**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

|  |  |  |  |
| --- | --- | --- | --- |
| 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 |

* 1. Contact Information

|  |  |  |
| --- | --- | --- |
| **Company** | **Delegate name** | **Delegate email** |
| **vivo** | **Xiang** | **panxiang@vivo.com** |
| **Intel** | **Yi guo**  | **Yi.guo@intel.com** |
| **InterDigital** | **Jaya Rao****Fumihiro Hasegawa** | **jaya.rao@interdigital.com****fumihiro.hasegawa@interdigital.com** |
| **Apple** | **Zhibin Wu** | **zhibin\_wu@apple.com** |

# 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.

|  |  |  |
| --- | --- | --- |
| 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:

|  |
| --- |
| 6.4.2 LPP PDU TransferFigure 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:

|  |
| --- |
| 6.5.2 NRPPa PDU Transfer for UE PositioningFigure 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 Positioning1. 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?**

|  |  |  |
| --- | --- | --- |
| 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. |
|  |  |  |

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?**

|  |  |  |
| --- | --- | --- |
| 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. |
|  |  |  |

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.

|  |
| --- |
| 8.3.5 RRC Inactive Transition Report8.3.5.1 GeneralThe 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 OperationFigure 8.3.5.2-1: RRC Inactive transition reportThe 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?**

|  |  |  |
| --- | --- | --- |
| 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 |

# Conclusion

**TBD**

# 4 References