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**Agenda item:** 8.11.2

**Source:** Intel Corporation

**Title:** Summary of latency results

**Document for:**  Discussion and decision

# Introduction

This is to summarize the call flow and corresponding latency results for each positioning methods (DL-TDOA, DL AoD, UL-TDoA, UL-AoA, Multi-RTT, DL NR E-CID, UL NR E-CID).

Note: DL-TDOA and DL AoD are handled together in the same call flow and same table, and UL-TDoA and UL-AoA are also handled together in the same call flow and same table.

# Summary

## Latency components and values used for evaluation

During the email discussion [R2-2009001], latency assumptions for different processing stages and nodes were derived. These latencies include processing delays of the various involved nodes (UE, gNB, AMF, LMF) and signalling delays between nodes.

Table 1 below summarizes the latency assumptions for the various components, as proposed in [R2-2009001].

Table 1: Latency Components

|  |  |  |
| --- | --- | --- |
| Label | Latency  [ms] | Description |
| Processing Latencies | | |
| TUEProc-RRCReconf | 10 | RRC Reconfiguration processing |
| TUEProc-RRCDLInfo | 5 | RRC DL information transfer |
| TUEProc-RRCULInfo | 2-5 | RRC UL information transfer |
| TUEProc-RRCLocationMeas | 2-5 | RRC Location Measurement Indication |
| TUEProc-LPPCapab | 10-20 | LPP Provide Capabilities |
| TUEProc-LPPAssi | 10 | LPP Provide Assistance Data |
| TUEProc-LPPLocationRe | 5 | LPP Request/Provide Location Information |
| TUEProc-MAC-SRSAct | 1-3 | MAC-CE SRS Activation/Deactivation |
| TgNBProc-RRC | 3 | RRC Processing |
| TgNBProc-NRPPa | 3 | NRPPa Processing |
| TgNBProc-NAS/LPP | 3 | NAS/LPP Processing |
| TAMFProc | 3 | AMF Processing |
| TLMFProc | 3 | LMF Processing |
| Signalling Propagation Delays between Nodes | | |
| TUE-gNB | 0-0.5 |  |
| TgNB-AMF | 3-10 |  |
| TAMF-LMF | 1-10 |  |
| TAMF-GMLC | 3-10 |  |
| Positioning Measurement Latencies | | |
| TLMF-Calc | 2-30 | Position Calculation latency |
| TDL-Meas | Wait for RAN1 | PHY DL-PRS measurement time; best possible case |
| TUL-Meas | Wait for RAN1 | PHY UL-PRS measurement time; assume the same value as for DL-PRS. |

## Call flow and latency analysis for DL-TDOA/DL-AoD

The figure 1 is used for latency analysis for DL-TDOA and DL-AoD.



Figure 1 procedure for DL-TDOA/DL-AoD

Table 2 summarizes the latency for UE assisted DL-TDOA and DL-AoD.

Table 2: Latency for UE assisted DL-TDOA and DL-AoD

|  |  |  |
| --- | --- | --- |
| **Positioning technique [DL-TDOA/DL-AoD, mode [UE-A] Figure 1** | | |
| **Latency Component** | **Value Range (ms)** | **Description of Latency Component** |
| Step 1 LPP Request capabilities | 18-34 | TLMFProc+ TAMF-LMF+ TAMFProc +TgNB-AMF + TgNBProc-NAS/LPP +TUE-gNB+ TUEProc-RRCDLInfo  Processing delays: 14ms  - UE: TUEProc-RRCDLInfo= 5ms  - gNB: TgNBProc-NAS/LPP= 3ms  - AMF: TAMFProc= 3ms  - LMF: TLMFProc= 3ms  Signalling delay:4-20.5ms  - UE-gNB: TUE-gNB= 0-0.5ms  - gNB-AMF: TgNB-AMF= 3-10ms  - AMF-LMF: TAMF-LMF= 1-10ms  Note 1: the LPP capability processing delay is counted together in response message. |
| Step 2 LPP Provide Capabilities | 25-54.5 | TLMFProc+ TAMF-LMF+ TAMFProc +TgNB-AMF + TgNBProc-NAS/LPP +TUE-gNB+  TUEProc-RRCULInfo+ TUEProc-LPPCapab  Processing delays: 21-34ms  - UE:  TUEProc-RRCULInfo= 2-5ms  TUEProc-LPPCapab= 10-20ms  - gNB: TgNBProc-NAS/LPP= 3ms  - AMF: TAMFProc= 3ms  - LMF: TLMFProc= 3ms  Signalling delay:4-20.5ms  - UE-gNB: TUE-gNB= 0-0.5ms  - gNB-AMF: TgNB-AMF= 3-10ms  - AMF-LMF: TAMF-LMF= 1-10ms |
| Step 3 LPP Provide Assistance Data | 28-44.5 | TLMFProc+ TAMF-LMF+ TAMFProc +TgNB-AMF + TgNBProc-NAS/LPP +TUE-gNB+  TUEProc-RRCDLInfo+ TUEProc-LPPAssi  Processing delays: 24ms  - UE:  TUEProc-RRCDLInfo= 5ms  TUEProc-LPPAssi= 10ms  - gNB: TgNBProc-NAS/LPP= 3ms  - AMF: TAMFProc= 3ms  - LMF: TLMFProc= 3ms  Signalling delay:4-20.5ms  - UE-gNB: TUE-gNB= 0-0.5ms  - gNB-AMF: TgNB-AMF= 3-10ms  - AMF-LMF: TAMF-LMF= 1-10ms |
| Step 4 LPP Request Location Information | 23-39.5 | TLMFProc+ TAMF-LMF+ TAMFProc +TgNB-AMF + TgNBProc-NAS/LPP +TUE-gNB+  TUEProc-RRCDLInfo+ TUEProc-LPPLocationRe  Processing delays: 19ms  - UE:  TUEProc-RRCDLInfo= 5ms  TUEProc-LPPLocationRe = 5ms  - gNB: TgNBProc-NAS/LPP= 3ms  - AMF: TAMFProc= 3ms  - LMF: TLMFProc= 3ms  Signalling delay:4-20.5ms  - UE-gNB: TUE-gNB= 0-0.5ms  - gNB-AMF: TgNB-AMF= 3-10ms  - AMF-LMF: TAMF-LMF= 1-10ms |
| Step 5 RRC Location Measurement Indication | 5-8.5 | TUEProc-RRCLocationMeas + TUE-gNB+ TgNBProc-RRC  Processing delays: 5-8ms  - UE:  TUEProc-RRCLocationMeas = 2-5ms  - gNB: TgNBProc-RRC= 3ms  Signalling delay:0-0.5ms  - UE-gNB: TUE-gNB= 0-0.5ms |
| Step 6 RRC Measurement Gap configuration | 13-13.5 | TgNBProc-RRC+ TUE-gNB+ TUEProc-RRCReconf  Processing delays: 13ms  - UE:  TUEProc-RRCReconf = 10ms  - gNB: TgNBProc-RRC= 3ms  Signalling delay:0-0.5ms  - UE-gNB: TUE-gNB= 0-0.5ms |
| Step 7 DL PRS measurement | **TDL-Meas** | RAN1 inputs |
| Step 8 LPP Provide Location Information | 20-39.5 | TLMFProc+ TAMF-LMF+ TAMFProc +TgNB-AMF + TgNBProc-NAS/LPP +TUE-gNB+  TUEProc-RRCULInfo+ TUEProc-LPPLocationRe  Processing delays: 16-19ms  - UE:  TUEProc-RRCULInfo= 2-5ms  TUEProc-LPPLocationRe= 5ms  - gNB: TgNBProc-NAS/LPP= 3ms  - AMF: TAMFProc= 3ms  - LMF: TLMFProc= 3ms  Signalling delay:4-20.5ms  - UE-gNB: TUE-gNB= 0-0.5ms  - gNB-AMF: TgNB-AMF= 3-10ms  - AMF-LMF: TAMF-LMF= 1-10ms |
| Step 9 LMF calculation | 2-30 | TLMF-Calc |
| Total values | 134-264 | Note 2: **TDL-Meas** is not counted. |

For both UE based and UE assisted positioning methods, the best case could be:

- Capability procedure (e.g. step 1-2 in figure 1) can be skipped if the network already knows the UE capability;

- Assistance procedure (e.g. step 3 in figure 1) can be skipped if the UE already obtains the assistance data;

- Measurement gap (e.g. step 5-6 in figure ) can be skipped if no additional gap request is needed;

## Call flow and latency analysis for UL-TDOA/UL-AoA

The figure 2 is used for latency analysis for UL-TDOA and UL-AoA.



Figure 2 procedure for UL-TDOA and UL-AoA

Table 3 summarizes the latency for UE assisted UL-TDOA and UL-AoA.

Table 3: Latency for UE assisted UL-TDOA and UL-AoA

|  |  |  |
| --- | --- | --- |
| **Positioning technique [UL-TDOA/UL-AoA, mode [UE-A] Figure 2** | | |
| **Latency Component** | **Value Range (ms)** | **Description of Latency Component** |
| Step 1 LPP Request capabilities | 18-34 | TLMFProc+ TAMF-LMF+ TAMFProc +TgNB-AMF + TgNBProc-NAS/LPP +TUE-gNB+ TUEProc-RRCDLInfo  Processing delays: 14ms  - UE: TUEProc-RRCDLInfo= 5ms  - gNB: TgNBProc-NAS/LPP= 3ms  - AMF: TAMFProc= 3ms  - LMF: TLMFProc= 3ms  Signalling delay:4-20.5ms  - UE-gNB: TUE-gNB= 0-0.5ms  - gNB-AMF: TgNB-AMF= 3-10ms  - AMF-LMF: TAMF-LMF= 1-10ms  Note: the LPP capability processing delay is counted together in response message. |
| Step 2 LPP Provide Capabilities | 25-54.5 | TLMFProc+ TAMF-LMF+ TAMFProc +TgNB-AMF + TgNBProc-NAS/LPP +TUE-gNB+  TUEProc-RRCULInfo+ TUEProc-LPPCapab  Processing delays: 21-34ms  - UE:  TUEProc-RRCULInfo= 2-5ms  TUEProc-LPPCapab= 10-20ms  - gNB: TgNBProc-NAS/LPP= 3ms  - AMF: TAMFProc= 3ms  - LMF: TLMFProc= 3ms  Signalling delay:4-20.5ms  - UE-gNB: TUE-gNB= 0-0.5ms  - gNB-AMF: TgNB-AMF= 3-10ms  - AMF-LMF: TAMF-LMF= 1-10ms |
| Step 3 NRPPa POSITIONING INFORMATION REQUEST | 13-29 | TLMFProc+ TAMF-LMF+ TAMFProc +TgNB-AMF + TgNBProc-NRPPa  Processing delays: 9 ms  - gNB: TgNBProc-NRPPa= 3ms  - AMF: TAMFProc= 3ms  - LMF: TLMFProc= 3ms  Signalling delay:4-20ms  - gNB-AMF: TgNB-AMF= 3-10ms  - AMF-LMF: TAMF-LMF= 1-10ms |
| Step 4 RRC SRS configuration | 13-13.5 | TgNBProc-RRC+ TUE-gNB+ TUEProc-RRCReconf  Processing delays: 13ms  - UE:  TUEProc-RRCReconf = 10ms  - gNB: TgNBProc-RRC= 3ms  Signalling delay:0-0.5ms  - UE-gNB: TUE-gNB= 0-0.5ms |
| Step 5 NRPPa POSITIONING INFORMATION RESPONSE | 13-29 | TLMFProc+ TAMF-LMF+ TAMFProc +TgNB-AMF + TgNBProc-NRPPa  Processing delays: 9 ms  - gNB: TgNBProc-NRPPa= 3ms  - AMF: TAMFProc= 3ms  - LMF: TLMFProc= 3ms  Signalling delay:4-20ms  - gNB-AMF: TgNB-AMF= 3-10ms  - AMF-LMF: TAMF-LMF= 1-10ms |
| Step 6 NRPPa Request UE SRS activation | 13-29 | TLMFProc+ TAMF-LMF+ TAMFProc +TgNB-AMF + TgNBProc-NRPPa  Processing delays: 9 ms  - gNB: TgNBProc-NRPPa= 3ms  - AMF: TAMFProc= 3ms  - LMF: TLMFProc= 3ms  Signalling delay:4-20ms  - gNB-AMF: TgNB-AMF= 3-10ms  - AMF-LMF: TAMF-LMF= 1-10ms |
| Step 7 MAC Activate UE SRS transmission | 1-3.5 | TUE-gNB +TUEProc-MAC-SRSAct  Processing delays: 13ms  - UE:  TUEProc-MAC-SRSAct = 1-3ms  Signalling delay:0-0.5ms  - UE-gNB: TUE-gNB= 0-0.5ms |
| Step 8 NRPPa Request UE SRS activate Response | 13-29 | TLMFProc+ TAMF-LMF+ TAMFProc +TgNB-AMF + TgNBProc-NRPPa  Processing delays: 9 ms  - gNB: TgNBProc-NRPPa= 3ms  - AMF: TAMFProc= 3ms  - LMF: TLMFProc= 3ms  Signalling delay:4-20ms  - gNB-AMF: TgNB-AMF= 3-10ms  - AMF-LMF: TAMF-LMF= 1-10ms |
| Step 9 NRPPa MEASUREMENT REQUEST | 13-29 | TLMFProc+ TAMF-LMF+ TAMFProc +TgNB-AMF + TgNBProc-NRPPa  Processing delays: 9 ms  - gNB: TgNBProc-NRPPa= 3ms  - AMF: TAMFProc= 3ms  - LMF: TLMFProc= 3ms  Signalling delay:4-20ms  - gNB-AMF: TgNB-AMF= 3-10ms  - AMF-LMF: TAMF-LMF= 1-10ms |
| Step 10 UL SRS measurement | TUL-measc | RAN1 inputs |
| Step 11 NRPPa MEASUREMENT RESPONSE | 13-29 | TLMFProc+ TAMF-LMF+ TAMFProc +TgNB-AMF + TgNBProc-NRPPa  Processing delays: 9 ms  - gNB: TgNBProc-NRPPa= 3ms  - AMF: TAMFProc= 3ms  - LMF: TLMFProc= 3ms  Signalling delay:4-20ms  - gNB-AMF: TgNB-AMF= 3-10ms  - AMF-LMF: TAMF-LMF= 1-10ms |
| Step 12 LMF calculation | 2-30 | TLMF-Calc  LMF calculation/estimation delay: 2-30  TLMF-Calc |
| Total values | 137-309.5 | Note 1: TUL-measc is not counted; |

## Call flow and latency analysis for Multi-RTT

The figure 3 is used for latency analysis for Multi-RTT.



Figure 3 procedure for Multi-RTT

Table 4 summarizes the latency for UE assisted Multi-RTT.

Table 4: Latency for UE assisted Multi-RTT

|  |  |  |
| --- | --- | --- |
| **Positioning technique [Multi-RTT] [UE-A] Figure 3** | | |
| **Latency Component** | **Value Range (ms)** | **Description of Latency Component** |
| Step 1 LPP Request capabilities | 18-34 | TLMFProc+ TAMF-LMF+ TAMFProc +TgNB-AMF + TgNBProc-NAS/LPP +TUE-gNB+ TUEProc-RRCDLInfo  Processing delays: 14ms  - UE: TUEProc-RRCDLInfo= 5ms  - gNB: TgNBProc-NAS/LPP= 3ms  - AMF: TAMFProc= 3ms  - LMF: TLMFProc= 3ms  Signalling delay:4-20.5ms  - UE-gNB: TUE-gNB= 0-0.5ms  - gNB-AMF: TgNB-AMF= 3-10ms  - AMF-LMF: TAMF-LMF= 1-10ms  Note 1: the LPP capability processing delay is counted together in response message. |
| Step 2 LPP Provide Capabilities | 25-54.5 | TLMFProc+ TAMF-LMF+ TAMFProc +TgNB-AMF + TgNBProc-NAS/LPP +TUE-gNB+  TUEProc-RRCULInfo+ TUEProc-LPPCapab  Processing delays: 21-34ms  - UE:  TUEProc-RRCULInfo= 2-5ms  TUEProc-LPPCapab= 10-20ms  - gNB: TgNBProc-NAS/LPP= 3ms  - AMF: TAMFProc= 3ms  - LMF: TLMFProc= 3ms  Signalling delay:4-20.5ms  - UE-gNB: TUE-gNB= 0-0.5ms  - gNB-AMF: TgNB-AMF= 3-10ms  - AMF-LMF: TAMF-LMF= 1-10ms |
| Step 3 NRPPa POSITIONING INFORMATION REQUEST | 13-29 | TLMFProc+ TAMF-LMF+ TAMFProc +TgNB-AMF + TgNBProc-NRPPa  Processing delays: 9 ms  - gNB: TgNBProc-NRPPa= 3ms  - AMF: TAMFProc= 3ms  - LMF: TLMFProc= 3ms  Signalling delay:4-20ms  - gNB-AMF: TgNB-AMF= 3-10ms  - AMF-LMF: TAMF-LMF= 1-10ms |
| Step 4 RRC SRS configuration | 13-13.5 | TgNBProc-RRC+ TUE-gNB+ TUEProc-RRCReconf  Processing delays: 13ms  - UE:  TUEProc-RRCReconf = 10ms  - gNB: TgNBProc-RRC= 3ms  Signalling delay:0-0.5ms  - UE-gNB: TUE-gNB= 0-0.5ms |
| Step 5 NRPPa POSITIONING INFORMATION RESPONSE | 13-29 | TLMFProc+ TAMF-LMF+ TAMFProc +TgNB-AMF + TgNBProc-NRPPa  Processing delays: 9 ms  - gNB: TgNBProc-NRPPa= 3ms  - AMF: TAMFProc= 3ms  - LMF: TLMFProc= 3ms  Signalling delay:4-20ms  - gNB-AMF: TgNB-AMF= 3-10ms  - AMF-LMF: TAMF-LMF= 1-10ms |
| Step 6 NRPPa Request UE SRS activation | 13-29 | TLMFProc+ TAMF-LMF+ TAMFProc +TgNB-AMF + TgNBProc-NRPPa  Processing delays: 9 ms  - gNB: TgNBProc-NRPPa= 3ms  - AMF: TAMFProc= 3ms  - LMF: TLMFProc= 3ms  Signalling delay:4-20ms  - gNB-AMF: TgNB-AMF= 3-10ms  - AMF-LMF: TAMF-LMF= 1-10ms |
| Step 7 MAC Activate UE SRS transmission | 1-3.5 | TUE-gNB +TUEProc-MAC-SRSAct  Processing delays: 13ms  - UE:  TUEProc-MAC-SRSAct = 1-3ms  Signalling delay:0-0.5ms  - UE-gNB: TUE-gNB= 0-0.5ms |
| Step 8 NRPPa Request UE SRS activate Response | 13-29 | TLMFProc+ TAMF-LMF+ TAMFProc +TgNB-AMF + TgNBProc-NRPPa  Processing delays: 9 ms  - gNB: TgNBProc-NRPPa= 3ms  - AMF: TAMFProc= 3ms  - LMF: TLMFProc= 3ms  Signalling delay:4-20ms  - gNB-AMF: TgNB-AMF= 3-10ms  - AMF-LMF: TAMF-LMF= 1-10ms |
| Step 9 NRPPa MEASUREMENT REQUEST | 13-29 | TLMFProc+ TAMF-LMF+ TAMFProc +TgNB-AMF + TgNBProc-NRPPa  Processing delays: 9 ms  - gNB: TgNBProc-NRPPa= 3ms  - AMF: TAMFProc= 3ms  - LMF: TLMFProc= 3ms  Signalling delay:4-20ms  - gNB-AMF: TgNB-AMF= 3-10ms  - AMF-LMF: TAMF-LMF= 1-10ms |
| Step 10 LPP Provide Assistance Data | 28-44.5 | TLMFProc+ TAMF-LMF+ TAMFProc +TgNB-AMF + TgNBProc-NAS/LPP +TUE-gNB+  TUEProc-RRCDLInfo+ TUEProc-LPPAssi  Processing delays: 24ms  - UE:  TUEProc-RRCDLInfo= 5ms  TUEProc-LPPAssi= 10ms  - gNB: TgNBProc-NAS/LPP= 3ms  - AMF: TAMFProc= 3ms  - LMF: TLMFProc= 3ms  Signalling delay:4-20.5ms  - UE-gNB: TUE-gNB= 0-0.5ms  - gNB-AMF: TgNB-AMF= 3-10ms  - AMF-LMF: TAMF-LMF= 1-10ms |
| Step 11 LPP Request Location Information | 23-39.5 | TLMFProc+ TAMF-LMF+ TAMFProc +TgNB-AMF + TgNBProc-NAS/LPP +TUE-gNB+  TUEProc-RRCDLInfo+ TUEProc-LPPLocationRe  Processing delays: 19ms  - UE:  TUEProc-RRCDLInfo= 5ms  TUEProc-LPPLocationRe = 5ms  - gNB: TgNBProc-NAS/LPP= 3ms  - AMF: TAMFProc= 3ms  - LMF: TLMFProc= 3ms  Signalling delay:4-20.5ms  - UE-gNB: TUE-gNB= 0-0.5ms  - gNB-AMF: TgNB-AMF= 3-10ms  - AMF-LMF: TAMF-LMF= 1-10ms |
| Step 12 RRC Location Measurement Indication | 5-8.5 | TUEProc-RRCLocationMeas + TUE-gNB+ TgNBProc-RRC  Processing delays: 5-8ms  - UE:  TUEProc-RRCLocationMeas = 2-5ms  - gNB: TgNBProc-RRC= 3ms  Signalling delay:0-0.5ms  - UE-gNB: TUE-gNB= 0-0.5ms |
| Step 13 RRC Measurement Gap configuration | 13-13.5 | TgNBProc-RRC+ TUE-gNB+ TUEProc-RRCReconf  Processing delays: 13ms  - UE:  TUEProc-RRCReconf = 10ms  - gNB: TgNBProc-RRC= 3ms  Signalling delay:0-0.5ms  - UE-gNB: TUE-gNB= 0-0.5ms |
| Step 14 a DL PRS measurement | TDL-measc | RAN1 inputs |
| Step 14 b UL SRS measurement | TUL-measc | RAN1 inputs |
| Step 15 LPP Provide Location Information | 20-39.5 | TLMFProc+ TAMF-LMF+ TAMFProc +TgNB-AMF + TgNBProc-NAS/LPP +TUE-gNB+  TUEProc-RRCULInfo+ TUEProc-LPPLocationRe  Processing delays: 16-19ms  - UE:  TUEProc-RRCULInfo= 2-5ms  TUEProc-LPPLocationRe= 5ms  - gNB: TgNBProc-NAS/LPP= 3ms  - AMF: TAMFProc= 3ms  - LMF: TLMFProc= 3ms  Signalling delay:4-20.5ms  - UE-gNB: TUE-gNB= 0-0.5ms  - gNB-AMF: TgNB-AMF= 3-10ms  - AMF-LMF: TAMF-LMF= 1-10ms |
| Step 16 NRPPa MEASUREMENT RESPONSE | 13-29 | TLMFProc+ TAMF-LMF+ TAMFProc +TgNB-AMF + TgNBProc-NRPPa  Processing delays: 9 ms  - gNB: TgNBProc-NRPPa= 3ms  - AMF: TAMFProc= 3ms  - LMF: TLMFProc= 3ms  Signalling delay:4-20ms  - gNB-AMF: TgNB-AMF= 3-10ms  - AMF-LMF: TAMF-LMF= 1-10ms |
| Step 17 LMF calculation | 2-30 | TLMF-Calc  LMF calculation/estimation delay: 2-30  TLMF-Calc |
| Total values | 246-455 | Note 2: TDL-measc and TUL-measc are not counted;  Note 3: DL PRS related procedure may be performed in parallel with UL SRS related procedure, and therefore we may only need to count the latency caused by DL PRS related procedure, i.e. the latency for Multi-RTT could be similar to the latency of DL-TDOA/DL-AoD |

## Call flow and latency analysis for NR E-CID

The figure 4-1 is used for latency analysis for NR Downlink E-CID



Figure 4-1 procedure for NR Downlink E-CID

Table 5 summarizes the latency for UE assisted NR Downlink E-CID.

Table 5: Latency for UE assisted NR Downlink E-CID

|  |  |  |
| --- | --- | --- |
| **Positioning technique [NR Downlink E-CID] [UE-A] Figure 4-1** | | |
| **Latency Component** | **Value Range (ms)** | **Description of Latency Component** |
| Step 1 LPP Request capabilities | 18-34 | TLMFProc+ TAMF-LMF+ TAMFProc +TgNB-AMF + TgNBProc-NAS/LPP +TUE-gNB+ TUEProc-RRCDLInfo  Processing delays: 14ms  - UE: TUEProc-RRCDLInfo= 5ms  - gNB: TgNBProc-NAS/LPP= 3ms  - AMF: TAMFProc= 3ms  - LMF: TLMFProc= 3ms  Signalling delay:4-20.5ms  - UE-gNB: TUE-gNB= 0-0.5ms  - gNB-AMF: TgNB-AMF= 3-10ms  - AMF-LMF: TAMF-LMF= 1-10ms  Note: the LPP capability processing delay is counted together in response message. |
| Step 2 LPP Provide Capabilities | 25-54.5 | TLMFProc+ TAMF-LMF+ TAMFProc +TgNB-AMF + TgNBProc-NAS/LPP +TUE-gNB+  TUEProc-RRCULInfo+ TUEProc-LPPCapab  Processing delays: 21-34ms  - UE:  TUEProc-RRCULInfo= 2-5ms  TUEProc-LPPCapab= 10-20ms  - gNB: TgNBProc-NAS/LPP= 3ms  - AMF: TAMFProc= 3ms  - LMF: TLMFProc= 3ms  Signalling delay:4-20.5ms  - UE-gNB: TUE-gNB= 0-0.5ms  - gNB-AMF: TgNB-AMF= 3-10ms  - AMF-LMF: TAMF-LMF= 1-10ms |
| Step 3 LPP Request Location Information | 23-39.5 | TLMFProc+ TAMF-LMF+ TAMFProc +TgNB-AMF + TgNBProc-NAS/LPP +TUE-gNB+  TUEProc-RRCDLInfo+ TUEProc-LPPLocationRe  Processing delays: 19ms  - UE:  TUEProc-RRCDLInfo= 5ms  TUEProc-LPPLocationRe = 5ms  - gNB: TgNBProc-NAS/LPP= 3ms  - AMF: TAMFProc= 3ms  - LMF: TLMFProc= 3ms  Signalling delay:4-20.5ms  - UE-gNB: TUE-gNB= 0-0.5ms  - gNB-AMF: TgNB-AMF= 3-10ms  - AMF-LMF: TAMF-LMF= 1-10ms |
| Step 4 UE measurement |  | FFS whether should be counted or not. |
| Step 5 LPP Provide Location Information | 20-39.5 | TLMFProc+ TAMF-LMF+ TAMFProc +TgNB-AMF + TgNBProc-NAS/LPP +TUE-gNB+  TUEProc-RRCULInfo+ TUEProc-LPPLocationRe  Processing delays: 16-19ms  - UE:  TUEProc-RRCULInfo= 2-5ms  TUEProc-LPPLocationRe= 5ms  - gNB: TgNBProc-NAS/LPP= 3ms  - AMF: TAMFProc= 3ms  - LMF: TLMFProc= 3ms  Signalling delay:4-20.5ms  - UE-gNB: TUE-gNB= 0-0.5ms  - gNB-AMF: TgNB-AMF= 3-10ms  - AMF-LMF: TAMF-LMF= 1-10ms |
| Step 6 LMF calculation | 2-30 | TLMF-Calc  LMF calculation/estimation delay: 2-30  TLMF-Calc |
| Total values | 106-197.5 | Note 2: TDL-measc is not counted; |

The figure 4-2 is used for latency analysis for NR Uplink E-CID



Figure 4-2 procedure for Uplink NR E-CID

Table 6 summarizes the latency for UE assisted NR Uplink E-CID.

Table 6: Latency for UE assisted NR Uplink E-CID

|  |  |  |
| --- | --- | --- |
| **Positioning technique [NR Uplink E-CID] [UE-A] Figure 4-2** | | |
| **Latency Component** | **Value Range (ms)** | **Description of Latency Component** |
| Step 1 NRPPa E-CID Measurement Initiation Request | 13-29 | TLMFProc+ TAMF-LMF+ TAMFProc +TgNB-AMF + TgNBProc-NRPPa  Processing delays: 9 ms  - gNB: TgNBProc-NRPPa= 3ms  - AMF: TAMFProc= 3ms  - LMF: TLMFProc= 3ms  Signalling delay:4-20ms  - gNB-AMF: TgNB-AMF= 3-10ms  - AMF-LMF: TAMF-LMF= 1-10ms |
| Step 2 RRC Measurement/SRS configuration | 13-13.5 | TgNBProc-RRC+ TUE-gNB+ TUEProc-RRCReconf  Processing delays: 13ms  - UE:  TUEProc-RRCReconf = 10ms  - gNB: TgNBProc-RRC= 3ms  Signalling delay:0-0.5ms  - UE-gNB: TUE-gNB= 0-0.5ms |
| Step 3 MAC Activate UE SRS transmission | 1-3.5 | TUE-gNB +TUEProc-MAC-SRSAct  Processing delays: 13ms  - UE:  TUEProc-MAC-SRSAct = 1-3ms  Signalling delay:0-0.5ms  - UE-gNB: TUE-gNB= 0-0.5ms |
| Step 4 gNB measurements | TUL-measc | RAN1 inputs |
| Step 5 RRC Measurement report | 5-8.5 | TUEProc-RRCULInfo+ TUE-gNB+ TgNBProc-RRC  Processing delays: 5-8ms  - UE:  TUEProc-RRCULInfo = 2-5ms  - gNB: TgNBProc-RRC= 3ms  Signalling delay:0-0.5ms  - UE-gNB: TUE-gNB= 0-0.5ms |
| Step 6 NRPPa E-CID Measurement Initiation Response | 13-29 | TLMFProc+ TAMF-LMF+ TAMFProc +TgNB-AMF + TgNBProc-NRPPa  Processing delays: 9 ms  - gNB: TgNBProc-NRPPa= 3ms  - AMF: TAMFProc= 3ms  - LMF: TLMFProc= 3ms  Signalling delay:4-20ms  - gNB-AMF: TgNB-AMF= 3-10ms  - AMF-LMF: TAMF-LMF= 1-10ms |
| Step 7 LMF calculation | 2-30 | TLMF-Calc  LMF calculation/estimation delay: 2-30  TLMF-Calc |
| Total values | 47-113.5 | Note 1: TUL-measc is not counted; |

# Reference

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[4] R2-2006578 Discussion on R17 positioning enhancement, Huawei, HiSilicon

[5] R2-2006750 Consideration on the support of low latency requirement, Intel Corporation

[6] R2-2007587 End-to-end latency reduction for DL/UL positioning, InterDigital, Inc.

[7] R2-2008261 [AT111-e][612][POS] Assumptions for analysis of commercial use cases (Ericsson) Ericsson

[8] TS 23.273, 5G System (5GS) Location Services (LCS); Stage 2.

[9] TS37.910

[10]TS38.331

[11] R2-2009001Report of [Post111-e][625][POS] End-to-end latency analysis (Intel) Intel Corporation

[12] R2-2010096 NR Positioning Latency Analysis and Enhancements Qualcomm Incorporated