**3GPP TSG RAN meeting #98e**  **RP-22xxxx**

**Electronic Meeting, December 12 – 16, 2022**

## Status Report to TSG

**Agenda item:** 9.2.6

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **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-222616 | | | | |
| **Target Completion Date**  **(indicate if changed)** | Study Item:  12/2022  (No change) | Core part: | Performance part: | Testing part: | |
| **Overall Completion level** | Study Item:  100% | 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 |
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## 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

##### 2.1.1.1 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 of 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 4GHz SL: 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**

1. 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



1. 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.
  1. 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:
    1. 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)
    2. positioning measurement report
    3. whether a dedicated frequency allocation (e.g., layer/BWP) is needed for SL PRS
    4. resource allocation procedure(s) of SL-PRS
    5. 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:
    1. co-existence between SL communication and SL positioning, backward compatibility
    2. 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:

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

**Agreement**

1. The impact of multipath for the carrier phase positioning will be evaluated during the SI
2. 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**

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

**Agreement**

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

**Agreement**

1. 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).
   1. 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:
  + Alt. 2: relative power unit is adopted as the metric to identify the gap
    - Example:

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 1  EIRP 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 independently  Apply 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 38.802  Note 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 1  dH = 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 1Tx  Optional: 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.

##### 2.1.1.2 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 of 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:

1. Resource selection mechanism for SL-PRS
2. Inter-UE coordination
3. 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:

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

##### 2.1.1.3 Decisions during RAN1#110bis-e

###### SL Positioning (LS responses):

**For response to SA2 LS in R1-2208338**

**Agreement**

The draft LS reply in R1-2210550 is endorsed.

LS reply to SA2 LS in R1-2208338 on terminology alignment for ranging/sidelink positioning is endorsed in R1-2210567.

###### Evaluation of SL Positioning:

**Observation**

The performance analysis for Rel-18 SL positioning shows that, with increasing of bandwidth of SL PRS, the positioning accuracy improves for both absolute positioning and relative positioning/ranging for all evaluated scenarios.

**Observation**

The performance analysis for Rel-18 SL positioning shows that different SL positioning methods can be used to determine absolute position of a target UE:

* Simulation results based SL-TDOA were provided in contributions from 10 sources ([Nokia 1], [OPPO 4], [CATT, GOHIGH 5], [Sony 6], [ZTE,CMCC 7], [Lenovo 9], [LG 10], [InterDigital 11], [Intel 15], [CEWiT 16])
* Simulation results based on SL-RTT (multi-RTT) were provided in contributions from 6 sources ([Huawei 2], [vivo 3], [LG 10], [InterDigital 11], [Qualcomm 14], [Samsung 12])
* Simulation results based on two anchors SL-AOA and single anchor SL-TOA+AOA were provided in contribution from 1 source ([Lenovo 9])

Note: at least the number of sources and the references can be further updated in next meeting depending on companies’ update of simulation results.

**Observation**

The performance analysis for Rel-18 SL positioning shows that, SL positioning methods can be used for relative positioning/ ranging between UEs. For relative positioning/ranging positioning accuracy,

* Simulation results based SL-RTT and/or AOA were provided in contributions from 10 sources ([Huawei 2], [vivo 4], [CATT, GOHIGH 5], [Sony 6], [ZTE, CMCC 7], [Xiaomi 8], [Lenovo 9], [LG 10], [Qualcomm 14], [Intel 15] )
* Results based SL-TDOA were provided in contribution from 1 source ([CEWiT 16])

Note: at least the number of sources and the references can be further updated in next meeting depending on companies’ update of simulation results.

**Observation**

For V2X use case in highway scenario, 13 sources ([Huawei 2], [vivo 3], [OPPO 4], [CATT,GOHIGH 5], [Sony 6], [ZTE,CMCC 7], [Lenovo 9], [LG 10], [Samsung 12], [Qualcomm 14], [Intel 15], [CEWiT 16], [Ericsson 17]) provide simulation results for FR1, and 1 source ([CEWiT 16]) provides simulation results for FR2.

* For absolute horizontal accuracy, the results were provided by 13 sources. 11 out of 13 sources show that, the target requirement set A can be achieved, and 9 out of 13 sources show that the target requirement set B cannot be achievable even by 100MHz.
  + The requirement 1.5m@90% (Set A)
    - is achieved with 20MHz bandwidth in contributions from 3 sources ([ZTE,CMCC 7], [Lenovo 9], [CEWiT 16]),
      * where SL ToA+AoA technique and optional antenna configuration is used in contribution from ([Lenovo 9])
    - and is achieved with at least 40MHz bandwidth in contributions from 4 sources ([Huawei 2], [CATT,GOHIGH 5], [LG 10], [Samsung 12]),
    - and is achieved with at least 100MHz bandwidth in contributions from 5 sources ([vivo 3], [OPPO 4], [Sony 6], [Lenovo 9], [Ericsson 17]),
      * where SL-TDOA technique is used in contribution from ([Lenovo 9])
    - and is NOT achieved with 100MHz bandwidth in contributions from 2 sources ([Qualcomm 14], [Intel 15])
  + The requirement 0.5m@90% (Set B)
    - is achieved with 40MHz in contribution from 1 source ([Samsung 12]),
    - and is achieved with at least100MHz in contributions from 3 sources ([Huawei 2], [CATT,GOHIGH 5], [ZTE,CMCC 7]),
      * where Joint Uu/SL positioning is used in contribution from ([ZTE,CMCC 7])
    - and is NOT achieved with100MHz bandwidth in FR1 or 400MHz in FR2 in contributions from 9 sources ([vivo 3], [OPPO 4], [Sony 6], [ZTE,CMCC 7], [Lenovo 9], [Qualcomm 14], [Intel 15], [CEWiT 16], [Ericsson 17]),
      * where SL-only positioning is used in contribution from ([ZTE,CMCC 7])
* For absolute vertical accuracy, the results were provided by 1 source out of 13 sources.
  + The requirement 3m@90% (Set A)
    - is achieved with at least 100MHz bandwidth in contribution from 1 source ([ZTE,CMCC 7])
  + The requirement 2m@90% (Set B)
    - is achieved with 100MHz bandwidth in contribution from 1 source ([ZTE,CMCC 7])
* For relative horizontal accuracy, the results were provided by 5 sources out of 13 sources. The performance of relative horizontal accuracy is worse than that of distance accuracy of ranging mainly due to additional angle estimation error. All 5 sources show Set B cannot be met even by 100MHz in the case without RSU-UE positioning.
  + The requirement 1.5m@90% (Set A)
    - is achieved with at least 40MHz bandwidth in contributions from 2 sources ([Huawei 2], [CATT,GOHIGH 5])
      * X = 20m in contribution from ([CATT,GOHIGH 5])
      * X = 50m in contribution from ([Huawei 2]) where RSU deployment is additionally used for performing relative positioning
    - and is achieved with at least 100MHz bandwidth in contributions from 3 source ([Huawei 2], [CATT,GOHIGH 5], [CEWiT 16])
      * X = 25m in contribution from ([CATT,GOHIGH 5])
      * X = 150m in contributions from ([Huawei 2], [CEWiT 16]), where BS or RSU deployment is additionally used for performing relative positioning
    - and is NOT achieved with 100MHz bandwidth in contributions from 4 sources ([Huawei 2], [vivo 3], [CATT,GOHIGH 5], [Sony 6])
      * X = 100m and 150m in contribution from ([CATT,GOHIGH 5])
      * X = 25m, 50m, and 100m in contribution from ([vivo 3])
      * X = 50m in contribution from ([Sony 6])
      * X = 50m and 150m in contribution from ([Huawei 2])
  + The requirement 0.5m@90% (Set B)
    - is achieved with at least 100MHz bandwidth in contributions from 1 source ([Huawei 2])
      * X = 50m in contribution from ([Huawei 2]) where RSU deployment is additionally used for performing relative positioning
    - is NOT achieved with 100MHz bandwidth in FR1 or 400MHz in FR2 in contributions from 5 sources ([Huawei 2], [vivo 3], [CATT,GOHIGH 5], [Sony 6], [CEWiT 16])
* For distance accuracy of ranging, the results were provided by 9 out of 13 sources. 5 of 9 sources show that the target requirement set A can be achievable by 20MHz, and 5 out of 9 sources show that the target requirement set B can be achievable by larger bandwidth, e.g. 40MHz or 100MHz, and 3 of 9 sources show that the target requirement set B cannot be achieved with 100MHz bandwidth.
  + The requirement 1.5m@90% (Set A)
    - is achieved with 20MHz bandwidth in contributions from 5 sources ([Huawei 2], [vivo 3], [CATT,GOHIGH 5], [ZTE,CMCC 7], [CEWiT 16])
      * X = 50m and 150 in contribution from ([Huawei 2])
      * X = 20m, 25m, 100m and 150m in contribution from ([CATT,GOHIGH 5])
      * X = 25m, 50m, and 100m in contribution from ([vivo 3])
      * X = 150m in contribution from ([CEWiT 16]), where RSU deployment is additionally used for performing distance ranging
      * X = 100m, 200m and 300m in contribution from ([ZTE,CMCC 7])
    - and is achieved with at least 40MHz bandwidth in contribution from 1 source ([LG 10])
      * X = 80m and 160m in contribution from ([LG 10])
    - and is achieved with at least 100MHz bandwidth in contributions from 4 sources ([Sony 6], [Lenovo 9], [Qualcomm 14], [Intel 15])
      * X = 50m in contribution from ([Sony 6])
      * X = 50m and 100m in contribution from ([Lenovo 9], [Intel 15])
      * X = 100 m in contribution from ([Qualcomm 14])
  + The requirement 0.5m@90% (Set B)
    - is achieved with at least 40MHz in contributions from 3 sources ([Huawei 2], [vivo 3], [CEWiT 16])
      * X = 50m in contribution from ([Huawei 2])
      * X = 25m, 50m, and 100m in contribution from ([vivo 3])
      * X = 150m in contribution from ([CEWiT 16]), where RSU deployment is additionally used for performing distance ranging
    - and is achieved with at least 100MHz in contributions from 4 sources ([Sony 6], [Huawei 2], [CATT,GOHIGH 5], [ZTE,CMCC 7])
      * X = 150m in contribution from ([Huawei 2])
      * X = 25m, 100m and 150m in contribution from ([CATT,GOHIGH 5])
      * X = 50m in contribution from ([Sony 6])
      * X = 100m in contribution from ([ZTE,CMCC 7]
    - and is NOT achieved with 100MHz bandwidth in contributions from 3 sources ([Lenovo 9], [Qualcomm 14], [Intel 15])
      * X = 50m and 100m in contribution from ([Lenovo 9], [Intel 15])
      * X = 100 m in contribution from ([Qualcomm 14])
* For angle accuracy of ranging, the results were provided by 6 sources out of 13 sources. All 6 sources show that both the target requirement set A and set B can be achieved by 20MHz or 40MHz.
  + The requirement 15°@90% (Set A)
    - is achieved with 20MHz bandwidth in contributions from 5 sources ([Huawei 2], [vivo 3] ,[CATT,GOHIGH 5], [Sony 6], [Lenovo 9]),
    - and is achieved with 40MHz bandwidth in contribution from 1 source ([ZTE,CMCC 7])
  + The requirement 8°@90% (Set B)
    - is achieved with 20MHz in contributions from 3 sources ([Huawei 2], [Sony 6], [Lenovo 9]),
    - and is achieved with at least 40MHz in contributions from 3 sources ([vivo 3], [CATT,GOHIGH 5], [ZTE,CMCC 7])
* Note: the above observations can be further updated in next meeting depending on companies’ new/update of simulation results, including editorial modifications, X values, replacing sources by references, additional sources and other revisions.
* Note: for each SL PRS bandwidth, the above observations are based on the best performance from each source.
* Note: for the relative positioning accuracy or distance accuracy of ranging, X is the maximum distance between UEs for performing relative positioning or ranging.
* Note: a list of the sources that used super resolution in the evaluations will be captured in the observations in next meeting.

**Observation**

For V2X use case in Urban grid scenario, 10 sources ([Huawei 2], [vivo 3], [OPPO, 4], [CATT,GOHIGH 5], [Sony 6], [ZTE,CMCC 7], [xiaomi 8], [Lenovo 9], [Intel 15], [CEWiT 16]) provide simulation results for FR1, and 1 source ([CEWiT 16]) provide simulation results for FR2.

* For absolute horizontal accuracy, the results were provided by 8 out of 13 sources. 5 out of 8 sources show that target requirements set A cannot be achieved, and 7 out of 8 sources show that target requirements set B cannot be achieved.
  + The requirement 1.5m@90% (Set A)
    - is achieved with 20MHz in contributions from 2 sources ([Lenovo 9], [CEWiT 16]),
      * where SL ToA+AoA technique and optional antenna configuration is used in contribution from ([Lenovo 9])
    - and is achieved with at least100MHz in contribution from 1 source ([ZTE,CMCC 7]),
    - and is NOT achieved with 100MHz bandwidth in contributions from 5 sources ([Huawei 2], [vivo 3], [OPPO, 4], [CATT,GOHIGH 5], [Intel 15])
  + The requirement 0.5m@90% (Set B)
    - is achieved with at least 100MHz in contribution from 1 source ([ZTE,CMCC 7]),
    - and is NOT achieved with 100MHz bandwidth in FR1 or 400MHz in FR2 in contributions from 7 sources ([Huawei 2], [vivo 3], [OPPO 4], [CATT,GOHIGH 5], [Lenovo 9], [Intel 15], [CEWiT 16])
* For Relative horizontal accuracy, the results were provided by 5 out of 13 sources. The performance of relative horizontal accuracy is worse than that of distance accuracy of ranging mainly due to additional angle estimation error. All 5 sources show that the target requirement set B is not achieved even by 100MHz. 3 sources show that the target requirement Set A can be achieved by 40MHz or 100MHz in case of X=10m.
  + The requirement 1.5m@90% (Set A)
    - is achieved with at least 40MHz bandwidth in contributions from 1 sources ([vivo 3])
      * only for the case of X = 10m and the relative positioning is performed with LOS link only in contribution from ([vivo 3])
    - and is achieved with at least100MHz bandwidth in contributions from 2 sources ([Huawei 2], [CATT,GOHIGH 5])
      * X = 10m in contributions from ([Huawei 2], [CATT,GOHIGH 5])
    - and is NOT achieved with 100MHz bandwidth in contributions from 5 sources ([vivo 3], [Huawei 2], [CATT,GOHIGH 5], [Sony 6], [CEWiT 16])
      * X = 50m in contribution from ([Huawei 2])
      * X = 25m in contribution from ([CATT,GOHIGH 5])
      * X = 30m in contribution from ([Sony 6])
      * X = 10m, 25m, and 50m in contribution from ([vivo 3])
  + The requirement 0.5m@90% (Set B)

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

**Agreement**

* With regards to the RTT-type solutions using SL, down-select between the following 2 alternatives:
  + Alt. 1: it corresponds to a single-sided RTT method
  + Alt. 2: it may correspond to either a single-sided or double-sided RTT method
    - With regards to the double-sided RTT,
      * companies are encouraged to analyze and evaluate the effect in performance for the single-sided SL RTT due to clock drift
      * Study the order of the SL-PRS transmissions for double-sided RTT
      * Study the impact of UE mobility
    - FFS study whether there is or what is the spec impact of double-sided RTT method
* Note: the above may correspond to RTT with one or multiple devices

**Agreement**

For the study of SL-AoA positioning method,

* Both SL Azimuth of arrival (AoA) and SL zenith of arrival (ZoA) measurement should be included
  + FFS: Definition of the measurements
* Study further whether other measurements can be applicable
* Study further the frame of reference (LCS or GCS)

**Agreement**

With regards to SL-TDOA positioning method for SL-only positioning,

* It corresponds to a method where SL-PRS is being transmitted from multiple anchor UEs to a target UE (i.e., DL-TDOA-like operation), and/or from a target UE to multiple anchor UEs (i.e. UL-TDOA-like operation) at least for the purpose of absolute positioning estimation of the target UE
* Study the detailed procedure, necessary signalling for SL-TDOA, method(s) to mitigate impact of synchronization error between multiple anchor UEs including whether such method(s) are needed.

**Agreement**

* From the potential candidate Positioning methods using at least SL measurements, at least the following should be introduced:
  + RTT-type solution(s) using SL
  + SL-AoA
  + SL-TDOA
* FFS: SL-AoD

**Agreement**

Regarding Scheme 1 SL-PRS resource allocation, a transmitting UE receives a SL-PRS resource allocation signaling from the network. Consider one or more of the following options:

* Opt. 1: through higher layers from the LMF
* Opt. 2: through Dynamic grant, or through configured grant type 1/type 2 from gNB
  + Up to further discussion which one or more of these shall be applicable

**Agreement**

For the sequence of the new reference signal for SL positioning/ranging, use

* Alt. 1: pseudorandom-based. Use existing sequence of DL-PRS as a starting point.

**Agreement**

From RAN1 perspective, the following cast types of SL-PRS transmission can be introduced for SL positioning: Unicast, Groupcast (not including many to one)

* Broadcast (as a working assumption).
* FFS: Applicability of the above cast types

**Agreement**

With regards to the frequency and time a slot has the following characteristics:

* With regards to the value N (comb size) and the number M of SL-PRS symbols within a slot *excluding* the symbol(s) used for AGC training / RxTx Turnaround:
  + At least the following values are considered as potential candidate values: N = {1,2,4,6,8,12}
  + FFS: the values considered as potential candidate values for M
  + FFS1: Whether to consider N>12 as a potential candidate value(s)
* The symbols of a SL-PRS resource within a slot are consecutive symbols
  + FFS: consecutive and/or non-consecutive symbols for shared resource pool (if supported)
* FFS: RE-Offset sequence within a SL-PRS resource, including whether to have in the end of the SL-PRS pattern a symbol with the same RE-offset as the first symbol, for phase-tracking purpose

**Agreement**

For a dedicated resource pool for SL positioning,

* With regards to which channels can be included in the resource pool in addition to SL-PRS, consider the following options:
  + Opt. 1: No other channel can be included beyond SL-PRS
  + Opt. 2: PSCCH which carries SCI associated with SL-PRS transmission(s) is included
  + Opt. 3: PSCCH which carries SCI associated with SL-PRS transmission(s) and PSSCH associated with SL-PRS transmission(s) are included
    - FFS: Details
    - FFS: definition of PSSCH associated with SL-PRS transmission(s)
* Note: Companies are encouraged to provide their analysis and views on the above

**Agreement**

With regards to the SL Positioning resource allocation, for SL Positioning resource (pre-)configuration in a shared resource pool with Rel-16/17/18 sidelink communication (if supported), backward compatibility with legacy Rel-16/17 UEs should be ensured.

**Agreement**

With regards to SL signaling of the reservation/indication of SL-PRS resource(s) for dedicated resource pool and shared resource pool (if supported) for positioning:

* Option A.1: SCI can be used for reserving/indicating one or more SL-PRS resource(s)
  + Note: This does NOT mean that only SCI is being used. There can still be higher layer signaling for the purpose of indicating a part of SL-PRS configuration.
  + FFS: Whether SCI is single stage SCI or two stage SCI
* FFS: SL-MAC-CE or other higher-layer signaling reservation/indication

**Agreement**

With regards to the Positioning methods supported using SL-PRS measurements

* at least the following measurements are considered:
  + SL Rx-Tx measurement
  + SL RSTD measurement
  + SL RSRP measurement
  + SL RSRPP measurement
  + SL RTOA measurement
  + SL Azimuth of arrival (AoA) and SL zenith of arrival (ZoA) measurement
* Companies are encouraged to study other measurements (e.g., time difference of arrival of 2 SL-PRS transmitted at 2 different times from the same anchor) and provide their analysis into why they are needed in light of the above measurements.
* Companies are encouraged to study potential enhancements, such as SL Rx-Tx measurement not being reported but the transmit time of SL-PRS being adjusted based on the measurement
* FFS any additional measurements

**Agreement**

At least for a dedicated resource pool for positioning,

* With regards to the bandwidth of SL-PRS transmission, downselect from the following alternatives:
  + Alt. 1: The bandwidth of SL-PRS can be same or smaller than that of the resource pool
  + Alt. 2: The bandwidth of SL-PRS shall be the same as that of the resource pool
* Note: Companies are encouraged to provide their analysis and views on the above alternatives
* FFS: Bandwidth of SL-PRS transmission for shared resource pool (if supported)

**Agreement**

Study further the granularity of time-domain resource allocation for SL-PRS transmission.

**Agreement**

With regards to the SL-PRS time domain behavior, at least study the following behaviors from Tx UE perspective:

* Periodic SL-PRS
  + SL-PRS is transmitted periodically with a transmission periodicity
  + FFS: any additional details, including whether or not higher layers can start/stop transmission.
* Semi-persistent SL-PRS
  + SL-PRS is transmitted periodically with a transmission periodicity after activation and until deactivation
  + FFS: any additional details
* Aperiodic SL-PRS
  + SL-PRS is transmitted at least once after [triggering/request]
    - Note: the brackets in the above means that companies are encouraged to study further whether “triggering” and/or “request” should be used and provide their definitions.
  + FFS: any additional details
* FFS: Applicability of the above time behaviors for scheme 1 & scheme 2
* FFS: Rx UE behavior is separately discussed.
* FFS: What mechanism(s) are used for activation/deactivation/triggering is part of the study

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

**Agreement**

* The following distributions are identified as candidates for modeling of the distribution for inter-TRP synchronization error (e.g., NR-RTD-Info in TS 37.355)
  + Uniform distribution
    - Note: this may already be consistent with the existing parameter NR-RTD-Info in TS 37.355
  + Normal distribution
* Note: it is up to RAN2 how to use the identified distributions

**Agreement**

* For LMF-based positioning integrity mode, TRP location (e.g., Geographical Coordinates in TS 38.455) is an error source for DL-TDOA, DL-AoD, UL-TDOA, UL-AoA and multi-RTT.
  + Note: Definition of “LMF-based positioning integrity mode” can be found in Table 9.4.1.1.1 in TR 38.857
  + FFS: Specification impact of TRP location as an error source for LMF-based positioning integrity mode
  + FFS: Model of the error source (e.g., distribution, mean and/or standard deviation for integrity)

**Agreement**

* Study the following alternatives for expression of angle of arrival measurement error for determination of positioning integrity for UL-AoA, and down select between Alt 1 and Alt 2:
  + Alt. 1: No conversion (e.g., the measurement error is expressed as error in AoA or ZoA in LCS/GCS)
  + Alt. 2: conversion function (defined function of AoA/ZoA in LCS)
* FFS: Distribution of AoA measurement error for an NLOS/LOS link
* FFS: Other Details (e.g., mean, standard deviation)

**Agreement**

* Timing measurement error can be modeled as Normal distribution.
  + Note: The timing measurement is applicable to RSTD, RTOA and UE/gNB Rx-Tx time difference measurement
  + Note: it is assumed that the timing measurement error is associated with the first path
* Note: it is up to RAN2 how to use the identified distribution

**Agreement**

Capture the following into the TR

* For UE-based positioning integrity mode, potential specification impacts related to errors in assistance data (e.g., to inter-TRP synchronization error and TRP locations) are at least enhancements in assistance data sent from the LMF to the UE (e.g., inclusion of parameters related to the error sources)
  + Note: Definition of “UE-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, study whether boresight direction of DL PRS (NR-DL-PRS-BeamInfo) and/or beam information (NR-TRP-BeamAntennaInfo) of DL PRS are error sources or not, focusing on the following aspects:
  + Granularity of boresight direction of DL-PRS and its influence on positioning integrity
  + Feasibility and complexity of modeling
  + Feasibility of obtaining quality/statistical parameters of beam information from the gNB
  + Influence on measurement errors at the UE
* Other aspects are not precluded
* Note: Definition of “UE-based positioning integrity mode” can be found in Table 9.4.1.1.1 in TR 38.857

**Agreement**

* From RAN1 perspective, study of the application of DNU flag for determination of positioning integrity is within the scope of RAN2 discussion.

**Agreement**

* The following distributions are identified as candidates for modeling of the distribution for TRP location (e.g., NR-TRP-LocationInfo in TS 37.355) error
  + Uniform distribution
    - Note: this may already be consistent with the uncertainty related to NR-TRP-LocationInfo specified in TS 37.355
  + Normal distribution
* Note: it is up to RAN2 how to use the identified distributions

**Agreement**

* In the agreement on the distribution of the timing measurement error, it is assumed that the timing measurement error contains TEG related TX/RX timing error if the TEG related information is provided.
  + Note: The timing measurement is applicable to RSTD, RTOA and UE/gNB Rx-Tx time difference measurement
  + Note: it is assumed that the timing measurement error is associated with the first path
* Note: no more discussion on TEG related TX/RX timing error as an independent error source from timing measurement error

**Agreement**

* Study to determine whether DL PRS RSRP/RSRPP measurement is an error source for DL-AoD, focusing at least on the following aspect
  + Impact of RSRP/RSRPP measurement on positioning accuracy
* FFS: Model of the error source (e.g., distribution, mean and/or standard deviation for integrity overbounding model, range)

**Agreement**

* Study to determine whether SFN initialization time is an independent error source for the following positioning methods and integrity mode
  + UL-TDOA with LMF-based positioning integrity mode
  + UE-assisted DL-TDOA with LMF-based positioning integrity mode
* 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

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

**Agreement**

The existing DL PRS and UL SRS for positioning can be re-used as the reference signals to enable positioning based on NR carrier phase measurements for both UE-based and UE-assisted positioning.

* FFS: Whether to consider enhancements of the existing DL PRS and UL SRS for better positioning performance

**Agreement**

For UE-assisted NR carrier phase positioning, at least consider the following options

* the difference between the carrier phase measured from the DL PRS signal(s) of the target TRP and the carrier phase measured from the DL PRS signal(s) of the reference TRP.
* the carrier phase measured from the DL PRS signal(s) of a TRP

**Agreement**

Make the following modification to the previous agreement on the initial phase model with an additional note:

1. In the evaluation of NR carrier phase positioning, ~~the offset between~~ both the initial phase of the transmitter and the initial phase of the receiver can be modeled as ~~a~~ independent random variables uniformly distributed within [0, ~~X~~2pi].
2. Note: The initial phase of a transmitter applies to all subcarriers of the same carrier frequency associated with the transmitter, and the initial phase of a receiver applies to all subcarriers of the same carrier frequency associated with the receiver.

[**R1-2210268**](file:///C:\Users\dchatt2\OneDrive%20-%20Intel%20Corporation\Documents\work\3gpp\RAN1\Contribution%20reviews\RAN1_110bE_review\allTdocs_R1-110bE\R1-2210268.zip) FL Summary #2 for improved accuracy based on NR carrier phase measurements Moderator (CATT)

**Agreement**

Further study the benefits of using the carrier phase measurements of multiple DL positioning frequency layers for NR carrier phase positioning, which may include the impact of the time gap between the carrier phase measurements of multiple DL PFLs.

* Note 1: The initial phase error and the frequency error for each PFLs can be modelled independently
* Note 2: For the evaluation, the PRS signals of all PFLs of a TRP can be assumed to be transmitted from the same ARP or from different ARPs of the TRP.
* Note 3: The location error for ARPs can be modelled independently.
* Note 4: The timing errors of the PFLs may not be the same for PFLs in different bands or frequency ranges.
* Note 5: In Rel-17, simultaneous reception of DL PRS from multiple frequency layers is not supported

**Agreement**

For UL UE-assisted NR carrier phase positioning, at least consider the carrier phase measured from the UL SRS for positioning purpose.

* Note: The use of MIMO SRS for positioning purpose is transparent to UE.

**Agreement**

Capture the following TP into TR 38.859 as a conclusion (for Section 6.3.1):

* The impact of multipath/NLOS on NR carrier phase positioning is evaluated during the study item. Based on the study, it is concluded that multipath/NLOS deteriorates the performance of carrier phase positioning and it is necessary to consider multipath mitigation for NR carrier phase positioning.
* The evaluation results for the impact of the multipath/NLOS on NR carrier phase positioning will be presented in Section 6.3.2.

**Agreement**

Add the following note to the previous agreement on error modelling of the initial phase:

* Note: The initial phases of a transmitter for different carriers can be assumed to be independent of each other. Similarly, the initial phases of a receiver for different carriers can be assumed to be independent of each other.

**Agreement**

Add a row of "PRU assumptions" in Table B.4.X.1-1: NR carrier phase positioning enhancements – evaluation scenarios and parameters” in Draft TR 38.859.

* Note: PRU deployment assumptions may include the assumptions of the number of PRUs, the PRU locations and location errors etc.

**Agreement**

Capture the following TP into TR 38.859 as an evaluation observation:

The impact of the initial phases of the transmitter and the receiver on NR carrier phase positioning is evaluated in the study item. The evaluation results from the sources (e.g., Huawei[1], vivo[2], CATT[6], ZTE[9]) show that if the initial phases of the transmitter and the receiver are not eliminated, it is impossible to support centimeter-accuracy positioning.

The effectiveness of using double differential technique with PRU to eliminate the impact of the initial phases of the transmitter and the receiver on NR carrier phase positioning are evaluated in the study item. The evaluation results from the sources (Huawei[1], CATT[6], ZTE[9], Ericsson [23]) show that the initial phases of the transmitter and the receiver can be removed effectively by the double differential technique with the use of the PRU:

1. Source [Huawei, 1] shows the positioning accuracy of <1cm (80%) for Inf-SH and < 1cm (50%) for Inf-DH can be reached when the PRU is located within a distance of 5m from the target UE.
2. Source [CATT, 6] shows the positioning accuracy of <1cm (80%) for Inf-SH and <1cm (50%) for Inf-DH can be reached under the under condition that the PRU is located a fixed location in LOS of the TRP.
3. Source [Ericsson 23] shows that the accuracy of <1cm (50%) when the PRU is located within 1m of the target UE. However, the effectiveness reduces when the PRU is located away from the target UE because the channel conditions of the PRU is different from the target UE.
4. Note: in the above results, all other error sources (except initial phase error) were not modelled.

(Not captured in TR) Note: The number of sources and the references, and the observations, can be further updated in next meeting depending on companies’ updates of simulation results.

**Agreement**

Capture the following TP into TR 38.859 as an evaluation observation (for Section 6.3.2):

The impact of the residual CFOs of the transmitter and the receiver on NR carrier phase positioning are evaluated during the study item.

1. The evaluation results from the sources (Huawei[1], ZTE[9]) shows the impact of residual CFOs on carrier phase positioning is negligible.
2. The evaluation results from the source (CATT[4]) shows the impact of the residual CFOs on the positioning performance of carrier phase positioning is removed with the use of the double differential technique with the PRU that is located a fixed location in LOS of the TRP.

(Not captured in TR) Note: The number of sources and the references, and the observations, can be further updated in next meeting depending on companies’ updates of simulation results.

**Agreement**

Capture the following TP into TR 38.859 (Section 6.3.1):

1. The use of the positioning reference unit (PRU) to facilitate NR carrier phase positioning has been studied during the study item.

For DL NR carrier phase positioning, the PRU works as a UE to receive the DL PRS reference signals and provide the DL carrier phase measurements to the LMF, where the double differential measurements can be obtained by the difference of the DL carrier phase measurements from the target UE and those from the PRU for eliminating the measurement errors.

For UL NR carrier phase positioning, the PRU works as a UE to transmit the UL SRS signals for positioning purpose. The TRPs provides the UL carrier phase measurements obtained from the UL SRS signals of the target UE and of the PRU to the LMF, where the double differential measurements can be obtained by the difference of these UL carrier phase measurements for eliminating the measurement errors.

**Agreement**

Further study the effectiveness of the following multipath mitigation methods for the carrier phase positioning and the potential on the standard work:

1. Identify and separate the first path and other paths.
2. Reporting of the carrier phase of the first path, and optionally, the additional paths.
3. The use of LOS/NLOS indication for the carrier phase measurements.

Note: Rel-17 LOS/NLOS indicator can be considered as a starting point.

1. The report of other channel information, such as RSRP/RSRPP.

**Agreement**

Further study the following approaches for NR carrier phase positioning, and identify the potential impact on the standard.

1. the reporting of the carrier phase measurements together with the existing positioning measurements.
2. the reporting of the carrier phase-based measurements alone without reporting the existing positioning measurements.

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

**Conclusion**

* From evaluations for a LPHAP device, RAN1 concludes that the existing Rel-17 positioning for UEs in RRC\_INACTIVE state cannot satisfy the target battery life required by LPHAP use case 6 in the majority of the evaluation scenarios that were examined.
* Based on the evaluations, enhancements to meet the target battery life in Rel-18 are necessary.

**Observation**

Capture the following in TR as an observation:

* For the evaluation on the battery life of the baseline LPHAP Type A device with battery capacity C2 of 800mAh:
  + Based on the results provided by all sources, the target requirement of 6~12 months is not achieved by the existing Rel-17 positioning for UEs in RRC\_INACTIVE state with baseline implementation factor K = 1 and baseline evaluation assumptions;
  + Based on the results provided by all sources, the target requirement of 6~12 months is not achieved by the existing Rel-17 positioning for UEs in RRC\_INACTIVE state with optional implementation factor K or optional evaluation assumptions;
  + For UE-assisted DL positioning, results are provided by 13 sources ([2/HW,Hisilicon], [4/Spreadtrum], [5/vivo], [6/Nokia,NSB], [8/CATT], [10/Sony], [11/ZTE], [12/xiaomi], [13/CMCC], [16/Samsung], [18/LGE], [20/Qualcomm], [21/Ericsson]) out of 20 sources, and the following is observed:
    - The target requirement of 6 months is achieved by 0 source, and is not achieved by 13 sources ([2],[4],[5],[6],[8],[10],[11],[12],[13],[16],[18],[20],[21]) even with the most power efficient case that I-DRX cycle of 10.24s, 1 RS per 1 I-DRX cycle, high SINR, CG-SDT for measurement reporting, and implementation factor K = 4.
    - The target requirement of 12 months is achieved by 0 source, and is not achieved by 13 sources ([2],[4],[5],[6],[8],[10],[11],[12],[13],[16],[18],[20],[21]) even with the most power efficient case that I-DRX cycle of 10.24s, 1 RS per 1 I-DRX cycle, high SINR, CG-SDT for measurement reporting, and implementation factor K = 4
  + For UE-based DL positioning, results are provided by 10 sources ([2/HW,Hisilicon], [4/Spreadtrum], [5/vivo], [6/Nokia,NSB], [8/CATT], [11/ZTE], [12/xiaomi], [13/CMCC], [18/LGE], [20/Qualcomm]) out of 20 sources, and the following is observed:
    - The target requirement of 6 months is achieved by 0 source, and is not achieved by 10 sources ([2],[4],[5],[6],[8],[11],[12],[13],[18],[20]) even with the most power efficient case that I-DRX cycle of 10.24s, 1 RS per 1 I-DRX cycle, high SINR, and implementation factor K = 4.
    - The target requirement of 12 months is achieved by 0 source, and is not achieved by 10 sources ([2],[4],[5],[6],[8],[11],[12],[13],[18],[20]) even with the most power efficient case that I-DRX cycle of 10.24s, 1 RS per 1 I-DRX cycle, high SINR, and implementation factor K = 4.
  + For UL positioning, results are provided by 12 sources ([2/HW,Hisilicon], [4/Spreadtrum], [5/vivo], [6/Nokia,NSB], [8/CATT], [11/ZTE], [12/xiaomi], [13/CMCC], [16/Samsung], [18/LGE], [20/Qualcomm], [21/Ericsson]) out of 20 sources, and the following is observed:
    - The target requirement of 6 months is achieved by 0 source, and is not achieved by 12 sources ([2],[4],[5],[6],[8],[11],[12],[13],[16],[18],[20],[21]) even with the most power efficient case that I-DRX cycle of 10.24s, 1 RS per 1 I-DRX cycle, high SINR, no SRS (re)configuration, and implementation factor K = 4.
    - The target requirement of 12 months is achieved by 0 source, and is not achieved by 12 sources ([2],[4],[5],[6],[8],[11],[12],[13],[16],[18],[20],[21]) even with the most power efficient case that I-DRX cycle of 10.24s, 1 RS per 1 I-DRX cycle, high SINR, no SRS (re)configuration, and implementation factor K = 4.
  + For DL+UL positioning, results are provided by 1 source ([20/Qualcomm]) out of 20 sources, and the following is observed:
    - The target requirement of 6 months is achieved by 0 source, and is not achieved by 1 source ([20]) even with the most power efficient case that I-DRX cycle of 10.24s, 1 RS per 1 I-DRX cycle, high SINR, no SRS (re)configuration, CG-SDT for measurement reporting, and implementation factor K = 4.
    - The target requirement of 12 months is achieved by 0 source, and is not achieved by 1 source ([20]) even with the most power efficient case that I-DRX cycle of 10.24s, 1 RS per 1 I-DRX cycle, high SINR, no SRS (re)configuration, CG-SDT for measurement reporting, and implementation factor K = 4.
* For the evaluation on the battery life of the optional LPHAP Type B device with battery capacity C2 of 4500mAh:
  + Based on the results provided by all sources, the target requirement of 6~12 months is not achieved by the existing Rel-17 positioning for UEs in RRC\_INACTIVE state with the baseline implementation factor K=1 and baseline evaluation assumptions;
  + For UE-assisted DL positioning, results are provided by 8 sources ([4/Spreadtrum], [5/vivo], [6/Nokia,NSB], [10/Sony], [11/ZTE], [13/CMCC], [18/LGE], [20/Qualcomm]) out of 20 sources, and the following is observed:
    - The target requirement of 6 months is achieved by 4 sources ([4],[6],[13],[20]) with the implementation factor K = 4 and by 2 sources ([11],[18]) with the implementation factor K >= 2, and is not achieved by 6 sources with the implementation factor K < 4 ([4],[5],[6],[10],[13],[20]) and by 2 sources ([11],[18]) with the implementation factor K < 2;
    - The target requirement of 12 months is achieved by 3 sources ([11],[18],[20]) with the case that I-DRX cycle of 10.24s, 1 RS per 1 I-DRX cycle, high SINR, CG-SDT for reporting and implementation factor K = 4, and is not achieved by 8 sources ([4],[5],[6],[10],[11],[13],[18],[20]) with the implementation factor K < 4.
  + For UE-based DL positioning, results are provided by 7 sources ([4/Spreadtrum], [5/vivo], [6/Nokia,NSB], [11/ZTE], [13/CMCC], [18/LGE], [20/Qualcomm]) out of 20 sources, and the following is observed:
    - The target requirement of 6 months is achieved by 4 sources ([4],[6],[13],[20]) with the implementation factor K = 4 and by 2 sources ([11],[18]) with the implementation factor K >= 2 , and is not achieved by 5 sources with the implementation factor K < 4 ([4],[5],[6],[13],[20]) and by 2 sources ([11],[18]) with the implementation factor K < 2;
    - The target requirement of 12 months is achieved by 3 sources ([11],[18],[20]) with the case that I-DRX cycle of 10.24s, 1 RS per 1 I-DRX cycle, high SINR, and implementation factor K = 4, and is not achieved by 7 sources ([4],[5],[6],[11],[13],[18],[20]) with the implementation factor K < 4.
  + For UL positioning, results are provided by 7 sources ([4/Spreadtrum], [5/vivo], [6/Nokia,NSB], [11/ZTE], [13/CMCC], [18/LGE], [20/Qualcomm]) out of 20 sources, and the following is observed:
    - The target requirement of 6 months is achieved by 4 sources ([4],[6],[13],[20]) with the implementation factor K = 4 and by 2 sources ([11],[18]) with the implementation factor K >= 2, and is not achieved by 5 sources ([4],[5],[6],[13],[20]) with the implementation factor K < 4 and by 2 sources ([11],[18]) with the implementation factor K < 2;
    - The target requirement of 12 months is achieved by 3 sources ([11],[18],[20]) with the case that I-DRX cycle of 10.24s, 1 RS per 1 I-DRX cycle, high SINR, no SRS (re)configuration, and implementation factor K = 4, and is not achieved by 7 sources ([4],[5],[6],[11],[13],[18],[20]) with the implementation factor K < 4.
  + For DL+UL positioning, results are provided by 1 source ([20/Qualcomm]) out of 20 sources, and the following is observed:
    - The target requirement of 6 months is achieved by 1 source ([20]) with implementation factor K = 4, and is not achieved by 1 source ([20]) with implementation factor K < 4;
    - The target requirement of 12 months is achieved by 1 source ([20]) with the case that I-DRX cycle of 10.24s, 1 RS per 1 I-DRX cycle, high SINR, no SRS (re)configuration, CG-SDT for measurement reporting, and implementation factor K = 4, and is not achieved by 1 source ([20]) with implementation factor K < 4.
* Note: The implementation factor K is a factor related to the reference device in the model to convert the relative power unit to the battery life. Four values are introduced for K with K = 1 as the baseline and K = 0.5, 2, 4 as optional values. The model is captured in the Annex A.4.
* Note: Without otherwise noted, “high SINR” in the observation refers to the evaluation case that no intra-/inter-frequency RRM and single SSB for synchronization purpose is considered.
* (Not captured in TR) Note: The number of sources and the references can be further updated in next meeting depending on companies’ updates of simulation results.

Chair’s note: references in the above observation are from [R1-2209345](file:///C:\Users\dchatt2\OneDrive%20-%20Intel%20Corporation\Documents\work\3gpp\RAN1\Contribution%20reviews\RAN1_110bE_review\allTdocs_R1-110bE\R1-2209345.zip)**.**

**Conclusion**

* Evaluations show that UE (re)entering RRC\_CONNECTED state to obtain SRS (re)configuration increases power consumption;
* Note: This intermediate conclusion may be updated before capturing it in the TR if new/different evaluations are provided and to add information about the number of sources.

**Agreement**

* For UL and DL+UL positioning for UEs in RRC\_INACTIVE, study the potential benefits and performance gains of enhancements on SRS for positioning in order to avoid frequent SRS (re)configuration, including at least the following:
  + The (pre-)configuration of SRS for positioning. FFS details, e.g., signaling and procedure, whether/how it is applicable to an area across multiple cells, consideration of UL overhead/capacity implied by (pre-)configuration and multiple cells, etc;
  + SRS for positioning activation/request procedure(s), e.g., network activation of SRS via paging, UE request to obtain/update SRS via RACH-based procedure;
    - FFS: Events of invalidity of SRS configuration to trigger the UE request procedure.
  + FFS whether it is applicable to UEs in RRC\_IDLE state.

**Conclusion**

* Evaluations show that extending paging DRX cycles beyond 10.24s provide power saving gains with respect to that with the baseline DRX cycle of 1.28s and is beneficial towards meeting the battery life requirement
* Note: This intermediate conclusion may be updated before capturing it in the TR if new/different evaluations are provided and to add information about the number of sources and to show the achievable gains.

**Conclusion**

* Evaluations show that minimizing gaps between PRS/SRS/paging/reporting/synchronization RS reduces the power consumption;
* Note: This intermediate conclusion may be updated before capturing it in the TR if new/different evaluations are provided and to add information about the number of sources.

**Agreement**

For the LPHAP study only:

* For the power consumption model of the ultra-deep sleep type, adopt the following option (i.e. revision of option 1 from previous agreement):
  + The relative power unit: 0.015
  + Additional transition energy: 10000
    - Note: Power consumption analysis from individual companies with additional transition energy of 5000 can be optionally evaluated and captured in the TR.
  + Total transition time: 400ms
* Note: Power consumption analysis from individual companies with Option 2 (revised from previous agreement) can be optionally evaluated and captured in the TR.
  + Option 2 additional transition energy is revised from 450 to 480.
* Note: No new device type is expected based on ultra-deep sleep power modeling.

###### Positioning for RedCap UEs:

**Observation**

Capture the following observations in the TR, regarding the baseline performance for positioning of Redcap UEs for IIOT scenarios:

* Based on the results provided by a majority of X sources, for InF-SH in FR1, the horizontal positioning requirement for IIOT use cases is not achieved by Rel.17 solutions using 5MHz or 20MHz of bandwidth.
  + Sources in R1-2208457, R1-2210179 show that UL TDOA cannot meet the requirement
  + Sources in R1-2209994, R1-2210179 show that multi-RTT cannot meet the requirement
  + Sources in R1-2208803, R1-2208985, R1-2209061, R1-2209108, R1-2209153, R1-2209217, R1-2209491, R1-2209740, R1-2210179 show that DL-TDOA cannot meet the requirement
  + Source in R1-2208652 shows that the requirement can be met using 20MHz of bandwidth.
  + Source in R1-2208652 shows that the requirement cannot be met using 5MHz of bandwidth.
* Based on the results provided by a majority of X sources, for InF-SH in FR2, the horizontal positioning requirement for IIOT use cases is achieved by Rel.17 solutions using 100MHz of bandwidth.
  + Sources in R1-2209994 show that multi-RTT can meet the requirement
  + Sources in R1-2209217 show that DL-TDOA can meet the requirement
* Based on the result provided by the following source, for InF-DH in FR1, the horizontal positioning requirement for IIOT use cases is not achieved by Rel.17 solutions using 20MHz of bandwidth.
  + Source in R1-2209108 show that the requirements for IIOT use cases cannot be met for InF-DH.
* Note: Editorial modifications and addition of references for the sources may be added by the rapporteur when capturing the agreement in the TR, including replacing sources by references and providing the number of sources in the main bullet points, and including additional sources and other revisions

**Observation**

Capture the following observations in the TR, regarding the baseline performance for positioning of Redcap UEs for commercial scenarios

* Based on the results provided by R1-2208457, for Umi in FR1, the horizontal positioning requirement for commercial use cases is not achieved by Rel.17 solutions using 20MHz of bandwidth and UL-TDOA.
* Based on the results provided by R1-2209740, for Umi in FR1, the horizontal positioning requirement for commercial use cases is not achieved by Rel.17 solutions using 20MHz of bandwidth and DL-TDOA.
* Based on the results provided by R1-2209994, for Umi in FR1, the horizontal positioning requirement for commercial use cases is not achieved by Rel.17 solutions using 20MHz or 5 MHz of bandwidth and multi-RTT.
* Note: Editorial modifications and addition of references for the sources may be added by the rapporteur when capturing the agreement in the TR, including replacing sources by references and providing the number of sources in the main bullet points, and including additional sources and other revisions.

**Observation**

Capture the following observations in the TR:

Regarding the performance for positioning of Redcap UEs using frequency hopping in IIoT scenarios, considering phase offset between hops:

* In FR1, based on the results provided by the following sources,
  + if the phase offset between hops in Frequency hopping is compensated, for InF SH the positioning requirement for IIOT use cases can be achieved using frequency hopping with partial overlap for the purpose of phase offset compensation,
    - Sources in R1-2208457 show that UL TDOA can meet the requirements
    - Sources in R1-2208457, R1-2209217, show that DL TDOA can meet the requirements
    - Sources in R1-2208652, show that the requirement cannot be met, even if the phase is compensated.
  + If the phase offset between hops in Frequency hopping is not compensated
    - Sources in R1-2209217 show that DL TDOA can meet the requirements if the random phase offset is set to be smaller than 0.5\*2π.
  + If the phase offset is ideally compensated
    - Sources in R1-2208652, show that DL TDOA can meet the requirements
* In FR2, based on the results provided by the following sources,
  + R1-2209994 observed that the requirements can be met even if the phase is not compensated
  + R1-2209217 observed that PRS frequency hopping can improve positioning performance if the random phase between hops can be adjusted in FR2, InF-SH scenario.
* Note: Sources used different combinations of number of hops, gap size between hops and partial overlap sizes in their evaluations
* Note: Editorial modifications and addition of references for the sources may be added by the rapporteur when capturing the agreement in the TR, including replacing sources by references and providing the number of sources in the main bullet points, and including additional sources and other revisions.

**Observation**

Capture the following observations in the TR:

Regarding the performance for positioning of Redcap UEs using frequency hopping in commercial scenarios, considering phase offset between hops:

* In FR1, based on the results provided (R1-2208457, R1-2209994), for the UMi positioning requirement for commercial use cases, positioning accuracy improvement is observed by X sources when the phase offset between hops in Frequency hopping is considered, if frequency hopping with partial overlap for the purpose of phase offset compensation is used, and if the phase offset is compensated.
  + Source in R1-2208457 shows that positioning accuracy improvement is observed with UL TDOA with phase offset compensation but requirements are not met
  + Source in R1-2208457 shows that positioning accuracy improvement is observed with DL TDOA with phase offset compensation but requirements are not met
  + Source in R1-2209994 shows that positioning accuracy improvement is observed with Multi RTT with phase offset compensation but requirements are not met
* Note: Sources used different combinations of number of hops, gap size between hops and partial overlap sizes in their evaluations
* Note: Editorial modifications and addition of references for the sources may be added by the rapporteur when capturing the agreement in the TR, including replacing sources by references and providing the number of sources in the main bullet points, and including additional sources and other revisions.

**Agreement**

For the evaluation of TX/RX frequency hopping for positioning of redcap UEs, the value of the gap between two consecutive hops includes at least from 100us to 5ms.

* Companies should indicate if other smaller values are used in their evaluations, and justify the feasibility of smaller values

**Agreement**

Study the potential enhancement of the UL SRS for positioning to enable Tx frequency hopping, including but not limited to partial overlapping between hops, hopping bandwidth, time gap between frequency hopping.

**Agreement**

Study the potential enhancement of the DL PRS to enable Tx or Rx frequency hopping, including but not limited to impact on processing capability, hopping bandwidth in the positioning frequency layer, time gap between frequency hopping, measurement period, partial overlapping between hops.

**Agreement**

For the evaluation of TX/RX frequency hopping for positioning of redcap UEs, the value of UE speed includes 3 km/h, 30 km/h, 60km/h.

* Other values are not precluded

**Conclusion**

The evaluation results for positioning for RedCap UEs using carrier phase measurements can be captured in the TR to show whether target requirement of positioning for RedCap UEs can be met or not, but any non-RedCap-specific enhancements regarding CPP should be studied under AI 9.5.2.2 in Rel-18.

* For the modelling of error sources specific to carrier phase measurements, the evaluations assumptions agreed in AI 9.5.2.2 are reused.
* Note: Phase-difference AoD can be included in the evaluations. Support of Phase-difference AoD for CPP should be discussed under AI 9.5.2.2.

##### 2.1.1.4 Decisions during RAN1#111

###### SL Positioning (LS responses and Bandwidth requirements for SL positioning):

**For response to SA2 LS in R1-2210821**

**Agreement**

RAN1 provides the following feedback on issue 6 with a copy of the 3 RAN1 agreements below:

“RAN1 has agreed to introduce UE autonomous SL-PRS resource allocation (e.g. similar to legacy Mode 2 solution), which can be used in out-of-coverage area. The details are still under discussion in RAN1.”, and include the following RAN1 existing agreements into the reply LS.

|  |
| --- |
| **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   **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**  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**

**RAN1 provides the following feedback on issue 3:**

“RAN1 assumes that any distinction between Assistant UE and anchor UE is transparent to RAN1. The anchor UE selection/reselection have not been discussed in RAN1. Whether/how physical layer measurement results will be used for determination of using assistant UE and the assistant UE selection/reselection will not be discussed in RAN1.”

**Agreement**

The draft LS in [R1-2212782](file:///C:\Users\dchatt2\OneDrive%20-%20Intel%20Corporation\Documents\work\3gpp\RAN1\Contribution%20reviews\RAN1_111_review\allTdocs_R1-111\R1-2212782.zip) is endorsed.

Final LS reply to SA2 on RAN dependency for Ranging/Sidelink Positioning is agreed in [R1-2212926](file:///C:\Users\dchatt2\OneDrive%20-%20Intel%20Corporation\Documents\work\3gpp\RAN1\Contribution%20reviews\RAN1_111_review\allTdocs_R1-111\R1-2212926.zip).

**For response to SA2 LS in R1-2210824**

**Agreement**

* Regarding SA2’s conclusion on PRU, suggest providing the following modification:
* “Based on that information, the PRU could be selected by an LMF to obtain measurements of RAN nodes, or to transmit the reference signals for positioning on Uu and possibly PC5, to help improve location accuracy for all UEs and/or to assist the positioning of specific other UEs”.

**Agreement**

* Regarding SA2’s first question, suggest providing the following response:
* RAN1 suggests SA2 check with RAN2 or RAN3 for the answer.

**Agreement**

* Regarding SA2’s second question, RAN1 responds as follows:
* From RAN1's perspective, a UE (which could be a PRU) that supports SL positioning can be allowed to support the positioning reference signal transmission capability and signal measurement capability on PC5, if the capability is introduced in R18.

**Agreement**

The draft LS response in R1-2212714 is endorsed with the following revisions:

* Regarding SA2’s second question, RAN1 ~~would~~ responds as follows
* RAN1 ~~kindly~~ respectfully requests SA2

**Agreement**

Final LS response to SA2 on Positioning Reference Units is agreed in R1-2212715.

**On bandwidth requirements for SL positioning**

Agreement

Capture the following as part of the Conclusions section of TR 38.859:

* + Evaluation results reported as part of the study indicate that, depending on sources, use-cases, scenarios, assumptions, and positioning methods used, the identified target requirements can be satisfied with different values of SL-PRS bandwidth choices.
    - For FR1 spectrum:
      * For certain sources and combinations of use-cases, scenarios, assumptions, and positioning methods, some target requirements can be satisfied with SL-PRS bandwidths of 20 MHz or 40 MHz.
      * For certain sources and other combinations of use-cases, scenarios, assumptions, and positioning methods, some target requirements require SL-PRS bandwidth of 100 MHz or may not be satisfied even with SL-PRS bandwidth of 100 MHz.
    - For FR2 spectrum, based on submitted results from up to two sources:
      * For certain sources and combinations of use-cases, scenarios, assumptions, and positioning methods, some target requirements can be satisfied with SL-PRS bandwidth of 200 MHz.
      * For certain sources and combinations of use-cases, scenarios, assumptions, and positioning methods, some of the target requirements may not be satisfied even with SL-PRS bandwidth of 400 MHz.
  + From RAN1’s perspective, it is recommended that SL-PRS bandwidths of up to 100 MHz are supported by the specifications in FR1 spectrum.

Note: The above recommendations are based on the evaluations in licensed and ITS spectra.

###### Evaluation of SL Positioning:

**Observation:**

Update the observation for V2X use case in highway scenario as follows

For V2X use case in highway scenario, 14 sources ([Huawei 2], [vivo 3], [OPPO 4], [CATT,GOHIGH 5], [Sony 6], [ZTE,CMCC 7], [Lenovo 9], [LG 10], [Samsung 12], [Fraunhofer 13], [Qualcomm 14], [Intel 15], [CEWiT 16], [Ericsson 17]) provide simulation results for FR1, and 2 sources ([LG 10], [CEWiT 16]) provide simulation results for FR2.

* For absolute horizontal accuracy, the results were provided by 14 sources. 12 out of 14 sources show that, the target requirement set A can be achieved, and 9 out of 13 sources show that the target requirement set B cannot be achievable even by 100MHz.
  + The requirement 1.5m@90% (Set A)
    - is achieved with 20MHz bandwidth in contributions from 2 sources ([Huawei 2], [ZTE,CMCC 7]),
      * where Joint Uu/SL positioning is used in contributions from ([Huawei 2], [ZTE,CMCC 7])
    - and is achieved with at least 40MHz bandwidth in contributions from 4 sources ([Huawei 2], [CATT,GOHIGH 5], [LG 10], [Samsung 12]),
      * where SL-only positioning is used in contribution from ([Huawei 2])
    - and is achieved with at least 100MHz bandwidth in contributions from 7 sources ([vivo 3], [OPPO 4], [Sony 6], [ZTE,CMCC 7], [Lenovo 9], [Fraunhofer 13], [CEWiT 16]),
      * where SL-only positioning is used in contribution from ([ZTE,CMCC 7])
      * where SL-TDOA technique is used in contributions from ([Lenovo 9], [CEWiT 16])
    - and is NOT achieved with 100MHz bandwidth in contributions from 3 sources ([Lenovo 9], [Qualcomm 14], [Intel 15])
      * where two anchors SL AoA technique is used in contribution from ([Lenovo 9])
    - and is achieved with 200MHz bandwidth in FR2 in contribution from 1 source ([CEWiT 16])
  + The requirement 0.5m@90% (Set B)
    - is achieved with at least100MHz in contributions from 5 sources ([Huawei 2], [CATT,GOHIGH 5], [ZTE,CMCC 7], [Samsung 12], [Fraunhofer 13]),
      * where Joint Uu/SL positioning is used in contribution from ([ZTE,CMCC 7])
    - and is NOT achieved with100MHz bandwidth in FR1 or 400MHz in FR2 in contributions from 9 sources ([vivo 3], [OPPO 4], [Sony 6], [ZTE,CMCC 7], [Lenovo 9], [Qualcomm 14], [Intel 15], [CEWiT 16], [Ericsson 17]),
      * where SL-only positioning is used in contribution from ([ZTE,CMCC 7])
    - and is NOT achieved with 200MHz bandwidth in FR2 in contribution from 1 source ([CEWiT 16])
    - and is achieved with 400MHz bandwidth in FR2 in contribution from 1 source ([LG 10])
* For absolute vertical accuracy, the results were provided by 1 source out of 14 sources.
  + The requirement 3m@90% (Set A)
    - is achieved with at least 100MHz bandwidth by using Joint Uu/SL positioning in contribution from 1 source ([ZTE,CMCC 7])
    - and is NOT achieved with 100MHz bandwidth by using SL-only positioning in contribution from 1 source ([ZTE,CMCC 7])
  + The requirement 2m@90% (Set B)
    - is achieved with 100MHz bandwidth by using Joint Uu/SL positioning in contribution from 1 source ([ZTE,CMCC 7])
    - and is NOT achieved with 100MHz bandwidth by using SL-only positioning in contribution from 1 source ([ZTE,CMCC 7])
* For relative horizontal accuracy, the results were provided by 7 sources out of 14 sources. The performance of relative horizontal accuracy is worse than that of distance accuracy of ranging mainly due to additional angle estimation error. 5 out of 7 sources show Set A can be achieved with at least 100MHz especially for the cases with smaller X values or RSU assist, and 5 out of 7 sources show that Set A cannot be met with 100MHz PRS bandwidth especially for the cases with larger X values or without RSU assist. All 7 sources show Set B cannot be met even by 100MHz in the case without RSU-UE positioning.
  + The requirement 1.5m@90% (Set A)
    - is achieved with 20MHz bandwidth in contribution from 1 source ([Lenovo 9])
      * X = 25m in contribution from ([Lenovo 9]) where RSU deployment is used for performing relative positioning
    - is achieved with at least 40MHz bandwidth in contributions from 2 sources ([Huawei 2], [CATT,GOHIGH 5])
      * X = 20m in contribution from ([CATT,GOHIGH 5])
      * X = 50m in contribution from ([Huawei 2]) where RSU deployment is additionally used for performing relative positioning
    - and is achieved with at least 100MHz bandwidth in contributions from 5 sources ([Huawei 2], [CATT,GOHIGH 5], [ZTE,CMCC 7], [Lenovo 9], [CEWiT 16])
      * X = 25m in contribution from ([CATT,GOHIGH 5])
      * X = 50m in contribution from ([ZTE,CMCC 7])
      * X = 25m, 50m and 100m in contribution from ([Lenovo 9]) where RSU deployment is used for performing relative positioning
      * X = 150m in contribution from ([Huawei 2]), where RSU deployment is additionally used for performing relative positioning
      * X = 200m in contribution from ([CEWiT 16])
    - and is NOT achieved with 100MHz bandwidth in contributions from 5 sources ([Huawei 2], [vivo 3], [CATT,GOHIGH 5], [Sony 6], [ZTE,CMCC 7])
      * X = 100m and 150m in contribution from ([CATT,GOHIGH 5])
      * X = 25m, 50m, and 100m in contribution from ([vivo 3])
      * X = 50m, 100m and 150m in contribution from ([Sony 6])
      * X = 50m and 150m in contribution from ([Huawei 2])
      * X = 150m and 300m in contribution from ([ZTE,CMCC 7])
  + The requirement 0.5m@90% (Set B)
    - is achieved with at least 100MHz bandwidth in contributions from 2 sources ([Huawei 2], [Lenovo 9])
      * X = 50m in contribution from ([Huawei 2]) where RSU deployment is additionally used for performing relative positioning
      * X = 25m in contribution from ([Lenovo 9]) where RSU deployment is used for performing relative positioning
    - is NOT achieved with 100MHz bandwidth in FR1 or 400MHz in FR2 in contributions from 7 sources ([Huawei 2], [vivo 3], [CATT,GOHIGH 5], [Sony 6], [ZTE,CMCC 7], [Lenovo 9], [CEWiT 16])
* For distance accuracy of ranging, the results were provided by 12 out of 14 sources. 7 of 12 sources show that the target requirement set A can be achievable by 100MHz, and 7 of 12 sources show that the target requirement set B cannot be achieved with 100MHz bandwidth.
  + The requirement 1.5m@90% (Set A)
    - is achieved with 20MHz bandwidth in contributions from 5 sources ([Huawei 2], [vivo 3], [CATT,GOHIGH 5], [ZTE,CMCC 7], [LG 10])
      * X = 50m and 150 in contribution from ([Huawei 2])
      * X = 100m and 150m in contribution from ([CATT,GOHIGH 5])
      * X = 25m, 50m, and 100m in contribution from ([vivo 3])
      * X = 50m, 100m, 150m, 200m and 300m in contribution from ([ZTE,CMCC 7])
      * X = 80m and 160m in contribution from ([LG 10])
    - and is achieved with at least 40MHz bandwidth in contribution from 2 sources ([CATT,GOHIGH 5], [Sony 6])
      * X = 20m and 25m in contribution from ([CATT,GOHIGH 5])
      * X = 50m in contribution from ([Sony 6])
    - and is achieved with at least 100MHz bandwidth in contributions from 7 sources ([OPPO 4], [Sony 6], [Lenovo 9], [Qualcomm 14], [Intel 15], [CEWiT 16], [Ericsson 17])
      * X = 50m, 100m and 150m in contribution from ([OPPO 4])
      * X = 50m in contribution from ([Sony 6])
      * X = 100 m in contribution from ([Lenovo 9])
      * X = 50m and 100m in contribution from ([Intel 15])
      * X = 200 m in contributions from ([Qualcomm 14], [CEWiT 16])
  + The requirement 0.5m@90% (Set B)
    - is achieved with at least 40MHz in contributions from 2 sources ([Huawei 2], [vivo 3])
      * X = 50m in contribution from ([Huawei 2])
      * X = 25m, 50m, and 100m in contribution from ([vivo 3])
    - and is achieved with at least 100MHz in contributions from 4 sources ([Sony 6], [Huawei 2], [CATT,GOHIGH 5], [ZTE,CMCC 7])
      * X = 150m in contribution from ([Huawei 2])
      * X = 25m, 100m and 150m in contribution from ([CATT,GOHIGH 5])
      * X = 50m in contribution from ([Sony 6])
      * X = 50m, 100m, 150m, 200m and 300m in contribution from ([ZTE,CMCC 7]
    - and is NOT achieved with 100MHz bandwidth in contributions from 7 sources ([OPPO 4], [Sony 6], [Lenovo 9], [LG 10], [Qualcomm 14], [Intel 15], [CEWiT 16])
      * X = 50m, 100m and 150m in contribution from ([OPPO 4])
      * X = 100m and 150m in contribution from ([Sony 6])
      * X = 100 m in contribution from ([Lenovo 9])
      * X = 80m and 160m in contribution from ([LG 10])
      * X = 50m and 100m in contribution from ([Intel 15])
      * X = 200 m in contributions from ([Qualcomm 14], [CEWiT 16])
    - and is achieved with at least 200MHz in FR2 in contribution from 1 source ([CEWiT 16])
      * X = 200 m in contribution from ([CEWiT 16])
* For angle accuracy of ranging, the results were provided by 6 sources out of 14 sources. All 6 sources show that both the target requirement set A and set B can be achieved by 20MHz or 40MHz.
  + The requirement 15°@90% (Set A)
    - is achieved with 20MHz bandwidth in contributions from 6 sources ([Huawei 2], [vivo 3], [CATT,GOHIGH 5], [Sony 6], [ZTE,CMCC 7], [Lenovo 9]),
      * X = 50m and 150m in contribution from ([Huawei 2]), where RSU deployment is additionally used for X=150m for performing ranging
      * X = 25m, 50m, and 100m in contribution from ([vivo 3])
      * X = 20m, 100m and 150m in contribution from ([CATT,GOHIGH 5])
      * X = 50m, 100m and 150m in contribution from ([Sony 6])
  + The requirement 8°@90% (Set B)
    - is achieved with 20MHz in contributions from 4 sources ([Huawei 2], [Sony 6], [ZTE,CMCC 7], [Lenovo 9]),
      * X = 50m and 150m in contribution from ([Huawei 2]), where RSU deployment is additionally used for X=150m for performing ranging
      * X = 50m, 100m and 150m in contribution from ([Sony 6])
    - and is achieved with at least 40MHz in contributions from 2 sources ([vivo 3], [CATT,GOHIGH 5])
      * X = 50m, and 100m in contribution from ([vivo 3])
      * X = 20m, 100m and 150m in contribution from ([CATT,GOHIGH 5])
* Note: for each SL PRS bandwidth, the above observations are based on the best performance from each source.
* Note: for the relative positioning accuracy or distance accuracy of ranging, X is the maximum distance between UEs for performing relative positioning or ranging.
* Note: Super resolution is used by sources ([Huawei 2], [vivo 3], [CATT,GOHIGH 5], [Sony 6], [ZTE,CMCC 7], [Lenovo 9], [LG 10], [Intel 15], [CEWiT 16]), and is not used by sources ([OPPO 4], [LG 10], [Fraunhofer 13], [Qualcomm 14], [Samsung 12])

**Observation:**

For Public safety use case, 3 sources ([Huawei 2], [ZTE,CMCC 7], [Qualcomm 14]) provide simulation results for FR1.

* For absolute horizontal positioning accuracy, the results were provided by 3 sources.
  + The requirement 1m@90%
    - is achieved with at least 100MHz in contribution from 1 source ([ZTE,CMCC 7])
    - is NOT achieved with at least 40MHz in contribution from 1 source ([Qualcomm 14])
    - and is NOT achieved with 100MHz in contribution from 1 source ([Huawei 2])
* For Relative horizontal accuracy, the results were provided by 1 out of 3 sources.
  + The requirement 1m@90%
    - is achieved with at least 100MHz in contribution from 1 source ([Huawei 2])
      * X = 20m in contribution from ([Huawei 2])
* For distance accuracy of ranging, the results were provided by 3 sources.
  + The requirement 1m@90%
    - is achieved with at least 40MHz in contribution from 1 source ([Huawei 2])
      * X = 20m in contribution from ([Huawei 2])
    - is achieved with at least 100MHz in contribution from 1 source ([ZTE,CMCC 7])
      * X = 50m and 100m in contribution from ([ZTE,CMCC 7])
    - is NOT achieved with at least 40MHz in contribution from 1 source ([Qualcomm 14])
* For angle accuracy of ranging, the results were provided by 2 out of 3 sources.
  + the requirement 15°@90% (Set A)
    - is achieved with at least 10MHz in contribution from 1 source ([Huawei 2])
      * X = 20m in contribution from ([Huawei 2])
    - is achieved with 20MHz in contribution from 1 source ([Qualcomm 14])
  + The requirement 8°@90% (Set B)
    - is achieved with at least 20MHz in contribution from 1 source ([Huawei 2])
      * X = 20m in contribution from ([Huawei 2])
    - is NOT achieved with 40MHz in contribution from 1 source ([Qualcomm 14])
* Note: for each SL PRS bandwidth, the above observations are based on the best performance from each source.
* Note: for the relative positioning accuracy or distance accuracy of ranging, X is the maximum distance between UEs for performing relative positioning or ranging.
* Note: Super resolution is used by sources ([Huawei 2], [ZTE,CMCC 7]), and is not used by source ([Qualcomm 14])

**Observation**

For absolute positioning, 5 sources ([Huawei 2], [ZTE,CMCC 7], [Qualcomm 14], [CEWiT 16], [Ericsson 17]) provide simulation results for Joint Uu-SL absolute positioning.

* For V2X use case, 4 sources ([Huawei 2], [ZTE,CMCC 7], [CEWiT 16], [Ericsson 17]) show performance improvement of Joint Uu-SL absolute positioning compared to SL-only positioning
* For V2X use case, 2 sources ([CEWiT 16], [Ericsson 17]) show performance improvement of Joint Uu-SL absolute positioning compared to Uu-only positioning
* For IIOT use case, 3 sources ([Huawei 2], [ZTE,CMCC 7], [CEWiT 16],) show performance improvement of Joint Uu-SL absolute positioning compared to SL-only positioning
* For IIOT use case, 3 sources ([Qualcomm 14], [ZTE,CMCC 7], [CEWiT 16],) show performance improvement of Joint Uu-SL absolute positioning compared to Uu-only positioning
* For Public safety, 1 source ([ZTE,CMCC 7]) show performance improvement of Joint Uu-SL absolute positioning compared to SL-only or Uu-only positioning.
* For commercial use case, 1 source ([ZTE,CMCC 7]) show performance improvement of Joint Uu-SL absolute positioning compared to SL-only positioning.
* For commercial use case, 2 sources ([ZTE,CMCC 7], [Qualcomm 14]) show performance improvement of Joint Uu-SL absolute positioning compared to Uu-only positioning.

**Observation**

Update the observation for SL absolute positioning methods as follows

The performance analysis for Rel-18 SL positioning shows that different SL positioning methods can be used to determine absolute position of a target UE:

* Simulation results based SL-TDOA were provided in contributions from 12 sources ([Nokia 1], [OPPO 4], [CATT, GOHIGH 5], [Sony 6], [ZTE,CMCC 7], [Lenovo 9], [LG 10], [InterDigital 11], [Samsung 12], [Fraunhofer 13], [Intel 15], [CEWiT 16])
* Simulation results based on SL-RTT (multi-RTT) were provided in contributions from 6 sources ([Huawei 2], [vivo 3], [LG 10], [InterDigital 11], [Qualcomm 14], [Samsung 12])
* Simulation results based on two anchors SL-AOA were provided in contribution from 1 source ([Lenovo 9])

**Observation**

Update the observation for relative positioning/ranging methods as follows

The performance analysis for Rel-18 SL positioning shows that, SL positioning methods can be used for relative positioning/ ranging between UEs. For relative positioning/ranging positioning accuracy,

* Simulation results based SL-RTT and/or AOA were provided in contributions from 12 sources ([Huawei 2], [vivo 3], [OPPO 4], [CATT, GOHIGH 5], [Sony 6], [ZTE, CMCC 7], [Xiaomi 8], [Lenovo 9], [LG 10], [Qualcomm 14], [Intel 15], [Ericsson 17])
* Results based SL-TDOA were provided in contribution from 1 source ([CEWiT 16])

**Observation**

Update the observation for relative positioning/ranging with different X values as follows:

Simulation results in contributions from 9 sources ([Huawei 2], [vivo 3], [CATT,GOHIGH 5], [Sony 6], [ZTE,CMCC 7], [xiaomi 8], [Lenovo, 9] [LG 10], [Intel 15]) show that relative horizontal accuracy and/or distance accuracy of ranging performance improves with X value decreasing, where X is the maximum distance between two UEs for performing relative positioning or ranging.

* In some simulation cases, a target requirement may be achieved in condition of a smaller X value but not be achieved in condition of a larger X value for a certain SL PRS bandwidth.
* In some simulation cases, a target requirement may be achieved in condition of a smaller X value and a smaller SL PRS bandwidth, but can be achieved in condition of a larger X value and a larger SL PRS bandwidth.

**Observation**

Update the observation for V2X use case in Urban grid scenario as follows

For V2X use case in Urban grid scenario, 11 sources ([Huawei 2], [vivo 3], [OPPO, 4], [CATT,GOHIGH 5], [Sony 6], [ZTE,CMCC 7], [xiaomi 8], [Lenovo 9], [Qualcomm 14], [Intel 15], [CEWiT 16]) provide simulation results for FR1, and 1 source ([CEWiT 16]) provide simulation results for FR2.

* For absolute horizontal accuracy, the results were provided by 9 out of 11 sources. 7 out of 9 sources show that target requirements set A cannot be achieved with 100MHz, and 9 sources show that target requirements set B cannot be achieved with 100MHz.
  + The requirement 1.5m@90% (Set A)
    - is achieved with at least100MHz by using Joint Uu/SL positioning in contribution from 3 sources ([ZTE,CMCC 7], [Qualcomm 14], [CEWiT 16])
      * where LOS-only links are used in contribution from ([CEWiT 16])
    - and is NOT achieved with 100MHz bandwidth in contributions from 7 sources ([Huawei 2], [vivo 3], [OPPO, 4], [CATT,GOHIGH 5], [ZTE,CMCC 7], [Lenovo 9], [Intel 15])
      * where SL-only positioning is used in contribution from ([ZTE,CMCC 7])
      * where two achors SL AOA positioning is used in contribution from ([Lenovo 9])
  + The requirement 0.5m@90% (Set B)
    - is achieved with at least 100MHz by using Joint Uu/SL positioning in contribution from 1 source ([ZTE,CMCC 7]),
    - and is NOT achieved with 100MHz bandwidth in FR1 or 400MHz in FR2 in contributions from 9 sources ([Huawei 2], [vivo 3], [OPPO 4], [CATT,GOHIGH 5], [ZTE,CMCC 7], [Lenovo 9], [Qualcomm 14], [Intel 15], [CEWiT 16])
      * where SL-only positioning is used in contribution from ([ZTE,CMCC 7])
      * where LOS-only links are used in contribution from ([CEWiT 16])
* For Relative horizontal accuracy, the results were provided by 6 out of 11 sources. The performance of relative horizontal accuracy is worse than that of distance accuracy of ranging mainly due to additional angle estimation error. All 6 sources show that the target requirement set B is not achieved even by 100MHz. 5 out of 6 sources show that the target requirement Set A can be achieved by 100MHz especially for the cases with smaller X values.
  + The requirement 1.5m@90% (Set A)
    - is achieved with 20MHz bandwidth in contributions from 2 sources ([Lenovo 9], [CEWiT 16])
      * X = 25m and 50m in contribution from ([Lenovo 9]) where RSU deployment is used for performing relative positioning
      * X = 250m and LOS-only links are used in contribution from ([CEWiT 16])
    - contribution from 1 sourceand is achieved with at least100MHz bandwidth in contributions from 4 sources ([Huawei 2], [CATT,GOHIGH 5], [Sony 6], [Lenovo 9])
      * X = 10m in contribution from ([CATT,GOHIGH 5])
      * X = 10m in contribution from ([Sony 6])
      * X = 10m and 50m in contribution from ([Huawei 2])
      * X = 25m, 50m and 100m in contribution from ([Lenovo 9])
    - and is NOT achieved with 100MHz bandwidth in contributions from 3 sources ([vivo 3], [CATT,GOHIGH 5], [Sony 6])
      * X = 25m in contribution from ([CATT,GOHIGH 5])
      * X = 50m in contribution from ([Sony 6])
      * X = 10m, 25m, and 50m in contribution from ([vivo 3])
  + The requirement 0.5m@90% (Set B)
    - is achieved with at least100MHz bandwidth in contribution from 1 source ([Lenovo 9])
      * X = 25m in contribution from ([Lenovo 9]) where RSU deployment is used for performing relative positioning
    - is NOT achieved with 100MHz bandwidth in FR1 or 400MHz in FR2 in contributions from 6 sources ([Huawei 2], [vivo 3], [CATT,GOHIGH 5], [Sony 6], [Lenovo 9], [CEWiT 16])
      * X = 10m, 30m and 50m in contribution from ([Sony 6])
      * X = 50m and 100m in contribution from ([Lenovo 9]) where RSU deployment is used for performing relative positioning
      * X = 250m and LOS-only links are used in contribution from ([CEWiT 16])
* For distance accuracy of ranging, the results were provided by 11 sources. 6 out of 11 sources show that the target requirement Set A can be achieved by 20MHz or 40MHz. 7 out of 11 sources show that the target requirement Set B cannot be achieved by 100MHz.
  + The requirement 1.5m@90% (Set A)
    - is achieved with at least 20MHz in contributions from 4 sources ([vivo 3], [CATT,GOHIGH 5], [Lenovo 9], [CEWiT 16])
      * X = 25m in contribution from ([vivo 3])
      * X = 25m in contribution from ([CATT,GOHIGH 5])
      * X = 100m in contribution from ([Lenovo 9])
      * X = 250m in contribution from ([CEWiT 16]) where RSU deployment is additionally used for performing distance ranging and LOS-only links are used
    - and is achieved with at least 40MHz in contributions from 2 sources ([ZTE,CMCC 7], [xiaomi 8])
      * X = 20m and 30m in contribution from ([ZTE,CMCC 7])
      * X = 20m, 50m and 100m in contribution from ([xiaomi 8])
    - and is achieved with at least 100MHz in contributions from 4 sources ([Huawei 2], [OPPO 4], [Sony 6], [Qualcomm 14])
      * X = 10 and 50m in contribution from ([Huawei 2])
      * X = 50m, 100m and 150m in contribution from ([OPPO 4])
      * X = 10m and 30m in contribution from ([Sony 6])
      * X = 30m in contribution from [Qualcomm 14])
    - and is NOT achieved with 100MHz bandwidth in contributions from 3 sources ([vivo 3], [ZTE,CMCC 7], [Intel 15])
      * X = 50m and 100m in contribution from ([vivo 3])
      * X = 50m, 80m and 100m in contribution from ([ZTE,CMCC 7])
      * X = 50m, 100m in contribution from ([Intel 15])
    - and is achieved with at least 200MHz in FR2 in contribution from 1 source ([CEWiT 16])
      * where LOS-only links are used in contribution from (CEWiT 16)
  + The requirement 0.5m@90% (Set B)
    - is achieved with at least 20MHz in contribution from 1 source ([CEWiT 16])
      * X = 250m and LOS-only links are used in contribution from ([CEWiT 16])
    - contribution from 1 sourceand is achieved with at least 100MHz in contributions from 4 sources ([Huawei 2], [CATT,GOHIGH 5], [Sony 6], [xiaomi 8])
      * X = 10m and 50m in contribution from ([Huawei 2])
      * X = 10m and 25m in contribution from ([CATT,GOHIGH 5])
      * X = 10m in contribution from ([Sony 6])
      * X = 20m, 50m, 100m in contribution from ([xiaomi 8])
    - and is NOT achieved with 100MHz bandwidth in FR1 or 400MHz in FR2 in contributions from 7 sources ([vivo 3], [OPPO, 4], [Sony 6], [ZTE,CMCC 7], [Lenovo 9], [Qualcomm 14], [Intel 15])
      * X = 30m and 50m in contribution from ([Sony 6])
      * X = 30m in contribution from [Qualcomm 14])
    - and is NOT achieved with at least 200MHz in FR2 in contribution from 1 source ([CEWiT 16])
      * where LOS-only links are used in contribution from ([CEWiT 16])
* For angle accuracy of ranging, the results were provided by 6 out of 11 sources. 5 out of 6 sources show that the target requirement Set A can be achieved with 20MHz or 40MHz, and 4 out 6 sources show that the target requirement Set B cannot be achieved with 100MHz.
  + The requirement 15°@90% (Set A)
    - is achieved with at least 20MHz in contribution from 4 sources ([Huawei 2], [Sony 6], [xiaomi 8], [Lenovo 9])
      * X = 10 and 50m in contribution from ([Huawei 2])
      * X = 10m, 30m and 50m in contribution from ([Sony 6])
      * Optional antenna configuration is used and X = 20m in contribution from ([xiaomi 8])
      * X = 50m and 100m in contribution from ([Lenovo 9])
    - and is achieved with at least 40MHz in contribution from 2 sources ([CATT,GOHIGH 5], [xiaomi 8])
      * X = 10m and 25m in contribution from ([CATT,GOHIGH 5])
      * Optional antenna configuration is used and X = 50m or 100m in contribution from ([xiaomi 8])
    - and is NOT achieved with 100MHz bandwidth in contributions from 2 sources ([vivo 3], [xiaomi 8])
  + The requirement 8°@90% (Set B)
    - is achieved with 20MHz in contribution from 1 source ([Lenovo 9])
      * X = 50m and 100m in contribution from ([Lenovo 9])
    - and is achieved with at least 40MHz in contribution from 1 source ([Huawei 2])
      * X = 10m and BS is additionally used for performing ranging in contribution from ([Huawei 2])
    - and is achieved with at least 100MHz in contribution from 3 sources ([Huawei 2], [Sony 6], [xiaomi 8])
      * X = 10m and 50m in contribution from ([Huawei 2])
      * X = 10m and 30m in contribution from ([Sony 6])
      * Optional antenna configuration is used and X = 20m in contribution from ([xiaomi 8])
    - and is NOT achieved with 100MHz bandwidth in contributions from 4 sources ([vivo 3], [CATT,GOHIGH 5], [Sony 6], [xiaomi 8])
      * X = 50m in contribution from ([Sony 6])
* Note: for each SL PRS bandwidth, the above observations are based on the best performance from each source.
* Note: for the relative positioning accuracy or distance accuracy of ranging, X is the maximum distance between UEs for performing relative positioning or ranging.
* Note: Super resolution is used by sources ([Huawei 2], [vivo 3], [CATT,GOHIGH 5], [Sony 6], [ZTE,CMCC 7], [xiaomi 8], [Lenovo 9], [Intel 15], [CEWiT 16]), and is not used by sources ([OPPO 4], [Qualcomm 14])

**Observation**

SL absolute positioning performance may be degraded due to uncertainty in the anchor UEs’ location coordinates and synchronization error (for SL-TDOA) between anchor UEs.

**Observation**

For IIOT use case in InF-SH scenario, 9 sources ([Nokia 1], [Huawei 2], [vivo 3], [OPPO 4], [CATT,GOHIGH 5], [ZTE,CMCC 7], [InterDigital 11], [Intel 15], [CEWiT 16]) provide simulation results for FR1, and 1 source ([CEWiT 16]) provides simulation results for FR2.

* For absolute horizontal poisoning accuracy, the results were provided by 8 out of 9 sources. 5 out of 8 sources show that the target requirements set A can be achieved with at least 100MHz, and 5 out of 8 sources show that the target requirements set B cannot be achieved with 100MHz.
  + The requirement 1m@90% (Set A)
    - is achieved with 20MHz in contributions from 1 source ([Huawei 2])
      * where Joint Uu/SL positioning is used in contribution from ([Huawei 2])
    - is achieved with 40MHz in contributions from 2 sources ([Huawei 2], [vivo 3])
      * where SL-only positioning is used in contribution from ([Huawei 2])
    - is achieved with at least 100MHz in contributions from 5 sources ([Nokia 1], [OPPO 4], [ZTE,CMCC 7], [InterDigital 11], [CEWiT 16])
      * where LOS-only links are used in contribution from ([CEWiT 16])
    - and is not achieved with 100MHz bandwidth in contribution from 1 source ([Intel 15]).
  + The requirement 0.2m@90% (Set B)
    - is achieved with at least 40MHz in contribution from 1 source ([Huawei 2])
      * where Joint Uu/SL positioning is used in contribution from ([Huawei 2])
    - and is achieved with at least 100MHz in contribution from 2 sources ([Huawei 2], [vivo 3])
      * where SL-only positioning is used in contribution from ([Huawei 2])
    - and is NOT achieved with 100MHz bandwidth in contributions from 6 sources ([Nokia 1], [OPPO 4], [ZTE,CMCC 7], [InterDigital 11], ([Intel 15]), [CEWiT 16])
    - and is achieved with at least 200MHzbandwidth in FR2 in contribution from 1 source ([CEWiT 16])
      * where LOS-only links are used in contribution from ([CEWiT 16])
* For absolute vertical accuracy, the results were provided by 1 out of 9 sources.
  + The requirement 1m@90% (Set A)
    - is NOT achieved with 100MHz bandwidth in contribution from 1 source ([InterDigital 11])
  + The requirement 0.2m@90% (Set B)
    - is NOT achieved with 100MHz bandwidth in contribution from 1 source ([InterDigital 11])
* For Relative horizontal accuracy, the results were provided by 3 out of 9 sources. The performance of relative horizontal accuracy is worse than that of distance accuracy of ranging mainly due to additional angle estimation error. All 3 sources show Set A can be met with 40MHz or 100MHz PRS bandwidth. All 3 sources show Set B cannot be met even by 100MHz.
  + The requirement 1m@90% (Set A)
    - is achieved with at least 40MHz in contributions from 2 sources ([vivo 3], [CATT,GOHIGH 5])
      * X = 10m in contributions from ([vivo 3], [CATT,GOHIGH 5])
    - is achieved with at least 100MHz in contribution from 1 source ([Huawei 2])
      * X = 10m in contribution from ([Huawei 2])
  + The requirement 0.2m@90%(Set B)
    - is NOT achieved with 100MHz bandwidth in contributions from 3 sources ([Huawei 2], [vivo 3], [CATT,GOHIGH 5])
* For distance accuracy of ranging, the results were provided by 5 out of 9 sources. 4 of 5 sources show that the target requirement set A can be achievable by 100MHz, and 3 of 5 sources show that the target requirement set B cannot be achieved with 100MHz bandwidth.
  + The requirement 1m@90% (Set A)
    - is achieved with at least 20MHz in contribution from 1 source ([vivo 3])
      * X = 10m in contribution from ([vivo 3])
    - is achieved with at least 40MHz in contribution from 1 source ([CATT,GOHIGH 5])
      * X = 10m in contribution from ([CATT,GOHIGH 5])
    - is achieved with at least 100MHz in contribution from 2 sources ([OPPO 4], [ZTE,CMCC 7])
      * X = 50m, 100m and 150m in contribution from ([OPPO 4])
      * X = 10m, 20m, 30m and 50m in contribution from ([ZTE,CMCC 7])
    - is NOT achieved with at least 100MHz in contribution from 1 source ([Intel 15])
      * X = 10m, and 50m in contribution from ([Intel 15])
  + The requirement 0.2m@90% (Set B)
    - is achieved with at least 100MHz in contribution from 2 sources ([vivo 3], [CATT,GOHIGH 5])
      * X = 10m in contributions from ([vivo 3], [CATT,GOHIGH 5])
    - and is NOT achieved with 100MHz bandwidth in contributions from 3 sources ([OPPO 4], [ZTE,CMCC 7], [Intel 15])
* For angle accuracy of ranging, the results were provided by 2 out of 9 sources.
  + The requirement 15°@90%(Set A)
    - is achieved with at least 20MHz in contribution from 1 source ([vivo 3])
      * X = 10m in contribution from ([vivo 3])
    - is achieved with at least 40MHz in contribution from 1 source ([CATT,GOHIGH 5])
      * X = 10m in contribution from ([CATT,GOHIGH 5])
  + The requirement 8°@90% (Set B)
    - is achieved with at least 20MHz in contribution from 1 source ([vivo 3])
      * X = 10m in contribution from ([vivo 3])
    - is achieved with at least 40MHz in contribution from 1 source ([CATT,GOHIGH 5])
      * X = 10m in contribution from ([CATT,GOHIGH 5])
* Note: for each SL PRS bandwidth, the above observations are based on the best performance from each source.
* Note: for the relative positioning accuracy or distance accuracy of ranging, X is the maximum distance between UEs for performing relative positioning or ranging.
* Note: Super resolution is used by sources ([Huawei 2], [vivo 3], [CATT,GOHIGH 5], [ZTE,CMCC 7], [Intel 15], [CEWiT 16]), and is not used by sources ([Nokia 1], [OPPO 4])

**Observation**

For IIOT use case in InF-DH scenario, 7 sources ([Nokia 1], [Huawei 2], [vivo 3], [ZTE,CMCC 7], [InterDigital 11], [Qualcomm 14], [CEWiT 16]) provide simulation results for FR1, and 1 source ([CEWiT 16]) provides simulation results for FR2.

* For absolute horizontal poisoning accuracy, the results were provided by 7 sources. 5 out of 7 sources show that the target requirements set A can be achieved with 100MHz, and 5 out of 7 sources show that the target requirements set B cannot be achieved with 100MHz.
  + The requirement 1m@90% (Set A)
    - is achieved with 20MHz in contribution from 1 source ([Huawei 2])
      * where Joint Uu/SL positioning is used in contribution from ([Huawei 2])
    - is achieved with 40MHz in contribution from 2 sources ([Huawei 2], [vivo 3])
      * where SL-only positioning is used in contribution from ([Huawei 2]
    - and is achieved with at least100MHz in contribution from 3 sources ([ZTE,CMCC 7], [Qualcomm 14], [CEWiT 16])
      * where LOS-only links are used in contribution from ([CEWiT 16])
    - and is NOT achieved with 100MHz bandwidth in FR1 in contribution from 2 sources ([Nokia 1], [InterDigital 11])
  + The requirement 0.2m@90% (Set B)
    - is achieved with at least 100MHz in contribution from 2 sources ([Huawei 2], [vivo 3])
    - is NOT achieved with 100MHz bandwidth in FR1 in contributions from 6 sources ([Nokia 1], [ZTE,CMCC 7], [InterDigital 11], [Qualcomm 14], [CEWiT 16])
    - is achieved with at least 200MHz bandwidth in FR2 in contribution from 1 source ([CEWiT 16])
      * where LOS-only links are used in contribution from ([CEWiT 16])
* For absolute vertical accuracy, the results were provided by 1 out of 7 sources.
  + The requirement 1m@90% (Set A)
    - is NOT achieved with 100MHz bandwidth in contribution from 1 source ([InterDigital 11])
  + The requirement 0.2m@90% (Set B)
    - is NOT achieved with 100MHz bandwidth in contribution from 1 source ([InterDigital 11])
* For Relative horizontal accuracy, the results were provided by 2 out of 7 sources.
  + The requirement 1m@90% (Set A)
    - is achieved with at least 40MHz in contribution from 1 source ([vivo 3])
      * X = 10m in contribution from ([vivo 3])
    - is achieved with at least 100MHz in contribution from 1 source ([Huawei 2])
      * X = 10m in contribution from ([Huawei 2])
  + The requirement 0.2m@90%(Set B) in InF-DH
    - is NOT achieved with 100MHz bandwidth in contribution from 2 sources ([Huawei 2], [vivo 3])
* For distance accuracy of ranging, the results were provided by 2 out of 7 sources.
  + The requirement 1m@90% (Set A)
    - is achieved with at least 20MHz in contribution from 1 source ([vivo 3])
      * X = 10m in contribution from ([vivo 3])
    - is achieved with at least 100MHz in contribution from 1 source ([ZTE,CMCC 7])
      * X = 10m in contribution from ([ZTE,CMCC 7])
    - and is NOT achieved with at least 100MHz in contribution from 1 source ([ZTE,CMCC 7])
      * X = 20m, 30m, and 50m in contribution from ([ZTE,CMCC 7])
  + The requirement 0.2m@90% (Set B)
    - is achieved with at least 100MHz in contribution from 1 source ([vivo 3])
      * X = 10m in contribution from ([vivo 3])
    - and is NOT achieved with 100MHz bandwidth in contribution from 1 source ([ZTE,CMCC 7])
* For angle accuracy of ranging, the results were provided by 1 out of 7 sources.
  + The requirement 15°@90% (Set A)
    - is achieved with at least 20MHz in contribution from 1 source ([vivo 3])
      * X = 10m in contribution from ([vivo 3])
  + The requirement 8°@90% (Set B)
    - is achieved with at least 40MHz in contribution from 1 source ([vivo 3])
      * X = 10m in contribution from ([vivo 3])
* Note: for each SL PRS bandwidth, the above observations are based on the best performance from each source.
* Note: for the relative positioning accuracy or distance accuracy of ranging, X is the maximum distance between UEs for performing relative positioning or ranging.
* Note: Super resolution is used by sources ([Huawei 2], [vivo 3], [ZTE,CMCC 7], [CEWiT 16]), and is not used by sources ([Nokia 1], [Qualcomm 14])

**Observation**

For Commercial use case, 5 sources ([Huawei 2], [ZTE,CMCC 7], [xiaomi 8], [Qualcomm 14], [Intel 15]) provide simulation results for FR1

* For absolute horizontal positioning accuracy, the results were provided by 3 out of 5 sources.
  + The requirement 1m@90%
    - is achieved with 40MHz in contribution from 1 source ([Huawei 2])
    - and is achieved with at least 100MHz in contribution from 2 sources ([ZTE,CMCC 7], [Qualcomm 14])
* For Relative horizontal accuracy, the results were provided by 1 out of 5 sources.
  + The requirement 1m@90%
    - is achieved with 40MHz bandwidth in contribution from 1 source ([Huawei 2]), where achor UE deployment is additionally used for performing distance ranging
    - is achieved with 100MHz bandwidth in contribution from 1 source ([Huawei 2])
      * X = 10m in contribution from ([Huawei 2])
* For distance accuracy of ranging, the results were provided by 4 out of 5 sources. All 4 sources show that the target requirement set can be achievable by 100MHz especially for the cases with smaller X values.
  + The requirement 1m@90%
    - is achieved with at least 20MHz in contribution from 1 source ([xiaomi 8])
      * X = 10m in contribution from ([xiaomi 8])
    - is achieved with at least 40MHz in contribution from 2 sources ([Huawei 2], [xiaomi 8])
      * X = 20m and 50m in contribution from ([xiaomi 8])
      * X = 10m in contribution from ([Huawei 2]) where achor UE deployment is additionally used for performing ranging
    - is achieved with at least 100MHz in contribution from 3 sources ([Huawei 2], [ZTE,CMCC 7], [Intel 15])
      * X = 10m in contributions from ([Huawei 2], [ZTE,CMCC 7], [Intel 15])
    - is NOT achieved with at least 100MHz in contribution from 2 sources ([ZTE,CMCC 7], [Intel 15])
      * X = 20m,50m, and 100m in contribution from ([ZTE,CMCC 7])
      * X = 25m and 50m in contributions from ([Intel 15])
* For angle accuracy of ranging, the results were provided by 1 out of 5 sources.
  + The requirement 15°@90% (Set A)
    - is achieved with at least 20MHz in contribution from 1 source ([Huawei 2])
      * X = 10m in contribution from ([Huawei 2])
  + The requirement 8°@90% (Set B)
    - is achieved with at least 40MHz in contribution from 1 source ([Huawei 2])
      * X = 10m in contribution from ([Huawei 2])
* Note: for each SL PRS bandwidth, the above observations are based on the best performance from each source.
* Note: for the relative positioning accuracy or distance accuracy of ranging, X is the maximum distance between UEs for performing relative positioning or ranging.
* Note: Super resolution is used by sources ([Huawei 2], [ZTE,CMCC 7], [xiaomi 8], [Intel 15]), and is not used by source ([Qualcomm 14])

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

**Agreement**

SL-AoD is included as a potential candidate positioning method, and

* SL-AoD should be deprioritized over the remaining methods that have been recommended to be introduced.

**Agreement**

With regards to the SL Positioning resource allocation, support

* 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: this does not imply that the design is the same for both types of resources pools
* Note: shared resources pool(s) should be supported with backward compatibility

**Agreement**

From RAN1 perspective, at least the following 2 operation scenarios are recommended for normative work:

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

**Agreement**

For Scheme 2, with regards to Resource allocation mechanism for SL-PRS, pick one or both of the following options:

* Option 1: A sensing based resource allocation should be introduced
* Option 2: A random resource selection should be introduced
* In either option 1 or 2, the legacy designs for UE autonomous resource allocation should be used as a starting point. Study if/what enhancements may be needed.

**Agreement**

With regards to the RTT-type solutions using SL, both single-sided and double-sided RTT methods should be introduced

* Strive to minimize the changes needed on top of the specification support for single-sided RTT, if any, for the introduction of double-sided RTT.
* Note: a UE should be able to support single-sided RTT without having to support double-sided RTT

**Agreement**

Capture the following TP into the TR 38.859 as a conclusion:

For the solutions for sidelink positioning,

* The following 2 operation scenarios are recommended for normative work
  + Operation Scenario 1: PC5-only-based positioning.
  + Operation Scenario 2: Combination of Uu- and PC5-based positioning.
* RTT-type solution(s) using SL, SL-AoA and SL-TDOA are recommended for normative work.
  + both single-sided and double-sided RTT methods, striving to minimize the changes needed on top of the specification support for single-sided RTT, if any, for the introduction of double-sided RTT
* A new sidelink reference signal (SL-PRS) is recommended for normative work.
  + Such a reference signal should use a Comb frequency domain structure and a pseudorandom-based sequence where the existing sequence of DL-PRS should be used as a starting point.
  + SCI can be used for reserving/indicating one or more SL-PRS resources
* Both a resource allocation Scheme 1 and Scheme 2 is recommended for normative work, where Scheme 1 corresponds to a network-centric operation SL-PRS resource allocation and Scheme 2 corresponds to UE autonomous SL-PRS resource allocation.
* With regards to the SL-PRS transmission, both dedicated resource pool and shared resource pool with Rel-16/Rel-17/Rel-18 SL communication are recommended for normative work.
  + For SL Positioning resource (pre-)configuration in a shared resource pool with Rel-16/17/18 sidelink communication, backward compatibility with legacy Rel-16/17 UEs should be ensured.
* Unicast, Groupcast (not including many to one) and Broadcast of SL-PRS transmission are recommended for normative work.

**Agreement**

A dedicated SL-PRS resource pool is (pre-)configured in the only SL BWP of a carrier.

**Agreement**

With regards to the power control for SL-PRS at least Open Loop PC should be introduced.

**Agreement**

For SL-TDOA, DL-TDOA-like operation and UL-TDOA-like operation should be introduced.

* A UE is not required to support both DL-TDOA-like operation and UL-TDOA-like operation

**Agreement**

With regards to the Positioning methods supported using SL-PRS measurements

* at least the following measurements should be introduced:
  + SL-PRS based Rx-Tx measurement
  + SL-PRS based RSTD measurement
  + SL-PRS based RSRP measurement
  + SL-PRS based RSRPP measurement
  + SL-PRS based RTOA measurement
  + SL-PRS based Azimuth of arrival (AoA) and SL zenith of arrival (ZoA) measurement

**Agreement**

Update the agreed TP into the conclusion section of the TR 38.859 as follows:

For the solutions for sidelink positioning,

* The following 2 operation scenarios are recommended for normative work
  + Operation Scenario 1: PC5-only-based positioning.
  + Operation Scenario 2: Combination of Uu- and PC5-based positioning.
* RTT-type solution(s) using SL, SL-AoA and SL-TDOA are recommended for normative work.
  + both single-sided and double-sided RTT methods, striving to minimize the changes needed on top of the specification support for single-sided RTT, if any, for the introduction of double-sided RTT
  + For SL-TDOA, DL-TDOA-like operation and UL-TDOA-like operation is recommended for normative work.
  + For the support of the above methods the following measurements are recommended for normative work:
    - SL-PRS based Rx-Tx measurement
    - SL-PRS based RSTD measurement
    - SL-PRS based RSRP measurement
    - SL-PRS based RSRPP measurement
    - SL-PRS based RTOA measurement
    - SL-PRS based Azimuth of arrival (AoA) and SL zenith of arrival (ZoA) measurement
* A new sidelink reference signal (SL-PRS) is recommended for normative work.
  + Such a reference signal should use a Comb frequency domain structure and a pseudorandom-based sequence where the existing sequence of DL-PRS should be used as a starting point.
  + SCI can be used for reserving/indicating one or more SL-PRS resources
  + With regards to the power control for SL-PRS at least Open Loop PC is recommended for normative work.
* Both a resource allocation Scheme 1 and Scheme 2 is recommended for normative work, where Scheme 1 corresponds to a network-centric operation SL-PRS resource allocation and Scheme 2 corresponds to UE autonomous SL-PRS resource allocation.
  + For resource allocation mechanism for SL-PRS in Scheme 2, a sensing based resource allocation, or a random resource selection, or both, should be introduced, where the legacy designs for UE autonomous resource allocation are used as a starting point.
* With regards to the SL-PRS transmission, both dedicated resource pool and shared resource pool with Rel-16/Rel-17/Rel-18 SL communication are recommended for normative work.
  + For SL Positioning resource (pre-)configuration in a shared resource pool with Rel-16/17/18 sidelink communication, backward compatibility with legacy Rel-16/17 UEs should be ensured.
* Unicast, Groupcast (not including many to one) and Broadcast of SL-PRS transmission are recommended for normative work.

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

**Agreement**

Capture the following in TR 38.859 in Clause “6.1.3 Summary of Evaluation Results for Integrity for RAT-Dependent Positioning Techniques”

* The distribution of timing measurement error has been studied with evaluations in the following sources: [R1-2208454, Huawei, HiSilicon], [R1-2208649, vivo], [R1-2208735, Nokia Nokia Shanghai Bell], [R1-2209214, R1-2211502, ZTE], [R1-2209488, InterDigital],[R1-2209737, R1-2212051, Samsung], [R1-2210176, Ericsson].
* The distribution of angle measurement error has been studied with evaluations in the following sources: [R1-2208454, R1-2210902, Huawei, HiSilicon], [R1-2208649, vivo], [R1-2209214, R1-2211502, ZTE], [R1-2210176, Ericsson].

**Agreement**

For LMF-based positioning integrity mode, for UL-TDOA, inter-TRP synchronization error can be caused in part by errors in SFN initialization time.

Note: Definition of “LMF-based positioning integrity mode” can be found in Table 9.4.1.1.1 in TR 38.857

**Conclusion**

* RAN1 could not reach consensus on whether beam information (NR-TRP-BeamAntennaInfo) and boresight direction of DL PRS (NR-DL-PRS-BeamInfo) are error sources or not for DL-AoD for UE-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**

Capture the following in TR 38.859 in Clause “Annex B.2: Evaluation Results for Integrity for RAT-Dependent Positioning Techniques”.

B.2.1 Results from source [Huawei, HiSilicon]

B.2.1.1 Description of evaluation scenarios

Details related to evaluation scenarios can be found in [1, 17, Huawei, HiSlilicon].

B.2.1.2 Evaluation results related to the distribution of measurement error

Details of the evaluation results related to the distribution of timing measurement error can be found in [17, Huawei, HiSlilicon].

Details of the evaluation results related to the distribution of angle measurement error can be found in [1, 17, Huawei, HiSlilicon].

B.2.2 Results from source [vivo]

B.2.2.1 Description of evaluation scenarios

Details related to evaluation scenarios can be found in [20, vivo].

B.2.2.2 Evaluation results related to the distribution of measurement error

Details of the evaluation results related to the distribution of timing measurement error can be found in [20, vivo].

Details of the evaluation results related to the distribution of angle measurement error can be found in [20, vivo].

B.2.3 Results from source [Nokia, Nokia Shanghai Bell]

B.2.3.1 Description of evaluation scenarios

Details related to evaluation scenarios can be found in [21, Nokia, Nokia Shanghai Bell].

B.2.3.2 Evaluation results related to the distribution of measurement error

Details of the evaluation results related to the distribution of timing measurement error can be found in [21, Nokia, Nokia Shanghai Bell].

B.2.4 Results from source [ZTE]

B.2.4.1 Description of evaluation scenarios

Details related to evaluation scenarios can be found in [6, 26, ZTE].

B.2.4.2 Evaluation results related to the distribution of measurement error

Details of the evaluation results related to the distribution of timing measurement error can be found in [6, 26, ZTE].

Details of the evaluation results related to the distribution of angle measurement error can be found in [6, 26, ZTE]

B.2.5 Results from source [InterDigital]

B.2.5.1 Description of evaluation scenarios

Details related to evaluation scenarios can be found in [30, InterDigital].

B.2.5.2 Evaluation results related to the distribution of measurement error

Details of the evaluation results related to the distribution of timing measurement error can be found in [30, InterDigital].

B.2.6 Results from source [Samsung]

B.2.6.1 Description of evaluation scenarios

Details related to evaluation scenarios can be found in [13, 31, Samsung].

B.2.6.2 Evaluation results related to the distribution of measurement error

Details of the evaluation results related to the distribution of timing measurement error can be found in [13, 31, Samsung].

B.2.7 Results from source [Ericsson]

B.2.7.1 Description of evaluation scenarios

Details related to evaluation scenarios can be found in [35, Ericsson].

B.2.7.2 Evaluation results related to the distribution of measurement error

Details of the evaluation results related to the distribution of timing measurement error can be found in [35, Ericsson].

Details of the evaluation results related to the distribution of angle measurement error can be found in [35, Ericsson].

**Agreement**

At least DL-PRS RSRPP of the first path or RSRP is an error source for DL-AoD for LMF-based positioning integrity mode.

* Note: RAN1 did not determine the model of the error source
* Note: Definition of “LMF-based positioning integrity mode” can be found in Table 9.4.1.1.1 in TR 38.857

**Agreement**

* Inter-TRP synchronization error is an error source for UE-assisted DL-TDOA for LMF-based positioning integrity mode
* FFS: Specification impact
* 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, for DL-TDOA, inter-TRP synchronization error can be caused in part by errors in SFN initialization time.

* 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, for DL-TDOA, DL-AoD, UL-TDOA, UL-AoA and multi-RTT, the following distributions are identified as candidates for modeling the distribution of TRP location (e.g., Geographical Coordinates in TS 38.455) error
  + Uniform distribution
  + Normal distribution
* Note: it is up to RAN2 how to use the identified distributions

**Agreement**

* For LMF-based positioning integrity mode, for UL-AoA, the following distributions are identified as candidates for modeling the distribution of ARP location (e.g., ARPLocationInformation in TS 38.455) error
  + Uniform distribution
  + Normal distribution
* Note: it is up to RAN2 how to use the identified distributions

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

**Agreement**

Capture the following TP into TR 38.859 as a conclusion (Section 6.3.3)

Regarding the reference signals for NR carrier phase positioning:

* Existing DL PRS and UL SRS for positioning purpose are recommended as the reference signals to enable positioning based on NR carrier phase measurements for both UE-based and UE-assisted positioning if NR CPP is introduced.
* Note: The use of SRS MIMO for NR carrier phase positioning is transparent for UE

**Agreement**

Capture the following TP into TR 38.859 as a conclusion.

Regarding the physical layer measurements for NR carrier phase positioning:

* New measurements are recommended to be introduced for supporting UE-based and UE-assisted NR carrier phase positioning, if NR CPP is introduced. The new measurements include, at least, the following:
  + For DL carrier phase positioning, the following candidate measurements are identified (potential down-selection may be considered during normative work).
    - the difference between the carrier phase measured from the DL PRS signal(s) of the target TRP and the carrier phase measured from the DL PRS signal(s) of the reference TRP;
    - the carrier phase measured from the DL PRS signal(s) of a TRP.
  + For UL carrier phase positioning, the carrier phases measured from the UL SRS for positioning purpose is identified as the UL carrier phase measurements.
* Note: this proposal does not imply which carrier phase measurements are mapped to which positioning technique

**Agreement**

Capture the following TP into TR 38.859 as a conclusion:

* Multipath mitigation methods for the carrier phase positioning are recommended to be introduced during normative work, if NR CPP is introduced. The candidate solutions may include, but are not limited to, the following:
  + Reporting of the carrier phase of the first path
  + At least reporting of the carrier phase of the first path, and optionally, the additional paths.
  + The use of LOS/NLOS indication for the carrier phase measurements.
    - Note: Rel-17 LOS/NLOS indicator can be considered as a starting point.
  + Reporting of other channel information together with carrier phase measurements, such as existing RSRP/RSRPP.

**Agreement**

Capture the following TP into TR 38.859 as a conclusion:

* At least the double differential technique with PRU is feasible for UE-based, and network-based NR carrier phase positioning, if NR CPP is introduced, at least, for eliminating the impact of the initial phases of the transmitter and the receiver.
  + Note 1: How to efficiently enable the use of the PRU for supporting NR double differential carrier phase positioning needs further discussion during the normative work.
  + Note 2: the required PRU density also needs further discussion
* Note 3: other methods for eliminating the impact of the initial phases of the transmitter and the receiver are not precluded

**Agreement**

Capture the following observation in TR 38.859 (Section 6.3.2):

The accuracy of NR carrier phase positioning is evaluated under different scenarios (e.g., InF-SH, InF-DH) defined in TS 38.901 without considering the error sources listed in Annex X.Y.Z (e.g., timing/ frequency errors, antenna PCO and ARP position errors). The evaluation results can be seen as the reference for studying the impacts of the error sources listed in Annex X.Y.Z. 9 out of 11 sources ([Huawei/R1-2210903][vivo/R12211014][ CATT/R1-2211205][ Nokia/R1-2211312][ZTE/R1-2212520][LGE/ R1- 2211924][ Qualcomm/R1-2212124][Samsung, R1-2212550][Ericsson, R1-2212515]) show that the centimeter-level positioning accuracy can be achieved by the use of carrier phase measurements at least when other error sources are not considered. 2 out of 11 sources ([Intel/R1-2211406][OPPO/R1-2211435[9]) show that the centimeter-level positioning accuracy can be achieved by the use of ideal resolution of integer ambiguity:

* Source [Huawei, R1-2210903] shows (additional results are available in Annex B.4.X[Huawei])
  + For InF-SH scenario:
    - (no differential) UL-CPP (Cases 1): <1.0cm @50% and <1.0cm @80%.
    - SD UL-CPP (Case 5): <1.0cm @50% and <1.0cm @80%.
    - DD DL-CPP (Case 9): <1.0cm @50% and <1.0cm @80%.
  + For InF-DH scenario
    - (no differential) UL-CPP (Cases 2): <1.0cm @50% and <1.0cm @80%.
    - SD UL-CPP (Case 6): <1.0cm @50% and 0.974m @80%.
    - DD DL-CPP (Case 10): <1.0cm @50% and 1.014m @80%.
* Source [vivo, R1-2211014] shows (additional results are available in Annex B.4.X[vivo])
  + For InF-SH scenario:
    - SD DL-CPP (Case 102): <1.0cm@50% and <1.0cm @80%
  + For InF-DH scenario
    - SD DL-CPP (Case 202): <1.0cm@50% and 0.33m @80%
* Source [CATT, R1-2211205] shows:
  + For InF-SH scenario:
    - SD DL-CPP (Cases 2): <1.0cm @50% and <1.0cm @80%.
    - DD DL-CPP (Cases 3): <1.0cm @50% and <1.0cm @80%.
    - DD DL-CPP (two subcarrier frequencies in one PFL) (Case 4): <1.0cm @50% and <1.0cm @80%.
    - DD DL-CPP (two carrier frequencies, two PFLs) (Case 5): <1.0cm @50% and <1.0cm @80%.
  + For InF-DH scenario
    - SD DL-CPP (Cases 7): 0.6cm @50% and 3.0cm @80%.
    - DD DL-CPP (Cases 8): 4.6cm @50% and 14.8cm @80%.
    - DD DL-CPP (two carrier frequencies, two PFLs) (Case 9): 1.0cm @50% and 2.7cm @80%.
* Source [Nokia, R1-2211312] shows:
  + For InF-SH scenario:
    - DD DL-CPP (Cases 1): <1cm @50% and <1cm @80%.
* Source [Intel, R1-2211406] shows:
  + For InF-SH scenario:
    - SD DL-CPP (Cases 1): <1cm @50% and <1cm @80% (with ideal resolution of integer ambiguity)
* Source [OPPO, R1-2211435] shows:
  + For InF-SH scenario:
    - SD DL-CPP (Cases 1): <1cm @50% and <1cm @80% (with ideal resolution of integer ambiguity)
* Source [ZTE, R1-2212520] shows:
  + For InF-SH scenario:
    - DL-CPP (multiple subcarriers within one PFL)(Case 4-1-1): 0.11m @ 50% and 0.51m @80%
    - DL-CPP (Case 4-1-2): 0.3cm @ 50% and 0.21m @ 80%
  + For InF-DH scenario:
    - DL-CPP (Case 4-2-1):0.33m @50% and 0.66m @ 80%.
* Source [LGE, R1- 2211924] shows:
  + For InF-SH scenario (100MHz and 50MHz Bandwidth):
    - SD DL-CPP (horizontal): <1cm @50% and <1cm @80%
    - SD DL-CPP (vertical): <1cm @50% and <1cm @80%
* Source [Qualcomm, R1-2212124] shows:
  + For InF-SH scenario (400MHz, FR2)
    - SD DL-CPP(Case 1): 0.002cm @50% and <0.005cm @80%
* Source [Samsung, R1-2212550] shows:
  + For InF-SH scenario (10MHz, @3GHz)
    - Round-trip carrier phase with slope: < 1cm @ 50% and <1 cm @ 80%
  + For InF-SH scenario (100MHz, @3.5GHz)
    - Time domain and perfect phase : < 1cm @ 50% and <1 cm @ 80%
    - Time domain and estimated phase : < 1cm @ 50% and ~1 cm @ 80%
* Source [Ericsson, R1-2212515] shows:
  + For InF-SH scenario
    - DD UL-CPP: <1cm @50% and 2cm @80%
* Note 1: Unless indicated otherwise, the results shown above are for horizontal positioning accuracy with a single carrier of bandwidth of 100MHz in FR1.
* Note 2: Evaluation results above are mainly used as examples. Additional results and more details of the evaluation assumptions may be provided by the sources in Annex B.4-X[Huawei, vivo, CATT, Nokia, Intel, OPPO,ZTE, LGE, Qualcomm, Samsung, Ericsson]).
* Note 3: The evaluation results for legacy positioning approach may also be available in each of the sources, or in TR 38.857.

**Agreement**

Adoptthe following TP modification for TR 38.859 (Section 6.3.2):

==== START of TP for TR 38.859 ====

6.3.2 Summary of Evaluations for NR Carrier Phase Positioning

<Unrelated part omitted>

The impact of the initial phases of the transmitter and the receiver on NR carrier phase positioning (CPP) is evaluated in the study item. The evaluation results from the sources (e.g., [73], [74], [75], [76], [Nokia/R1-2211312]) show that if the impact of the initial phases of the transmitter and the receiver are not mitigated, it is impossible to support centimeter-level positioning accuracy.

The effectiveness of using double differential technique with PRU to eliminate the impact of the initial phases of the transmitter and the receiver on NR carrier phase positioning are evaluated in the study item. The evaluation results from the sources ([73], [CATT/[R1-2211205](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_111/Docs/R1-2211205.zip)], [ZTE/R1-2212520], [77], [Nokia/R1-2211312])) show that the initial phases of the transmitter and the receiver can be removed effectively by the double differential technique with the use of PRU:

* Source [73] shows the positioning accuracy of <1cm (80%) for InF-SH and < 1cm (50%) for InF-DH can be reached when the PRU is located within a distance of 5m from the target UE.
* Source [CATT/[R1-2211205](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_111/Docs/R1-2211205.zip)] shows the positioning accuracy of <1cm (80%) for InF-SH and 4.6cm (50%) for InF-DH can be reached under the condition that the PRU is located a fixed location in LOS of the TRP.
* Source [77] shows that the accuracy of <1cm (50%) when the PRU is located within 1m of the target UE. However, the effectiveness reduces when the PRU is located away from the target UE because the channel conditions of the PRU is different from the target UE.
* Source [Nokia/R1-2211312] shows the positioning accuracy of < 1cm (80%) for InF-SH can be reached under the condition that the PRU is located a fixed location as shown in [Nokia/R1-2211312].
* Source [ZTE/R1-2212520] shows the positioning accuracy of < 1cm (50%) for InF-SH can be reached under the condition that the integer ambiguity range N is limited to ±1.
* Source [IIT Kanpur, R1-2212519] shows the distance accuracy degrades from 0.5cm @ 50% and 5.2cm @80% to 3.3cm @50% and 4.8cm @ 80% by the initial phase offset for InF-DH scenario.
* Note 1: in the above results, all other error sources (except initial phase error) were not modelled.
* Note 2: Unless indicated otherwise, the results shown above are for horizontal positioning accuracy with a single carrier of bandwidth of 100MHz in FR1.
* Note 3. Evaluation results above are mainly used as examples. Additional results and more details of the evaluation assumptions may be provided by the sources in Annex B.4-X[Huawei, vivo, CATT, Nokia, ZTE, IIT Kanpur].

==== END of TP ====

**Agreement**

Adoptthe following TP modification for TR 38.859 (Section 6.3.2):

==== START of TP for TR 38.859 ====

6.3.2 Summary of Evaluations for NR Carrier Phase Positioning

<Unrelated part omitted>

The impact of the residual CFO at the transmitter and the receiver for NR carrier phase positioning was evaluated during the study item.

* The evaluation results from the sources ([73], [76]) show that the impact of residual CFO on carrier phase positioning is negligible.
* The evaluation results from the source ([75]) show that the impact of the residual CFO on the performance of carrier phase positioning can be mitigated with the use of the double differential technique with a PRU that is located at a fixed location in LOS of the TRP.
* The evaluation results from the source [vivo/R1-2211014] show that the impact of residual CFO on carrier phase measurement is negligible. However carrier phase positioning accuracy degrades significantly with residual CFO with SD DL-CPP:
* With UE residual CFO 30Hz and TRP residual CFO 10Hz, the accuracy drops from 0.0044m to 0.2m @80% and from 0.0014m to [0.0017m@50%](mailto:0.0017m@50%25) in InF-SH.
* With UE residual CFO 100Hz and TRP residual CFO 10Hz, the accuracy drops from 0.0044m to 0.27m @80% and from 0.0014m to [0.0024m@50](mailto:0.0024m@50)% in InF-SH.
* The evaluation results from the source [LGE, R1- 2211924] show that carrier phase positioning accuracy degrades slightly with residual CFO with DD DL-CPP:
* With maximum residual CFO 30Hz between UE and TRP, the accuracy drops from 0.0010m to 0.0018m @50% and from 0.0046m to 0.0208m @80% in InF-SH.
* With maximum residual CFO 100Hz between UE and TRP, the accuracy drops from 0.0010m to 0.0027m @50% and from 0.0046m to 0.0440m @80% in InF-SH.
* The evaluation results from the source [Qualcomm, R1-2212124] show the impact of Doppler in FR1 at 3kmph is small enough that it has negligible impact on the carrier phase positioning accuracy with DD DL-CPP, in the simulated scenario under the agreed modelling for residual CFO.
* Note 1: Unless indicated otherwise, the results shown above are for horizontal positioning accuracy with a single carrier of bandwidth of 100MHz in FR1.
* Note 2. Evaluation results above are mainly used as examples. Additional results and more details of the evaluation assumptions may be provided by the sources in Annex B.4-X [Huawei, vivo, CATT, ZTE, LGE, Qualcomm].

==== END of TP ====

**Agreement**

Capture the following observation in TR 38.859:

The impact of the ARP errors on NR carrier phase positioning is evaluated. 9 out of 9 sources ([Huawei, R1-2210903][vivo, R1-2211014][ CATT, R1-2211205][ ZTE, R1-2212520][ LGE, R1- 2211924][ Qualcomm, R1-2212124][ Ericsson, R1- R1-2212515] [Samsung R1-2212550]) show that the ARP errors may have significant impact on NR carrier phase positioning accuracy. 3 out of 8 sources ([Huawei, R1-2210903][ CATT, R1-2211205][ZTE, R1-2212520]) show the impact of gNB ARP position errors on multi-frequency carrier phase positioning is much smaller than the impact on single-frequency carrier phase positioning.

* Source [Huawei, R1-2210903] shows:
  + When double differential is not used:
    - For InF-SH scenario with 1cm ARP error:
      * UL-CPP (Case 23): 1.3368m @50% and 2.121m @80%
    - For InF-DH scenario with 1cm ARP error:
      * UL-CPP (Case 24): 1.2329m @ 50% and 1.9317m @80%
  + When double differential is used:
    - For InF-SH scenario with 1cm ARP error:
      * (PRU 5m) DD UL-CPP (Case 27): <1cm @ 50% and 0.57269m @80%
      * (PRU 2m) DD UL-CPP (Case31): <1cm @ 50% and <1cm @80%
    - For InF-DH scenario with 1cm ARP error:
      * (PRU 5m) DD UL-CPP (Case 28): 0.75118m @ 50% and 1.3217m @80%
      * (PRU 2m) DD UL-CPP (Case 32): 0.56419m@ 50% and 1.1915m @80%
  + When multi-frequency carrier phase positioning is used:
    - For InF-SH scenario with 1cm ARP error and random initial phase:
      * (PRU 5m) DD UL-CPP (Case 47): 1.252cm @ 50% and 2.765cm @80%
    - For InF-SH scenario with 5cm ARP error and random initial phase:
      * (PRU 5m) DD UL-CPP (Case 48): 5.986cm @ 50% and 0.11879m @80%
* Source [vivo, R1-2211014] shows:
  + For InF-SH scenario with 1cm ARP error:
    - SD DL-CPP: 0.09m @50% and 0.20m @80%.
  + For InF-SH scenario with 5cm ARP error:
    - SD DL-CPP: 0.18m @50%and 0.28m @80%
* Source [CATT, R1-2211205] shows:
  + For InF-SH scenario with 1cm ARP error:
    - DD DL-CPP (Cases 11): <1.0cm @50% and 11.2cm @80%.
    - DD DL-CPP (two subcarrier frequencies within one PFL) (Case 12): <1.0cm @50% and 1.79 cm @80%.
    - DD DL-CPP (two carrier frequencies) (Case 13): <1.0cm @50% and 1.3cm @80%.
  + For InF-SH scenario with 5cm ARP error:
    - DD DL-CPP (two carrier frequencies, two PFLs) (Case 15): 3.3cm @50% and 5.6cm @80%.
  + For InF-DH scenario with 1cm ARP error:
    - DD DL-CPP (two carrier frequencies, two PFLs) (Case 17): 1.5cm @50% and 3.3cm @80%.
* Source [ZTE, R1-2212520] shows:
  + For InF-SH scenario with 1cm ARP error:
    - DL-CPP (single carrier, case 3-2-1): 0.24m@50% and 0.44m@80%.
    - DL-CPP (multiple subcarriers within one PFL, case 3-2-4): 0.12m @50% and 0.25m@80%
  + For InF-SH scenario with 5cm ARP error:
    - DL-CPP (single carrier, case 3-2-3): 0.28m@50% and 0.44m@80%
    - DL-CPP (multiple subcarriers within one PFL, case 3-2-6): 0.15m@50% and 0.30m@80%
* Source [LGE, R1- 2211924] shows:
  + For InF-SH scenario with 1cm ARP error:
    - DD DL-CPP (single carrier): 0.188m (50%), 0.386m (80%)
* Source [Qualcomm, R1-2212124] shows:
  + For InF-SH scenario with 1cm ARP error
    - DD DL-CPP(Case 6, FR2): 3.487cm (50%) and 7.907cm (80%) (PRU-UE range R = 1m, more results with other values of R are available in Annex B.4-X-Qualcomm)
    - DD DL-CPP(Case 14, FR1): 0.05m (50%) and 0.18m (80%)
* Source [Ericsson, R1- R1-2212515] shows:
  + For InF-SH scenario with 1cm ARP error (average PRU-UE distance = 1m)
    - DD DL-CPP: 1.5cm (50%) and 3.0cm (80%)
  + For InF-SH scenario with 5cm ARP error (average PRU-UE distance = 1m)
    - DD DL-CPP: 10cm (50%) and 0.44m (80%)
* Source [Samsung R1-2212550] shows:
  + For InF-SH scenario with 2cm ARP error and random initial phase
    - DL-CPP (single carrier, case 08): 1.06m @50% and 1.54m @80%
* Note 1: Unless indicated otherwise, the results shown above are for horizontal positioning accuracy with a single carrier of bandwidth of 100MHz in FR1.
* Note 2. Evaluation results above are mainly used as examples. Additional results and more details of the evaluation assumptions may be provided by the sources in Annex B.4-X [Huawei, vivo, CATT, ZTE, LGE, Qualcomm, Ericsson].
* Note 3: The evaluation of multi-frequency carriers is based on the agreed assumption in Annex A.4 without requiring a UE to simultaneously measure more than one DL PFL.

**Agreement**

Capture the following observation in TR 38.859:

The impact of the UE/TRP phase center offset (PCO) errors on NR carrier phase positioning is evaluated in the study item. 2 out of 4 sources ([Huawei, R1-2210903][vivo, R1-2211014]) when UE/TRP antenna PCO model of Example 2 is used, the impact of the PCO errors can be significant. 2 out of 4 sources ([CATT, R1-2211205][Qualcomm, R1-2212124]) shows when UE/TRP antenna PCO model of Example1 is used, the impact of the PCO errors can be negligiable.

* Source [Huawei, R1-2210903] shows:
  + For InF-SH scenario with a=3:
    - SD DL-CPP (Case 37): 0.8469m @50% and 1.3922m @80%.
    - DD DL-CPP (Case 41): < 1cm @50% and <1cm @80%.
  + For InF-DH scenario with a=3:
    - SD DL-CPP (Case 38): 0.9192m @50% and 1.4393m @80%.
    - DD DL-CPP (Cases 42): 0.4896m @50% and 1.2148m @80%
* Source [vivo, R1-2211014] shows:
  + For InF-SH scenario with SD DL-CPP:
    - PCO model (a=1, w=[-2, +2], dPhi= [0, 5]): <1cm @50% and 0.06m @80%
    - PCO model (a=3, w=[-5, +5], dPhi= [0, 5]): <1cm @50% and 0.06m @80%
    - PCO model (a=3, w=[-5, +5], dPhi= [0, 20]): 0.046m @50% and 0.19m @80%
* Source [CATT, R1-2211205] shows:
  + For InF-SH scenario:
    - DD DL-CPP (Cases 20/21): < 1cm @50% and <1cm @80%.
  + For InF-DH scenario:
    - DD DL-CPP (Cases 22/23): <=1.3cm @50% and <=2.8cm @80%
* Source [Qualcomm, R1-2212124] shows:
  + For InF-SH scenario:
    - DD DL-CPP (Cases 4, FR2):
      * PCO model (a=0, w=5: 0.014cm @50% and 0.063cm @80%
      * PCO model (a=1, w=5: 0.015cm @50% and 0.076cm @80%
      * PCO model (a=3, w=5: 0.014cm @50% and 0.270cm @80%
    - DD DL-CPP (Cases 12, FR2):
      * PCO model (a=1, X=5: 0.04m @50% and 0.08m @80%
      * PCO model (a=3, X=5: 0.04m @50% and 0.08m @80%
* Note 1: Unless indicated otherwise, the results shown above are for horizontal positioning accuracy with a single carrier of bandwidth of 100MHz in FR1.
* Note 2. Evaluation results above are mainly used as examples. Additional results and more details of the evaluation assumptions may be provided by the sources in Annex B.4-X [Huawei, vivo, CATT, Qualcomm]

**Agreement**

Adoptthe following TP modification for TR 38.859

==== START of TP for TR 38.859 ====

Annex A.3: Evaluation Methodology for NR Carrier Phase Positioning

<Unrelated part omitted>

1. **Table A.3-1: Assumptions for evaluation of NR carrier phase positioning**

| **Assumptions** | **Value** | |
| --- | --- | --- |
| Scenarios | 1. Baseline: InF-SH, InF-DH 2. Optional: Indoor Open Office, Umi, Highway scenarios    1. Other evaluation scenarios are not precluded    2. Existing Rel-17 DL/UL reference signals for the Uu interface are to be used for the Highway scenario. | |
| Frequency errors – Note 1 | **Ideal** | **Practical** |
| Initial residual CFO  (is the same for one measurement instances [or multiple phase measurement instances]) | 0 (UE/TRP) | 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) | 0 (UE/TRP) | Uniform distribution within:   * [-0.1, 0.1] ppm (UE) * [-0.02, +0.02] ppm (each TRP) within measurement duration |
| Antenna reference point (ARP) location error of a TRP | No ARP error | 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 |
| Initial phase of a transmitter | Modelled as a random variable uniformly distributed within [0, 2pi]   * The initial phase of a transmitter applies to all subcarriers of the same carrier frequency associated with the transmitter The initial phases of a transmitter for different carriers can be assumed to be independent of each other. | |
| Initial phase of a receiver | Modelled as a random variable uniformly distributed within [0, 2pi]   * The initial phase of a receiver applies to all subcarriers of the same carrier frequency associated with the receiver * The initial phases of a receiver for different carriers can be assumed to be independent of each other. | |
| UE/TRP antenna phase center offset (PCO) | *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.   + Note: Example 1 may be more suitable for modelling the PCO of a uncalibrated antenna; while Example 2 may be more suitable for modelling the residual PCO of a calibrated antenna (see [R1-2208206]). * *w* is 0 or a random variable uniformly distributed within [-2, +2], or [-5, +5], or [-X, +X] degrees.   + value of X is left up to companies * Note: the above model is valid only when absolute value of *dPhi* < Y degrees   + value of Y is left up to companies | |
| Time instances for carrier phase measurements | 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) | |
| Note 1: The Doppler frequency can be determined based on the UE speed in the evaluation assumption. | | |

==== END of TP for TR 38.859 ====

**Agreement**

Capture the following TP into TR 38.859 as an evaluation observation (for Section 6.3.2):

The potential benefits of using the carrier phases of multiple carriers or multiple subcarriers are evaluated in the study item.

* The evaluation results from the sources (e.g., [Huawei/R1-2210903][CATT/R1-2211205][ZTE/ R1-2212520]) show that the use of the carrier phases of multiple carriers or multiple subcarriers together with double differential technique are beneficial for improving the accuracy of double differential carrier phase positioning.
* The evaluation results from the source [IIT Kanpur/R1-2212519] shows the use of multiple subcarrier technique is beneficial over single carrier.
* The evaluation from the sources [Qualcomm/R1-2212124]) show that combining carrier phase measurements from multiple groups of subcarriers is inferior to coherent processing of all subcarriers to obtain a single more accurate carrier phase measurements.
* One source ([vivo /R1-2211014]) show there is no benefit with the use of the carrier phases of multiple carriers for carrier phase positioning when single differential carrier phase positioning is used.
* The evaluation results from the source [Samsung/R1-2212250] show that the use of the carrier phases of multiple subcarriers together with round trip carrier phase technique is beneficial for improving the accuracy of carrier phase positioning.
* Source [Huawei, R1-2210903] shows:
  + When single-frequency carrier phases are used:
    - For InF-SH scenario with 5cm ARP error and random initial phase:
      * (PRU within 5m) DD UL-CPP (Case 45): 0.73594m @ 50% and 1.3812m @80%
  + When multi-frequency carrier phases are used:
    - For InF-SH scenario with 5cm ARP error and random initial phase:
      * (PRU within 5m) DD UL-CPP (Case 48): 5.986cm @ 50% and 0.11879m @80%
* Source [vivo/R1-2211014] shows:
  + When multi-frequency carrier phases are used:
    - For InF-SH scenario without other errors,
      * SD DL-CPP horizontal accuracy (Cases 703): < 1cm @50% and <1cm @80%.
    - For InF-SH scenario with ARP error
      * SD DL-CPP horizontal accuracy (Cases 703): < 1cm @50% and 0.18m @80%
    - For InF-SH scenario with initial phase error
      * SD DL-CPP horizontal accuracy (Cases 704): < 0.18m @50% and 0.34m @80%
    - For InF-SH scenario with PCO
      * SD DL-CPP horizontal accuracy (Cases 705): < 0.18m @50% and 0.13m @80%
* Source [CATT, R1-2211205[4]) shows:
  + For InF-SH scenario with other errors (ARP error, random initial phase, CFO/ Oscillator-drift)
    - DD DL-CPP horizontal accuracy (Cases 27/28): < 1cm @50% and <=2cm @80%.
  + For InF-DH scenario:
    - DD DL-CPP horizontal accuracy (Cases 29): 1.6cm @50% and 3.5cm @80%
* Source [ZTE/R1-2212520]) shows
  + When multiple subcarriers with in one PFL are used:
    - For InF-SH scenario with other errors (initial phase on both TRP and UE sides)
      * DL-CPP accuracy (Case 1-2-9, N is limited to +1): 0.12 m@50% and 0.25m @80%
* Source [Qualcomm, R1-2212124) shows:
  + For InF-SH scenario:
    - DD DL-CPP horizontal accuracy (Case 8, FR2): 0.05526m @50% and 1.42119m @80%.
* Source [IIT Kanpur, R1-2212519[20]) shows:
  + For InF-DH scenario:
    - Distance accuracy (Case 3): 0.44cm @50% and 0.55cm @80%
* Source [Samsung, R1-2212550] shows:
  + For InF-SH scenario (10MHz, @3GHz)
  + With multiple sub-carriers and round-trip carrier phase: < 1cm @ 50% and <1 cm @ 80%
* Note 1: Unless indicated otherwise, the results shown above are for horizontal positioning accuracy with a single carrier of bandwidth of 100MHz in FR1.
* Note 2. Evaluation results above are mainly used as examples. Additional results and more details of the evaluation assumptions may be provided by the sources in Annex B.4-X [Huawei, vivo, CATT, ZTE, Qualcomm, IIT Kanpur].

**Agreement**

Capture thefollowing for TR 38.859 as observation (Section 6.3.2):

The positioning accuracy of Phase-Difference-based AoD positioning has been evaluated.

Source [Qualcomm R1-2212124] shows that a positioning accuracy of 1m (80%) for InF-SH with 20 MHz, is achievable.

**Agreement**

Adoptthe following TP modification for TR 38.859 (Section 6.3.2):

==== START of TP (for TR 38.859) ====

6.3.2 Summary of Evaluations for NR Carrier Phase Positioning

The methodology for the evaluation of NR carrier phase positioning can be found in Annex A.3.

Different evaluation assumptions may be used for the evaluation cases by different sources. Different algorithms and methods may also be used for estimating the carrier phases and determining UE’s location based on the carrier phases. Thus, for the observations of evaluation results presented in this section, it is important to consider the details of the evaluation assumptions as well as the algorithms and methods provided by each source in the references (e.g., in Annex B.4).

==== END of TP ====

**Agreement**

Capture the following TP into TR 38.859 in section 6.3.1.

* The potential solutions of integer ambiguity resolution for NR carrier phase positioning were investigated in the study item, which include the following:
  + Reporting of the carrier phases of more than one frequency from UE/TRP to LMF;
    - Note: frequency refers to frequency of carrier or frequency of subcarrier(s)
  + Reporting of the determined integer ambiguity and/or the search range of the integer ambiguity from UE/TRP to LMF;
  + Reporting of the carrier phase measurements together with the legacy positioning measurements from UE/TRP to LMF;
  + Reporting of the new measurements from UE /TRP to LMF, e.g., based on carrier phase differentials across multiple subcarriers within a carrier;
    - Note: carrier phase differentials across multiple subcarriers within a carrier can be equivalent to time of arrival
  + LMF configure the integer ambiguity range between the TRP and target UE (for UE-based NR CPP).

**Agreement**

Adoptthe following TP for TR 38.859 (Section 6.3.2):

The effectiveness of using round-trip carrier phase technique to mitigate the impact of the initial phases of the transmitter and the receiver on NR carrier phase positioning is evaluated by source [Samsung/R1-2212859] for InF-SH, which shows the horizontal positioning accuracy of:

* 0.5cm @80% with continuous sub-carrier allocation in 10 MHz BW (i.e. with enhanced PRS),
* 1cm @80% with Comb-4 sub-carrier allocation in 10 MHz BW and no sub-carrier offset change between symbols (i.e. with enhanced PRS), and
* 1.5cm @80% with Comb-4 sub-carrier allocation in 10 MHz BW and with sub-carrier offset change between symbols (i.e. with existing PRS).

Note: The evaluation results assumed phase coherency between the transmit path and the receive path of each device

**Agreement**

Capture the following TP in the Conclusion of TR 38.859.

Based on the study, it is concluded that it is feasible to use existing DL PRS and SRS signals to obtain the carrier phase measurements for achieving a horizontal accuracy of up to a few centimeters at least at 50% under certain conditions, including the PRU(s) being located in LOS with TRP(s), and the locations of the PRU(s) and TRPs known with centimeter-level accuracy, in the agreed evaluation assumptions.

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

**Response to LS from RAN2 in R1-2210804**

**Agreement**

Reply to RAN2 with regards to the feasibility of SRS in multiple cells as the following

* SRS positioning configuration for LPHAP across multiple cells is feasible from RAN1’s perspective after checking the potential issues of interference, timing alignment (depending on uplink synchronization conditions), spatial relation, and power control, with or without potential enhancements depending on deployment conditions.

**Agreement**

The draft LS in R1-2212727 is endorsed. Final LS reply to RAN2 on SRS in multiple cells is agreed in R1-2212728.

**Response to LS from SA2 in R1-2210825**

**Agreement**

Reply to SA2 with regards to LPHAP information delivery to RAN as the following.

* RAN1 currently has not identified the need from the physical layer perspective for SA2 to consider LPHAP information delivery to RAN before the positioning procedure is triggered.

**Agreement**

The draft LS in R1-2212724 is endorsed. Final LS reply to SA2 on LPHAP information delivery to RAN is agreed in R1-2212725.

**Observation**

Capture the following as an observation in TR 38.859 Section 6.4.3:

* Evaluation results of extending DRX cycle are provided by 13 sources ([2/HW,Hisilicon], [3/vivo], [4/CATT], [6/Spreadtrum], [7/Nokia,NSB], [8/xiaomi], [9/Intel], [11/ZTE], [12/Sony], [13/CMCC], [18/Samsung], [19/Qualcomm], [20/Ericsson]) out of 19 sources, the following is observed:
  + Results with extended DRX cycle beyond 10.24s provide power saving gains with respect to that with the baseline DRX cycle of 1.28s, and is beneficial towards meeting the battery life requirement as extended DRX cycle beyond 10.24s allows a UE to remain in a deeper sleep state for a longer duration.
  + From the evaluations,
    - Power saving gains achieved with extended DRX cycle with respect to baseline DRX cycle 1.28s are provided by 2 sources ([3/vivo], [13/CMCC]):
      * In [3/vivo], 87%~90% power saving gains are achieved with DRX cycle of 30.72s with respect to that with the baseline DRX cycle of 1.28s;
      * In [13/CMCC], 35.05%~53.70% power saving gains are achieved with DRX cycle of 10.24s with respect to that with the baseline DRX cycle of 1.28s, and 37.56%~57.53% power saving gains are achieved with DRX cycle of 20.48s with respect to that with the baseline DRX cycle of 1.28s;
    - Results on battery life of extended DRX cycle together with ultra-deep sleep state are provided by 13 sources ([2/HW,Hisilicon], [3/vivo], [4/CATT], [6/Spreadtrum], [7/Nokia,NSB], [8/xiaomi], [9/Intel], [11/ZTE], [12/Sony], [13/CMCC], [18/Samsung], [19/Qualcomm], [20/Ericsson]), and the target requirement of 6~12 months is achieved by 12 sources in some cases.

**Observation**

Capture the following as an observation in TR 38.859 Section 6.4.3:

* Evaluation results of UE (re)entering RRC\_CONNECTED state to obtain SRS (re)configuration for UL/DL+UL positioning are provided by 7 sources ([2/HW,Hisilicon], [3/vivo], [4/Futurewei], [9/Intel], [11/ZTE], [13/CMCC], [19/Qualcomm], [20/Ericsson]) out of 19 sources, the following is observed:
  + UE (re)entering RRC\_CONNECTED state to obtain SRS (re)configuration increases power consumption, and results without SRS (re)configuration procedure provide power saving gains with respect to that with (re)entering RRC\_CONNECTED state to obtain SRS (re)configuration.
  + From the evaluations,
    - In [2/HW,Hisilicon], 65.2790% of total power is consumed by SRS (re)configuration for UL positioning; UE (re)entering RRC\_CONNECTED state to obtain SRS (re)configuration increases the power consumption by 3 times;
    - In [3/vivo], UE (re)entering RRC\_CONNECTED state to obtain SRS (re)configuration every 10.24s/20.48s/40.96s increases the power consumption by 8.71%/4.47%/2.23% with DRX cycle of 1.28s and by 13.38%/6.69%/3.34% with DRX cycle of 10.24s;
    - In [4/Futurewei], 23.81%~52.62% of total power is consumed by SRS (re)configuration for UL positioning, and 21.65%~26.54% of total power is consumed by SRS (re)configuration for DL+UL positioning;
    - In [11/ZTE], 11.6%~34.4% of total power is consumed by SRS (re)configuration for UL positioning with ultra-deep sleep state option 1 with additional transition energy 10000, and 46.2%~77.5% of total power is consumed by SRS (re)configuration for UL positioning with ultra-deep sleep state option 2;
    - In [13/CMCC], 11.28%~52.41% of total power is consumed by SRS (re)configuration for UL positioning; Without SRS (re)configuration procedure, 55.07%/20.38%/11.85% power saving gains are achieved for DRX cycle of 1.28s/10.24s/20.48s.
* Evaluation results on battery life assuming no SRS (re)configuration together with ultra-deep sleep state are provided by 11 sources ([2/HW,Hisilicon], [3/vivo], [6/Spreadtrum], [7/Nokia,NSB], [8/xiaomi], [9/Intel], [11/ZTE], [13/CMCC], [18/Samsung], [19/Qualcomm], [20/Ericsson]) out of 19 sources, and the target requirement of 6~12 months is achieved by all 11 sources.

**Observation**

Capture the following observation in TR 38.859 Section 6.4.3:

* Summary table of results of overall enhancements (Table 8 in Section 3.2.1).
* Evaluation results on the battery life of overall enhancements including at least one or combinations of DRX cycle beyond 10.24s, ultra-deep sleep state, minimized gaps between PRS/SRS/paging/reporting/synchronization, and no SRS (re)configuration procedure, are provided by 13 sources ([2/HW,Hisilicon], [3/vivo], [4/CATT], [6/Spreadtrum], [7/Nokia,NSB], [8/xiaomi], [9/Intel], [11/ZTE],[12/Sony], [13/CMCC], [18/Samsung], [19/Qualcomm], [20/Ericsson]) out of 19 sources.
* For the evaluation with ultra-deep sleep state option 1 with additional transition energy 10000, results are provided by 13 sources ([2/HW,Hisilicon], [3/vivo], [4/CATT], [6/Spreadtrum], [7/Nokia,NSB], [8/xiaomi], [9/Intel], [11/ZTE],[12/Sony], [13/CMCC], [18/Samsung], [19/Qualcomm], [20/Ericsson]) out of 19 sources, and the following is observed:
  + For the baseline LPHAP Type A device with battery capacity C2 of 800mAh, the target requirement of 6~12 months is achieved by 1 source ([20/Ericsson]) with baseline implementation factor K = 1, and is achieved by 8 sources ([3/vivo], [4/CATT], [7/Nokia,NSB], [8/xiaomi], [9/Intel], [11/ZTE], [13/CMCC], [19/Qualcomm]) with optional implementation factor K;
  + For the optional LPHAP Type B device with battery capacity C2 of 4500mAh, the target requirement of 6~12 months is achieved by 8 sources ([3/vivo], [4/CATT], [7/Nokia,NSB], [8/xiaomi], [9/Intel], [11/ZTE], [13/CMCC], [19/Qualcomm]) with baseline implementation factor K = 1, and is achieved by 6 sources ([3/vivo], [6/Spreadtrum], [7/Nokia,NSB], [11/ZTE], [13/CMCC], [19/Qualcomm]) with optional implementation factor K;
* For the evaluation with ultra-deep sleep state option 1 with additional transition energy 5000, results are provided by 4 sources ([3/vivo], [9/Intel], [11/ZTE], [13/CMCC]) out of 19 sources, and the following is observed:
  + For the baseline LPHAP Type A device with battery capacity C2 of 800mAh, the target requirement of 6~12 months is achieved by 2 sources ([3/vivo], [9/Intel]) with baseline implementation factor K = 1, and is achieved by 4 sources ([3/vivo], [9/Intel], [11/ZTE], [13/CMCC]) with optional implementation factor K;
  + For the optional LPHAP Type B device with battery capacity C2 of 4500mAh, the target requirement of 6~12 months is achieved by 3 sources ([3/vivo], [11/ZTE], [13/CMCC]) with baseline implementation factor K = 1, and is achieved by 3 sources ([3/vivo], [11/ZTE], [13/CMCC]) with optional implementation factor K;
* For ultra-deep sleep state option 2 (including TDMed with ultra-deep sleep option 1 for power cycles in which paging reception is required), results are provided by 4 sources ([2/HW,Hisilicon], [8/xiaomi], [11/ZTE], [13/CMCC]) out of 19 sources, and the following is observed:
  + For the baseline LPHAP Type A device with battery capacity C2 of 800mAh, the target requirement of 6~12 months is achieved by 4 sources ([2/HW,Hisilicon], [8/xiaomi], [11/ZTE], [13/CMCC]) with baseline implementation factor K = 1, and is achieved by 2 sources ([11/ZTE], [13/CMCC]) with optional implementation factor K;
  + For the optional LPHAP Type B device with battery capacity C2 of 4500mAh, the target requirement of 6~12 months is achieved by 1 source ([13/CMCC]) with baseline implementation factor K = 1, and is achieved by 1 source ([13/CMCC]) with optional implementation factor K;

**Agreement**

Updated the previous observation in TR 38.859 Section 6.4.3 (editorial modifications references for the sources can be made when incorporating into the TR):

* For the evaluation on the battery life of the baseline LPHAP Type A device with battery capacity C2 of 800mAh:
* Based on the results provided by all sources, the target requirement of 6~12 months is not achieved by the existing Rel-17 positioning for UEs in RRC\_INACTIVE state with baseline implementation factor K = 1 and baseline evaluation assumptions.
* Based on the results provided by all sources, the target requirement of 6~12 months is not achieved by the existing Rel-17 positioning for UEs in RRC\_INACTIVE state with optional implementation factor K or optional evaluation assumptions.
* For UE-assisted DL positioning, results are provided by 14 sources ([34], [36], [3/vivo], [7/Nokia, NSB], [40], [12/Sony], [43], [8/xiaomi], [45], [48], [50], [52], [53], [9/Intel]) out of 20 sources, and the following are observed:
* The target requirement of 6 months is achieved by 0 source, and is not achieved by 14 sources ([34],[36], [3/vivo], [7/Nokia, NSB],[40], [12/Sony],[43], [8/xiaomi],[45],[48],[50],[52],[53], [9/Intel]) even with the most power efficient case that I-DRX cycle of 10.24s, 1 RS per 1 I-DRX cycle, high SINR, CG-SDT for measurement reporting, and implementation factor K = 4.
* The target requirement of 12 months is achieved by 0 source, and is not achieved by 14 sources ([34],[36], [3/vivo],, [7/Nokia, NSB],[40], [12/Sony],[43], [8/xiaomi],[45],[48],[50],[52],[53], [9/Intel]) even with the most power efficient case that I-DRX cycle of 10.24s, 1 RS per 1 I-DRX cycle, high SINR, CG-SDT for measurement reporting, and implementation factor K = 4.
* For UE-based DL positioning, results are provided by 11 sources ([34], [36], [3/vivo], [7/Nokia, NSB], [40], [43], [8/xiaomi], [45], [50], [52],[9/Intel]) out of 20 sources, and the following are observed:
* The target requirement of 6 months is achieved by 0 source, and is not achieved by 11 sources ([34],[36], [3/vivo], [7/Nokia, NSB],[40],[43], [8/xiaomi],[45],[50],[52],[9/Intel]) even with the most power efficient case that I-DRX cycle of 10.24s, 1 RS per 1 I-DRX cycle, high SINR, and implementation factor K = 4.
* The target requirement of 12 months is achieved by 0 source, and is not achieved by 11 sources ([34],[36], [3/vivo], [7/Nokia. NSB],[40],[43], [8/xiaomi],[45],[50],[52],[9/Intel]) even with the most power efficient case that I-DRX cycle of 10.24s, 1 RS per 1 I-DRX cycle, high SINR, and implementation factor K = 4.
* For UL positioning, results are provided by 13 sources ([34], [36], [3/vivo], [7/Nokia, NSB], [40], [43], [8/xiaomi], [45], [48], [50], [52], [53], [9/Intel]) out of 20 sources, and the following are observed:
* The target requirement of 6 months is achieved by 0 source, and is not achieved by 13 sources ([34], [36], [3/vivo], [7/Nokia, NSB], [40], [43], [8/xiaomi], [45], [48], [50], [52], [53], [9/Intel]) even with the most power efficient case that I-DRX cycle of 10.24s, 1 RS per 1 I-DRX cycle, high SINR, no SRS (re)configuration, and implementation factor K = 4.
* The target requirement of 12 months is achieved by 0 source, and is not achieved by 13 sources ([34], [36], [3/vivo], [7/Nokia, NSB], [40], [43], [8/xiaomi], [45], [48], [50], [52], [53], [9/Intel]) even with the most power efficient case that I-DRX cycle of 10.24s, 1 RS per 1 I-DRX cycle, high SINR, no SRS (re)configuration, and implementation factor K = 4.
* For DL+UL positioning, results are provided by 1 source ([52]) out of 20 sources, and the following are observed:
* The target requirement of 6 months is achieved by 0 source, and is not achieved by 1 source ([52]) even with the most power efficient case that I-DRX cycle of 10.24s, 1 RS per 1 I-DRX cycle, high SINR, no SRS (re)configuration, CG-SDT for measurement reporting, and implementation factor K = 4.
* The target requirement of 12 months is achieved by 0 source, and is not achieved by 1 source ([52]) even with the most power efficient case that I-DRX cycle of 10.24s, 1 RS per 1 I-DRX cycle, high SINR, no SRS (re)configuration, CG-SDT for measurement reporting, and implementation factor K = 4.
* For the evaluation on the battery life of the optional LPHAP Type B device with battery capacity C2 of 4500mAh:
* Based on the results provided by all sources, the target requirement of 6~12 months is not achieved by the existing Rel-17 positioning for UEs in RRC\_INACTIVE state with the baseline implementation factor K=1 and baseline evaluation assumptions.
* For UE-assisted DL positioning, results are provided by 9 sources ([36], [3/vivo], [7/Nokia, NSB], [12/Sony], [43], [45], [50], [52], [8/xiaomi]) out of 20 sources, and the following are observed:
* The target requirement of 6 months is achieved by 5 sources ([36], ,[45],[52], [8/xiaomi], [10/Sony]) with the implementation factor K = 4 and by 4 sources ([43],[50], [3/vivo], [7/Nokia, NSB]) with the implementation factor K >= 2, and is not achieved by 5 sources with the implementation factor K < 4 ([36] ,[42],[45],[52], [8/xiaomi]) and by 4 sources ([43],[50], [3/vivo], [7/Nokia, NSB]) with the implementation factor K < 2.
* The target requirement of 12 months is achieved by 5 sources ([43],[50],[52], [3/vivo], [7/Nokia. NSB]) with the case that I-DRX cycle of 10.24s, 1 RS per 1 I-DRX cycle, high SINR, CG-SDT for reporting and implementation factor K = 4, and is not achieved by 9 sources ([36], [3/vivo], [7/Nokia, NSB], [10/Sony],[43],[45],[50],[52], [8/xiaomi]) with the implementation factor K < 4.
* For UE-based DL positioning, results are provided by 8 sources ([36], [3/vivo], [7/Nokia, NSB], [43], [45], [50], [52], [8/xiaomi]) out of 20 sources, and the following are observed:
* The target requirement of 6 months is achieved by 4 sources ([36], [45],[52], [8/xiaomi]) with the implementation factor K = 4 and by 4 sources ([43],[50], [3/vivo], [7/Nokia, NSB]) with the implementation factor K >= 2 , and is not achieved by 4 sources with the implementation factor K < 4 ([36], [45],[52], [8/xiaomi]) and by 4 sources ([43],[50], [3/vivo], [7/Nokia, NSB]) with the implementation factor K < 2;
* The target requirement of 12 months is achieved by 5 sources ([43],[50],[52], [3/vivo], [7/Nokia, NSB]) with the case that I-DRX cycle of 10.24s, 1 RS per 1 I-DRX cycle, high SINR, and implementation factor K = 4, and is not achieved by 8 sources ([36], [3/vivo], [7/Nokia, NSB], [43], [45], [50], [52], [8/xiaomi]) with the implementation factor K < 4.
* For UL positioning, results are provided by 8 sources ([36], [3/vivo], [7/Nokia, NSB], [43], [45], [50], [52], [8/xiaomi]) out of 20 sources, and the following are observed:
* The target requirement of 6 months is achieved by 4 sources ([36], ,[45],[52], [8/xiaomi]) with the implementation factor K = 4 and by 4 sources ([43],[50],[3/vivo], [7/Nokia, NSB]) with the implementation factor K >= 2, and is not achieved by 4 sources ([36] ,[45],[52], [8/xiaomi]) with the implementation factor K < 4 and by 4 sources ([43],[50],[3/vivo],[7/Nokia, NSB]) with the implementation factor K < 2;
* The target requirement of 12 months is achieved by 5 sources ([43],[50],[52],[3/vivo],[7/Nokia, NSB]) with the case that I-DRX cycle of 10.24s, 1 RS per 1 I-DRX cycle, high SINR, no SRS (re)configuration, and implementation factor K = 4, and is not achieved by 8 sources ([36], [3/vivo], [7/Nokia, NSB], [43], [45], [50], [52], [8/xiaomi]) with the implementation factor K < 4.
* For DL+UL positioning, results are provided by 1 source ([52]) out of 20 sources, and the following are observed:
* The target requirement of 6 months is achieved by 1 source ([52]) with implementation factor K = 4, and is not achieved by 1 source ([52]) with implementation factor K < 4;
* The target requirement of 12 months is achieved by 1 source ([52]) with the case that I-DRX cycle of 10.24s, 1 RS per 1 I-DRX cycle, high SINR, no SRS (re)configuration, CG-SDT for measurement reporting, and implementation factor K = 4, and is not achieved by 1 source ([52]) with implementation factor K < 4.
* Note: The implementation factor K is a factor related to the reference device in the model to convert the relative power unit to the battery life. Four values are introduced for K with K = 1 as the baseline and K = 0.5, 2, 4 as optional values. The model is captured in the Annex A.4.
* Note: Without otherwise noted, “high SINR” in the observation refers to the evaluation case that no intra-/inter-frequency RRM and single SSB for synchronization purpose is considered.

**Conclusion**

The conclusion from RAN1#110bis-e on the benefit of extending paging DRX cycle will be captured in the TR.

**Observation**

Capture the following as an observation in TR 38.859 Section 6.4.3:

* Evaluation results of minimized gaps between PRS/SRS/paging/reporting/synchronization are provided by 10 ([2/HW,Hisilicon], [3/vivo], [6/Spreadtrum], [8/xiaomi], [11/ZTE], [12/Sony], [13/CMCC], [18/Samsung], [19/Qualcomm], [20/Ericsson]) sources out of 19 sources, the following is observed:
  + Minimizing gaps between PRS/SRS/paging/reporting/synchronization reduces power consumption, and results with minimized gaps between PRS/SRS/paging/reporting/synchronization provide power saving gains with respect to that without minimized gaps.
  + From the evaluations,
    - Comparative results with and without optimization of minimized gaps between PRS/SRS/paging/reporting/synchronization are provided by 3 sources ([12/Sony], [13/CMCC], [20/Ericsson]):
      * In [12/Sony], 8%~35% and 12.7%~44.5% power saving gains are achieved for DRX cycle 1.28s and 13.2% and 34% power saving gains for DRX cycle 10.24 sec, with minimized gaps between PRS/SRS/paging/reporting/synchronization with sleep states in TR 38.840 and ultra-deep sleep state option 1 with additional transition energy 10000;
      * In [13/CMCC], 5.48%~15.59%, 1.05%~3.60%, and 0.54%~1.96% power saving gains are achieved with minimized gaps between PRS/SRS/paging/reporting/synchronization for DRX cycle 1.28s, 10.24s, and 20.48s with sleep states in TR 38.840; 17.14%~33.33% power saving gains are achieved with minimized gaps between PRS/SRS/paging/reporting/synchronization for DRX cycle of 20.48s with ultra-deep sleep option 1.
  + Results on battery life of assuming minimized gaps between PRS/SRS/paging/reporting/synchronization together with DRX cycle equal to or larger than 10.24s and ultra-deep sleep state are provided by 10 sources ([2/HW,Hisilicon], [3/vivo], [6/Spreadtrum], [8/xiaomi], ~~[9/Intel]~~, [11/ZTE], [12/Sony], [13/CMCC], [18/Samsung], [19/Qualcomm], [20/Ericsson]), and the target requirement of 6~12 months is achieved by 9 sources.
* Results of paging and/or PEI triggered positioning are further provided by 2 sources ([11/ZTE], [18/Samsung]) based on minimized gaps, which is beneficial to improve battery life as it allows a UE to perform positioning measurement and/or reporting behaviors:
  + In [11/ZTE], PEI triggered positioning improves battery life by 0.24~1.64 months, for DRX cycle 10.24s, with multiple ultra-deep sleep state options;
  + In [18/Samsung], paging triggered positioning improves battery life by 0.08 (6.02%) ~0.17 (7.98%) months for DL positioning, and by 0.02 (1.71%)~0.05 (1.96%) months for UL positioning; PEI triggered positioning improves battery life by 0.09 (6.77%) ~0.62 (29.11%) months for DL positioning, and by 0.04 (2.90%) ~0.47 (20.61%) months for UL positioning, for DRX cycle 10.24s and 20.48s, and ultra-deep sleep state option 1 with additional transition energy 10000.
* Results on battery life of skipping paging reception are further provided by 1 source ([2/HW, HiSilicon] out of 19 sources, configuring a DRX cycle longer than positioning periodicity (up to 81.92s) or without paging reception can achieve 44.32%~89% power saving gain and is beneficial to improve battery life as it allows a UE to wake up using ultra-deep sleep state option 2 when only performing positioning related operations to achieve the target requirement of LPHAP. When UE wakes up to perform other operations than just positioning related operations, the UE uses ultra-deep sleep state option 1.
* Results of only using TRS-based synchronization in adjacent slot to SRS ~~is~~ are further provided by 1 source ([2/HW,HiSilicon]) under ultra-deep sleep state option 2 without paging reception, which achieves 23.33% power saving gain and further improves battery life with respect to that using SSB-based synchronization for UL positioning.

**Observation for TR 38.859 Section 6.4.3:**

* Evaluation results of simplified PRS configuration on both battery life and accuracy are provided by 1 source ([11/ZTE]) out of 19 sources, the following is observed:
  + In the case of K=1, C2=800, DRX cycle = 10.24s with ultra-deep sleep option 2, 1-symbol PRS can satisfy 6-month battery life but more than 1 symbol PRS cannot.
  + The positioning accuracy of 1-symbol PRS and comb size > 12 barely reduces and can meet the accuracy requirement in some cases.

**Agreement**

* For the conclusion section of the TR:
  + For UL and DL+UL positioning for UEs in RRC\_INACTIVE state, the enhancements on SRS for positioning in order to avoid frequent RRC connection for SRS (re)configuration is recommended for normative work.
* For the potential specification impact section of the TR:
  + For UL and DL+UL positioning for UEs in RRC\_INACTIVE state, the details of solutions for enhancements on SRS for positioning to avoid frequent RRC connection for SRS (re)configuration can be further discussed during normative work, which may include but are not limited to one or combinations of the following:
    - SRS for positioning configurations in multiple cells.
      * Note: Details including issues such as interference, timing advance, spatial relation information, pathloss reference and common SRS parameters across multiple cells can be further discussed during normative work.
    - Pre-configuration of one or multiple SRS for positioning configurations.
    - SRS for positioning activation/request procedure(s).

**Agreement**

Extending DRX cycle beyond 10.24s was studied and found beneficial towards meeting the battery life requirement for LPHAP, and is recommended for normative work on Rel-18 positioning enhancements from RAN1’s perspective.

* Note: no RAN1 specification impact has been identified

**Agreement**

From RAN1’s perspective, DL PRS measurement for UEs in RRC\_IDLE state is recommended for the normative work.

**Agreement**

For the conclusion section of the TR:

* Enhancements on simplified DL PRS configuration with 1-symbol PRS can be studied further and if needed, specified during normative phase.

**Agreement**

For the conclusion section of the TR:

The study of Rel-18 LPHAP focuses on the evaluation of whether the existing Rel-17 positioning techniques for UEs in RRC\_INACTIVE state can support the battery life and positioning requirements, and on the analysis of potential enhancements to address any limitations for UEs in RRC\_INACTIVE and/or RRC\_IDLE states, as outlined in Clause 6.4.

The target use case for LPHAP is studied and confirmed that the use case 6 defined by SA1 as the single representative use case. The performance requirement of LPHAP use case 6 is defined, including horizontal accuracy, positioning interval, and battery life. It is assumed that 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 objective of the LPHAP evaluations from the perspective of lower layers is on UE power consumption, as outlined in Clause 6.4.1.

The evaluations on the existing Rel-17 positioning techniques for UEs in RRC\_INACTIVE state show that the target battery life required by LPHAP use case 6 cannot be satisfied for majority of the evaluation scenarios that are examined. Based on the evaluation, it is concluded that enhancements to meet the target battery life in Rel-18 are necessary.

The following enhancements are recommended for normative work:

* For UL and DL+UL positioning for UEs in RRC\_INACTIVE state, the enhancements on SRS for positioning in order to avoid frequent RRC connection for SRS (re)configuration is recommended for normative work.
* Extending DRX cycle beyond 10.24s was studied and found beneficial towards meeting the battery life requirement for LPHAP, and is recommended for normative work on Rel-18 positioning enhancements from physical layer’s perspective.
* From physical layer’s perspective, DL PRS measurement for UEs in RRC\_IDLE state is recommended for the normative work.

###### Positioning for RedCap UEs:

**Agreement**

Update the following observations in the TR

**Observation**

Regarding the performance for positioning of Redcap UEs using frequency hopping in IIoT scenarios, considering phase offset between hops:

* In FR1, based on the results provided by the following sources,
  + - if the phase offset between hops in Frequency hopping is compensated, for InF SH the positioning requirement for IIOT use cases can be achieved using frequency hopping with partial overlap for the purpose of phase offset compensation,
      * Sources in R1-2208457 show that UL TDOA can meet the requirements
      * Sources in R1-2208457, R1-2209217, R1-2211016 show that DL TDOA can meet the requirements
      * Sources in R1-2208652, show that the requirement cannot be met, even if the phase is compensated.
    - If the phase offset between hops in Frequency hopping is not compensated
      * Sources in R1-2209217 and R1-2211619 show that DL TDOA can meet the requirements if the random phase offset is set to be equal or smaller than 0.~~5~~2\*2π.
      * Sources in R1-2211732 show that DL TDOA cannot meet the requirement with the random phase offset distributed from [-π, π].
  + ~~If the phase offset is ideally compensated~~ 
    - * ~~Sources in R1-2208652, show that DL TDOA can meet the requirements~~
* In FR2, based on the results provided by the following sources,
  + - R1-2209994 observed that the requirements can be met even if the phase is not compensated
    - R1-2209217 observed that PRS frequency hopping can improve positioning performance if the random phase between hops can be adjusted in FR2, InF-SH scenario.
* Note: Sources used different combinations of number of hops, gap size between hops and partial overlap sizes in their evaluations
* Note: Editorial modifications and addition of references for the sources may be added by the rapporteur when capturing the agreement in the TR, including replacing sources by references and providing the number of sources in the main bullet points, and including additional sources and other revisions.

**Observation**

Regarding the performance for positioning of Redcap UEs using Rx hopping for reception of the DL PRS or Tx hopping for transmission of the UL SRS in IIoT scenarios, considering time gap between hops:

* In FR1 for InF SH, based on the results provided by the following sources,
  + For UL-TDOA, source in R1-2210905 shows that the requirement can be met for a gap of 1ms and cannot be met for a gap of 5ms.
  + For DL-TDOA, source in R1-2210905 shows that the requirement can be met for a gap of 1ms and cannot be met for a gap of 5ms.
  + For DL-TDOA, source in R1-2212743 shows that the requirement can be met for a gap of 1ms and cannot be met for a gap of more than 2ms
  + For DL-TDOA, source in R1- 2211016 shows that the requirement can be met for a gap of 4ms
  + For DL-TDOA, source in R1- 2212517 shows that the requirement can be met for a gap of 5ms

**Observation**

Regarding the performance for positioning of Redcap UEs using Rx hopping for reception of the DL PRS or Tx hopping for transmission of the UL SRS in IIoT or commercial scenarios, considering time gap between hops together with UE speed:

* In FR1, for InF SH based on the results provided by the following sources,
  + For UL-TDOA, source in R1-2210905 shows that the horizontal accuracy requirement can be met for a gap of 140us for UE speed of up to 120km/h
  + For DL-TDOA, source in R1-2211016 shows that the horizontal accuracy requirement can be met for a gap of 2 or 4 ms for UE speed of up to 30km/h, and cannot be met for 60km/h
  + For DL-TDOA, source in R1-2212743 shows that the requirement can be met for a gap of 0.1ms for UE speed of up to 150km/h; the horizontal accuracy requirement can be met for a gap of 0.2ms for UE speed of up to 60km/h; the horizontal accuracy requirement can be met for a gap of 0.5ms for UE speed of up to 30km/h; the horizontal accuracy requirement can be met for a gap of 1ms, 2ms, 5ms for UE speed of up to 3km/h.
* In FR1, for UMi, based on the results provided by the following sources,
  + For multi-RTT, source in R1-2212126 shows that the requirement for commercial scenarios cannot be met, but performance of frequency hopping with 5 hops and 640 usec switching gap degrades only marginally for speeds of 30 or 60 kmh over 3kmh.

**Observation**

Regarding the performance for positioning of Redcap UEs using Rx hopping for reception of the DL PRS in IIoT scenarios, considering timing error during the frequency hopping:

* In FR1, for InF SH based on the results provided by the following sources,
  + For DL-TDOA, source in R1-2211016 shows the IIOT horizontal accuracy requirement cannot be met if the timing error is 3ns
  + For DL-TDOA, source in R1-2212743 shows the IIOT horizontal accuracy requirement can be met if the timing error is 2ns, but cannot be met if the timing error is 3ns

**Observation**

In FR1, for InF-SH, the performance of carrier phase positioning with RedCap UEs using 20MHz of bandwidth was evaluated without modeling the agreed error sources

* Sources in [R1-2211016] [R1-2211207] show that a redcap UE using CPP can meet the IIOT requirement under ideal conditions and known integer ambiguity.
* Source in [R1-2212743] shows that a redcap UE using CPP cannot meet the IIOT requirements with a fixed search range of integer ambiguity.
* Source in [R1-2211016] shows that with an estimated integer ambiguity, a redcap UE using CPP cannot meet the IIOT requirements
* Source in [R1-2212054] shows that a redcap UE using CPP can meet the IIOT requirements, under some conditions for integer ambiguity resolution.
* Source in [R1-2212517] shows that a redcap UE using CPP can meet the IIOT requirements if frequency hopping enhancements are also used and cannot meet the IIOT requirements without enhancements.
* Source in [R1-2212126] shows that a redcap UE using phase-difference AoD improves performance over RSRPP-based AoD but cannot meet the IIoT requirements.

**Agreement**

Capture the following in the TR conclusions:

* From RAN1 perspective, for positioning of RedCap UEs, support of PRS frequency hopping and SRS frequency hopping is recommended for normative work.
  + During the normative phase, the complexity of the corresponding capabilities for RedCap UEs should be addressed for the introduction of appropriate capabilities for RedCap UEs.

**Agreement**

The observation for baseline performance for positioning of RedCap UEs for IIOT scenarios is updated as follow:

Observation

Capture the following observations in the TR, regarding the baseline performance for positioning of Redcap UEs for IIOT scenarios:

* Based on the results provided by a majority of X sources, for InF-SH in FR1, the horizontal positioning requirement for IIOT use cases is not achieved by Rel.17 solutions using 5MHz or 20MHz of bandwidth.
  + - Sources in R1-2208457, R1-2210179 show that UL TDOA cannot meet the requirement
    - Sources in R1-2209994, R1-2210179 show that multi-RTT cannot meet the requirement
    - Sources in R1-2208803, R1-2208985, R1-2209061, R1-2209108, ~~R1-2209153~~, R1-2209217, R1-2209491, R1-2209740, R1-2210179, R1-2212054, R1-2211314 show that DL-TDOA cannot meet the requirement
    - Source in R1-2208652 shows that the requirement can be met using 20MHz of bandwidth.
    - Source in R1-2208652 shows that the requirement cannot be met using 5MHz of bandwidth.
    - Source in R1-2211926 shows that UL-AoA cannot meet the requirement
    - Source in R1-2212126 shows that DL-AoD cannot meet the requirement
* Based on the results provided by a majority of X sources, for InF-SH in FR2, the horizontal positioning requirement for IIOT use cases is achieved by Rel.17 solutions using 100MHz of bandwidth.
  + - Sources in R1-2209994 show that multi-RTT can meet the requirement
    - Sources in R1-2209217 show that DL-TDOA can meet the requirement
* Based on the result provided by the following source, for InF-DH in FR1, the horizontal positioning requirement for IIOT use cases is not achieved by Rel.17 solutions using 20MHz of bandwidth.
  + - Source in R1-2209108, R1-2211437, R1-2212743 show that the requirements for IIOT use cases cannot be met for InF-DH.

**Agreement**

The observation for baseline performance for positioning of RedCap UEs for commercial scenarios is updated as follow:

Observation

* Based on the results provided by R1-2208457 and R1-2211016, for Umi in FR1, the horizontal positioning requirement for commercial use cases is not achieved by Rel.17 solutions using 5MHz or 20MHz of bandwidth and UL-TDOA.
* Based on the results provided by R1-2209740 ~~and,~~ R1-2211016, R1-2212743 and R1-2212054, for Umi in FR1, the horizontal positioning requirement for commercial use cases is not achieved by Rel.17 solutions using 5MHz or 20MHz of bandwidth and DL-TDOA.
* Based on the results provided by R1-2209994 and R1-2211016, for Umi in FR1, the horizontal positioning requirement for commercial use cases is not achieved by Rel.17 solutions using 20MHz or 5 MHz of bandwidth and multi-RTT.

**Agreement**

Capture the following in section 6.5.3 of the TR:

The following has been identified for potential specification impact of NR positioning for RedCap UEs:

* Maximum tolerable phase error, timing gap, and timing error between hops
  + Considerations for IIoT, commercial, Public Safety and V2X scenarios, and UE capabilities
* Details on the Tx or Rx hopping pattern(s), including frequency overlapping between hops, if supported.

#### 2.1.2 Remaining Open issues

None.

## 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.

##### 2.2.1.2 Decisions during RAN2#119bis-e

RAN2 has discussed the following topics: 1) Sidelink positioning; 2) RAT-dependent integrity; 3) LPHAP (Low Power High Accuracy Positioning), 4) RedCap positioning.

Sidelink positioning

Based on the report of email discussion 406 in R2-2209607, the selected proposals in R2-2210363, R2-2210167 and Summary of [AT119bis-e][424] in R2-2210911, RAN2 discussed open issues related to Sidelink positioning and made the following agreements:

Agreement:

Protocol options between UE and LMF for hybrid PC5+Uu positioning and PC5-only positioning in-coverage are studied and RAN2 will down-select during normative work.

1. Extension of LPP, whereby new signaling shall be defined to support hybrid Uu and PC5 based positioning, i.e. extend the existing LPP to support sidelink based positioning between UE and LMF

2. Enhancement of LPP whereby SLPP/RSPP signaling can be transported within LPP transparently, i.e. use the newly defined SLPP/RSPP to support sidelink based positioning and use the existing LPP to support Uu based positioning; and the SLPP/RSPP is carried as a container in LPP

3. Use of SLPP/RSPP between the UE and the LMF

Agreement:

Proposal 3 (modified): In order to enable sidelink positioning, SLPP/RSPP shall support at least the following functionalities:

1. SL Positioning Capability Transfer

2. SL Positioning Assistance Data exchange

3. SL Location Information Transfer

4. Error handling

5. Abort

This agreement does not imply any specific signalling structure.

Agreements:

Proposal 5: Unicast/one-to-one operation is assumed as baseline for exchange of sidelink positioning signaling.

Proposal 6 (modified): RAN2 shall study applicability of at least the following positioning signaling for groupcast/broadcast (in addition to unicast), including addressing any security aspects (involving SA3 where needed). FFS the specific use case:

• SL positioning capability transfer

• SL positioning assistance data

• FFS SL location information transfer

Agreements:

Proposal 1 (modified): RAN2 agrees to support unicast SLPP/RSPP session-based operation and to study the applicability of groupcast/broadcast to SLPP/RSPP group operation. FFS if groupcast/broadcast operation, if supported, would be session-based or sessionless.

Proposal 3 (modified): RAN2 agrees to support at least unicast SLPP/RSPP “centralized” operation in the sense used in R2-2210911, i.e., operation where one UE performs range and/or position calculations based on measurement/location information relating to itself and/or other UEs. RAN2 will follow SA2 on which UE(s) can perform the calculation and related RAN1 definitions.

RAT-dependent integrity

Based on proposals in R2-2210892, R2-2210918, RAN2 discussed open issues related to RAT-dependent integrity and agreed:

Agreement:

Proposal 1-2. RAN2 study the usage of DNU flag for the RAT-dependent positioning integrity (assuming RAN1 agree to leave it to RAN2) and conclude on whether to indicate the DNU presence in the integrity principle equation.

Agreement:

Proposal 4. RAN2 will study the both UE-based and LMF-based integrity for RAT-dependent cases.

Agreement:

Proposal 7 (modified). RAN2 agree that R17 UE-based integrity mode signaling can be used as baseline with the following aspects:

- UE sends capability info to LMF on integrity for UE-based mode using LPP capability transfer procedure

- LMF sends the assistance data for integrity calculation to UE for integrity of UE-based mode

- LMF sends integrity requirement e.g., TIR to UE in LPP request location information message for integrity of UE-based mode

- UE sends integrity result to LMF using LPP location information Transfer message

Agreement:

LMF provides, in assistance data, the information of error sources (e.g., originated from RAN node) to UE for integrity in UE-based mode.

LPHAP

Based on proposals in R2-2209405, RAN2 discussed open issues related to LPHAP and agreed:

Agreement:

RAN2 do not introduce a new device type for positioning only.

Agreement:

Proposal 2: RAN2 agree that support of MT-SDT in Rel-18 positioning is treated as low priority in SI. (14/15)

Agreement:

Proposal 3 (modified): RAN2 agree to study enhancements on SRS configuration (12/15). Further study the following candidate enhancements on SRS configuration, including the possible interference and changes of spatial relations problems.

- a) Validity area mechanism; (12/13)

- b) SRS update mechanism; (10/13)

- c) Pre-configure multiple SRS, which could include broadcast transmission of configurations with UE-specific determination along with the network of a configuration; (9/13)

FFS if item c would require network nodes to measure multiple SRS configurations for the same UE simultaneously.

LS to RAN1 to ask them about interference issues with SRS configurations across multiple cells and about the validity of SRS parameters.

Agreement:

RAN2 will study the following candidate enhancements on DL-PRS configuration after there is progress in RAN1 and potentially RAN4.

- a) Simplified PRS configuration; (2/15)

- b) PRS is configured close to SSBs; (2/15)

- c) Limit PRS reception in a time period; (3/15)

RAN2 can consider the feasibility of configuration alignment between PRS and DRX (at least paging DRX).

Agreement:

Exposure of LPHAP information to the gNB and/or LMF (e.g., as a UE capability) can be discussed in normative work if any enhancement for LPHAP is agreed, taking into account any guidance from SA2.

Agreement:

Further discuss the two candidate solutions on how to report measurements taken in RRC\_IDLE as below:

Alt1: measurement is performed in IDLE and reported in CONNECTED, including the concerns:

- Whether the mechanism of measurement in IDLE and report in CONNECTED is more beneficial for power saving than legacy mechanism, i.e. RRC\_INACTIVE positioning.

- Whether the CN can handle the measurement reports from the UE in RRC\_CONNECTED, while the positioning was performed in RRC\_IDLE.

Alt2: measurement is performed in IDLE and report is carried with initial access messages, including the concern:

- Is there AS context/security issue on sending the measurements to LMF?

RedCap positioning

Based on the selected proposals in R2-2209963 and R2-2209563, RAN2 discussed open issues related to RedCap positioning and agreed:

Agreement:

Information on RedCap UE capability from the UE to the LMF (e.g., restricted bandwidth capability) can be discussed in WI phase.

Agreement:

RAN2 wait for RAN1 conclusion on the signalling design for assistance data for frequency hopping.

2.2.1.3 Decisions during RAN2#120

RAN2 has discussed the following topics: 1) Sidelink positioning; 2) RAT-dependent integrity; 3) LPHAP (Low Power High Accuracy Positioning); 4) RedCap positioning.

Sidelink positioning

Based on the Summary of agenda item 8.2.2 on sidelink positioning in R2-2213118, RAN2 discussed the left issues related to Sidelink positioning and made the following agreements:

Agreements:

Proposal 1 (modified) Abbreviation of SLPP is used as the working name of new protocol for sidelink positioning between UEs at least for RAN2’s TP to TR 38.859, and inform other WGs, i.e. SA2 and RAN1:

- SLPP: Sidelink Positioning Protocol

Proposal 2 (modified) RAN2 to confirm either of UEs including target UE and one or multiple anchor UEs may be OOC in partial coverage scenarios, but with at least one UE being in coverage. How to enable the procedures/signaling for supporting SL positioning in partial coverage will be further discussed in normative work.

Proposal 9 RAN2 to enable the support of SL-PRS configuration in normative work based on the progress in RAN1.

Proposal 12 RAN2 to discuss the details of functionalities of LMF for supporting SL positioning in normative work.

Agreements:

Proposal 13 (modified) RAN2 confirm that from RAN2 perspective, it is feasible to send at least the following positioning signaling for groupcast/broadcast (in addition to unicast):

• SL positioning capability (5)

• SL positioning assistance data (6)

Location information is not excluded and can be further considered in normative work.

Proposal 14 (modified) RAN2 to further discuss in normative work:

- the security issues (e.g., requirements for ciphering and/or integrity) on specific information of SL positioning capability and assistance data in groupcast/broadcast and consult to SA2 and SA3.

- the use cases for applying groupcast/broadcast.

LS to SA2/SA3 to indicate the agreement, that we are aware of SA2’s security concern, and inquire what security constraints would apply to transmission of SL positioning capability and distribution of assistance data by groupcast/broadcast. Inquire of SA2 if they have identified groupcast/broadcast use cases.

Agreements:

UE roles are not captured in the diagram of the positioning architecture. Can discuss in normative work if some information is needed in stage 2 in association with the architecture (e.g., a NOTE with the figure).

RAN2 confirm the intention to follow SA2 architecture design.

RAN2 will not work on LTE PC5 in the study item. RAN2 leave it to RAN to determine if LTE PC5 is in scope of a future WI.

Agreement:

Sidelink positioning supports a session-based concept in SLPP, in which signalling messages within a session can be associated with one another by the involved UEs. The relationship to upper-layer designs from SA2 can be discussed during normative work.

FFS if there is also sessionless operation and what aspects of session-based operation would not be included.

Agreement:

At least in the case that positioning methods are supported that do not require a mutual exchange of SLPP messages associated with one another among UEs, SLPP sessionless operation can be supported. FFS if sessionless operation can be operated with security.

Agreement:

From RAN2 perspective, if it is determined to support group positioning, it is feasible to perform at least ranging with the estimate calculation at multiple UEs.

RAT-dependent integrity

Based on the Summary of agenda item 8.2.3 on RAT-dependent integrity in R2-2213127 and report of [AT120][420][POS], RAN2 discussed the left issues related to RAT-dependent integrity and agreed:

Agreement:

Proposal 1 (modified): Use DNU flag for RAT-dependent integrity, with the meaning that the concerned assistance data cannot be used for integrity calculation but may be usable for positioning. Signalling details and relation to error sources can be determined in normative work. FFS which positioning methods are affected based on the progress in RAN1.

Agreements:

Replace “error sources” with “results related to integrity” in the fourth bullet and the last note.

Replace “assistance data” with “results related to integrity” in bullets 2 and 3.

TP in R2-2213143 is endorsed to be merged into the main TP to 38.859, with these changes.

LPHAP

Based on Summary of AI 8.2.4 for LPHAP in R2-2213120 and report of [AT120][421][POS] in R2-2213144, RAN2 discussed the left issues related to LPHAP and agreed:

Agreements:

Proposal1 (modified): SRS positioning validity area for UL positioning in RRC\_INACTIVE can avoid reconfiguration of SRS configuration upon cell reselection and is recommended for normative work from R2’s perspective if feasible from R1’s perspective

 The solution should not require the gNB to monitor multiple SRS configuration simultaneously for a UE

Proposal2 (modified): SRS configuration request can be discussed during normative work from RAN2 perspective.

 Scenarios requiring SRS configuration request include:

 Scenario1: During the UL positioning procedure, when the SRS configuration turns invalid, e.g., when the UE moves out of the SRS positioning validity area.

 Scenario2: At the initiation of UL positioning procedure when an event is detected.

 Detailed solution for the SRS update, e.g., with RRC message, UL MAC, or NG-AP message can be discussed in the WI phase

Proposal3 (modified): Pre-configuration of multiple SRS configurations (e.g., for multiple SRS positioning validity areas) is feasible from RAN2 perspective and can be discussed in normative work.

 The pre-configuration of multiple SRS configurations can be delivered to the UE either by dedicated signalling or SI broadcast

Agreements:

Proposal2: Alignment between DRX and PRS is beneficial from power saving point of view for LPHAP and is recommended to normative work. (14/15)

 Two directions of solutions for DRX/PRS alignments are considered: (a) PRS alignment with fixed DRX (b) DRX alignment with fixed PRS

 Solutions for the PRS/DRX alignment, e.g., LMF-based/UE-based solution, is to be discussed

 Impacts to different RRC states (RRC\_INACTIVE and RRC\_IDLE) is to be discussed

Proposal3: DL positioning in RRC\_IDLE is recommended to normative work from R2’s perspective if power saving benefits are confirmed by R1. (15/15)

 Measurement is performed in RRC\_IDLE while measurement report is sent in RRC\_CONNECTED

 Feasibility of measurement report in msg5 should be evaluated with SA2/3 involved.

 Whether the CN can handle the measurement reports from the UE in RRC\_CONNECTED, while the positioning measurement was performed in RRC\_IDLE, can be evaluated in the WI phase with SA2 involved.

Proposal4: Leave the evaluation of whether UL positioning in RRC\_IDLE is feasible to R1. (13/14)

 R2 can continue the discussion in WI phase if it is feasible from R1’s perspective

Proposal1 (modified): Paging relaxation by skipping paging reception in RRC\_INACTIVE for LPHAP is beneficial from power saving point of view and feasible from R2’s perspective. Skipping paging reception in RRC\_INACTIVE is recommended for normative work from R2’s perspective for achieving LPHAP requirements, if feasible and beneficial from RAN1 perspective. (8/11)

 The power saving gain can be further evaluated in R1.

 Impacts of skipping paging for UE in RRC\_INACTIVE to the core network could be evaluated with SA2 involved in the WI phase.

RedCap positioning

Based on the proposals in R2-2211465, RAN2 discussed the left issues related to RedCap positioning and agreed:

Agreement:

Proposal 2 (modified): The decision on RedCap positioning recommendation is left to RAN1. No recommendation is needed from RAN2 on this.

RAN2 finalized the TP from RAN2’s perspective and send the LS to RAN1 to capture Text Proposal for TR 38.859.

Agreements:

Sidelink positioning is recommended for normative work, including:

- Sidelink positioning in-coverage, partial coverage and out-of-coverage scenarios may be supported.

- How to enable the procedures/signaling for supporting SL positioning in in-coverage, partial coverage and out-of-coverage scenarios will be further discussed in normative work.

- Protocols between UE and UE

- RAN2 will enable the support of SL-PRS configuration in normative work based on the progress in RAN1.

- RAN2 will design protocol and procedures for SL positioning between UEs (SLPP) in normative work.

- Protocols between LMF and UE

- RAN2 will discuss the details of functionalities of LMF for supporting SL positioning in normative work.

- RAN2 will discuss the protocol details to support sidelink positioning procedures between UE and LMF in normative work.

Both UE-based and LMF-based integrity for RAT-Dependent Positioning Techniques are recommended for normative work.

LPHAP is recommended for normative work, including:

- Enhancements on SRS configuration

- SRS positioning validity area for UL positioning in RRC\_INACTIVE is recommended for normative work from R2’s perspective if feasible from R1’s perspective.

- SRS configuration request is recommended for normative work from RAN2 perspective.

- Pre-configuration of multiple SRS configurations (e.g., for multiple SRS positioning validity areas) is feasible from RAN2 perspective and recommended for normative work.

- Alignment between DRX and PRS is recommended to normative work.

- DL positioning in RRC\_IDLE is recommended to normative work from R2’s perspective if power saving benefits are confirmed by R1.

- Skipping paging reception in RRC\_INACTIVE is recommended for normative work from R2’s perspective for achieving LPHAP requirements, if feasible and beneficial from RAN1 perspective.

The potential specification impact for the RedCap positioning are studied in higher layer, and agreed that the decision on RedCap positioning recommendation is left to RAN1. No recommendation is needed from RAN2.

Rel-18 positioning study item is complete from RAN2 perspective.

Above all, RAN2 concluded that Rel-18 positioning study item is complete from RAN2 perspective.

#### 2.2.2 Remaining Open issues

None.

## 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.

2.3.1.2 Decisions during RAN3#117bis-e

RAN3 discussed the further enhancements to NR positioning, including support of Sidelink Positioning, UL CPP measurements, LPHAP, RedCap Positioning and Positioning Integrity, etc.

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

* RAN3 will align with RAN1/RAN2 decisions on terminologies for Ranging/Sidelink positioning.
* Currently, there are no known open issues that require RAN3 action during the study phase. Therefore, TUs may not be needed at RAN3#118 (unless there is incoming LS requesting RAN3 action).

2.3.1.3 Decisions during RAN3#118

Based on the incoming LSs, RAN3 discussed the potential RAN3 impact, on support of Sidelink Positioning, LPHAP, etc. Based on the discussion, RAN3 concluded that no need to reply the LSs.

Then RAN3 discussed and agreed the TP ([R3-226887](file:///C:\Users\sunjiancheng\Desktop\Inbox\R3-226887.zip)) for TR to capture the following agreements:

* Specify the support of the Sidelink resource pools, the Sidelink positioning measurements, the UL CPP measurements, the LPHAP, the RedCap positioning and the positioning Integrity, as needed, taking into account RAN1/RAN2 decisions.
* Specify the support of other functionality related to WI objectives that impact RAN3, as needed.

And RAN3 prepared an LS to RAN, RAN1, RAN2 and SA2 in [R3-226889](file:///E:\WORK\1%203GPP\Meeting\RAN%2098-e\Inbox\R3-226834.zip), to notify the RAN3 progress of this positioning study item.

Above all, RAN3 Chair will report to RAN that this R18 positioning SI is completed in RAN3.

#### 2.3.2 Remaining Open issues

None.

## 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*

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

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

* **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*

* **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*

* **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 |

##### 2.4.1.2 Decisions during RAN4#104bis-e

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

*RF architecture*

* **Agreement:**
  + Prioritize the single RF chain (Tx/Rx) for BS and UE in the study

*PRS/SRS bandwidth aggregation scenario*

* **Agreements:**
* Prioritize intra-band contiguous CA with simultaneous PRS/SRS transmission for the RF and RRM impacts study.
* CA configurations with 2, 3 and 4 CCs should be investigated and the configuration with 2 CCs should be prioritized over 3 and 4 CCs.
* The TAE and group delay need be studied. In addition, phase noise needs be studied for FR2.

*RF impairment model and assessment*

* **Agreements:**
* RAN4 to evaluate the impact of group delay on the performance of PRS/SRS aggregation covering PRS/SRS resources with both same PRS bandwidth and different bandwidths
* Studying TAE for single RF chain architecture
  + For single RF chain architecture, TAE between PFLs/carriers transmitted from different antennas is FFS

*Baseline assumption for FFT processing*

* **Agreement:**
* Assumption should be discussed in RRM session

*Notifying RAN1 of UE transmit power limitation*

* **Agreement:**
* Notifying RAN1 on UE transmit power limitation due to prioritization of PCell over SCell is not needed at this point in time

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

*RAN4 study on RF requirement*

* **Agreement:**
* RAN4 shall wait for conclusion from RAN1 evaluation of impact of different error sources on carrier phase measurement before starting study on RF requirement for NR carrier phase measurement

*Scope of RAN4 study*

* **Agreement:**
* No further discussion is needed in RAN4 at this time

**Relevant documents**

|  |  |  |  |
| --- | --- | --- | --- |
| **T-doc number** | **Title** | **Source** | **Status** |
| R4-2217790 | Email discussion summary for [104-bis-e][138] FS\_NR\_pos\_UERF | Moderator (Intel) | noted |
| R4-2217739 | WF on expanded and improved NR positioning – UE RF aspects | Intel Corporation | approved |

###### RRM aspects in accuracy improvement study based on PRS/SRS bandwidth aggregation for intra-band carriers

*Conditions/assumptions for PRS/SRS bandwidth aggregation*

* **Agreement:**
* Regarding FFT size
  + FFT/IFFT size is up to UE implementation.
  + Multicarrier (MC) positioning requirements should allow UE implementation flexibility i.e. single FFT/IFFT or multiple FFTs/IFFTs (i.e. FFT/IFFT per PFL) implementations.
  + Impact of UE implementation flexibility in terms of FFT/IFFT on MC positioning requirements shall be discussed during the WI phase.
* Regarding numerology across carriers
  + For PRS bandwidth aggregation, a common numerology is required across all intra-band contiguous PFLs to be aggregated.
* Regarding proximity of PFLs in frequency and time domains
  + To study the RRM impact, prioritize the aggregation of PRS or SRS transmitted in the same slot and in the same symbols from the intra-band contiguous PFLs.
* Regarding Co-location of carriers
  + PRS resources in different PFLs to be aggregated for MC positioning measurements, shall be transmitted by the same TRP or FFS whether can also by transmitted by the co-located TRPs.
    - PRS resources to be aggregated from different PFLs should be associated with a common Antenna Reference Point (ARP) or
    - If PRS resources in different PFLs are transmitted from different antennas, then the antennas shall be physical close to each other.
      * The condition on physical proximity between antennas is beyond the scope of RRM.
* Regarding PRS BW of carriers
  + PRS resources to be aggregated for MC positioning measurements from different PFLs can have different bandwidths (i.e. different number of PRS RBs).
* Regarding number of carriers
  + Number of intra-band contiguous PFLs for the aggregation of PRS or SRS is up to RF agreements.
  + To study the RRM impact, the number of PFLs is the same as the number of PFLs agreed in RF session.

*Impact of MRTD/MTTD on PRS/SRS bandwidth aggregation*

* **Agreement:**
* RRM impact of possible timing error between PRS/SRS from different PFLs in single RF chain (Tx/Rx) architecture if defined by RF session will be considered in MC positioning requirements during the WI.
* No further discussion needed on impact of existing MRTD/MTTD on MC positioning measurement.

*Impact of timing and frequency offset on PRS/SRS bandwidth aggregation*

* **Agreement:**
* RRM impact of possible frequency offset between PRS/SRS from different PFLs in single RF chain (Tx/Rx) architecture if defined by RF session will be considered in MC positioning requirements during the WI.
* RRM impact of possible timing error/offset is covered under issue 1-2-1.

*Impact of CA/DC on PRS/SRS bandwidth aggregation*

* **Agreement:**
* Regarding relation between CA/DC and PRS/SRS bandwidth aggregation capabilities
  + Multicarrier positioning capability (MCPC) (e.g. number of intra-band contiguous PFLs) is to be defined during the WI.
  + FFS: Impact of MC positioning measurement on the carrier aggregation/dual connectivity (CA/DC) for communication when both are configured in parallel:
    - Following issues related to concurrent CA/DC operation for communication and MC positioning measurement for further study during the SI and/or to be addressed during the WI:
      * Whether MC positioning measurements should not impact the ongoing CA/DC operation.
      * Whether the impact is limited to the case with MC positioning measurements without gaps.
      * Whether the existing Rel-16/Rel-17 PRS measurement restrictions for PRS measurement can be extended to MC positioning measurements.
      * Impact of switching time of CCs.
      * Whether MC positioning measurements can be done only on the activated CCs.
* Regarding impact of carriers configured for CA/DC on PRS/SRS bandwidth aggregation
  + The impact of number of PFLs configured for MC positioning measurement on the PRS measurement period shall be part of WI.

*Applicable RRC state for PRS/SRS bandwidth aggregation*

* **Agreement:**
* PRS/SRS bandwidth aggregation may be supported in RRC\_INACTIVE subject to UE capability.
  + MC positioning requirements in RRC\_INACTIVE shall be part of the WI.
  + Any issue related to the feasibility can be discussed during the SI.

*RRM requirements for PRS/SRS bandwidth aggregation*

* **Agreement:**
* MC positioning requirements including PRS measurement period/reporting/accuracy (including margins), etc. shall be part of the WI.
  + MC positioning requirements will be defined with and without measurement gaps subject to RAN1 agreements during the WI phase.
    - The corresponding requirements shall be part of the WI.

*Tentative work plan*

* **Agreement:**
* The work plan in R4-2216685 is agreeable from RRM perspective.

###### RRM aspects for NR Carrier Phase Measurements

*RAN4 study on carrier phase measurements*

* **Agreement:**
* Regarding when to initiate RAN4 study carrier phase measurements,
  + RAN4 wait for conclusive RAN1 outcome on carrier phase measurements before starting RAN4 feasibility study on carrier phase measurement aspects.

*Conditions/assumptions for carrier phase measurements*

* **Agreement:**
* If carrier phase measurement is considered feasible based on RAN1 outcome, then further discuss if single carrier PRS/SRS transmission can be prioritized for the RRM impact study.

*Carrier phase measurements in RRC\_INACTIVE*

* **Agreement:**
* If carrier phase measurement is considered feasible based on RAN1 outcome, then further investigate if carrier phase measurement is also supported in RRC\_INACTIVE.

*RRM requirements for carrier phase measurements*

* **Agreement:**
* If carrier phase measurement is considered feasible based on RAN1 and RAN4 outcome, then carrier phase positioning measurement requirements including measurement period/reporting/accuracy (including margins), etc. shall be part of the WI.

**Relevant documents**

|  |  |  |  |
| --- | --- | --- | --- |
| **T-doc number** | **Title** | **Source** | **Status** |
| R4-2217153 | Email discussion summary for [104-bis-e][220] FS\_NR\_pos\_enh2\_RRM | Moderator (Ericsson) | noted |
| R4-2217257 | WF on Improved NR Positioning | Ericsson | approved |

##### 2.4.1.3 Decisions during RAN4#105

###### Study of accuracy improvement based on PRS/SRS bandwidth aggregation for intra-band carriers

*TAE for single RF chain architecture*

* **Agreement:**
  + No need to discuss TAE for single RF chain architecture
    - TAE refers to the TAE requirements across carriers in BS specification

*Content to be included in LS to RAN1*

* **Agreement:**
* PRS/SRS bandwidth aggregation for intra-band contiguous carrier is feasible for single chain Tx/Rx architectures at both the UE and gNB
* The assumption for a single-chain Tx architecture is that PRS/SRS resources to be aggregated are transmitted from a single Tx antenna
  + Single chain Tx architecture means the single RF chain with single antenna
* LS to RAN1 with the above content was approved (R4-2220545)

###### Study of accuracy improvement based on NR carrier phase measurements

*RAN4 study on RF requirement*

* **Agreement:**
  + RAN4 will uphold its previous agreement on RF issues related to carrier phase measurement for positioning
    - *Agreement from RAN4 #104Bis-e (R4-2217739): RAN4 shall wait for conclusion from RAN1 evaluation of impact of different error sources on carrier phase measurement before starting study on RF requirement for NR carrier phase measurement.*
  + Carrier phase measurement discussions will be left for WI phase

**Relevant documents**

|  |  |  |  |
| --- | --- | --- | --- |
| **T-doc number** | **Title** | **Source** | **Status** |
| R4-2220117 | Topic summary for [105][137] FS\_NR\_pos\_UERF | Moderator (Intel) | noted |
| R4-2220544 | WF for the study on expanded and improved NR positioning | Intel Corporation | approved |
| R4-2220545 | LS for the study on expanded and improved NR positioning | Qualcomm Inc. | approved |

###### RRM aspects in accuracy improvement study based on PRS/SRS bandwidth aggregation for intra-band carriers

*Conditions/assumptions for PRS/SRS bandwidth aggregation*

* **Agreement:**
* Regarding numerology across PFLs
  + For PRS bandwidth aggregation, a common numerology is required across all intra-band contiguous PFLs to be aggregated.
  + For SRS bandwidth aggregation, a common numerology is required across all intra-band contiguous PFLs to be aggregated.
* Regarding PRS and SRS BWs of PFLs
  + PRS resources to be aggregated for MC positioning measurements from different PFLs can have different bandwidths (i.e. different number of PRS RBs).
  + SRS resources to be aggregated for MC positioning measurements from different PFLs can have different bandwidths (i.e. different number of SRS RBs).
* Regarding proximity of PFLs in frequency and time domains
  + PRS resources from different PFLs to be aggregated are transmitted in the same slot and in the same symbols
  + SRS resources in different carriers to be aggregated are transmitted in the same slot and in the same symbols
* Regarding Co-location of carriers
  + Focus on same TRP and de-prioritize collocated TRPs for PRS/SRS CA.
    - PRS resources from different PFLs to be aggregated are transmitted by the same TRP and associated with a common Antenna Reference Point (ARP)
* Regarding Activation/deactivation of PFLs
  + Discuss whether MC positioning measurements can be performed on the activated or deactivated CC’s or on non-serving carriers during the WI phase.

*Impact of CA/DC on PRS/SRS bandwidth aggregation*

* **Agreement:**
* Regarding Impact on CA/DC operation,
  + Discuss the impact of MC positioning measurement on the CA/DC for communication when both are configured in parallel during the WI phase

*Overall conclusion*

* **Agreement:**
* PRS/SRS bandwidth aggregation across PFLs for positioning measurements is feasible from RRM perspective

###### RRM aspects for NR Carrier Phase Measurements

*RAN4 study on carrier phase measurements*

* **Agreement:**
* Regarding when to initiate RAN4 study carrier phase measurements,
  + RAN4 did not perform feasibility studies for RRM aspects of carrier phase measurements and needs to wait for conclusive RAN1 study outcomes

###### RRM LS and TP

An LS is sent to RAN1 and RAN2 (CC RAN) in R4-2220439 with an attachment R4-2220735, which is the agreed TP to TR38.859 on RRM aspects.

**Relevant documents**

|  |  |  |  |
| --- | --- | --- | --- |
| **T-doc number** | **Title** | **Source** | **Status** |
| R4-2220071 | Topic summary for [105][225] FS\_NR\_pos\_enh2 \_RRM | Moderator (Ericsson) | noted |
| R4-2220438 | WF on expanded and improved NR positioning | Ericsson | approved |
| R4-2220439 | LS for study on expanded and improved NR positioning | Qualcomm Inc. | approved |
| R4-2220735 | Text Proposals to TR 38.859 for Expanded and Improved NR Positioning for RAN4 RRM aspects | Huawei | approved |

#### 2.4.2 Remaining Open issues

None.

## 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)

**RAN1 #110bis-e**

1. R1-2208338 LS on Terminology Alignment for Ranging/Sidelink Positioning SA2, Xiaomi
2. R1-2208580 Draft Reply LS on Terminology Alignment for Ranging/Sidelink Positioning vivo
3. R1-2209208 Draft Reply LS on Terminology Alignment for Sidelink Positioning ZTE
4. R1-2209843 Discussion on terminology alignment for ranging/SL positioning Huawei, HiSilicon
5. R1-2210033 [Draft] Reply LS on Terminology Alignment for Ranging/Sidelink Positioning xiaomi
6. R1-2210037 Work Plan for Study Item on Expanded and Improved NR Positioning Intel Corporation, CATT, Ericsson
7. R1-2210233 Draft TR 38.859 v020: Study on expanded and improved NR positioning Intel, CATT, Ericsson
8. R1-2210672 Draft TR 38.859 v020: Study on expanded and improved NR positioning Intel, CATT, Ericsson
9. R1-2210692 Session notes for 9.5 (Study on expanded and improved NR positioning) Ad-Hoc Chair (Huawei)
10. R1-2210715 Draft TR 38.859 v020: Study on expanded and improved NR positioning Intel, CATT, Ericsson
11. R1-2210717 Comments to Draft TR 38.859 v020: Study on expanded and improved NR positioning Intel, CATT, Ericsson
12. R1-2210795 Post-meeting Comments to Draft TR 38.859 v020: Study on expanded and improved NR positioning Rapporteur (Intel Corporation)
13. R1-2210443 Moderator summary on discussion on incoming SA2 LS in R1-2208338 on terminology alignment Moderator (Xiaomi)
14. R1-2210550 [Draft] Reply LS on Terminology Alignment for Ranging/Sidelink Positioning Xiaomi
15. R1-2210567 Reply LS on Terminology Alignment for Ranging/Sidelink Positioning RAN1, xiaomi
16. R1-2208363 Evaluation of SL positioning Nokia, Nokia Shanghai Bell
17. R1-2208452 SL positioning evaluations Huawei, HiSilicon
18. R1-2208647 Evaluation of sidelink positioning performance vivo
19. R1-2208820 Evaluation methodology and results of SL positioning OPPO
20. R1-2208980 Evaluation methodology and performance evaluation for SL positioning CATT, GOHIGH
21. R1-2209104 Discussion on evaluation of SL positioning Sony
22. R1-2209212 Discussion on evaluation of SL positioning ZTE, CMCC
23. R1-2209290 Discussion on evaluation of sidelink positioning xiaomi
24. R1-2209392 SL Positioning Evaluation and Performance Lenovo
25. R1-2209459 Summary #1 for SL positioning evaluation Moderator (ZTE)
26. R1-2209460 Summary #2 for SL positioning evaluation Moderator (ZTE)
27. R1-2209482 Discussion on evaluation of SL positioning LG Electronics
28. R1-2209486 Evaluation results for SL positioning InterDigital, Inc.
29. R1-2209735 Discussion on Evaluation for SL Positioning Samsung
30. R1-2209782 SL positioning scenarios Sharp
31. R1-2209989 Sidelink Positioning Evaluation Assumptions and Results Qualcomm Incorporated
32. R1-2210038 Evaluation of SL positioning Intel Corporation
33. R1-2210111 Evaluation results and observations on V2X and IIoT use case for sidelink positioning CEWiT
34. R1-2210174 Evaluation of NR SL positioning and ranging Ericsson
35. R1-2210579 Summary #3 for SL positioning evaluation Moderator (ZTE )
36. R1-2208364 Potential solutions for SL positioning Nokia, Nokia Shanghai Bell
37. R1-2208372 Potential solutions for sidelink positioning FUTUREWEI
38. R1-2208453 Discussion on SL positioning solutions Huawei, HiSilicon
39. R1-2208558 Discussion on potential solutions for SL positioning Spreadtrum Communications
40. R1-2208648 Discussion on potential solutions for sidelink positioning vivo
41. R1-2208773 Discussion on potential solutions for sidelink positioning China Telecom
42. R1-2208821 Discussion on potential solutions for SL positioning OPPO
43. R1-2208981 Discussion on potential solutions for SL positioning CATT, GOHIGH
44. R1-2209058 Potential solutions for SL positioning Intel Corporation
45. R1-2209105 Consideration on potential solutions for SL positioning Sony
46. R1-2209151 Discussion on potential solutions for SL positioning NEC
47. R1-2209213 Discussion on potential solutions for SL positioning ZTE
48. R1-2209291 Discussion on sidelink positioning solutions xiaomi
49. R1-2209341 Discussion on potential solutions for SL positioning CMCC
50. R1-2209393 Potential SL Positioning Solutions Lenovo
51. R1-2209483 Discussion on potential solutions for SL positioning LG Electronics
52. R1-2209487 Potential solutions for SL positioning InterDigital, Inc.
53. R1-2209533 Potential solutions for SL positioning Faunhofer IIS, Fraunhofer HHI
54. R1-2209589 Discussions on Potential solutions for SL positioning Apple
55. R1-2209675 Discussion on potential solutions for SL positioning DENSO CORPORATION
56. R1-2209736 Discussion on Potential Solutions for SL Positioning Samsung
57. R1-2209783 Views on potential solutions for SL positioning Sharp
58. R1-2209797 Discussion on sidelink positioning ASUSTeK
59. R1-2209907 Discussion on potential solutions for SL positioning NTT DOCOMO, INC.
60. R1-2209990 Potential Solutions for Sidelink Positioning Qualcomm Incorporated
61. R1-2210097 The potential solutions for sidelink positioning MediaTek Inc.
62. R1-2210102 Considerable solutions on sidelink positioning in NR ITL
63. R1-2210112 Discussion on enhancements for sidelink based positioning CEWiT
64. R1-2210175 On potential solutions for SL positioning Ericsson
65. R1-2210341 Moderator Summary #1 on potential solutions for SL positioning Moderator (Qualcomm Incorporated)
66. R1-2210381 Moderator Summary #2 on potential solutions for SL positioning Moderator (Qualcomm Incorporated)
67. R1-2210522 Moderator Summary #3 on potential solutions for SL positioning Moderator (Qualcomm Incorporated)
68. R1-2210598 Moderator Summary #4 on potential solutions for SL positioning Moderator (Qualcomm Incorporated)
69. R1-2208454 Error source for NR RAT-dependent positioning Huawei, HiSilicon
70. R1-2208516 Discussion on integrity of RAT dependent positioning BUPT
71. R1-2208649 Discussion on solutions for integrity of RAT-dependent positioning vivo
72. R1-2208735 Views on solutions for integrity of RAT-dependent positioning techniques Nokia, Nokia Shanghai Bell
73. R1-2208800 Discussions on Integrity for NR Positioning OPPO
74. R1-2208982 Discussion on solutions for integrity of RAT dependent positioning techniques CATT
75. R1-2209002 Discussion on error sources for RAT dependent positioning Spreadtrum Communications
76. R1-2209106 Discussion on Error Sources for Integrity of NR Positioning Sony
77. R1-2209214 Discussion on integrity of RAT dependent positioning ZTE
78. R1-2209292 Error source for NR RAT-dependent positioning integrity xiaomi
79. R1-2209342 Discussion on integrity for RAT-dependent positioning CMCC
80. R1-2209394 Integrity aspects for RAT-dependent positioning Lenovo
81. R1-2209488 Discussion on integrity for RAT dependent positioning techniques InterDigital, Inc.
82. R1-2209737 Discussion on Integrity of RAT Dependent Positioning Samsung
83. R1-2209784 Views on solutions for integrity of RAT dependent positioning techniques Sharp
84. R1-2209908 Discussion on solutions for integrity of RAT dependent positioning techniques NTT DOCOMO, INC.
85. R1-2209991 Integrity for RAT dependent positioning Qualcomm Incorporated
86. R1-2210176 Error Sources characterization for integrity of RAT dependent positioning techniques Ericsson
87. R1-2210274 FL summary #1 on integrity of RAT dependent positioning techniques Moderator (InterDigital, Inc.)
88. R1-2210428 FL summary #2 on integrity of RAT dependent positioning techniques Moderator (InterDigital, Inc.)
89. R1-2210633 FL summary #3 on integrity of RAT dependent positioning techniques Moderator (InterDigital, Inc.)
90. R1-2208455 Discussion on NR carrier phase positioning Huawei, HiSilicon
91. R1-2208650 Discussion on carrier phase measurement enhancements vivo
92. R1-2208736 Views on improved accuracy based on NR carrier phase measurement Nokia, Nokia Shanghai Bell
93. R1-2208774 Discussion on improved accuracy based on NR carrier phase measurement China Telecom
94. R1-2208801 Discussions on Carrier Phase Measurement for NR Positioning OPPO
95. R1-2208983 Discussion on improved accuracy based on NR carrier phase measurement CATT
96. R1-2209059 Carrier phase positioning in NR systems Intel Corporation
97. R1-2209152 Discussion on NR carrier phase positioning NEC
98. R1-2209215 Discussion on carrier phase measurement based positioning ZTE
99. R1-2209293 Improved accuracy based on NR carrier phase measurement xiaomi
100. R1-2209343 Discussion on carrier phase positioning CMCC
101. R1-2209395 On NR carrier phase measurements Lenovo
102. R1-2209489 Discussion on positioning based on NR carrier phase measurement InterDigital, Inc.
103. R1-2209534 NR carrier phase measurements for positioning Faunhofer IIS, Fraunhofer HHI
104. R1-2209543 Discussion on double difference method and gNB synchronization Locaila
105. R1-2209546 Views on NR carrier phase measurement for positioning accuracy enhancement IIT Kanpur, CEWiT
106. R1-2209738 Discussion on NR Carrier Phase Measurement Samsung
107. R1-2209785 Views on improved accuracy based on NR carrier phase measurement Sharp
108. R1-2209805 Discussion on OFDM based carrier phase measurement in NR LG Electronics
109. R1-2209909 Discussion on improved accuracy based on NR carrier phase measurement NTT DOCOMO, INC.
110. R1-2209992 Phase Measurements in NR Positioning Qualcomm Incorporated
111. R1-2210099 On NR carrier phase measurement MediaTek Inc.
112. R1-2210177 Improved accuracy based on NR carrier phase measurement Ericsson
113. R1-2210267 FL Summary #1 for improved accuracy based on NR carrier phase measurements Moderator (CATT)
114. R1-2210268 FL Summary #2 for improved accuracy based on NR carrier phase measurements Moderator (CATT)
115. R1-2210269 FL Summary #3 for improved accuracy based on NR carrier phase measurements Moderator (CATT)
116. R1-2210765 FL Summary #4 for improved accuracy based on NR carrier phase measurements Moderator (CATT)
117. R1-2208456 Evaluation and solutions for LPHAP Huawei, HiSilicon
118. R1-2208517 Discussion on Low Power High Accuracy Positioning Quectel
119. R1-2208559 Discussion on evaluation on LPHAP Spreadtrum Communications
120. R1-2208651 Discussion on Low Power High Accuracy Positioning vivo
121. R1-2208737 Views on LPHAP Nokia, Nokia Shanghai Bell
122. R1-2208802 Discussion on Low Power High Accuracy Positioning OPPO
123. R1-2208984 Discussion on Low Power High Accuracy Positioning CATT
124. R1-2209060 On Low Power High Accuracy Positioning Intel Corporation
125. R1-2209107 Discussion on Low Power High Accuracy Positioning Sony
126. R1-2209216 Discussion on low power high accuracy positioning ZTE
127. R1-2209294 Discussion on Low Power High Accuracy Positioning xiaomi
128. R1-2209344 Discussion on low power high accuracy positioning CMCC
129. R1-2209345 Summary for low power high accuracy positioning Moderator (CMCC)
130. R1-2209396 LPHAP considerations Lenovo
131. R1-2209490 Discussions on Low Power High Accuracy Positioning (LPHAP) techniques InterDigital, Inc.
132. R1-2209739 Discussion on LPHAP Samsung
133. R1-2209786 Views on low power high accuracy positioning Sharp
134. R1-2209806 Discussion on LPHAP in idle/inactive state LG Electronics
135. R1-2209910 Discussion on Low Power High Accuracy Positioning NTT DOCOMO, INC.
136. R1-2209993 Requirements, Evaluations, Potential Enhancements for Low Power High Accuracy Positioning Qualcomm Incorporated
137. R1-2210178 Evaluations for Low Power High Accuracy Positioning Ericsson
138. R1-2210242 Discussion on Low Power High Accuracy Positioning CATT
139. R1-2210398 Discussion on low power high accuracy positioning ZTE
140. R1-2210616 FL summary #2 for low power high accuracy positioning Moderator (CMCC)
141. R1-2210617 FL summary #3 for low power high accuracy positioning Moderator (CMCC)
142. R1-2208457 Discussion on RedCap positioning Huawei, HiSilicon
143. R1-2208652 Discussion on positioning for RedCap UEs vivo
144. R1-2208738 Views on Positioning for RedCap UEs Nokia, Nokia Shanghai Bell
145. R1-2208803 Discussion on Positioning for RedCap Ues OPPO
146. R1-2208985 Discussion on positioning for RedCap UEs CATT
147. R1-2209061 Enhancements for positioning for RedCap UEs Intel Corporation
148. R1-2209108 Considerations on positioning for RedCap UEs Sony
149. R1-2209153 Discussion on positioning support for RedCap UEs NEC
150. R1-2209217 Discussion on Positioning for RedCap UE ZTE
151. R1-2209346 Discussion on RedCap positioning CMCC
152. R1-2209397 Positioning for RedCap devices Lenovo
153. R1-2209491 Discussions on positioning for RedCap UEs InterDigital, Inc.
154. R1-2209590 Discussions on Positioning for RedCap Ues Apple
155. R1-2209740 Discussion on Positioning for RedCap UEs Samsung
156. R1-2209787 Views on positioning for RedCap UEs Sharp
157. R1-2209807 Discussion on positioning support for RedCap Ues LG Electronics
158. R1-2209911 Discussion on positioning for RedCap UEs NTT DOCOMO, INC.
159. R1-2209994 Positioning for Reduced Capability UEs Qualcomm Incorporated
160. R1-2210179 Positioning for RedCap Ues Ericsson
161. R1-2210474 Feature Lead Summary #1 for Positioning for RedCap UEs Moderator (Ericsson)
162. R1-2210475 Feature Lead Summary #2 for Positioning for RedCap UEs Moderator (Ericsson)
163. R1-2210476 Feature Lead Summary #3 for Positioning for RedCap UEs Moderator (Ericsson)

**RAN1 #111**

1. R1-2210821 LS on RAN dependency for Ranging/Sidelink Positioning SA2, xiaomi
2. R1-2210960 Draft reply LS on RAN dependency for Ranging/Sidelink Positioning vivo
3. R1-2211135 Discussion on RAN dependency for Ranging/Sidelink Positioning CATT
4. R1-2211136 Draft reply LS on RAN dependency for Ranging/Sidelink Positioning CATT
5. R1-2211378 Draft Reply LS on RAN dependency for Ranging/Sidelink Positioning Intel Corporation
6. R1-2211448 Discussion on the LS on RAN dependency for Ranging/Sidelink Positioning OPPO
7. R1-2211495 Draft Reply LS on RAN dependency for Ranging and Sidelink Positioning ZTE
8. R1-2211544 Reply LS on RAN dependency for Ranging/Sidelink Positioning Spreadtrum Communications
9. R1-2212077 Draft Reply to SA2 LS on RAN dependency for Ranging/Sidelink Positioning Qualcomm Incorporated
10. R1-2212278 Discussion on Reply LS on RAN dependency for Ranging/Sidelink Positioning Xiaomi Technology
11. R1-2212478 Discussion on RAN dependency for Ranging/SL positioning Huawei, HiSilicon
12. R1-2210824 LS Out on Positioning Reference Units SA2, CATT
13. R1-2210959 Draft reply LS on positioning reference unit vivo
14. R1-2211137 Discussion on Positioning Reference Units CATT
15. R1-2211138 Draft reply LS on Positioning Reference Units CATT
16. R1-2211332 [Draft] Reply LS on Positioning Reference Units xiaomi
17. R1-2211438 Discussion on LS Out on Positioning Reference Units OPPO
18. R1-2211496 Draft Reply LS on Positioning Reference Units ZTE
19. R1-2211858 Draft Reply LS on Positioning Reference Units Intel Corporation
20. R1-2212016 Draft reply LS on Positioning Reference Units Samsung
21. R1-2212475 Discussion on positioning reference unit Huawei, HiSilicon
22. R1-2212499 draft reply LS on Positioning Reference Units Ericsson
23. R1-2210804 LS on SRS in multiple cells RAN2, Huawei
24. R1-2210961 Draft reply LS on SRS on multiple cells vivo
25. R1-2211439 Discussion on LS Out on SRS in multiple cells OPPO
26. R1-2211494 Draft Reply LS on SRS in multiple cells ZTE
27. R1-2211655 Discussion on SRS in multiple cells CMCC
28. R1-2212473 Discussion on SRS in multiple cells Huawei, HiSilicon
29. R1-2212474 Draft reply LS on SRS in multiple cells Huawei
30. R1-2212498 draft reply LS on SRS in multiple cells Ericsson
31. R1-2210825 LS on LPHAP information delivery to RAN SA2, Huawei
32. R1-2210958 Draft reply LS on LPHAP information delivery to RAN vivo
33. R1-2211139 Discussion on LPHAP information delivery to RAN CATT
34. R1-2211140 Draft reply LS on LPHAP information delivery to RAN CATT
35. R1-2211497 Draft Reply LS on LPHAP information delivery ZTE
36. R1-2212476 Discussion on LPHAP information delivery to RAN Huawei, HiSilicon
37. R1-2212477 Draft reply LS on LPHAP information delivery to RAN Huawei
38. R1-2212500 draft Reply LS on LPHAP information delivery to RAN Ericsson
39. R1-2212847 Session notes for 9.5 (Study on expanded and improved NR positioning) Ad-Hoc Chair (Huawei)
40. R1-2213017 Draft TR 38.859 v020: Study on expanded and improved NR positioning Rapporteurs (Intel, CATT, Ericsson)
41. R1-2213018 Post-meeting Comments to Draft TR 38.859 v030: Study on expanded and improved NR positioning Moderator (Intel Corporation)
42. R1-2212713 Summary of discussion of reply LS on Positioning Reference Units Moderator (CATT)
43. R1-2212714 Draft Reply LS on Positioning Reference Units Moderator (CATT)
44. R1-2212715 Reply LS on Positioning Reference Units RAN1, CATT
45. R1-2212750 Moderator summary 1 on discussion of SA2 LS in R1-2210821 on RAN dependency for Ranging/Sidelink Positioning Moderator(xiaomi)
46. R1-2212781 Moderator summary 2 on discussion of SA2 LS in R1-2210821 on RAN dependency for Ranging/Sidelink Positioning Moderator (xiaomi)
47. R1-2212782 [draft] Reply LS on RAN dependency for Ranging/Sidelink Positioning xiaomi
48. R1-2212926 Reply LS on RAN dependency for Ranging/Sidelink Positioning RAN1, xiaomi
49. R1-2212950 Summary of offline discussion on bandwidth requirements on SL positioning Moderator (Intel Corporation)
50. R1-2210831 Evaluation of SL positioning Nokia, Nokia Shanghai Bell
51. R1-2210900 Finalizing SL positioning evaluation Huawei, HiSilicon
52. R1-2211011 Evaluation of sidelink positioning performance vivo
53. R1-2211202 Further performance evaluation for SL positioning CATT, GOHIGH
54. R1-2211267 Discussion on evaluation of SL positioning LG Electronics
55. R1-2211301 Evaluation of latency requirements for sidelink positioning TOYOTA Info Technology Center
56. R1-2211368 Discussion on evaluation of sidelink positioning xiaomi
57. R1-2211404 Evaluations of SL positioning Intel Corporation
58. R1-2211446 Evaluation results for SL positioning OPPO
59. R1-2211500 Discussion on evaluation of SL positioning ZTE, CMCC
60. R1-2211506 Summary #1 for SL positioning evaluation Moderator (ZTE)
61. R1-2211507 Summary #2 for SL positioning evaluation Moderator (ZTE)
62. R1-2211615 Evaluation of SL positioning Sony
63. R1-2211720 Evaluation results for SL positioning InterDigital, Inc.
64. R1-2211739 SL Positioning Evaluation and Performance Lenovo
65. R1-2212049 Discussion on Evaluation for SL Positioning Samsung
66. R1-2212121 Sidelink Positioning Evaluation Assumptions and Results Qualcomm Incorporated
67. R1-2212379 Evaluation of SL positioning Fraunhofer IIS, Fraunhofer HHI
68. R1-2212427 Evaluation results and observations on V2X and IIoT use case for sidelink positioning CEWiT
69. R1-2212512 Evaluation of NR SL positioning and ranging Ericsson
70. R1-2212739 Evaluations of SL positioning Intel Corporation
71. R1-2210832 Potential solutions for SL positioning Nokia, Nokia Shanghai Bell
72. R1-2210837 Potential solutions for sidelink positioning FUTUREWEI
73. R1-2210901 Remaining issues for SL positioning solutions Huawei, HiSilicon
74. R1-2211012 Discussion on potential solutions for sidelink positioning vivo
75. R1-2211203 Further discussion on potential solutions for SL positioning CATT, GOHIGH
76. R1-2211238 Discussion on potential solutions for SL positioning Spreadtrum Communications
77. R1-2211268 Discussion on potential solutions for SL positioning LG Electronics
78. R1-2211302 Discussion on potential solutions for sidelink positioning TOYOTA Info Technology Center
79. R1-2211369 Discussion on sidelink positioning solutions xiaomi
80. R1-2211405 Potential solutions for SL positioning Intel Corporation
81. R1-2211447 Discussion on potential solutions for SL positioning OPPO
82. R1-2211501 Discussion on potential solutions for SL positioning ZTE
83. R1-2211530 Discussion on potential solutions for sidelink positioning China Telecom
84. R1-2211616 Discussion on potential solutions for SL positioning Sony
85. R1-2211685 Discussion on potential solutions for SL positioning CMCC
86. R1-2211723 Potential solutions for SL positioning InterDigital, Inc.
87. R1-2211740 Potential SL Positioning Solutions Lenovo
88. R1-2211818 On Potential solutions for SL positioning Apple
89. R1-2211949 Discussion on potential solutions for SL positioning DENSO CORPORATION
90. R1-2211988 Discussion on potential solutions for SL positioning NTT DOCOMO, INC.
91. R1-2212050 Discussion on Potential Solutions for SL Positioning Samsung
92. R1-2212122 Potential Solutions for Sidelink Positioning Qualcomm Incorporated
93. R1-2212178 Views on potential solutions for SL positioning Sharp
94. R1-2212192 The potential solutions for sidelink positioning MediaTek Inc.
95. R1-2212195 Discussion on sidelink positioning ASUSTeK
96. R1-2212337 Potential solutions for sidelink positioning in NR ITL
97. R1-2212371 Discussion on potential solutions for SL positioning NEC
98. R1-2212378 Potential solutions for SL positioning Fraunhofer IIS, Fraunhofer HHI
99. R1-2212428 Discussion on enhancements for sidelink based positioning CEWiT
100. R1-2212513 On potential solutions for SL positioning Ericsson
101. R1-2212661 Moderator Summary #1 on potential solutions for SL positioning Moderator (Qualcomm Incorporated)
102. R1-2212758 Moderator Summary #2 on potential solutions for SL positioning Moderator (Qualcomm Incorporated)
103. R1-2212900 Moderator Summary #3 on potential solutions for SL positioning Moderator (Qualcomm Incorporated)
104. R1-2212938 Moderator Summary #4 on potential solutions for SL positioning Moderator (Qualcomm Incorporated)
105. R1-2210902 Remaining issues for RAT-dependent integrity Huawei, HiSilicon
106. R1-2211013 Discussion on solutions for integrity of RAT-dependent positioning vivo
107. R1-2211204 Further discussion on solutions for integrity of RAT dependent positioning techniques CATT
108. R1-2211311 Views on solutions for integrity of RAT-dependent positioning techniques Nokia, Nokia Shanghai Bell
109. R1-2211434 Discussions on Integrity for NR Positioning OPPO
110. R1-2211502 Discussion on integrity of RAT dependent positioning ZTE
111. R1-2211617 On Error Sources for Integrity of NR Positioning Sony
112. R1-2211686 Discussion on integrity for RAT-dependent positioning CMCC
113. R1-2211713 Discussions on Integrity for NR RAT-dependent Positioning BUPT
114. R1-2211726 Discussion on integrity for RAT dependent positioning techniques InterDigital, Inc.
115. R1-2211742 Integrity aspects for RAT-dependent positioning Lenovo
116. R1-2211989 Discussion on solutions for integrity of RAT dependent positioning techniques NTT DOCOMO, INC.
117. R1-2212051 Discussion on Integrity of RAT Dependent Positioning Samsung
118. R1-2212123 Integrity for RAT dependent positioning Qualcomm Incorporated
119. R1-2212179 Views on solutions for integrity of RAT dependent positioning techniques Sharp
120. R1-2212514 Error Sources characterization for integrity of RAT dependent positioning techniques Ericsson
121. R1-2212551 FL summary #1 on integrity of RAT dependent positioning techniques Moderator (InterDigital)
122. R1-2212722 FL summary #2 on integrity of RAT dependent positioning techniques Moderator (InterDigital)
123. R1-2212793 FL summary #3 on integrity of RAT dependent positioning techniques Moderator (InterDigital)
124. R1-2212933 FL summary #4 on integrity of RAT dependent positioning techniques Moderator (InterDigital)
125. R1-2210903 Remaining issues for carrier phase positioning Huawei, HiSilicon
126. R1-2211014 Discussion on carrier phase measurement enhancements vivo
127. R1-2211100 High precision positioning of dual frequency carrier phase BUPT
128. R1-2211205 Further discussion on improved accuracy based on NR carrier phase measurement CATT
129. R1-2211259 Experiment and Simulation Result on Carrier Phase Based Positioning Locaila
130. R1-2211312 Views on improved accuracy based on NR carrier phase measurement Nokia, Nokia Shanghai Bell
131. R1-2211370 Improved accuracy based on NR carrier phase measurement xiaomi
132. R1-2211406 Improved positioning accuracy with NR carrier phase measurements Intel Corporation
133. R1-2211435 Discussions on Carrier Phase Measurement for NR Positioning OPPO
134. R1-2211503 Discussion on carrier phase measurement based positioning ZTE
135. R1-2211687 Discussion on carrier phase positioning CMCC
136. R1-2211728 Discussion on positioning based on NR carrier phase measurement InterDigital, Inc.
137. R1-2211743 On NR carrier phase measurements Lenovo
138. R1-2211924 Discussion on OFDM based carrier phase measurement in NR LG Electronics
139. R1-2211990 Discussion on improved accuracy based on NR carrier phase measurement NTT DOCOMO, INC.
140. R1-2212052 Discussion on NR Carrier Phase Measurement Samsung
141. R1-2212124 Phase Measurements in NR Positioning Qualcomm Incorporated
142. R1-2212193 The potential solutions for carrier phase measurement MediaTek Inc.
143. R1-2212359 Discussion on NR carrier phase positioning NEC
144. R1-2212380 NR carrier phase measurements for positioning Fraunhofer IIS, Fraunhofer HHI
145. R1-2212415 Views on NR carrier phase measurement for positioning accuracy enhancement IIT Kanpur, CEWiT
146. R1-2212515 Improved accuracy based on NR carrier phase measurement Ericsson
147. R1-2212519 Views on NR carrier phase measurement for positioning accuracy enhancement IIT Kanpur, CEWiT
148. R1-2212520 Discussion on carrier phase measurement based positioning ZTE
149. R1-2212545 FL Summary #1 for improved accuracy based on NR carrier phase measurements Moderator (CATT)
150. R1-2212546 FL Summary #2 for improved accuracy based on NR carrier phase measurements Moderator (CATT)
151. R1-2212547 FL Summary #3 for improved accuracy based on NR carrier phase measurements Moderator (CATT)
152. R1-2212550 Discussion on NR Carrier Phase Measurement Samsung
153. R1-2212859 Discussion on NR Carrier Phase Measurement Samsung
154. R1-2212937 FL Summary #4 for improved accuracy based on NR carrier phase measurements Moderator (CATT)
155. R1-2210904 Remaining issues for LPHAP Huawei, HiSilicon
156. R1-2211015 Discussion on Low Power High Accuracy Positioning vivo
157. R1-2211055 Discussions and evaluation of LPHAP enhancements FUTUREWEI
158. R1-2211206 Further discussion on Low Power High Accuracy Positioning CATT
159. R1-2211239 Discussion on evaluation and solutions for LPHAP Spreadtrum Communications
160. R1-2211313 Views on LPHAP Nokia, Nokia Shanghai Bell
161. R1-2211371 Discussion on Low Power High Accuracy Positioning xiaomi
162. R1-2211407 On Low Power High Accuracy Positioning Intel Corporation
163. R1-2211436 Discussion on Low Power High Accuracy Positioning OPPO
164. R1-2211504 Discussion on low power high accuracy positioning ZTE
165. R1-2211618 Views on Low Power High Accuracy Positioning Sony
166. R1-2211688 Discussion on low power high accuracy positioning CMCC
167. R1-2211730 Discussions on Low Power High Accuracy Positioning (LPHAP) techniques InterDigital, Inc.
168. R1-2211744 LPHAP considerations Lenovo
169. R1-2211925 Discussion on LPHAP in idle/inactive state LG Electronics
170. R1-2211991 Discussion on Low Power High Accuracy Positioning NTT DOCOMO, INC.
171. R1-2212053 Discussion on LPHAP Samsung
172. R1-2212125 Requirements, Evaluations, Potential Enhancements for Low Power High Accuracy Positioning Qualcomm Incorporated
173. R1-2212516 Evaluations for Low Power High Accuracy Positioning Ericsson
174. R1-2212690 Summary #1 for low power high accuracy positioning Moderator (CMCC)
175. R1-2212691 Summary #2 for low power high accuracy positioning Moderator (CMCC)
176. R1-2212692 Summary #3 for low power high accuracy positioning Moderator (CMCC)
177. R1-2212723 Summary #1 of LPHAP information delivery to RAN Moderator (Huawei)
178. R1-2212724 Draft Reply LS on LPHAP information delivery to RAN Moderator (Huawei)
179. R1-2212725 Reply LS on LPHAP information delivery to RAN RAN1, Huawei
180. R1-2212726 Summary #1 of SRS in multiple cells Moderator (Huawei)
181. R1-2212727 Draft Reply LS on SRS in multiple cells Moderator (Huawei)
182. R1-2212728 Reply LS on SRS in multiple cells RAN1, Huawei
183. R1-2212928 Summary #4 for low power high accuracy positioning Moderator (CMCC)
184. R1-2210905 Remaining issues of RedCap positioning Huawei, HiSilicon
185. R1-2210921 Discussion on Positioning for RedCap UEs Quectel
186. R1-2211016 Discussion on positioning for RedCap UEs vivo
187. R1-2211207 Further discussion on positioning for RedCap UEs CATT
188. R1-2211314 Views on Positioning for RedCap UEs Nokia, Nokia Shanghai Bell
189. R1-2211408 Enhancements for positioning for RedCap UEs Intel Corporation
190. R1-2211437 Discussion on Positioning for RedCap Ues OPPO
191. R1-2211505 Discussion on Positioning for RedCap UE ZTE
192. R1-2211619 Views on positioning for RedCap UEs Sony
193. R1-2211689 Discussion on RedCap positioning CMCC
194. R1-2211732 Discussions on positioning for RedCap UEs InterDigital, Inc.
195. R1-2211741 Public Safety Personal Protection Equipment (PPE) FirstNet, AT&T, UK Home Office, Erillisverkot, MINISTERE DE L’INTERIEUR, SyncTechno Inc., Softil, Nkom
196. R1-2211745 Positioning for RedCap devices Lenovo
197. R1-2211819 On Positioning for RedCap UEs Apple
198. R1-2211926 Discussion on positioning support for RedCap Ues LG Electronics
199. R1-2211992 Discussion on positioning for RedCap UEs NTT DOCOMO, INC.
200. R1-2212054 Discussion on Positioning for RedCap UEs Samsung
201. R1-2212126 Positioning for Reduced Capabilities UEs Qualcomm Incorporated
202. R1-2212180 Views on positioning for RedCap UEs Sharp
203. R1-2212197 The potential solutions for RedCap UEs for positioning MediaTek Inc.
204. R1-2212368 Discussion on positioning support for RedCap UEs NEC
205. R1-2212517 Positioning for RedCap Ues Ericsson
206. R1-2212601 Feature lead summary #1 for Positioning for RedCap UEs Moderator (Ericsson)
207. R1-2212602 Feature lead summary #2 for Positioning for RedCap UEs Moderator (Ericsson)
208. R1-2212603 Feature lead summary #3 for Positioning for RedCap UEs Moderator (Ericsson)
209. R1-2212743 Discussion on Positioning for RedCap UE ZTE
210. R1-2212949 Feature lead summary #4 for Positioning for RedCap UEs Moderator (Ericsson)
211. R1-2213017 Draft TR 38.859 v020: Study on expanded and improved NR positioning Rapporteurs (Intel, CATT, Ericsson)
212. R1-2213018 Post-meeting Comments to Draft TR 38.859 v020: Study on expanded and improved NR positioning Moderator (Intel Corporation)

**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

**RAN2#119bis-e:**

1. R2-2209351 LS on Terminology Alignment for Ranging/Sidelink Positioning (S2-2207129; contact: Xiaomi) SA2 LS in Rel-18 FS\_Ranging\_SL To:RAN1, RAN2, RAN3 Late
2. R2-2209588 Work Plan for Study Item on Expanded and Improved NR Positioning CATT, Intel Corporation, Ericsson Work Plan FS\_NR\_pos\_enh2
3. R2-2210040 Discussion on Terminology alignment with SA2 Xiaomi discussion Rel-18
4. R2-2210041 Draft Reply LS on Terminology Alignment for Ranging & Sidelink Positioning Xiaomi LS out Rel-18 To:SA2 Cc:RAN1, RAN3
5. R2-2209400 Discussion on SL Positioning CATT discussion Rel-18 FS\_NR\_pos\_enh2
6. R2-2209402 Draft Reply LS on Terminology Alignment for Ranging/Sidelink Positioning CATT LS out Rel-18 FS\_NR\_pos\_enh2 To:SA2 Cc:RAN1, RAN3
7. R2-2209425 Discussion on sidelink positioning Huawei, HiSilicon discussion Rel-18 FS\_NR\_pos\_enh2
8. R2-2209536 SL-PRS configuration MediaTek Inc. discussion Rel-18 FS\_NR\_pos\_enh2
9. R2-2209560 Discussion on sidelink positioning vivo discussion Rel-18 FS\_NR\_pos\_enh2
10. R2-2209606 Support of sidelink positioning Intel Corporation discussion Rel-18 FS\_NR\_pos\_enh2
11. R2-2209607 Report of email discussion 406 on sidelink Intel Corporation discussion Rel-18 FS\_NR\_pos\_enh2 Late
12. R2-2209671 Protocol aspects of sidelink positioning Nokia Germany discussion Rel-18
13. R2-2209693 Discussion on Sidelink Positioning InterDigital, Inc. discussion Rel-18 FS\_NR\_pos\_enh2
14. R2-2209729 Further discussion on sidelink positioning OPPO discussion Rel-17 FS\_NR\_pos\_enh2
15. R2-2209767 Sidelink Positioning Architecture and Protocol Stack Apple discussion Rel-18 FS\_NR\_pos\_enh2
16. R2-2209979 Discussion on potential solutions for SL positioning Spreadtrum Communications discussion Rel-18
17. R2-2210003 On SL Positioning Protocol and Architecture Aspects Lenovo discussion Rel-18
18. R2-2210042 Discussion on SL positioning Xiaomi discussion Rel-18
19. R2-2210085 Discussion on sidelink positioning ZTE, Sanechips discussion Rel-18 NR\_pos\_enh-Core
20. R2-2210115 Discussion on Sidelink Positioning LG Electronics Deutschland discussion
21. R2-2210167 Considerations on Sidelink positioning CMCC discussion Rel-18 FS\_NR\_pos\_enh2
22. R2-2210210 Considerations on sidelink positioning Sony discussion Rel-18 FS\_NR\_pos\_enh2
23. R2-2210316 SL positioning Terminology and Protocol Aspects Ericsson discussion Rel-18
24. R2-2210363 Study of Sidelink Positioning Architecture, Signaling and Procedures Qualcomm Incorporated discussion
25. R2-2210481 Discussion on SL positioning Samsung discussion Rel-18 FS\_NR\_pos\_enh2
26. R2-2210546 Discussion on out-of-coverage sidelink positioning Samsung R&D Institute UK discussion
27. R2-2209403 Discussion on RAT dependent integrity CATT discussion Rel-18 FS\_NR\_pos\_enh2
28. R2-2209426 Discussion on RAT-dependent integrity Huawei, HiSilicon discussion Rel-18 FS\_NR\_pos\_enh2
29. R2-2209561 Discussion on RAT-dependent integrity vivo discussion Rel-18 FS\_NR\_pos\_enh2
30. R2-2209608 Integrity for RAT dependent positioning methods Intel Corporation discussion Rel-18 FS\_NR\_pos\_enh2
31. R2-2209694 Discussion on RAT-dependent Integrity InterDigital, Inc. discussion Rel-18 FS\_NR\_pos\_enh2
32. R2-2209725 Consideration on RAT-dependent integrity OPPO discussion Rel-17 FS\_NR\_pos\_enh2
33. R2-2209961 Discussion on RAT-dependent positioning integrity Lenovo discussion Rel-18
34. R2-2209980 Discussion on solutions for integrity of RAT-dependent positioning techniques Spreadtrum Communications discussion Rel-18
35. R2-2210084 Discussion on RAT-dependent methods positioning integrity ZTE, Sanechips discussion Rel-18 NR\_pos\_enh-Core
36. R2-2210116 Discussion on RAT-dependent positioning integrity Xiaomi discussion
37. R2-2210140 Discussion on RAT-dependent integrity CMCC discussion Rel-18 FS\_NR\_pos\_enh2
38. R2-2210211 Considerations on solution for integrity of RAT dependent positioning Sony discussion Rel-18 FS\_NR\_pos\_enh2
39. R2-2210317 RAT-dependent integrity and TP for TR Ericsson discussion Rel-18
40. R2-2210364 Integrity of NR Positioning Technologies Qualcomm Incorporated discussion
41. R2-2210547 Discussion on integrity of RAT dependent positioning techniques Samsung R&D Institute UK discussion
42. R2-2209401 Discussion on LPHAP CATT discussion Rel-18 FS\_NR\_pos\_enh2
43. R2-2209405 Report of [Post119-e][407][POS] LPHAP upper layer enhancements (CATT) CATT discussion Rel-18 FS\_NR\_pos\_enh2
44. R2-2209424 Discussion on the LPHAP Huawei, HiSilicon discussion Rel-18 FS\_NR\_pos\_enh2
45. R2-2209562 Discussion on LPHAP vivo discussion Rel-18 FS\_NR\_pos\_enh2
46. R2-2209609 Support of LPHAP Intel Corporation discussion Rel-18 FS\_NR\_pos\_enh2
47. R2-2209695 Discussion on LPHAP InterDigital, Inc. discussion Rel-18 FS\_NR\_pos\_enh2
48. R2-2209727 Further consideration on LPHAP OPPO discussion Rel-17 FS\_NR\_pos\_enh2
49. R2-2209768 Potential LPHAP enhancements Apple discussion Rel-18 FS\_NR\_pos\_enh2
50. R2-2209962 Discussion on low power high accuracy positioning Lenovo discussion Rel-18
51. R2-2210083 Discussion on LPHAP ZTE, Sanechips discussion Rel-18 NR\_pos\_enh-Core
52. R2-2210117 Discussion on LPHA positioning Xiaomi discussion
53. R2-2210168 Considerations on LPHAP CMCC discussion Rel-18 FS\_NR\_pos\_enh2
54. R2-2210212 Considerations on on solution for Low Power High Accuracy Positioning Sony discussion Rel-18 FS\_NR\_pos\_enh2
55. R2-2210318 LPHAP and Text Proposal for TR Ericsson discussion Rel-18
56. R2-2210365 Enhancements to Positioning in RRC\_INACTIVE State for LPHAP Qualcomm Incorporated discussion
57. R2-2210482 Discussion on LPHAP Samsung discussion Rel-18 FS\_NR\_pos\_enh2
58. R2-2209404 Discussion on RedCap Positioning CATT discussion Rel-18 FS\_NR\_pos\_enh2
59. R2-2209563 Discussion on RedCap positioning vivo discussion Rel-18 FS\_NR\_pos\_enh2
60. R2-2209643 Discussion on RedCap Positioning Huawei, HiSilicon discussion
61. R2-2209696 Discussion on Redcap Positioning InterDigital, Inc. discussion Rel-18 FS\_NR\_pos\_enh2
62. R2-2209756 RedCap positioning Intel Corporation discussion Rel-18 FS\_NR\_pos\_enh2
63. R2-2209963 Discussion on RedCap positioning Lenovo discussion Rel-18
64. R2-2210082 Discussion on RedCap positioning ZTE, Sanechips discussion Rel-18 NR\_pos\_enh-Core
65. R2-2210118 Discussion on RedCap UE positioning Xiaomi discussion
66. R2-2210319 Positioning for RedCap UEs Ericsson discussion Rel-18

**RAN2#120:**

1. R2-2211130 LS Out on Positioning Reference Units (S2-2209590; contact: CATT) SA2 LS in Rel-18 FS\_eLCS\_Ph3 To:RAN1 Cc:RAN2, RAN3
2. R2-2211131 LS on LPHAP information delivery to RAN (S2-2209591; contact: Huawei) SA2 LS in Rel-18 FS\_eLCS\_Ph3 To:RAN1, RAN2 Cc:RAN3
3. R2-2211139 LS on RAN dependency for Ranging/Sidelink Positioning (S2-2209961; contact: Xiaomi) SA2 LS in Rel-18 FS\_Ranging\_SL To:RAN1, RAN2, RAN3
4. R2-2211145 Reply LS on Terminology Alignment for Ranging/Sidelink Positioning (R1-2210567; contact: Xiaomi) RAN1 LS in Rel-18 FS\_Ranging\_SL To:SA2 Cc:RAN2, RAN3
5. R2-2211222 Discussion on the PRU LS from SA2 CATT discussion Rel-18 FS\_NR\_pos\_enh2
6. R2-2211223 Open Issue List of Study Item on Expanded and Improved NR Positioning CATT discussion Rel-18 FS\_NR\_pos\_enh2
7. R2-2211224 Text Proposals of TR 38.859 for Expanded and Improved NR Positioning CATT discussion Rel-18 FS\_NR\_pos\_enh2
8. R2-2211225 draft LS to capture Text Proposal for TR 38.859 CATT LS out Rel-18 FS\_NR\_pos\_enh2 To:RAN 1 Cc:RAN3
9. R2-2211253 Discusison on the reply to SA2 LS on LPHAP Huawei, HiSilicon discussion Rel-18 FS\_NR\_pos\_enh2
10. R2-2211758 Discussion on reply LS on RAN dependency for Ranging Sidelink Positioning OPPO discussion Rel-18 FS\_NR\_pos\_enh2
11. R2-2212179 [Draft] Response LS to SA2 on the Ranging and Sidelink positioning Spreadtrum Communications LS out Rel-18 FS\_NR\_pos\_enh2 To:SA WG2 Cc:RAN WG1, RAN WG3
12. R2-2212809 Discussion on LS from SA2 on RAN dependency Xiaomi discussion Rel-18
13. R2-2212810 Draft Reply LS on RAN dependency for Ranging & Sidelink Positioning Xiaomi LS out Rel-18 To:SA2 Cc:RAN1, RAN3
14. R2-2212856 RAN dependency for Ranging/Sidelink Positioning Qualcomm Incorporated discussion
15. R2-2211226 Discussion on SL Positioning CATT discussion Rel-18 FS\_NR\_pos\_enh2
16. R2-2211230 Discussion on sidelink positioning vivo discussion Rel-18 FS\_NR\_pos\_enh2
17. R2-2211252 Discussion on Sidelink Positioning Huawei, HiSilicon discussion Rel-18 FS\_NR\_pos\_enh2
18. R2-2211462 Support of sidelink positioning Intel Corporation discussion Rel-18 FS\_NR\_pos\_enh2
19. R2-2211661 Server UE functions MediaTek Inc. discussion Rel-18 FS\_NR\_pos\_enh2
20. R2-2211688 SLPP/RSPP protocol design Apple discussion FS\_NR\_pos\_enh2
21. R2-2211839 Further discussion on sidelink positioning OPPO discussion Rel-18 FS\_NR\_pos\_enh2
22. R2-2211917 Considerations on sidelink positioning Sony discussion Rel-18 FS\_NR\_pos\_enh2
23. R2-2212082 Considerations for UE Positioning using Sidelink Fraunhofer IIS, Fraunhofer HHI discussion
24. R2-2212096 On SL Positioning Protocol and Architecture Lenovo discussion Rel-18
25. R2-2212109 Discussion of session-based and session-less sidelink positioning Nokia Germany discussion Rel-18
26. R2-2212112 Protocol and coverage aspects of sidelink positioning Nokia Germany discussion
27. R2-2212169 Discussion on potential solutions for SL positioning Spreadtrum Communications discussion Rel-18
28. R2-2212359 NW Assisted Ranging and Protocol Name and terminologies Ericsson discussion Rel-18
29. R2-2212470 Study of signalling procedures and design considerations for sidelink positioning LG Electronics Deutschland discussion Rel-18
30. R2-2212506 Discussion on Sidelink Positioning InterDigital Communications discussion Rel-18
31. R2-2212554 Signaling procedures to enable sidelink positioning Sharp discussion Rel-18 FS\_NR\_pos\_enh2
32. R2-2212647 Discussion on SL-PRS resource allocation schemes Samsung discussion Rel-18 FS\_NR\_pos\_enh2
33. R2-2212685 Discussion on sidelink positioning ZTE Corporation discussion Rel-18 FS\_NR\_pos\_enh2
34. R2-2212710 Considerations on Sidelink positioning CMCC discussion Rel-18 FS\_NR\_pos\_enh2
35. R2-2212811 Discussion on SL positioning Xiaomi discussion Rel-18
36. R2-2212857 Study of Sidelink Positioning Architecture, Signaling and Procedures Qualcomm Incorporated discussion
37. R2-2212883 Discussion on SL-POS protocol architecture design Samsung Electronics Romania discussion
38. R2-2212941 Protocol considerations for sidelink positioning Philips International B.V. discussion Rel-18 38.859 FS\_NR\_pos\_enh2 Late
39. R2-2211227 Discussion on RAT dependent integrity CATT discussion Rel-18 FS\_NR\_pos\_enh2
40. R2-2211231 Discussion on RAT-dependent integrity vivo discussion Rel-18 FS\_NR\_pos\_enh2
41. R2-2211251 Discussion on RAT-dependent Integrity Huawei, HiSilicon discussion Rel-18 FS\_NR\_pos\_enh2
42. R2-2211463 Integrity for RAT dependent positioning methods Intel Corporation discussion Rel-18 FS\_NR\_pos\_enh2
43. R2-2211838 Consideration on RAT-dependent integrity OPPO discussion Rel-18 FS\_NR\_pos\_enh2
44. R2-2211918 Considerations on some aspects for integrity of RAT dependent positioning Sony discussion Rel-18 FS\_NR\_pos\_enh2
45. R2-2212050 Discussion on RAT-dependent integrity Lenovo discussion Rel-18
46. R2-2212074 Discussion on RAT-dependent positioning integrity Xiaomi discussion
47. R2-2212170 Discussion on solutions for integrity of RAT-dependent positioning techniques Spreadtrum Communications discussion Rel-18
48. R2-2212242 Integrity of NR Positioning Technologies Qualcomm Incorporated discussion
49. R2-2212358 Text proposal and Signaling for Integrity Computation at LMF Ericsson discussion Rel-18
50. R2-2212361 Text proposal and Signaling for Integrity Computation at LMF Ericsson discussion Rel-18 Withdrawn
51. R2-2212505 Use of DNU flag for RAT-dependent positioning integrity Nokia, Nokia Shanghai Bell discussion Rel-18 FS\_NR\_pos\_enh2
52. R2-2212509 Discussion on RAT-dependent Integrity InterDigital Communications discussion Rel-18
53. R2-2212564 Discussion on RAT dependent integrity BUPT discussion Late
54. R2-2212625 Discussion on the integrity issues CMCC discussion Rel-18 FS\_NR\_pos\_enh2
55. R2-2212684 Discussion on RAT-dependent methods positioning integrity ZTE Corporation discussion Rel-18 FS\_NR\_pos\_enh2
56. R2-2212884 Discussion on RAT-dependent integrity Samsung Electronics Romania discussion
57. R2-2211228 Discussion on LPHAP CATT discussion Rel-18 FS\_NR\_pos\_enh2
58. R2-2211232 Discussion on LPHAP vivo discussion Rel-18 FS\_NR\_pos\_enh2
59. R2-2211250 Discussion on LPHAP Huawei, HiSilicon, CATT, China Unicom, Nokia, Spreadtrum discussion Rel-18 FS\_NR\_pos\_enh2
60. R2-2211464 Support of LPHAP Intel Corporation discussion Rel-18 FS\_NR\_pos\_enh2
61. R2-2211840 Further consideration on LPHAP OPPO discussion Rel-18 FS\_NR\_pos\_enh2
62. R2-2211919 Considerations on some aspects for LPHAP Sony discussion Rel-18 FS\_NR\_pos\_enh2
63. R2-2212051 Discussion on low power high accuracy positioning Lenovo discussion Rel-18
64. R2-2212072 SRS Configuration for supporting LPHAP Fraunhofer IIS, Fraunhofer HHI discussion
65. R2-2212075 Discussion on LPHA positioning Xiaomi discussion
66. R2-2212180 Discussion on LPHAP Spreadtrum Communications discussion Rel-18
67. R2-2212230 DL Positioning measurement report THALES discussion
68. R2-2212243 Enhancements to Positioning in RRC\_INACTIVE State for LPHAP Qualcomm Incorporated discussion
69. R2-2212360 UL SRS Inactive mode complexities and Sequence ID Management and Simulations Recommendations Ericsson discussion Rel-18
70. R2-2212510 DRX related enhancement for LPHAP Nokia, Nokia Shanghai Bell discussion Rel-18 FS\_NR\_pos\_enh2
71. R2-2212512 Discussion on LPHAP InterDigital Communications discussion Rel-18
72. R2-2212648 Discussion on the alignment between PRS and DRX Samsung discussion Rel-18 FS\_NR\_pos\_enh2
73. R2-2212683 Discussion on LPHAP ZTE Corporation discussion Rel-18 FS\_NR\_pos\_enh2
74. R2-2212711 Further considerations on LPHAP CMCC discussion Rel-18 FS\_NR\_pos\_enh2
75. R2-2211229 Discussion on RedCap Positioning CATT discussion Rel-18 FS\_NR\_pos\_enh2
76. R2-2211233 Discussion on RedCap positioning vivo discussion Rel-18 FS\_NR\_pos\_enh2
77. R2-2211270 Discussion on RedCap Positioning Huawei, HiSilicon discussion
78. R2-2211465 Support of RedCap Intel Corporation discussion Rel-18 FS\_NR\_pos\_enh2
79. R2-2212052 Discussion on RedCap positioning Lenovo discussion Rel-18
80. R2-2212076 Discussion on RedCap UE positioning Xiaomi discussion
81. R2-2212228 RedCap positioning requirements for Public Safety Personal Protection Equipment (PPE FirstNet, AT&T, UK Home Office, Erillisverkot, MINISTERE DE L’INTERIEUR, SyncTechno Inc., Softil, Nkom discussion
82. R2-2212362 Positioning for RedCap UEs including Bluetooth and Text Proposal Ericsson discussion Rel-18
83. R2-2212515 Discussion on positioning for RedCap UE InterDigital Communications discussion Rel-18
84. R2-2212682 Discussion on RedCap positioning ZTE Corporation 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)

**RAN3#117bis-e:**

1. R3-225624 Work Plan for Study Item on Expanded and Improved NR Positioning(CATT, Intel Corporation, Ericsson)
2. R3-225318 LS on Terminology Alignment for Ranging/Sidelink Positioning (SA2)
3. R3-225548 Enhancements to Positioning in RRC\_INACTIVE State for LPHAP (Qualcomm Incorporated)
4. R3-225556 Remaining RAN3 aspects of Rel-18 NR Positioning study (Nokia, Nokia Shanghai Bell)
5. R3-225569 Discussion on the SA2 LS on Terminology Alignment for Ranging/Sidelink Positioning (Ericsson)
6. R3-225625 Consideration on SL Positioning Terms and Scenarios (CATT)
7. R3-225647 Discussion on sidelink positioning (Huawei)
8. R3-225710 Further discussion on sidelink positioning (Samsung)
9. R3-225799 Consideration on Sidelink positioning (CMCC)
10. R3-225826 Discussion on sidelink positioning configuration (ZTE Corporation)
11. R3-225940 Summary of Offline Discussion on Positioning\_PosEnh (Nokia – Moderator)

**RAN3#118:**

1. R3-226670 Work Plan for Study Item on Expanded and Improved NR Positioning (Intel Corporation, CATT, Ericsson)
2. R3-226171 LS on RAN dependency for Ranging/Sidelink Positioning (SA2)
3. R3-226180 LS on SRS in multiple cells (RAN2)
4. R3-226175 Reply LS on Terminology Alignment for Ranging/Sidelink Positioning (RAN1)
5. R3-226183 Reply LS on Terminology Alignment for Ranging/Sidelink Positioning (RAN2)
6. R3-226303 Remaining Issues on R18 Positioning (TP included) (Huawei)
7. R3-226570 Consideration on the incoming LSs from SA2 (CATT)
8. R3-226590 Conclusion on sidelink positioning SI (Samsung)
9. R3-226746 Discussion on the LS on sidelink positioning and LPHAP (ZTE)
10. R3-226758 Overview of the received Positioning LSes on Rel-18 Positioning (Ericsson)
11. R3-226304 [DRAFT] Reply LS on LPHAP indication delivery to RAN (Huawei)
12. R3-226305 [DRAFT] Reply LS on SRS in multiple cells (Huawei)
13. R3-226734 Reply LS on RAN dependency for Ranging and Sidelink Positioning (Xiaomi)
14. R3-226887 TP to TR 38.859 capturing RAN3 Rel-18 Positioning SI agreements (Ericsson, Intel Corporation, Huawei, CATT, Samsung, ZTE, Nokia, Nokia Shanghai Bell, Xiaomi)
15. R3-226889 LS on Study on expanded and improved NR positioning (Huawei, CATT, Ericsson, Intel Corporation)

**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

**RAN4 #104bis-e**

1. R4-2215430, “Discussion on accuracy improvement based on PRS/SRS bandwidth aggregation for intra-band carriers,” CATT
2. R4-2215432, “Discussion on RRM aspects in the study on expanded and improved NR positioning,” CATT
3. R4-2215825, “RRM requirements on expanded and improved NR positioning,” OPPO
4. R4-2215875, “Discussion on PRS/SRS accuracy improvement for BW aggregation,” LG Electronics Polska
5. R4-2215883, “On accuracy improvement based on bandwidth aggregation for positioning,” Ericsson
6. R4-2215884, “On accuracy improvement based on NR carrier phase measurements,” Ericsson
7. R4-2215885, “RRM aspects of expanded and improved NR positioning,” Ericsson
8. R4-2216227, “Discussion on NR positioning measurement accuracy improvement based on bandwidth aggregation,” Nokia, Nokia Shanghai Bell
9. R4-2216228, “Discussion on NR positioning measurement accuracy improvement based on carrier phase measurements,” Nokia, Nokia Shanghai Bell
10. R4-2216229, “RRM impacts for NR positioning accuracy improvements bandwidth aggregation and carrier phase measurements,” Nokia, Nokia Shanghai Bell
11. R4-2216541, “Further discussion on CA based positioning enhancement,” ZTE Corporation
12. R4-2216685, “Work Plan for Study Item on Expanded and Improved NR Positioning Intel Corporation, CATT,” Ericsson
13. R4-2216725, “Study of PRS/SRS bandwidth aggregation - RF aspects,” Qualcomm Inc.
14. R4-2216931, “Email discussion summary for [104-bis-e][220] FS\_NR\_pos\_enh2\_RRM,” Moderator (Ericsson)
15. R4-2216974, “Email discussion summary for [104-bis-e][138] FS\_NR\_pos\_UERF,” Moderator (Intel)
16. R4-2217153, “Email discussion summary for [104-bis-e][220] FS\_NR\_pos\_enh2\_RRM,” Moderator (Ericsson)
17. R4-2217257, “WF on Improved NR Positioning,” Ericsson
18. R4-2217739, “WF on expanded and improved NR positioning – UE RF aspects,” Intel Corporation
19. R4-2217790, “Email discussion summary for [104-bis-e][138] FS\_NR\_pos\_UERF,” Moderator (Intel)

**RAN4 #105**

1. R4-2218441, “Discussion on RRM aspects on PRS/SRS bandwidth aggregation for intra-band carriers,” CATT
2. R4-2218517, “Study of PRS/SRS bandwidth aggregation - RRM aspects,” Qualcomm Inc.
3. R4-2218603, “RRM aspects in the study on expanded and improved NR positioning,” ZTE Corporation
4. R4-2218611, “RRM aspects in the study on expanded and improved NR positioning,” ZTE Corporation
5. R4-2218997, “RRM requirements on PRS SRS Bandwitdh Aggregation,” OPPO
6. R4-2219084, “Discussion on NR positioning measurement accuracy improvement based on bandwidth aggregation,” Nokia, Nokia Shanghai Bell
7. R4-2219186, “RRM aspects in the study on expanded and improved NR positioning,” ZTE Corporation
8. R4-2219357, “Further discussion on CA based positioning enhancement,” ZTE Corporation
9. R4-2219411, “Discussion on RF impairments for NR positioning,” Huawei, HiSilicon
10. R4-2219465, “RF issues related to bandwidth aggregation for positioning measurement,” Ericsson
11. R4-2219466, “RF issues related to carrier phase measurement for positioning,” Ericsson
12. R4-2219467, “RRM issues related to bandwidth aggregation for positioning measurement,” Ericsson
13. R4-2219468, “RRM issues related to carrier phase measurement for positioning,” Ericsson
14. R4-2219552, “RRM aspects for PRS/SRS CA,” Huawei, HiSilicon
15. R4-2219553, “RRM aspects for carrier phase measurement,” Huawei, HiSilicon
16. R4-2219771, “RRM aspects for PRS/SRS bandwidth aggregation for intra-band carriers,” Nokia, Nokia Shanghai Bell
17. R4-2219772, “RRM aspects for NR carrier phase measurements,” Nokia, Nokia Shanghai Bell
18. R4-2219915, “Discussion on NR positioning measurement accuracy improvement based on carrier phase measurements,” Nokia, Nokia Shanghai Bell
19. R4-2220037, “Study of PRS/SRS bandwidth aggregation - RF aspects,” Qualcomm Inc.
20. R4-2220071, “Topic summary for [105][225] FS\_NR\_pos\_enh2\_RRM,” Moderator (Ericsson)
21. R4-2220117, “Topic summary for [105][137] FS\_NR\_pos\_UERF,” Moderator (Intel)
22. R4-2220438, “WF on expanded and improved NR positioning,” Ericsson
23. R4-2220439, “LS on RRM agreements on expanded and improved NR positioning,” Ericsson
24. R4-2220544, “WF for study on expanded and improved NR positioning,” Intel Corporation
25. R4-2220545, “LS for study on expanded and improved NR positioning,” Qualcomm Inc.
26. R4-2220735, “Text Proposals to TR 38.859 for Expanded and Improved NR Positioning for RAN4 RRM aspects,” Huawei

* 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