School of Information Sciences

UNIVERSITY OF PITTSBURGH

ptp++: A Precision Time Protocol Simulation Model for OMNeT++ / INET

Martin Lévesque, PhD
Plan

Introduction

Background – Precision Time Protocol (PTP)

OMNeT++ Simulation model

Simulation results

Conclusions
Introduction

Emerging smart applications require tight synchronization requirements.
◦ Smart power grid.
◦ Internet-of-Things (IoT).
◦ Smart cities.

Efficiency and reliability improvements via machine-to-machine (M2M) communications.

IEEE 1588 Precision Time Protocol (PTP): Key synchronization protocol.
Not currently part of OMNeT++ / INET.
Precision Time Protocol (PTP)
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Offset time from the slave clock perspective is approximated by:
\[ \theta \leftarrow \frac{D_1 - D_2}{2} \]

A given slave clock adjusts its time as follows:
\[ t \leftarrow t - \theta \]

For precise synchronization performance, \( D_1 \) should be close to \( D_2 \) (symmetrical). Challenging requirement to meet in practice.

Asymmetry mitigation mechanisms:
- Residence time measurement, peer-to-peer path correction, etc.
PTP OMNeT++ model
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PTPNode:
- Node having PTP support.
- Master or slave.
- Implemented as an application. Follow the OSI layers, use of the INET modules.

Software and hardware clocks.

Allows to study asymmetry mitigation mechanisms.

Stats collector:
- Time deviation: Average, standard deviation, min-max, PDF.
Simulation results

Scenario: Measurement of the synchronization performance over multiple hops with background traffic.

Slave nodes synchronize with the master node.

Two trafgen nodes generate at the intermediate nodes – Asymmetric conditions.

With and without quality-of-service (QoS) – PTP packets prioritization.

Fig.: Simulation model.
Simulation results – Without QoS

![Graph showing synchronization error (μs) against downstream load (Mbps) for different upstream loads (0 Mbps, 30 Mbps, 60 Mbps, 90 Mbps).]
Simulation results – With QoS
Conclusions

The OMNeT++ PTP model allows to measure synchronization performance under different conditions.

Variable traffic load can significantly influence the synchronization performance.

Prioritized QoS improves the accuracy drastically.

Future works: Investigate the model with realistic conditions.
  ◦ With security (timestamps).
  ◦ Increase the number of nodes and intermediate nodes.
  ◦ Variety of applications: triple-play, smart grid, etc.
Questions?