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

|  |  |  |
| --- | --- | --- |
| Company | Name | Email Address |
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| Qualcomm | Sven Fischer | sfischer@qualcomm.com |

# 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.

|  |  |
| --- | --- |
| 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?**

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Comments |
| Huawei, HiSilicon | No | Currently, we only considered the case of deferred MT-LR and we have never discussed about the other cases. Considering the time, we think we should leave MO-LR, MT-LR and NI-LR to the future releases. |
| vivo | Yes | As all the LCS/LPP message can be transferred in RRC\_INACTIVE, the proposal seems agreeable.If this proposal is agreed from RAN2 perspective, then we suppose SA2 should be informed, as the low power deferred MT-LR procedure may be impacted at least. |
| Intel | Yes | As agreed, RRC state is transparent to LPP, LMF. Do not see the problem to support all location service type. We also do not see the specification impact.  |
| Fraunhofer | Yes | We support all three cases. However, we also agree with Huawei that we have agreed only for the deferred MT-LR so far in discussions. |
| Ericsson | No | Agree with Huawei. This needs to be atleast acked with SA2. We have no time to check with them so this should be considered for Rel-18. SA2 so far only specifies MT-LR deferred procedure for Inactive state. |
| CATT | No | MT-LR and NI-LR are not supported naturally in RRC\_INACTIVE state because UE will enter RRC\_CONNECTED state after paging according to the existing procedure of MT-LR/NI-LR. Enhancement is required to support MT-LR and NI-LR in RRC\_INACTIVE state which are not discussed yet.It seems LCS message of MO-LR can be supported naturally without specification impact. So the location service types of deferred MT-LR and LCS message of MO-LR can be supported for RRC\_INACTIVE state in Rel-17. |
| Xiaomi | Yes | For MO-LR, the uplink LCS/LPP message can be sent by SDT, and the subsequent DL LCS/LPP message also can be sent by on-going SDT. For other location service triggered by network, if there is on-going SDT, the on-going SDT can be used, otherwise the RRC inactive UE will be triggered to transmit to RRC connected.  |
| ZTE | Yes | Agree with Intel that supporting all types introduces no additional spec impact. |
| Qualcomm | No | All the LCS/LPP messages can be transferred in RRC\_INACTIVE, however, this does not imply that all location service types can be supported. MT-LR is triggered by an external LCS client or AF and NI-LR is triggered by an AMF. This cannot be supported with SDT in this Release. MO-LR could at least be instigated in RRC\_INACTIVE with SDT, however, it is questionable and requires SA2 input whether MO-LR procedure can be supported in RRC\_INACTIVE (see 23.273 for the current specification of MT-LR, MO-LR and NI-LR). The event reporting of a deferred MT-LR can be supported in RRC\_INACTIVE, when properly designed, which could extend battery life. E.g., consider a battery powered tracking device which needs to report location at intervals of e.g. 1 hour or whenever there is a location change by more than x metres. The initial location initiation can be performed in connected state with a minuscule power saving (at most) by using inactive state. But the subsequent location reporting will benefit greatly from occurring in inactive state – e.g., for 8760 location reports over 1 year – which will extend battery life. |

## 3.2 Stage2 procedure for RRC\_INACTIVE positioning

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

|  |  |
| --- | --- |
| 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).**

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Comments |
| Huawei, HiSilicon | Yes | We should know how the staeg3 procedures are assembled into the stage2 procedures by giving a complete description of the signalling flow  |
| vivo | Yes with clarification | At least DL/UL/UL+DL positioning procedure in RRC\_INACTIVE should be captured in stage 2 spec to present how does positioning in RRC\_INACTIVE works.The details in Annex A/B/C need further discussion, e.g., the following mechanism in Annex A is not clear, the current flag *moreMessagesOnTheWay* is in LPP message, which is invisible to RRC layer, the flag in the Annex A seems new flag in RRC message, which is not essential.

|  |
| --- |
| 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. |

 |
| Intel | No | Do not see the need to describe SDT+positioning in the stage 2 specification considering SDT and RRC INACTIVE are transparent to positioning procedure.  |
| Fraunhofer | Yes |  |
| Ericsson | No | Yes agree with Intel that SDT and RRC Inactive should be transparent to positioning procedure.If anything is to be captured then it can infact be in SA2 specification similar to existing procedures. |
| CATT | Yes | DL and RAT-independent positioning in RRC\_INACTIVE state (Annex A); and UL/ UL+DL positioning in RRC\_INACTIVE state (Annex B/C) should be discussed and captured because there is specification impact.  |
| Xiaomi | No | We think there is no need to capture the detailed SDT procedures in the TS 38.305. |
| ZTE | No  | Firstly annex A B and C are changes towards 23.273, which is SA2’s spec, no need to capture them in 38.305. Secondly, the procedures introduce nothing new (only the PDU transfer in different transmission state)but adding SDT procedures. To minimize the specification impact, we still suggest to add note under section 5.2.1, 6.4.2, 7.3.2, 7.3.3 and 7.3.4 in 38.305:Note: the above procedures between a UE and a NG-RAN Node can be proceeded in UE RRC\_CONNECTED state or by SDT in RRC\_INACTIVE state as defined in TS 38.331. |
| Qualcomm | Yes, in principle | Otherwise positioning in RRC\_INACTIVE cannot be supported.Some details of all procedures require some further fine-tuning. |

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

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Comments |
| Huawei, HiSilicon | Yes | We should send an LS to SA2 such that SA2 can investigate the SA2 impacts  |
| vivo | Yes with clarification | We shall LS to SA2 when we reach the consensus on the procedures in RAN2. |
| Intel | No | If majority companies want to send the LS. We can simply inform SA2 of RAN2 agreements, e.g. positioning can be performed for the UEs in RRC\_INACTIVE. RRC state, SDT are transparent to positioning procedure,etc.  |
| Fraunhofer | Yes |  |
| Ericsson | Depends | If the objective is to capture the RRC Inactive positioning procedure in SA2 specs. |
| CATT | Yes | We can include the RAN2 agreements in the LS. |
| ZTE | Yes | If other companies think it is necessary to capture annex A B and C in the 23.273, we should ask SA2’s opinion first |
| Qualcomm | Yes | The SA2 specifications currently do not support positioning in RRC\_INACTIVE. Some SA2 updates seem needed. |

## 3.3 DL assistance data transfer

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

|  |  |
| --- | --- |
| 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.**

|  |  |  |
| --- | --- | --- |
| Company | Option(s) | Comments |
| Huawei, HiSIlicon | Option1/2 | We suggest to leave the Option3 out of the discussion now until the discussion for PRS reconfiguration is finalized. If it is agreed, it can be naturally applied here. For Option4, it seems that the currently agreed stage2 baseline for Downlink positioning does not support this.  |
| vivo | 1,2,3,4 with clarification | We think option 1 is a subset of option 3. |
| Intel | All | All are possible based on RAN2 agreements. Also copied RAN2 agreements. Agreements:Any uplink LCS or LPP message can be transported in RRC\_INACTIVE from RAN2 perspective. Follow Rel-17 SDT framework for INACTIVE UL and DL positioning: If the UE initiated data transmission using UL SDT, the network can send DL LCS, LPP message and RRC message (e.g. to configure SRS (TBD on what message is used), if UL positioning 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.  |
| Fraunhofer | All above | For the deferred MT LR and for pre-configured assistance data (Option 3), we need to discuss the validity criteria and validity time. In particular, the validity criteria can be used to support different assistance data pre-configured to the UE out of which the currently applicable assistance data can be selected by the UE based on where the UE currently finds itself in. This could be for example, based on where the UE is currently camped in. Alternatively, the assistance data (already provided to the UE and stored by the UE) can be triggered by the network. **Proposal 1 from [9]: Provide multiple sets of pre-configured assistance data to the UE and select the most suitable one based on validity conditions (e.g. validity area, validity time).**We see the need that the network needs to provision the A/D based on area within the RNA.  |
| Ericsson | 1,2,3 and 4 dependent upon SDT WI | We are also fine with the proposal suggested by Fraunhofer; * Provide multiple sets of pre-configured assistance data to the UE and select the most suitable one based on validity conditions (e.g. validity area, validity time).
 |
| CATT | 1,2,3 | The pre-configure assistance data when UE in RRC\_CONNECTED state is different the AD in existing one shot AD via LPP. The pre-configure assistance data will cover more TRPs than the TRPs configured in the existing one shot AD’s, so the validity area of pre-configure assistance data will help UE search PRS more efficiently.4 can wait for the SDT progress.  |
| Xiaomi | 1,2,3,4 |  |
| ZTE | 1,2,3,4 |  |
| Qualcomm | See comment | The question is not quite clear, but since an LMF is not aware of the UE RRC state, it cannot act differently compared to e.g., Rel-16. If a LMF initiated message can indeed be delivered in RRC\_INACTIVE seems to depend on whether a UE has initiated SDT before that, and therefore, seems rather random and unpredictable by an LMF. |

# 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.

|  |  |
| --- | --- |
| 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?**

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Comments |
| Huawei, HiSilicon | Yes | We think we can adopt this approach as the baseline for R17 with the support from the majority of the companies. We can think about other optimizations in the future release.  |
| vivo | Yes | Proponent for solution 2 as the baseline.Solution 1 can be seen as the enhancement that UE can indicate network for SRS configuration update/request. If there is not enough time for Solution 1, at least Solution 2 should be agreed in this release. |
| Intel |  | We can use it as baseline for further discussion. But we do not see the need to capture it in stage 2. It would be good to make the question separately. So if the question is whether we should capture it into stage 2, our answer is No.If the question is whether we should use it as baseline for further discussion, our answer is yes.  |
| Fraunhofer | Yes | We are happy to go with the majority view here. |
| Ericsson | Agree with Intel, i.e. Yes for discussion without spec impact |  |
| CATT | Yes | Annex C can be the baseline for UL and UL+DL positioning in RRC\_INACIVE for further discussion. |
| Xiaomi |  | Share the same view as Intel. |
| ZTE | Yes | Agree with Intel |
| Qualcomm | No | Before this can be a baseline, at least the following issues need to be corrected:(1) The procedure begins with an Event Report using SDT where the gNB provides the Event Report Acknowledgment in Subsequent DL SDT. However, at this stage, the UE has no measurements to report and therefore, the SDT is complete from UE point of view. Therefore, a gNB may likely complete the SDT with the RRC Release and Event Report Acknowledgement, as it is the case for the DL-only procedure before any positioning procedure can be instigated by an LMF. If the following positioning procedure is to be exectured in RRC\_INACTIVE the UE needs to provide an indication/assistance data to a gNB of an expected DL response and positioning procedure to avoid an RRC\_RELEASE with Event Report ACK (as for DL-only).(2) The UE receives a LPP Request Location Information each time an event is triggered. This is not only inefficient but also rather useless since assistance data are provided in Step 1 anyhow. The LPP Request Location Information should be moved to Step 1 where periodic/triggered location is invoked by an LMF.(3) The procedure ends with an LPP Acknowledgement from an LMF. However, an LMF will send a LPP Acknowledgement only if requested by the UE. It would be rather inefficient if a UE need to request a LPP Acknowledgement in RRC\_INACTIVE, but in any case, also requires that the LPP layer is aware of the RRC state.(4) The procedure seems to support periodic SRS only. However, since an LMF is not aware of the RRC state it is unclear what happens if an LMF requests e.g., semi-persistent SRS.  |

## 4.2 SRS configuration

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

|  |  |
| --- | --- |
| 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]:

|  |
| --- |
| **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**

|  |  |  |
| --- | --- | --- |
| Company | Option(s) | Comments |
| Huawei, Hisilicon | Option2 | For Option1, we think RRCReconfiguration cannot be supported for SDT. For Option3, we have discussed it during the first POS session on preconfiguration and it was not agreed that SRS can be part of the preconfiguration in this release. Same for Option4 |
| vivo | 2,3 | For 1, agree with HW.For 3, Pre-configuration of SRS for latency reduction in RRC\_CONNECTED is not in the scope of this release. While for positioning in RRC\_INACTIVE, the pre-configuration is not precluded.For 4, posSIB is not a good way to configure the SRS as the positioning SRS is configured per UE. |
| Intel | All | Same comments as question 4. In addition, RRCReconfiguration is used to configure SRS in Rel-16. Do not understand why it cannot be used for R17 in RRC\_INACTIVE.  |
| Fraunhofer | All options | We suggest to split the SRS configuration shall be divided into common and UE-specific for RRC\_INACTIVE. The common configuration shall be coordinated among multiple cells. The reception of UE-specific part shall trigger the SRS transmission (periodic) in the RRC\_INACTIVE (e.g. deferred MT-LR) case.  |
| Ericsson | Option 2 |  |
| CATT | 1,2,4 | Option 2 may work.Option 1 and 4 can work together as well. The available SRS of this cell can be broadcast via posSI and gNB may select one of available SRS via msg4/msg B for one UE. |
| Xiaomi | 1,2,3 | The positioning SRS is UE specific, so configured by posSIB is not reasonable. |
| ZTE | all | All of the options can be used to transfer SRS configuration. If option 1 is adopted, we wonder if we should tell SDT the conclusion to see whether other detailed signalling design is needed. |
| Qualcomm | 1,2,3 | How can (UE-specific) SRS be configured via posSIB? If this is supposed to mean pre-configured SRS it would create quite some overhead if PRS for many UEs must be send via posSI, but only a small subset will be applicable to individual UEs. |

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

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Comments |
| Huawei, HiSilicon |  | We think there should be only one SRS-config. But within the SRS-config, there can be multiple SRS resource sets and SRS resources. The details should be up to R1 to decide |
| vivo | No for R17 | We suppose it means on-demand SRS. Not in the scope of R17. |
| Intel | No | Do not see the need.  |
| Fraunhofer | Yes | As long as there is validity criteria associated with different SRS resource sets, then there a single SRS config could be provided. We propose to associate validity criteria (e.g. list of cells) to a SRS resource set. Alternatively, have different SRS configs associated with validity area. |
| Ericsson | No | We should keep the solution simple. One config is enough. |
| CATT | No | Stick to the existing mechanism: one config. |
| Xiaomi | No | One configuration is enough. |
| ZTE | No | It seems no need to introduce multiple SRS configurations for RRC\_INACTIVE.  |
| Qualcomm | Yes | The SRS configurations can be preconfigured while the UE is in RRC\_CONNECTED for use in RRC\_INACTIVE as in Question 6. Even in Rel-16, a UE may receive multiple SRS configs (e.g., for MIMO SRS and positioning SRS). |

## 4.3 SRS type in RRC\_INACTIVE

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

|  |  |
| --- | --- |
| 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?**

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Comments |
| Huawei, HiSIlicon | Yes | Since R1 thinks it is feasible |
| vivo | Yes | RAN1 already claimed the feasibility of SP SRS. How to support SP SRS should be clarified in RAN2. The main difference between the SP SRS and Periodic SRS is that the SR SPS needs to be activated/deactivated by MAC CE. If we agree that the semi-persistent SRS can be configured by RRCRelease with suspendConfig, the UE will enter RRC\_INACTIVE after it receives the SP SRS configuration.For activation, we suppose there are two solutions:- Solution 1: If there is ongoing SDT, the network can send SRS activation command to the UE in INACTIVE. Otherwise, the network shall transition the UE to RRC\_CONNECTED.- Solution 2: Send the Activation MAC CE along with the SRS configuration when gNB releases the UE to RRC\_INACTIVE.For deactivation, we suppose there are two solutions:- Solution 1: If there is ongoing SDT, the network can send SRS deactivation command to the UE in INACTIVE. Otherwise, the network shall transition the UE to RRC\_CONNECTED.- Solution 2: gNB can choose not to send the SP Positioning SRS Deactivation MAC CE command to the UE in RRC\_INACTIVE and only wait for the TA timer to expire. |
| Intel | Yes | Considering RAN2 has agreed to support periodic SRS and RAN1 has confirmed the feasibility to support semi-persistent SRS, we do not see additional efforts to support the semi-persistent SRS compared with periodic SRS for RRC\_INACTIVE UEs. |
| Fraunhofer | Yes |  |
| Ericsson | No | Rel-17 only Periodic UL SRS as we can minimize spec and implementation/verification effort.  |
| CATT | Yes | Share the same understanding as Intel. We do not see additional efforts to support SP SRS. |
| Xiaomi | Yes |  |
| ZTE | Yes |  |
| Qualcomm | Yes | LMF is not aware of RRC state and cannot behave differently in different RRC states. |

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

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Comments |
| Huawei, HiSIlicon | Yes |  |
| vivo | Yes | See above in Q8 |
| Intel | Yes |  |
| Fraunhofer | Yes |  |
| CATT | Yes |  |
| Xiaomi | Yes |  |
| ZTE | Yes |  |
| Qualcomm | Yes | But it must be included in the baseline procedure discussed in Question 5. |

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

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Comments |
| Huawei, HiSIlicon | NO | We don’t see the need to support it in this release based on the supported stage2 baseline |
| vivo | No | no need to discuss it as RAN1 did not claim to support it. |
| Intel | No | RAN1 has no consensus on this.  |
| Fraunhofer | Yes | But in interest of time, we can go with the majority view.  |
| Ericsson  | No |  |
| CATT | No |  |
| Xiaomi | No |  |
| ZTE | No |  |
| Qualcomm | Yes | LMF is not aware of RRC state and cannot behave differently in different RRC states. |

## 4.4 TA and SRS configuration validity

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

|  |  |
| --- | --- |
| 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.**

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Comments |
| Huawei, HiSIlicon | Yes | The above options are to follow the CG-SDT solution which we think can be reused here |
| vivo | Yes with clarification | c) is a subset of d). |
| Intel | Yes |  |
| Fraunhofer |  Comments | For c) and d), we suggest that the UE can continue transmission if it receives timer configuration via SDT. (i.e. only timer is provided via SDT and the rest of the configuration continues to be valid).  |
| Ericsson | Yes | Seems reasonable. |
| CATT | Yes |  |
| Xiaomi | Yes |  |
| ZTE | Yes |  |
| Qulcomm | No | An LMF need to know for how long a UE transmits SRS to e.g., select a proper positioning method, configure TRP measurements, etc. It is unclear what happens if a LMF requests SRS for e.g., 100 periodic SRS transmissions and the UE stops after some timer (unknown to an LMF) expires. |

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

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Comments |
| Huawei, HiSilicon | No | There is no need for this if we go for the option in Annex C |
| vivo | Yes | When the UE moves out of the specific area and the validity criteria are not met, the UE shall not send the SRS anymore. In this case, the LMF cannot get the measurement result and will transition the UE into RRC\_CONNECTED to update the SRS configuration.This indication mechanism can be seen as an enhancement to baseline solution in Annex C. |
| Intel | No | The question is not clear to us. Does that mean, the UE shall trigger the resume procedure to indicate the need of SRS configuration after the release of SRS configuration upon change of cell? If yes, then our thinking is We can handle it similar to HO procedure or reuse the mechanism on handling of CG configuration. For RRC\_INACTIVE, the RAN could be aware of the release of SRS by detecting whether there is SRS transmission from UE or by setting RNA=current cell. This is similar to HO case, i.e. the network can be aware of the cell change. And therefore do not need additional efforts from UE side.. OrWe can wait for agreements from SDT session on handling of CG configuration. So far CG configuration is fully released autonomously by the UE on change of a cell. They may discuss how to trigger the setup of it again in the new cell. We can reuse the mechanism on this.  |
| Fraunhofer | Yes | Our understanding is that the UE chooses one from the multiple configured SRS for positioning, and informs the network of the configuration chosen. |
| CATT | No | The procedure of UL/UL+DL positioning shows that UE indicates event report to CN which will trigger the SRS configuration to this UE. There is no need of more indication from UE. |
| Xiaomi | No |   |
| ZTE | No | If the posSRS configuration is released, UE does not need to indicate for SRS update.  |
| Qualcomm |  | The question is not quite clear. However, if this means the UE can request a SRS for UL positioning as in [12], our answer is Yes. |

**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?**

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Comments |
| Huawei, HiSIlicon | Yes for UE measurement, no for SRS transmission | The SRS transmission should follow the SRS transmission in the UE context and the RRCReconfig in the RRCResume message |
| vivo |  | Not in RAN2 scope, should ask RAN1 and RAN4  |
| Intel | Yes | RRC state is transparent to positioning procedure, and therefore SRS transmission and UE measurement should not be impacted unless the SRS configuration is released by target node.  |
| Fraunhofer | Yes | The validity should depend on time and location of the UE. Switching between the RRC states should not affect the validity. |
| Ericsson | RAN2 cannot say for sure for UE measurements. Need to check with RAN4 | If there are different measurement intervals/duration when UE measurements are performed in connected and inactive state then this will impact the performance and hence RAN4 should be consulted. In connected mode, there is a dedicated gap that is provided whereas in inactive mode UE has to perform the measurement along with other inactive mdoe RRM measurements such as cell reselection etc. Anyhow good to check with RAN4. |
| CATT |  | From RAN2’s procedure perspective, we do not see the limitation on the SRS transmission and UE measurement when UE switches from Inactive to connected mode. But not sure if there is limitation in RAN4’s on measurement when switching from Inactive to connected mode.  |
| Xiaomi |  | Yes from RAN2 perspective, but it needs further check from RAN1 and RAN4. |
| ZTE | Not sure | If SRS configuration is different between RRC\_CONNECTED and RRC\_INACTIVE, SRS configuration may not be valid; Even if they are not valid, it seems no RAN2 spec impact. |
| Qualcomm | Yes | The same as for SRS configuration provided in RRC\_CONNECTED for use in RRC\_INACTIVE (Question 6/7). We cannot see why the opposite state transition can not be supported.We see no reason why the measurements should become invalid, but agree, that this is more a RAN4 issue. |

**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?**

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Comments |
| Huawei, HiSilicon | Yes | It can be reused. There is no PDCCH monitoring to deliver the TA to the UE when there is SRS transmission. Hence, the same rationale applies for SRS transmission as for CG-SDT  |
| vivo | Yes | If agreeable in RAN2, Need further confirm with RAN1. |
| Intel | Yes |  |
| Fraunhofer | Yes | We support the option of the RSRP changes activating / deactivating the SRS. We do not see a need to couple RSRP to TAT and then TAT to activating or deactivating the SRS. The reason is that RSRP could be associated to multiple other parameters (e.g. spatial relation, power control) and not just TAT. Change in RSRP > threshold value 🡺 trigger stop transmissions.  |
| Ericsson | Yes, but | Overall the feature would be limited as Positioning would be for mobile UEs and hence it is clear that the TA would not be aligned for duration long enough to get good reliable measurements and would also cause interference without closed loop power control.Thus RAN2 should also discuss the use case if it is for stationary sort of devices. |
| CATT | Yes |  |
| Xiaomi | Yes |  |
| ZTE | Yes |  |

# 5. Other enhancements

|  |  |
| --- | --- |
| 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**

|  |  |  |
| --- | --- | --- |
| Company | Option(s) | Comments |
| Huawei, Hisilicon | c) | 1. Is not within the scope for the WID. B) can be discussed in R1 first
 |
| vivo | c) | For a), the DL-ECID has been supported as the LPP message can be transferred in RRC\_INACTIVE. The UL ECID depends on whether the measurement report can be transferred in RRC\_INACTIVE, which relies on SDT conclusion.For b), the LS is cc RAN2. Meanwhile, the discussion is still ongoing in RAN1 and RAN4, and the spec impact in RAN2 is not clear. RAN 2 may further discuss based on further conclusions and requirements from RAN1. |
| Intel | C in RAN2B wait for RAN1A out of scope | C) UE capability should be discussed in both RAN1 and RAN2. b) DL PRS reception priority should be discussed in RAN1 first. Wait for the outcome from RAN1;a) To support ECID in RRC\_INACTIVE. We did not agree this during SI discussion, and therefore it is not in the scope of the WI.  |
| Ericsson | None | As LMF should be unaware of RRC State; why would capability differentiaon be needed. Is the capability for gNB; then presumely it is ok? |
| CATT | None | a) is not in the scope. b)waits for RAN1.c) do not see the new required capabilities so far.  |
| Xiaomi | None | If the UE capability means LPP capability, there is no need to discuss since the RRC sate is transparent to LMF. |
| ZTE | B | In RAN1#106b, RAN1 already has the conclusion that PRS is deprioritized compared with other signals/channels. RAN2 can confirm that this can be applied in RRC\_INACTIVE to solve DL-SDT and PRS confliction. |
| Qualcomm | A, C, but no need to study | (a) We can not see how E-CID can be prohibited in RRC\_INACTIVE. LMF selects the positioning method without knowledge of the RRC state and a LPP message is transparent to a gNB.(b) Seems to be independent on RRC\_STATE. (c) UE capabilities for positioning in RRC\_INACTIVE are required. E.g., a Rel-16 UE is not supposed to transmit SRS or perform measurements in RRC\_INACTIVE, etc. |

# 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.