**3GPP TSG RAN WG1 Meeting #101-e** [**R1-200**](file:///E%3A%5C1%20Meetings%5CRAN1%5C2020%2005_TSRR1_101%5CInbox%5CR1-200xxxx.doc)**4701**

**e-meeting, 25th May – 5th June 2020**

**Source: Moderator (CATT)**

**Title: FL Summary for NR Positioning Enhancements**

**Agenda item: 8.2**

**Document for: Discussion and Decision**

# Introduction

At RAN#86 meeting, the study item on NR Positioning Enhancements was approved **Error! Reference source not found.**. From RAN1’s perspective, the SI includes the following objectives:

1. *Study enhancements and solutions necessary to support the high accuracy (horizontal and vertical), low latency, network efficiency (scalability, RS overhead, etc.), and device efficiency (power consumption, complexity, etc.) requirements for commercial uses cases (incl. general commercial use cases and specifically (I)IoT use cases as exemplified in section 3 above (Justification)):*
	1. *Define additional scenarios (e.g. (I)IoT) based on TR 38.901 to evaluate the performance for the use cases (e.g. (I)IoT). [RAN1]*
	2. *Evaluate the achievable positioning accuracy and latency with the Rel-16 positioning solutions in (I)IoT scenarios and identify any performance gaps. [RAN1]*
	3. *Identify and evaluate positioning techniques, DL/UL positioning reference signals, signalling and procedures for improved accuracy, reduced latency, network efficiency, and device efficiency.
	Enhancements to Rel-16 positioning techniques, if they meet the requirements, will be prioritized, and new techniques will not be considered in this case. [RAN1, RAN2]*

*NOTE 1: Sidelink is not part of this objective.*

*NOTE 2: Involve RAN4 for validating assumptions for the systems evaluations where appropriate.*

*NOTE 3: The commercial use cases and requirements are applicable to a limited geographic area.*

As stated above, the SI will define the IIOT use cases with the associated performance requirements for identifying the performance gap and the simulation scenarios for the IIOT use cases with associated parameters.

This document provides a summary of the issues and proposals for “AI 8.2.1 Additional Scenarios for Evaluation” from the contributions [2-18] and “AI 8.2.2 Evaluation of achievable positioning accuracy and latency” ” from the contributions [19-33] (Note: There is no treatment for the contributions to other AIs under 8.2 according to meeting agenda).

This summary covers the following aspects:

* Target Positioning Performance in Rel-17
* Additional evaluation scenarios for IIOT use cases
* Evaluation parameters common for all scenarios
* Evaluation parameters common for all IIOT scenarios
* Evaluation scenarios for general commercial use cases in Rel-17
* DL PRS and UL SRS configurations in simulation evaluation
* Evaluation of simulation results

Based on the meeting arrangement, the main goal for this meeting is to reach the agreements on the scenarios and simulation assumption for Rel-17 positioning enhancements SI.

Please note of the following highlights will be used in this summary:

* The Purple highlights are proposals and issues for discussion with high priority during this meeting
* The YELLOW highlights are proposals and issues for discussion in this meeting
* The BLUE highlights are offline consensus/conclusion based on offline discussion or comments
* The GREYed sections are issues that have been discussed or resolved, or no further discussion is expected during this meeting.

# Issues/proposals

## Target Positioning Performance in Rel-17

Background

In SID, it says, “*Enhancements to Rel-16 positioning techniques, if they meet the requirements, will be prioritized, and new techniques will not be considered in this case*.” To evaluate whether the enhancements to Rel-16 positioning techniques meet the requirements, there is a need first to define the target performance in order to identify the performance gap.

The SID provides the exemplary performance targets in the justification of the SI [1]: “NR Positioning in Rel-17 should evaluate and specify enhancements and solutions to meet the following exemplary performance targets:

(a) For general commercial use cases (e.g., TS 22.261):

 - sub-meter level position accuracy (< 1 m)

(b) For IIoT Use Cases (e.g., 22.804):

 - position accuracy < 0.2 m

The target latency requirement is < 100 ms; for some IIoT use cases, latency in the order of 10 ms is desired.”

In addition, in the email discussin prior to the meeting, the following proposal was discussed in Rapporteur’s summary [2]:

|  |
| --- |
| Proposal 2‑1* Define target positioning requirements in Rel-17 with one of the following options:
	+ Option 1: Select one IIOT scenario (or multiple IIOT scenarios) from Table 8.1.7 in TR 22.804 as the target IIOT scenario(s), and then define the target positioning requirements in Rel-17 based on the positioning requirements defined in TR 22.804 for the selected IIOT scenario(s);
	+ Option 2: Define the target positioning requirements in Rel-17 with the consideration of the positioning performance defined in Table 8.1.7 in TR 22.804 (e.g., using the exemplary performance targets in the SID), but the target positioning requirements may not necessarily be associated with particular IIOT scenario(s).
* In R17, CDFs of horizontal and vertical positioning errors are used as a performance metrics in NR positioning evaluations with at least the following percentiles of positioning errors 67%, 80%, 90%, [95%], [99%].

FFS: whether to consider the confidence level of the accuracy in R17 performance metrics* In R17, Positioning latency will be considered in terms of:
	+ FFS: physical layer only, or RAN (PHY, MAC, RRC, NPP, NPPa etc.) only, or End to End
* FFS: whether to define the target performance for UE heading
 |

Submitted Proposals

* (Futurewei) ***Proposal 1:***
	+ Support Option 2 from the Rapporteur’s summary, to avoid unnecessary lengthy discussion time to achieve consensus on down-selection.
		- Option 2: Define the target positioning requirements in Rel-17 with the consideration of the positioning performance defined in Table 8.1.7 in TR 22.804 (e.g., using the exemplary performance targets in the SID), but the target positioning requirements may not necessarily be associated with particular IIOT scenario(s).
* (Huawei) ***Proposal 1:***
	+ Select InF-SH for IIoT scenario with first priority for evaluations.
		- InF-DH is considered as second priority for evaluations
* (Huawei) ***Proposal 2:***
	+ The target positioning accuracy is set to [0.2m - 0.5m]@90% for at least InF-SH scenario
		- Accuracy target for other scenarios may be relaxed if supported
* (Huawei) ***Proposal 3:***
	+ Consider to adopt the following simplified physical layer latency representation
* (Huawei) ***Proposal 4:***
	+ Consider to adopt the resource utilization of PRS and SRS as the metric for network efficiency
* (Huawei) ***Proposal 5:***
	+ Consider to adopt either the transmission energy for burst SRS transmission or the average transmission power for periodic SRS transmission for evaluating UE power consumption
* (vivo)***Proposal 1:***
	+ For general commercial use cases, sub-meter level positioning accuracy (< 1 m) is mostly for indoor deployment scenarios.
* (vivo)***Proposal 2:***
	+ For IIoT use cases, the target positioning requirements should be defined similarly as it for Rel-16 commercial use cases in TR38.855 with a CDF value.
		- Horizontal positioning error < 0.5m for 80% of UEs for IIoT use cases.
		- Vertical positioning error < 0.5m for 80% of UEs for IIoT use cases.
		- End to end latency < 100ms for IIoT use cases.
* (ZTE)***Proposal 1:***
	+ Interested companies need to evaluate if Rel.16 positioning solutions and novel positioning methods can meet the requirement of Rel.17 commercial use cases based on a loose bound requirement at first, then stricter requirements are discussed for next stage.
* (CATT)***Proposal 1:***
	+ Select three IIoT use cases (Factories of the Future 13.3, 15.5 and 15.6) from Table 8.1.7 in TR 22.804 as the target IIoT use cases, and the target positioning requirements in Rel-17 should be defined based on the positioning requirements of the selected IIoT use cases
* (CATT)***Proposal 2:***
	+ Based on the positioning requirements of the three selected IIoT use cases, one unified target positioning requirements for Rel-17 is defined as follows

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Requirements | Scenario | Horizontal accuracy | Verticalaccuracy  | Availability | Latency for position estimation of UE | UE Mobility |
| Target positioning requirements in Rel-17 | * Process automation – plant asset management
* Inbound logistics
 | < [20] cm | < [1]m | 90% | 100 ms | < 30 km/h |

* (CATT)***Proposal 3:***
	+ For assessing scalability of positioning solutions, latency of positioning procedure should be studied as a function of number of devices to be positioned
* (CATT)***Proposal 4:***
	+ Average power consumption of devices should be studied as a function of configured time and frequency resources for positioning
* (NOK)***Proposal 1:***
	+ We prefer option-1 defining the exemplary positioning requirements in Rel-17 by selecting one IIOT scenario from Table 8.1.7 in TR 22.804.
		- The target accuracy performance must be indicated with CDF values in a statistic manner for horizontal and vertical positioning methods
		- Power consumption and latency requirements must be minimum performance requirements.
* (NOK)***Proposal 2:***
	+ Latency of positioning procedure should be studied. A goal of latency study is to identify latency bottle neck in the positioning service process, and improve the bottle neck issue
		- UE<>gNB measurement and report latency requirement
		- gNBs<>LMF request and report latency requirement (may include RAN3 for the study)
* (NOK) ***Proposal 6****:*
	+ Performance target is achieved with the best performance achievable with resource allocation, accordingly the DL PRS and UL SRS configuration selections must be done with the consideration of the best performance.
* (Intel) ***Proposal 1****:*
	+ Performance targets provided in study item description document are confirmed as design targets for evaluation of NR positioning enhancements.
* (Samsung) ***Proposal 1****:*
	+ The target positioning requirements should be defined following the IIoT use cases with positioning level 1, 2 and 8 in Table 8.1.7 in TR 22.804.
* (Samsung) ***Proposal 3***:
	+ Positioning accuracy including relative positioing accuracy should be the baseline metric for evaluation. Latency, signalling overhead and UE power consumption can be considered additionally as metrics for evaluation in an analytical manner
* (CMCC) ***Proposal 1***:
	+ The IIoT logistics and warehousing use case should be considered with the following positioning requirements
		- Horizontal positioning accuracy: < 0.1m (for 90% UEs);
		- Vertical positioning accuracy: < 0.2m (for 90% UEs);
		- End-to-end latency: < 10ms
* (OPPO) ***Proposal 1***:
	+ The performance requirement for Rel-17 positioning is: positioning accuracy < 1m at 90% of the CDF curve and the target latency is < 1s
* (LGE) ***Proposal 1***:
	+ Th For performance requirement of IIOT use case in Rel.17
		- Selecting one or multiple scenarios in appendix #1 for target IIOT scenario(s), and then define the appropriate target positioning requirements.
		- Analyzing based on CDF of horizontal and/or vertical positioning accuracy should be used.
		- Only the perspective of physical layer such as preparation time, BWP switching, RS preparation time, BWP switching, RS Rx/Tx processing time, etc. should be discussed for aspect of positioning latency.
		- The issues related with power consumption, scalability/capacity and network efficiency could be evaluated analytically.
* (Sony) ***Proposal 1***:
	+ RAN1 needs to define intermediate positioning requirements derived from Table 1 and Table 2
* (Sony) ***Proposal 2***:
	+ The requirement parameters to be used for the evaluation of NR positioning enhancements are:
		- Horizontal accuracy and its corresponding minimum cumulative distributive function (cdf) target.
		- Vertical accuracy and its corresponding minimum cdf target.
		- Latency
* (Sony) ***Proposal 3***:
	+ Positioning requirements as follows: Horizontal positioning error < [1]m for [FFS] % of UEs, Vertical positioning error < [1]m for [FFS] % of UEs, and End to end latency < [1]s.
* (Sony) ***Proposal 4***:
	+ Prioritize RAT-dependent techniques during NR Rel-17 study item.
* (CEWiT) ***Proposal 3***:
	+ In Rel 17 additional percentile value e.g. 95%, 99% can be considered as accuracy metric both for vertical and horizontal positioning.
* (CEWiT) ***Proposal 5***:
	+ Quantification of Power consumption for performance evaluation of positioning should be introduced.

FL Comments

Based on the comments, we have a diverge views on how to define the target performance requirements in R17, and thus, we may list multiple options for further discussion in the meeting.

Initial Proposal for Discussion

* With the understanding that the target positioning accuracy requirement may not be met for every scenario, the target positioning accuracy requirements in Rel-17 are defined as follows:
	+ - For general commercial use cases:
			* Option 1: (from the performance target mentioned in SID)
				+ Horizontal position accuracy (< 1 m)
				+ Vertical position accuracy (< TBD m)

**Supported by**:

* + - * Option 2:
				+ …

**Supported by**:

* + - For IIOT use cases:
			* Option 1: (from the performance target mentioned in SID)
				+ Horizontal position accuracy (< 0.2 m)
				+ Vertical position accuracy (<TBD m)
				+ Note

**Supported by**:

* + - * Option 2: (based on the best evaluation results of selected IIOT use cases)
				+ Horizontal position accuracy (<TBD, based on simulation evaluation)
				+ Vertical position accuracy (<TBD, based on simulation evaluation)

**Supported by**:

* + - * Option 3: defined as IIOT use case(s) dependent, e.g., separate target requirements for different IIOT scenarios)
				+ Horizontal position accuracy for each evaluated IIOT scenario (<TBD, based on simulation evaluation)
				+ Vertical position accuracy for each evaluated IIOT scenario (< TBD, based on simulation evaluation

**Supported by**:

Additional Comments

|  |  |
| --- | --- |
| **Company** | **Comments**  |
|  |  |

Initial Proposal for Discussion

* CDFs of positioning errors are used as a performance metrics in NR positioning evaluation with at least the following percentiles [50%], 67%, 80%, 90%, [95%].
* The target horizontal and vertical positioning accuracy requirements are defined based on availability of X%. X is given with one of the following options:
	+ Option 1: X = 80%
		- Supported by:
	+ Option 2: X = 90%:
		- Supported by:
	+ Option 3: X > 90% (e.g., 95%)
		- Supported by:

Additional Comments

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| --- | --- |
| **Company** | **Comments**  |
|  |  |

Initial Proposal for Discussion

* The analysis of the positioning delay, power consumption, scalability/capacity and network efficiency for positioning enhancement is conducted in RAN1 with one of the following options:
	+ Option 1: the analysis is from physical layer point of view only
		- Supported by:
	+ Option 2: the analysis is limited to physical layer (e.g., including higher layer message delays, loading, etc.)
		- Supported by:

Additional Comments

|  |  |
| --- | --- |
| **Company** | **Comments**  |
|  |  |
|  |  |

Issues for further discussion

TBD

## Additional evaluation scenarios for IIOT use cases

Background

*As defined in SID, one of the main objectives for RAN1 is to define additional scenarios (e.g. (I)IoT) based on TR 38.901 to evaluate the performance for the use cases (e.g. (I)IoT)][1].*

Submitted Proposals

* (Futurewei) ***Proposal 1:***
	+ Thechannel models, parameters and modelling techniques as described for IIOT scenarios in TR 38.901 are adopted for this Study Item.
* (Huawei) ***Proposal 1:***
	+ Select InF-SH for IIoT scenario with first priority for evaluations.
		- InF-DH is considered as second priority for evaluations
* (vivo) ***Proposal 3:***
	+ Focus on one or two scenarios as the typical IIoT positioning scenarios for evaluation, pick the InF-SH scenario and InF-DH scenario.
* (vivo) ***Proposal 4:***
	+ Study a mixed scenario such as the scenario with 50% UEs are InF-SH and 50% UEs are InF-DH
* (ZTE) ***Proposal 5:***
	+ InF-DH is appropriate for alleys, assembly and production area, which should be considered for further study
* (CATT) ***Proposal 5:***
	+ InF-DH and InF-SH scenarios should be selected as the mandatory scenarios for positioning evaluation in Rel-17. Other scenarios already defined in 38.901 can also be selected as optional scenarios for evaluation.
* (NOK) ***Proposal 5***:
	+ Select one scenario with relatively high LOS probability for targeted performance demonstration.
		- Option -1: select InF-SH and InF-DH scenarios and check if the performance requirements are satisfied.
		- Option -2: select InF-DH scenario only with adjusting cluster density or cluster size

 ( current setting cluster density r=0.6, hc=6m, d\_cluster=2m in Table 5 [2] )

* (Intel) ***Proposal 2***:
	+ Prioritize three representative I-IoT scenarios for NR Positioning evaluations
	+ Use the following three I-IoT representative scenarios for NR positioning evaluations in Rel-17
		- InF-SL
		- InF-SH
		- InF-DH
* (Samsung) ***Proposal 2***:
	+ InF-SH should be considered as baseline scenario for evaluation
* (Samsung) ***Proposal 3***:
	+ Positioning accuracy including relative positioing accuracy should be the baseline metric for evaluation. Latency, signalling overhead and UE power consumption can be considered additionally as metrics for evaluation in an analytical manner
* (CMCC) ***Proposal 2***:
	+ The InF-DH scenario should be defined as the evaluation scenario
* (OPPO) ***Proposal 2***:
	+ To evaluate NR positioning in rel-17 for IIOT use cases, use the InF-SH and InF-DL as baseline scenarios
* (LGE) ***Proposal 2***:
	+ For IIOT InF scenarios:
		- If one scenario is required, InF-SH scenario is appropriate and then InF-DH scenario should be considered in the next priority
* (Sony) ***Proposal 5***:
	+ Select InF-DL and InF-DH scenarios for the evaluation of IIoT positioning in Rel-17
* (CEWiT) ***Proposal 1***:
	+ For Rel 17 positioning enhancement, InF-DL and InF-DH or mix of both in single scenario should be considered for evaluation of positioning for IIoT use cases.
* (CEWiT) ***Proposal 2***:
	+ In Rel 17, at least InH scenario should be considered along with InF scenarios.
* (E///) ***Proposal 5***:
	+ The InF-SL and InF-DL models are NOT adopted as scenarios for performance evaluations in the Rel. 17 positioning study item
* (E///) ***Proposal 6***:
	+ The Inf-HH model is adopted as a complimentary IIOT scenario for performance evaluations in the Rel. 17 positioning study

FL Comments

From the proposals of the interested companies, it seems most companies prefer selecting InF-SH and InF-DH models for the performance evaluations in the Rel-17 positioning enhancements, although some companies also proposed other InF models.

Initial Proposal for Discussion

* InF-SH and InF-DH models in TR 38.901 are adopted as the baseline scenarios for defining the channel models, parameters and modelling techniques for performance evaluations in the Rel. 17 positioning enhancements for IIOT use cases
* Note: Individual companies may consider other InF models in TR 38.901 as complimentary evaluation scenarios in their simulation investigation

Additional Comments

|  |  |
| --- | --- |
| **Company** | **Comments**  |
|  |  |
|  |  |

Issues for further discussion

TBD

## Evaluation parameters common for all scenarios

Background

In Rel-16 the scenario parameters common to all scenarios for positioning evaluation are defined in Table 6.1.1-1 in TR 38.855, which includes the carrier frequency, the PRS/SRS bandwidth, subcarrier spacing, gNB/UE noise figures, UE max. TX power, UE antenna configuration, UE radiation pattern and network synchronization, etc. Reuse most of the common parameters defined in Table 6.1.1-1 in TR 38.855 (including Table 6.1.1-2 for UE radiation pattern in FR2) for IIOT scenarios with possible modifications may minimize simulation overhead.

Submitted Proposals

* (Huawei) ***Proposal 6:***
	+ Adopt the evaluation methodology in the Appendix
* (vivo) ***Proposal 5:***
	+ Reuse the common parameters defined in Table 6.1.1-1 in TR 38.855 except the carrier frequency, bandwidth, and subcarrier spacing for IIoT scenarios.
		- Modify the carrier frequency to 3.5 GHz and 28 GHz as defined in Table 7.8-7 in TR38.901.
		- Focus on the 100 MHz bandwidth with 30 KHz subcarrier spacing for FR1 and 400 MHz bandwidth with 120 KHz subcarrier spacing for FR2, respectively.
* (ZTE) ***Proposal 2:***
	+ The scenario parameters common to all scenarios in table 6.1.1-1 in TR 38.855 are reused for evaluation in Rel.17, but the bandwidth should be no less than 100MHz
* (CATT) ***Proposal 6***:
	+ Reuse the common parameters defined in Table 6.1.1-1 in TR 38.855 (including Table 6.1.1-2 for UE radiation pattern in FR2) for IIoT scenarios.
* (NOK) ***Proposal 3:***
	+ Reuse the common parameters used in Rel-16 SI performance study (in Table 6.1.1-1 in TR 38.855). Further down scoping of BW, carrier frequency must be considered
* (NOK) ***Proposal 7***:
	+ In addition to evaluating IIoT scenarios RAN1 should at most evaluate UMi. Note: RAN1 to consider if changes to the UMi assumptions from TR 38.855 are needed.
* (Intel) ***Proposal 3***:
	+ Reuse common system parameters as provided in Table 1 for NR Positioning evaluations in Rel-17 with the following minor changes relative to the 3GPP TR 38.855.
		- FR1: Keep only 4GHz carrier, 100MHz BW and 30kHz SCS
		- FR2: Keep only 400MHz BW and 120kHz SCS
	+ Reuse UE antenna model from the 3GPP TR 38.855 as defined in Table 1 for FR1 and Table 2 for FR2
	+ Reuse gNB antenna model corresponding to indoor office deployment scenario in the 3GPP TR 38.855 and as defined by Table 3 in this document
* (Intel) ***Proposal 4***:
	+ Reuse evaluation parameters for indoor factory evaluations as defined in Table 4 and Table 5 with proposed modifications marked in red colour
* (Samsung) ***Proposal 3***:
	+ Evaluation parameters in the below table can be a starting point with addtional consideration to include IIoT channel model in TR 38.901
* (LGE) ***Proposal 3***:
	+ For parameters in IIOT InF scenarios:
		- Common parameters (in Table 4-1 [2]): selecting one of bandwidths in each carrier (FR1 and FR2) would be preferred.
		- Scenario parameters (in Table 4-3 [2]): fixed value of height both UE and gNB should be applied for each evaluation.
* (CEWiT) ***Proposal 6***:
	+ Table 1 should be agreed as common scenario parameters.

FL Comments

In Rel-16 the scenario parameters common to all scenarios for positioning evaluation are defined in Table 6.1.1-1 in TR 38.855, which includes the carrier frequency, the PRS/SRS bandwidth, subcarrier spacing, gNB/UE noise figures, UE max. TX power, UE antenna configuration, UE radiation pattern and network synchronization, etc. Most companies propose reusing most of the common parameters defined in Table 6.1.1-1 in TR 38.855 (including Table 6.1.1-2 for UE radiation pattern in FR2) for IIOT scenarios, with possible modifications to minimize simulation overhead.

Initial Proposal for Discussion

* Adopt the parameters defined in Table 2‑1 as the baseline parameters for all scenarios in the evaluation of the positioning performance in Rel-17.
* Note: Individual companies may consider additional parameter values in their simulation investigation

Interested companies are encouraged to add the comments to the Options and FFS in the following table.

**Table 2‑1: Common scenario parameters applicable for all scenarios (modified from by Table 6.1.1-1 in TR 38.855)**

|  |  |  |  |
| --- | --- | --- | --- |
|  | FR1 Specific Values | FR2 Specific Values  | Comments (to each of the parameter) |
| Carrier frequency, GHz  | Option 1: 4GHz – Note 1Supported by: Option 2: 3.5GHz – Note 2Supported by:  | Option 1: 30 GHz – Note 1Supported by: Option 2: 28GHz – Note 2Supported by:  |  |
| Bandwidth, MHz | 100MHz for 4GHz | 400MHz |  |
| Subcarrier spacing, kHz | 30kHz for 100MHz  | 120kHz |  |
| gNB model parameters  |  |  |  |
| gNB noise figure, dB | 5dB | 7dB |  |
| UE max. TX power, dBm | 23dBm – Note 1 | 23dBm – Note 1EIRP should not exceed 43 dBm. |  |
| UE model parameters  |  |  |  |
| UE noise figure, dB | 9dB – Note 1 | 13dB – Note 1 |  |
| UE antenna configuration | Panel model 1 – Note 1Mg = 1, Ng = 1, P = 2, dH = 0.5λ,(M, N, P, Mg, Ng) = (1, 2, 2, 1, 1) | Multi-panel Configuration 1 and Panel Configuration a – Note 1- Multi-panel Configuration 1: (Mg, Ng) = (1, 2); Θmg,ng=90°; Ω0,1=Ω0,0+180°; (dg,H, dg,V)=(0,0)- Panel Configuration a:- Each antenna array has shape dH=dV=0.5λ- Config a: (M, N, P) = (2, 4, 2),- the polarization angles are 0° and 90°- The antenna elements of the same polarization of the same panel is virtualized into one TXRU- Optional: Provided by company |  |
| 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]Option 1:– T1: 0ns (perfectly synchronized), 50nsSupported by: Option 2:– T1: 0ns (perfectly synchronized) onlySupported by:  |  |
| Note 1: According to 3GPP TR 38.802Note 2: According to 3GPP TR 38.901 |  |

Issues for further discussion

TBD

## Evaluation parameters for IIOT scenarios

Background

The scenario parameters common to InF scenario(s) may be developed from the consideration of both the simulation assumptions for large scale calibration for InF scenarios in Table 7.8-7 in TR 38.901,Table 7.2-4 of 38.901 and the evaluation parameters for indoor office scenarios in Table 6.1.1-3 in TR 38.855 as the starting point.

Submitted Proposals

* (vivo) **Proposal 6:**
	+ The absolute time of arrival model in TR38.901 should be considered for positioning evaluation in IIoT scenario.
* (vivo) **Proposal 8:**
	+ Modify the clutter density and height in DH scenario if increasing the probability of LOS is needed.
* (vivo) **Proposal 9:**
	+ For the first step, calibrate the IIoT positioning simulation platform with the same parameters, and agree on some basic parameter configurations of DL PRS and UL SRS
* (ZTE) **Proposal 3:**
	+ Common evaluation parameters for IIOT channels in table 7.8-7 in TR 38.901 are reused for evaluation in Rel.17, but the BS antenna configurations, UT antenna configurations, carrier frequency, bandwidth should follow table 6.1.1-1 in TR 38.855
* (ZTE) **Proposal 4:**
	+ A proper configuration to increase LOS probability for some scenarios should be evaluated
* (CATT) **Proposal 7:**
	+ It is preferred to model absolute time of arrival for positioning evaluation in Rel-17
* (CATT) **Proposal 7:**
	+ It is preferred not to introduce blockage modelling for positioning evaluation in Rel-17
* (CATT) **Proposal 9:**
	+ The scenario parameters common to InF scenario(s) can be developed with the consideration of the parameters for InF scenarios defined in Table 7.8-7 in TR 38.901, Table 7.2-4 in TR 38.901 and the parameters for indoor office scenarios in Table 6.1.1-3 in TR 38.855, e.g., as shown in Table 2.
* (NOK) **Proposal 4:**
	+ In order to make reasonable LOS assumption for InF-DH, adjust cluster density or cluster size factors
* (Intel) **Proposal 5**:
	+ Reuse InF channel models defined in the 3GPP TR 38.901 including modelling of NLOS offset in propagation delay for NLOS models
* (CMCC) **Proposal 3**:
	+ The common InF scenario parameters can be defined based on that for the corresponding scenarios given in Table 7.8-7 in TR 38.901
* (CMCC) **Proposal 4**:
	+ Regarding the UE distribution in the common InF-DH scenario parameter, the UE height should be uniformly distributed within a pre-defined range, e.g., UE antenna height ~U([0.5]m~[9]m).
* (OPPO) **Proposal 3**:
	+ The absolute time of arrival shall be included in rel-17 positioning evaluation and it is modelled according to the Section 7.6.9 in TR 38.901
* (Sony) **Proposal 6**:
	+ Use the scenarios parameters in TR 38.901 [2] as the baseline parameters. Additional parameter modification, such as number of BS, multi-beam operation can be further studied (FFS)
* (CEWiT) **Proposal 2**:
	+ LOS link based achievable positioning accuracy should be used to compare the deviation of actual positioning accuracy.
* (CEWiT) **Proposal 7**:
	+ Table 2 and 3 should be agreed as scenario specific parameters.
* (CEWiT) **Proposal 8**:
	+ For uniform results across different sources, common parameters for DL-PRS and UL-SRS for positioning should be defined in evaluation methodologies of Rel 17 positioning enhancement.
* (Qualcomm) **Proposal 1**:
	+ For InF-DH with D = 20m, consider clutter parameter change with hc = 3, r = 0.4, dclutter = 5, which ensures 95% of the UEs have at least 4 LOS links as illustrated in Figure 2 4.
* (Qualcomm) **Proposal 2**:
	+ When deriving CDF values for positioning accuracy, consider only the UEs inside the convex hull of the base stations.
* (Qualcomm) **Proposal 3**:
	+ Introduce randomized UE height in dropping procedure, drawn from a uniform distribution over [1m – 3m].
* (Qualcomm) **Proposal 4**:
	+ Introduce variable base station height and evaluate the performance in addition to the case of fixed base station height.
* (Qualcomm) **Proposal 5**:
	+ For TDOA evaluations, baseline should be considered with perfect network synchronization.
* (Qualcomm) **Proposal 6**:
	+ Consider mobility as additional scenario for evaluation. A simple route or path trajectory can be defined in the layout along with a mobility model defining the velocities and accelerations consistent with the dynamics of the use-case applications (e.g. a line segment as illustrated in Figure 2 7). Spatial consistency procedure in [2] shall also be enabled in the mobility simulation with configurations agreed by the group.
* (Fraunhofer) **Proposal 1**:
	+ To better evaluate the performance derive complementary conditional probability density functions from the overall statistics. This shall include:
		- Positioning accuracy in a defined area representing deployment optimized for positioning, for example separate position accuracy statistics for the “passage way”.
		- Generate a separate analysis set from all drops: Positioning accuracy for drops with at least 3 links in LOS state.
* (Fraunhofer) **Proposal 2**:
	+ Consider further refinement of the absolute-time-of arrival model. For example, study the impact of the distance, clutter density and TRP height to the statistical properties of the absolute-time-of arrival.
* (Fraunhofer) **Proposal 3**:
	+ For the IIOT scenario apply InF-SH and InF-DH with selected values of the parameters hc, r and dClutter chosen within the defined range in TR 38.901
* (E///) **Proposal 1**:
	+ The InF-DH model with BS height 8m, UE height 1.5m, clutter size 2m, clutter height 6m, clutter density 0.6 and ksubsce=3.2m (previously used for InF-DH model calibration) is NOT adopted as a scenario for performance evaluations in the Rel. 17 positioning study
* (E///) **Proposal 2**:
	+ The InF-SH model with BS height 8m, UE height 1.5m, clutter size 10m, clutter height 2m, clutter density 0.2 and ksubsce=582.6m (previously used for InF-SH model calibration) is adopted as a complimentary IIOT scenario for performance evaluations in the Rel. 17 positioning study
* (E///) **Proposal 3**:
	+ The InF-DH model with BS height 8m, UE height 1.5m, clutter size 2m, clutter height 2m, clutter density 0.4 and ksubsce=50.9m is adopted as the main IIOT scenario for performance evaluations in the Rel. 17 positioning study
* (E///) **Proposal 4**:
	+ The InF-SH model with BS height 8m, UE height 1.5m, clutter size 10m, clutter height 2.6m, clutter density 0.4 and ksubsce=115.7m is adopted as a complimentary IIOT scenario for performance evaluations in the Rel. 17 positioning study
* (E///) **Proposal 7**:
	+ The ‘small hall’ deployment defined in table 7.8-7 in 38.901 with rectangular size 120m x 60m, room height 10m and 18 TRPs with an inter TRP distance of 20m is adopted as the main deployment for IIOT performance evaluations in the Rel. 17 study item
* (E///) **Proposal 8**:
	+ The ‘large hall’ deployment defined in table 7.8-7 in 38.901 with rectangular size 300m x 150m, room height 10m and 18 TRPs with an inter TRP distance of 50m is adopted as complimentary deployment for IIOT performance evaluations in the Rel. 17 study item
* (E///) **Proposal 9**:
	+ For UE evaluation assumptions in FR2, adopt 3 or 4 UE panels with each panel consisting of arrays with (M, N, P) = (1, 4, 2) and 0.5λ antenna element separation
* (E///) **Proposal 10**:
	+ Model UE panel positions as follows where Pi represents the panel position and orientation of the ith UE panel. P1: Θ0=90°, Ω0=270°, x0=0m, y0=0m, z0=0.08m; P2: Θ1= Θ0-90°, Ω1=Ω0, x1= x0, y1=y0+0.03m, z1= z0+0.08m; P3: Θ2= Θ0, Ω2=Ω0+180°, x2= x0, y2=y0+0.06m, z2= z0; P4: Θ3= Θ0+90°; Ω3=Ω0, x3= x0, y3=y0+0.03m, z1= z0-0.08m
* (E///) **Proposal 11**:
	+ 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
* (E///) **Proposal 12**:
	+ To model power reduction due to MPE issue, a maximum transmit power reduction of 10 dB is applied for a blocked panel that is randomly chosen
* (E///) **Proposal 13**:
	+ To model blockage, a loss of 10 dB is applied for a blocked panel in case the UE is a handheld device
* (E///) **Proposal 14**:
	+ In FR2 the UE RX/TX timing error for antenna panel k is modelled as zero mean stochastic variables ε\_k^RX/ε\_k^TX with normal distributions truncated at 3σ. Evaluations should be performed both without timing errors (σ^RX=σ^TX=0) and for σ^RX and σ^TX of the order of a few nanoseconds, exact values TBD

Initial Proposal for Discussion

* Absolute-time-of arrival model is considered in the evaluation of all scenarios
	+ Supported by:
* If absolute-time-of arrival model is considered,
	+ Option 1: the absolute-time-of arrival model in TR 38.901 is used without modification
		- Supported by:
	+ Option 2: further modification to the absolute-time-of arrival model in TR 38.901 is considered, e.g., different values of  and from the value shown in TR 38.901
		- Supported by:

Additional Comments

|  |  |
| --- | --- |
| **Company** | **Comments**  |
|  |  |
|  |  |

Initial Proposal for Discussion

* Blockage model is not considered in the evaluation of all scenarios;
	+ Supported by:
* Note: If the consensus is to consider Blockage model, then it needs further discussion on the details of model type (A or B) and details of the modelling parameters, e.g., the number of blockers, the blocker extensions, locations, etc.),

Additional Comments

|  |  |
| --- | --- |
| **Company** | **Comments**  |
|  |  |
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Initial Proposal for Discussion

* Discuss the scenario parameters common to all InF scenario(s) in Table 2‑2, which is developed with the consideration of the parameters for InF scenarios provided by Table 7.8-7 in TR 38.901, Table 7.2-4 of 38.901 and the parameters for indoor office scenarios in Table 6.1.1-3 in TR 38.855:
* Note: Individual companies may consider additional parameter values in their simulation investigation

Interested companies are encouraged to add the comments to the Options and FFS in the following table.

Table 2‑2 Parameters common to InF scenario(s)

|  | FR1 Specific Values  | FR2 Specific Values | Comments (to each of the parameter) |
| --- | --- | --- | --- |
| Channel model | InF-SH, InF-DHFFS: InF-SL, InF-DL, InF-HH | InF-SH, InF-DHFFS: InF-SL, InF-DL, InF-HH |  |
| Layout  | Hall size | InF-SH: 300x150 mInF-DH: 120x60 mFFS: InF-SL: 120x60 mFFS: InF-DL: 300x150 mFFS: InF-HH: 300x150 m |  |
| BS locations | 18 BSs on a square lattice with spacing D, located D/2 from the walls.- for the small hall (L=120m x W=60m): D=20m- for the big hall (L=300m x W=150m): D=50m |  |
| Room height | 10m |  |
| Total gNB TX power, dBm | 24dBm | 24dBmEIRP should not exceed 58 dBm |  |
| gNB antenna configuration | (M, N, P, Mg, Ng) = (4, 4, 2, 1, 1), dH=dV=0.5λ – Note 1 | (M, N, P, Mg, Ng) = (4, 8, 2, 1, 1), dH=dV=0.5λ – Note 1One TXRU per polarization per panel is assumed |  |
| gNB antenna radiation pattern | Single sector – Note 1 | 3-sector antenna configuration – Note 1 |  |
| Peneteration loss | 0dB |  |
| Number of floors | 1 |  |
| UE horizontal drop procedure | 100% indoor, uniformly distributed over the horizontal area |  |
| UE antenna height | Option 1: UE-height =1.5mSupported by:Option 2: uniform distribution within [X1, X2]m; FFS: {X1, X2}Supported by: |  |
| UE mobility | 3km/h |  |
| Min gNB-UE distance (2D), m | 0m |  |
| gNB antenna height | Option 1: 8 m for InF-SH and InF-DHSupported by:Option 2: uniform distribution within [Y1, Y2]m; FFS: {Y1, Y2}Supported by: |  |
| Clutter parameters: {density , height ,size } | Low clutter density: {20%, 2m, 10m}High clutter density:Option 1: {60%, 6m, 2m}Supported by:Option 2: {Z1>=40%, Z2, Z3}; FFS: {Z1>4=40%, Z2, Z3}Supported by: |  |
| Note 1: According to 3GPP TR 38.802Note 2: According to 3GPP TR 38.901 |  |

## Evaluation scenarios for general commercial use cases in Rel-17

Background

As defined in SID, the commercial uses cases considered in R17 SI includes both the general commercial use cases and specifically (I)IoT use cases. Thus, we may need to discuss which of the channel models are considered for the general commercial use cases in the evaluation of the positioning performance.

Submitted Proposals

* (NOK) **Proposal 7**:
	+ In addition to evaluating IIoT scenarios RAN1 should at most evaluate UMi. Note: RAN1 to consider if changes to the UMi assumptions from TR 38.855 are needed.
* (E///) **Proposal 15**:
	+ Include UMi and IOO as Rel. 17 evaluation scenarios for evaluations of commercial use cases restricted to a limited geographic area
* (E///) **Proposal 16**:
	+ Don’t include UMa as a Rel. 17 positioning enhancement evaluation scenario
* (E///) **Proposal 17**:
	+ Use the same lognormal parameters for the NLoS excess delay in IOO, UMi and UMa as the ones defined for the InF model in 38.901, i.e. log10(NLOS excess delay/1s) is normally distributed with mean mu=-7.5 and standard deviation sigma=0.4
* (E///) **Proposal 18**:
	+ The usage of channel measurement based evaluations as a complement to evaluations based on statistical channel models is encouraged e.g. for development of discrimination between LoS and NLoS

Initial Proposal for Discussion

The following scenario(s) are considered in Rel-17 SI for the evaluation of the positioning enhancements

* UMi street canyon for FR1 and FR2 (ISD 200m) as defined in TR 38.855
* FFS: other scenarios defined in TR 38.855

Additional Comments

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| --- | --- |
| **Company** | **Comments**  |
|  |  |
|  |  |

## DL PRS and UL SRS Configurations in simulation evaluation

Background

In order to have a practical understanding on the achievable positioning performance with Rel-16 positioning technologies for the IIOT scenarios, we assume the simulation evaluation may use any, or a combination, of the positioning technologies (e.g., OTDOA, UTDOA, multi-RTT). In addition, positioning performance depends heavily on the DL/UL RF resources configured for supporting the positioning, there is also a need to decide whether to have a common set of the configurations for DL PRS and UL SRS for positioning during the evaluation of the positioning performance in Rel-17.

Submitted Proposals

* (Huawei) **Proposal 7:**
	+ No need to define a baseline reference signal, positioning technique, nor positioning algorithm for evaluations.
* (CATT) **Proposal 10:**
	+ A common understanding is needed on the reasonable DL PRS and UL SRS configurations for Rel-17 positioning simulation evaluation
* (NOK) **Proposal 6**:
	+ Performance target is achieved with the best performance achievable with resource allocation, accordingly the DL PRS and UL SRS configuration selections must be done with the consideration of the best performance.
* (Samsung) **Proposal 5**:
	+ The below table can be a starting point for PRS configuration for evaluation
* (LGE) **Proposal 4**:
	+ For DL PRS and UL SRS configuration
		- It is not necessary to consider additional parameters. But, detail values of several parameters would be adjusted according to further discussion

FL Comments

It seems there are divergent views on whether to define the baseline configurations for DL PRS and UL SRS for positioning during the evaluation of the positioning performance in Rel-17.

Initial Proposal for Discussion

Adopt one of the following options for the configurations for DL PRS and UL SRS for positioning:

* Option 1: No need to define the baseline configurations for DL PRS and UL SRS for positioning technique.
	+ FFS: Positioning performance is evaluated with
		- the best performance achievable with any resource allocation supported by the standard, or
		- the best performance achievable with the consideration of practical resource allocation, e.g., resource usage percentage, or …
	+ Supported by:
* Option 2: Define the baseline configurations for DL PRS and UL SRS for positioning technique with a few key parameters, e.g., Comb-N, total number of OFDM symbols for a positioning fix, etc.
* Option 3: ….
* nor positioning algorithm for evaluations

Table 2‑4 presents some suggestions on DL PRS configurations for the purpose of the evaluation of the positioning performance.

Additional Comments

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| --- | --- |
| **Company** | **Comments**  |
|  |  |
|  |  |

Issues for further discussion

TBD

## Evaluation of simulation results

Background

A number of proposals were presented for the initial simulation evaluation results [19-33] with the following proposals:

Submitted Proposals

* (vivo) **Proposal 1:**
	+ The vertical positioning target for RAT-dependent techniques shouldn’t be the same as the horizontal positioning.
* (vivo) **Proposal 2:**
	+ The vertical positioning evaluation with RAT-dependent techniques can be put on a lower priority.
* (vivo) **Proposal 3:**
	+ UE location measurement time needs to be evaluated and reduced.
* (vivo) **Proposal 4:**
	+ The overhead for low latency positioning needs to be evaluated.
* (NOK) **Proposal 1:**
	+ In addition to overall positioning accuracy performance companies should report results for parameter estimation (e.g., RSTD) for performance comparison.
* (NOK) **Proposal 2:**
	+ CDF curves of positioning accruacy should be reported and values provided for 50%, 80%, and 90% of UEs.
* (NOK) **Proposal 3:**
	+ Adopt option 3 above for handling the latency evaluations during the SI. Agree on baseline values (e.g., X) at next RAN1 meeting.
* (NOK) **Proposal 4:**
	+ RAN1 does not expect to performed detailed simulations for network efficiency and UE efficiency.
* (CMCC) **Proposal 1:**
	+ The physical layer latency should be provided in percentage of a total end-to-end latency, e.g., [50]%, in the evaluation.
* (Sony) **Proposal 1:**
	+ An evaluation of a positioning requirement (e.g. positioning accuracy) should also consider the implication to the other positioning requirement(s) (e.g. end to end latency in positioning estimation).
* (Sony) **Proposal 2:**
	+ End to end latency positioning estimation shall be properly defined, particularly the start and the end-point.
* (Sony) **Proposal 3:**
	+ Assess and break-down the end to end latency and identify the latency target that can be evaluated by RAN1/2.
* (Sony) **Proposal 4:**
	+ In evaluation the positioning requirement, consider the scenario where the location server (LS) has knowledge of coarse UE positioning estimate.
* (Fraunhofer) **Proposal 1:**
	+ Characterize the positioning technologies versus channel parameters. At least the following complementary analysis shall be derived from the simulations
		- ToA estimator accuracy relative to the delay introduced by the absolute time of arrival model
		- ToA estimator accuracy versus K-factor
* (Fraunhofer) **Proposal 2:**
	+ Consider interference for Rel-17 NR positioning evaluation which includes interference from other positioning RSs and uncorrelated interference

In addition, there is a need to define the template for the TR for presenting the evaluation results.

Initial Proposal for Discussion

* For TR 38.857, the template used in TR 38.855 for the inclusion of simulation results will be reused.
* In addition, the following parameters should be provided for each scenario together with the simulation results.

|  |  |  |
| --- | --- | --- |
| **Parameter** | **[Source 1, scenario, FRx]** | **Comments** (to each of the parameter) |
| Channel model (baseline, otherwise state any modifications) |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
| Reference Signal Physical Structure and Resource Allocation (RE pattern) |  |  |
| Reference signal (type of sequence, number of ports, …)  |  |  |
| Number of sites |  |  |
| Number of symbols used per slot per positioning estimate |  |  |
| Number of slots 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 |  |  |
| Beam-related assumption (beam sweeping / alignment assumptions at the tx and rx sides) |  |  |
| Precoding assumptions (codebook, nrof antenna elements used, etc) |  |  |
| Additional notes, if any |   |  |

Additional Comments

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| --- | --- |
| **Company** | **Comments**  |
|  |  |
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Initial Proposal for Discussion

* CDFs of positioning errors are used as a performance metrics in NR positioning evaluation with at least the following percentiles [50%], 67%, 80%, 90%, [95%].
	+ Note: In addition to overall positioning accuracy performance companies are encouraged to report the estimation accuracy of UE/gNB measurements (e.g., RSTD) for performance comparison.

Additional Comments

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| --- | --- |
| **Company** | **Comments**  |
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Initial Proposal for Discussion

* Average positioning latency may be evaluated
	+ FFS: whether the latency evaluation is from physical layer perspective only, or as the percentage of a total end-to-end latency (this may depends on how the performance target for positioning delay is defined)

Additional Comments

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| --- | --- |
| **Company** | **Comments**  |
|  |  |
|  |  |

Initial Proposal for Discussion

* RAN1 does not expect to performed detailed simulations for network efficiency and UE efficiency

Additional Comments

|  |  |
| --- | --- |
| **Company** | **Comments**  |
|  |  |
|  |  |

Issues for further discussion

TBD

# Summary

TBD

 References

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