**3GPP TSG-RAN WG2 Meeting #112-eDRAFT R2-2010868**

**Electronic meeting, November 2nd – 13th, 2020**

**Agenda item:** 8.11.2

**Source:** CATT

**Title:** Gathering of latency enhancement solutions (CATT)‎

**Document for:** Discussion and Agreement

# 1 Introduction

This is to describe and discuss the proposed latency enhancements in a format suitable for developing into a TP. The proposed latency enhancements of the following offline discusion as per the draft summary report [1]

* [AT112-e][607][POS] Gathering of latency enhancement solutions (CATT)

Scope: Describe and discuss the proposed latency enhancements in a format suitable for developing into a TP.

Intended outcome: Text proposal in R2-2010868

Deadline: Friday 2020-11-13 0000 UTC

There are two rounds to discuss the latency enhancement solutions.

1st round is to collect companies’ view on these solutions and summarise potential agreements. Initial deadline: Monday 2020-11-09 1900 UTC

2nd round is to collect the text proposals from companies for developing into a TP. Initial deadline: Thursday 2020-11-12 0000 UTC

The remainder of this document is organized as the following. In Section 2 we provide descriptions on the proposaed latency enhancement based on company contribution [2-14]. In Section 3 the discussions are summarized with proposed TP.

# 2 Discussion

In section 2.1-2.7, these proposed latency enhancements will be discussed in several aspects.

All participants to this discussion are encouraged to leave their name/contact in section 5.

## 2.1 Support for location server functionality in the RAN

The functionality of Support for Location Server functionality in the RAN is mentioned in some contributions and according to the analysis of R2-2010096, the improvements of reducing positioning procedure latency is large.

**Observation 1:** Location Server functionality in the RAN (e.g., LMC) could reduce the positioning procedure latency significantly. With the given assumptions, the improvements can be:

- for UL+DL methods: 40% - 55%;

- for UL-only methods: 50% - 61%;

- for DL-only methods: 23% - 41%.

One architecture to support Location Server functionality in the RAN (e.g., LMC) is shown in following figure:



A possible Rel-16 procedure for splitting between LMF (for "component A") and LSS (for "component B")（as defined in R2-2010096）would be the Deferred MT-LR for periodic and triggered events specified for commercial location services. The procedures for "component A" can be performed in advance of when it is needed. A location request for an MT-LR or MO-LR can include a time T of when the location is required. The LMF would then perform the procedures required for "component A" before the time T. A very small latency for "component B" would allow a client to treat a location estimate as current as there would be little time for location degradation due to movement of the target UE.

Additionally, in R[2-2009023](file:///E:\WORK\1%203GPP\Meeting\RAN2%20112-e\2%20During\Docs\R2-2009023.zip), it is also proposed to reduce the number of Hops between gNB, AMF and LMF as far as possible, so as to achieve the positioning requirement of greatly reducing end-to-end delay.

Both two companies mentioned local positioning functionality as below:

R2-2010096 Proposal 2: Specify support for location server functionality in the RAN (referred to as "Location Server Surrogate" (LSS)). The LSS should support at least the following functions:

- Processing of LCS Event Reports;

- cordinating UE and TRP measurement reports;

- performing position calculation (in case of UE-assisted mode);

- reporting UE location estimates to (external) clients.

R2-2009023 Proposal: To reduce the latency, following enhancement directions are considered in WI phase:

* Reduce the number of hops between gNB, AMF and LMF, e.g. Local NR positioning in NG-RAN (To reduce the latency caused by the transmission/processing from AMF/LMF, i.e. only gNB is shown in the positioning);

**Q1: Please provide your views if location server functionality in the RAN is captured into TR as an enhancement of latency.**

|  |  |  |
| --- | --- | --- |
| **Company name** | **Agree/Disagree** | **Comments** |
| Huawei/HiSilicon | Disagree | We don’t think the location server functionality is beneficial for latency enhancement.  First, We dont think it is part of the SID  Second, the evaluation for local LMF-based positioning has already been done by SA2, which does not make any conclusion on the latency gain of local LMF compared with LMF being deployed physically adjacent to gNB and RAN3 dose not evaluate the latency gain.  C:\Users\y00397895\AppData\Roaming\eSpace_Desktop\UserData\y00397895\imagefiles\E79128FF-7765-4A23-8B57-C0C632000E50.png  Third, the way to compare the latency of LSS/local LMF-based positioning with that of LMF-based positioning in R2-2010096 and R2-2009023 is questionable, which only counts the number of signalling. While the latency of the signaling can vary significantly with different distance of deployment between the LMF, gNB and AMF. |
| Qualcomm | Agree | The latency improvements can be seen from the analysis in R2-2010096 which is based on RAN2 assumptions. |
| InterDigital | Agree | Having the location server functionality (e.g. LMC) in RAN enables to significantly reduce the latency for DL, UL and DL+UL methods. Especially for the DL+UL positioning methods, supporting LMC in RAN allows for more efficient coordination for PRS and SRS for positioning configuration and processing of DL and UL measurements. In light of this, we agree to capture in TR about reduction of latency as a potential benefit of supporting location server functionality in RAN. |
| CATT | Agree | The location server functionality in NG-RAN can reduce the end-to-end latency for position estimation of UE. Therefore, we agree to capture the option in TR as a potential solution for enhancement of positioning latency. |
| ZTE | Disagree | We share the similar view with Huawei.  We also do not think the location server can have advantage for latency enhancement. Besides, the privacy issue of user data may be occurred if we introduce the location server. Considering the location server discussion is about the network architecture, we think RAN3 should also be involved in this discussion. |
| Ericsson | Disagree | This has been extensively discussed in past. There was no consensus on this and we do not see companies stand change either now. We still belive we should look for other options such as deploy 5GS within factory premises if there is latency caused by transport.  With Non Public Network one can deploy not only local LMF but also local AMF; as such the whole 5G Core can be within factory premises. |
| Nokia |  | It is too early to capture in the TR any latency enhancement solutions as we have not had detailed discussions of the different solutions on the table. The email discussion [Post111-e][625] on latency analysis scope was, to quote, “Discuss which nodes and which procedures are involved in a positioning latency analysis, and capture expected latency values where possible”. This was done in Phase 1 of that email discussion. In Phase 2, an additional discussion to “collect potential enhancements/directions to reduce the latency” was launched but only 2 companies proposed solutions (but only at a very high level). However, the latency analysis for the proposed enhancement solutions were not shown in Phase 2 of the email discussion. There are some contributions for this meeting proposing enhancement solutions (and some show latency analysis also) but we have not had detailed discussion of these contributions. We prefer to just document in the TR, the latency analysis done so far and use it as a baseline to perform latency analysis for any proposed solutions during the work item phase.  On this specific solution about location server functionality in the RAN, we acknowledge its potential to reduce latency due to the shorter signaling time it entails, yet we must not repeat the same discussions we had during Rel-16 study of NR positioning (TR 38.855). Instead, we must take the study outcome in TR 38.855 and the subsequent study in RAN3 into account. This of course requires lot of time which we cannot do now in this study phase of this Rel-17 study item. |
| Intel | Agree | The scope of this email discussion is not to do down selection, but  *Describe and discuss the proposed latency enhancements in a format suitable for developing into a TP.*  It would be good to capture all potential enhancement direction in the TR. And then do down selection later. However, we also agree, it is not clear whether RAN2 can make decision by ourself considering the situation in Rel-16. |

**Summary 1**:

8 companies responded. 4 companies agree to capture the solution into TR, 3 companies disagree to capture it and one company believe it is too early to capture any latency enhancement solutions in TR.

Rapporteur’s comments:

Based on the comments it looks like there is no majority to disagree it. This solution can be captured in the TR as a potential solution for the further discussion in SI, because Location Server functionality in the RAN (e.g., LMC) could reduce the positioning procedure latency significantly. With the given assumptions, according to the latency analysis in R2-2010096, the improvements can be:

- for UL+DL methods: 40% - 55%;

- for UL-only methods: 50% - 61%;

- for DL-only methods: 23% - 41%.

The text proposal is put in 7.x.1 Location server functionality in the RAN for company’s further review.

## 2.2 The capability procedure

Based on R2-2009023, LPP capability exchange is about 33-88.5 ms. In R2-2008810, it is stated that Positioning capabilities of UE may be reported to AMF directly before there is a location request, instead of to LMF via LPP session, in order to reduce the positioning latency. This solution also works for the positioning in Idle/Inactive mode. AMF can store these capabilities before UE steps into RRC\_CONNECTED mode.

Additionally, in R2-2010072, it is stated that Time to First Fix should be considered for positioning latency studies:

**Observation 1**: Time to first fix should be considered in latency studies and any improvements in this area can be studied. Considering TTFF in latency may relax the other core latency requirements for performing measurements and reporting to the location server for positioning computation.

Potential improvement during TTFF can be storage of UE positioning capabilities by AMF. AMF would thus forward it to LMF as depicted in below diagram for the MT-LR procedure.

Below are the proposals from the three companies:

R2-2008810 Proposal 7: Support the process that UE location capabilities report to AMF in idle/inactive directly without entering into RRC\_CONNECTED mode in LPP session, in order to reduce the latency and support the positioning in Idle/Inactive mode.

R2-2010072 Proposal 2: RAN2 to consider solutions that would save latency during capability transfer and send an LS to SA2 to provide solution that minimizes latency in retrieving capability from UE to LMF via LPP.

R2-2009023 Proposal: To reduce the latency, following enhancement directions are considered in WI phase:

* Skip the capability procedure (can reduce the latency caused by exchange of capability as above)

**Q2: Please provide your views if enhancement of capability procedure is captured into TR as an enhancement of latency.**

|  |  |  |
| --- | --- | --- |
| **Company name** | **Agree/Disagree** | **Comments** |
| Huawei/HiSilicon | Disagree | 1. We don't see much benefit for UE location capabilities reporting to AMF, since it only saves the signalling delay from UE-gNB-AMF, which is only about 3-10.5ms according to R2-2009001 but at the expense of the additional complexity of AMF.  2. This also means UE location capabilities should be stored in AMF. Serveral problems may be caused.  1) AMF needs to store all the positioning capabilities for all UEs (UE positioning capabilities are transparent to AMF) in the network, which probably incurs additional complexity and is hard to realize because the UE number in the network can be huge!.  2) There may be a lot of spec impacts including RAN2, SA2, CT1, CT4. An alternative is to store UE positioning capabilities in LMF without any spec impact. When a new LMF is selected for certain UE, the new LMF can either request context from the old LMF, or request capabilities from the UE. The LMF change can rarely happen so that there would be little  lantecy impacts. |
| Qualcomm | Unclear | Generally, we are not against capturing enhancement proposals in the TR which have been evaluated. However, why an AMF should store positioning capabilities is rather unclear, since they could also be stored at an LMF (which seems a possibible implementation option already since Rel-9). |
| InterDigital |  | We think the capability transfer procedure cannot be skipped altogether since the ability for the UE to support a positioning method and assess the assistance data is determined at LMF based on UE capability. However, we think enhancements to the procedure can be considered such that capability transfer via LPP need not be done at all times and that the UE context (related to positioning capability) can be retrieved by LMF. |
| vivo | Unclear | Same view with QC. |
| Xiaomi | Unclear | If the AMF/LMF save the UE positioning capability and then LMF does’t require the capability when UE positioning is performed. We wonder how to handle the case as follows.  For instance, the DL-TDOA and A-GNSS capabilities are reported to network and network performs UE postioning with A-GNSS method. With UE moving, such as in the uderground parking lot without GNSS signal, the network can’t used the A-GNSS any more. Network don’t know how to choose a suitable postioning method from the saved capabilites. |
| CATT | Agree | The AMF is able to store the radio capabilities for some UEs. Therefore, the location related capability of these UEs can also be stored in the AMF without introducing too much complexity. If LMF stores positioning capability, however AMF chooses different LMF, the interaction between AMF and LMF would be more complex and the delay of exchanging UE positioning capability is inevitable. We prefer to capture this potential solution into TR. |
| ZTE | Unclear | We share the similar view with Qualcomm. |
| Ericsson | Agree | There are two reasons atleast the LMF may not be able to store capabilities.   * It is OPTIONAL to send SUPI (UE ID) because of privacy security or over untrusted LMF * LMF should be stateless; and it releases the UE context after LPP session is over. This was also discussed in Rel-15 for stroing UE subscription info in LMF but was not accepted. *For roaming cases; HSS/VLR may have fetched from LMF with regards to positioning subscription but rather it was only agreed to be stored in HLR and not in LMF.*   It is strage that Huawei is ok to store capabilitues in LMF but not in AMF. And that QC thinks it was not Ok to store subscription info in LMF but then ok to store the capabilities.  AMF is already storing UL SRS for positioning capabilities. Further AMF stores other NAS capabilities, paging capabilities, UE NW capabilities. LMF as such should be stateless and it may release the UE context after LPP session is over. Further, it is not guaranteed that UE ID (SUPI) would always be availble in LMF. As providing UEID to LMF is OPTIONAL.  It may take up to 80ms to fetch the capabilities using current mechanis so if any optimization that can be done should be considered for the SI.  If capabilities are already stored in AMF; then either AMF fwds the capability to LMF unsolicitely or LMF may fetch it from AMF directly instead from the UE. Basically similar to how gNB obtains radio capability from AMF, LMF could also do the same. It will also save Uu load.  It should be captured in TR and SA2 may evaluate further. |
| Spreadtrum | Unclear | Like storing UE Uu radio capabilities, the positioning related capability of UEs can also be stored in the AMF to reduce the latency. But more discussion is needed. |
| Nokia |  | It is too early to capture in the TR any latency enhancement solutions as we have not had detailed discussions of the different solutions on the table. The email discussion [Post111-e][625] on latency analysis scope was, to quote, “Discuss which nodes and which procedures are involved in a positioning latency analysis, and capture expected latency values where possible”. This was done in Phase 1 of that email discussion. In Phase 2, an additional discussion to “collect potential enhancements/directions to reduce the latency” was launched but only 2 companies proposed solutions (but only at a very high level). However, the latency analysis for the proposed enhancement solutions were not shown in Phase 2 of the email discussion. There are some contributions for this meeting proposing enhancement solutions (and some show latency analysis also) but we have not had detailed discussion of these contributions. We prefer to just document in the TR, the latency analysis done so far and use it as a baseline to perform latency analysis for any proposed solutions during the work item phase.  We also agree with the comments from Huawei, Qualcomm and InterDigital. We are open to discussing capability related enhancements but we need more analysis to see if the gain is worth the complexity. A CN based solution to exchange capability with LMF is only shifting the latency from RAN to CN side. We need to see if there is really any improvement in the E2E latency. |
| Intel | Agree | Same as above. It would be good to collect potential enhancement direction, and this is the scope of the email discussion. |

**Summary 2**:

11 companies responded. 3 companies agree to capture the solution into TR, 7 companies anwer as unclear, and one company disagree it.

Rapporteur’s comments:

Based on the comments it looks like there is no majority to disagree it so far. Companies think SA2 will be involved for the further discussion, because we need to see if there is really any improvement in the E2E latency, not only shifting the latency from RAN to CN side.

The text proposal is put in 7.x.2 The capability procedure for company’s further review.

## 2.3 SRS configuration and PRS configuration optimization

According to R2-2009023, SRS configuration+activation (step 3-8) is 66- 133ms and LPP assistance data is 28-44.5ms, if the latency consumption of these two parts can be reduced, the total E2E latency can be further optimized.

According to R[2-2010096](file:///E:\WORK\1%203GPP\Meeting\RAN2%20112-e\2%20During\Docs\R2-2010096.zip), Latencies for Deferred MT-LR Event Reporting is provided as below:

**Table 19: Latencies for Deferred MT-LR Event Reporting.**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **End-to-End Latency [ms]** | | | | | |
| **LMF only** | | | **LMF and LSS** | | |
| **Baseline** | **Configuration Signalling in Advance** | **Configuration Signalling in Advance for DL-only Positioning** | **Configuration Signalling in Advance and LSS** | **Configuration Signalling in Advance and LSS for DL-only Positioning** | **LSS with Positioning and Event Reporting in RRC\_INACTIVE state** |
| UL+DL Positioning | 284-535.5 | 164-320 | NA | 100-150 | NA | 61-98.5 |
| UL-only Positioning | 221-448 | 139-287.5 | NA | 76-120.5 | NA | 55-91 |
| DL-only Positioning | 218-402.5 | 124-229.5 | 72-135.5 | 92-137.5 | 54-89.5 | 53-86.5 |

So SRS configuration and PRS configuration optimizations can reduce the latency caused by by SRS/PRS confi[guration.](file:///E:\WORK\1%203GPP\Meeting\RAN2%20112-e\1%20Before\文稿规划\POS\CR\backup\R2-200xxxx%20Minor%20corrections%20on%20description%20of%20sfn0-Offset%20in%20SSB-Configuration.docx). Here are the solutions proposed in R2-2009023 and R2-2010096:

Option 1： DL PRS assistance information can be pre-configured to UE. Multiple DL PRS configurations can be associated with DL PRS configuration ID and activated when necessary;

Option 2：SRS for positioning configuration information can be pre-configured to UE. Multiple configurations of SRS for positioning can be associated with SRS for positioning configuration ID and activated when necessary;

Option 3： Specify signalling and procedures for Deferred MT-LR（as proposed in R2-2010096）to support positioning configuration signalling in advance;

**Q3: Please provide your views which option(s) of SRS configuration and PRS configuration optimizations is captured into TR as an enhancement of latency.**

|  |  |  |
| --- | --- | --- |
| **Company name** | **Option1/2/3** | **Comments** |
| Huawei/HiSilicon |  | Not sure what preconfiguration means.  Even in Rel-16, assistance data can be provided to the UE in advance, and UE will not take measurement until UE receives LPP RequestLocationInformation message. Would that be considered as pre-configuration as well?  For SRS, we assume reusing periodic MIMO-SRS can save a lot of latency as shown in our contribution R2-2010276, we do not need capability exchange, activation request/response, MAC CE activation, etc. Even for positioning SRS, we already support SP-SRS/AP-SRS for positioning that can be activated rather dynamically.  For deferred MT-LR, the procedure is already defined. Not sure what kind of enhancement we are talking about. The current event report is to AMF and then to the LMF, but we can directly enhance LPP triggered report to LMF. |
| Qualcomm | All | All options can be captured. This may require primarily procedure description changes. E.g., SRS configurations are currently deleted after cell change, state transitions, etc. or LMF does not know whether the UE has/supports assistance data via broadcast, etc. |
| InterDigital | Option 1 and 2 | Preconfiguring PRS and/or SRSp in UE/RAN and activating the preconfigurations when triggered is beneficial for reducing latency associated with assistance data transfer (for PRS config) and RRC ignalling (for SRSp config). Thus, Option 1 and Option 2 should be captured into TR. Through joint optimization of preconfiguration and activation mechanism, further benefit in latency reduction and accuracy enhancement can be expected. |
| Vivo | All | All these options can improve latency performance. |
| Xiaomi | All |  |
| CATT |  | Preconfiguring PRS and/or SRSp in UE/RAN is beneficial for reducing positioning latency. But it seems that have be supported in R16. No sure if further enhancement is needed. |
| ZTE | 1 and 2 |  |
| Ericsson | Option 3 | Option 3 should be considered.  Option 2 is very complex. UL SRS in Inactive may not be controlled. What should be the UE power and beam directions? Positioning Ues are mostly Ues on move then as Huawei also acks there are many uncertainties as:   * DL synchronization * TA maintenance * Cell reselection * Triggering of AP-SRS * Resource allocation/Release   This may increase lot of signalling with Context Fetch between gNBs.  For Option 1 same view as Huawei; not sure what is preconfiguration; if it is same as Deferred where one may pre-configure then we are fine. |
| Spreadtrum | Option 3 | For option1 we agree with Huawei’s view, not sure what preconfiguration means.  For Option2, we are not sure how to implement preconfigured SRS. Because the spatial relation of SRS will change as time going. |
| Nokia |  | It is too early to capture in the TR any latency enhancement solutions as we have not had detailed discussions of the different solutions on the table. The email discussion [Post111-e][625] on latency analysis scope was, to quote, “Discuss which nodes and which procedures are involved in a positioning latency analysis, and capture expected latency values where possible”. This was done in Phase 1 of that email discussion. In Phase 2, an additional discussion to “collect potential enhancements/directions to reduce the latency” was launched but only 2 companies proposed solutions (but only at a very high level). However, the latency analysis for the proposed enhancement solutions were not shown in Phase 2 of the email discussion. There are some contributions for this meeting proposing enhancement solutions (and some show latency analysis also) but we have not had detailed discussion of these contributions. We prefer to just document in the TR, the latency analysis done so far and use it as a baseline to perform latency analysis for any proposed solutions during the work item phase.  All options mentioned looks promising to reduce the latency but these require more time for evaluation. |
| Intel | all | Same as above. We should capture all potential solutions, and then do down selection later. |

**Summary 3**:

11 companies responded. 8 companies agree to capture the solution into TR, 2 companies think it is already supported in Rel-16, and one company think that more time is required for evaluation.

Rapporteur’s comments:

Based on the comments it looks like no majority to disagree it.

The text proposal is put in 7.x.3 SRS configuration and PRS configuration optimization for company’s further review.

## 2.4 The parallel handling of positioning related messages

In some contributions, it was proposed that in parallel handling some location-related messages and steps can further reduce the total end to end latency.

Here are the solutions proposed in R[2-2009577](file:///E:\WORK\1%203GPP\Meeting\RAN2%20112-e\2%20During\Docs\R2-2009577.zip) and R[2-2008886](file:///E:\WORK\1%203GPP\Meeting\RAN2%20112-e\2%20During\Docs\R2-2008886.zip):

Option 1：For UL-TDOA/UL-AOA positioning method, some NRPPa messages can be merged into one message, such that the total end to end latency can be further reduced.

The main enhancements are as following:

* NRPPa positioning information request and NRPPa measurement request are merged into one message;
* NRPPa positioning information response and NRPPa measurement response are merged into one message;
* gNB can immediately active SRS without SRS activation request from LMF and it implies LMF don’t need to send SRS activation request.

Option 2：For UL&DL-based positioning methods, RAN2 to study potential enhancements related to provisioning of PRS and SRSp, coordinated triggering of SRSp transmission and PRS reception, and measurement report transmission/forwarding

**Q4: Please provide your views which option(s) of parallel handling of positioning related messages/steps is captured into TR as an enhancement of latency.**

|  |  |  |
| --- | --- | --- |
| **Company name** | **Option1/2** | **Comments** |
| Huawei/HiSilicon | Neither | For Option 1, we think is may only works for the cases when the psoitioning procedure only involves the serving gNB. For example, how can LMF request the measurement from neighboring gNBs together with the request of positioning information? Because at this time, LMF hasn’t received the SRS configuration from the information response.  For Option 2, similar problem occurs when the neighboring gNBs are involved in the positioning process. It’s far from easy to coordinate the timing/triggering of PRS transmission by both serving gNB and neighboring gNBs with the SRSp transmission by UE.RAN4 is discussing the spacing between SRS and PRS in R16 and this is some kind of coordination |
| Qualcomm | None | Option 1 seems generally not feasible, since TRPs can only be configured e.g., once the SRS is known. Immediate SRS activation is possible in Rel-16 e.g., with periodic SRS.  Option 2 is unclear, but looks more RAN1 centric. |
| InterDigital | Option 1 and 2 | Option 1 and Option 2 are related and, in certain aspects, overlapping. While Option 1 focuses on enhancements in the network (i.e. NRPPa signaling between LMF and gNB) primarily for UL based positioning, Option 2 focuses on procedural aspects involving the LMF, gNB and UE for UL+DL positioning method. In general, parallel handling and optimizations of certain procedures (e.g. configuring and triggering PRS/SRSp, coordinated DL/UL measurements) can minimize latency and improves signaling efficiency. As such, the aforementioned procedures that can be done in parallel should be captured into TR. |
| vivo | None | Both 1 and 2 can be resolved by implementation. We can choose to send the messages simulaniously rather than define a new message. |
| Xiaomi | Option 1 an 2 | Both option 1 and 2 can reduce the positioning latency, for option 1, on HW’s comments, if neighbour gNBs is involved, the LMF can send the NRPPa measurement request message to the neighbour gNBs to acquire the SRS meaaurment. |
| CATT | None | The parallel handling of some positioning related messages is more about implementation. The latency related with the parallel messages may be ignored in the latency evaluation. |
| ZTE | None | Same view with vivo, this can be solved by network implementation. |
| Ericsson | None | The merging of message appears more implementation and could be possibly done by implementation. But it has more RAN3 impacts which needs to be looked by appropriate group. |
| Spreadturm | None | It is up to network implementation. |
| Nokia |  | It is too early to capture in the TR any latency enhancement solutions as we have not had detailed discussions of the different solutions on the table. The email discussion [Post111-e][625] on latency analysis scope was, to quote, “Discuss which nodes and which procedures are involved in a positioning latency analysis, and capture expected latency values where possible”. This was done in Phase 1 of that email discussion. In Phase 2, an additional discussion to “collect potential enhancements/directions to reduce the latency” was launched but only 2 companies proposed solutions (but only at a very high level). However, the latency analysis for the proposed enhancement solutions were not shown in Phase 2 of the email discussion. There are some contributions for this meeting proposing enhancement solutions (and some show latency analysis also) but we have not had detailed discussion of these contributions. We prefer to just document in the TR, the latency analysis done so far and use it as a baseline to perform latency analysis for any proposed solutions during the work item phase.  Option 1 which is from R[2-2009577](file:///E:\WORK\1%203GPP\Meeting\RAN2%20112-e\2%20During\Docs\R2-2009577.zip) is not detailed enough to understand the enhanced call flow and how it results in latency reduction but from the current description, I do have the same comment as Huawei and Qualcomm that this is not currently feasible with neighbour gNBs involved.  In Option 2, we need more details about how the coordinated triggering would work. I have seen some other enhancement in that paper which proposes a priority indication and have UE perform the measurements with higher priority. How this will work is also unclear but it also involves RAN1/RAN4 areas of discussion. |
| Intel | All | The intention of email discussion is to capture potential solutions instead of the down selection. |

**Summary 4**:

11 companies responded. 3 companies agree to capture the solution into TR, 8 companies disagree to capture any options in TR.

Rapporteur’s comments:

Based on the comments it looks like there is a majority to disagree the option(s) of parallel handling of positioning related messages/steps captured in TR. So there is no proposal on it.

## 2.5 Measurement gaps (MG) optimizations

Measurement Gap is about 18-22ms based on the analysis in R2-2009023. The configuration of measurement gap results in additional latency due to the transmission and reception of RRC ignalling.

So measurement gaps (MG) optimizations can reduce the latency caused by measurement gap request procedure. Here are the solutions proposed in R2-2009023 and R2-2008886:

Option1: MG-less operation – UE may operate w/o measurement gaps to process DL PRS

Option2: Support of semi-persistent a-periodic MGs, their pre-configuration and association with MG configuration ID

Option 3: Avoiding or minimizing the latency due to measurement gap configuration. As an example, the UE may be triggered to perform measurement of DL PRS based on lower layer ignalling (e.g. in MAC CE) from gNB without configuration of measurement gap. The configuration of certain criteria/rules in the UE for determining whether to perform measurement of PRS based on a configured timer or priority indication can be considered for eliminating measurement gap configuration.

Option4: Fast activation of measurement gap configuration: UE sends indication to gNB using lower layer signaling to either skip or request a measurement gap configuration. The gNB may then activate/deactivate a preconfigured measurement gap (e.g. in MAC CE) based on the indication sent by the UE.

**Q5: Please provide your views which option(s) of measurement gaps (MG) optimizations is captured into TR as an enhancement of latency.**

|  |  |  |
| --- | --- | --- |
| **Company name** | **Option1/2/3/4** | **Comments** |
| Huawei/HiSilicon | Option1 | We are supportive of MG-less operation.  1. This can reduce the latency caused by MG configuration.  2. The data transmission process wouldn’t be affected if there is no measurement gap for processing DL PRS. So it may bring some gain from the apect of the latency for data transmission. |
| Qualcomm | None | This seems RAN1/4 business. It seems there is already some measurement gap enhancements work ongoing in RAN4. |
| InterDigital | Option 1/3 and Option 2/4 | Option 1 seems to be covered within Option 3 and Option 2 seems to be covered within Option 4. While Option 1 or 3 describes the methods to allow UE to receive PRS outside of measurement gap, Option 2 or 4 describes ignalling gap which is configured aperiodically or semi-persistently.  In principle, all options shall be captured in TR. The ignallin that allow for skipping MG configuration and/or fast triggering of MG should be captured in TR. As we identified in RAN1 latency analysis, in R1-2008489, that the existing procedure for the UE to request for MG using RRC ignalling upon receiving the location request in LPP/NAS increases latency ignallingly. |
| Vivo |  | Seems RAN1 scope. |
| Xiaomi |  | We think MG optimizations should be studied in RAN1. |
| CATT | Option 1/3 | MG-less operation can reduce the latency caused by MG configuration. Besides, option 2/4 only reduces the delay of RRC ignalling processing, and seems that RAN4’s work needs to be considered. |
| ZTE | None | This part should be discussed in RAN1&RAN4. |
| Ericsson | None | Option 1 Looks more like RAN1/RAN4 or could already be solved by NW PRS configuration; so UE does not need to ask for gaps.  Other options look complicated.  I think the MG should be looked from other RAN groups RAN1/4 |
| Spreadtrum | None | Seems RAN1/4 scope |
| Nokia |  | It is too early to capture in the TR any latency enhancement solutions as we have not had detailed discussions of the different solutions on the table. The email discussion [Post111-e][625] on latency analysis scope was, to quote, “Discuss which nodes and which procedures are involved in a positioning latency analysis and capture expected latency values where possible”. This was done in Phase 1 of that email discussion. In Phase 2, an additional discussion to “collect potential enhancements/directions to reduce the latency” was launched but only 2 companies proposed solutions (but only at a very high level). However, the latency analysis for the proposed enhancement solutions were not shown in Phase 2 of the email discussion. There are some contributions for this meeting proposing enhancement solutions (and some show latency analysis also) but we have not had detailed discussion of these contributions. We prefer to just document in the TR, the latency analysis done so far and use it as a baseline to perform latency analysis for any proposed solutions during the work item phase.  Also, we agree with Qualcomm. These solutions needs to be discussed in RAN1/RAN4 first. |
| Intel | all | The intention of email discussion is to capture potential solutions instead of the down selection.The measurement gap can be discussed in RAN2 and RAN4, however RAN4 is not working on this. |

**Summary 5**:

11 companies responded. 4 companies agree to capture option1 into TR, 7 companies think it is RAN1/4 business.

Rapporteur’s comments:

Based on the comments it looks like there is a majority to discuss it in RAN1/4 first.

The text proposal is put in 7.X.5 Measurement gaps (MG) optimizations for company’s further review.

## 2.6 Enhancements for prioritized transmission of PRS/SRS

According to R2-2008886, in Rel-16, both PRS and SRSp are assigned with low priorities. As a result, PRS is not received or SRSp is not transmitted/dropped when either transmission of data in DL/UL or other reference signals are scheduled.

In Rel-17, it can be envisioned that supporting prioritized positioning based on the assignment and indication of higher priority for the reception/transmission of PRS/SRSp may enable satisfying the low latency positioning requirements. For DL-based positioning, the priority indication for PRS may be either indicated by LMF in assistance information or indicated by RAN in lower layer/RRC signalling. The UE may trigger the reception and measurement of PRS based on the received priority indication.

For UL-based positioning, the UE may trigger the transmission of SRSp based on the reception of the priority indication in lower layer/RRC signalling. The priority of the positioning reference signal can be associated with the type of the positioning reference signal (e.g. periodic vs. aperiodic positioning reference signals).

So some company proposed to support prioritization of PRS and/or SRSp.

**Proposal 4:** RAN2 should study mechanisms for supporting prioritization of PRS and/or SRSp with respect to data and other reference signals for reducing positioning latency

**Q6: Please provide your view if prioritized transmission of PRS/SRS is captured into TR as an enhancement of latency.**

|  |  |  |
| --- | --- | --- |
| **Company name** | **Agree/Disagree** | **Comments** |
| Huawei/HiSilicon | Agree | We think this should be better handled in RAN1, e.g. handling between PRS/CSI-RS/SSB/PDCCH/PDSCH, and between SRS/PUSCH/PUCCH is more related to physical layer consideration.  Wait for the RAN1 input on the enhancements for prioritized transmission of PRS/SRS. |
| Qualcomm |  | This seems RAN1 business. |
| InterDigital | Agree | Prioritized transmission of PRS and/or SRSp as an enhancement over Rel-16 procedures is beneficial for supporting the Rel-17 positioning services with low latency requirements (e.g. under 100ms). Note that the latency analysis currently performed in RAN2 and RAN1 assumes there is no ongoing data transmission that is scheduled when PRS/SRSp is transmitted. However, this may not be the case in practice where PRS/SRSp transmission is delayed/dropped in favor of data and other RS due to lower priority for PRS/SRSp. In this case, applying priority indication for PRS/SRSp provides scheduling flexibility at UE/RAN for satsifying the QoS associated with positioning service and data transmission. As such, techniques associated with prioritized handling of PRS/SRSp should be captured in TR. |
| vivo |  | In general, we are fine with the proposal, But this should be captured by RAN1. |
| Xiaomi | Agree | The PRS/SRS transmission priority should be studied by RAN1 and RAN2 can study the signalling procedure based on RAN1 input. |
| CATT |  | Wait for the RAN1 input on the enhancements |
| ZTE |  | The prioritized transmission of PRS/SRS should be discussed in RAN1. |
| Ericsson |  | Wait for the RAN1 input on the enhancements for prioritized transmission of PRS/SRS. |
| Spreadtrum |  | Wait for the RAN1’s progress. |
| Nokia |  | It is too early to capture in the TR any latency enhancement solutions as we have not had detailed discussions of the different solutions on the table. The email discussion [Post111-e][625] on latency analysis scope was, to quote, “Discuss which nodes and which procedures are involved in a positioning latency analysis, and capture expected latency values where possible”. This was done in Phase 1 of that email discussion. In Phase 2, an additional discussion to “collect potential enhancements/directions to reduce the latency” was launched but only 2 companies proposed solutions (but only at a very high level). However, the latency analysis for the proposed enhancement solutions were not shown in Phase 2 of the email discussion. There are some contributions for this meeting proposing enhancement solutions (and some show latency analysis also) but we have not had detailed discussion of these contributions. We prefer to just document in the TR, the latency analysis done so far and use it as a baseline to perform latency analysis for any proposed solutions during the work item phase.  Also, we agree with Qualcomm. These solutions needs to be discussed in RAN1 first. |
| Intel |  | Agree, RAN1 is working on this. |

**Summary 6**:

11 companies responded. 10 companies think it would be better handled in RAN1at first and 3 companies agree to capture it in TR.

Rapporteur’s comments:

Based on the comments it looks like there is a majority to wait for the agreement from RAN1.

The text proposal is put in 7.X.6 Enhancements for prioritized transmission of PRS/SRS for company’s further review.

## 2.7 Measurement report optimization

According to R2-2009897, it is proposed to introduce a positioning measurement report, with configured grant (CG) mechanism. The gNB can allocate resources for the UE that has been requested to perform positioning procedure. The configured grant resources are used by the UE to transmit the positioning measurement results. Note: configured grant mechanism has been part of the NR URLLC. Hence, the specification impact can be kept the minimum.

Additionally, in R2-2009039, it is also stated that Grant Free UL Transmission enables reduce UL transmission delays and achieve URLLC Reliability targets.

Grant Free UL Transmission enables reduce UL transmission delays and achieve URLLC Reliability targets. For low latency and reliability requirements, it is required to support UL GF transmission with multiple repetitions (i.e. UL data transmission without scheduling request). Additionlly, this pre-allocated grant should adapt to the PRS period, so the best latency result is performed.



Figure configured grant resource adapt PRS repetition period

This configured grant can be defined as positioning use only uplink resources. CG need adopt the positioning window, but gNB doesn’t know the offset or the timing of the completed positioning measurement/calculation. So, a new type or separate CG for positioning need to be introduced

The following proposed solutions are from companies:

R2-2009039 Proposal 5: Grant-free UL transmission can be used to adapt the PRS period and positioning specific configured grant should be introduced in Rel-17.

R2-2009897 Proposal 8: Positioning latency reduction is facilitated by RAN2 in the context of RAN procedures/protocol on LPP signalling, RRC signalling, and MAC layer.

**Q7: Please provide your views if measure report optimization is captured into TR as an enhancement of latency.**

|  |  |  |
| --- | --- | --- |
| **Company name** | **Agree/Disagree** | **Comments** |
| Huawei/HiSilicon | Disagree | Our understanding on the configured grant for PRS measurement reporting should only be used in INACTIVE state NR positioning based on small data transmission. Allocating exclusive configured grant for positioning for CONNECTED state UE will fragment the specification, e.g. it means that physical channel – transport channel – logical channel – RLC channel – radio bearer – RRC message and up to NAS container are dedicated for an LPP message, which is breaks the standard interface between layers. UE will not be able to use CG for other RRC message, or NAS message, or even UP data.  Besides, for CG-based transmission, if you want to use apply CG transmission for a certain logical channel, this can already been enabled by the configuration of logical channel. |
| Qualcomm |  | Proposal 5 seems RAN1 business, and Proposal 8 is too general/unclear. |
| InterDigital | Agree | It is clear that the use of CG for sending measurement reports enables to minimize the latency associated with the scheduling procedure (i.e. SR/BSR) and it should be captured in TR. However, to fully realize the low latency benefits how the CG is properly aligned and triggered at UE with suitable offset upon completion of PRS measurement and processing should be further studied, potentially in the work item phase. |
| Vivo | Agree | This can be used as positioning use only uplink resources, so that periodic positioning measurement report could be sent without waiting any L1 signals. |
| Xiaomi | Agree | The measure report optimization can be further studied for latancy reduction. |
| CATT | Agree | Grant-free UL transmission for PRS measurement reporting can be capured into TR as an enhancement of latency. |
| Ericsson | Neutral/OK | This could be useful but already should be supported.  The only missing part could be NRPPa impact. LMF does not send what periodicty has been configured to gNB. So, if LMF does so, gNB can use it. |
| Spreadtrum | Partially Agree | CG could be useful that periodic positioning measurement report which can be sent to the network without waiting L1 signals. It is up to the network implementation to configure CG. It is not good to introduce large impacts to the spec. |
| Nokia |  | It is too early to capture in the TR any latency enhancement solutions as we have not had detailed discussions of the different solutions on the table. The email discussion [Post111-e][625] on latency analysis scope was, to quote, “Discuss which nodes and which procedures are involved in a positioning latency analysis, and capture expected latency values where possible”. This was done in Phase 1 of that email discussion. In Phase 2, an additional discussion to “collect potential enhancements/directions to reduce the latency” was launched but only 2 companies proposed solutions (but only at a very high level). However, the latency analysis for the proposed enhancement solutions were not shown in Phase 2 of the email discussion. There are some contributions for this meeting proposing enhancement solutions (and some show latency analysis also) but we have not had detailed discussion of these contributions. We prefer to just document in the TR, the latency analysis done so far and use it as a baseline to perform latency analysis for any proposed solutions during the work item phase.  We agree that proposal 5 need to be discussed in RAN1 first and proposal 8 is not clear. Proposals in R2-2009897, in general, are too high level and needs more details to discuss further. |
| Intel | Agree | Same as above, to capture all potential enhancement in the TR, although it is not clear to me what impact will be, should not existing CG already work? |

**Summary 7**:

10 companies responded. 6 companies agree or partialy agree measure report optimization is captured into TR. 2 companies disagree or Neutral on it while share the samliar comments: CG-based transmission already is supported. And 2 companies think it should be discussed in RAN1 first.

Rapporteur’s comments:

Based on the comments it looks like there is a majority to capture measure report optimization in TR. Although the CG-based transmission is already supported, the option still can be captured in TR for further discussion in SI.

The text proposal is put in 7.x.4 Measure report optimization for company’s further review.

And, companies can input if any on the following questsion.

**Q8: Do you see any other solutions on latency that have not been covered by previous discussions?**

|  |  |
| --- | --- |
| **Company name** | **Issues and comments if any** |
| InterDigital | Given the similarity with on-demand PRS, which has been agreed to be studied in RAN1 and RAN2 in Rel-17, on-demand SRS for positioining should also be covered in the study as an enhancement for reducing latency for UL and UL+DL based positioning methods. Especially in multi-RTT, UE-centric configuration of SRS (i.e., on-demand SRS) will provide benefits in latency reduction and accuracy improvement. UE-based multi-RTT will also benefit from on-demand SRS in terms of latency reduction and performance improvement. |
|  |  |
|  |  |
|  |  |
|  |  |

**Summary 8**:

Only one company proposed the on-demand SRS which depends on the agreement from RAN1. RAN2 can discuss this option later when there is clear agreement from RAN1 on it. So there is no proposal on it.

## 2.8 Skeleton of text proposal

In order to reach a format suitable for developing into a TP, below please find the draft skeleton to capture companies’ text proposal in 2nd round.

# 7 Studied NR positioning enhancements

*(from objective 1c. Includes positioning techniques, DL/UL positioning reference signals, signalling and procedures for improved accuracy, reduced latency, network efficiency, and device efficiency for both RAN1 and RAN2.  
Enhancements to Rel-16 positioning techniques, if they meet the requirements, will be prioritized, and new techniques will not be considered in this case. )*

## 7.X Enhancements on latency

### 7.X.1 xx aspect

Potential solution 1: Companies’ text proposal

Potential solution 2:

### 7.X.2 xx aspect

Potential solution 1:

Potential solution 2:

Note: this skeleton is for capturing the text proposal, not the final skeleton of TR.

**Q9: Please insert your views and comments to** **the skeleton of text proposal in the table below.**

|  |  |  |
| --- | --- | --- |
| **Company name** | **Agree/Disagree** | **Comments** |
| Huawei, HiSilicon | Agree |  |
| Qualcomm | Agree |  |
| InterDigital | Agree | We are ok with the proposed skeleton for capturing the text proposals |
| Xiaomi | Agree |  |
| CATT | Agree |  |
| ZTE | Agree |  |
| Ericsson | Disagree | * similar to RAN1 to add 8.1.3 “8.1.3 higher layer latency analysis for Rel-16” to capture the latency analysis results from RAN2, * 8.2.x to capture potential solution from RAN2 perspective; * 8.4.x to capture RAN2 conclusion on potential solutions if any; |
| Spreadtrum | Agree |  |
| Nokia |  | We prefer to just document in the TR, the latency analysis done so far and use it as a baseline to perform latency analysis for any proposed solutions during the work item phase. If we are to adopt the proposed skeleton above then we need more time to discuss the various solutions before we can see what to capture in the TR. |
| Intel | Disagree | SO far, in the TR skeleton, there is section 7 on enhancement, and section 8.2 Performance analysis of studied NR positioning enhancements.  There are two options:  1 to capture the potential enhancement in section 7, and then the performance analysis in section 8.2  2 as Ericsson suggested, to capture both in 8.2.  Option 2 is more clear. |
| vivo | Agree |  |

## 2.9 Text proposal

### 7.X.1 Location server functionality in the RAN

Location server functionality in the RAN was studied in TR 38.855 [1] section 9.3.1 and TR 38.856 [2]. By moving the location server to the NG-RAN the number of signalling hops (and therefore, the complexity and latency) can be reduced significantly. As shown in [3], location server functionality in the RAN (e.g., LMC) could reduce the positioning procedure latency between 41% and 61% compared to a 5GC LMF.

However, in order to reduce latency and better support NR positioning a "full" location server functionality (e.g., LMC) would not necessarily be required in the NG-RAN. The RAN location server functionality could be restricted to radio related coordination and signalling as well as to position calculation. In order to distinguish this reduced NG-RAN location server from an LMC considered in [1][2], the term "Location Server Surrogate" (LSS) is used. The potential positioning architecture is illustrated in Figure 1. The following functions can be considered as a starting point: The LSS in the gNB receives measurements from the UE and/or TRPs, calculates a location (for UE assisted mode) and sends a location to a UE or external client. In addition, the LSS would coordinate DL-PRS and UL-SRS (and beams) between UE and serving/neighbour TRPs.

There is no conclusion on LMC in NG-RAN from RAN3 or SA2 during Rel-16 SI. RAN3 did not evaluate the benefits of any of the architecture options in terms of latency towards the core network, RAN3 also did not fully evaluate, e.g., mobility issues associated with the introduction of the LMC[2].

RAN3 could not reach consensus on any recommendation for normative work[2].



Figure 1: Positioning Architecture with LSS.

[1] 3GPP TR 38.855, "Study on NR positioning support".

[2] 3GPP TR 38.856, "Study on local NR positioning in NG-RAN".

[3] R2-2010096, "NR Positioning Latency Analysis and Enhancements", Qualcomm Incorporated.

**Q10: Please insert your comments to text proposal of** **Location server functionality in the RAN in the table below if you agree to capture this potential solution in TR.**

|  |  |
| --- | --- |
| **Company name** | **Comments** |
| Intel | We need to clarify whether RAN2 can decide on this or not considering the situation in R16, and would be good to mention the history, i.e. no conclusion in RAN3 and SA2. |
| Ericsson | RAN3 discussed in Rel-16 and could not provide recommendation to pursue this. Hence, we do not see any need to discuss this further. Even if captured in TR, RAN2 should not do any recoomendation for this. There are deployment options available for local 5GC nodes. |
| Qualcomm | RAN3 discussed an LMC or local LMF, but not an LSS as propsed here.  For the actual TP, we should add the message sequence as shown in Figure 3 of R2-2010095, which explains the Proposal. This can be shown either in addition to Figure 1 above, or instead. |
| InterDigital | We are generally ok with the TP. We suggest studying the functions supported by LSS further, with a slight modification to the TP as follows:  **The following functions can be considered as a starting point:** The LSS in the gNB receives measurements from the UE and/or TRPs, calculates a location (for UE assisted mode) and sends a location to a UE or external client. In addition, the LSS would coordinate DL-PRS and UL-SRS (and beams) between UE and serving/neighbour TRPs. |
| ZTE | 1. Considering only half of involved companies agree the proposal 1, we do not think we need to add this part in the TR in this meeting. 2. LSS function should be discussed in RAN3 and SA2 before it is captured in the TR. Hence, we prefer to send an LS to RAN3&SA2 and ask their opinions after this meeting instead of capture this part in TR directly. |
| CATT | To Intel: Done, no conclusion in RAN3 and SA2 was added in the TP.  To Qualcomm: More detail such as message sequence would better be specified later.  To InterDigital: Done.  To ZTE: It’s the potential solution in TR, but not the recommened solution in TR so far. |

### 7.X.2 The capability procedure

Time to first fix should be considered in latency studies and any improvements in this area can be studied. Considering TTFF in latency may relax the other core latency requirements for performing measurements and reporting to the location server for positioning computation.

Potential improvement during TTFF can be storage of UE positioning capabilities by AMF. AMF would thus forward it to LMF.

One potential way is that UE provides the positioning capabilities as part of first attach procedure or after expiry of certain timer in Tracking Area update message. AMF stores the capabilities and provides to the selected LMF. It could be done even before first positioning to speed up even the first one.

There can be cases when AMF does not have the capability stored. In such case, legacy mechanism where LMF fetches from UE can be realized. In such case when LMF has not obtained capability from AMF; LMF may upload the obtained UE capabilities to AMF.

The alternative 2: the LMF stores and forwards the capability to AMF, and then AMF store it.

Note: All approaches will have CT4 impact but should be minimal. SA2 will need to be consulted for stage 2 aspects.

**Q11: Please insert your comments to text proposal of** **SRS configuration and PRS configuration optimization in the table below if you agree to capture this potential solution in TR.**

|  |  |
| --- | --- |
| **Company name** | **Comments** |
| Intel | I assume there are different alternatives:  Alt1: the LMF forwards the capability to AMF, and then AMF store it;  Alt 2: as described, UE can provide it over NAS or over RRC and forwarded to AMF, both using containers (could be done even before first positioning to speed up even the first one).  We should also mention:  All approaches will have CT4 impact but should be minimal. SA2 will need to be consulted for stage 2 aspects. |
| Ericsson | Yes. As this reduces TTFF and is similar to what we have for gNB fetching capability and uploading caplity to/from AMF. Similar handling could be studied by SA2 and CT. |
| Qualcomm | The possibility for an LMF to store the UE capabilities should be added/mentioned. |
| InterDigital | We agree with Intel and Qualcomm that there are potentially different alternatives for the LMF to manage and retrieve the context related to UE capability. The solutions provided in the TP can be considered as a starting point. However, further discussion may be necessary on how/who stores the UE capability considering positioning during Idle mode. |
| ZTE | Both AMF and LMF may have the capability to handle/keep the UE positioning related capabilities in the TR as alternatives. |
| vivo | Actions when LMF change should be metioned about how AMF transmits the capability to LMF. |
| Xiaomi | LMF may also have the capability to save the UE positioning capabilities. Whether the AMF/LMF will release the UE postioning capabilities or not. |
| CATT | The alternative 2 has been added. The message sequence is deleted and may be specified later. |

### 7.X.3 SRS configuration and PRS configuration optimization

According to [1], SRS configuration+activation (step 3-8) is 66- 133ms and LPP assistance data is 28-44.5ms, if the latency consumption of these two parts can be reduced, the total E2E latency can be further optimized.

Potential solution 1: DL PRS assistance information can be pre-configured in UE. Multiple DL PRS configurations can be associated with DL PRS configuration ID and activated when necessary;

Potential solution 2: SRS for positioning configuration information can be pre-configured in UE. Multiple configurations of SRS for positioning can be associated with SRS for positioning configuration ID and activated when necessary;

In addition, for Deferred MT-LR procedure, several steps in the baseline positioning procedures would not need to be executed each time the event is triggered, e.g, UE Capability signaling, Assistance Data via broadcast or dedicated signaling, UL-SRS configuration. The latency with the baseline positioning procedures can be reduced 35.8% to 43.1% [2].

Potential solution 3: Specify signalling and procedures for Deferred MT-LR to support positioning configuration signalling in advance.

[1] R2-2009023, " Solution directions to reduce end-to-end latency ". Intel Corporation

[2] R2-2010096, "NR Positioning Latency Analysis and Enhancements", Qualcomm Incorporated.

**Q12: Please insert your comments to text proposal of** **SRS configuration and PRS configuration optimization in the table below if you agree to capture this potential solution in TR.**

|  |  |
| --- | --- |
| **Company name** | **Comments** |
| Ericsson | Only Potential solution 3 should be captured.  for Deferred MT-LR procedure one may already prefetch the capability and also provide configuration in advance. We do not see need to further capture for Potential solution 1 or Potential solution 2. As Deferred MT-LR procedure is in palce no need for Potential solution 1 and Potential solution 2. The Deferred MT-LR procedure already can provide configuration in advance so no further optimization needed. |
| InterDigital | We are ok with the proposed TP. A suggested change in Potential solution 1 and solution 2 would be to change the wording “to UE” to “in UE” |
| vivo | We are ok with the TP. |
| Xiaomi | May be better to add some explations for option 1, for exmpale, what is the difference between pre-configured DL PRS assistance information and assistance information in positioning SIB. |
| CATT | To Xiaomi: details can be specified later.  To InterDigital: done. |

### 7.X.4 Measurement report optimization

Grant Free UL Transmission enables reduce UL transmission delays and achieve URLLC Reliability targets. If this procedure can be used for periodic positioning measurement reporting, then signals and multiple configuration latency can be saved.

CG Type 1 is very much similar to LTE semi-persistent scheduling (SPS) where UL data transmission is based on RRC reconfiguration without any L1 signaling. RRC provides the grant configuration to UE through higher layer parameter without the detection of any UL grant in a DCI. So the periodic positioning measurement report could be sent without waiting uplink configuration.

The impact on NRPPa and measurement report optimization will be further studied in SI.

**Q13: Please insert your comments to text proposal of Measurement report optimization in the table below if you agree to capture this potential solution in TR.**

|  |  |
| --- | --- |
| **Company name** | **Comments** |
| Intel | I assume the existing solution can work, no specification impact? |
| Ericsson | Agree with Intel. No RAN2 specification impact. |
| InterDigital | From the TP it seems to imply that the existing CG solution can be directly applied for sending periodic measurement reports. It is unclear how the CG can be aligned and triggered at the UE (with offset) upon completion of PRS measurement. We think the TP should be modified/expanded to describe some aspects of the solutions related to measurement report optimization that can be studied in the SI stage. |
| ZTE | Same view with Intel&Ericsson. |
| vivo | Agree with modification. This TP gives a direction of optimization on the relationship of CG type and logical channel. We should mention that various particular methods should be studied and the details are open discussed. |
| CATT | The further studied part is added at the end of TP as companies suggested. |

### 7.X.5 Measurement gaps (MG) optimizations

The following options to reduce the latencies associated with measurement gap configurations are identified:

Option1: MG-less operation-UE may operate w/o measurement gaps to process DL PRS

Option2: Support of semi-persistent a-periodic MGs, their pre-configuration and association with MG configuration ID

Option3: Avoiding or minimizing the latency due to measurement gap configuration. As an example, the UE may be triggered to perform measurement of DL PRS based on lower layer signalling (e.g. in MAC CE) from gNB without configuration of measurement gap. The configuration of certain criteria/rules in the UE for determining whether to perform measurement of PRS based on a configured timer or priority indication can be considered for eliminating measurement gap configuration.

Option4: Fast activation of measurement gap configuration: UE sends indication to gNB using lower layer signaling to either skip or request a measurement gap configuration. The gNB may then activate/deactivate a preconfigured measurement gap (e.g. in MAC CE) based on the indication sent by the UE.

These approaches can be supported based on coordination between LMF and gNB via NRPPa signaling where the gNB can be triggered by LMF upon sending the LPP location information request to the UE.

Note: Measurement gaps (MG) optimizations rely on RAN1/4 conlcusion. RAN1/4 should evaluate it at first.

**Q14: Please insert your comments to text proposal of Measurement gaps (MG) optimizations in the table below if you agree to capture this potential solution in TR.**

|  |  |
| --- | --- |
| **Company name** | **Comments** |
| Ericsson | No need to capture. Measurement gaps (MG) optimizations rely on RAN1/4 conlcusion. RAN1/4 should evaluate it at first. |
| Qualcomm | Seems RAN1 made already a conclusion:  Agreement:  Capture the following in the TR:   * The following enhancements of signaling & procedures for reducing NR positioning latency are recommended for normative work, including DL and DL+UL positioning methods   + The details of the solutions are left for further discussion in normative work, which may include the following aspects:     - Latency reduction related to the measurement gap     - Latency reduction related to the reporting and request (e.g., via RRC signaling, MAC-CE and/or physical layer procedure, and/or priority rules)     - Latency reduction related to measurements   Given that there are no specific solutions (it seems), RAN2 should capture the proposals available. |
| InterDigital | We are generally ok with the listing of the options to be studied as part of the TP. However, we think the TP can be further improved since the listed options seem to be overlapping. As we have indicated previously, some aspects of Option 1 are covered within Option 3 and aspects of Option 2 are covered within Option 4. |
| vivo | No need to capture, it is RAN1 scope. |
| Xiaomi | We assume RNA1 will capture it in TR. |
| CATT | Will delete it. |

### 7.X.6 Enhancements for prioritized transmission of PRS/SRS

In Rel-16, both PRS and SRSp are assigned with low priorities. As a result, PRS is not received or SRSp is not transmitted/dropped when either transmission of data in DL/UL or other reference signals are scheduled.

In Rel-17, it can be envisioned that supporting prioritized positioning based on the assignment and indication of higher priority for the reception/transmission of PRS/SRSp may enable satisfying the low latency positioning requirements.

For DL-based positioning, the priority indication for PRS may be either indicated by LMF in assistance information or indicated by RAN in lower layer/RRC signalling. The UE may trigger the reception and measurement of PRS based on the received priority indication.

For UL-based positioning, the UE may trigger the transmission of SRSp based on the reception of the priority indication in lower layer/RRC signalling. The priority of the positioning reference signal can be associated with the type of the positioning reference signal (e.g. periodic vs. aperiodic positioning reference signals).

The potential areas for further study in RAN2 for supporting prioritized transmission of PRS/SRS may include:

­ L2/L3 signalling for indicating the priority assigned for the reception of PRS and transmission of SRSp

­ Handling of prioritized PRS/SRSp transmission when priority level assigned to positioning is comparable to or higher than data reception/transmission

­ Triggering of positioning measurement reports with low latency for prioritized positioning

Note: Enhancements for prioritized transmission of PRS/SRS relies on conclusion in RAN1.

**Q15: Please insert your comments to text proposal of Enhancements for prioritized transmission of PRS/SRS in the table below if you agree to capture this potential solution in TR.**

|  |  |
| --- | --- |
| **Company name** | **Comments** |
| Ericsson | No need to capture in RAN2 TR. RAN1 needs to evaluate and capture. |
| InterDigital | We are ok with the TP. While we agree that the support for prioritized PRS/SRSp depends on the conclusion in RAN1, some aspects related to signaling (e.g. in LPP) for indicating the priority can be studied in RAN2 |
| vivo | No need to capture in RAN2 as we discussed before it need to be evaluated by RAN1 first. |
| Xiaomi | The PRS/SRS transmission priority should be studied by RAN1 and RAN2 can study the signalling procedure based on RAN1 input. So we assume RAN1 will capture it in TR. |
| CATT | Will delete it. |

# 3 Summary

Based on company feedback, the following is observed and summarized:

## 3.1 Summary of the potential solutions

**Summary 1:** supporting for location server functionality in the RAN:

8 companies responded. 4 companies agree to capture the solution into TR, 3 companies disagree to capture it and one company believe it is too early to capture any latency enhancement solutions in TR.

Rapporteur’s comments:

Based on the comments it looks like there is no majority to disagree it. This solution can be captured in the TR as a potential solution for the further discussion in SI, because Location Server functionality in the RAN (e.g., LMC) could reduce the positioning procedure latency significantly. With the given assumptions, according to the latency analysis in R2-2010096, the improvements can be:

- for UL+DL methods: 40% - 55%;

- for UL-only methods: 50% - 61%;

- for DL-only methods: 23% - 41%.

**Summary 2:** The capability procedure

11 companies responded. 3 companies agree to capture the solution into TR, 7 companies anwer as unclear, and one company disagree it.

Rapporteur’s comments: Based on the comments it looks like there is no majority to disagree it so far. Companies think SA2 will be involved for the further discussion, because we need to see if there is really any improvement in the E2E latency, not only shifting the latency from RAN to CN side.

**Summary 3**: SRS configuration and PRS configuration optimization

11 companies responded. 8 companies agree to capture the solution into TR, 2 companies think it is already supported in Rel-16, and one company think that more time is required for evaluation.

Rapporteur’s comments: Based on the comments it looks like no majority to disagree it.

**Summary 4**: The parallel handling of positioning related messages

11 companies responded. 3 companies agree to capture the solution into TR, 8 companies disagree to capture any options in TR.

Rapporteur’s comments: Based on the comments it looks like there is a majority to disagree the option(s) of parallel handling of positioning related messages/steps captured in TR.

**Summary 5**: Measurement gaps (MG) optimizations

11 companies responded. 4 companies agree to capture option1 into TR, 7 companies think it is RAN1/4 business.

Rapporteur’s comments: Based on the comments it looks like there is a majority to discuss it in RAN1/4 first.

**Summary 6**: Enhancements for prioritized transmission of PRS/SRS

11 companies responded. 10 companies think it would be better handled in RAN1at first and 3 companies agree to capture it in TR.

Rapporteur’s comments: Based on the comments it looks like there is a majority to wait for the agreement from RAN1.

**Summary 7**: Measurement report optimization

9 companies responded. 5 companies agree or partialy agree measure report optimization is captured into TR. 2 companies disagree or Neutral on it while share the samliar comments: CG-based transmission already is supported. And 2 companies think it should be discussed in RAN1 first.

Rapporteur’s comments:

Based on the comments it looks like there is a majority to capture measure report optimization in TR. Although the CG-based transmission is already supported, the option still can be captured in TR for further discussion in SI.

## 3.2 Summary of the TP

The following enhancements for reducing NR positioning latency are captured as the potential direction in potential solution section of TR. They are not the recommended solutions in TR. More details will be specified later in the SI stage.

* location server functionality in the RAN
* enhancement of capability procedure
* SRS configuration and PRS configuration optimizations
* measurement report optimization

# 4 Conclusion

Based on the discussion, there are proposals:

**Proposal 1: Capture the following enhancements for reducing NR positioning latency as the potential direction in potential solution section of TR. (Note: not as the recommened enhancements)**

* + **location server functionality in the RAN**
  + **enhancement of capability procedure**
  + **SRS configuration and PRS configuration optimizations**
  + **measurement report optimization**

The TP are available in section 5 Text proposal for potential solutions.

**Proposal 2: Ask RAN2 to confirm as below, according to recommendation in RAN1:**

**The following enhancements of signaling & procedures for reducing NR positioning latency are aligned with RAN1, including DL and DL+UL positioning methods**

* + **The details of the solutions are left for further discussion, which may include the following aspects:**
    - **Latency reduction related to Measurement gaps (MG) optimizations**
    - **Latency reduction related to Measurement report optimization**
  + **The following enhancements of signaling & procedures for reducing NR positioning latency can be studied and should be aligned with RAN1, if needed**
    - **Latency reduction related to SRS configuration and PRS configuration optimization**
    - **Latency reduction related Enhancements for prioritized transmission of PRS/SRS**

**Proposal 3: Continue the discussion on below two potential enhancements：**

* + **Latency reduction related to support location server functionality in the RAN**
  + **Latency reduction related to the capability procedure and send an LS to SA2 for the further evaluation, if needed**

# 5 Text Proposal for potential solutions

Based on the discussion, there are the potential solutions text proposals:

### X.Y.1 Location server functionality in the RAN

Location server functionality in the RAN was studied in TR 38.855 [1] section 9.3.1 and TR 38.856 [2]. By moving the location server to the NG-RAN the number of signalling hops (and therefore, the complexity and latency) can be reduced significantly. As shown in [3], location server functionality in the RAN (e.g., LMC) could reduce the positioning procedure latency between 41% and 61% compared to a 5GC LMF.

However, in order to reduce latency and better support NR positioning a "full" location server functionality (e.g., LMC) would not necessarily be required in the NG-RAN. The RAN location server functionality could be restricted to radio related coordination and signalling as well as to position calculation. In order to distinguish this reduced NG-RAN location server from an LMC considered in [1][2], the term "Location Server Surrogate" (LSS) is used. The potential positioning architecture is illustrated in Figure 1. The following functions can be considered as a starting point: The LSS in the gNB receives measurements from the UE and/or TRPs, calculates a location (for UE assisted mode) and sends a location to a UE or external client. In addition, the LSS would coordinate DL-PRS and UL-SRS (and beams) between UE and serving/neighbour TRPs.

There is no conclusion on LMC in NG-RAN from RAN3 or SA2 during Rel-16 SI. RAN3 did not evaluate the benefits of any of the architecture options in terms of latency towards the core network, RAN3 also did not fully evaluate, e.g., mobility issues associated with the introduction of the LMC[2].

RAN3 could not reach consensus on any recommendation for normative work[2].



Figure 1: Positioning Architecture with LSS.

[1] 3GPP TR 38.855, "Study on NR positioning support".

[2] 3GPP TR 38.856, "Study on local NR positioning in NG-RAN".

[3] R2-2010096, "NR Positioning Latency Analysis and Enhancements", Qualcomm Incorporated.

### X.Y.2 The capability procedure

Time to first fix should be considered in latency studies and any improvements in this area can be studied. Considering TTFF in latency may relax the other core latency requirements for performing measurements and reporting to the location server for positioning computation.

Potential improvement during TTFF can be storage of UE positioning capabilities by AMF. AMF would thus forward it to LMF.

One potential way is that UE provides the positioning capabilities as part of first attach procedure or after expiry of certain timer in Tracking Area update message. AMF stores the capabilities and provides to the selected LMF. It could be done even before first positioning to speed up even the first one.

There can be cases when AMF does not have the capability stored. In such case, legacy mechanism where LMF fetches from UE can be realized. In such case when LMF has not obtained capability from AMF; LMF may upload the obtained UE capabilities to AMF.

The alternative 2: the LMF stores and forwards the capability to AMF, and then AMF store it.

Note: All approaches will have CT4 impact but should be minimal. SA2 will need to be consulted for stage 2 aspects.

### X.Y.3 SRS configuration and PRS configuration optimization

According to [1], SRS configuration+activation (step 3-8) is 66- 133ms and LPP assistance data is 28-44.5ms, if the latency consumption of these two parts can be reduced, the total E2E latency can be further optimized.

Potential solution 1: DL PRS assistance information can be pre-configured in UE. Multiple DL PRS configurations can be associated with DL PRS configuration ID and activated when necessary;

Potential solution 2: SRS for positioning configuration information can be pre-configured in UE. Multiple configurations of SRS for positioning can be associated with SRS for positioning configuration ID and activated when necessary;

In addition, for Deferred MT-LR procedure, several steps in the baseline positioning procedures would not need to be executed each time the event is triggered, e.g, UE Capability signaling, Assistance Data via broadcast or dedicated signaling, UL-SRS configuration. The latency with the baseline positioning procedures can be reduced 35.8% to 43.1% [2].

Potential solution 3: Specify signalling and procedures for Deferred MT-LR to support positioning configuration signalling in advance.

[1] R2-2009023, " Solution directions to reduce end-to-end latency ". Intel Corporation

[2] R2-2010096, "NR Positioning Latency Analysis and Enhancements", Qualcomm Incorporated.

### X.Y.4 Measurement report optimization

Grant Free UL Transmission enables reduce UL transmission delays and achieve URLLC Reliability targets. If this procedure can be used for periodic positioning measurement reporting, then signals and multiple configuration latency can be saved.

CG Type 1 is very much similar to LTE semi-persistent scheduling (SPS) where UL data transmission is based on RRC reconfiguration without any L1 signaling. RRC provides the grant configuration to UE through higher layer parameter without the detection of any UL grant in a DCI. So the periodic positioning measurement report could be sent without waiting uplink configuration.

The impact on NRPPa and measurement report optimization will be further studied in SI.

# 6 References

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2. R2-2008810 Further discussion on enhancements for commercial use cases, CATT
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4. R2-2009001 Report of [Post111-e][625][POS] End-to-end latency analysis (Intel), Intel Corporation
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7. R2-2010276 Discussion on IDLE INACTIVE pos, on-demand PRS and latency analysis, Huawei, HiSilicon
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13. R2-2009897 Considerations on potential positioning enhancements, Sony
14. R2-2010627 Discussion on enhancement for commercial use cases, Samsung R&D Institute UK
15. R2-2008261 [AT111-e][612][POS] Assumptions for analysis of commercial use cases, Ericsson

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