School of Information Sciences

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

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Plan

Introduction

Background – Precision Time Protocol (PTP)

OMNeT++ Simulation model

Simulation results

Conclusions

Introduction

Emerging smart applications require tight synchronization requirements.

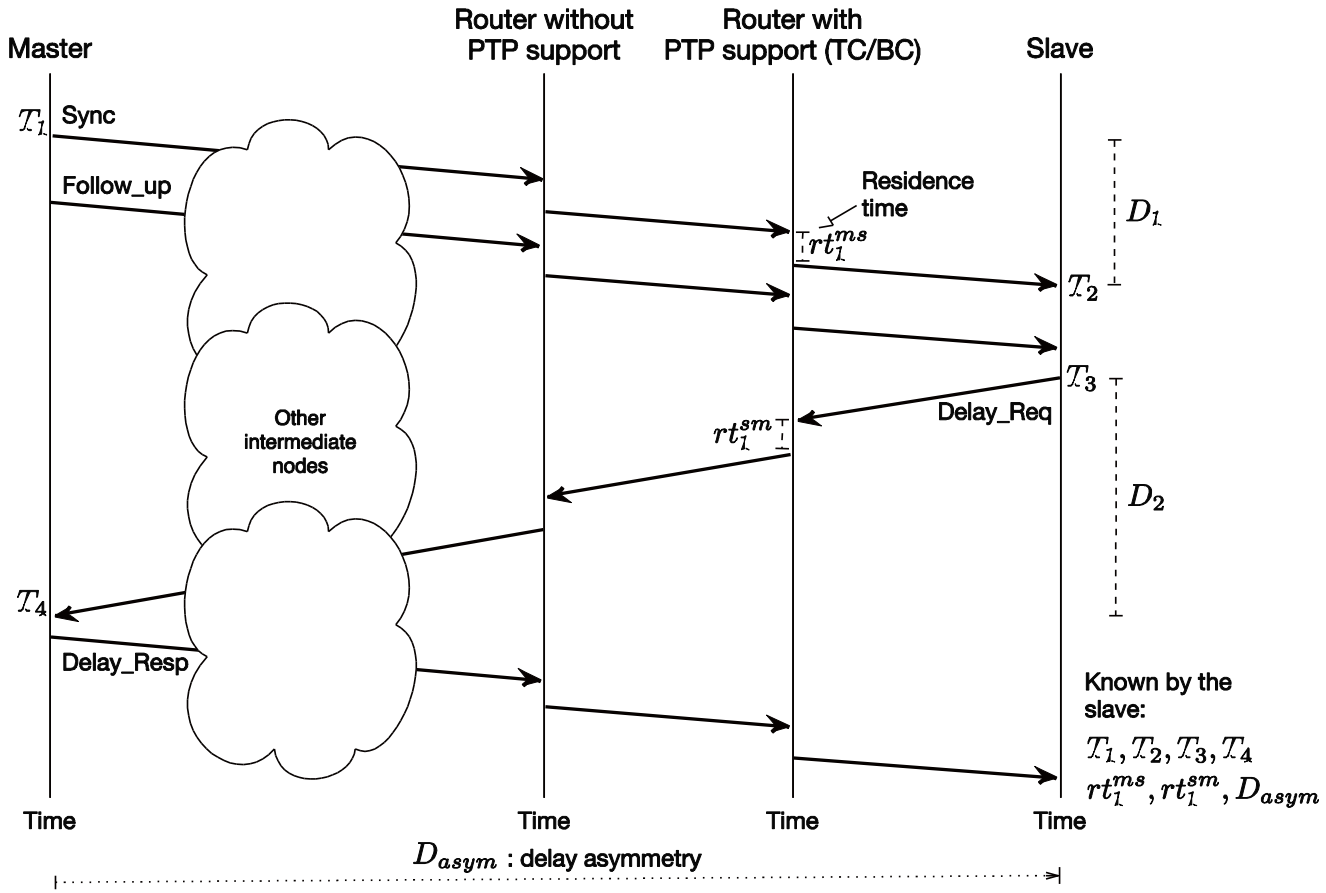
- Smart power grid.
- Internet-of-Things (IoT).
- Smart cities.

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)



Precision Time Protocol (PTP)

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:

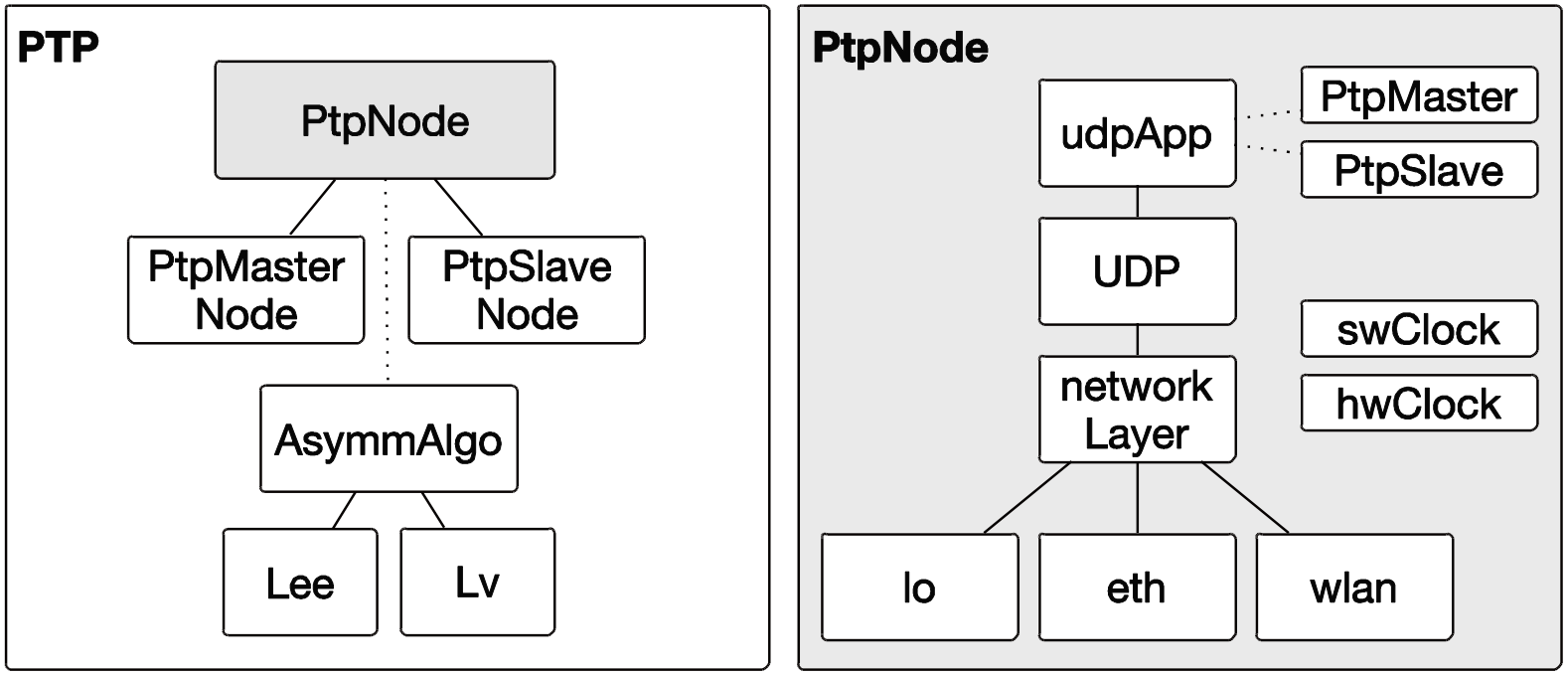
$$t \leftarrow t - \theta$$

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



PTP OMNeT++ model

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.

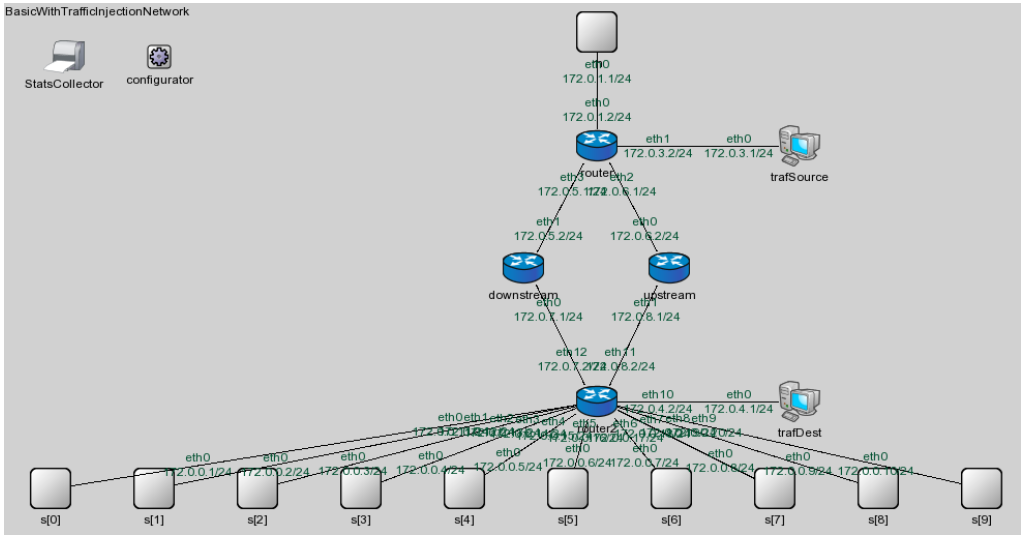
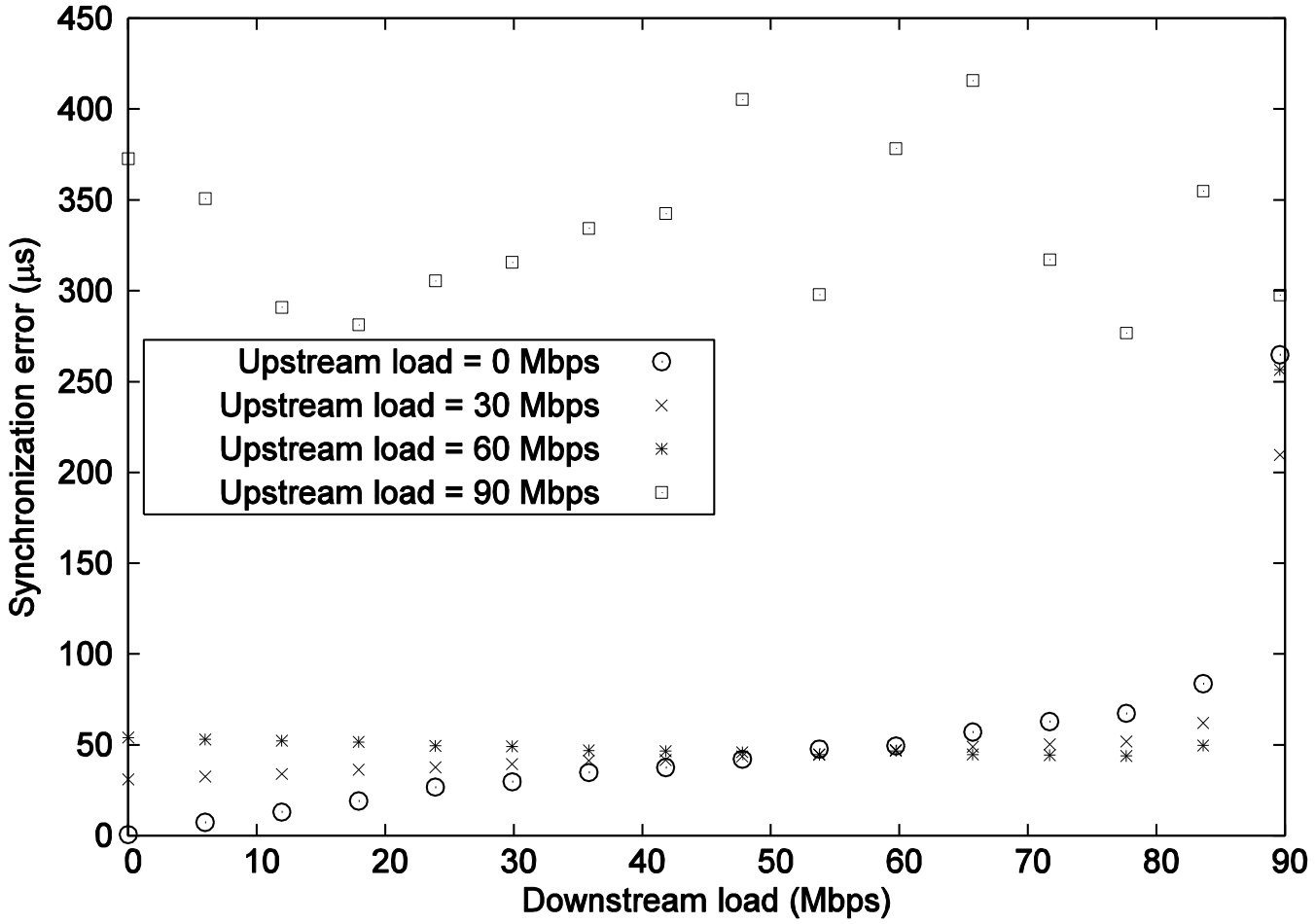
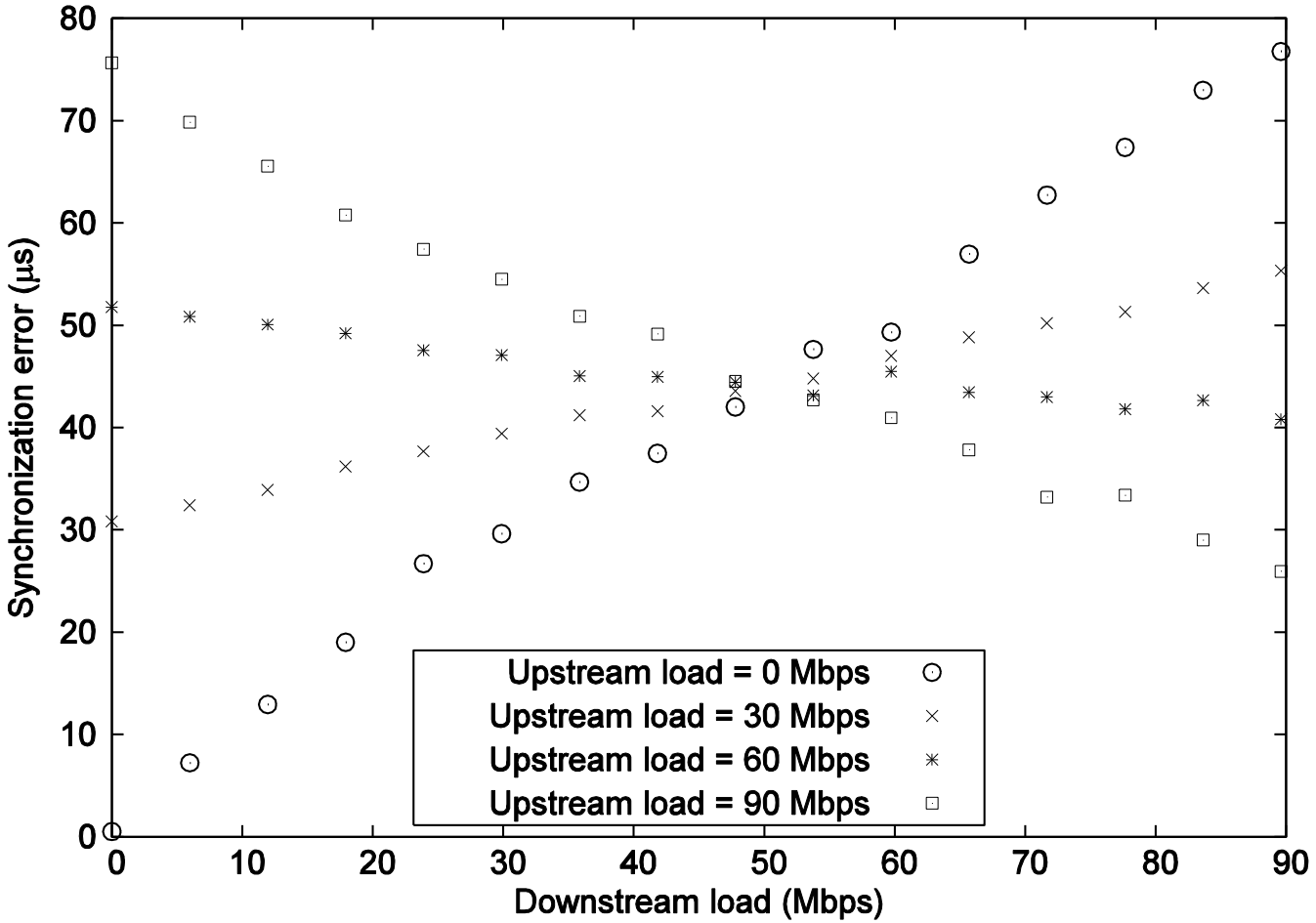


Fig.: Simulation model.

Simulation results – Without QoS



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 ?