NeST: Network Stack Tester

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Introduction

Network Experimentation
- Physical testbeds

Network Namespaces
- Virtualize network stack
- Complex virtual topologies can be created
- Minimal system resources

Existing tools
- Mininet
- Flexible Network Tester (Flent)
- Transperf
- Netesto
- TEACUP
NeST: Network Stack Tester

- Python package to simplify the process of network experimentation by using Linux network namespaces
- Intuitive APIs to: build a virtual network, run experiments and collect statistics
- Simplifies the process to reproduce network experiments
- Less physical resources, less error prone and less prerequisites
- Multiple instances of the same network topology can co-exist, and different experiments can be run in parallel on every instance
- Open source tool released under GPLv2 License
- Link: [https://nitk-nest.github.io/](https://nitk-nest.github.io/)

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Peer to peer topology

# Create two nodes
n0 = Node('n0')
n1 = Node('n1')

# Connect nodes and get corresponding interfaces
(n0_n1, n1_n0) = connect(n0, n1)

# Assign addresses to the interfaces
n0_n1.set_address('10.0.0.1/24')
n1_n0.set_address('10.0.0.2/24')

# Set link properties
n0_n1.set_attributes('5mbit', '5ms')

# Create an experiment named 'mytest' to run
# on the built topology
exp = Experiment('mytest')

# Add 1 flow from n0 to n1 from time t=0s to t=10s
exp.add_flow(Flow(n0, n1, n1_n0.get_address(), 0, 10, 1))

# Run the experiment
exp.run()
Peer to peer topology

1. Invoke topology related API
   - Create two nodes
     - \( n_0 = \text{Node}('n0') \)
     - \( n_1 = \text{Node}('n1') \)
   - Connect nodes and get corresponding interfaces
     - \( (n_0, n_1) = \text{connect}(n_0, n_1) \)
   - Assign addresses to the interfaces
     - \( n_0.n_1.set_address('10.0.0.1/24') \)
     - \( n_1.n_0.set_address('10.0.0.2/24') \)
   - Set link properties
     - \( n_0.n_1.set_attributes('5mbit', '5ms') \)

2. Request Engine to build topology with \text{iproute2}

3. Store mapping between user given names and NeST’s internal names

4. Invoke experiment related API
   - Create an experiment named ‘mytest’ to run
     - \( \text{exp} = \text{Experiment}('mytest') \)

5. Request Engine to run networking tools to create flows and obtain results
   - \( \text{exp.add_flow(Flow(n0, n1, n1.n0.get_address(), 0, 10, 1))} \)

6. Convert NeST’s internal names to user-given names while displaying results
   - \( \text{exp.run()} \)
Scope and Limitations

Scope
- Advanced traffic control
- TCP parameters
- Netperf, ss, tc
- Addition of new tools is easy (e.g., httpperf)

Limitations
- Effects of hardware level optimizations are not seen
- Lack of support for all implementations of network stacks
- Lack of advanced debugging functions
Motivation
How accurate are NeST results compared to a physical testbed?

▶ 4 CUBIC TCP flows from Node0 to Node1
▶ Two experiments run with two different qdiscs at Router: CoDel and FIFO.

Figure: Simple topology for NeST Validation
Experiment 1: Plots

CoDel

(a) cwnd: NeST

(b) cwnd: Physical Testbed

FIFO

(a) cwnd: NeST

(b) cwnd: Physical Testbed
Experiment 1: Plots

CoDel

(a) Throughput: NeST

(b) Throughput: Physical Testbed

FIFO

(a) Throughput: NeST

(b) Throughput: Physical Testbed
Experiment 1: Plots

CoDel

(a) Link Utilization

(b) Queue Backlog

FIFO

(a) Link Utilization

(b) Queue Backlog
Motivation

How does NeST perform in emulating and running experiments on a fairly complex topology?

Figure: Complex topology for NeST validation
Experiment 2: Plots

(a) \textit{cwnd}: NeST

(b) \textit{cwnd}: Flent

(a) Throughput: NeST

(b) Throughput: Flent

(a) RTT: NeST

(b) RTT: Flent
Experiment 2: Plots

(a) Link Utilization: Router0

(b) Link Utilization: Router1

(c) Link Utilization: Router3

To view other plots, please check: https://gitlab.com/nitk-nest/nest-anrw20
Epilogue

- NeST can be obtained from PyPI (Python Package Index)
- NeST is open source software. Contributions are welcome.
- Website: https://nitk-nest.github.io/

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