**3GPP TSG RAN WG1 #109-e R1-220xxxx**

**e-Meeting, May 9th – 20th, 2022**

**Agenda item:** **9.5.1.3**

**Source: Moderator (Qualcomm)**

**Title: Moderator Summary #1 for [109-e-R18-Pos-04] Email discussion on potential solutions for SL positioning**

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

# Introduction

The study on expanded and improved NR positioning introduces sidelink positioning as an objective [1]:

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| --- |
| * Study solutions for sidelink positioning considering the following: [RAN1, RAN2] * Scenario/requirements   + Coverage scenarios to cover: in-coverage, partial-coverage and out-of-coverage   + Requirements: Based on requirements identified in TR38.845 and TS22.261 and TS22.104   + Use cases: V2X (TR38.845), public safety (TR38.845), commercial (TS22.261), IIOT (TS22.104)   + Spectrum: ITS, licensed * Identify specific target performance requirements to be considered for the evaluation based on existing 3GPP work and inputs from industry forums [RAN1] * Define evaluation methodology with which to evaluate SL positioning for the uses cases and coverage scenarios, reusing existing methodologies from sidelink communication and from positioning as much as possible [RAN1]. * Study and evaluate performance and feasibility of potential solutions for SL positioning, considering relative positioning, ranging and absolute positioning: [RAN1, RAN2]   + Evaluate bandwidth requirement needed to meet the identified accuracy requirements [RAN1]   + Study of positioning methods (e.g. TDOA, RTT, AOA/D, etc) including combination of SL positioning measurements with other RAT dependent positioning measurements (e.g. Uu based measurements) [RAN1]   + Study of sidelink reference signals for positioning purposes from physical layer perspective, including signal design, resource allocation, measurements, associated procedures, etc, reusing existing reference signals, procedures, etc from sidelink communication and from positioning as much as possible [RAN1]   + Study of positioning architecture and signalling procedures (e.g. configuration, measurement reporting, etc) to enable sidelink positioning covering both UE based and network based positioning [RAN2, including coordination and alignment with RAN3 and SA2 as required]   Note: When the bandwidth requirements have been determined and the study of sidelink communication in unlicensed spectrum has progressed, it can be reviewed whether unlicensed spectrum can be considered in further work. Checkpoint at RAN#97 to see if sufficient information is available for this review. |

The focus on the 9.5.1.3 SubAgenda is the following objective:

* Study of positioning methods (e.g. TDOA, RTT, AOA/D, etc) including combination of SL positioning measurements with other RAT dependent positioning measurements (e.g. Uu based measurements) [RAN1]
* Study of sidelink reference signals for positioning purposes from physical layer perspective, including signal design, resource allocation, measurements, associated procedures, etc, reusing existing reference signals, procedures, etc from sidelink communication and from positioning as much as possible [RAN1]

In this paper, we summarize some common elements in the contributions and identify some areas and positions where contributing companies are aligned from which some agreements could be derived at this meeting.

# Email Discussion Information

This contribution provides the moderator’s summary of SL positioning evaluation, subject to the following email discussion.

[109-e-R18-Pos-04] Email discussion on evaluation of SL positioning by May 20 - Alex (Qualcomm)

* Check points: May 16, May 20

All companies, please provide your initial inputs before Thursday May 12th 23:59 UTC, so that there is enough time to stabilize some of the proposals before the 1st checkpoint.

**Thursday May 12th 23:59 UTC - Friday, May 13th, 11:59 UTC**

Based on received feedback, a new set of proposals are provided as follos:

* The previous Feature Lead proposals have been denote as “CLOSED
* A new set of Feature lead proposals is included with the categorization of “HIGH”, “MEDIUM”, “LOW”
* Considering the first check-point next Monday, it would be most appreciated if you could provide your feedback at least to the proposals tagged with “HIGH” (note that 4 proposals out of the 16 are denoted as “HIGH”), by **Friday, May 13th, 11:59 UTC**, if possible.

# Delegate Contact Information

As requested by the Chair, please provide the main Person of contact (PoC) for each company interested/contributing/providing comments for this subagenda in the table below:

|  |  |
| --- | --- |
| vivo | Huaming Wu, huaming.wu@vivo.com |
| CATT | Xiaotao Ren, renxiaotao@catt.cn |
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# Sidelink Positioning Methods & Measurements, including combination with other RAT dependent positioning measurements

## SL Positioning Methods & Measurements

Based on the submitted contributions, the following statements/proposals are identified to be related to the sub-topc of SL Positioning Methods & Measurements:

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| --- | --- |
| Futurewei | RAN1 should discuss the SL UE support of the positioning methods and measurements defined in Rel-16, and Rel 17.  The SL positioning study should investigate the BW size, non-ideal synchronization, and NLOS propagation impact on the SL positioning accuracy. |
| Nokia, NSB | Different positioning techniques based on time and angle-based measurements such as TDOA, Multi-RTT, AoA, AoD, etc. should be studied for sidelink positioning, to better evaluate their advantages and drawbacks. |
| Huawei, HiSilicon | SL positioning should support:   * RTT-based method for absolute and relative positioning * AoA-based method for absolute and relative positioning * TDOA-based method for absolute positioning   Note: For absolute positioning, the position of the transmitters, such as RSU, is known.  To support the above SL positioning methods, the following measurements should be reported:   * RSTD and/or RTOA measurements for TDOA-based method * Rx-Tx timing difference for RTT-based method * AoA for AoA-based method   Support to fix UE locations based on measurements at different time instances considering UE’s mobility characteristics.  UE timing drift should be considered in SL positioning or ranging. |
| NTT DOCOMO | * For SL-positioning, at least RTT mechanism is supported. * For SL-positioning, study whether TDOA mechanism can be supported or not, in consideration of time-misalignment among synchronizing UEs. |
| Samsung | Study the feasibility of TDOA for absolute and relative SL positioning considering synchronization error between UEs.  For instance, carrier phase measurements can be studied not only for Uu but also for SL. |
| CEWiT, Reliance Jio, Saankhya Labs, IITM, IITK | For Rel 18 study, both time-based (TDOA, M-RTT) and angle-based (AOD, AOA) positioning methods should be considered.  Time difference of arrival (TDOA) method should be defined for sidelink to measure RSTD for positioning over sidelink: For angle-based methods for sidelink positioning, antenna configuration consideration should be studied using practical UE capabilities and sidelink positioning architecture |
| CATT, GOHIGH | The potential positioning methods of TDOA, AOD/AOA, RTT for sidelink positioning should be further studied.  Support at least the following measurements for sidelink positioning:   * SL Rx-Tx time difference * SL AOA * SL RSRP/RSRPP |
| vivo | Prioritize RTT and AoA for sidelink positioning considering to achieve relative positioning and ranging (e.g., ranging for distance and ranging for angle).  Double-side RTT should be considered for SL positioning.  Two antenna panels as the distributed antenna system can be considered for V2X positioning.  The unified SL Positioning method can be introduced to support reporting one or more measurement results, similar to the TRP measurement result in TS 38.455.  Suggest UE Rx – Tx time difference for SL positioning can be defined as T, which is the timing gap between transmission of SL-PRS and receiving SL-PRS to/from other UE.  SL-PRS RSRP is needed to be introduced for SL-PRS measurement and reporting.  SL-AoA is needed to be introduced for SL-PRS measurement and reporting. |
| CMCC | RAN1 should further study which or which combination of positioning methods (e.g. TDOA, RTT, AOA/D, etc) should be selected for NR SL positioning, based on the evaluation results of:   * Positioning accuracy performance by using each method; * Feasibility of resolving the respective method’s bottleneck in Rel-18 of each method.   Initial views from our company on which methods to be supported in Rel-18 SL positioning are:   * RTT can be supported in Rel-18 SL positioning for both absolute positioning and relative positioning /ranging; * TDOA can be supported only in the case where the anchor devices are RSUs in Rel-18 SL positioning, both absolute positioning; * Whether AoA/AoD can be supported should be subject to UE capability, for both absolute positioning and relative positioning/ranging. |
| ZTE | From standard perspective, support all in-coverage, partial-coverage and out-of-coverage scenarios. The legacy positioning methods should be reused.   * For in-coverage and partial-coverage, support both absolute positioning and relative positioning.   For out-of-coverage, support relative positioning which TDOA may not be applicable  Time synchronization between anchor UEs need to be considered for SL TDOA positioning |
| China Telecom | Study the angle measurement based solution for sidelink positioning  Consider the RTT measurement based solution for sidelink positioning  Consider the TDOA measurement based solution for sidelink positioning |
| Qualcomm | Support a SL-RTT positioning method, wherein at least 2 devices transmit and receive SL-PRS waveform(s) and perform SL Rx-Tx measurements  Study both single-sided and double-sided SL-RTT methods  Support SL-AoA positioning method  For devices with a limited number of Tx antennas, SL-RTT and SL-AoA are more suitable and effective methods than the RSRP-based SL-AoD approach  From RAN1 perspective, SL-only positioning corresponds to a positioning mode wherein all the UEs performs SL positioning/ranging measurements and location/range is computed using measurements derived on SL without network involvement  Support UE Rx-Tx time difference measurements derived on SL-PRS to enable SL-RTT ranging  Support angle of arrival (both azimuth and zenith angles) measurements to enable SL-AoA positioning  If SL-TDoA and SL-AoD are supported, introduce RSTD, RSRP, and RSRPP measurements |
| ROBERT BOSCH GmbH | For studying sidelink positioning method (e.g., TDO, RTT, AOA/D, …) consider the relevant positioning technique (e.g., relative, ranging, or absolute) and the deployment scenario  Study sidelink positioning techniques considering both LOS and NLOS conditions  Study carrier phase based positioning for sidelink positioning techniques |
| Apple | As a first step, RAN1 should decide which of the existing Uu RAN-based positioning techniques are suitable to be re-designed for SL positioning. Candidate SL-positioning schemes are:   |  |  |  |  | | --- | --- | --- | --- | |  | DL based positioning | UL based positioning | DL and UL based positioning | | Techniques | SL-TDOA-1 (DL-like),  SL-AoD | SL-TDOA-2 (UL-like),  SL-AoA | SL-multi-cell RTT,  SL-E-CID Type positioning |   Issues to be addressed include:  Establishment of a common synchronization reference and the positioning reference UE (for TDOA based schemes) |
| Xiaomi | Round trip time measurement and measurement report exchange are supported in NR sidelink ranging. |
| Sharp | As the potential positioning methods for sidelink, whether/which of the Rel-16/17 positioning technologies are reused for sidelink positioning should be discussed |
| OPPO | OTDOA, RTT, and AoA/AoD based positioning methods should be studied for UE-based or UE-assisted absolute positioning, and RTT based and AoA/AoD based positioning methods should be studied for ranging  Measurements including RSTD, Rx-Tx time difference, SL-PRS RSRP, SL AoA/AoD, etc., could be supported depending on the positioning methods to be used in sidelink positioning. |
| Sony | Relative positioning is estimated based on received power measurement (e.g., RSRP) and/or timing measurement (e.g., TDOA). |
| Localia | Study use case, solution and impact to sidelink positioning when applying the phase-based AoA measurement method  Consider using the carrier phase method for V2V synchronization and the necessary impact on gNodeB structure. |
| Lenovo | Support SL-TDoA for satisfying the absolute positioning use cases in SL  Support the following two types of RTT methods for SL positioning:   * One-way SL-RTT * Two-way SL-RTT   Support angular-based SL positioning methods for antenna calibrated entities and fixed anchor nodes, e.g., gNBs or RSUs  RAN1 to support the SL fingerprinting method to satisfy coarse positioning techniques and to be used in conjunction with other SL positioning methods to enhance UE position estimation |
| Spreadtrum | RAN1 should consider the following positioning techniques for SL positioning: RTT based positioning, TDOA based positioning, AOA/D based positioning |
| LGE | RTT-based positioning is supported for relative SL positioning.  SL Multi-RTT positioning is supported for absolute SL positioning, regardless of the synchronization error between UEs  TDOA positioning with T-UE’s SL PRS transmission is supported for absolute SL positioning  SL TDOA positioning with S-UE’s SL PRS transmission is supported for absolute SL positioning  RSSI-based relative positioning based on the layer-1 or layer-2 service/destination ID associated to UE transmission is supported  Azimuth of arrival (AoA) and zenith of arrival (ZoA) based SL positioning is supported  Azimuth of departure (AoD) and zenith of departure (ZoD) based SL positioning is supported  SL positioning supports per-panel location estimation if UE uses multiple panels  SL synchronization procedure is performed by the UE that performs SL positioning |
| Mediatek | Slightly prefer to use the terminology of SL RTOA measurements for RTT technique under sidelink  Define the measurement types of SL RSTD, SL PRS-RSRP, SL PRS-RSRPP, SL RTOA and SL AOA |
| Intel | * + - One or more of TDoA, AoA/AoD, and RTT based positioning methods may be adapted for positioning utilizing combinations of Uu and PC5 links involving:       * multiple UEs and one or more TRPs,       * one or more UEs, and one or more RSUs, and one or more TRPs, or       * one or more UEs and one or more RSUs.     - For different positioning methods, consider support of the currently defined measurements that may include RSTD, SL-PRS-RSRP, AoD, and Rx-Tx measurements.     - AoA/ZoA measurements may also be considered for optional support, e.g., by RSUs. |
| NEC | The movement of reference points should be taken into account for the study of sidelink positioning methods including OTDOA, RTT, AOA/D, etc, especially for DL positioning.  Timing/power/AoA/AoD based positioning methods can be combined with carrier phase based positioning method to firstly used to reduce the searching space of the integer ambiguity and corresponding measurement should be conducted |
| Interdigital | Study pros and cons of RTT-based and TDOA-based positioning methods  For TDOA based positioning, study methods where the target UE transmit PRSs to anchor UEs or receive PRSs from anchor UEs  Evaluate pros and cons of angle-based positioning methods and discuss prioritization of angle based positioning methods with respect to timing based positioning methods |

Based on the submitted tdocs, and proposals summarized above, in the table below we provide a list of methods that were proposed, along with a first categorization of what is companies’ preferences:

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| --- | --- | --- |
| Method | Study | Prioritize or Support |
| RTT | Nokia, FW, CEWiT, OPPO, Apple, Spreadtrum, IDC | QC, HW, DCM, CATT, vivo, CMCC, Xiaomi, Lenovo, LGE, MTK |
| AoA | Nokia, FW, CEWiT, OPPO, Apple, Spreadtrum, IDC | QC, HW, CATT, vivo, LGE, MTK |
| TDOA | QC, Nokia, FW, DCM, DCM, CEWiT, CATT, OPPO, Apple, Spreadtrum, IDC | HW, CMCC, Localia, Lenovo, LGE, MTK |
| AoD | QC, Nokia, FW, CEWiT, OPPO, Apple, Spreadtrum, IDC | LGE, MTK(?) |
| “E-CID-like for SL ” | Apple | Lenovo, LGE |
| Carrier phase Positioning | Localia, NEC, Bosch, Samsung |  |

Based on the above, the following proposal is made:

##### [CLOSED] Feature Lead Proposal 3.1-v0

With regards to the Positioning methods supported using SL measurements study further the following methods:

* + SL-RTT
    - Study both single-sided (also known as one-way) and double-sided (also known as two-way) RTT
  + SL-AoA
    - Include both Azimuth of arrival (AoA) and zenith of arrival (ZoA) in the study
  + SL-TDOA
    - Consider synchronization error(s) between UEs and any mechanisms/procedures to address this
  + SL-AoD
    - Corresponds to a method where RSRP and/or RSPPP measurements similar to the DL-AoD method in Uu.
    - Include both Azimuth of departure (AoD) and zenith of departure (ZoD) in the study
  + A positioning method that uses existing SL measurements (e.g. RSSI, RSRP), destination/source IDs information, zone-ID information, etc, may be used.
  + Carrier phase positioning for Sidelink Positioning
* Consider in the study at least the following aspects:
  + Definition(s) of the corresponding SL measurements for each method
  + Which method is applicable to absolute or relative positioning or ranging, including whether such categorization is needed to be discussed.
  + For angle-based methods, antenna configuration consideration(s) using practical UE capabilities
  + Per-panel location estimation if UE uses multiple panels
* Note: The above categorization does not necessarily mean that there will be separate SL positioning methods specified, or whether there will be a unified SL Positioning method.

##### Companies views

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| --- | --- |
| vivo | On the study of carrier phase for sidelink, it’s not clear to us how we can proceed on this for sidelink given carrier phase for NR positioning is studied in another agenda. We prefer not to consider it for sidelink before the details of it is clear based on the study of another agenda. |
| CATT | Support including the carrier phase positioning in the proposal.  Since the carrier phase positioning had been studied in Rel-18, we prefer to study the solution the evaluation the performance of carrier phase positioning in sidelink positioning, in order to improve the accuracy of sidelink positioning. |
| MTK | Similar view as vivo, not to consider carrier phase measurement for sidelink now |
| Fraunhofer | The phase measurements can provide information to achieve the SL relative velocity requirements, hence we support the bullet independent from the discussions in 9.5.2 |
| ZTE | For the specification of carrier phase based positioning, UE’s initial located is obtained through TOA/TDOA/AOA/AOD. We think whether carrier phase measurement is an independent positioning method or is configured under each legacy positioning method as an enhancement should be firstly discussed. |
| Huawei, HiSilicon | Share the view that CPP should be firstly discussed in AI9.5.2.2 in general so should be deleted from this proposal.  Not sure how destination/source IDs information is relevant to positioning methods.  Study positioning methods considering the UE’s mobility in V2X scenario, as the UE’s displacement (e.g. compared to the distance to an RSU) may be non-negligible in SL positioning compared to Uu positioning. |
| Spreadtrum | Considering carrier phase for NR positioning is studied in another agenda, we also think that it's a little premature to discuss carrier phase positioning for sidelink positioning now. |
| InterDigital | We agree with vivo and others and phase error measurement should be at least down prioritized for SL positioning.  We also suggest to study what roles a SL node, e.g., a UE or RSU will perform in each method in terms of configuring, coordinating, performing and reporting the related measurement. Thus, we propose to add an aspect to the study, as proposed below.  ….   * Consider in the study at least the following aspects:   + Definition(s) of the corresponding SL measurements for each method   + Which method is applicable to absolute or relative positioning or ranging, including whether such categorization is needed to be discussed.   + For angle-based methods, antenna configuration consideration(s) using practical UE capabilities   + Per-panel location estimation if UE uses multiple panels   + Identification of the role of SL nodes participating in each method (e.g., target UE, anchor UE, RSU, etc.,) and interaction/coordination between the nodes to perform the related measurements.   …. |
| Futurewei | Carrier phase is the subject of another AI, and we prefer not to consider it here now. We are OK considering E-CID-like for SL, for instance based on S-SSB measurements. |
| CMCC | We are open for studying all of the methods except the carrier phase positioning, at least this should be suspended until more outcomes have been achieved in the parallel sub-adgenda for Uu carrier phase positioning. |
| NEC | **Comment 1**: Considering the limited band of ITS for V2X, carrier phase based positioning should be considered to achieve improved accuracy.  Comment 2: Suggest removing sub-bullet for SL-TDOA since it is not a method but factors to consider when designing the method. |
| Sony | We are OK with the proposed scope above. Carrier phase positioning should be discussed in another AI. It may be discussed in the context of sidelink positioning at later stage (subject to RANP approval). |
| OPPO | We share the view as others that carrier phase positioning is being studies in another agenda, the concrete solution for this method is far from clear now. If considered in this agenda, we need to consider the possibilities that may happen in carrerier phase positioning when design the solutions for SL-positioning, it would slow down the progress dramatically.  And, we also do not understand how to use “SL measurements (e.g. RSSI, RSRP), destination/source IDs information, zone-ID information” as independent positioning method to meet the accuracy requirements considered in this item. Furthermore, it seems desirable if we can keep the methods list a bit shorter from working load perspective.  So, maybe we can only keep SL-RTT, SL-AoA, SL-TDOA, and SL-AoD in the list, and up to companies to study other methods. |
| Lenovo | Support the FL’s proposal as a starting point of discussions. Share the view with companies, that the carrier phase technique needs to be first studied in the parallel agenda. |
| Apple | Okay with above scope. Agree that carrier phase positioning should be postponed. |
| Locaila | In order to meet the positioning accuracy requirements in limited bandwidth, a study on Carrier Phase Positioning is required. |
| Samsung | OK for the direction of proposal 3-1 in general.  We suggest the following modification as  Note: ~~A~~ positioning methods ~~that uses~~ may reuse existing SL measurements (e.g. RSSI, RSRP), destination/source IDs information, zone-ID information~~, etc, may be used~~  Per-panel location estimation or (pre-)configuration if UE uses multiple panels |
| Qualcomm | We’re ok with the proposal. We share the view to study carrier phase in the other AI first before sidelink. |
| DCM | OK with the proposal. We also are not sure carrier phase positioning should be included. |
| LGE | We share the view with other companies that carrier phase measurement for SL positioning can be considered after study in UU link based positioning. Other parts of the proposal is ok for us. |
| Sharp | We prefer to focus on existing Rel-16/17 positioning mehods for the enhancement on sidelink and it may be premature to study carrier phase positioning now. |
| Xiaomi | We share the view that carrier phase shall be studied in other agenda first. We are open to study other positioning methods. |
| Philips | Would prefer to keep carrier phase positioning for improved accuracy in a narrow bandwidth. |
| Nokia, NSB | Carrier phase methods for NR positioning are being studied as part of A.I. 9.5.2.2, it may be premature to include them here already. |
| Ericsson | We agree with other companies on not including carrier phase at this stage.  For positioning methods in-coverage scenario, TRPs should be involved as point of references. The SL measurements should be combined with TRP based measurements for absolute positioning of UEs. |

##### FL Observations

Seems overall there is good convergence on most of the methods to be studied, except the carrier phase for Sidelink. In short, with regards to this topic, we observe the following:

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| In favor of keeping in the study related to this subagenda the carrier phase for Sidelink:   * CATT, Fraunhofer, NEC, Localia, Samsung, Philips (6)   Against/concerns/low-priority keeping in the study related to this subagenda the carrier phase for Sidelink:   * Vivo, MTK, ZTE, Huawei, HiSilicon, Spreadtrum, Interdigital, Futurewei, CMCC, Sony, OPPO, Lenovo, Apple, Qualcomm, NTT DOCOMO, LGE, Sharp, Xiaomi, Nokia, NSB, Ericsson (18) |

There is majority support to not consider the carrier phase in this study, for several reasons described in the companies responses. In an attempt to find a way forward, my suggestion is the following:

* Note: When the study of carrier phase positioning and the evaluations of sidelink positioning have progressed, it can be reviewed whether carrier phase for sidelink can be considered in further work. Checkpoint at RAN1#110-e-Bis to see if sufficient information is available for this review.

With regards to additional modifications suggested by individual companies, the FL makes the following observation:

* Huawei, HiSilicon suggested to remove “destination/source IDs information”.
  + Since this method has “e.g.”, if a company thinks that this information could be useful, they could provide their analysis in net meeting. So my suggestion is to remove it.
* Huawei, HiSilicon suggested to add to consider UE’s mobility.
  + It is a reasonable consideration to be included.
* Interdigital suggested to include the following: Identification of the role of SL nodes participating in each method (e.g., target UE, anchor UE, RSU, etc.,) and interaction/coordination between the nodes to perform the related measurements.
  + It may indeed be useful for companies to provide a description of what they envision from each method with regards to how the SL devices interact.
* NEC “Suggest removing sub-bullet for SL-TDOA since it is not a method but factors to consider when designing the method.”
  + As as FL i am adding it in the bullet of what to consider, since many companies, in their Tdoc, pointed out that this may be a main issue that needs to be discussed.
* OPPO and Samsung commented on the 4th method:
  + OPPO: “And, we also do not understand how to use “SL measurements (e.g. RSSI, RSRP), destination/source IDs information, zone-ID information” as independent positioning method to meet the accuracy requirements considered in this item. Furthermore, it seems desirable if we can keep the methods list a bit shorter from working load perspective. So, maybe we can only keep SL-RTT, SL-AoA, SL-TDOA, and SL-AoD in the list, and up to companies to study other methods.
  + Samsung: “Note: ~~A~~ positioning methods ~~that uses~~ may reuse existing SL measurements (e.g. RSSI, RSRP), destination/source IDs information, zone-ID information~~, etc, may be used~~“
    - This may be a focus topic that we could take up in the 2nd round of discussion. For now i keep it since most companies showed interest in this method.
* Samsung also suggested the following change: “Per-panel location estimation or (pre-)configuration if UE uses multiple panels”
  + However, it is unclear to me what was Samsung’s intention.

##### [HIGH] Feature Lead Proposal 3.1-v1

With regards to the Positioning methods supported using SL measurements study further the following methods:

* + SL-RTT
    - Study both single-sided (also known as one-way) and double-sided (also known as two-way) RTT
  + SL-AoA
    - Include both Azimuth of arrival (AoA) and zenith of arrival (ZoA) in the study
  + SL-TDOA
  + SL-AoD
    - Corresponds to a method where RSRP and/or RSPPP measurements similar to the DL-AoD method in Uu.
    - Include both Azimuth of departure (AoD) and zenith of departure (ZoD) in the study
  + ~~Carrier phase positioning for Sidelink Positioning~~
  + A positioning method that uses existing SL measurements (e.g. RSSI, RSRP), ~~destination/source IDs information~~, zone-ID information, etc, may be used.
* Consider in the study at least the following aspects:
  + Definition(s) of the corresponding SL measurements for each method
  + Which method is applicable to absolute or relative positioning or ranging, including whether such categorization is needed to be discussed.
  + For angle-based methods, antenna configuration consideration(s) using practical UE capabilities
  + Per-panel location estimation if UE uses multiple panels
  + UE’s mobility, especially for V2X scenarios
  + For SL-TDOA, synchronization error(s) between UEs and any mechanisms/procedures to address it
* Note: The above categorization does not necessarily mean that there will be separate SL positioning methods specified, or whether there will be a unified SL Positioning method.
* Note: When the study of carrier phase positioning and the evaluations of sidelink positioning have progressed, it can be reviewed whether carrier phase for sidelink can be considered in further work. Checkpoint at RAN1#110-e-Bis to see if sufficient information is available for this review.
* Note: Companies are encouraged to describe the role of SL nodes and their interaction/coordination participating in each method.

Companies are encouraged to reply if they support the above proposal, and specifically, provide arguments in favor or against keeping the following subbulet together with the SL-RTT, SL-AoA, SL-TDOA, SL-AoD bullets:

* + A positioning method that uses existing SL measurements (e.g. RSSI, RSRP), ~~destination/source IDs information~~, zone-ID information, etc, may be used.

##### Companies views

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## Joint SL and Uu Positioning

Based on the submitted contributions, the following statements/proposals are identified to be related to the sub-topc of Joint SL & Uu Positioning:

|  |  |
| --- | --- |
| Futurewei | For position determination SL UE should support the aggregation of DL PRS resources with SL positioning resources |
| Nokia, NSB | Besides offering a standalone positioning solution, SL can be also utilized to enhance or offload Uu-based positioning, or simply offload Uu control signaling for positioning purposes via SL communications. |
| NTT DOCOMO | * Study whether SL-positioning can use Uu measurement or not.   + If supported, some UE in SL-positioning method can be replaced to gNB. * Study availability of Uu positioning instead of SL-positioning in use cases assumed for SL-positioning.   + If available, study priority order between Uu positioning and SL positioning and detailed procedure. |
| Fraunhofer IIS, Fraunhofer HHI | Integrate the reporting of sidelink measurements into the reporting framework for DL-TDOA, UL-TDOA and multi-RTT based positioning |
| vivo | Prioritize sidelink-based positioning. The combination of SL positioning with Uu positioning is of low priority. |
| CMCC | Joint scheme b/w NR Uu and SL positioning can be considered to facilitate the positioning accuracy performance. |
| Qualcomm | From RAN1 perspective, joint SL/Uu positioning corresponds to a positioning mode wherein at least one of the UEs performs SL positioning/ranging measurements and location/range is computed using measurements derived on both SL and Uu. |
| ROBERT BOSCH GmbH | Study possible mechanisms combing sidelink and Uu positioning and study whether this combination requires any RAN impacts. |
| Apple | Hybrid SL positioning with a mix of gNBs and SL-UEs in the positioning candidate set should also be considered. |
| Sony | Support hybrid positioning where the UE receives reference signal for positioning from both direct-link (Uu) and sidelink (PC5) and jointly utilize for positioning estimation purpose. |
| Lenovo | RAN1 to support hybrid positioning under the following models:   * Hybrid Positioning Model A - Hybrid positioning using hybrid interfaces including the support of Uu and SL measurements for SL position calculation. * Hybrid Positioning Model B - Hybrid positioning using hybrid technologies including the support of RAT-dependent and RAT-independent methods for SL position calculation. |
| Ericsson | Hybrid ranging involving gNBs and UEs should be studied |

Based on the submitted tdocs, and proposals summarized above, the following proposal is made:

##### [CLOSED]Feature Lead Proposal 3.2-v0

For in-coverage and partial-coverage scenarios, study hybrid positioning methods wherein one or more of UE(s) perform SL measurements and position/ranging is estimated using measurements derived on both SL and Uu positioning. Include in the study at least the following aspects:

* What incremental change(s) on top of SL-only Positioning/ranging, if any, are needed
* Whether Uu positioning includes both RAT dependent and RAT-independent methods

##### Companies views

|  |  |
| --- | --- |
| vivo | We’re okay to study hybrid positioning.  However, a couple of points we’d like to make/emphasize  1. priority of study on SL-only positioning/ranging is still needed given we need to cover out of coverage case which hybrid positioning cannot address. Furthermore, it’s not possible to identify incremental change(s) if we don’t know the details of SL-only positioning.  2. different design aspects on top of SL-only positioning/ranging should be avoided as much as possible. Otherwise, we have concerns on the design complexity of SL-PRS and other aspects on protocol/procedure etc. |
| CATT | In Rel-18, we prefer to prioritize the sidelink positioning only and low priority for hybrid positioning, since we should first specify the sidelink positioning, then consider to support the hybrid methods.  In addition, we prefer to focus on in-coverage scenario for the hybrid positioning methods, if we want to support the hybrid methods. |
| ZTE | We agree with studying hybrid positioning methods but the solutions for SL positioning should firstly be specified. Since all or part of the UEs are inside the network coverage for in-coverage and partial coverage scenarios, we can consider hybrid positioning method combining SL positioning with other RAT dependent positioning (e.g. Uu based positioning) to improve positioning accuracy and study its potential specification impacts. |
| Huawei, HiSilicon | Fine to study in general. However, we also view that positioning based on sidelink purely should be looked into firstly. Only after having a design for SL positioning, can it be evaluated whether incremental changes are needed on top.  One question for clarification is why should RAT-independent methods be considered as Uu positioning and we think it should be out of scope from SID. |
| Spreadtrum | We are fine to study hybrid positioning methods. |
| InterDigital | The study for hybrid positioning should be down-prioritized. When Uu positioning measurements is available, it is conceivable that additional SL measurement provides certain level of improvement of positioning accuracy. But in our view, this is a secondary use case for SL-based positioning. It is more important to study and develop SL-only positioning solutions when Uu positioning is not available or severely impaired. It can be evaluated later on (if time allows) if the developed SL-only positiong solutions when used together with Uu positiong measurements will improvie positioning performance. |
| Futurewei | We support the study of hybrid positioning methods. We prefer to focus on the RAT-dependent solutions. |
| CMCC | “Sidelink positioning only” case should be studied first, otherwise, it is not clear how to support hybrid positioning methods. For the hybrid positioning methods, we also prefer to study in-coverage scenario first then move on to partial coverage case if there is remaining time budget, then main intention is to focus on the fundamental coverage scenarios and simplify the design workload. |
| NEC | We think hybrid and SL positioning are with equal importance. In addition, we suggest removing sub-bullet 2 since RAT-independent methods have no RAN1 impacts. |
| Sony | We support to study hybrid positioning and we prefer to only consider RAT-dependent (at least from RAN1 point of view). |
| OPPO | We support to further study the hybrid positioning methods, we believe it is an important feature to improve the accuracy of 3GPP based positioning, and SL-positioning and Uu-based positioning complement each other should be a more popular scenario than SL only or Uu only positioning in practice. Furthermore, we also think only RAT-dependent solution should be considered in this item. |
| Lenovo | Generally supportive of the overall proposal regarding Hybrid positioning. At this stage, it may not be clear if there will be any incremental/major changes on top of the SL-only pos. solution. On bullet 2, not sure if there is a typo, instead of Uu, should it rather be SL? Since Uu already supports RAT-dependent and RAT-independent methods. |
| Apple | Supportive of the proposal |
| Locaila | Support the study of hybrid positioning. |
| Samsung | OK for the direction of proposal 3-2 in general |
| Qualcomm | We support the proposal. Hybrid methods are an important feature to futher improve positioning accuracy. We also share the view to focus on RAT-depedent solutions at this stage. |
| DCM | We support the proposal in general. In addition, how to decide which mechanism from SL-only positioning / hybrid positioning / Uu-only positioning is selected should be added as another sub-bullet. |
| LGE | We also share the view with other companies that stand-alone SL positioning should be prioritized to hybrid positioning. In addition, stand-alone SL positioning should be available regardless of the network coverage. |
| Sharp | Although we are generally OK to study hybrid positioning, we would like to prioritize to study sidelink-based positioning first. |
| xiaomi | We are supportive to study hybrid solutions, but think the study on SL stand-alone positioning shall be prioritized at this stage. |
| Philips | Similar to others, we are ok to study hybrid positioning, but think that SL stand-alone positioning should be prioritized in this initial phase. |
| Nokia, NSB | OK, but we prefer to focus on SL standalone |
| Ericsson | We do not agree that SL stand-along positioning should be prioritized over hybrid positioning.  In our view, Hybrid positioning should have the same priority as SL stand-alone positioning.  Furthermore, we do not agree with the bullet on ‘incremental changes’. Rather the objective should be to study SL+UU based hybrid positioning. So we suggest to remove the sub-bullet on incremental changes.  For in-coverage scenario, UE assisted network based SL+Uu hybrid positioning should be studied. The objective should include hybrid ranging and hybrid positioning. |

##### FL Observations

Seems all companies are OK to study hybrid positioning, but 10 out 23 companies explicitly say that it should be lower priority than SL-only Positioning. Specifically, the split is as follows:

* OK to study Hybrid Positioning, but SL positioning should be first looked into / prioritized over hybrid
  + Vivo, CATT, ZTE, Huawei, HiSilicon, Interdigital, CMCC, LGE, Sharp, Xiaomi, Philips, Nokia, NSB (10)
* OK with the proposal as is OR OK to study Hybrid Positioning OR equal importance between hybrid and SL Positioning
  + Spreadtrum, Futurewei, NEC, Sony, OPPO, Lenovo, Apple, Localia, Samsung, Qualcomm, NTT DOCOMO, Ericsson (13)

It was also pointed out by several companies that “”Uu Positioning” should correspond to “RAT dependent methods” as shown in the SID:

* + Study of positioning methods (e.g. TDOA, RTT, AOA/D, etc) including combination of SL positioning measurements with other RAT dependent positioning measurements (e.g. Uu based measurements) [RAN1]

Finally, at least one company pointed out that we could focus this proposal on the in-coverage cases.

Based on the above, the revised proposal is the following:

##### [MEDIUM] Feature Lead Proposal 3.2-v1

At least for in-coverage ~~and partial-coverage~~ scenarios, study hybrid positioning methods wherein one or more of UE(s) perform SL measurements and position/ranging is estimated using measurements derived on both SL and Uu positioning. ~~Include in the study at least the following aspects:~~

* Note: Companies are encouraged to focus their study on the solutions for standalone SL positioning, while providing information on any change(s) needed in their solutions for enabling hybrid positioning.
* Note: Uu positioning corresponds to RAT dependent methods

##### Companies views

|  |  |
| --- | --- |
|  |  |

# Sidelink Reference Signals for Positioning Purposes (SL-PRS)

## 4.1 Reuse of existing SL reference Signals for Sidelink positioning

Based on the submitted contributions, there were a few companies that suggest to study (and/or support) using one or more of the existing SL reference signals.

|  |  |
| --- | --- |
| Futurewei | Consider supporting the S-SSB based SL position determination |
| Nokia, NSB | Currently defined reference signals over the NR SL are not suitable for positioning purposes. |
| NTT DOCOMO | * Study the following alternatives for SL-PRS.   + Alt 1: Define SL-PRS as a new reference signal.     - Configuration/Indication/Cast-type/Mapping resource/Mapping procedure (rate-matching vs puncturing)/Sequence   + Alt 2: Define SL-PRS as an existing reference signal.     - Configuration/Indication/Cast-type/Mapping resource modification * Supporting SL-PRS as independent signal would lead to significant modification of SL structure. * Support SL-positioning RS multiplexed on PSSCH. |
| Ericsson | A sidelink ranging solution should reuse existing signals |
| Samsung | Study and evaluate performance of SL positioning reference signals considering the following   * Reusing SL synchronization signal in Rel-16 * Reusing DL PRS or positioning SRS design in Rel-16 |

Based on the submitted tdocs, and proposals summarized above, the following proposal is made:

##### [CLOSED][MERGED WITH 4.2.1]Feature Lead Proposal 4.1-v0

Study whether existing SL reference Signals can be reused for sidelink Positioning.

* Limit the study to the existing S-SSB and SL-CSIRS reference signals.

##### Companies views

|  |  |  |
| --- | --- | --- |
| vivo | The wording of this proposal “whether … can be reused” sounded like feasibility study only and not clear about the scope of the study. At least performance evaluation/comparision should be mentioned to see whether such signal can meet the positioning accuracy requirements. | |
| CATT | Low priority.  We prefer to define new SL-PRS based on DL-PRS. The existing SL reference signals cannot meet the accuracy requirements of SL positioning. | |
| MTK | We prefer to have new SL-PRS, but also to slightly prefer to base on SRS | |
| Fraunhofer | It reads from the contributions and proposals that few companies are keen on studying the SL RSs. In our view the UL/DL positioning reference signals are the better starting point especially when targeting high accuracy, multi SL users and extended coverage scenarios. | |
| ZTE | We prefer to not reuse the existing SL reference signals (e.g. SL-CSIRS). Large bandwidth is required for high-accuracy positioning if timing based positioning methods are used. Current sidelink RS in Rel-15/16 is always configured and limited within the bandwidth of PSSCH/SL-data resource pool. If current sidelink RS is reused for SL positioning, it is difficult to satisfy the positioning requirement. | |
| Huawei, HiSilicon | When we study using the existing SL reference Signals for sidelink Positioning, we also wonder what target we are talking about. | |
| Spreadtrum | We prefer to introduce new sidelink positioning reference signal for sidelink positioning. | |
| InterDigital | We agree with the proposal in principle. However, considering SL PTRS is introduced in R16 V2X, we prefer to also include SL-PTRS in the study in addition to SSB and CSI-RS. | |
| Futurewei | We understand and support new SL positioning RS. However, we do not see how this would exclude the use of other existing signals for positioning solutions. Not all applications may require high accuracy, which implies very wide band for SL PRS, therefore simple solutions based on S-SSB or SL-CSIRS should be considered as well. These type of solutions will come with minimal spec changes and overhead. | |
| CMCC | Not preferred.  In NR sidelink, S-SSB only occupies 11 PRBs and the BW is too limited to meet the requirement. In addition, SL-CSIRS are multiplexed on PSSCH, which may not be suitable for SL positioning purpose, because this may not only bring back the issue of processing data and positioning RS simultaneously, but also cannot fulfill the requirement for positioning due to the bandwidth may not be large enough. | |
| NEC | Although we agree existing RS can be re-used as a starting point, we do not agree to limit the study since we do not know if the existing design can fulfill the target requirements at current stage. | |
| Sony | Low Priority. We should focus on the reference signal that is optimized for positioning purpose (i.e, in providing good accuracy). |
| OPPO | We do not think S-SSB and SL-CSIRS can be used as SL-PRS, S-SSB is transmitted from multiple UEs in SFN manner, it is impossible to use it for either absolute positioning or ranging, and the density of SL-CSIRS is only 1, it cannot ensure the accuracy if use for positioning. We prefer to deprioritize existing SL siganls and leave it up to companies to study. |
| Lenovo | Prefer to use existing PRS/SRS design, which has been designed specifically to meet the positioning requirements. | |
| Apple | Although the S-SSB and SL-CSI-RS may be re-used in a CID-like manner, we think that positioning signals based on the PRS/SRS design are optimized for positioning and should be the starting point of the design. | |
| Locaila | We prefer to define new SL-PRS. | |
| Samsung | OK for the main bullet of proposal 4-1.  For the sub-bullet, no need to limit to S-SSB and SL-CSI-RS, infact SL PSSCH DMRS might be a better option. | |
| Qualcomm | In our view, neither S-SSB nor SL CSI-RS is suitable for use as a positioning reference signal and there is no need to study further. S-SSB has very limited bandwidth (11 PRBs) and is SFNed from multiple UEs. Meanwhile, SL CSI-RS is limited to a single symbol, can only be transmitted together with PSSCH, is limited to the allocated PSSCH bandwidth and shares resources with other sidelink signals. | |
| DCM | Same view with Samsung. | |
| LGE | We think S-SSB and SL CSI-RS are not appropriate for SL positioning. The frequency of S-SSB transmission is too low, and its transmission is scheduled so dynamic transmission is not possible. As for CSI-RS, it too sparse in time and frequency domain, so it’s hardly expected to meet the SL positioning requirements. | |
| Sharp | We prefer to introduce new positioning reference signals, but we are ok to study to reuse existing SL reference signals. | |
| xiaomi | We share the view of othe companies that existing SL signals are not suitable for positioinig purpose. We prefer to define new SL positioning signals other than reusing existing SL signals. | |
| Philips | We prefer to introduce new positioning reference signal for sidelink positioning | |
| Nokia, NSB | Deprioritize study of existing SL reference signals for sidelink positioning. We prefer to define new reference signal for SL positioning. | |
| Ericsson | We support the proposal. As mentioned by Futurewei, the existing SL reference signals may still be considered for applications relying on simple solutions that reuse existing SL reference signals. | |

##### FL Observations

Most companies consider reusing existing SL reference signals as low priority, or explicitly say that these will not meet requirements:

* Low priority to study existing SL reference signals / prefer to have a new SL-PRS
  + CATT, MTK, vivo, Fraunhofer, ZTE, Speadtrum, CMCC, NEC, Sony, OPPO, Lenovo, Apple, Localia, Qualcomm, LGE, Sharp, Xiaomi, Philips, Nokia, NSB
* OK to study the existing SL reference signals
  + Futurewei, Samsung, NTT DOCOMO, Ericsson

Maybe, one way to progress on this is to close the 4.1 section and try to merge it with Section 4.2, as shown later.

## 4.2 Design of a new SL reference Signal (SL-PRS)

#### 4.2.1 General proposals on a new SL-PRS reference signal

Based on the submitted contributions, there appears to be a lot of companies that suggested to study (or directly support) designing a new reference signal for SL Positioning, as shown in the statements below:

|  |  |
| --- | --- |
| Futurewei | RAN1 should consider the UL PRS design as the starting point of the S-PRS design |
| Nokia, NSB | A new reference signal should be defined over SL interface for positioning purposes. For this, the structure of the UL SRS can be re-used, with any necessary modifications to be studied.  Study mechanisms to support multiplexing of SL PRS belonging to different users in time, frequency or code domain, such as in coordination with the target UEs.  Allocation of frequency bands for SL positioning purposes, and any required modifications to the configuration and use of SL resource pools should consider the bandwidth requirements of SL positioning based on the performance evaluations to be conducted.  Study mechanisms to support co-existence of SL PRS transmissions with other SL transmissions. |
| Samsung | Study and evaluate performance of SL positioning reference signals considering the following   * Reusing SL synchronization signal in Rel-16 * Reusing DL PRS or positioning SRS design in Rel-16 |
| CEWiT, Reliance Jio, Saankhya Labs, IITM, IITK | New positioning reference signal should be designed for sidelink positioning. CSI-RS can be used as the baseline. |
| Fraunhofer IIS, Fraunhofer HHI | The sidelink reference signals for positioning should be based on SRS-Pos. |
| vivo | Introduce a new SL reference signal (i.e., SL PRS) for SL positioning.  SL PRS can be transmitted without PSSCH transmission in the resource pool.  SCI should be transmitted with the associated SL PRS.  Slot level SL PRS transmission should be supported. |
| CMCC | RAN1 should further study which signal should be used as design baseline for sidelink positioning RS, b/w PRS and SRS-Pos  Parameters of SL positioning RS, e.g., number of symbols, RS comb size, and RS BW, should be (pre)configured on resource pool level.  Configuration of SL positioning RS should be tied to BWP  Multiplexing rule b/w PSCCH and positioning RS resources may need to be re-designed for NR SL positioning. |
| ZTE | SL-PRS design, consider DL-PRS like signals to reduce the specification complexity |
| China Telecom | Consider the angle estimation based on the waveform measurement. Consider the possibility of introducing SRS-Pos or PRS as the reference signal  For the angle estimation based on the RSRP measurement, consider the possibility of the CSI-RS or PRS as the reference signal used here for positioning, and some modifications of physical procedures especially beam management related are required  Introduce PRS or SRS-Pos into sidelink as the reference signal for time of flight measurement.  Introduce PRS or SRS-Pos into sidelink as the reference signal for TDOA measurement |
| Qualcomm | Sidelink PRS to use DL-PRS as a starting point and enhance the design if necessary |
| ROBERT BOSCH GmbH | Study SPRS design, allocation and signalling considering the following aspects:   * Reusing NR Uu SPRS design as much as possible * Impact of sidelink synchronization method and sidelink broadcast channel * Impact on sidelink control channel design including coexistence to old releases * SPRS scheduling impact on SL resource (re-)selection / reservation, * SPRS allocation with interference avoidance mechanism * SPRS allocation with periodic reservation and/or dynamic (on demand) allocation * SPRS request and response should consider the different casting types, i.e., unicast, groupcast, and broadcast   Study whether SPRS design should consider both full sensing UEs and partial sensing/DRX capabilities introduced with Rel-17  Study enhancing Sidelink positioning accuracy using S-PRS bandwidth aggregation (will be introduced in Rel-18). |
| Xiaomi | PRS is considered as the baseline for sidelink positioning signal design if coverage performance requirement of sidelink positioning can be satisfied, otherwise SRS is considered as the baseline |
| Sharp | For reference signals for sidelink positioning, the starting point for the discussion of the structure is PRS and SRS for positioning in Rel-16/17.   * The difference of the SL environment from DL/UL should be considered * The trade-off between the performance of sidelink positioning and the overhead of the reference signals should be considered |
| Sony | Consider supporting multiplexing of sidelink positioning reference signal from several UEs within a given set of resources |
| Localia | Study new sidelink positioning reference signal efficient for supporting phase-based measurement method |
| Lenovo | RAN1 to consider at least the following design criteria for SL PRS:   * Configurable transmission bandwidth and allocation in time frequency resources * Configurable periodicity and transmission duration (number of symbols) * Good auto and cross correlation properties in the presence of time and frequency offsets and /or Doppler effects * Sufficient degree of randomization and orthogonalization for PRS transmission from multiple Initiator UEs * PAPR   RAN1 to consider at least the following configurability options for SL PRS:   * Unambiguous identification of initiator UEs and responder UEs |
| Spreadtrum | Sidelink positioning reference signals should be introduced for sidelink positioning |
| LGE | A method to make SL PRS transmission and reception reliable between the distant UEs needs to be studied.  If RX UE fails to receive SL PRS or the quality of the received SL PRS does not meet a condition, UE sends SL PRS retransmission request to TX UE |
| Intel | For SL-PRS design, both NR-PRS and SRS-for-positioning should be studied for potential support.   * + - Specification support of up to 100 MHz/400 MHz BW for FR1/FR2 (licensed bands) should be considered for SL positioning.     - In addition, RAN1 should study the performance for SL positioning in limited bandwidth scenarios, e.g., up to 20 MHz. |
| NEC | Sidelink positioning reference signal (S-PRS) should be designed with NR DL PRS and UL SRS-Pos as a baseline and the design should be adapted to sidelink slot formats  S-PRS transmission pattern should be determined based on S-PRS design and related evaluation.  − including number of OFDM symbols, number of repetitions, gap between two repetitions, etc. |
| Interdigital | Study PRS configuration structure, using the Uu positioning PRS hierarchical structure |

Based on the above, the FL proposal is to study a new SL positioning reference signal for SL positioning ranging:

##### [CLOSED]Feature Lead Proposal 4.2.1-v0

Study a new SL positioning reference signal (SL-PRS) for sidelink positioning/ranging.

* The study could at least include: Sequence design, frequency domain pattern, time domain pattern (e.g. number of symbols, repetitions, etc), time domain behavior, configuration/triggering/activation of the SL-PRS, AGC time, Tx-Rx Turanround time, supportable bandwidth(s), multiplexing options with other SL channels, randomization/orthogonalization options.

##### Companies views

|  |  |
| --- | --- |
| CATT | Support |
| MTK | okay |
| Fraunhofer | We miss a proposal similar to 4.1-v0 on the study for reusing of UL or DL positioning reference signals as a baseline for SL-PRS. We assume the study/evaluation of solution on the SL specific ehnacements for the issues treated in the following proposals become easier. |
| ZTE | Support to study a new SL positioning reference signal. |
| Huawei, HiSilicon | We appreciate the effort. However, this proposal can mean everything or is saying nothing.  Can we try to make some points more concrete? For example, what sequces can be the starting point? What options we can focus on the frame structure for SL-RS transmission? If there are other concrete proposals later, then we don’t need to agree on this proposal. |
| Spreadtrum | Support |
| InterDigital | We agree with the proposal |
| Futurewei | We support proposal in principle, but we notice that most of companies consider as starting point either DL PRS or UL PRS (SRS Pos) therefore we think that the proposal should be focus only on these two type of sequences, and emphasize the reuse (and extension) of the existing design. |
| CMCC | Support.  Both PRS and SRS-Pos in NR Uu positioning can be baseline. |
| NEC | Agree |
| Sony | Support and consider the legacy positioning signals as the baseline. |
| OPPO | Support. |
| Lenovo | Support proposal, However, it would be better to add a clarification to assist in the selection of SL PRS. Suggestion the following modification for the 1st line of the proposal:  “Study new SL positioning reference signal for SL positioning/ranging based on the existing PRS/SRS design, the study of other existing SL RS is also not precluded” |
| vivo | Support the intention.  However, as stated in the SID “reusing existing reference signals, procedures, etc from sidelink communication and from positioning as much as possible”, we suggest a rewording to the main bullet.  “Study new SL positioning reference signal for SL positioning/ranging based on existing PRS/SRS and SL design aspects”. |
| Apple | Support overall idea. Lenovo’s languate seems to be fine for a high level agreement at this time. |
| vivo2 | Also,the sub-bullet seems not needed given FL’s proposals in the following sub-sections of 4.2. |
| Locaila | Support. |
| Samsung | OK for the direction of proposal 4.2.1 in general.  We suggest to add the following note as  “Note: RAN1 strives to reuse design aspects from DL PRS and/or Positioning SRS” |
| Qualcomm | We support the proposal. |
| DCM | OK |
| LGE | We support the proposal in general. But we prefer to reuse the existing positioning reference siganls as much as possible. NR PRS and SRS for positioning should be a starting point for a new SL PRS. |
| Sharp | Agree with the FL proposal. |
| Xiaomi | We are fine with the proposal. We are also supportive if the candidate SL\_PRS signaling design baseline can be listed to narrow the discussion scope: DL PRS or UL SRS for positioning. |
| Nokia, NSB | OK |
| Ericsson | DL-PRS and UL-SRS for positioning should be the starting point for studying signals used for sidelink positioning measurements.  The sub-bullet is to detailed and includes a broad list. This items can be considered later. So suggest to remove the sub-bullet. |

##### FL Observations

As was noted in Section 4.1 and 4.2.1, there is strong support looking more closely at a new SL reference signal. It was pointed out by a few companies that it may be useful to clarify that the existing PRS/SRS design should be used as a baseline. Based on this input, the revised proposal is:

##### [HIGH]Feature Lead Proposal 4.2.1-v1

Study new SL positioning reference signal for SL positioning/ranging based on the existing PRS/SRS design and SL design aspects

* The study could at least include: Sequence design, frequency domain pattern, time domain pattern (e.g. number of symbols, repetitions, etc), time domain behavior, configuration/triggering/activation of the SL-PRS, AGC time, Tx-Rx Turanround time, supportable bandwidth(s), multiplexing options with other SL channels, randomization/orthogonalization options.
* Note: The study of existing SL reference signal for SL positioning/ranging is not precluded. Companies are encouraged to perform performance evaluation/comparision to investigate whether such reference signals can meet the positioning accuracy requirements.

Companies are encourage to comment whether they consider the first subbulet useful, or they prefer to remove it.

##### Companies views

|  |  |
| --- | --- |
|  |  |

#### 4.2.2 SL-PRS Sequence design Proposals

Based on the submitted contributions, there appears to be a good set of companies that have proposals on what should be the sequence of SL-PRS. In the table below, we summarize the corresponding proposals.

|  |  |
| --- | --- |
| Futurewei | RAN1 should consider the UL PRS design as the starting point of the S-PRS design |
| Huawei, HiSilicon | The candidate SL-PRS sequences should support the pseudo-random sequences.  Companies should report the used sequences for SL-PRS transmission in the evaluations. |
| CATT, GOHIGH | Gold sequence should be adopted as the sequence of S-PRS. |
| vivo | The of SL PRS can be associated with some UE information (e.g., pre-configured sequence ID, source ID). |
| ZTE | * Sequence: gold sequence or ZC (Zadoff-Chu) sequence   + Gold sequence is preferable to align with sidelink CSI-RS design. |
| Apple | DL-PRS and positioning SRS both considered as candidates for the SL-PRS.   * + UE may be configured with one or both of these variants.   + UE may indicate its capability to support one or both of these variants. |
| OPPO | DMRS sequence of sidelink PSCCH/PSSCH should be used as SL-PRS, and low-PAPR sequence can be considered if larger coverage needs to be supported in sidelink positioning |
| Sony | Consider UL-SRS as the sidelink reference signal for positioning, as the baseline during the evaluation. |
| Lenovo | RAN1 to further study the feasibility of SL PRS Gold sequence signals for UEs without power limitations such as vehicular UEs or RSUs  RAN1 to further consider the feasibility of SL PRS ZC signals for UEs with power limitations such as commercial handheld devices, IIoT and pedestrian UEs |
| LGE | Either NR DL PRS sequence or SRS sequence for positioning is the starting point for SL PRS sequence design |
| Mediatek | ZC is slightly preferred over the Gold as the sequence for SL-PRS, due to the low PAPR property |
| Qualcomm | Sidelink PRS to use DL-PRS as a starting point and enhance the design if necessary. |

Based the submitted contributions, we observe there is a need for more discussion on whether a ZC-based or a Pseudo-rando sequence should be used as baseline for SL-PRS, as summarized below (please feel to correct/remove/add in the comment section):

|  |  |  |
| --- | --- | --- |
| Option 1: Use as baseline Pseudo-random sequence (e.g. Gold sequence signals, similar to DL-PRS/SL-CSIRS) | Option 2: Use as baseline ZC-based design, (e.g. similar to UL SRS) | Option 3: Study/consider both options |
| Huawei, HiSilicon, CATT, GOHIGH, OPPO, Qualcomm | Futurewei, ZTE, Sony, Mediatek | Apple, Lenovo, LGE |

Therefore, the following proposal is made:

##### [CLOSED]Feature Lead Proposal 4.2.2-v0

Study further both the following options with regards to the sequence design for the new SL Positioning Reference Signal:

* Option 1: ZC-based design, (e.g. similar to the sequences used for NR SRS)
* Option 2: Pseudorandom sequence (e.g. Gold sequence signals, similar to DL-PRS, or SL-CSI-RS).

##### Companies views

|  |  |
| --- | --- |
| CATT | Support Option 2.  We prefer to reuse the Gold sequence, similar to DL-PRS. |
| MTK | We are okay to study both before making decision |
| ZTE | Thanks for FL’s summary table but we want to clarify that Gold sequence is preferred for us to align with sidelink CSI-RS design. |
| Huawei,  HiSilicon | If it would be helpful to guide the further study, we suggest adding a note to consider high Doppler shift especially for V2X scenario. |
| Spreadtrum | We are open to discuss both Option 1 and Option 2. |
| InterDigital | We favor Gold sequence, as it is used for SL RS. In addition, we consider the SL PRS transmission coverage requirement is not as stringent as the UL transmission and thus the PAPR requirement is of less concern. |
| Futurewei | We are open to discuss both options, but we have a slight preference for Option 1. |
| CMCC | Open.  Both the sequences of PRS and SRS-Pos can be used as baseline. |
| Sony | It is a bit confusing when we see the table and the proposal (i.e, Option 1 in table 1 is about pseudo random sequence while, Option 1 in the FL proposal is about ZC-based design).  Our preference is ZC-based design (Option 1 as in the FL proposal). |
| OPPO | Support the proposal to further study the 2 sequences. But in our view only one sequence is use as SL-PRS at the end, maybe we can add this restriction at this stage. |
| Lenovo | We are currently open to both options regarding the new SL PRS. For clarification, is the eventual outcome to downselect the two options for eventual support? |
| vivo | As pointed out by Sony, the numbering of options in table and proposal is not matched which cause confusion.  Before we jump into discussion on sequence design for SL-PRS, maybe a high level principle should be discussed first: whether we follow PRS or SRS to begin with.  Furthermore, for study of sequence, we’d like to know what aspect(s) to look into for further study. |
| Apple | We are fine with studying both options. |
| Locaila | We support the study of both ZC and PN sequence design for the new SL-PRS. |
| Samsung | OK for the direction of proposal 4.2.2 in general |
| Qualcomm | We are ok with the proposal. In terms of the options, we support Option 2 since it is a better fit with the existing NR sidelink signals. |
| DCM | OK with this proposal to study further. |
| LGE | We’re open to both options but slightly prefer option 2 due to the performance degradation of ZC sequence under UE mobility. |
| Sharp | We are OK to study both options. |
| Xiaomi | We are supportive to study both options, but think finally only 1 SN shall be supported. |
| Nokia, NSB | OK |
| Ericsson | During study phase, both options could be considered. We feel it is a bit too early to be discussing down selection to specific sequence designs. |

##### FL Observations

Most of the companies seem OK to study both options. A few of the companies explicitly provided a preference for either one or the other. It doesn’t seem possible clearly to downselect now. To improve the proposal, a few suggestions were made:

* Could we agree that eventually a single option will be supported?
* Could we add which aspects should be studied with regards to these 2 sequences?

##### [HIGH]Feature Lead Proposal 4.2.2-v1

Study further both the following options with regards to the sequence design for the new SL Positioning Reference Signal:

* Option 1: ZC-based design, (e.g. similar to the sequences used for NR SRS)
* Option 2: Pseudorandom sequence (e.g. Gold sequence signals, similar to DL-PRS, or SL-CSI-RS).
* Note 1: Companies are encouraged to consider at least the following aspects in their study: PAPR aspects, high mobility, commonality with other SL-RS, performance evaluation(s)
* Note 2: RAN1 should downselect one of the options

Companies are encouraged to provide views specifically on the 2 Notes:

* Question 1: What additional elements are you interested in including in Note 1?
* Question 2: Do you support Note 2?

##### Companies views

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#### 4.2.3 SL-PRS Frequency domain Pattern

Based on the submitted contributions, several proposals were made with regards to the SL-PRS frequency domain pattern:

|  |  |
| --- | --- |
| Huawei, HiSilicon | The comb structure of PRS should be supported for SL-PRS design. |
| Futurewei | RAN1 should consider the UL PRS design as the starting point of the S-PRS design |
| Nokia, NSB | A new reference signal should be defined over SL interface for positioning purposes. For this, the structure of the UL SRS can be re-used, with any necessary modifications to be studied. |
| Samsung | Study frequency domain behaviour for SL positioning reference signal as   * The number of supported sub-channels for SL positioning reference signal |
| Fraunhofer IIS, Fraunhofer HHI | Support the sidelink transmission in the whole carrier bandwidths up to 40 MHz which are defined in TS 38.101-1  RAN1 to study the impact of the following options to improve the sidelink accuracy in Rel-18:   * Option 1: for sidelink positioning in inter and intra-band operation: allow a maximum transmission and reception for UE capable devices according to the bandwidth allowed for Uu: {50, 60, [70], 80, 90, 100} MHz. * Option 2: allow bandwidth extension by applying CA for SL   Support staggered SRS for the sidelink positioning reference signal.  Study the use of low power positioning reference signals with a bandwidth higher than the bandwidth allocated for sidelink (communication) signals |
| vivo | Support reuse of one or more comb sizes of DL-PRS for the SL-PRS pattern.  Partial staggered pattern can be considered for SL-PRS pattern considering SL structure (e.g, excluding the PSCCH symbol, AGC, or GP symbol for SL-PRS transmission) |
| ZTE | SL-PRS Pattern   * Comb size |
| OPPO | Both full RE mapping pattern and comb-like pattern should be further studied for SL-PRS design. |
| Qualcomm | RAN1 to further study contiguous or comb structure ZC sequence design for SL PRS |
| Mediatek | Consider partial staggering or non-staggering structure for SL-PRS |
| Interdigital | Study PRS patterns for SL positioning, using the Uu PRS patterns as the starting point |

Based on the above, it seems that companies consider a comb-based design for SL-PRS, and therefore the following proposal is made:

##### [CLOSED] Feature Lead Proposal 4.2.3-v0

With regards to the frequency domain pattern, study further a Comb-N SL-PRS design. Study at least the following aspects:

* N>=1 (where N=1 corresponds to full RE mapping pattern)
* Fully staggered SL-PRS pattern (i.e., N symbols of SL-PRS with comb-N and, at each symbol a different RE offset is used), Partially staggered SL-PRS pattern, Unstaggered SL-PRS patterns
* The number of symbols of SL-PRS within a slot, and any relation to the comb-N options

##### Companies views

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| --- | --- |
| CATT | Support |
| MTK | okay |
| ZTE | Agree to further discuss comb pattern of SL-PRS. |
| Spreadtrum | Support |
| InterDigital | We think it will be beneficial to have one or more target PRS bandwith requirements based on the supported positioning method and use case and apply such requirements to the frequency domain pattern design. In addition, this may be related to PRS slot structure, e.g. whether or not PRS is multiplexed with other SL channels within a slot either in time or frequency domain. Thus we propose to make the following change to the proposal:  With regards to the frequency domain pattern, study further a Comb-N SL-PRS design. Study at least the following aspects:   * N>=1 (where N=1 corresponds to full RE mapping pattern) * Fully staggered SL-PRS pattern (i.e., N symbols of SL-PRS with comb-N and, at each symbol a different RE offset is used), Partially staggered SL-PRS pattern, Unstaggered SL-PRS patterns * The number of symbols of SL-PRS within a slot, and any relation to the comb-N options * Consideration for PRS multiplexing with other channels |
| Futurewei | Support |
| CMCC | Support |
| NEC | OK |
| Sony | Okay |
| OPPO | Support |
| Lenovo | Support FL’s proposal. |
| vivo | OK in principle.  On the suggested modification from InterDigital, we don’t think multiplexing with other channels is the only aspect need to be considered for comb design. Either we add all aspects worth consideration together or not at all. |
| Apple | We are fine with the proposal. |
| Locaila | Doppler-resistant block-type pattern such as PTRS is required. |
| Samsung | OK for the direction of proposal 4.2.3 in general |
| Qualcomm | Support |
| DCM | OK with this proposal to study further. |
| LGE | Support with one comment. Staircase pattern should also be included for study, which is beneficial for multiplexing different comb patterns in a slot. |
| Sharp | Support |
| Xiaomi | Agree |
| Nokia, NSB | OK |
| Ericsson | This is a further detail. These aspects can be studied of course. |

##### FL Observations

Most of the companies seem OK with the proposal in the current form. Two additional comments:

* LGE: “Staircase pattern should also be included for study”
  + FL: A staircase pattern is an example of pattern that can be fully/partially staggered, so it is within the study clearly.
* Localia: “Doppler-resistant block-type pattern such as PTRS”
  + Maybe we could add the expression “RE offset repetitions”, which I think is what you are referring as “block-type pattern”.

##### [HIGH] Feature Lead Proposal 4.2.3-v1

With regards to the frequency domain pattern, study further a Comb-N SL-PRS design. Study at least the following aspects:

* N>=1 (where N=1 corresponds to full RE mapping pattern)
* Fully staggered SL-PRS pattern (i.e., N symbols of SL-PRS with comb-N and, at each symbol a different RE offset is used), Partially staggered SL-PRS pattern, Unstaggered SL-PRS patterns
* The number of symbols of SL-PRS within a slot, any relation to the comb-N option, RE offset repetitions within a slot

##### Companies views

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#### 4.2.4 SL-PRS Time domain Behavior

Based on the submitted contributions, several proposals were made with regards to the SL-PRS time domain pattern:

|  |  |
| --- | --- |
| Samsung | Study time domain behaviour for SL positioning reference signal as   * The number of supported symbols for SL positioning reference signal * Aperiodic (one shot or N shots), semi-persistent or periodic |
| Fraunhofer IIS, Fraunhofer HHI | Support the allocation of “double burst” (e.g. pairs of SRS-pos) for relative speed measurements |
| CATT, GOHIGH | Periodic, semi-persistent and aperiodic S-PRS should be supported in Rel-18.  The semi-persistent S-PRS and aperiodic S-PRS transmission procedure should be triggered explicitly by the related signaling procedure. |
| CMCC | RAN1 should further study which type of RS in time domain should be supported in Rel-18, including periodic, semi-persistent, and aperiodic |
| ZTE | * SL-PRS Pattern   + Number of OFDM symbols within a slot * Periodicity: specify the periodicity of SL-PRS and the modification based on the DL-PRS’s periodicity. * Repetition |
| OPPO | Both periodic SL-PRS transmission and on-demand SL-PRS transmission should be considered in sidelink positioning. |
| Lenovo | RAN1 to consider at least the following configurability options for SL PRS:   * Support of periodic/semi-persistent/aperiodic transmission of SL PRS |
| LGE | The following types of SL PRS transmission are supported.   * Semi-persistent SL PRS transmission * Aperiodic SL PRS transmission * On-demand SL PRS transmission   When LMF/gNB schedules the SL PRS resources, the following operations are supported.   * Semi-persistent SL PRS resources can be allocated to UE based on a single UE request. * Aperiodic SL PRS resources can be allocated to UE based on the UE request per SL PRS transmission. |
| NEC | Periodic, aperiodic and semi-persistent resource configuration for S-PRS and related reporting should be supported. |
| Huawei, HiSilicon | Support at least aperiodic PRS triggered by SCI for sidelink positioning. |

Based on the above proposals, and also Section 4.2.5, it may be beneficial at this point to clarify the following two aspects:

* A 1st aspect is whether the SL-PRS is an “always-On” or “On-demand” signal (see for example, the NR Rel-16 DL-PRS and the new feature added in NR Rel-17 on on-demand DL-PRS)
* A 2nd aspect is whether the SL-PRS is configured through high-layer (RRC/LPP/SLPP/PC5-RRC), activated through MAC-CE, or triggered through SCI, or any combination of those. This aspect might be referred to, in some of the above papers, as “periodic” (e.g. high-layer configured), “semi-persistent” (high-layer configured with MAC-CE used for activation), “aperiodic” (high-layer configured with SCI used for triggering).

I think it will be useful to start with the 1st aspect in this proposal, and ask the companies whether they find it useful to clarify this aspect, whether we need to study both options for SL positioning, or not:

##### [CLOSED]Feature Lead Proposal 4.2.4-v0

With regards to the time-domain behavior of the SL-PRS, companies are encouraged to provide their views, whether they support one or both of the following options to be studied:

* Option 1: Always-on SL-PRS
  + SL-PRS is pre-configured and is always transmitted in a given deployment (i.e., similar to the NR Rel-16 DL-PRS defined in the Uu interface)
* Option 2: On-demand SL-PRS
  + Request/configuration/activation/triggering message(s), or a combination of such messages, is needed for one or more instances of a SL-PRS to be transmitted
* Note: How SL-PRS is configured, e.g, through high layers, and/or activated/deactivated through MAC-CE, and/or triggered by SCI, or any combination of signaling, is a separate topic.

##### Companies views

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| --- | --- |
| CATT | Support to study both Option 1 and Option 2.  We prefer that periodic, semi-persistent and aperiodic S-PRS should be supported in Rel-18. |
| MTK | 1, We have some concern on Option 1 for the pre-configured SL-PRS. The main reason is, the RTT measurement is quite important for relative positioning. So it requires UE A🡪 UE B 🡪 UE A as one sided or A🡪B🡪A🡪B as two sided, the transmission A🡪 B and B🡪 is expected to be as close as possible especially under mobility. So we prefer option 2  2, We also assume that option 2 may contain “coordination” between UEs for SL-PRS transmission. So we suggest to add a note that “Option 2 may contain coordination between UEs for SL-PRS configuration |
| ZTE | Open to discuss. In our understanding we can firstly choose and prioritize Option 1 as a starting point. |
| Huawei, HiSilicn | Our first preference is option 2.  Keeping both options open for further study is fine since for now everything is open for more study/discussion because we are thinking it is somehow related with RS resource allocation schemes.  One question for clarification on the categorization into “Always-on SL-PRS” and “On-demand SL-PRS” is that even DL-PRS may not be always ON, and periodic Uu RS may not be always ON. On the other hand, does “On-demand SL-PRS” also includes some sort of periodic signal that is transmission is configured, instead of pre-configured. |
| Spreadtrum | Open to discuss both Option 1 and Option 2. We prefer Option 2. |
| **Feature Lead Clarification** | Clarification to avoid ambiguity: “On-demand PRS” includes periodic PRS that is configured but NOT pre-configured. If it helps with the discussion, consider the “i.e.” as deleted in option 1:   * SL-PRS is pre-configured and is always transmitted in a given deployment ~~(i.e., similar to the NR Rel-16 DL-PRS defined in the Uu interface)~~ |
| InterDigital | We are ok to study both options. Option 1 may be more suitable for positioning involving RSU. |
| Futurewei | We are open to discuss both options, however we prefer Option 2, we also notice that the positioning signaling and procedure may be triggered by upper layers and therefore we are not sure if would be compatible with Option 1. |
| CMCC | Support to study both options.  We believe at this initial stage, either type of PRS should not be precluded and can be further studied. |
| NEC | Both options should be studied. |
| Sony | Let’s keep it open at this stage. We support to study both options. |
| OPPO | We support to further study both options, always-on is more suitable for TDOA based absolute positioning, and on-demand is preferable for RTT based method. |
| Lenovo | We have a preference towards Option 2. In the case of out-of-coverage , Option 1 may challenging to always transmit PRS given the resource selection mechanisms in Mode 2, and therefore has dependency on the type of coverage scenario. |
| vivo | Not against the study, but we don’t feel this “always on” or “on demand” is part of physical layer SL-PRS design.  We prefer to discuss this after we know more about PHY SL-PRS design itself. For instance, after we know the number of symbols of SL-PRS within a slot, whether to support symbol level SL-PRS, etc. |
| Apple | We are okay to study both options |
| Locaila | Support to study Option 1. |
| Samsung | Study two options.  For option 2, we sugget adding “deactivation” as   * Option 2: On-demand SL-PRS   Request/configuration/activation/deactivation/triggering message(s), or a combination of such messages, is needed for one or more instances of a SL-PRS to be transmitted |
| Qualcomm | The terminology used is a bit confusing in the context of sidelink. Is the intention to separate pre-configuration from network-based configuration? Or is the intention to have (pre-)configuration in Option 1 and include PC5-RRC configuration also in Option 2?  We support studying both options and propose the following update to the proposal, addressing the terminology comment above:  With regards to the time-domain behavior of the SL-PRS, companies are encouraged to provide their views, whether they support one or both of the following options to be studied:   * Option 1: Always-on SL-PRS   + SL-PRS is (pre-)configured and is always transmitted in a given deployment (i.e., similar to the NR Rel-16 DL-PRS defined in the Uu interface) * Option 2: On-demand SL-PRS   + Request/PC5-RRC/configuration/activation/triggering message(s), or a combination of such messages, is needed for one or more instances of a SL-PRS to be transmitted * Note: How SL-PRS is configured, e.g, through high layers, and/or activated/deactivated through MAC-CE, and/or triggered by SCI, or any combination of signaling, is a separate topic. |
| DCM | We think Option 2 is much better, but we are OK to study both. |
| LGE | We prefer option 2. Always-on SL PRS transmission is not feasible because there is no scheduler such as gNB/LMF in Uu link based positioning. In this sense, on-demand approach is more aligned with SL transmission property. If a periodic SL PRS is configured in option 2, isn’t is same as semi-persistent? That is, a periodic SL PRS transmission can be activated or deactivated based on the needs. |
| Sharp | We are OK to study both options. |
| Xiaomi | We are fine to study both but more prefer to option 2. Burst TXs of PRS are needed for RTT measurement.  We also think there is no need to differentiate pre-configuration and NW configuration. (Pre-)configuration has been widely used in sidelink discussion, that is, preconfiguration is used when OOC and NW configuration is used when IC. |
| Huawei, HiSilicon | Thanks for the clarification from FL.  We are confused by adding “PC5-RRC” prior to “/configuration”, is it correct interpretation that “configuration” means “Uu-RRC” (not for the preconfiguration)?  In addition, we think it should be helpful to add the following Note to make it clear.   * Option 2: On-demand SL-PRS   + Request/PC5-RRC/Uu-RRC configuration/activation/triggering message(s), or a combination of such messages, is needed for one or more instances of a SL-PRS to be transmitted   + Note: This may include periodic, semi-persistent, and/or aperiodic SL-PRS. |
| Nokia, NSB | OK to study both, but prefer Option 2. Regarding terminology, prefer to stick to existing SL conventions, hence “(pre-)configured” as proposed by Qualcomm. |
| Ericsson | Ok to study both options for now. |

##### FL Observations

Good support to study both options, even though there seems to be clear majority to support only Option 2. There may be some further clarification needed with regards to the terms pre-configuration, PC5-RRC configuration, Uu-RRC configuration. At least in within SL context, the term pre-configuration and NW configuration, has been widely used with the term (pre-)configuration. It may be more appropriate to continue with this approach for SL positioning. Therefore we make the following proposal:

##### [MEDIUM]Feature Lead Proposal 4.2.4-v1

With regards to the time-domain behavior of the SL-PRS, study the following options:

* Option 1: Always-on SL-PRS
  + SL-PRS is (pre-)configured and is always transmitted in a given deployment
* Option 2: On-demand SL-PRS
  + Request/PC5-RRC-configuration/Uu-RRC-configuration /activation/deactivation/triggering message(s), or a combination of such messages, is needed for one or more instances of a SL-PRS to be transmitted
* Note: This may include periodic, semi-persistent, and/or aperiodic SL-PRS.
* Note: How SL-PRS is configured, e.g, through high layers, and/or activated/deactivated through MAC-CE, and/or triggered by SCI, or any combination of signaling, is a separate topic.

##### Companies views

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#### 4.2.5 SL-PRS Configuration/Triggering/Activation

Based on the submitted contributions, several proposals were made with regards to the SL-PRS Configuration/Triggering/Activation:

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| --- | --- |
| NTT DOCOMO | * For SL-positioning,   + Study details on configuration/indication/report |
| Huawei, Hisilicon | Support at least aperiodic PRS triggered by SCI for sidelink positioning  Consider the following SL-PRS configuration schemes:   * Alt1: SL-PRS is (pre-)configured by higher layers, and SCI is used for time/frequency reservation. * Alt2: SL-PRS is configured by SCI. |
| CATT, GOHIGH | For all types of S-PRS (periodic, semi-persistent and aperiodic S-PRS), the required measurements are configured through SLPP (the definition is up to RAN2). And corresponding SL measurements are also reported through SLPP. |
| CMCC | SL positioning RS should also be transmitted along with PSCCH to reserve further resources and mitigate the resource collision possibility  Procedure for CSI-RS measurement in Rel-16 NR sidelink could be a reference for SL positioning RS resource configuration/indication.  The usage of 2nd SCI for reception can be precluded by defining a similar procedure to CSI-RS measurement for SL positioning RS. |
| ZTE | Support using SCI to trigger SL-PRS and consider the following 2 cases:   * SCI can schedule both SL-PRS and SL-data; * SCI can either schedule SL-PRS or SL-data.   If mode 1 resource allocation for SL positioning is supported   * Support using DCI to dynamically or semi-persistently schedule SL-PRS and consider whether a new DCI format other than DCI format 3\_0 is needed |
| China Telecom | The detail of the resource configuration and trigger signaling design should be as compatible as possible with existing sidelink capabilities |
| Lenovo | RAN1 to consider the triggering mechanism of SL PRS transmission(s), e.g., from UE/gNB/LMF and higher layers |
| LGE | It is supported that LMF/gNB initiates the SL PRS procedure, including SL positioning group configuration  It is supported that LMF/gNB schedules the SL PRS resources  To shorten the SL positioning latency, the SL PRS related parameters such as SL positioning method, SL PRS resource or resource set configuration, etc. allowed in a resource pool can be (pre-)configured.  When LMF/gNB schedules the SL PRS resources, the following operations are supported.   * Semi-persistent SL PRS resources can be allocated to UE based on a single UE request. * Aperiodic SL PRS resources can be allocated to UE based on the UE request per SL PRS transmission. |
| Mediatek | RAN1 to discuss the configured parameters for SL-PRS transmission. Once agreed, RAN2 may further handle the corresponding signalling  RAN1 to discuss the required assistance information for SL-PRS measurement. Once agreed, RAN2 may further handle the corresponding signalling  RAN1 to discuss whether there are pre-defined time/frequency physical resources for SL-PRS allocation. SCI could be used to indicate the occupation within the pre-defined physical resources |
| Intel | RAN1 to investigate potential solutions for conveying SL-PRS configuration and scheduling information from a transmitting UE over SL.   * + - * For different requirements and use-cases (in-coverage, inter-cell, partial coverage), different options that enable trade-off between flexibility, overhead, and reliability should be studied carefully.   If the currently defined formats for first and second stages of SCI are to be re-used for SL-PRS-related scheduling information, solutions to distinguish such SCI as against those for SL communications (PSSCH scheduling) should be explored.  As a baseline mechanism, Mode 2 resource allocation for PSSCH, using resource reservation indication via PSCCH, should be considered for transmission of SL-PRS.   * + - * FFS: Detailed options for indication of SL-PRS configuration and scheduling information, including potential availability of assistance information from serving gNB for in-coverage scenarios.   RAN1 to study suitable options for efficient signalling of SL-PRS configurations and scheduling information based on potential enhancements to resource reservation mechanism currently specified for PSSCH transmissions.  RAN1 to study potential ways to realize coordination and muting patterns across a number of transmitting UEs in a distributed manner. |
| Qualcomm | The network indicates resources for SL-PRS and trigger or configure SL-PRS transmission for in-coverage UEs.  Higher layers indicate resources for SL-PRS and trigger or configure SL-PRS transmission for out-of-coverage UEs. |
| Futurewei | Consider whether the S-PRS configuration should be controlled by gNB when SL UEs are in coverage or partial coverage. |
| Apple | Issues to be addressed include:  Configuration, transmission and measurement of SL positioning reference signals to or from the target UE |
| ROBERT BOSCH GmbH | For studying sidelink positioning method (e.g., TDO, RTT, AOA/D, …) keep L1/L2 layer impact being minimum and independent of sidelink positioning signal design. |

Based on the submitted contributions, and proposals summarized above, the following proposal is made:

##### [CLOSED]Feature Lead Proposal 4.2.5-v0

With regards to the configuration/activation/triggering of SL-PRS, study the following options:

* Option 1: High-layer-only signaling involvement in the SL-PRS configuration
  + No Lower layer involvement, e.g., SL-MAC-CE or SCI or DCI, for the activation or the triggering of a SL-PRS.
  + Based on the study, this option may correspond to
    - A SL-PRS configuration that is a single-shot or multiple shots
    - A high-layer configuration that may be received from an LMF, a gNB, or a UE
* Option 2: High-layer and lower-layer signaling involvement in the SL-PRS configuration
  + Lower-layer may correspond to SL-MAC-CE, or SCI, or DCI
* Based on the study, different options may be more appropriate for different scenarios (e.g., in-coverage, partial coverage, out of coverage), for different resource allocation selections procedures, resource reservation mechanisms, etc. Include aspects in the study related to flexibility, overhead, and reliability as/if needed.

##### Companies views

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| --- | --- |
| CATT | We support Option 2.  Both the high-layer and lower-layer signaling can be introduced in the SL-PRS configuration. |
| MTK | Support option 2 |
| ZTE | We think at least option 2 should be supported for scheduling flexibility and latency. If sidelink resource collision happens for sidelink resource selection mode 2 (or in out of coverage scenario), UEs need to be aware of other UE’s SL-PRS configuration and lower-layer signaling like SCI can be used to avoid resource waste. |
| Huawei, HiSilicon | Support the revised Option 2 to be clearer,   * Option 2: High-layer and lower-layer signaling involvement in the SL-PRS configuration   + Lower-layer may correspond to SL-MAC-CE, or SCI, or DCI   + High layer signaling can be used for SL-PRS configuration and lower layer signaling can be used for triggering/activating transmission of SL-PRS.   We believe that under OOC scenario, the sensing based resource allocation is anyway needed. SCI would be needed for resource indication/reservation of SL-PRS. It is unclear how Option1 works under OOC scenario. |
| Spreadtrum | We prefer Option 2. |
| InterDigital | Examples for high-layer can be provided in the proposal for clarification, e.g., RRC, LPP.  For out-of-coverage, when UEs don’t have PC5-RRC connection (i.e., no unicast connection), lower layer signaling may be used for SL PRS configuration/activation/triggering purpose. Thus we propose to add the following option.  Option 3 : Lower-layer signaling |
| Futurewei | We prefer Option 2. In our opinion, in OOC scenarios both lower and higher layers will be involved. |
| CMCC | Option 2.  This is related to the resource allocation of SL-PRS, without SCI reservation in NR sidelink, resource collision may happen more frequently which will have bad impacts on system performance. |
| NEC | Option 2 since for SL positioning, it might be more dynamic than Uu interface positioning and thus hybrid signalling is needed. |
| Sony | Option 2. A good interaction between high and lower layer signalling is needed to support SL-Pos |
| OPPO | In our view this issue should be deffered, it is highly related to the concrete design of other aspects, including resource allocation and SL-PRS transmission procedure,etc.. |
| Lenovo | Support Option 2 |
| vivo | We also feel this could be discussed at a later stage after we know more about PHY SL-PRS design. |
| Apple | Decision on this can be deferred. |
| Samsung | This proposal is a bit confusing for us.  In our understanding, activation and triggering should involve lower layers (MAC CE and/or L1 control). So, we suggest to modify the main bullet as  With regards to the configuration~~/activation/triggering~~ of SL-PRS, study the following options:  Also, the third bullet seems not necessary. |
| Qualcomm | We support Option 1 as it provides a unified approach for both in-coverage and out-of-coverage scenarios and avoids duplicating work in WGs and multiple layers.  In out-of-coverage scenarios, the signaling would come from the protocol or application layer. |
| DCM | Option 2. |
| LGE | Support option 2. Lower layer approach has a benefit of requiring less latency for SL positioning, which is crucial to meet the latency requirement. |
| Sharp | We prefer Option 2. |
| Xiaomi | We are not sure what SL PRS configuration includes here, for example, whether SL PRS time-freq. resource scheduling information is included in the configuration here. Hope it can be clarified. |
| Nokia, NSB | OK to study both, prefer Option 2. |
| Ericsson | Similar view as vivo and Apple. As this is a signaling detail aspect, this can be discussed later. |

##### FL Observations

Based on the above replies, we make the following observations:

Support/Prefer of Option 1:

* Qualcomm

Support/Prefer of Option 2:

* CATT, MTK, ZTE, Huawei, Hisilicon, Spreadtrum, Futurewei, CMCC, NEC, Sony, Lenovo, NTT DOCOMO, LGE, Sharp, Nokia, NSB

Include Option 3 (Low-layer Only):

* Interdigital

Defer an agreement:

* OPPO, vivo, Apple, Ericsson

I interpret that the 3 companies that suggest to defer an agreement, they mean to defer a downselection, but still keep the options for further study.

To Xiaomi: Yes the intention is to consider all the necessary SL PRS parameters, and time-freq. resource is one of them.

Based on the above, the updated proposal is:

##### [MEDIUM]Feature Lead Proposal 4.2.5-v1

With regards to the configuration~~/activation/triggering~~ of SL-PRS, study the following options:

* Option 1: High-layer-only signaling involvement in the SL-PRS configuration
  + No Lower layer involvement, e.g., SL-MAC-CE or SCI or DCI, for the activation or the triggering of a SL-PRS.
  + Based on the study, this option may correspond to
    - A SL-PRS configuration that is a single-shot or multiple shots
    - A high-layer configuration that may be received from an LMF, a gNB, or a UE
* Option 2: High-layer and lower-layer signaling involvement in the SL-PRS configuration
  + Lower-layer may correspond to SL-MAC-CE, or SCI, or DCI
  + High layer signaling can be used for SL-PRS configuration and lower layer signaling can be used for triggering/activating transmission of SL-PRS.
* Option 3: Only lower-layer signaling involvement in the SL-PRS configuration
  + Lower-layer may correspond to SL-MAC-CE, or SCI, or DCI
* Based on the study, different options may be more appropriate for different scenarios (e.g., in-coverage, partial coverage, out of coverage), for different resource allocation selections procedures, resource reservation mechanisms, etc. Include aspects in the study related to flexibility, overhead, and reliability as/if needed.

##### Companies views

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#### 4.2.6 AGC & Tx-Rx turnaround time considerations for SL-PRS

Based on the submitted contributions, some companies commented with regards to the AGC and Tx-Rx turnaround time for the SL-PRS:

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| --- | --- |
| Huawei, HiSilicon | There should be an AGC symbol before the SL-PRS symbols and a GAP symbol after the SL-PRS symbols. |
| vivo | AGC and GP symbol are needed for the SL PRS pattern. |
| CMCC | Slot structure in NR sidelink should be reused as much as possible for sidelink positioning RS slot, which including AGC symbol, GP symbol and the potential PSCCH symbols, the remaining symbols can be regarded as candidates for positioning RS. |
| ZTE | For the number of OFDM symbols within a slot for SL-PRS, consider adding AGC symbol for power adjustment and gap symbol(s) for Rx/Tx switch |
| Qualcomm | Sidelink PRS transmissions accommodate AGC training at the receiver and RAN1 to further study the details.  Sidelink PRS transmission accommodate Rx-Tx turnaround time and RAN1 to further study the details |
| LGE | In a resource pool for SL positioning, if both transmission and reception resource are allocated within a slot, a TX/RX switching gap between two resources needs to be supported |
|  |  |

Based on the submitted tdocs, and proposals summarized above, the following proposal is made:

##### [CLOSED]Feature Lead Proposal 4.2.6-v0

SL PRS structure should include time for AGC training and Rx-Tx turnaround time, when needed.

* Study the details, including at least: number of symbol(s), if any, for AGC and Rx-Tx turnaround time, conditions under which these are needed.

##### Companies views

|  |  |
| --- | --- |
| CATT | Support. |
| MTK | okay |
| ZTE | Support adding AGC symbol for power adjustment and gap symbol(s) for Rx-Tx turnaround time. |
| Huawei, HiSilicon | Support. |
| Spreadtrum | Support. |
| InterDigital | We think this topic is related to whether a SL PRS can be multiplexed with other SL channels/signals in one SL slot, either in time or in frequency. The consideration of AGC and guard symbol associated with the SL PRS can be different depending on how SL PRS is multiplexed (e.g., in a SL PRS-only slot, SL PRS + PSCCH slot). Thus, we suggest the following change to the proposal.  SL PRS structure should include time for AGC training and Rx-Tx turnaround time, when needed.   * Study the details, including at least: consideration for multiplexing between PRS and other channels within a slot, number of symbol(s), if any, for AGC and Rx-Tx turnaround time, conditions under which these, are needed. |
| Futurewei | Support |
| CMCC | Support. |
| NEC | Support |
| OPPO | Support. |
| Lenovo | Support |
| vivo | Support |
| Apple | There needs to be a discussion on if the SL PRS is in a standalone slot, or multiplexed with other signals. If multiplexed with other signals, the relative BWs (and power boosting) may determine if separate AGC and gap signals are needed. As an example, if the SL PRS is of the same BW as the PSSCH (and placed in the PSSCH region of the slot), and it is based on a comb and is power boosted, then no gap or AGC signal is needed. This can change if one of the conditions changes e.g. different BW.  Addition by InterDigital can address this issue. With the following modification:  SL PRS structure should include time for AGC training and Rx-Tx turnaround time, if ~~when~~ needed. |
| vivo2 | On the suggested modification from InterDigital, we don’t think multiplexing with other channels should be emphasized here as part of AGC/GP study given the multiplexing is already covered as part of study in proposal 5.1. |
| Locaila | Support. |
| Samsung | OK for the direction of proposal 4.2.6 in general |
| Qualcomm | Support |
| DCM | This proposal is related to whether SL-PRS is independent signal (i.e. standalone) or multiplexed on another chanel. Further study is necessary. |
| LGE | Support |
| Sharp | Support |
| xiaomi | If SL PRS are multiplexed with other SL channels, it may be able to reuse the AGC/GP symbol of that SL channels. From our understanding, this possibility is not precluded but included in the details part. With thiss understanding, we support this proposal. |
| Nokia, NSB | OK |
| Ericsson | Share similar view as DCM. |

##### FL Observations

Most companies seem OK with the current version of the proposal. It was pointed out by a few companies that this proposal is related to whether the SL-PRS is standalone or multiplexwed with other channels. Overall, the expression of the proposal “conditions under which these are needed” is trying to encompass different considerations and reasons for which AGC and Rx-Tx turnaround time may be needed. Therefore, significant changes may not be needed at this point. Potentially, I am suggesting to change the “when”, to “if”, even though at this early point of the study, its not clear whether it creates any difference of the meaning of the proposal.

##### [MEDIUM]Feature Lead Proposal 4.2.6-v1

SL PRS structure should include time for AGC training and Rx-Tx turnaround time, if ~~when~~ needed.

* Study the details, including at least: number of symbol(s), if any, for AGC and Rx-Tx turnaround time, conditions under which these are needed.

##### Companies views

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#### 4.2.7 SL-PRS Numerology

Based on the submitted contributions, there was some limited discussion the SL-PRS numerology:

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| --- | --- |
| Lenovo | SL PRS can support the same numerology as already supported in SL FR1 |

##### [CLOSED]Feature Lead Request

Companies are encouraged to provide more views with regards to the SL-PRS numerology (SCS & CP options for FR1, FR2)

##### Companies views

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| --- | --- |
| CATT | We prefer to support the SCS&CP options which had been specified in R16 V2X for SL-PRS. |
| ZTE | Due to lack of basic FR2 functionalities, e.g. beam management in Rel-16/17 sidelink, we prefer to deprioritize FR2 enhancement for SL positioning in Rel-18 and focus on the numerology for FR1. |
| Huawei, HiSilicon | Suppport. |
| InterDigital | We think the SL PRS numerology should align with the current SL BWP configuration. |
| Futurewei | Support |
| CMCC | SCS & CP in NR sidelink should be reused. |
| NEC | We prefer not to introduce any new numerology design |
| Sony | We have the same view as CATT that we should reuse the numerology that has been specified for V2X. |
| OPPO | SCS&CP options as NR sidleink and NR Uu should be resused for SL-PRS. |
| Lenovo | Support |
| vivo | We also support to focus on SL-PRS for FR1 with the same numerology as for NR sidelink. |
| Apple | Re-use the existing numerology. |
| Locaila | Support. |
| Samsung | Use the same numerology as already supported in SL FR1 |
| Qualcomm | We support using the SL SCS and CP already defined for NR sidelink. |
| DCM | Same numerology is preferred. FR2 should not be included. |
| LGE | We share the same view with CATT that R16 numerology can be a baseline for SL PRS. |
| Sharp | We support using the same numerology as already supported in SL FR1 |
| Xiaomi | Same numerology as NR SL communication shall be supported for SL PRS. |
| Nokia, NSB | Support the Rel-16 sidelink numerologies. |

##### [LOW]Feature Lead Proposal 4.2.7-v0

With regards to the numerologies of the SL-PRS, limit the study, to those supported for NR Sidelink.

##### Companies views

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# SL Positioning Resource Allocation

Based on the submitted contributions, it may be beneficial to start the topic of SL Positioning Resource Allocation, by discussing it in two subtopics:

## 5.1 Resource pool for SL Positioning or Shared resource pool?

|  |  |
| --- | --- |
| Nokia, NSB | Study which SL resources (e.g., PSCCH, PSSCH, etc. within SL resource pools or independent time/frequency resources as in the case of S-SSB) can be utilized to transmit/receive SL PRS, and any required changes to the SL frame structure.  Allocation of frequency bands for SL positioning purposes, and any required modifications to the configuration and use of SL resource pools should consider the bandwidth requirements of SL positioning based on the performance evaluations to be conducted. |
| Huawei, HiSilicon | Support a dedicated resource pool used for SL positioning only.  Consider the reserved slots as a part of the dedicated resource pool for positioning to transmit SL-PRS. |
| Samsung | Study the following approaches for SL positioning resource configuration as   * Approach 1: SL positioning resources are configured in the same resource pool with SL data transmission. * Approach 2: SL positioning resources are configured in separate resource pools with SL data transmission. |
| CATT, GOHIGH | Considering the compatibility for Rel-16/17, the dedicated resource pool for sidelink positioning should be introduced  The SPCI used for the scheduling of S-PRS, can be transmitted in the dedicated resource pool for sidelink positioning or the legacy resource pool for Rel-16/17 sidelink. |
| vivo | A dedicated resource pool should be studied for SL PRS transmission in Rel-18. |
| CMCC | In Rel-18, dedicated resource pool for SL positioning RS should be (pre)configured other than multiplexing with data in a same resource pool, and only TDM configuration is supported for SL data and positioning RS resource pools. |
| ZTE | For SL-PRS resource configuration, we are open to study the following options:   * Alt 1: Dedicated SL-PRS configuration   + SL-PRS configuration is separate from SL resource pool. * Alt 2: SL-PRS is configured in SL resource pool   In Rel-18, TDM between SL-PRS and SL-data is only considered |
| China Telecom | It is beneficial to configure a dedicated sidelink PRS resource pool and support the trigger scheme of sidelink PRS transmission |
| Qualcomm | Support SL PRS-only resource pools where only SL-PRS transmissions can take place without other SL signals or channels  There is no data/control transmission in time-frequency grid of SL PRS resources  FDM multiplexing with other signals at RE level inside of SL PRS time-frequency grid is precluded  Transmission of other SL signals and channels in the same OFDM symbol as SL PRS is precluded |
| Apple | Decide on whether or not the time resources for the SL positioning signal transmission are within the time resources of the slots for the resource pool  Decide on the frequency resources for SL-positioning signals  SL positioning reference signal can be configured   * + in same slot as SL PSSCH/PSCCH/PSFCH (uses same resource allocation method as PSSCH/PSCCH/PSFCH).     - Discussion needed on modifications to SL-slot structure   + in independent SL positioning slots (uses independent resource allocation method)     - Discussion needed on structure of a new SL positioning slot |
| Xiaomi | Study whether sidelink positioning reference signal can use a separate frequency layer/BWP than sidelink communication BWP. |
| OPPO | Standalone SL-PRS transmission within a slot from a single UE perspective should be considered for SL-PRS design in sidelink positioning.  Following 2 options should be considered for SL-PRS resource pool:   * + Option 1: Dedicated resource pool;   + Option 2: Shared resource pool with sidelink communication. |
| Lenovo | RAN1 to study the possibility of multiplexing SL PRS with existing sidelink physical channels considering aspects such interference and resource efficiency  RAN1 to study and define the hierarchical SL PRS resource configuration considering the potential relationship among SL Positioning frequency layers or SL BWPs or resource pool |
| LGE | It needs to be studied whether a resource pool is shared for both SL positioning and SL communication, or a separate resource pool is configured for each SL service.  If a resource pool for SL communication is shared for SL positioning, a solution to protect the legacy SL communication from SL positioning needs to be developed  If a separate resource pool is configured for SL positioning, SL PRS resource set and SL PRS resource similar to NR positioning are defined for SL positioning  It is supported that UE selects the SL PRS resources based on sensing  When UE selects the SL PRS resources, the resource selection procedure based on sensing defined in Rel.16 NR SL communication is reused as much as possible  Control channel associated with the SL PRS resources needs to be transmitted to indicate the control information for the SL PRS resources being transmitted, and the resource reservation information  Congestion control in SL positioning needs to be studied |
| Intel | For SL-PRS resource allocation, resource pool(s) may be (pre-)configured either dedicated for SL-PRS or shared with resource pool(s) (pre-)configured for PSSCH.  Both cases wherein SL-PRS may or may not be multiplexed with PSSCH in a slot from a transmitting UE should be considered for further study. |
| NEC | Both reusing frequency resource within PSSCH bandwidth and introducing dedicated frequency resource should be considered for S-PRS transmission.  The resource allocation of S-PRS in time and frequency domain should support non-continuous resource allocation. |
| Interdigital | Study a mechanism to share time and frequency resources to support co-existence between SL communication and SL positioning  Study how SCI can be multiplexed with PRS |

Based on the submitted tdocs, and proposals summarized above, the following proposal is made:

##### [CLOSED]Feature Lead Proposal 5.1-v0

With regards to the SL Positioning resource allocation, study further the following 2 options for SL Positioning resource (pre-)configuration:

* + Option 1: Dedicated resource pool for SL-PRS
    - This option may or may not include control information for the purpose of SL positioning operation, but it precludes PSSCH/ PSFCH included in the same resource pool
    - Include in the study at least the following aspects:
      * + which slots can be used, SL frame structure, SL positioning slot structure, multiplexing of SL-PRS with control information (if included in the same slot)
        + the bandwidth requirements of SL positioning based on the performance evaluations
  + Option 2: Shared resource pool with sidelink communication.
    - Include in the study at least the following aspects:
      * + co-existence between SL communication and SL positioning, backward compatibility
        + Multiplexing considerations of SL-PRS with other PHY channels (PSCCH, PSSCH, PSFCH) and any modifications in the SL-slot structure

##### Companies views

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| --- | --- | --- |
| CATT | Support to study both options.  We prefer Option 1, i.e., dedicated resource pool for SL-PRS. | |
| MTK | We prefer option 1 | |
| ZTE | The above two options in Proposal 5.1-v0 is a good starting point for discussion. For Option 1, the hierarchical sidelink resource configuration is SL Frequency --> SL BWP --> SL resource pool according to TS 38.331 [6]. If dedicated SL-PRS configuration is supported, we should further discuss whether SL-PRS resources are configured on dedicated SL-PRS Frequency or dedicated SL-PRS BWP or dedicated SL-PRS resource pool.  For Option 2, even though SL-PRS and SL-data share resource pool, we need consider enlarging the frequency domain range of SL-PRS for high-accuracy positioning. | |
| Huawei, HiSilicon | Fine in general. Better to clarify “control information”, I assume it is saying SCI scheduling PRS or resource for measurement reporting. | |
| Spreadtrum | We are fine to study both Option 1 and Option 2. | |
| InterDigital | We agree with the options. | |
| Futurewei | We are open to study both options. | |
| CMCC | Both of the options can be studied and our preference is option 1, since option 2 may make the resource allocation more complicated due to the collision b/w SL-PRS and dara, moreover, FDM b/w positioning RS and data should be avoided. | |
| NEC | We should study both options and we think both options can be supported for different circumstances | |
| Sony | At this stage, we need to study both options. We prefer to prioritize option 1. | |
| OPPO | Support the 2 options. Available spectrum for SL is very limited, shared resource pool with SL communication should be strived for, especially for on-demand transmitted SL-PRS, to ensure resource efficiency. Dedicated resource pool can also be considered for the cases where SL-PRS cannot co-ex with SL communication channels, or always-on SL-PRS. |
| Lenovo | We are open to study both options at this current stage. Furthermore, we also share ZTE’s view that further study is needed on whether to define SL PRS Frequency layer or dedicated SL-PRS BWP due to special BW requirements for positioning  SL PRS resource configuration design should also be thought from a forward compatibility point of view e.g., SL PRS resource pool configuration may also be incompatible when aggregating PRS resources in a SL multi-carrier scenario to leverage even larger BWs.  Hence, the SL-PRS configuration should study whether there is a need to introduce a SL PRS frequency layer or SL PRS BWP in addition to its relationship to a dedicated SL PRS resource pool. | |
| vivo | Our preference is option 1.  We have a question on the aspects listed for study of option 2. Why only co-existence and multiplexing are mentioned, while bandwidth requirement and performane evalution is not mentioned as part of study for option 2 even though they are explicitly mentioned for option 1? We don’t think these apects listed are fair for comparison between option 1 and option 2. | |
| Apple | We are fine with studying both options. A decision can be made on whether to down-select to one or keep both based on the positioning scenario. | |
| Samsung | Direction is fine. However, we can simplify this proposal as follows:  With regards to the SL Positioning resource allocation, study further the following 2 options for SL Positioning resource (pre-)configuration:   * + Option 1: Dedicated resource pool for SL-PRS     - This option may or may not include control information for the purpose of SL positioning operation, ~~but it precludes PSSCH/ PSFCH included in the same resource pool~~     - This option may or may not include sensing for resource allocation of SL-PRS     - ~~Include in the study at least the following aspects:~~       * + ~~which slots can be used, SL frame structure, SL positioning slot structure, multiplexing of SL-PRS with control information (if included in the same slot)~~         + ~~the bandwidth requirements of SL positioning based on the performance evaluations~~   + Option 2: Shared resource pool with sidelink communication.     - Include in the study at least the following aspects:       * + co-existence between SL communication and SL positioning, backward compatibility         + ~~Multiplexing considerations of SL-PRS with other PHY channels (PSCCH, PSSCH, PSFCH) and any modifications in the SL-slot structure~~ | |
| Qualcomm | We prefer Option 1 as it will minimize interference seen by PRS and improve measurement quality. | |
| DCM | Option 2.  Separate pool degrades SL communication performance since the resources becomes always unavailable. | |
| LGE | We support the proposal with one comment  For clarification, option 1 needs slight modification.   * + Option 1: Dedicated resource pool for SL positioning   As said above, we need FFS whether control information, measurement report related to SL PRS is transmitted in the dedicated pool or the SL communication pool. | |
| Sharp | We are OK to study both options. | |
| Xiaomi | We share ZTE and Lenovo view that option 1 shall also include the study on whether a dedicated frequency layer/BWP is needed for SL PRS. In addition, as we have not discussed which layer the control information for SL PRS belongs to, it may be too early to preclude PSSCH in the dedicated resource pool option. | |
| Philips | We support studying both options. | |
| Nokia, NSB | OK to study both Option 1 and Option 2. | |
| Ericsson | Ok to study both options. | |

##### FL Observations

Support/preference/prioritize Option 1:

* CATT, MTK, CMCC, Sony, vivo, Samsung, Qualcomm, LGE

Support/preference Option 2:

* NTT DOCOMO

Support Both options

* OPPO

Study Both options

* ZTE, spreadtrum, Huawei, HiSilicon, NEC, Apple, Sharp, Philips, Nokia, NSB, Ericsson

At least 3 companies suggested to add in the items to be studied “whether a dedicated frequency layer/BWP is needed for SL PRS”.

1 company suggested to remove the aspects that are noted for further study, while adding an additional item for study.

* In order to be inclusive at this early stage of the study item, and in order to guide what companies consider useful to be added, I prefer to be inclusive of the items that should be considered.

Based on all the above comments, the revised proposal reads as follows:

##### [MEDIUM]Feature Lead Proposal 5.1-v1

With regards to the SL Positioning resource allocation, study further the following 2 options for SL Positioning resource (pre-)configuration:

* + Option 1: Dedicated resource pool for SL-PRS Positioning
  + This option may or may not include control information (i.e., configuration/activation/triggering of SL-PRS and/or resource for reporting) for the purpose of SL positioning operation~~, but it precludes PSSCH/ PSFCH included in the same resource pool~~
    - Include in the study at least the following aspects:
      * + which slots can be used, SL frame structure, SL positioning slot structure, multiplexing of SL-PRS with control information (if included in the same slot)
        + whether a dedicated frequency layer/BWP is needed for SL PRS
        + sensing for resource allocation of SL-PRS
        + Whether control information, measurement report related to SL Positioning is transmitted in the dedicated pool or the SL communication pool.
  + Option 2: Shared resource pool with sidelink communication.
    - Include in the study at least the following aspects:
      * + co-existence between SL communication and SL positioning, backward compatibility
        + Multiplexing considerations of SL-PRS with other PHY channels (PSCCH, PSSCH, PSFCH) and any modifications in the SL-slot structure

For either Option, study the bandwidth requirements of SL positioning based on the performance evaluations.

##### Companies views

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| --- | --- |
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## 5.2 SL Positioning Resource Allocation Modes

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| --- | --- |
| Nokia, NSB | Prioritize re-using existing resource allocation modes 1 and 2 from NR SL communications for scheduling SL PRS transmissions, and study any necessary modifications |
| Huawei, HiSilicon | For in-coverage scenarios, both mode 1 based and mode 2 based SL positioning resource allocation should be supported.  For out-of-coverage, mode-2 based SL positioning resource allocation should be supported |
| Samsung | Study feasibility of UE allocated resources for SL positioning including:   * Sensing based resource allocation * Resource allocation by another UE   Study feasibility of network allocated resources for SL positioning including:   * Resources for SL positioning reference signals * Resources for reporting SL positioning measurements. |
| CATT, GOHIGH | For the resource allocation of S-PRS in resource pool:   * Under the in-coverage scenario, gNB should schedule the resources of S-PRS for all UEs, similar to the Mode 1 mechanism in Rel-16 NR V2X. * Under the out-of-coverage scenario or partial coverage scenario, the resources of S-PRS should be allocated by resource sensing and exclusion, similar to the Mode 2 mechanism in Rel-16 NR V2X. Random resource selection mechanism can also be considered to reduce the sidelink positioning latency. |
| vivo | SL mode 1 and mode 2 resource allocation mechanisms should be studied.  SL mode 2 resource allocation can be used for SL PRS resource allocation with some modification (e.g., the SL PRS is used for RSRP measurement). |
| CMCC | Resource allocation for SL positioning PRS should reuse the Rel-16 mechanism in NR sidelink as much as possible.   * For mode 1, gNB should take the responsibility for resource allocation; * For mode 2, take the legacy mode 2 resource selection procedure as baseline with the consideration of potential enhancements towards RE-level multiplexing of SL positioning RS.   Centralized scheduling mechanism, e.g., mode 2(d) like method discussed in Rel-16 NR sidelink, can be considered for resource allocation for SL positioning PRS |
| ZTE | Support both Mode 1 and Mode 2 resource allocation for SL positioning |
| Qualcomm | The network indicates resources for SL-PRS and trigger or configure SL-PRS transmission for in-coverage UEs  Higher layers indicate resources for SL-PRS and trigger or configure SL-PRS transmission for out-of-coverage UEs. |
| Xiaomi | Both gNB scheduling and UE autonomous resource selection based resource allocation shall be supported for NR sidelink positioning. |
| OPPO | Both network centric (mode 1 like) and UE autonomous resource allocation (mode 2 like) should be considered for SL-PRS |
| Lenovo | RAN1 to support Mode 1 coordination of SL PRS resources for one or more UEs participating in a SL positioning session  RAN1 to support Mode 2 coordination of SL PRS resources for one or more UEs participating in a SL positioning session |
| Spreadtrum | For SL PRS transmission, the resource allocation mode 1 and the resource allocation mode 2 can be considered |
| Intel | RAN1 to investigate potential solutions for both gNB-controlled resource allocation as well as UE-autonomous resource selection for SL-PRS. |
| NEC | Both network based and UE based resource allocation for S-PRS resources and related reporting should be supported.  − If the dedicated frequency resource for S-PRS is introduced, corresponding resource allocation scheme should be studied separately. |
| Interdigital | Study both mode 1 and mode 2 for PRS resource allocation/scheduling where mode 1 and mode 2 can be considered at least for in-coverage or out-of-coverage scenario, respectively. |
|  |  |
| Mediatek | RAN1 to study the coordination mechanism for SL-PRS configuration |

Based on the submitted tdocs, and proposals summarized above, the following proposal is made:

##### [CLOSED]Feature Lead Proposal 5.2-v0

With regards to the SL Positioning resource selection, study the following two schemes:

* Scheme 1: Network-centric operation SL positioning resource selection (e.g. similar to a legacy Mode 1 solution)
  + The network (e.g. gNB, LMF, gNB & LMF) is responsible and control the resource selection
  + At least applicable to in-coverage scenarios
* Scheme 2: UE autonomous resource allocation (e.g. similar to legacy Mode 2 solution)
  + One, or one or more, of the UE(s) participating in the sidelink positioning operation is responsible for resource selection
  + At least applicable to out-of-coverage scenarios
* Study also which mode shall be applicable to partial coverage scenarios.
* In either scheme, include in the study any potential mechanisms, if needed, for SL-PRS resource coordination across a number of transmitting UEs.

##### Companies views

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| --- | --- |
| CATT | Support the proposal in principle, and we prefer the following revision:  And we prefer to de-prioritize the partial coverage scenarios to reduce the work load. Updated Feature Lead Proposal 5.2-v0 With regards to the SL-PRS ~~Positioning~~ resource allocation~~selection~~, study the following two schemes:   * Scheme 1: Network-centric operation SL-PRS ~~Positioning~~ resource allocation~~selection~~ (e.g. similar to a legacy Mode 1 solution)   + The network (e.g. gNB, LMF, gNB & LMF) is responsible and control the SL-PRS resource allocation~~selection~~   + At least applicable to in-coverage scenarios * Scheme 2: UE autonomous SL-PRS resource allocation (e.g. similar to legacy Mode 2 solution)   + One, or one or more, of the UE(s) participating in the sidelink positioning operation is responsible for SL-PRS resource allocation~~selection~~   + At least applicable to out-of-coverage scenarios * ~~Study also which mode shall be applicable to partial coverage scenarios.~~ * In either scheme, include in the study any potential mechanisms, if needed, for SL-PRS resource coordination across a number of transmitting UEs. |
| MTK | Okay for CATT’s revision |
| ZTE | Support. |
| Huawei, HiSilicon | Per the last bullet, study SL-PRS resource coordination across a number of transmitting UEs. I assume this SL-PRS resource coordination across a number of transmitting UEs is possible for scheme 2 but what this means in scheme 1 is unclear. In addition, similar to legacy mode 2 solution, scheme 2 should also be supported in coverage scenarios. |
| Spreadtrum | Support. |
| InterDigital | We agree with the schemes for study. |
| Futurewei | As we proposed in our contribution R1-2203058, the IUC like solutions may be considered for defining the resource allocation and coordination between SL UEs for OOC. We support both NW centric and SL-UE autonomous resource allocation. |
| CMCC | Support the proposal and the modifications from CATT, but one more comment is, the meaning of “One, or one or more” in scheme 2 should be further clarified. |
| NEC | Support |
| Sony | OK to study |
| OPPO | A general comments, in our view the resource allcoaiton scheme is only related to the coverage status of the UE to use the allocated resource, it has nothing to do with the coverage status of other UEs, so it seems not proper to tie a resource allocation scheme with coverage scenario, which is a concept for coverage status of multiple UEs.  For Scheme 1, it can be used as long as the UE to use the resource is in coverage, if Scheme 1 discussed here is similar as legacy Mode 1, which means the scheduling is received directly from gNB(rather than forwarded from another in coverage UE), only in coverage UE can support this scheme.  And, Scheme 2 can work even the UE is in coverage if the network configures the UE to do so.  For the last sub-bullet, if coordination across transmitting UEs are introduced into either Scheme 1 or Scheme 2, to avoid potential confusion, they should be regarded as new schemes.  In general, we suggest the following:  With regards to the SL Positioning resource selection, study the following two schemes:   * Scheme 1: Network-centric operation SL positioning resource selection (e.g. similar to a legacy Mode 1 solution)   + The network (e.g. gNB, LMF, gNB & LMF) is responsible and control the resource selection   + ~~At least~~ Only applicable to an in-coverage UE ~~scenarios~~. * Scheme 2: UE autonomous resource allocation (e.g. similar to legacy Mode 2 solution)   + One, or one or more, of the UE(s) participating in the sidelink positioning operation is responsible for resource selection   + ~~At least applicable to out-of-coverage scenarios~~ * ~~Study also which mode shall be applicable to partial coverage scenarios.~~ * Study other scheme(s) ~~In either scheme~~, include ~~in the study~~ any potential mechanisms, if needed, for SL-PRS resource coordination across a number of transmitting UEs on top of either Scheme 1 or Scheme 2. |
| Lenovo | Support FL’s proposal. We prefer that the partial coverage scenario be kept at the current stage so that the study is open to all coverage scenarios. |
| vivo | We have a similar understanding that scheme 1 is only for in-coverage and scheme 2 is applicable to in-/partial-/out-of-coverage.  We prefer not to study any new scheme rather the study should be on the details of scheme 1 and 2 (i.e., potential modification(s) to legacy mode 1 and mode 2 resource allocation for SL-PRS). |
| Apple | Fine with CATT’s update. |
| Samsung | OK for the direction of proposal 5-2 in general  Suggest to remove the last two bullets. |
| Qualcomm | We support the proposal and would be ok with CATT’s modifications. |
| DCM | OK with FL version.  We do not support CATT’s version since ‘SL-PRS resource allocation’ implies standalone signaling, which is not agreed yet. High-level text is better. |
| LGE | Scheme 1 is only available in in-coverage area. Scheme 2 should be available regardless of the network coverage. This is in line with the existing SL mode-1 and mode-2 operation. We propose to clarify this point on top of CATT version. Updated Feature Lead Proposal 5.2-v0 With regards to the SL-PRS ~~Positioning~~ resource allocation~~selection~~, study the following two schemes:   * Scheme 1: Network-centric operation SL-PRS ~~Positioning~~ resource allocation~~selection~~ (e.g. similar to a legacy Mode 1 solution)   + The network (e.g. gNB, LMF, gNB & LMF) is responsible and control the SL-PRS resource allocation~~selection~~   + ~~At least~~Only applicable to in-coverage scenarios * Scheme 2: UE autonomous SL-PRS resource allocation (e.g. similar to legacy Mode 2 solution)   + One, or one or more, of the UE(s) participating in the sidelink positioning operation is responsible for SL-PRS resource allocation~~selection~~   + ~~At least~~ applicable regardless of the network coverage ~~to out-of-coverage scenarios~~ * ~~Study also which mode shall be applicable to partial coverage scenarios.~~   In either scheme, include in the study any potential mechanisms, if needed, for SL-PRS resource coordination across a number of transmitting UEs. |
| Sharp | Support |
| xiaomi | Similar as that in SL communication, scheme 2 shall apply to all coverage scenarios. UEs in RRC\_idle state cannot use scheme 1 but can use scheme 2 when IC. |
| Philips | We support the proposal and would be ok with CATT’s modifications. |
| Nokia, NSB | Support with CATT+LGE’s updates |
| Ericsson | schemes can be further studied. But we prefer not to use SL-PRS as proposed by CATT. Note that we still have the proposal to study existing reference signals as proposed in Section 4.1. So we prefer the language in the original FL proposal. |

##### FL Observations

Overall good support in the direction of looking at both schemes. Several suggestions from a lot of companies, which hopefully are all addressed in the revised proposal below. 1 company raises concerns on the CATT’s version (and additional changes on top of that made by other companies) due to: “‘SL-PRS resource allocation’ implies standalone signaling, which is not agreed yet”. This proposal is related to SL-PRS, and it is a “study” proposal. It doesn’t imply that SL-PRS, a standalone signaling is agreed. I also note this proposal as “MEDIUM”, to see if there is first progress on the “HIGH” proposal (Section 4.2.1) that clearly says that SL-PRS is being studied.

##### [MEDIUM]Feature Lead Proposal 5.2-v1

With regards to the SL-PRS ~~Positioning~~ resource allocation~~selection~~, study the following two schemes:

* Scheme 1: Network-centric operation SL-PRS ~~Positioning~~ resource allocation~~selection~~ (e.g. similar to a legacy Mode 1 solution)
  + The network (e.g. gNB, LMF, gNB & LMF) is responsible and control the SL-PRS resource allocation~~selection~~
  + ~~At least~~ Only applicable to an in-coverage UE ~~scenarios~~.
* Scheme 2: UE autonomous SL-PRS resource allocation (e.g. similar to legacy Mode 2 solution)
  + ~~One, or one or more~~,At least one of the UE(s) participating in the sidelink positioning operation is responsible for SL-PRS resource allocation~~selection~~
  + ~~At least~~ applicable regardless of the network coverage ~~to out-of-coverage scenarios~~
* ~~Study also which mode shall be applicable to partial coverage scenarios.~~
* ~~In either scheme,~~ Other Schemes are not precluded to be studied; Include in the study, when applicable, any potential mechanisms, if needed, for SL-PRS resource coordination across a number of transmitting UEs (e.g. IUC-like solutions).

##### Companies views

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# SL PHY-layer Positioning Procedures

With regards to the SL PHY-layer positioning procedures, we could start the discussion from the following 2 topics:

## 6.1 SL-PRS Power control

|  |  |
| --- | --- |
| CATT, GOHIGH | S-PRS power control should be introduced in Rel-18.   * The minimum pathloss between DL pathloss and SL pathloss can be adopted as the compensated pathloss for the S-PRS power control. |
| Vivo | Open-loop power control scheme should be studied for SL PRS. |
| ZTE | Study power control for SL-PRS transmission |
| Qualcomm | RAN1 to study power control for SL-PRS, including whether it is necessary |
| OPPO | In sidelink positioning SL-PRS is at least subject to DL pathloss based power control. |
| Lenovo | RAN1 to study SL power control and interference mitigation methods to improve SL PRS detectability/hearability |
| LGE | Further discussions are needed whether DL pathloss or SL pathloss or both are needed to adapt the transmission power of the SL PRS |
| Mediatek | Develop the power control mechanism for SL-PRS |

Based on the submitted tdocs, and proposals summarized above, the following proposal is made:

##### [CLOSED]Feature Lead Proposal 6.1-v0

Study power control mechanisms for SL-PRS transmission, including whether it is necessary, whether and which aspects of the SL Power control mechanisms can be reused, any differentiations needed for out of coverage, in coverage and partial coverage cases.

##### Companies views

|  |  |
| --- | --- |
| CATT | Support. |
| ZTE | Support to study the power control of SL-PRS. |
| Huawei, HiSilicon | OK. |
| Spreadtrum | We are fine to shtuy the power control of SL-PRS. |
| InterDigital | We agree with the proposal. |
| Futurewei | Support |
| CMCC | Support. |
| Sony | OK to study the above |
| OPPO | Support. |
| Lenovo | Support |
| vivo | Support |
| Apple | We are fine to study this. |
| Locaila | Support. |
| Samsung | OK. However, we can remove the some details as  Study power control mechanisms for SL-PRS transmission, including whether it is necessary, ~~whether and which aspects of the SL Power control mechanisms can be reused, any differentiations needed for out of coverage, in coverage and partial coverage cases~~. |
| Qualcomm | Support |
| DCM | OK |
| LGE | Support |
| Sharp | Support |
| Xiaomi | OK |
| Nokia, NSB | OK |
| Ericsson | ok to study |

##### [MEDIUM]Feature Lead Proposal 6.1-v1

Study power control mechanisms for SL-PRS transmission, including whether it is necessary.

##### Companies views

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| --- | --- |
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## 6.2 SL-PRS Beam management

|  |  |
| --- | --- |
| CATT, GOHIGH | There is no need to specify S-PRS beam management in Rel-18. |
| ZTE | Deprioritize Rel-18 NR sidelink positioning in FR2 |
| China Telecom | For the angle estimation based on the RSRP measurement, consider the possibility of the CSI-RS or PRS as the reference signal used here for positioning, and some modifications of physical procedures especially beam management related are required |

Based on the submitted tdocs, and proposals summarized above, the following proposal is made:

##### [CLOSED]Feature Lead Request

Companies are encouraged to provide more views with regards to SL-PRS beam management procedures

##### Companies views

|  |  |
| --- | --- |
| CATT | We think there is no need to specify S-PRS beam management in Rel-18, since the sidelink beam management mechanism has not been introduced in legacy NR V2X |
| ZTE | Depriorite SL-PRS beam management and wait until specifying regular SL communication is completed. |
| Huawei, HiSilicon | We think it should be in general deprioritized because FR2 beam management is not supported yet for SL communication. |
| Spreadtrum | Depriorite SL-PRS beam management. |
| InterDigital | SL FR2 design is included in R18 and may be dealt with after RANP #97. Thus we propose to defer SL positioning with beam management until after R18 SL FR2 baseline design is completed. |
| Futurewei | Deprioritize |
| CMCC | No need to discuss at this stage since it has not been started discussing in NR sidelink evolution. |
| Sony | Low priority |
| OPPO | It is out of the scope of this study item. |
| Lenovo | Can be deprioritized |
| vivo | Depriorite SL-PRS beam management until SL communication for FR2 is completed. |
| Apple | Low priority |
| Locaila | Low priority. |
| Samsung | This issue depends on SL in FR2, which is deferred to Q4. So SL-PRS beam management should not be within the scope of this study. |
| Qualcomm | Even though Rel-16 and Rel-17 sidelink communications were not fully optimized for FR2, the system is able to work over FR2 and we think that SL-PRS design should follow the same principle. For example, S-SSB has a (pre-)configurable number of repetitions to better accommodate operation over FR2 and PTRS is also included for the same purpose. |
| DCM | Deprioritize |
| LGE | We also agree to deprioritize the beam management for SL PRS |
| Sharp | Low priority |
| Xiaomi | Agree to deprioritize |
| Nokia, NSB | Deprioritize SL-PRS beam management. This does not imply that FR2 cannot be used, AT&T’s field measurements in Rel-16 have demonstrated that FR2 sidelink can work well without beam management. |
| Ericsson | The scope may be too huge if we consider the beam management aspect. Suggest to deprioritize this. |

##### FL Observations

All companies prefer to deprioritize this aspect.

##### [LOW]Feature Lead Proposal 6.2-v0

Deprioritize SL-PRS beam management study, until at least, SL communication for FR2 has progressed.

##### Companies views

|  |  |
| --- | --- |
|  |  |

# SL Positioning Architecture And Signaling Discussion

A lot of companies provided proposals and discussions on the high-layer architecture, procedures, and System-level proposals; topics that are already being discussed in SA2 ([TR 23.700-86](https://www.3gpp.org/ftp/Specs/archive/23_series/23.700-86/23700-86-020.zip)). It may be more efficient to try to avoid repetition of the discussions unless it is considered necessary. Example of proposals that appear to be already discussed in SA2, and may be more related to potential SL Positioning architecture(s) are shown in the subsections below:

## General proposals

|  |  |
| --- | --- |
| NTT DOCOMO | * Support the following SL-positioning procedure to obtain its own location.   + Step 1: UE that requires its own location transmits information and/or signal to surrounding UEs   + Step 2: The surrounding UEs receive the information and/or signal and transmit corresponding information and/or signal to the UE * Study whether a case where a UE requires other UE’s location is considered in Rel-18 SL positioning or not. |
| Samsung | Study a procedure for SL UE to decide whether to perform absolute positioning or relative positioning or ranging depending on availability and quality of measurement source(s). |
| CATT, GOHIGH | The sidelink positioning procedure can be triggered by the positioning operation indication signaling or the positioning operation request signaling. |
| vivo | Unicast, groupcast and broadcast should be studied for SL positioning in Rel-18. |
| Apple | RAN1 should discuss the specifics of the SL positioning techniques based on the existing RAN-dependent techniques and update the associated signaling, measurements and procedures for the new SL-positioning schemes.. Issues to be addressed include:  Identification of the positioning set and the target UE  Establishment of new SL measurements. |
| Sony | Consider to adapt positioning procedure based on the region/zone of the UE.  Consider supporting positioning procedure with the assistance of another UE for the estimation of relative positioning and relative angle |
| Lenovo | Support the following 4 different models for SL positioning, which distinguish the configuration entity and positioning calculation entity for in-coverage, and partial and out-of-coverage scenarios:   * SL Positioning Model 1a - UE-assisted positioning * SL Positioning Model 1b – UE-assisted positioning * SL Positioning Model 2a – UE-based positioning * SL Positioning Model 2b - UE-based positioning   In SL positioning, both the initiator and responding UEs can be supported to perform SL positioning measurements within the same session |
| LGE | It is supported that LMF/gNB calculates the final location of the UE  It is supported that UE initiates the SL PRS procedure, including the SL positioning group selection  It is supported that UE calculates the final location of the UE  SL positioning procedure needs to be shortened from that of Rel.17 NR positioning, so that the SL positioning latency requirement can be met.  For SL positioning, a group of UEs that participate in SL positioning needs to be associated into a SL positioning group.  The SL positioning group can be created by a UE or LMF/gNB. Further discussions are needed on which UE can initiate or join the SL positioning group, how to generate and accept the request, how to leave or release the SL positioning group, etc. |
| Mediatek | RAN1 to discuss whether the capability transfer and the items are required for positioning measurement. The capability may contain the measurement and transmission capability. Once agreed, RAN2 may further deal with the corresponding signalling |
| Intel | For SL-PRS transmissions, both unicast and groupcast-based identification of destination UEs should be considered. |
| Interdigital | Study both MO-LR and MT-LR for sidelink positioning  Study information exchange among UEs and necessity of each cast type, i.e., broadcast, multi-cast and unicast, using SL communication as the starting point  Study both UE-assisted and UE-based SL positioning for in-coverage, partial-coverage and out-of-coverage  Study discovery methods to find anchor UEs |

In addition to the set of proposals shown above, there were several proposals that were targeted to In-coverage/partial-coverage scenarios, and others targeted to Out Of coverage scenarios as shown in the following subsections:

## In and Partial coverage Proposals

|  |  |
| --- | --- |
| Futurewei | In this study RAN1 should consider as working assumption that LMF is extended to support SL positioning for SL UE in coverage or partial coverage.  RAN1 should send a LS to RAN2 and RAN3 to ask extending the existing LMF protocol for SL UEs in coverage or partial coverage. |
| CEWiT, Reliance Jio, Saankhya Labs, IITM, IITK | For in coverage and partial coverage scenarios, present positioning architecture should be sufficient. |
| Qualcomm | Study positioning procedures that enable the calculation entity being:   * In partial-coverage/in-coverage scenarios, UE(s) involved in a SL positioning session or the LMF. |
| Apple | RAN1 should discuss the assumption on the positioning entity (LMF) in the case of in-coverage, partial-coverage and out of-coverage cases |
| NEC | Both UE assisted and UE based positioning methods should be supported.  −    Including corresponding signalling and procedure for study |
| Interdigital | Study the destination of measurement reports sent from the target UE : anchor UE, LMF or gNB  Study roles of the LMF in SL (sidelink) positioning and its interaction with the gNB which schedules resources for SL positioning |
| Ericsson | It should be possible for LMF to request sidelink positioning measurements between UEs. |
| CATT | For the operations of SL positioning with LMF, the legacy Uu positioning system architecture and signalling procedures with LMF can be reused as defined in TR 38.305 [3]. |
| ZTE | For the design of NG-RAN UE SL positioning architecture, in order to reduce the spec impact, we suggest to take the existing positioning architecture (including communications between UE and NG-RAN, UE and LMF, NG-RAN and LMF) as a baseline and introduce or update the UE-2-UE positioning module. |
| Intel | In terms of measurement reporting, they may be reported to gNB or to another UE(/RSU) and include references for PRS resource set and resource IDs.  In general, the measurement reports can be routed to the LMF via a serving gNB. Similar to Uu positioning, GNSS-RTK assistance data or other assistance information may be broadcasted by serving cell when in coverage. |
| LGE | The SL positioning group can be created by a UE or LMF/gNB. Further discussions are needed on which UE can initiate or join the SL positioning group, how to generate and accept the request, how to leave or release the SL positioning group, etc. |

Based on the above set of proposals, the on-going work in SA2, and that, in the SID description, the study of positioning architecture and signalling to enable sidelink positioning covering both UE based and network based positioning is within RAN2 scope, including coordination and alignment with RAN3 and SA2 as required, the following proposal is made:

##### [CLOSED]Feature Lead Proposal 7.1.1-v0

* From RAN1 perspective, for in-coverage and partial coverage scenarios, RAN1 assumes that the network may be involved in the SL positioning/ranging, and/or hybrid (SL/Uu) Positioning, which are all up for study in the other WGs.

##### Companies views

|  |  |
| --- | --- |
| CATT | We prefer to de-prioritize the partial coverage scenarios to reduce the work load, so the partial coverage scenarios can be removed in the proposal. |
| ZTE | Fine with FL’s assessment. |
| Spreadtrum | Support. |
| Futurewei | Support |
| CMCC | Agree with CATT to de-prioritize the partial coverage scenarios due to workload. |
| NEC | Support but partial coverage should be clearly defined. |
| Sony | We should focus on the introduction of SL-Positioning (e.g. signal design, etc) and this can be facilitated in in-coverage scenario. |
| OPPO | Support. |
| Lenovo | Support |
| Apple | Support |
| vivo | Is the intention to focus on out-of-coverage in RAN1? If so, we support this proposal. |
| Samsung | OK |
| Qualcomm | Support |
| DCM | OK |
| LGE | First of all, we prefer to deprioritize the involvement of gNB/LMF in SL positioning. We prefer to prioritize the stand-alone SL positioning.  Apart from the prioritization, as commented in other proposal, stand-alone SL positioning should be available regardless of the network coverage. Especially in in-coverage area, stand-alone SL positioning without involvement with gNB/LMF would be beneficial in shortening the SL positioning latency. We don’t support to assume the involvement of gNB/LMF for SL positioning in in-coverage area. We propose the following modification. Feature Lead Proposal 7.1.1-v0 From RAN1 perspective, for in-coverage and partial coverage scenarios, ~~RAN1 assumes~~ it is supported that the network may be involved in the SL positioning/ranging, and/or hybrid (SL/Uu) Positioning, which are all up for study in the other WGs. |
| Xiaomi | OK |
| Huawei, HiSilicon | On partial coverage, we do not need to exlucde it in the solution. On other hand, the support of partial coverage do not rely on the RAN1 specification effort. |
| Philips | In partial-coverage/in-coverage scenarios, we should consider that either the UE(s) involved in a SL positioning session or the LMF can be the position calculating entity. |
| Nokia, NSB | OK |
| Ericsson | Do not agree with the view from LG. We cannot agree to deprioritizing network involvement.  The concern we have with this proposal is the ‘which are all up for study in the other WGs’. We need to idenfy if there is any RAN1 specification impact. For those aspects that don’t involve RAN1 spec impact, we don’t need to discuss them in RAN1. |

##### FL Observations

Support of the proposal

* ZTE, Spreadtrum, Futurewei, OPPO, Lenovo, Apple, Samsung, Qualcomm, NTT DOCOMO, Xiaomi, Nokia, NSB

Deprioritize partial coverage from the proposal

* CATT, CMCC

1 company comments that “On partial coverage, we do not need to exlucde it in the solution”. There seems to be a bit of different preferences on whether we should prioritize parital coverage or not. In either case, with regards to this proposal, we could limit to the “in coverage”. This does not mean that RAN1 has made an agreement of prioritizing or deprioritizing partial coverage, rather it means that this proposal just treats one of the scenarios.

1 company suggests, to try to include in a single proposal a statement for all the coverage scenarios, that, the network may or may not be involved. Such a statement is even more broad than trying to clarify some basic principles for the individual coverage scenarios. There is strong support, to make sure that we are all on the same page that, for OoO, the network is not involved. It was also suggested to change the “From RAN1 perspective, RAN1 assumes”, to the expression, “It is supported”. Since positioning architecture decisions are up to the other WGs, i believe that it is more appropriate to use the expression “From RAN1 perspective, RAN1 assumes”, rather than “It is supported”.

Based on the above considerations, the revised proposal is:

##### [LOW] Feature Lead Proposal 7.1.1-v1

* From RAN1 perspective, for in-coverage ~~and partial coverage~~ scenarios, RAN1 assumes that the network may be involved in the SL positioning/ranging, and/or hybrid (SL/Uu) Positioning.
* Note: Positioning architecture and signalling procedures are up for study in the other WGs

##### Companies views

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| --- | --- |
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## Out of Coverage (OOC) Scenarios

|  |  |
| --- | --- |
| Futurewei | The SL positioning solutions should support the necessary configurations and controls for OOC SL positioning.  Consider reusing or extending the IUC framework defined in Rel 17 for OOC SL positioning solutions. |
| Nokia, NSB | UEs may perform functionalities related to coordination and/or configuration of a SL positioning session, especially in out-of-coverage scenarios. Such role may depend on the capability, eligibility, and suitability of UEs that might be potentially involved in SL positioning.  Study mechanisms to allow UEs to exchange information on resources used for SL positioning to coordinate between concurrent SL positioning sessions. |
| CEWiT, Reliance Jio, Saankhya Labs, IITM, IITK | Out-of-coverage case should be considered for sidelink-based positioning architecture enhancements. |
| ZTE | Consider the SL positioning structure design via PC5 interface including PC5-S and PC-5 RRC. |
| Apple | RAN1 should discuss the assumption on the positioning entity (LMF) in the case of in-coverage, partial-coverage and out of-coverage cases |
| Qualcomm | Study positioning procedures that enable the calculation entity being:   * in out-of-coverage scenarios, UE(s) involved in a SL Positioning session |
| NEC | Both UE assisted and UE based positioning methods should be supported.  −    Including corresponding signalling and procedure for study |
| Interdigital | Study the destination of measurement reports sent from the target UE : anchor UE, LMF or gNB |
| Ericsson | In out-of-coverage, UE-based positioning solution should between pairs of UEs, where UEs discover other UEs capable of supporting in positioning, and initiate unicast ranging measurements towards these nodes. A UE acting as a location server for another UE, i.e. centralizing assisdance data from other UEs, is not supported. |
| CATT | For the operation of SL positioning without LMF, the following issues are suggested to be addressed:   * In the relative positioning, ranging and absolute positioning scenarios of SL positioning, the target UE can directly send a request information to other assisted UEs to initiate the positioning. This may be defined as device to device location service(request) which will be discussed in SA2. * In the absolute positioning scenarios of SL positioning, the assisted UEs may be the positioning anchor nodes (e.g. RSUs), and the assisted UEs can broadcast positioning indication information to assist the target UE to trigger the positioning procedure. This may be defined as group location service in SA2. |

Based on the above set of proposals, the on-going work in SA2, and that, in the SID description, the study of positioning architecture and signalling to enable sidelink positioning covering both UE based and network based positioning is within RAN2 scope, including coordination and alignment with RAN3 and SA2 as required, the following proposal is made:

##### [CLOSED]Feature Lead Proposal 7.1.2-v0

* From RAN1 perspective, at least for out of coverage scenarios, RAN1 assumes that the network is not involved in a SL positioning/ranging, which is up for study in the other WGs.

##### Companies views

|  |  |
| --- | --- |
| CATT | Support |
| MTK | Okay. |
| ZTE | Fine with FL’s assessment. |
| Spreadtrum | Support. |
| InterDigital | We agree with the proposal. |
| Futurewei | Support |
| CMCC | Support |
| NEC | OK |
| OPPO | Support. |
| Lenovo | Support |
| Apple | Support |
| vivo | We don’t understand the last part of sentence of this proposal “which is up for study in the other WGs”. What is the word “which” referring to? The network is not involved in SL positioning for out-of-coverage? What will other WGs to study? To study RAN1’s assumption or what?  Either we remove it (our modification is below) or add more text to clarify. Right now, this proposal is confusing.  From RAN1 perspective, at least for out of coverage scenarios, RAN1 assumes that the network is not involved in a SL positioning/ranging~~, which is up for study in the other WGs~~. |
| Samsung | OK |
| Qualcomm | Support |
| DCM | OK |
| LGE | As commented in other proposal, stand-alone SL positioning should be available regardless of the network coverage. It has a benefit of less latency for SL positioning, compare to one with gNB/LMF involvement. We propose the following modification. Feature Lead Proposal 7.1.2-v0 From RAN1 perspective, ~~at least for out~~ regardless of coverage scenarios, ~~RAN1 assumes~~ it is supported that the network ~~is~~ may not be involved in a SL positioning/ranging, which is up for study in the other WGs. |
| Xiaomi | OK |
| Huawei, HiSilicon | We would like to clarify whether this “out of coverage scenario” corresponds to the “out of coverage” definition in TS 38.304, which is SL frequency specific rather than UE specific. In this definition, it should be possible that the SL carrier is out of coverage, while UE may still has access to the network, but the network has no control over the SL carrier. |
| Philips | It is ok to focus on out-of-coverage, but we should design the solutions by keeping in mind the partial coverage and in-coverage scenarios to make sure the solution for sidelink positioning can also be reused for the partial coverage and in-coverage scenarios. |
| Nokia, NSB | OK |
| Ericsson | Similar comment as previous proposal.  The concern we have with this proposal is the ‘which are all up for study in the other WGs’. We need to idenfy if there is any RAN1 specification impact. For those aspects that don’t involve RAN1 spec impact, we don’t need to discuss them in RAN1. |

##### FL Observations

Support of the proposal

* CATT, MTK, ZTE, Spreadtrum, Interdiital, Futurewei, CMCC, NEC, OPPO, Lenovo, Apple, Samsung, Qualcomm, NTT DOCOMO, Xiaomi, Nokia, NSB

1 company suggests, to try to include in a single proposal a statement for all the coverage scenarios, that, the network may or may not be involved. Such a statement is even more broad than trying to clarify some basic principles for the individual coverage scenarios. There is strong support, to make sure that we are all on the same page that, for OoO, the network is not involved. It was also suggested to change the “From RAN1 perspective, RAN1 assumes”, to the expression, “It is supported”. Since positioning architecture decisions are up to the other WGs, i believe that it is more appropriate to use the expression “From RAN1 perspective, RAN1 assumes”, rather than “It is supported”.

1 company would like to understand what was the intention behind the “which is up for study in the other WGs”. The intention was to say that the “positioning architecture and signaling procedures” is up to the other WGs (as is already written in the SID).

1 company wanted to clarify

* whether this “out of coverage scenario” corresponds to the “out of coverage” definition in TS 38.304, which is SL frequency specific rather than UE specific. In this definition, it should be possible that the SL carrier is out of coverage, while UE may still has access to the network, but the network has no control over the SL carrier.

In my understanding, i don’t see how, one way or the other way would change the discussion in this proposal. The intention is, from RAN1 perspective, to agree that we are planning to discuss SL Positioning solutions without assuming the network is involved in these cases.

##### [LOW] Feature Lead Proposal 7.1.2-v1

* From RAN1 perspective,
  + For out of coverage scenarios, RAN1 assumes that the network is not involved in a SL positioning/ranging.
* Note: Positioning architecture and signalling procedures are up for study in the other WGs

##### Companies views

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| --- | --- |
|  |  |

## 7.2 Positioning Measurements Report

Based on the submitted contributions, the following proposals are identified with regards to the sidelink positioning measurement report:

|  |  |
| --- | --- |
| CATT, GOHIGH | For all types of S-PRS (periodic, semi-persistent and aperiodic S-PRS), the required measurements are configured through SLPP (the definition is up to RAN2). And corresponding SL measurements are also reported through SLPP. |
| Apple | RAN1 should discuss the specifics of the SL positioning techniques based on the existing RAN-dependent techniques and update the associated signaling, measurements and procedures for the new SL-positioning schemes.. Issues to be addressed include:  Feedback of positioning measurement and assistance information to the positioning estimator |
| Fraunhofer IIS, Fraunhofer HHI | Integrate the reporting of sidelink measurements into the reporting framework for DL-TDOA, UL-TDOA and multi-RTT based positioning |
| Lenovo | Measurement quality metrics should also be supported to assess quality of SL positioning measurements  Support different SL Positioning reporting types including one-shot, triggered and periodic reports |
| Interdigital | Study contents measurements and destination of measurement reports applicable for SL positioning methods in in-coverage, out-of-coverage or partial coverage scenarios |
| Intel | In terms of measurement reporting, they may be reported to gNB or to another UE(/RSU) and include references for PRS resource set and resource IDs.  In general, the measurement reports can be routed to the LMF via a serving gNB. Similar to Uu positioning, GNSS-RTK assistance data or other assistance information may be broadcasted by serving cell when in coverage. |
| Qualcomm | From RAN1 perspective, with regards to the SL positioning measurement report, use as a starting point the assumption that a SL positioning report shall be a high-layer report. Up to RAN2 & SA2 working groups to identify and design the necessary architecture, signaling and protocols  Study information to be included in a sidelink positioning measurement report, in addition to the basic UE measurements, including at least the following: time stamp(s), quality metric(s), UE-ID(s), SL-PRS resource ID(s). |
| ROBERT BOSCH GmbH | For studying sidelink positioning method (e.g., TDO, RTT, AOA/D, …) keep L1/L2 layer impact being minimum and independent of sidelink positioning signal design. |

Based on the submitted tdocs, and proposals summarized above, the following proposal is made:

##### [CLOSED]Feature Lead Proposal 7.2-v0

With regards to the Sidelink Positioning measurement report,

* Study the contents of the measurement report (e.g. time stamp(s), quality metric(s), ID(s))
* Study the time domain behavior of the measurement report (e.g. one-shot, triggered, periodic)
* RAN1 assumes that the Sidelink Positioning measurement report shall be a high-layer report.

##### Companies views

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| --- | --- |
| CATT | Support.  We prefer that SLPP should be introduced to configure/report the measurements. |
| ZTE | Where to process the SL positioning measurement request/report (e.g.PC5-S, PC5-RRC, or others) should be defined in RAN2. |
| Huawei, HiSilicon | It is not clear what this “high-layer” means, especially for L2 (MAC). Can FL clarify? |
| **Feature Lead Clarification** | With regards to Huawei, HiSilicon question, the intention of the 3rd bullet is to consider reporting above MAC layer. Assume, the bullet is rewritten to the following and provide further based on that . Sorry for the ambiguity.   * RAN1 assumes that the Sidelink Positioning measurement report shall be a a higher-layer report (wherein higher-layer report in this proposal doesn’t include MAC-CE reporting). |
| InterDigital | For clarification, examples for high-layer signaling used to carry reports should be mentioned, e.g., RRC, LPP. Lower-layer based measurement reporting should not be precluded (e.g., MAC-CE, SCI-2). Thus we propose to remove the third bullet. Feature Lead Proposal 7.2-v0 With regards to the Sidelink Positioning measurement report,   * Study the contents of the measurement report (e.g. time stamp(s), quality metric(s), ID(s)) * Study the time domain behavior of the measurement report (e.g. one-shot, triggered, periodic) * ~~RAN1 assumes that the Sidelink Positioning measurement report shall be a high-layer report.~~ |
| Futurewei | Support in principle. The last bullet may not be necessary. A separate discussion on architecture is needed, and maybe RAN2 involved. |
| CMCC | Support.  We prefer to reuse the design in NR Uu positioning as much as possible. |
| NEC | Ok in principle, and share the similar view as above to remove the last bullet. |
| Sony | Generally fine. However, the above proposal on the measurement contents does not explicitly mention the actual measurement result itself? (e.g., timing-based measurement, such as RTT /TDOA results, or angle or power-based measurement results?) |
| OPPO | Support the proposal. |
| Lenovo | Support FL’s proposal. Due to the potential size of such SL Pos. measurement reports, we prefer to use higher-layer signalling. |
| Apple | Support general proposal. On assumption of higher layer report, we should have a discussion on this first. We may end up at the same conclusion but we should understand what measurements are needed first. |
| vivo | We’re not sure we need to agree on this at the early stage of SI. We prefer to defer the discussion until more progress of PHY SL-PRS design. |
| Samsung | OK for the direction of proposal 7-2 in general.  We suggest to remove the third bullet. |
| Qualcomm | We support the proposal |
| DCM | Probably third bullet should also be studied. |
| LGE | Support the proposal in general. We may study the benefit of reporting the measurement report in a lower layer for short latency. We propose to include the following FFS.   * RAN1 assumes that the Sidelink Positioning measurement report shall be a a higher-layer report (wherein higher-layer report in this proposal doesn’t include MAC-CE reporting).   FFS whether the measurement can be reported in a lower layer |
| Sharp | Fine |
| Xiaomi | We are fine with the proposal. |
| Huawei, HiSilicon2 | Thanks for the clarification from the FL  We tend to agree with InterDigital/vivo/SS that the last bullet should be deleted for now. |
| Philips | Agree with Interdigital and LG to not exclude lower layer reporting. |
| Nokia, NSB | Lower layer reporting should not be precluded at this point, so we agree with InterDigital and LGE. |
| Ericsson | Ok to further study |

##### FL Observations

There is good support for the first 2 bullets of the proposal.

* At least 8 companies suggested to remove the 3rd bullet at this point of the study / or study it further
  + Huawei, HiSilicon, Interdigital, vivo, Samsung, NEC, Apple, NTT DOCOMO, Philips, Nokia, NSB
* The 3rd bullet is supported by at least 5 companies
  + CATT, CMCC, Lenovo, Qualcomm, Xiaomi
* 1 company suggests to keep the 3rd bullet, but add “"FFS whether the measurement can be reported in a lower layer”
* Indeed, the proposal would make some progress without the 3rd bullet, at this early stage of the study, so the new Proposal is the following:

##### [MEDIUM] Feature Lead Proposal 7.2-v1

With regards to the Sidelink Positioning measurement report,

* Study the contents of the measurement report (e.g. time stamp(s), quality metric(s), ID(s), angular/timing/power measurements, etc)
* Study the time domain behavior of the measurement report (e.g. one-shot, triggered, periodic)
* ~~RAN1 assumes that the Sidelink Positioning measurement report shall be a high-layer report.~~

##### Companies views

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# Other Proposals

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| --- | --- |
| Nokia, NSB | * Target UE: UE to be positioned (in this context, using SL, i.e. PC5 interface).   Note: We prefer to use a simpler definition than the one provided in 3GPP TR 23.700-86 [2].   * Anchor UE (or Supporting UE): UE supporting positioning of target UE, e.g., by transmitting and/or receiving reference signals for positioning, providing positioning-related information, etc., over the SL interface.   Note: Any UE can be both target UE and anchor UE at the same time, or switch roles during a positioning session.  Note: In [2], the terms called “Reference UE” and “Assistant UE” are defined. From the RAN perspective, we see that the naming “Reference UE” might create confusion with the Positioning Reference Unit (PRU) introduced in Rel. 17. Second, we see that the defined roles for “Reference UE” and “Assistant UE” in [2] are interchangeable, and see no need to define such types of UEs separately.   * Sidelink positioning: Positioning UE using reference signals transmitted over SL, i.e., PC5 interface, to obtain absolute position, relative position, or ranging information.   Note: In [2], the definition of “sidelink positioning” is not logically connected to absolute/relative positioning or ranging over SL. We propose to have “sidelink positioning” as a collective term that covers all, so as not to list them every time separately and explicitly.   * Ranging: determination of the distance and/or the direction between a UE and another entity, e.g., anchor UE.   Note: While relative positioning information refers to relative coordinates of a UE with respect to another entity, ranging information refers to only the distance and/or angle between them.  Note: In [2], ranging definition also covers relative positioning. However, we see these terms differently as captured in the Note above.   * Sidelink positioning reference signal (SL PRS): reference signal transmitted over SL for positioning purposes. * SL PRS (pre-)configuration: (pre-)configured parameters of SL PRS such as time-frequency resources including its bandwidth and periodicity. The (pre-)configuration information provided to UEs can be part of an “assistance data for SL positioning”.   Align on the above-provided terminology on SL positioning, to be used (at least) during the study. |
| NTT DOCOMO | * For SL-positioning,   + Study measurement UE determination   + Study cast-type to be used in SL-positioning method |
| CATT, GOHIGH | Proposal 1: the solutions for sidelink positioning should include the following aspects:.   1. Sidelink positioning methods 2. Sidelink positioning reference signal 3. Sidelink positioning measurement and configuration 4. Sidelink positioning physical-layer procedures |
| CMCC | The evaluation of TDOA and RTT should be based on ITS band (20/40MHz) and licensed band in FR1in Rel-18 SL positioning. |
| ZTE | Rel-18 NR sidelink positioning can focus on ITS and licensed spectrum first. |
| ROBERT BOSCH GmbH | Study the impact of sidelink positioning to improved positioning integrity of, e.g., Uu-based positioning |
| Xiaomi | RAN1 shall study whether/how to evaluate the impact of in-band emission on sidelink positioning solutions |
| Sony | Consider to support UE-types classification for V2X positioning (e.g., RSU, VRU, Car). |
| Lenovo | Focus the licensed band SL Positioning study on FR1. Consider FR2 for evaluation if time permits and based on ongoing FR2 SL enhancements in separate SI  RAN1 to discuss the relationship between Uu PRS and SL PRS configuration and associated measurements for hybrid positioning model A (using both Uu and SL interfaces)  RAN1 to further discuss the benefits of PRUs in the context of SL positioning |
| Spreadtrum | Energy efficiency for sidelink positioning reference signals transmission should be considered. |
| NEC | The potential sidelink positioning methods should be evaluated based on sidelink features to identify the feasible items.  The applicability of absolute positioning and relative positioning should be studied to meet different sidelink positioning requirements. |
| Interdigital | Agree on the following definitions : “anchor UE” as the UE who transmit PRS to or receive PRS from the “target UE” whose position is to be determined  A study a framework to allow the target UE to process PRS measurements for SL positioning |
| Ericsson | 3GPP should prioritize exploiting complementary benefits of fixed wireless network infrastructure to benefit over competing non-3GPP ranging solutions. |
| Fraunhofer IIS, Fraunhofer HHI | Support the transmission and reception of positioning sidelink RSs with PRUs. |

##### [CLOSED]Feature Lead Request

Companies are encouraged to suggest whether any of the proposals above should be included in the other sections/subsections, or whether any of these proposals are considered beneficial to be discussed in this meeting.

##### Companies views

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| Huawei, HiSilicon | We think that the terminology alignment from Nokia could be considered as the baseline in the discussion.  Some clarification between anchor UE and reference UE (used by other WG) could be needed. |
| InterDigital | To facilitate the discussion, it will be good to align terminologies about UEs involved in SL positioning. In our proposal, we propose to use anchor UE and target UE. We defined “target UE” as the UE who position is to be determined. “Anchor UE” transmit PRS to or receive PRS from the “target UE”. |
| Futurewei | We are open to discuss Nokia’s proposal as the basis for terminology. |
| NEC | Comment 1: we also support ternomology proposed by Nokia.  Comment 2: we think how to choose anchor UE should also be studied since some UE may not be suitable as anchor UE, e.g., UE with very high speed.  Comment 3: identification of anchor UEs should also be studied. |
| Lenovo | We are fine with Nokia’s terminology as a good starting point. In addition, in the context of ranging we propose to introduce the terminology “Initiator UE – A UE that initiates/triggers a SL positioning/ranging session” and “Responder UE – A UE that responds to a SL positioning/ranging session from an initiator UE”. An initiating UE may not necessarily be an anchor UE, while positioning measurements can be performed either at the Initiating UE and/or Responding UE as in the case with e.g., double-sided RTT. |
| Apple | Agree that we should decide on common terminology for this study. |
| vivo | Fine to discuss common terminology. |
| LGE | We’re fine with the terminologies provided by Nokia except one point. If the ranging includes both distance and direction, it is equivalent to the relative positioning. It becomes just a matter of representation. So to avoid unnecessary confusion, we propose the following modification to the definition of ranging as follows.   * Ranging: determination of the distance ~~and/~~or the direction between a UE and another entity, e.g., anchor UE.   Note: While relative positioning information refers to relative coordinates of a UE with respect to another entity, ranging information refers to only the distance ~~and/~~or angle between them. |
| Xiaomi | We are fine with Nokia’s terminology. On Ranging, we think distance and/or the direction shall be kept. For example, when performing evaluation, for relative positioning, the horizontal possitioing accuracy will be evaluated; while for ranging, the ranging distance accuracy and/or ranging direction accuracy will be evaluated. |
| Nokia, NSB | Agree to align on terminology. Regarding LGE’s proposal on ranging, the problem is that ranging has already been defined by SA1, e.g. in TS 22.261 “Ranging-based services are the applications utilizing the distance between two UEs **and/or** the direction of one UE from the other one”; if we replace “and/or” by “or”, then this will result in inconsistent definitions of ranging. |

##### FL Observations

At least 10 companies (Huawei, HiSilicon, Interdigital, Futurewei, NEC, Lenovo, Apple, Vivo, LGE, Xiaomi, Nokia, NSB) showed interest in discussing some terminology to facilitate the discussion. Based on this, the following section & proposal is initiated:

## Terminology Alignment

The following proposals were made with regards to the terminology:

|  |  |
| --- | --- |
| Nokia | * **Target UE:** UE to be positioned (in this context, using SL, i.e. PC5 interface).   Note: We prefer to use a simpler definition than the one provided in 3GPP TR 23.700-86 [2].   * **Anchor UE (or Supporting UE):** UE supporting positioning of target UE, e.g., by transmitting and/or receiving reference signals for positioning, providing positioning-related information, etc., over the SL interface.   Note: Any UE can be both target UE and anchor UE at the same time, or switch roles during a positioning session.  Note: In [2], the terms called “Reference UE” and “Assistant UE” are defined. From the RAN perspective, we see that the naming “Reference UE” might create confusion with the Positioning Reference Unit (PRU) introduced in Rel. 17. Second, we see that the defined roles for “Reference UE” and “Assistant UE” in [2] are interchangeable, and see no need to define such types of UEs separately.   * **Sidelink positioning:** Positioning UE using reference signals transmitted over SL, i.e., PC5 interface, to obtain absolute position, relative position, or ranging information.   Note: In [2], the definition of “sidelink positioning” is not logically connected to absolute/relative positioning or ranging over SL. We propose to have “sidelink positioning” as a collective term that covers all, so as not to list them every time separately and explicitly.   * **Ranging:** determination of the distance and/or the direction between a UE and another entity, e.g., anchor UE.   Note: While relative positioning information refers to relative coordinates of a UE with respect to another entity, ranging information refers to only the distance and/or angle between them.  Note: In [2], ranging definition also covers relative positioning. However, we see these terms differently as captured in the Note above.   * **Sidelink positioning reference signal (SL PRS):** reference signal transmitted over SL for positioning purposes. * **SL PRS (pre-)configuration:** (pre-)configured parameters of SL PRS such as time-frequency resources including its bandwidth and periodicity. The (pre-)configuration information provided to UEs can be part of an “assistance data for SL positioning”. |
| Lenovo | * **Initiator UE:** A UE that initiates/triggers a SL positioning/ranging session * **Responder UE:** A UE that responds to a SL positioning/ranging session from an initiator UE.   An initiating UE may not necessarily be an anchor UE, while positioning measurements can be performed either at the Initiating UE and/or Responding UE as in the case with e.g., double-sided RTT. |
| LGE | * **Ranging:** determination of the distance ~~and/~~or the direction between a UE and another entity, e.g., anchor UE.   Note: While relative positioning information refers to relative coordinates of a UE with respect to another entity, ranging information refers to only the distance ~~and/~~or angle between them. |

Companies are encouraged to provide their support or not support (or suggested modifications) on the following Terminology:

##### [MEDIUM] Feature Lead Proposal 8.1-v0

For the purpose of RAN1 discussion during this stuty item, the following terminology is used:

* **Target UE:** UE to be positioned (in this context, using SL, i.e. PC5 interface).
* **Anchor UE (or Supporting UE):** UE supporting positioning of target UE, e.g., by transmitting and/or receiving reference signals for positioning, providing positioning-related information, etc., over the SL interface.
  + Note: Any UE can be both target UE and anchor UE at the same time, or switch roles during a positioning session.
* **Sidelink positioning:** Positioning UE using reference signals transmitted over SL, i.e., PC5 interface, to obtain absolute position, relative position, or ranging information.
* **Ranging:** 
  + Option 1: determination of the distance and/or the direction between a UE and another entity, e.g., anchor UE.
  + Option 2: determination of the distance or the direction between a UE and another entity, e.g., anchor UE.
* **Sidelink positioning reference signal (SL PRS):** reference signal transmitted over SL for positioning purposes.
* **SL PRS (pre-)configuration:** (pre-)configured parameters of SL PRS such as time-frequency resources including its bandwidth and periodicity. The (pre-)configuration information provided to UEs can be part of an “assistance data for SL positioning”.
* **Initiator UE:** A UE that initiates/triggers a SL positioning/ranging session
* **Responder UE:** A UE that responds to a SL positioning/ranging session from an initiator UE.

##### Companies views

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# Proposals for GTW (TBD)

This section will contain the stable proposals for discussion during online time

## 13.1 <Date>

## 13.2 <Date>

## 13.3 <Date>

# References

* + - 1. R1-2203058 Considerations on sidelink reference signals for positioning purposes FUTUREWEI
      2. R1-2203129 Potential solutions for SL positioning Nokia, Nokia Shanghai Bell
      3. R1-2203164 Discussion on solutions to support SL positioning Huawei, HiSilicon
      4. R1-2203335 Consideration on potential solutions for SL positioning Spreadtrum Communications
      5. R1-2203467 Discussion on potential solutions for SL positioning CATT, GOHIGH
      6. R1-2203566 Discussion on potential solutions for sidelink positioning vivo
      7. R1-2203624 Discussion on potential solutions for SL positioning ZTE
      8. R1-2203659 Discussion on potential solutions for sidelink positioning China Telecom
      9. R1-2203720 Discussion on potential solutions for SL positioning LG Electronics
      10. R1-2203738 Considerations on potential solutions for SL positioning Sony
      11. R1-2203752 The potential solutions for sidelink positioning MediaTek Inc.
      12. R1-2203823 Discussion on sidelink positioning solutions xiaomi
      13. R1-2203911 Discussion on Potential Solutions for SL Positioning Samsung
      14. R1-2203943 Discussion on Potential Solutions for SL Positioning NEC
      15. R1-2203980 Discussion on potential solutions for SL positioning OPPO
      16. R1-2204092 carrier phase measurement method for sidelink positioning Locaila
      17. R1-2204132 Potential solutions for SL positioning InterDigital, Inc.
      18. R1-2204253 Discussions on Potential solutions for SL positioning Apple
      19. R1-2204310 Discussion on potential solutions for SL positioning CMCC
      20. R1-2204385 Discussions on potential solutions for SL positioning NTT DOCOMO, INC.
      21. R1-2204559 On Potential SL Positioning Solutions Lenovo
      22. R1-2204667 Views on potential solutions for SL positioning Sharp
      23. R1-2204755 Discussion on potential solutions for sidelink based positioning CEWiT
      24. R1-2204835 Potential solutions for SL positioning Fraunhofer IIS, Fraunhofer HHI
      25. R1-2204869 Views on potential solutions for SL positioning ROBERT BOSCH GmbH
      26. R1-2204940 Views on potential solutions for SL positioning Intel Corporation
      27. R1-2204950 Potential solutions for SL positioning Ericsson
      28. R1-2205038 Potential Solutions for Sidelink Positioning Qualcomm Incorporated
      29. RP-213588 “Revised SID on Study on expanded and improved NR positioning,” Intel (Email discussion moderator), RAN #94-e.