3GPP TSG-RAN WG1 Meeting #102-e DRAFT R1- 2007367

e-Meeting, August 17th – 28th, 2020

**Agenda Item: 8.5.1**

**Source: Moderator (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

### Summary and proposal

* 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.

|  |  |
| --- | --- |
| 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 mProposal 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

|  |  |
| --- | --- |
| 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. |
| ZTE | We are generally fine with the proposal. Regarding the latency for physical layer, at least how to understand/define physical layer latency should be discussed first. |
| Qualcomm | We are not fine in the proposal for the following main reasons:* End-To-End latency target at least for IIoT cases should be <10 msec as written in the SI description as a desired latency for some IioT use cases. This aspect does not appear in the above description at all.

*To address the higher accuracy location requirements resulting from new applications and industry verticals, 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.*** * For vertical, we still think that there needs to be more time to nail down the number, so we prefer to keep 1m in brackets.
 |
| Intel | We would like to propose the following upper bounds for the latency requirements:For commercial use case: end-to-end latency < 100 ms, PHY layer latency < 100 msFor IIoT use case: end-to-end latency < 10 ms, PHY layer latency < 10 msWe agree that definition is required, it can be addressed in the agenda item 8.5.2. |
| CMCC | We have two concerns regarding the FL proposal. For the vertical accuracy of IIoT use cases, considering the localization of the stored goods on the shelf, high vertical accuracy is a need as urgent as the horizontal one. By this stage, we are ok to leave it open:**In Rel-17 target positioning requirements for IIoT use cases:*** Vertical position accuracy (< [0.2 or 1] m) for 90% of UEs

For the physical layer latency, it’s kind of confusing to me that why we define such a stringent physical layer latency of less than 10ms when a much more relaxed end-to-end latency of < 100ms is supported. In fact, according to the analysis from several companies, the physical layer latency plays the majority roles in the end-to-end latency. For us, this 10ms physical layer latency matches a tighter end-to-end latency requirement, and if a less than 100ms end-to-end latency is agreed, a more relaxed should be considered for the physical layer latency. We would like to echo the comments from Intel:**In Rel-17 target positioning requirements for IIoT use cases:*** End-to-end latency for position estimation of UE (<10ms)
* Physical layer latency for position estimation of UE (< 10ms)
 |
| Fraunhofer | Agree with FL proposal |
| Lenovo, Motorola Mobility | Largely agree with FL’s proposal, however we also have similar physical and higher layer target latency concerns shared by Nokia and LG. If we make assumptions on the e2e target requirement without consultation from other WGs, there might be a mismatch between actual and target e2e values, resulting in the target e2e values not being achievable. Furthermore, the horizontal and vertical accuracy requirements for the commercial use cases are relaxed when compared to the IIoT requirements. Similarly, we wonder if the physical and e2e target latency requirements for commercial use cases would have to be as stringent as the IIoT use cases.  |
| OPPO | Regarding the positioning accuracy for IIOT, we share the same view as Huawei to keep it open for this meeting. 0.2m is kind of over-optimistic. Suggest to keep the current [0.2m, 0.5m] for FFS. |
| Qualcomm2 | Sorry for the updated comment. We actually have a preference to still keep the brackets in the precentage of commercial use cases. It is not obvious to us that we need to change the 80% of Rel-16 to 90% in Rel-17.  |
| Ericsson | We’re fine with Huawei’s proposal on accuracy for iiot.Regarding latency, more discussion are needed, so we also suggest to keep it in bracket.  |
| SONY | Generally, support the FL proposal#1. However, we need to address the concern as raised by Nokia/NSB on the target latency requirement. Aiming physical layer latency < 10ms while maintaining end-to-end latency 100 ms seems to provide a tiny margin in physical layer and large margin (90ms) in the higher layer. We think having physical layer latency of 10 ms should provide even lower than 100 ms end-to-end latency. |
| SS | For latency requirement, we share the similar view as Nokia that we should have some further discussion or at least have a clear picture of how the latency is analyzed before jumping to the conclusion. For accuracy requirement, we are OK with commercial case but for IIoT case, 0.2 m is too optimistic.  |
|  |  |

### Update #1

Based on the comments received, there are still concerned regarding the physical layer latency, the percentile used for accuracy in commercial use case, and the exact value of vertical accuracy for IIOT. the following update is proposed, with changes highlighted in **red**. Brackets on values mean that the issue is still open:

Feature lead Proposal 1a: 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 (< [0.2m, 0.5m] m) for 90% of UEs
* Vertical position accuracy (< [0.2 or 1] m) for 90% of UEs
* End-to-end latency for position estimation of UE (<[100ms, 10ms])
* Physical layer latency for position estimation of UE (< [10ms])

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

### Update #2

During the online discussion, it became rather clear than some issues will not be resolved with a single requirements for e.g. latency or accuracy. Therefore, it is proposed to take a different approach and see requirements as service levels for use cases. Positioning for IIOT may have multiple use cases which have various level of demands on accuracy/latency. Thus we propose to set multiple requirements for accuracy and latency. Each set of requirement for accuracy and latency could be combined in a service level. Then, during evaluation and in the TR conclusion, we will be able to identify what potential enhancements satisfy what requirements/service level.  We hope that can provide a way forward:

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

·         **Horizontal position accuracy (< 1 m) for X1 of UEs**

o   **X1 =80% or 90%**

·         **Vertical position accuracy (< 3 m) for [X2] of UEs**

o   **X2 =80% or 90%**

·         **End-to-end latency for position estimation of UE (< 100 ms)**

·         **Physical layer latency for position estimation of UE (< X3)**

o   **X3 =[10ms] to be determined, based on higher layer latency consideration.**

o   **Note: X3 may have multiple value for corresponding to different service level.**

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

·         **Horizontal position accuracy (< X4) for 90% of UEs**

o   **X4 = 0.2m, or 0.5m**

·         **Vertical position accuracy (< X5 m) for 90% of UEs**

o   **X5 = 0.2m or 1m**

·         **End-to-end latency for position estimation of UE (< X6)**

o   **X6 = 10ms or 100ms**

·         **Physical layer latency for position estimation of UE (< X7)**

o   **X7 =[10ms] (to be determined based on higher layer latency consideration)**

**FFS: the combination of X1-X7 requirements depend on different use cases and service level to be identified**

**Note1: Target positioning requirements may not necessarily be reached for all scenarios**

**Note2: companies to report values for X1-X7 (alternatively, the service level) when presenting potential enhancement results**

Companies are encouraged to provide their comments in the table below

|  |  |
| --- | --- |
| Company | Comment |
| Qualcomm | For X6,X7 add the note:·         **End-to-end latency for position estimation of UE (< X6)**o   **X6 = 10ms or 100ms**·         **Physical layer latency for position estimation of UE (< X7)**o   **X7 =[10ms] ~~(to be determined based on higher layer latency consideration)~~*** **Note: X6, X7 may have multiple values for corresponding to different service level.**
* **Note: Depending on the End-To-End latency, X7 target may need to be set to a smaller value than [10 ms]**
 |
| CATT | Support FL Proposal 1c in principle to set multiple requirements for accuracy and latency.For X6 (**= 10ms or 100ms**), we prefer to change it as follows, as SID says: *for some IIoT use cases, latency in the order of 10 ms is desired*.·         **End-to-end latency for position estimation of UE (< X6)**o   **X6 = [10ms] or [100ms]** |
| CMCC | Regarding the accuracy, we are basically fine with defining multiple targets to make it use case specific. For clarificaion, I’m wondering that if we do so, do we still need the **Note 1: Target positioning requirements may not necessarily be reached for all scenarios?** For me, this note seems to indicate that only one target performance is defined for all use cases.  |
| Huawei/HiSilicon | Firstly, for X4 and X5, we would like to clarify whether the accuracy is the accuracy of the first fix or it can be the one in the stable tracking period, becuase clearly the accuracy can be different for the two cases. Secondly, regarding the latency, we do not think X3 or X7 will be reflected for different service levels. For X6, we think it is safer to put 10ms in brackets. We would also like to clarify that the latency means TTFF latency, because when we claimed that Rel-16 target in TR 38.855 was TTFF latency in RAN2, we received different views. If so, at least from our side, 10ms TTFF latency cannot be reached based on our evaluations. |
| ZTE | - Propose to revise the note for X7.**X7 =[10ms] (to be determined based on the definition of physical layer latency and higher layer latency consideration)**- Agree with HW, for X6, 10ms should be in bracket. |
| vivo | Same views with Huawei for X6, we also hope to keep 10ms in brackets.For X7 and X3, we agree with QC to remove the content in the blacket(**~~to be determined based on higher layer latency consideration~~**~~)~~ For the FFS **the combination of X1-X7 requirements depend on different use cases and service level to be identified and Noted2**，we think most companies agree with the requirement is independent with the specific use case in the RAN1#101-e. The FFS will make our discussion go back to the previous stage. Furthermore, it is difficult for the summary of the evaluation results, target, and uses cases and may incur more discussion about the target is for which requirement and use case. So we are afraid we cannot accept the FFS and Note 2, and suggest to remove it. |
| Intel | We propose the following changes:**Feature lead Proposal 1c:  In Rel-17 target positioning requirements for commercial use cases are defined as follows:**·         **Horizontal position accuracy (< 1 m) for X1 of UEs**o   **X1 =~~80% or 90%~~ 85 % (as a compromise and to reduce the number of options)**·         **Vertical position accuracy (< 3 m) for [X2] of UEs**o   **X2 =~~80% or 90%~~ 85 % (as a compromise and to reduce the number of options)**·         **End-to-end latency for position estimation of UE (< 100 ms)**·         **Physical layer latency for position estimation of UE (< X3)**o   **~~X3 =[10ms]~~ X3 = 100ms ~~to be determined, based on higher layer latency consideration.~~**o   **Note: X3 may have multiple value for corresponding to different service level.****In Rel-17 target positioning requirements for IIoT use cases are defined as follows:**·         **Horizontal position accuracy (< X4) for 90% of UEs**o   **X4 = 0.2m, or 0.5m**·         **Vertical position accuracy (< X5 m) for 90% of UEs**o   **X5 = 0.2m or 1m**·         **End-to-end latency for position estimation of UE (< X6)**o   **X6 = in order of 10ms, 10ms is used for evaluation ~~10ms or 100ms~~**·         **Physical layer latency for position estimation of UE (< X7)**o   **X7 =[10ms] (to be determined based on higher layer latency consideration)****FFS: the combination of X1-X7 requirements depend on different use cases and service level to be identified****Note1: Target positioning requirements may not necessarily be reached for all scenarios** |
| Fraunhofer | We can limit the combinations already. Based on the above discussions then the main targeted service levels (SLs) are:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **Commercial– SL1** | **Commercial– SL2** | **IIoT - SL1** | **IIoT - SL2** | **IIoT – SL3** |
| **Horizontal position accuracy** | < 1 m for [X1:90%] of UEs | < 1 m for [X1:80%] of UEs | <0.2m(X4) for 90% of UEs | <0.5m(X4) for 90% of UEs | <0.5m(X4) for 90% of UEs |
|  **Vertical position accuracy** | < 3 m for [X2:90%] of UEs | < 3 m for [X2:80%] of UEs | <0.2m(X5) for 90% of UEs | <1m(X5) for 90% of UEs | <1m(X5) for 90% of UEs |
| **End-to-end latency for position estimation** | <100ms | <100ms | <100ms (X6) | <10ms (X6) | <100ms (X6) |
| **Physical layer latency** | X3 [<10ms] | X3 [<10ms] | <10ms (X7) | <10ms (X7) | <10ms (X7) |

* Commercial service levels with X1 can be concluded in this meeting, no real added value from X1.
* SL1 supports high accuracy use cases, SL2 supports low latency IIot use cases and SL3 supports challenging environments (ex. InF-DH).
 |
| LG | We understand the motivation of multiple requirements for accuracy and latency and agree with most of this proposal. There is still one concern about X6. We are currently considering the target requirement ​​less than 10ms for physical layer latency. In our understanding, the end-to-end latency includes the phsical layer latency and RAN1 does not exactly know how much end-to-end latnecy is required at this time. Under the situation, 10ms for end-to-end latency seems too tight and we are not sure it is achievable. So, for X6, 10ms should be in bracket. |
| SONY | * We support to define multiple service levels and it should cover both accuracy and latency requirements.
* Considering we are in the scope of positioning enhancements. We propose to keep X1, X2 = 90%
 |
| Nokia/NSB | We are okay with the proposed update from Intel except the part that says **10ms is used for evaluation** It is a shame that so much time has been wasted on this proposal over two meetings when this proposal still says barely more than the SID already has written and agreed at RAN plenary. We suggest to not spend any valuable online time on this topic and try to converge offline if at all possible.  |
| OPPO | For **X6**: we shall put both values in [ ]. Becasue we just made an agreement last week to send LS to RAN2 to ask for the latency compoenents of higher layer positioning protocols. Without the values of latency of higher layer signalling, how can we decide the values for end-to-end latency.Agreement:Text proposal for LS to RAN WG2 and CC SA WG2 and RAN WG3 for analysis of latency of NR positioning protocols defined in Rel.16:RAN1 evaluates physical layer latency and its potential reduction for NR Rel-17 positioning solutions. In order to evaluate End-To-End latency of NR positioning solutions the input from RAN2 is needed on latency components of NR/NG-RAN/5GC higher layer positioning protocols. RAN1 respectfully asks if RAN2 can provide a list of latency components with corresponding range of values for the existing and any potential enhanced NR positioning solutions, keeping in mind the End-To-End latency described as desired in the study item description (RP-200928) |
| SS | OK with the proposal. One comment for IIoT scenario, the vertical accuracy should be equal or larger than horizontal accuracy requirement so that X4=0.5 and X5=0.2 should be excluded.  |
| Lenovo, Motorola Mobility | Support FL’s restructuring of the proposal into multiple service requirements for better progress. On end-to-end latency for the IIoT use case, support the following rewording:**End-to-end latency for position estimation of UE (< X6)** o   **X6 = in the order of 10ms (to be finalized based on higher layer latency considerations)**o **X7 = [10ms] ~~(to be determined based on higher layer latency consideration)~~**Also fine with QC’s proposed two notes. |
| Ericsson | For the FL proposal 1c: for the accuracy requirements, we’re ok with keeping two possible values, with the understanding that they represent different use cases. For latency, we’re ok keeping them in brackets until this is resolved via the LS to RAN2. For SL definition, we support the proposal given by Fraunhofer, with the understanding that the different X1-X7 values are in bracket and to be finalized.  |

### Update #3

The feature lead proposal 1c is modified into 1d below, based on the feedback. New items are highlighted in yellow. For X3 and X6, there are companies for and against the addition of the additional sentence regarding phy layer latency, so the option capture both until it is converged.

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

**·         Horizontal position accuracy (< 1 m) for X1 of UEs**

**o   X1 =85% ~~80% or 90%~~**

**·         Vertical position accuracy (< 3 m) for [X2] of UEs**

**o   X2 =85% ~~80% or 90%~~**

**·         End-to-end latency for position estimation of UE (< 100 ms)**

**·         Physical layer latency for position estimation of UE (< X3)**

**o   X3 =[10ms] ~~to be determined, based on higher layer latency consideration.~~  OR (to be determined based on the definition of physical layer latency and higher layer latency consideration)**

**o   Note: X3 may have multiple value for corresponding to different service level.**

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

**·         Horizontal position accuracy (< X4) for 90% of UEs**

* + **X4 = 0.2m, or 0.5m**
		- **FFS: accuracy correspond to first fix or it can be the one in the stable tracking period**

**·         Vertical position accuracy (< X5 m) for 90% of UEs**

* + **X5 = 0.2m or 1m**
		- **FFS: accuracy correspond to first fix or it can be the one in the stable tracking period**

**·         End-to-end latency for position estimation of UE (< X6)**

**o   ~~X6 = 10ms or 100ms~~ X6 = [10ms] or [100ms]**

**·         Physical layer latency for position estimation of UE (< X7)**

**o   X7 =[10ms] ~~(to be determined based on higher layer latency consideration)~~  (to be determined based on the definition of physical layer latency and higher layer latency consideration)**

**~~FFS: the combination of X1,X2, [X3], X4,X5 X6, [X7] requirements depend on different use cases and service level to be identified~~**

**~~Note1: Target positioning requirements may not necessarily be reached for all scenarios~~**

**Note1: companies to report values for X1-X7 (alternatively, the service level, if agreed) when presenting potential enhancement results**

**Note2: X6, X7 may have multiple values for corresponding to different service level.**

**Note3: Depending on the End-To-End latency, X7 target may need to be set to a smaller value than [10 ms]**

Companies are encouraged to provide their comments in the table below

|  |  |
| --- | --- |
| Company | Comment |
| CATT | Support FL proposal in principle. A small update: The note in first part(i.e., in the part of commercial use case, the note which related to X3) may be combined with Note2 in the end of the proposal. The updated Note2 is shown as follows,**Note2: X3, X6, X7 may have multiple values for corresponding to different service level.** |
| vivo | For X3 and X7, we suggest aligning the wording as below**X3 =[10ms] or [to be determined based on the definition of physical layer latency and higher layer latency consideration]****X7 =[10ms] or [to be determined based on the definition of physical layer latency and higher layer latency consideration]**For the different service levels, we don’t want to spend too much time to define different service level. We prefer to remove all the notes.  |
| CMCC | It seems to me that the current proposal is going on a totally different path from what we agreed (at least we made common understadning) in the last meeting since companies shared diverse views on some key target performance values. We do show sympathy for the FL to try to make some progress, however, the current proposal causes more confusion to me. If we go this way, according to Note 1 and Note 2, different target performance can be defined for different service level, and it can totally up to different companies, then I’m wondering how do we capture the evaluation results and performance gap? To which target performance we are studying the enhancement for? Suppose that 3 service levels are defined in IIoT use cases. If evaluation results show that SL3 can be achieved, do we respectively identify the performance gap to SL2 and SL1? Then considering a specific enhancement, the improvement can achieve SL2 but not SL1, then do we say the enhancement enough?  |
| Huawei/HiSilicon | Agree with vivo.In addition, we do not think 85% for X1 and X2 is a typical number, and we do not even evulate such a percentile. Slightly preferred 90%. |
| Intel  | Support, except for 100ms for end-to-end latency in the IIoT use case.We would like to clarify whether both or only one value in the brackets should be evaluated. |
| OPPO | First of all, We sympathize the concerns raised by CMCC. The positioning performance requirement shall be a single value, which is the best we can achieve. As in the agreement made in RAN1#101e, the target positioning requirement may not necessarily be reached at all scenario:Agreement:* 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 at least for IIoT use cases
* Note: Modifications to parameters in the InF-DH models will be discussed separately.
* Note: Target performance and performance gap identification will be discussed separately.
* Note: Individual companies may consider additional InF models in TR 38.901 as complementary evaluation scenarios in their simulation investigation and the evaluation results can be considered to be captured in the TR 38.857.
* Note: Target positioning requirements may not necessarily be reached for all scenarios.

 We shall settle down to a single performance requirement. That single perforamnce requirement can be reached in some scenarios, and can not be reached in other scenarios (for example more NLOS). Regarding X1/X2, we share the same view as HW/vivo, 90% is preferred.  |
| Fraunhofer | We would like to have progress here but also would like to understand what do we want to agree on: The proposal in update2 mentions “ during evaluation and in the TR conclusion, we will be able to identify what potential enhancements satisfy what requirements/service level.” Is this is still valid? If yes how? Our perference is to have clear perfomance targets as in Rel-16 (similar to OPPO comment). To recall, we defined 2 performance targets based on the deployment scenario (<3m for indoor and <10m for outdoor). Similarly one can do the same for InF-DH and InF-SH (in 8.5.2 the observations made are mostly based on the InF channel model). From an evaluation perspective, SL1 is probably achievable in InF-SH and SL2 is a challenging target for InF-DH.  |
| Nokia/NSB | Copying our comments from the email thread here: We are not okay with the language around “stable tracking period”. We also have some concern about service level breakdown. I’m sorry to say but honestly I think we are not only trying to rewrite the SID here but in fact going backwards. The SID has clear requirements in our view and the only thing we should need to agree is the percentage of UEs. 85% is okay as a compromise for us. PHY layer latency requirements could also be discussed from our side but trying to agree to this whole new proposal seems quite challenging and with very little benefit.  |

There are companies who support defining grouping of X1-X7 in service levels. Based on the proposals in comments, the following option are given. Note that the values are given in brackets:

**Proposal 1e: for grouping of X1-X7:**

* **Option 1: up each companies to provide the set of X1-X7**
* **Option 2: X1-X7 are grouped in service levels (SLs):**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **Commercial– SL1** | **Commercial– SL2** | **IIoT - SL1** | **IIoT - SL2** | **IIoT – SL3** |
| **Horizontal position accuracy** | < 1 m for [X1:90%] of UEs | < 1 m for [X1:80%] of UEs | <0.2m(X4) for 90% of UEs | <0.5m(X4) for 90% of UEs | <0.5m(X4) for 90% of UEs |
|  **Vertical position accuracy** | < 3 m for [X2:90%] of UEs | < 3 m for [X2:80%] of UEs | <0.2m(X5) for 90% of UEs | <1m(X5) for 90% of UEs | <1m(X5) for 90% of UEs |
| **End-to-end latency for position estimation** | <100ms | <100ms | <100ms (X6) | <10ms (X6) | <100ms (X6) |
| **Physical layer latency** | X3 [<10ms] | X3 [<10ms] | <10ms (X7) | <10ms (X7) | <10ms (X7) |

* **Option 3: FFS other definition of SL**

Companies are encouraged to provide their comments in the table below

|  |  |
| --- | --- |
| Company | Comment |
| CATT | We prefer Option 1. |
| vivo | We prefer not to define grouping of X1-X7 in different service levels. We can understand the intention of this proposal, but we are worried about how to evaluate, identify the gap, and summarize the results in TR if the requirement is different. |
| Huawei/HiSilicon | Option 1. |
| LG | Support option 2. But, the following notes need to be attached.Note1: X3 and X7 may be changed according to the definition of physical layer latency and higher layer latency consideration)Note2: X3, X6, and X7 may have multiple values for corresponding to different service level.  |
| OPPO | Prefer to have single value for X1-X7. As agreed in last meeting:Agreement:* 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 at least for IIoT use cases
* Note: Modifications to parameters in the InF-DH models will be discussed separately.
* Note: Target performance and performance gap identification will be discussed separately.
* Note: Individual companies may consider additional InF models in TR 38.901 as complementary evaluation scenarios in their simulation investigation and the evaluation results can be considered to be captured in the TR 38.857.
* Note: Target positioning requirements may not necessarily be reached for all scenarios.

The target positioning requirement shall be the best we can achieve and it can be reached ONLY in some scenarios, but not necessarily all the scenarios. It does not make sense to specify multiple target requirements. |
| Fraunhofer | Not clear how the results with Option1 can be captured in the TR. Option2 or set values for X1,2,3,4 and 5 (X6 and X7 can have different values) |
| Nokia/NSB | Copying our comments from the email thread here: We are not okay with the language around “stable tracking period”. We also have some concern about service level breakdown. I’m sorry to say but honestly I think we are not only trying to rewrite the SID here but in fact going backwards. The SID has clear requirements in our view and the only thing we should need to agree is the percentage of UEs. 85% is okay as a compromise for us. PHY layer latency requirements could also be discussed from our side but trying to agree to this whole new proposal seems quite challenging and with very little benefit. We don’t support this proposal 1e.  |
| Futurewei | This proposal is so arbitrary, some X are % and some are accuracy in m. Also, dont see why not agreeing to these would hamper progress. Companies would still report their evaluations and the corresponding assumptions. Support Option 1. |

## UE/gNB Rx/Tx calibration error

### Summary and proposal

* 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

|  |  |
| --- | --- |
| 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

|  |  |
| --- | --- |
| 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. |
| ZTE  | Alt1 is preferred. We only need to investigate what extent the timing error will affect positioning accuracy. |
| Qualcomm | OK with Alt. 1. Sending an LS to Ran4, would not result to an answer for at least a year from now. At this stage, it would be a Study in RAN1 where we can sweep a few values and understand the sensitivity.  |
| Intel | We suggest Alt 3., which is combination of Alt1 and Alt2. RAN1 should conduct the study before the next meeting, therefore companies need to agree on the tentative values for X and Y this meeting. Then RAN1 can send the LS to RAN4 and ask for feedback on the proposed tentative values for X and Y. |
| Fraunhofer | The proposal from Intel is a good way forward. |
| OPPO | Alt2 is preferred. However, the proposal from Intel is also acceptable.  |
| CATT v2 | Update our views: both Alt-2 in FL proposal and Alt-3 proposed by Intel are OK for us.Although Alt-2 is preferred, but if RAN1 sends LS to RAN4 at this meeting, RAN4 will discuss and reply at next meeting. For RAN1, the reply LS from RAN4 will be too late to be applied to positioning performance evaluation. Therefore, Alt-3 seems to be a better choice. |
| Ericsson | Alt1. Based on the time constraints of the SI (there is only one meeting left to complete the study), it is unrealistic to involve another WG on the issue. We support leaving X and Y open for companies to report when submitting their evaluation results.  |
| SONY | Support Alt.1 |
| SS | Alt1 |
|  |  |

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

|  |  |
| --- | --- |
| 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. |
| ZTE | Since it’s optional assumption, we don’t need FFS here any more, it’s up to each company to bring their results. |
| QC | Support. To address ZTE’s concern, we are OK to change the FFS to:* *Any additional Time varying aspects of the timing errors, if simulated, can be left up to each company to report.*
 |
| Intel | Independent per UE/gNB per panel to consider worst case performance evaluation. |
| Fraunhofer | Support FL proposal and remove FFS. |
| OPPO | OK |
| SONY | Support Alt.1 |
| SS | Alt1 |
|  |  |

### Update #1 for proposal 2

Based on the comments, it seems there is no consensus on how to proceed with the error variance values. There are 4 companies supporting alt1, 3 companies supporting alt2, and 4 companies supporting a new alt3 proposed by intel. Alt3 seem to be a hybrid solution, but requires RAN1 to agree on values first – something we have not succeeded in during last meeting. The updated proposal contains alt3. In the moderator’s view, if there is no consensus the default solution for the issue is alt1, as companies will have to chose how to simulate anyway, but we hope that a consensus can be reached and that simulation can be performed based on an agreement instead:

Feature lead proposal 2a: 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
* Alt3: companies to agree on the tentative values for X and Y this meeting. RAN1 to send an LS to RAN4 and ask for feedback on the proposed tentative values for X and Y.

Companies are encouraged to provide their comments in the table below

|  |  |
| --- | --- |
| Company | Comment |
| Nokia/NSB | Support Alt 1. At this point in the study we agree with Huawei’s comment above that even if RAN4 input would be ideal it is likely not practical in the time we have. We think Alt 3 is not a good way forward.  |
| CATT | Support Alt3. |
| vivo | For us, a baseline value can help us to evaluate the effect and summarize the conclusion. Maybe a tentative value can be provided and up to companies to decide which values are used in their simulation.So we propose to modify the Alt1 as below* Alt1: The tentative values for X and Y are provided in this meeting, and it is up to companies to provide the values of X and Y used in their simulations
 |
| Intel | Alt3. |
| SONY | Alt.3. RAN4 feedbacks would be beneficial when we make conclusions in the next meeting. |
| Fraunhofer | Alt.3 |

### Update #1 for proposal 3

There seem to be a majority to endorse the proposal (6 companies), while 3 companies do not support the proposal. we propose the following for offline consensus, including the FFS update from QC, highlighted in **red**:

Proposal for offline consensus 3a: Apply the timing errors as follows:

* For each UE drop,
	+ For each panel (in case of multiple panels)
		- Draw a random sample for the Tx error according to [-2\*Y,2\*Y] and another random sample for the Rx error according to the same [-2\*Y,2\*Y] distribution.
* For each gNB
	+ For each panel (in case of multiple panels)
		- Draw a random sample for the Tx error according to [-2\*X,2\*X] and another random sample for the Rx error according to the same [-2\*X,2\*X] distribution.
* Any additional Time varying aspects of the timing errors, if simulated, can be left up to each company to report.
* For UE evaluation assumptions in FR2, it is assumed that the UE can receive or transmit at most from one panel at a time with a panel activation delay of 0ms.

Companies are encouraged to provide their comments in the table below

|  |  |
| --- | --- |
| Company | Comment |
| Nokia/NSB | Okay.  |
| Qualcomm | OK |
| CATT | Support. |
| ZTE | OK. |
| Huawei/HiSilicon | OK |
| vivo | Support in principle We would like to ask the meaning of the last sub-bullet.  |
| Intel | OK |
| LG | Support. |
| OPPO | Clarification is needed: is it up to companies to provided the values of X and Y? |

### Conclusion for UE/gNB Rx/Tx calibration error

The issue is now closed with the following agreement:

|  |
| --- |
| Agreement:Apply the timing errors as follows: * For each UE drop,
	+ For each panel (in case of multiple panels)
		- Draw a random sample for the Tx error according to [-2\*Y,2\*Y] and another random sample for the Rx error according to the same [-2\*Y,2\*Y] distribution.
* For each gNB
	+ For each panel (in case of multiple panels)
		- Draw a random sample for the Tx error according to [-2\*X,2\*X] and another random sample for the Rx error according to the same [-2\*X,2\*X] distribution.
* Any additional Time varying aspects of the timing errors, if simulated, can be left up to each company to report.
* For UE evaluation assumptions in FR2, it is assumed that the UE can receive or transmit at most from one panel at a time with a panel activation delay of 0ms.
 |

## UE mobility

### Summary and proposal

* 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.

|  |  |
| --- | --- |
| source | proposal |
| [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

|  |  |
| --- | --- |
| 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 UEDirection: 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. |
| ZTE | Option 1. We have similar concern as Nokia and LG. |
| Qualcomm | It is preferred to try to nail down something than just going with Option 1. We have a preference to go with Option 2, and if the details are leading to too much debate, we can just say: * **Option X: 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:**
		- **Up to each company**
	+ **Position update rate: the time interval between two position update of a track**
		- **Up to each company**
	+ **Segment starting point: UE dropping procedures applies**
	+ **Orientation :**
		- **Up to each company**
 |
| Intel | Option 1. |
| Fraunhofer | We prefer a modified option2 :* **Modified Option 2:**
	+ **Velocity & acceleration:**
		- **Constant speed 3km/h, zero acceleration.**
	+ **Position update rate: the time interval between two position update of a track**
		- **Up to each companies; range:[1ms-100ms]**
	+ **Segment starting point: UE dropping procedures applies**
	+ **Segment length : [100ms]**
	+ **Position event rate: one position per segment**

Track mode: we prefer option 4 (Antenna assumptions for a change in UE orientation need to be clarified), since the majority prefers Linear track it fine for us as well. To clarify our understanding is that we have a “position update rate” and “position event rate”: The UE positions on a track “position update rate” (in the FL proposal) is related to the UE position on the track; this term is relevant when several measurements may be performed sequentially for One Position Estimate OR for multiple for processing multiple position estimates (ex. Kalman filter processing). The estimated UE position “position event rate” is not necessarily related to the rate the position of the UE on the track is updated (this term is not part of mobility proposal) . A position update rate of 100*ms* is too high for some potential enhancements like phase measurements so it should be kept for companies to decide (or provided as a range of values [1ms-100ms] while the “position event rate” can be agreed on. In our contribution, the “position event rate” is related to the segment.What is still not discussed is the LOS/NLOS channel condition over the track; we see the three options:1. The LOS/NLOS UE-TRP links are maintained over the track
2. The LOS/NLOS conditions are updated  (for example as in [16])
3. Up to each company
 |
| InterDigital | We can combine Option 2, 3 and 4. We can at least agree to support linear and loop model since they are realistic mobility models for moving UEs in factory environments such as AGVs. Companies can provide details assumed for evaluation (e.g., parameters used in Option 4). The velocity of UE should be at 3km/h to maintain consistency among companies’ evaluation results. For simplicity, we can assume constant speed, i.e., no acceleration. As Fraunhofer proposed we can let companies report position update rate and explain justification for the assumed update rate. |
| OPPO | Option 1The details of mobility model can be defined by each company, which can be determined based on each individual use case. Do not see the motivation to define a unfied model. |
| Ericsson | We support Option 1. |
| SONY | Support Option 1 |
| SS | Option1 |
|  |  |

### Update #1 for proposal 4

The majority of companies are either preferring option 1 or 2. The following update is proposed, taking into account the QC way forward for option 2:

**Feature lead proposal 4a:**

**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:**
		- **Up to each company**
	+ **Position update rate: the time interval between two position updates of a track**
		- **Up to each company**
	+ **Segment starting point: UE dropping procedures applies**
	+ **Orientation :**
		- **Up to each company**

Companies are encouraged to provide their comments in the table below

|  |  |
| --- | --- |
| Company | Comment |
| Nokia/NSB | Support option 1. Option 2 still leaves almost everything up to each company so this brings very little value in our view.  |
| Qualcomm | Support Option 2. Even if Option 2 leaves several stuff up to each company; it still nails down that we ll evaluate a linear track. There can be infinite different types of tracks that one could try, so we think it is a progress, given the way discussions are happening. |
| CATT | Support Option 2. |
| ZTE | Option 1. Leave up to each company. |
| Huawei/HiSilicon | Option 2 with the following update.* One of the duplicated “Velocity and acceleration“ should be removed.
* Add another sub-bullet: motion sensor error: Up to each company.
 |
| CATT v2 | We would like to update our views: Support Option 2 and prefer it had better to be updated as follows in **RED**:**Feature lead proposal 4a:****For UE mobility down-select 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: define the optional mobility model as follows,**
	+ **Track mode: linear track with fixed path trajectory**
	+ **Other details are up to each company, e.g. ,**
		- **Orientation of the linear track**
		- **Velocity & acceleration of UE mobility**
		- **Position update rate (the time interval between two position updates of a track)**
 |
| vivo | Whether the Segment starting point is mean that we only drop UE in the Segment starting point and the distance of the segment starting point depends on the Velocity and Position update rate. If yes, we support option 2. |
| Intel | Option 1. |
| Fraunhofer | Propose to remove duplicated terms and define position events (I hope this clarifies the question from Nokia and vivo’s remark): * **Option 2: the mobility model is defined as follows ~~use Track mode: linear track~~**

**~~Velocity & acceleration:~~** **~~Direction: a linear path with a fixed direction.~~** * + **Track mode: linear track with fixed path trajectory and a fixed direction**
	+ **Velocity & acceleration:**
		- **Up to each company**
	+ **Position update rate: the time interval between two position updates of a track**
		- **Up to each company**
	+ **Segment starting point: UE dropping procedures applies**
	+ **Position event rate:**
		- **one position per segment**
	+ **~~Orientation :~~**
		- **~~Up to each company~~**

**A segment comprises one or more successive positions on that track and is defined by the *position update rate* and the *UE velocity/acceleration*.**  |
| LG | We prefer option 1. Details of the optional mobility model are up to each company. |
| SONY | Option 1. |
| InterDigital | We support Option 2. The update from CATT is fine with us. The difference between Option 1 and Option 2 is whehter to allow the system to have apriori knowledge about UE mobility. It is important to have such prior knowledge to improve accuracy for moving UEs. We prefer to have a loop model, but for simplicity, it is ok to limit to a linear track. |
| OPPO | Option 1 |
| SS | Option 1 |
| Fraunhofer\_v2 | As a compromise between Opt1 and Opt2, we propose the following:**For the optional UE-Mobility model a linear track is assumed. Companies shall provide the applied values/assumptions for the following parameters:*** **orientation**
* **velocity and acceleration**
* **position update rate**
* **position event rate**
* **segment starting point**
* **assumptions on spatial consistency and LOS/NLOS conditions on the track**

**Note1: a position update rate is the time interval between two position updates of a track.****Note2: a segment comprises one or more successive positions on that track and is defined by the position update rate and the UE velocity/acceleration and can define the position update rate** |
| Ericsson  | Option 1 |

Based on the feedback, there is an even split between the two options. Since we are pressed with time, it is proposed to leave the mobility model to companies.

**Proposal 4b for offline consensus:**

**Conclusion:For UE mobility, the details of the optional mobility model are left to companies.**

### conclusion for proposal 4

the discussion has reached the following conclusion online and can now be closed:

|  |
| --- |
| Conclusion:For UE mobility, the details of the optional mobility model are left to companies. |

## Latency considerations

### Summary and proposal

* 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.
*

|  |  |
| --- | --- |
| source | proposal |
| [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.
 |
|  |  |

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

|  |  |
| --- | --- |
| 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. |

|  |  |
| --- | --- |
| Qualcomm | We don’t agree with the proposals above. There are several papers with much more detailed (and correct) approach. The simplified approach hides the actual big latency factors (e.g. Measuremnt gap configuration as an example). We can try to agree where the physical layer starts and where it ends.***Alternative Proposal on PHy-layer Latency: For PHY-layer latency analysis consider the time duration between the following time instances:*** * ***Start Time: Transmission of the PDSCH from the gNB that is carrying the location request message***
* ***End Time: Decoding of the PHY-layer PUSCH carrying the UE’s report***

The above includes, all the necessary phy layer aspects: the first PDSCH carrying the location request, UE requesting measurement gap, gNb configuring MG, UE receiving PRS, UE processing PRS, UE transmitting the UL package, gNB decoding the PUSCH package. Note that in the URLLC SI, gNB decoding timeline of PUSCH was also considered, and can be used as starting point. **A Proposal on High layer latency evaluation is also needed, based on the previous discussion.** Agreement:Higher layer positioning latency can be evaluated in this SI.* FFS: how to evaluate higher-layer positioning latency
* FFS: which higher-layers should be included in the evaluation

***Proposal on High layer Latency: For Higher-layer latency analysis consider the time duration between the following processing and signaling delays, when applicable:**** ***Location Request from LMF to AMF***
* ***Location Request from LMF to serving gNB***
* ***Location Information Report from serving gNB to AMF***
* ***Location Information Report from AMF to LMF***
* ***Positioning Derivation/Processing Time in the LMF***
* ***Positioning Report from LMF to AMF***
* ***Positioning Report from AMF to GMLC***
* ***Positioning Report from GMLC to LCS Client***
 |
| Intel | Similar aspects are under discussion in the agenda item 8.5.2, therefore we propose to discuss PHY layer latency definition and its evaluation in another agenda item. |
| Fraunhofer | If detailed latency factors are taken into account then we need to take the UL, DL and UL- DL for UE assisted and UE-based. |
| Lenovo, Motorola Mobility | We also share the wholistic view with other companies that the physical layer latency should at least consider the instance that the PRS is transmitted by the gNB to the instance that the report is received by the gNB provided that UE-assisted/UE-based positioning has been configured.  |
| Ericsson | From the RAN1 perspective, the only part of the latency budget we can influence is the RS duration and number of occasions. In the latency diagram presented by nokia, all other variables such as SR request, pusch transmission for reporting, and processing delays are constants that RAN1 cannot really optimize. So these fixed element of the latency budget should be identified to know the remaining latency left for the RS.Therefore, we propose the following to be identified by RAN1:* Quantify the fixed physical layer delay NR positioning, including PRS processing and the delays in UL reporting.
* Ask RAN2 for the typical higher layer processing delay

Based on latency targets for end to end latency for a given service, derive the physical layer (RS transmission) latency budget as the remaining part of the latency budget once higher layer and fixed physical layer delay budget are removed. |
| SONY | Generally, align with Nokia/NSB view. Physical layer latency shall consider time for the transmission of reference signal (for positioning), processing (measurement) time, and time for the positioning measurement report. |
| SS | The latency in option 1 only consider transmission but not the feedback including measurement/reporting from the UE. |
|  |  |

### Update #1 for proposal 5

Based on the feedback, it is proposed to go forward with defining physical layer latency to include physical signal transmission as well as processing delay and reporting. What remains to be defined is the exact values for delays due to processing at the UE and PUSCH-based reporting. There is one concrete proposal to go forward for DL methods from qualcomm, but as mentioned by e.,g. Fraunhofer, different methods (UL, UL+DL) will have different processing delays. Using Qualcomm’s wording as a starting point, the following is proposed:

**Feature lead proposal 5a:**

**For DL methods, DL PRS Physical layer latency is defined between the following time instants:**

* **Start Time: Transmission of the PDSCH from the gNB that is carrying the location request message**
* **End Time: Decoding of the PHY-layer PUSCH carrying the UE’s report**
* **FFS: breakdown of the latency constants:**
	+ **values for DL PRS processing delay and UL PUSCH reporting relay**
* **FFS latency definition for UL and UL+DL methods**

Companies are encouraged to provide their comments in the table below

|  |  |
| --- | --- |
| Company | Comment |
| Nokia/NSB | We are okay with the proposal. Maybe we can add a note to the last FFS point like: Note: A unified definition between DL, UL, and/or UL+DL methods can be considered. |
| Qualcomm | OK, and OK with the comment from Nokia, what about changing to sth a bit stronger:**Note: Strive to identify a unified definition between DL, UL, and/or UL+DL methods.**  |
| CATT | For the start time, it is clear that PDSCH carrying location request message. But for the end time, the proposal says PUSCH carrying the UE’s report, so it had better to clarify what is the meaning of UE’s report. The UE’s report refers to measurement report, or location information report? It looks like it also is related to UE-based positioning or UE-assistant positioning. |
| ZTE | We agree that we should only focus on the start time and end time of physical layer latency, while the exact components can be discussed in AI 8.5.2, so FFS may not need. |
| Huawei/HiSilicon | We do not think DL positioning should be prioritized over UL, and/or UL+DL.We also would like to clarify the meaning of ”location request message” in the first bullet.Our proposal is copied here from email #2.* The PHY-layer latency for TTFF (time to first fix) in NR Rel-16 Positioning is defined as
	+ For UE measurement for positioning and DL E-CID
		- Starting from the transmission by the gNB MAC entity of the PDSCH conveying the LPP message containing RequestLocationInformation
		- Ending with the successful reception by the gNB MAC entity of the PUSCH conveying the LPP message containing ProvideLocationInformation.
	+ For NG-RAN measurement for positioning
		- Starting from the reception by the TRP of the NRPPa message MEASUREMENT REQUEST
		- Ending with the transmission by the TRP of the NRPPa message MEASUREMENT RESPONSE
	+ For UL E-CID
		- Starting from the reception by the serving gNB of the NRPPa message E-CID MEASUREMENT INITIATION REQUEST
		- Ending with the transmission by the serving gNB of the NRPPa message E-CID MEASUREMENT INITIATION RESPONSE
 |
| vivo | We can’t understand the meaning of **PHY-layer PUSCH,** at least, we suggest removing PHY-layer as below* **End Time: Decoding of the ~~PHY-layer~~ PUSCH carrying the UE’s report**

For the first FFS, we prefer not to list sub-bullets of this FFS as they are not complete aspects identified. |
| Intel | OK for DL UE-assisted methods. |
| LG | We agree with only proposal not FFS. We have three concerns.Firstly, since the details of components are discussed in AI 8.5.2, we suggest to remove for preventing duplicated discussion. Secondly, it is also necessary to clarify the word of “UE’s report“. In our understanding, this UE‘s report means positioning measurement report. The last concern is that the procedure (Decoding of the PHY-layer PUSCH) is only related to UE-assisted positioning, so a separated discription for End-time needs to be considered for UE-based positioning. |
| SONY | OK in principle, we share the same view as NOK |
| InterDigital | We support the proposal and we agree with Nokia to add the note. |
| OPPO | Agree with CATT, we shall differentiate UE-based and UE-assisted. And the current proposal only applied to DL-based UE-assisted method. If it is UL-based UE-assisted method, both start time and end time shall be revised. |
| SS | Should be clarified that it is for DL-based UE-assisted method only.  |
| Lenovo, Motorola Mobility | Support the proposal but a further note is needed to differentiate the definition between UE-assisted and UE-based positioning techniques: **Note: This applies to UE-assisted positioning. FFS the definition for UE-based positioning.** This can have an impact on whether a measurement report is required or not for the physical layer latency analysis |

### Update #2 for proposal 5

Based on the feedback, it is proposed to refocus the proposal to apply only to UE-assisted, DL-based methods. We propose to use Huawei’s proposal as a starting point for other methods

**Feature lead proposal 5b:**

* **For UE assisted DL methods, Physical layer latency for TTFF (time to first fix) is defined between the following time instants:**
	+ **Start Time: Transmission of the PDSCH from the gNB that is carrying the LPP message containing RequestLocationInformation**
	+ **End Time: Successful decoding of the PUSCH carrying the UE’s report (LPP message containing ProvideLocationInformation.)**
* **Note: Strive to identify a unified definition between DL, UL, and/or UL+DL methods.**

**Feature lead proposal 5c:**

* **For DL-ECID, Physical layer latency for TTFF (time to first fix) is defined between the following time instants:**
	+ - **Starting from the transmission by the gNB MAC entity of the PDSCH conveying the LPP message containing RequestLocationInformation**
		- **Ending with the successful reception by the gNB MAC entity of the PUSCH conveying the LPP message containing ProvideLocationInformation.**
* **For UE assisted NG-RAN measurement for positioning (UL methods) Physical layer latency for TTFF (time to first fix) is defined between the following time instants:**
	+ - **Starting from the reception by the TRP of the NRPPa message MEASUREMENT REQUEST**
		- **Ending with the transmission by the TRP of the NRPPa message MEASUREMENT RESPONSE**
* **For UL E-CID**
	+ - **Starting from the reception by the serving gNB of the NRPPa message E-CID MEASUREMENT INITIATION REQUEST**
		- **Ending with the transmission by the serving gNB of the NRPPa message E-CID MEASUREMENT INITIATION RESPONSE**

Companies are encouraged to provide their comments in the table below

|  |  |
| --- | --- |
| Company | Comment |
| vivo | Support in principleHowever, I am confused with the wording of MAC entity in DL ECID, I prefer the wording in Feature lead proposal 5b.And UE-B methods are missing, we prefer to add it as below * **For UE-based methods, Physical layer latency for TTFF (time to first fix) is defined between the following time instants:**
	+ **Start Time: Transmission of the PDSCH from the gNB that is carrying the LPP message containing RequestLocationInformation**
	+ **End Time: Complete the Calculation of Location Estimate at the UE or successful decoding of the PUSCH carrying the UE’s report (LPP message containing ProvideLocationInformation).**
 |
| Huawei/HiSilicon | OK with the current version, except for **UE assisted NG-RAN measurement for positioning,** which should be **NG-RAN measurement for positioning**. (without UE assisted)Also OK to keep the aligned wording for 5c as 5b.**Feature lead proposal 5c:** * **For DL-ECID, Physical layer latency for TTFF (time to first fix) is defined between the following time instants:**
	+ - **Start Time: Transmission of the PDSCH from the gNB that is carrying the LPP message containing RequestLocationInformation**
		- **End Time Successful decoding of the PUSCH by the gNB of the PUSCH carrying the UE’s report (LPP message containing ProvideLocationInformation).**
* **For NG-RAN measurement for positioning (UL methods) Physical layer latency for TTFF (time to first fix) is defined between the following time instants:**
	+ - **Starting from the reception by the TRP of the NRPPa message MEASUREMENT REQUEST**
		- **Ending with the transmission by the TRP of the NRPPa message MEASUREMENT RESPONSE**
* **For UL E-CID**
	+ - **Starting from the reception by the serving gNB of the NRPPa message E-CID MEASUREMENT INITIATION REQUEST**
		- **Ending with the transmission by the serving gNB of the NRPPa message E-CID MEASUREMENT INITIATION RESPONSE**
 |
| Intel  | One of the criteria to define latency is to cover the following scenarios:1. R16 solutions
	1. These are already known and we can possibly use existing signaling to define start and end time for R16 positioning techniques. We will need to do it for the UA-A, UE-B as well as for the cases when location request comes from NW or UE. Certainly that some of the techniques can have identical triggers for start/end time.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | R16 DL-TDOA | R16 DL-AoD | R16 UL-TDOA | R16 UL AoA | R16 Multi-RTT | R16 ECID |
| Start time |  |  |  |  |  |  |
| End time |  |  |  |  |  |  |

1. R17 enhancements
	1. These are undefined yet but latency definition should cover those as well if possible.

In summary, it would be good to have general definition (if we can come up with proper wording to define it). This is one of the reasons I have used abstract terms like source triggering location request and destination awaiting location info, as well as start / end trigger of L1 latency calculation. My understanding that such structure can cover all existing and new scenarios for all types of positioning techniques. |
| LG | In our view, we also would like to add the physical layer latency for UE-based positioning. 1) For the proposal from vivo, we have a question on the second sub-bullet. In the UE-based positioning, we can probabily exclude the UE’s reporting part as follows:* For UE-based methods, Physical layer latency for TTFF (time to first fix) is defined between the following time instants:
	+ Start Time: Transmission of the PDSCH from the gNB that is carrying the LPP message containing RequestLocationInformation
	+ End Time: Complete the Calculation of Location Estimate at the UE

2) We may need to clarify the UL-ECID. In our understanding, UL-ECID was supported in LTE, it was undefined in NR.3) For DL based and UE-assisted positioning, we are not sure that we need to separtely consider the physical layer latency between ECID and other DL based positioning methods.Updated 08/27:Regarding our modified proposal, there was an input for consideration on the reporting of UE’s location/coordianate estimate for the UE-based positioning since it is defined in section 8.12.2.2 of TS 38.305. We understand this, the explicit UE’s location reporting is not defined in Provide Location Information in the current 37.355 for RAT-dependent technique, so we are not sure if the reporting of UE’s location is included in the physical layer procedure. |
| OPPO | What we study here is the **latency in PHY layer**. So we shall focus on the latency caused by phyiscial layer functions. For positioning, the physical layer functions generally only included receiving and measuring DL PRS and transmitting UL SRS. So in in our view, the criteria to define PHY layer latency is to focus on the phy layer function itself, without involving any higher layer signalling start time and end time.For DL signal, the PHY layer latency is the time needed for obtaining the meaurement, RSTD, RSRP or UE Rx-Tx time difference.For UL signal: the phy layer latency is the time needed for the UE to finish transmitting the SRS for positioning. |
| Nokia/NSB | We are confused by the need for the DL-ECID bullet and the UL-ECID bullets. Don’t those fall under DL UE assisted and UE assisted NG-RAN measurement? We are okay with propsoal 5b and the second bullet of 5c.  |
| Qualcomm | There is no need to split the UE-assisted and DL ECID, You can actually see that in the proposals 5b adn 5c, the start and end time are the same! Lets simpify things. **Feature lead proposal 5b:** * **For UE assisted DL methods (and DL-ECID), Physical layer latency for TTFF (time to first fix) is defined between the following time instants:**
	+ **Start Time: Transmission of the PDSCH from the gNB that is carrying the LPP message containing RequestLocationInformation**
	+ **End Time: Successful decoding of the PUSCH carrying the UE’s report (LPP message containing ProvideLocationInformation.)**

Simialrly, for UE assisted and UL ECID, again they can be merged simply as:* **For UE assisted NG-RAN measurement for positioning (UL methods) and UL ECID Physical layer latency for TTFF (time to first fix) is defined between the following time instants:**
	+ - **Start Time: Reception by the TRP of the NRPPa measurement request message**
		- **End Time: The transmission by the TRP of the NRPPa measurement response message**

Maybe, for UL ECID the message has a “ECID” in the naming, but still, we can just simplify here the discussion. Finally for UE-based, no need to really complicate about MO-LR, MT-LR, things can be simple, by using terms like “if applicable”. * **For UE-based methods, Physical layer latency for TTFF (time to first fix) is defined between the following time instants:**
	+ **Start Time: Transmission of the PDSCH from the gNB that is carrying the LPP message RequestLocationInformation if applicable, otherwise,**
		- **Alt. 1: transmission of the PUSCH carrying the MG Request from the UE.**
		- **Alt. 2: Transmission of the PDSCH from the gNB that is carrying the LPP message containing ProvideAssistanceData**
		- **Alt. 3: Reception of the earliest DL PRS**
	+ **End Time: Successful decoding of the PUSCH at gNB that is carrying the LPP message containing ProvideLocationInformation if applicable, otherwise Calculation of Location Estimate at the UE**

In other words, we make the following proposal:**Proposal:** Physical Layer Latency Start and End times are defined as follows:

|  |  |  |
| --- | --- | --- |
| **Method** | **Start** | **End** |
| UE assisted DL-only & DL-ECID | Transmission of the PDSCH from the gNB carrying the LPP Request Location Information message | Successful decoding of the PUSCH carrying the UE’s report |
| UL-only method & UL ECID | Reception by the TRP of the NRPPa measurement request message | The transmission by the TRP of the NRPPa measurement response message |
| UE-based | Transmission of the PDSCH from the gNB carrying the LPP Request Location Information if applicable, otherwise,* Alt. 1: transmission of the PUSCH carrying the MG Request from the UE.
* Alt. 2: Transmission of the PDSCH from the gNB carrying the LPP message containing the assistance data
* Alt. 3: Start of the Reception of DL PRS

Note: Suggest to downselect this meeting, If not, we can leave it up to next meeting. | Successful decoding of the PUSCH at gNB carrying the LPP Provide Location Information message if applicable, otherwise Calculation of Location Estimate at the UE |

 |

### Update #3 for proposal 5

Based on the discussion, there are differing views on what constitutes the physical layer latency. One view is to exclude measurements/protocol messages carried by physical channels. Another view is to include all physical channel activity including RS and PDSCH/PUSCH. To revise the proposal, and Qualcomm provided a new wording encompassing all the methods for positioning. We propose to use this as a starting point for the online discussion.

**Proposal 5f: Physical Layer Latency Start and End times are defined as follows:**

|  |  |  |
| --- | --- | --- |
| **Method** | **Start** | **End** |
| UE assisted DL-only & DL-ECID | Transmission of the PDSCH from the gNB carrying the LPP Request Location Information message | Successful decoding of the PUSCH carrying the UE’s report |
| UL-only method & UL ECID | Reception by the TRP of the NRPPa measurement request message | The transmission by the TRP of the NRPPa measurement response message |
| UE-based | Transmission of the PDSCH from the gNB carrying the LPP Request Location Information if applicable, otherwise,* Alt. 1: transmission of the PUSCH carrying the MG Request from the UE.
* Alt. 2: Transmission of the PDSCH from the gNB carrying the LPP message containing the assistance data
* Alt. 3: Start of the Reception of DL PRS

Note: Suggest to downselect this meeting, If not, we can leave it up to next meeting. | Successful decoding of the PUSCH at gNB carrying the LPP Provide Location Information message if applicable, otherwise Calculation of Location Estimate at the UE |

### Status at the beginning of Friday 28th online discussion:

During the email discussion, the proposed table converged to the following:

**Proposal 5g: Physical Layer Latency Start and End times are defined as follows:**

|  |  |  |
| --- | --- | --- |
| **Method** | **Start** | **End** |
| UE assisted DL-only & DL-ECID & Multi-RTT | Transmission of the PDSCH from the gNB carrying the LPP Request Location Information message | Successful decoding of the PUSCH carrying the UE’s measurement report |
| UL-only method & UL ECID & Multi-RTT | Reception by the gNB of the NRPPa measurement request message | The transmission by the gNB of the NRPPa measurement response message |
| UE-based | Transmission of the PDSCH from the gNB carrying the LPP Request Location Information if applicable, otherwise,·         Alt. 1: transmission of the PUSCH carrying the MG Request from the UE.·         Alt. 2: Transmission of the PDSCH from the gNB carrying the LPP message containing the assistance data·         Alt. 3: Start of the Reception of DL PRSNote: Suggest to downselect this meeting, If not, we can leave it up to next meeting.Note: The high layers latency components may be subject to adjustment for different alternatives. | Successful decoding of the PUSCH at gNB carrying the LPP Provide Location Information message if applicable, otherwise Calculation of Location Estimate at the UE  |

## Power consumption

### Summary and proposal

* 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.

|  |  |
| --- | --- |
| 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. |
| ZTE | Agree with Nokia,CATT and LG. We have agreed that it’s up to each company on how to evaluate the power consumption for positioning. |
| QC | We could be open to vivo’s approach, but we are worried about the time needed to evaluate further these details, and whether this analysis would result into a different set of enhancements compared to a simple model. This is not the same as the Latency Analysis where a more detailed model would show more clearly where the delays are. We believe that for power consumption modelling, one could use a simple model and still make the same observations on what needs to be optimized to get power savings. Having said the above, we woudl be OK to go with vivo’s approach if the group considers it necessary, but we would prefer to understand better for which enhancement such a detailed analysis would be beneficial compared to a simple power modelling.  |
| Intel | Up to each company how to evaluate the power consumption. |
| InterDigital | We can let companies explain the details about analysis. |
| Lenovo, Motorola Mobility | The study of RRC Idle/Inactive positioning is yet to commence making the UE power consumption evaluation details unclear. A common understanding among companies of the power evaluation model and applicable scenarios for current positioning methods is required to make some progress. Rather than choose between Option 1 and Option 2, perhaps an high-level FFS is needed on what scenarios to prioritize, e.g. UL-based, DL-based, UL+DL positioning methods / UE-based vs UE-assisted positioning. |
| OPPO | We have previous agreement on that. It is up to each company on how to evaluate the power consumption for positioning |
| SONY | Similar view as Nokia and CATT |
| SS | Agree with Nokia |
|  |  |

### Update #1 for proposal 6

The majority of companies has expressed no support to either options, and to leave it to each company to evaluate the power consumption. Based on the comments the following update is proposed:

**Feature lead proposal 6a: For power consumption evaluation, it is up to each company to detail their methodology for evaluation.**

Companies are encouraged to provide their comments in the table below

|  |  |
| --- | --- |
| Company | Comment |
| Nokia/NSB | Okay with the message but we don’t think anything is needed to be agreed or concluded. The prior agreement is very clear in our view.  |
| Qualcomm | We prefer to not make the above agreement and still try to see if there is a way to work out a common way to evaluate. If it doesnt pan out, what is shown above would be the default understanding (together with the preivous agreement).  |
| CATT | Support FL proposal to conclude on this issue. |
| ZTE | We had agreement before, so we don’t need another conclusion. |
| vivo | I sincerely hope the power model can be considered in the SI considering the power consumption is our objectives.Otherwise, I wonder how to summarize the evaluation results for device efficiency if it all depends on the company. And I think the quantitative results is better for us to represent the achievement in device efficiency.For the before QC question, we are open to other models and think that the model which can be used to evaluate should be fair for different enhancements. Considering the timeline, we recommend that a rough model can be agreed upon and detailed parameter and details up to each company. The rough model can be as option 2 that we modified and others. |
| Intel | Support FL’s proposal. |
| LG | Support FL proposal. |
| SONY | Support |
| OPPO | SUpport |

### Conclusion for proposal 6

This discussion item has been concluded online with the following conclusion:

|  |
| --- |
| Conclusion:For power consumption evaluation, it is up to each company to detail their methodology (including power model) for evaluation. |

## Network efficiency

### Summary and proposal

* 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. |
| ZTE | Support. Suggest to add “FFS: how to calculate PRS/SRS resource utilization”.In our understanding, PRS resource utilization should may depend on number of frequency layers, PRS periodicity, number of PRS resources within a set, PRS resource repetition number, PRS bandwidth, number of TRP, and the number of occasions used for measurement etc. The same goes for SRS. |
| Qualcomm | It is not only PRS utilization, but also Measurement gaps needed. PRS may be 3 msec long, but a MG may be 6 msec.  |
| Intel | The PRS/SRS resource utilization can be considered as a metric; however, we need to define other assumptions, including the number of users, traffic characteristics of the positioning requests, etc.Considering these aspects are not provided by the current evaluation methodology, we do not see a strong motivation to define such metric. As an option, we could consider a simplified single user scenario for evaluation. |
| Fraunhofer | The Tx antenna configuration (wide and narrow beam) defines the Network efficiency as well. |
| Lenovo, Motorola Mobility | Support. |
| OPPO | The efficiency of beam sweeping operation shall be considered in network efficiency too. Multiple DL PRS resources in one set are used to support beam sweeping. How to generate he Tx beams, wide beam or narrow beam, number of beams, covering the whole cell area, all those factors have impact on how much resources are used for positioning.Measurement gap shall also be considered too. |
| Sony | We think it is not only PRS/SRS resource utilization. We should also consider the PRS/SRS resource utilization from different TRP. |
| SS | Support but definition of PRS resource utilization should be clarified.  |
|  |  |

### Update #1 for proposal 7

Based on the feedback, it is proposed to go forward with resource utilization as the metric for network efficiency. Companies are encouraged to resolve the FFS defining resource utilization.

**Feature lead proposal 7a Network efficiency is defined with PRS/SRS resource utilization**

* FFS: what is included in resource utilization

Companies are encouraged to provide their comments in the table below

|  |  |
| --- | --- |
| Company | Comment |
| Nokia/NSB | Support.  |
| Qualcomm | The fact that MG need to be considered is not included and was pointed out by a couple of companies. One could argue that the „FFS“ could be understood that it may include MG-related considerations. Is there a way to add this, (together with other aspects brought up by other companies) in the FFS bullet? Example:* **FFS: what is included in resource utilization, e.g. PRS/SRS/MG configurations, beam sweeping assumptions**
 |
| CATT | We support FL proposal in principle, and suggest to change it as follows,**Updated proposal 7a: Network efficiency should be evaluated at least with the metric of DL-PRS/SRS-Pos resource utilization.*** FFS: How to define DL-PRS/SRS-Pos resource utilization.
 |
| ZTE | Agree with CATT. |
| Huawei/HiSilicon | Regarding Qualcomm’s comment:It is unclear why MG is listed here. MG may have UE experience data rate drop, but from network perspective, one UE conducting measurement does not prevent gNB from scheduling other UEs. |
| vivo | SupportWe think MG is a UE-Specific configuration, it belongs to devise efficiency other than network efficiency.For R16 PRS，it is a cell-specific signal and independent with UE. Maybe no relationship with the number of users. For SRS, I agree with intel, the number of users should be considered. And the network efficiency of SRS can not be calculated if only consider a single user. |
| Intel | We are not clear when FFSs in the proposal is planned to be resolved. The next meeting for SI is the last one and companies need to provide evaluations for the network efficiency. Therefore, we would like to reiterate our previous proposal. |
| Fraunhofer | Agree with the clarification for FFS from Qualcomm  |
| LG | We are OK. But, CATT’s proposal looks better. |
| SONY | The updated version does not help much. CATT’s proposal is better. |
| OPPO | QC’s suggested wording is better |
| SS | Support and prefer CATT’s wording |
| Lenovo, Motorola Mobility | Support CATT’s wording for the Proposal 7a. The FFS can be modified to include QC’s examples: **FFS: How to define DL-PRS/SRS-Pos resource utilization, e.g. based on PRS/SRS/MG configurations, beam sweeping assumptions** |

### Update #2 for proposal 7

Basd on the feedback, the following update to proposal 7 is given. Please note that whether we include MGs, RS configurations, etc in the definition is to be resolved in the FFS:

**Feature lead proposal 7b Network efficiency is defined with PRS/SRS resource utilization**

**• FFS: what is included in resource utilization, e.g. PRS/SRS/MG configurations, beam sweeping assumptions**

### Conclusion for proposal 7

The discussion is has reached the following online agreement and is now closed:

|  |
| --- |
| Agreement:PRS/SRS resource utilization is the metric used to evaluate network efficiency* FFS: what is included in resource utilization, e.g. PRS/SRS/MG configurations, beam sweeping assumptions
 |

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

### Summary and proposal

* 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. |
| ZTE | We think the excess delay modelling is necessary, otherwise we don’t find the motivation to evaluate IOO,UMi and Uma since we have done this in Rel-16 SI phase. And also the modeling should be different for indoor and outdoor scenarios. As explained in our contribution, we prefer to have another option,Option 4: The NLOS excess delay can be scaled according to ISD value based on the baseline assumptions for different scenarios,

|  |  |  |  |
| --- | --- | --- | --- |
| Scenarios | UMi | UMa | IOO |
|  |  | -6.9 | -6.5 | -7.5 |
|  | 1.0 | 1.4 | 0.4 |

 |
| Qualcomm | We are OK with either Option 2 or 3. We think it would be constructive to add some of such scenarios in the TR, and going with Option 1 would not be good for Rel-17 Positioning. We can have in the TR results with both appraoches: baseline without the DeltaTau, and optional results with the Deltatau included.  |
| Intel  | Option 1. |
| CATT v2 | Clarify our views: we only support Option 3 for IOO scenario.The reason is the same as we explained in above. IOO is a kind of indoor scenario similar with InF scenario. For UMi and UMa scenarios, need further study to determine the modelling for absolute delay of arrival. |
| Fraunhofer | Support Option 1 |
| OPPO | Option 1 |
| Ericsson | Support option 3. Regarding the applicability of he values for UMi, field studies have shown similar excess delays betwen UMi, IOO and Inf, as quoted in our contribution from RAN1#101 (R1-2004650). In response to ZTE, the proposed value seem to give unreasonable excess delay well beyond the cell size.

|  |  |  |  |
| --- | --- | --- | --- |
| Scenarios | UMi | UMa | IOO |
|  |  | -6.9 | -6.5 | -7.5 |
|  | 1.0 | 1.4 | 0.4 |
|  |  |  |  |  |
| Mean delay [s] | 1.8E-06 | 5.7E-05 | 4.8E-08 |
| Mean delay \* c [m] | 535.07 | 17125.95 | 14.50 |
| Median delay [s] | 1.3E-07 | 3.2E-07 | 3.2E-08 |
| Median delay \* c [m] | 37.77 | 94.87 | 9.49 |

Note that the following was agreed at ran1#101:Agreement:Absolute-time-of arrival model defined in TR 38.901 without modification is considered in the evaluation of all scenarios. |
| SONY | We think that it is important to model the absolute time of arrival for UMa, UMi, IOO. However, since NLOS excess delay parameters have been defined yet for these scenarios, we suggest to reuse NLOS excess delay parameters from InF, i.e., Option 3. For future studies, companies are encouraged to share realistic NLOS excess delay values for UMa, UMi, IOO based on measurements. |
| SS | Option 1 |
| ZTE2 | To Ericsson, UMi and UMa are for outdoor scenarios,why we have cell size here?We can go for Option3, at least NLOS excess delay should be included. |

### Update #1 for proposal 8

Since there is no consensus on the issue, it is proposed to focus on option 2, i.e. leave it to companies to provide their assumption with respect to absolute time of arrival modelling .

**Feature lead proposal 8a. for the absolute time of arrival modelling in IOO, UMa, Umi, companies may provide the details of their model, if any.**

Companies are encouraged to provide their comments in the table below

|  |  |
| --- | --- |
| Company | Comment |
| CATT | To be honest, we prefer that RAN1 can achieve consensus on modelling of absolute time of arrival at least for IOO scenario. If most of companies don’t want it, we are also fine with the FL proposal. |
| vivo | Agree with CATT |
| Intel | We do not see additional motivation and learning that can be acquired from this evaluation. |

### Conclusion for proposal 8

The discussion has reached the following agreement online and can be closed:

|  |
| --- |
| Agreement:For the absolute time of arrival modelling in IOO, UMa, Umi, companies may provide the details of their model, if any |

## 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. |
| ZTE | Option 1. |
| Intel | Option 1. |
| Fraunhofer | Option 1 |
| OPPO  | Option 1 |
| SONY | Support Option 1 |
| SS | Option 2 since we do see the need for define a new gNB height on the roof since it is pragmatic deployment. |

### Conclusion for proposal 9

Based on the feedback, the following offline consensus is proposed:

Proposal for offline consensus: **conclusion: RAN1 will not define additional optional values for UE and gNB antenna heights for evaluations.**

This discussion item is now closed with the following conclusion captured online:

|  |
| --- |
| Conclusion:RAN1 will not define additional optional values for UE and gNB antenna heights for evaluations. |

## Futher details on 4-panel UE model

### Summary and proposal

* 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. |
| ZTE | Support Option 1. |
| Qualcomm | OK to go with Option 1 |
| Intel | Option 1. |
| Fraunhofer | Support Option 3.  |
| OPPO | Option 1 |
| SONY | We prefer Option 3. We believe it is most representative of the handsets in the market, for FR2. |
| SS | Option 1 |

### Conclusion and offline consensus

Based on the feedback, the following offline consensus is proposed:

Proposal for offline consensus: **conclusion: Do not define additional details for the optional UE antenna configuration of 4 UE panels.**

This discussion item has been close online with the following conclusion

|  |
| --- |
| Conclusion:RAN1 will not define additional details for the optional UE antenna configuration of 4 UE panels for evaluations. |

##  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  |
| Intel  | Each company is welcome to provide additional analysis on top of the agreed baseline configuration settings.  |

### 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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6. R1-2005577, Remaining Issues on Scenarios for Evaluation of NR Positioning, Sony
7. R1-2005710, Remaining issues on additional scenarios for evaluation of NR Positioning Enhancements, CATT
8. R1-2005877, Remaining details on additional scenarios for NR positioning evaluations, Intel Corporation
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16. R1-2006458, Additional scenarios for evaluation, Fraunhofer IIS, Fraunhofer HHI
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18. R1-2006914, Remaining details on additional scenarios for evaluation, Ericsson