# 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. If no, provide performance gaps | IIoT requirements of 0.2m are met  Yes/No. If no, provide performance gaps | IIoT requirements of 0.5m are met Yes/No. If no, provide performance gaps |
| [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 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 State of positioned UE (RRC IDLE, INACTIVE, CONNECTED) at the start and end time for the physical layer latency evaluation
  + For Rel.16 UE assisted solutions, it is applicable for UEs in RRC CONNECTED state only
* 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 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. If no, provide performance gaps | IIoT requirements of 10ms 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 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

##### 8.2.1.2.1 Description of evaluation scenarios

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

##### 8.2.1.2.2 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 State 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 8.2.1.2.2-1: 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 |  |  |

##### 8.2.1.2.3 Observations on NR positioning latency enhancements

Table 8.2.1.2.3-1: 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] |  |  |  |

#### 8.2.1.3 Network efficiency analysis for NR positioning enhancements

##### 8.2.1.3.1 Description of evaluation scenarios

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

##### 8.2.1.3.2 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.

##### 8.2.1.3.3 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.

#### 8.2.1.4 UE efficiency analysis for NR positioning enhancements

##### 8.2.1.4.1 Description of evaluation scenarios

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

##### 8.2.1.4.2 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.

##### 8.2.1.4.3 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.