for PSSCH when PSSCH is transmitted in the same slot at least when SL PRS is transmitted without a time gap from PSSCH transmission.*
  + *FFS: SL PRS transmit power if and when SL PRS is transmitted with a time gap with respect to PSSCH, e.g., in the PSFCH region.*

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| **Company** | **Comments** |
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### [Medium] FL1 Proposal 3.1-4

* *For TPC for PSCCH associated with SL PRS in dedicated resource pools the following options are considered further:*
  + *Option A: Same Tx power between PSCCH and SL PRS (no need for AGC but transient gap may still be needed due to PSD change if BW of PSCCH and SL PRS are different). RAN1 to consider sending an LS to RAN4 for confirmation.*
  + *Option B: Same Tx PSD between PSCCH and SL PRS (AGC symbol may be needed between PSCCH and SL PRS if BW are different)*
  + *Option C: Independent power control between PSCCH and SL PRS (AGC symbol or AGC symbol and transient gap may be needed between PSCCH and SL PRS)*
  + *Other options are not precluded.*

*Please provide justifications for your preference.*

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| **Company** | **Comments** |
| CATT | Support.  We prefer Option B. |
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### [Medium] FL1 Proposal 3.1-5

* *For OLPC for SL PRS, filtered RSRP is reported by a receiving UE* 
  + *FFS: If, in addition or as alternative, Tx power may be reported from transmitting UE to receiving UE(s) for groupcast(/broadcast) cases.*

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| **Company** | **Comments** |
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* 1. SL PRS Power Control - Others

***Summary of observations based on submitted contributions:***

* *RAN1 to discuss whether power control for the purpose of congestion control should be applied to SL-PRS?* 
  + *Proposed by: Nokia*
* *Whether to support CL PC for SL PRS transmissions?* 
  + *Yes: Nokia, IDCC (PC of SL PRS based on feedback from Rx UE)*

As can be seen from the above, further inputs and discussions would be necessary to progress on these.

1. Other issues

**Background:** In addition to the aspects discussed above, in contributions, some further considerations have been raised.

Inputs from submitted contributions.

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| **Reference** | **Views** |
| Fraunhofer [25] | *Observation 1: Using the existing release of TS38.101-1 the maximum allowed bandwidth for SL is restricted to 40MHz.*  *Proposal 1: Inform in an LS RAN4 that Rel-18 support 100MHz in FR1 is restricted by RAN4 specification. Current restrictions means that RAN1 specification may not be implemented in Rel-18.* |
| Spreadtrum [11] | *Proposal 12: Considering energy efficient of SL-PRS transmission, feedback mechanisms should be considered.* |
| Continental Automotive [7] | *Observation 2: When a UE that wishes to transmit an SL PRS cannot find a suitable comb size and RE offset value to avoid overlap with other existing SL PRS transmissions, a procedure for requesting muting of SL PRS transmissions is desired.*  *Proposal 2.1: A UE intending to transmit SL PRS may send a request for existing SL PRS transmissions to be muted at indicated occasions.*  *Proposal 2.2: Upon receiving such a request, a UE already transmitting SL PRS may mute its own SL PRS transmissions based on the priority indicated by the requesting UE and several other considerations detailed in Section 2.2. of this contribution.* |
| Lenovo [22] | *Proposal 15: RAN1 to support muting of SL-PRS transmissions. FFS further details such as the type of muting configurations, etc.* |
| Sharp [34] | *Proposal 1: Muting is supported for SL-PRS.*  *• The muting functionality as specified for DL-PRS can be considered as a starting point.* |
| CMCC [35] | *Proposal 8: SL-PRS muting mechanism can be introduced to further alleviate the congestion condition.*   * *The corresponding enhancements on resource selection procedure for Scheme 2 may be required.* |
| IDCC [36] | *Proposal 22: Study SL muting indication and signalling.* |

On the proposal to send an LS to RAN4 on potential practical support of 100 MHz SL BW in Rel-18, it may not be necessary as this should be known to RAN4 already.

### [Low] FL1 Question 4.1

* *Companies are encouraged to provide further feedback on the LS to RAN4, support of lower-layer feedback in response to SL PRS reception, or any other issues not listed above below.*

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| **Company** | **Comments** |
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In addition, several companies proposed to consider SL PRS muting in this agenda as well as in AI 9.5.1.3.

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| **Reference** | **Views** |
| Continental Automotive [7] | *Observation 2: When a UE that wishes to transmit an SL PRS cannot find a suitable comb size and RE offset value to avoid overlap with other existing SL PRS transmissions, a procedure for requesting muting of SL PRS transmissions is desired.*  *Proposal 2.1: A UE intending to transmit SL PRS may send a request for existing SL PRS transmissions to be muted at indicated occasions.*  *Proposal 2.2: Upon receiving such a request, a UE already transmitting SL PRS may mute its own SL PRS transmissions based on the priority indicated by the requesting UE and several other considerations detailed in Section 2.2. of this contribution.* |
| Lenovo [22] | *Proposal 15: RAN1 to support muting of SL-PRS transmissions. FFS further details such as the type of muting configurations, etc.* |
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| CMCC [35] | *Proposal 8: SL-PRS muting mechanism can be introduced to further alleviate the congestion condition.*   * *The corresponding enhancements on resource selection procedure for Scheme 2 may be required.* |
| IDCC [36] | *Proposal 22: Study SL muting indication and signalling.* |

### [Low] FL1 Proposal 4.2

* *RAN1 to further study support of muting of SL PRS resources.*

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| **Company** | **Comments** |
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1. Proposals for Tuesday GTW

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1. Outcome from RAN1 #112bis-e

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# References

1. RP-223549, “New WID on Expanded and Improved NR Positioning”, Intel Corporation, CATT, Ericsson, December 2022
2. TR 38.859, “Study on expanded and improved NR positioning (Release 18)”, December 2022
3. Chairman’s Notes, 3GPP RAN1 #112, Athens, Greece, February 2023
4. R1-2302293 Design of SL positioning reference signal SL-PRS Nokia, Nokia Shanghai Bell
5. R1-2302326 Discussion on SL positioning reference signal FUTUREWEI
6. R1-2302377 Design on SL-PRS and power control Huawei, HiSilicon
7. R1-2302388 On sidelink positioning reference signal transmission coordination Continental Automotive
8. R1-2302490 Discussion on SL positioning reference signal vivo
9. R1-2302553 Discussion on SL positioning reference signal OPPO
10. R1-2302583 Discussion on SL positioning reference signal TOYOTA Info Technology Center
11. R1-2302605 Discussion on SL positioning reference signal Spreadtrum Communications
12. R1-2302708 Further discussion on SL positioning reference signal CATT, GOHIGH
13. R1-2302801 On SL Positioning Reference Signals Intel Corporation
14. R1-2302851 Discussion on SL positioning reference signal Sony
15. R1-2302874 Discussion on Sidelink Positioning Reference Signal Panasonic
16. R1-2302926 Discussion on SL positioning reference signal LG Electronics
17. R1-2302988 Discussion on sidelink positioning reference signal xiaomi
18. R1-2303027 Discussion on SL positioning reference signal China Telecom
19. R1-2303063 SL positioning reference signal Sharp
20. R1-2303133 On SL Positioning Reference Signal Samsung
21. R1-2303239 Discussion on SL positioning reference signal CMCC
22. R1-2303263 Discussion on SL PRS Aspects Lenovo
23. R1-2303276 Discussion on SL positioning reference signal ZTE
24. R1-2303306 Discussion on SL positioning reference signal design CEWiT
25. R1-2303414 Design considerations on SL positioning reference signal Fraunhofer IIS, Fraunhofer HHI
26. R1-2303443 SL-PRS design and power control for SL-PRS InterDigital, Inc.
27. R1-2303488 On SL positioning reference signal Apple
28. R1-2303550 SL positioning reference signal design Ericsson
29. R1-2303595 Reference Signal Design for SL Positioning Qualcomm Incorporated
30. R1-2303683 Discussion on SL positioning reference signal NEC
31. R1-2303784 Discussion on sidelink positioning reference signal ASUSTeK
32. R1-2303837 Reference signal design for sidelink positioning MediaTek (Chengdu) Inc.
33. R1-2302928 Discussion on resource allocation for SL positioning reference signal LG Electronics
34. R1-2303065 Resource allocation for SL positioning reference signal Sharp
35. R1-2303241 Discussion on resource allocation for SL positioning reference signal CMCC
36. R1-2303445 Resource allocation for SL positioning reference signal InterDigital, Inc.