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

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

Agenda Item: 8.11.3.2

Source: Huawei, HiSilicon

Title: Text proposal for IDLE and INACTIVE positioning

**Document for: Discussion**

# Introduction

After RAN2#112e, the following email discussion is 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 contribution, we propose a text proposal for the TR for the study of positioning enhancement in R17

# Discussion

In this text proposal, we propose the following based on the current TR 38.857 and the progress in the email discussion

* Reorganize the sections for IDLE/INACTIVE positioning
* Adding the definition for IDLE/INACTIVE positioning
* Implementing RAN2 agreements for the discussions in [Post112-e][609]

# Text proposal

================================FIRST CHANGE=====================================

# 2 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication, edition number, version number, etc.) or non‑specific.

- For a specific reference, subsequent revisions do not apply.

- For a non-specific reference, the latest version applies. In the case of a reference to a 3GPP document (including a GSM document), a non-specific reference implicitly refers to the latest version of that document *in the same Release as the present document*.

[1] 3GPP TR 21.905: "Vocabulary for 3GPP Specifications".

[2] RP-193237: "new SID on NR Positioning Enhancements".

[3] 3GPP TR 38.855: "Study on NR Positioning (Release 16)".

[4] R1-2009433 Evaluation results for Rel-16 positioning and Rel-17 enhancement Huawei, HiSilicon

[5] R1-2007665 Evaluation of NR positioning performance vivo

[6] R1-2007720 Evaluation of achievable positioning accuracy BUPT

[7] R1-2007754 Evaluation of achievable accuracy and latency ZTE

[8] R1-2007859 Discussion of evaluation of NR positioning performance CATT

[9] R1-2007908 NLOS Identification and Mitigation FUTUREWEI

[10] R1-2009390 Update of Evaluation Results for NR Positioning Performance in I-IoT Scenarios Intel Corporation

[11] R1-2007997 NR Positioning Latency Evaluations Lenovo, Motorola Mobility

[12] R1-2008225 Evaluation of NR positioning in IIOT scenario OPPO

[13] R1-2009555 Results on evaluation of achievable positioning accuracy and latency Nokia, Nokia Shanghai Bell

[14] R1-2009502 Discussion on Performance evaluation of Rel-17 positioning Sony

[15] R1-2008416 Discussions on evaluation of achievable positioning accuracy and latency for NR positioning LG Electronics

[16] R1-2008489 Evaluation of achievable positioning latency InterDigital, Inc.

[17] R1-2009708 Evaluation of achievable Positioning Accuracy & Latency Qualcomm Incorporated

[18] R1-2009428 Evaluation of positioning enhancements Fraunhofer IIS, Fraunhofer HHI

[19] R1-2008720 Positioning evaluation results on potential enhancements for additional use cases CeWiT

[20] R1-2008764 Evaluation of achievable positioning accuracy and latency Ericsson

[21] R1-2008765 Potential positioning enhancements Ericsson

[22] R1-2007666 Discussion on potential positioning enhancements vivo

[23] R1-2005380 Evaluation of achievable positioning accuracy and latency vivo

[24] 3GPP TS 22.261 Service requirements for the 5G system; Stage 1 (Release 17)

[25] RP-202094 Revised SID: Study on NR Positioning Enhancements CATT, Intel Corporation

[26] 3GPP TS 38.901 Study on channel model for frequencies from 0.5 to 100 GHz (Release 16)

[xx] 3GPP TS 24.571 Control plane Location Services (LCS) procedures (Release 16)

======================================NEXT CHANGE===================================

# 7 Studied NR positioning enhancements

The following enhancements have been considered during this study:

* Partial staggering and non-staggering RE mapping of SRS for positioning with different combinations of comb-factors and symbol lengths, including the methods/signalling for addressing potential time-domain aliasing due to the partial/non-staggering RE mapping.
* Semi-persistent and a-periodic transmission and reception of DL PRS
	+ Semi-persistent means MAC-CE triggered
	+ Aperiodic would correspond to DCI-triggered
* On-demand transmission and reception of DL PRS
	+ On-demand corresponds to the UE-initiated or network-initiated request of PRS and/or SRS, i.e. UE or LMF request/suggesting/recommending specific PRS pattern, ON/OFF, periodicity, BW, etc.
* Multipath mitigation techniques including but not limited to the following:
	+ The applicable scenarios and performance benefits of multipath mitigation techniques
	+ The methods/measurement/signaling for the LOS/NLOS detection and identification
	+ The measurements for supporting the multipath mitigation/utilization
	+ The procedure and signaling for supporting the multipath mitigation/utilization
	+ Implementation-based solutions (e.g., outlier rejection) without the need of any additional specified method/measurements/procedures/signaling.
	+ Note: The above study applies to DL only, UL only, DL+UL positioning solutions for UE-based and UE-assisted positioning.
* NR positioning for UEs in RRC\_IDLE state and UEs in RRC\_INACTIVE state, including the benefits on latency, network/UE efficiency and UE power consumption. The following UE positioning procedures are under the scope of RRC\_IDLE/RRC\_INACTIVE positioning if any of them are performed when the UE is in RRC\_IDLE/RRC\_INACTIVE.
* Service layer support
	+ LCS messages defined in Clause 4.1.2 for location services in TS 24.571 [xx]
* NRPPa
	+ E-CID information transfer (UE-associated)
	+ Positioning information transfer (UE-associated)
	+ Measurement information transfer (non-UE-associated)
* Uu Signaling and procedure
	+ RRC signaling for positioning (e.g., posSRS configuration)
	+ LPP signaling for positioning (e.g., Capability transfer, Assistance data transfer, Location information transfer)
	+ MAC procedure/L1 signaling (e.g., activation/deactivation for semi-persistent/aperiodic posSRS)
	+ Transmission of UL-PRS and reception of DL-PRS
	+ Reception for assistance information broadcast
* For reducing NR positioning latency, more efficient signaling & procedures enabling a device to request and report positioning information, which may include, but not limited to, the following aspects:
	+ DL PRS/SRS configuration, activation or triggering.
	+ The request for positioning information (the assistance data, etc.).
	+ The report of positioning information (the measurement report, etc.).
	+ Note: It is not within RAN1 scope to analyze positioning architecture enhancements to enable such more efficient signaling & procedures.
	+ Note: RAN1 does not make any assumptions on whether the LCS architecture specified in TS 23.273 is enhanced or not.
* Simultaneous transmission by the UE and reception by the gNB of the SRS for positioning across multiple CCs and multiple slots, including
	+ The scenarios and performance benefits of the enhancement
	+ The impact of channel spacing, TA and timing offset, phase offset, frequency error, and power imbalance across slots or CCs to the positioning performance for intra-band contiguous/ non-contiguous and inter-band scenarios
* Scenario, benefits, and methods for improving the accuracy of the UL AoA and DL-AoD methods for both UE-based and network-based (including UE-assisted) positioning
* Scenario, benefits, methods and signaling for improving positioning accuracy in the presence of the UE Rx/Tx transmission delays, and/or gNB Rx/Tx transmission delays for UE-based and network-based (including UE-assisted) positioning.
* Aggregating multiple DL positioning frequency layers of the same or different bands for improving positioning performance for both intra-band and inter-band scenarios
* The scenarios and performance benefits of aggregating multiple DL positioning frequency layers
* The impact of channel spacing, timing offset, phase offset, frequency error, and power imbalance among CCs to the positioning performance for intra-band contiguous/ non-contiguous and inter-band scenarios
* UE complexity considerations

================================SECOND CHANGE===================================

# 10 Identified NR impacts in Rel-17

## 10.1 NR positioning for UEs in RRC\_IDLE/RRC\_INACTIVE state

### 10.1.a UL and DL Positioning in RRC\_INACTIVE

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).

The following procedures are recommended for normative work for DL positioning methods in RRC\_INACTIVE:

* + Reporting of PRS measurement performed in RRC\_INACTIVE when the UE is in RRC\_INACTIVE/RRC\_CONNETED.

NOTE: The following procedures have already been supported by UE in RRC\_CONNECTED and can be reused for UE in RRC\_INACTIVE

* + - On-demand SI request in RRC\_INACTIVE for assistance data delivery in RRC\_INACTIVE
		- Assistance data delivery in RRC\_CONNECTED for RRC\_INACTIVE downlink positioning
		- *RequestLocationInformation* can be sent in RRC\_CONNECTED for PRS measurement in RRC\_INACTIVE

The following procedures are recommended for normative work for UL positioning methods in RRC\_INACTIVE if SRS transmission is supported in RRC\_INACTIVE.

* + Delivery of SRS configuration for UE SRS transmission in RRC\_INACTIVE when the UE is in RRC\_CONNECTED.

NOTE: The following procedures have already been supported for UE in RRC\_CONNECTED and can be reused for UE in RRC\_INACTIVE

* + - NRPPa message for uplink positioning for UE in RRC\_INACTIVE

The following procedures are recommended for normative work for NR E-CID in RRC\_INACTIVE

* + Reporting of RRM measurement performed in RRC\_INACTIVE in LPP for DL NR E-CID by the UE in RRC\_INACTIVE
	+ Reporting of RRM measurement performed in RRC\_IDLE in RRC message for UL NR E-CID by the UE in RRC\_INACTIVE.

NOTE: The following procedures have already been supported for NR E-CID in RRC\_ INACTIVE

* + Reporting of RRM measurement performed in RRC\_INACTIVE in LPP/RRC by the UE in RRC\_CONNECTED

### 10.1.b DL Positioning in RRC\_IDLE

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.

The following procedures are recommended for normative work for DL positioning methods in RRC\_IDLE:

Reporting of PRS measurement performed in RRC\_IDLE when the UE is in RRC\_CONNETED.

NOTE: The following procedures have already been supported by UE in RRC\_CONNECTED and can be reused for UE in RRC\_IDLE

* + - On-demand SI request in RRC\_IDLE for assistance data delivery in RRC\_IDLE
		- Assistance data delivery in RRC\_CONNECTED for RRC\_IDLE downlink positioning
		- *RequestLocationInformation* can be sent in RRC\_CONNECTED for PRS measurement in RRC\_IDLE

NOTE: The following procedures have already been supported for NR E-CID in RRC\_IDLE

* + Reporting of RRM measurement performed in RRC\_IDLE in LPP/RRC by the UE in RRC\_CONNECTED

### 10.1.c RAT-Independent positioning

RAT-Independent positioning in RRC\_IDLE/INACTIVE is recommended for normative work. The exact procedures that can be supported for RAT-Independent positioning in RRC\_IDLE/INACTVE can be further studied.

### 10.1.d NAS transport/NG-AP transport

UL NAS signalling transport is recommended for normative work for positioning in RRC\_INACTIVE. UL NAS signalling transport is not supported for positioning in RRC\_IDLE. DL NAS signalling transport is not supported for positioning in RRC\_IDLE/INACTIVE.

Transport of UE-associated NRPPa message in RRC\_INACTIVE for RRC\_INACTIVE positioning has already been supported. Transport of non-UE-associated NRPPa message is not relevant for positioning in RRC\_IDLE/RRC\_INACTIVE

## 10.2 On-demand transmission and reception of DL PRS

From a physical layer perspective, on-demand transmission and reception of DL PRS, which includes at least the following is recommended

* UE-initiated request of on-demand DL PRS transmission
* LMF (network)-initiated request of on-demand DL PRS transmission
* Above enhancements are recommended for both DL and DL+UL positioning methods and both UE-based and UE-assisted positioning solutions.

## 10.3 Aggregation of DL PRS resources

Simultaneous transmission by the gNB and reception by the UE of intra-band one or more contiguous carriers in one or more contiguous PFLs can be studied further and if needed, specified during normative work

* From both gNB and UE perspective, the applicability and feasibility of this enhancement for different scenarios, configurations, bands and RF architectures, can be further studied

## 10.4 Aggregation of SRS for positioning resources

Simultaneous transmission by the UE and aggregated reception by the gNB of the SRS for positioning in multiple contiguous intra-band carriers can be studied further and if needed, specified during normative work.

* From both gNB and UE perspective, the applicability and feasibility of this enhancement for different scenarios, configurations, particular bands and RF architectures, can be further studied.

## 10.5 Enhancements for UE Rx/Tx and gNB Rx/Tx timing delays

The methods, measurements, signaling, and procedures for improving positioning accuracy in the presence of the UE Rx/Tx timing delays, and/or gNB Rx/Tx timing delays are recommended for normative work, including

* DL, UL and DL+UL positioning methods
* UE-based and UE-assisted positioning solutions
* Note: The details of the solutions are left for further discussion in normative work.

## 10.6 Enhancements for angle based methods

The enhancements of the procedure, measurements, reporting, and signalling for improving the accuracy of

* UL AoA is recommended for normative work for network-based positioning solutions.
* DL-AoD is recommended for normative work for UE-based and network-based (including UE-assisted) positioning solutions.

## 10.7 Enhancements of information reporting from UE and gNB for supporting multipath/NLOS mitigation

Enhancements of information reporting from UE and gNB for supporting multipath/NLOS mitigation can be studied further, and if needed, specified during normative work for improving positioning accuracy.

* Note: The details of the enhancements of reporting are left for further discussion in normative work, which may include, but are not limited to the following information associated with multi-path, e.g., LOS/NLOS identification, time of arrival of the multi-path components, signal power and/or relative power, power delay profile, angle, and/or polarization information, coherence bandwidth, etc.

## 10.8 Enhancements of signaling & procedures for reducing NR positioning latency

Aperiodic reception of DL PRS from the TRPs of the serving gNB and aperiodic reception of DL PRS from the TRPs of the neighbouring gNBs can be studied further and if needed, specified during normative work.

* Note: Aperiodic reception corresponds to DCI-triggered reception

Semi-persistent reception of DL PRS from the TRPs of the serving gNB and Semi-persistent reception of DL PRS from the TRPs of the neighbouring gNBs can be studied further and if needed, specified during normative work.

* Note: Semi-persistent reception in the above corresponds to MAC-CE activated reception

The following enhancements of signaling & procedures for reducing NR positioning latency are recommended for normative work, including DL and DL+UL positioning methods

* + The details of the solutions are left for further discussion in normative work, which may include the following aspects:
		- Latency reduction related to the measurement gap
		- Latency reduction related to the reporting and request of the measurement (e.g., via RRC signaling, MAC-CE and/or physical layer procedure, and/or priority rules)
		- Latency reduction related to measurements

The following enhancements of signaling & procedures for reducing NR positioning latency can be studied and specified, if needed

* + Latency reduction related to the request and response of positioning assistance data (e.g., via RRC signaling, MAC-CE and/or physical layer procedure)
	+ Latency reduction related to the reception of DL PRS (e.g., priority rules for the reception of DL PRS)

No assumptions are made on whether the LCS architecture specified in TS 23.273 is enhanced or not.

## 10.9 Void

=======================================END OF CHANGES============================