3GPP TSG-RAN WG2 Meeting #121bis-e R2-23xxxxx

Online Meeting, 17-26 April 2023

**Agenda item: 7.2.2**

**Source: CATT**

**Title: [AT121bis-e][428][POS] Sidelink positioning stage 2 (CATT)**

**WID/SID: NR\_pos\_enh - Release 18**

**Document for: Discussion and Agreement**

# 1 Introduction

This document is to kick off the following email discussion:

* [AT121bis-e][428][POS] Sidelink positioning stage 2 (CATT)

      Scope:

-        Discuss the proposals for an architecture figure at stage 2 level and attempt to converge.

-        Discuss the proposals for SLPP signalling procedures between UEs and attempt to reach agreement on a basic set of procedures.

      Intended outcome: Report to CB session

      Deadline: Monday 2023-04-24 2359 UTC

In this email discussion Sidelink positioning stage 2 are discussed based on following contributions to decide if these proposals and TPs in the contributions can be agreed.

1. R2-2302503 Discussion on sidelink positioning CATT discussion Rel-18 NR\_pos\_enh2
2. R2-2302740 Further considerations on sidelink positioning Intel Corporation discussion Rel-18 NR\_pos\_enh2
3. R2-2304033 Discussion on SL positioning Xiaomi discussion Rel-18
4. R2-2303591 Sidelink Positioning Protocol (SLPP) Signaling and Procedures Qualcomm Incorporated
5. R2-2302655 Discussion of signalling procedures Nokia Germany discussion Rel-18
6. R2-2302958 Discussion on sidelink positioning vivo discussion Rel-18 FS\_NR\_pos\_enh2

# 2 Architecture figure at stage 2 level

This section will discuss the stage-2 sidelink positioning architecture. Taking the figures proposed in contribution R2-2302503, R2-2302740, R2-2303591 and R2-2304033 into consideration.

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| **Contributions** | **Proposed architecture** |
| R2-2302503 CATT | Figure 1 UE Sidelink Positioning Overall Architecture applicable to NG-RAN  **Proposal 1: Capture Sidelink Positioning Architecture in Figure 1 in TS 38.305.** |
| R2-2302740 Intel | |  | | --- | | NOTE: Anchor UE/node is only supported in NR |   Figure 1 Overall architecture to support SL positioning  **Proposal 10: In order to support sidelink based positioning for in coverage and out of coverage case, RAN2 to confirm the SL positioning architecture (including the concept of an anchor node/UE) shown in figure 1.**  **Proposal 11: To support sidelink based positioning, RAN2 to confirm the corresponding functionality of the anchor node, i.e. (interact with the target UE over PC5 to deliver assistance data, perform SL-PRS transmission/measurement and location estimation).**  **Proposal 12: RAN2 confirms that either the target UE or the anchor UE may handle the functionality of the SL positioning server UE** |
| R2-2303131  LG | Note: UE A, UE B, UE C and UE D can be Target UE, Anchor UE and SL Positioning Server UE.  **Figure 1: UE Positioning Overall Architecture applicable to NG-RAN**  **Proposal 7. RAN2 to capture figure 1 for architecture diagram to support sidelink positioning in TS 38.305.** |
| R2-2303591 Qualcomm | Figure 2: UE Positioning Overall Architecture applicable to NG-RAN  **Proposal 1:** The UE Positioning Architecture applicable to NG-RAN should be applicable to all coverage scenarios (e.g., no separate architecture for in-coverage or out-of-coverage scenarios is needed).  **Proposal 2:** Extend the UE Positioning Architecture applicable to NG-RAN as shown in Figure 2. |
| R2-2304033 xiaomi | Fig 1 architecture for supporting SL positioning  **Proposal 8 RAN2 to agree the architecture.** |

**Rapporteur’s comment:**

RAN2 has agreed to follow SA2 on the architecture in SI stage. Based on that, only the UE roles are not captured in the diagram of the positioning architecture. The difference among companies’ contribution is on how to represent the interface relationship of terminals. For faster convergence, the architecture based on the figure proposed by CATT may be as the baseline for further discussion.

**Question 1:** Do you agree to take the architecture proposed in CATT’s contribution as baseline? If yes, Please provide comments to polish the architecture. If no, please provide your suggestion.

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| Company | Yes/No | Comments |
| Qualcomm | Yes with comment | In general we are fine with CATT’s proposed architecture. We do wonder if UE B is intended to be an NR-only UE. |
| OPPO | Yes |  |
| LG | Yes but | We also proposed an architecture diagram n R2-2303131 in this meeting, as below;    Same question, UE B is only NR-only UE? |
| CATT | Yes | feedback on LG and Qualcomm’s question:  More cases should be captured in the architecture. For Uu interface, both NR-only UE and LTE+NR UE are involved in the architecture. |
| Fraunhofer | Yes |  |
| Lenovo | Yes, with comments | CATT’s proposed architecture is basically fine for us, but there seems missing PC5 link between UEB🡨🡪UEC, UEB🡨🡪UED, and UEA🡨🡪UED. In addition, we have concern on why UE-B has no SET functionality. |
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**Summary:**

# 3 SLPP signalling procedures between UEs for out of coverage

The proposals for SLPP signalling procedures between UEs and attempt to reach agreement on a basic set of procedures will be discussed in this section.

In RAN2#121 meeting, RAN2 agreed the basic signaling procedure for PC5-only positioning.

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| Agreement:  With respect to the overall signaling procedure for PC5-only positioning (including at least IC and OOC; FFS if there are differences for PC), it is proposed to agree that the sidelink positioning procedure comprises the following series of steps as a baseline, between the LMF/positioning server UE/NG-RAN/candidate Anchor UE(s) and Target UE(s):  1. Triggering event  2. Sidelink positioning capability exchange  3. Sidelink positioning assistance data transfer  4. SL Positioning Request Location Information  5. Measurement of SL-PRS  6. Location calculation  7. SL Positioning Provide Location Information  Some steps may have dependencies on SA2 and can be revisited in this light. The order is subject to further discussion. FFS if discovery and selection of anchor UEs and/or server UE are part of the positioning layer in RAN2 scope.  LS to SA2 to ask for confirmation and guidance on the SA2 aspects. |

The above series of steps have been captured in the proposals from companies. Clause 3.1- 3.2 will further discuss the details of steps.

## Involved UE roles in general sidelink positioning procedure

The following contributions discuss SLPP signalling procedures for out of coverage scenario or LMF-independent SLPP procedures:

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| **Contributions** | **Proposed procedures** |
| CATT  R2-2302503 | Figure 2.3-1: SLPP signaling procedures for OOC scenario |
| Nokia  R2-2302655 | *(a) Target UE and server UE are two different nodes. (b) Target UE acts as the server UE*  ***Fig. 2*** *–Server UE-assisted SL positioning.*  [black font / solid lines indicate = mandatory steps, grey font / dashed lines = optional steps] |
| Intel  R2-2302740 | Figure 3 UE sidelink positioning for out of coverage scenario |
| vivo  R2-2302958 | Figure 2.2.2-1: LMF-independent sidelink positioning signaling procedures |

CATT, Intel and vivo put all involved UE roles in the general procedure, even when anchor UE or target UE acts as server UE. However Nokia distinguish the two cases. Server UE always acts as an entity in general procedure when server UE is target UE/ anchor UE/ the 3rd UE, shown in figure 1.

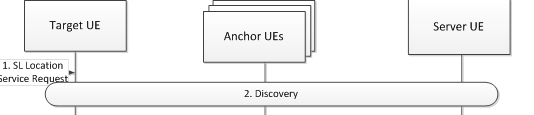


Figure1 Server UE as an entity



Figure2 Target UE/anchor UE act as server UE

**Question 2**: Do you agree that server UE acts as an entity separately shown in figure 1 in the general sidelink positioning procedures between UEs for out of coverage scenario?

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| Company | Yes/No | Comments |
| Qualcomm | See comment | We find this question somewhat unclear. Our view is there is no need to distinguish UE role in the description of SLPP signaling procedures (as in the call flow suggested as a baseline in [AT121bis-e][424], Question 4). |
| OPPO | Yes | The entities shown in the signalling procedure are just logical entities. Including each logical entity independently in the signalling procedure is clearer to present every necessary step to be involved in the SLPP. We know that if two UE roles are actually co-located in the same UE, then no inter-UE signalling is needed between them. |
| LG | See comment | We also proposed a high-level overall procedure in R2-2303131 in this meeting, as below;    We think it would be better for stage-2 understanding to be matched between an architecture diagram and a high-level overall procedure, i.e. UE A/B/C/D in procedure can be used in procedure as architecture. Also, which can be extended from Figure 5.2-1 in current stage-2 document (TS 38.305).  [CATT]: According to the scope defined by Chair, “- Discuss the proposals for SLPP signalling procedures between UEs”, the procedures which include LMF and AMF are not discussed here. |
| CATT | Yes | Agree with OPPO. |
| Fraunhofer | Yes | How a server UE is selected by the target UE is not clear. There may be one or more UE that may advertise server capability. We need to capture that the target UE selects one server UE.  In CATT’s contribution, we see that the server UE is responsible for selecting anchor UEs. If our understanding is correct, then we share this viewpoint.  We presume Step 4 also means includes initial measurements. |
| Lenovo | No | We prefer Figure2 and share the comments that the “SL positioning server UE” as a functionality which is part of a target UE or an anchor UE.  Since the need for a SL Positioning server UE caters to only certain limited scenarios in SL Positioning based on coverage situations and UE capabilities based on SA2’s solutions, and such UEs may be discoverable and further selected for result calculation purposes only.  It is assumed that a target UE and anchor UEs have sufficient capabilities to perform SL Positioning including, configuration, measurements and result calculation across all coverage scenarios, and the results calculation is usually up to UE implementation. The functions for the server UE may be resolved if the SL Positioning Server UE may be integrated as part of the Anchor UE or Target-UE or if the server UE is simply a set of UE capabilities.  In addition, the scope of introducing additional discovery and selection procedures for a separate server UE entity may increase the complexity of the SL positioning framework. We also wonder in which scenarios will a server UE always be available, so we would tend to prefer more flexibility in the SL positioning procedures. |
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**Summary:**

## Involved UEs in capability and assistant data exchange procedures

CATT and Intel proposed target UE needs to exchange sidelink positioning capability and assistant data with anchor UEs. Nokia and vivo proposed the sidelink positioning capability and assistant data exchange only between target UE / anchor UEs and server UE, not between target UE and anchor UE.

**Question 3**: What is your view on sidelink positioning capability and assistant data exchange procedures for out of coverage scenario?

Option 1: The sidelink positioning capability and assistant data exchange happen between target UE/anchor UEs and server UE, but don’t happen between target UE and anchor UEs when there is server UE;

Option 2: The sidelink positioning capability and assistant data exchange can happen between target UE and anchor UEs whatever there is server UE or not;

Option 3: Others.

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| --- | --- | --- |
| Company | Options | Comments |
| Qualcomm | Option 3 | RAN2 has agreed that Capability and Assistance data can be exchanged between UEs via unicast, groupcast or broadcast. As such, it seems unnecessary to levy a restriction on distribution of Capability and Assistance data. Rather, Capability and Assistance data can be exchanged between UEs participating in a sidelink positioning and ranging transaction. |
| OPPO | Option 3 | If unicast is employed, we prefer to follow the Uu based positioning implementation, for example, the anchor UE could firstly send the assistance data to the server UE, then the server UE can forward the assistance data to the target UE.  If broadcast is employed, then nothing could prevent from direct signalling exchange between the anchor UE and the target UE. |
| LG | Option 1 but | According to agreement in RAN2#121, server UE takes a role of location server.  RAN2 confirm that for cases without LMF involvement, besides method determination, assistant data distribution and anchor UE selection (agreed in RAN2), the SL positioning server UE may perform SL-PRS configuration coordination and location calculation.  But, we think RAN2 should firstly decide whether server UE is either target UE or anchor UE, or not. |
| CATT | Option 2 | In some case, there may be no unicast SL connection between anchor UE and server UE. SLPP capabilities and SLPP assistant data (e.g. SL-PRS configuration) can be exchanged between target UE and anchor UEs directly.  For groupcast/broadcast, any SLPP signalling exchange should be happened between the anchor UE and the target UE. |
| Fraunhofer | (soft) Option 1 | The sidelink positioning capability and assistant data exchange happen between target UE/anchor UEs and server UE is supported, if the target UE and anchor UE do not exchange information directly. |
| Lenovo | Option 3 | From our side it is necessary to exchange sidelink positioning capability and assistance data between target UE and anchor UE since the PRS transmission/reception and corresponding measurements are performed between target and anchor UEs.  But we also share the view that the sidelink positioning capability and assistance data exchange are not limited to the case only between target UE and anchor UEs. Since it may be transmitted by either unicast or groupcast/broadcast, the capability/assistance data exchange can also be performed between target/anchor UE and server UE during the SLPP session. |
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**Summary**

The following series of steps based on previous agreement are proposed by companies, between the server UE/ candidate Anchor UE(s) and Target UE(s):

1. Discovery procedure

2. SL connection establishment

3. Anchor UEs selection

4. Positioning methods selection

We will further discuss these steps to figure out if these steps may be included in the general sidelink positioning procedures.

## Discovery procedure aspect

All above companies considered that discovery procedure between target UE and anchor UEs should be performed. CATT considered discovery procedure should also be performed between target UE / anchor UEs and server UE.

**Question 4**: Do you agree discovery procedure should be included in the sidelink positioning procedure for out of coverage scenario?

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| Company | Yes/No | Comments |
| Qualcomm | Yes |  |
| OPPO | Yes | The target UE should perform discovery procedure to find the UEs supporting SLPP in the proximity, since the positioning measurement should be done between target UE and anchor UEs. |
| LG | Yes | It is an essential step for sidelink communication/positioning for SL-PRS transmission/measurement even in session-less operation. |
| CATT | Yes |  |
| Fraunhofer | Yes |  |
| Lenovo | Yes | It used to find candidate UEs and get in touch with other UEs, although as we mentioned earlier the discovering an additional server UE increases the complexity of the overall SL positioning procedures. |
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**Question 5**: What is your view on which discovery procedure is needed for out of coverage scenario?

Option 1: Discovery procedure between target UE and anchor UEs;

Option 2: Discovery procedure between target UE and server UE;

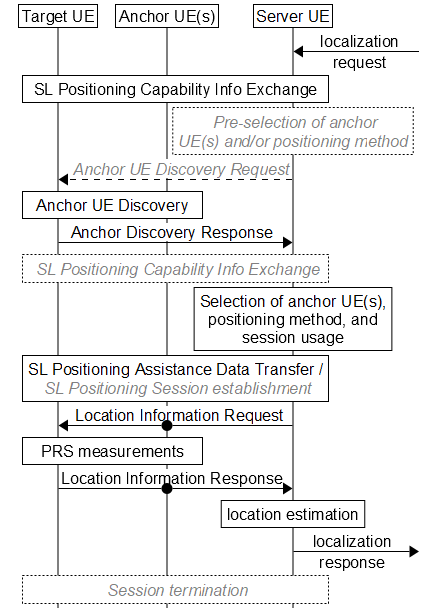
Option 3: Discovery procedure between server UE and anchor UEs.

Option 4: Not distinction in which UEs participate in the Discovery procedure.

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| --- | --- | --- |
| Company | Option 1/2/3 | Comments |
| Qualcomm | Option 4 | Since a UE is permitted to undertake any role, we see no need to draw a distinction in which UEs participate in the Discovery procedure. Rather, Discovery should enable SLPP-capable UEs to learn of the presence of other SLPP-capable UEs. |
| OPPO | Option 4 | Agree with Qualcomm |
| LG | See comments | If server UE is neither target UE nor anchor UE, discovery procedure could be very complicated. SL-PRS is transmitted/received between target UE and anchor UEs, so discovery is needed between two UE types. If the location server role (including anchor UE selection) is performed in server UE, discovery is needed between server UE and target/anchor UEs. Moreover, two discovery results should be exchanged in order to find overlapped anchor UEs. Therefore, server UE should be at least either target UE or anchor UE, but we still believe target UE can take a role of server UE if we do not see some benefit for anchor UE taking a role of server UE, except positioning calculation. In this sense, discovery is needed between target UE and anchor UEs. |
| CATT | Option 4 | Agree with Qualcomm |
| Fraunhofer | Option 4 | Our understanding is that the UEs may discover each other, but the target UE either takes the server role itself or requests other UE to take server role after discovery. |
| Lenovo | Option 4 | We think all options are needed, depends on specific scenarios.  When a location service is initiated in a target UE, the target UE may perform discovery to select candidate anchor UEs/server UEs; When the location service is initiated from other entities, server UE may need to perform discovery to select target UE and/or candidate anchor UE. Since a UE may take any UE role, the discovery can be performed between any UEs during the SLPP session to get in touch each other. |
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**Summary:**

Nokia and vivo mentioned that server UE sends Anchor UE (discovery)Request message to target UE before the discovery procedure between target UE and anchor UEs. And after the discovery procedure, target UE sends Anchor UE (discovery) Provide message to server UE.

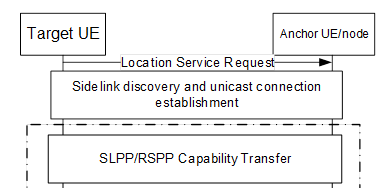
**Question 6**: Do you agree to include Anchor UE (discovery) Request and Anchor UE (discovery) Provide steps in the sidelink positioning procedures for out of coverage scenario?

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| Company | Yes/No | Comments |
| Qualcomm | No | Per our answer to Question 5 since a UE is permitted to undertake any role, we see no need to draw a distinction in which UEs participate in the Discovery procedure. Rather, Discovery should enable SLPP-capable UEs to learn of the presence of other SLPP-capable UEs. Furthermore, our view is that design of Discovery should be up to SA2. |
| OPPO |  | We agree that target UE should perform the anchor UE discovery procedure. However, the target UE should firstly do the discovery procedure to pre-filter the UEs in proximity and then can perform the SL capability exchange between the target UE, anchor UE and the server UE.  Also, the SL capability exchange may be only feasible after the unicast link between a pair of UEs is established. |
| LG | No | See Q5 comments |
| CATT | No strong view |  |
| Fraunhofer | Yes | Server UE needs input (initial measurements) from target UE to be able to select suitable anchors. |
| Lenovo |  | We tend to agree the discovery procedure is needed but the detailed steps related to discovery procedure are in SA2’ scope. Fine to follow majority views on this. |
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**Summary:**

## SL connection establishment aspect

CATT and Intel proposed to include unicast SL connection establishment procedure before sidelink positioning capability exchange.



**Question 7**: Do you agree to include unicast SL connection establishment procedure before sidelink positioning capability exchange for out of coverage scenario?

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| --- | --- | --- |
| Company | Yes/No | Comments |
| Qualcomm | No | In addition to unicast, RAN2 has agreed that Groupcast and Broadcast can be used for Capability and Assistance data exchange between UEs. Imposing a requirement for unicast call establishment seems unnecessary and significantly constraining sidelink positioning operation, resulting in additional over-the-air resources consumed and incurring the latency of unicast call establishment. |
| OPPO | Yes for unicast |  |
| LG | No | Unicast is not always required for sidelink positioning e.g. session-less operation and groupcast/broadcast. |
| CATT | Yes for unicast | For session-based sidelink positioning, unicast SL connection should be established for each pair of UEs to exchange the SLPP messages. |
| Fraunhofer | No strong view | Capability can be exchanged also via groupcast or broadcast. For some case, unicast may be beneficial (if the UE wants to exchange information with server UE only and not broadcast). |
| Lenovo | See comments | For unicast transmission of capability info transfer, the SL unicast connection establishment is needed. In case of groupcast/broadcast is supported, then SL unicast connection establishment seems not necessary before the step. |
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**Summary:**

## Anchor UEs selection

All companies suggest that server UE performs anchor UEs selection. But they have different views on when the selection happens.

* Nokia and vivo suggested server UE performs anchor UE selection after sidelink positioning capability exchange between server UE and anchor UEs.
* CATT suggested server UE performs anchor UE selection before sidelink positioning capability exchange between target UE and anchor UEs.

This issue is related to anchor UEs selection criteria. For the solution of Nokia and vivo, server UE performs anchor UEs selection may depend on the information which is obtained from discovery and capability of anchor UEs. For the solution of CATT, anchor UEs selection depends on the information which is obtained from discovery of anchor UEs.

**Question 8**: Do you agree to include anchor UE selection in the general procedures? If yes, which option of information is preferred for the anchor UE selection?

Option 1: the information obtained from both discovery and capability of anchor UEs;

Option 2: the information obtained from discovery of anchor UEs;

Option 3: Others.

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| --- | --- | --- | --- |
| Company | Yes/No | Options | Comments |
| Qualcomm | Yes | 3 | Option 3: “the information obtained from SLPP capability exchange.”  Our view is UE anchor selection can be based on SLPP Capability exchange, subsequent to Discovery procedures, with Discovery providing information on UE SLPP support. |
| OPPO | Yes | Option 3 | We think UE selection should be done after both procedures. Suppose there are lots of UEs around the target UE. The first job for the target UE is to identify the UEs supporting the SLPP and could serve as the adapt UE roles such as anchor UEs or location server UE using the discovery msg. Then more detailed information such as AS-level capability could be exchanged in-between the UEs survive after the discovery procedure. |
| LG | Yes | Option 3 | Agree with Qualcomm and OPPO. |
| CATT | Yes | Option 2 | SLPP capability exchange procedure is after unicast SL connection establishment. Target UE/server UE needs to establish unicast SL connection with all candidate anchor UEs to obtain capabilities. And release the unicast SL connection with the candidate anchor UEs which are not selected. Both latency and signalling overhead are increased. |
| Fraunhofer | Yes | Option 3 | Anchor UE selection may depend on capabilities plus measurements (initial) provided to server by target UE. |
| Lenovo | Yes | Option 3 | This issue is related with our previous offline discussion on discovery signalling, it also depends on specific AS layer parameters agreed to be indicated in the SL Positioning discovery signalling. According to current SA2’ solution, UE role and support of SLPP is transmitted in discovery signalling, we prefer this can be used to filter candidate anchor UEs, the final anchor UE selection should be performed after the discovery procedure, which can take the UE capability information into account, e.g., the supported SL Positioning methods. In addition to the UE capability information, some other AS layer information/conditions such as based on SL measurements, LOS/NLOS, etc may also contribute to anchor UE selection.  Therefore, we prefer option3: the information obtained from both discovery and AS-layer information/conditions. |
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**Summary:**

## Positioning methods selection

CATT and Nokia considered server UE performs positioning method selection along with anchor UE selection.

**Question 9**: Do you agree to include positioning methods selection in the general procedures? If yes, does the server UE perform positioning method selection for out of coverage scenario?

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| --- | --- | --- | --- | --- | --- | --- |
| Company | | Include positioning method selection(Yes/No) | | Server UE perform selection (Yes/No) | | Comments |
| Qualcomm | | Yes with comments | | No | | We agree that positioning method selection can be part of sidelink positioning procedures. However, we do not see a need to restrict selection of positioning method to a server UE. Since any UE participating in sidelink positioning can undertake any role, a UE initiating a sidelink positioning session could specify the positioning method, with another UE performing server function. |
| OPPO | No | | Yes | | We think we could follow the Uu-based positioning procedure, wehre the positioning method is selected implicitly after the sidelink positioning capability has been exchanged and is reflected in the LPP ProvideAssistanceData (which positioning method specific assistance data is provided to the UE). | |
| LG | | No | | Yes | | Method selection is one of location server roles (i.e. LMF or server UE) and up to implementation due to it is algorithm aspect. No need to be included in general procedure. |
| CATT | | Yes | | Yes | | Server UE is terminal equipment, the behaviour of UE should be clear in the specification. |
| Fraunhofer | | Yes | | Yes | | The target UE can request a server UE supporting the requested positioning method, or a target UE can select a server UE based on the positioning method it supports (unless a server UE has to support all SL positioning methods specified). |
| Lenovo | | No | | No | | In current NR Uu positioning, the positioning method is determined by LMF by implementation and no explicit procedure is indicated. We think it can be a UE implementation behaviour and will be indicated by corresponding SL Positioning assistance data transmission.  Additionally, on which entity determines the positioning method, we prefer not to limit it to only server UE, other UEs which initiated the location service e.g., target UE can also determine the positioning method. In addition, the selection of the positioning method is determined based on the availability of suitable anchors. For the out-of-coverage scenario, if the server UE is unavailable (as a separate UE entity), we would like to avoid a situation where the SL procedures fail due to the dependency on a server UE for positioning method selection. |
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Most of companies propose the general positioning procedure for sidelink positioning, while vivo specifies two different sidelink positioning signaling procedures for different positioning methods.

**Question 10**: Do you agree to capture the general positioning procedure applied to all sidelink positioning?

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| --- | --- | --- |
| Company | Yes/No | Comments |
| Qualcomm |  | We find this question somewhat unclear. Our expectation is the SLPP specification will capture required positioning procedures. |
| OPPO | Yes | It is not clear what is the essential difference between LMF-involved and server UE-involved SLPP procedure, and therefore we think one general positioning procedure is enough. |
| LG | Yes |  |
| CATT | Yes |  |
| Lenovo | Yes | The SL positioning procedure should be inclusive for all SL positioning methods. |
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**Summary:**

# 4 Conclusion

Companies discussed the proposals and TPs in the email discussion, here are the proposals:

**TBD**

# 5 Reference

[1] R2-2302503 Discussion on sidelink positioning CATT

[2] R2-2302655 Discussion of signalling procedures Nokia Germany

[3] R2-2302740 Further considerations on sidelink positioning Intel Corporation

[4] R2-2302958 Discussion on sidelink positioning vivo

[5] R2-2303591 Sidelink Positioning Protocol (SLPP) Signaling and Procedures Qualcomm Incorporated

[6] R2-2304033 Discussion on SL positioning Xiaomi