**3GPP TSG-RAN WG2 Meeting #113-e *Draft* R2-21xxxxx**

**Electronic meeting, Jan 25th – Feb 5th, 2021**

**Agenda item:** 8.11.2.1

**Source:** CATT

**Title:** Report of [AT113-e][608][POS] Continue discussion of latency enhancements

**Document for:** Discussion and Agreement

# 1 Introduction

This is to continue discussion of the proposals in R2-2100407 and R2-2101950. The goal of this discussion [AT113-e][608] is:

* converge to an agreeable TP for latency enhancements
* recommendations from RAN2 perspective
* [AT113-e][608][POS] Continue discussion of latency enhancements (CATT)

Scope: Discuss the proposals in R2-2100407 and R2-2101950 and converge to an agreeable TP. Additional latency enhancements from the previous email discussion can be captured if they have a clear consensus. Recommendations from RAN2 perspective should be clarified.

Intended outcome: Endorsable TP

Deadline: Tuesday 2021-02-02 1200 UTC

Rapporteur would like to have the following schedule for this email discussion to have time for preparing the summary report.

* Phase 1 (**Monday 2021-02-01 10:00 UTC**): Companies are invited to provide inputs and comments.
* Phase 2 (**Tuesday 2021-02-02 8:00 UTC**): Rapporteur will provide draft summary with proposals.

The remainder of this document is organized as the following. Section 2 contains the questionnaire on proposals in R2-2100407 and R2-2101950. The purpose is to collect the views and identify the commonalties and differences in order to converge to an agreeable TP and recommendations from RAN2 perspective.

# 2 Discussion

## 2.1 RAN2 centric objective proposals in R2-2100407

### 2.1.1 Request and response of positioning assistance data aspect

According to the email discussion results in [Post112-e][617][POS]: 8/11 companies supported request and response of positioning assistance data aspect to be further studied, and 6/10 companies support option 3 in [AT112-e][607].

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

The proposal on Request and response of positioning assistance data aspect in the report of [Post112-e][617][POS] included both RAN1 centric and RAN2 centric objectives. However that statement brought confusion to companies because RAN1 centric objective is different from RAN2.

So the proposal on this aspect has been simplified here and focused on the discussion result in RAN2 only.

**Proposal 1: RAN2 to agree Deferred MT-LR for Latency reduction related to the request and response of positioning assistance data.**

**Q1-1: Do you agree with proposal 1?**

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| **Company name** | **Agree/Disagree** | **Comments** |
| Qualcomm | Agree with clarification and modification. | The positioning configuration signaling in advance is not restricted to deferred MT-LR; it is equally applicable to MT-LR, NI-LR, and MO-LR, as described in R2-2010095, R2-2101469 and commented in ED [Post112-e][617][POS].  The Proposal could be:  "Latency reduction via location scheduling in advance of the time of when the location is needed".  This is applicable to Capabilities, Assistance Data, and Location Requests. |
| Ericsson | Agree with QC |  |
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**Q1-2: If your answer to Question 1-1 was "Yes", do you agree with the text proposal #1 below? Or do you have any suggestion on the text proposal #1?**

**--------------------------------Text Proposal #1-----------------------------------------------------------------------------------**

* + The details of the solutions are left for further discussion in normative work, which may include the following aspects:
    - Latency reduction related to the request and response of positioning assistance data (e.g., via Deferred MT-LR)

**----------------------------End of Text Proposal #1-------------------------------------------------------------------------------**

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| **Company name** | **Agree/Disagree** | **Comments** |
| Qualcomm | Agree with modification | The details of the solutions are left for further discussion in normative work, which may include the following aspects:   * Latency reduction related to the measurement gap * Latency reduction related to measurement time * Latency reduction related to the reporting and request of the measurements (e.g., via location scheduling in advance of the time of when the location is needed, via RRC signaling, MAC-CE and/or physical layer procedure, and/or priority rules) * Latency reduction related to the request and response of positioning assistance data (e.g., via location scheduling in advance of the time of when the location is needed, via RRC signaling, MAC-CE and/or physical layer procedure) |
| Ericsson | Agree | Other latency reduction such as measurement gap is not part of RAN2 so we should only capture   * + - Latency reduction related to the request and response of positioning assistance data (e.g., via Deferred MT-LR) |
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**Q1-3: If your answer to Question 1-1 was "Yes", do you agree text proposal # 2 as recommendation from RAN2 perspective?**

**--------------------------------Text Proposal #2-----------------------------------------------------------------------------------**

The following enhancements of signaling & procedures for reducing NR positioning latency are recommended for normative work, including DL and DL+UL positioning methods

* + The details of the solutions are left for further discussion in normative work, which may include the following aspects:
    - **Latency reduction related to the request and response of positioning assistance data (e.g., via Deferred MT-LR)**

**----------------------------End of Text Proposal #2-------------------------------------------------------------------------------**

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| **Company name** | **Agree/Disagree** | **Comments** |
| Qualcomm | Agree with modification | See our response to Q1-2. |
| Ericsson | Agree |  |
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### 2.1.2 Measurement report optimization aspect

According to the email discussion results in [Post112-e][617][POS]: 11/12 companies agreed to study latency reduction related to the reporting and request of the measurements and one company agreed with condition (depends on the context). However companies had different understanding on detail solutions, e.g. CG-based solution.

RAN2 only discussed the CG-based solution because other RAN1 related solutions are not discussed by RAN2 before.

Some company mentioned that CG-based solution is not clear and there is no consensus during the online meeting. So this email continues to discuss the proposal of CG-based here.

There are only two candidate CG-Based solutions from companies, according to the results in [AT112-e][607].

* Option 1(summarized from five companies’ comments): Using the existed CG-based transmission for a certain logical channel.

It is already supported by the configuration of logical channel in NR Rel-16 which is up to the network implementation to configure CG. However there is NRPPa spec impact. gNB may get the PRS period from LMF via NRPPa.

* Option2: New type or separate CG for positioning which is used to adapt the PRS period and positioning specific configured grant may be introduced in Rel-17.

This can be used as positioning use only uplink resources, so that periodic positioning measurement report could be sent without waiting any L1 signals.

Discussion results in [Post112-e][617][POS] show that: **2 companies**(vivo, InterDigital) support the option2 and 5 companies think option1 has worked now(i.e. using the existing CG-based transmission).

In addition, R2-2101392 has also mentioned the following:

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| LMF configures the measurement periodicity; i.e the interval when the UE shall report the measurements. LMF should provide the configuration info to gNB so that gNB can configure the UL grant accordingly. However, this requires RAN3 input as it is over NRPPa. |

From the understanding of rapporteur, the above statement is true. For R15/16 configured grant, they are configured for a certain UE mainly based on the QoS parameter for a certain QoS flow/PDU session. While for sending the measurement report for positioning to the network, it would be impossible for the network to configure CG periodicity based on the periodicity of the deferred MT-LR.

Companies are invited to review the options and answer the questions as below:

**Q2-1: Which option do you prefer?**

**– Option 1: Drop the CG-based solution.**

**– Option 2: Agree the existing CG-based solution for Latency reduction related to the reporting and request of the measurements.**

**– Option 3: Keep CG-based solution for Latency reduction related to the reporting and request of the measurements.**

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| **Company name** | **Option1/ 2/ 3** | **Comments** |
| Qualcomm |  | To us, it is still unclear what a "CG-based solution" includes and what latency gains can be achieved. However, it does not have to be ruled-out if proponents can show an end-to-end solution and corresponding latency gains. It has been mentioned that additional NRPPa signalling may be required, which would add additional latency.  We think CG would be more appropriate for the "idle/inactive positioning" objective. |
| Ericsson | Option 2/3 | CG solution allows gNB to provide the UL grant in advance so UE can report the measurement timely (without delay). We can explore both Option2/3. We should anyway prioritize the legacy existing framework. But if any minor update etc needed then we should also consider those. |
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**Q2-2: If your answer to Question 2-1 was "Option2", do you agree with the text proposal #3 below? Or do you have any comments on the text proposal #3?**

**--------------------------------Text Proposal #3-----------------------------------------------------------------------------------**

The following enhancements of signaling & procedures for reducing NR positioning latency can be studied and specified, if needed

* + Latency reduction related to the reporting and request of the measurements (existing CG-based transmission)

**----------------------------End of Text Proposal #3-------------------------------------------------------------------------------**

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| **Company name** | **Agree/Disagree** | **Comments** |
| Qualcomm | Agree with modification | As commented in our response to Q1-1:  Latency reduction related to the reporting and request of the measurements (e.g., via location scheduling in advance of the time of when the location is needed, existing CG-based transmission, via RRC signaling, MAC-CE and/or physical layer procedure, and/or priority rules) |
| Ericsson | Agree with Modification | * + Latency reduction related to the reporting and request of the measurements (CG-based transmission)   We should anyway prioritize the legacy existing framework. We will not introduce completely new CG for positioning only. |
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**Q2-3: If your answer to Question 2-1 was "Option2", do you agree to recommend text proposal#4 from RAN2 perspective?**

**--------------------------------Text Proposal #4-----------------------------------------------------------------------------------**

The following enhancements of signaling & procedures for reducing NR positioning latency are recommended for normative work, including DL and DL+UL positioning methods

* + The details of the solutions are left for further discussion in normative work, which may include the following aspects:
    - Latency reduction with existing CG-based scheme by aligning the CG periodicity with PRS measurement report periodicity

**----------------------------End of Text Proposal #4 -------------------------------------------------------------------------------**

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| **Company name** | **Agree/Disagree** | **Comments** |
| Qualcomm | Disagree | This requires more studies before a recommendation on this specific proposal can be made. |
| Ericsson | Agree with modification | * + - Latency reduction with CG-based scheme by aligning the CG periodicity with PRS measurement report periodicity |
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### 2.1.3 Capability procedure aspect

According to the email discussion results in [Post112-e][617][POS]: **9/12 companies** agree with the capability procedure aspect for latency reduction, 1/12 company disagree and 2/12 companies share the concern and issues to be investigated. In R2-2101392 has proposed detailed solution for latency reduction with AMF storing the positioning capability.

There are mainly two solutions:

Solution1: UE provide the UE positioning capability to the AMF in an un-solicited manner



**Solution2**: the AMF request the UE positioning capability and UE sends it to the AMFin a solicited manner



However, as we discussed in [Post112-e][617][POS], this solution mainly involves the work from CT1/CT4 and SA2. There is little work RAN2 can do for normative work, and mainly the request discussion. Therefore we only captured the baseline, and details can be further studied and LS will be sent to SA2 in WI phase.

**Proposal 2:** **RAN2 to agree capture capability procedure for latency reduction and SA2 will be involved in WI.**

**Q3-1: Do you agree with proposal 2?**

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| **Company name** | **Agree/Disagree** | **Comments** |
| Qualcomm | Agree with clarification and modification | As mentioned in our response to Q1-1, the "Latency reduction via location scheduling in advance of the time of when the location is needed" is applicable to Capabilities, Assistance Data, and Location Requests.  As long as this is within the scope, we agree with the proposal. |
| Ericsson | Agree | Not sure if we understand QC comments. These are two different things; positioning application which require periodic reporting and thus once Capabilities have been provided; the location server will not have to re-fetch for the next periodicity. But this is not applicable to all positioning application for e.g. a snapshot of location info requiring applications |
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**Q3-2: If your answer to Question 3-1 was "Yes", do you agree with the text proposal #5 below? Or do you have any comments on the text proposal #5?**

**--------------------------------Text Proposal #5-----------------------------------------------------------------------------------**

The following enhancements of signaling & procedures for reducing NR positioning latency are considered as beneficial:

* + **Latency reduction related to storing UEcapability in AMF procedure. It is proposed thatSA2 should study whether this should be recommended for normative work in SA/CT.**

**-------------------------------- End of Text Proposal #5 -------------------------------------------------------------------------**

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| **Company name** | **Agree/Disagree** | **Comments** |
| Qualcomm | Agree with modification | * Latency reduction related to capability procedure (e.g., via location scheduling in advance of the time of when the location is needed, storing capabilities at LMF and/or AMF, etc.) * SA/CT will be involved during WI. |
| Ericsson | Agree |  |
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**Q3-3: If your answer to Question 3-1 was "Yes", do you agree to recommend text proposal #6 from RAN2 perspective?**

**--------------------------------Text Proposal #6-----------------------------------------------------------------------------------**

The following enhancements of signaling & procedures for reducing NR positioning latency are recommended for normative work, including DL and DL+UL positioning methods

* + The details of the solutions are left for further discussion in normative work, which may include the following aspects:
    - **Latency reduction related to storing UEcapability in AMF procedure. It is proposed thatSA2 should study whether this should be recommended for normative work in SA/CT.**

**----------------------------End of Text Proposal #6 -------------------------------------------------------------------------------**

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| **Company name** | **Agree/Disagree** | **Comments** |
| Qualcomm | Agree with modification | See our response to Q3-2. |
| Ericsson | Agree |  |
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### 3.2.3 Architecture enhancement aspect

According to the email discussion results in [Post112-e][617][POS]: **2/9companies**(InterDigital, Qualcomm) agree with the aspect, **4/9 companies**(Intel, Nokia, Apple, Convida) suggest other groups involved (e.g. SA2 and RAN3 should be involved for the architecture enhancement) and **3/9 companies**(Huawei/HiSilicon, ZTE, Ericsson) disagree it.

It seems there is no clear consensus on if architecture enhancement aspect for latency reduction will be further studied in RAN2.

Companies think RAN3 and SA2/SA3 may be involved address architecture and security aspects whenever that may be. Therefore rapporteur suggests there is no proposal on architecture enhancement aspect for latency reduction.

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| **Company name** | **Agree/Disagree** | **Comments** |
| Qualcomm |  | It seems rather obvious that other groups need to be involved, which applies to almost all objectives being discussed here, incl. e.g., capability procedure aspects, etc.  It should be clarified how the e.g., latency reduction via RRC signaling, MAC-CE and/or physical layer procedure is supposed to work without any architecture enhancements. Those studies seem clearly under RAN2 scope (including the related architectural aspects). Similar to Proposal 2 by the rapporteur, SA2 and others can be involved during WI phase. |
| Ericsson | Agree with rapporteur | We do not think we can get consensus on this. Already RAN3 has captured the details in their Rel-16 TR. |
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## 2.2 RAN1 centric objective proposals in R2-2100407

There is no any agreement on latency in RAN #90-e and no relative objective is added in new WID of ePOS [2] because RAN1 is waiting for the progress of RAN2 on latency.

Measurement gap and priority rules for the reception of DL PRS were discussed in [Post112-e][617][POS]. However they are RAN1 centric objective. Now there is agreement on measurement gaps optimizations and priority rules for the reception of DL PRS from RAN1 as below:

* **The details of the solutions are left for further discussion in normative work, which may include the following aspects:**
  + **Latency reduction related to the measurement gap**
* **The following enhancements of signaling & procedures for reducing NR positioning latency can be studied and specified, if needed**
  + **Latency reduction related to the reception of DL PRS (e.g., priority rules for the reception of DL PRS)**

It seemed that the RAN1 centric objectives proposals in R2-2100407 had brought confusion to companies according to the online meeting #113-e. Because some of them were discussed in RAN2 while others not. Therefore these RAN1 centric objective proposals are not discussed again in this email discussion because RAN1 have reached the agreement and captured them into TR.

Only the agreements which are in the email discussion scope are listed above just for your information.

## 2.3 New proposals in R2-2101950

### 2.3.1 Broadcast delay optimization aspect

According to R2-2101392, broadcast delays for positioning are substantial and cannot be ignored.i.e. the total delay would be Periodicty\*NumberOfSegments + NumberOfSegments\*SI\_WindowLenghth. Currently SI-windows with same length for all SI messages is configured. By introducing a separate SI window length for the SI messages carrying positioning SIBs, it is possible to configure this window short enough, without consideration of any legacy SIB impact. The short SI window has the advantage of shortening the acquisition time of multiple segments and also of all positioning SIBs that is of interest for the UE.

R2-2101392 **Proposal 2:** Adjustable and Short SI Window length of 1 slot is considered in Rel-17 for posSIBs.

Additionally, in order to reduce broadcast delays, it should be made possible that each posSIB segment are sent in a separate back to back SI messages. Considering 3 segments of a posSIB; if each segment is scheduled back to back in different SI messages, it will reduce the latency.

R2-2101392 **Proposal 3:** Flexible SI scheduling allowing back to back delivery of posSIB segments is considered to reduce broadcast delays.

**Rapporteur’s comments:** There is a new posSIBs broadcast mechanism(proposal 2&3 below) which is quite different from the legacy broadcast mechanism as summarized in R2-2101950. The broadcast delay optimization is not in the scope of latecy analysis[3][4] for Rel-17 SI. On the other hand, it is observerd that the proposals 2&3 may reduce the latency of braodcast AD.

So RAN2 will discuss at first if the broadcast delay optimization is in the scope of latecy reduction, and then evaluate the candidate solutions within both implementation effort and the gains.

**Q4-1: Do you agree broadcast delay optimization aspect should be a part of latency reduction?**

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| **Company name** | **Agree/Disagree** | **Comments** |
| Qualcomm | Disagree | The main benefit of broadcast is that a UE could always have valid assistance data stored. This already implies a latency reduction. The available broadcast periodicities can already be very small, therefore, we do not see a need for System Information enhancements.  However, if any System Information enhancements are going to be studied (e.g., for other purposes than latency reduction), it should not be specific to positioning. |
| Ericsson | Agree | RRC Broadcast is part of end to end delay. It should be captured. Even QC comment confirms that it should be then atleast be part of TTFF; i.e a UE coming to a new cell (wity new systemInfoAreaID) will have to reacquire some of the posSIBs before starting the positioning session.  It is considered that the positioning application would be even more widely used in coming few years. Broadcast would play a key role in providing mass scale positioning solutions. Resources need to be scheduled in a fair proportional way. Hence, the standard should allow flexibility in how NW can deliver the posSIBs along with serving the data communication; e.g providing resources for other NR SI scheduling.  Positioning WI has in past added 40 new posSIBs. So, it should be the responsible group at least to motivate the need of flexibility in SI scheduling so that all these posSIBs can be broadcasted timely; i.e without much delay.  At least RAN2 should acknowledge that delays in broadcast would incur latency in positioning TTFF and even after TTFF. |
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**Q4-2: If your answer to Question 4-1 was "Yes", please provide your views: e.g. performance evaluation of the solutions above, or specifying the solutions above in detail.**

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| **Company name** | **Comments** |
| Ericsson | Analysis and solution have been provided in R2-2101392.  Even considering a modest posSI scheduling;   * shortest SI window length with 15KhZ numerology would give 5ms SI window length. * The SI periodicity can be any value (rf8, rf16, rf32, rf64, rf128, rf256, rf512). Considering NW uses a moderate periodicity of rf128 for GNSS Almanac which has 3 segments   The total delay would be Periodicty\*NumberOfSegments + NumberOfSegments\*SI\_WindowLenghth = 1280\*3 + 3\*5 = 3885ms.  Broadcast delays are also substantial and cannot be ignored. Broadcast latency is based upon the configured SI Window length and periodicity, number of posSIB segments and number of posSI that UE has to acquire. Some posSIBs can be considered as part of TTFF whereas some are updated frequently, and thus broadcast delays impacts latency during TTFF and also after TTFF i.e also during positioning estimation. Latency will incur if NW is unable to provide small periodicity (interval) and SI Window.  Flexibility in NW on posSI scheduling may reduce latency such as configuring positioning specific SI Window or scheduling different segments of posSIB back to back.  For above example the total delay would be:  NumberOfSegments\*SI\_WindowLenghth = 3\*1 = 3ms; (Considering posSI Window of 1ms) |
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**Q4-3: If your answer to Question 4-1 was "Yes", do you recommend broadcast delay optimization aspect from RAN2 perspective?**

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| **Company name** | **Agree/Disagree** | **Comments** |
| Ericsson | Agree | At least RAN2 should acknowledge that the positioning procedure can be delayed when UE has to acquire several posIS and posSIBs which have several segments and when the periodicity and SI Window configured values are large. Even if we do not capture min/max that was captured for end to end delay; we should note the factors that can influence the delay such as SI Window, Periodicy, posSIB segments, number of posSI that UE has to acquire. |
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### 2.3.2 The additional delay incurred by Beam Failure and NLOS

This new proposal on beam failure and NLOS effects is highly related with RAN1. But considering this is the last meeting for Rel-17 SI, RAN2 may discuss it here.

Based on R2-2100933, single or multiple beam/TRP failures that involve DL-PRS transmissions can impact the overall positioning performance and incur additional latency, including RAT-dependent positioning techniques that rely on DL and UL positioning measurements. In addition, the latency evaluations performed by RAN1 and RAN2, did not consider the additional delays incurred through retransmissions of the measurement report, which can affect the overall end-to-end latency.

**Observation 6:** Beam failure events and measurement report retransmissions can introduce additional delays, which may affect the end-to-end latency of determining a UE’s location estimate.

Also, for Rel-17 IIoT positioning, other non-ideal positioning radio events may occur such as the effect of multiple NLOS beams/multipath components or a lack of suitable LOS beams will impact the quality of the DL-PRS measurements performed at UE and thus decrease the computed positioning accuracy at the LMF (UE-assisted positioning) or at the UE (UE-based positioning). This is an additional concern since it has been established that certain indoor factory setting have a high probability of NLOS components.

**Observation 7:** NLOS TRPs/links can incur additional latency in terms of beam reselection procedures, request of PRS configuration and thus affect the accuracy of a location estimate.

Below is the proposal from Lenovo, Motorola Mobility:

R2-2100933 **Proposal 7:** RAN2 to study mechanisms for mitigating the effects of beam failure and NLOS effects, which can impact the end-to-end positioning latency.

**Rapporteur’s comments:** It seems that there is no clear evaluation on latency and clear candidate latency reduction sultion in the contribution.

**Q5-1: Do you agree mechanisms for mitigating the effects of beam failure and NLOS effects as one of aspects of latency reduction?**

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| **Company name** | **Agree/Disagree** | **Comments** |
| Qualcomm |  | We understand this is related to the reliability of the communication link? If so, it has generally an impact on latency, but seems out of scope of the positioning WI. |
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**Q5-2: If your answer to Question 5-1 was "Yes", please provide your views: e.g. performance evaluation of the solutions above, or specifying the solutions above in detail.**

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| **Company name** | **Comments** |
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## 2.4 Text Proposals for high layer latency analysis for NR positioning enhancements

This section is text proposals for the TR 38.857 clause 8.2 Performance analysis of studied NR positioning enhancements. Observations from companies are captured here based on the contributions. Companies are invited to review these text proposals here.

**--------------------------------Text Proposal #6-----------------------------------------------------------------------------------**

# 2 References

[26] 3GPP TS 38.901 Study on channel model for frequencies from 0.5 to 100 GHz (Release 16)

[X1] R2-2010096 NR Positioning Latency Analysis and Enhancements, Qualcomm Incorporated

[X2] R2-2009023 Solution directions to reduce end-to-end latency, Intel Corporation

[X3] R2-2009039 Discussion on positioning enhancement, vivo[X4] R2-2009897 Considerations on potential positioning enhancements, Sony

[X5] R2-2101392 Discussion on Latency Aspects Ericsson

[X6] R2-2008810 Further discussion on enhancements for commercial use cases, CATT

**--------------------------------End of Text Proposal #6-------------------------------------------------------------------------------**

**--------------------------------Text Proposal #7-----------------------------------------------------------------------------------**

## 8.2 Performance analysis of studied NR positioning enhancements

*¨*This clause presents the observations made by sources regarding the studied NR positioning enhancements. Detailed results can be found in annex C.2.

### 8.2.3 High layer analysis for NR positioning enhancements

#### 8.2.3.1 Request and response of positioning assistance data aspect

##### 8.2.3.1.1 Observations from source [X1]

Table 8-x: Latencies for Deferred MT-LR Event Reporting.

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|  | End-to-End Latency [ms] | | |
| LMF only | | |
| Baseline | Configuration Signalling in Advance | Configuration Signalling in Advance for DL-only Positioning |
| UL+DL Positioning | 284-535.5 | 164-320 | NA |
| UL-only Positioning | 221-448 | 139-287.5 | NA |
| DL-only Positioning | 218-402.5 | 124-229.5 | 72-135.5 |

An end-to-end latency target of 100 ms can be achieved for an Deferred MT-LR with configuration signalling in advance for DL-only positioning and with the best case assumptions; however, this target latency cannot be achieved for the worst case assumptions.

##### 8.2.3.1.2 Observations from source [X2]

Based on latency analysis table, we could see:

1 LPP capability exchange (step 1, 2): 33-88.5 ms

2 SRS configuration+activation (step 3-8): 66- 133ms

3 SRS measurement request (step 9): 13-29 ms

* Processing delays: 9 ms
  + gNB: TgNBProc-NRPPa= 3ms
  + AMF: TAMFProc= 3ms
  + LMF: TLMFProc= 3ms
* Signalling delay:4-20ms
  + gNB-AMF: TgNB-AMF= 3-10ms
  + AMF-LMF: TAMF-LMF= 1-10ms

4 LPP assistance data (step 11): 28-44.5 ms

The following solutions can be considered for latency reduction of NR positioning solutions from RAN2 perspective:

Pre-configuration and minimization of DL/UL transactions (can reduce the latency caused by 2, 4 as above)

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

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

#### 8.2.3.2 Measurement report optimization aspect

##### 8.2.3.2.1 Observations from source [X3,X5]

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).

If this procedure can be used for PRS period reporting, then signals and multiple configuration latency can be saved. And this pre-allocated grant should adapt to the PRS period, so the best latency result is performed.

LMF configures the measurement periodicity; i.e the interval when the UE shall report the measurements. LMF should provide the configuration info to gNB so that gNB can configure the UL grant accordingly. However, this requires RAN3 input as it is over NRPPa.

##### 8.2.3.2.2 Observations from source [X4]

We consider 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 minimum.

In case configured grant is not deployed, we can also consider the UE to skip scheduling request (SR) transmission. In addition, as the process in the legacy approach, it is not guaranteed that the gNB receives or immediately allocate the uplink resources (PUSCH). This will further increase the latency. A method to reduce the latency is to configure the UE to monitor downlink control channel (PDCCH) containing uplink grant after the measurement gap.

#### 8.2.3.3 Capability procedure aspect

##### 8.2.3.3.1 Observations from source [X2]

|  |  |  |
| --- | --- | --- |
| **Positioning technique [Multi-RTT] [UE-A] Figure 3** | | |
| **Latency Component** | **Value Range (ms)** | **Description of Latency Component** |
| Step 1 LPP Request capabilities | 18-34 | TLMFProc+ TAMF-LMF+ TAMFProc +TgNB-AMF + TgNBProc-NAS/LPP +TUE-gNB+ TUEProc-RRCDLInfo  Processing delays: 14ms  - UE: TUEProc-RRCDLInfo= 5ms  - gNB: TgNBProc-NAS/LPP= 3ms  - AMF: TAMFProc= 3ms  - LMF: TLMFProc= 3ms  Signalling delay:4-20.5ms  - UE-gNB: TUE-gNB= 0-0.5ms  - gNB-AMF: TgNB-AMF= 3-10ms  - AMF-LMF: TAMF-LMF= 1-10ms  Note, the LPP capability processing delay is counted together in response message. |
| Step 2 LPP Provide Capabilities | 25-54.5 | TLMFProc+ TAMF-LMF+ TAMFProc +TgNB-AMF + TgNBProc-NAS/LPP +TUE-gNB+  TUEProc-RRCULInfo+ TUEProc-LPPCapab  Processing delays: 21-34ms  - UE:  TUEProc-RRCULInfo= 2-5ms  TUEProc-LPPCapab= 10-20ms  - gNB: TgNBProc-NAS/LPP= 3ms  - AMF: TAMFProc= 3ms  - LMF: TLMFProc= 3ms  Signalling delay:4-20.5ms  - UE-gNB: TUE-gNB= 0-0.5ms  - gNB-AMF: TgNB-AMF= 3-10ms  - AMF-LMF: TAMF-LMF= 1-10ms |

1 LPP capability exchange (step 1, 2): 33-88.5 ms

The following solutions can be considered for latency reduction of NR positioning solutions from RAN2 perspective:

1. Skip the capability procedure (can reduce the latency caused by 1 as above)

##### 8.2.3.3.2 Observations from source [X5]

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. UE provide the UE positioning capability to the AMF in an un-solicited manner



Additionally, AMF may fetch it from UE. An example illustrating MO-LR case; the highlighted in red would be new steps.



##### 8.2.3.3.3 Observations from source [X6]

The capabilities of UEs may be reported to core network before the location request. The process related with capabilities can be removed for all Positioning scenarios, so the latency of these processes will be reduced.

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.

When LMF needs the location capabilities of UE, AMF may forward the capabilities of this UE to LMF after step 10 LMF Selection, before step 12 UE positioning in Figure 6.1.2-1: 5GC-MT-LR Procedure for the commercial location services.



#### 8.2.3.4 Broadcast Delay aspect

Even considering a modest posSI scheduling;

* shortest SI window length with 15KhZ numerology would give 5ms SI window length.
* The SI periodicity can be any value (rf8, rf16, rf32, rf64, rf128, rf256, rf512). Considering NW uses a moderate periodicity of rf128 for GNSS Almanac which has 3 segments

The total delay would be Periodicty\*NumberOfSegments + NumberOfSegments\*SI\_WindowLenghth = 1280\*3 + 3\*5 = 3885ms.

Broadcast delays are also substantial and cannot be ignored. Broadcast latency is based upon the configured SI Window length and periodicity, number of posSIB segments and number of posSI that UE has to acquire. Some posSIBs can be considered as part of TTFF whereas some are updated frequently, and thus broadcast delays impacts latency during TTFF and also after TTFF i.e also during positioning estimation. Latency will incur if NW is unable to provide small periodicity (interval) and SI Window.

Flexibility in NW on posSI scheduling may reduce latency such as configuring positioning specific SI Window or scheduling different segments of posSIB back to back.

For above example the total delay would be:

NumberOfSegments\*SI\_WindowLenghth = 3\*1 = 3ms; (Considering posSI Window of 1ms)

**--------------------------------End of Text Proposal #7-------------------------------------------------------------------------------**

Text proposal#6 and #7 are captured from contributions of companies. These text proposals will be submitted in clause 8.2 Performance analysis of studied NR positioning enhancements in TR 38.857.

**Please Note: Only when the text proposals in section 2.1 agreed, the relative aspect in text proposals#6&7 will be captured accordingly in clause 8.2.**

**Q6-1: Do you agree with the text proposals#6&7 if your answer of Q1-1, Q2-1, Q3-1 is/are yes accordingly? Please provide your comments/suggestion on these texts.**

|  |  |  |
| --- | --- | --- |
| **Company name** | **Agree/Disagree** | **Comments** |
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# 3 Conclusion

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

**TBD**

# 4 References

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5. R2-2008810 Further discussion on enhancements for commercial use cases, CATT
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7. R2-2009001 Report of [Post111-e][625][POS] End-to-end latency analysis (Intel), Intel Corporation
8. R2-2009023 Solution directions to reduce end-to-end latency, Intel Corporation
9. R2-2010096 NR Positioning Latency Analysis and Enhancements, Qualcomm Incorporated
10. R2-2010276 Discussion on IDLE INACTIVE pos, on-demand PRS and latency analysis, Huawei, HiSilicon
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12. R2-2010072 Enhancements for commercial use cases, Ericsson
13. R2-2009039 Discussion on positioning enhancement, vivo
14. R2-2009137 Discussion on positioning enhancements for commercial use cases, Spreadtrum Communications
15. R2-2009577 Positioning enhancements on RRC idle/inactive UE and latency reduction, Beijing Xiaomi Electronics
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18. R2-2008261 [AT111-e][612][POS] Assumptions for analysis of commercial use cases, Ericsson
19. R2-2101950 Summary of AI 8.11.2.1 Latency analysis and latency enhancements CATT
20. R2-2100933 On Positioning Latency Reduction Solutions Lenovo, Motorola Mobility
21. R2-2101392 Discussion on Latency Aspects Ericsson

# 5 Participants

|  |  |
| --- | --- |
| **Company Name** | **Participant name/contact** |
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# 6 Annex

The agreement on latency in potential positioning enhancements after RAN1 #103-e meeting is below:

|  |
| --- |
| Agreement:  Capture the following in the TR:   * The enhancements of signaling & procedures for reducing NR positioning latency are recommended for normative work, including DL and DL+UL positioning methods   + The details of the solutions are left for further discussion in normative work, which may include the following aspects:     - Latency reduction related to the measurement gap     - Latency reduction related to the reporting and request of the measurements (e.g., via RRC signaling, MAC-CE and/or physical layer procedure, and/or priority rules)     - Latency reduction related to measurement time * The following enhancements of signaling & procedures for reducing NR positioning latency can be studied and specified, if needed   + Latency reduction related to the request and response of positioning assistance data (e.g., via RRC signaling, MAC-CE and/or physical layer procedure)   + Latency reduction related to the reception of DL PRS (e.g., priority rules for the reception of DL PRS) * No assumptions are made on whether the LCS architecture specified in TS 23.273 is enhanced or not. |

There is no any agreement on latency in RAN #90-e and no relative objective is added in new WID of ePOS [2].