**3GPP TSG RAN WG1 Meeting #102-E R1-2007359**

**e-Meeting, August 17th – 28th, 2020**

**Source: Intel Corporation**

**Title: Template for collection of NR positioning evaluation results**

**Agenda item: 8.5.2**

**Document for: Discussion and Decision**

# 1 Introduction

In this contribution, we propose template for collection of NR positioning evaluation results from different companies. The motivation to develop this template is to have unified structure for collection of results, simplify integration of the results in the 3GPP TR that is expected to be finalized at the next meeting and facilitate analysis of results and preparation of conclusions based on submitted results.

# 2 Template for Collection of Evaluation Results

In this section of contribution, we provide example of template that we propose for collection of NR positioning evaluation results from different companies. Companies are encouraged to use it when providing results for the Section 8 of the 3GPP TR [38.857](https://www.3gpp.org/DynaReport/38857.htm) and follow the style and structure of the template. It is up to each company to decide which specific performance analysis to fill in: accuracy, latency, network and UE efficiency.

**--------------------------------------- Start of template for collection of NR positioning results --------------------------------**

# 8 Performance evaluations for R17 performance targets

## 8.1 Performance analysis of Rel-16 positioning solutions

Including accuracy and latency (objective 1b) performance, compared to rel17 performance targets

### 8.1.1 Positioning accuracy analysis

#### 8.1.1.1 Results from source [X]

Accuracy and latency analysis provided by Source X

##### 8.1.1.1.1 Description of evaluation scenarios

Brief description of evaluation scenarios and key parameters of evaluation

It is recommended to put the following information into the table for each evaluated case

* Case ID: Case counter, starts from 1
* Scenario: InF-SH, InF-DH, ….
* Frequency Band: FR1 or FR2
* Positioning Technique: - e.g. name of R.16 positioning technique (R.16 DL-TDOA, R.16 UL-TDOA, R.16 Multi-RTT, R.16 DL-AOD, R.16 UL-AOA, etc. or their combination)

Table 8.1.1.1.1-1: Rel.16 NR positioning - evaluation scenarios and parameters

|  |  |  |  |
| --- | --- | --- | --- |
| Parameter | [Case ID], [Scenario], [Frequency Band], [Technique] | [Case ID], [Scenario], [Frequency Band], [Technique] | [Case ID], [Scenario], [Frequency Band], [Technique] |
| Channel model (baseline, otherwise state any modifications) |  |  |  |
| Carrier frequency |  |  |  |
| Subcarrier spacing |  |  |  |
| Reference Signal Transmission Bandwidth |  |  |  |
| Reference Signal Physical Structure and Resource Allocation (RE pattern) (reference to figure in contribution) |  |  |  |
| Reference signal  (type of sequence, number of ports, …) |  |  |  |
| Number of sites |  |  |  |
| Number of symbols used per occasion |  |  |  |
| number of occasions used per positioning estimate |  |  |  |
| Power-boosting level |  |  |  |
| Uplink power control (applied/not applied) |  |  |  |
| interference modelling (ideal muting, or other) |  |  |  |
| Description of Measurement Algorithm (e.g. super resolution, interference cancellation, ….) |  |  |  |
| Description of positioning technique / applied positioning algorithm (e.g. Least square, Taylor series, etc) |  |  |  |
| Network synchronization assumptions |  |  |  |
| UE/gNB Tx/Rx  Calibration Error |  |  |  |
| Beam-related assumption (beam sweeping / alignment assumptions at the tx and rx sides) |  |  |  |
| Precoding assumptions (codebook, nrof antenna elements used, etc) |  |  |  |
| Additional notes, if any |  |  |  |

##### 8.1.1.1.2 Positioning accuracy evaluation results

Table 8.1.1.1.2-1: Rel.16 NR positioning - horizontal location error results from [X]

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  |  | 50% | 67% | 80% | 90% |
| [Case ID], [Scenario], [Frequency Band], [Technique] | Convex UEs |  |  |  |  |
| (Optional) All UEs |  |  |  |  |
| [Case ID], [Scenario], [Frequency Band], [Technique] | Convex UEs |  |  |  |  |
| (Optional) All UEs |  |  |  |  |

Table 8.1.1.1.2-2: Rel.16 NR positioning - altitude location error results from [X]

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  |  | 50% | 67% | 80% | 90% |
| [Case ID], [Scenario], [Frequency Band], [Technique] | Convex UEs |  |  |  |  |
| (Optional) All UEs |  |  |  |  |
| [Case ID], [Scenario], [Frequency Band], [Technique] | Convex UEs |  |  |  |  |
| (Optional) All UEs |  |  |  |  |

Companies are welcome to provide results in the form of CDF. It is recommended to limit figure scale X- axis [0 : 0.2 : 5]m or less and Y-axis [0 : 0.1 : 1]

Legends of lines recommended to be marked by tags: [Case ID], [Scenario], [Frequency Band], [Technique]

##### 8.1.1.1.3 Observations on Rel-16 NR positioning accuracy

Table 8.1.1.1.3-1: Rel.16 NR positioning – horizontal accuracy performance summary [X]

|  |  |  |  |
| --- | --- | --- | --- |
| Simulation case  (Horizontal Error) | Commercial horizontal accuracy requirements [1]m @[90]% are met - Yes/No.  If no, provide performance gaps | IIoT horizontal accuracy requirements of [0.2]m @[90]%are met - Yes/No. If no, provide performance gaps | IIoT horizontal accuracy requirements of [0.5]m @[90]%are met -Yes/No.  If no, provide performance gaps |
| [Case ID], [Scenario], [Frequency Band], [Technique] |  |  |  |
| [Case ID], [Scenario], [Frequency Band], [Technique] |  |  |  |

Table 8.1.1.1.3-2: Rel.16 NR positioning – vertical accuracy performance summary [X]

|  |  |  |  |
| --- | --- | --- | --- |
| Simulation case  (Vertical Error) | Commercial vertical accuracy requirements [3]m @[90]% are met - Yes/No.  If no, provide performance gaps | IIoT vertical accuracy requirements of [0.2]m @[90]% are met - Yes/No. If no, provide performance gaps | IIoT vertical accuracy requirements of [1]m at @[90]% are met - Yes/No.  If no, provide performance gaps |
| [Case ID], [Scenario], [Frequency Band], [Technique] |  |  |  |
| [Case ID], [Scenario], [Frequency Band], [Technique] |  |  |  |

### 8.1.2 Physical layer latency analysis for Rel-16

#### 8.1.1.2 Results from source [X]

Latency analysis provided by Source X

At least the following information is provided for positioning physical layer latency analysis:

* Source initiating request for positioning measurements/location for a given UE (UE, Network))
* Destination awaiting for positioning measurements/location for a given UE (UE, Network)
* Start and end triggers/events for physical layer latency evaluation
* Initial and final RRC States of positioned UE (RRC IDLE, INACTIVE, CONNECTED) at the start and end time for the physical layer latency evaluation
* Positioning
  + technique (enumeration): (1) DL-TDOA , (2) DL AOD, (3) UL-TDOA, (4) UL-AOA, (5) Multi-RTT, (6) E-CID
  + type: DL, UL, DL+UL
  + mode: UE-based, UE-assisted
* Latency component w/ value range and description, including information on any parallel (simultaneous) components
* Total latency value

Latency components are recommended to be captured in table and ordered consequently in time starting from the earliest one

Table 8.1.1.2-1: Rel.16 NR positioning latency [X]

|  |  |  |
| --- | --- | --- |
| [Case ID], [Scenario], [Frequency Band], [Technique]  Source [UE, NW]/Destination [UE, NW]  Positioning technique [DL-TDOA, E-CID, …], type [DL, UL, DL+UL], mode [UE-A, UE-B],  Initial and Final RRC States [IDLE, INACTVE, CONNECTED] | | |
| Latency Components | Value Range, ms | Description of Latency Component |
| Start trigger |  |  |
| Name of component 1 |  |  |
| Name of component 2 |  |  |
|  |  |  |
| Name of last component |  |  |
| End trigger |  |  |
| Total values |  |  |

##### 8.1.1.2.1 Latency analysis for Rel.16 solutions

Table 8.1.1.2.1-1: NR positioning enhancements - accuracy performance summary [X]

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Description  Evaluation Case | L1 Latency, ms | Commercial requirements [100]ms are met -Yes/No - If no, provide performance gaps | IIoT requirements of [10ms] are met - Yes/No.  If no, provide performance gaps | IIoT requirements of [100]ms are met - Yes/No. If no, provide performance gaps |
| [Case ID], [Scenario], [Frequency Band], [Technique] |  |  |  |  |
| [Case ID], [Scenario], [Frequency Band], [Technique] |  |  |  |  |

## 8.2 Performance of studied NR positioning enhancements

Including performance of positioning techniques, DL/UL positioning reference signals, signalling and procedures for improved accuracy, reduced latency, network efficiency, and device efficiency ((objective 1c).

### 8.2.1 Positioning accuracy analysis for NR positioning enhancements

#### 8.2.1.1 Results from source [X]

##### 8.2.1.1.1 Description of evaluation scenarios

Brief description of evaluation scenarios and key parameters of evaluation. section

It is recommended to put the following information into the table

* Case ID: Case counter, Case ID should increment from previous section
* Scenario: InF-SH, InF-DH,…
* Frequency Band: FR1, FR2
* Positioning Technique: - e.g. R.17 enhanced positioning technique (naming up to companies)

Table 8.2.1.1.1-1: NR positioning enhancements - evaluation scenarios and parameters

|  |  |  |  |
| --- | --- | --- | --- |
| Parameter | [Case ID], [Scenario], [Frequency Band], [Technique] | [Case ID], [Scenario], [Frequency Band], [Technique] | [Case ID], [Scenario], [Frequency Band], [Technique] |
| Channel model (baseline, otherwise state any modifications) |  |  |  |
| Carrier frequency |  |  |  |
| Subcarrier spacing |  |  |  |
| Reference Signal Transmission Bandwidth |  |  |  |
| Reference Signal Physical Structure and Resource Allocation (RE pattern) (reference to figure in contribution) |  |  |  |
| Reference signal  (type of sequence, number of ports, …) |  |  |  |
| Number of sites |  |  |  |
| Number of symbols used per occasion |  |  |  |
| number of occasions used per positioning estimate |  |  |  |
| Power-boosting level |  |  |  |
| Uplink power control (applied/not applied) |  |  |  |
| interference modelling (ideal muting, or other) |  |  |  |
| Description of Measurement Algorithm (e.g. super resolution, interference cancellation, ….) |  |  |  |
| Description of positioning technique / applied positioning algorithm (e.g. Least square, Taylor series, etc) |  |  |  |
| Network synchronization assumptions |  |  |  |
| UE/gNB Tx/Rx  Calibration Error |  |  |  |
| Beam-related assumption (beam sweeping / alignment assumptions at the tx and rx sides) |  |  |  |
| Precoding assumptions (codebook, nrof antenna elements used, etc) |  |  |  |
| Evaluated Enhancement  for Rel.17 |  |  |  |
| Additional notes, if any |  |  |  |

##### 8.2.1.1.2 Positioning accuracy evaluation results for NR positioning enhancements

Table 8.2.1.1.2-1: NR positioning enhancements - horizontal location error results from [X]

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  |  | 50% | 67% | 80% | 90% |
| [Case ID], [Scenario], [Frequency Band], [Technique] | Convex UEs |  |  |  |  |
| (Optional) All UEs |  |  |  |  |
| [Case ID], [Scenario], [Frequency Band], [Technique] | Convex UEs |  |  |  |  |
| (Optional) All UEs |  |  |  |  |

Table 8.2.1.1.2-2: NR positioning enhancements - altitude location error results from [X]

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  |  | 50% | 67% | 80% | 90% |
| [Case ID], [Scenario], [Frequency Band], [Technique] | Convex UEs |  |  |  |  |
| (Optional) All UEs |  |  |  |  |
| [Case ID], [Scenario], [Frequency Band], [Technique] | Convex UEs |  |  |  |  |
| (Optional) All UEs |  |  |  |  |

Companies are welcome to provide results in the form of CDF.

It is recommended to limit figure scale X- axis [0 : 0.2 : 5]m or less and Y-axis [0 : 0.1 : 1].

Legends of lines recommended to be marked by tags: [Case ID], [Scenario], [Frequency Band], [Technique]

##### 8.2.1.1.3 Observations on NR positioning enhancements

Table 8.2.1.1.3-1: NR positioning enhancements – horizontal accuracy performance summary [X]

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Simulation case  (Horizontal Error) | Gain vs Rel.16 solution, @[90%], [m] | Commercial horizontal accuracy requirements [1]m @[90]% are met - Yes/No.  If no, provide performance gaps | IIoT horizontal accuracy requirements of [0.2]m @[90]%are met - Yes/No. If no, provide performance gaps | IIoT horizontal accuracy requirements of [0.5]m @[90]%are met -Yes/No.  If no, provide performance gaps |
| [Case ID], [Scenario], [Frequency Band], [Technique] |  |  |  |  |
| [Case ID], [Scenario], [Frequency Band], [Technique] |  |  |  |  |

Table 8.2.1.1.3-2: NR positioning enhancements – vertical accuracy performance summary [X]

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Simulation case  (Vertical Error) | Gain vs Rel16 solution @[90]% | Commercial vertical accuracy requirements [3]m @[90]% are met - Yes/No.  If no, provide performance gaps | IIoT vertical accuracy requirements of [0.2]m @[90]% are met - Yes/No. If no, provide performance gaps | IIoT vertical accuracy requirements of [1]m at @[90]% are met - Yes/No.  If no, provide performance gaps |
| [Case ID], [Scenario], [Frequency Band], [Technique] |  |  |  |  |
| [Case ID], [Scenario], [Frequency Band], [Technique] |  |  |  |  |

### 8.2.2 Physical layer latency analysis for NR positioning enhancements

#### 8.2.2.1 Results from source [X]

##### 8.2.2.1.1 Description of evaluation scenarios

Brief description of evaluation scenarios and key parameters of evaluation. section

##### 8.2.2.1.2 Latency analysis of NR positioning enhancements

Companies are invited to briefly describe enhancement comparing to R.16

At least the following information is provided for positioning physical layer latency analysis:

* Source initiating request for positioning measurements/location for a given UE (UE, Network)
* Destination awaiting for positioning measurements/location for a given UE (UE, Network)
* Start and end triggers/events for physical layer latency evaluation
* Initial and final RRC States of positioned UE (RRC IDLE, INACTIVE, CONNECTED) at the start and end time for the physical layer latency evaluation
* Positioning technique and enhancements
* Latency component w/ value range and description, including information on any parallel (simultaneous) components
* Total latency value

Latency components are ordered consequently in time starting from the earliest one

Table 8.2.2.1.2-1: NR positioning enhancements – latency analysis [X]

|  |  |  |
| --- | --- | --- |
| [Case ID], [Scenario], [Frequency Band], [Technique]  Source [UE, NW] / Destination [UE, NW]  Positioning technique [DL-TDOA, E-CID, …], type [DL, UL, DL+UL], mode [UE-A, UE-B],  Initial and Final RRC States [IDLE, INACTVE, CONNECTED] | | |
| Latency Component | Value Range, ms | Description of Latency Component |
| Start trigger |  |  |
| Name of component 1 |  |  |
| Name of component 2 |  |  |
|  |  |  |
| Name of last component |  |  |
| End trigger |  |  |
| Total values |  |  |

##### 8.2.2.1.3 Observations on NR positioning latency enhancements

Table 8.2.2.1.3-1: NR positioning enhancements - physical layer latency performance summary [X]

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Description  Evaluation Case | L1 Latency,ms | Gain over R16, ms | Commercial requirements [100]ms are met  Yes/No.  If no, provide performance gaps | IIoT requirements of [10]ms are met  Yes/No.  If no, provide performance gaps | IIoT requirements of [100]ms are met  Yes/No.  If no, provide performance gaps |
| [Case ID], [Scenario], [Frequency Band], [Technique] |  |  |  |  |  |
| [Case ID], [Scenario], [Frequency Band], [Technique] |  |  |  |  |  |

### 8.2.3 Network efficiency analysis for NR positioning enhancements

#### 8.2.3.1 Results from source [X]

##### 8.2.3.1.1 Description of evaluation scenarios

Brief description of evaluation scenarios and key parameters of evaluation. section

##### 8.2.3.1.2 Network efficiency analysis of NR positioning enhancements

Companies are invited to briefly describe enhancement comparing to R.16.

Companies are invited to describe the methodology/model of network efficiency analysis.

##### 8.2.3.1.3 Observations on network efficiency of NR positioning enhancements

Companies are invited to present the observations/results based on their evaluation/analysis of network efficiency for NR positioning enhancements.

### 8.2.4 UE efficiency analysis for NR positioning enhancements

#### 8.2.4.1 Results from source [X]

##### 8.2.4.1.1 Description of evaluation scenarios

Brief description of evaluation scenarios and key parameters of evaluation. section

##### 8.2.4.1.2 UE efficiency analysis of NR positioning enhancements

Companies are invited to briefly describe enhancement comparing to R.16.

Companies are invited to describe the methodology/model of UE efficiency analysis.

##### 8.2.4.1.3 Observations on UE efficiency of NR positioning enhancements

Companies are invited to present the observations/results based on their evaluation/analysis of UE efficiency for NR positioning enhancements.

**--------------------------------------- End of template for collection of NR positioning results ---------------------------------**

# Conclusion

In this contribution, we have provided template for collection of NR positioning evaluation results. Our proposal is to review and agree on template for preparation of evaluation results towards the next meeting.