3GPP TSG-RAN WG2 Meeting #116-e**R2-211xxxx**

Online, November 1st – 12th, 2021

**Agenda item:** 8.11.2

**Source:** Samsung

**Title:** Summary of agenda 8.11.2 Latency enhancements

**Document for:**  Discussion, Decision

# 1. Introduction

This document summarizes the following contributions submitted for Agenda Item 8.11.2 on enhancements of signalling, and procedures for positioning latency reduction:

R2-2109460 Discussion on positioning latency reduction ZTE discussion

R2-2109481 Discussion on Enhancements for Latency Reduction CATT discussion

R2-2109663 Leftover issues on Latency reduction Intel Corporation discussion

R2-2109665 Summary of [Post115-e][605][POS] Pre-configured assistance data (Intel) Intel Corporation discussion

R2-2109824 Positioning Latency Reduction Enhancements Lenovo, Motorola Mobility discussion

R2-2109915 Time T and Measurement Gap for Measurement Time Window Ericsson discussion

R2-2109978 Discussion on latency enhancement vivo discussion

R2-2110103 Further consideration of positioning latency enhancements OPPO discussion

R2-2110178 Discussion on latency reduction techniques from other groups Huawei, HiSilicon discussion

R2-2110179 Text Proposal for finer granularity of responseTime Huawei, HiSilicon discussion

R2-2110180 Discussion on pre-configured PRS Huawei, HiSilicon discussion

R2-2110336 Discussion on the response time Samsung discussion

R2-2110359 Considerations on positioning latency Sony discussion

R2-2110798 PRS Measurements outside measurement Gap Ericsson discussion

R2-2110822 Remaining Issues on Scheduling Location in Advance Qualcomm Incorporated discussion

R2-2110928 Discussion on Enhancements for Latency Reduction InterDigital, Inc. discussion

R2-2111075 Discussion on the priority rule for latency reduction CMCC discussion

R2-2111081 Simulation study for multiple QoS class handling for latency reduction Samsung Electronics discussion

R2-2111083 Handling of multiple QoS for latency reduction Samsung Electronics discussion

R2-2111084 Discussion on the Pre-configured Assistance Data Samsung Electronics discussion

R2-2111086 Latency reduction via configured grant for positioning Samsung Electronics discussion

R2-2111105 Positioning enhancements on latency reduction Xiaomi discussion

# 2. Overview of the main topics discussed to reduce positioning latency

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| Topic | Company/Contribution |
| Scheduled location time | R2-2109663 IntelR2-2109915 EricssonR2-2109978 vivoR2-2110178 HuaweiR2-2110822 QualcommR2-2111105 Xiaomi |
| Preconfigured assistance data | R2-2109460 ZTER2-2109481 CATTR2-2109665 IntelR2-2109824 LenovoR2-2109978 vivoR2-2110103 OPPOR2-2110180 HuaweiR2-2110928 InterDigitalR2-2111084 SamsungR2-2111105 Xiaomi |
| Response time enhancements (including reduced granularity) | R2-2109824 LenovoR2-2109978 vivoR2-2110179 HuaweiR2-2110336 Samsung |
| Prioritization of measurements/reports | R2-2109460 ZTER2-2109824 LenovoR2-2110103 OPPOR2-2110180 HuaweiR2-2111075 CMCCR2-2110798 Ericsson |
| Multiple QoS class | R2-2111081 SamsungR2-2111083 Samsung |
| Measurement gap configuration  | R2-2109663 Intel R2-2109978 vivo R2-2110359 Sony R2-2110798 Ericsson R2-2110928 InterDigital  |
| Storing positioning capabilities | R2-2109663 IntelR2-2110178 Huawei |
| Configured grant (CG-based) enhancements | R2-2109824 LenovoR2-2110103 OPPOR2-2110359 SonyR2-2111086 Samsung |
| Latency reduction during HO | R2-2109481 CATT  |

# 3. Discussion

## Overview:

There are multiple items on which the contributions discussed. Some are quite in progress already, others are relatively not prevailed. Since the time is scarce resource as always, it is good to have some priority on each items based on WID scope and the progress status of related WG. For some items, there is several companies requesting to consider even with incomplete progress of leading WG such as “3.4 Prioritization of positioning measurement/reporting and priority rules”, “3.5 Configured UL grant for location reports” is neither in the WID scope nor had enough progress on leading WG, which means low priority. Therefore, rapporteur propose to discuss in short on the available items to be discussed in this meeting, and to find some condition to be considered in upcoming meeting for ones not discussed in this meeting.

**Proposal 0: RAN2 discuss on which items in latency reduction AI can be considered for the discussion in this meeting based on WID and the progress of related WG, and make the conditions to be considered in the upcoming meeting for ones not discussed in this meeting.**

## 3.1 Scheduled location time

Multiple contributions discuss the issue on whether the scheduled location time needs to be provided to the UE/NG-RAN or not. The company proposals related to this topic are summarized in the Table below.

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| Scheduled location time |
| R2-2109663 Intel | **Observation 1:** The LPP RequestLocationInformation message already includes the expected response time for the UE/NG-RAN to perform positioning measurements and additionally providing the scheduled location time may be redundant.**Proposal 1:** RAN2 is proposed to confirm that Scheduled Location Time does not need to be provided to the NG-RAN and/or UE and the LMF can implicitly take it into account to scheduled positioning procedures. |
| R2-2109915 Ericsson | **Observation 1:**Sending the below parameters via LPP message enables application/network the possibility and flexibility to tune positioning QoS performance* T window with start time and end time, associated with scheduled location time T
* measurement time window length, which defines the time duration of a measurement report
* expected number of measurement reports
* number of measurement occasions inside one measurement instance

**Observation 2:** The expected number of measurement reports can be mapped to reportingAmount in PeriodicalReportingCriteria IE in RequestLocationInformation message. **Proposal 1:** Including signalling of 'T window', 'measurement time window length', and 'number of measurement occasions inside one measurement instance' in LPP RequestLocationInformation to enable the network to better serve the positioning QoS. **Proposal 2:** The parameter 'expected number of measurement reports' can be set by the reportingAmount in PeriodicalReportingCriteria IE in RequestLocationInformation message.**Proposal 3:** Set reportingInterval in PeriodicalReportingCriteria IE in RequestLocationInformation message longer than 'measurement time window length'.**Proposal 4:** Improve the granularity of reportingInterval by adding millisecond, ten-microseconds to the time unit.**Proposal 5:** Including the T window information in the RRC Location Measurement Indication message is helpful for gNB to configure the appropriate measurement gaps for scheduled location time positioning.**Proposal 6:** When using multi-RTT for scheduled location time positioning, gNB configures UL SRS near the measurement gap to guarantee the positioning accuracy for scheduled location time positioning. |
| R2-2109978 vivo | **Proposal 1**: Agree to the working assumption: the scheduled location time is transparent to UE/NG-RAN, how to ensure the measurements to determine the location at or close to the scheduled time is up to LMF implementation.**Proposal 2**: LS to SA2 informing them of the above working assumption and requesting feedback in case they have any concern. |
| R2-2110178 Huawei | **Proposal 1**: RAN2 to conclude that the scheduled location time has no impacts on RAN stage 3 specifications. |
| R2-2110822 Qualcomm | **Observation 1:** With the current LPP specification, the time when the UE should obtain the measurements/location estimate cannot be controlled by an LMF. The available LPP Response Time defines the time when to send a measurement report (at the latest), but not the time when the location measurements should be obtained/valid.**Observation 2:** Without providing the Scheduled Location Time T to the UE and TRPs, the LMF cannot reliably determine the UE location at the scheduled location time, and therefore, the location estimate returned to an LCS Client for a scheduled location time cannot be treated by the LCS Client as a reliable estimate of the location of the UE at the scheduled location time.**Observation 3:** With the Scheduled Location Time T provided to the UE in advance, an LMF can reliably request a time when the provided measurements/location estimate are/is to be obtained. **Observation 4:** With the Scheduled Location Time T provided to the UE in advance, the UE measurement process is not constrained by the response time. The only requirement is that the UE has location measurements available valid for the time T, but the time when and for how long to perform the measurements could be determined by the UE; e.g., based on radio situation. Therefore, the quality of the location measurements/estimate may generally be better with a Scheduled Location Time T provided to the UE.**Observation 5:** With the Scheduled Location Time T provided to the TRPs in advance, an LMF can reliably request a time when the provided measurements are to be obtained. **Observation 6:** With the Scheduled Location Time T provided to the TRPs in advance, the UL measurements performed at different TRPs would be obtained for the same scheduled location time T which would generally also improve location accuracy.**Observation 7:** With the Scheduled Location Time T provided to the UE and TRPs in advance, the UL and DL measurements for Multi-RTT can be made at the same location time which would generally improve location accuracy.**Observation 8:** A Scheduled Location Time in the Location Request is already supported in OMA LPPe.**Proposal 1:** Include a "Scheduled Location Time" with uncertainty window in LPP CommonIEsRequestLocationInformation, defining the desired time when the location estimate is to be obtained. In the case of UE-assisted mode, the uncertainty defines the time window within which the location measurements should be performed.**Proposal 2:** Include a "Scheduled Location Time" with measurement time window in the NRPPa Measurement Request message, defining the time window within which the location measurements should be performed. **Proposal 3:** Send an LS to RAN3 requesting RAN3 to add support for a "Scheduled Location Time" with uncertainty window in NRPPa Measurement Request message, defining the time window within which the location measurements should be performed. |
| R2-2111105 Xiaomi | **Proposal 1:** The LPP location information request message and/or NRPPa measurement request message will be sent by LMF at or near to the scheduled location time T.**Proposal 2:** In order to ensure that the preparation phase can be completed before the scheduled location time T, the response time can be carried in the following messages:* LPP capability request
* NRPPa positioning information request
* NRPPa positioning activation request

**Proposal 3:** The positioning latency reduction can be achieved without sending the scheduled location time T to UE or NG-RAN, so it is not necessary to send the time T to UE or NG-RAN. |

**Summary:**

In the last RAN2 115-e meeting, RAN2 sent the reply LS to SA2 confirming that the scheduled location time T would allow the latency for obtaining and reporting the location of a target device to be reduced by the duration of the location preparation phase [23]. However, it was hard to draw any consensus on whether the scheduled location time needs to be provided to UE/NG-RAN or not. Regarding this issue multiple contributions are submitted this time and there are still two camps of thoughts as below:

* **Option A:** The scheduled location time does not need to be provided to the UE/NG-RAN, since the LMF can implicitly trigger the positioning procedure at or close to it. The existing *responseTime* IE in LPP can be also used/updated for LMF to control the timing of performing measurement at the UE/NG-RAN.
* **Option B:** Providing the scheduled location time (with uncertainty/measurement window) to the UE/NG-RAN would allow LMF to reliably trigger measurement at or close to it. LPP and/or NRPPa signaling needs to be updated to deliver this information.

For the support of Option A, several companies have expressed their view in Intel, vivo, Huawei, and Xiaomi. From the contributions, it is observed that the positioning latency reduction can be achieved without sending the scheduled location time to the UE or NG-RAN and *responseTime* in LPP can be reused or updated for the LMF to control the timing of measurement at the UE/NG-RAN. Vivo also proposes to send LS to SA2 to inform them of the agreement in RAN2 and request any feedback on that if option A is agreed.

For the support of Option B, Qualcomm describes several observations about the usefulness of providing the scheduled location time for allowing the LMF to reliably control the measurement timing at the UE/NG-RAN. It is also proposed to include the scheduled location time with measurement time window in LPP/NRPPa referring to OMA LPPe. On the other hand, Ericsson proposes to introduce several new parameters in LPP (e.g., T window, measurement time window length, …) for aligning the measurement timing configuration with the scheduled location time. Although the main purpose of this is explained to be for enabling the network to better serve the positioning QoS, it seems to belong to Option B in terms of providing the measurement timing information associated with the scheduled location time. Therefore, based on the above, rapporteur would like to propose RAN2 to further discuss whether the scheduled location time (including other information associated with it) needs to be provided to the UE/NG-RAN or not.

**Proposal 1: RAN2 is proposed to further discuss whether the scheduled location time (including other information associated with it) needs to be provided to the UE/NG-RAN or not.**

## 3.2 Preconfigured assistance data

Contributions discuss on the support of using stored/preconfigured assistance data and validity conditions/criteria (FFS from last meeting). Company proposals on this topic are summarized in the table as below:

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| On stored/preconfigured assistance data, validity conditions/criteria and other related enhancements |
| R2-2109460 ZTE | **Proposal 1:** Support pre-configured assistance data to be assistance data out of any LPP session, or in a specific LPP session.**Proposal 2:** Support LMF initiated activation and deactivation command of the pre-configured assistance data. |
| R2-2109481 CATT | **Observation 1:** Area ID can save 85% signalling resources compared with cell list for pre-configured assistance based on a specified area.**Proposal 1:** RAN2 to agree to area ID within each TRP for pre-configured assistance based on a specified area.**Proposal 2:** RAN2 to discuss the candidate areaID: systemInformationAreaID（SIAID）or RAN area ID.  |
| R2-2109824 Lenovo | **Proposal 3:** RAN2 to support validity Option A based on a validity area. FFS signalling details.**Proposal 4:** Option B on timer-based validity requires further discussion, if time permits.**Proposal 5:** Further discussion in relation to the extra signalling cost of Option C: modification/release signalling of pre-configured AD are needed.**Proposal 6:** Support Option 1, and the priority indication for multiple (pre-) configured assistance data sets (Option 4) can be discussed under the context of the complete definition of priority of PRS configuration for measurement.  |
| R2-2109978 vivo | **Proposal 4:** The pre-configuration of assistance data is applicable for the deferred MT-LR.**Proposal 5:** The pre-configuration of assistance data is applicable for location requests with scheduled location time. |
| R2-2110103 OPPO | **Proposal 3:** RAN2 to agree that the validity condition(s) A (validity area), B (validity timer or a numerical limit on number of times the AD is utilized) and C (explicit modification or releases from the LMF/NG-RAN) of the pre-configured positioning assistance data. |
| R2-2110180 Huawei | **Proposal 3:** The LMF should be able to release part or all of the PRS assistance data.**Proposal 4:** LMF can decide to release the dedicated LPP configuration for PRS when it sends the cancel location indication or cancel location acknowledgement to the UE.**Proposal 5:** LMF should be able to explicitly indicate the PRS priority of PRS configuration for a specific positioning frequency layer**Observation 3:** The UE does not know the priority of the AD when it received AD from both PosSIB and from LPP. The information of AD a UE used cannot be aligned with the LMF.**Proposal6:** The priority of dedicated PRS configurations are higher than that in posSIB |
| R2-2111084 Samsung | **Proposal 1.** RAN2 agree to have a list of cells for the validity information associated preconfigured AD. **Proposal 2.** RAN2 to discuss about the introduction of the serving beam as a validation information for preconfigured AD.**Proposal 3.** RAN2 agree to have an absolute time information and/or relative time (i.e., validity timer) as a validation information for preconfigured AD.**Proposal 4.** RAN2 discuss on the feasibility of the combination of area (cell or beam) and time (absolute time info or validity timer) to associate with the preconfigured AD. |
| R2-2111105 Xiaomi | **Proposal 4:** If PRS configuration broadcasted by gNB is different from the preconfigured assistance data, UE will use the PRS configuration broadcasted by the gNB.**Proposal 5:** The LMF can trigger UE to use preconfigured assistance data to make measurements on PRS by LPP Request Location Information message. |
| R2-2110928 InterDigital | **Observation 1:** For latency reduction, it is beneficial if the pre-configured assistance data, received via dedicated signalling or posSIB, in one LPP positioning session is usable in other future LPP sessions**Proposal 1:** UE can use preconfigured PRS configurations for making measurements on DL-PRS so long as the associated validity conditions/criteria are met, irrespective of the status of LPP session**Proposal 2:** Support providing area validity condition/criteria (e.g. consisting of a list of cell) to UE which is associated with preconfigured assistance data**Proposal 3:** Support providing time validity condition/criteria (e.g. valid time duration/timer) to UE which is associated with preconfigured assistance data**Proposal 4:** The validity conditions/criteria associated with the preconfigured PRS configurations are provided to the UE using LPP assistance data transfer procedure or posSIB**Proposal 5:** The validity conditions/criteria are configured and associated in UE on a per-PRS configuration basis when the assistance data is transfered via dedicated signalling (e.g. via LPP assistance data) **Proposal 6:** The validity conditions/criteria are configured and associated in UE on a per-assistance data basis (e.g. consisting of multiple PRS configurations) when the assistance data is transferred via posSIB**Observation 2:** Reconfiguring PRS configuration via assistance data update can result in significant latency**Observation 3:** Measurement driven triggering for using a preconfigured PRS is beneficial and effective for latency reduction**Proposal 7:** Support dynamic triggering of a preconfigured PRS at UE by LMF or gNB for initiating measurements on DL-PRS**Proposal 8:** Support dynamic triggering of a preconfigured SRSp at UE by gNB |

**Summary:**

Based on the contributions there are the discussions already covered in the post email discussion. First the issues identified in that post email discussion should be resolved, and then the other spin-off issues and related stage 3 level details can be further discussed. So, in this summary, the rapporteur proposes to handle the preconfigured AD related issues to be discussed first in respective post email discussion.

**Proposal 2: RAN2 discuss the preconfiguration of Assistance data issues based on the summary document of [Post115-e][605][POS] Pre-configured assistance data (Intel)** (R2-2109665).

## 3.3 Response time granularity

Granularity of Response time and need for related capability are discussed in contributions. The company proposals related to this topic are summarized in the Table below.

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| Response time granularity |
| R2-2109824 Lenovo | **Proposal 1:** Introduce additional finer time granular values and step sizes (e.g. 10ms or 100ms) for the *responseTime* IE, e.g., in range of ten-millisecond.**Proposal 2:** RAN2 to discuss if new UE capabilities for granular response time values are required after finalizing the new values and step sizes of *responseTime* IE. |
| R2-2109978 vivo | **Proposal 6:** Introduce finer granularity of *unit* in *ResponseTime* as ten-millisecondes. |
| R2-2110179Huawei | Text Proposal for TS 37.355: finer granularity of *responseTime* |
| R2-2110336 Samsung | **Proposal 1:** RAN2 to extend “unit” fields in *ResponseTime* IE in *LPP RequestLocationInformation* to include “ten-milliseconds” supporting the finer granularity, ranging from 10ms to 1280ms.**Observation 1:** The support of low latency response (e.g., ten-millisecond level response time) can depend on the UE capability.**Proposal 2:** RAN2 to introduce a new capability for the support of ten-millisecond level response time in *ProvideCapabilities* IE for each positioning method in *LPP ProvideCapabilities*. |

**Summary:**

RAN2 has already sent the reply LS to RAN1 [24], confirming that RAN2 can signal the finer granularity for response time in LPP. Now the remaining issue is about details on how to introduce finer granularity of *responseTime*. Regarding the specific granularity, all companies addressing this topic are supportive of introducing the finer granularity with the unit of ten-milliseconds. In detail, vivo, Huawei, Samsung propose to extend unit in *ResponseTime* to include ten-milliseconds. Therefore, it is proposed to introduce finer granularity of *ResponseTime* by extending the ‘unit’ field to include “ten-milliseconds”. Rapporteur thinks RAN2 can consider the text proposal in Huawei as a baseline.

**Proposal 3-1: RAN2 agrees to introduce finer granularity for *responseTime* IE by extending the ‘unit’ field to include “ten-milliseconds”.**

For a new UE capability related to granular *responseTime*, Lenovo, Huawei, Samsung have expressed their view on this. Lenovo proposes RAN2 to discuss if the new UE capabilities are required after finalizing the new value and Huawei, Samsung include some text proposals to introduce the new UE capability for finer granularity of *ResponseTime*. From the companies’ views, it seems like there is at least a majority which thinks that new UE capabilities need to be introduced. On the other hand, there are different views on whether it needs to be indicated per each positioning method separately or not. Thus, it is proposed to discuss introducing UE capability for the support of ten-milliseconds unit in *ResponseTime* with FFS on if it needs to be indicated per each positioning method or not.

**Proposal 3-2: RAN2 is proposed to discuss introducing new UE capability for the support of ten-milliseconds unit in *ResponseTime* IE. FFS if it needs to be indicated per each positioning method or not.**

## 3.4 Prioritization of positioning measurements/reporting and priority rules

The company proposals related to this topic are summarized in the Table below.

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| Prioritization of measurements/reports and priority rules |
| R2-2109460 ZTE | **Observation 1:** The current defined measurement period that is used for DL PRS measurement is calculated based on all configured DL PRSs in ProvideAssistanceData message, which leads to large latency for a location information report.**Observation 2:** UE can report one early location information report before the configured responseTimeEarlyFix.**Observation 3:** If UE cannot transmit all measured location information to the LMF via early location information report, the location information acquired between early location information report and final location information report can only be uploaded at the end of response time, which may cause extra-latency.**Proposal 3:** Support UE to conduct DL PRS measurement based on a subset of regular assistance data or a subset of pre-configured assistance data provided by ProvideAssistanceData message. **Observation 4:** By configuring an appropriate value of responseTimeEarlyFix for a specific positioning service, LMF can receive the early location information report earlier than before.**Proposal 4:** Support of associating a subset of DL PRS with an early location information report.**Proposal 5:** Support UE to report more than one early location information reports before the final response time. |
| R2-2109824 Lenovo | **Observation 1:** The current response time configured by the LMF is best effort and lacks flexibility to enable multiple low latency measurements and associated positioning techniques. **Proposal 7:** RAN2 to support the configuration of priority rules associated to the configured measurements, positioning techniques, and associated reports. FFS on how to indicate the measurement priority and optionally associated response times.**Proposal 8:** RAN2 to support the dropping of low priority measurements that do not meet the required response time. The UE may explicitly indicate the dropped measurements or the LMF may implicitly infer the dropped measurements based on the provided measurement configuration. |
| R2-2110103 OPPO | **Observation 1:** both of the allowedPHY-PriorityIndex and allowedCG-List, introduced in the R16 URLLC WI, could help reduce the latency regarding the location measurement report to be carried on the dynamic grant and configured grant, respectively. **Proposal 1:** RAN2 to agree that no RAN2 impact is foreseen for reducing the latency regarding the transmission of the location report. |
| R2-2110180 Huawei | **Observation 1:** The definition of priorities for PRS measurements is incomplete and the information of which PRS a UE used for measurements is unsynchronized between the UE and the LMF.**Observation2:** RAN2 should define the priorities of the PRS configuration when the two approaches for PRS configuration with nr-DL-PRS-AssistanceData and nr-SelectedDL-PRS-IndexList are used simultaneously.**Proposal1:** Re-use the NR-SelectedDL-PRS-IndexList IE to indicate the priority the PRS in different frequency layers.**Proposal2:** Send a LS to request RAN1 to on the definition of priorities for PRS configuration. |
| R2-2111075 CMCC | **Observation:** In the study phase, priority rules for the reception of DL PRS are listed as the potential solution for the collision handling rule to reduce the latency.**Proposal:** RAN2 is kindly asked to support physical layer priority rules for the reception of DL PRS and DL signals/channels carrying LPP signaling. |
| R2-2110798 Ericsson | Proposal 2 : Send an LS to RAN1 saying Option 1 gNB based indication is preferred. |

**Summary:**

There are two categories on ‘prioritization regarding positioning measurement/reporting’. One is prioritization among DL-PRS to be measured (and possibly related AD/reporting configurations), and another is prioritization between reception of DL-PRS and other DL channel /signals carrying LPP message.

For the first one (regarding the prioritization among DL-PRS) ZTE, Lenovo and Huawei discussed that there could be the enhancement of the latency reduction in giving priority to the measurement target i.e., DL-PRS, and/or some partial assistance data information including positioning method, reporting configuration. In this direction, the prioritized measurement can be associated with the shorter response time compared to the original response time value. By selectively measuring and reporting the prioritized ones, the shorter latency can be achieved than the originally configured response time.Based on this, we can propos the following:

**Proposal 4-1: RAN2 agree to introduce the prioritization of at least DL-PRS can be adopted for the shorter measurement reporting latency than measuring all the DL-PRS indicated in AssistanceData.**

If this is agreeable, then there could be further details to be discussed such as :

**Proposal 4-2:RAN2 further discuss on:**

* **Association between DL-PRS set and responseTimeEarlyFix, more than one early location information reports before the final response time**
* **Support the dropping of low priority measurements that do not meet the required response time.**
* **Reuse the NR-SelectedDL-PRS-IndexList IE to indicate the priority the PRS in different frequency layers**

Regarding another issue, i.e., prioritization between DL-PRS and other DL channel/signals carrying LPP message, CMCC proposed to adopt the physical layer prioritization rule and Ericsson goes one step further to adopt the solution option 1 for the prioritization rule. Please find the conclusion which is in the discussion on PRS measurement outside of MG as below for the reference:

* Further study
	+ Further details of which other DL signals/channels to be prioritized
	+ How the UE determines DL PRS’s priority based on one or more of the following:
		- Opt. 1: Based on indication/configuration from serving gNB
		- Opt. 2: Other options (e.g., implicit, signalling from LMF, etc)
	+ Whether UE can do the measurement for both inside MG (if MG is configured) and outside MG in a measurement period
	+ How to do the PRS measurement when the conditions cannot be satisfied, e.g. when BWP switching happens
	+ Prioritization conditions of processing PRS over other DL channels/signals or vice versa.

Since these are the conclusion from RAN1 discussion, we wonder if these conclusion has any impact to RAN2. Therefore, we have the following proposal:

**Proposal 4-3: RAN2 further discuss if there is any specification impact by the RAN1’s conclusion on the prioritization between DL-PRS measurement and other DL channel/signals carrying LPP messages.**

## 3.5 Multiple QoS class

There are few contributions discussing specific aspects related to latency reduction enhancements. The company proposal related to this topic is summarized in the Table below:

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| Multiple QoS class |
| R2-2111081 Samsung | **Observation 1.** With 3GPP UMi model and some deployment scenario, proposed scheme shows clear benefit on the latency reduction compared to the legacy single QoS class request. **Observation 2.** Above latency reduction gain is increasing on the increasing number of active UEs.**Proposal 1.** Introduce multiple QoS level information i.e., accuracy values to LPP location information request procedure when LMF receives the service request with multipleQoS class from LCS client. |
| R2-2111083 Samsung | **Observation 1.** In current LPP procedure, if the indicated Qos in first requested location information is not fulfilled, another location information procedure will be requested, and sequential processing of location measurement/estimate makes unnecessary latency for obtaining meaningful location estimate at LMF, when LMF is requested for multipleQoS class service.**Proposal 1.** Introduce multiple QoS level information i.e., accuracy values to LPP location information request procedure when LMF receives the service request with multipleQoS class from LCS client. |

**Summary:**

One company Samsung has provided the new method to reduce the latency by using multiple QoS class. And also there is the simulation result to highlight the gain. The rationale is simple such as LMF can indicates the multiple QoS class to UE in LPP RequestLocationInformation and if UE cannot fulfil the stringent QoS class, the less stringent QoS class is tried so that additional LPP transaction can be reduced. This is only possible when LMF receives the corresponding multiple QoS class input in Location Service request from the LCS client. And SA2 already specified this part.

**Proposal 5-1: RAN2 agree that LMF can indicate the multiple QoS level information i.e., accuracy values to UE in location information request procedure when this LCS request from LCS client is initiated for the multipleQoS class.**

## 3.6 Measurement gap request/configuration

The company proposals related to this topic are summarized in the Table below.

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| Measurement gap request/configuration |
| R2-2109663 Intel | **Proposal 4:** In order to support MG activation request procedure, LMF needs to be able to provide MG configuration related information to the gNB. For this purpose, NRPPa signaling needs to be defined, for which RAN3 needs to be consulted.**Proposal 5:** The UE can be pre-configured in advance with a set of MG patterns for DL PRS processing in order to reduce overall positioning latency.**Proposal 6:** The UE may perform request for activation of MG from this pre-configured set using UL MAC CE, following which the UE should utilize the MG once it gets confirmation from the network. **Proposal 7:** A new DL MAC CE for activation/deactivation of configured MG shall be supported to allow the gNB to activate/deactivate MG at the UE. **Proposal 8:** The MG configuration shall not be configured via MAC CE.  |
| R2-2109978 vivo | **Proposal 3:** The LMF should indicate whether the LMF will help to request MG when LMF sends the LPP RequestLocationInformation message to the UE. |
| R2-2110359 Sony | **Proposal 1:** Define a timing relationship between LPP location information request and NRPPa on MG activation request. |
| R2-2110798 Ericsson | **Observation 1:** In an indoor IIoT factory positioning (e.g. single cell), a gNB-DU can control and steer multiple TRPs to support DL measurements based on DL PRS without the need of measurement gaps**Proposal 1:** Send an LS to RAN1 saying Alternate 1 (Serving cell based PRS config) is preferred. |
| R2-2110928 InterDigital | **Observation 4:** The procedure and signalling for measurement gap configuration causes significant latency**Proposal 9:** Support preconfiguring of measurement gap (MG) configurations in UE and fast activation of a MG preconfiguration using MAC CE**Proposal 10:** Support selecting and configuring a MG approach (e.g. MG-less or fast activation of preconfigured MG) based on the type of PRS configuration (i.e. aperiodic, periodic, semi-persistent) provided to UE |

**Summary:**

There was the two main directions on MG related enhancement for positioning procedure.

* Fast activation of MG
	+ UE’s activation request
	+ LMF’s activation request
* Measuring PRS without MG (i.e., gap-less measurement)s

Both items are initiated from RAN1 discussion, and some progress was made.

For fast activation of MG, the following agreements were made:

In RAN1#106bis-e :

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| Agreement:Support the following options (in the agreement made in RAN1#106-e) for a new mechanism of MG activation request for the purpose of positioning.* Option 2: by UE (via UCI or UL MAC CE)
	+ Select only one of UCI and UL MAC CE in RAN1#106bis-e
* Option 1: by LMF (via an NRPPa message)
	+ Note: This is transparent to the UE
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| Agreement:Support using UL MAC CE for MG activation request by UE (Option 2) for the purpose of positioning.Agreement:Support the following option (from the agreement made in RAN1#106-e) for a new MG activation procedure to be performed by the gNB for the purpose of positioning.* Option 2: DL MAC CE
* FFS: Deactivation process

Agreement:With regards to MG activation by DL MAC CE, further study* DL MAC CE payload
* The necessity of pre-configuration of MGs in higher layers.
 |

UE’s activation means that UE request to gNB on the required MG corresponding to the required LPP measurement. And LMF’s activation means that LMF request to gNB on the required MG corresponding to the required LPP measurement. While LMF’s activation needs NRPPa signaling which is in the RAN3’s area, UE’s activation needs RAN2 discussion including the signaling among UE/gNB/LMF.

Since UE’s activation request is to use MAC CE for the indication as in RAN1 agreement, there is not much space to indicate all the details for the MG configuration. It is expected that the reduced form of MG configuration can be used for the indication from UE to gNB. For this, UE and gNB should share the knowledge on relation between the reduced version and the full form of MG configuration a priori.

**Proposal 6-0: RAN2 agree that UE’s MG activation request mechanism needs preconfiguration of possible MG configuration to UE.**

If above proposal is agreeable, the further details can be discussed. Intel, vivo, and InterDigital seem to have the same background for the UE’s MG activation option in the fast MG activation category such that LMF can inform the MG configuration related information (including PRS types, periodicity, PRS occasion information etc) to gNB and gNB can configure the several possible MG configurations to UE before requesting Location Information to UE. Once UE is requested to measure the PRS then UE can choose one of the preconfigured MGs and request to gNB via MAC CE. Then gNB will confirm the usage of that MG via MAC CE. This operation seems to be considered in RAN1 discussion.

Therefore, we have the following proposals for the baseline operation of the UE’s MG activation request.

**Proposals:**

**Proposal 6-1. For UE’s MG activation request, RAN2 agree that LMF is able to indicate the information related to MG configuration to gNB, FFS the details for the MG configuration related information.**

**Proposal 6-2. For UE’s MG activation request, RAN2 agree that gNB can configure multiple of possible MG configurations to UE before requesting Location Information to UE. FFS for signaling details of gNB’s configuration i.e., Id assignment to each MG, and the signaling layer.**

**Proposal 6-3. For UE’s MG activation request, RAN2 agree that UE can choose one of the MG preconfigured and indicate to gNB via MAC CE once it is pre-configured with the MG configurations by gNB and Location Information is requested by the LMF.**

**Proposal 6-4. For UE’s MG activation request, RAN2 agree that gNB will activate/deactivate the indicated MG to be used to UE via MAC CE once it is indicated by UE on specific MG configuration.**

Additionally, there is the other option in fast MG activation, i.e., LMF’s MG activation request, and it is unclear if these two options can be operable simultaneously. Therefore, we need the following proposal as vivo and sony said:

**Proposal 6-5. For fast MG activation, RAN2 discuss the following sub items regarding LMF’s activation request**

* **whether option 1 (activation request by UE) and 2 (activation request by LMF) can be configured simultaneously,**
* **whether LMF’s indication is necessary in the LPP RequestLocationInformation to UE that LMF can handle the MG configuration for positioning.**
* **Define timing relationship between LPP RequestLocationInformation and NRPPa on MG activation request when option 2 is agreed.**

The remaining item is to measure PRS without MG. Ericsson and InterDigital have different discussion point on this. Since this was not prevailed in RAN2 domain, rapporteur suggest to discuss each topic in RAN2 first.

**Proposal 6-6. RAN2 discuss the following sub items for the PRS measurement without MG:**

* **Down-selection of the PRS applicability between serving cell PRS only OR all PRS under conditions to PRS of non-serving cell**
* **Configurability to UE on MG for positioning between selecting fast MG activation and PRS measurement without MG**

## 3.7 Storing Capabilities

Storage of UE positioning related capabilities in 5GC and the variability of said capabilities is discussed in contributions, with the company proposals listed in the Table below.

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| Storing Capabilities |
| R2-2109663 Intel | **Observation 2:** Storing UE positioning capability in AMF has no RAN2 impact except potential issue on whether the UE needs to indicate that the capabilities are non-variable.**Proposal 2:** It is proposed to agree that:* RAN2 does not see the need to introduce the indication on whether UE positioning capability is “variable” or not, since the LMF can be aware of this based on received UE positioning capability.
* RAN2 assumes that the issue can be resolved by network implementation considering the issue also exists in Rel-16 even if positioning capability is not stored in AMF.

**Proposal 3:** Storing UE positioning capability in AMF has no RAN impact except potential stage 2 description. |
| R2-2110178 Huawei | **Proposal 2:** For AMF storing positioning capabilities for latency reduction, RAN2 should down-select from the following options: Option1: Legacy solution for AMF storing UE radio capability (e.g., the request record of the UE positioning capability);  Option2: AMF should store the complete capability of the UE. |

**Summary:**

RAN2 has sent the reply LS to SA2 [25], including RAN2’s agreement that the UE positioning capability can be variable in specific example situations. On the other hand, there was a discussion on if some indication needs to be defined to inform the LMF whether the positioning related capability is variable or not. At the last RAN2-115e meeting, several companies have expressed their view on this issue and the majority opinion was that any new indicator is not needed. In the same vein, the only contribution submitted regarding this issue by Intel has the same view with the majority. From rapporteur’s perspective, there seems to be the consensus that there is no need to introduce new indication on whether UE capability is variable or not, and therefore it is proposed to make agreements as below.

**Proposal 7-1: RAN2 agrees that there is no need to introduce new indication to inform the LMF on whether UE positioning capability is variable or not.**

If the above is agreed, it is proposed to wrap up the discussion on the impact of storing UE positioning capability on RAN2 stage 3 spec. with the following agreement.

**Proposal 7-2: RAN2 agrees that storing UE positioning capability in AMF has no RAN2 impact except potential stage 2 description**

In the contribution from Huawei, it is observed that there can be an ambiguity problem when the LMF interprets non-availability of a specific positioning capability at AMF side and two options are provided to resolve that ambiguity problem. From the rapporteur’s perspective, how to manage and interpret the UE positioning capability stored in AMF seems like a network implementation issue and it is not clear what impact is foreseen from RAN2 perspective. Therefore, it is suggested that discussions on this topic are down-prioritized in RAN2, at least until further inputs to specify any impact on RAN2 are provided.

## 3.8 Configured UL grant for location reports

The company proposals related to this topic are summarized in the Table below.

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| Configured UL grant for location reports |
| R2-2109824 Lenovo | **Observation 2:** Although CG-based solution is intended for ProvideLocationInformation messages, it can be equally applicable to other UL LPP messages. **Observation 3:** The impact of CG-based measurement reporting will also be tackled during the RRC\_INACTIVE positioning discussion.**Proposal 9:** Support assistance information between gNB and LMF for enabling lower latency measurement reports enabled using the CG-based solution for low latency positioning measurement reporting. FFS RAN3 for further impacts.**Proposal 10:** Introduce additional finer time granular values for the reportingAmount and reportingInterval IEs corresponding to a periodical reporting configuration. FFS the values to be supported to align with the CG-based solution. |
| R2-2110103 OPPO | **Observation 2:** sending the location measurement/ estimation results on the dynamic UL grant is considered to be time-consuming.**Proposal 2:** RAN2 to agree that NRPPa msg should support the transmission of the PRS measurement period and starting position in time of the other TPRS to the serving gNB from LMF for configuring proper CG for UE to send location measurement/location estimation results towards the serving gNB for deferred 5GC-MT LR.  |
| R2-2110359 Sony | **Proposal 2:** Support CG-PUSCH for positioning where the PUSCH resource is used to carry the LPP measurement report.  |
| R2-2111086 Samsung | **Observation 1.** In LMF based CG configuration indication case, the reduction of latency related to getting UL grant (SR, BSR, and UL grant reception) is on the cost of one additional delay of NRPPa (13~29 ms).**Observation 2.** In UE based CG configuration indication case, the reduction of latency related to getting UL grant (SR, BSR, and UL grant reception) is on the cost of no additional delay or 2 additional RRC procedures (26~27ms).**Proposal 1.** RAN2 discuss which method between LMF based or UE based CG configuration indication is better to reduce the total latency on measurement reporting. |

**Summary:**

Contributions all have the positive intention to adopt the CG based measurement reporting. We need first to agree on the necessity of CG based measurement report/location estimate. Since CG-based measurement reporting was discussed and excluded in RAN plenary discussion (RP-210903), we can further discuss this issue after the other issues are resolved.

**Proposal 8-1: (Low Priority) RAN2 agree the necessity of the CG-based transmission of LPP ProvideLocationInformation message to LMF.**

If this is agreeable, then further details can be discussed on which method between LMF based one (LMF indicates to the gNB the UL grant information related to CG configuration) or UE based one (UE indicates to the gNB the required UL grant information) can be introduced. As Lenovo, Oppo shows the preference on the impact on NRPPa, which means the LMF based one, Samsung and Sony have the neutral position over either UE- or LMF-based method. So for the progress we can propose the following:

**Proposal 8-2: RAN2 agree that LMF-based CG-based transmission where LMF transmits the assistance information for CG-configuration to gNB via NRPPa.**

**Proposal 8-3: FFS for the following sub items:**

* **The further details on assistance information can be FFS.**
* **Having finer granular value for reportInterval and reportAmount IE can be FFS.**

## 3.9 Latency reduction during HO

The company proposal related to this topic is summarized in the Table below:

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| Latency reduction during HO |
| R2-2109481 CATT | **Observation 2:** When upper layers request a PDCP entity re-establishment, the transmitting PDCP entity shall: - for SRBs, discard all stored PDCP SDUs and PDCP PDUs [2];**Observation3:** When upper layers request a PDCP entity re-establishment, the receiving PDCP entity shall: - for SRBs, discard all stored PDCP SDUs and PDCP PDUs [2];**Observation 4:** All LPP message carried in *ULInformationTransfer* are discarded during the handover because of the exisiting mechanism of PDCP entity re-establishment.**Observation 5:** This is a challeng of latency if the LPP messages from UE to LMF or from LMF to UE are lost during the handover, not only for RAT-Independent but also for DL RAT-Dependent positioning methods.**Proposal 3:** Latency can be reduced if there is a mechanism to make sure LPP messages won’t be lost during the handover.**Proposal 4:** UE can follow the existing mechanism to retransmisit *ulInformationTransfer* message for the corresponding target cell during the handover to reduce the latency so the LPP messages won’t be sent/receive correctly. |

**Summary:**

In rapporteur’s understand, this problem is not specific for NR but also for the base architecture using RRC message to carry LPP message within. Since RRC message transmission might not be available during handover, LPP message cannot be transmitted at that time. This could be the intrinsic problem. However in the legacy LPP and RRC procedure, there was not specific solution for this case. In the light of this, it is unclear how frequently this LPP packet drop happens due to the PDCP re-establishment even with the NR’s smaller cell coverage. Even it still worth to discuss on the problem in NR perspective, WID objective didn’t capture anything related to this problematic behavior in RRC. Therefore, this also can be further considered after the remaining issues are all resolved.

**Proposal 9-1: (Low Priority) RAN2 discuss if the handover makes a significant problem on latency increase between LMF and UE due to LPP message discarding in NR.**

# Summary of Proposals for Discussion

Based on the discussion above on contributions related to latency reduction, the following is proposed:

**Proposal 0: RAN2 discuss on which items in latency reduction AI can be considered for the discussion in this meeting based on WID and the progress of related WG, and make the conditions to be considered in the upcoming meeting for ones not discussed in this meeting.**

**Proposal 1: RAN2 is proposed to further discuss whether the scheduled location time (including other information associated with it) needs to be provided to the UE/NG-RAN or not.**

**Proposal 2: RAN2 discuss the preconfiguration of Assistance data issues based on the summary document of [Post115-e][605][POS] Pre-configured assistance data (Intel) (R2-2109665).**

**Proposal 3-1: RAN2 agrees to introduce finer granularity for responseTime IE by extending the ‘unit’ field to include “ten-milliseconds”.**

**Proposal 3-2: RAN2 is proposed to discuss introducing new UE capability for the support of ten-milliseconds unit in ResponseTime IE. FFS if it needs to be indicated per each positioning method or not.**

**Proposal 4-1: (Low Priority) RAN2 agree to introduce the prioritization of at least DL-PRS can be adopted for the shorter measurement reporting latency than measuring all the DL-PRS indicated in AssistanceData.**

**Proposal 4-2: (Low Priority) RAN2 further discuss on:**

* **Association between DL-PRS set and responseTimeEarlyFix, more than one early location information reports before the final response time**
* **Support the dropping of low priority measurements that do not meet the required response time.**
* **Reuse the NR-SelectedDL-PRS-IndexList IE to indicate the priority the PRS in different frequency layers**

**Proposal 4-3: RAN2 further discuss if there is any specification impact by the RAN1’s conclusion on the prioritization between DL-PRS measurement and other DL channel/signals carrying LPP messages.**

**Proposal 5-1: RAN2 agree that LMF can indicate the multiple QoS level information i.e., accuracy values to UE in location information request procedure when this LCS request from LCS client is initiated for the multipleQoS class.**

**Proposal 6-0: RAN2 agree that UE’s MG activation request mechanism needs preconfiguration of possible MG configuration to UE.**

**Proposal 6-1. For UE’s MG activation request, RAN2 agree that LMF is able to indicate the information related to MG configuration to gNB, FFS the details for the MG configuration related information.**

**Proposal 6-2. For UE’s MG activation request, RAN2 agree that gNB can configure multiple of possible MG configurations to UE before requesting Location Information to UE. FFS for signaling details of gNB’s configuration i.e., Id assignment to each MG, and the signaling layer.**

**Proposal 6-3. For UE’s MG activation request, RAN2 agree that UE can choose one of the MG preconfigured and indicate to gNB via MAC CE once it is pre-configured with the MG configurations by gNB and Location Information is requested by the LMF.**

**Proposal 6-4. For UE’s MG activation request, RAN2 agree that gNB will activate/deactivate the indicated MG to be used to UE via MAC CE once it is indicated by UE on specific MG configuration.**

**Proposal 6-5. For fast MG activation, RAN2 discuss the following sub items regarding LMF’s activation request**

* **whether option 1 (activation request by UE) and 2 (activation request by LMF) can be configured simultaneously,**
* **whether LMF’s indication is necessary in the LPP RequestLocationInformation to UE that LMF can handle the MG configuration for positioning.**
* **Define timing relationship between LPP RequestLocationInformation and NRPPa on MG activation request when option 2 is agreed.**

**Proposal 6-6. RAN2 discuss the following sub items for the PRS measurement without MG:**

* **Down-selection of the PRS applicability between serving cell PRS only OR all PRS under conditions to PRS of non-serving cell**
* **Configurability to UE on MG for positioning between selecting fast MG activation and PRS measurement without MG**

**Proposal 7-1: RAN2 agrees that there is no need to introduce new indication to inform the LMF on whether UE positioning capability is variable or not.**

**Proposal 7-2: RAN2 agrees that storing UE positioning capability in AMF has no RAN2 impact except potential stage 2 description**

**Proposal 8-1: (Low Priority) RAN2 agree the necessity of the CG-based transmission of LPP ProvideLocationInformation message to LMF.**

**Proposal 8-2: RAN2 agree that LMF-based CG-based transmission where LMF transmits the assistance information for CG-configuration to gNB via NRPPa.**

**Proposal 8-3: FFS for the following sub items:**

* **The further details on assistance information can be FFS.**
* **Having finer granular value for reportInterval and reportAmount IE can be FFS.**

**Proposal 9-1: (Low Priority) RAN2 discuss if the handover makes a significant problem on latency increase between LMF and UE due to LPP message discarding in NR.**

# References

1. R2-2109460 Discussion on positioning latency reduction ZTE discussion
2. R2-2109481 Discussion on Enhancements for Latency Reduction CATT discussion
3. R2-2109663 Leftover issues on Latency reduction Intel Corporation discussion
4. R2-2109665 Summary of [Post115-e][605][POS] Pre-configured assistance data (Intel) Intel Corporation discussion
5. R2-2109824 Positioning Latency Reduction Enhancements Lenovo, Motorola Mobility discussion
6. R2-2109915 Time T and Measurement Gap for Measurement Time Window Ericsson discussion
7. R2-2109978 Discussion on latency enhancement vivo discussion
8. R2-2110103 Further consideration of positioning latency enhancements OPPO discussion
9. R2-2110178 Discussion on latency reduction techniques from other groups Huawei, HiSilicon discussion
10. R2-2110179 Text Proposal for finer granularity of responseTime Huawei, HiSilicon discussion
11. R2-2110180 Discussion on pre-configured PRS Huawei, HiSilicon discussion
12. R2-2110336 Discussion on the response time Samsung discussion
13. R2-2110359 Considerations on positioning latency Sony discussion
14. R2-2110798 PRS Measurements outside measurement Gap Ericsson discussion
15. R2-2110822 Remaining Issues on Scheduling Location in Advance Qualcomm Incorporated discussion
16. R2-2110928 Discussion on Enhancements for Latency Reduction InterDigital, Inc. discussion
17. R2-2111075 Discussion on the priority rule for latency reduction CMCC discussion
18. R2-2111081 Simulation study for multiple QoS class handling for latency reduction Samsung Electronics discussion
19. R2-2111083 Handling of multiple QoS for latency reduction Samsung Electronics discussion
20. R2-2111084 Discussion on the Pre-configured Assistance Data Samsung Electronics discussion
21. R2-2111086 Latency reduction via configured grant for positioning Samsung Electronics discussion
22. R2-2111105 Positioning enhancements on latency reduction Xiaomi discussion
23. R2-2108958 Reply LS to SA2 on scheduled location time (S2-2105122; contact: CATT) RAN2 LS To: SA2 Cc:RAN3
24. R2-2106919 Reply LS on granularity of response time (R1-2106316; contact: Huawei) RAN2 LS To: RAN1
25. R2-2106971 Response LS on storage of UE Positioning Capabilities (S2-2105153; contact: Qualcomm) RAN2 LS To: SA2 Cc: RAN3