**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%3A%5CWORK%5C1%203GPP%5CMeeting%5CRAN2%20112-e%5C2%20During%5CDocs%5CR2-2009023.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 SIDSecond, 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.pngThird, 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. |

## 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 littlelantecy 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. |

## 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%3A%5CWORK%5C1%203GPP%5CMeeting%5CRAN2%20112-e%5C2%20During%5CDocs%5CR2-2010096.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%3A%5CWORK%5C1%203GPP%5CMeeting%5CRAN2%20112-e%5C1%20Before%5C%E6%96%87%E7%A8%BF%E8%A7%84%E5%88%92%5CPOS%5CCR%5Cbackup%5CR2-200xxxx%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 signaling (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. |

## 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%3A%5CWORK%5C1%203GPP%5CMeeting%5CRAN2%20112-e%5C2%20During%5CDocs%5CR2-2009577.zip) and R[2-2008886](file:///E%3A%5CWORK%5C1%203GPP%5CMeeting%5CRAN2%20112-e%5C2%20During%5CDocs%5CR2-2008886.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%3A%5CWORK%5C1%203GPP%5CMeeting%5CRAN2%20112-e%5C2%20During%5CDocs%5CR2-2009577.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. |

## 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 signaling.

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 signaling (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 measuremnt gap which is configured aperiodically or semi-persistently.In principle, all options shall be captured in TR. The mechanims 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 signaling upon receiving the location request in LPP/NAS increases latency significantlly. |
| 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 signaling 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. |

## 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. |

## 2.7 Measure 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. |

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. |
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## 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. |

# 3 Conclusion

TBD

# 4 References

1. R2-2010669 Summary of 8.11.2 Enhancements for commercial use cases
2. R2-2008810 Further discussion on enhancements for commercial use cases, CATT
3. R2-2008886 Discussion on End-to-End Latency Reduction for DL/UL Positioning, InterDigital, Inc.
4. R2-2009001 Report of [Post111-e][625][POS] End-to-end latency analysis (Intel), Intel Corporation
5. R2-2009023 Solution directions to reduce end-to-end latency, Intel Corporation
6. R2-2010096 NR Positioning Latency Analysis and Enhancements, Qualcomm Incorporated
7. R2-2010276 Discussion on IDLE INACTIVE pos, on-demand PRS and latency analysis, Huawei, HiSilicon
8. R2-2010277 Discussion on R17 positioning enhancement, Huawei, HiSilicon
9. R2-2010072 Enhancements for commercial use cases, Ericsson
10. R2-2009039 Discussion on positioning enhancement, vivo
11. R2-2009137 Discussion on positioning enhancements for commercial use cases, Spreadtrum Communications
12. R2-2009577 Positioning enhancements on RRC idle/inactive UE and latency reduction, Beijing Xiaomi Electronics
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

# 5 Participants

|  |  |
| --- | --- |
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