**3GPP TSG-RAN WG2 Meeting #124R2-23xxxxx**

**Chicago, USA, November 2023**

**Agenda item:** 7.2.2

**Source:** Intel Corporation

**Title:** Report of [Post123bis][404][POS] SLPP forwarding (Intel)

**Document for:**  Discussion and decision

# Introduction

This is the summary of the following email discussion:

* [Post123bis][404][POS] SLPP forwarding (Intel)

Scope: Discuss proposals to RAN2#123bis on SLPP forwarding and conclude on whether the feature is needed; begin development of a TP towards next meeting if necessary.

Intended outcome: Report to next meeting and possible TP

Deadline: Long

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# Phase 1 Discussion

There were several contributions to the last RAN2 meeting discussing the need and details of SLPP forwarding. The table below seeks to capture the proposals put forth by different companies, in order to facilitate the discussion.

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| **Company/Contribution** | **Proposal(s)** |
| Vivo (R2-2309668) | **Observation 1:** If it is required that anchor UEs must be in the coverage of both target UE and server UE, there are fewer (or even no) valid anchor UEs, which impacts the positioning accuracy or even the availability of positioning. If anchor UEs only need to be in the coverage of target UE, the valid anchor UEs are more but SLPP forwarding via target UE may need to be supported.  **Proposal 2:** For UE-only Operation, RAN2 to discuss whether the selected anchor UEs must be in the coverage of both target UE and server UE, or just be in the coverage of target UE.  **Proposal 3:** For UE-only Operation, if selected anchor UEs are only required in the coverage of target UE, discuss whether SLPP forwarding is supported. If supported, the TP in the Annex can be considered as the baseline for further discussion. |
| MediaTek (R2-2310195) | **Proposal 1:** The target UE is required to support transfer of SLPP information between the server (UE or LMF) and an anchor UE. FFS if anchor UEs have the same requirement.  **Proposal 2:** The Request Capabilities and Provide Capabilities messages can be forwarded.  **Proposal 3:** If assistance data model 1 is supported, the Request Assistance Data and Provide Assistance Data messages can be forwarded.  **Proposal 4:** RAN2 further discusses whether assistance data model 2 is supported, and if so, whether the Provide Assistance Data message can be forwarded.  **Proposal 5:** The Request Location Information and Provide Location Information messages can be forwarded.  **Proposal 6:** The Server UE Selection Indication and Server UE Selection Confirm messages cannot be forwarded.  **Proposal 7:** The Error message can be forwarded.  **Proposal 8:** RAN2 further discusses whether the Abort message can be forwarded.  **Proposal 9:** For SLPP messages that can be forwarded, the “-IEs” structure for each message contains a list of entries with forwarding information provided for each entry.  **Proposal 10:** RAN2 further discusses how to identify the source and destination of a forwarded SLPP message. |
| Intel (R2-2310217) | **Observation 1:** Based on updated RAN plenary guidance, the scenario when some of the involved UEs are not in the coverage of the same LMF is no longer valid.  **Proposal 9:** For both LMF involved and UE only based SL positioning operation, RAN2 discuss and agree that SLPP forwarding is not needed. |
| CEWiT (R2-2309741) | **Proposal 8:** For in-coverage scenarios, SLPP forwarding is not required if LMF communicates with each UE. SLPP forwarding shall be used only when LMF communicates to other UEs via the target UE. |
| LG (R2-2310429) | **Proposal 1.** RAN2 to deprioritize following features for R18 sidelink positioning:   1. SLPP groupcast/broadcast communication (i.e. SLPP unicast is only supported in R18) 2. SLPP groupcast reliable transport (i.e. SLPP unicast reliable transport is only supported in R18) 3. Multiple target UE and group positioning scenario (i.e. Single target UE scenario is only supported in R18) 4. Partial coverage scenario (i.e. SLPP groupcast is not supported in R18) 5. SLPP forwarding for OOC UE in partial coverage scenario (i.e. LMF is involved in in coverage scenario only in R18) 6. SLPP session-less operation (i.e. SLPP broadcast is not supported in R18) |

From the above contributions, it is clear that companies have different understanding on whether SLPP forwarding is necessary and the associated scenario(s) where it is essential to support. Given that there was not much discussion on the need and details of SLPP forwarding in the last RAN2 meeting, it would be a good idea to start by collecting company views on the need for SLPP forwarding and the motivation/scenarios where such forwarding would be essential to have. It is also worth mentioning the updated scope for the WI as per RAN plenary guidance, which is bound to have some impact on the necessity of SLPP forwarding:

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| * Specify unicast session-based signalling and procedures to facilitate support of SL positioning for single target UE (it is not precluded to apply the procedures to multiple target UEs but no signaling optimizations will be considered for this case) [RAN2, RAN3]:   + Specify the protocol and procedures for SL positioning between UEs (Protocol for Sidelink positioning procedures (SLPP)).   + Specify the protocol and procedures for SL positioning between UEs and a single LMF for in coverage scenario only, including joint PC5-Uu scenarios.     - NOTE: Assumes all involved UEs are served by same LMF.   + For SL-TDOA, RAN2 will not work on procedures for synchronization of the anchor UEs. RAN2 can discuss and implement agreed RAN1 parameters related to synchronization. |

Based on the above guidance, the rapporteur thinks that (at least for the in-coverage scenario) the key assumption is that all UEs engaged in SL positioning (including joint PC5-Uu positioning) are under coverage of and being served by the same LMF. One can further surmise that the intention of the note is to say that the LMF can communicate with all UEs engaged in SL positioning. However based on last meeting’s contributions, it seems companies have different understanding on this. With this in mind, companies are invited to share their understanding on the following:

**Q1: Do companies agree that for LMF based operation, the target UE should always be able to directly communicate with LMF (i.e. no forwarding is needed to the target UE)?**

1. **Yes**
2. **No (please comment)**

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| --- | --- | --- |
| **Company’s name** | **Selected Option** | **Comments** |
| Apple | Yes | Direct connectivity to LMF is sufficient in this release. |
| Huawei, HiSilicon | Yes |  |
| vivo | Yes | We think that it is rare case that target UE is out of coverage since one goal of network deployment is to eliminate this as much as possible. Also, if target UE is out of coverage, the network does not know where target UE is and the paging will fail. In this case, the positioning will fail. |
| OPPO | Yes |  |
| Huawei, HiSilicon | Yes |  |
| ZTE | Yes |  |
| Ericsson | Yes |  |
| InterDigital | Yes | We prefer a simple scenario/solution. |
| LG | Yes | Considering R18 timeline, network-based/assisted involving LMF can be limited where target UE is directly connected to LMF (i.e. in-coverage scenario) in this release. We can further discuss the extended cases using SL relay after R18 completion. |
| CEWiT | Yes |  |
| MediaTek | Yes | We understand that SA2 designed flexible procedures where any UE, not just the target, might be in the role of UE1. However, after discussing the LCS framework, it seems most reasonable if the LMF is assumed always to be able to reach the target UE directly, and this seems in line with the RAN plenary update of the WID. |

**Q2: Do companies agree that for LMF based operation, the anchor UEs should always be able to directly communicate with the LMF (i.e. no forwarding is needed between LMF and the anchor UEs)?**

1. **Yes**
2. **No (please comment)**

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| --- | --- | --- |
| **Company’s name** | **Selected Option** | **Comments** |
| Apple | Yes | Direct connectivity to LMF is sufficient in this release. |
| Huawei, HiSilicon | Yes |  |
| Vivo | No | If forwarding is not supported and anchor UEs should always directly communicate with the LMF, SA2 needs to discuss how **LMF** triggers selected anchor UEs **in idle/inactive state** to enter to connected state, which is not supported by current SA2 spec.  Also, it is possible that multiple AMFs connect to one same LMF. If target UE and anchor UEs connect to different AMF with same LMF, SA2 needs to discuss and address, e.g., how does LMF communicates with multiple AMFs, including LMF allocating new correlation IDs between LMF and anchor UEs?  If forwarding is supported, LMF can communicate with anchor UEs via target UE. SA2 may not need to discuss the above issues any more.  Forwarding procedure is quite simple, see our TP in R2-2309668. |
| OPPO | Yes | It is clear from the WID that all involved UEs are assumed to be served by the LMF. Regarding vivo’s concern, we think such scenario is rare case. Generally, AMF could cover a large area. |
| Huawei, HiSilicon | Yes |  |
| ZTE | Yes | To simplify the procedure in Rel-18, it is ok to let LMF to talk to every UE in the session |
| Ericsson | Yes, but should be up to LMF implementation | However, to reduce the overhead of LMF to maintain communication with every UE; we can also have the option where target UE sends the necessary info to other UEs. In such case the SL session ID is the only parameter that is needed by the LMF.  Then We can leave it to LMF implementation |
| InterDigital | Yes |  |
| LG | Yes | Considering R18 timeline, we suggest simple procedures between operation modes and coverage scenarios in this release, i.e., UE-only operation can be performed in OOC scenario, and Network-based/assisted operation can be performed in IC scenario. |
| CEWiT | See comments | Direct communication with LMF is preferable at this stage. However, we think SLPP forwarding may come in handy in some scenarios. As pointed out by Ericsson, we prefer to leave it to the LMF implementation. |
| MediaTek | No; see comments | We understand the LCS framework only intends to put the LMF in correspondence with the target UE. From RAN2 perspective, it looks attractive to have the server talk to the anchor UEs directly, the way the LMF talks to gNBs in Uu positioning, but it seems to have SA2 impact. Thus we think the LMF cannot be assumed to be in contact with the anchor UEs for the same positioning operation as the target.  Also, LMF selection runs independently for different UEs, and it seems problematic to guarantee that all UEs would be associated with the same LMF. |

**Q3: Based on the above questions, do companies think that SLPP forwarding needs to be supported for the case of LMF based positioning?**

1. **No, target and anchor UEs are assumed to be able to directly communicate with the LMF**
2. **Yes, SLPP forwarding by the target UE is necessary to transfer SLPP information between the LMF and the anchor UE(s)**
3. **Other (please comment)**

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| --- | --- | --- |
| **Company’s name** | **Selected Option** | **Comments** |
| Apple | No | Direct connectivity to LMF is sufficient in this release. |
| Huawei, HiSilicon |  | First need to clarify what does it mean by SLPP forwarding. My understanding is that it is just to decode the SLPP message between the UE first and then re-compile it in another message and sent it to the LMF  There is no spec impacts for us either way if SLPP forwarding is needed or not. But before the discussion, we need to be clear about what is “SLPP forwarding” |
| vivo | Yes with comments | See our comments in Q2.  Note that we think SLPP messages are between LMF and UEs from the perspective of protocol, and “SLPP forwarding” is some like the thing of transfer layer and be transparent forwarding, i.e., target UE does not decode the forwarded SLPP message since the SLPP message is between LMF and an anchor UE. |
| OPPO | No | SLPP forward is for the partial coverage scenario. No need to define in this release |
| ZTE | No | If the UE(target UE, anchor UEs) are all in coverage, directly communication is sufficient in this release |
| Ericsson | Yes with comments | We need to first define what is SLPP forwarding:  SLPP forwarding in this case is not transparent fwd. The target UE will parse the content of AD from LMF and then provide it to respective anchor UEs. This can simply be sequence ID, comb factor etc. |
| InterDigital | 1) |  |
| LG | No | Revised R18 WID clearly mentions that RAN2 work focuses on OOC and IC scenarios. WID say that for OOC, RAN2 specify the protocol and procedures for SL positioning between UEs, and for IC, RAN2 specify the protocol and procedures for SL positioning between UEs and a single LMF for in coverage scenario only (NOTE: Assumes all involved UEs are served by same LMF). So, we think that for PC, the OOC procedure may work, i.e. additional procedure for PC scenario is not needed in R18. Therefore, SLPP forwarding is out of scope of R18 WID. |
| CEWiT | 3) | We think this shall be based on LMF implementation and let SLPP forwarding be an optional feature. If the LMF chooses to communicate directly with the UEs, SLPP forwarding is not required. If for some scenarios, the LMF opts to communicate with anchor UEs via the target UE, it shall activate SLPP forwarding. |
| MediaTek | No (see comments) | As we understand the proposed WF in SA2, there would be some form of SLPP “forwarding” (i.e., propagation of information UEx ⬄ UE1 ⬄ LMF), but the forwarding will be specified in CT1 rather than RAN2. So from RAN2 perspective, we understand that this scenario can be addressed without impact to us. |

The other scenario to consider is for the **UE-only operation**, whereby the server UE is involved. For this scenario, the downscoping in RAN is not so clear, so the basic premise of whether the target UE and the anchor UE(s) are able to communicate directly over PC5 interface or whether SLPP forwarding is needed. The rapporteur assumes that the target UE should at least be able to communicate directly with the anchor UE(s), since they need to perform SL-PRS measurements over the PC5 interface.

**Q4: Do companies agree that for UE only operation, the target UE should always be able to directly communicate with the server UE (i.e. no forwarding is needed to the target UE)?**

1. **Yes**
2. **No (please comment)**

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| **Company’s name** | **Selected Option** | **Comments** | |
| Apple | Yes | Direct connectivity to the server UE is sufficient in this release. | |
| Huawei, HiSilicon | | Yes | According to the newly agreed SA2 CR, because of the single LMF assumption, SA2 has already changed their procedure in S2-2311465.  Within the procedure, it can be seen that in step 19 that all the SLPP message are sent from a single UE1 to LMF. |
| vivo | Yes |  | |
| OPPO | Yes |  | |
| ZTE | Yes |  | |
| Ericsson | Yes |  | |
| InterDigital | Yes |  | |
| LG | Yes | According to TS 23.586, if target UE does not support SL Positioning Server functionalities, a SL Positioning Server UE (either co-located with a SL Reference UE/Located UE, or operated by a separate UE) is discovered and selected. | |
| CEWiT | Yes |  | |
| MediaTek | Yes (but see comments) | We think this is a reasonable simplification considering the limited time. However, we have the impression that SA2 intended flexibility here as well, and we should be aware that we are specifying a subset of what SA2 intended to support. | |

For the communication between the server and the anchor UE, RAN2 has following agreements:

The SL-PRS sequence ID can be provided to the TX UE by the LMF/Server UE (via SLPP signalling). If the Tx UE does not receive a sequence ID via SLPP message from the server, the Tx UE is expected to select one by itself. FFS exact SLPP signalling.

Reuse the Request/Provide Assistance Data messages for server to get the assistance data from Anchor UEs. FFS on how to capture.

The above seems to imply that the server can communicate with anchor UE. So, it would be good to get company confirmation on this aspect.

**Q5: Do companies agree that UE only operation, the anchor UEs should always be able to directly communicate with the server UE (i.e. no forwarding is needed between server UE and the anchor UEs)?**

1. **Yes**
2. **No (please comment)**

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| --- | --- | --- |
| **Company’s name** | **Selected Option** | **Comments** |
| Apple | Yes | Direct connectivity to the server UE is sufficient in this release. |
| Huawei, HiSllicon | Yes |  |
| vivo | No | We agree the server can communicate with anchor UEs from the perspective of protocol. But it does not mean direct communication.  Anchor UEs are required to be able to directly communicate with target UE (i.e., in the coverage of target UE). If server UE and target UE are different UE, the valid anchor UEs are likely to be less or even zero if anchor UEs are also required to be able to directly communicate with server UE, which will greatly decrease positioning accuracy or even the availability of positioning. |
| OPPO | Yes | No need to use too many anchor UEs, i.e., UEs out of reach of server UE for SL positioning, at least in this release. Generally, the positioning accuracy depends highly on the available bandwidth. |
| ZTE | Yes | In RAN2#123bis, we have already agreed that server UE can get multiple SL-PRS configurations from multiple anchor UEs. So direct link between server and anchor should be reasonable |
| Ericsson | Yes |  |
| InterDigital | Yes | We prefer the unified scenario/solution for UE-only operation. |
| LG | No | According to RAN1 design, SL-PRS should be transmitted/received directly between target UE and anchor UEs. But, as mentioned in R2-2306334, if server UE is not the same UE with target UE, all anchor UEs cannot be guaranteed to directly connect to server UE. In this case, additional procedure (e.g. SLPP forwarding) is needed, but that could increase complexity and latency. To achieve R18 completion, server UE should be target UE in UE-only operation. We can further discuss for separated server UE cases later. |
| CEWiT | No | Forwarding may be required when the target UE does not have server capability. |
| MediaTek | No (but see comments) | Same understanding of the procedure as described by LG, but we think it is too restrictive to limit the server to always be the same as the target (it’s an important case that the target may be a low-complexity device without the capability of being a server).  We think it would be possible to assume the “everyone can communicate directly” scenario for Rel-18, but it may be too restrictive. The alternative would be to have some kind of SLPP “forwarding”, and with SA2 not having concluded on all details of UE-only operation, we think it might be possible for this forwarding to be handled in upper layers and specified by CT1, as in network-involved operation. |

**Q6: Based on the above questions, do companies think that SLPP forwarding needs to be supported for the case of UE-only operation?**

1. **No, target and anchor UEs are assumed to be able to directly communicate with the server UE**
2. **Yes, SLPP forwarding by the target UE is necessary to transfer SLPP information between the server UE and the anchor UE(s)**
3. **Yes, SLPP forwarding by the anchor UE is necessary to transfer SLPP information between the server UE and other anchor UE(s)**
4. **Other (please comment)**

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| --- | --- | --- |
| **Company’s name** | **Selected Option** | **Comments** |
| Apple | No | Direct connectivity to the server UE is sufficient in this release. |
| Huawei, HiSilicon | No | Noting needs to be changed for the UE-only scenario |
| vivo | 2) Yes, SLPP forwarding by the target UE | If SLPP forwarding is not supported, valid anchor UEs are likely to be less or even zero, which will greatly decrease positioning accuracy or even the availability of positioning. See our comments in Q5.  Note that we think SLPP messages are between LMF and UEs from the perspective of protocol, and “SLPP forwarding” is some like the thing of transfer layer and be transparent forwarding, i.e., target UE does not decode the forwarded SLPP message since the SLPP message is between LMF and an anchor UE.  Forwarding procedure is quite simple, see our TP in R2-2309668. |
| OPPO | No |  |
| ZTE | 1) | If there are 3 separate UEs, target, server, anchor, target and anchor should directly talk to server; if server is the target or anchor, then target(server) and anchor (server) can directly talk to each other.  Actually we are not sure whether server UE gathers anchor UE’s assistance data and provides them to the target UE is a kind of ‘SLPP forwarding’ or not. The forwarding node is server UE here. |
| InterDigital | 1) |  |
| LG | 1) | See Q5 answer. |
| CEWiT | 4) | There may be cases where both direct as well as SLPP forwarding need to be supported depending on the visibility of the positioning server UE. |
| MediaTek | 1) or 2) | 1) may be too restrictive as noted above, and we think 2) could be considered if the forwarding can be specified in upper layers. |

If the need for SLPP forwarding is established, the next aspects for discussion pertain to the approach used for forwarding and which SLPP information needs to be forwarded. For the former question, different approaches can be considered and companies are invited to comment on the following question.

**Q7: Which approach do companies prefer for the SLPP forwarding (if supported)?**

1. **Regenerate SLPP message approach, i.e. the "forwarding node" receives the message (which indicates a different destination ID) from the server, and then generates the corresponding SLPP message to the destination UE;**
2. **SLPP container-based approach, i.e. the "forwarding node" receives the message (which indicates a different destination ID) from the server, and then encapsulates it within an SLPP message as a container and sends to the destination UE;**
3. **Others (please comment)**

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| --- | --- | --- |
| **Company’s name** | **Selected Option** | **Comments** |
| Huawei, HiSilicon | 1) | The UE will regenerate a new SLPP message containing the originating UE’s Application layer ID and send it in an SLPP message to the LMF/server UE  The use of the application layer id has been clear in SA2 spec |
| vivo | 2) with comments | Approach 1) needs the "forwarding node" deeply participating in the positioning, i.e., completely decode the information related to detail positioning information and then regenerate the SLPP message, which will greatly increase the implementation complexity of "forwarding node", and also consume the resource of CPU memory, but it is unnecessary.  For Approach 2), we want to make it clearer, see the following (extracted from R2-2309668):  Figure 5.6.2-1: SLPP Message Forwarding procedure  1. Endpoint A needs to send an SLPP message to Endpoint B, but Endpoint A cannot directly communicate with Endpoint B. Endpoint A sends a *MessageForwarding* message to target UE. In the *MessageForwarding* message, the SLPP message is included as a container and the destination is set to Endpoint B.  2. Target UE decodes the *MessageForwarding* message and gets to know that the destination is Endpoint B. If Endpoint B is an UE and there is no sidelink unicast connection between Target UE and Endpoint B, target UE initiates the sidelink unicast connection setup procedure with Endpoint B.  3. Target UE sends a *MessageForwarding* message to Endpoint B. In the *MessageForwarding* message, the SLPP message is included as a container and the destination is set to Endpoint B. Endpoint B decodes the *MessageForwarding* message and gets to know that the destination is itself. Endpoint B decodes the SLPP message. |
| OPPO | 2) |  |
| ZTE | 1) | Agree with HW |
| Ericsson | 1) | It is not a transparent forwarding. But target UE can parse the content from LMF and then provide the content to other UEs (e.g. Anchor UE). |
| LG | 2) | We prefer to follow SL relay. |
| CEWiT | 2) |  |
| MediaTek | 1) | We think this can be done without requiring “deep decoding” of the IEs; see our paper in R2-2310195, with a potential ASN.1 encoding. But as noted above, we think this issue can be avoided if forwarding is specified in upper layers. |

Secondly, as per discussion in R2-2310195, the different SLPP information which may require forwarding should be discussed. Company views are invited for the following question:

**Q8: Which of the SLPP information needs to be forwarded between the LMF/Server UE and the anchor UE(s)?**

1. **SL positioning capability information (SLPP Request/Provide Capabilities msg)**
2. **SL positioning assistance data information (SLPP Request/Provide AD msgs)**
3. **SL positioning location information (SLPP Request/Provide Location Information msgs)**
4. **Others (e.g. Abort, Error)**

|  |  |  |
| --- | --- | --- |
| **Company’s name** | **Selected Option** | **Comments** |
| Huawei, HiSilicon |  | Not sure about what are the spec impacts. If SLPP can be forwarded, all the SLPP information can be forwarded from stage3’s perspective. No sure whether description in stage2 level is needed dependent on different scenarios. |
| vivo | All | We think that SLPP forwarding is a common function, i.e., it is message forwarding, not information forwarding (actually, information forwarding is a quite strange term). In principle, any SLPP message can be forwarded via forwarding function. We think that the specification should not make the restriction of which SLPP messages can be forwarded. Actually, which SLPP messages are forwarded depends on the sender of SLPP message. |
| OPPO |  | Agree with Huawei |
| ZTE |  | We support LMF/server UE to directly talk to anchor UEs. So no SLPP information needs to be forwarded |
| Ericsson | All | Our view that it is information forwarding and thus it is not transparent forwarding |
| LG | All | We don’t need to have limitation on forward message type if SLPP forwarding is supported. |
| CEWiT | All |  |
| MediaTek | See comment | Per the comments above, we understand that this is more CT1’s issue to resolve, and they likely will simply put a container for an SLPP PDU, allowing all information to be forwarded. If we do it within SLPP, however, we understand that there is a need to specify something in the message formats to support it, so we would have to take an affirmative decision on what could be forwarded. |

Based on the responses to the above questions, the stage 3 details to enable such forwarding (if supported) need to be discussed. The rapporteur intends to provide more details (including possibly a TP) once company views to the above questions are received and compiled, as part of Phase 2 for this discussion.

# Phase 2 Discussion

[TBF]

# Summary/Conclusion

[TBF]

# References

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| [1] | RAN2#123bis meeting, Chariman Notes. |