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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# 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)?**

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| **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. |
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**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. |
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**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. |
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**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?**

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| --- | --- | --- |
| **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. |

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?**

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| --- | --- | --- |
| **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 |  |
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**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?**

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| **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 |  |
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**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.**

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| --- | --- | --- |
| **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. |
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**Summary:**

# Conclusion

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

[TBF]