Improvements in OMNeT++/INET Real-Time Scheduler for Emulation Mode

Artur Scussel, Christoph Brandauer, Georg Panholzer, Ferdinand von Tüllenburg
Performance Evaluation

- Question:
  - How precise is communication quality emulation (part. delay)?

Test 1: Ping to local Standard Host

Test 2: Ping over emulated Link

1 Gbps 10 ms delay (bidirectional)
Problem Evaluation - Results

Ping local (Test 1)
- Ping local test:
  - RTT range: [0.7, 22.1] ms
  - Average (Mean): ~11 ms
- Test w/o emulation:
  - Ping to eth1 (Host1)
  - RTT < 1 ms (all time)

Ping remote (Test 2)
- Ping remote test:
  - RTT range: [31.4, 60.8] ms
  - Average (Mean): ~44 ms
  - Expected RTT (Mean): ~21 ms
- Test w/o emulation:
  - Ping to Host 3 w/o emulation.
  - RTT < 1 ms (all time)
Demo I – Unmodified Version

ExtClient Example without Modification
Problem Analysis & First Enhancements

1. Issue: Incorrect Timeout Computation
   - RT Scheduler synchronizes event processing with wall-clock
   - Incoming / Outgoing Packets are induced in FES
   - Timeout Computation corrected and code optimized by A. Vargas and R. Hornig (by themselves)

2. Issue: Kernel pcap Buffering
   - Pcap Default:
     - Kernel buffers packets before passing to OMNeT++
   - Work around:
     - pcap immediate mode
     - Risk of increased packet loss

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Enhancements were integrated in INET 3.0 (actually INET 2.99.1)
Results

**Ping local (Test 1)**
- Ping local test:
  - RTT range [0.8, 1.3] ms
  - Average (Mean): ~1 ms

**Ping remote (Test 2)**
- Ping remote test:
  - RTT range [21.1, 22.2] ms
  - Average (Mean): ~21 ms

**But Packet Loss increases**
- Test: 10Mbit/s; packet size 100 Bytes (125 packets/s)
  - With immediate mode: 3.4% loss
  - Without immediate mode 1.6%

*Further studies needed*
Demo 2

Ping App

Ping Reply

Ping Request

EctClient Sim.

Peer
10.1.1.1

OMNeT++ Environment

Virtual Machine

ExtClient Example with Modification
Summary & Future Work

- **Starting Situation exhibits**
  - High Delays,
  - High Delay Variation

- **Issues found**
  - Incorrect Timeout Computation
  - Bugs in RTScheduler
  - Kernel pcap Buffering

- **Correcting these issues**
  - Enhances delay precision, responsiveness
  - Increases packet loss

- **Future Work**
  - Investigation of packet loss issue
  - Check other packet capturing mechanisms (e.g., PF_RING)
  - Multi-threading