3GPP TSG-RAN WG1 Meeting #102-e R1-20NNNNN

e-Meeting, August 17th – 28th, 2020

**Agenda Item: 8.5.1**

**Source: Ericsson**

**Title: FL summary for additional scenarios for evaluation of NR positioning enhancements**

**Document for: Discussion, Decision**

# Introduction

The following summary provides a list of issues to be discussed during RAN1#102e regarding AI 8.5.1 “Additonal scenarios for evaluation” of the NR positioning enhancement SI[1] based on submitted contribution[2-19]

# Aspects for email discussions

## Accuracy and latency requirements

* In [4], it is proposed to downselect some of the accuracy requirements regarding vertical accuracy for commercial and IIOT use cases, horizontal accuracy for IIOT use cases and latency for IIOT. Moreover it is proposed to remove brackets for the remaining requirements.
* In [5] the target percentile is proposed to be 90%, vertical accuracy for commercial use cases is 3m. for IIOT it is proposed to have different requirements for SH and DH channels, and ask for input to other WGs regarding latency.
* In [7], it is proposed to use the 90% percentile, and use vertical accuracy of 3m for commercial cases, 1m for IIOT, and 0.2m for horizontal accuracy for IIOT. It is also proposed to remove remaining brackets.
* In [8] it is proposed to have physical layer latency less or equal to 100ms for commercial use cases, and 10ms for IIOT use cases.
* In[9], it is proposed to set vertical accuracy at 0.5m and horizontal accuracy at <1m. for IIOT use case.
* In [11], it is proposed to re-use service levels fro 22.804 and 22.261 for accuracy requirements, and have accuracy as the primary metric, with other metrics considered secondary.
* In [12], the proposed accuracy is 0.2m both vertical and horizontal for I(IOT use cases, and 1m/3m horizontal/vertical for commercial use cases. Latency is proposed to be under 10ms end to end and physical for IIOT, and 100ms (end to end) /50ms (physical ) for commercial use cases
* [14] proposes to use the 90percentile for commercial use case and the 99percentile for IIOT. The V/H accuracy is proposed to be 2m / 1m for commercial use case and 0.2m/0.2m for IIOT. End to end latency is proposed to be 100ms and physical layer latency is tentatively proposed at 18ms. Target latency of 100ms is proposed.
* In [18] it is proposed to use the 90 percentile for accuracy, and not specify a target accuracy for commercial use cases. For iiot use cases horizontal accuracy of 0.2m is proposed, and either 0.2 or 1m of vertical accuracy.

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| source | proposal |
| [4] | ***Proposal 1:***   * In Rel-17 target positioning requirements for **commercial use cases** are defined as follows:   + Horizontal position accuracy (< 1 m) for ~~[~~90%~~]~~ of UEs   + Vertical position accuracy (< ~~[2 or~~ 3~~]~~ m) for ~~[~~90%~~]~~ of UEs   + End-to-end latency for position estimation of UE (< ~~[~~100 ms~~]~~)   + ~~FFS:~~ Physical layer latency for position estimation of UE (< [10 ms]) * In Rel-17 target positioning requirements for **IIoT use cases** are defined as follows:   + Horizontal position accuracy (< X m) for ~~[~~90%~~]~~ of UEs     - X = ~~[~~0.2 ~~or 0.5]~~ m   + Vertical position accuracy (< Y m) for ~~[~~90%~~]~~ of UEs     - Y = ~~[0.2 or~~ 1~~]~~ m   + End-to-end latency for position estimation of UE (< ~~[10ms, 20ms, or~~ 100ms~~]~~)   + ~~FFS:~~ Physical layer latency for position estimation of UE (< [10ms])   Note: Target positioning requirements may not necessarily be reached for all scenarios |
| [5] | ***Proposal 1:*** *The target positioning requirements for Rel-17 should adopt following suggestions,*   * *The target percentile of UEs required to meet the position accuracy requirement is 90%.* * *Vertical position accuracy for commercial use cases is 3 m.* * *Different IIOT channels have different position accuracy requirements, e.g. X=0.5 and Y=1 for InF-SH channel and X=0.5 and Y=1 for InF-DH channel.* * *Wait for more inputs from other working groups to decide the latency requirement.* |
| [7] | ***Proposal 1:*** ***We prefer the following numbers for Rel-17 target positioning requirements:***   * ***In Rel-17 target positioning requirements for commercial use cases are defined as follows:***   + ***Horizontal position accuracy (< 1 m) for 90%of UEs***   + ***Vertical position accuracy (<3m) for 90% of UEs***   + ***End-to-end latency for position estimation of UE (<100 ms)***   + ***Physical layer latency for position estimation of UE (<10 ms)*** * ***In Rel-17 target positioning requirements for IIoT use cases are defined as follows:***   + ***Horizontal position accuracy (< X m) for 90%of UEs***     - ***X = 0.2m***   + ***Vertical position accuracy (< Y m) for 90% of UEs***     - ***Y = 1m***   + ***End-to-end latency for position estimation of UE (<100ms)***   + ***Physical layer latency for position estimation of UE (< 10ms).*** |
| [8] | Proposal 4   * + **We suggest defining a PHY layer latency less than or equal to 100 ms for the commercial use cases and less than or equal to 10 ms for the IIoT use cases** |
| [9] | *Proposal 1: The performance requirement for Rel-17 positioning is:*   * *Horizontal positioning accuracy < 0.5 m for 90% UEs* * *Vertical positioning accuracy < 1m for 90%UEs* |
| [11] | ***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 and Table 7.3.2.2-1 of TS 22.261.*  ***Proposal 2****: 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.* |
| [12] | **Proposal 1: In Rel-17 target positioning requirements for IIoT use cases are defined as follows:**   * **Horizontal position accuracy (< X m) for [90%] of UEs** * **X = 0.2 m** * **Vertical position accuracy (< Y m) for [90%] of UEs** * **Y =0.2 m** * **End-to-end latency for position estimation of UE (<10ms)** * **Physical layer latency for position estimation of UE (< 10ms)**   **Proposal 2: In Rel-17 target positioning requirements for commercial use cases are defined as follows:**   * **Horizontal position accuracy (< 1 m) for [90%] of UEs** * **Vertical position accuracy (<3 m) for [90%] of UEs** * **End-to-end latency for position estimation of UE (< 100 ms)** * **Physical layer latency for position estimation of UE (< 50 ms)** |
| [14] | ***Proposal 1:***   * Rel-17 target positioning requirement could be defined as below:   + For commercial use cases:     - Horizontal position accuracy (< 1 m) for 90% of UEs     - Vertical position accuracy (< 2 m) for 90% of UEs     - End-to-end latency for position estimation of UE (< 100ms)     - FFS: Physical layer latency for position estimation of UE (< [18ms])       * At least for the case where measurement gap configuration is required   + For IIoT use cases:     - Horizontal position accuracy (< 0.2 m) for 99% of UEs     - Vertical position accuracy (< 0.2 m) for 99% of UEs     - End-to-end latency for position estimation of UE (<100ms)     - FFS: Physical layer latency for position estimation of UE (< [18ms])       * At least for the case where measurement gap configuration is required |
| [18] | Proposal 1 Accuracy for commercial and IIOT use cases is defined for 90 percent of UEs  Proposal 2 Do not specify a target for vertical accuracy for commercial use cases  Proposal 3 In Rel-17 target positioning requirements for IIoT use cases are defined as follows:  - Horizontal position accuracy (< X m) for [90%] of UEs  - X = 0.2 m  - (Optional) Vertical position accuracy (< Y m) for [90%] of UEs  - Y = 0.2 or 1 m  Proposal 4 Target latency should include at least 100ms end to end, for both IIOT and commercial use cases |

It seem the majority of companies agree that the performance should be evaluated for 90 percent of UEs.

For commercial use cases:

* most company agree to 3m for vertical accuracy, except for one company proposing 2m and one company proposing not to specify the target vertical accuracy.
* End to end Latency is supported to be 100ms for all companies with a proposal.
* Physical latency proposal range from 10 to 18ms

For IIOT use cases

* Horizontal accuracy is split between 0.2 and 0.5m. vertical accuracy proposals include 1m, 0.5m or 0.2m
* End to end Latency is supported to be 100ms for all companies with a proposal.
* Physical latency proposal range from 10 to 18ms

Based on the submitted proposals, it is proposed to downselect options for accuracy and latency based on the majority view. the following is proposed to update the previous agreement:

Feature lead Proposal 1: In Rel-17 target positioning requirements for commercial use cases are defined as follows:

* Horizontal position accuracy (< 1 m) for 90% of UEs
* Vertical position accuracy (< 3 m) for 90% of UEs
* End-to-end latency for position estimation of UE (< 100 ms)
* Physical layer latency for position estimation of UE (< [10 ms])

In Rel-17 target positioning requirements for IIoT use cases are defined as follows:

* Horizontal position accuracy (< 0.2 m) for 90% of UEs
* Vertical position accuracy (< 1 m) for 90% of UEs
* End-to-end latency for position estimation of UE (<100ms)
* Physical layer latency for position estimation of UE (< [10ms])

Note: Target positioning requirements may not necessarily be reached for all scenarios

Companies are encouraged to provide their comments in the table below

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| Company | Comment |
| Nokia/NSB | Most of the FL proposal is okay for us. One aspect that requires further study in our view is the PHY layer latency requirement. We think it should remain as FFS if there is a specific requirement for this depending on the overall latency analysis. If we say PHY layer can up to 10 ms but overall latency is 100 ms then we are leaving a 90 ms latency for the upper layers. If that is realistic or not isn’t for RAN1 to decide in our view and should require some input from other WGs. The definition of PHY layer latency is still unclear so we need to first make progress there before we could agree to a requirement. |
| CATT | Support FL proposal. And we share the same view with Nokia/NSB that the PHY layer latency should be defined clearly. In fact, FL proposal 5 in section 2.4 had given the draft definition of physical layer latency. |
| Huawei/HiSilicon | For positioning accuracy aspects for IIoT use case, we suggest to keep it open for this meeting. We do not want the industry to be misled by the over-optimistic results assuming ideal condition. Keeping the current [0.2m or 0.5m] is preferred for this meeting.  The remaining proposals (with the understanding of physical layer latency still being kept in brackets implied the values are still FFS) are fine. |
| vivo | Agree with the FL proposal 1. |
| LG | We agree with most of the proposal. However, regarding latency, some companies consider co-working with other WGs and they are discussed in AI 8.5.2. So, the detailed values about higher layer latency should remain as FFS. In addition, according to our analysis, the total delay for grant based positioning measurement with measurement gap configuration exceeds 10ms. Therefore, we would like to discuss necessity of separate target requirement considering with/without measurement gap configuration request. It seems necessary to leave it as FFS at this stage. |

## UE/gNB Rx/Tx calibration error

* In [2] it is proposed to adopt a modelling of the impact of RxTx errors
* In [4], it is propose to further discuss the source of the error and the way to model the timing error
* In [5] it is proposed to have independent error per UE panels.
* In [8] it is proposed not to include timing error modelling in the methodology
* In [15], it is propose to consult RAN4 on any agreement regarding the timing error model
* In [17] a methodology to apply the timing error is proposed
* In [18] it is proposed to leave it to companies to provide values for the T1 and T2

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| source | proposal |
| [2] | ***Proposal 1: Adopt the following modeling of the impact on DL TOA and UL TOA from gNB/UE Rx and Tx calibration error*** |
| [4] | ***Proposal 4:***   * ***FFS UE/gNB RX and TX timing error modeling.*** |
| [5] | ***Proposal 3:*** *On how to apply UE/gNB RX and TX timing error,*   * *UE RX and TX timing error will be generated randomly per UE in single panel use case, which will be added on UE Rx-Tx measurement.* * *UE RX and TX timing error will be generated randomly per panel per UE in multiple panels use case, both UE Rx-Tx and RSTD measurements should take into account the error in simulation.* * *gNB RX and TX timing error should be generated randomly per gNB, all timing measurements on gNB side will be added the error according to the corresponding gNB.* |
| [8] | Proposal 5  **Do not include the timing error modelling into the evaluation methodology** |
| [15] | **Observation 1:** We agree that timing error can be a matter to ToA measurement especially with multi antenna panel cases. However, a detailed simulation of how this error impacts Tx/Rx measurements may require detailed study of the problem to accurately model it. The overall impact on the performance can be quantified without detailed simulations.  **Observation 2**: RAN4 has also been discussing this issue and may better understand the appropriate modeling.  RAN1 should consider waiting for RAN4 progress in Rel-16 on this issue or at least consult RAN4 on any detailed agreements reached in Rel-17 on this topic. |
| [17] | ***Proposal 1: Apply the timing errors as follows:***   * ***For each UE drop,***    + ***For each panel (in case of multiple panels)***     - ***Draw a random sample for the Tx error according to [-2\*Y,2\*Y] and another random sample for the Rx error according to the same [-2\*Y,2\*Y] distribution.***   + ***For each gNB***      - ***For each panel (in case of multiple panels)***       * ***Draw a random sample for the Tx error according to [-2\*X,2\*X] and another random sample for the Rx error according to the same [-2\*X,2\*X] distribution.*** * ***Note: The above modelling does not take into account that the Tx/Rx errors are time-varying. Further analysis would be needed for such aspects to be evaluated if needed.*** |
| [18] | **Proposal 9 The values for X and Y characterizing the UE /gNB Rx and Tx timing error are provided by companies when submitting results.**  **Proposal 8 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.** |

There is such a variety of proposal that it is proposed to first gauge what is preferred for the FFS to resolve:

For X and Y values there does not seem to be proposals for values to resolve the FFS, except for [18] proposing to leave it to companies. In [15] it is proposed to involve RAN4 in the topic.

Feature lead proposal 2: for X and Y values in the modelling of Rx and Tx timing error,

* Alt1: it is up to companies to provide the values of X and Y used in their simulations
* Alt2: send LS to RAN4 on appropriate modelling of the Tx and Rx timing errors

Companies are encouraged to provide their comments in the table below

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| Company | Comment |
| Nokia/NSB | We are okay with either Alternative. As we have already agreed that Tx/Rx timing error can optionally be modelled we have a preference for Alt 1. If we were to agree on some baseline values (i.e., not go with Alt 1) then we should probably consult RAN4 on if the values are appropriate. |
| CATT | We prefer Alt2. RAN4 can give the exact values of X and Y used in the simulation. |
| Huawei/HiSilicon | We would like to reach a common understanding on how the Tx/Rx calibration error should be added to the simulation.  Regarding the value of X and Y, we are fine with Alt.1, but RAN4 is not recommended to be involved, especially considering the next meeting will the last one for RAN1 for this study. |
| vivo | In our opinion, it is still unclear what is the Rx and Tx timing error and what is the benefit to model it. Before we decide how to model it or the specific X and Y values, firstly the explanation and benefit for the Rx and Tx timing error need to be clarified.  Some companies say it can be calibrated before positioning, some companies think only part of it can be calibrated, and some think it includes the antenna panel switching and timing jitter. So, we are confused about it and prefer to unify the understanding of Tx/Rx timings. |

For the FFS on how the Rx and timing error are applied several companies propose a similar way to generate random timing error, and it seems there is a common view between proposal as to which part of Rx and Tx error to include in different methods. The proposal in [17] and [18] are used as a start for the discussion

Feature lead proposal 3: Apply the timing errors as follows:

* For each UE drop,
  + For each panel (in case of multiple panels)
    - Draw a random sample for the Tx error according to [-2\*Y,2\*Y] and another random sample for the Rx error according to the same [-2\*Y,2\*Y] distribution.
* For each gNB
  + For each panel (in case of multiple panels)
    - Draw a random sample for the Tx error according to [-2\*X,2\*X] and another random sample for the Rx error according to the same [-2\*X,2\*X] distribution.
* FFS: time varying aspects of the timing errors
* 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.

Companies are encouraged to provide their comments in the table below

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| Company | Comment |
| Nokia/NSB | What do we gain from this proposal? The prior agreement already says that they are drawn from those distributions and are generated independently per panel. |
| CATT | In our point of view, FL’s proposal gives the details on the 2nd FFS(how the Rx and Tx timing errors are applied) in the agreement from last meeting, as shown in below:   |  | | --- | | Agreement:  Optional: The UE/gNB RX and TX timing error, in FR1/FR2, can be modeled as a truncated Gaussian distribution with zero mean and standard deviation of T1 ns, with truncation of the distribution to the [-T2, T2] range, and with T2=2\*T1:          T1:  [X] ns for gNB and [Y] ns for UE   * FFS: X, Y           Note: RX and TX timing errors are generated per panel independently          FFS: how the Rx and Tx timing errors are applied |   We support FL’s proposal as the optional simulation assumptions to align the details on the generation of Rx and Tx timing errors in the simulation among different companies. |
| Huawei/HiSilicon | OK |
| vivo | The meaning and benefit of timing error needs to be further clarified first. |

## UE mobility

* In [4], it is proposed to to further define the mobility model’s spatial consistency
* In [4] two options for the track model of the mobility are proposed
* In [6] and [8] it is proposed to down prioritize / not consider the mobility model
* In [7] it is further proposed to consider velocity and acceleration, positioning update rate. The track is set to a linear track with fixed trajectory.
* In [10] it is proposed to add new scenarios with fixed trajectories.
* In [13] it is proposed to consider constant velocity and turn models, and to report switching mechanisms /trajectories assumed in the simulations
* In [15] it is proposed to not define a mobility model
* [16] proposes to use a linear track where a UE drop is considered as a segment with a set of positions. A model for LOS/Nlos probability in mobility is proposed.
* In [17] it is propose to add mobility as a new scenario for evaluation.

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| [4] | ***Proposal 5:***   * ***The absolute time of arrival with spatial consistency should be calibrated.***   ***Proposal 6:***   * ***UE mobility can be modeled as the following:***   ***Option1:***  ***Track mode: linear track***  ***Velocity & acceleration: constant speed [6-9]km/h, zero acceleration.***  ***Position update rate: >100ms***  ***Direction: a linear path with a fixed direction.***  ***Option2:***  ***Track mode: a loop track***  ***Velocity & acceleration: constant speed [6-9]km/h, zero acceleration.***  ***Position update rate: >100ms***  ***Direction: a loop path with a fixed direction.*** |
| [6] | **Proposal 2: Down prioritize UE mobility model and let interested proponent to use their own model/assumption.** |
| [7] | ***Proposal 3: A common mobility model for the movement of UE should be considered with the following details of the mobility model as the starting point:***   * ***UE mobility can be optionally considered in evaluation with the following details.***   + ***Spatial consistency should be considered according to TR 38.901 (Section 7.6.3)***   + ***Track mode: linear track with fixed path trajectory***   + ***Velocity & acceleration:***     - ***Option 1: constant speed 30km/h, zero acceleration.***     - ***Option 2: initial constant acceleration period + constant speed 30Km/h period***   + ***Position update rate: the time interval between two position update of a track >1ms*** |
| [8] | **Proposal 3: Do not include user mobility model into the NR positioning evaluations** |
| [10] | ***Proposal 1：We suggest to add new scenarios with fixed trajectories in both InF-SH and InF-DH.*** |
| [13] | **Proposal 1 : Adopt constant velocity and coordinated turn model in Equation (1) and (2)**    **Proposal 2 : Adopt UE speed of 3km/h for velocity and turn rate of 30 degrees per second and report standard deviation assumed in the disturbance**    **Proposal 3: Companies to report switching mechanism and or exemplary trajectories assumed in the simulation**  **Proposal 4: Companies to report which cell edge movement model, illustrated in Figure 1, 2 and 3 in the contribution, was adopted in the simulation when UE at the cell edge in the IIoT scenario** |
| [15] | **Proposal 3**: Do not define the details of the optional mobility model. |
| [16] | **Proposal 1: When UE mobility is applied, a “drop” is considered as a “segment” represented by a set of positions. The segment is characterized by:**   * **Track mode: linear** * **Segment starting point: UE dropping procedures applies** * **Orientation : random**   **Proposal 2: As a first model for the LOS/NLOS sequence generation we propose to derive the parameters for a 2-state Markov model from the parameters used for the LOS/NLOS probability model.**  **Proposal 4: In case of simulation of mobile devices using tracks, the orientation of the UE along the track is updated according the segment direction.** |
| [17] | ***Proposal 3. Consider mobility as additional scenario for evaluation. A simple route or path trajectory is defined in the layout along with a mobility model defining the velocities and accelerations consistent with the dynamics of the use-case applications:***   * ***The line segment from coordinate (D,D) to coordinate (5D,D) with velocity of 3km/hr, as illustrated in Figure 4-1).*** * ***Spatial consistency procedure in* [2] *shall also be enabled in the mobility simulation (as described in further detail in this contribution).*** |

Based on the proposals, there are many parameters to be considered for a mobility study. Some companies propose not to move forward with mobilities. Proponents have different views on how to setup the mobility models.

**Feature lead proposal 4:**

**For UE mobility downselect between the following options:**

* **For all options, Spatial consistency should be considered according to TR 38.901 (Section 7.6.3)**
* **Option 1: Do not define the details of the optional mobility model.**
* **Option 2: use Track mode: linear track**

**Velocity & acceleration:**

**Direction: a linear path with a fixed direction.**

* + **Track mode: linear track with fixed path trajectory**
  + **Velocity & acceleration:**
    - **Option 2-1constant speed [6-9]km/h, zero acceleration.**
    - **Option 2-2: constant speed 30km/h, zero acceleration.**
    - **Option 2-3: initial constant acceleration period + constant speed 30Km/h period**
  + **Position update rate: the time interval between two position update of a track** 
    - **Option 2.4 1ms**
    - **Option 2.5 100ms**
  + **Segment starting point: UE dropping procedures applies**
  + **Orientation : random**
* **Option 3: use Track mode: a loop track**

**Velocity & acceleration: constant speed [6-9]km/h, zero acceleration.**

**Position update rate: >100ms**

**Direction: a loop path with a fixed direction.**

* **Option 4 Adopt constant velocity and coordinated turn model in Equation (1) and (2) in [13]**
  + **Adopt UE speed of 3km/h for velocity and turn rate of 30 degrees per second**
  + **report standard deviation assumed in the disturbance**
  + **Companies to report switching mechanism and or exemplary trajectories assumed in the simulation**

Companies are encouraged to provide their comments in the table below

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| Company | Comment |
| Nokia/NSB | Support option 1. We have some doubts about how the positioning accuracy would be reported for UEs which use these mobility models as we expressed during the GTW call. Can the proponents clarify how the accuracy would be calculated for users in the mobility model? |
| CATT | Support Option 2-2. |
| Huawei/HiSilicon | We prefer either option 1 or option 2.  For option 2, we support Option 2-1 and option 2.5. Regarding starting position of the linear track, we think UE dropping should be on the track with very limited region, e.g. only the green part in the following figure.  We also need to report the motion sensor error model. |
| vivo | It will be easier to model mobility and reduce the overhead by dropping multiple UEs to represent a moving UE. In option2, we don’t see the need for Segment starting point and random orientation.  For the speed, we think it is faster than pedestrian, but no more than 1/3 speed of vehicle(30km/h).  Position update rate=speed\* Position update rate=6(km/h)/3.6\*0.1s=0.16m, it is enough to evaluate the accuracy in R17, 1ms is too dense and will lead a heavy overhead for simulation.  In conclusion, Option 5 is needed and may be more effective:   * Option 5: use Track mode: linear track   Drop way: dropping multiple UEs to represent a moving UE  Direction: a linear path with a fixed direction(we prefer a unify track as a baseline).   * + Track mode: linear track with fixed path trajectory   + Velocity & acceleration:     - Option constant speed [3,6 or 9]km/h , zero acceleration.   + Position update rate: the time interval between two position update of a track   100ms |
| LG | We prefer option 1. In our view, details of the optional mobility model are up to each proponent company. |

## Latency considerations

* In [2], it is proposed to to define physical layer latency as the sum of all RS durations across all occasions
* In [8] it was proposed to leave higher layer latency to RAN2/3 WGs, and have RAN1 focus on PHY latency.
* In [13] proposes to focus on physical layer latency.
* In [15], it is propose to use the PRS transmission period and transmit occasion as baseline. Latency of LMF can be considered, along for measurement delay.

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| [2] | ***Proposal 2: Consider to adopt the following simplified physical layer latency representation*** |
| 8] | Proposal 6   * + **RAN1 to focus on estimation of the PHY layer latency**   + **Higher-layer latency estimation can be done in RAN2/RAN3 working groups** |
| [14] | ***Proposal 2:***   * RAN1 NR positioning SI prioritizes the analysis and evaluation for the physical layer latency than end-to-end latency |
| [15] | **Proposal 4:** RAN1 may define the latency study scope, and interested companies can study the latency performance   * As a baseline, the latency of PRS transmission period and transmission occasions (i.e. , ) for one UE’s measurement report to achieve the accuracy requirement can be used. * Latency of LMF averaging can be considered to achieve the accuracy requirement over multiple UE measurement report occasions. (i.e. , ). * The time for UE to report the measurements can be considered as well. |
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Based on the proposals, most companies agree to define physical layer latency in RAN1, with proposals for how to define it.

**Feature lead proposal 5: Physical layer latency is defined as**

* **Option 1:**
* **Option 2: latency also includes latency of LMF averaging over multiple UE measurement report occasions. (i.e. T\_Report ×N , N≥1) and the time for UE to report the measurements.**

Companies are encouraged to provide their comments in the table below

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| Company | Comment |
| Nokia/NSB | We think there are some good proposals for the physical layer latency in other AIs at this meeting. For example, in AI 8.5.3 our TDoc we provide the following Figure    One way to define the physical layer latency (at least for DL techniques) is the time from PRS transmission until the gNB receives the RSTD measurement report. |
| CATT | In our point of view, both Option 1 and Option 2 are not consider other factors which impact the latency, such as UL grant and scheduling delay, we slightly prefer Nokia/NSB’s definition of physical layer latency. And if the number of combined occasions of the DL-PRS or SRS-Pos to derive the measurements is more than 1 (assuming it is N), the one-shot latency should be multiplied by N. |
| Huawei/HiSilicon | Regarding Nokia’s proposal, normally SR transmission should be followed by a BSR from UE, followed by the actual transmission if SR is modelled here.  Our simplified proposal is roughly calculated from reception of measurement gap configuration (if needed) at the UE till the scheduled report at least for DL part. Normally the expected queuing delay for the first PRS reception is half the periodicity, and the another half periodicity of PRS is related to PRS measurement and UL scheduling aspects. |
| vivo | As we have illustrated in out TDoc R1-2005380, we think the physical latency can be defined as the following, which including measurement gap configuration process, RS measurement process and reporting process.    ***=***   * ***is the periodicity of PRS*** * ***is up to UE ability and the signal that needs to measure, as usually*** * ***is the periodicity of the measurement gap*** * ***is the time to request the gap*** * ***is the time required by UE to configure gaps; RRC reconfiguration delay***   ***is the time to report*** |
| LG | We are same on the page with nokia/NSB’s view. In addition, the procedure can change in accordance with UE-based or UE-assistance mode, so we also need to consider it. |

## Power consumption

* In [2], it is proposed to to model power consumption based on the framework used in 38.840. Power modelling parameters are proposed as well as traffic models and PRS transmission options for CDRX.
* In [17] it is proposed to conduct an analysis of power saving from PRS / SRS processing relaxation when DRX is configured, according to the amount of DRX’d signals.

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| source | Proposal |
| [2] | ***Proposal 3: Adopt the following parameter for PRS RRM power evaluation***   |  |  |  | | --- | --- | --- | | N: Number of TRPs for intra-frequency measurement & search | Synchronous case | | | FR1 | FR2 | | N=8 | 200 | 320 |   ***Proposal 4: Adopt the calibration configuration with FTP traffic model for positioning based on PRS and SRS.***   * ***Both configuration with no CDRX and configuration with CDRX as agreed in the calibration configuration are evaluated.*** * ***For configuration with CDRX, PRS may or may be received in on-duration and SRS should always be configured in on-duration.*** |
| [17] | ***Proposal 2: Consider a first-order study independent of TR 38.840, for evaluation of power savings from enhancements targeted at reducing power consumption for positioning. For example:***   * ***Analyze power-savings from relaxing PRS/SRS processing when DRX is configured based on the fraction of PRS/SRS that are skipped*** * ***Analyze power-savings from new RRC idle/inactive positioning modes based on the number of additional transmissions and receptions needed in RRC connected Positioning to achieve the same performance as that of RRC Idle/Inactive Positioning.*** |

Based on the existing proposal, it seems that the two options differ in the amount of details in the power consumption consideration

**Feature lead proposal 6: for power consumption evaluation, downselect between:**

* **Option 1: Consider a first-order study independent of TR 38.840, for evaluation of power savings from enhancements targeted at reducing power consumption for positioning.** 
  + **Analyze power-savings from relaxing PRS/SRS processing when DRX is configured based on the fraction of PRS/SRS that are skipped**
  + **Analyze power-savings from new RRC idle/inactive positioning modes based on the number of additional transmissions and receptions needed in RRC connected Positioning to achieve the same performance as that of RRC Idle/Inactive Positioning.**
* **Option 2:** 
  + **reuse the CDRX framework from 38.840 with the following parameter for PRS RRM power evaluation**

|  |  |  |
| --- | --- | --- |
| N: Number of TRPs for intra-frequency measurement & search | Synchronous case | |
| FR1 | FR2 |
| **N=8** | **200** | **320** |

* + **the calibration configuration with FTP traffic model is used for positioning based on PRS and SRS.**
  + **Both configuration with no CDRX and configuration with CDRX as agreed in the calibration configuration are evaluated.**
  + **For configuration with CDRX, PRS may or may be received in on-duration and SRS should always be configured in on-duration.**

Companies are encouraged to provide their comments in the table below

|  |  |
| --- | --- |
| Company | Comment |
| Nokia/NSB | The agreement from last RAN1 meeting was:  Agreement:   * UE power consumption for NR positioning can be optionally evaluated in the SI. * Note: It is up to each company on how to evaluate the power consumption for positioning. The UE power consumption models developed in TR38.840 can be considered as the starting point for defining the UE power consumption model for the evaluation for NR positioning   Given this note we think that no further agreements are needed on power consumption evaluation. |
| CATT | We share the same view with Nokia/NSB that it is up to each company on how to evaluate the power consumption, as we agreed last meeting. |
| Huawei/HiSilicon | From our side, we think that some preliminary alignment among companies should be helpful for the evaluation among interested companies, especially when it comes to power saving gain for IDLE/INACTIVE state positioning.  Therefore, the power model for PRS measurement should at least be set. |
| vivo | **Option 2 is better for us**  Reply to Nokia and CATT, we think the device efficiency(ie, UE power consumption) is an objective, same with accuracy and latency. And it has the evaluation model or method for accuracy and latency, while the UE power consumption doesn’t have a common evaluation model, it is difficult to evaluate the performance of enhancement.  We believe that a quantitative evaluation of power consumption for positioning is necessary and it will help to choose a suitable positioning solution with efficient power consumption. So we prefer to further discuss the evaluation model of UE power model. In our contribution R1-2005382, we also discussed power consumption model and evaluated power consumption for PRS measurement in detail.  **Therefore, we recommend option 2 can be modified as below**   * **Option 2:**    + **reuse the CDRX framework from 38.840 with the following parameter for PRS RRM power evaluation**  |  |  |  | | --- | --- | --- | | N: Number of TRPs for intra-frequency measurement & search | Synchronous case | | | FR1 | FR2 | | **N=8** | **[200]** | **[320]** |      * + **the calibration configuration [with FTP traffic model] is used for positioning based on PRS and SRS.**   + **Both configuration with no CDRX and configuration with CDRX as agreed in the calibration configuration are evaluated.**   + **For configuration with CDRX, PRS may or may be received in on-duration and SRS should always be configured in on-duration.**   + **For frequency layer i, the power of PRS measurement is represented as:**   **For Nf frequency layers, the total power is**  **where**  *-*  is total power over slots over which measurements are carried out in frequency layer i  *-*  is the slot average power for PRS measurements in frequency layer i  *-*  is the number of slot over which measurements are carried out  *-*  is the power for measurement gap switching  *-*  is total power for Nf frequency layers |
| LG | We share the similar view with Nokia/NSB and CATT. Further details in addition to the previous agreement is up to companies. |

## Network efficiency

* In [2], it is proposed to to use resource utilization to measure network efficiency.
* In [5], it is proposed to take RS overhead into account. The number of total resources UE need to process within a time window is proposed as a metric
* In [9], it is proposed to consider the signalling overhead, amount of relevant beams and ratio of resources used for positioning RS (PRS and SRS)
* [13] propose to use resource utilization for network efficiency and UE complexity for UE efficiency.
* In [15], the metric for network efficiency is the accuracy gain over the total PRS resources

|  |  |
| --- | --- |
| Source | Proposal |
| [2] | ***Proposal 5: Consider to adopt the resource utilization of PRS and SRS as the metric for network efficiency.*** |
| [5] | ***Proposal 2:*** *RS overhead should be a critical factor considered for network efficiency. Similarly, the number of total resource that UE need to process within a window can be a metric for UE efficiency.* |
| [9] | *Proposal 2: Consider to adopt the following metrics for network efficiency:*   * *The ratio of resources used for DL PRS and/or SRS for positioning.* * *The ratio of PRS resource with valid Tx beam directions in multi-beam system.* * *The signaling overhead for positioning.* |
| [14] | ***Proposal 3:***   * In terms of efficiency, RAN1 consider the following metric:   + For network efficiency: PRS/SRS resource utilization   + For UE efficiency: complexity |
| [15] | **Proposal 5**: Interested companies can study positioning performance accuracy over resource allocation/configuration (e.g., comb size, number of symbols, etc) and PRS transmission occasions as PRS/SRS resource utilization. |
| [18] | **Proposal 5 Network efficiency can be evaluated by complementing simulation results with the number of resources needed to obtain the results. Alternatively, the percentage of UL/DL transmission dedicated to positioning could be provided.** |

It seems that a majority of companies consider the resource utilization as a good metric for network efficiency. The following is proposed:

**Feature lead proposal 7**

* + **Network efficiency is defined with PRS/SRS resource utilization**

Companies are encouraged to provide their comments in the table below

|  |  |
| --- | --- |
| Company | Comment |
| Nokia/NSB | Support. |
| CATT | We support FL proposal in principle, and suggest to change it as follows,  **Updated proposal 7: Network efficiency should be evaluated at least with the metric of DL-PRS/SRS-Pos resource utilization.** |
| Huawei/HiSilicon | Support FL’s proposal. If the definition is clearly defined, it is expected to be used for evaluations in our understanding. |
| vivo | Support. |
| LG | Support. |

## Time of Arrival Modelling for UMa, UMi and IOO

* In [3], it is proposed to reopen the agreement regarding absolute time of arrival for UMa, UMi and IOO
* In [4] and [7], it is proposed to reuse the absolute time of arrival model for indoor scenarios of commercial use cases
* In [5], it is proposed to parameterize the absolute time of arrival with different means and variances for UMi, UMa, and IOO.
* In [8] it is propose to keep the channel modelling for UMa, UMi, IOO, without modification
* In [15] it is proposed to use an approximate absolute TOA model.

|  |  |
| --- | --- |
| Source | Proposal |
| [3] | ***Proposal 1:*** The NLOS offset of Table 7.6.9-1 of TR38.901 should not be reused without adaptation for the UMi, UMa and IOO scenarios. Further studies on the appropriate values are needed. |
| [4] | ***Proposal 2:***   * ***Reuse the absolute time of arrival model for IIOT scenarios in Indoor scenario for commercial use cases.*** |
| [5] | ***Proposal 4:*** *The absolute time of arrival model for UMi, UMa and IOO scenarios can be assumed as in the following table,*   |  |  |  |  |  | | --- | --- | --- | --- | --- | | Scenarios | | UMi | UMa | IOO | |  |  | -6.9 | -6.5 | -7.5 | |  | 1.0 | 1.4 | 0.4 | |
| [7] | ***Proposal 2: Reusing the absolute-time-of arrival model for InF scenarios defined in TR 38.901 to the evaluation of IOO scenario.*** ***The values of parameters and***  ***for generation of the excess delay in NLOS for IOO scenario are shown in the below Table:***   |  |  |  | | --- | --- | --- | | Scenario | | IOO | |  |  | -7.5 | |  | 0.4 | |
| [8] | Proposal 7   * + **Do not modify channel modelling for the UMi, UMa, and IOO scenarios** |
| [15] | **Proposal 1**: Approximate absolute time of arrival models for UMi, UMa, and IOO scenarios are applicable however, some parameters of the absolute time of arrival models are left to individual companies.   * One way is to add an additional delay with absolute LOS delay to LOS and NLOS fast fading channels to (7.5-27) and (7.5-30) respectively in TR38.901.   The excess delay in NLOS can be ignored for UMi, UMa, and IOO for the simplified models or brought by individual companies (i.e., no agreed values). |
| [18] | **Proposal 10 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.** |

Based on the proposed options, the following is proposed for discussion

**Feature lead proposal 8. for the absolute time of arrival modelling in IOO, UMa, Umi, downselect between:**

* **Option 1: do not modify the channel modelling for the UMi, UMa, and IOO scenarios**
* **Option 2: up to companies to disclose the model details (no agreed value)**
* **Option 3: 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.**

Companies are encouraged to provide their comments in the table below

|  |  |
| --- | --- |
| Company | Comment |
| Nokia/NSB | We think the best way would be to agree option 1 and companies can note in their results that absolute ToA was not modelled when bringing results for those scenarios. However, we are also okay with option 2. Option 3 would need detailed justification for why this model can apply to both indoor and outdoor environments. It does not seem realistic at this point to us. |
| CATT | Support Option 3. Since RAN1 had agreed to model absolute time of arrival in the evaluation for all InF scenarios, it is critical to model it for IOO scenario, since IOO scenario is also a kind of indoor scenario and it has similar hall size, the number of BS and ISD as InF scenarios. |
| vivo | For option3, the lognormal parameters defined for the InF model in 38.901 may be only appropriate for IOO scenario, but not suitable for Umi and Uma considering the area size and ISD and so on. Since we think evaluation for general commercial use cases should focus on the Indoor scenario, we prefer to model the absolute time of arrival modelling in IOO to evaluate the more realistic results. But we don’t think it is necessary to model the absolute time of arrival for Umi and Uma, for it is hard to reach uniform and reasonable parameters. |
| LG | We prefer option 2. |

## UE and gNB antenna height

* In [8], it is propose not to pursue further values for UE and gNB antenna height
* In [11]it is proposed to have a uniform distribution of UE height, as an option.

|  |  |
| --- | --- |
| Source | Proposal |
| [8] | Proposal 2   * + **Do not define optional values for UE and gNB antenna heights** |
| [11] | ***Proposal 3****: The optional UE height can be assumed to be in the range of [0.5m, 2m] with uniform distribution. The optional gNB height can be assumed to be 10m and the gNBs are installed on the roof.* |

Based on the available proposal, it is proposed to discuss whether using optional values for UE and gNB antenna heights:

**Feature lead proposal 9 for UE and gNB antenna heights,**

* + **Option 1: Do not define optional values for UE and gNB antenna heights**
* **Option 2: The optional UE height can be assumed to be in the range of [0.5m, 2m] with uniform distribution. The optional gNB height can be assumed to be 10m and the gNBs are installed on the roof.**

Companies are encouraged to provide their comments in the table below

|  |  |
| --- | --- |
| Company | Comment |
| Nokia/NSB | Support option 1. |
| CATT | In fact, we had reached the agreements on optional values for UE and gNB antenna heights, as shown in below,   |  | | --- | | Agreement:  Optional: For evaluating vertical positioning performance, UE antenna height can be uniformly distributed within [0.5, X2]m, where X2 = 2m for InF-SH and X2= for InF-DH defined in TR 38.901.  Agreement:  Optional: For evaluating vertical positioning performance, gNB antenna height can also be set to two fixed heights, which is either {4, 8} m, or {max(4,), 8}. |   The above values in the agreements can satisfy the requirements of configurations of UE/gNB antenna heights, including the vertical accuracy evaluation. Therefore, we don’t see the need to define additional values for UE and gNB antenna heights. |
| Huawei/HiSilicon | Support option 1. |
| vivo | Support option 1. The benefit for optional values for UE and gNB antenna heights are unclear. |
| LG | Support option 1. |

## Futher details on 4-panel UE model

* In [3], it is proposed to reeuse or adapt the already agreed 2-panels UE model for 4-panels.
* In [8] and [15], it is proposed not to pursue further additional UE antenna considerations.

|  |  |
| --- | --- |
| source | Proposal |
| [3] | ***Proposal 2:*** For the optional 4-panel UE antenna, the panel configuration as already agreed for 2-panel UE antenna can be reused or adapted. |
| [8] | Proposal 1   * + **We suggest not to consider new UE antenna configurations in addition to the existing baseline configuration with the two panels** |
| [15] | **Proposal 2**: Do not define additional details for the optional UE antenna configuration of 4 UE panels. |
| [18] | **Proposal 6 Following evaluation assumptions being discussed in NR Rel-17 feMIMO WI, the 4-panels of the UE in the UE antenna configuration for FR2 can be assumed to be placed at the left, right, top, and bollom of the UE.**  **Proposal 7 Following evaluation assumptions being discussed in NR Rel-17 feMIMO WI, each panel for UE antenna configuration for FR2 can be assumed to have (M, N, P) = (1, 4, 2) with a horizontal antenna spacing of dH = 0.5 λ.** |

Based on the proposal, the following is proposed

**Feature lead proposal 10:**

**For 4-panel UEs, downselect between the following:**

* **Option 1: Do not define additional details for the optional UE antenna configuration of 4 UE panels.**
* **Option 2: the panel configuration as already agreed for 2-panel UE antenna can be reused or adapted.**
* **Option 3: The 4-panels of the UE in the UE antenna configuration for FR2 can be assumed to be placed at the left, right, top, and bollom of the UE. Each panel for UE antenna configuration for FR2 can be assumed to have (M, N, P) = (1, 4, 2) with a horizontal antenna spacing of dH = 0.5 λ.**

Companies are encouraged to provide their comments in the table below

|  |  |
| --- | --- |
| Company | Comment |
| Nokia/NSB | Support option 1. |
| CATT | Support option 1. |
| vivo | Support option 1. |

## Other proposals:

The following proposals have been made by one company each. As these are proposal not seen in more than 1 contribution, it is propose not to pursue them. Companies are welcome to support / comment the proposals below:

|  |  |
| --- | --- |
| Company | Comment |
| Huawei/HiSilicon | A more practical indoor gNB antenna modelling is important but 32 TRx gNB is not a typical configuration for indoor deployment.  Also for the indoor case, ground reflection cannot be neglected as it will cause a very close path relative to the main path and degrading the TOA measurement even in the LOS condition. Ground reflection is already specified in 38.901 that can be implemented very easily and can also be adjusted to reflect the wall reflection. |
| vivo | It is necessary to identify the performance gap in NLOS scenario |

## Reduced gNB antenna scale

* In [2], it is proposed to add (M,N,P,Mg,Ng) = (1,4,1,1,1) antenna configuration for gNB.

|  |  |
| --- | --- |
| Source | Proposal |
| [2] | ***Proposal 6: Consider to adopt additional (M,N,P,Mg,Ng) = (1,4,1,1,1) antenna configuration for gNB.*** |

## Ground reflection and wall reflection

* In [2], it is proposed include ground reflection and wall reflections

|  |  |
| --- | --- |
| Source | Proposal |
| [2] | ***Proposal 7: Consider evaluating positioning with explicit ground reflection and wall reflection.*** |

## Clutter parameters for InF

* In [4], it is proposed to add an additional clutter parameter settings (60%, 6m, 2m} to be evaluated.

|  |  |
| --- | --- |
| source | Proposal |
| [4] | ***Proposal 3:***   * ***The clutter parameter {60%, 6m, 2m} should be evaluated to identify the performance gap with NLOS conditions.*** |

## Scenario parameters

* In [6], it is propose to add further options for the scenario parameters to include more practically implemented settings

|  |  |
| --- | --- |
| source | Proposal |
| [6] | **Proposal 1: Define the new set of practical scenario parameters (e.g. basic parameters (smaller bandwidth) and DL PRS and UL SRS configuration) for evaluation of positioning techniques.** |

## Blockage model and MPE

* In [6], it is propose to add hand blockage and MPE impact in the scenarios

|  |  |
| --- | --- |
| source | Proposal |
| [6] | **Proposal 3: To model the effect of hand- and body-blockage a loss of [10] dB is applied to a randomly selected UE panel; larger values, e.g. [20] dB or [30] dB can also be considered. This power reduction is applicable to handheld UEs at FR2 frequencies, such as tools in indoor factory scenarios.**    **Proposal 4: To model the effect of the MPE issue a transmit power reduction of [10] dB is applied to a randomly selected UE panel. This transmit power reduction is applicable to handheld UEs when performing UL-based positioning at FR2 frequencies, such as tools in indoor factory (InF) scenarios.** |

# Conclusion

**TBD**

# References

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