**3GPP TSG-RAN WG2 Meeting #114-eR2-2106588**

**Electronic, 19th – 27th May, 2021**

Agenda Item: 8.11.3

Source: Huawei, HiSilicon

Title: [AT114-e][620][POS] RRC state exposure for positioning (Huawei)

Document for: Discussion and Agreement

# Introduction

This document is to handle the following email discussion:

* [AT114-e][620][POS] RRC state exposure for positioning (Huawei)

      Scope: Discuss the possible need to specify having RRC state of the UE exposed to LPP layer in the UE and/or LMF.

      Intended outcome: Report to CB session, in R2-2106588

      Deadline:  Thursday 2021-05-27 0000

During the online discussion, the issue was briefly discussed during the discussion of whether the selection of SDT vs non-SDT should be up to the lower layer, based on which this email discussion unfolds.

* 1. TDocs under AI 8.11.3

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| --- | --- | --- | --- |
| RefCode | TdocNum | Title | Source |
| 4802, CATT | R2-2104802 | Positioning for UEs in RRC\_INACTIVE state | CATT |
| 5216, HW | R2-2105216 | Discussion on positioning in RRC INACTIVE state | Huawei, HiSilicon |
| 5222, HW | R2-2105222 | Draft LS to SA2 on INACTIVE positioning | Huawei, HiSilicon |
| 5303, IDC | R2-2105303 | Discussion on Positioning in RRC INACTIVE state | InterDigital, Inc. |
| 5304, IDC | R2-2105304 | Discussion on Positioning Information reporting using SDT | InterDigital, Inc. |
| 5309, IDC | R2-2105309 | Discussion on Positioning during Mobility in RRC\_INACTIVE | InterDigital, Inc. |
| 5339, OPPO | R2-2105339 | Supporting positioning in RRC\_INACTIVE state | OPPO |
| 5340, OPPO | R2-2105340 | Discussion on UL Positioning methods in RRC\_INACTIVE state | OPPO |
| 5546, Spreadtrum | R2-2105546 | Discussion on positioning in RRC\_INACTIVE state | Spreadtrum Communications |
| 5561, XIAOMI | R2-2105561 | Discussion on positioning for UEs in RRC Inactive | Xiaomi |
| 5601, LEN | R2-2105601 | On Positioning in RRC\_INACTIVE state | Lenovo, Motorola Mobility |
| 5703, SONY | R2-2105703 | Considerations on positioning RRC Inactive | Sony |
| 5710, FRAUN | R2-2105710 | Considerations on Assistance data for positioning in RRC\_INACTIVE mode. | Fraunhofer IIS; Fraunhofer HHI |
| 5971, ERI | R2-2105971 | On Maximizing benefits of SDT | Ericsson |
| 6083, QC | R2-2106083 | Positioning of UEs in RRC Inactive State | Qualcomm Incorporated |
| 6104, INTEL | R2-2106104 | Support of UL and RAT independent positioning in RRC\_INACTIVE | Intel Corporation |
| 6369, SAM | R2-2106369 | Support of positioning result reporting in Inactive state | Samsung Electronics |
| 6408, VIVO | R2-2106408 | Discussion on UL positioning support in RRC\_INACTIVE state | vivo |
| 6409, VIVO | R2-2106409 | Discussion on open issues of positioning support in RRC\_INACTIVE state | vivo |
| 6429, ZTE | R2-2106429 | Discussion on DL INACTIVE positioning | ZTE Corporation, Sanechips |
| 6430, ZTE | R2-2106430 | Discussion on MG for INACTIVE positioning | ZTE Corporation, Sanechips |
| 6434, INTELetAL | R2-2106434 | Support of Positioning in RRC\_INACTIVE | Intel Corporation, Apple, OPPO, Xiaomi, InterDigital Inc., Spreadtrum, CATT, Huawei, HiSilicon, ZTE, vivo, Convida Wireless, Nokia |

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# Background

Exposure of the RRC state to LMF/LPP in the summary

In the summary of AI 8.11.3, the following has been summarized regarding the tdocs discussing the exposure of the RRC state of the UE to the LMF and the LPP layer of the UE.

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| In addition, the following proposals have also been provided by various sources in the contributions that RRC state should not be visible to the LMF:   |  | | --- | | In the joint contribution, the following has been proposed:  [6434, INTELetAL]  **Proposal 3: Same as legacy, the transition to RRC\_INACTIVE is up to network implementation, and it is invisible to the LMF;**  **Proposal 4: RRC state (RRC\_CONNECTED or RRC\_INACTIVE) is transparent to positioning procedure ( LPP/LCS in UE and LMF);**  [5339, OPPO]  Proposal 3 No additional RRC state information is transmitted to LMF.  [5561, XIAOMI]  Proposal 2: The LPP don’t need to select transport and RRC state is invisible to LPP and LCS message.  Proposal 3: Whether RRC inactive UE transmits to RRC connected to send or receive LPP message is determined by AS layer mechanism.  [5216, HW]  Proposal 1: Do not expose the RRC state to LMF.  [6409, VIVO]  Proposal 3: RRC state of UE is invisible to LPP layer and the LPP message is just submitted to lower layers which decide how to deliver it (SDT, transfer to RRC\_CONNECTED, etc.). Therefore, LPP message transmission adaptive to the RRC state is not supported.  [6429, ZTE]  Proposal 2: RRC state is not exposed to LPP. |   The following sources have proposed to expose the RRC state to the LMF   |  | | --- | | **[**5601, LEN]  Proposal 5: RAN2 to support RRC state awareness at the LMF for optimized, efficient, and low latency delivery of LPP messages in either RRC\_CONNECTED or RRC\_INACTIVE states.   * Note: RRC state exposure to LMF does not assume any control by the LMF (LPP) on any RRC state behavior of the UE, selection of transport, etc.   Proposal 6: RAN2 to consider the following signalling support for RRC state awareness at the LMF and send corresponding LS to RAN3/SA2, where applicable:   * Option 1: The LMF can request for state transition notifications directly with NG-RAN using NRPPa messages (requires RAN3 feasibility confirmation). * Option 2: The LMF can request for state transition notifications via the AMF from NG-RAN (requires SA2 feasibility confirmation). * Option 3: The UE can directly feedback the RRC state indication to the LMF (under RAN2 scope).   Note: Options 1 and 2 can be based on operator local configuration (OAM).  Proposal 10: Support UE autonomous RRC release indication for UEs performing RRC\_INACTIVE state positioning. FFS RAN3 impacts to NRPPa.  **[**6083, QC]  Proposal 4: Clarify the agreement from RAN2#113bis as follows:  WA: Any uplink LCS or LPP message can be transported in RRC\_INACTIVE from RAN2 perspective, subject to the data volume supported by AS layers. I.e. RAN2 do not specify a restriction on message type.  WA: The "positioning function" in the UE as well as an LMF need to be aware of the UE RRC state.  NOTE: The LMF awareness of RRC State may be implicit; e.g., based on the sequence of events/steps performed (i.e., if an LMF foremost has allowed (or supports) positioning in RRC\_INACTIVE), or may be explicit (e.g., an indication in the messages).  **[**6369, SAM]  Proposal 2. By exposing the RRC state of the UE to LPP, LPP can further generate the reduced version of measurement report when UE is in inactive state, which can increase the efficacy of SDT solution. | |

## Transport of LPP message

In the current stage2 spec, the description for the transport of the LPP message is as follows:

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| 6.4.2 LPP PDU Transfer Figure 6.4.2-1 shows the transfer of an LPP PDU between an LMF and UE, in the network- and UE-triggered cases. These two cases may occur separately or as parts of a single more complex operation.    Figure 6.4.2-1: LPP PDU transfer between LMF and UE (network- and UE-triggered cases)  1. Steps 1 to 4 may occur before, after, or at the same time as steps 5 to 8. Steps 1 to 4 and steps 5 to 8 may also be repeated. Steps 1 to 4 are triggered when the LMF needs to send an LPP message to the UE as part of some LPP positioning activity. The LMF then invokes the Namf\_Communication \_N1N2MessageTransfer service operation towards the AMF to request the transfer of a 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].  2. If the UE is in CM-IDLE state (e.g. if the NG connection was previously released due to data and signalling inactivity), the AMF initiates a network triggered service request as defined in TS 23.502 [26] in order to establish a signalling connection with the UE and assign a serving NG-RAN node.  3. 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 NG-RAN Node in an NGAP Downlink NAS Transport message defined in TS 38.413 [30]. The AMF need not retain state information for this transfer; it can treat any response in step 7 as a separate non-associated transfer.  4. The NG-RAN Node forwards the DL NAS Transport message to the UE in an RRC DL Information Transfer message.  5. Steps 5 to 8 are triggered when the UE needs to send an LPP PDU to the LMF as part of some LPP positioning activity. If the UE is in CM-IDLE state, the UE instigates a UE triggered service request as defined in TS 23.502 [26] in order to establish a signalling connection with the AMF and assign a serving NG-RAN node.  6. The UE includes the LPP PDU in the payload container of an UL NAS Transport message, and the Routing Identifier, which has been received in step 4, in the Additional Information of the UL NAS Transport message defined in TS 24.501 [29]. The UE then sends the UL NAS Transport message to the serving NG-RAN node in an RRC UL Information Transfer message.  7. The NG-RAN node forwards the UL NAS Transport Message to the AMF in an NGAP Uplink NAS Transport message.  8. The AMF invokes the Namf\_Communication\_N1MessageNotify service operation towards the LMF indicated by the Routing Identifier received in step 7. The service operation includes the LPP PDU received in step 7 together with the LCS Correlation ID in the N1 Message Container as defined in TS 29.518 [28]. |

Transport of the UE-associated NRPPa message

The description for the transport of the UE-associated NRPPa message is as follows:

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| 6.5.2 NRPPa PDU Transfer for UE Positioning Figure 6.5.2-1 shows NRPPa PDU transfer between an LMF and NG-RAN Node to support positioning of a particular UE.    Figure 6.5.2-1: NRPPa PDU Transfer between an LMF and NG-RAN node for UE Positioning  1. Steps 1 to 3 are triggered when the LMF needs to send an NRPPa message to the serving NG-RAN Node for a target UE as part of a NRPPa positioning activity. The LMF then invokes the Namf\_Communication\_N1N2MessageTransfer service operation towards the AMF to request the transfer of a NRPPa PDU to the serving NG-RAN Node for the UE. The service operation includes the NRPPa PDU together with the LCS Correlation ID in the N2 Message Container as defined in TS 29.518 [28].  2. If the UE is in CM-IDLE state (e.g. if the NG connection was previously released due to data and signalling inactivity), the AMF performs a network triggered service request as defined in TS 23.502 [26] in order to establish a signalling connection with the UE and assign a serving NG-RAN Node.  3. The AMF forwards the NRPPa PDU to the serving NG-RAN Node in an NGAP Downlink UE Associated NRPPa Transport message over the NG signalling connection corresponding to the UE and includes the Routing ID related to the LMF. The AMF need not retain state information for this transfer – e.g. can treat any response in step 4 as a separate non-associated transfer.  4. Steps 4 and 5 are triggered when a serving NG-RAN Node needs to send an NRPPa message to the LMF for a target UE as part of an NRPPa positioning activity. The NG-RAN Node then sends an NRPPa PDU to the AMF in an NGAP Uplink UE Associated NRPPa Transport message and includes the Routing ID received in step 3.  5. The AMF invokes the Namf\_Communication\_N2InfoNotify service operation towards the LMF indicated by the Routing ID received in step 4. The service operation includes the NRPPa PDU received in step 4 together with the LCS Correlation ID in the N2 Info Container as defined in TS 29.518 [28]. Steps 1 to 5 may be repeated. |

# Discussion

Exposure of the RRC state to LPP layer

We first need to discuss whether the LPP layer of the UE should be aware of the RRC state the UE is in.

In the legacy, the when the LPP layer sends the LPP PDU to the network, it does not differentiate between the RRC state of the lower layer: when the LPP PDU is delivered to the NAS layer, the NAS layer will determine the UE behaviour for the transport of the LPP LDU. When the RRC layer receives the NAS message:

* If the UE is in RRC\_IDLE, the UE is in CM\_IDLE. The NAS layer would trigger NAS layer service request to the network. the RRC layer would transit the RRC state of the UE from RRC\_IDLE to RRC\_CONNECTED for sending the NAS message.
* If the UE is in RRC\_INACTIVE, the CM state of the UE is still CM\_CONNECTED with suspend, and would not trigger NAS service request to the network, in this case, the lower layer only needs to send *RRCResumeRequest* to the network and request to transit the UE from RRC\_INACTIVE to RRC\_CONNECTED for the transport of the LPP PDU.

During the online discussion, it has also been mentioned that the awareness of the RRC state in the LPP layer is the internal UE behaviour and questions are raised on what specification impacts this will have.

Companies are invited to provide feedbacks on the following question:

***Question1*: Do companies think that the RRC state of the UE should be exposed to the LPP layer of the UE and the reason?**

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| Company | Yes/No | Reason |
| vivo | No | To enable the LPP layer be aware of the RRC state, cross-layer interaction is needed.  If the RRC state is exposed to the LPP layer, the LPP layer may perform the segmentation to meet SDT criteria. However, as the number of segmented messages increases, the gain of latency and power saving by using SDT will decrease. |
| Intel | No | We agree that the LPP could be aware of RRC state based on UE implementation since it is UE internal behavior although we do not see the need to let LPP be aware of UE RRC sate. But we do not see the need to specify this. |
| Ericsson | No | But important thing is UE LPP layer knows the QoS; and it should be indicating to lower layer that use transmission mode which fulfils the QoS. |
| Qualcomm | Yes | Here is a simple example:  1. UE encounters a trigger (e.g. periodic trigger or geographic area related trigger) requiring an event report to an external Client.  2.The location QoS indicates low delay.  3. Normally, the UE would obtain a bunch of measurements (e.g. for GNSS, DL-AOD, DL-TDOA, WiFi, etc.) and send them to the network as fast as possible. The LPP message size might be large but that would not necessarily add much to latency or power by itself.  4. Now suppose that the event reporting and location layer is aware that the UE is in RRC\_INACTIVE state and that the UE and network support SDT. If the UE sends a large enough message in (3), there will be an additional delay to enter RRC CONNECTED state (or extra delays associated with SDT segmentation) which could be avoided if the UE sends a smaller message via SDT. A UE optimized for power and/or latency minimization might then decide to reduce and prioritize the measurements in (3) to ensure that SDT can be used. If the UE does not do that, the lower power and latency benefits of SDT may seldom if ever be used. |
| CATT | No | During current NR positioning in RRC\_INACTIVE, only whether and how to transport LCS or LPP message in RRC\_INACTIVE are discussed and agreed. How to transport LCS or LPP message depends on AS layer. And as for SDT enabling/selection, it was agreed that the total data volume across all SDT RBs are considered. Thus, no matter whether segmentation in LPP is performed, the total data volume of LPP messages is considered during SDT selection in AS layer. Thus, there is no motivation to expose the RRC state of the UE to the LPP layer of the UE.  In addition, we think it is the internal UE behaviour to having RRC state of the UE exposed to LP layer in the UE. No need to specify. |
| InterDigital | No, with comments | We do not think RRC state should be exposed to the LPP layer of UE if the motivation is to optimize the content and size of LPP messages sent using SDT as this could impact the positioning QoS (i.e. accuracy, latency).  From our understanding SDT is not imposing any restrictions on LPP layer such that only small payload LPP messages can be sent. Rather, SDT is a transport mechanism at AS layer that allows data to be sent in INACTIVE and still enable power savings to be achieved.  We think that instead of exposing the RRC state to LPP layer it may be more beneficial for gNB to have awareness of UE transporting the LPP messages in INACTIVE for supporting certain suitable configurations at AS layer.  For example, the gNB can configure the data volume threshold for SDT (i.e. SRB2) and/or configured grant parameters based on UE indication/feedback to gNB. In this case, whether the LPP messages can be sent with SDT in INACTIVE or transition the UE to CONNECTED can be up to gNB. This would also allow the LPP layer to be agnostic to RRC state while ensuring flexibility at AS layer and RAN when transporting the LPP messages using mechanisms that are generic and not specific to positioning. |
| Apple | No | It is not clear to us that there is any essential impact from RRC state to LPP layer procedures. The LMF does not need to make any optimizations based on RRC state of UE. We are fine to let UE and gNB to make decisions whether to enter RRC\_CONENCTED by following standard SDT procedures and based on conditions discussed in SDT WI. At least in R17, we think the positioning-specific optimisation to exposure RRC state (to LMF or UE LPP layer) is not justified and no need to specify. |
| OPPO | No | We see no gain to expose the RRC state to the LPP layer.  Even LPP layer pre-process the messages to meet the SDT requirement, i.e. segment the message based on the SDT data volume, whether use SDT for LPP message transmission still depends on lower layer. Since SDT or non-SDT selection also relies on whether the corresponding RB support SDT, and whether the RSRP fulfil the SDT threshold.  Furthermore, additional signalling interaction that expose RRC state to LPP may cause extra latency, which is against with the initial motivation of supporting positioning in RRC\_INACTIVE state, i.e. latency reduction. |
| ZTE | No | We do not think there is enough benefit to expose RRC state to LPP or LMF.   1. Even AMF does not know UE’s RRC state, we do not think it is appropriate to expose UE RRC state for LPP or LMF but not AMF. 2. Consideration of data validation   Currently, RAN2 has already made agreement that the SDT is responsible for the data transmission during INACTIVE positioning. If the data size is over the SDT threshold, UE may switch to RRC\_CONNECTED. Hence when large chunk of data(e.g. some positioning measurement reports) is needed to be transported, more appropriate method(SDT or legacy) will be selected by lower layers. Either LMF or UE can receive the data in time. However, if LPP can force UE to keep transporting data via SDT in INACTIVE, the data may not be delivered in time because SDT does not have as much transportation resource as the legacy mechanism.   1. Complexity and influence to other WGs.   If UE state is exposed to LPP or LMF, a lot of discussion is going to be discussed not only in RAN2 but also in other WGs (e.g. SA). Considering the time budget is not enough, we do not prefer to do the further discussion on this issue. |
| Lenovo, Motorola Mobility | Yes | As vivo, mentioned a fundamental aspect of this discussion is to meet the SDT criteria, which supports the UL transmission of positioning messages in RRC\_INACTIVE state. CG-SDT can be configured based on the number of manageable segments configured by the LMF to be transmitted in UL, while remaining in RRC\_INACTIVE state. The LMF can better configure UE segmentation of a certain LPP message by the UE, based on the RRC state knowledge at the LMF. We have the additional following points in an attempt to try and allay companies concerns:  - Having RRC state awareness does not necessarily imply having control over transport selection and UE state behaviour, which can be still up to lower layers. RRC state awareness has the flexibility to still leave these aspects up to the lower layers. It also does not imply that the UE is forced to keep using SDT all the time, this aspect remains under gNB control.  - Rather than just an optimization, we view the lack of this awareness as an inefficient use of SDT (from a positioning perspective) to support the Rel-17 positioning procedures and meet the desired KPIs especially in terms of transitional latency to send measurement reports.  - For gNB to have awareness about the LPP message there is in any case some cross-layer interaction, which would be required for the UE to transport of an LPP message.  - The decision to remain in RRC\_INACTIVE and use SDT or transition is RRC\_CONNECTED is still up to the gNB control and we view that this as a separate issue raised by most companies. The LMF can use RRC state transition notifications to better improve its delivery of LPP messages given the limitation of the SDT data volume threshold.  - From a positioning perspective, the LPP procedures can be proactive to accommodate the lower procedures when transmitting the measurement report by provisioning smaller reports, enabling/disabling segmentation, rather than adopting a reactive approach.  - We disagree on the latency concern regarding this, as this can be a subscription-based interaction between the LMF and NG-RAN (similar to the current AMF and NG-RAN procedure) and can run in parallel to the existing positioning procedures which can be also flexibly cancelled, whenever required. Rather, having no RRC state notifications can potentially increase the inevitable transitional latency to RRC\_CONNECTED state caused by unnecessary overprovisioning of the measurement report.  -The AMF is currently supported to be aware about the UE’s RRC state, especially if it transitions to RRC\_INACTIVE state. The complexity of involving other WGs happens in any case when discussing a feature. If RAN2 agrees on the need of this aspect, LS can be sent to relevant WGs, so this need not be a stumbling block. |
| Xiaomi | No | We think this is up to UE implementation and don’t need to specify. |
| Huawei, HiSilicon | No | We think there is no good motivation to support the exposure of RRC state to the LPP. Companies have argued about legacy. But transport with SDT does not necessarily mean that legacy will be higher compared with transport with RRC connected mode. |
| Samsung | Yes | We can say this is a good-to-have feature. This might not be a critical one, but can increase the efficiency of positioning operation which is also WID objective. In the opposite side to the vivo’s comment, if the RRC state is not known to LPP layer, so big sized LPP message is given to the lower layer, this might also trigger the state transition, which removes the efficacy of positioning in inactive state. Or RRC might segment the received LPP msg for matching to CG-SDT not going connected. This also decreases the gain of SDT on latency and power saving. So, we think the best thing is LPP to reduce its content to the allowed level. Of course this should be negotiated by LMF according to the QoS requirement.  This awareness might be through UE internal operation, i.e., UE implementation or cross layer indication. |
| Spreadtrum | No | If the LPP layer of the UE needs to aware of the RRC state, it involves the cross-layer actions between LPP layer and RRC layer and additional impact on SDT WI. |

In addition, during the summary and online discussion, the relationship between the two issues of the awareness of the RRC state and SDT vs non-SDT selection have been discussed. It is proposed to further discuss this during the email discussion.

Companies are invited to provide feedback on the following question:

***Question2*: Do companies think there is relevance between the awareness of the RRC state and the SDT vs non-SDT selection and why?**

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| Company | Yes/No | Reason |
| vivo | No | As no positioning specific work is expected in SDT WI, the SDT vs non-SDT selection shall follow the SDT framework. |
| Intel | No | Positioning in RRC\_INACTIVE can work well without this awareness. We do not see the need to enhance this further in Rel-17. |
| Ericsson | No but | However, If the question is interpreted as: Should UE LPP layer provide or influence the transmission mode that can be used by the lower layer to select the transmission mode than the answer is yes. |
| Qualcomm |  | Don't understand the question. "SDT vs non-SDT selection" depends on the RRC\_STATE. I.e., if the UE is in RRC\_CONNECTED or RRC\_IDLE, there is no "SDT vs non-SDT selection" anyhow? |
| CATT | No | SDT selection should not be decided by LPP layer of the UE, since there may be other non-LPP/LCS messages carrying by SDT. So we think there is no motivation to expose the RRC state to the LPP layer of the UE. |
| InterDigital | No | From our understanding is no relevance between LPP awareness of RRC state and on selection of SDT vs. non-SDT. Referring to our response to Question 1, SDT is a transport mechanism supported by AS layer when in INACTIVE that the LPP layer can use. When SDT is not configured then clearly the legacy non-SDT procedure applies. In both cases, we think the transport of the LPP messages can be decided by AS layer without making the LPP layer aware of RRC state. |
| Apple | No | I assume the question is about awareness in LPP layer, then the answer is NO. |
| OPPO | No | SDT vs non-SDT selection relies the lower layer transmission condition, e.g. 1) data volume, 2) RSRP, 3) whether the RB support SDT.  There is no relationship with awareness of the RRC state. |
| ZTE |  | I’m not sure whether i understand the question correctly.  Based on my understanding, if the RRC state is exposed to LPP, at least it is possible for LPP to modify its PDU which is not larger than the SDT threshold in some scenarios. So LPP can select whether to use SDT or non-SDT method for data transportation by modify LPP PDU. From this point of view, i think the answer of this question is yes in some cases.  BTW, we do not support to expose the UE RRC state to LPP. |
| Lenovo, Motorola Mobility | No | The RRC state awareness need not impact the SDT vs non-SDT selection, which can be handled and controlled by the network. This can be handled independently by the procedures being discussed under the SDT framework.  Just to reiterate that this RRC state awareness discussion can be decoupled from lower layer control of transport and UE state behaviour. |
| Xiaomi | No | We think the SDT or non-SDT is based on the AS layer mechanism. In the SDT session, UE needs to be allowed to use SDT, and then the data volume threshold will be used for UE to determine whether to use SDT. |
| Huawei, HiSilicon | No | Two separate issues |
| Samsung | No | We also think the determination of transmission method is only dependent on the lower layer. And this is independent on the exposure of RRC to LPP. |
| Spreadtrum | No | We think that LPP layer only needs to submit the messages to lower layers which decide whether to deliver it using SDT or not. |

Exposure of RRC state to LMF

Another aspect of the discussion is the awareness of the RRC state to the LMF.

In legacy, the RRC state of the UE is not known to the LMF. As shown by the description for the transport of the LPP message and UE associated NRPPa message in section 2.2 and 2.3, the AMF would trigger an NAS layer service request if the UE’s state in the AMF is CM\_IDLE when the LMF sends an LPP message to the UE or UE-associated NRPPa signalling to the gNB.

While for RRC\_INACTIVE state, the UE’s state in AMF would be CM\_CONNECTED; AMF can know if the UE is in RRC\_INACTIVE only if the AMF requests the UE’s RRC state to the gNB and the gNB updates the LMF with RRC inactive transition report with the following NG-AP message, as in TS 38.413.

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| 8.3.5 RRC Inactive Transition Report8.3.5.1 General The purpose of the RRC Inactive Transition Report procedure is to notify the AMF when the UE enters or leaves RRC\_INACTIVE state. The procedure uses UE-associated signalling. 8.3.5.2 Successful Operation   Figure 8.3.5.2-1: RRC Inactive transition report  The NG-RAN node initiates the procedure by sending an RRC INACTIVE TRANSITION REPORT message to the AMF. Upon reception of the RRC INACTIVE TRANSITION REPORT message, the AMF shall take appropriate actions based on the information indicated by the *RRC State* IE. |

***Question3*: Do companies think that the RRC state of the UE should be exposed to the LMF and the reason?**

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| --- | --- | --- |
| Company | Yes/No | Reason |
| vivo | No | To enable the LMF be aware of the RRC state, cross-layer interaction may be needed (e.g. by LPP from UE). Based on the exposure, the LMF may adapt the configuration to the UE.  However, the LMF will select the positioning method based on the QoS requirement, UE/network positioning capability and send the corresponding measurement configuration to UE/gNB. The LMF shall optimize the configuration irrespective of RRC state.  Further, when the RRC state transition occurs, the benefit may be invalid. For instance, the potential procedure of RRC state to be visible to LMF for adaptive transmission is as follows:   1. UE/gNB inform the LMF when UE enters RRC\_INACTIVE; 2. LMF send adapted configuration for RRC\_INACTIVE to UE; 3. UE perform measurement based on the configuration.   When RRC state transition to RRC\_CONNECTED occurs during step 2 or step 3, the UE/gNB shall inform the LMF again, then LMF shall send another configuration for RRC\_CONNECTED and the ongoing step 2 or step 3 may result in vain. |
| Intel | No | The motivations listed by some companies are:  1 can adjust the assistance data, e.g.to help reduce the power consumption;   1. can adjust the measurement, e.g. to avoid larger measurement report and make it fit SDT…   All of them are optimizations since Positioning in RRC\_INACTIVE can definitely work without these optimizations. We do not see the need to enhance this further in Rel-17. |
| Ericsson | No | Basically, rather than state exposure, what is needed from UE is whether UE is low power device (PHR measurement report, low battery indication etc.) and whether UE supports SDT and what is the data volume threshold.  In such case, LMF may select positioning method and provide AD to meet positioning requirements for these scenarios.  But as such we do not see any need of NRPPa Report as above |
| Qualcomm | Yes | The individual steps for the UE positioning procedure (in particular for UL and UL+DL, but also for DL-only in the case of message segmentation is needed) would be different in RRC\_INACTIVE.  The server behaviour may be different for a UE in RRC\_INACTIVE, e.g., in terms of LCS QoS and positioning method(s) or mode (UE-based/UE-assisted) selection.  UE capabilities may also be different in different RRC states, which may impact the server selection of positioning method/mode. Certainly, a Rel-16 UE is not expected to make measurements in RRC\_INACTIVE for certain positioning methods and if a low power/low latency position fix is required, the server may exploit the RRC\_INACTIVE state and UE capabilities to make a proper decision.  However, there may not be a new/explicit "RRC Inactive transition report" etc. message required. The server may be aware of the UE state by the sequence of events/steps triggered; e.g., if a server has allowed positioning in RRC\_INACTIVE during the "location preparation phase" (for a deferred MT-LR; e.g., based on UE and NG-RAN capabilities). |
| CATT | No | We don’t see motivation to expose the RRC state of the UE to the LMF.  But the LMF can provide its preferred RRC state to NG-RAN node to assist RRC state selection in NG-RAN node for the UE. For example: If the latency is sensitive for this location service, LMF can provide its preference to NG-RAN node that keeping UE in RRC\_CONNECTED is preferred. |
| InterDigital | No, with comments | The RRC state of UE need not be exposed to the LMF because in our view the LMF should neither impose any restriction on UE from operating in INACTIVE nor should the LMF provide an oversimplified PRS configuration that could compromise the positioning accuracy.  However, the understanding at LMF that UE can operate in INACTIVE state for power savings has some benefits. For example, when the UE is in INACTIVE, it is desirable for the UE to not use a PRS configuration that can result in cancelling any power saving gains due to frequent measurement and reporting. For INACTIVE state operation, ideally the LMF should provide a PRS configuration that is optimized for low power measurements (e.g. aligned with DRX configuration).  To enable this, the LMF can come to know of the UE RRC state either explicitly (e.g. signalling from UE or gNB) or implicitly. We think explicit indication to LMF of UE RRC state is not necessary since it can result in unnecessary signalling each time the RRC changes. On the contrary, implicit indication can be supported via measurement reports sent by UE when in INACTIVE or the UE may request specific PRS configurations via on-demand framework. Based on this LMF can update the PRS configuration, if needed, using similar procedure considered for LMF/UE-initiated on-demand PRS. |
| Apple | No | See comment in Q1 |
| OPPO | No | Currently, LMF can send DL LPP messages through RAN paging or SDT mechanism. And UL transmission can also be supported with SDT. We don’t see the motivation of the exposure of RRC state to LMF.  And as replied in Q1, additional signalling interaction that expose RRC state to LMF may cause extra latency, which is against with the initial motivation of supporting positioning in RRC\_INACTIVE state, i.e. latency reduction. |
| ZTE | No | Please check our comment in Q1. |
| Lenovo, Motorola Mobility | Yes | Support RRC state exposure to the LMF, which can be viewed as valuable information needed by the LMF to better manage all positioning procedures in RRC\_INACTIVE state. This can be achieved via explicit subscription-based signalling, where the LMF can subscribe to receive such state transition notifications/reports, which ultimately also depend on the operator local deployment (OAM). As described above, the RRC state notifications at the LMF can be based on extending the current mechanism applied to the AMF and as such will not have significant spec impact.  The lack of RRC state awareness at the LMF may result in frequent transitions to RRC\_CONNECTED state as the LMF may continue to configure the measurement report as in RRC\_CONNECTED state without consideration of the SDT data volume threshold and UE capabilities. If the LMF is enabled to at least receive notifications regarding the UE operation in RRC\_INACTIVE state, this will allow suitably sized measurement reports to be proactively configured and reported to the LMF that will actually meet the SDT data volume threshold criteria, while remaining in RRC\_INACTIVE. Another benefit is that the LMF can configure the UE to segment the UL LPP messages based on the awareness that the UE is operating in RRC\_INACTIVE state.  Additionally, for UL-based and (DL+UL) positioning, RRC state awareness can enable optimal SRS activation/deactivation by the LMF depending on the operating state of the UE and UE’s RRC\_INACTIVE SRS transmission capabilities.  We also share the same view as Qualcomm on the issues raised and we would also be open to implicit indications of the RRC state at the LMF. |
| Xiaomi | No | The current positioning procedure can be reused without LMF knowing the UE RRC state. |
| Huawei, HiSilicon | No | Currently, even AMF may not know if the RRC state of the UE is in RRC\_INACTIVE. There will be huge spec impact to enable this without justifiable benefits. |
| Samsung | Not necessary | We agree with Vivo’s comment on possible unnecessary signalling and state transition when direct reconfiguration on inactive measurement/report to UE happens. Instead, it is possible that the indirect configuration, i.e., LMF can just configure the UE on allowing UE’s adaptive measurement report according to its current RRC state. If UE is in inactive mode, UE can measure/report only some configured for inactive state. Otherwise, UE does the normal operation. In this scenario, LMF doesn’t need to know the UE’s state in real time, and no modification of NRPPa signalling is expected. |
| Spreadtrum | No | Same with Q1. LMF also should not be aware of the RRC state of UE. Although we think that LMF can adjust the positioning configuration for SDT transmission, there can be multiple sets of this configuration. It is not necessary for the LMF to be aware of the current RRC status of the UE. |

# Conclusion

**TBD**

# 4 References