3GPP TSG RAN WG2 Meeting #119bis-e R2-220xxxx

**Electronic meeting, Online, October 2022**

**Agenda item:** x.x

**Source:** Intel Corporation

**Title:** Summary of [Post119-e][406][POS] Sidelink positioning protocol issues

**Document for:**  Discussion, Agreement

# Introduction

This document pertains to the following email discussion related to sidelink positioning protocol issues:

* [Post119-e][406][POS] Sidelink positioning protocol issues (Intel)

Scope: Discuss protocol design issues for sidelink positioning:

* Extension of LPP vs. use of SLPP/RSPP between UE and LMF when in coverage
  + Considering PC5-only and PC5+Uu cases
* Procedure types for SLPP/RSPP
  + LPP procedure types can be considered as a starting point for discussion
* Cast types for positioning signalling on PC5
  + In line with agreement from RAN2#119-e, this point does not include SL-PRS transmission, where we will follow RAN1

Intended outcome: Report to next meeting

Deadline: Long

Companies are requested to provide their views on the issues listed in this document.

# Contact Information

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| --- | --- | --- |
| Company | Name | Email Address |
| OPPO | Liu Yang | liuyangbj@oppo.com |
| CATT | Jianxiang Li | lijianxiang@catt.cn |
| Intel | Ansab Ali | ansab.ali@intel.com |
| vivo | Xiang Pan | panxiang@vivo.com |
| Qualcomm | Dan Vassilovski | dvassilo@qti.qualcomm.com |
| Nokia | Stepan Kucera | stepan.kucera@nokia.com |
| ZTE | Yu Pan | pan.yu24@zte.com.cn |
| Huawei, HiSilicon | Yinghao Guo | **yinghaoguo@huawei.com** |
| MediaTek | Xuelong Wang | xuelong.wang@mediatek.com |
| Lenovo | Robin Thomas/Hyung-Nam Choi | rthomas@lenovo.com/hchoi5@lenovo.com |
| LG | Jonggil Nam | jonggil.nam@lge.com |
| Spreadtrum Communications | Huifang Fan | Huifang.fan@unisoc.com |
| Sony | Anders Berggren | Anders.Berggren@sony.com |
| Philips | Rob Davies | rob.j.davies@philips.com |

# Relevant Company Contributions

1. R2-2207081 Discussion on sidelink positioning vivo discussion Rel-18 FS\_NR\_pos\_enh2
2. R2-2207090 Discussion of sidelink positioning OPPO discussion Rel-17 FS\_NR\_pos\_enh2
3. R2-2207106 SL Positioning Architecture and Protocol Stack CATT discussion Rel-18 FS\_NR\_pos\_enh2
4. R2-2208685 Discussion of sidelink positioning procedures Nokia, Nokia Shanghai Bell discussion Rel-18 FS\_NR\_pos\_enh2
5. R2-2207286 Principles for sidelink positioning MediaTek Inc. discussion Rel-18
6. R2-2207388 Support of sidelink positioning Intel Corporation discussion Rel-18 FS\_NR\_pos\_enh2
7. R2-2207435 On Sidelink Positioning Architecture Apple discussion Rel-18 FS\_NR\_pos\_enh2
8. R2-2207486 Discussion on Sidelink Positioning InterDigital, Inc. discussion Rel-18 FS\_NR\_pos\_enh2
9. R2-2207586 Discussion on sidelink positioning ZTE, Sanechips discussion Rel-18 NR\_pos\_enh-Core
10. R2-2207684 Discussion on potential solutions for SL positioning Spreadtrum Communications discussion Rel-18
11. R2-2207828 Considerations on sidelink positioning Sony discussion Rel-18 FS\_NR\_pos\_enh2
12. R2-2207865 On SL Positioning Architecture and Procedures Lenovo discussion Rel-18
13. R2-2207868 Discussion on sidelink positioning Huawei, HiSilicon discussion Rel-18 FS\_NR\_pos\_enh2
14. R2-2208080 SL positioning Ericsson discussion Rel-18
15. R2-2208126 Study of Sidelink Positioning Architecture, Signaling and Procedures Qualcomm Incorporated discussion
16. R2-2208253 Protocol considerations for sidelink positioning Philips International B.V. discussion Rel-18 FS\_NR\_pos\_enh2
17. R2-2208301 Discussion on functions of LMF in SL positioning Samsung discussion Rel-18 FS\_NR\_pos\_enh2
18. R2-2208320 Discussion on out-of-coverage sidelink positioning Samsung R&D Institute UK discussion
19. R2-2208453 Initial considerations on Sidelink positioning CMCC discussion Rel-18 FS\_NR\_pos\_enh2
20. R2-2208582 Discussion on SL positioning Xiaomi discussion Rel-18

# Discussion

## Signaling between UE and LMF while in coverage

Based on the discussion in RAN2#119-e meeting [1], it was agreed that in order to support sidelink positioning procedures between UEs, a new protocol (name FFS, e.g. RSPP or SLPP) shall be defined. On the other hand, when it comes to signaling for sidelink positioning between UEs and LMF, it was proposed to reuse and extend the LPP for sidelink positioning procedures between UE and LMF. However, there was no consensus and the following was agreed:

Agreement:

Study the potential impact to LPP for support of sidelink positioning procedures between UE and LMF. FFS how much impact (if any), e.g., only to carry the new protocol, and if the PC5-only and hybrid PC5+Uu cases are the same or different.

In light of the above, two different scenarios, PC5-only based positioning and PC5+Uu based (i.e. hybrid) positioning were identified. In the following discussion, we can consider the two separately.

For the case of combination of Uu- and PC5-based positioning, a typical scenario may consist of LMF exchanging positioning related signaling for both Uu and PC5 based positioning. For instance, the LMF may request positioning capabilities for both the Uu and the SL interface; LMF may also provide both DL-PRS configuration and SL-PRS configuration to the UE; Finally, the LMF may request location information over both the Uu and the SL interface. In this case, it needs to be first discussed whether the two positioning procedures (and the associated signaling) over PC5 and Uu interfaces should be considered separate/independent of each other or can some correlation be assumed between them? In other words, do companies assume that the Uu and PC5 based positioning procedures are considered part of the same positioning session?

**Question 1: Do companies think that for the case of hybrid (Uu and PC5-based) positioning, the Uu and PC5 based positioning procedures are part of the same positioning session (for in coverage scenario)?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes/No** | **Comments** |
| OPPO | Yes | Generally, we think that Uu based positioning should be tried at first for in coverage scenario. The SL-based positioning could be triggered later to calibrate/replace a particular Uu positioning result, e.g., after a NLOS Uu measurement result has been obtained by the network.  Note that it could be possible to use only one SL positioning measurement result to replace one NLOS Uu positioning measurement result for the positioning, as indicated in following figure: one RTT Uu positioning measurement result is detected to be NLOS, and therefore is latterly replaced by the SL positioning measurement result (LOS) for triangulation positioning of the target UE. In such kind of implementation, Uu and SL should belong to the same positioning session. |
| CATT | Case by case | 1. For the case that both target UE and anchor UEs are in coverage, the Uu and PC5 based positioning procedures are considered part of the same positioning session. LPP procedures can be used for both Uu and PC5 positioning signaling when anchor UE and target UE can connect with LMF directly, and only AS procedures (SL-PRS transmission and measurement) are performed between target UE and anchor UEs. The costs of deployment offering LCS service will be reduced by anchor UEs replacing of gNB by sidelink positioning. There is only signaling between LMF and target UE in hybrid Uu+PC5 which may reduce the on air signaling of target UE.    2. For the case of target UE is in coverage and some anchor UEs are out of coverage (partial coverage case), positioning procedures (and the associated signaling) over PC5 and Uu interfaces should be considered separate/independent of each other when anchor UE (RSU) cannot connect with network and LMF. SLPP/RSPP procedures are used for SL positioning, and LPP procedures are used for Uu positioning. Anchor UE (RSU) in this case will help improve the coverage of LCS service by sidelink positioning. |
| Ericsson | Yes | 1. For in-coverage scenario; if the target UE is in NLOS w.r.t gNB but there is other reference/assisting UE which is in LOS w.r.t gNB then one possibility is that reference/assisting UE perform Uu measurements whereas reference UE and target UE perform SL based measurement.  To reduce cost of implementing new SL-PRS and to minimize interference, even the UL-SRS for positioning can be configured for in-coverage scenario rather than SL-PRS; i.e either the reference UE or target UE Or both UEs transmit UL-SRS and perform each other’s TOA estimation and provide the result to LMF.  gNB would provide the UL-SRS configuration of one UE to other similar to how in NRPPa LMF provides UL-SRS configuration to listening neighbor gNBs.  2. For partial coverage (i.e target UE is OOC, but assistance or reference UE is in coverage) U2N relay can be used where using L2 U2N relay even the LPP can be transported on top of NAS.    Figure: LPP Protocol Stack for L2 UE-to-NW relay |
| Intel | Yes | In our understanding, given that the end points for the positioning procedure are still the UE and the LMF and the fact that LMF may provide positioning related configuration for both Uu and PC5 interface to the same UE, we can model the Uu and PC5 based positioning transactions (using LPP and SLPP/RSPP respectively) as part of the same positioning session. |
| vivo | Yes | For a single location request, the AMF may only allocate one correlation ID used to identify the target UE positioning session. From the view of LMF, Uu- and PC5-based positioning can be treated as different positioning methods for one positioning session, and can be combined to improve the location accuracy.  For the case of separate positioning sessions, SA2 related impacts are foreseen, e.g., dedicated LCS request for SL positioning or multiple location sessions for one location request. |
| Qualcomm | ~~Yes~~ No | We think that the term “positioning session” has been misunderstood and that some “Yes” answers to this Question from others would become “No” if a precise definition of “positioning session” was provided that is relevant to impacts and support by LPP and SLPP.  A positioning session can refer to all the procedures and signalling used by one coordinating entity (e.g. an LMF) to obtain location(s) of one or more UEs to support some upper layer service request. When both Uu and PC5 based procedures and signalling are used, then “the Uu and PC5 based positioning procedures are part of the same positioning session” from the perspective of the coordinating entity and the answer to the question is “Yes”. However, other entities (e.g. one more UEs) involved in the positioning session do not need to be aware of this. These other entities can support the Uu and PC5 based procedures and signalling but can see these procedures and signalling as associated with separate transactions that are not necessarily for the same session. This would be similar to using different position methods for the same LPP session for Uu positioning. The LMF knows that the different LPP position methods apply to the same LPP session. The UE does not know that unless the same LPP messages and transactions are used to convey information for all the different position methods. When different LPP transactions and messages are used for the different position methods, the UE may not know if the different position methods refer to the same LPP session or to different LPP sessions. There seem to be no problems with this – e.g. LPP has been defined for around 12 years now and in all that time, there was never any urgent need to include session related information in LPP messages. The same approach can be applied to Uu and PC5 based procedures and signalling which would also typically support different Uu and PC5 related position methods. In this case, the term “positioning session” would refer to what is seen by the other entities where the Uu and PC5 based positioning procedures are not (necessarily) seen as part of the same positioning session which leads to a “No” answer to the question.  The avoidance of having to notify the other entities of the common Uu and PC5 positioning session (as seen by a coordinating entity) would allow SLPP and LPP to be defined and used independently even though a coordinating entity (e.g. LMF) can be aware of the common positioning session. In particular, this means that SLPP signalling would not need to convey LPP session related information and vice versa. This should reduce SLPP and LPP impacts.  ~~Currently, a location session is invoked by the AMF in order to obtain the location of the target UE or perform some other location related service such as transferring assistance data to the target UE. Within a single location session, an LPP session may be used between a location server (LMF) and the target UE in order to obtain location related measurements or a location estimate or to transfer assistance data to support a single location request (e.g., for a single MT-LR, MO-LR or NI-LR). Similarly, an NRPPa session may be used (alone or in addition to an LPP session) between a LMF and the serving NG-RAN node of the target UE to support a single location request.~~  ~~If Uu (UL and/or DL) and PC5-based location measurements are to be used to locate an in-coverage target UE, or Uu- and PC5-based assistance data are to be transferred to the target UE for the location session, the "Uu and PC5 based positioning procedures" must be part of the same location session.~~ |
| Nokia | Yes | Both PC5 and Uu signaling and procedures may support the positioning of an in-coverage UE within a self-contained process (said session), defined by state & controlling actions of the LMF. |
| ZTE | Yes | ‘Hybrid’ or ‘PC5 only’ is respect to target UE that whether the target UE only needs to preform SL positioning(transmitting or receiving SL-PRS), or target UE has to perform SL positioning and uu positioning(transmitting SRS, receiving DL-PRS and transmitting or receiving SL-PRS).  In the Rel-17 way, one positioning session only contains one UE (which is literally the ‘target UE’). However in the hybrid scenario, since LMF may calculate target UE’s location using uu measurement result and SL measurement result, we do not see the need to restrict a sidelink positioning session to only contain sidelink positioning procedures. |
| Huawei, HiSilicon | Yes | The definition of LPP positioning is already formally defined in LPP spec as follows:  4.1.2 LPP Sessions and Transactions  An LPP session is used between a Location Server and the target device in order to obtain location related measurements or a location estimate or to transfer assistance data. A single LPP session is used to support a single location request (e.g., for a single MT-LR, MO-LR or NI-LR). Multiple LPP sessions can be used between the same endpoints to support multiple different location requests (as required by TS 23.271 [3]). Each LPP session comprises one or more LPP transactions, with each LPP transaction performing a single operation (capability exchange, assistance data transfer, or location information transfer). In E-UTRAN and NG-RAN, the LPP transactions are realized as LPP procedures. The instigator of an LPP session will always instigate the first LPP transaction, but subsequent transactions may be instigated by either end. LPP transactions within a session may occur serially or in parallel. LPP transactions are indicated at the LPP protocol level with a transaction ID in order to associate messages with one another (e.g., request and response).  Since joint Uu and PC5 positioning serves a single location service request, it belongs to a single LPP session |
| MediaTek | Yes | We think a single positioning session should be used for all cases as discussed, as long as the intention of the location request is to locate a single target UE. For this positioning session, both Uu measurement and SL measurement can be performed by the involved entities including gNB, target UE and other possible assisting UE(s), depending the cases.  But it is important to distinguish between a location session (initiated by the AMF) and a session of a specific positioning protocol; if we determine to use LPP for the Uu part and RSPP/SLPP for the PC5 part of Uu/PC5 hybrid positioning, the single location session would contain sessions of both protocols, similar to the current situation with LPP and NRPPa as described by Qualcomm. |
| Lenovo | Yes, but see comments | It is unclear if the Moderator is referring to the same “LPP” or “SLPP” session. We see that hybrid (Uu and PC5-based) is beneficial to improve Uu positioning estimate as well as the PC5 positioning estimate. The proposal should emphasize which type of session is referred to as “same”. In principle, we would be supportive of both.  Further study is also needed on how the LPP protocol will be exposed to the SLPP/RSPP layer and vice versa. |
| LG | Yes | It would be signaling burdensome to separate positioning sessions on each anchor UEs in hybrid (i.e., Uu- and PC5-based) positioning. Hybrid positioning involved LMF can be used for a target UE in in-coverage scenarios. A location session will be invoked by AMF for a single location request, and an LPP session will be established between LMF and a target UE. Through this LPP session, LMF can provide the relevant information (e.g., assistance data transfer) to the target UE to assist in PC5-based positioning, and LMF can be also provided the relevant information (e.g., location information transfer) from the target UE regarding PC5-based positioning. We don’t see some reason to separate session and procedure. |
| Spreadtrum Communications | Yes | For single location request, Uu and PC5 positioning can be used to determine the target UE’s location cooperatively. And a single LPP session is used to support a single location request. |
| Sony | Yes | The LMF is responsible for setting up the measurement configuration, and has thus a peer to peer connection to all involved entities for PRS and SL-PRS configuration. Also what is important is the total duration of hybrid positioning measurement. The session should be within a time window (relatively short) |
| Philips | Yes (see comments) | From LMF point of view a single positioning session may include Uu-based positioning, PC5-based positioning or both. However, the PC5-based positioning and Uu-based positioning could use separate sessions or different session concepts. In particular since PC5-based positioning also needs to work in partial coverage and out-of-coverage situations some form of session coordination is likely needed between the Target UE and one or more Reference UEs. This may use a different session concept than for e.g. acquiring the position of one of the Reference UEs over Uu The LMF can combine the results of the PC5-based positioning and Uu-based positioning sessions. |

**Summary:**

For the case of hybrid (Uu + PC5) positioning, with respect to carrying the positioning related singling between the LMF and the UE, at least three different options can be identified based on company comments and contributions:

1. **Hybrid Uu and SL positioning is achieved by jointly using the SLPP/RSPP, LPP, and NRPPa procedures, i.e. use the newly defined SLPP/RSPP to support sidelink based positioning and use the existing LPP to support Uu based positioning [15]**
2. **Extension of LPP, whereby new signaling shall be defined to support hybrid Uu and PC5 based positioning, i.e. extend the existing LPP to support sidelink based positioning between UE and LMF [1], [2] [9] [14] [20];**
3. **Enhancement of LPP whereby SLPP/RSPP signaling can be transported as a transparent container within LPP , i.e. use the newly defined SLPP/RSPP to support sidelink based positioning and use the existing LPP to support Uu based positioning [15], but the SLPP/RSPP is carried as a container in LPP[13];**

Companies are invited to comment and list any pros and cons for the options to facilitate further discussion.

**Question 2: For the case of hybrid (Uu + PC5) based positioning, which of the options above do companies support for sidelink positioning procedures between UE and LMF for in coverage scenario?**

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| --- | --- | --- |
| **Company** | **Supported option** | **Comments** |
| OPPO | 2 | The new protocol SLPP/RSPP should be run dedicatedly between two peers UE, but not between UE and LMF, which simplifies the spec effort.  Also, A-GNSS positioning is already supported by LPP in the way that GNSS assistance data are conveyed from LMF to UE. We see no reason why LPP should not do the same thing to support the SL positioning. |
| CATT | 2 and 3 | Different solutions apply to different requirement and use cases. Option 2 is for partial coverage in Q1, and option 3 is for in coverage in Q1. Container of SLPP/RSPP in LPP will be more flexible and may change accordingly with SLPP when the SLPP/RSPP message in detail is modified. |
| Ericsson | 2 | For NW coverage; i.e when NW is involved for Positioning for in-coverage and partial coverage, LPP extension is efficient and further reuse of existing reference signal is also beneficial. We do not see the need of container based solution.  Pure SLPP/RSPP should be used only for OOC |
| Intel | 3 or 2 | In our view, given that we have agreed to support SLPP/RSPP for the case of PC5 interface between UEs, option 1 appears logical to support. However, this implies that the SLPP/RSPP signaling shall be carried over the Uu interface as well, i.e., separate procedure from Uu based positioning which seems redundant given that we already have to support LPP. LPP can thus be utilized for supporting the SL based positioning signaling between the LMF and the target/anchor UE. From that perspective, we think Options 2 and 3 may be simpler. Specifically, option 3 may result in least specification impact to LPP |
| vivo | 2 or 3 | Option 2 is a straightforward way to extend the LPP to support the SL positioning as a new positioning method.  Option 3 has benefits for reducing the effort to maintain the LPP specification and is acceptable to us if preferred by the majority. |
| Qualcomm | 1 or 3 | Our preference is for 1 (see also our response to Question 3). We consider 1 and 3 to be mostly equivalent. The impacts on the NAS transport messages would need to be studied but should be minor (e.g., an additional SLPP bit). Option 3 does not require an "enhancement of LPP", since this is existing LPP functionality (e.g., currently used for LPP + (OMA) LPPe).i  In our view, RAN2 should adopt an approach minimizing specification changes and imposing the minimum change requirements on the network and UE. Supporting SLPP/RSPP at the LMF enables parallel Uu-based positioning ranging (using LPP/NRPPa procedures) and PC5-based (positioning using SLPP procedures). This includes UE-to-UE, LMF-Initiated (MT-LR) and LMF-assisted (MO-LR). This approach (LMF SLPP/RSPP support) will address all work item uses cases for out-of-coverage, in-coverage and partial coverage with minimal impact to the specifications, the UE and the network components.  Option 2 is not desired, since it affects all UEs, including non sidelink capable UEs which will need to support the modified LPP, and increases the ASN.1 footprint (and therefore memory requirements) for all UEs. Modifying LPP will also result in duplication of functionality in SLPP/RSPP and LPP, resulting in added specification development and added specification maintenance moving forward.   * Option 2 could also impact UEs and LMFs which do not need to support sidelink positioning due to the visibility at an ASN.1 level. For example, if an LMF or UE were to receive an LPP message with sidelink positioning content, even if this content is not supported, the decoding of the LPP message might need to be sidelink capable. * Option 3 has some of the same disadvantages as Option 2 in that UEs would also need to support LPP in addition to SLPP, and thus have a potentially large ASN.1 footprint. * Option 1 would allow a smaller protocol to be defined with enhancements (not present in LPP) to reduce ASN.1 footprint size and processing support. That could simplify UE implementation when LPP does not otherwise need to be supported. |
| Nokia | 2 | In coverage, extended LPP should suffice for hybrid positioning communications between the UE and the LMF. SLPP shall be reserved for communications between SL UEs. However, all protocols will have to be used, possibly simultaneously, in an integrated manner to support hybrid positioning sessions. For example, SLPP may be used to activate pre-configured resources, known from LPP-delivered assistance data.  Agree with Ericsson that pure SLPP/RSPP should be used only for OOC. |
| ZTE | 1 or 2 | If it is just for UE to differ uu positioning and SL positioning, only an indication from LMF is enough, the other LPP will not need to extend, as solution 1;  If NW will coordinate UE’s SL resources for positioning, or NW will need the Uu measurements and SL measurements together, extending the existing LPP (or NRPPa) to support sidelink based positioning is needed, like solution 2 |
| Huawei, HiSilicon | 3 | PC5-only design can be separately done with only RSPP involved. The defined IE which may be used in Hybrid case can be borrowed in container. This can decouple the design on RSPP and LPP. |
| MediaTek | 1 or 3 | Our preference is to define a new SLPP/RSPP protocol to support sidelink based positioning. And we share the same view as Qualcomm on disadvantage of extending the current LPP and its potential impact to other non-relevant UEs. |
| Lenovo | Option 1 or 2, with comments | We think that at this stage it would be too early to finalize these aspects on Hybrid (Uu+PC5) positioning. Priority should be given to PC5-only positioning and associated SLPP procedures. We would then have a better idea about the overall complexity of SLPP and the required impacts, which could be then be decided to be extended or not to LPP for the purposes of Uu+PC5 positioning.  We think Option 3 is a signalling detail, which could be best handled during the WI stage. |
| LG | 2 and 3 | Current LPP should be extended for SLPP in hybrid (i.e., Uu + PC5) based positioning. Option 2 is a simple and straightforward method. In addition, Option 3 can be another option that may have minimal impact on current LPP spec. |
| Spreadtrum Communications | 2 and 3 | Option 2 is a simple and straightforward way. And option 3 has minimal impact on current LPP spec. |
| Sony | 2, 1 | In the case of in coverage the LMF would have direct connection to all involved UE, hence there would not be need for any “SLPP” signaling.  Option 1 has benefits with less impact on existing protocols. |
| Philips | 1 or 3 | Agree with Qualcomm and Mediatek. In general, we think that the hybrid case should not be developed separately from the PC5-only case, so if for PC5-only a dedicated SLPP/RSPP protocol is developed, the same SLPP/RSPP protocol should be used for the hybrid case as well, and in this way avoid defining two protocols. |

**Summary:**

For the case of PC5 only based positioning, while we have agreed to use SLPP/RSPP for SL positioning procedures between UEs over sidelink interface, we still need to consider how the positioning related singling between the LMF and the UE is carried and the same three options as above can be applicable as well.

1. **SL positioning is achieved by using the SLPP/RSPP, i.e. use the newly defined SLPP/RSPP to support sidelink based positioning over BOTH the Uu and PC5 interface**
2. **Extension of LPP, whereby new signaling shall be defined to support PC5 based positioning, i.e. extend the existing LPP to support sidelink based positioning between UE and LMF**
3. **Enhancement of LPP whereby SLPP/RSPP signaling can be transported as a transparent container within LPP , i.e. use the newly defined SLPP/RSPP to support sidelink based positioning and SLPP/RSPP signaling is carried as a container in LPP;**
4. **Existing U2N relay**

**Question 3: For the case of PC5-only based positioning, which of the options above do companies support for sidelink positioning procedures between UE and LMF for in coverage scenario?**

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| --- | --- | --- |
| **Company** | **Supported option** | **Comments** |
| OPPO | 2, but | Although it is PC5 only based positioning, LMF needs to be involved also, so as the reply to Q2, 2 is preferred. However, we doubt in the IC scenario, if the SL-PRS configuration can be autonomously chosen by UEs and transmitted between each other via SLPP/RSPP (not involve LMF)? |
| CATT | 3 | When both target UE and anchor UEs are in coverage connecting with LMF, option 3 is a good choice for target UE because of the benefit as below:  a).Only one connection between target UE and LMF, comparing multi-connections with anchor UEs with SLPP (option1).  b).Flexible change together with SLPP compared with option2. |
| Ericsson | 2, and 4; i.e., use existing U2N relay. | An example below from TS 23.304  The SMF/UPF can be replaced by LMF and LPP can be relayed. |
| Intel | 3 | To some extent, the reasoning form our response to the previous question still applies. Even if there is no Uu based positioning and associated (LPP) signaling to consider, LPP can still be utilized to (transparently) carry the SL based positioning signaling between the target/anchor UE and the LMF. Otherwise, we have to discuss what protocol should be used to carry RSPP/SLPP across the LMF, the serving gNB and the UE which may impact multiple WGs. |
| vivo | 2 or 3 | If LMF is involved, PC5-only based positioning is the subset of hybrid positioning, thus the comment for Q2 also applies to Q3. |
| Qualcomm | 1 | In our view Option 1 (SLPP is transported over the PC5 or Uu interface) provides the greatest flexibility and incurs the minimal changes to the specifications, the UE and the network. Specifically, LMF SLPP support enables PC5-based positioning with LMF involvement. This includes LMF-initiated positioning (MT-LR) and LMF-assisted positioning (MO-LR). This approach also enables UE-to-UE PC5-based positioning without LMF involvement, and thus allows a self-contained solution based on SLPP minimizing RAN2 specification work and minimizing changes levied on the UE and Network components. I.e., the same solution can be used with or without LMF support.  As a secondary approach, Option 3, encapsulating SLPP within LPP could be used. However, this would require sidelink-only capable UEs (and sidelink-only capable LMFs) to support LPP, which is not necessary with Option 1. |
| Nokia | 2 | Same as above. Extended LPP is the communication means between target UE and the LMF. |
| ZTE | 2 | If both target UE and anchor UEs are in coverage and PC5-only positioning is applied, LMF may also need to coordinate SL-PRS resources of different UEs to avoid conflict, especially in mode 1 scenario.  Also the capability and measurement report can use LPP to carry or interact. |
| Huawei, HiSilicon | 3 | LPP is the protocol terminated between UE and LMF. Positioning related functionalities between UE and LMF should be carried by LPP spec. |
| MediaTek | 1 or 4 | Our preference is to enable SL positioning by using the new protocol SLPP/RSPP over both Uu and PC5 interface.  Meanwhile, we support to study the possibility to enable the L2 relay based SL positioning operation. |
| Lenovo | 1, It depends on scenario | At least in the case of PC5-only positioning, this would depend on whether an LMF-independent or LMF -dependent architecture would be considered. For an LMF-dependent architecture, Option 1 may be further considered. |
| LG | 2 and 3 | We see this case is the same as Q2. |
| Spreadtrum Communications | 2 and 3 | Same as Q2 |
| Sony | Depending other aspects | For the case of PC5 only, if all UEs are in coverage, there would not be any need for a relay. The second aspect is whether LMF is responsible for configuring SL-PRS, or it would be the “anchor” UE .This may also depend on the option to support the LMF as a UE. |
| Philips | 1 or 3 | Same as Q2. |

**Summary:**

## Further details on SLPP/RSPP

While RAN2 did agree to the use of a new protocol for sidelink positioning procedures between UEs over sidelink, details of how the signaling works still need to be discussed. Specifically, it needs to be discussed what underlying functionality shall be supported by SLPP/RSPP for sidelink based positioning. Note that for the purpose of this discussion, we only consider out of coverage scenario (i.e. no CN involvement), since that is the only scenario where usage of SLPP/RSPP is currently agreed to be supported. We also assume one-to-one SL positioning for the time being.

Considering the company contributions on this aspect, it seems evident that there is a clear majority that prefer to support at least the following operations:

Procedure 1: Exchange of SL positioning capabilities



Figure 1: LPP Capability Transfer procedure

Procedure 2: Transfer of positioning related assistance data



Figure 2: LPP Assistance Data Transfer procedure

Procedure 3: Transfer of location information (positioning measurements and/or position estimate)



Figure 3: LPP Location Information Transfer procedure

In addition, there is Error handling, abort procedure to consider (as in LPP):

Procedure 4: Error handling



Figure 4: Error handling

Procedure 5: Abort



Figure 5: Abort

In addition, there are the following NRPPa procedures that may also need to be considered.

Procedure 6: TRP information exchange (NRPPa)



Figure 6: LMF-initiated TRP Information Exchange Procedure

Procedure 7: Location information transfer (NRPPa)



Figure 7: LMF-initiated Location Information Transfer Procedure

Procedure 8: UL information delivery (NRPPa)



Figure 8: LMF-initiated UL Information Request Procedure

Procedure 9: SRS activation/deactivation (NRPPa)



Figure 9: Positioning Activation/Deactivation Procedure.

**Question 4: Companies are invited to provide comments on which procedures should be supported for SLPP/RSPP?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Procedures 1-9** | **Comments** |
| OPPO | 1-7 | 6 is necessary to convey the geometric position information of the anchor UEs to the location server UE, at least for server-based SL positioning method.  7 is necessary to convey the SL measurement result towards the location server UE, at least for server-based SL positioning method.  Regarding 8, the location server UE could directly retrieve the SL-PRS configuration from the transmitting UE  Regarding 9, if necessary, the location server UE could directly ask the activation of the SL-PRS transmission. |
| CATT | 1-5 | Procedure 6 and 7 can be merged into procedure 2 and 3. Procedure 8 can also be merged into procedure 2. Procedure 9 can be implemented by SL MAC CE. |
| Ericsson | None | We do not have agreement yet if there will be UE location server.  With the capability fetch procedures; it appears one UE can control another UE. The need of UE as location server where one UE controls another UE should be discussed and currently in our view should not be in the scope.  SA2 has defined UE location server as computing position on behalf of other UE; it does not say capability fetch and configurations.  **Location Server UE:** A UE offering location server functionality in lieu of LMF, for Sidelink Positioning and Ranging over Sidelink. It interacts with a Target UE, Reference UEs, Assistant UE and Located UEs as necessary in order to calculate the location of the Target UE. |
| Intel | At least 1-5 | At least the LPP procedures (1-5) shall be supported, given that there is a clear analogue for SL positioning procedure. For NRPPa, it needs to be further discussed how the anchor UE configures SL-PRS transmission/reception and the role of the location server UE (which is still FFS). Also, the activation and deactivation in case of SL-PRS may also depend on the overall design in RAN1 |
| vivo | At least 1-5 | Agree with CATT and Intel. |
| Qualcomm | 1-5 | We think the LPP transaction types are also suitable/sufficient for SLPP.  The functionality of 6 can be realized with SLPP Assistance Data Transfer. We do not think there are non-UE associated procedures applicable to SLPP.  The functionality of 7 is equivalent to SLPP Location Information Transfer.  The functionality of 8/9 may depend a bit on RAN1 but could be realized via SLPP Assistance Data and/or Location Information Transfer procedures. |
| Nokia | 1-5 | In absence of agreements on the nature of UE-based LMF, we only observe the usefulness of adopting existing LPP procedures albeit some clarification may be needed (eg, procedure for deciding who is the server). However, the adoption of NRPPa procedures is less clear – questions around the control over resource allocation / activation as well as master / servant relationship will require further discussion and adaptation as mentioned above. |
| ZTE | 1-5, maybe 9 | Procedure 6-8 are the same with 1-5 actually.  Procedure 9 is for one UE to trigger other UEs to send SL-PRS via RSPP, which is also possible for further study |
| Huawei, HiSilicon | 1-5 | 1-5  The functionality of TRP information exchange of 6 and Positioining information request of 8 can be merged into 2 assistance data transfer. The functionality of 7, location information transfer can be merged into the location information transfer of 3.  activation and de-activation of SL-PRS should be discussed in RAN1 first if RAN1 wants to have SP-SL-SRS. |
| MediaTek | 1-5 | Procedure 6-8 may be covered by 1-5. Procedure 9 can be subject to further study (including also the input from RAN1) |
| Lenovo | 1-5 | On a procedural and message level, it would be fine to re-use 1-5 for SLPP/RSPP. However, further discussion is required on the type of UEs/entities involved which can initiate such procedures. Procedures 6-9 are applicable to gNBs and TRPs and we do not yet see the motivation of re-using the same procedures for SLPP/RSPP and enabling SL positioning. Beam management/TRP procedures are not supported in SL, while RAN1 has yet to agree on detailed SL PRS-related configuration procedures. |
| LG | At least 1-5 | Agree with Intel. |
| Spreadtrum  Communications | 1-5 | Procedure 6 and 8 may be merged into procedure 2. And Procedure 7 may be merged into procedure 3. And procedure 9 may be wait for further study. |
| Sony | Depends | Depends on aspects as mentioned earlier, and to early and not the main scope of RAN2 at this point to elaborate on RAN3 interfaces details. |
| Philips | 1-5 | Not clear what procedures 6 to 9 mean in this context. It is also confusing that the figures show gNB. How is gNB involved, given that the question was considering OOC? |

For each of the above signaling transactions, company views are also invited on whether we can assume to follow the corresponding LPP/NRPPa procedure (and associated signaling) as baseline for SLPP/RSPP.

**Question 5: In order to support SL positioning procedure 1-9 (if agreed), do companies agree to follow the corresponding LPP/NRPPa procedure (and associated signaling) as baseline for SLPP/RSPP?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes/No** | **Comments** |
| OPPO | Yes |  |
| CATT | Yes |  |
| Ericsson | No | We should not show in terms of UE location server; but simply UE1 and UE2 where UE1 and UE2 perform ranging. |
| Intel | Yes |  |
| vivo | Yes |  |
| Qualcomm | Yes for 1-5 | It's O.K. as baseline/starting point, but we expect more flexibility and extended functionality would be required for the SLPP transactions.  For procedures 6-9, we do not think that SLPP should be used between LMF and gNB. |
| Nokia | Yes with comments | Agree with Ericsson that UE-based LMF role must be first clarified but in general, the adoption of LPP/NRPPa-inspired atomic transactions as baseline is agreeable. |
| ZTE | Yes |  |
| Huawei, HiSilicon | Yes |  |
| MediaTek | Yes |  |
| Lenovo | Yes, but for Proc. 1-5 | For Proc. 1-5 we are fine to follow the baseline procedures, however the relevance and motivation behind Procedures 6-9 requires further clarity. |
| LG | Yes |  |
| Spreadtrum  Communications | Yes |  |
| Sony | Yes | Ok as a starting point. |
| Philips | Yes |  |

**Summary:**

## Cast types for positioning signaling over PC5

During the last meeting, there was some discussion on support of different cast types for positioning signaling over PC5. It was further clarified that the discussion of cast types shall be applicable for positioning (control) signaling and not transmission/reception of SL-PRS.

Agreement:

RAN2 will study the question of cast type for positioning signalling. For SL-PRS, follow RAN1 decision and consider cast type if something arises in RAN2 scope.

Therefore, for this the sake of this discussion, we assume that it only pertains to positioning (control) signaling and not groupcast/broadcast of SL-PRS (for which we can follow RAN1 decision).

From email rapporteur perspective, it is assumed that unicast/one-to-one operation can be taken as baseline operation, similar to how legacy Uu based positioning operates. For Uu based positioning, positioning session is assumed to be operated between LMF and UE; for the case of sidelink positioning, at least in case of out of coverage scenario, unicast/one-to-one operation can similarly be assumed between the anchor UE and target UE. For instance, the sidelink capability exchange procedure, the transfer of assistance information and location transfer operation can all be assumed to operate in a one-to-one fashion between the target UE and anchor UE. Note that this does not preclude the target UE configuring multiple assistant UEs/nodes for SL-PRS transmission/reception to enable location estimation of the target UE.

**Question 8: Do companies agree that unicast/one-to-one operation is assumed as baseline for sidelink positioning signaling?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes/No** | **Comments** |
| OPPO | Yes |  |
| CATT | Yes | Agree with rapporteur, unicast operation can be taken as baseline. The integrity and ciphering function ‎are applied to the PDCP PDUs for the sidelink unicast link. |
| Ericsson | Yes |  |
| Intel | Yes |  |
| vivo | Yes |  |
| Qualcomm | See comment | One-to-many positioning is expected to be a common use case for sidelink positioning/sidelink ranging, potentially the most common use case. Although one-to-many positioning sessions could be realized through multiple unicast connections, each unicast link establishment requires the exchange of 4 PC5-S messages (*DirectCommunicationRequest*, *DirectSecurityModeCommand*, *DirectSecurityModeComplete*, *DirectCommunicationAccept*) and 4 PC5-RRC messages (*UECapabilityEnquirySidelink*, *UECapabilityInformationSidelink*, *RRCReconfigurationSidelink*, *RRCReconfigurationCompleteSidelink*), as per the top figure below . Such an approach is inefficient in bandwidth utilization and in latency. Broadcast/groupcast support for sidelink positioning enables a more efficient and expedient solution (lower two figures) for one-to-many positioning operation and provides a solution addressing all the work item use cases, including V2X, public safety, commercial and IIOT.   * Given the very low latency requirements of V2X and limited ITS spectrum, using unicast between all pairs of vehicles (e.g. on a crowded highway) might not only lead to unacceptably high delay but also to congestion of the available bandwidth to the point where sidelink positioning might not support critical V2X requirements. |
| Nokia | Yes with comments | Broadcast / groupcast are needed for efficient and scalable design. Unicast can be used initially without precluding the usage of broadcast in the future, if that is what is meant by baseline. |
| ZTE | Yes |  |
| Huawei, HiSilicon | Yes | Can serve as the baseline |
| MediaTek | Yes | We agree to unicast as a baseline, but we have some sympathy for Qualcomm’s analysis above, and there may be benefits to supporting broadcast/groupcast. |
| Lenovo | Yes | Seems to be typo in the Question number, Shouldn’t it be Question 6?  We are fine to assume unicast operation as baseline, however the actual unicast operations to be considered as baseline should be briefly outlined in the proposal for clarity. |
| LG | Yes | We think that at least unicast/one-to-one operation can be used for sidelink positioning signaling. FFS for which sidelink positioning method the unicast operation is used. |
| Spreadtrum Communications | Yes with comments | We agree to unicast as baseline. |
| Sony | Yes, with comments | Yes, as the starting point, and for ranging, but for absolute positioning, it depends whether the Unicast configuration is for both the transmitting and receiving side, or potentially only for the receiving side, E.g. in case the RSU are statically configured to broadcast SL-PRS. We expect one-to-many shall also be supported. |
| Philips | Yes | Can serve as baseline |

**Summary:**

In addition to the unicast operation, some companies think that support of other cast types (groupcast and broadcast) needs to be studied. In the last meeting, there were some proposals by companies to support different cast types for positioning signaling.

In [15], it is proposed to study SLPP transport of PC5 mechanisms to provide flexibility in cast types. In [9], the applicability of different positioning control signaling (i.e., capability transfer, AD, measurement reports) for different cast types is discussed. In [5], the one-to-many and many-to-one models are considered with respect to transmission/reception of SL-PRS (and does not seem to directly relate to how the positioning control signaling is transmitted). In [6], it is noted that while the positioning assistance data can be broadcasted and multiple nodes may transmit SL PRS, the underlying positioning transactions themselves are typically expected to be performed between a target UE and an anchor UE, i.e., one to one. [8] and [12] propose to study whether and how certain SLPP messages can be transferred between UE using different cast types (e.g. broadcast, groupcast, unicast).

Based on the above, the key question that needs to be asked is whether companies see real benefit for groupcast or broadcast transmission of certain positioning control signaling, considering the use cases envisioned for this work. Since we are still in the early stages of this study, it would be good to get company views on what scenarios/uses cases they have in mind for supporting groupcast/broadcast for SLPP signaling over sidelink. To this end, it would be good to identify what specific SLPP signaling needs to be sent in a groupcast or broadcast fashion. The use cases listed in [9] can be used as the starting point:

Table 1. Suggested cast type of different SL positioning control signaling [9]

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Capability interaction | Measurement report | Assistance data interaction (excluding SL-PRS configuration) | SL-PRS configuration |
| Broadcast | √ | × | √ | √ |
| groupcast | √ | × | √ | √ |
| unicast | √ | √ | √ | √ |

**Question 9: Companies are invited to comment on what type of positioning signaling (if any) they think should be applicable for groupcast/broadcast?**

**Use case 1: Sidelink capability transfer (LPP like)**

**Use case 2a: Transfer of SL positioning assistance data (LPP like)**

**Use case 2b: Transfer of SL positioning assistance data (RRC posSIB like)**

**Use case 2c: Transfer of SL positioning assistance data (RRC SRS like)**

**Use case 3: Location information transfer (LPP like)**

**Use case 4: TRP information exchange (NRPPa like)**

**Use case 5: Location information transfer (NRPPa like)**

**Use case 6: UL information delivery (NRPPa like)**

**Use case 7: SRS activation/deactivation (NRPPa like)**

**Others?**

**Note: Discovery related signaling is assumed out of scope for this discussion since it should not be part of positioning session itself.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Use cases (1-7)** | **Comments** |
| OPPO | 1,2a | Different from the Uu positioning where the LMF only needs to retrieve the positioning capability from only 1 UE, for the SL positioning, the location server UE/LMF needs to retrieve SL positioning capabilities from several anchor UEs and target UEs, which may consume significantly more time.  If the SL-PRS configuration could be set autonomously by the anchor UEs, it is cumbersome for the location server UE to retrieve the SL-PRS configuration one-by-one. In addition, broadcast of the SL-PRS configuration could avoid potential SL-PRS transmission collision from different UEs, i.e., UE preparing to transmit the SL-PRS will monitor the configuration of the SL-PRS already used in proximity. |
| CATT | 2b, 2c | SLPP messages can’t be transmitted via broadcast/groupcast if we agree SLPP is carried over control plane, because sidelink SRBs won’t be for broadcast/groupcast. See TS 38.323 clause 6.2.2 as below:  *6.2.2.4 Data PDU for sidelink DRBs for groupcast and broadcast, for the sidelink SRB0‎ and for the sidelink SRB4*  *6.2.2.5 Data PDU for sidelink SRBs for unicast*  *6.2.2.6 Data PDU for sidelink DRBs for unicast with 12 bits PDCP SN*  *6.2.2.7 Data PDU for sidelink DRBs for unicast with 18 bits PDCP SN*  Furthermore, there is no integrity and ciphering protection for SLRBs for groupcast and broadcast. All positioning signaling (e.g. sidelink capability, measurement result or location information) which should be ciphered can’t be transmitted via broadcast/groupcast.  The SL-PRS configuration perhaps may be transmitted using broadcast/groupcast similarly as RRC posSIB depending on the progress of RAN1. RAN2 can postpone the SL-PRS configuration issue until there is agreement from RAN1. |
| Ericsson | It is unclear with server paradigm | An easy way is that; Reference Signal configuration of one UE can be groupcast (if a suitable group has been identified). All the listening UEs will perform the measurement and then measurements can be obtained by one master UE using unicast. |
| Intel | Not for use case 1, 3, 4, 5  FFS on resource allocation for SL-PRS (wait for RAN1) | For Use case 1, 3, 4, 5, we do not see the need to support groupcast/broadcast for this info.  For use case 2 and its variants, 6 and 7, there may be some benefit to sending the AD in a groupcast/broadcast way. However, assistance information transfer/(de)activation are related to RAN1 discussion on resource allocation for SL-PRS. So, we should wait a bit for the overall design to mature and we can revisit this aspect. |
| vivo | 1, 2a/2b/2c | Broadcast/groupcast of positioning capability benefits for anchor UE selection to avoid unnecessary sidelink unicast connection setup.  If anchor UE can autonomously determine its SL PRS configuration, Broadcast/groupcast of SL positioning assistance data is similar to posSIB and benefits for signalling overhead reduction.  For 2a/2b/2c, we understand that it may be one single procedure for sidelink positioning. |
| Qualcomm | 1  2a, [2b], [2c]  3 | The three fundamental LPP transaction types (capability transfer, assistance data transfer, and location information transfer) are well-suited and can be used for SLPP positioning for PC5-based, out-of-coverage operation.  Between UEs engaged in out-of-coverage sidelink positioning sessions, understanding respective capabilities, measurement configuration (including for example SL-PRS configuration) and exchanging measurement results are required aspects of a positioning or ranging session. As such, the three fundamental LPP transaction types (capability transfer, assistance data transfer, and location information transfer) are well-suited and can be used for SLPP positioning for PC5-based, out-of-coverage operation.  In the case of posSIBs are used for SL assistance data transfer (2b), we think it will be broadcast only.  We think Case 2c is not desired and can be achieved with SLPP. However, it also depends a bit on RAN1 outcome.   * All three cast types (Broadcast, Groupcast, Unicast) can be applicable to SLPP message transfer for these transaction types depending on the scenario (e.g., for a pair of UEs, it can be unicast, for a two or more UEs broadcast/groupcast can be used). |
| Nokia | 1,2a/b/c,7 | Agree with OPPO on 1 and 2a  Bulk resource activation may require 7 |
| ZTE | 1 2a 2b | UE to broadcast/groupcast capability is beneficial for the positioning session establishment;  UE to broadcast/groupcast SL-PRS configuration is beneficial for SL-PRS transmission in OOC |
| Huawei, HiSilicon | 1 and 2a | PC5-S signaling can still broadcast to multiple UEs, e.g., DCR message. Between 1 and 2a, we think 2a has higher priority to be broadcasted |
| MediaTek | 1, 2a/2b/2c, 3 | We think that we can study the possibility to use broadcast/groupcast to deliver 1/2a/2b/2c/3 to multiple UEs. |
| Lenovo | At least Use case 2, groupcast for 1 | Seems to be typo in the Question number, Shouldn’t it be Question 7?  Use cases 2a and 2c follow from the Uu unicast operation, which can be UE-specific. We understand that this could also be supported in a broadcast and groupcast scenario. Use case 2b is a straight-forward extension of the Uu operation, where such information may be broadcasted. Other use cases need to be further studied, e.g., it is not clear why Use case 7 is needed at this stage as this needs to be decided by RAN1 after finalization of the SL-PRS configuration functionality.  In the case of Use case 1, capability transfer is normally considered sensitive information and therefore broadcasting of such information would be undesirable and therefore further study would be needed on the support broadcast of capabilities. However, we do see a scenario where capabilities may be groupcasted to members of a SL positioning group, where such information may be restricted to the group members. |
| LG | 2a, 2b, 7 | In our opinion, broadcast type can be used on connection-less mode, on the other hand, groupcast type can be used on both connection-based and connection-less modes. In this way, posSIB (2b) is needed for broadcast and connection-less groupcast, but LPP-like assistance data transfer (2a) is needed for connection-based groupcast. For PRS activation/deactivation (7), we think PHY layer signaling is enough but it is being discussed in RAN1 so RAN2 can wait for RAN1 decision. |
| Spreadtrum Communications | 2b, 2c | We have some sympathy for CATT’s analysis above. Ciphering protect should be considered for sidelink positioning signalling via broadcast and groupcast. |
| Sony | 2b at least | Most LPP transaction types would be peer-to-peer, and not for groupcast/broadcast. But PosSIB is designed for broadcast.  How NRPPa protocol is translated to “SLPP” is currently not clear. |
| Philips | See comments | Unclear at this moment if any of these use cases need to be supported. Also, security aspects need to be considered (as indicated by CATT). |

**Summary:**

# Conclusion

The discussion above can be summarized in the form of the following proposals:

[TBF]