**3GPP TSG-RAN WG2 Meeting #113-eR2-201**

**Electronic, 25th Jan– 05th Feb, 2021**

**Source: Huawei, HiSilicon**

**Title: [Post112-e][609][POS] Positioning support in RRC\_IDLE and RRC\_INACTIVE (Huawei)**

**Agenda item: 8.11.2**

**Document for:** **Discussion and Decision**

Introduction

During RAN2#112-e, the following agreement has been made regarding positioning in IDLE/INACTIVE.

Agreements:

Positioning measurement reporting (including location estimates for UE-based) should be supported in RRC\_INACTIVE; involvement of SDT is FFS. Reporting of specific measurements is pending RAN1 decision.

Then, email discussion is proposed to be triggered after the meeting

* [Post112-e][609][POS] Positioning support in RRC\_IDLE/RRC\_INACTIVE (Huawei)

 Scope: Discuss potential solutions for positioning support in RRC\_IDLE/RRC\_INACTIVE, distinguishing clearly between what can be supported in idle and what can be supported in inactive. Rapporteur is asked to provide update on RAN1 agreements.

 Intended outcome: Report to next meeting

 Deadline: Long

In this email discussion, first, we review related agreements made in RAN1 on IDLE/INACTIVE positioning during the SI phase and its impacts on RAN2; next, we proceed to the scope of the discussion prescribed online.

Contact Information

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| **Company** | **Delegate name** | **Delegate email** |
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# RAN1 agreement on IDLE/INACTIVE positioning

In the following, the agreements in RAN1 on IDLE/INACTIVE positioning would be reviewed by observations.

RAN1#102e

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| Agreement:* NR positioning for UEs in RRC\_IDLE state and UEs in RRC\_INACTIVE state will be investigated in Rel-17, including the benefits on latency, network/UE efficiency and UE power consumption
* FFS: which positioning methods to be supported, e.g., DL positioning, UL positioning, DL+UL positioning and/or Multi-RTT
* FFS: the details of how to enable the UE positioning in RRC\_IDLE state and RRC\_INACTIVE state
	+ Reference signals (e.g., based on DL PRS signals, UL SRS signals, both of them, etc.)
	+ Signaling and procedures (e.g., based on PRACH procedure, paging triggered UL SRS transmission, etc.)
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***Observation1: The above agreement is mainly for the sake of progress and does not provide substantial contents.***

RAN1#103e

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| Agreement:Capture the following observations (Editorial modifications and updates to references to be made when capturing in the TR):* The results for the UE efficiency (power saving) in the RRC\_IDLE/RRC\_INACTIVE states were analyzed by 2 sources (Huawei/HiSi, vivo) out of 17 sources (assumptions may be different between the different sources)
* In one source (Huawei/HiSi), the following observations were made:
	+ RRC\_IDLE/RRC\_INACTIVE state positioning can save about 7%-40% power consumption compared to C-DRX configuration
* In one source (vivo), the following observations were made:
	+ Positioning report in the RRC\_IDLE state can provide 44.32 % of power saving gain compared to the report in the RRC\_CONNECTED state
	+ Positioning measurement and report in the RRC\_IDLE state can provide at least 48.38 % of power saving gain compared to the measurement and report in the RRC\_CONNECTED state
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***Observation2: The simulation results from the two sources show the gain in power saving for IDLE/INACTIVE positioning.***

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| Agreement:* NR positioning for UEs in RRC\_INACTIVE state is recommended for normative work, including
	+ DL, UL and DL+UL positioning methods
	+ UE-based and UE-assisted positioning solutions
	+ Support of UE positioning measurements for UEs in RRC\_inactive state
		- Options that can be considered include DL-PRS or DL-PRS and SSB
	+ Support of gNB positioning measurements for UEs in RRC\_inactive state
* The details of how to enable the UE positioning in RRC\_ INACTIVE state can be further discussed during normative work. These details may include, but are not limited to the following aspects:
	+ UL reference signals (e.g., SRS for positioning, PRACH preambles) for UL measurements
	+ Signalling and procedures for support the assistance data delivery, DL-PRS configuration, UL reference signals for positioning resource configuration, measurement reporting), which may be developed based on the enhancements of existing signalling and procedures (e.g., existing 2-step and/or 4-step PRACH procedures, paging procedure, small data transmission).
 |

***Observation3: The above two bullets are recommended for normative work and listed for future study, respectively, for positioning in RRC\_INACTIVE. They may serve as the baseline for the study of RRC\_INACTIVE positioning in RAN2.***

Agreement:

Capture the following in the TR:

From a physical layer perspective, it is feasible for a UE to perform DL positioning measurement in RRC\_IDLE state.

* Note: This does not imply that measurements have to be reported in RRC\_IDLE state.

Conclusion:

It is up to RAN2 to decide whether to support the enhancements of NR positioning reporting of DL positioning measurements and/or positioning estimates for RRC\_IDLE UEs.

***Observation4: The above agreement and conclusion may serve as the baseline for the study of RRC \_IDLE positioning in RAN2. Note that only DL positioning is considered for future study in IDLE. So, UL positioning in IDLE is not considered within the scope of study.***

***Question1: Any comment on the above observations from the rapporteur or the RAN1 agreement’s impacts on RAN2 in general?***

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| **Company** | **Comment** |
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# Definition of IDLE/INACTIVE positioning

Before proceeding to the details, some general discussions are needed on the definition of RRC\_IDLE/INACTIVE positioning since it is still not clear what IDLE/INACTIVE positioning is. On the general procedures of positioning, the following figure is excerpted from positioning stage-2 spec [1].



**Figure 1, Location Service Support by NG-RAN**

From the figure, we can observe that only procedure 1, 3a, 3b, and 5 may involvement the action from the UE and NG-RAN, hence related to the RRC state of the UE.

**For 1 and 5,** it involve the service layer support and RAN signalling

* LCS request/response for MO-LR

**For 3a,** the NG-RAN procedures, not all NG-RAN procedures are related to the RRC states of the UE, which include both UE-associated and non-UE-associated procedures that are related to positioning of a certain UE:

* E-CID information transfer (UE-associated)
* Positioning information transfer (UE-associated)
* Measurement information transfer (non-UE-associated)

**While for 3b**, it not only includes the signalling procedure but also physical layer procedures such as the transmission/reception of reference signals

* RRC signaling (e.g., posSRS configuration)
* LPP signaling (e.g., Capability transfer, Assistance data transfer, Location information transfer)
* MAC procedure/L1 signalling (e.g., activation/deactivation for semi-persistent/aperiodic posSRS)
* Transmission of UL-PRS and reception of DL-PRS
* Reception for assistance information broadcast

From the understanding of the rapporteur, if any of the above procedures happens for a UE in RRC\_IDLE/INACTIVE, it falls within the scope of IDLE/INACTIVE positioning. Hence, we would like to ask the following question

***Question2, Do companies agree the below procedures are under the scope of IDLE/INACTIVE positioning if any of them happens for a UE in RRC\_IDLE/INACTIVE? Are there any other procedure should be under the scope of IDLE/INACTIVE positioning?***

* ***Service layer support***
	+ ***LCS request/response sent/received for MO-LR***
* ***NRPPa***
	+ ***E-CID information transfer (UE-associated)***
	+ ***Positioning information transfer (UE-associated)***
	+ ***Measurement information transfer (non-UE-associated)***
* ***Uu Signaling and procedure***
	+ ***RRC signaling (e.g., posSRS configuration)***
	+ ***LPP signaling (e.g., Capability transfer, Assistance data transfer, Location information transfer)***
	+ ***MAC procedure/L1 signalling (e.g., activation/deactivation for semi-persistent/aperiodic posSRS)***
	+ ***Transmission of UL-PRS and reception of DL-PRS***
	+ ***Reception for assistance information broadcast***

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| **Company** | **Y/N** | **Comment** |
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# RRC\_IDLE/INACTIVE positioning

In this section, we discuss the potential solutions for the procedures listed in question 2 to support RRC\_IDLE/INACTIVE positioning, including LCS request/response, E-CID positioning and UL/DL positioning related procedures. Note that uplink-downlink positioning (e.g., multi-RTT) involves solutions for both UL and DL positioning related procedures and thus considered as covered by the discussion on UL and DL positioning already.

LCS request/response for MO-LR

Location services can be instigated from the 5GC for an NI-LR or MT‑LR, or from the UE in case of an MO-LR. While in the relevance of UE signalling, we need to discuss for the cases of MT/NI-LR and MO-LR respectively.

* For MO-LR, UE initiates the LCS request in NAS message and after the LMF receives the LCS request. If this needs to be enabled in IDLE/INACTIVE, we need to study how the NAS message be transmitted.
* For MT/NI-LR, the LCS request comes from the LCS client/from the network itself and no signalling from the UE is required.

Note that in R17, we have another work item for small data transmission in RRC\_INACTIVE, mainly designed for the transmission of user plane mobile originating data. Positioning in RRC\_INACTIVE can take advantage of the uplink transmission mechanism in small data and transmit control plane NAS signalling with it. However, IDLE mode small data transmission is not supported and MT-data is also not in the scope

Based on the above discussion, rapporteur would like to ask the following questions:

***Question3a, Do companies think MO-LR request in IDLE/INACTIVE should be supported by the UE in RRC\_IDLE/INACTIVE?***

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| **Company** | **IDLE(Y/N)** | **INACTIVE(Y/N)** | **Comment** |
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***Question3b, Do companies think MO-LR response in IDLE/INACTIVE should be supported by the UE in RRC\_IDLE/INACTIVE?***

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| **Company** | **IDLE(Y/N)** | **INACTIVE(Y/N)** | **Comment** |
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E-CID positioning

E-CID positioning is the part that has been touched neither in RAN1 nor in RAN2 for the study in RRC\_IDLE/INACTIVE positioning for R17.

In R16, early measurement has been supported by the work item of eDCCA. With early measurement, the UE can measure candidate PSCell/SCell frequencies in IDLE/INACTIVE and reports the results when the UE is in RRC\_CONNECTED, afterwards. In this way, when the UE reports these RRM measurement in CONNECTED, the network can quickly get the measurement from the UE such that the PSCell and SCell configuration can be earlier than previously when the UE can only perform and report the measurement in RRC\_CONNECTED.

Nevertheless, under the current framework of early measurement, the UE still needs to get into the RRC\_CONNECTED to upload the RRC measurement, although the measurement is performed in RRC\_IDLE/INACTIVE. There are two options for the UE to transfer the measurements to the network, as shown in the figure below:

* **Option1:**
	+ **For UE in RRC\_INACTIVE**, NW sends *RRCResume* to the UE, after the reception of which, the UE transits to the RRC\_CONNECTED. NW indicates the request for early measurement based on whether the UE supports early measurement in UE context for RRC\_INACTIVE. Then, the UE reports the measurement report in the *RRCResumeComplete*
* **Option2:**
	+ **For UE in either IDLE or INACTIVE,** the UE can indicate the availability of early measurement in *RRCSetupCompelte* or *RRCResumeComplete*. After the reception of the indication, the NW can request the report of the early measurement in *UEInformationRequest* and the UE responds with *UEInformationResponse*.



**Figure 2, Early Measurement for RRC\_IDLE/INACTIVE**

Based on the scope of eDCCA in R16, RRM measurement in RRC\_IDLE/INACTIVE is in place, which can be potentially taken advantage of for IDLE/INACTIVE mode positioning. For IDLE/INACTIVE positioning, the requirement is that the UE stays out of CONNECTED and sends the measurement to the network in IDLE/INACTIVE. Hence, rapporteur would like to ask the following question for DL E-CID and UL E-CID, respectively.

First, we need to understand whether the RRM measurement performed in IDLE/INACTIVE can be reported by the UE in IDLE/INACTIVE with LPP message. Note that, for the discussion of small data transmission, data transmission in RRC\_IDLE is not within the scope.

***Question4a, Do companies think reporting of RRM measurement performed in IDLE/INACTIVE in LPP should be supported by the UE in RRC\_IDLE/INACTIVE?***

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| **Company** | **IDLE(Y/N)** | **INACTIVE(Y/N)** | **Comment** |
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Next, the UE can also report the RRM measurement to the gNB and then gNB reports it to the LMF with NRPPa signalling. However, currently, the NRPPa E-CID Measurement Initiation Request is assumed for the NG-RAN serving the target UE in RRC\_CONNECTED/INACTIVE state. If this is supported, some modifications to the NRPPa spec is needed for RRC\_IDLE.

***Question4b, Do companies think UE can report the RRM measurement performed in IDLE/INACTIVE to the network in RRC message and UL E-CID procedure should be enhanced for the UE in RRC\_IDLE/INACTIVE?***

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| **Company** | **IDLE(Y/N)** | **INACTIVE(Y/N)** | **Comment** |
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Downlink positioning

### PRS capability

Before the downlink positioning procedure performed by the UE and LMF, the UE needs first to transfer its PRS capability to the network. For MO-LR, the UE may piggyback the PRS capability with the LCS request in the NAS message. For MT/NI-LR, the LMF needs to request the capability from the UE if it does not keep the UE’s capability in its memory.

However, the UE may only need to send its PRS capability in the first time when the UE performs positioning in RRC\_CONNECTED and LMF can keep its PRS capability ever since. Hence, there may not be the need to transfer PRS capability in RRC\_IDLE/INACTIVE and it only needs to be transferred during the first fix when the UE is in RRC\_CONNECTED.

***Question5a, Do companies agree that we should support ProcvideCapbilities for PRS in RRC\_IDLE/INACTIVE?***

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| **Company** | **IDLE(Y/N)** | **INACTIVE(Y/N)** | **Comment** |
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***Question5b, Do companies agree that we should support RequestCapbilities for PRS in RRC\_IDLE/INACTIVE?***

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| **Company** | **IDLE(Y/N)** | **INACTIVE(Y/N)** | **Comment** |
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### DL-PRS configuration

For MO-LR, the UE needs to request assistance data, including e.g. PRS configuration, from the network. This message can be encapsulated within the same NAS message along with LCS request and *ProvideCapabilities* to be sent to the network. Excerpt from clause 7.3.3 of TS 38.305 is shown as below.

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| --- |
| 1. The UE sends an MO-LR Request included in a UL NAS TRANSPORT message as specified in TS 24.501 [29] to the AMF. The MO-LR request may carry an LPP PDU to instigate one or more LPP procedures to transfer capabilities, request assistance data, request location information and/or transfer location information. |

Rapporteur would like to ask the following question:

***Question6, Do companies agree that we should support RequestAssistanceData for DL-PRS for UE in RRC\_IDLE/INACTIVE?***

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| **Company** | **IDLE(Y/N)** | **INACTIVE(Y/N)** | **Comment** |
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With the UE PRS capability sent to the LMF, we can discuss the delivery of DL-PRS assistance data. In general, for positioning in IDLE/INACTIVE, we think there are two approaches for PRS configuration:

* **Option 1**: The network broadcasts *posSIB*.
	+ UE requests the system information if it is not broadcasted and acquires the assistance information by reading the system information; Note that in this case, no stage3 spec change is needed.
* **Option 2:** The LMF sends PRS assistance data via LPP message to UE
1. UE receives the LPP message in RRC\_CONNECTED and keeps it when the UE moves to INACTIVE; Note that in this case, no stage3 spec change is needed
2. The UE/GMLC transmits the LCS request for the UE in RRC\_IDLE/INACTIVE and the UE receives LPP message for PRS configuration in IDLE/INACTIVE

**For Option1**, we think this is already supported in R16, with the definition of *RRCSystemInfoReqeust* as a CCCH message. UE can request the DL-PRS configuration by on-demand SI request in IDLE/INACTIVE by sending the *RRCSystemInfoRequest*.

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| ***RRCSystemInfoRequest message***-- ASN1START-- TAG-RRCSYSTEMINFOREQUEST-STARTRRCSystemInfoRequest ::= SEQUENCE { criticalExtensions CHOICE { rrcSystemInfoRequest RRCSystemInfoRequest-IEs, criticalExtensionsFuture-r16 CHOICE { rrcPosSystemInfoRequest-r16 RRC-PosSystemInfoRequest-r16-IEs, criticalExtensionsFuture SEQUENCE {} } }}RRCSystemInfoRequest-IEs ::= SEQUENCE { requested-SI-List BIT STRING (SIZE (maxSI-Message)), --32bits spare BIT STRING (SIZE (12))}RRC-PosSystemInfoRequest-r16-IEs ::= SEQUENCE { requestedPosSI-List BIT STRING (SIZE (maxSI-Message)), --32bits spare BIT STRING (SIZE (11))}-- TAG-RRCSYSTEMINFOREQUEST-STOP-- ASN1STOP |

**For Option 2(a)**, while the UE is initially in RRC\_CONNECTED, the network can send LPP message with DL-PRS configuration to the UE. The UE can then keep this configuration when the UE transits to RRC\_IDLE/INACTIVE. For UE initially in IDLE/INACTIVE, the AMF would initiate a network triggered service request to establish a signalling connection with the UE. The AMF can then transfer the LPP PDU to the UE in CONNECTED, as descripted in TS 38.305. For both cases, NG-RAN can then release the UE back into the INACTIVE/IDLE, when the UE can use this configuration.

***Question7a, Do companies agree that the Option1 and 2a are already supported by the current stage3 spec and can be reused for PRS measurement IDLE/INACTIVE positioning?***

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| **Company** | **Yes/No** | **Comment** |
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**For option 2(b),** the network sends the PRS configuration to the UE while the UE is in RRC\_IDLE/INACTIVE with LPP message. In order to reduce the procedure latency, and avoid the UE resuming the RRC connection wasting UE power consumption, NG-RAN can transfer the LPP PDU to UE while keeping the UE in IDLE/INACTIVE. The procedure is depicted in Figure 3 and this LPP message delivery solution can be used for any UE terminated LPP messages.



**Figure 3, DL-PRS Configuration in IDLE/INACTIVE**

An important note that for the discussion in small data transmission in R17, we only support MO-data transmission and MT-data transmission is not part of the scope. However, if the support for MO-data is in place, the spec impacts to support MT-data will not be large. Also, data transmission in RRC\_IDLE is out of the scope for small data in R17.

***Question7b, Do companies agree that we should support DL-PRS configuration delivery to the UE in RRC\_IDLE/INACTIVE?***

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| **Company** | **IDLE(Y/N)** | **INACTIVE(Y/N)** | **Comment** |
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### PRS measurement triggering

During the RAN1 discussion in the SI, the following agreements have been made on the PRS measurement and highlighted below

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| Agreement:* NR positioning for UEs in RRC\_INACTIVE state is recommended for normative work, including
	+ DL, UL and DL+UL positioning methods
	+ UE-based and UE-assisted positioning solutions
	+ Support of UE positioning measurements for UEs in RRC\_inactive state
		- Options that can be considered include DL-PRS or DL-PRS and SSB
	+ Support of gNB positioning measurements for UEs in RRC\_inactive state
* The details of how to enable the UE positioning in RRC\_ INACTIVE state can be further discussed during normative work. These details may include, but are not limited to the following aspects:
	+ UL reference signals (e.g., SRS for positioning, PRACH preambles) for UL measurements
	+ Signalling and procedures for support the assistance data delivery, DL-PRS configuration, UL reference signals for positioning resource configuration, measurement reporting), which may be developed based on the enhancements of existing signalling and procedures (e.g., existing 2-step and/or 4-step PRACH procedures, paging procedure, small data transmission).

Agreement:Capture the following in the TR:From a physical layer perspective, it is feasible for a UE to perform DL positioning measurement in RRC\_IDLE state.* Note: This does not imply that measurements have to be reported in RRC\_IDLE state.

Conclusion:It is up to RAN2 to decide whether to support the enhancements of NR positioning reporting of DL positioning measurements and/or positioning estimates for RRC\_IDLE UEs. |

In order to support UE to measure PRS in IDLE/INACTIVE, the first issue is to trigger UE for the positioning measurements. There are two cases how the *RequestLocationInformation* message can be sent to the UE:

* **Option1, *RequestLocationInformation* in RRC\_CONNECTED**
	+ The current spec can already support this with deferred MT-LR and there is no specification impact for this. The LMF can send the message to the UE while the UE is in CONNECTED by setting the type for the request as *periodicalReporting* and the UE can continue the measurement in IDLE/INACTIVE
* **Option2, *RequestLocationInformation* in RRC\_INACTIVE/IDLE**
	+ The network can send this to the UE with the similar procedure depicted in Figure 2. It can also be sent along with the DL-PRS assistance information sent in *RRCRelease* as showed in Figure 2.

In R16, PRS measurement is only defined for RRC\_CONNECTED in 38.215. From the agreement from RAN1 above, it can be seen that PRS measurement in RRC\_INACTIVE has already been agreed. Similar to DL-PRS configuration delivery, the procedure depicted in Figure 3 can be used for any UE terminated LPP messages.

Assuming that PRS measurement is supported for both IDLE/INACITVE, rapporteur would like to ask the following two questions.

***Question8a, Do companies agree that the current stage3 spec already supports the transfer of RequestLocationInformation in RRC\_CONNECTED for PRS measurement in IDLE/INACTIVE?***

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| **Company** | **Y/N** | **Comment** |
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Again, one note is that MT-data transmission in INACTIVE and data transmission in IDLE is not part of the scope in small data.

***Question8b, Do companies agree that we should support the transfer of RequestLocationInformation when the UE is in RRC\_IDLE/INACTIVE?***

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| **Company** | **IDLE(Y/N)** | **INACTIVE(Y/N)** | **Comment** |
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### UE measurement reporting

During the RAN1 discussion in the SI, the following agreements have been made on the PRS measurement reporting and highlighted below

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| Agreement:* NR positioning for UEs in RRC\_INACTIVE state is recommended for normative work, including
	+ DL, UL and DL+UL positioning methods
	+ UE-based and UE-assisted positioning solutions
	+ Support of UE positioning measurements for UEs in RRC\_inactive state
		- Options that can be considered include DL-PRS or DL-PRS and SSB
	+ Support of gNB positioning measurements for UEs in RRC\_inactive state
* The details of how to enable the UE positioning in RRC\_ INACTIVE state can be further discussed during normative work. These details may include, but are not limited to the following aspects:
	+ UL reference signals (e.g., SRS for positioning, PRACH preambles) for UL measurements
	+ Signalling and procedures for support the assistance data delivery, DL-PRS configuration, UL reference signals for positioning resource configuration, measurement reporting), which may be developed based on the enhancements of existing signalling and procedures (e.g., existing 2-step and/or 4-step PRACH procedures, paging procedure, small data transmission).

Agreement:Capture the following in the TR:From a physical layer perspective, it is feasible for a UE to perform DL positioning measurement in RRC\_IDLE state.* Note: This does not imply that measurements have to be reported in RRC\_IDLE state.

Conclusion:It is up to RAN2 to decide whether to support the enhancements of NR positioning reporting of DL positioning measurements and/or positioning estimates for RRC\_IDLE UEs. |

Note that for the discussion in this section, the assumption is still that PRS measurement can be performed in both IDLE/INACTIVE.

After the receiving the *RequestLocationInformation* message and the indication of continuing the measurement in IDLE/INACTIVE, the UE can then measure PRS of multiple TRPs and report the measurement results to the network in RRC\_IDLE/INACTIVE.

For UE in INACTIVE, the positioning measurement reporting can also be supported for UE in INACTIVE based on the framework of small data in Rel-17. It can transfer the positioning data to the core network by sending *RRCResumeRequest*, potentially with a proper cause value. The gNB can then send the RRC Release message to keep the UE in INACTIVE, to save the power of the UE. The AMF also has the context of this UE in INACTIVE, it can transfer the LPP data to LMF using a UE-associated message. For UE in IDLE, small data transmission in Rel-17 is not supported. Also, for UE in IDLE, the AMF does not have the UE context and it might be difficult to transfer the LPP data to the LMF.

The rapporteur thus would like to ask the following question

***Question9a, Do companies agree that we should support the report of PRS measurement performed in IDLE/INACTIVE when the UE is in RRC\_IDLE/INACTIVE?***

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| **Company** | **IDLE(Y/N)** | **INACTIVE(Y/N)** | **Comment** |
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Furthermore, for PRS measurement performed in RRC\_IDLE/INACTIVE, UE should be able to report these measurement results to the network when the UE transits to RRC\_CONNECTED. This was supported for NB-IOT positioning, for which, measurement is performed during IDLE and measurement report is sent to the network during RRC\_CONNECTED.

***Question9b, Do companies agree that we should support the report of PRS measurement performed in RRC\_IDLE/INACTIVE when the UE is in RRC\_CONNECTED?***

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| **Company** | **Y/N** | **Comment** |
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Uplink positioning

For uplink positioning, the last RAN1 meetings have made the following agreements, which are highlighted below.

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| Agreement:* NR positioning for UEs in RRC\_INACTIVE state is recommended for normative work, including
	+ DL, UL and DL+UL positioning methods
	+ UE-based and UE-assisted positioning solutions
	+ Support of UE positioning measurements for UEs in RRC\_inactive state
		- Options that can be considered include DL-PRS or DL-PRS and SSB
	+ Support of gNB positioning measurements for UEs in RRC\_inactive state
* The details of how to enable the UE positioning in RRC\_ INACTIVE state can be further discussed during normative work. These details may include, but are not limited to the following aspects:
	+ UL reference signals (e.g., SRS for positioning, PRACH preambles) for UL measurements
	+ Signalling and procedures for support the assistance data delivery, DL-PRS configuration, UL reference signals for positioning resource configuration, measurement reporting), which may be developed based on the enhancements of existing signalling and procedures (e.g., existing 2-step and/or 4-step PRACH procedures, paging procedure, small data transmission).

Agreement:Capture the following in the TR:From a physical layer perspective, it is feasible for a UE to perform DL positioning measurement in RRC\_IDLE state.* Note: This does not imply that measurements have to be reported in RRC\_IDLE state.

Conclusion:It is up to RAN2 to decide whether to support the enhancements of NR positioning reporting of DL positioning measurements and/or positioning estimates for RRC\_IDLE UEs. |

In this chapter, we discuss the uplink positioning under the assumption that SRS is transmitted in INACTIVE

### SRS capability

To help the NG-RAN to decide to include the SRS configurations in the RRC release message, or help the NG-RAN to decide to release the UE to INACTIVE to sending SRS when there is no data service, an indication or information can be sent from the LMF to the NG-RAN. Namely, LMF can provide assistant information to NG-RAN to help NG-RAN to decide configuring the UE to continuing sending SRS when the UE is released to INACTIVE. Additionally, the UE can report the corresponding capabilities to the LMF, such as the capability of sending SRS in INACTIVE. Then LMF can select the proper UL positioning method with this capability information.

***Question10, Do companies think we should support the reporting of SRS capability for UE in INACTIVE?***

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| **Company** | **Y/N** | **Comment** |
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### SRS configuration

If the UE can transmit SRS during INACTIVE, the UE first needs to get the SRS configuration from the network. The key issue now is how to configure UE to send SRS when entering IDLE/INACTIVE. There are two cases for UE in different states:

* **Option1**: For CONNECTED
	+ A natural solution is to include the SRS configurations in *RRCRelease* message when the UE is in CONNECTED. Similar solution has been adopted in PUR for NB-IoT and eMTC for IDLE/INACTIVE UL transmission.
* **Option2**: For INACTIVE
	+ Delivery of SRS configuration when the UE is in INACTIVE without entering CONNECTED.

For option 1, the UE needs to transfer into CONNECTED state if the UE is initially in IDLE/INACTIVE state. This would lead to extra signalling latency and cause extra power consumption. Another option is to configure SRS to UE without transfer UE into CONNECTED state. An example of the procedure of configuring SRS for the UE in INACTIVE state is illustrated in Figure 3.



**Figure 4, SRS configuration in INACTIVE**

Base on the discussion above, the rapporteur would like to ask the following question:

***Question11a, Do companies think we should support the delivery of SRS configuration for UE SRS transmission in INACTIVE when the UE is in CONNECTED?***

|  |  |  |
| --- | --- | --- |
| **Company** | **Y/N** | **Comment** |
|  |  |  |

***Question11b, Do companies think we should support the delivery of SRS configuration for UE SRS transmission when the UE is in INACTIVE?***

|  |  |  |
| --- | --- | --- |
| **Company** | **Y/N** | **Comment** |
|  |  |  |

### SRS-related signalling in NRPPa

When LMF determines to perform uplink positioning for a UE, it first requests the SRS configuration from the gNB with NRPPa message POSITIONING INFORMATION REQUEST. Then, the network responds with POSITIONING INFORMATION RESPONSE to the LMF with the configured SRS to the UE and update the SRS configuration to the LMF with POSITIONING INFORMATION UDPATE when it happens.

After the SRS configuration of the UE, if semi-persistent or aperiodic SRS is configured to the UE, the LMF needs to activate/deactivate the SRS for the UE (not) to transmit by sending the POSITIONING ACTIVATION REQUEST and POSITIONING DEACTIVATION.

When the SRS is transmitted by the UE, the LMF request the TRP measurement with the NRPPa message MEASUREMENT REQUEST sent to the corresponding TRPs.

For these NRPPa messages, they are transported to the gNB by the NRPPa transport in the NG-AP. Note that from the perspective of NG-AP, it does not differentiate between CM-CONNECTED with RRC\_CONNECTED or with RRC\_INACTIVE. So from the understanding of the rapporteur, the above NRPPa signalling for INACTIVE is already supported.

***Question12, Do companies agree that the current stage3 spec already supports the NRPPa message for uplink positioning for UE in INACTIVE?***

|  |  |  |
| --- | --- | --- |
| **Company** | **Y/N** | **Comment** |
|  |  |  |

## General discussion on NAS/NG-AP signalling transport in IDLE/INACTIVE

Finally, rapporteur would like to touch on the general support of NAS signalling transport for UE in IDLE/INACTIVE.

From the above sections, we have generally discussed the support of transmission of UL message for positioning which are transported with uplink NAS message, such as, *ProvideLocationInformation, LCS request, etc;* and DL message for positioning, which are transported with downlink NAS message, such as, *RequestLocationInformation, ProvideAssistanceData, etc.* While for the NAS transport, it consists of two parts: (a) the RRC signalling where dedicated NAS message are sent from the UE to the NG-RAN with SRB2; (b) the NG-AP NAS transport within which the NAS message are transported from the NG-RAN to the AMF.

Note that the inputs from different companies on these questions shall be aligned with the responses above.

***Question13a, Do companies think we should support the transport of UL NAS message in IDLE/INACTIVE for IDLE/INACTIVE positioning?***

|  |  |  |  |
| --- | --- | --- | --- |
| **Company** | **IDLE(Y/N)** | **INACTIVE(Y/N)** | **Comment** |
|  |  |  |  |

***Question13b, Do companies think we should support the transport of DL NAS message in IDLE/INACTIVE for IDLE/INACTIVE positioning?***

|  |  |  |  |
| --- | --- | --- | --- |
| **Company** | **IDLE(Y/N)** | **INACTIVE(Y/N)** | **Comment** |
|  |  |  |  |

Then, for UL positioning methods, such as UL-AOA, TL-TDOA, and UL-ECID, NRPPa message will be utilized for LMF to notify the measurement in the gNB. For DL positioning methods, the network needs to obtain the PRS information with the message TRP INFORAMTION REQUEST/RESPONSE. There are two classes of NRPPa messages, as mentioned by the following text in [1]

|  |
| --- |
| Positioning and data acquisition transactions between a LMF and NG-RAN node are modelled by using procedures of the NRPPa protocol. There are two types of NRPPa procedures:- UE associated procedure, i.e. transfer of information for a particular UE, including the procedures supporting the Positioning Information Transfer and E-CID Location Information Transfer functions;- Non UE associated procedure, i.e. transfer of information applicable to the NG-RAN node and associated TRP, including the procedures supporting the OTDOA Information Transfer, Assistance Information Transfer, TRP Information Transfer, and Measurement Information Transfer functions. |

 From our understanding, both UE-associated and non-UE associated procedures are related to the positioning in IDLE/INACTIVE. In the NG-AP protocol, the UL and DL NRPPa message are transported with DOWNLINK (NON-)UE ASSOCIATED NRPPA TRANSPORT and UPLINK (NON-)UE ASSOCIATED NRPPA TRANSPORT, respectively.

Note that from the perspective of NG-AP, it does not differentiate between CM-CONNECTED with RRC\_CONNECTED or RRC\_INACTIVE. So from the understanding of the rapporteur, the NRPPa transport for INACTIVE is already supported.

Note that the inputs from different companies on these questions shall be aligned with the responses above.

***Question14a, Do companies think we should support the transport of UE-associated NRPPa message in IDLE/INACTIVE for IDLE/INACTIVE positioning?***

|  |  |  |  |
| --- | --- | --- | --- |
| **Company** | **IDLE(Y/N)** | **INACTIVE(Y/N)** | **Comment** |
|  |  |  |  |

While for non-UE-associated signalling, since it is “non-UE-associated” and not related to the RRC state of the UE, we don’t need to support the transport for non-UE associated NRPPa message.

***Question14b, Do companies agree that we don’t need to discuss the transport of non-UE-associated NRPPa message in IDLE/INACTIVE for IDLE/INACTIVE positioning?***

|  |  |  |
| --- | --- | --- |
| **Company** | **Y/N** | **Comment** |
|  |  |  |

Discussion on RAT-independent positioning

In addition to the above positioning methods for RAT-dependent positioning, 3GPP also supports RAT-independent positioning, including Barometric pressure sensor, WLAN, Bluetooth, TBS, Motion Sensor, A-GNSS, etc. From our understanding, if general support for NAS signalling transport is supported for IDLE/INACTIVE, these positioning methods can also be supported.

***Question15, Do companies agree that RAT-independent positioning can also be supported for IDLE/INACTIVE positioning, if NAS signalling transport is generally supported?***

|  |  |  |
| --- | --- | --- |
| **Company** | **Y/N** | **Comment** |
|  |  |  |

Any other issues

If companies find other issues that need to be addressed, they can be input here.

|  |  |
| --- | --- |
| **Company** | **Comment** |
|  |  |

Conclusions

In this contribution, we have an email discussion on RRC\_IDLE/INACTIVE positioning and based on the opinions from different companies, we propose the following:

**Proposal TBD**

References

[1] TS 38.305, Stage 2 functional specification of User Equipment (UE) positioning in NG-RAN, 3GPP