SEVEN Solutions

When every nanosecond counts

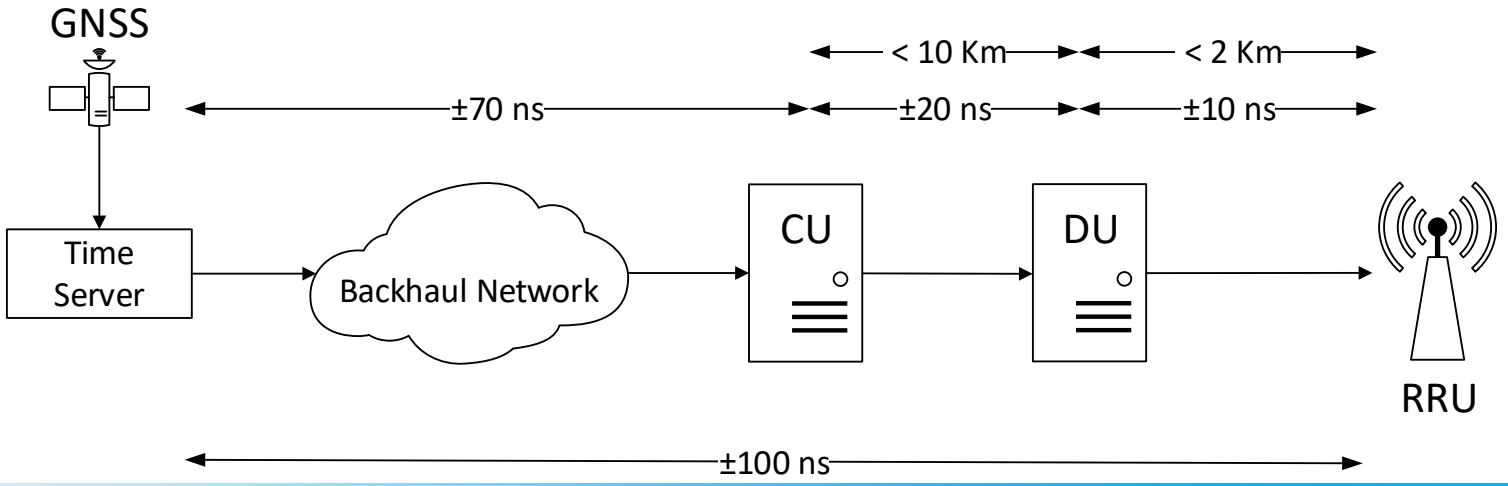
Ultra-accurate time transfer based on the IEEE-1588 High Accuracy Profile. A high scalability and resilience approach

www.sevensols.com

Summary

- The road to 5G
- Limitations of the IEEE 1588 – 2008 (PTPv2)
- The upcoming IEEE 1588 revision: High Accuracy profile
- Scalability and resiliency
- Performance data
- Live demo

- Timing and synchronization is critical to improve current telecom service capabilities
- Dedicated timing network: Necessary? It depends...
  - Interconnection with common reference (GNSS, UTC(k), …)



Data taken from Dr. Han Li, China Mobile. WSTS 2017

Limitations of the IEEE 1588 – 2008 (PTPv2)

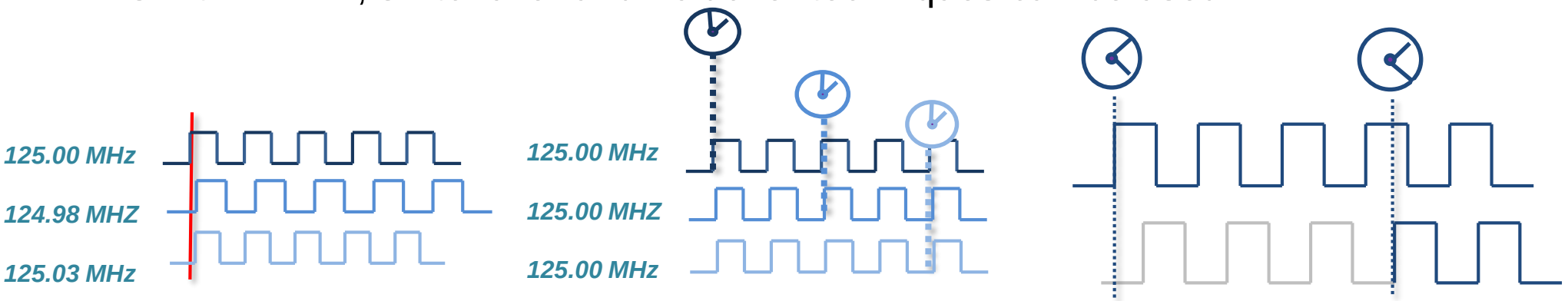
- Several “telecom” profiles.
- Per-link calibration is mandatory.
- Accuracy and precision is not enough.
- Heavily affected by Packet Delay Variation (PDV).
- Best Master Clock Algorithm (BMCA) is unsecure. You must trust the source.
- Asymmetry needs to be measured and taking into account.

The upcoming standard: High Accuracy profile

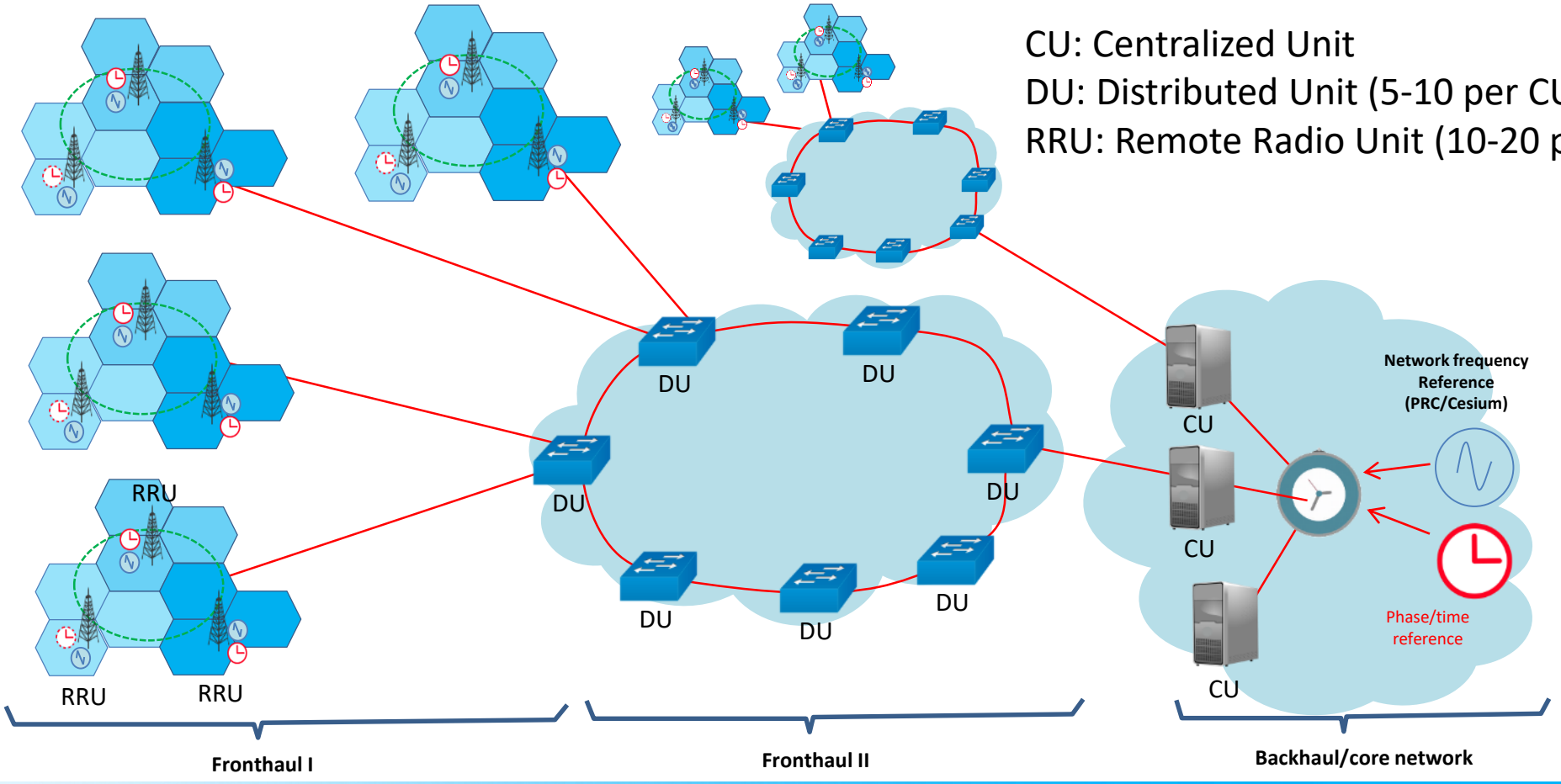
- Main ideas coming from White Rabbit (WR) Protocol
- WR born at CERN and tested through several years
- WR brought to industry by Seven Solutions already in 2010
- IEEE1588 with HA expected in 2018/2019.
- 3rd default PTP Profile included in Annex J of the IEEE1588
- HA allows:
  - Clock sync (L1 synchronization)
  - Timestamp enhancement through phase detection
  - Automatic precise evaluation of link asymmetry.
- Fully compatible with PTPv2

The upcoming standard: High Accuracy profile

- Sub-nanosecond accuracy of synchronization. L1-Sync + Phase difference measurement.
- Calibration procedures and dynamic evaluation of medium asymmetry.
- Low bandwidth utilization for time synchronization
- Hops of over 80 Km (validated with WR implementation on longer links)
- As with PTPv2, switchover and holdover techniques can be used



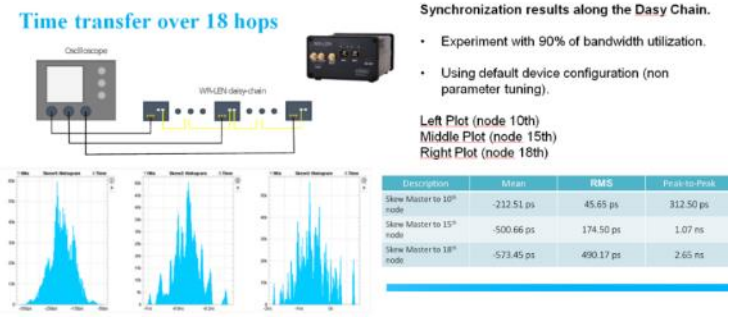
5G Network example



CU: Centralized Unit
DU: Distributed Unit (5-10 per CU)
RRU: Remote Radio Unit (10-20 per DU)

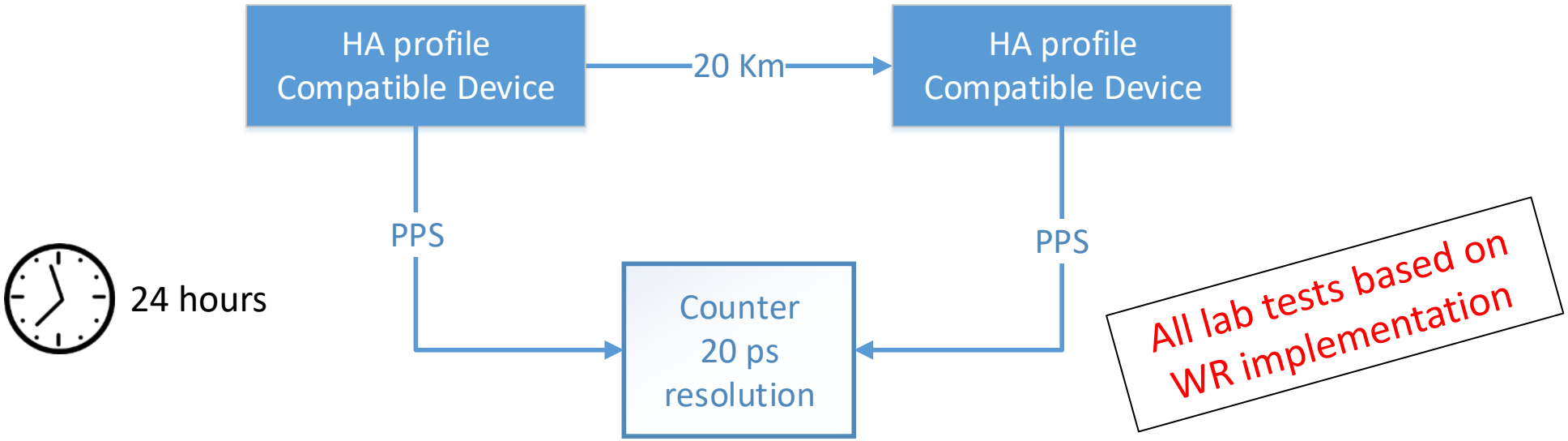
Scalability and resiliency

- Possibility to have multiple grandmasters connected to independent time sources: GNSS, UTC (k), multiport device. (Maciej. PhD. 2016, J. L. Gutierrez et al. EFTF. 2016)
- 15 hops maintaining sub-nanosecond (Seven Solutions. ITSF 2016, Torres-Gonzalez et al., ISPCS 2016)
- Up to 120Km per hop (see next results)

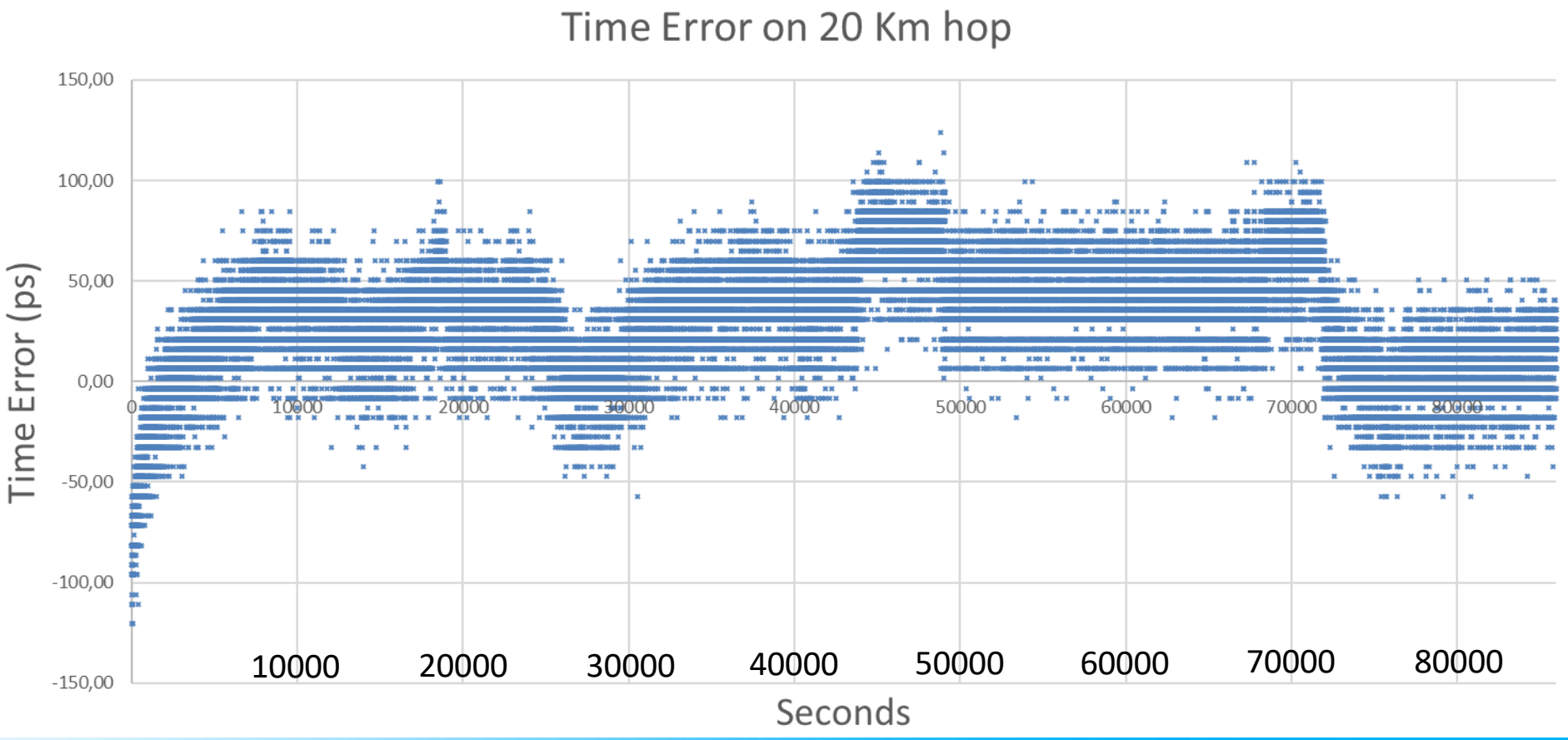


Performance data

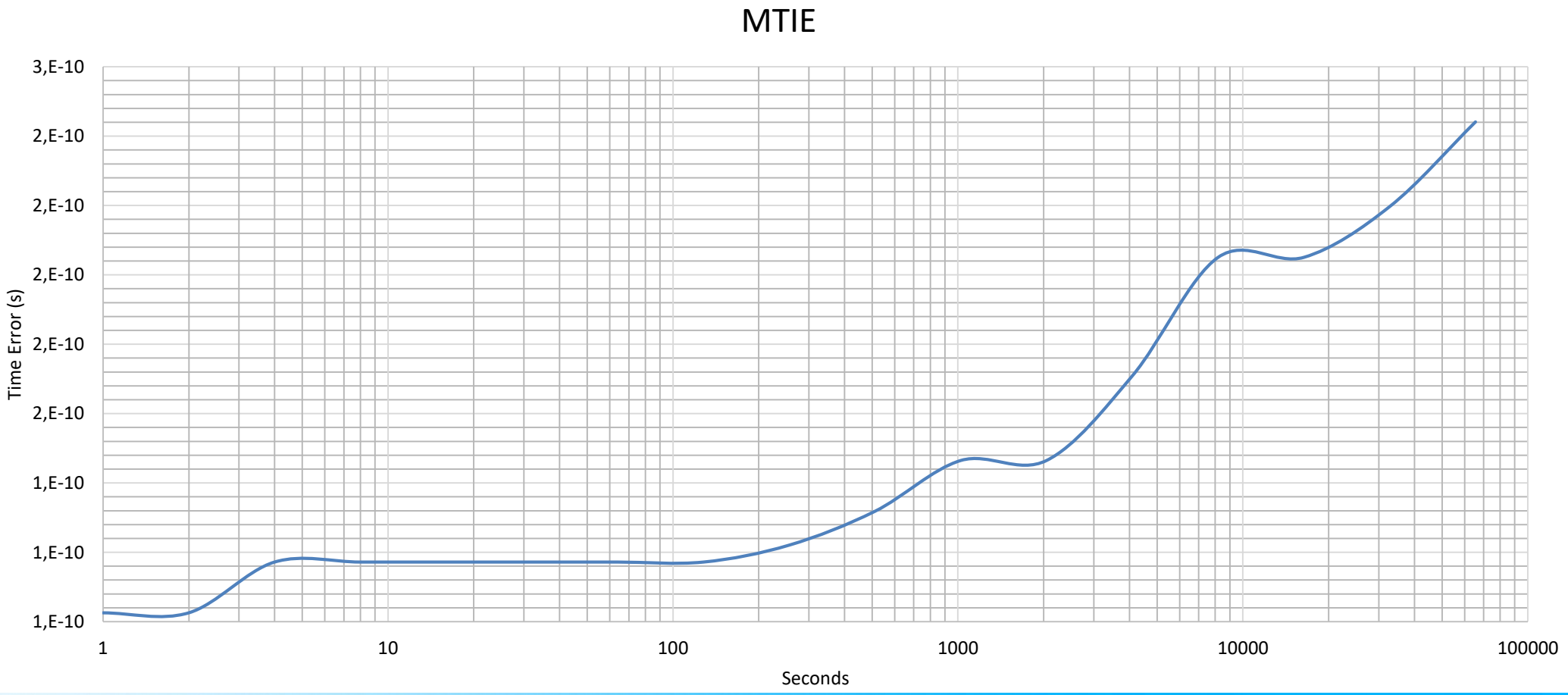
Synchronization performance of the current WR implementation that is representative to the future HA implementations.



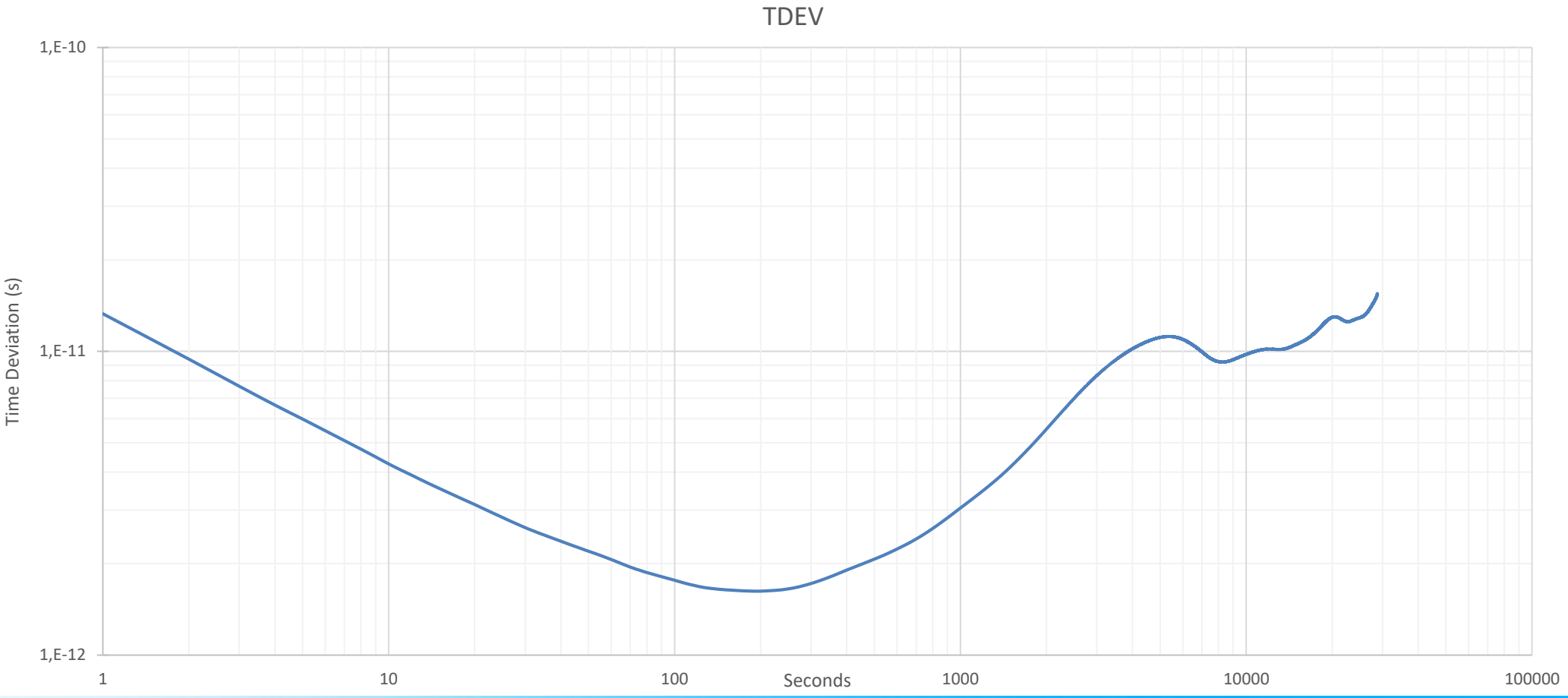
Performance data



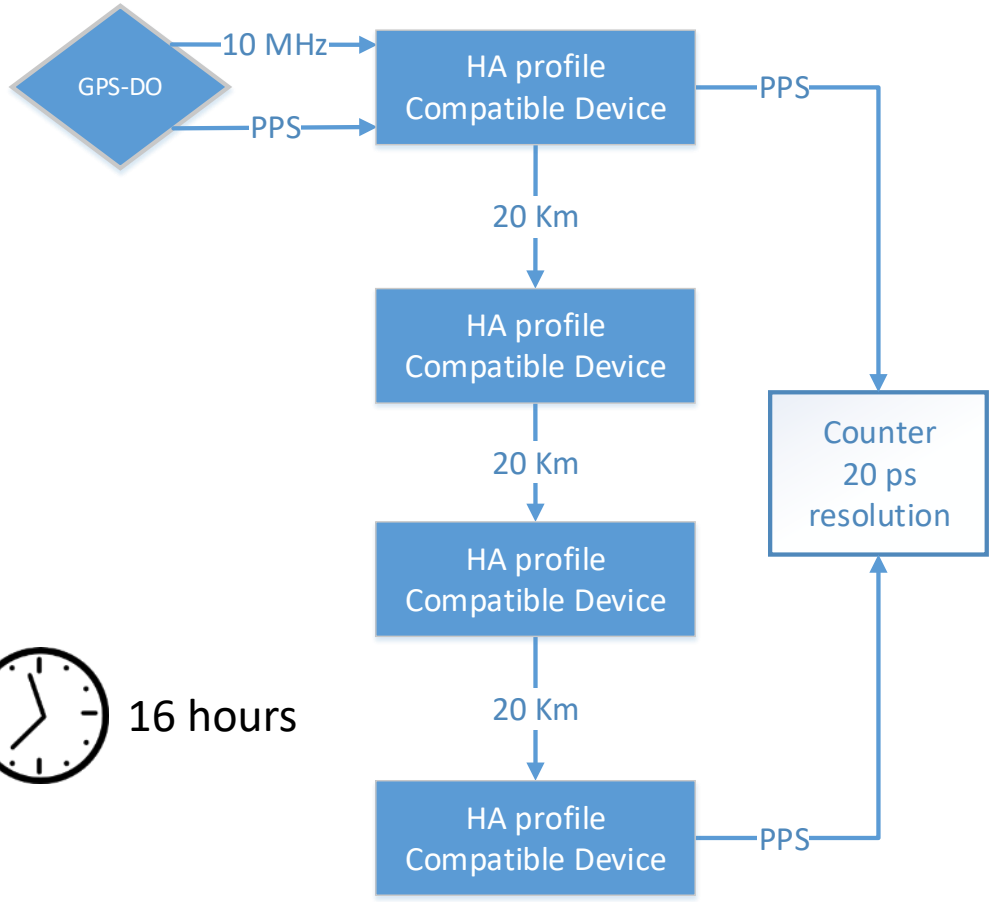
Performance data



Performance data



Performance data



16 hours

GM

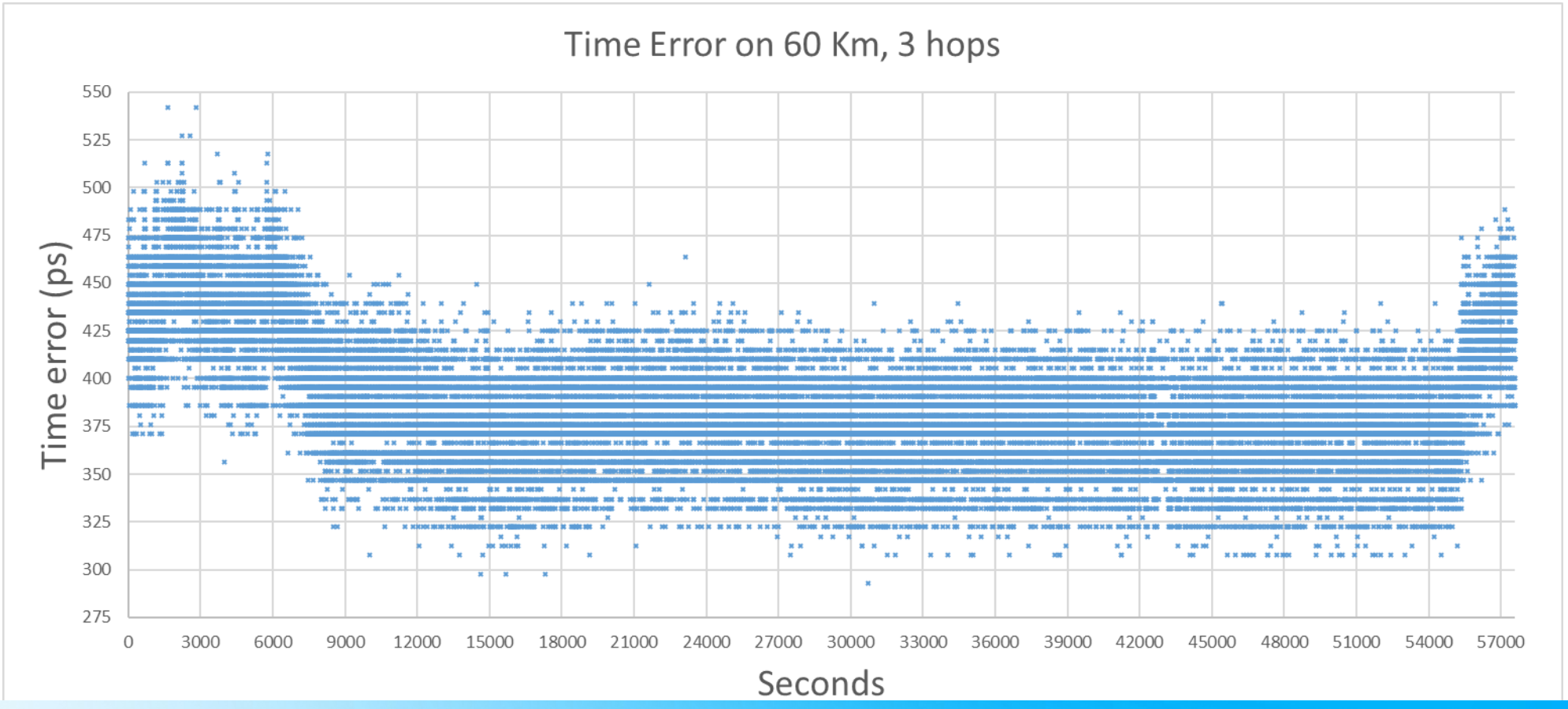
CU

DU

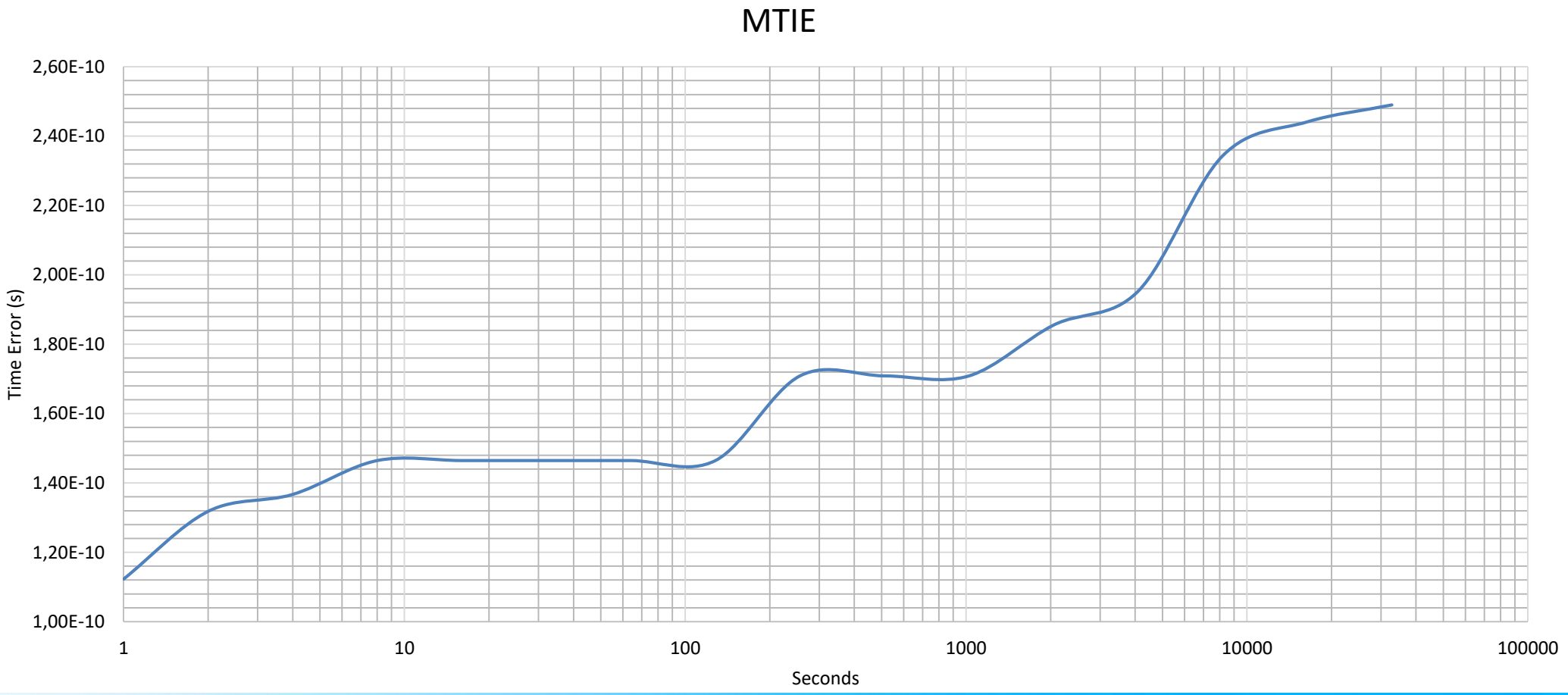
RRU

All lab tests based on WR implementation

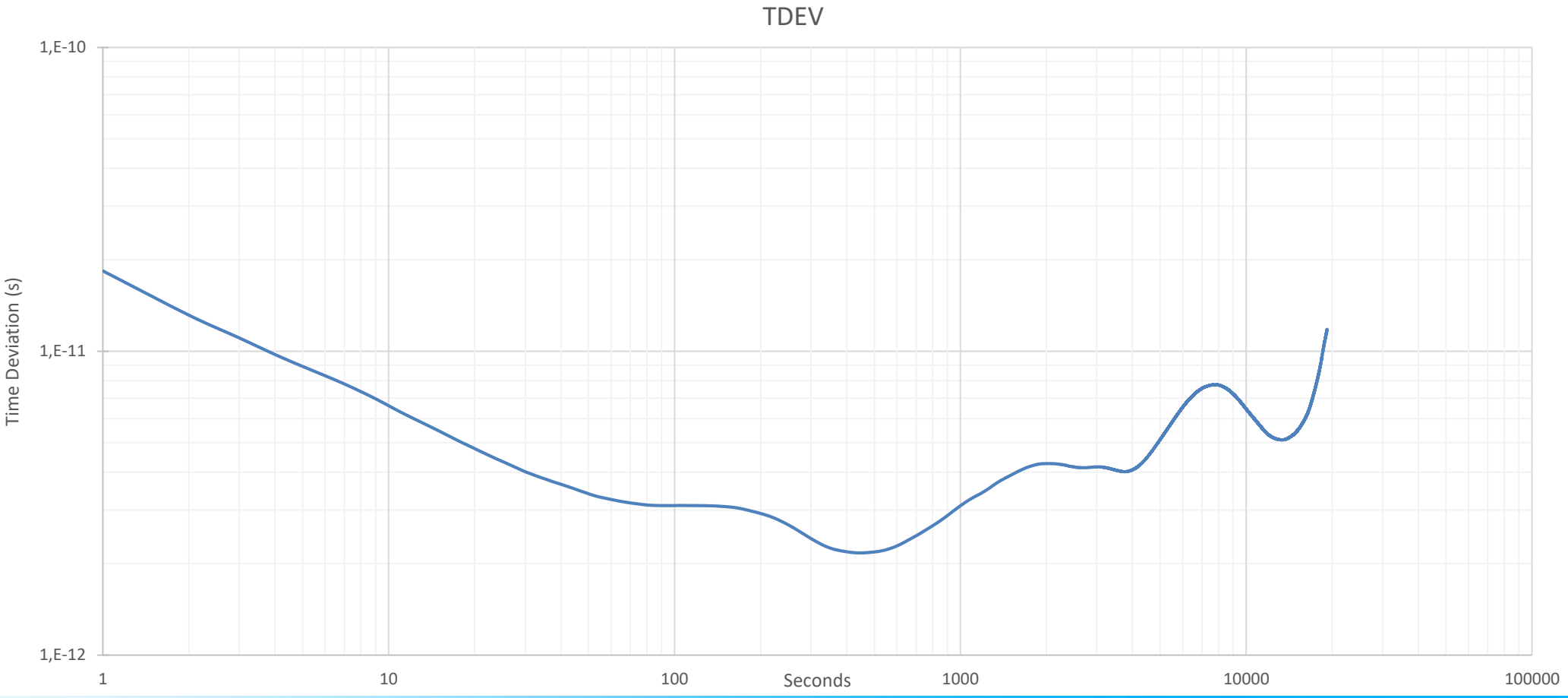
Performance data



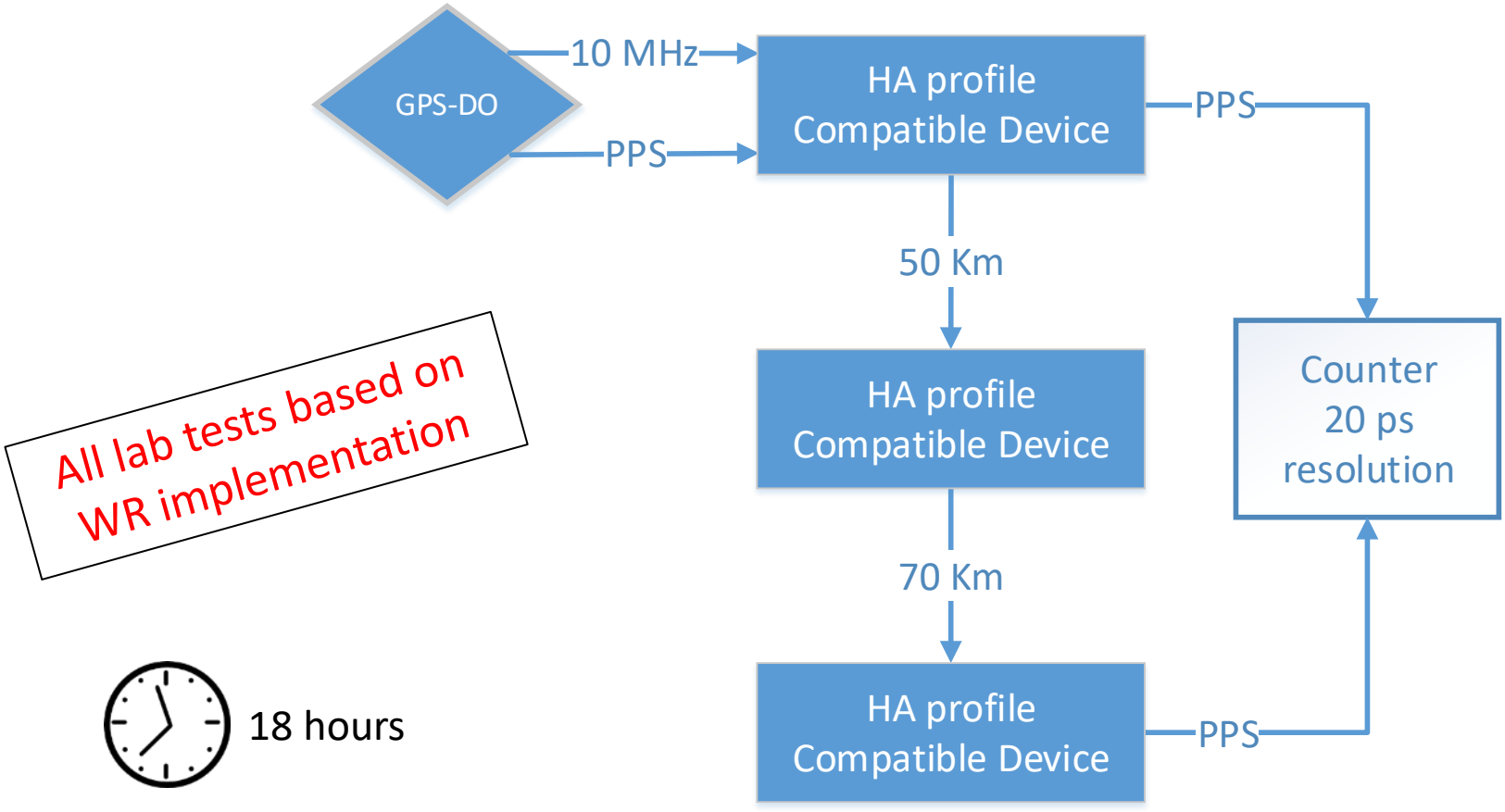
Performance data



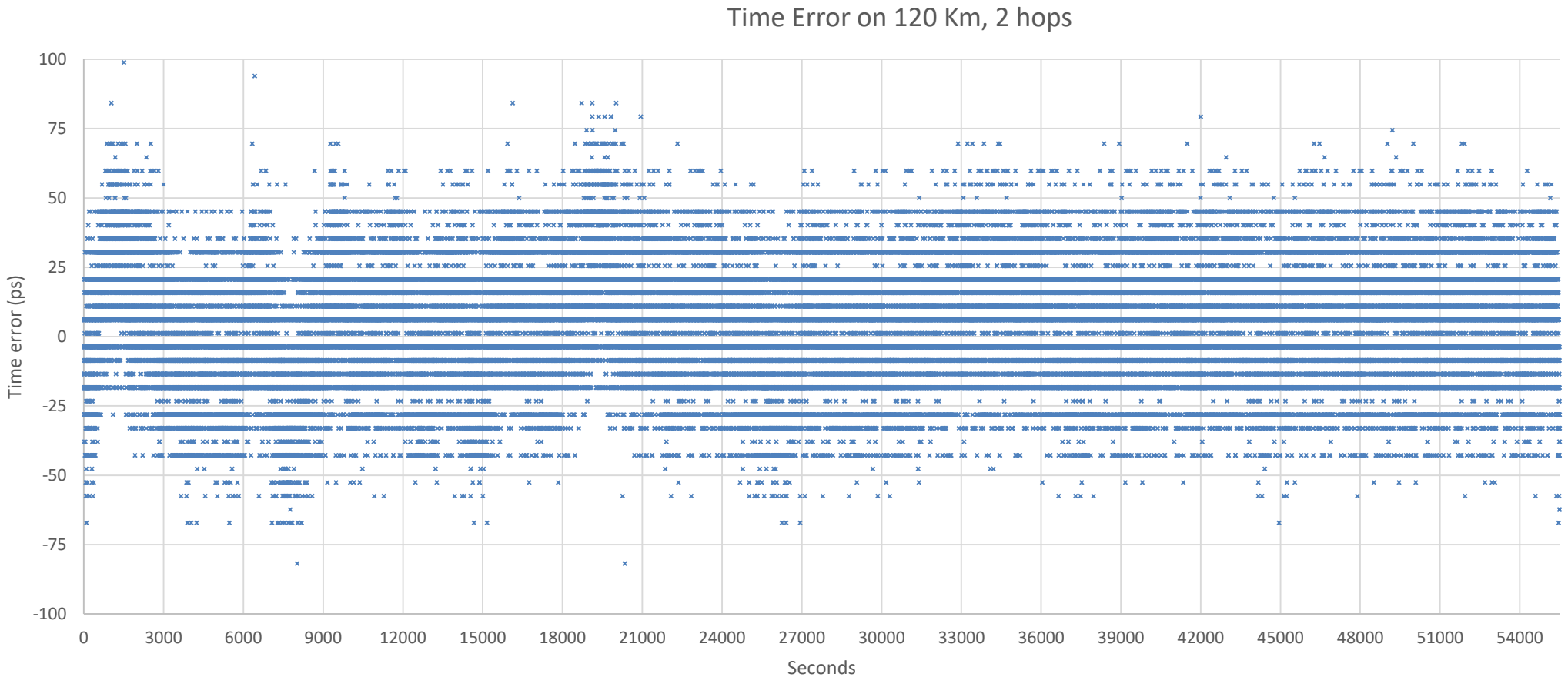
Performance data



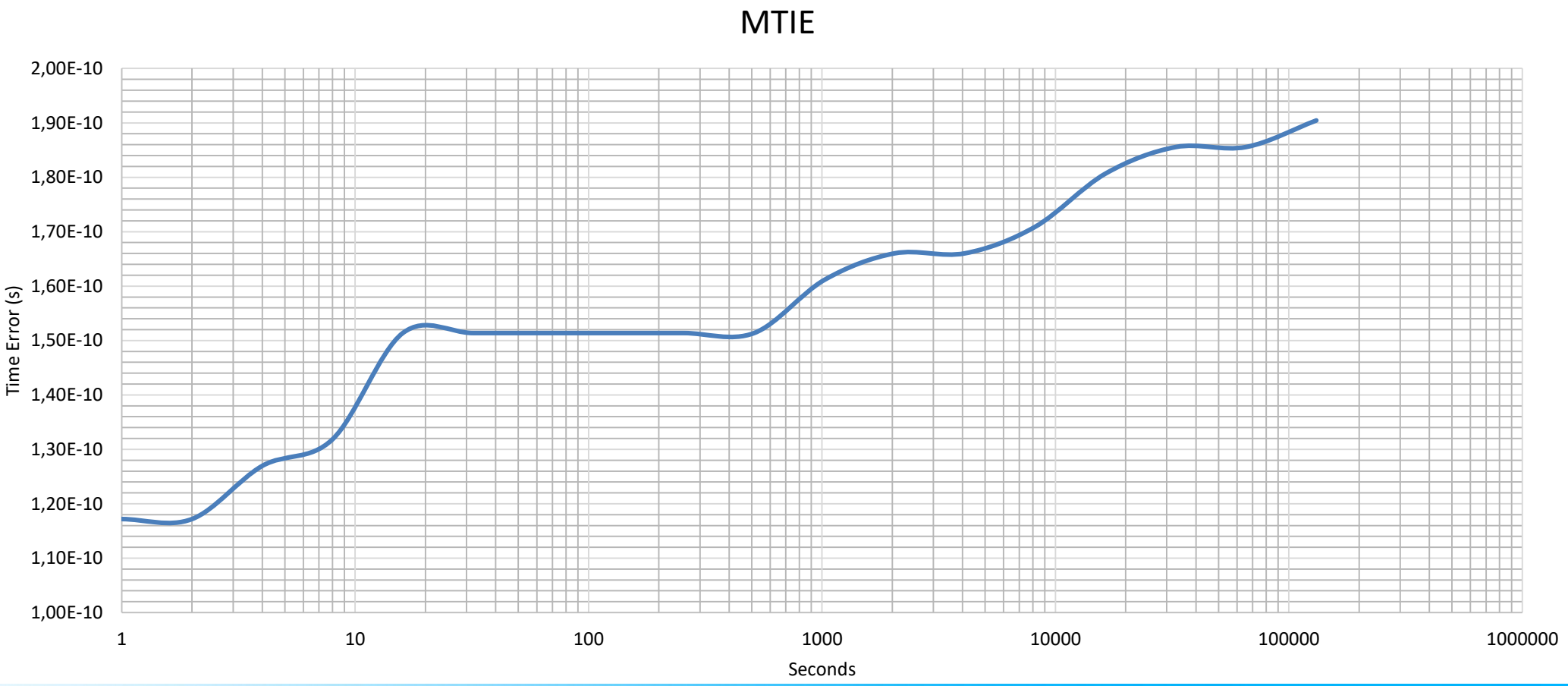
Performance data



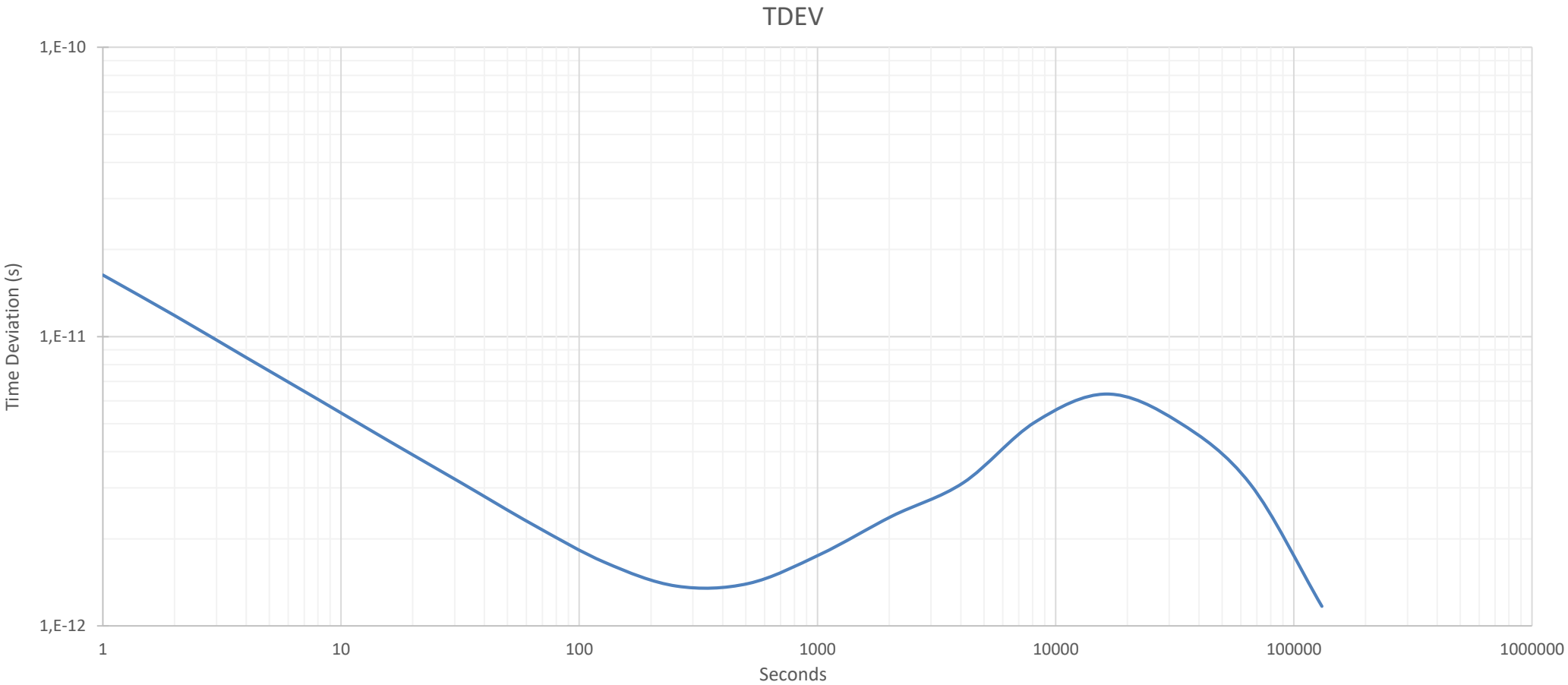
Performance data



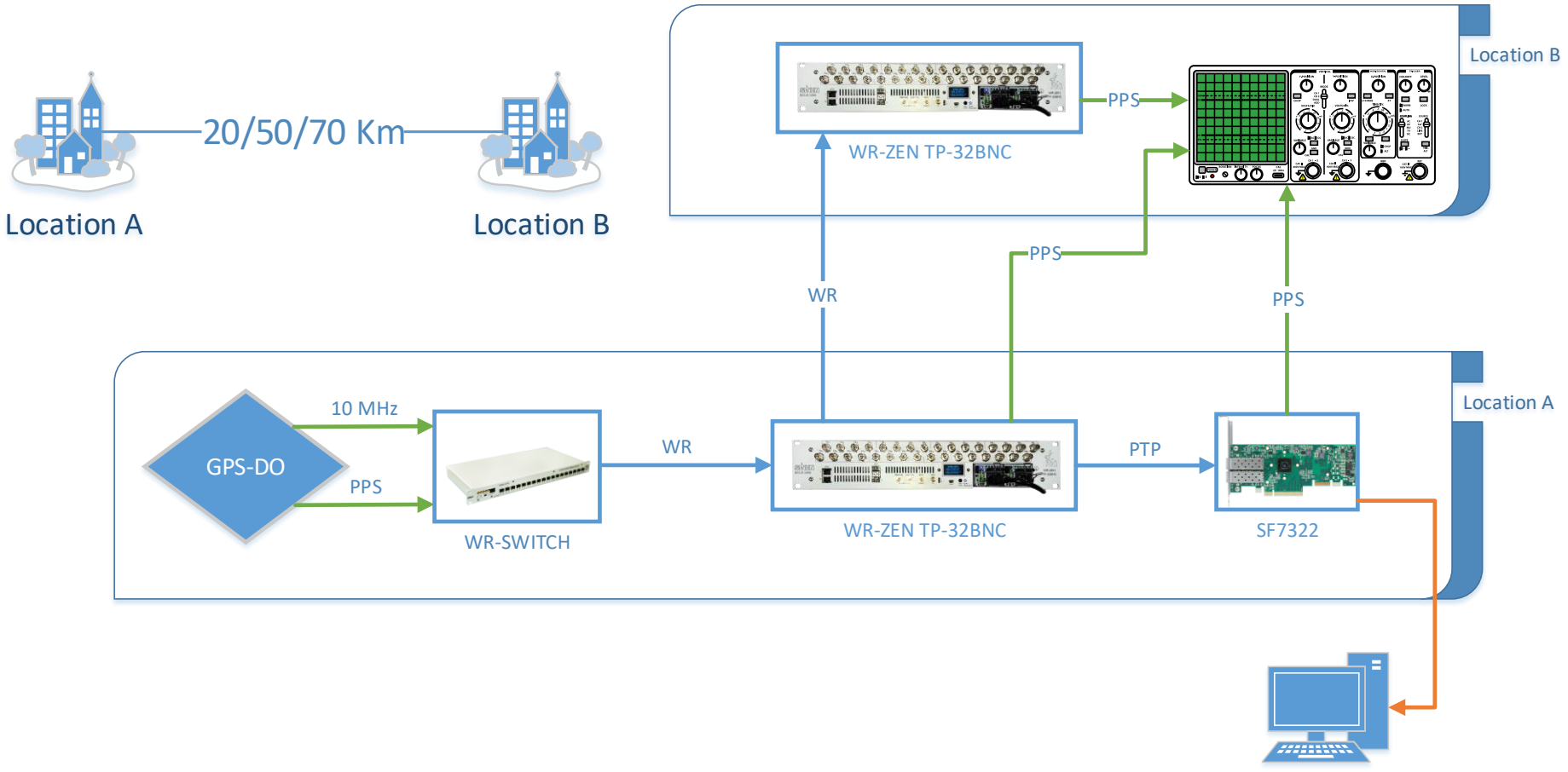
Performance data



Performance data



Live demo


20/50/70 Km
Location A
Location B
Location B
WR-ZEN TP-32BNC
PPS
PPS
WR
PPS
Location A
10 MHz
GPS-DO
PPS
WR-SWITCH
WR
WR-ZEN TP-32BNC
PTP
SF7322

Conclusions

- **WR and HA match 5G time transfer requirements**
  - Distance scalability with low time error budget (nanosecond)
  - Validated in the presented results
  - Live trials already in place
- High Accuracy profile:
  - Intensively based on White Rabbit approach (developed and promoted by CERN)
  - Clock distribution (L1 synchronization)
  - Phase offset measurement
- We have a live set up in the booth