**3GPP TSG RAN WG1 Meeting #101-e R1-200xxxx**

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

**Source: Moderator (CATT)**

**Title: FL Summary #2 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 [1]. 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.

# 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]:

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| Proposal 2.1‑1   * 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

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| Requirements | Scenario | Horizontal accuracy | Vertical  accuracy | 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.

## Proposals for Discussion

### Proposal 2.1‑1

* In Rel-17 target positioning accuracy requirements for **commercial use cases** will be defined with one of the following options:
  + Option 1: (based on the performance target mentioned in SID and Table 7.3.2.2-1 of TS 22.261)
    - * + Horizontal position accuracy (<1 m)
        + Vertical position accuracy (< [2 or 3] m)
        + Latency for position estimation of UE ([10ms or 15ms or 1s])

**Supported by**: CATT, Futurewei, Huawei, HiSilicon

* + Option 2: (based on the performance evaluation results)
    - * + Horizontal position accuracy (< TBD m)
        + Vertical position accuracy (< TBD m)
        + Latency for position estimation of UE (TBD s)

**Supported by**:

* + **Note 1:** For the positioning latency, it needs to clarify it is end-to-end delay, or only physical layer delay, or RAN delay without considering CN and others
  + **Note 2:** For Option 2, the performance evaluation will not be limited Rel-16 positioning techniques, but also consider the potential Rel-17 positioning enhancements.
* In Rel-17 target positioning accuracy requirements for **IIoT use cases** will be defined with one of the following options:
  + Option 1: based on the performance target mentioned in SID , TS 22.804, and TS 22.261 (vertical)
    - * + Horizontal position accuracy (< [0.2 or 0.3 or 0.5 or 1] m)
        + Vertical position accuracy (< [2 or 3] m)
        + Latency for position estimation of UE (<[10ms or 15ms or 1s])

**Supported by**: CATT, Futurewei, Huawei, HiSilcon

* + Option 2: based on the best evaluation results of selected IIoT use cases
    - * + Horizontal position accuracy (< TBD m)
        + Vertical position accuracy (< TBD m)
        + Latency for position estimation of UE (<TBD s)

**Supported by**:

* + Option 3: defined as IIoT use case(s) dependent, e.g., separate target requirements for different IIoT scenarios cases
    - * + Horizontal position accuracy for each evaluated IIoT scenario (< TBD m)
        + Vertical position accuracy for each evaluated IIoT scenario (< TBD m)
        + Latency for position estimation of UE (<TBD s)

**Supported by**:

* + **Note 1:** For the positioning latency requirements, it needs to discuss whether it is end-to-end delay, or only from physical layer perspective, or something else.
  + **Note 2:** For Option 2 and Option 3, the performance evaluation will not be limited Rel-16 positioning techniques, but may also consider the potential Rel-17 positioning enhancements.

Additional Comments

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| **Company** | | **Comments** |
| vivo | We propose to identify the scenario(s) that need to satisfy the target before we determine a performance target.  For latency, we propose to define the target of the end-to-end latency and physical layer latency respectively. Or define the target of the end-to-end latency and confirm the percentage of physical layer latency. Then we can focus on evaluating physical layer latency in RAN1 side.  For proposal 2.1-1, option 1 is prefered for commercial use cases and IIoT use cases with the modification as below.   * + Option 1: (based on the performance target mentioned in SID and Table 7.3.2.2-1 of TS 22.261)     - * + Horizontal position accuracy (<1 m)         + Vertical position accuracy (< [2 or 3] m)         + End-to-end latency ([100 ms]), physical layer latency([10 ms])   + Option 1: based on the performance target mentioned in SID, TS 22.804, and TS 22.261 (vertical)     - * + Horizontal position accuracy (< [0.5] m)         + Vertical position accuracy (< [2 or 3] m)         + End-to-end latency ([100 ms]), physical layer latency([10 ms])   Note：The vertical position accuracy in there is only by Rat-dependent technology. |
| Nokia/NSB | To be honest we think this entire discussion is not needed. The SID clearly states: “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 our view the only remaining details are 1) to decide on the number of UEs this requirement needs to be met for (i.e., 80% as in Rel-16 or new value) and 2) if a vertical accuracy requirement applies as well. We should follow the SID and avoid a long discussion on requirements. |
| CATT | * In Rel-17 target positioning accuracy requirements for **commercial use cases** will be defined as follows:   + Option 1: (based on the performance target mentioned in SID and Table 7.3.2.2-1 of TS 22.261)     - * + Horizontal position accuracy (<1 m)         + Vertical position accuracy (< 3 m)         + Latency for position estimation of UE (<1s) * In Rel-17 target positioning accuracy requirements for **IIoT use cases** will be defined as follows:   + Option 1: based on the performance target mentioned in SID , TS 22.804, and TS 22.261 (vertical)     - * + Horizontal position accuracy (< 0.2 m)         + Vertical position accuracy (< 1 m)         + Latency for position estimation of UE (<100ms) |
| Futurewei | As mentioned in our Tdoc, to agree on specific scenario and its associated requirements would be a complicated process. If that’s achieveable by the group, we are fine. Our preference is the fall back requirement is as described in the SID. We understand these are not normative, but those targets in the SID is a good general requirements. |
| Intel | We prefer option 1 for both proposals.   * In our view RAN1 should follow numbers provided in SID as a target performance requirements for NR Positioning Enhancements SI, where sub-meter level position accuracy (< 1 m) is defined for general commercial use cases and position accuracy < 0.2 m for IIoT use cases. * Regarding vertical positioning accuracy we are open to discuss [2 or 3] m for both cases. * End-to-end latency can be considered as [10ms or 100ms] for both cases |
| CMCC | Regarding the target positioning accuracy requirements for **commercial use cases**, we prefer option 1 with following requirements:   * + Option 1: (based on the performance target mentioned in SID and Table 7.3.2.2-1 of TS 22.261)     - * + Horizontal position accuracy (<1 m)         + Vertical position accuracy (< 3 m)         + **End-to-end latency** for position estimation of UE (1s)   Regarding the target positioning accuracy requirements for **IIoT use cases**, as the logistics and warehousing services we identified in our contribution, we prefer option 2 with following requirements:   * + Option 2: based on the best evaluation results of selected IIoT use cases     - * + Horizontal position accuracy (< 0.1 m)         + Vertical position accuracy (< 0.2 m)         + **End-to-end latency** for position estimation of UE (<10ms)   Note that the above requirements are the inputs from our consumers, which seems quite stringent from RAN1 perspective, hence, we are also fine following the target requirement justified in the SID, which are:   * + Option 2: based on the best evaluation results of selected IIoT use cases     - * + Horizontal position accuracy (< 0.2 m)         + Vertical position accuracy (< 0.2 m)         + **End-to-end latency** for position estimation of UE (<100ms) |
| Qualcomm | Option1 is preferred for both commercial and IIoT use cases but referring to SID without the table of TS22.261.   * Regarding vertical accuracy, we propose to replace “[2 or 3] m” with TBD m in Option1. As vertical accuracy is an important metric for many IIoT use cases, we think it is too early to put down a relaxed target for it, considering many companies only report horizontal accuracy in their initial evaluation. * For latency target, the listed options [10ms or 15ms or 1s] are too extreme. Propose to also include 100ms in the latency target options. |
| Huawei, HiSilicon | We support Option 1 for both cases. Even for Option 1, the numbers are in brackets and the range so far in the brackets are broad enough which possibly covers the values in other options. Therefore, it may not be good for progress to debate which options we should take.  Instead, to us, the target should be higher than the target set for Rel-16 and higher than what Rel-16 positioning techniques can achieve and can be reached at least for some scenarios by enhancement to Rel-16. With this principle in mind, we can take into the evaluation results into account when nail down the number or remove the brackets in option1. |
| LG | To avoid long discussion on determining target performance, we prefer that at least several candidate values could be determined. We are generally fine with option 1 for both commercial use cases and IIoT use cases, and we are open to discuss the necessity of a more tight requirement of vertical positioning accuracy. The latency requirement would be quite different depending on the kind of latency such as the physical-layer or end-to-end, so we prefer to define the specific latecy requirement value after deciding the target latency (physical-layer or end-to-end). |
| Verizon | Regarding the target positioning accuracy requirements for **IIoT use cases**, we have very simiar need in the logistics and warehousing services to what CMCC identified in their contribution. There are strong commercial need for higher accuracy beyond logistcs and wharehuasing too and they are growing by the day. Therefore we would like to ask the std to shoot for:  Option 2: based on the best evaluation results of selected IIoT use cases   * + - * + Horizontal position accuracy (< 0.1 m) 🡨 yes, <0.1m         + Vertical position accuracy (< 0.2 m) 🡨 yes, vertical         + End-to-end latency for position estimation of UE (<10ms)   This does seem a bit stringent from RAN1 perspective at this stage, for that, we can consider it in a more relaxed (e.g., less NLOS) environement. But we really hope at least for some cases, we can claim a (horizontal) accuracy of <0.1m.  At the very least, we should meet the target requirement in the SID:   * + Option 2: based on the best evaluation results of selected IIoT use cases     - * + Horizontal position accuracy (< 0.2 m)         + Vertical position accuracy (< 0.2 m)         + End-to-end latency for position estimation of UE (<100ms)   We hope we don’t relax further. |
| Fraunhofer | From a usecase perspective most requirements TS 22.261 and TS 22.804 are below 1m. Centimetre level accuracy requirements should not be disclosed from Rel-17 and it is our understanding behind the SI objectives (<0.2m).  Option2 can be misinterpreted as putting primary results as performance targets. In our analysis, the lower bound for the positioning error mainly depends on the InF number of LOS/NLOS between the UE and the TRPs and geometry consideration. We think it is logical for a service provider targeting an accuracy below *20cm* to ensure the positioning service area has a good LOS coverage and an “optimal” deployment.  Based on this understanding we support Option2.  Additionally the requirement for the InF can be defined per LOS detectability which is independent on the scenario (SH, DH, DL, SL) choice. With a proper selection of the environment parameter (dClutter, hc and r) it is sufficient to use InF-DH only.  We propose the following requirement for Rel-17:   |  |  |  | | --- | --- | --- | |  | Requirement | Availability | | Overall accuracy InF-DH | <1m | 80% | | [Overall accuracy InF-SH] | <0.2m | 95% | | InF (# of LOS links <=4) | <1m | 80% | | InF (# of LOS links >4) | < 1m | 80% | | InF (# of LOS links >=[8]) | < 0.2m | 95% | |
| ZTE | From our point of view, the SID has already defined the target requirements for horizontal position accuracy. So we only need to consider the vertical position accuracy and what kind of latency requirement for comercial use cases and IIOT use cases.  In Rel-17 target positioning accuracy requirements for commercial use cases should be defined as follows:   * + Option 1: (based on the performance target mentioned in SID and Table 7.3.2.2-1 of TS 22.261)     - * + Horizontal position accuracy (<1 m)         + Vertical position accuracy (< [2 or 3] m)         + Latency for position estimation of UE ([100ms or 1s])   In Rel-17 target positioning accuracy requirements for IIoT use cases, as we know, accuracy has dependency on latency and scenario. So it’s better to have loose bound and upper bound for latency. As for the scenario, we suggest the following requirements are applied to InF-SH (and InF-DH with increased LOS probability).   * + Option 3: defined as IIoT use case(s) dependent, e.g., separate target requirements for different IIoT scenarios cases     - * + Horizontal position accuracy for each evaluated IIoT scenario (< 0.2 m)         + Vertical position accuracy for each evaluated IIoT scenario (<1 m)         + Latency for position estimation of UE (<[10ms or 100ms]) |
| Ericsson | For Rel-17 target positioning accuracy requirements for **commercial use cases**, we think that the scenario should focus on outdoor UMi, as indoor scenario requirement clearly will be fullfiled by IIOT solutions. For UMi, we don’t see a use case where vertical accuracy could be meaningful. Thus for commercial use cases we support a requirement of 1m in horizontal accuracy and no requirements for vertical accuracy.  commercial use cases:   * + - * + Horizontal position accuracy (<1 m)         + No requirements on Vertical position accuracy         + End-to-end latency for position estimation of UE (TBD [10ms or 15ms or 1s])   For In Rel-17 target positioning accuracy requirements for **IIoT use cases** we support option 1 with the following performance targets   * + - * + Horizontal position accuracy (< [0.2] m)         + Vertical position accuracy [TBD] m )         + End-to-end latency for position estimation of UE (TBD <[10ms or 100 ms or 1s])   We can discuss End-to-end latency within the range of values provided by the FL proposal after the scenario discussion is concluded. For vertical positioning, the accuracy is very dependent on the base station height in the deployment as well as the method chosen. Moreover some use cases are more dependent on vertical accuracy than others. Therefore, we would not like to set the same vertical positioning accuracy target for all methods and all scenarios.  Note that the requirements cannot be expected to be met in all IIOT models (e.g. when the model has almost no LOS links).  Note 2 in the Proposal 2.1-1 says, ‘For Option 2 and Option 3, the performance evaluation will not be limited Rel-16 positioning techniques, but may also consider the potential Rel-17 positioning enhancements’. We don’t understand why it should be limited to option 2 and 3. We think evaluations for all options should be applicable for both rel 16 methods and rel17 enhancements.  With regards to latency, we prefer to consider physical layer latency only in RAN1, since this is all we can control from RAN1 perspective. The latency budget part of the physical layer latency should be discussed with higher layer working group. |
| OPPO | We support option1 in both use cases.  For commercial use cases: the option 1 can be :   * Horizontal position accuracy (<1 m) at 80% if the CDF * Vertical position accuracy (< [2 or 3] m) at 80% of the CDF * Latency: we specify the PHY layer latency [10ms, 50ms, 100ms]   For IIOT use case, the option1 can be revisd:   * Horizontal position accuracy (<1 m) at 90% if the CDF * Vertical position accuracy (< [2 or 3] m) at 90% of the CDF * Latency: we specify the PHY layer latency [10ms, 50ms, 100ms] |

FL Comments

#### Revision #1

* + In Rel-17 target positioning requirements for **commercial use cases** are defined as follows:
    - * + Horizontal position accuracy (<1 m)
        + Vertical position accuracy (< [2 or 3] m)
        + End-to-end latency for position estimation of UE (<[100m]s)
        + FFS: Physical layer latency for position estimation of UE (<[10ms])

**Supported by**:

* + In Rel-17 target positioning requirements for **IIoT use cases** are defined as follows:
    - * + Horizontal position accuracy (< [0.2] m)

FFS: X = [ 0.2]m

* + - * + Vertical position accuracy (< Y m)

FFS: Y = [0.2 or 1]m

* + - * + End-to-end latency for position estimation of UE (<[100ms or 1s])
        + FFS: Physical layer latency for position estimation of UE ([10ms])

**Supported by**:

Additional Comments

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| **Company** | | **Comments** |
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### Proposal 2.1‑2

* 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**: CATT, Huawei, HiSilicon
  + Option 3: X > 90% (e.g., 95%)
    - **Supported by**:

Comments

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| **Company** | | **Comments** |
| vivo | The CDF of positioning errors with [50%], 67%, 80%, 90%, [95%] is okay for us  Option 1 is preferred for the CDF value as target. |
| Nokia/NSB | We don’t really understand why 67% is needed but okay with the first bullet in principle. For the 2nd bullet we support option 2: X = 90%. |
| CATT | We think Option2: X=90% is a reasonable target CDF point for Rel-17 horizontal and vertical positioning accuracy evaluation. |
| Intel | From our perspective following set of CDF points is enough: 67%, 80%, 90%. If deployments optimized for positioning are considered, we are open to include additional values e.g. 95% or even higher.  Regarding availability of X for target and vertical positioning accuracy requirements we think it can be an output metric of the study and there is no strong need to discuss it right now. Each company can report the value of X for agreed target positioning requirements. |
| CMCC | We support option 2: X = 90%. |
| Qualcomm | Instead of reporting the positioning error at indicated percentiles, each company reports the CDF values for the target accuracy and summarizes the results in the TR. Also, keep a separate CDF for UEs in convex-hull and exclude the UE with insufficient LOS links from the CDF. |
| Huawei, HiSilicon | We think option 2 would be a good option. 80% was set for Rel-16. However, 95% would bring too much simulation load. 95% will require a large number of dropped UEs so as to get a stable results for the CDF value. For example, If we have 500 UEs, 95% CDF value corresponds to the worst 25 UEs, and we do not see sufficient ergodicity within the 25 UEs, and CDF value at 95% have large variance across simulations. |
| Verizon | Option 2 X=90% is ok, assuming decent CDF shape. |
| Fraunhofer | See input to Proposal 8.1-1 |
| ZTE | It’s dependent on which IIOT scenario we want to evaluate and what kind of simulation assumptions are set. So we suggest to consolidate it after we discuss the evaluation scenario and simulation assumption. |
| Ericsson | We support to set the target accuracy at 90% CDF. However this should be complemented with more cdf points in the evaluation in order to have CDFs that are comparable. |
| OPPO | We suggest to use different value for commercial use cases and IIOT use case:  For commercial use cases: 80%  For IIOT: 90% |

#### Revision #1

* The target horizontal and vertical positioning accuracy requirements are defined based on availability of 90%.
  + **Supported by:**

Additional Comments

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| **Company** | | **Comments** |
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Proposal 2.1‑3

Comments

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| --- | --- | --- |
| **Company** | | **Comments** |
| vivo | For the RAN1 side work, we agree with focusing on the solution of physical layer latency, but the analysis shouldn’t be limited to the physical layer unless the target of physical latency is defined in PHY layer only or reach a consensus. |
| Nokia/NSB | We are confused by the proposal. It mentions power consumption, scalability, etc but we think those are a separate discussion from latency. For latency as we discussion in [our TDoc](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_101-e/Docs/R1-2003720.zip) we support option 2 where RAN1 agrees on some assumed signalling delay values (with confirmation from RAN2/3 via LS). |
| CATT | We think the analysis is not limited to physical layer but including higher layer message delays, loading, etc.), especially for the positioning delay, as the positioning delay is latency for position estimation of UE, which is End to End delay. |
| Intel | RAN1 should consider at least physical aspects of NR positioning other WGs can be asked whether it is required for progress in Rel-17 NR Positioning |
| Qualcomm | Support Option 2. We should not assume optimization only for PHY layer. Higher layer considerations should be made, which can be left to RAN2/RAN3. |
| Fraunhofer | See input to Proposal 8.1-3 and 8.1-4 |

# 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.

## Proposals for Discussion

### Proposal 3.1‑1

* 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
  + FFS: Clutter parameters {density , height ,size } for InF-DH model
* Note: Individual companies may consider additional InF models in TR 38.901 as complimentary evaluation scenarios in their simulation investigation

Comments

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| --- | --- | --- |
| **Company** | | **Comments** |
| vivo | Okay for InF-SH and InF-DH models as the baseline  The clutter parameters {density =60%, height =6m,size =2m}in Table 7.8-7 in TR38.901 as a baseline. And we don’t exclude any reasonable modification. |
| Nokia/NSB | Support the proposal. |
| CATT | Support Proposal. |
| Futurewei | Propose the following revision to the above proposal:   * At least the 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: Up to company to declare the Clutter parameters {density , height ,size } for the evaluated scenarios * Note: Individual companies may consider additional InF models in TR 38.901 as complimentary evaluation scenarios in their simulation investigation |
| Intel | Additionally to the InF-SH and InF-DH scenarios we suggest to use InF-SL scenario. Using these three channel models, we can cover all IIoT cases with different probability of LOS states. |
| CMCC | We support the proposal. |
| Qualcomm | We support to adopt InF-SH as baseline. For InF-DH, we support it conditionally depending on the decision on cluster parameter change.   * If clutter parameter change cannot be agreed, InF-DH should be excluded from the baseline scenarios as it does not require simulation to confirm that target accuracy cannot be met.   For clutter parameter adjustment, each proposal should state the target number of LOS links and the associated percentile (e.g. X% of the UE have at least Y LOS links). Note that the LOS probability depends on the base station height. The decision on new parameter must consider the other proposal in Table 5‑1 for variable base station height. |
| Huawei, HiSilicon | Support the proposal. Spotted one typo: should “complimentary” be “complementary”? |
| LG | Support the proposal with multiple baseline scenarios, but we think that the positioning accuracy requirement does not have to be satisfied for all scenarios. |
| Verizon | Support the proposal. For the most stringent requriement, e.g., <0.2m (or <0.1m ☺ ), it can be based on InF-SH. |
| Fraunhofer | Essential is the number of TRPs available at LOS and the ATOA parameter  The main difference between SH and DH is the LOS probability. All other parameters are **identical**. With a proper selection of the environment parameter (dClutter, hc and r) it is sufficient to randomize the BS-height only. 🡺 it is sufficient to use InF-DH only.  InF-SH just increases the number of drops with high LOS probability.  To cover also the performance for links with less than 4 LOS links a separate statistics for the position error of these drops may be worthwhile |
| ZTE | Support the proposal. We should discuss to align clutter parameters {density , height ,size } . |
| Ericsson | The InF-SH and InF-DH models both allow for a wide range of parameter settings as defined in ‘Table 7.2-4: Evaluation parameters for InF’ in 38.901. Many companies here seem to mean the specific (but rather arbitrary and not very representative for reality) parameter settings used for large scale calibration of the InF-SH and InF-DH model as given in ‘Table 7.8-7: Simulation assumptions for large scale calibration for the indoor factory scenario’. We propose to modify the wording of the proposal to reflect this fact. We also propose to clarify the use of the large and small hall BS deployments defined in Table 7.8-7 in TR 38.901. The modified proposal thus becomes:   * The InF-SH model with parameter settings used for large scale calibration as defined by Table 7.2-4 and Table 7.8-7 in TR 38.901 are adopted as a first baseline scenario for defining the channel models, parameters and modelling techniques for performance evaluations in the Rel. 17 positioning enhancements for IIoT use cases. * The InF-DH model defined by Table 7.2-4 in TR 38.901 is adopted as a second baseline scenarios for defining the channel models, parameters and modelling techniques for performance evaluations in the Rel. 17 positioning enhancements for IIoT use cases.   + FFS: Clutter parameters {density , height ,size } for InF-DH model. * The small and large hall BS deployments defined in Table 7.8-7 in TR 38.901 are adopted as baseline BS deployments for performance evaluations in the Rel. 17 positioning enhancements for IIoT use cases both for the InF-SH and the InF-DH model. * Note: Individual companies may consider additional InF models in TR 38.901 as complimentary evaluation scenarios in their simulation investigation   For this proposal, our preferences are given below:  For Inf-DH, as a baseline, we propose the following {density , height ,size } values   * BS height 8m, UE height 1.5m, clutter size 2m, clutter height 2m, clutter density 0.4 and ksubsce=50.9m   For Inf-SH we support the calibration settings are a first set of evaluation paramters, and also would like to see a secondary optional parameter set that is more demanding   * BS height 8m, UE height 1.5m, clutter size 10m, clutter height 2.6m, clutter density 0.4 and ksubsce=115. |
| OPPO | Support the proposal |

FL Comments

It looks most companies are fine with the proposal. Given that the Clutter parameters {density , height ,size } for InF-DH model are discussed in other proposals in Section 5, we suggest remove the FFS from the proposal.

#### Revision #1

* 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 additional InF models in TR 38.901 as complimentary evaluation scenarios in their simulation investigation

Additional Comments

|  |  |  |
| --- | --- | --- |
| **Company** | | **Comments** |
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# 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.
* (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

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.

## Proposals for Discussion

### Proposal 4.1‑1

* Adopt the parameters defined in Table 4-1 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 or different parameter settings in their simulation investigation

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

**Table 4-1 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 1  Supported by: CATT, Fraunhofer  Option 2: 3.5GHz – Note 2  Supported by: | Option 1: 30 GHz – Note 1  Supported by: CATT  Option 2: 28GHz – Note 2  Supported by: | vivo: Option 2 is preferred.  At least, we propose to choose one of the 2 options for reducing the overhead of simulation.  CATT: Support Option1.  Intel: We prefer Option 1 (4 GHz and 30 GHz)  CMCC: We support Option 1.  For FR1, our deployment in vertical industries would be at 4.9GHz, and some other operators may be at 3.5 GHz, so we think that evaluation at 4GHz is reasonable.  Qualcomm: Option 2 is preferred.  Huawei/HiSilicon: Either is fine, as long as single option is adopted. Slightly prefer 4GHz, and 30GHz.  Verizon: Option 2 is prefered, moderately.  ZTE: Slightly prefer Option 1.  Ericsson: We support Option 2 for both FR1 and FR2.  OPPO: Option 2 is slightly preferred. And we shall only choose one option, not both. |
| Bandwidth, MHz | 100MHz for 4GHz | 400MHz | Huawei/HiSilicon: Suggest removing “4GHz” from the column for FR1.  Fraunhofer:  At least for “**commercial use cases”** a lower bandwidth shall be considered |
| Subcarrier spacing, kHz | 30kHz for 100MHz | 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 configuration | Panel model 1 – Note 1  Mg = 1, Ng = 1, P = 2, dH = 0.5λ, (M, N, P, Mg, Ng) = (1, 2, 2, 1, 1) | Option 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  Supported by: CATT  Option 2 [18]:  - 4 UE panels:  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  - Panel Configuration:  - Each antenna array has shape dH=dV=0.5λ  - (M, N, P) = (1, 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  Supported by:  Ericsson | vivo: Option1 is preferred.  The 4 UE panels model may bring additional channel modeling overhead and complexity.  NOK: Agree with vivo but think that companies could also bring results with option 2 as additional cases.  CATT: Support Option 1. We prefer to reuse the UE antenna configuration in TR 38.855 and avoid a long discussions on this issue.  Intel: option 1 is preferred as a baseline, option 2 is up to proponents selection  Qualcomm: Option 1 is preferred.  Huawei, HiSilicon: We think Option 1 should be the baseline. For option 2, as the antenna locations are different (distributed antenna), it may be considered for Rel-17 enhancement evaluation.  LG: option 1 is preferred, but option 2 does not need to be precluded and it is up to each company  ZTE: Option 1 as baseline.  Ericsson: Note that Option 1 for FR2 is the old model originally from 3GPP TR38.802. A problem with this model is that the two panels do not have any separation as (dg,H, dg,V)=(0,0) in Option 1. Given that centimeter level accuracy requirements are expected in Rel-17 NR positioning (e.g., < 0.2 m accuracy), the impact on positioning accuracy due to different panel positions need to be considered. Hence, it is important to model the panel positions at the UE which is why we propose Option 2. In addition, Option 2 is aligned with real mm-wave UE implementations which do have 3-4 antenna panels with (M, N, P) = (1, 4, 2) rather than (2, 4, 2).  In reply to the 4 panel comment from vivo, it should be noted that 4 panels were already considered for evaluations in 3GPP TR 38.802 (see Table A.2.1-4). So, we think it should be ok to consider 4 panels for evaluations in Rel-17. Note also that the total number of antenna elements is the same in option 1 (2 antenna panels with 16 antenna elements each) and option 2 (4 antenna panels with 8 antenna elements each). Channel modelling overhead and complexity is therefore not increased in option 2.  OPPO: Option 1 is preferred |
| 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), 50ns  Supported by:  Option 2:  – T1: 0ns (perfectly synchronized), 50ns (Optional)  Supported by: CATT, OPPO | | vivo: Option1 and option2 are both OK.  The perfectly synchronized can be evaluated as a high priority. But we can’t exclude the synchronization error scenario to our evaluation scope.  NOK: It is clear that 50 ns synchronization error will mean that timing techniques can’t meet the requirements so what is the point. Suggest only perfectly synchronized case is studied.  CATT: Support Option 2.  Intel: Option 1 is OK  CMCC: Considering the indoor factory scenarios, where the synchronization issue may not be as bad as that in the outdoor scenarios, we are fine with Option 2.  Qualcomm: Option 2 is preferred.  Moreover, to reduce the simulation effort, for TDOA based algorithm, we propose to skip T1:50ns because the average clock error is too high comparing to the target accuracy, which does not require simulation to conclude that target performance cannot be met.  Huawei/HiSilicon: We do not think evaluating 50ns is needed, which will not bring meaningful conclusion, so we support option 2.  LG: both options are fine.  Verzon: best for us is 0 and 10ns. Otherwise no strong opinion. 50ns is too high even today.  Fraunhofer: 50ns is not in line with position accuracy of 1m or 0.2m. Additionally [2ns] (optional) [5ns] as (optional)  ZTE: Option 2. It’s hard to meet the requirement with so high synchronization error.  Ericsson: We are ok with Option 2. Agree with other companies that perfectly synchronized case should be the main focus for indoor factory scenarios.  OPPO: Prefer Option 2. |
| Note 1: According to 3GPP TR 38.802  Note 2: According to 3GPP TR 38.901 | | |  |

FL Comments

* For Carrier frequency,4 companies prefer Option 1; 5 companies prefer Option 2; and 1 company is fine either way. Given that it should not have any significant impact on simulation results to choose either Option 1 or Option 2, suggest simply taking the majority view to adopt Option 2.
* For Bandwidth, all companies are fine to use 100MHz for FR1 and 400MHz for FR2. One company also suggests smaller BW for commercial case. Suggest use 100MHz as baseline case.
* UE antenna configuration: Although Option 2 may be more aligned with UE implementation, it seems most companies (except 1) are preferring Option 1. Suggest taking Option 1 as the baseline case.
* Network synchronization: Most companies prefer Option 2. Suggest taking Option 2.

#### Revision #1

* Adopt the parameters defined in **Table**  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 or different parameter settings in their simulation investigation

**Table 4‑1: Common scenario parameters applicable for all scenarios**

|  |  |  |
| --- | --- | --- |
|  | FR1 Specific Values | FR2 Specific Values |
| Carrier frequency, GHz | 3.5GHz | 28GHz |
| Bandwidth, MHz | 100MHz | 400MHz |
| Subcarrier spacing, kHz | 30kHz for 100MHz | 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 configuration | Panel model 1 – Note 1  Mg = 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]  – T1: 0ns (perfectly synchronized), 50ns (Optional) | |
| Note 1: According to 3GPP TR 38.802  Note 2: According to 3GPP TR 38.901 | | |

Additional Comments

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| **Company** | | **Comments** |
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Issues for further discussion

* Whether to model power reduction due to MPE issue
* Whether to model the power loss for a blocked panel in case the UE is a handheld device
* Whether to model UE RX/TX timing error of antenna panels in FR2
* …

Additional Comments

|  |  |  |
| --- | --- | --- |
| **Company** | | **Comments** |
| Ericsson | Regarding UE RX/TX timing error of antenna panels, note that the RX/TX chains corresponding to the different antenna panels may have different delays primarily due to differences in filter group delays. The size of such delay differences could depend strongly on UE building practices. One may also note that the part of such delay differences that don’t vary with time could in principle be measured and the UEs could be calibrated to take such delay differences into account. This may, however, not always be economically feasible and time varying delay differences would not be captured. Generally, one may therefore assume that some RX/TX timing errors and RX/TX timing error differences between different UE antenna panels remain even after calibration of the UE. We therefore propose to model UE RX/TX timing errors per antenna panel *k* in FR2 as stochastic variables /. The stochastic variables would have zero mean and the distribution could be selected as normal distributions truncated at /.   * **Proposal**: In FR2 the UE RX/TX timing error for antenna panel *k* is modelled as zero mean stochastic variables / with normal distributions truncated at /.   + for and a value of 4 nano-seconds can be assumed.   Regarding the MPE issue, this is an issue we should consider when multiple antenna panels are used in FR2 for UEs that are handheld (i.e., tools etc in indoor scenerios). In this case, the available transmit power may be different on different antenna panels as the UE may need to comply with MPE requirements. For instance, a UE may need to apply a power back off in one of the panels to meet these requirements. These power reductions may have impact on the accuracy of positioning estimates. Hence, power reduction due to MPE needs to be modelled in the evaluations. We propose the following simple model that can be considered for evaluations:   * **Proposal**: 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 (only applicable for UEs that are handheld. e.g., tools in indoor factory scenarios, etc.)   In additional, handheld UEs (e.g., tools etc) can experience further handle blockage. This can also have an impact on positioning accuracy and may need to be modelled in FR2 evaluations. We propose the following simple model for FR2 evaluations:   * **Proposal**: To model hand blockage, a loss of 10 dB is applied for a randomly chosen blocked panel (only applicable for FR2 UEs that are handheld. e.g., tools in indoor factory scenarios, etc.) |

# 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

## Proposals for Discussion

### Proposal 5.1‑1

* Absolute-time-of arrival model is considered in the evaluation of all scenarios
  + Supported by: Nokia/NSB; CATT, Futurewei, Qualcomm, Huawei, HiSilicon,OPPO
* 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: Nokia/NSB; CATT, Qualcomm, Huawei, HiSilicon,OPPO
  + 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** |
| vivo | We agree to introduce the absolute-time-of arrival model in the evaluation of all scenarios  Option 1 is preferred considering the limited timeline of the SID, it is not essential to consume time in the modification of the absolute-time-of arrival. |
| Nokia/NSB | No need to rehash arguments. We should take the model that 3GPP has already spent time on and move on. |
| CATT | Support Proposal 5.1-1 and Option 1 without additional discussion on modifications on modelling of absolute-time-of arrival.  As absolute time of arrival is important for positioning evaluation in Rel-17, the propagation time delay due to the total path length should considered in the fast fading model. We prefer to model absolute time of arrival for InF scenarios according to Section 7.6.9 in TR 38.901. |
| Intel | Prefer Option1, SID doesn’t have objectives to redefine channel model |
| CMCC | We support Proposal 5.1-1 with Option 1. |
| Qualcomm | Support enabling absolute-time of arrival model in the simulation and Option 1.  The values of and in TR38.901 were studied and agreed on among companies when InF model was developed. Unless there is a strong evidence showing the default values are inadequate for InF-DH scenario, we should not try to adjust and . |
| Huawei, HiSilicon | We support to consider TOA model in the evaluations and the models in 901 without modification is used, i.e., option 1. |
| LG | We agree with this proposal and prefer option 1. |
| Fraunhofer | Support Option 2: For IIOT scenarios consider = -8.5 for FR1 scenarios  Motivation:  We distinguish mainly 3 scenarios   1. Number of LOS links is sufficient and reliable LOS detection 2. Number of LOS links is not sufficient 3. LOS detection is not reliable   The ATOA model is only relevant for #2 and #3.  We recently investigated the ATOA model in TR38.901 from the datasets which was part of the input for TR38.901 InF models. Our finding is that the ATOA model don’t refelect the reality especially in scenarios where the TRP-UE distance is within 20m or below. = -8.5 is found to be the right value from the scenario based on the FR1 measurements [here](https://arxiv.org/pdf/1906.12145.pdf) (for FR2 we didn’t perform an analysis yet).  Bottom-line🡪 we think the ATOA parameters needs to be refined and it has a main impact on the observation of this SI. It is understandable that this hard to agree on within this meeting.  It also makes sense to provide a separate statistic for the ToA estimation error on top of the error introduced by the ATOA model to study RAN1 technologies independent from the ATOA model. |
| ZTE | Consider absolute-time-of arrival model and option 1. |
| Ericsson | Absolute time of arrival must be considered in all scenario to offier a realistic evaluation. We support option 1, i.e.adding the modelled values of of and to all scenarios, including outdoor if agreed. |
| OPPO | We shall re-use the absolute-time-of arrival model in TR 38.901. |

FL Comments

* It seems most companies prefer using the absolute-time-of arrival model in TR 38.901 w/o modification.

#### Revision #1 of Proposal 5.1-1

* Absolute-time-of arrival model without modification is considered in the evaluation of all scenarios
  + **Supported by:**

Additional Comments

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| --- | --- | --- |
| **Company** | | **Comments** |
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### Proposal 5.1‑2

* Blockage model is not considered in the evaluation of all scenarios;
  + Supported by: Nokia/NSB; CATT, Futurewei, Qualcomm, Huawei, HiSilicon, OPPO
* 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** |
| vivo | We agree with no blockage model is introduced in positioning evaluation. |
| Nokia/NSB | Blockage can be considered as an optional addition for interested companies but the baseline should assume no blockage. |
| CATT | We prefer not to introduce blockage modelling for positioning evaluation in Rel-17 as we need to spend a lot of time to discuss the details of blockage modelling and to calibrate the performance of the modelling. |
| Futurewei | If Proposal 5.1-1 is adopted, then this is not needed. |
| Intel | Agree with proposal |
| CMCC | We support the proposal. |
| Qualcomm | Support the proposal. |
| Huawei, HiSilicon | We support the proposal. |
| LG | Agree with this proposal. |
| Fraunhofer | In principle we like the proposal to use the blockage model. The advantage is the correlation between the links can be taken into account.  But within the available time frame it is not realistic to find consolidated parameters. Furthermore, the mounting position of the device (antenna panel orientation) etc. is a key factor for the behaviour. These effects are FFS |
| ZTE | Support the proposal. |
| Ericsson | Support the proposal (no blockage model)  Note that this issue should not be mixed with UE-hand blockage which we propose in Section 4.1, which should be modelled in applicable use cases. |
| OPPO | Support with the proposal |

FL Comments

* It seems we have the consensus of not considering blockage model in simulation evaluation.

#### Offline Consensus

* Blockage model is not considered in the simulation evaluation of all scenarios

Additional Comments

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| --- | --- | --- |
| **Company** | | **Comments** |
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### Proposal 5.1‑3

* Consider mobility as additional scenario for evaluation with a simple route or path trajectory defined in the layout along with a mobility model defining the velocities and accelerations consistent with the dynamics of the use-case application. Spatial consistency procedure is also be enabled in the mobility simulation with configurations agreed by the group.
  + Supported by: Qualcomm

Additional Comments

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| --- | --- | --- |
| **Company** | | **Comments** |
| vivo | As our understanding, many parameters need to be modified and the complexity and run time of simulation will significantly increase if the spatial consistency model is introduced. We are worried there isn’t time to do it. |
| Nokia/NSB | No strong view yet but some questions to the proponents, how would the positioning accuracy be reported? Over a set amount of time/positioning fixes? Would a UE that meets requirements during a certain percent of the route be considered as meeting the overall requirements? |
| CATT | Mobility scenario and related spatial consistency procedure can be optional for R17 positioning evolution. |
| Intel | We do see some value of this kind of analysis, however our understanding is that it requires the modelling of the spatial consistence for the channel, which may not be sufficiently accurate and also requires discussion on how to capture performance. Therefore, we think it shouldn’t be considered as a baseline. |
| Qualcomm | According to TR22.804, many IIoT positioning applications (e.g. AGV) requires locating UE in mobility up to 30km/h. Adding mobility scenario would allow better modelling of the use cases with device in motion. Moreover, it opens up the possibility of using prior observation and estimation along the moving path to improve the positioning accuracy through filtering (e.g. Kalman filter).  In terms of the definition of accuracy, the model can assume a fixed reporting interval, which gives a sequence of points on the mobility path according to the defined velocity and acceleration. The position accuracy of each reporting point can then be evaluated and regarded as one data point in the CDF. With that, the same performance analysis for dropping based evaluation can apply. |
| Huawei, HiSilicon | Can be considered as optional and modelling is up to proponents. |
| Fraunhofer | Support the proposal. We have same understanding as Qualcomm on this issue: one option is to define the number of “snaps” or fixes on a UE track and the error is not per UE but snap (i.e. the UE position is seen in the overall statistics as X UEs). The percent of positioning will determine the positioning error. |
| ZTE | Mobility scenario might be useful, but it may consume time on discussing the assumption and also it’s hard to define requirement. Hence, we don’t need to consider it in Rel.17. |
| Ericsson | We do not support mobility as a baseline evaluation, but companies are welcome to provide results as a second option. |
| OPPO | That can be considered as an optional. And it is up to company to model it. |

FL Comments

* It seems companies are fine to consider the mobility as additional scenario, but not as the baseline scenario. However, given the limited time and the lack of majority interest, suggest allowing the proponents to define the mobility model.

#### Revision #1 of Proposal 5.1-3

* Mobility scenarios may be considered as optional. It is up to each company to provide the mobility models with the evaluation results for the proposed mobility scenarios.
  + **Supported by:**

Additional Comments

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| **Company** | | **Comments** |
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### Proposal 5.1‑4

* Discuss the scenario parameters common to all InF scenario(s) in Table 5‑1 , 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 5‑1 Parameters common to InF scenario(s)

|  | | FR1 Specific Values | | FR2 Specific Values | Comments (to each of the parameter) |
| --- | --- | --- | --- | --- | --- |
| Channel model | | InF-SH, InF-DH  FFS: InF-SL, InF-DL, InF-HH | | InF-SH, InF-DH  FFS: InF-SL, InF-DL, InF-HH |  |
| Layout | Hall size | InF-SH: 300x150 m  InF-DH: 120x60 m  FFS: InF-SL: 120x60 m  FFS: InF-DL: 300x150 m  FFS: InF-HH: 300x150 m | | | vivo: The Hall size should be the same if only SH and DH scenarios(such as InF-SH: 120x60 m InF-DH: 120x60 m) are selected. If the size is different, more scenario variables need to be considered and it is difficult to evaluate them at the same level.  Intel: We suggest to add InF-SL: 120x60 m scenario for evaluation  Ericsson: we agree with vivo that the hall size should be the same in SH and DH and should use the small hall size. As a secondary option, The ‘Large hall’ deployment could, however, be useful to study the effect of a larger TRP distance as well as of a larger delay spread. So we’re fine with having the large hall for Inf SH and DH as a secondary option. |
| 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 | | | NOK: We think that other smaller values of D could also be considered as optional. This could also model the case where DL PRS-only TPs or SRS-only RPs are deployed for a factory to meet the requirements.  Intel: OK with proposal  ZTE: A denser spacing (e.g. 10m) can be considered for InF-DH scenario.  Ericsson: Ok with proposal |
| Room height | 10m | | |  |
| Total gNB TX power, dBm | | 24dBm | 24dBm  EIRP 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 1  One 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 | | | NOK: We think QC’s proposals on looking at a subset of the UEs is worth further discussion. UE drop can still be as described here but not al UE location estimates need to be used for the final CDF generation in our view (e.g., due to DOP errors).  Ericsson: Allow also UEs uniformly dropped inside the convex hull of the horizontal BS deployment area (QC’s proposal). |
| UE antenna height | | Option 1: UE-height =1.5m  Supported by: CATT  Option 2: uniform distribution within [X1, X2]m; FFS: {X1, X2}  Supported by: CATT  Note: Companies supporting Option 2 please provide the proposed values for [X1, X2] in comment column | | | vivo: Option 1 is the baseline parameter for evaluation.  Option 2 only be considered when vertical positioning based on Rat dependent is defined and evaluated.  Furthermore, if the UT height change to the uniform distribution, there are other impacts, such as LOS probability, .  For option 1 UT height, the ， are negative exponential function and the range of LOS probability is from 0 to 1.  will occur when , and the LOS probability will more than 1. Therefore, maybe, we set as constant can resolve the problem.  CATT:  We support both Option 1 and Option 2.  In our point of view, Option 1 can be baseline configuration, and Option 2 can be enhancement configuration.  Intel: We prefere option 1. For Option 2 the height of a UE can be bounded with value. In that case there is no need to modify the LOS probability formulas.  CMCC: We prefer Option 2. For X1, we propose to set it as 0.5m (also open to other reasonable values); for X2, it depends on the cluster height . Take InF-DH as an example, considering the original model in TR38.901, X2 can be 6m; if parameter modification of InF-DH is considered, then X2 should be  Qualcomm: support Option 2 with uniform distribution within [1, 3]m.  Huawei/HiSilicon: We support option2. [0.5, 2] for InF-SH, [0.5, hc] for In-DH. We have to make sure that UE height is below hc; otherwise LOS probability should be modified, and it does not map to the SH/DH description that UE is Clutter-embedded.  Fraunhofer:  Option 2, uniform distribution [1,3] All UEs below hc  ZTE: Prefer option 1 as baseline. We should consider LOS probability carefully when UE antenna height and gNB antenna height are uniform distribution.  Ericsson: both options ok.  OPPO: we support Option 1. Agree with ZTE that the LOS probability model need be considered carefully if the height is uniformly distributed. That is the issue for Option 2. |
| UE mobility | | 3km/h | | |  |
| Min gNB-UE distance (2D), m | | 0m | | |  |
| gNB antenna height | | Option 1: 8 m for InF-SH and InF-DH  Supported by: CATT  Option 2: uniform distribution within [Y1, Y2]m; FFS: {Y1, Y2}  Supported by:  Note: Companies supporting Option 2 please provide the proposed values for [Y1, Y2] in comment column | | | vivo: Option 1 is the baseline parameter for evaluation.  Option 2 only be considered when vertical positioning based on Rat dependent is defined and evaluated.  As our understanding, SH and DH are high BS scenarios. We doubt whether the scenario is SH or DH if the BS height change to the uniform distribution. And there are the same problems with LOS probability.  CATT:  We support both Option 1 and Option 3 as follows.  Option 3: Two fixed values for gNB antenna height with 4m and 8m.  In our point of view, Option 1 can be baseline configuration, and Option 3 can be enhancement configuration.  Option 3 is configured for vertical accuracy evaluation. The gNBs located in the different height levels will improve the vertical accuracy in positioning evaluation.  Intel: We prefer option 1.  CMCC: We are ok with option 1. Further considering the evaluation of vertical accuracy, we are also fine to support Option 3 proposed by CATT in the above comments.  Qualcomm: support Option 1 as baseline and Option2 for vertical accuracy but with additional consideration on the selection of gNB antenna height listed below:   * As gNB antenna height is a factor affecting the LOS probability. The minimum gNB antenna height need to be considered jointly with the clutter parameters for InF-DH. * Random selection on gNB antenna height is not preferred, as it may create unfavored deployment scenario for positioning. Instead, it should be selected from a discrete set of heights and assigned with reasonable consideration in deployment. For example, neighboring base stations can be staggered with 2 levels of antenna height.   Huawei/HiSilicon: We would like to ask for clarification by Option 2 with the following alternatives:   * Alt.1 The gNB height is also randomly generated per drop * Alt.2 A fixed gNB height is used across UE drops * Alt.3 The gNB height is randomly generated per X>1 drops   Should we also limit gNB height to be always above clutter height, since both SH/DL has its characteristics.  Fraunhofer:  Option2 Uniform distribution  Scenario 1: [3,10]  Scenaro 2: [8,10]  ZTE: Prefer option 1 as baseline. We should consider LOS probability carefully when UE antenna height and gNB antenna height are configurable.  Ericsson: Option 1. We also think that option3 is more realistic than option 2. If different gNB antenna heights are to be used, a deployment with different but fixed gNB antenna height for each gNB antenna (i.e. for each TRP) should be specified. To have random gNB antenna height makes little sense as deployment does not change randomly.  OPPO: Option 1. |
| Clutter parameters: {density , height ,size } | | Low clutter density:  {20%, 2m, 10m}  High clutter density:  Option 1: {60%, 6m, 2m}  Supported by:  Option 2: FFS: {40%<=Z1<60%, 2m<=Z2<6m, 2m<=Z3<=6m}  Supported by: CATT  Note: Companies supporting Option 2 please provide the proposed values for [Z1, Z2, Z3] in comment column | | | vivo: Option 1 is the baseline parameter for evaluation.  Option 2 can be considered as a complementary evaluation parameter if interested.  We think the current clutter scenario exists, such as the picture in CMCC. Even though the target may be difficult to reach in the cluster scenarios, we can consider it as the worst benchmark and identify the gap with our target.  CATT:  We prefer to set the values of clutter parameters {density , height ,size } to {40%, 2m, 2m}. In our point of view, three clutter parameters (density; height ; size ) should be relaxed to increase the LOS probability for DH scenario.  According to our evaluation, if the clutter parameters are changed from default values{60%, 6m, 2m} to proposed values{40%, 2m, 2m}, can be improved from 5% to 40% in 50% CDF point of LOS probability curve.  Intel: We prefer option 1.  CMCC: We think option 1 should be the baseline. To increase the LOS probability for the InF-DH scenario, it shoud be seen as a modification case to be differentiated with the original one.  Qualcomm: support Option2 in general but have the following request on format change when proposing values:   * As the goal is to improve the availability of LOS links in InF-DH scenario, it is important to understand the impact of new parameter values on this metric. Companies supporting Option2 can provide the proposed parameters along with the LOS availability defined as “Z4% of the UEs having at least Z5 LOS links”. The proposed change to the reporting format is [Z1, Z2, Z3, Z4, Z5] * For example, based on our study, with [ , , , 95% of the UEs will have at least 4 LOS links when ISD = 20m.   Huawei/HiSilicon: We support option 2. We think r=40%, hc=2, dclutter=2 to comply with Table 7.2-4 of TS 38.901 and also to achieve reasonable LOS probability. Otherwise, we can accept r=40%, hc=3, dclutter=6, but it is not align with typical clutter size in Table 7.2.4 of TS 38.901.  Fraunhofer:  In our understanding “default” is a wrong expression, in the whole TR38.901 it is used once to reflect BS parameters for the pathloss models. The values are simply used for the calibration.  For InF-DH support Proposal 1 from Qualcomm: {density , height ,size }.  These parameters are within the InF-DH range as defined in TR38.901 and are already challenging enough for the requirements.  ZTE: Support the low clutter density configuration. Option 2 should consider UE antenna height, gNB antenna height and base station spacing.  Ericsson: we prefer to evaluate two scenarios of clutter density for the high density case, as we feel that Three InF models are needed to cover the huge range of industrial scenarios. We propose:   * For low clutter density (same as proposed): * InF-SH {20%, 2m, 10m} [very high LOS probability] * For high clutter density   + InF-SH {40%, 2.6m, 10m} [intermediate scenario with medium LOS probability]   + InF-DH {40%, 2m, 2m} [very tough scenario with low LOS probability]   Note: The clutter size Z3 is fixed to 10m for InF-SH and to 2m for InF-DH according to Table 7.2-4 in 38.901. The clutter height and clutter density is, however, variable within certain limits.  OPPO: option 1. |
| Note 1: According to Table A.2.1-7 in 3GPP TR 38.802 | | | | |  |

FL Comments

* Hall size: 3 companies suggest using 120x60 m for both InF-SH and InF-DH
* BS locations: two companies suggest considering smaller BS distances
* UE horizontal drop procedure: some companies suggest considering UEs uniformly dropped inside the convex hull
* UE antenna height: the support for Option 1 and Option 2 seems evenly distributed
* gNB antenna height : more companies prefer Option 1, and Option 2 may be used as an option for investigating vertical positioning performance
* Clutter parameters: {density , height ,size } for High clutter density: It seems we need to have separate discussion specifically for this issue.

#### Revision #1 of Proposal 5.1-4

* Adopt the parameters defined in Table 5‑1 as the baseline parameters for all InF scenarios in the evaluation of the positioning performance in Rel-17.
* Note: Individual companies may consider additional parameter values or different parameter settings in their simulation investigation
  + **Supported by:**

|  | | FR1 Specific Values | | FR2 Specific Values | Comments (to each of the parameter) |
| --- | --- | --- | --- | --- | --- |
| Channel model | | InF-SH, InF-DH  FFS: InF-SL, InF-DL, InF-HH | | InF-SH, InF-DH  FFS: InF-SL, InF-DL, InF-HH |  |
| Layout | Hall size | InF-SH:  Option 1: 300x150 m  Supported by:  Option 2: 120x60 m  Supported by:  InF-DH: 120x60 m  FFS: InF-SL: 120x60 m  FFS: InF-DL: 300x150 m  FFS: 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    Optional: D=10m for small hall  Supported by: | | |  |
| Room height | 10m | | |  |
| Total gNB TX power, dBm | | 24dBm | 24dBm  EIRP 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 1  One 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 | | Option 1: 100% indoor, uniformly distributed over the horizontal area  Supported by:  Option 2: uniformly distributed over convex hull of the horizontal BS deployment area  Supported by: | | |  |
| UE antenna height | | See Proposal 5.1-5 | | |  |
| UE mobility | | 3km/h | | |  |
| Min gNB-UE distance (2D), m | | 0m | | |  |
| gNB antenna height | | See Proposal 5.1-6 | | |  |
| Clutter parameters: {density , height ,size } | | Low clutter density:  {20%, 2m, 10m}  High clutter density:  See Proposal 5.1-7 | | |  |
| Note 1: According to Table A.2.1-7 in 3GPP TR 38.802 | | | | |  |

### Proposal 5.1‑5

* UE antenna height is set to 1.5m as a baseline parameter.
* For evaluating vertical positioning performance, UE antenna height may also be set by one of the following options:
* (Option 1) uniform distribution within [X1, X2]m
  + FFS: X1 = [0.5 or 1]
  + FFS: X2 = [2 or 3] for InF-SH, and X2=hc for InF-DH

**Supported by:**

* (Option 2) up to each company to decide

**Supported by:**

Additional Comments

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

### Proposal 5.1‑6

* gNB antenna height is set to 8m as a baseline parameter.
* For evaluating vertical positioning performance, gNB antenna height may also be set as one of the following options:
  + (Option 1) uniform distribution within [Y1=4, Y2=8]m

**Supported by:**

* + (Option 2) Fixed two values [Y1=4], [Y2=8]m

**Supported by:**

* + (Option 3) up to each company to decide

**Supported by:**

Additional Comments

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

### Proposal 5.1‑7

* Clutter parameters {density , height ,size } for high clutter density are set by one [or more] of the following options:
  + - Option 1: {60%, 6m, 2m}
      * **Supported by**:
    - Option.2: {40%, 2m, 2m}
      * **Supported by**:
    - Option.3: {40%, 3m, 5m}
      * **Supported by**:

Additional Comments

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

# 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

## Proposals for Discussion

### Proposal 6.1‑1

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

|  |  |  |
| --- | --- | --- |
| **Company** | | **Comments** |
| vivo | We prefer only choice IOO scenario for evaluations of commercial use cases in R17 considering some RAT-independent techniques such as GNSS have already reached a sub-meter level positioning accuracy in outdoor scenarios and the most of the demand of sub-meter level positioning accuracy is the indoor scenario. |
| Nokia/NSB | Support the proposal. No need for FFS in our view either. |
| CATT | Support Proposal 6.1-1. |
| Intel | The main focus of NR Positioning Enhancement SI should be on IIoT deployment, we prefer not to study other deployments in Rel-17 SI |
| Qualcomm | Propose to include InH for FR1/FR2 and UMa for FR1. There is no need to exclude scenarios that were done in Rel-16. |
| Huawei/HiSilicon | What is the difference between the UMi evaluation and Rel-16 UMi evaluation? We do not think excessive delay can be modelled for UMi. |
| LG | Support this proposal |
| Fraunhofer | Support Proposal in general (remove FFS). Having the focus on the additional scenarios and with the limited time our preference is to keep it optional. |
| ZTE | We should focus on IIOT scenario. |
| Ericsson | Support the proposal without any FFS. |
| OPPO | We do not support the proposal. Rel17 shall focus on InF scenario. |

FL Comments

* It seems there are different views on whether to consider based line scenarios for commercial use cases.

#### Revision #1 of Proposal 6.1-1

* In Rel-17 SI for the evaluation of the positioning enhancements for commercial use cases,
  + Alt.1. UMi street canyon for FR1 and FR2 (ISD 200m) defined in TR 38.855 are considered as baseline scenarios
    - **Supported by:**
  + Alt.2, IOO for FR1 and FR2 as defined in TR 38.855 are considered as baseline scenarios
    - **Supported by:**
  + Alt.3. No baseline scenarios. Individual companies may consider any scenario(s) defined in TR 38.855 as additional scenarios
    - **Supported by:**

Additional Comments

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

## Proposals for Discussion

### Proposal 7.1‑1

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, which include
  + Comb-N
  + total number of OFDM symbols for a positioning fix
  + …

Supported by: CATT

Additional Comments

|  |  |  |
| --- | --- | --- |
| **Company** | | **Comments** |
| vivo | Option 1 is preferred. |
| Nokia/NSB | While it would ideally be better to have a common baseline for comparison of results, we think in practice there is no need for this as companies have different positioning algorithms, etc. The target is to see if Rel-16 techniques can meet the requirements so if a configuration with Rel-16 is used that should be okay in our view. |
| CATT | A common understanding is needed on the reasonable DL PRS and UL SRS configurations for Rel-17 positioning simulation evaluation, in order to align the simulation results among different companies.  We prefer to define a few key parameters of DL-PRS and SRS-Pos configurations as follows:   |  |  |  | | --- | --- | --- | | Key parameters | DL PRS | SRS-Pos | | Comb-N: | 6 | 8 | | Total number of OFDM symbols for a positioning fix | 12 | 12 | |
| Intel | Option 1, the baseline configuration is up to proponents |
| Qualcomm | It may be very time consuming to try to agree on a baseline configuration, especially due to the very high flexibility of DL PRS in Rel-16. To avoid such tedious exercise, we are OK to Support Option 1 assuming that each company will report the PRS/SRS configuration that they are simulating. |
| Huawei/HiSilicon | The “best” in the FFS is misleading and uncomfortable to us, and we should not run in a campaign on the debate whose performance is the global optimum.  Suggest to either remove the entire FFS bullet, or the two instances of “best”. |
| Fraunhofer | Option 1:  Companies shall select the parameters and provide the parameters relevant for the latency and power consumption (including averaging, if applied) |
| ZTE | During the SI phase, we try to find the upper bound of performance based on Rel.16 methods , so option 1 is preferred. |
| Ericsson | Option 1. We don’t think a baseline for RSs is needed. |
| OPPO | Option 1. |

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.

#### Revision #1 of Proposal 7.1-1

* It will be up to companies to define the configurations for DL PRS and UL SRS for the evaluation of positioning performance.
  + **Supported by:**

Additional Comments

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

# 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.

## Proposals for Discussion

### Proposal 8.1‑1

* 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

|  |  |  |
| --- | --- | --- |
| **Company** | | **Comments** |
| vivo | We think it is a repeated question with proposal 2.1-2 except the note. And we don’t see the significant benefit of reporting RSTD for the note. |
| Nokia/NSB | Support. |
| CATT | Support Proposal 8.1-1.  We prefer that CDFs of positioning errors are used as a performance metrics in NR positioning evaluation with the percentiles 50%, 67%, 80%, 90%. |
| Futurewei | Support |
| Intel | From our perspective following set of CDF points is enough: 67%, 80%, 90%. If deployments optimized for positioning are considered, we are open to include additional values e.g. 95% or even higher. Optionally, additional measurements accuracy statistic can be shared by companies |
| Qualcomm | In addition to the positioning errors at the listed percentiles, companies shall provide the percentile for the target accuracy in SID, if it is met. Also, keep a separate CDF for UEs in convex-hull and exclude the UE with insufficient LOS links from the CDF. |
| Huawei/HiSilicon | OK with the proposal. |
| LG | We are agree with this proposal |
| Fraunhofer | Support: Focus on the 80% and 95% percentiles  Beside the positioning errors CDF, in addition to the accuracy measurements provided information on the SINR at input of the demodulator for performance comparison.  Optional: distinguish between interference from orthogonal signals (e.g. different COMB offset) and non-orthogonal (uncorrelated) signals |
| ZTE | Support. |
| Ericsson | Support reusing the same percentiles as for rel16. 50%, 67%, 80%, 90%, |
| OPPO | Ok with the proposal and we shall focus on 80% and 90%. |

FL Comments

* It seems we have the consensus to use CDF percentiles 50%, 67%, 80%, 90%.
* Estimation accuracy of UE/gNB measurements are only encouraged to provide, but not required.

#### Revision #1 of Proposal 8.1-1

* CDFs of positioning errors are used as a performance metrics in NR positioning evaluation with at least the following percentiles 50%, 67%, 80%, 90%.
  + 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.
  + **Supported by:**

Additional Comments

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

### Proposal 8.1‑2

* 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 |  | Huawei/HiSilicon: Suggest changing to “Timing calibration assumption”, which includes residual gNB synchronization error, gNB/UE residual group delay error, … |
| 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

|  |  |  |
| --- | --- | --- |
| **Company** | | **Comments** |
| vivo | We are curious why the NLOS pathloss of DH less than SH in Table 7.4.1-1 TR 38.901 and copied as below. As our understanding, the path loss of DH should be larger than SH because of the clutter. |
| CATT | Support Proposal 8.1-2. |
| Intel | OK with proposal |
| Fraunhofer | At least for UMi reduced bandwidth may be applicable. Therefore, the bandwidth shall be included |
| ZTE | Support the proposal. |
| Ericsson | support |

FL Comments

* It seems most companies are fine to proposal 8.1-2. For network synchronization assumptions, suggest keeping the term as used in simulation assumptions.

#### Revision #1 of Proposal 8.1-2

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

|  |  |
| --- | --- |
| **Parameter** | **[Source 1, scenario, FRx]** |
| 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

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

### Proposal 8.1‑3

* Positioning latency will be evaluated in the SI with one of the following options:
  + Option 1: end-to-end latency (both physical and higher layers) and will be evaluated with one of the following alternatives. The latency for higher layers will be evaluated in an analytical manner.
* Supported by: Nokia/NSB
  + Option 2: physical layer latency only
    - Supported by: CATT, Futurewei, Huawei, HiSilicon,OPPO
* The evaluation of the physical layer latency will be conducted in one of the following options:
  + Option 1: numerical evaluation and analysis
    - Supported by: Huawei, HiSilicon
  + Option 2: analysis only
    - Supported by: CATT,OPPO

FFS: whether the positioning latency is presented based the averaged value, the maximum value, or CDF

Additional Comments

|  |  |  |
| --- | --- | --- |
| **Company** | | **Comments** |
| vivo | For the requirement, we think it is end-to-end latency. Considering the RAN1 only want to focus on evaluating physical layer latency, we should define the target of the end-to-end latency and physical layer latency respectively. Or define the target of the end-to-end latency and confirm the percentage of physical layer latency. Then we can focus on evaluating physical layer latency in the RAN1 side. Whether high layer latency needs to be evaluated is depended on the RAN2 side. |
| Nokia/NSB | See our comments to Proposal 2.1-3. |
| CATT | Performance evaluation in R17 SI stage should focus on positioning accuracy evaluation. For latency requirements, first of all, a clear definition and calculation method of positioning latency should be clarified, and then try to evaluate the latency of different positioning techniques. In our point of view, RAN1 cannot accurately simulate end-to-end latency, which involves a lot of factors and it should be obtained by analysis instead of simulation. When discussing NR positioning enhancements, we should identify its impact on positioning latency and pay attention to the reduction of physical layer latency. |
| Intel | In RAN1 we prefer to focus on physical layer latency, but we are open to estimate the end-to-end latency by consulting with others WGs |
| CMCC | From RAN1 perspective, only physical layer latency should be analytically evaluated. |
| Qualcomm | For positioning latency, we believe study on end-to-end latency with higher layer assumption is more important than physical layer latency alone. Therefore, Option 1 is preferred.  Regarding the physical layer latency, the evaluation should at least include analysis. Numerical results can be optionally provided by each company. |
| Huawei/HiSilicon | We suggest taking a simple method by multiplying RS periodicity and number of occasion combined.  Note that in the LS from SA2 RP-200541, they cannot reach consensus on quantitative evaluation on latency reduction for a new positioning architecture. |
| LG | For the latency enhancement, we would like to focus on the physical layer latency reduction since it is difficult to accurately evaluate and analyze higher layer latency in RAN 1. |
| Fraunhofer | The latency shall be based on the periodicity (including muting and beam sweeping if applied) and used averaging of the PRS. This can be aligned with Proposal 3fromHuawei. Agree with Nokia proposal (option 3) on the overall latency. |
| Ericsson | With regards to latency, we prefer to consider physical layer latency only in RAN1, since this is all we can control from RAN1 perspective. The latency budget part of the physical layer latency should be discussed with higher layer working groups, so that a physical latency performance target can be set. |
| OPPO | Support Option 2 in both:   * + Option 2: physical layer latency only   Option 2: analysis only |
| Nokia/NSB\_2 | Moving our comments from proposal 2.1-3 here. For latency as we discussion in [our TDoc](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_101-e/Docs/R1-2003720.zip) we support option 2 where RAN1 agrees on some assumed signalling delay values (with confirmation from RAN2/3 via LS). This is similar to what I believe Intel proposes above and in our view is an important way to address the latency requirement in Rel-17. |

#### Revision #1 of Proposal 8.1-3

* Physical layer positioning latency will be studied at least through analysis. Numerical evaluation can be optionally provided by each company. Companies are also encouraged to provide the analysis of higher layer latency.
  + **Supported by:**

Additional Comments

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

### Proposal 8.1‑4

* Network efficiency and UE efficiency will be evaluated in the SI in an analytical manner, i.e., RAN1 does not expect to performed detailed simulations for network efficiency and UE efficiency.

Supported by: CATT

Additional Comments

|  |  |  |
| --- | --- | --- |
| **Company** | | **Comments** |
| vivo | Is the intention to prevent any company submit simulation results for efficiency? As 3GPP is contribution driven, we don’t think this proposal is needed. There’s no proposal to mandate simulations for efficiency.  As in SID objective 1c, “Identify and evaluate positioning techniques, DL/UL positioning reference signals, signalling and procedures for improved accuracy, reduced latency, network efficiency, and device efficiency.” Rather, network and UE efficiency evaluations for potential positioning enhancements and solutions should be encouraged. |
| Nokia/NSB | Support. Should maybe also mention that they will be evaluated to identify potential enhancements as they are targeted to be improved per the SID. We agree with the intention above from vivo that companies should be allowed to bring evaluations of power consumption, etc, just that we are not agreeing to simulation assumptions for those metrics. |
| CATT | Support Proposal 8.1-4. |
| Futurewei | The evaluation of Network and UE efficiency should be optional |
| Intel | OK with proposal |
| CMCC | We support the Proposal. |
| Qualcomm | Support the proposal. |
| Huawei/HiSilicon | Unclear what analytical evaluation is in people’s mind. However, we agree with the “i.e. xxx” but we think same quantitative analysis may involve. For example, the efficiency can be calculated by the ratio of radio resources occupied by PRS and SRS within the total amount radio resources; |
| LG | Support this proposal. |
| Fraunhofer | Support Proposal 8.1-4.  At least for us the definition of network and UE efficiency is not clear. Can we define the network efficiency by scalability: where The scalability shall be given together with the required resources. Assuming [5%] of the available RE are used for positioning. What does UE efficiency imply (given that power consumption is discussed in Proposal 8.1-4)? |
| Ericsson | Ok with proposal. We’re ok with companies providing either analytical or simulated results. But we should not have mandatory simulation scenarios just to evaluate efficiency. |
| OPPO | Support |

FL Comments

It seems most companies are fine with the proposal, but some companies question whether numerical evaluation is allowed. Suggest using the wording “at least” to avoid the misunderstanding.

#### Revision #1 of Proposal 8.1-4

* Network efficiency and UE efficiency will be evaluated at least in an analytical manner.
  + Note: It will be up to each company on whether to use other methods (e.g., numerical simulation) for the evaluation.

**Supported by:**

Additional Comments

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

### Proposal 8.1‑5

* UE power consumption will be evaluated in the SI.
  + FFS: how to evaluate the power consumption for positioning, e.g., based on the model developed in TR38.840

|  |  |  |
| --- | --- | --- |
| **Company** | | **Comments** |
| vivo | Power consumption should be evaluated in the SI and FFS on how to evaluate the power consumption for positioning.  A quantitative evaluation of power consumption for positioning based on a simple model should be considered as it will help to select suitable positioning solutions to efficient power consumption. In addition, since UE power saving study has been completed in Rel-16, and the conclusions and methods of that study have been captured in TR38.840; we can largely reuse their models and the methods when evaluating positioning power consumption, which greatly reduces the complexity of quantitative evaluation. |
| CMCC | For us, power consumption sure is an important issue for the industrial devides. However, note that positioning accuracy is the most concerned performance metric, the evaluation of the power consumption can be as a lower priority. Companies can provide results with left over workload. |
| Huawei/HiSilicon | Regarding power consumption, for simplicity, the transmission energy for burst SRS transmission or the average transmission power for periodic SRS transmission can be used for evaluating UE power consumption. |
| Fraunhofer | Support Proposal 8.1-5.  For the power consumption a cost function based on 3 input parameters shall be used: Number of symbols to be transmitted, number of symbols to be received and the Overhead for synchronization (assuming one synchronization per slot). |
| ZTE | From our point of view, it’s hard to evaluate the power consumption. Aternatively, intrested companies can provide potential techniques to balance the performace and power consumption. |
| Nokia/NSB | We sympathize with the proposal but would like to clarify. Does the main bullet mean we would evaluate according to some agreed configuration?  We agree with CMCC above and also agree that power consumption is an important metric but think that taking the time to agree on a model is not needed given the workload and fact that we only have a clear requirement target for accuracy/latency in the SID. |

#### Revision #1 of Proposal 8.1-5

* UE power consumption will be evaluated.
  + Note: It is up to each company on how to evaluate the power consumption for positioning, e.g., based on the model developed in TR38.840.

**Supported by:**

Additional Comments

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

### Proposal 8.1‑6

* CDF values for positioning accuracy for IIoT scenarios are derived based on one [or more] of the following options:
  + Option 1: all Ues
    - Supported by:
  + Option 2: only the Ues inside the convex hull of the base stations
    - Supported by: Nokia/NSB

|  |  |  |
| --- | --- | --- |
| **Company** | | **Comments** |
| Intel | Support both options |
| Qualcomm | Support Option 2. |
| Huawei, HiSilicon | It seems like UE is below clutter, while gNB is above clutter, so it means that UE is always outside the convex hull in the vertical dimension.  We are ok with option 2 with modification that the convex hull is only considered in the horizontal plane. |
| Fraunhofer | Support both options.  We would like to propose a third option which can combined with option 2.  Option 2: only the UEs inside the convex hull of the base stations according to LOS TRPs-UE links. Or option 3 (according to proposal 1 in our contribution R1-2004517 and inline with proposal1 in R1-2004490 which was missing from the Tdoc conclusion):  Generate a separate analysis set from all drops: Positioning accuracy for drops with at least 3/4 links in LOS state.   |  |  |  |  | | --- | --- | --- | --- | |  | Requirement | 80% | 95% | | Option1: Overall accuracy InF-DH | <1m |  |  | | Option1: Overall accuracy InF-SH | <0.2m |  |  | | InF (# of LOS links <4) | <1m |  |  | | InF (# of LOS links >4) | < 1m |  |  | | InF (# of LOS links >8) | < 0.2m |  |  | |
| Nokia/NSB | We support option 2. Companies can of course bring as results for all UEs optionally if they wish. |

#### Revision #1 of Proposal 8.1-6

* CDF values for positioning accuracy for IIoT scenarios are derived based on :
  + Case 1 (Required): the UEs inside the convex hull of the horizontal BS deployment area.
  + Case 2 (Optional): all the UEs

**Supported by:**

Additional Comments

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

# Comments to TR skeleton for TR 38.857

Background

TR skeleton for TR 38.857 is available in [35] for endorsement. Interested companies are encouraged to provide the comments to the TR skeleton.

Additional Comments

|  |  |  |
| --- | --- | --- |
| **Company** | | **Comments** |
| vivo | * The content table on page 3 is not matching the actual content. * Suggest to move section 5.2 Performance evaluation metrics to become section 6.2. * Suggest to add a sub-section 6.1 for scenarios and models * On editor’s notes under section 8.1, “Including accuracy [and latency]  (objective 1b) performance, compared to rel17 performance targets”. Suggest remove square brackets around ‘and latency’ because it’s clearly stated in SID objective 1b that “Evaluate the achievable positioning accuracy and latency with the Rel-16 positioning solutions in (I)IoT scenarios and identify any performance gaps.” * On editor’s notes under section 8.2, “Including performance of positioning techniques, DL/UL positioning reference signals, signalling and procedures for improved accuracy[, reduced latency, network efficiency, and device efficiency]  ((objective 1c).”. Again, suggest remove square brackets around ‘reduced latency, network efficiency, and device efficiency’ as objective 1c in SID says “Identify and evaluate positioning techniques, DL/UL positioning reference signals, signalling and procedures for improved accuracy, reduced latency, network efficiency, and device efficiency.” |
| Intel | We OK with TR skeleton |
| Huawei/HiSilicon | We have the following comments:   1. Contents in page 3 are not aligned with the headings in the TR body. 2. Unclear relation between clause 5.2 and performance metric in clause 6. Suggest merging into one. 3. Suggest changing clause 6 to “Additional scenarios, channel models, and performance metrics” (remove enhancement as it includes evaluation of Rel-16 solutions, which has no enhancement at all) 4. Suggest adding “6.1 IIoT use cases”, and “6.2 general commercial use cases” 5. Suggest changing clause 8.1 to “Performance of Rel-16 positioning solutions for IIoT use cases”. 6. Suggest changing 7 to 8.2, and changing current 8.2 to 8.3. 7. Suggest adding “8.4 Summary for evaluations”. 8. Annex has the endorsement meeting RAN1#100, which needs to be fixed when providing the t-doc number. |
| Nokia/NSB | Agree with the comments from vivo above. We base our comments below on the section numbers from page 3. In addition:   * Not sure that Section 6.1. is needed. If we reuse scenarios and models from Rel-16 we can just refer to TR 38.855 directly rather than copy pasting. Saves space and makes the TR more readable. * Suggest to call Section 7 “Studied NR Positioning Enhancements” or “Potential NR Positioning Enhancements”. Similar comment for section 8.2 title.   We also suggest to add (or move 6.3.3) a subsection 6.4 “Other Metrics” and list Latency, Network Efficiency, and Device Efficiency as sub-subsections. While we may not agree to numerically evaluate those metrics (still FFS) it is clear from SID that those should impact our study. Analytical observations, etc could eventually go there. |

# Summary

This document provides a summary of the issues and proposals for “AI 8.2.1 Additional Scenarios for Evaluation” and “AI 8.2.2 Evaluation of achievable positioning accuracy and latency” based on the contributions [2-33], and the initial set of proposals suggested to be further discussed in the meeting.

References

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3. [R1-2003284](file:///E:\1%20Meetings\RAN1\2020%2005_TSRR1_101\Inbox\R1-2003284.doc) IIoT Scenarios for Positioning Futurewei

1. [R1-2003295](E:\\1 Meetings\\RAN1\\2020 05_TSRR1_101\\Inbox\\R1-2003295.doc) Discussion on scenarios and evaluation methodology for Rel-17 positioning Huawei, HiSilicon
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3. [R1-2003479](file:///E:\1%20Meetings\RAN1\2020%2005_TSRR1_101\Inbox\R1-2003479.doc) Additional scenarios for evaluation on positioning enhancements ZTE
4. [R1-2003640](file:///E:\1%20Meetings\RAN1\2020%2005_TSRR1_101\Inbox\R1-2003640.doc) IIoT use cases and scenarios for evaluation of NR Positioning Enhancements CATT
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5. [R1-2004141](file:///E:\1%20Meetings\RAN1\2020%2005_TSRR1_101\Inbox\R1-2004141.doc) Discussion on additional scenarios for evaluation LG Electronics
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3. [R1-2003428](file:///E:\1%20Meetings\RAN1\2020%2005_TSRR1_101\Inbox\R1-2003428.doc) Evaluation of achievable accuracy and latency for NR positioning enhancements vivo
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