

# On Network-verified UE location for NR NTN

Agenda Item:

9.3.2.7

Source:

Intel Corporation

Document for:

Discussion

# Introduction

- The following objective is captured in Rel-18 NR NTN WID [RP-222654]

## 4.1.3 Network verified UE location

Pending on the conclusion of the RAN SI FS\_NR\_NTN\_netw\_verif\_UE\_loc study item, study and evaluate, if needed, solutions for network to verify UE reported location information [RAN2,RAN1,RAN3].

RAN is expected to determine by RAN#98 whether the study has identified any need for Network verified UE location specification support in Rel-18.

# Solutions for NTN network-verified UE location

## Multi-RTT

- The following conclusion was made on RAN1#111 meeting on multi-RTT

**Conclusion:**

For network verification of UE location in NR NTN with single satellite in view with multi-RTT positioning:

- From RAN1 perspective, if the UE's Rx-Tx time difference measurements report can be assumed to be trusted, multi-RTT positioning method using Rx-Tx time difference measurements can meet the accuracy requirement of less than 10km with 90% confidence, in case of:
  - At least LEO600 based deployment
  - Earth fixed cells
  - Earth moving cell at least if UE dwell time within the cell is enough to perform at least two RTT measurements
- Note: the required over-the-air latency reported in evaluations ranged from less than 10s up to 180s

- Based on the conclusion from RAN1, Multi-RTT can be used to meet the positioning accuracy requirement. Hence, it should be adopted for NTN network-verified UE location.

# Solutions for NTN network-verified UE location

## DL-TDOA

- The following conclusion was made on RAN1#111 meeting on DL-TDOA

### Conclusion

For network verification of UE location in NR NTN with single satellite in view with DL-TDOA positioning:  
From RAN1 perspective, if the UE's RSTD measurements report can be assumed to be trusted, DL-TDOA positioning method can meet the accuracy requirement of less than 10km with 90% confidence, in case of:

- At least LEO600 based deployment
- Earth fixed cells
- Earth moving cell at least if UE dwell time within the cell is enough to perform at least two RSTD measurements

Note 1: the above is based on evaluation results that didn't account for UE Clock drift

Note 2: the required over-the-air latency reported in evaluations ranged from less than 20s up to 180s

Note 3: The requirements of Network verification of UE location may not be met if realistic assumption on UE clock drift is considered.

- It is not clear from the RAN1 conclusion if DL-TDOA method can be used to meet the positioning accuracy requirement in realistic scenario with UE clock drift. Other than that, DL-TDOA can be considered for NTN network-verified UE location.

# Solutions for NTN network-verified UE location

## UL-TDOA

- There is no conclusion in RAN1 on UL-TDOA solution for NTN network-verified UE location
- The following observation was made on RAN1#111 meeting on UL-TDOA

### Observation

For network verified UE location based on UL-TDOA positioning method with single satellite:

Two companies commented on the suitability of the method: Assuming the ambiguity of the mirror image position is resolved and if the measurements needed to perform UL-TDOA can be assumed to be trusted:

- One source observed that UL-TDOA cannot meet the target requirement for both earth fixed beam and earth moving beam. With 180s latency, positioning error performance that can be achieved is 34 km, CDF=90% and 13km, CDF=80%.
  - o This source reported that the timing measurement error of SRS can be smaller than 26.7ns with 95% probability under 30 degree elevation angle for LEO-600 set-1, rural LOS S-band scenario.
- One source observed that the geometry of UE location relative to the satellite orbit will impact the positioning performance in UL-TDOA method e.g. for UE's location at 200km away from the orbital plane, the NTN UE location verification accuracy requirement can be met and the positioning error of UL-TDOA method can be smaller than 10 km with 95% probability (for UE's location at 200km away from the orbital plane) and a latency of 220 seconds in case of LEO600km and 342 seconds in case of LEO1200km. For UE located under the satellite orbit, NTN UE location verification accuracy requirement can be met only with 30% probability.

- UL-TDOA can be considered for NTN network-verified UE location.

# Network verified UE location specification support

- The following proposal is made considering the RAN1 input discussed above

## *Proposal:*

- *Specify multi-RTT positioning technology for network verification of UE location in NR NTN with single satellite in view*
- *Either specify (both DL-TDOA and UL-TDOA) or (neither DL-TDOA nor UL-TDOA) as they are based on the same technology principle but different direction of DL/UL:*
  - *Both DL-TDOA and UL-TDOA positioning technologies can be considered as solutions for NR NTN network-verified UE location with single satellite in view, or*
  - *Neither DL-TDOA nor UL-TDOA positioning technologies can be considered as solutions for NR NTN network-verified UE location with single satellite in view*

# Potential enhancements for network verified UE location

- The following enhancements can be considered as potential enhancements for NR NTN network verified UE location
  - Assistance data to be transferred from gNB to the LMF and from UE to the LMF
    - E.g. satellite ephemeris, serving satellite beam information, UE beam information, etc.
  - Definition of UE RX-TX time difference measurements for Multi-RTT
  - (If agreed to be introduced) Definition of RSTD measurements/reporting for DL-TDOA
  - (If agreed to be introduced) Fixed TA for SRS transmission for UL-TDOA

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