# 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 Source X – Positioning accuracy and latency analysis

Accuracy and latency analysis provided by Source X

#### 8.1.1.1 Positioning accuracy analysis

##### 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].

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

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

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Simulation case | Location type | Commercial requirements are met Yes/No | IIoT requirements of 0.2m are met  Yes/No | IIoT requirements of 0.5m are mete Yes/No |
| [Case ID], [Scenario], [Frequency Band], [Technique] | Horizontal |  |  |  |
| Vertical |  |  |  |
| [Case ID], [Scenario], [Frequency Band], [Technique] | Horizontal |  |  |  |
| Vertical |  |  |  |

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

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

* Source of positioning request (UE, Network)
* Destination of positioning measurements or data (UE, Network)
* Start and end triggers/events for physical layer latency evaluation
* Initial and final RRC State of positioned UE (RRC IDLE, INACTIVE, CONNECTED)
* Positioning technique (DL-TDOA, Multi-RTT, etc.), 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 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 RRC State [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 |  |  |

##### 8.2.1.1.3 Observations on Rel.16 latency

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

|  |  |  |  |
| --- | --- | --- | --- |
| Description  Evaluation Case | L1 Latency | Commercial requirements are met Yes/No | IIoT requirements of 10ms are met  Yes/No |
| [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 Source X – Positioning accuracy and latency analysis for NR positioning enhancements

Accuracy and latency analysis provided by Source X

#### 8.2.1.1 Positioning accuracy analysis for NR positioning enhancements

##### 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].

##### 8.2.1.1.3 Observations on NR positioning enhancements

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

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Simulation case | Location type | Commercial requirements are met Yes/No | IIoT requirements of 0.2m are met  Yes/No | IIoT requirements of 0.5m are met  Yes/No |
| [Case ID], [Scenario], [Frequency Band], [Technique] | Horizontal |  |  |  |
| Vertical |  |  |  |
| [Case ID], [Scenario], [Frequency Band], [Technique] | Horizontal |  |  |  |
| Vertical |  |  |  |

#### 8.2.1.2 Physical layer latency analysis for 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 of positioning request (UE, Network)
* Destination of positioning measurements or data (UE, Network)
* Start and end triggers/events for physical layer latency evaluation
* Initial and final RRC State of positioned UE (RRC IDLE, INACTIVE, CONNECTED)
* Positioning technique (DL-TDOA, Multi-RTT, etc.), 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 ordered consequently in time starting from the earliest one

Table 8.2.1.2-1: 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 RRC State [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 |  |  |

##### 8.2.1.1.3 Observations on NR positioning latency enhancements

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

|  |  |  |  |
| --- | --- | --- | --- |
| Description  Evaluation Case | L1 Latency | Commercial requirements are met  Yes/No | IIoT requirements of 10ms are met  Yes/No |
| [Case ID], [Scenario], [Frequency Band], [Technique] |  |  |  |
| [Case ID], [Scenario], [Frequency Band], [Technique] |  |  |  |