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

Electronic, November 1-12, 2021

**Agenda item:** 8.11.3

**Source:** OPPO

**Title:** [AT116-e][625][POS] Proposals from RRC\_INACTIVE positioning summary

**Document for:**  Discussion and Decision

# 1 Introduction

This document aims at capturing views related to the following e-mail discussion:

* [AT116-e][625][POS] Proposals from RRC\_INACTIVE positioning summary (OPPO)

 Scope: Discuss the proposals from the agenda item summary and identify agreeable aspects.

 Intended outcome: Report to CB session

 Deadline: Thursday 2021-11-11 0100 UTC

Companies are invited to provide their views on the questions by 2021-11-10 0100 UTC.

In [17], the contributions [1]-[16] submitted in Agenda Item 8.11.3 RRC\_INACTIVE have been summarized with several proposals. And in this document, we will collect companies’ views on the proposals in the summary document.

1. R2-2109461 Discussion on positioning in RRC INACTIVE state ZTE
2. R2-2109758 Supporting positioning in RRC\_INACTIVE state OPPO
3. R2-2109759 Discussion on UL Positioning methods in RRC\_INACTIVE state OPPO
4. R2-2109825 On Positioning in RRC\_INACTIVE state Lenovo, Motorola Mobility
5. R2-2109918 Discussion on RRC Inactive mode Positioning Ericsson
6. R2-2109980 Discussion on UL positioning in RRC\_INACTIVE vivo
7. R2-2110021 Support of UL&UL+DL positioning in RRC\_INACTIVE Intel Corporation
8. R2-2110174 Way-forward for RRC\_INACTIVE positioning Huawei, CATT, China Unicom, CMCC, Fraunhofer, Futurewei, HiSilicon, Intel Corporation, Spreadtrum Communications, OPPO, VIVO, Xiaomi, ZTE Corporation
9. R2-2110249 UE Positioning in RRC\_INACTIVE mode Fraunhofer IIS; Fraunhofer HHI
10. R2-2110337 Discussion on the measurement reporting in RRC\_INACTIVE Samsung
11. R2-2110360 Considerations on positioning RRC Inactive Sony discussion Rel-17
12. R2-2110823 Remaining issues for positioning of UEs in RRC\_INACTIVE State Qualcomm Incorporated
13. R2-2110929 Discussion on Positioning in RRC INACTIVE state InterDigital, Inc.
14. R2-2110930 Discussion on reporting of positioning information using SDT InterDigital, Inc.
15. R2-2111076 Considerations on Positioning in RRC\_INACTIVE state CMCC
16. R2-2111106 Discussion on positioning for UEs in RRC Inactive Xiaomi
17. R2-2111251 Summary for AI 8.11.3 on positioning in RRC\_INACTIVE OPPO discussion

# 2 Contact from companies

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# 3. General issue and DL positioning in RRC\_INACTIVE

## 3.1 Location service type

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

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| ZTE [1] | Proposal 1: Support all location service types from RAN2 perspective including MT-LR, MO-LR, NI-LR and deferred MT-LR. |
| Xiaomi [16] | Proposal 1: Both MO-LR, MT-LR and deferred MT-LR can be supported for RRC inactive UE. |

Based on the contributions proposed above, the following proposal was made in [17] concerning location service type in RRC\_INACTIVE:

**Proposal 1: Support MT-LR, MO-LR, NI-LR and deferred MT-LR for RRC\_INACTIVE state.**

Companies are invited to express their views on the above proposal:

**Question 1: Do companies agree to support the location service types of MT-LR, MO-LR, NI-LR and deferred MT-LR for RRC\_INACTIVE state?**

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## 3.2 Stage2 procedure for RRC\_INACTIVE positioning

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

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| Qualcomm [12] | Proposal 8: Capture the procedures in Annex A and Annex B of R2-2108383 [2] for the LPP PDU and LCS message transfer with SDT in RRC\_INACTIVE state, respectively, in TS 38.305 [6].Proposal 2: Send an LS to SA2 including the baseline procedure for DL-only and RAT-independent positioning in RRC\_INACTIVE state as shown in Annex A of this contribution requesting SA2 to determine any SA2 specification impacts. A draft response LS is proposed in R2-2110824 [4].  |

Based on the above contribution as well as companies’ feedback of the summary document, the following proposals were made in [17]:

**Proposal 2:** **RAN2 discuss whether to capture the following procedures in TS 38.305:**

* **LPP PDU and LCS message transfer with SDT in RRC\_INACTIVE state;**
* **DL and RAT-independent positioning in RRC\_INACTIVE state;**
* **UL/ UL+DL positioning in RRC\_INACTIVE state.**

**Proposal 4: Send LS to SA2 including the baseline procedure for RAT-dependent and RAT-independent positioning.**

Companies are invited to express their views on the above proposals:

**Question 2: Do companies agree to capture the following procedures in TS 38.305?**

1. **LPP PDU and LCS message transfer with SDT in RRC\_INACTIVE state (Annex D);**
2. **DL and RAT-independent positioning in RRC\_INACTIVE state (Annex A);**
3. **UL/ UL+DL positioning in RRC\_INACTIVE state (Annex B/C).**

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**Question 3: Do companies agree to send LS to SA2 including the baseline procedure of both RAT-dependent and RAT-independent positioning?**

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## 3.3 DL assistance data transfer

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

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| OPPO [2] | Proposal 1 For positioning in RRC\_INACTIVE state, the positioning assistance data can be delivered to UE in the following ways: a) positioning system information, b) pre-configured when UE in RRC\_CONNECTED state; c) send to UE during ongoing SDT procedure. |
| Xiaomi [16] | Proposal 2: The following options can be considered for different use cases to configure positioning assistance data for RRC Inactive UE:Option 1: The existing deferred MT-LR procedureOption 2: The pre-configured positioning assistance dataOption 3: The gNB broadcasts posSIBOption 4: The existing LPP provide assistance data message sent to UE directly when there is ongoing SDT |

Based on the above contributions, the following proposal was made in the summary document [17]:

**Proposal 3: For positioning in RRC\_INACTIVE state, the positioning assistance data can be delivered to UE through the following ways:**

* **the existing deferred MT-LR procedure;**
* **positioning system information, i.e. posSIB;**
* **pre-configure assistance data when UE in RRC\_CONNECTED state;**
* **send to UE in RRC\_INACTIVE during ongoing SDT procedure.**

Companies are invited to give their views on the above proposal:

**Question 4: Do companies agree with the following approaches for DL positioning assistance data delivery:**

* **Option 1: the existing deferred MT-LR procedure;**
* **Option 2: positioning system information, i.e. posSIB;**
* **Option 3: pre-configure assistance data when UE in RRC\_CONNECTED state;**
* **Option4: send to UE in RRC\_INACTIVE during ongoing SDT procedure.**

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# 4. UL and UL+DL positioning in RRC\_INACTIVE

## 4.1 Stage 2 procedure for UL/ UL+DL positioning in RRC\_INACTIVE state

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

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| Huawei, CATT, China Unicom, CMCC, Fraunhofer, Futurewei, HiSilicon, Intel Corporation, Spreadtrum Communications, OPPO, VIVO, Xiaomi, ZTE Corporation [8] | Proposal1: Adopt the stage2 procedure in Section 5 as baseline for UL and UL+DL positioning in RRC\_INACIVE. |
| vivo [6] | Proposal 4: Capture the procedure of UL positioning with semi-persistent SRS in RRC\_INACTIVE into the stage 2 specification.  |
| Qualcomm [12] | Proposal 3: The baseline procedure for UL/ UL+DL positioning in RRC\_INACTIVE state should be based on the "Low Power Periodic and Triggered 5GC-MT-LR Procedure" as specified in Clause 6.7 in TS 23.273[3] but using NR SDT instead of LTE EDT. In particular, the location request and assistance data information are provided during the positioning initiation phase and there is (normally) no need for an LMF to obtain additional location measurements from the UE or from the NG-RAN after an Event Report (with location measurements) has been received (i.e., the same as for the DL-only baseline procedure).Proposal 4: Support the UE triggering of SRS transmission for UL positioning (if requested/allowed by an LMF during the "location preparation phase") with an RRC message (e.g., LocationMeasurementIndication or a new message) provided along with an RRC Resume Request at SDT initiation. Proposal 5: Support pre-configuration of UL SRS during the location preparation phase. One or more SRS configurations, each associated with an identifier, can be provided to the serving gNB/UE during the location preparation phase and "activated" by the serving gNB when SRS is needed.Proposal 6: Support exchange of UE positioning context over Xn interface for positioning of UEs in RRC\_INACTIVE state. The UE positioning context includes at least the pre-configured SRS configurations.Proposal 7: The Deferred 5GC-MT-LR Procedure with SDT for UL+DL positioning in Annex B, Procedure 1 is used as baseline for further work.NOTE 1: Some details may depend on further progress of SDT work item.NOTE 2: Whether such a procedure needs to be captured in Stage 2 specification or not can be decided later when the procedure has been fully developed/agreed. That is, the procedure can be considered as "running baseline".NOTE 3: Once the procedure is stable from RAN2 perspective, send an LS to SA2 including the baseline procedure. |

Regarding to the stage 2 procedure for UL/ UL+DL positioning in RRC\_INACTIVE state, currently we have two solutions on the table:

* Solution 1: proposed by Qualcomm as in Annex B
* Solution 2: proposed by Huawei, CATT, China Unicom, CMCC, Fraunhofer, Futurewei, HiSilicon, Intel Corporation, Spreadtrum Communications, OPPO, VIVO, Xiaomi and ZTE Corporation as in Annex C

Considering the significant majority view, we made the following proposal in [17]:

**Proposal 9: Adopt the stage2 procedure in Annex C as baseline for UL and UL+DL positioning in RRC\_INACIVE.**

Companies are invited to express their views on the above proposal:

**Question 5: Can we adopt the stage2 procedure in Annex C as baseline for UL and UL+DL positioning in RRC\_INACIVE?**

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## 4.2 SRS configuration

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

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| ZTE [1] | Proposal 4: Support SRS configuration carried by• SDT DL RRC messageo Message B or 4 can be considered in the case when 2 or 4 step RACH based access is chosen for SDT• RRCRelease with SuspendConfig• SRS configuration in RRC\_CONNECTED |
| vivo[6] | Proposal 1: The gNB can configure the UE with semi-persistent SRS by RRCRelease with suspendConfig. |
| Sony [11] | Proposal 2: When the UE is in RRC\_CONNECTED state, the UE receives the configuration of SRS positioning to be used in RRC\_INACTIVE state.  |
| Qualcomm [9] | Proposal 5: Support pre-configuration of UL SRS during the location preparation phase. One or more SRS configurations, each associated with an identifier, can be provided to the serving gNB/UE during the location preparation phase and "activated" by the serving gNB when SRS is needed. |
| CMCC [15] | Proposal 1: For UL positioning, positioning system information is used to deliver the SRS configuration in RRC\_INACTIVE. FFS indication for RRC\_INACTIVE.Proposal 2: RAN2 is kindly asked to confirm that one or multiple set of the SRS configuration can be pre-configured to the RRC\_INACTIVE UE. |
| OPPO [3] | Proposal 1 SRSp for positioning in RRC\_inactive state can be configured in either RRC\_CONNECTED or RRC\_INACTIVE state.Proposal 2 Similar as in RRC\_CONNECTED mode, SRSp is configured by RRC signalling. |
| Fraunhofer [9] | Proposal 5: A list of cells where the SRS configuration is valid in RRC\_INACTIVE state shall be signaled to the UE. Proposal 6: The SRS configuration shall be divided into common and UE-specific for RRC\_INACTIVE. The common configuration shall be coordinated among multiple cells. Proposal 7: For periodic SRS, common SRS configuration may be provided once and receiving the UE-specific part via SDT in RRC\_INACTIVE shall trigger the periodic SRS.  |

Based on the contributions above, the following proposal is given in the summary document [17]:

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| **Proposal 5: SRS for positioning in RRC\_INACTIVE state can be configured through the following ways:*** **SDT DL RRC message**
	+ - * **Msg B / Msg 4 of RA-SDT**
* **RRCRelease with SuspendConfig**
* **pre-configure positioning SRS in RRC\_CONNECTED**
* **positioning system information, i.e. posSIB**

**FFS whether UE can be configured with more than one SRS configurations for RRC\_INACTIVE positioning.** |

Companies are invited to express their views on the above proposal:

**Question 6: Do companies agree with the following options on configuring SRS** **for positioning in RRC\_INACTIVE state:**

* **Option 1: SDT DL RRC message, i.e. Msg B / Msg 4 of RA-SDT**
* **Option 2: RRCRelease with SuspendConfig**
* **Option 3: pre-configure positioning SRS in RRC\_CONNECTED**
* **Option 4: positioning system information, i.e. posSIB**

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**Question 7: Do companies agree that UE can be configured with more than one SRS configurations for RRC\_INACTIVE positioning?**

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## 4.3 SRS type in RRC\_INACTIVE

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

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| ZTE[1] | Proposal 3: RAN2 confirms the support of periodic SRS and semi-persistent SRS in RRC\_INACTIVE state.Proposal 5: For UL/DL+UL positioning in RRC INACTIVE, periodic SRS or semi-persistent SRS should start to be transmitted after RRCRelease signalling.If SRS BWP/SCS configured by RRCRelease with SuspendConfig is not aligned with SDT BWP/SCS, SRS should not be transmitted during SDT active period |
| Ericsson [5] | Proposal 6 Aperiodic UL SRS Transmission in Inactive mode is not supported. |
| vivo [6] | Proposal 1: The gNB can configure the UE with semi-persistent SRS by RRCRelease with suspendConfig.Proposal 2: The SP Positioning SRS Activation MAC CE command can be sent along with the configuration of semi-persistent SRS when gNB releases the UE to RRC\_INACTIVE.Proposal 3: gNB can choose not to send the SP Positioning SRS Deactivation MAC CE command to the UE in RRC\_INACTIVE. |
| Intel [7] | Proposal 1: RAN2 confirms that semi-persistent SRS is supported for UEs in RRC\_INACTIVE.Proposal 2: The UE can transmit SRS (semi-persistent, periodic SRS) in RRC\_INACTIVE if configured by the network. It is unrelated to whether SDT is configured or not.Proposal 3: Follow Rel-17 SDT framework for INACTIVE UL positioning: If the UE initiated data transmission using UL SDT, the network can send SRS activation command (MAC CE), (if UL positioning is supported) to the UE.  Otherwise, if UE did not initiate UL SDT, rely on legacy operation, i.e. the network shall transition the UE to RRC\_CONNECTED, e.g. based on RAN paging. |
| Sony [11] | Proposal 1: Support Aperiodic SRS for positioning in RRC\_INACTIVE state.Proposal 3: The configuration of SRS positioning can contain the activation for a UE to transmit periodic SRS positioning when the UE is in RRC\_INACTIVE state.Proposal 4: Support triggering mechanism during RRC\_INACTIVE state to support semi-persistent and aperidic SRS for positioning. |
| OPPO [3] | Proposal 3 AP and SP SRSp are not supported for positioning in RRC\_INACTIVE state. |
| InterDigital [13] | Proposal 5: Support procedure for configuring and activation of semi-persistent SRSp configuration in UE (i.e. via RRC and MAC CE using SDT) for enabling transmission of semi-persistent SRSp in INACTIVEProposal 10: For MO-LR, support providing SRSp configurations (e.g. periodic, semi-perisistent) to UE for performing SRSp transmission in INACTIVE  |

Based on the summary in [17], the following proposals were given:

**Proposal 6: Support SP SRS for positioning in RRC\_INACTIVE state and SP SRS activation MAC CE is used by network to trigger SP SRS transmission.**

**Proposal 7: RAN2 further discuss whether to support AP SRS in RRC\_INACTIVE state.**

Companies are invited to express their views on the above proposal:

**Question 8: Do companies agree to support SP SRSp for positioning in RRC\_INACTIVE state?**

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**Question 9: Do companies think SP SRSp activation MAC CE can be reused for triggering SRSp transmission?**

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**Question 10: Do companies agree to support AP SRSp for positioning in RRC\_INACTIVE state?**

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## 4.4 TA and SRS configuration validity

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

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| Ericsson [5] | Proposal 3 Send a LS to RAN1 to investigate how TA can be adjusted in inactive mode or limit the use case such that inactive mode positioning is valid only for UEs which are fixed.Proposal 4 RAN2 to send a LS to RAN1/RAN4 asking whether UL SRS Tx can be continued or aborted when UE switches from Inactive to connected mode. Proposal 5 RAN2 to send a LS to RAN4 asking UE measurements validity when UE has performed measurements in different RRC states. Should the previous measurements be discarded, or can it be continued after state transition. |
| Intel [7] | Proposal 4: Regarding how to maintain TA for SRS transmission in RRC\_INACTIVE, solution on UL data transmission via CG-SDT in SDT WI can be reused.  |
| vivo [6] | Proposal 5: The SRS configuration for positioning in RRC\_INACTIVE should be valid within a specific area and period.Proposal 6: The validity criteria can be delivered along with the SRS configuration when gNB releases the UE to RRC\_INACTIVE.Proposal 7: The UE should be able to indicate that the SRS is invalid and initiate SRS configuration update for positioning in RRC\_INACTIVE. |
| Huawei, CATT, China Unicom, CMCC, Fraunhofer, Futurewei, HiSilicon, Intel Corporation, Spreadtrum Communications, OPPO, VIVO, Xiaomi, ZTE Corporation [8] | Proposal2: Follow the CG\_SDT approach for Positioning SRS configuration and TA Proposal2.1: The posSRS configuration is released when the UE sends RRCResumeRequest to an gNB other than the gNB where it is released to RRC\_INACTIVE state.  Proposal2.2: UE releases posSRS configuration when TA timer expires in RRC\_INACTIVE.  Proposal2.3: TA timer configuration can be included in RRCRelease with suspendConfig for UL positioning in RRC\_INACTIVE. Proposal2.4: When cell reselection is performed and UE initiates RRC resume procedure to the cell which is different from the cell in which the posSRS is configured, the TA timer configuration for SRS should be released. |
| Sony [11] | Proposal 5: Support to introduce validation scheme when the UE can transmit SRS for positioning in RRC\_INACTIVE state. As part of the validation scheme, the UE can transmit SRS for positioning when the UE is still camp to the same cell or a pre-configured group of cells. |
| Xiaomi [16] | Proposal 7: The CG-SDT TA timer should be reused for UL positioning in RRC inactive. |
| OPPO [3] | Proposal 4 To support UL positioning in RRC\_INACTIVE, reuse SDT TA timer for TA validation.Proposal 5 To support UL positioning in RRC\_INACTIVE, reuse RSRP change based solution for TA validation.Proposal 6 The SRSp configuration is considered as invalid if TA is not valid. |
| Fraunhofer [9] | Proposal 8: UE shall receive several configurations, each configuration has a validity scope and the UE shall be configured to select an applicable configuration corresponding to its coarse location or based on measurement. Proposal 9: The transmission of positioning SRS in RRC\_INACTIVE mode shall be stopped if the UE moves away from validity area (consisting a list of cells) or exceeds the validity timer. Proposal 10: The positioning SRS in RRC\_INACTIVE mode shall be triggered to stop if the RSRP on an associated DL-RS (SSB or PRS) falls below a certain threshold or rises above a certain threshold configured by the network. |
| InterDigital [13][14] | Proposal 5: For UE-based positioning, the UE can send to LMF multiple buffered location estimates (e.g. with timestamps) determined in RRC INACTIVE after transitioning to RRC CONNECTED. Proposal 6: Support configuring of validity conditions/criteria (e.g. TA timer) in UE associated with SRSp configurations intended to be used during RRC INACTIVE stateProposal 7: Support indication to the gNB for a new SRSp configuration if a validity condition/criteria is not satisifiedProposal 9: UE can send an indication (e.g. in MAC CE) to gNB for indicating the detection of a triggering event (e.g. for deferred MT-LR) and initiating activation of semi-persistent SRSp transmission in INACTIVE Proposal 13: Support providing validity condititions/criteria (e.g. list of cells) to UE for ensuring usage of PRS/SRSp configurations in INACTIVE that are valid across different cells/gNBs when making DL-PRS measurements and/or SRSp transmission during mobility |

Based on the proposals above, we have the following proposal in summary document [17]:

**Proposal 8: Follow the CG-SDT approach for Positioning SRS configuration and TA:**

* **The posSRS configuration is released when the UE sends RRCResumeRequest to an gNB other than the gNB where it is released to RRC\_INACTIVE state.**
* **UE releases posSRS configuration when TA timer expires in RRC\_INACTIVE.**
* **TA timer configuration can be included in RRCRelease with suspendConfig for UL positioning in RRC\_INACTIVE.**
* **When cell reselection is performed and UE initiates RRC resume procedure to the cell which is different from the cell in which the posSRS is configured, the TA timer configuration for SRS should be released.**

**FFS whether UE can indicate network for SRS configuration update;**

**FFS on UE behaviour for SRS transmission and measurement reporting after state transition.**

**FFS on whether** **RSRP change based solution is reused for TA validation.**

Companies are invited to express their views on the above proposal:

**Question 11: Do companies agree with the following CG-SDT approach for TA and SRSp configuration maintenance:**

1. **TA timer configuration can be included in RRCRelease with suspendConfig for UL positioning in RRC\_INACTIVE;**
2. **UE releases posSRS configuration when TA timer expires in RRC\_INACTIVE;**
3. **The posSRS configuration is released when the UE sends RRCResumeRequest to an gNB other than the gNB where it is released to RRC\_INACTIVE state;**
4. **When cell reselection is performed and UE initiates RRC resume procedure to the cell which is different from the cell in which the posSRS is configured, the TA timer configuration for SRS should be released.**

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**Question 12: Do companies agree that UE can indicate network for SRS configuration update?**

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**Question 13: Please provide your views on whether the SRS transmission and UE measurement are still valid when UE switches from Inactive to connected mode?**

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**Question 14: Please provide your views on whether RSRP change based TA validation solution in CG-SDT can be reused for positioning in RRC\_INACTIVE?**

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# 5. Other enhancements

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| Lenovo [4] | Proposal 1: RAN2 to support RRC\_INACTIVE reporting of RRM measurements along with other DL-based positioning methods.Proposal 2: RAN2 to at least consider the support of LMF-initiated on-demand DL-PRS in RRC\_INACTIVE state to enable update of the DL-PRS configuration. |
| ZTE [1] | Proposal 2: RAN2 should confirm RAN1’s solution to handle the confliction between DL-PRS and DL-SDT channels/signals reception in RRC\_INACTIVE state, i.e., reception of DL PRS has lower priority than other DL signals/channels. |
| Lenovo [4] | Proposal 7: RAN2 to confirm if the capability information among UEs performing RRC\_CONNECTED or RRC\_INACTIVE positioning will be different and whether special RRC\_INACTIVE capability is necessary. Send LS to RAN1. |

Based on the contributions and proopsals above, we have the following proposal in the summary document [17]:

**Proposal 10: RAN2 further discuss the following issues of positioning in RRC\_INACTIVE:**

* **Whether to support ECID in RRC\_INACTIVE**
* **DL-PRS reception priority**
* **UE capability**

Companies are invited to express their views on the above proposal:

**Question 15: Do companies agree to further study the following aspects for positioning in RRC\_INACTIVE:**

1. **Whether to support ECID in RRC\_INACTIVE**
2. **DL-PRS reception priority**
3. **UE capability**

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# 6. Conclusion

Based on the summary in the previous sections, we propose following:

# Annex A:

Low Power Periodic and Triggered 5GC-MT-LR Procedure with SDT (DL-only and RAT-Independent positioning)



Figure A: Low Power Periodic and Triggered 5GC-MT-LR Procedure with SDT (DL-only and RAT-Independent positioning).

1. Steps 1-21 for the deferred 5GC-MT-LR procedure for periodic or triggered location events specified in TS 23.273, clause 6.3.1 are performed.

 The serving gNB then sends an *RRCRelease* with *suspendConfig* to move the UE to RRC\_INACTIVE state.

2. The UE monitors for occurrence of the trigger or periodic event requested during step 1. The UE determines which positioning method(s) will be used for the detected event from the request in Step 1 (based on the position method(s) included in an LPP Request Location Information message carried in the LCS Periodic-Triggered Invoke Request during Step 1).
When the event is detected (or slightly before) the UE performs the location measurements.

3. The UE sends an RRC UL Information Transfer message containing an UL NAS Transport message along with the RRC Resume Request with SDT.
The UE includes the LCS Event Report and LPP Provide Location Information (PLI) message in the payload container of the UL NAS Transport message, and the Deferred Routing Identifier received during Step 1 in the Additional Information of the UL NAS Transport message as defined in TS 24.501.
The RRC message as well as the embedded LPP PLI may include the *moreMessagesOnTheWay* flag [TS 37.355].

NOTE 1: The *moreMessagesOnTheWay* flag would be included when not all the location measurements obtained at step 2 can be included in the LPP PLI message.

NOTE 2: The *moreMessagesOnTheWay/noMoreMessages* flag in the RRC Resume Request would indicate whether the serving gNB should wait for a response from the serving AMF before sending the RRC Release at step 7c and may further indicate whether the UE will send additional UL messages prior to such a response from the serving AMF.

4. The serving gNB sends the SS Event Report with the LPP PLI message in an NGAP Uplink NAS Transport message to the serving AMF. The AMF determines the LMF from the Deferred Routing Identifier received in the Additional Information IE of the UL NAS TRANSPORT message and forwards the LCS Event Report with embedded LPP message via triggering Namf\_Communication\_N1MessageNotify service operation towards the LMF. The AMF also includes the Payload Container Type and the Correlation Identifier set to the Deferred Routing Identifier.

NOTE 3: If the *moreMessagesOnTheWay* flag was provided in step 3, the LMF waits until all LPP message segments were received before sending the LCS Event Report Acknowledgement at step 7.

5. If the *moreMessagesOnTheWay* flag was provided in step3, the UE sends the additional LPP PLI message segments in the SDT subsequent data transmission phase.
The UE includes the LPP PDU in the payload container of an UL NAS Transport message, and the Deferred Routing Identifier, which has been received in step 1, in the Additional Information of the UL NAS Transport message defined in TS 24.501. The UE then sends the UL NAS Transport message to the serving NG-RAN node in an RRC UL Information Transfer message.

6. If step 5 occurred, the serving gNB sends the LPP PLI message in an NGAP Uplink NAS Transport message to the serving AMF. The AMF determines the LMF from the Deferred Routing Identifier received in the Additional information IE of the UL NAS TRANSPORT message and forwards the LPP PLI message via triggering Namf\_Communication\_N1MessageNotify service operation to the LMF. The AMF also includes the Payload Container Type and the Correlation Identifier set to the Deferred Routing Identifier.

NOTE 4: The Payload container type is set to "LPP message container" whereas the Payload container type at step 4 was set to "LCS message container". The LMF would realize from the *moreMessagesOnTheWay* flag in the LPP message and from the Deferred Routing Identifier that this message is a continuation of the LPP measurement reporting.

NOTE 5: Steps 5 and 6 may be repeated for providing additional LPP message segments when needed.

7. If step 3 did not include the *moreMessagesOnTheWay* flag or if step 3 did include the *moreMessagesOnTheWay* flag and once the *noMoreMessages* flag in an LPP PLI has been received, the LMF sends an SS Event Report Acknowledgement to the UE via triggering an Namf\_Communication\_N1N2MessageTransfer service operation to the serving AMF at step 7a. Upon receipt of the SS Event Report Acknowledgment, the AMF sets the Payload Container Type to "LCS message container" and includes the Acknowledgement of the Event Report in the payload container in the DL NAS TRANSPORT message sent to the serving gNB at step 7b. The serving gNB then provides the SS Event Report Acknowledgement to the UE at step 7c in an DL Information Transfer message along with the RRC Release message.

8. Steps 28-31 for the deferred 5GC-MT-LR procedure for periodic or triggered location events specified in TS 23.273, clause 6.3.1 are performed.

# Annex B



1. Steps 1-21 for the deferred 5GC-MT-LR procedure for periodic or triggered location events specified in TS 23.273 [8], clause 6.3.1 are performed.

 At Step 15 of this procedure described in Figure 6.3.1-1 of TS 23.273 [8], the LMF may perform one or more positioning procedures to obtain an initial UE location estimate. During this step, the LMF may request and obtain the UE positioning capabilities which may include an indication that the UE can support UL+DL positioning in RRC\_INACTIVE state.

 The LMF may also provide an UL-SRS configuration, or a set of alternative UL-SRS configurations to the serving gNB via an NRPPa Positioning Information Request message. The serving gNB may then send an NRPPa Positioning Information Response message that indicates whether UL positioning can be supported for the UE in RRC\_INACTIVE state. For a subsequent change of anchor gNB, the UL-SRS configuration(s) is sent to the new serving gNB as part of the transfer of a UE context to the new serving gNB.

 The serving gNB then sends an *RRCRelease* with *suspendConfig* to move the UE to RRC\_INACTIVE state.

2. The UE monitors for occurrence of the trigger or periodic event requested during step 1. The UE determines which positioning method(s) will be used for the detected event from the request in Step 1 (based on the position method(s) included in an LPP Request Location Information message carried in the LCS Periodic-Triggered Invoke Request during Step 1).

3. When event reporting is allowed in RRC\_INACTIVE state and after (or slightly before) an event is detected and if CG-SDT resources are not configured or cannot be selected, the UE performs a 2-step or 4-step RACH procedure. In the case of a 2-step RACH, the UE includes an RRC Resume Request message in the PUSCH payload for MsgA; in the case of a 4-step RACH, the UE sends an RRC Resume Request message in msg3 to the gNB.
Otherwise, if CG-SDT resources are configured on the selected UL carrier and are valid, the UE sends an RRC Resume Request message in the CG transmission to the gNB.
The UE sends a "Location Event Indication" along with the RRC Resume Request to trigger UL positioning at the gNB.
UL-SRS is already configured in the UE and anchor gNB during Step 1.

Editor's Note: The "Location Event Indication" may be a new RRC message or an extension of the RRC *LocationMeasurementIndication* message.

4. The serving gNB fetches the UE context from the anchor gNB. The UE context includes the UL-SRS configuration(s) (as determined during Step 1).

5. The serving gNB determines the UL-SRS configuration based on the UE context information received at Step 4b and sends a NRPPa Positioning Information Update message to the LMF via the serving AMF (probably through the anchor gNB).

6. The LMF may send a NRPPa Positioning Activation message (possibly with a starting time) to the serving gNB to request UL-SRS activation in the UE.

7. The serving gNB provides the UL-SRS configuration to the UE along with the RRC Release message over msg4 or MsgB. The message may also include the CG Configuration and a MAC-CE SRS Activation Request (possibly with a starting time).

 NOTE: The UL-SRS configuration at this step may be an index to a pre-configured UL-SRS configuration (during Step 1), or a delta-UL-SRS configuration, etc.

8. The serving gNB sends a NRPPa Positioning Activation Response message to the LMF when activation in the UE was successful.

9. The LMF sends a NRPPa Measurement Request to a group of gNBs incl. the UL-SRS measurement configuration.

10. The UE transmits UL-SRS according to the activated configuration at Step 7.

11. The UE measures the DL-PRS, and each configured gNB at Step 9 measures the UL-SRS.

12. Same as Step 3, but with the RRC Resume Request message including the SS LCS Event Report indicating the type of event being reported. The LCS Event Report includes an LPP Provide Location Information message containing the DL-PRS measurements.

13. The serving gNB sends the SS LCS Event Report to the anchor gNB, which provides the SS LCS Event Report to the LMF (via serving AMF).

14. The gNBs that performed the UL-SRS measurements provide an NRRPPa Measurement Response message to the LMF including the UL-SRS measurements performed at Step 11b.

15. The LMF may send a NRPPa Positioning Deactivation Request message to the anchor gNB which forwards the message to the serving gNB. The serving gNB sends the UL-SRS Deactivation to the UE at Step 15b.

Editor's Note: This may be a downlink message in response to UL SDT.

16. The LMF sends a SS LCS Event Report Acknowledgement to the anchor gNB.

17. The serving gNB provides the SS LCS Event Report Acknowledgement to the UE along with the RRC Release message.

18. Steps 28-31 for the deferred 5GC-MT-LR procedure for periodic or triggered location events specified in TS 23.273 [8], clause 6.3.1 are performed.

# Annex C

### UL solution



1. Steps 1-21 of TS 23.273, Clause 6.3.1 for deferred MT-LR for Periodic or Triggered Location Events are performed.
2. The UE is released by the anchor gNB from RRC\_CONNECCTED to RRC\_INACTIVE by *RRCRelease* with *SuspendConfig*. The UE may be configured with CG-SDT or RA-SDT for small data transmission.
3. The UE monitors for occurrence of the triggered or periodic event requested in step 16 of TS 23.273 Clause 6.3.1.
4. If a certain event is triggered or the periodic timer of the periodic event expires, the UE sends Event Report to the network with Small Data Transmission from the UE to the gNB and then to the LMF.

NOTE: The serving gNB of the UE when UE performs step 4 might be the same or different from the anchor gNB where the UE is released to the RRC\_INACTIVE state. If the serving gNB is the same as the anchor gNB, either RA-SDT or CG-SDT can be performed; if the serving gNB is different from the anchor gNB, only RA-SDT can be performed.

1. When the LMF receives the event report and if it can handle this event report, the LMF returns a supplementary services acknowledgment for the event report to the UE by subsequent DL Small data Transmission from gNB to the UE.
2. If location estimate is needed for the Event Report and the LMF determines to perform UL positioning for the UE based on prior knowledge of the UE capability for UL positioning, the LMF sends NRPPa message POSITIONING INFORMATION REQUEST to the serving gNB of the UE with the field Requested SRS transmission characteristics for the SRS transmission in the UL.
3. After the request from the LMF, according to the Requested SRS transmission characteristics field within POSITIONING INFORMATION REQUEST, the gNB configures the SRS of the UE and send the configuration to the LMF.
4. If the SRS configuration in Step 7 includes Semi-Persistent SRS, LMF sends POSITIONING ACTIVATION REQUEST for the activation of Semi-Persistent SRS. Otherwise, this step is absent.
5. The serving gNB configures the UE with *RRCRelease* message with *SuspendConfig* to keep the UE in RRC\_INACTIVE state. The *RRCRelease* message contains the SRS configuration for UL positioning and TA timer configuration for uplink transmission. If the Semi-Persistent SRS is configured, the serving gNB activates the UL-SRS transmission and sends the NRPPa Positioning Activation Response message.
6. The LMF sends a NRPPa MEASUREMENT REQUEST to a group of TRPs for SRS measurement with the SRS configuration.
7. The UE transmits SRS after it receives the SRS configuration from the serving gNB and the gNBs that have received the NRPPa message for measurement request perform measurement of the SRSs sent by the UE.

NOTE: The UE will release the SRS configuration when the TA timer expires. The network shall take the length of the time it takes to perform the measurement into account in the TA timer configuration.

1. After performing the SRS measurements, the gNBs send measurement results to the LMF with NRPPa message MEASUREMENT RESPONSE.
2. When the SRS transmission stops due to TA timer expires, the UE should send POSITIONING INFORMATION UPDATE to the LMF, indicating the SRS transmission in the UE has stopped.
3. Steps 28-31 of TS 23.273, Clause 6.3.1 for deferred MT-LR for Periodic or Triggered Location Events are performed.

### UL+DL solution



1. Steps 1-21 of TS 23.273, Clause 6.3.1 for deferred MT-LR for Periodic or Triggered Location Events are performed.
2. The UE is released by the anchor gNB from RRC\_CONNECCTED to RRC\_INACTIVE by *RRCRelease* with *SuspendConfig*. The UE may be configured with CG-SDT or RA-SDT for small data transmission.
3. The UE monitors for occurrence of the triggered or periodic event requested in step 16 of TS 23.273 Clause 6.3.1.
4. If a certain event is triggered or the periodic timer of the periodic event expires, the UE sends Event Report to the network with Small Data Transmission from the UE to the gNB and then to the LMF.

NOTE: The serving gNB of the UE when UE performs step 4 might be the same or different from the anchor gNB where the UE is released to the RRC\_INACTIVE state. If the serving gNB is the same as the anchor gNB, either RA-SDT or CG-SDT can be performed; if the serving gNB is different from the anchor gNB, only RA-SDT can be performed.

1. When the LMF receives the event report and if it can handle this event report, the LMF returns a supplementary services acknowledgment for the Event Report to the UE by subsequent DL Small data Transmission from gNB to the UE
2. If location estimate is needed for the Event Report and the LMF determines to perform UL+DL positioning for the UE based on prior knowledge of the UE capability for UL+DL positioning, the LMF sends LPP message *RequestLocationInformation* to the UE via subsequent DL Small Data Transmission from the gNB to the UE.
3. For the UL+DL positioning, the LMF sends NRPPa message POSITIONING INFORMATION REQUEST to the serving gNB of the UE with the field Requested SRS transmission characteristics for the SRS transmission in the UL positioning.
4. After the request from the LMF, according to the Requested SRS transmission characteristics field within POSITIONING INFORMATION REQUST, the gNB configures the SRS of the UE and send the configuration to the LMF.
5. If the SRS configuration in Step 7 includes Semi-Persistent SRS, LMF sends POSITIONING ACTIVATION REQUEST for the activation of Semi-Persistent SRS.
6. The serving gNB sends to the UE the *RRCRelease* message with *SuspendConfig* to keep the UE in RRC\_INACTIVE state. The *RRCRelease* message also contains the SRS configuration for UL positioning and TA timer configuration for uplink transmission. If the Semi-Persistent SRS is configured, the serving gNB activates the UL-SRS transmission and sends the NRPPa Positioning Activation Response message.
7. The LMF sends a NRPPa MEASUREMENT REQUEST to a group of gNBs for SRS measurement including the SRS configuration.
8. The UE sends SRS after it receives the SRS configuration from the serving gNB and the gNBs that have received the NRPPa message for measurement request perform measurement of the SRSs sent by the UE.

NOTE: The UE will release the SRS configuration when the TA timer expires. The network shall take the length of the time it takes to perform the measurement into account in the TA timer configuration.

1. At the same period of time the UE performs SRS transmission, the UE also performs PRS measurement for DL positioning.
2. After performing the SRS measurements, the gNBs send measurement results to the LMF with NRPPa message MEASUREMENT RESPONSE.
3. When the SRS transmission stops due to TA timer expires, the UE should send POSITIONING INFORMATION UPDATE to the LMF, indicating the SRS transmission in the UE has stopped.
4. With Small Data Transmission, the UE sends the LPP message *ProvideLocationInformation* for the sending the PRS measurement results from step 12a to the LMF.
5. After successful reception of the LPP message, the LMF sends an LPP acknowledgement to the UE. The LPP ACK message is sent along with the *RRCRelease* message with *suspendConfig* such that the UE stays in RRC\_INACTIVE.
6. Steps 28-31 of TS 23.273, Clause 6.3.1 for deferred MT-LR for Periodic or Triggered Location Events are performed.

# Annex D:

### 6.4.3 LPP PDU Transfer in RRC\_INACTIVE State using Small Data Transmission

Figure 6.4.3-1 shows the transfer of an LPP PDU between a UE and LMF in the UE-triggered cases when the UE is in RRC\_INACTIVE state and supports Small Data Transmission (SDT).



Figure 6.4.3-1: LPP PDU transfer between UE and LMF in RRC\_INACTIVE state using SDT

**Preconditions:** The conditions of allowing the UE to perform SDT are fulfilled (TS 38.321 [39], TS 38.331 [14]).

0. The LMF sends an LPP PDU to the UE as part of some LPP positioning activity as described in Steps 1-4 in clause 6.4.2, Figure 6.4.2-1.
The serving gNB then sends an *RRCRelease* with *suspendConfig* to move the UE to RRC\_INACTIVE state.

1. The UE sends an RRC UL Information Transfer message containing an UL NAS Transport message along with the RRC Resume Request with SDT. The UE includes the LPP PDU in the payload container of the UL NAS Transport message, and the Routing Identifier which has been received in step 0 in the Additional Information of the UL NAS Transport message as defined in TS 24.501 [29].

2. The gNB forwards the UL NAS Transport Message to the AMF in an NGAP Uplink NAS Transport message.

3. The AMF invokes the Namf\_Communication\_N1MessageNotify service operation towards the LMF indicated by the Routing Identifier received in step 2. The service operation includes the LPP PDU received in step 2 together with the LCS Correlation ID in the N1 Message Container as defined in TS 29.518 [28].

4. If the LMF needs to send an LPP message to the UE in response to the received LPP PDU at Step 3, the LMF invokes the Namf\_Communication \_N1N2MessageTransfer service operation towards the AMF to request the transfer of an LPP PDU to the UE. The service operation includes the LPP PDU together with the LCS Correlation ID in the N1 Message Container as defined in TS 29.518 [28].

5. The AMF includes the LPP PDU in the payload container of a DL NAS Transport message, and a Routing Identifier identifying the LMF in the Additional Information of the DL NAS Transport message defined in TS 24.501 [29]. The AMF then sends the DL NAS Transport message to the serving gNB in an NGAP Downlink NAS Transport message defined in TS 38.413 [30].

Either:

6. The gNB sends an RRC Release message with '*suspendConfig*' to the UE. If an DL NAS Transport message has been received in time at Step 5, the RRC Release message is sent along with an RRC DL Information Transfer message. The RRC DL Information Transfer message includes the DL NAS Transport message received at Step 5.

Or:

7. If an DL NAS Transport message has been received at Step 5, the gNB transitions the UE to RRC\_CONNECTED state and sends a RRC DL Information Transfer message including the DL NAS Transport message received at Step 5 to the UE.

### 6.4.4 LCS Message Transfer in RRC\_INACTIVE State using Small Data Transmission

Figure 6.4.4-1 shows the transfer of an LCS message (see TS 24.571 [41]) between a UE and AMF/LMF in the UE-triggered cases when the UE is in RRC\_INACTIVE state and supports Small Data Transmission (SDT).



Figure 6.4.4-1: LCS message transfer between UE and LMF in RRC\_INACTIVE state using SDT

**Preconditions:** The conditions of allowing the UE to perform SDT are fulfilled (TS 38.321 [39], TS 38.331 [14]).

1. The UE sends an RRC UL Information Transfer message containing an UL NAS Transport message along with the RRC Resume Request. The UE includes the Location Services message in the payload container of the UL NAS Transport message. The Payload container type of the UL NAS Transport message is set to 'Location services message container' as defined in TS 24.501 [29]. The Additional Information of the UL NAS Transport message as defined in TS 24.501 [29] depends on the LCS message type and is set according to 24.571 [41].

2. The gNB forwards the UL NAS Transport Message to the AMF in an NGAP Uplink NAS Transport message.

3. If the Additional information IE is included in the UL NAS TRANSPORT message from step 2, the AMF invokes a service operation towards the LMF dependent on the LCS message type as specified in TS 23.273[35] and TS 24.571 [41].

4. If the LMF needs to send an LCS message to the UE in response to the received LCS message at Step 3, the LMF invokes a service operation towards the AMF dependent on the LCS message type as specified in TS 23.273[35] and TS 24.571 [41].

5. If Step 4 occurs or if the AMF needs to send an LCS message to the UE in response to the received LCS message at Step 2, the AMF sends a DL NAS Transport message to the serving gNB in an NGAP Downlink NAS Transport message defined in TS 38.413 [30].

Either:

6. The gNB sends an RRC Release message with *'suspendConfig'* to the UE. If an DL NAS Transport message has been received in time at Step 5, the RRC Release message is sent along with an RRC DL Information Transfer message. The RRC DL Information Transfer message includes the DL NAS Transport message received at Step 5.

Or:

7. If an DL NAS Transport message has been received at Step 5, the gNB transitions the UE to RRC\_CONNECTED state and sends a RRC DL Information Transfer message including the DL NAS Transport message received at Step 5 to the UE.