**3GPP TSG RAN meeting #97e RP-22xxxx**

**Electronic Meeting, September 12th – 16th, 2022**

## Status Report to TSG

**Agenda item:** 9.2.5

|  |  |
| --- | --- |
| **WI / SI Name** | Study on expanded and improved NR positioning |
| included in this status report | Study Item: Yes | Core part: | Performance part: | Testing part: |
| **Acronym** | FS\_NR\_pos\_enh2 |
| **Unique ID** |  |
| **TSG Tdoc of latest approved WI/SI description (if any)** | RP-213588 |
| **Target Completion Date****(indicate if changed)** | Study Item: 12/2022(No change) | Core part:  | Performance part:  | Testing part:  |
| **Overall Completion level** | Study Item: 40% | Core part:  | Performance Part:  | Testing part:  |

Note: Overall completion level percentage numbers should use one of the colors below:

* xx%: Normal progress, no RAN plenary action needed
* xx%: Progress behind schedule, may need RAN plenary intervention. If so, SR should clearly define requested action
* xx%: Progress critically behind, RAN plenary shall intervene. SR should define requested action

**Source:**

|  |  |
| --- | --- |
| **Leading WG** | RAN1 |
| **Rapporteur** | **Name** | Alexey Khoryaev |
| **Company** | Intel Corporation |
| **Email** | alexey.khoryaev@intel.com |
| **Name** | Ren Da |
| **Company** | CATT |
| **Email** | renda@catt.cn |
| **Name** | Florent Munier |
| **Company** | Ericsson |
| **Email** | florent.munier@ericsson.com |

## 1 Work plan related evaluation

|  |  |
| --- | --- |
| **Do you want to modify the time budget for this WI/SI compared to what was endorsed at the last RAN meeting?** | No |

*If you answered No: Then please remove the Excel file from the zip file of this status report.*

*If you answered Yes: Then please fill out the attached Excel template to request a modification of the time budgets for your WI /SI. The Excel table has to be filled out for all affected RAN WGs and up to the target date of the WI/SI. The basis are the endorsed time budgets of the last RAN meeting. Please highlight all changes of the values.
 One time unit (TU) corresponds to ~ 2 hours in the meeting.
 If this status report covers a WI with Core and Performance part, then please have one line for each in the attached Excel table.
 Note: If no Excel table is attached, then this means no time budget change.*

**Additional explanations/motivations for the time budget changes in the attached Excel table:**

## 2. Detailed progress in RAN WGs since last TSG meeting (for all involved WGs)

 NOTE: Agreements and Open issues impacted cross-TSG aspects shall be explicitly highlighted

## 2.1 RAN1

#### 2.1.1 Agreements

##### Decisions during RAN1#109-e

**Agreement**

TR skeleton for TR 38.859 for study on expanded and improved NR positioning is endorsed in R1-2205398.

###### SL Positioning Scenarios and Requirements:

**Agreement**

Following two operation scenarios are considered for studies on SL positioning:

* Scenario 1: PC5-only-based positioning
* Scenario 2: Combination of Uu- and PC5-based positioning solutions

**Agreement**

For evaluations for SL positioning:

* For V2X and public safety use-cases, at least in-coverage and out-of-coverage scenarios are considered.
* For IIoT and commercial use-cases, at least in-coverage scenarios are considered.

**Agreement**

For the purpose of evaluations, in-coverage and out-of-coverage scenarios are prioritized during the SI.

* Note: This prioritization is not intended to down-scope support of SL positioning for partial coverage scenarios.

**Agreement**

For evaluations for SL positioning:

* Operation in FR1 with channel bandwidths of up to 100 MHz are considered.
* Optional: Operation in FR2 with channel bandwidths of up to 400 MHz are considered.

**Agreement**

Positioning accuracy requirements for SL positioning are expressed as accuracy requirements of particular percentiles of UEs for one or more of the following metrics:

* Ranging accuracy, expressed as the difference (error) between the calculated distance/direction and the actual distance/direction in relation to another node
* Relative positioning accuracy, expressed as the difference (error) between the calculated horizontal/vertical position and the actual horizontal/vertical position relative to another node
* Absolute positioning accuracy. expressed the difference (error) between the calculated horizontal/vertical position and the actual horizontal/vertical position
* Note: the exact applicability of particular requirements may vary across use-cases

**Agreement**

For evaluations of relative positioning, the horizontal plane is assumed parallel to the ground.

**Working assumption**

For evaluation of V2X use-cases for SL positioning, the following accuracy requirements are considered:

* Set A (similar to “Set 2” defined in TR 38.845)
	+ Horizontal accuracy of 1.5 m (absolute and relative); Vertical accuracy of 3 m (absolute and relative) for 90% of UEs
* Set B (similar to “Set 3” defined in TR 38.845)
	+ Horizontal accuracy of 0.5 m (absolute and relative); Vertical accuracy of 2 m (absolute and relative) for 90% of UEs
* Note 1: For evaluated SL positioning methods, companies are expected to report:
	+ (1) whether each of the two requirements are satisfied, and
	+ (2) %-ile of UEs satisfying the target positioning accuracy for a requirement that may not be satisfied with 90%.
* Note 2: target positioning requirements may not necessarily be reached for all scenarios and deployments
* Note 3: all positioning techniques may not achieve all positioning requirements in all scenarios

**Agreement**

For evaluation of public safety use-cases for SL positioning solutions, the following accuracy requirements are considered:

* 1 m (absolute or relative) horizontal accuracy and 2 m (absolute or relative between 2 UEs) or 0.3 m (relative positioning change for one UE) vertical accuracy for 90% of UEs
* Relative speed: up to 30 km/hr.
* Note 1: For evaluated SL positioning methods, companies are expected to report:
	+ (1) whether the requirement is satisfied, and
	+ (2) %-ile of UEs satisfying the target positioning accuracy if the requirement may not be satisfied with 90%.
* Note 2: target positioning requirements may not necessarily be reached for all scenarios and deployments
* Note 3: all positioning techniques may not achieve all positioning requirements in all scenarios

**Agreement**

For evaluation of commercial use-cases for SL positioning solutions, the following accuracy requirements are considered:

* 1 m (absolute or relative) horizontal accuracy and 2 m (absolute or relative) vertical accuracy for 90% of UEs
* Relative speed: up to 30 km/hr.
* Note 1: For evaluated SL positioning methods, companies are expected to report:
	+ (1) whether the requirement is satisfied, and
	+ (2) %-ile of UEs satisfying the target positioning accuracy if the requirement may not be satisfied with 90%.
* Note 2: target positioning requirements may not necessarily be reached for all scenarios and deployments
* Note 3: all positioning techniques may not achieve all positioning requirements in all scenarios

**Working assumption**

For evaluation of IIoT use-cases for SL positioning solutions, the following accuracy requirements are considered:

* For horizontal accuracy,
	+ Set A: 1 m (absolute or relative) for 90% of UEs
	+ Set B: 0.2 m (absolute or relative) for 90% of UEs
* For vertical accuracy,
	+ Set A: 1 m (absolute or relative) for 90% of UEs
	+ Set B: 0.2 m (absolute or relative) for 90% of UEs
* Relative speed: up to 30 km/hr.
* Note 1: For evaluated SL positioning methods, companies are expected to report:
	+ (1) whether each of the two requirements are satisfied, and
	+ (2) %-ile of UEs satisfying the target positioning accuracy for a requirement that may not be satisfied with 90%.
* Note 2: target positioning requirements may not necessarily be reached for all scenarios and deployments
* Note 3: all positioning techniques may not achieve all positioning requirements in all scenarios

**Agreement**

For evaluations in Rel-18, ranging requirements for SL positioning are defined as:

* For a given use-case, the value of the distance requirement for ranging distance accuracy is same as the value identified for horizontal positioning accuracy for relative positioning.
* The requirement on ranging direction accuracy is Y degrees for 90% of UEs.
	+ FFS: Exact definition of ranging direction accuracy, including value(s) of Y and reference direction

**Agreement**

For Rel-18 studies on SL positioning, focus on positioning accuracy

* Note: End-to-end positioning latency is expected to satisfy a latency budget of X second(s).
	+ FFS: value of X

###### Evaluation Methodology for SL Positioning:

**Agreement**

For SL positioning evaluation, V2X use case with highway and urban grid scenarios defined in TR 37.885 is supported.

* The road configuration for urban grid and highway provided in TR 37.885 Annex A is reused

**Agreement**

For SL positioning evaluation in highway and urban grid scenarios, UE dropping option A defined in section 6.1.2 of TR 37.885 is used, i.e.

* UE dropping option A is used for the highway scenario:
	+ Vehicle type distribution: 100% vehicle type 2.
	+ Clustered dropping is not used.
	+ Vehicle speed is 140 km/h in all the lanes as baseline and 70 km/h in all the lanes optionally.
* UE dropping option A is used for the urban grid scenario:
	+ Vehicle type distribution: 100% vehicle type 2.
	+ Clustered dropping is not used.
	+ Vehicle speed is 60 km/h in all the lanes.
	+ In the intersection, a UE goes straight, turns left, turns right with the probability of 0.5, 0.25, 0.25, respectively.

**Agreement**

For SL positioning evaluation in highway and urban grid scenarios, antenna model follows the description in TR 37.885 section 6.1.4.

* Vehicle UE option 1 is the baseline (Vehicle UE antenna is modelled in Table 6.1.4-8 and 6.1.4-9 in TR 37.885)
* Vehicle UE option 2 (two panels) can be optionally selected by companies

**Agreement**

For SL positioning evaluation in highway and urban grid scenarios, channel model follows description in TR 37.885 section 6.2.

**Agreement**

* The following performance metrics for SL positioning accuracy evaluation is defined:
	+ For relative and absolute positioning
		- horizontal accuracy
		- vertical accuracy
	+ For ranging
		- Ranging for distance, i.e. accuracy of distance
		- Ranging for angle, i.e. accuracy of angle
* Companies are required to output
	+ The percentiles of positioning accuracy error including 50%, 67%, 80%, 90% of UEs,
		- FFS others
	+ And the CDF of positioning accuracy error
* Performance metrics other than positioning accuracy, such as PHY/end-to-end latency, are up to companies

**Agreement**

* For absolute positioning evaluation, anchor UEs’ locations are known
	+ In the evaluation of SL only positioning
		- Anchor UEs are used to locate target UEs
	+ In the evaluation of Joint Uu/SL positioning
		- Both BS and anchor UEs are used to locate target UEs
* In the evaluation, relative positioning or ranging is performed between two UEs within X m
	+ FFS X which can be different for different scenarios, e.g. highway, urban grid, etc.
	+ Companies can consider to provide simulation results based on multiple X values
* Positioning method should be reported by companies.

**Agreement**

For SL positioning evaluation,

* The existing pattern and sequence of DL-PRS or positioning SRS can be reused as baseline for evaluation purpose.
	+ Companies should provide the description if other pattern and sequence are evaluated,
	+ AGC settling time is considered by companies
* Explicit simulation of all links, individual parameters estimation is applied. Companies should provide description of applied algorithms for estimation of signal location parameters.
* As baseline for absolute positioning, sidelink anchors location coordinates are perfectly known.
	+ Uncertainty in the sidelink anchors location coordinates can be considered by companies
* As baseline, Perfect synchronization between network and anchor UEs in the evaluation is assumed.
	+ Network synchronization error and timing errors defined in TR 38.857 Table 6-1 can also be optionally used by companies for Synchronization between BS and BS, between BS and anchor UEs, and between anchor UEs.

**Agreement**

For SL positioning evaluation in highway and urban grid, the following simulation parameters are used for FR1

**Evaluation parameters for SL positioning in FR1**

|  |  |  |
| --- | --- | --- |
| **Parameters** | **Urban grid for eV2X** | **Highway for eV2X** |
| Carrier frequency  | Uu : 4 GHz SL: 6 GHz | Uu : 2 GHz or 4GHzSL: 6 GHz |
| BS Tx power  | Macro BS: 49dBm  | Macro BS: 49dBm  |
| UE Tx power  | Vehicle UE or UE type RSU: 23dBm | Vehicle UE or UE type RSU: 23dBm |
| BS receiver noise figure | 5dB | 5dB |
| UE receiver noise figure | 9 dB |

**Agreement**

* For SL absolute positioning evaluation in highway scenario, the following options are supported
* Alt 1 as optional: BS and UE-type RSU deployment follows TR 36.885, where wrap around method of 19\*3 hexagonal cells with 500m ISD in Figure A.1.3-3 of TR 36.885 section A.1.3 is used.
* Alt 2 as baseline: BSs are disabled, UE-type RSUs are uniformly located with 200m spacing on both sides of highway symmetrically.
	+ Optional: staggered/unsymmetrical UE-type RSU distribution like



* For SL absolute positioning evaluation in urban grid scenario, BS and UE-type RSU deployment follows the description in TR 36.885 section A.1.3.
* Companies can provide additional BS/ UE-type RSU deployment, e.g. additional UE-type RSUs are added to UE-type RSU deployment in TR 36.885

Note: For absolute positioning in highway, Alt 1 is assumed for evaluation of joint Uu/SL positioning, Alt 2 is assumed for evaluation of SL only positioning.

**Agreement**

* For evaluation of relative positioning or ranging in highway scenario
* BSs are disabled,
* UE type RSU may be disabled (as baseline) or enabled (as optional)
	+ If enabled, UE-type RSUs are uniformly located with 200m spacing on both sides of highway symmetrically.
		- Optional: staggered/unsymmetrical UE-type RSU distribution like



* For evaluation of relative positioning or ranging in urban grid scenario
* BSs are disabled (baseline), or enabled (optional)
	+ companies should report their assumption
* UE type RSU may be disabled or enabled (companies should report their assumption)
	+ If enabled, UE type RSU deployment follows the description in TR 36.885 section A.1.3.
	+ If enabled, companies can provide additional RSU deployment, e.g. additional RSUs are added to RSU deployment in TR 36.885

**Agreement**

* For SL positioning evaluation, simulation bandwidths of 10, 20, 40 and 100 MHz in FR1 can be used.
* For SL positioning evaluation, simulation bandwidths of 100, 200 and 400MHz in FR2 can be used.

**Agreement**

* For SL positioning evaluation of Public safety use cases
* Companies should provide detailed simulation assumptions including selected scenarios, channel models, center frequency, UE drop models, etc.
	+ Evaluation methodology on channel model of TR 36.843 is reused,
		- Reuse the parameters of “Channel models” specified in Section A.2.1.2 of TR 36.843 with modification: Each component of channel model reuses what is specified in TR 38.901
	+ Anchor UE height should be reported by companies, e.g. anchor UE height is the same as TRP
* The performance metrics at least include absolute positioning accuracy and ranging with distance accuracy. Optionally, relative positioning accuracy or ranging with angle accuracy.
* For SL positioning evaluation of Commercial use cases
* Companies should provide detailed simulation assumptions including selected scenarios, channel models, center frequency, UE drop models, etc.
	+ Evaluation methodology on channel model of TR 36.843 is reused,
		- Reuse the parameters of “Channel models” specified in Section A.2.1.2 of TR 36.843 with modification: Each component of channel model reuses what is specified in TR 38.901
	+ Anchor UE height should be reported by companies, e.g. anchor UE height is the same as TRP
* The performance metrics at least include absolute positioning accuracy and ranging with distance accuracy. Optionally, relative positioning accuracy or ranging with angle accuracy

**Agreement**

For SL positioning evaluation for IIOT use cases, InF-SH and/or InF-DH defined in TR 38.857 are used

**Agreement**

For SL positioning evaluation on indoor factory scenarios, companies can select one of the following options for UE-2-UE channel model

* Option 1: BS-2-UE channel model defined in TR 38.901 is revised
	+ The UE parameters in the channel model defined in 38.901, e.g. UE height, antenna model, transmit power are used to replace gNB’s corresponding parameters.
		- Anchor UE height should be reported by companies, e.g. anchor UE height is the same as TRP.
* Option 2: D2D channel mode from 36.843 A.2.1.2 is used

**Agreement**

For SL positioning evaluation on IIOT use case, the performance metrics at least include absolute accuracy and relative accuracy.

* FFS how to select anchor UEs/RSU for absolute positioning, e.g. 20 anchor UEs/RSU are randomly deployed in the simulation area

###### Potential Solutions for SL Positioning:

**Agreement**

Study power control mechanisms for SL-PRS transmission, including whether it is necessary.

**Agreement**

With regards to the Positioning methods supported using SL measurements study further the following methods:

* + RTT-type solutions using SL
		- Study both single-sided (also known as one-way) and double-sided (also known as two-way) RTT
	+ SL-AoA
		- Include both Azimuth of arrival (AoA) and zenith of arrival (ZoA) in the study
	+ SL-TDOA
	+ SL-AoD
		- Corresponds to a method where RSRP and/or RSRPP measurements similar to the DL-AoD method in Uu.
		- Include both Azimuth of departure (AoD) and zenith of departure (ZoD) in the study
* Consider in the study at least the following aspects:
	+ Definition(s) of the corresponding SL measurements for each method
	+ Which method is applicable to absolute or relative positioning or ranging, including whether such categorization is needed to be discussed.
	+ For angle-based methods, antenna configuration consideration(s) using practical UE capabilities
	+ Per-panel location, if UE uses multiple panels.
	+ UE’s mobility, especially for V2X scenarios
	+ Impact of synchronization error(s) between UEs
	+ Existing SL measurements (e.g. RSSI, RSRP), and UE ID information etc, may be used.
* Note: The above categorization does not necessarily mean that there will be separate SL positioning methods specified, or whether there will be a unified SL Positioning method.
* Note: When the study of carrier phase positioning and the evaluations of sidelink positioning have progressed, it can be reviewed whether carrier phase for sidelink can be considered in further work. Checkpoint at RAN1#110-e-Bis to see if sufficient information is available for this review.
* Note: Companies are encouraged to describe the role of SL nodes and their interaction/coordination participating in each method.

**Agreement**

With regards to the numerologies of the SL-PRS, limit the study to those supported for NR Sidelink.

* Note 1: NR Sidelink supports {15, 30, 60 kHz} in FR1 and {60, 120 kHz} in FR2
* Note 2: This doesn’t imply that SL-PRS FR2-specific optimization(s) are expected to be studied

**Agreement**

Study new reference signal for SL positioning/ranging using the existing PRS/SRS design and SL design framework as a starting point.

* The study could at least include: Sequence design, frequency domain pattern, time domain pattern (e.g. number of symbols, repetitions, etc), time domain behavior, configuration/triggering/activation/de-activation of the SL-PRS, AGC time, Tx-Rx Turanround time, supportable bandwidth(s), multiplexing options with other SL channels, randomization/orthogonalization options.
* Note: The study of existing SL reference signal for SL positioning/ranging is not precluded. Companies are encouraged to perform performance evaluation/comparison to investigate whether such reference signals can meet the positioning accuracy requirements.

**Agreement**

With regards to the configuration/activation/deactivation/triggering of SL-PRS, study the following options:

* Option 1: High-layer-only signaling involvement in the SL-PRS configuration
	+ No Lower layer involvement, e.g., SL-MAC-CE or SCI or DCI, for the activation or the triggering of a SL-PRS.
	+ Based on the study, this option may correspond to
		- A SL-PRS configuration that is a single-shot or multiple shots
		- A high-layer configuration that may be received from an LMF, a gNB, or a UE
* Option 2: High-layer and lower-layer signaling involvement in the SL-PRS configuration
	+ Lower-layer may correspond to SL-MAC-CE, or SCI, or DCI
	+ For example, high layer signaling can may be used for SL-PRS configuration and lower layer signaling can may be used for initiating SL positioning and/or configuration/triggering/activating/deactivating/indicating and potential resource indication/reservation transmission of SL-PRS.
* Option 3: Only lower-layer signaling involvement in the SL-PRS configuration
	+ Lower-layer may correspond to SL-MAC-CE, or SCI, or DCI
* Note 1: Include aspects in the study related to flexibility, overhead, latency, and reliability as/if needed.

**Agreement**

With regards to the Sidelink Positioning measurement report,

* Study the contents of the measurement report (e.g. time stamp(s), quality metric(s), ID(s), angular/timing/power measurements, etc)
* Study the time domain behavior of the measurement report (e.g. one-shot, triggered, aperiodic, semi-persistent, periodic)
* FFS whether the Sidelink Positioning measurement can be a high-layer report and/or a lower layer report.

**Agreement**

For the purpose of RAN1 discussion during this study item, at least the following terminology is used:

* **Target UE**: UE to be positioned (in this context, using SL, i.e. PC5 interface).
* **Sidelink positioning**: Positioning UE using reference signals transmitted over SL, i.e., PC5 interface, to obtain absolute position, relative position, or ranging information.
* **Ranging**: determination of the distance and/or the direction between a UE and another entity, e.g., anchor UE.
* **Sidelink positioning reference signal (SL PRS)**: reference signal transmitted over SL for positioning purposes.
* **SL PRS (pre-)configuration**: (pre-)configured parameters of SL PRS such as time-frequency resources (other parameters are not precluded) including its bandwidth and periodicity.
* Continue discussion on additional terminology clarification(s) such as: Initiator UE, Responder UE, Sidelink Positioning group, reference UE, etc, including whether such terminology is needed within RAN1 discussion.

**Agreement**

For the purpose of RAN1 discussion during this study item, at least the following terminology is used:

* **Anchor UE**: UE supporting positioning of target UE, e.g., by transmitting and/or receiving reference signals for positioning, providing positioning-related information, etc., over the SL interface.
	+ FFS: clarification of the knowledge of the location of the anchor UE

**Agreement**

With regards to the frequency domain pattern, study further a Comb-N SL-PRS design. Study at least the following aspects:

* N>=1 (where N=1 corresponds to full RE mapping pattern)
* Fully staggered SL-PRS pattern (e.g., M symbols of SL-PRS with comb-N with M=N and, at each symbol a different RE offset is used), Partially staggered SL-PRS pattern (e.g., M symbol(s) of SL-PRS with comb-N, with M<N, at each symbol a different RE offset is used), Unstaggered SL-PRS patterns (e.g., M symbol(s) of SL-PRS with comb- N, at each symbol a same RE offset is used, N > 1)
* The number of symbols of SL-PRS within a slot
	+ Any relation to the comb-N option
	+ RE offset pattern repetitions within a slot
* FFS: Other frequency domain pattern(s)

**Agreement**

For a potential new SL PRS, study further the following

* Number of symbol(s) for AGC and/or Rx-Tx turnaround time
* Conditions under which AGC training and/or Rx-Tx turnaround time are needed

**Agreement**

With regards to the SL Positioning resource allocation, study further the following 2 options for SL Positioning resource (pre-)configuration:

* Option 1: Dedicated resource pool for SL-PRS
	+ Include in the study at least the following aspects:
		- which slots can be used, SL frame structure, SL positioning slot structure, multiplexing of SL-PRS with control information (if included in the same slot)
		- positioning measurement report
		- whether a dedicated frequency allocation (e.g., layer/BWP) is needed for SL PRS
		- resource allocation procedure(s) of SL-PRS
		- This option may or may not include control information (i.e., configuration/activation/deactivation/triggering of SL-PRS) for the purpose of SL positioning operation
* Option 2: Shared resource pool with sidelink communication.
	+ Include in the study at least the following aspects:
		- co-existence between SL communication and SL positioning, backward compatibility
		- Multiplexing considerations of SL-PRS with other PHY channels (PSCCH, PSSCH, PSFCH) and any modifications in the SL-slot structure

**Agreement**

With regards to the SL-PRS resource allocation, study the following two schemes:

* Scheme 1: Network-centric operation SL-PRS resource allocation (e.g. similar to a legacy Mode 1 solution)
	+ The network (e.g. gNB, LMF, gNB & LMF) allocates resources for SL-PRS
* Scheme 2: UE autonomous SL-PRS resource allocation (e.g. similar to legacy Mode 2 solution)
	+ At least one of the UE(s) participating in the sidelink positioning operation allocates resources for SL-PRS
	+ Applicable regardless of the network coverage
* FFS: potential mechanisms, if needed, for SL-PRS resource coordination across a number of transmitting UEs (e.g. IUC-like solutions).
* Note: Other Schemes are not precluded to be studied
* FFS how to handle resource allocation of SL-Positioning measurement report

###### Solutions for integrity of RAT dependent positioning techniques:

**Agreement**

* Study sources of error for timing-based positioning and angle-based positioning methods, focusing on the following aspects
	+ Origin of the error source
		- e.g., At UE and/or network side
		- e.g., From assistance information, and/or measurements
	+ Model of the error source (e.g., distribution, mean and/or standard deviation for integrity overbounding model, range)
	+ Criteria to become an error source (e.g., whether it is quantifiable, how much influence an error source has on determination on integrity)
* It is encouraged to provide evaluation assumptions (e.g., requirements in TS 38.101, TS 38.104, TS 38.133, evaluation assumptions in TR 38.857) if evaluation is used to determine a distribution, mean and standard deviation or range of values of an error source
* UE-based/assisted DL positioning methods, UL and DL&UL positioning methods are considered in the study

**Agreement**

* At leastthe following errorsources for timing-based positioning methods are studied
	+ TRP/UE measurements errors (e.g., ToA, Rx-Tx timing difference)
		- FFS: Effect of multipath/NLoS channels on TRP/UE measurement errors
	+ Error in assistance data (e.g., TRP location, Inter-TRP synchronization errors (e.g., RTD))
	+ TRP/UE Timing error
	+ FFS: Further study identification of error sources resulting from the multipath/NLoS channel/radio propagation environment, including multipath/NLoS channel itself as an error source
* Other error sources are not precluded
* FFS: details of each error source, e.g., mean/standard deviation/range associated with each error

**Agreement**

* At leastthe following errorsources for angle -based positioning methods are studied
	+ TRP/UE measurements errors (e.g., AoA, RSRP, RSRPP)
		- FFS: Effect of multipath/NLoS channels on TRP/UE measurement errors
	+ Error in assistance data (e.g TRP location, TRP beam antenna information)
	+ FFS: Further study identification of error sources resulting from the multipath/NLoS channel/radio propagation environment, including multipath/NLoS channel itself as an error source
* Other error sources are not precluded
* FFS: details of each error source, e.g., mean/standard deviation/range associated with each error

**Agreement**

For the purpose of discussion of error sources, reuse the definitions for RAT-dependent integrity and update the references to GNSS in Section 8.1.1a in TS38.305 to also include RAT-dependent methods.

* Note: The intention of the proposal is not to make text proposals for TS 38.305
* FFS: whether to modify and/or how to modify, for the purpose of discussion in RAN1, terms in 8.1.1a in TS 38.305 (e.g., definitions for “Error”, “Bound”, “Time-to-Alert (TTA)”, “DNU”, “Residual Risk”, “irMinimum, irMaximum”) for RAT dependent positioning methods

**Agreement**

In addition to the agreed aspects for the study, study the following aspects for error sources for timing/angle based positioning methods

* Mapping between an error source and a positioning method (e.g., DL, UL, DL&UL positioning method)
	+ e.g., error in TRP location can be an error source for UE-based DL-AoD
* Other aspects are not precluded

###### Improved accuracy based on NR carrier phase measurement:

**Agreement**

NR carrier phase positioning performance will be evaluated at least with the carrier phase measurements of a single measurement instance.

**Agreement**

The impact of integer ambiguity on NR carrier phase positioning and potential solutions to resolve the integer ambiguity will be studied in the SI.

**Agreement**

The study of the accuracy improvement based on NR carrier phase measurements in Rel-18 SI may include:

* UE-based and UE-assisted carrier phase positioning,
* UL carrier phase positioning and DL carrier phase positioning.
* NR carrier phase positioning with the carrier phase measurements of one carrier frequency or multiple frequencies
* Combination of NR carrier phase positioning with another standardized Rel. 17 positioning method, e.g., DL-TDOA, UL-TDOA, Multi-RTT, etc.
* Note: The use of “carrier phase positioning” does not necessarily mean it is a standalone positioning method
* FFS: whether SL carrier phase positioning is to be discussed in Rel-18 SI

**Agreement**

* The impact of multipath for the carrier phase positioning will be evaluated during the SI
* The methods of mitigating the impact of multipath for the carrier phase positioning will be studied during the SI, if it is considered to be necessary after the evaluation.

**Agreement**

* Reuse the simulation assumptions of NR Rel-16/17 for carrier phase positioning
	+ Note: Optional modification of the simulation assumptions defined in NR Rel-16/17 are allowed only if needed.
* The evaluation scenarios:
	+ Baseline: InF-SH, InF-DH
	+ Optional: IOO, Umi, Highway
		- Note 1: Other evaluation scenarios are not precluded.
		- Note 2: Existing Rel-17 DL/UL reference signals in Uu interface is to be used for the Highway scenario.
* Frequency range:
	+ Baseline: FR1
	+ Optional: FR2

**Agreement**

* In addition to the evaluation assumptions of NR Rel-16/17, the following error sources may also be considered during the evaluation:
	+ Phase noise (FR2)
	+ CFO/Doppler
	+ Oscillator-drift
	+ Transmitter/receiver antenna reference point location errors
	+ Transmitter/receiver initial phase error
	+ Phase center offset
* Note: Other error sources are not precluded
* Note: UE mobility can be considered in the evaluations
* Note: one or more error sources can be evaluated jointly
* Note: companies should provide the error sources model with their evaluations

**Agreement**

* For the purposes of discussion, for NR downlink and/or uplink carrier phase positioning, the carrier phase (CP) at a RF frequency at a receiver is a phase that is a function of the signal propagation time from an Tx antenna reference point of a transmitter (e.g., a TRP or a UE) to a Rx antenna reference point of the receiver (e.g., a UE or a TRP).
	+ The propagation time can be expressed in a fractional part of a cycle of the RF frequency and a number of integer cycles, but the CP may be independent of the number of integer cycles.

**Agreement**

The use of PRUs to facilitate NR carrier phase positioning can be evaluated in the SI by RAN1.

###### LPHAP (Low Power High Accuracy Positioning):

**Agreement**

Confirm that use case 6 defined in TS 22.104 is the single representative use case for the study of LPHAP.

**Agreement**

At least the relative power unit is adopted as the performance metric to evaluate the power consumption of the Rel-17 RRC\_INACTIVE state positioning and potential enhancements.

**Agreement**

A reference device (e.g., a mobile phone) with reference traffic type, reference battery capability, and reference battery life is defined for the purpose of identification of the performance gap that achieved by the Rel-17 RRC\_INACTIVE state positioning baseline and the target battery life of LPHAP use case 6.

**Agreement**

* Adopt the following parameters as the common evaluation parameters for the LPHAP evaluation:
	+ Frequency range: FR1 (baseline); FR2 (optional)
	+ SCS: 30kHz for FR1 (baseline); 120kHz for FR2 (optional)
	+ BW of the DL PRS and UL SRS pos: 100MHz;
	+ Single-sample measurement per position fix (baseline); 4-sample measurement per position fix (optional)
	+ UE mobility: up to 3km/h
* Note: It is up to each company to provide detailed power model and evaluation results on power consumption in FR2.

**Agreement**

In the LPHAP evaluation, the power consumption of 5GC data traffic is not modelled. Only the power consumption of the traffic type related to LPHAP positioning (e.g., obtaining/updating SRS configurations, DL PRS measurement reporting, etc.) is considered.

* Note: This does not preclude the power consumption of paging monitoring in the baseline evaluation, but rather assumes that no power consumption of 5GC data traffic is considered during a power cycle.

**Agreement**

Adopt the following power consumption model common for the baseline evaluation of Rel-17 RRC\_INACTIVE state positioning.

|  |  |
| --- | --- |
| **Power State** | **Relative power** |
| PDCCH-only (PPDCCH) | 50Note |
| PDCCH + PDSCH (PPDCCH+PDSCH) | 120 |
| SSB proc. (PSSB) | 50 |
| UL | 250 (0 dBm)700 (23 dBm) |
| (Optional) PRACH | [210] |
| (Optional) BWP switching | [50] |
| (Optional) Intra-frequency RRM measurement (Pintra) | [60] (synchronous case, N=8, measurement only; Pintra, meas-only)[80] (combined search and measurement; Pintra, search+meas) |
| (Optional) Inter-frequency RRM measurement (Pinter) | [60] (measurement only per freq. layer; Pinter, meas-only)[150] (neighbor cell search power per freq. layer; Pinter, search-only)Micro sleep power assumed for switch in/out a freq. layer |
| Note: Power scaling to 20MHz reception bandwidth follows the rule in Section 8.1.3 of TR 38.840, i.e., max{reference power \* 0.4, 50}. |

**Agreement**

Adopt the following power consumption model for UL SRS for positioning transmission.

|  |  |
| --- | --- |
| **Power State** | **Relative power** |
| SRS | 210 (baseline);700 (optional) |

**Agreement**

* In Rel-18 low power and high accuracy positioning, adopt the following requirement:
	+ Horizontal positioning accuracy < 1 m for 90% of UEs
	+ Positioning interval / duty cycle of 15-30 s
	+ UE battery life of 6 months – 1 year
* Note: Setting an exact value each from the set of positioning interval / duty cycle and UE battery life in the evaluation and identification of performance gap will be discussed separately when necessary.

**Conclusion**

* At least when the positioning accuracy is evaluated without jointly evaluating the associated power consumption, the target horizontal positioning accuracy requirement on LPHAP of <1m can be achieved by Rel-16/17 positioning techniques with a positioning bandwidth of at least 100MHz.
* The main aspect of RAN1 evaluation is on power consumption.
* Note: This does not preclude the case that the positioning accuracy can be revisited, if found necessary at later stage.

**Agreement**

* Study further at least the following models and parameter values of conversion between the relative power unit and the battery life to identify the performance gap:
	+ Alt. 1: battery life is used as the metric to identify the gap
		- Example:

$$T2= \frac{P1\*T1}{X}\* \frac{C2}{C1}\* \frac{1}{P2}$$

$$Gap\_{BatLife}= T2\_{req}-T2$$

* + Alt. 2: relative power unit is adopted as the metric to identify the gap
		- Example:

$$P2\_{req}= \frac{P1\*T1}{X}\* \frac{C2}{C1}\* \frac{1}{T2\_{req}}$$

$$Gap\_{PowUnit}= P2\_{req}-P2$$

in which

* C1 is the battery capacity of the reference device;
* T1 is the battery life of the reference device;
* P1 is the relative power unit obtained based on the reference traffic type;
* X is the percentage of the power consumed by the reference traffic type;
* C2 is the battery capacity of the LPHAP device;
* P2 is the evaluated relative power unit of the LPHAP device;
* P2\_req is the target relative power unit of the LPHAP device;
* T2\_req is the target battery life of the LPHAP device
* Examples of these parameters are provided as follows:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **C1** | **T1** | **X** | **reference traffic type** | **C2** | **T2req** |
| [4500] mAh | [10] hours | [20] % | [FTP (model 3)] | [800] mAh | [12] months |

**Agreement**

Adopt the following periodicity of DL PRS / UL SRS for positioning in the baseline evaluation of Rel-17 RRC\_INACTIVE positioning:

* 1 DL PRS / UL SRS for positioning occasion per N I-DRX cycle(s);
	+ Candidate values of N to evaluate is 1 and 8 for I-DRX cycle of 1.28s;
		- Note: Individual company may consider either one or both in the evaluation.
	+ Candidate value of N to evaluate is 1 for I-DRX cycle of 10.24s.

**Agreement**

* The I-DRX configuration is included in the baseline evaluation of Rel-17 RRC\_INACTVIE positioning.
	+ Note: This does not preclude the case where no I-DRX cycle nor paging is considered in the evaluation of potential solutions to maximize the battery life.
* Adopt the following I-DRX cycle to evaluate:
	+ 1.28s (baseline); 10.24s (optional).

**Agreement**

* Adopt the power consumption model, additional transition energy and total transition time of the three sleep types (deep sleep, light sleep, and micro sleep) in TR38.840 as the evaluation baseline:
* FFS: whether/how an additional new ultra-deep sleep mode can be considered in the evaluation of potential solutions to maximize the battery life, including the determination of the relative power, additional transition energy and total transition time, if necessary.

**Agreement**

* Adopt the following reference configuration and assumption for DL PRS to define the power consumption model for DL PRS measurement:
	+ 1 Number of PFL;
	+ 8 DL PRS resources per slot are measured;
	+ DL PRS instance of smaller than or equal to 1 slot duration;
* Adopt the following table as the power consumption model for DL PRS measurement (derived from Table 22 in TR38.840):

|  |  |  |
| --- | --- | --- |
| **N: Number of** **TRPs for DL PRS measurement** | **Synchronous case (baseline)** | **Asynchronous case (optional)** |
| **FR1 (baseline)** | **FR2** **(optional)** | **FR1** | **FR2** |
| N=4 (baseline) | 120 | 195 | 140 | 255 |
| N=8 (optional) | 150 | 225 | 170 | 285 |

**Agreement**

* For DL positioning, at least the following power components and parameter values are considered for the baseline evaluation of Rel-17 RRC\_INACTIVE positioning:
	+ For the UE-assisted DL positioning,
* SSB proc. with 2 ms duration and the periodicity of I-DRX cycle;
* Paging with 2 ms duration, the periodicity of I-DRX cycle, and group paging rate of 10%;
* DL PRS measurement with 0.5 ms duration;
* CG-SDT with 1ms duration and the periodicity of positioning interval;
	+ - * RRCRelsease after the CG-SDT can be optionally included with [1] ms duration;
* (Optional) BWP switching with [1] ms duration;
* (Optional) Intra-/inter-frequency RRM measurement in low SINR condition with [1] ms duration;
* (Optional) RA-SDT (e.g., including CORSET0 + SIB1, PRACH, RAR, Msg 3/4/5) in case of CG-SDT is unavailable;
	+ For the UE-based DL positioning,
		- SSB proc. with 2 ms duration and the periodicity of I-DRX cycle;
		- Paging with 2 ms duration, the periodicity of I-DRX cycle, and group paging rate of 10%;
		- DL PRS measurement with 0.5 ms duration;
		- (Optional) BWP switching with [1] ms duration;
		- (Optional) Intra-/inter-frequency RRM measurement in low SINR condition with [1] ms duration;
* Note: The power component and parameter values for UE-assisted DL positioning is also applicable to the DL part of UE-assisted DL+UL positioning method.
* Note: Individual company may consider additional power components and different parameter values in bracket in the evaluation.
* Note: Companies are encouraged to provide the assumption on the timeline between different power consumption events in the evaluation of potential enhancements to reduce the transition times between different power states and to extend the sleeping time as much as possible.

**Agreement**

* For UL positioning, at least the following power components and parameter values are considered for the baseline evaluation of Rel-17 RRC\_INACTIVE positioning:
	+ SSB proc. with 2 ms duration and the periodicity of I-DRX cycle;
	+ Paging with 2 ms duration, the periodicity of I-DRX cycle, and group paging rate of 10%;
	+ UL SRS for positioning transmission with 0.5 ms duration;
	+ (Optional) BWP switching with [1] ms duration;
	+ (Optional) Intra-/inter-frequency RRM measurement in low SINR condition with [1] ms duration;
* Note: The power component and parameter values for UL positioning is also applicable to the UL part of UE-assisted DL+UL positioning method.
* Note: Individual company may consider additional power components and different parameter values in bracket in the evaluation.
* Note: Companies are encouraged to provide the assumption on the timeline between different power consumption events in the evaluation of potential enhancements to reduce the transition times between different power states and to extend the sleeping time as much as possible.

###### Positioning for RedCap UEs:

**Agreement**

For evaluation of RedCap UE positioning performances, all RAT based positioning methods can be considered. Sources should detail the chosen method(s) when presenting performance evaluations.

**Agreement**

For evaluation of positioning performance of redcap UEs, adopt the general parameters are detailed in the table below

* TBD parameters are discussed separately
* **Table 6-1: Common scenario parameters applicable for all scenarios for Redcap UEs evaluations**

|  |  |  |
| --- | --- | --- |
|  | **FR1 Specific Values** | **FR2 Specific Values**  |
| Carrier frequency, GHz  | 3.5GHz, 700MHz (optional) Note 1 | 28GHz Note 1 |
| Bandwidth, MHz | TBD | TBD |
| Subcarrier spacing, kHz | 30KHz, 15KHz (for 700MHz carriers) | 120kHz |
| **gNB model parameters**  |  |  |
| gNB noise figure, dB | 5dB | 7dB |
| **UE model parameters**  |  |  |
| UE noise figure, dB | 9dB – Note 1 | 13dB – Note 1 |
| UE max. TX power, dBm | 23dBm – Note 1 | 23dBm – Note 1EIRP should not exceed 43 dBm. |
| UE antenna radiation pattern  | Omni, 0dBi | Antenna model according to Table 6.1.1-2 in TR 38.855 |
| PHY/link level abstraction | Explicit simulation of all links, individual parameters estimation is applied. Companies to provide description of applied algorithms for estimation of signal location parameters. |
| Network synchronization | The network synchronization error, per UE dropping, is defined as a truncated Gaussian distribution of (T1 ns) rms values between an eNB and a timing reference source which is assumed to have perfect timing, subject to a largest timing difference of T2 ns, where T2 = 2\*T1– That is, the range of timing errors is [-T2, T2]– T1: 0ns (perfectly synchronized), 50ns (Optional) |
| UE/gNB RX and TX timing error | (Optional) The UE/gNB RX and TX timing error, in FR1/FR2, can be modeled as a truncated Gaussian distribution with zero mean and standard deviation of T1 ns, with truncation of the distribution to the [-T2, T2] range, and with T2=2\*T1:- T1: X ns for gNB and Y ns for UE- X and Y are up to sources - Note: RX and TX timing errors are generated per panel independentlyApply the timing errors as follows: - For each UE drop, - For each panel (in case of multiple panels)- Draw a random sample for the Tx error according to [-2\*Y,2\*Y] and another random sample for the Rx error according to the same [-2\*Y,2\*Y] distribution. - For each gNB - For each panel (in case of multiple panels)- Draw a random sample for the Tx error according to [-2\*X,2\*X] and another random sample for the Rx error according to the same [-2\*X,2\*X] distribution. - Any additional Time varying aspects of the timing errors, if simulated, can be left up to each company to report.- For UE evaluation assumptions in FR2, it is assumed that the UE can receive or transmit at most from one panel at a time with a panel activation delay of 0ms. |
| Note 1: According to TR 38.802Note 2: According to TR 38.901 |

**Agreement**

For the evaluation of RedCap positioning, the following bandwidth can be evaluated:

* FR1: 20MHz baseline, 5MHz optional
* FR2: 100MHz

**Agreement**

Adopt the following table for the UE model parameters

|  |  |  |
| --- | --- | --- |
|  | **FR1 Specific Values** | **FR2 Specific Values**  |
| **UE model parameters**  |  |  |
| UE antenna configuration | Panel model 1 – Note 1dH = 0.5λ,for 1Rx UEs: (M, N, P, Mg, Ng) = (1, 1, 1, 1, 1)for 2Rx UEs: (M, N, P, Mg, Ng) = (1, 1, 2, 1, 1) | * (M, N, P, Mg, Ng) = (1, 2, 2, 1, 1) **as minimum antenna configuration (baseline)**
* (M, N, P, Mg, Ng) = (2, 2, 2, 1, 1) **as optional configuration.**
 |
| UE antenna radiation pattern  | Omni, 0dBi | Antenna model according to Table 6.1.1-2 in TR 38.855 |
| Number of UE branches | Baseline: 1Rx 1TxOptional: 2Rx 1 Tx | TBD |
| Note 1: According to 3GPP TR 38.802 |

**Agreement**

The following scenarios are evaluated for positioning performance of Redcap

* Baseline: (Case 1): Umi street canyon, as described in Table 6.1-1-4 of 38.855
* Optional outdoor:
	+ (Case 2): Uma, as described in Table 6.1-1-6 of 38.855
	+ (Case 3): Rma (FFS details of the scenario)
* Baseline: (Case 4): InF-SH as described in Table 6.1-1 of 38.857
* Optional indoor: (Case 5) Indoor Open Office, as described in Table 6.1-1-3 of 38.855
* Optional indoor: (Case 6) InF-DH as described in Table 6.1-1 of 38.857

**Agreement**

The FR2 UE antenna configuration is as follow:

* (M, N, P, Mg, Ng) = (1, 2, 2, 1, 1) as minimum antenna configuration (baseline)
* (M, N, P, Mg, Ng) = (2, 2, 2, 1, 1) as optional configuration.

**Agreement**

The evaluation methodology for RedCap UEs positioning performance uses DL PRS and/or UL SRS for positioning.

* The methodology does not define any baseline reference signal configuration. Sources should detail the chosen configuration of reference signal(s) when presenting performance evaluations.

**Agreement**

For evaluation of positioning performance of redcap UEs in 700MHz band, the gNB antenna model is:

* gNB antenna configuration from TR38.830, (M,N,P,Mg,Ng) = (4,2,2,1,1), (dH, dV) = (0.5, 0.8)λ

**Agreement**

Use 2Rx and 1Tx for baseline number of UE branches in FR2 in the UE antenna configuration table for RedCap UEs evaluation.

* FFS: optional configurations for number of UE branches in FR2.

##### Decisions during RAN1#110

**Agreement**

The draft TR in 8267 is agreed in principle. Updated TR endorsed in R1-2208275.

###### SL Positioning Scenarios and Requirements:

**Agreement**

* For ranging between two devices, ranging direction accuracy is defined as accuracy of angle of arrival (AoA) at a receiving node.
* The following requirements on ranging direction accuracy are considered:
	+ Set A: Y = ±15° for 90% of the UEs
	+ Set B: Y = ±8° for 90% of the UEs
	+ Note 1: For evaluations of ranging direction accuracy, companies are expected to report:
		- whether each of the two requirements are satisfied, and
		- %-ile of UEs satisfying the target positioning accuracy for a requirement that may not be satisfied with 90%.
	+ Note 2: target positioning requirements may not necessarily be reached for all scenarios and deployments.
	+ Note 3: all positioning techniques may not achieve all positioning requirements in all scenarios.

**Agreement**

Confirm the following working assumption on positioning accuracy requirements for V2X with the changes indicated below:

* + For evaluation of V2X use-cases for SL positioning, the following accuracy requirements are considered:
		- Set A (similar to “Set 2” defined in TR 38.845)
			* Horizontal accuracy of 1.5 m (absolute ~~and~~ or relative); Vertical accuracy of 3 m (absolute ~~and~~ or relative) for 90% of UEs
		- Set B (similar to “Set 3” defined in TR 38.845)
			* Horizontal accuracy of 0.5 m (absolute ~~and~~ or relative); Vertical accuracy of 2 m (absolute ~~and~~ or relative) for 90% of UEs
		- Note 1: For evaluated SL positioning methods, companies are expected to report:
			* whether each of the two requirements are satisfied, and
			* %-ile of UEs satisfying the target positioning accuracy for a requirement that may not be satisfied with 90%.
		- Note 2: target positioning requirements may not necessarily be reached for all scenarios and deployments
		- Note 3: all positioning techniques may not achieve all positioning requirements in all scenarios

**Agreement**

Confirm the following working assumption on positioning accuracy requirements for IIoT:

* + For evaluation of IIoT use-cases for SL positioning solutions, the following accuracy requirements are considered:
		- For horizontal accuracy,
			* Set A: 1 m (absolute or relative) for 90% of UEs
			* Set B: 0.2 m (absolute or relative) for 90% of UEs
		- For vertical accuracy,
			* Set A: 1 m (absolute or relative) for 90% of UEs
			* Set B: 0.2 m (absolute or relative) for 90% of UEs
	+ Relative speed: up to 30 km/hr.
	+ Note 1: For evaluated SL positioning methods, companies are expected to report:
		- whether each of the two requirements are satisfied, and
		- %-ile of UEs satisfying the target positioning accuracy for a requirement that may not be satisfied with 90%.
	+ Note 2: target positioning requirements may not necessarily be reached for all scenarios and deployments
	+ Note 3: all positioning techniques may not achieve all positioning requirements in all scenarios

**Conclusion**

Further prioritization amongst the identified use-cases for SL positioning is not pursued during this SI in RAN1.

###### Evaluation Methodology for SL Positioning:

**Agreement**

For SL positioning evaluation in IIOT use case, companies should report how to drop anchor UEs and how to select anchor UEs

**Agreement**

Adopt the tables in section 3 of R1-2207606 as templates to collect SL positioning simulation results from each company.

**Agreement**

In the evaluation, relative positioning or ranging is performed between two UEs within X m, where X value(s) are reported by companies, and companies should also report the minimum distance used in the evaluations for each use case. The assumption used for X will be included in the TR for each set of results.

**Agreement**

For SL positioning evaluation purpose, the following assumptions are further adopted

* Companies should report whether SL-PRS and other SL signals are FDMed or not FDMed, and whether other SL signals are present
* Adopting system level simulations (rather than the link level simulations) as the baseline tool
* For SL positioning evaluation in highway scenario or urban grid scenario, the performance metrics can include absolute horizontal accuracy, relative horizontal accuracy, ranging with distance accuracy, and ranging with direction accuracy (optionally).
* In highway and urban grid scenarios, companies can further consider other UE types, e.g. pedestrian UE or VRU devices.

###### Potential Solutions for SL Positioning:

Agreement

With regards to the Positioning methods supported using at least SL measurements, potential candidate positioning methods include at least the following:

* + RTT-type solution(s) using SL
	+ SL-AoA
	+ SL-TDOA
* Note: other methods can still be studied
* Note: The above categorization does not necessarily mean that there will be separate SL positioning methods specified.

Agreement

A new reference signal should be introduced for supporting SL positioning/ranging.

Agreement

Regarding SL-PRS resource allocation, both Scheme 1 and Scheme 2 should be introduced for supporting SL positioning/ranging:

* Scheme 1: Network-centric operation SL-PRS resource allocation (e.g. similar to a legacy Mode 1 solution)
	+ The network (e.g. gNB, LMF, gNB & LMF) allocates resources for SL-PRS.
* Scheme 2: UE autonomous SL-PRS resource allocation (e.g. similar to legacy Mode 2 solution)
	+ At least one of the UE(s) participating in the sidelink positioning operation allocates resources for SL-PRS

Agreement

With regards to the SL Positioning resource allocation, one of the following alternatives should be introduced for supporting SL positioning/ranging:

* Alt. 1: only dedicated resource pool(s) can be (pre-)configured for SL-PRS
* Alt. 2: either dedicated resource pool(s) and/or ~~a~~ shared resource pool(s) with sidelink communication can be (pre-)configured for SL-PRS
* Note: whether other signals/channels can be present in the dedicated resource pool can be further discussed

Agreement

For the content of the sidelink positioning measurement report, potential elements may include at least the following:

* One or more sidelink positioning measurement(s)
* Timestamp(s) associated with a sidelink positioning measurement
* Quality metric(s) associated with a sidelink positioning measurement
* Identification Information for a sidelink positioning measurement
* FFS any detail for the above

Agreement

For the sequence of the new reference signal for SL positioning/ranging, down select between Alt 1 and Alt 2:

* Alt. 1: pseudorandom-based. Use existing sequence of DL-PRS as a starting point.
* Alt. 2: ZC-based (SRS sequence as a starting point)

Agreement

With regards to the frequency domain pattern, a Comb-N SL-PRS occupying M symbol(s) design should be introduced for the support of NR SL positioning

* Note: there could be multiple values for M, N

Agreement

Regarding Scheme 2 SL-PRS resource allocation, study at least the following aspects:

* Resource selection mechanism for SL-PRS
* Inter-UE coordination
* Aspects for congestion control mechanisms for SL-PRS

Agreement

* With regards to the configuration/activation/deactivation/triggering of SL-PRS, Option 3 from the previous corresponding RAN1 #109 agreement will not be considered further.
* With regards to reservation of SL-PRS, it can be considered based on the Option 1 or Option 2 from the previous corresponding RAN1 #109 agreement.

Agreement

With regards to the frequency domain pattern for multi-symbol SL-PRS, prioritize partially and fully staggered SL-PRS.

* Note: this does not preclude comb N=1
* FFS: single symbol SL-PRS, if supported

###### Solutions for integrity of RAT dependent positioning techniques:

**Agreement**

* For LMF-based positioning integrity mode, at least the followings are error sources for timing related measurements :
	+ RSTD measurement is an error source for DL-TDOA
	+ RTOA measurement is an error source for UL-TDOA
	+ UE Rx-Tx time difference measurement is an error source for Multi-RTT
	+ gNB Rx-Tx time difference measurement is an error source for Multi-RTT
* FFS : Model of the error source (e.g., distribution, mean and/or standard deviation for integrity overbounding model, range)
* Note : Definition of “LMF-based positioning integrity mode” can be found in Table 9.4.1.1.1 in TR 38.857

**Agreement**

* For LMF-based positioning integrity mode, at least angle of arrival measurement is an error source for UL-AoA
* FFS : Model of the error source (e.g., distribution, mean and/or standard deviation for integrity overbounding model, range)
* FFS: The error can be expressed as the error of the AoA/ZoA in LCS or GCS or the error of a defined function of AoA/ZoA in LCS.
* Note : Definition of “LMF-based positioning integrity mode” can be found in Table 9.4.1.1.1 in TR 38.857

Agreement

For UE-based positioning integrity mode, at least the following are error sources in assistance data :

* TRP location (e.g., NR-TRP-LocationInfo in TS 37.355) and Inter-TRP synchronization (e.g., NR-RTD-Info in TS 37.355) are error sources for DL-TDOA
* TRP location (e.g., NR-TRP-LocationInfo in TS 37.355) is an error source for DL-AoD
	+ FFS: whether boresight direction of DL-PRS (e.g., NR-DL-PRS-BeamInfo in TS 37.355) is an error source
	+ FFS: whether beam information of DL-PRS (e.g., NR-TRP-BeamAntennaInfo in TS 37.355) is an error source
* FFS : Model of the error source (e.g., distribution, mean and/or standard deviation for integrity overbounding model, range)
* Other error sources are not precluded
* FFS : Applicability of the above error sources to LMF-based positioning integrity mode
* Note : Definition of “UE-based positioning integrity mode” can be found in Table 9.4.1.1.1 in TR 38.857

Agreement

For LMF-based positioning integrity mode, ARP location (e.g., ARPLocationInformation in TS 38.455) is an error source for UL-AoA.

* FFS : Model of the error source (e.g., distribution, mean and/or standard deviation for integrity)
* Note : Definition of “LMF-based positioning integrity mode” can be found in Table 9.4.1.1.1 in TR 38.857
* FFS : Whether the error statistics of ARP location is available at the gNB
* Other error sources are not precluded

Agreement

For LMF-based positioning integrity mode, at least inter-TRP synchronization is an error source for UL-TDOA.

* FFS : Specification impact of inter-TRP synchronization as an error source for UL-TDOA
* Note : Definition of “LMF-based positioning integrity mode” can be found in Table 9.4.1.1.1 in TR 38.857

Agreement

Study the distribution of RSTD, RTOA and UE/gNB Rx-Tx time measurement error considering the following aspects:

* Whether TEG-related timing error is an independent error source from timing related measurement error (e.g., RTOA, RSTD, UE/gNB Rx-Tx time difference)
* Whether the measurement error is considered for each ToA or for the reported RSTD value
* Other Details (e.g., mean and standard deviation)

Note : it is encouraged to provide the evaluation assumptions used by companies (e.g., requirements in TS 38.101, TS 38.104, TS 38.133, evaluation assumptions in TR 38.857, LOS/NLOS probability, measurement algorithm) and results (e.g., error histogram) if evaluation is used to determine the distribution, mean and standard deviation or range of values of an error source.

Agreement

Study the distribution of arrival measurement error focusing on the following aspects

* Whether the angle of arrival measurement error can be expressed as the error of the AoA/ZoA in LCS or GCS or the error of a defined function of AoA/ZoA in LCS
* Distribution of AoA measurement error for an NLOS/LOS link
* Other Details (e.g., mean, standard deviation)

Note: It is encouraged to provide evaluation assumptions (e.g., requirements in TS 38.101, TS 38.104, TS 38.133, evaluation assumptions in TR 38.857, LOS/NLOS probability, measurement algorithm) and results (e.g., error histogram) if evaluation is used to determine the distribution, mean and standard deviation or range of values of an error source.

###### Improved accuracy based on NR carrier phase measurement:

Agreement

Endorse the templates in section 17 under (H)(Round 1) Proposal 17-1 in R1-2207690 to collect carrier-phase based positioning simulation results, with the following notes:

* The TR editor can adjust the sections/sub-sections arrangement
* Adjust the titles of the tables to refer to NR carrier-phase based positioning
* The detailed rows of the tables can be further discussed

Agreement

In the evaluation of NR carrier phase positioning, the following frequency errors can be considered, which are modeled independently for each UE and each TRP:

* + Initial Residual CFO (is the same for one measurement instances [or multiple phase measurement instances]):
		- Ideal: 0 (UE/TRP)
		- Practical: uniform distribution within
			* + [-30, +30] Hz (FR1, UE), [-100, +100] Hz (FR1, UE),
				+ [-120, +120] Hz (FR2, UE), [-400, +400] Hz (FR2, UE),
				+ [-10, +10] Hz (for each TRP, FR1),
				+ [-40, +40] Hz (for each TRP, FR2).
	+ Oscillator-drift (is the same for one or multiple phase measurement instances for positioning fix):
		- Ideal: 0 (UE/TRP)
		- Practical: uniform distribution within [-0.1, 0.1] ppm (UE), [-0.02, +0.02] ppm (each TRP) within measurement duration
* Note: The Doppler frequency can be determined based on the UE speed in the evaluation assumption.

Agreement

In the evaluation of NR carrier phase positioning, the offset between the initial phase of the transmitter and the initial phase of the receiver can be modeled as a random variable uniformly distributed within [0, X].

* Possible values of X: 2pi
	+ Other values FFS

Agreement

In the evaluation of NR carrier phase positioning, the antenna reference point (ARP) location error of a TRP can be modeled as follows:

* + Ideal: no ARP error
	+ Practical: a zero-mean, truncated Gaussian distribution with zero mean and standard deviation of T=[1, 5] cm truncated to 2T in each of (x, y, z) direction

**Agreement**

In the evaluation of NR carrier phase positioning, the following the UE/TRP antenna phase center offset (PCO) model can be considered as the starting point:

*dPCO* *= a \* dPhi + w*

 where

* + *a* is the scale factor, *a=[0, 1, 3]*
		- *FFS: other values*
	+ *dPhi* is the direction difference (in degrees):
		- Example 1, *dPhi* is the difference between the true and the calculated (or measured) directions between a transmitter (UE/TRP) and a receiver (TRP/UE).
		- Example 2: *dPhi* is the direction difference between one UE to two TRPs, or between one TRP to two UEs.
	+ *w* is 0 or a random variable uniformly distributed within [-2, +2], or [-5, +5], or [-*X*, +*X*] degrees
		- FFS: value of *X* or left up to companies
	+ Note: the above model is valid only when absolute value of *dPhi < Y* degrees
		- FFS: value of *Y* or left up to companies

Agreement

For the evaluation of NR carrier phase positioning, UE position can be calculated by the use of the carrier phase measurements obtained at the *M* sequential time instances, where

* + Baseline:
		- M=1
	+ Optional :
		- M=4
		- Other values of M
	+ Companies should report their assumptions on UE mobility (e.g. speed)

Agreement

Further evaluate the following multipath mitigation methods for the carrier phase positioning, which include, but are not limited to, the following:

* + The methods of estimating the carrier phase of the first path
		- Note: Both time-domain and frequency-domain methods can be considered
	+ LOS/NLOS/ Multi-path indication for the carrier phase measurements for improving the accuracy of the position calculation
		- Rel-17 LOS/NLOS indicator can be used as the starting point
	+ measurements of the first path and additional paths
		- E.g. carrier phase measurements, timing measurements
	+ other channel information, such as RSRP/RSRPP, CIR/CFR, etc.

###### LPHAP (Low Power High Accuracy Positioning):

Agreement

In the LPHAP evaluation, adopt the following model to convert the relative power unit to the battery life:

* Alt. 1: battery life is used as the metric to identify the gap

* + K is an implementation factor, K = 1 (baseline); K = 0.5, 2, 4 (optional)
* Note: The definition of the notations will be captured in the updates of TR.
* Note: The voltage is assumed to be the same for the reference device and the LPHAP device.

Agreement

* In the LPHAP evaluation, adopt the following example parameter values in the conversion model to evaluate the battery life:
	+ For the reference device in the conversion model:

|  |  |  |  |
| --- | --- | --- | --- |
| **C1 (mAh)** | **T1 (hour)** | **X** | **reference traffic type** |
| 4500 | 12 | 20%  | FTP (model 3) |

* + For the LPHAP device, consider 2 typesin the conversion model:

|  |  |  |
| --- | --- | --- |
| **LPHAP device** | **C2 (mAh)** | **T2req (month)** |
| Type A (baseline) | 800 | 6~12 |
| Type B (optional) | 4500 | 6~12 |

* Note: As the reference device and LPHAP device characteristics, and therefore the parameter values of the model for determining battery life, is dependent on implementation factors, manufacturer, design options and cost options, it is up to individual company to evaluate the optional K values, and report the corresponding parameter values.

Agreement

In the LPHAP evaluation, adopt the example value of relative power unit of the reference device P1 = 50 to further align the battery life among companies.

Agreement

For the purpose of LPHAP evaluation, an ultra-deep sleep state is considered. The following options of the power consumption model of the ultra-deep sleep state can be further discussed:

* + Option 1:
		- The relative power unit: 0.015
		- Additional transition energy: 2000
		- Total transition time: 400ms
	+ Option 2:
		- The relative power unit: 0.01
		- Additional transition energy: 450;
		- Total transition time: 25ms
		- FFS: restrictions in processing associated with option 2 after the UE comes out of ultra-deep sleep state
	+ Notes: the values above can be further discussed

Agreement

For option 1 in the agreement above, the value of additional transition energy is changed to “a value between 2000 and 20000”. FFS which value.

Agreement

For the purpose of LPHAP evaluation, the following assumptions on eDRX configuration and/or paging reception can be optionally considered:

* + The eDRX cycle to evaluate: 20.48s; 30.72s;
	+ For paging reception:
		- 1 paging occasion is included in one eDRX cycle
		- 10% paging rate
	+ No paging reception can be optionally evaluated;
	+ 1 DL PRS and/or UL SRS for positioning occasion per 1 eDRX cycle
		- Minimizing the gap between PRS measurement, SRS transmission and/or measurement reporting with paging monitoring in time domain can be evaluated.

Agreement

The tables to collect evaluation results from each source in section 3.3.2 of R1-2207993 are endorsed.

Agreement

Capture the following in TR as an observation:

* Evaluations of baseline Rel-17 RRC\_INACTIVE state positioning with the evaluation assumptions agreed for the study show that the power consumption on deep sleep state accounts for the highest proportion in the total power.

###### Positioning for RedCap UEs:

**Agreement**

For the purpose of the Rel-18 study

* The target accuracy requirements for RedCap UEs for commercial use cases are defined as follows:
	+ Indoor and outdoor
		- Horizontal position accuracy (< 3 m) for 90% of UEs
		- Vertical position accuracy (< 3 m) for 90% of UEs
* The target accuracy requirements for RedCap UEs for IIoT use cases are defined as follows:
	+ Horizontal position accuracy (<1 m) for 90% of UEs
	+ Vertical position accuracy (< 3 m) for 90% of UEs
* Note: the requirements may not be met in all scenarios and use cases

**Agreement**

CDF values for evaluations of Redcap UE Positioning scenarios are derived based on:

* The reported CDF points used as performance metrics in the evaluation include at least the 50%, 67%, 80%, 90% percentiles.
* For indoor scenarios
	+ (Required): The UEs inside the convex hull of the horizontal BS deployment area.
	+ (Optional): All the UEs

**Agreement**

The following table is endorsed to capture the evaluation scenarios and parameters in the evaluation results section of the TR:

**Table 3.2-2 evaluation scenarios and parameters template**

|  |  |
| --- | --- |
| **Parameter** | **Case XYZ (channel model, FRx)** |
| Scenario (baseline, otherwise state any modifications) |  |
| Carrier frequency |  |
| Subcarrier spacing |  |
| Reference Signal Transmission Bandwidth |  |
| Reference Signal Physical Structure and Resource Allocation (RE pattern) (reference to figure in contribution) |  |
| Reference signal(type of sequence, number of ports, …) |  |
| Number of sites |  |
| Number of symbols used per occasion |  |
| number of occasions used per positioning estimate |  |
| Power-boosting level |  |
| Uplink power control (applied/not applied) |  |
| interference modelling (ideal muting, or other) |  |
| Description of Measurement Algorithm (e.g. super resolution, interference cancellation, ….) |  |
| Description of positioning technique / applied positioning algorithm (e.g. Least square, Taylor series, etc) |  |
| Network synchronization assumptions |  |
| UE/gNB RX and TX timing error |  |
| Beam-related assumption (beam sweeping / alignment assumptions at the tx and rx sides) |  |
| Precoding assumptions (codebook, nrof antenna elements used, etc) |  |
| UE antenna configuration |  |
| Number of UE branches |  |
| Description of enhancement solutions, if any |  |
| gNB antenna configuration |  |
| UE noise figure |  |
| UE antenna height |  |
| gNB antenna height |  |
| Additional notes, if any |  |

Agreement

Endorse the templates in section 7 in R1-2207749 to collect RedCap UE positioning simulation results, with the following notes:

* The first table as endorsed in previous agreement
* Add a column to the second table for capturing whether the requirement is met or not met
* The TR editor can adjust the sections/sub-sections arrangement
* Adjust the titles of the tables to refer to RedCap UE positioning

Agreement

For the evaluation of redcap UEs in the RMa scenarios, companies should report their evaluations parameters with their results.

Agreement

The potential benefits and performance gains of frequency hopping of the DL PRS and UL SRS can be investigated in release 18, which may take into account at least the following:

* The impact of Doppler, phase offset, timing offset, power imbalance among hops
* RedCap UE capability and complexity considerations
* Impact of RF retuning during frequency hopping
* Details of frequency hopping (including Tx hopping and/or Rx hopping, BWP switching) for the study are FFS

#### 2.1.2 Remaining Open issues

The following opens need to be addressed in RAN1:

* Studies on Sidelink (SL) positioning:
	+ Study and evaluation of performance and feasibility of potential solutions for SL positioning, considering relative positioning, ranging and absolute positioning
* Studies on improved accuracy, integrity, and power efficiency:
	+ Study solutions for Integrity for RAT dependent positioning techniques:
		- Identification of the error sources.
	+ Study solutions for accuracy improvement based on NR carrier phase measurements
		- Reference signals, physical layer measurements, physical layer procedures to enable positioning based on NR carrier phase measurements for both UE-based and UE-assisted positioning
	+ Study requirements on LPHAP as developed by SA1 and evaluate whether existing RAN functionality can support these power consumption and positioning requirements:
		- Study, including evaluations, of potential physical layer aspects for LPHAP support
* Studies on positioning support for RedCap UEs, considering the following:
	+ Evaluation of positioning performance of existing positioning procedures and measurements with RedCap UEs
	+ Based on the evaluation, assessment of the necessity of enhancements and, if needed, identify enhancements to help address limitations associated with for RedCap UEs

## 2.2 RAN2

#### 2.2.1 Agreements

##### 2.2.1.1 Decisions during RAN2#119-e

RAN2 has discussed the following topics: 1) Sidelink positioning; 2) RAT-dependent integrity; 3) LPHAP (Low Power High Accuracy Positioning).

###### Sidelink positioning

Based on selected proposals in R2-2207081, R2-2207865 and R2-2207105, RAN2 discussed open issues related to Sidelink positioning and made the following agreements:

Agreements:

Proposal 1 (modified): Confirm that for sidelink positioning in-coverage, partial coverage and out-of-coverage scenarios shall be supported. FFS if partial coverage case assumes anything about which UEs are in coverage.

Proposal 2: Study the architecture and signaling procedures to enable at least the following two operation scenarios:

- Operation Scenario 1: PC5-only-based positioning.

- Operation Scenario 2: Combination of Uu- and PC5-based positioning.

Agreement:

RAN2 follow SA2 on the architecture, including the possibility of a UE as a location server. FFS from RAN2 perspective if there are cases without a UE in the location server role.

Agreement:

Proposal 4 (modified): Align with SA2/RAN1 on the terms for sidelink positioning, and introduce the following terms of UE role as the baseline for further discussion:

- Target UE: UE to be positioned

- Anchor UE: UE supporting positioning of target UE, e.g., by transmitting and/or receiving reference signals for positioning, providing positioning-related information, etc., over the SL interface. FFS: clarification of the knowledge of the anchor UE.

Additional roles can be considered.

Agreements:

Introduce a new protocol for sidelink positioning procedures between UEs (name FFS, e.g., RSPP, SLPP). FFS where it is specified.

The new protocol is a separate ASN.1 module from LPP (this does not necessarily imply whether it is included in 37.355).

Agreement:

Study the potential impact to LPP for support of sidelink positioning procedures between UE and LMF. FFS how much impact (if any), e.g., only to carry the new protocol, and if the PC5-only and hybrid PC5+Uu cases are the same or different.

Agreement:

RAN2 wait for SA2 on the triggering of the positioning procedures from upper layers.

Agreement:

RAN2 will study the question of cast type for positioning signalling. For SL-PRS, follow RAN1 decision and consider cast type if something arises in RAN2 scope.

###### RAT-dependent integrity

Based on proposals in R2-2207389, R2-2207869 and TPs in R2-2208127, RAN2 discussed open issues related to RAT-dependent integrity and agreed:

Agreements:

Proposal 1: RAN2 to confirm the integrity principle of operation defined in the section 8.1.1a of TS38.305, including integrity definition (e.g., Error, Bound, Time to Alert, DNU, Residual Risk, irMinimum, irMaximum and Correlation Times; FFS if all parameters are needed in the RAT-dependent case), Equations for the GNSS integrity are reused for RAT dependent positioning methods.

Proposal 2 (modified): RAN2 may add the mapping between Integrity definition/Fields (Integrity Alerts, error bounds (mean, StdDev), Residual Risks, Integrity correlation times ) and Error sources/assistance data for RAT-dependent positioning methods later once RAN1 identifies new error sources.

###### LPHAP

Based on proposals in R2-2208180, R2-2207488, selected proposals in R2-2207105, RAN2 discussed open issues related to LPHAP and agreed:

Agreements:

Proposal 1: RAN2 shall restrict the use case for any LPHAP discussions in RAN2 to Tracking of workpiece (in- and outdoor) in assembly area and warehouse (Use case # 6 in Table A.7.2-1 in TS 22.104).

RAN2 to consider at least the ‘Low Power Periodic and Triggered 5GC-MT-LR Procedures’ in TS 23.273. Other procedures are not excluded from discussion.

RAN2 shall wait for RAN1 conclusions from evaluations on UE power consumption with respect to baseline functionality and whether enhancements are needed. RAN2 will study potential areas for higher layer enhancements that may result in reduction of UE power consumption.

#### 2.2.2 Remaining Open issues

The following opens need to be addressed:

* Sidelink positioning:
	+ Architecture details (follow SA2) and take into account of RAN1 discussion;
	+ Protocol: details of SLPP/RSPP, and the potential impact to LPP for support of sidelink/hybrid positioning procedures between UE and LMF.
	+ Cast type for positioning signalling.
	+ TP to capture RAN2 agreements.
* RAT dependent integrity:
	+ Once RAN1 identifies new error sources, RAN2 to define the mapping between Integrity definition/Fields (Integrity Alerts, error bounds (mean, StdDev), Residual Risks, Integrity correlation times) and Error sources/assistance data for RAT-dependent positioning methods.
	+ TP to capture RAN2 agreements.
* LPHAP:
	+ Study potential areas for higher layer enhancements that may result in reduction of UE power consumption.
	+ Note, RAN2 shall wait for RAN1 conclusions from evaluations on UE power consumption with respect to baseline functionality and whether enhancements are needed.
	+ TP to capture RAN2 agreements.

## 2.3 RAN3

#### 2.3.1 Agreements

##### 2.3.1.1 Decisions during RAN3#117-e

RAN3 has discussed the further enhancements to NR positioning (See Tdocs [406] – [422]), including support of Sidelink Positioning, UL CPP measurements, LPHAP, RedCap Positioning and Positioning Integrity, etc.

Based on the discussion, the following **agreements** are achieved:

* From RAN3’s perspective, the current NG-RAN positioning architecture can in principle be re-used to support Sidelink Positioning in in-coverage and partial coverage scenarios.
* Whether and how to support SL Positioning and Ranging Service Authorizations signalling to NG-RAN can be investigated by RAN3 during the WI phase, taking into account SA2 decisions on this aspect.
* The potential impacts of SL resource pools, SL positioning measurements, UL CPP measurements, LPHAP, RedCap positioning and positioning Integrity on the RAN3 specifications can be examined during the WI phase, taking into account RAN1/RAN2 decisions.

On handling of the Rel-17 leftover issue, i.e., “UL Positioning for SDT without anchor relocation”, it is agreed that this item is not in the scope of this SI. It can be discussed by RAN3 in R18 WI if included in the WID objectives, or in TEI18.

#### 2.3.2 Remaining Open issues

The following opens need to be addressed:

* Architecture and signalling procedures for SL positioning (e.g. combination of Uu- and PC5-based positioning), LPHAP, etc in coordination with RAN2.
* Any other RAN3 impact, is pending to the progress of RAN1/RAN2/SA2.

## 2.4 RAN4

#### 2.4.1 Agreements

##### 2.4.1.1 Decisions during RAN4#104-e

###### Accuracy improvement study based on PRS/SRS bandwidth aggregation

*Intra-band CA scenario*

1. **Agreement:**
* Intra-band contiguous CA scenario will be prioritized in study.

*Scope of study based on PRS/SRS bandwidth aggregation*

1. **Agreement:**
* Deprioritize power imbalance discussion

**Way forward:** Further discuss the following in the next RAN4 meeting:

* RF architecture – can we focus on a single RF architecture (i.e., single Tx/Rx chain), align on target architectures
* Studying RF impairment model (timing/group delay/frequency/phase) first to assess performance and accuracy gain with realistic impairments
* Studying achievable accuracy gain when TAE is within specified requirement for intra-band contiguous CA
* Notifying RAN1 of the UE transmit power limitation due to potential prioritization

*Initial conclusion on feasibility*

1. **Agreement:**
* PRS/SRS bandwidth aggregation for intra-band contiguous carrier is feasible for single chain Tx/Rx architectures

###### Accuracy improvement study based on carrier phase measurements

*Scope of study based on carrier phase measurements*

1. **Agreement:**
* Wait for RAN1 conclusion or RAN1 LS to start RAN4 work on accuracy improvement study based on carrier phase measurements

**Relevant documents**

|  |  |  |  |
| --- | --- | --- | --- |
| **T-doc number** | **Title** | **Source** | **Status** |
| R4-2214462 | WF on expanded and improved NR positioning study | Intel Corporation | Approved |
| R4-2214248 | Email discussion summary for [104-e][137] FS\_NR\_pos\_UERF | Moderator (Intel Corporation) | Noted |

#### 2.4.2 Remaining Open issues

The following opens need to be addressed:

* Study solutions for accuracy improvement based on PRS/SRS bandwidth aggregation for intra-band contiguous carriers considering e.g., timing errors, phase coherency, frequency errors, etc. [RAN4]
* Study solutions for accuracy improvement based on NR carrier phase measurements after receiving inputs from RAN1. [RAN4]

## 2.5 RAN5

#### 2.5.1 Agreements

#### 2.5.2 Remaining Open issues

#### 2.5.3 Remaining Open issues with cross-WG dependencies

## 2.6 RAN6

#### 2.6.1 Agreements

#### 2.6.2 Remaining Open issues

## 3. Detailed progress in SA/CT WGs since last TSG meeting (for all involved WGs)

NOTE: This section only needs to be filled in for WI/SIs where there is a corresponding relevant WI/SI in SA/CT.

## 3.1 SAx/CTs

#### 3.1.1 Agreements with cross-TSG impacts

#### 3.1.2 Remaining Open issues with cross-TSG impacts

NOTE: This section should also flag any critical dependencies that need TSG attention.

## 4. References

NOTE: This can be e.g. a list of all related Tdocs in the affected WGs since last TSG, references to LSs, produced TRs/TSs, the work/study item description or status reports of previous TSGs.

**RAN1 #109-e**

1. R1-2205574 Session notes for 9.5 (Study on expanded and improved NR positioning) Ad-Hoc Chair (Huawei)
2. R1-2204804 Draft skeleton of TR38.859 Intel Corporation
3. R1-2204805 Work Plan for Study Item on Expanded and Improved NR Positioning Intel Corporation, CATT, Ericsson
4. R1-2205358 FL summary on TR 38.859 skeleton for Rel-18 SI on expanded and improved NR positioning Moderator (Intel Corporation)
5. R1-2205398 Draft skeleton of TR38.859 Rapporteur (Intel Corporation)
6. R1-2205194 Potential SL Positioning Scenarios and Requirements Lenovo
7. R1-2204309 Discussion on SL positioning scenarios and requirements CMCC
8. R1-2204948 SL positioning scenarios and requirements Ericsson
9. R1-2203057 Considerations on scenarios and target requirements for sidelink positioning FUTUREWEI
10. R1-2203127 SL positioning scenarios and requirements Nokia, Nokia Shanghai Bell
11. R1-2203162 Discussion on scenarios and requirements Huawei, HiSilicon
12. R1-2203334 Consideration on SL positioning scenarios and requirements Spreadtrum Communications
13. R1-2203465 Discussion on SL positioning scenarios and requirements CATT, GOHIGH
14. R1-2203564 Discussion on SL positioning scenarios and requirements vivo
15. R1-2203622 Discussion on scenarios and requirements for SL positioning ZTE
16. R1-2203718 Discussion on SL positioning scenarios and requirements LG Electronics
17. R1-2203737 Considerations on SL positioning scenarios and requirements Sony
18. R1-2203751 Scenarios and requirements for sidelink positioning MediaTek Inc.
19. R1-2203821 Discussion on sidelink positioning scenarios and requirement xiaomi
20. R1-2203909 On SL Positioning Scenarios and Requirements Samsung
21. R1-2203941 SL positioning scenarios and requirements NEC
22. R1-2203978 Discussion on SL positioning scenarios and requirements OPPO
23. R1-2204094 Discussion on V2X use cases, scenarios, and requirements for sidelink positioning TOYOTA Info Technology Center
24. R1-2204130 Potential scenarios and requirements for SL positioning InterDigital, Inc.
25. R1-2204251 Discussion on SL positioning scenarios and requirements Apple
26. R1-2204557 Potential SL Positioning Scenarios and Requirements Lenovo
27. R1-2204666 Views on SL positioning scenarios and requirements Sharp
28. R1-2204753 Discussion on sidelink based positioning requirements & scenarios CEWiT
29. R1-2204806 On SL positioning scenarios and requirements Intel Corporation
30. R1-2204833 SL positioning scenarios and requirements Fraunhofer IIS, Fraunhofer HHI
31. R1-2205036 Sidelink Positioning Scenarios and Requirements Qualcomm Incorporated
32. R1-2205177 FL summary #1 on SL positioning scenarios and requirements Moderator (Intel)
33. R1-2205527 FL summary #2 on SL positioning scenarios and requirements Moderator (Intel)
34. R1-2205595 FL summary #3 on SL positioning scenarios and requirements Moderator (Intel)
35. R1-2204754 Discussion on evaluation methods and results of sidelink based positioning CEWiT
36. R1-2205186 Discussion on Evaluation for SL Positioning Samsung
37. R1-2203128 Evaluation of SL positioning Nokia, Nokia Shanghai Bell
38. R1-2203163 Evaluation of SL positioning Huawei, HiSilicon
39. R1-2203466 Evaluation methodology and performance evaluation for SL positioning CATT, GOHIGH
40. R1-2203565 Evaluation of sideilnk positioning performance vivo
41. R1-2203623 Discussion on evaluation for SL positioning ZTE
42. R1-2203719 Discussion on evaluation of SL positioning LG Electronics
43. R1-2203822 Discussion on sidelink positioning evaluation methodology xiaomi
44. R1-2203910 Discussion on Evaluation for SL Positioning Samsung
45. R1-2203942 Evaluation of SL positioning NEC
46. R1-2203979 Discussion on evaluation methodoloty of SL positioning OPPO
47. R1-2204061 Discussion on sidelink postioning design CENC
48. R1-2204131 Evaluation methodology for SL positioning InterDigital, Inc.
49. R1-2204252 On Evaluation of SL positioning Apple
50. R1-2204558 SL Positioning Evaluation Methodology Lenovo
51. R1-2204834 SL positioning evaluation methodology Fraunhofer IIS, Fraunhofer HHI
52. R1-2204949 Evaluation of SL positioning Ericsson
53. R1-2205037 Sidelink Positioning Evaluation Assumptions and Results Qualcomm Incorporated
54. R1-2205227 Summary #1 of [109-e-R18-Pos-03] Email discussion on evaluation of SL positioning Moderator (ZTE)
55. R1-2205228 Summary #2 of [109-e-R18-Pos-03] Email discussion on evaluation of SL positioning Moderator (ZTE)
56. R1-2203566 Discussion on potential solutions for sidelink positioning vivo
57. R1-2204385 Discussions on potential solutions for SL positioning NTT DOCOMO, INC.
58. R1-2203058 Considerations on sidelink reference signals for positioning purposes FUTUREWEI
59. R1-2203129 Potential solutions for SL positioning Nokia, Nokia Shanghai Bell
60. R1-2203164 Discussion on solutions to support SL positioning Huawei, HiSilicon
61. R1-2203335 Consideration on potential solutions for SL positioning Spreadtrum Communications
62. R1-2203467 Discussion on potential solutions for SL positioning CATT, GOHIGH
63. R1-2203624 Discussion on potential solutions for SL positioning ZTE
64. R1-2203659 Discussion on potential solutions for sidelink positioning China Telecom
65. R1-2203720 Discussion on potential solutions for SL positioning LG Electronics
66. R1-2203738 Considerations on potential solutions for SL positioning Sony
67. R1-2203752 The potential solutions for sidelink positioning MediaTek Inc.
68. R1-2203823 Discussion on sidelink positioning solutions xiaomi
69. R1-2203911 Discussion on Potential Solutions for SL Positioning Samsung
70. R1-2203943 Discussion on Potential Solutions for SL Positioning NEC
71. R1-2203980 Discussion on potential solutions for SL positioning OPPO
72. R1-2204092 carrier phase measurement method for sidelink positioning Locaila
73. R1-2204132 Potential solutions for SL positioning InterDigital, Inc.
74. R1-2204253 Discussions on Potential solutions for SL positioning Apple
75. R1-2204310 Discussion on potential solutions for SL positioning CMCC
76. R1-2204559 On Potential SL Positioning Solutions Lenovo
77. R1-2204667 Views on potential solutions for SL positioning Sharp
78. R1-2204755 Discussion on potential solutions for sidelink based positioning CEWiT
79. R1-2204835 Potential solutions for SL positioning Fraunhofer IIS, Fraunhofer HHI
80. R1-2204869 Views on potential solutions for SL positioning ROBERT BOSCH GmbH
81. R1-2204940 Views on potential solutions for SL positioning Intel Corporation
82. R1-2204950 Potential solutions for SL positioning Ericsson
83. R1-2205038 Potential Solutions for Sidelink Positioning Qualcomm Incorporated
84. R1-2205202 Moderator Summary #1 for [109-e-R18-Pos-04] Email discussion on potential solutions for SL positioning Moderator (Qualcomm)
85. R1-2205457 Moderator Summary #2 for [109-e-R18-Pos-04] Email discussion on potential solutions for SL positioning Moderator (Qualcomm)
86. R1-2203165 Error source for NR RAT-dependent positioning Huawei, HiSilicon
87. R1-2203177 Initial Views on solutions for integrity of RAT-dependent positioning techniques Nokia, Nokia Shanghai Bell
88. R1-2203336 Consideration on solutions for integrity of RAT dependent positioning techniques Spreadtrum Communications
89. R1-2203468 Discussion on solutions for integrity of RAT dependent positioning techniques CATT
90. R1-2203567 Discussion on solutions for integrity of RAT dependent positioning vivo
91. R1-2203625 Discussion on integrity of RAT dependent positioning ZTE
92. R1-2203739 Considerations on solution for integrity of RAT dependent positioning techniques Sony
93. R1-2203912 Discussion on Integrity of RAT Dependent Positioning Samsung
94. R1-2203965 Discussions on Integrity for NR Positioning OPPO
95. R1-2204133 Integrity for RAT dependent positioning techniques InterDigital, Inc.
96. R1-2204311 Discussion on solutions for integrity of RAT-dependent positioning techniques CMCC
97. R1-2204386 Discussion on solutions for integrity of RAT dependent positioning techniques NTT DOCOMO, INC.
98. R1-2204523 Discussion on integrity of RAT dependent positioning techniques LG Electronics
99. R1-2204560 Integrity for RAT-dependent positioning Lenovo
100. R1-2204668 Views on solutions for integrity of RAT dependent positioning techniques Sharp
101. R1-2204951 Solutions for integrity of RAT dependent positioning techniques Ericsson
102. R1-2205039 Integrity for RAT dependent positioning Qualcomm Incorporated
103. R1-2205344 Feature Lead summary #1 on Email discussion [109-e-R18-Pos-05] on integrity of RAT dependent positioning techniques Moderator (InterDigital)
104. R1-2203469 Discussion on improved accuracy based on NR carrier phase measurement CATT
105. R1-2203634 Use cases and applications on Carrier Phase Based Positioning for NR Locaila
106. R1-2203626 Discussion on Carrier Phase Measurement Based Positioning ZTE
107. R1-2203166 Discussion on NR carrier phase positioning Huawei, HiSilicon
108. R1-2203178 Initial Views on improved accuracy based on NR carrier phase measurement Nokia, Nokia Shanghai Bell
109. R1-2203337 Consideration on improved accuracy based on NR carrier phase measurement Spreadtrum Communications
110. R1-2203568 Discussion on carrier phase measurement enhancements vivo
111. R1-2203635 "Continuous PRS for improved carrier phase measurement Document for: Discussion & Decision" Dankook University
112. R1-2203660 Discussion on improved accuracy based on NR carrier phase measurement China Telecom
113. R1-2203753 On carrier phase measurement MediaTek Inc.
114. R1-2203824 Improved accuracy based on NR carrier phase measurement xiaomi
115. R1-2203913 Discussion on NR Carrier Phase Measurement Samsung
116. R1-2203966 Discussions on Carrier Phase Measurement for NR Positioning OPPO
117. R1-2204134 Potential solutions for carrier phase based positioning InterDigital, Inc.
118. R1-2204312 Discussion on carrier phase positioning CMCC
119. R1-2204387 Discussion on improved accuracy based on NR carrier phase measurement NTT DOCOMO, INC.
120. R1-2204524 Discussion on OFDM based carrier phase measurement in NR LG Electronics
121. R1-2204561 On NR carrier phase measurements Lenovo
122. R1-2204669 Views on improved accuracy based on NR carrier phase measurement Sharp
123. R1-2204807 Design Aspects of Carrier Phase Measurements for NR Positioning Enhancements Intel Corporation
124. R1-2204836 NR carrier phase measurements for positioning Fraunhofer IIS, Fraunhofer HHI
125. R1-2204952 Improved accuracy based on NR carrier phase measurement Ericsson
126. R1-2205040 Phase Measurements in NR Positioning Qualcomm Incorporated
127. R1-2205164 FL Summary for improved accuracy based on NR carrier phase measurement Moderator (CATT)
128. R1-2205165 FL Summary #2 for improved accuracy based on NR carrier phase measurement Moderator (CATT)
129. R1-2205166 FL Summary #3 for improved accuracy based on NR carrier phase measurement Moderator (CATT)
130. R1-2203167 Requirements and evaluation methodology for LPHAP Huawei, HiSilicon
131. R1-2203179 Initial Views on LPHAP Nokia, Nokia Shanghai Bell
132. R1-2203470 Discussion on Low Power High Accuracy Positioning CATT
133. R1-2203569 Discussion on Low Power High Accuracy Positioning vivo
134. R1-2203627 Discussion on low power high accuracy positioning(LPHAP) ZTE
135. R1-2203825 LPHAP (Low Power High Accuracy Positioning) xiaomi
136. R1-2203914 Discussion on LPHAP Samsung
137. R1-2203967 Disucssion on Low Power High Accuracy Positioning OPPO
138. R1-2204155 Discussions on Low Power High Accuracy Positioning (LPHAP) techniques InterDigital, Inc.
139. R1-2204313 Discussion on low power high accuracy positioning CMCC
140. R1-2204426 Discussion on Low Power High Accuracy Positioning Quectel
141. R1-2204525 Discussion on LPHAP in idle/inactive state LG Electronics
142. R1-2204562 LPHAP considerations Lenovo
143. R1-2204670 Views on low power high accuracy positioning Sharp
144. R1-2204953 On the requirements, evaluations and potential enhancements for Low Power High Accuracy Positioning) Ericsson
145. R1-2205041 Requirements, Evaluations, Potential Enhancements for Low Power High Accuracy Positioning Qualcomm Incorporated
146. R1-2205354 FL summary #2 for AI 9.5.2.3 – low power high accuracy positioning Moderator (CMCC)
147. R1-2205355 FL summary #3 for AI 9.5.2.3 – low power high accuracy positioning Moderator (CMCC)
148. R1-2205594 FL summary for AI 9.5.2.3 – low power high accuracy positioning (EOM) Moderator (CMCC)
149. R1-2203168 Discussion on RedCap positioning Huawei, HiSilicon
150. R1-2203968 Discussion on Positioning for RedCap Ues OPPO
151. R1-2205042 Positioning for Reduced Capabilities UEs Qualcomm Incorporated
152. R1-2203180 Initial Views on Positioning for RedCap UEs Nokia, Nokia Shanghai Bell
153. R1-2203471 Discussion on positioning for RedCap UEs CATT
154. R1-2203570 Discussion on positionig for RedCap Ues vivo
155. R1-2203628 Discussion on Positioning for RedCap UE ZTE
156. R1-2203696 Discussion on positioning support for RedCap UEs NEC
157. R1-2203740 Discussion on positioning for RedCap UEs Sony
158. R1-2203754 The potential solutions for RedCap UEs for positioning MediaTek Inc.
159. R1-2203826 Initial views on the positioning for RedCap UEs xiaomi
160. R1-2203915 Discussion on Positioning for RedCap Ues Samsung
161. R1-2204157 Evaluation assumptions and potential solutions for positioning for RedCap UEs InterDigital, Inc.
162. R1-2204254 Discussions on Positioning for RedCap UEs Apple
163. R1-2204314 Discussion on RedCap positioning CMCC
164. R1-2204388 Discussion on positioning for RedCap UEs NTT DOCOMO, INC.
165. R1-2204425 Discussion on Positioning for RedCap UEs Quectel
166. R1-2204526 Discussion on positioning support for RedCap Ues LG Electronics
167. R1-2204563 Positioning for RedCap devices Lenovo
168. R1-2204671 Views on positioning for RedCap UEs Sharp
169. R1-2204808 On enhancements for NR positioning support of RedCap UEs Intel Corporation
170. R1-2204954 Positioning for RedCap Ues Ericsson
171. R1-2205526 Feature Lead Summary#1 for [109-e-R18-Pos-08] Positioning for RedCap UEs Moderator (Ericsson)
172. R1-2203181 Initial Views on Other topics for Positioning Nokia, Nokia Shanghai Bell
173. R1-2203472 Discussion on solutions of carrier phase positioning in multipath scenarios CATT
174. R1-2203571 Discussion on PRS measurement in IDLE state vivo
175. R1-2203629 Discussion on Positioning with Multiple Frequency Layers (Carriers) ZTE
176. R1-2203916 Discussion on expended and improved NR positioning Samsung
177. R1-2204158 Efficient usage of available bandwidths for positioning InterDigital, Inc.
178. R1-2204916 Considerations on the CA positioning Huawei, HiSilicon
179. R1-2204955 Considerations for PRS/SRS bandwidth aggregation Ericsson

**RAN1 #110**

1. R1-2208147 Session notes for 9.5 (Study on expanded and improved NR positioning) Ad-Hoc Chair (Huawei)
2. R1-2207458 Draft TR 38.859 v001: Study on expanded and improved NR positioning Intel Corporation, CATT, Ericsson
3. R1-2208157 Draft TR 38.859 v010: Study on expanded and improved NR positioning Intel Corporation, CATT, Ericsson
4. R1-2208267 Draft TR 38.859 v010: Study on expanded and improved NR positioning Intel Corporation, CATT, Ericsson
5. R1-2208275 Draft TR 38.859 v010: Study on expanded and improved NR positioning Intel Corporation, CATT, Ericsson
6. R1-2205836 SL positioning scenarios and requirements Nokia, Nokia Shanghai Bell
7. R1-2205853 Discussion on SL positioning scenarios and requirements LG Electronics
8. R1-2205866 Remaining issues of scenarios and requirements for sidelink positioning Huawei, HiSilicon
9. R1-2205899 Discussion on scenarios and requirements for SL positioning ZTE
10. R1-2206044 Discussion on SL positioning scenarios and requirements vivo
11. R1-2206066 Discussion on requirements for sidelink positioning TOYOTA Info Technology Center
12. R1-2206122 Considerations on SL positioning scenarios Sony
13. R1-2206238 SL positioning scenarios and requirements NEC
14. R1-2206287 Discussion on SL positioning scenarios and requirements OPPO
15. R1-2206403 Discussion on SL positioning scenarios and requirements CATT, GOHIGH
16. R1-2206496 Potential SL Positioning Scenarios and Requirements Lenovo
17. R1-2206588 On scenarios and requirements for SL positioning Intel Corporation
18. R1-2206829 On SL Positioning Scenarios and Requirements Samsung
19. R1-2206916 Remaining issues on SL positioning scenarios and requirements CMCC
20. R1-2207071 Further discussion on sidelink based positioning requirements & scenarios CEWiT
21. R1-2207085 Discussions on SL positioning scenario and requirements InterDigital, Inc.
22. R1-2207236 Sidelink Positioning Scenarios and Requirements Qualcomm Incorporated
23. R1-2207282 Views on SL positioning scenarios and requirements Sharp
24. R1-2207340 Discussion on Sidelink positioning scenarios and requirements Apple
25. R1-2207507 Views on SL positioning scenarios and requirements ROBERT BOSCH GmbH
26. R1-2207577 Discussion on sidelink positioning scenarios and requirement Xiaomi
27. R1-2207618 Scenarios and requirements for sidelink positioning Ericsson
28. R1-2207626 Considerations on sidelink positioning in NR ITL
29. R1-2207738 FL summary #1 on SL positioning scenarios and requirements Moderator (Intel)
30. R1-2208158 FL summary #2 on SL positioning scenarios and requirements Moderator (Intel)
31. R1-2205837 Evaluation of SL positioning Nokia, Nokia Shanghai Bell
32. R1-2205854 Discussion on evaluation of SL positioning LG Electronics
33. R1-2205867 Evaluation assumptions and results for SL positioning Huawei, HiSilicon
34. R1-2205900 Discussion on evaluation of SL positioning ZTE
35. R1-2206045 Evaluation of sidelink positioning performance vivo
36. R1-2206123 Initial Performance Evaluation of SL Positioning Sony
37. R1-2206239 Evaluation of SL positioning NEC
38. R1-2206288 Remaining details on evaluation methodology of SL positioning OPPO
39. R1-2206404 Evaluation methodology and performance evaluation for SL positioning CATT, GOHIGH
40. R1-2206497 SL Positioning Evaluation Methodology and Performance Lenovo
41. R1-2207686 SL Positioning Evaluation Methodology and Performance Lenovo
42. R1-2206830 Discussion on Evaluation for SL Positioning Samsung
43. R1-2207072 Discussion on evaluation methods and results of sidelink based positioning CEWiT
44. R1-2207086 Evaluation results for SL positioning InterDigital, Inc.
45. R1-2207124 Evaluation methodology for SL positioning Fraunhofer IIS, Fraunhofer HHI
46. R1-2207237 Sidelink Positioning Evaluation Assumptions and Results Qualcomm Incorporated
47. R1-2207508 Views on Evaluation of SL positioning for VRU Protection ROBERT BOSCH GmbH
48. R1-2207578 Discussion on evaluation of sidelink positioning Xiaomi
49. R1-2207606 FL summary#2 for SL positioning evaluation ZTE
50. R1-2207619 Simulation assumptions and evaluations for NR SL positioning Ericsson
51. R1-2207686 SL Positioning Evaluation Methodology and Performance Lenovo
52. R1-2207605 FL summary#1 for SL positioning evaluation ZTE
53. R1-2207606 FL summary#2 for SL positioning evaluation ZTE
54. R1-2205746 Potential sidelink positioning solutions FUTUREWEI
55. R1-2205838 Potential solutions for SL positioning Nokia, Nokia Shanghai Bell
56. R1-2205855 Discussion on potential solutions for SL positioning LG Electronics
57. R1-2205868 Discussion on solutions to support SL positioning Huawei, HiSilicon
58. R1-2205901 Discussion on potential solutions for SL positioning ZTE
59. R1-2205994 Discussion on potential solutions for SL positioning Spreadtrum Communications
60. R1-2206046 Discussion on potential solutions for sidelink positioning vivo
61. R1-2206124 Discussion on potential solutions for SL positioning Sony
62. R1-2206240 Discussion on Potential Solutions for SL Positioning NEC
63. R1-2206289 Discussion on potential solutions for SL positioning OPPO
64. R1-2206405 Discussion on potential solutions for SL positioning CATT, GOHIGH
65. R1-2206498 On Potential SL Positioning Solutions Lenovo
66. R1-2206589 Potential solutions for SL positioning Intel Corporation
67. R1-2206693 Discussion on potential solutions for sidelink positioning China Telecom
68. R1-2206831 Discussion on Potential Solutions for SL Positioning Samsung
69. R1-2206917 Discussion on potential solutions for SL positioning CMCC
70. R1-2207073 Discussion on enhancement for sidelink positioning support CEWiT
71. R1-2207087 Potential solutions for SL positioning InterDigital, Inc.
72. R1-2207125 Potential solutions for SL positioning Fraunhofer IIS, Fraunhofer HHI
73. R1-2207238 Potential Solutions for Sidelink Positioning Qualcomm Incorporated
74. R1-2207283 Views on potential solutions for SL positioning Sharp
75. R1-2207341 Discussions on Potential solutions for SL positioning Apple
76. R1-2207411 Discussion on potential solutions for SL positioning NTT DOCOMO, INC.
77. R1-2207443 Discussion on handling Anchor UE DENSO AUTOMOTIVE
78. R1-2207479 The potential solutions for sidelink positioning MediaTek Inc.
79. R1-2207484 Discussion on sidelink positioning ASUSTeK
80. R1-2207579 Discussion on sidelink positioning solutions Xiaomi
81. R1-2207620 On potential solutions for SL positioning Ericsson
82. R1-2207846 Moderator Summary #1 on potential solutions for SL positioning Moderator (Qualcomm)
83. R1-2207875 Moderator Summary #2 on potential solutions for SL positioning Moderator (Qualcomm)
84. R1-2207974 Moderator Summary #3 on potential solutions for SL positioning Moderator (Qualcomm)
85. R1-2208186 Moderator Summary #4 on potential solutions for SL positioning Moderator (Qualcomm)
86. R1-2205869 Error source for NR RAT-dependent positioning Huawei, HiSilicon
87. R1-2205902 Discussion on integrity of RAT dependent positioning ZTE
88. R1-2205995 Discussion on error sources for RAT-dependent positioning Spreadtrum Communications
89. R1-2206047 Discussion on solutions for integrity of RAT dependent positioning vivo
90. R1-2206125 Considerations on Integrity for RAT dependent positioning Sony
91. R1-2206273 Discussions on Integrity for NR Positioning OPPO
92. R1-2206406 Discussion on solutions for integrity of RAT dependent positioning techniques CATT
93. R1-2206490 Views on solutions for integrity of RAT-dependent positioning techniques Nokia, Nokia Shanghai Bell
94. R1-2206499 Integrity aspects for RAT-dependent positioning Lenovo
95. R1-2206650 Error source for NR RAT-dependent positioning integrity Xiaomi
96. R1-2206832 Discussion on Integrity of RAT Dependent Positioning Samsung
97. R1-2206918 Discussion on integrity for RAT-dependent positioning CMCC
98. R1-2207088 Discussion on integrity for RAT dependent positioning techniques InterDigital, Inc.
99. R1-2207239 Integrity for RAT dependent positioning Qualcomm Incorporated
100. R1-2207284 Views on solutions for integrity of RAT dependent positioning techniques Sharp
101. R1-2207412 Discussion on solutions for integrity of RAT dependent positioning techniques NTT DOCOMO, INC.
102. R1-2207621 Error Sources characterization for integrity of RAT dependent positioning techniques Ericsson
103. R1-2207744 FL summary #1 on integrity of RAT dependent positioning techniques Moderator (InterDigital)
104. R1-2207922 FL summary #2 on integrity of RAT dependent positioning techniques Moderator (InterDigital)
105. R1-2208189 FL summary #3 on integrity of RAT dependent positioning techniques Moderator (InterDigital).
106. R1-2205870 Evaluation and solutions for NR carrier phase positioning Huawei, HiSilicon
107. R1-2205903 Discussion on carrier phase measurement based positioning ZTE
108. R1-2206048 Discussion on carrier phase measurement enhancements vivo
109. R1-2206227 Solutions for Integer Ambiguity, TRP synchronization and Vertical Positioning Locaila
110. R1-2206274 Discussions on Carrier Phase Measurement for NR Positioning OPPO
111. R1-2206407 Discussion on improved accuracy based on NR carrier phase measurement CATT
112. R1-2206491 Views on improved accuracy based on NR carrier phase measurement Nokia, Nokia Shanghai Bell
113. R1-2206500 On NR carrier phase measurements Lenovo
114. R1-2206590 Improved positioning accuracy with NR carrier phase measurements Intel Corporation
115. R1-2206651 Improved accuracy based on NR carrier phase measurement Xiaomi
116. R1-2206694 Discussion on improved accuracy based on NR carrier phase measurement China Telecom
117. R1-2206833 Discussion on NR Carrier Phase Measurement Samsung
118. R1-2206919 Discussion on carrier phase positioning CMCC
119. R1-2207090 Discussion on positioning based on NR carrier phase measurement InterDigital, Inc.
120. R1-2207126 NR carrier phase measurements for positioning Fraunhofer IIS, Fraunhofer HHI
121. R1-2207240 Phase Measurements in NR Positioning Qualcomm Incorporated
122. R1-2207285 Views on improved accuracy based on NR carrier phase measurement Sharp
123. R1-2207360 Discussion on OFDM based carrier phase measurement in NR LG Electronics
124. R1-2207413 Discussion on improved accuracy based on NR carrier phase measurement NTT DOCOMO, INC.
125. R1-2207480 On carrier phase measurement MediaTek Inc.
126. R1-2207622 Improved accuracy based on NR carrier phase measurement Ericsson
127. R1-2207710 Discussion on OFDM based carrier phase measurement in NR LG Electronics
128. R1-2207742 Discussion on NR Carrier Phase Measurement Samsung
129. R1-2207690 FL Summary for improved accuracy based on NR carrier phase measurements Moderator (CATT)
130. R1-2207691 FL Summary #2 for improved accuracy based on NR carrier phase measurements Moderator (CATT)
131. R1-2208206 FL Summary #3 for improved accuracy based on NR carrier phase measurements Moderator (CATT)
132. R1-2205871 Evaluation and solutions for LPHAP Huawei, HiSilicon
133. R1-2205904 Discussion on low power high accuracy positioning ZTE
134. R1-2205996 Discussion on evaluation on LPHAP Spreadtrum Communications
135. R1-2206049 Discussion on Low Power High Accuracy Positioning vivo
136. R1-2206275 Disucssion on Low Power High Accuracy Positioning OPPO
137. R1-2206408 Discussion on Low Power High Accuracy Positioning CATT
138. R1-2206492 Views on LPHAP Nokia, Nokia Shanghai Bell
139. R1-2206501 LPHAP considerations Lenovo
140. R1-2206591 Discussion on power saving evaluation and techniques for LPHAP Intel Corporation
141. R1-2206652 Discussion on Low Power High Accuracy Positioning Xiaomi
142. R1-2206834 Discussion on LPHAP Samsung
143. R1-2206920 Discussion on low power high accuracy positioning CMCC
144. R1-2207091 Discussions on Low Power High Accuracy Positioning (LPHAP) techniques InterDigital, Inc.
145. R1-2207241 Requirements, Evaluations, Potential Enhancements for Low Power High Accuracy Positioning Qualcomm Incorporated
146. R1-2207286 Views on low power high accuracy positioning Sharp
147. R1-2207361 Discussion on LPHAP in idle/inactive state LG Electronics
148. R1-2207414 Discussion on Low Power High Accuracy Positioning NTT DOCOMO, INC.
149. R1-2207623 Evaluations for Low Power High Accuracy Positioning Ericsson
150. R1-2206921 Summary for low power high accuracy positioning Moderator (CMCC)
151. R1-2207993 Summary for low power high accuracy positioning Moderator (CMCC)
152. R1-2205872 Discussion on RedCap positioning Huawei, HiSilicon
153. R1-2205905 Discussion on Positioning for RedCap UE ZTE
154. R1-2206050 Discussion on positioning for RedCap UEs vivo
155. R1-2206126 Discussion on positioning for RedCap UEs Sony
156. R1-2206276 Discussion on Positioning for RedCap Ues OPPO
157. R1-2206426 Discussion on positioning for RedCap UEs CATT
158. R1-2206473 Discussion on positioning support for RedCap UEs NEC
159. R1-2206493 Views on Positioning for RedCap UEs Nokia, Nokia Shanghai Bell
160. R1-2206502 Positioning for RedCap devices Lenovo
161. R1-2206592 Positioning for RedCap UEs Intel Corporation
162. R1-2206835 Discussion on Positioning for RedCap UEs Samsung
163. R1-2206922 Discussion on RedCap positioning CMCC
164. R1-2207092 Discussions on positioning for RedCap UEs InterDigital, Inc.
165. R1-2207242 Positioning for Reduced Capabilities UEs Qualcomm Incorporated
166. R1-2207287 Views on positioning for RedCap Ues Sharp
167. R1-2207342 Discussions on Positioning for RedCap Ues Apple
168. R1-2207362 Discussion on positioning support for RedCap Ues LG Electronics
169. R1-2207415 Discussion on positioning for RedCap UEs NTT DOCOMO, INC.
170. R1-2207482 The potential solutions for RedCap UEs for positioning MediaTek Inc.
171. R1-2207624 Considerations for RedCap Positioning Ericsson
172. R1-2207749 Feature Lead Summary #1 for Positioning for RedCap Ues Moderator (Ericsson)
173. R1-2207750 Feature Lead Summary #2 for Positioning for RedCap Ues Moderator (Ericsson)

**RAN2#119e:**

1. R2-2207105 Summary of pre-discussion on Rel-18 expanded and improved NR positioning CATT discussion Rel-18 FS\_NR\_pos\_enh2
2. R2-2207387 RAN1 agreements on Expanded and improved NR positioning Intel Corporation discussion Rel-18 FS\_NR\_pos\_enh2
3. R2-2207737 Work Plan for Study Item on Expanded and Improved NR Positioning CATT, Intel Corporation, Ericsson Work Plan Rel-18 FS\_NR\_pos\_enh2
4. R2-2208080 SL positioning Ericsson discussion Rel-18
5. R2-2207081 Discussion on sidelink positioning vivo discussion Rel-18 FS\_NR\_pos\_enh2
6. R2-2207090 Discussion of sidelink positioning OPPO discussion Rel-17 FS\_NR\_pos\_enh2
7. R2-2207106 SL Positioning Architecture and Protocol Stack CATT discussion Rel-18 FS\_NR\_pos\_enh2
8. R2-2207229 Discussion of sidelink positioning procedures Nokia Germany agenda
9. R2-2207286 Principles for sidelink positioning MediaTek Inc. discussion Rel-18
10. R2-2207388 Support of sidelink positioning Intel Corporation discussion Rel-18 FS\_NR\_pos\_enh2
11. R2-2207435 On Sidelink Positioning Architecture Apple discussion Rel-18 FS\_NR\_pos\_enh2
12. R2-2207486 Discussion on Sidelink Positioning InterDigital, Inc. discussion Rel-18 FS\_NR\_pos\_enh2
13. R2-2207586 Discussion on sidelink positioning ZTE, Sanechips discussion Rel-18 NR\_pos\_enh-Core
14. R2-2207684 Discussion on potential solutions for SL positioning Spreadtrum Communications discussion Rel-18
15. R2-2207828 Considerations on sidelink positioning Sony discussion Rel-18 FS\_NR\_pos\_enh2
16. R2-2207865 On SL Positioning Architecture and Procedures Lenovo discussion Rel-18
17. R2-2207868 Discussion on sidelink positioning Huawei, HiSilicon discussion Rel-18 FS\_NR\_pos\_enh2
18. R2-2208126 Study of Sidelink Positioning Architecture, Signaling and Procedures Qualcomm Incorporated discussion
19. R2-2208253 Protocol considerations for sidelink positioning Philips International B.V. discussion Rel-18 FS\_NR\_pos\_enh2
20. R2-2208301 Discussion on functions of LMF in SL positioning Samsung discussion Rel-18 FS\_NR\_pos\_enh2
21. R2-2208320 Discussion on out-of-coverage sidelink positioning Samsung R&D Institute UK discussion
22. R2-2208453 Initial considerations on Sidelink positioning CMCC discussion Rel-18 FS\_NR\_pos\_enh2
23. R2-2208582 Discussion on SL positioning Xiaomi discussion Rel-18
24. R2-2207082 Discussion on RAT-dependent integrity vivo discussion Rel-18 FS\_NR\_pos\_enh2
25. R2-2207107 Discussion on RAT dependent integrity CATT discussion Rel-18 FS\_NR\_pos\_enh2
26. R2-2207389 Support of RAT dependent integrity Intel Corporation discussion Rel-18 FS\_NR\_pos\_enh2
27. R2-2207487 Discussion on RAT-dependent Integrity InterDigital, Inc. discussion Rel-18 FS\_NR\_pos\_enh2
28. R2-2207585 Discussion on RAT-dependent methods positioning integrity ZTE, Sanechips discussion Rel-18 NR\_pos\_enh-Core
29. R2-2207685 Discussion on solutions for integrity of RAT-dependent positioning techniques Spreadtrum Communications discussion Rel-18
30. R2-2207702 Discussion on RAT-dependent positioning integrity Lenovo discussion Rel-18
31. R2-2207829 Considerations on solution for integrity of RAT dependent positioning Sony discussion Rel-18 FS\_NR\_pos\_enh2
32. R2-2207869 Discussion on RAT-dependent integrity Huawei, HiSilicon discussion Rel-18 FS\_NR\_pos\_enh2
33. R2-2207911 Discussion on RAT-dependent positioning integrity Xiaomi discussion
34. R2-2208079 RAT-dependent integrity Ericsson discussion Rel-18
35. R2-2208127 Integrity of NR Positioning Technologies Qualcomm Incorporated discussion
36. R2-2208318 Discussion on integrity of RAT dependent positioning techniques Samsung R&D Institute UK discussion
37. R2-2208322 Discussion of RAT-dependent positioning integrity Nokia, Nokia Shanghai Bell discussion Rel-18 FS\_NR\_pos\_enh2
38. R2-2207083 Discussion on LPHAP vivo discussion Rel-18 FS\_NR\_pos\_enh2
39. R2-2207089 Consideration on LPHAP OPPO discussion Rel-17 FS\_NR\_pos\_enh2
40. R2-2207111 Discussion on LPHAP CATT discussion Rel-18 FS\_NR\_pos\_enh2
41. R2-2207390 Support of LPHAP Intel Corporation discussion Rel-18 FS\_NR\_pos\_enh2
42. R2-2207436 On LPHAP Apple discussion Rel-18 FS\_NR\_pos\_enh2
43. R2-2207488 Discussion on LPHAP InterDigital, Inc. discussion Rel-18 FS\_NR\_pos\_enh2
44. R2-2207584 Discussion on LPHAP ZTE, Sanechips discussion Rel-18 NR\_pos\_enh-Core
45. R2-2207703 Discussion on low power high accuracy positioning Lenovo discussion Rel-18
46. R2-2207830 Considerations on solution for Low Power High Accuracy Positioning Sony discussion Rel-18 FS\_NR\_pos\_enh2
47. R2-2207867 Discussion on the LPHAP Huawei, HiSilicon discussion Rel-18 FS\_NR\_pos\_enh2 Revised
48. R2-2207912 Discussion on LPHA positioning Xiaomi discussion
49. R2-2208078 Discussion on Low Power High Accuracy Positioning Ericsson discussion Rel-18
50. R2-2208128 Limitations of RRC\_INACTIVE positioning for LPHAP Qualcomm Incorporated discussion
51. R2-2208180 Use case and area of focus for LPHAP study Nokia, Nokia Shanghai Bell discussion Rel-18 FS\_NR\_pos\_enh2
52. R2-2208454 Initial considerations on LPHAP CMCC discussion Rel-18 FS\_NR\_pos\_enh2
53. R2-2208626 Discussion on the LPHAP Huawei, HiSilicon, Deutsche Telekom discussion Rel-18 FS\_NR\_pos\_enh2

**RAN3#117e:**

1. R3-225033 Summary of offline discussion on Rel-18 Positioning SI Ericsson (moderator)
2. R3-224628 Work Plan for Study Item on Expanded and Improved NR Positioning (CATT, Intel Corporation, Ericsson)
3. R3-224629 TR 38.859 skeleton info (CATT, Intel Corporation, Ericsson)
4. R3-224513 Potential RAN3 impacts of NR carrier phase positioning (Nokia, Nokia Shanghai Bell)
5. R3-224514 Potential RAN3 impacts of positioning support for RedCap UEs (Nokia, Nokia Shanghai Bell)
6. R3-224533 Discussion on Carrier Phase Positioning (Ericsson)
7. R3-224630 Discussion on SL Positioning Architecture and Signaling Procedures (CATT)
8. R3-224631 Discussion on LPHAP and inactive positioning (CATT)
9. R3-224701 Discussion on positioning enhancement (Huawei)
10. R3-224702 Discussion on sidelink positioning (Huawei)
11. R3-224765 Discussion on sidelink positioning (Xiaomi)
12. R3-224799 Discussion on service authorization for sidelink positioning to NG-RAN (ZTE)
13. R3-224833 Initial discussion on sidelink positioning (Samsung)
14. R3-224916 Initial consideration on Sidelink positioning (CMCC)
15. R3-224956 Consideration on sidelink positioning (ZTE)
16. R3-224982 Discussion on other potential RAN3 impact (Beijing Xiaomi Mobile Software)
17. R3-224530 Study on Rel-18 NR Sidelink Positioning (Ericsson)

**RAN4 #104-e**

1. R4-2212149, Work Plan for Study Item on Expanded and Improved NR Positioning, Intel Corporation
2. R4-2212210, On the feasibility of PRS/SRS bandwidth aggregation for enhanced positioning accuracy, Qualcomm Incorporated
3. R4-2212211, On improved positioning via NR carrier phase measurements, Qualcomm Incorporated
4. R4-2213277, On accuracy improvement based on PRS/SRS bandwidth aggregation, Ericsson
5. R4-2213278, On accuracy improvement based on NR carrier phase measurements, Ericsson
6. R4-2213589, Discussion on NR positioning measurement accuracy improvement based on bandwidth aggregation, Nokia, Nokia Shanghai Bell
7. R4-2213688, Discussion on CA based positioning enhancement, ZTE Corporation
8. R4-2213689, Discussion on carrier phase based positioning, ZTE Corporation
9. R4-2213730, RF impacts on positioning bandwidth aggregation for intra-band carriers, Huawei, HiSilicon
10. R4-2213731, RF aspects of carrier phase measurements, Huawei, HiSilicon
11. R4-2214115, Email discussion summary for [104-e][137] FS\_NR\_pos\_UERF, Moderator (Intel Corporation)
12. R4-2214248, Email discussion summary for [104-e][137] FS\_NR\_pos\_UERF, Moderator (Intel Corporation)
13. R4-2214462, WF on expanded and improved NR positioning study, Intel Corporation
* 10.01.2022 minor adaptations for RAN #95e
* 04.10.2021 minor adaptations for RAN #94e
* 08.08.2021 minor adaptations for RAN #93e
* 17.05.2021 minor adaptations for RAN #92e
* 28.01.2021 minor adaptations for RAN #91e
* 09.11.2020 minor adaptations for RAN #90e
* 31.08.2020 minor adaptations for RAN #89e
* 20.04.2020 minor adaptations for RAN #88e
* 18.02.2020 minor adaptations for RAN #87e
* 14.11.2019 minor adaptations for RAN #86
* 18.08.2019 minor adaptations for RAN #85
* 12.05.2019 minor adaptations for RAN #84
* 27.02.2019 minor adaptations for RAN #83
* 21.11.2018 completion levels with colours added (for RAN #82)
* v04.81 31.07.2018 simplification of template and addition of cross-TSG aspects (for RAN #81)
* v04.80 21.05.2018 minor adaptations for RAN #80
* v04.79 26.02.2018 minor adaptations for RAN #79
* v04.78 18.11.2017 minor adaptations for RAN #78
* v04.77 06.08.2017 minor adaptations for RAN #77
* v04.76 15.05.2017 minor adaptations for RAN #76
* v04.75 31.01.2017 minor adaptations for RAN #75
* v04.74 28.10.2016 minor adaptations for RAN #74
* v04.73 01.09.2016 adaptations for RAN #73 (time units in extra Excel table, RAN6 reporting included)
* v04.72 26.05.2016 adaptations for RAN #72 (introduction of NR & GERAN TUs)
* v04.71 10.02.2016 minor adaptations for RAN #71
* v04.70 30.10.2015 minor adaptations for RAN #70
* v04.69 12.08.2015 minor adaptations for RAN #69
* v04.68 21.05.2015 minor adaptations for RAN #68
* v04.67 01.02.2015 minor adaptations for RAN #67
* v04.66 16.11.2014 minor adaptations for RAN #66
* v04.65 16.08.2014 minor adaptations for RAN #65
* v04.64 22.05.2014 minor adaptations for RAN #64
* v04.63 24.01.2014 restructuring for RAN #63 to cover Core & Perf. in one doc file
* v03.62 11.11.2013 section 1.2.3 adapted for RAN #62
* v03 11.08.2013 section 1.2.3 added on time budget
* v02 07.05.2010 history added, some spelling corrections
* v01 13.11.2009 First version of the template