Assessment of IEEE 1588-based timing system of the ITER Neutral Beam Test Facility

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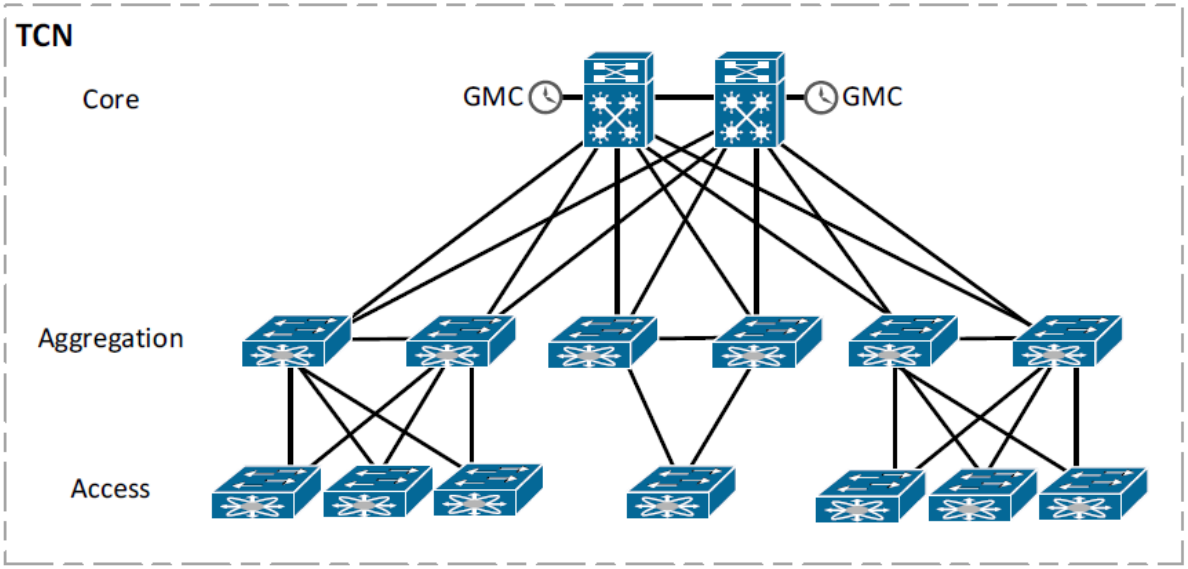

Fig. 1. ITER TCN scheme

Outline

- ITER CODAC Networks
- Time Communication Network (TCN)
- Precision Time Protocol in ITER
- MITICA TCN Topology
- Omnet++ Simulation tool
- Omnet++ Modelling
- Hardware Apparatus
- Simulation data comparison
  - Slave – Switch
  - Slave – GMC
- Performance comparison
- Conclusions

ITER CODAC Networks

- **Time Communication Network (TCN)**
- **Data Archive Network (DAN)**
- **Synchronous Databus Network (SDN)**
- **Plant Operation Network (PON)**

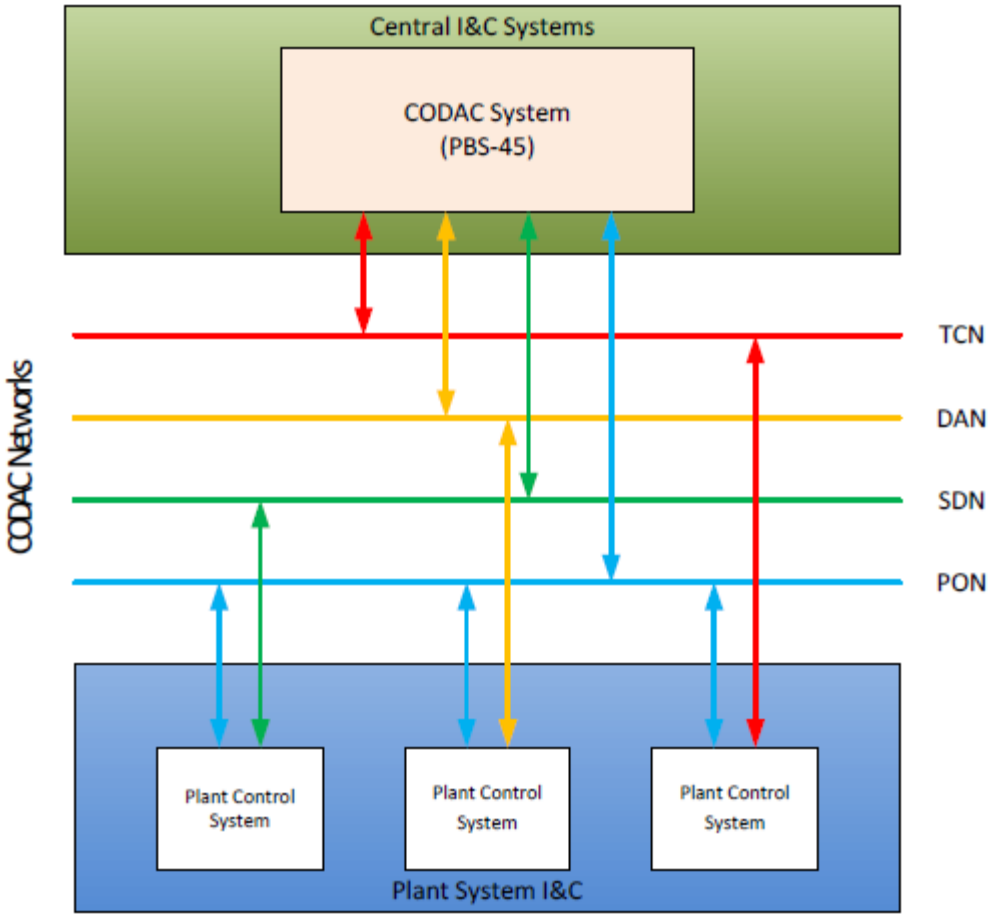

Fig. 2. CODAC Networks Interaction

Time Communication Network (TCN)

- It manages the synchronization for all the connected devices
- Based on Ethernet, it adopts multicast UDP/IPv4 strategies
- It relies on the Precision Time Protocol (PTPv2)
- It guarantees less than 1µs accuracy with an RMS of 50 ns at maximum
- Its APIs support various kinds of hardware modules to synchronize the plant hosts to the network time

Precision Time Protocol in ITER

- PTPd software pre-installed in CODAC
- Hardware timestamping performed by external devices
- Synchronization between CODAC time and external modules clock
- Only E2E delay mechanism supported by now

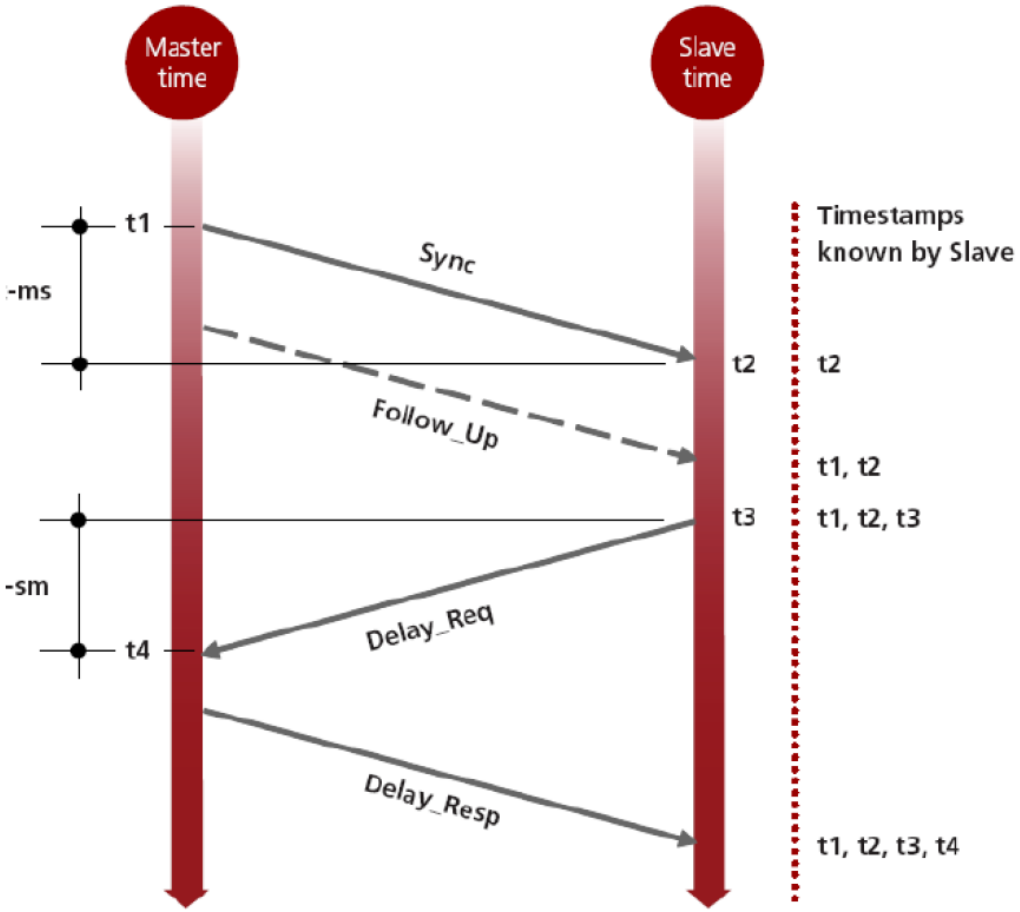

Fig. 3. PTP timestamping scheme

MITICA TCN Topology

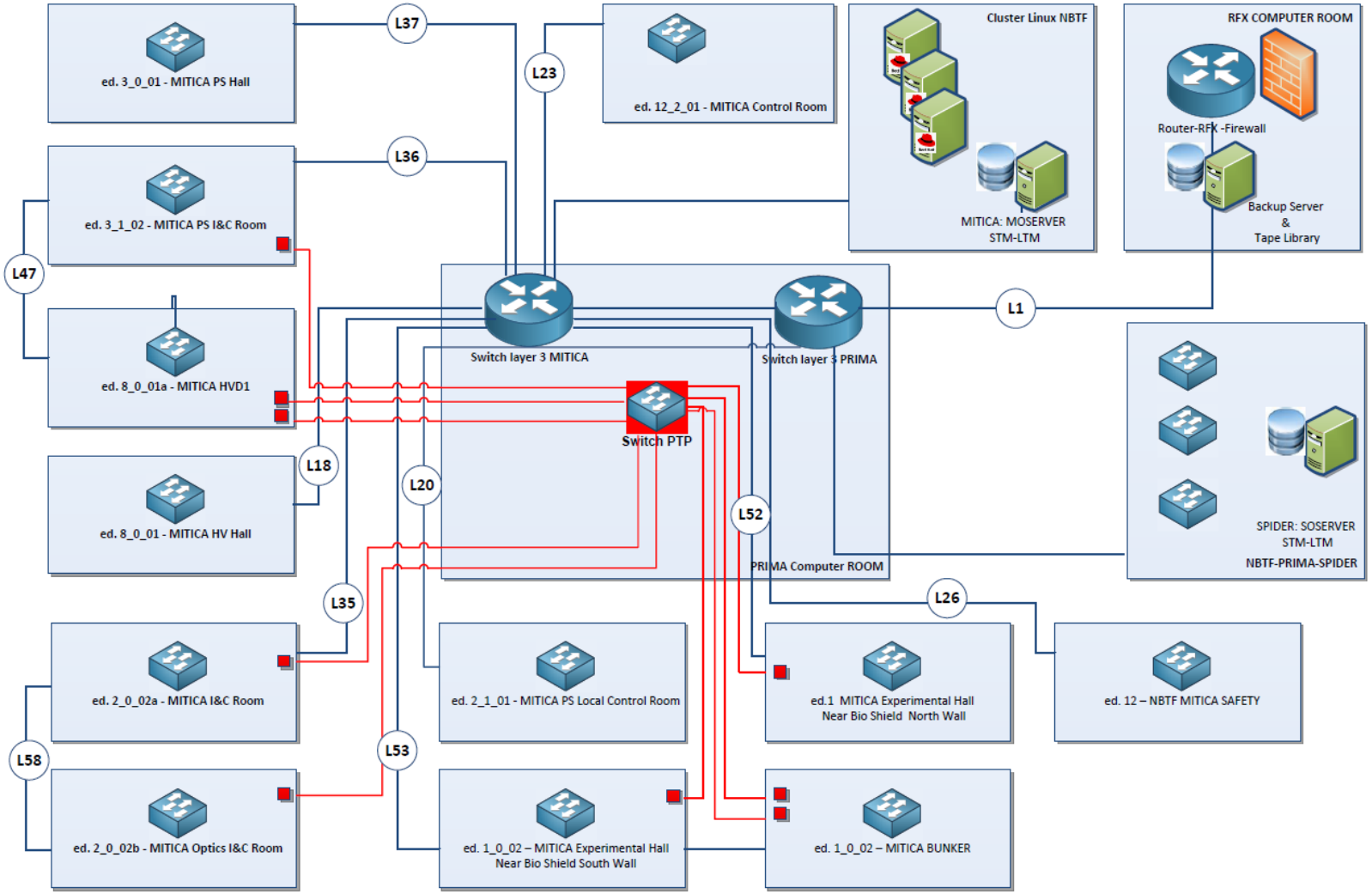

Fig. 4. Network Topology

Omnet++ Simulation tool

- **Open-source discrete event simulator**
- **Based on C++ libraries and frameworks**
- **Modular and highly extensible**
- **"PTP-sim project" to simulate PTP networks**
  - **libPTP library**
  - **libPLN library**

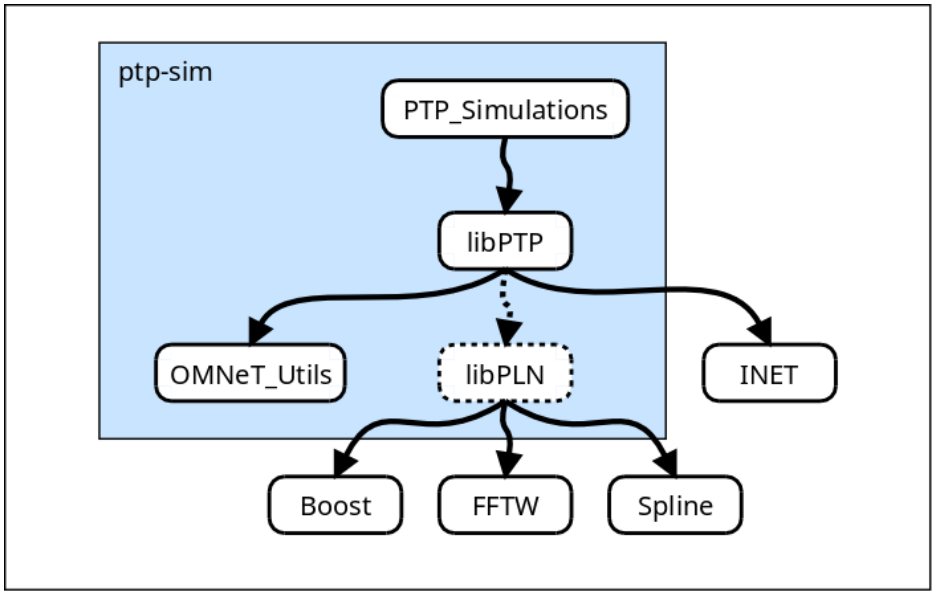

Fig. 5. PTP-sim flow

Omnet++ Modelling

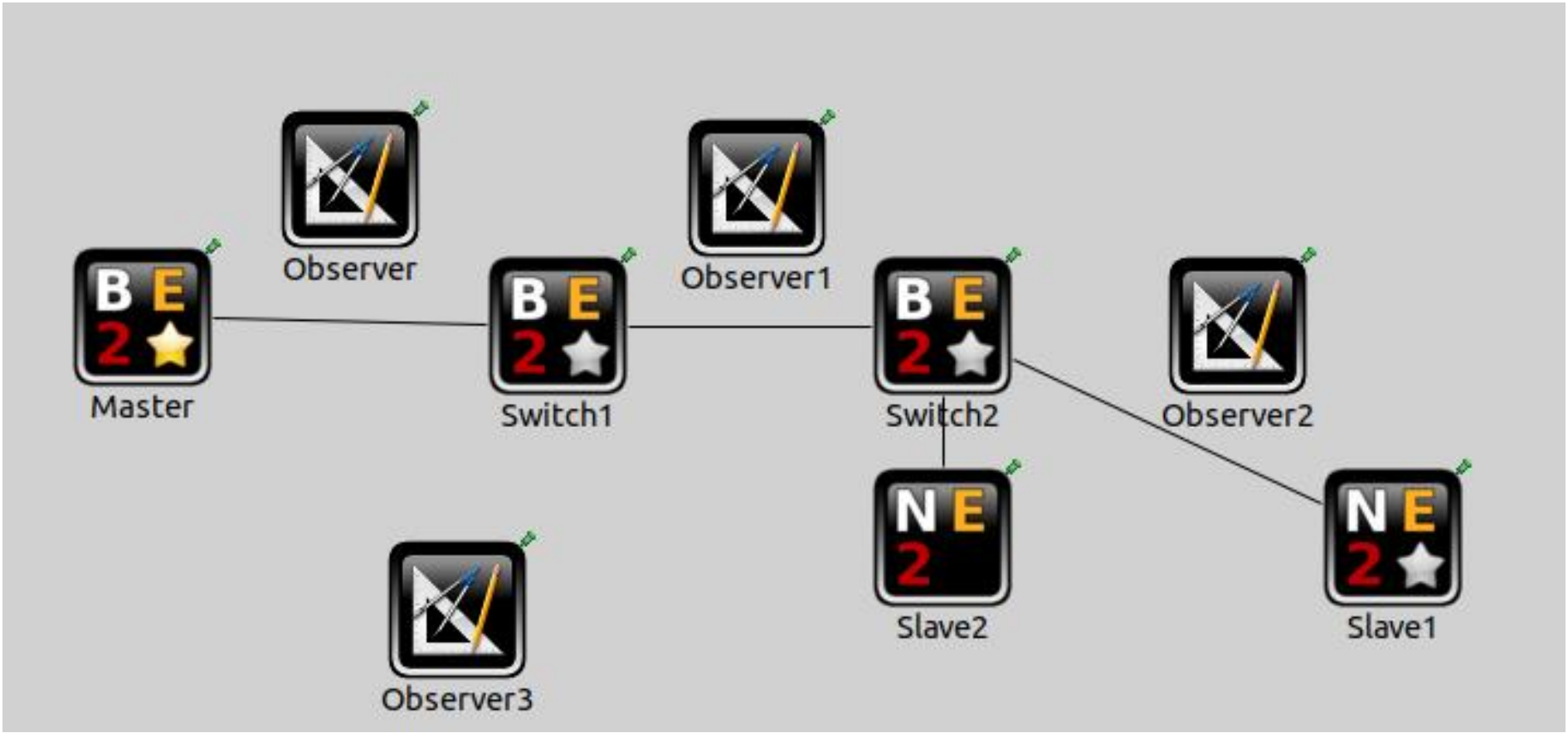

Fig. 6. Omnet++ test simulation

Hardware Apparatus

1 GMC: Meinberg Mycrosync RX201

2 switches: Kyland SICOM 3000A

2 slaves: NI PXI-6683H

Simulation data comparison (Slave - Switch)

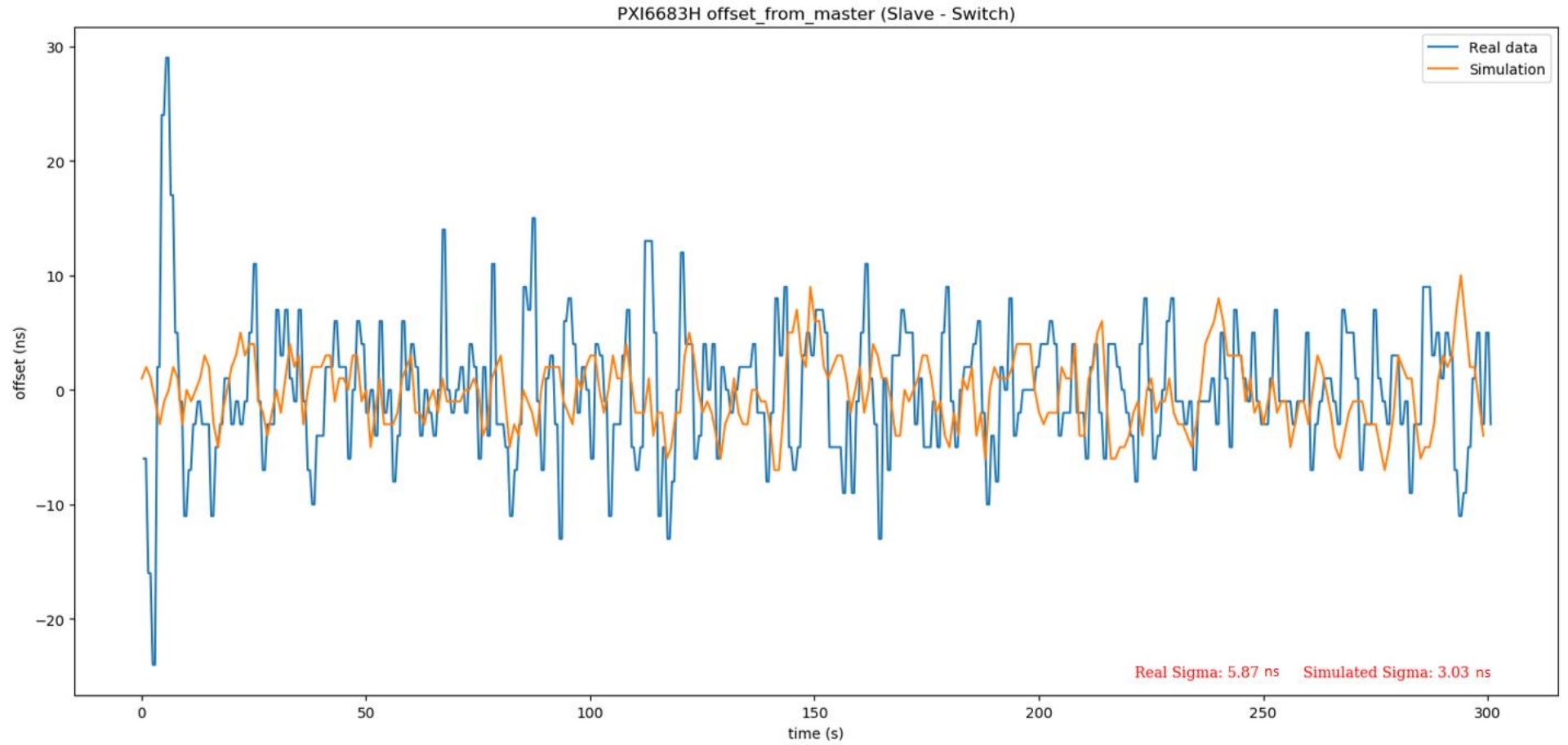

Fig. 7. Slave – Switch delay simulation comparison

Simulation data comparison (Slave - GMC)

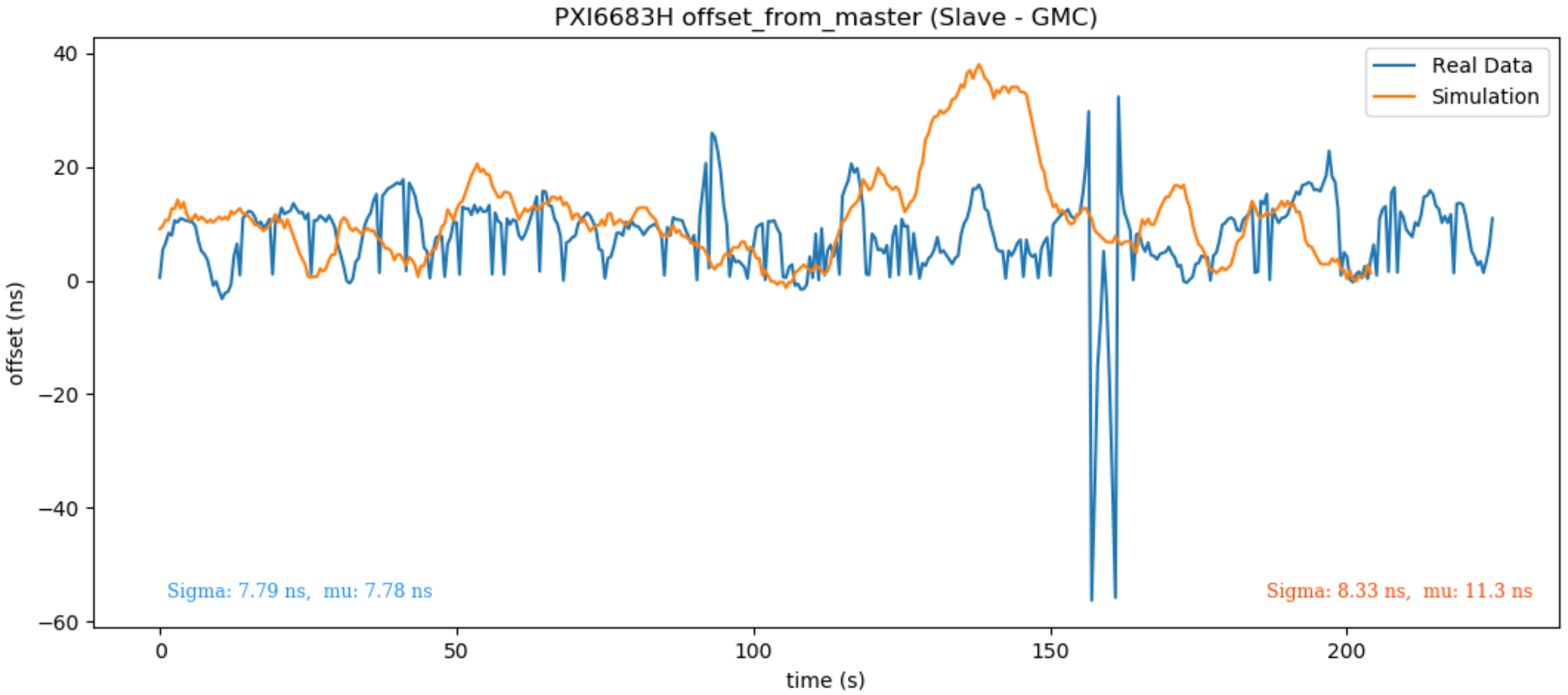

Fig. 8. Slave – GMC delay simulation comparison

Performance comparison (real data)

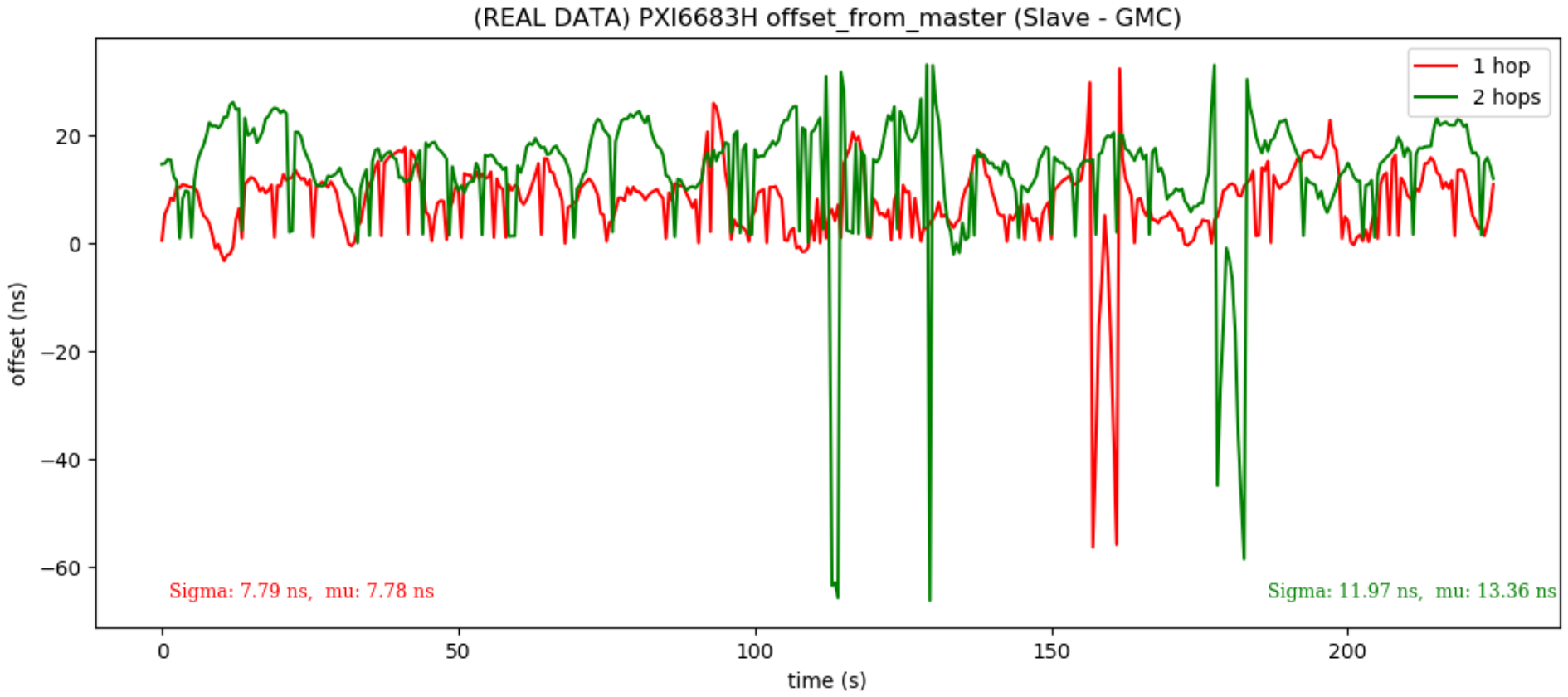

Fig. 9. Slave delay with different hops

Performance comparison (simulation)

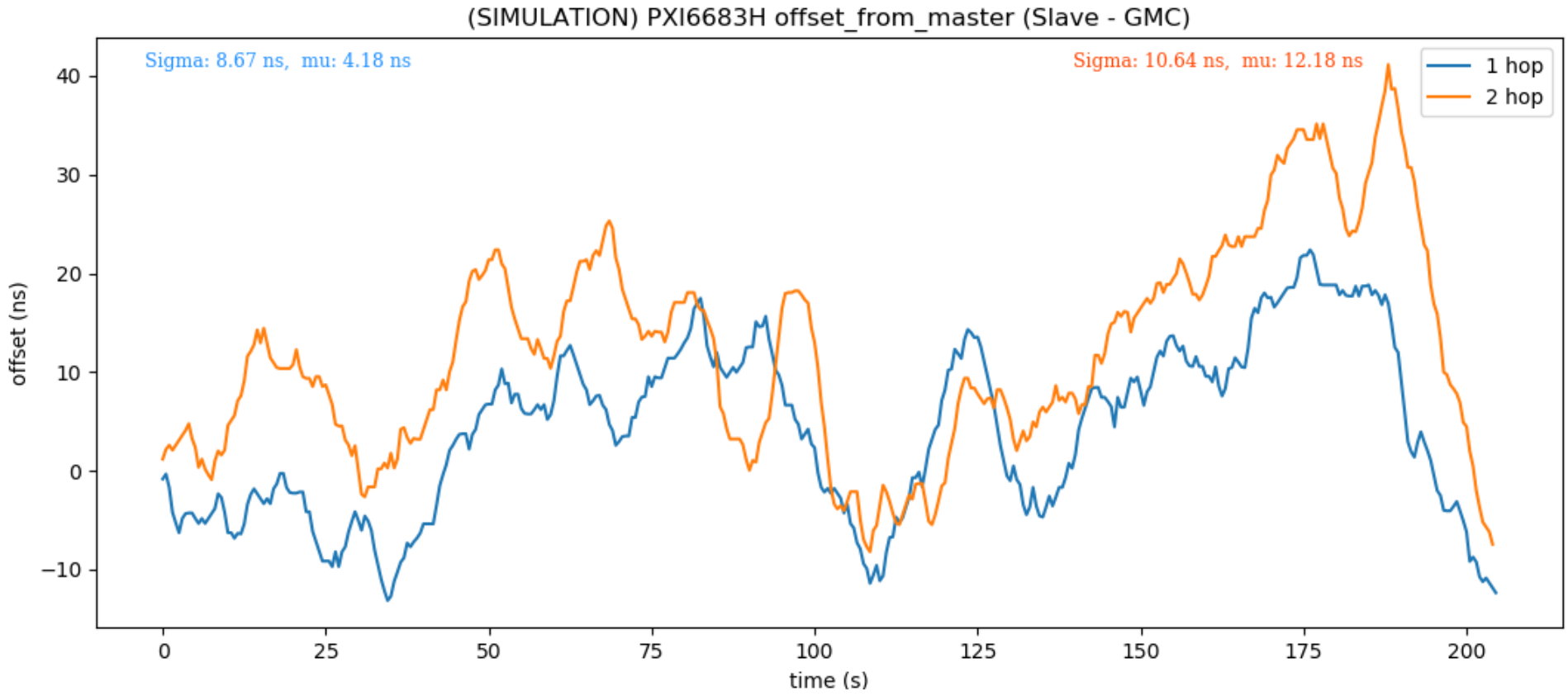

Fig. 10. Simulation of slave delay with different hops

Conclusions

- **Hardware apparatus compliant with the project requirements**
- **TCN APIs and features have been tested**
- **Omnet++ simulation tool gave good results and will be adopted to study more complicated topologies**
- **The test campaign has been concluded and the RMS constraints have been respected both in the 1-hop case and in the 2-hops scenario.**

Thank you very much

Any questions?