

Simulation-based Evaluation of a Synchronous Transaction Model

for Time-Sensitive Software-Defined Networks

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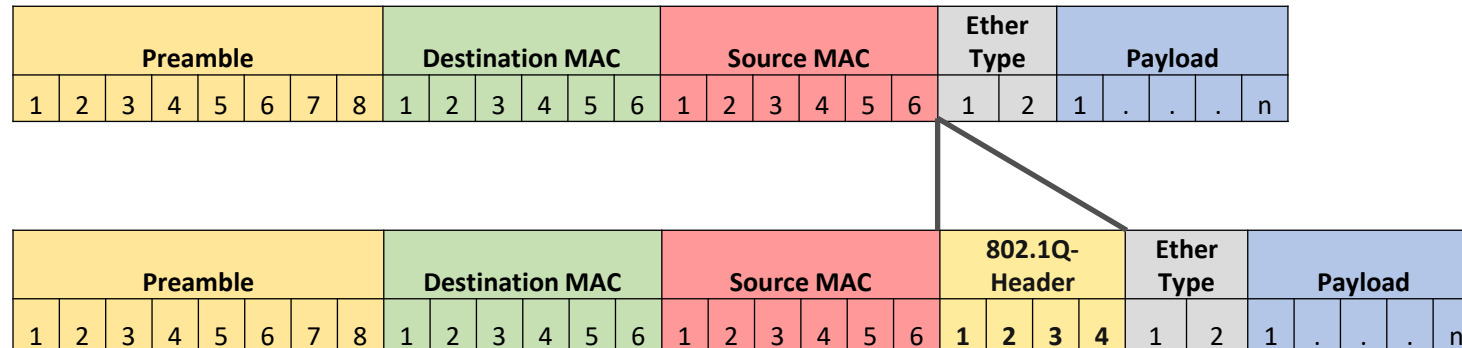
Conclusion and Outlook

Introduction



Time Sensitive Networking

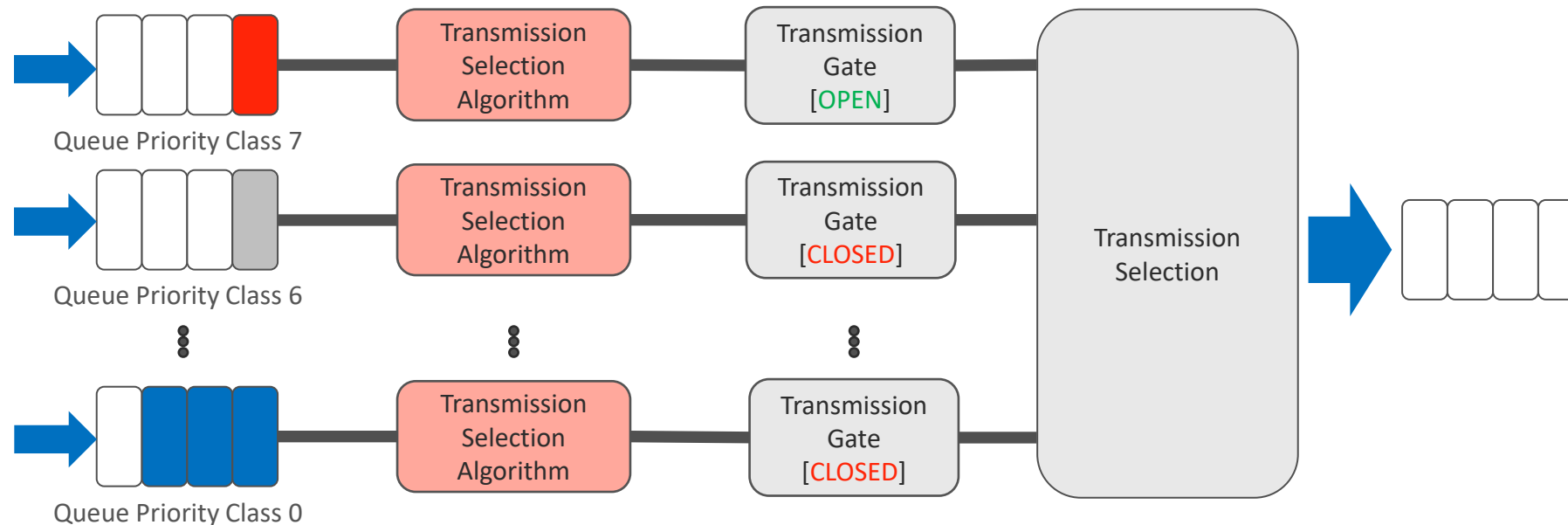
- Designed for industrial control equipment and vehicle communication networks
- Defined in IEEE 802.1Q
- Supports ethernet in real-time environments through time synchronization and traffic prioritization
- Bases on Ethernet frames with Q-Tag holding a VLAN ID and priority code point



Time Sensitive Networking

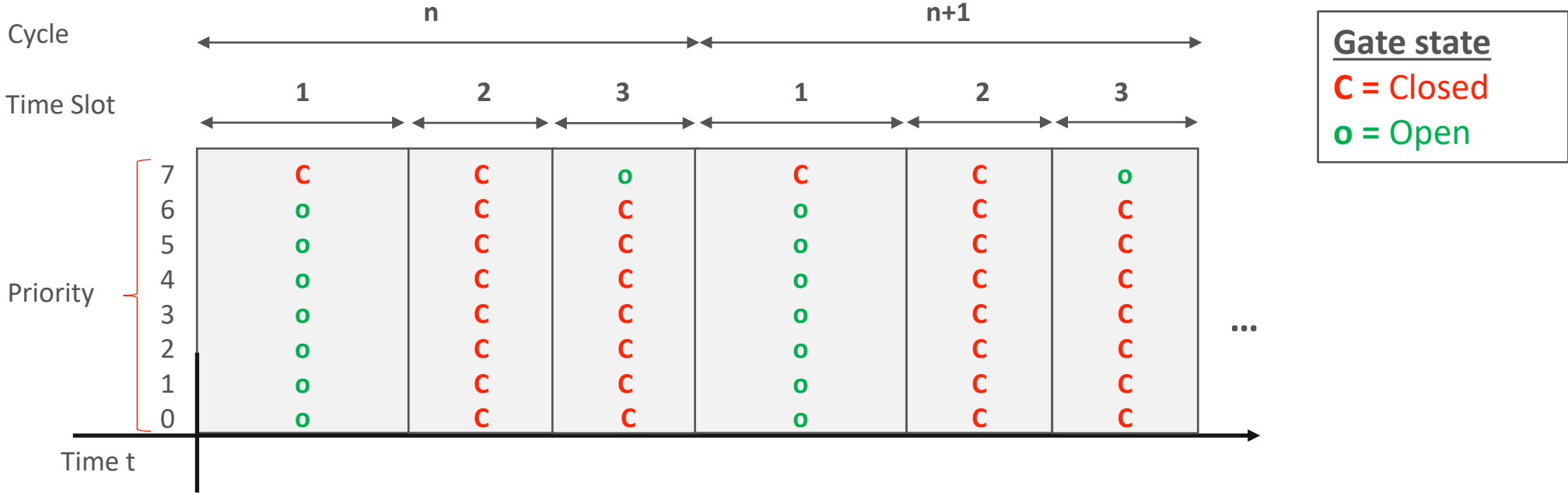
Frame Selector

- Each port has a frame selector instance to control the forwarding of packets according to QoS guaranties
- Different transmission selection algorithms can be used
- State changes of gates can be timed using a Gate Control List

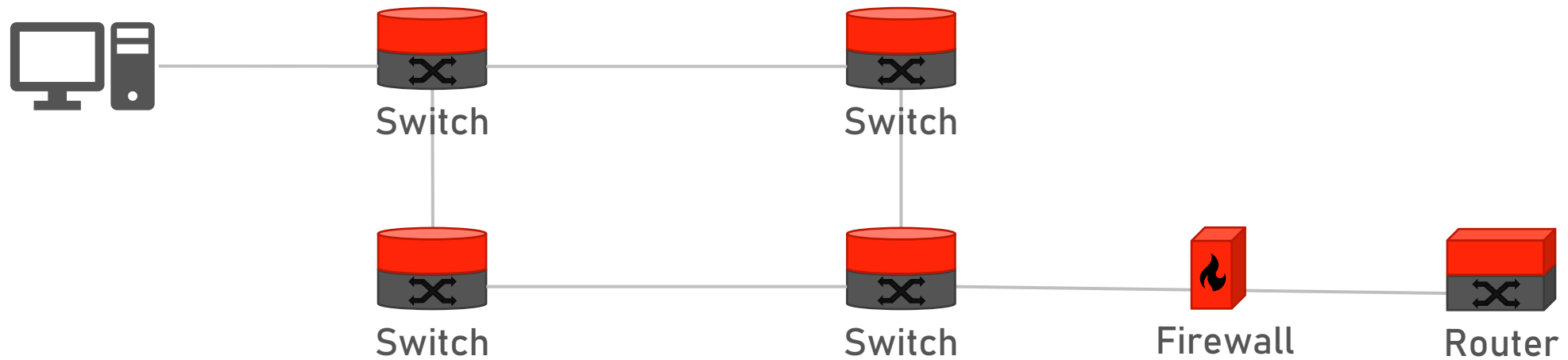


Time Sensitive Networking

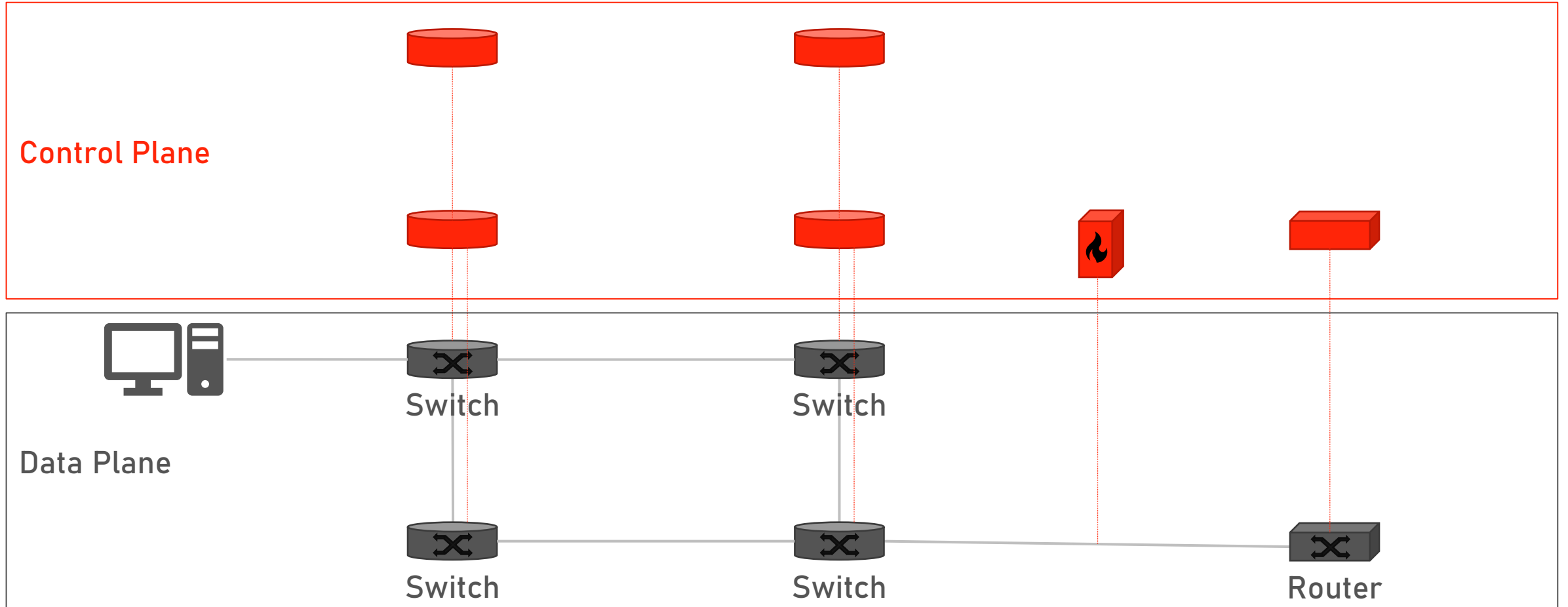
Gate Control List (GCL)



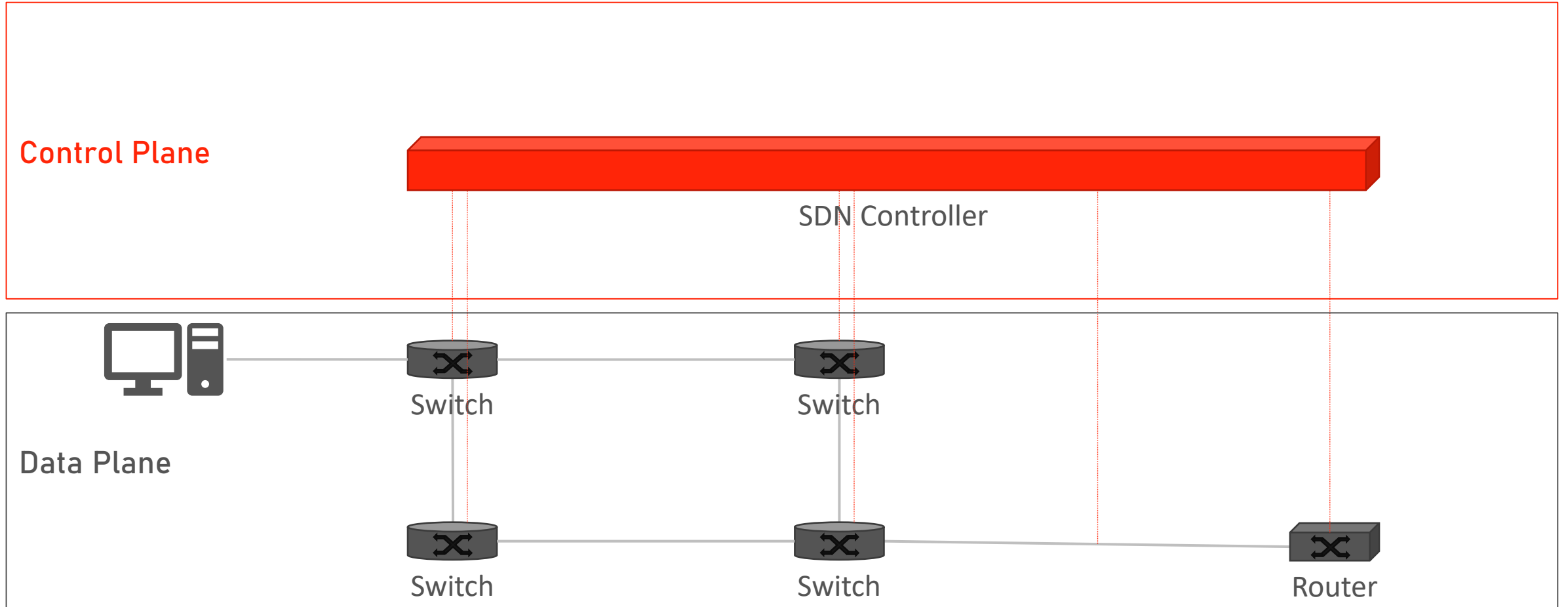
Software-Defined Networking



Software-Defined Networking



Software-Defined Networking



Transactions

A

Atomicity

C

Consistency

I

Isolation

D

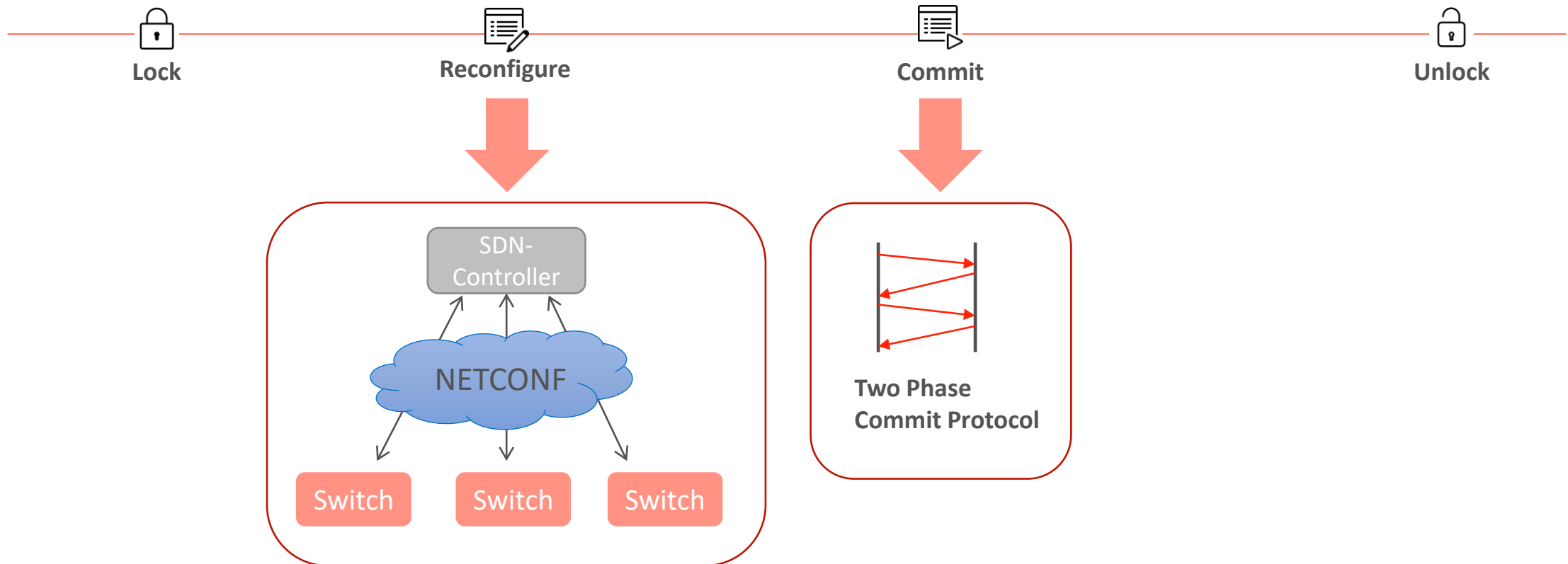
Durability

Concept

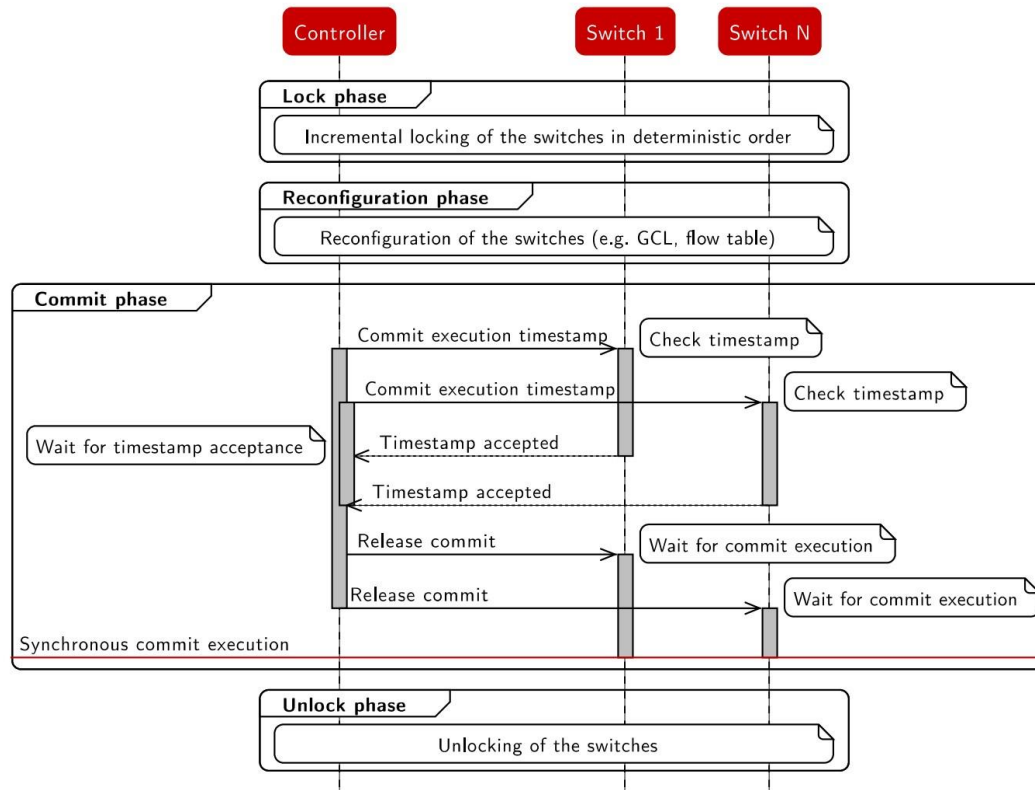


Overview

Four Phases



Example



Lock

- MAC-Address is used for ordering



Reconfigure

- Instantiate copy of running configuration
- Lock candidate configuration
- Apply reconfigurations to candidate configuration



Commit

- All devices are synchronized
- Commit execution timestamp is based on worst-case execution time of commit phase



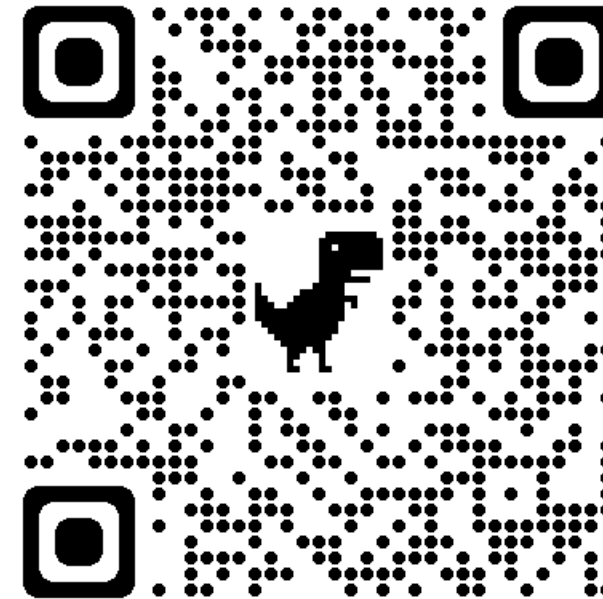
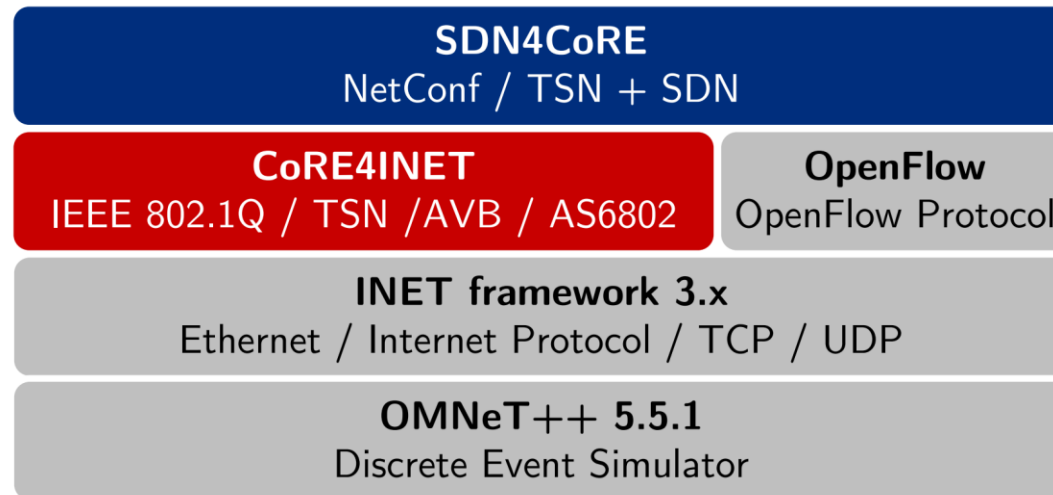
Unlock

- All acquired locks will be unlocked

Evaluation

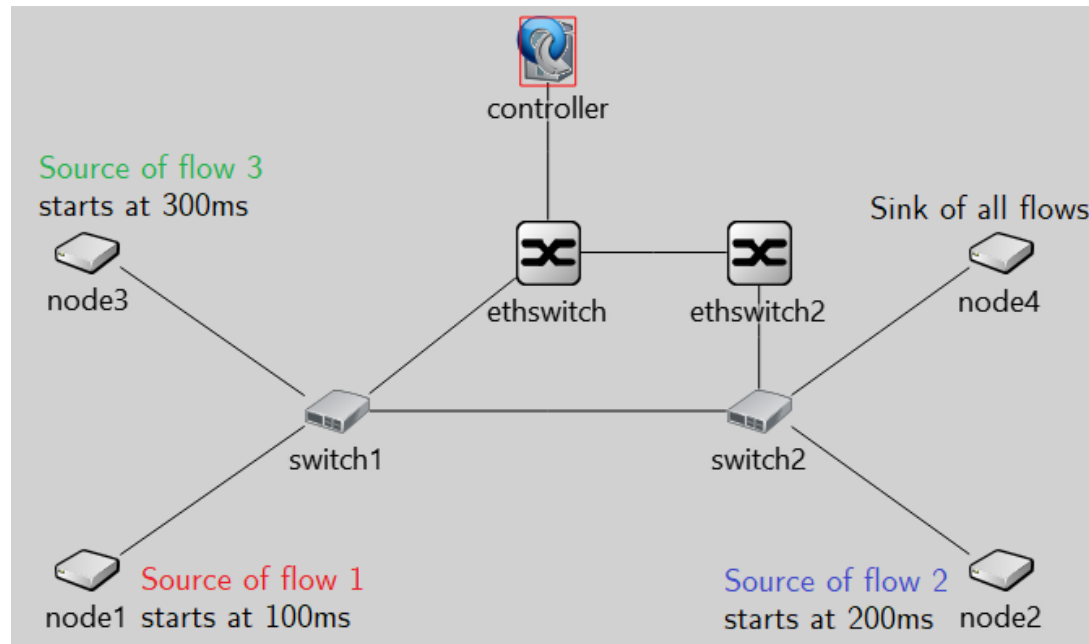


Simulation Environment



<https://github.com/CoRE-RG/SDN4CoRE>

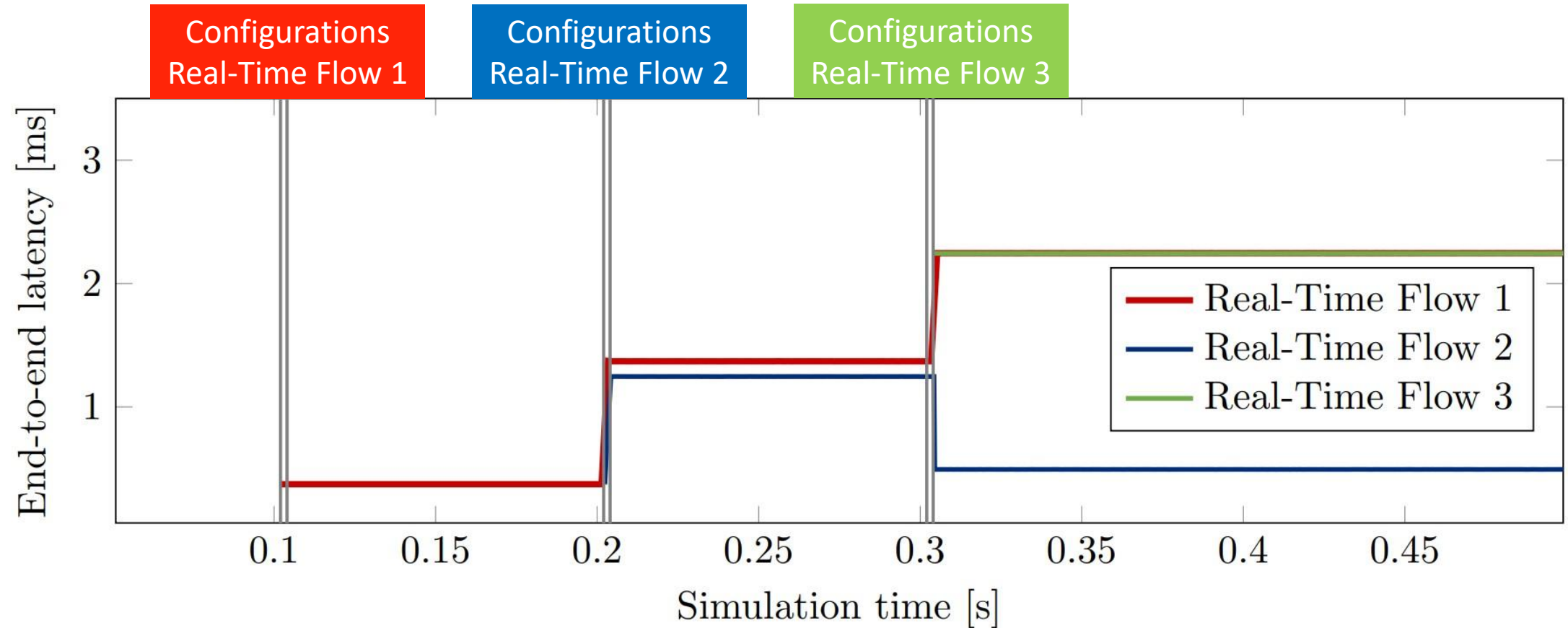
Evaluation Network



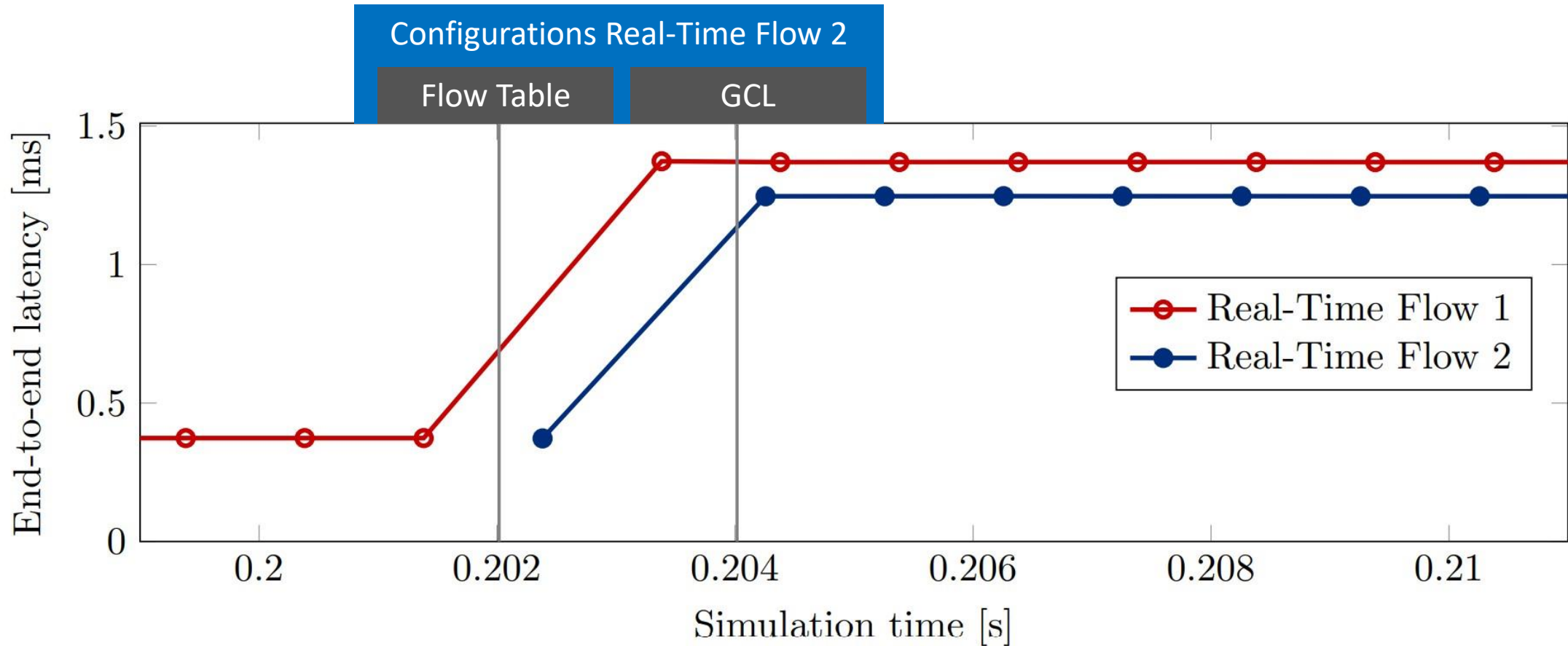
Network Details

- On all devices a TDMA schedule is used repeating every 1 ms
- Traffic at the nodes is started sequentially with an offset of 100 ms
- All traffic sources send one full sized Ethernet-frame every millisecond
- All packets share the same priority
- For each node two modifications are needed
 1. Add the new flow to switches flowtable
 2. Update GCL schedule on switches

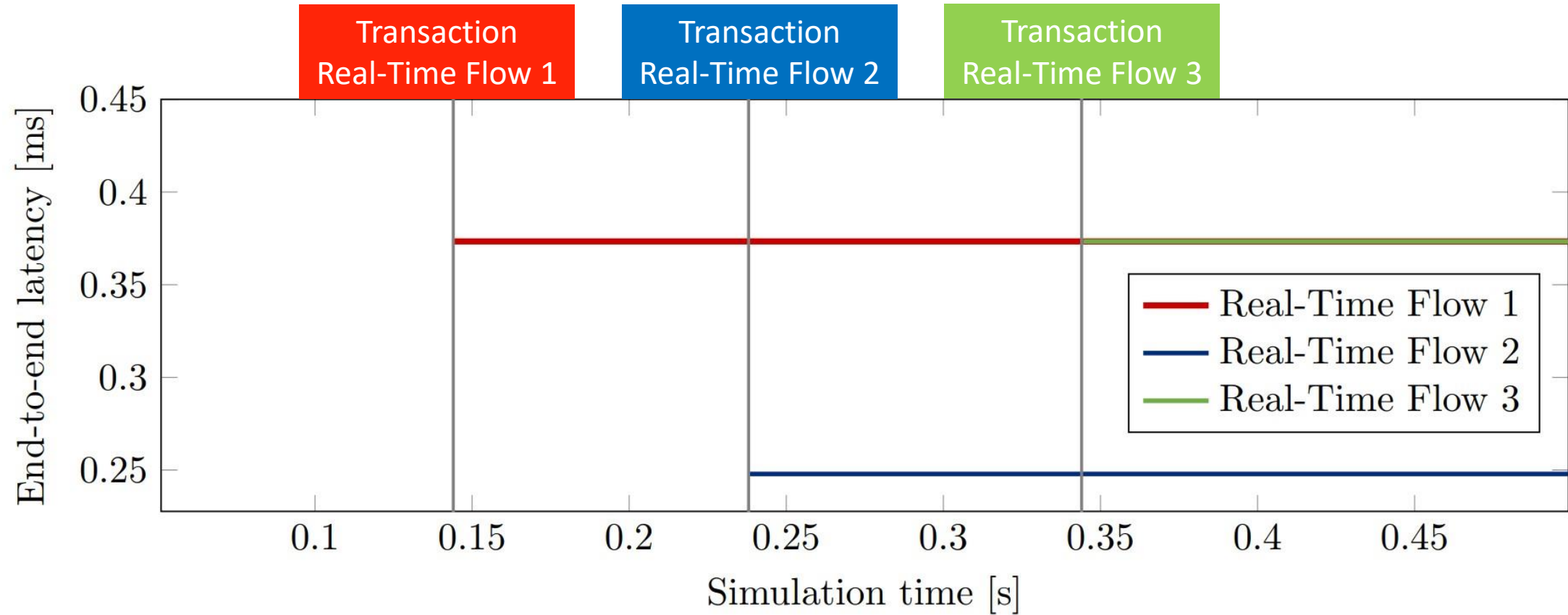
Non-Transactional Configurations



Non-Transactional Configurations



Time-Synchronous Transactions



Conclusions & Outlook

Conclusions & Outlook



- Non-transactional reconfiguration
 - May lead to inconsistencies causing increased latencies
 - **Not suitable for time critical traffic**
- Time-synchronous transactions
 - Don't affect latencies of real-time traffic
 - **Suitable for time critical traffic**



- Future Work
 - Investigate performance under various forms of modifications
 - Compare different forms of commit synchronization

Many thanks for
your interest and attention.

We'll be looking forward to your questions