Topology Generation, Instrumentation, and Experimental Control Tools for Emulation Testbeds

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http://www.cs.purdue.edu/homes/fahmy/software/emist/

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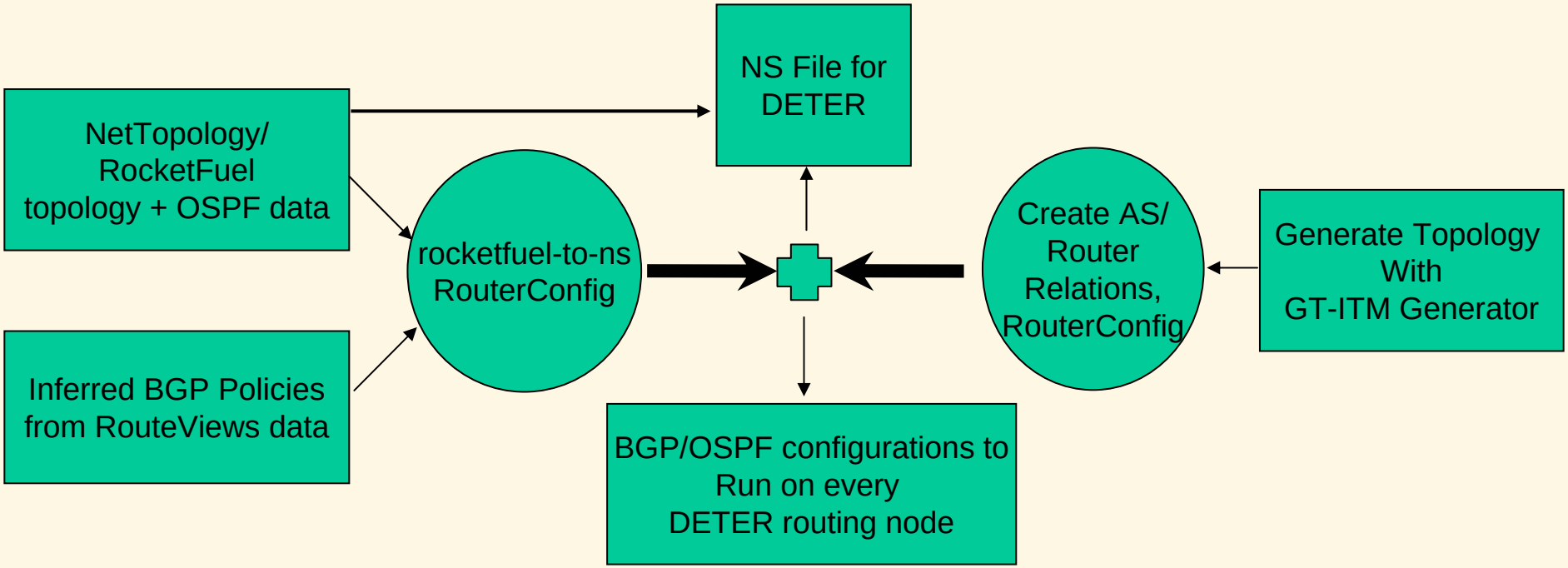
An Automated Experiment

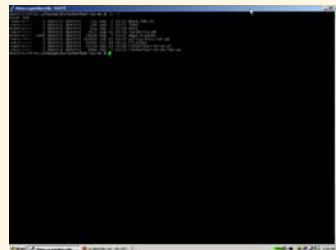
- Create a topology via a topology generator or based on available data. If applicable, create BGP/OSPF router configurations
- Create disk images on DETER with the desired tools and setup scripts
- Run an *event server* to which test nodes will attach
- Server triggers events, which are executed on test nodes. Loop capability allows easy iteration over experimental parameters
- Collected data is analyzed by scripts or can be interactively examined

Our Tools

- Can be found at http://www.cs.purdue.edu/homes/fahmy/software/emist/
- Topology generation and router configuration tools
  - From real data or generated topologies
- Scriptable Event System (SES)
  - Centralized experiment control
- Software link monitor
- Measurement and data integration tools, traffic generators, and other useful scripts

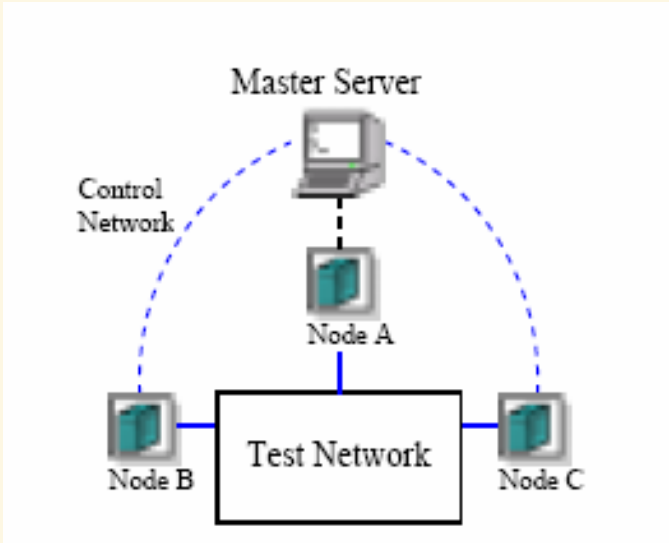
Topology/Routing Tools





Scriptable Event System

- A master application runs either on the main “users” account or on one of the test nodes.
- Communication between the master and experimental nodes is done via the control network that is free of experimental traffic.
- The server runs a script that defines the experiment:
  1. Starts measurements and configures software
  2. Launches attacks/benchmarks
  3. Once the benchmarks are complete, terminates the attack
  4. Copies local measurement logs to a central location

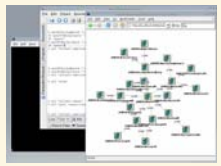


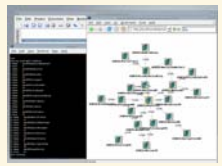
Sample Event Script

```
0 node0 node2 node3 r1 r2 "./tmeas -f /usr/local/tmeas.out"
1 "pause"
0 node2 "/usr/bin/ttcp -r > /dev/null"
1 "pause"
0 node0 node2 "rm /usr/local/dump.dmp"
1 "pause"
0 node0 node2 r1 r2 "sh /proj/DDoSImpact/exp/bell/scripts/dump.sh"
1 "pause"
5 node3 "./flood node1 -U -s10 -W160-1000 -D80000"
9 node0 "/usr/bin/ttcp -v -t node2 < /usr/local/f30m >/usr/local/ttcp.out!"
1 "pause"
0 node0 node1 node2 node3 r1 r2 "stop"
1 "pause"
0 node0 node2 r1 r2 "killall tcpdump"
1 "pause"
0 node0 "cp /usr/local/dump.dmp /proj/DDoSImpact/exp/bell/data/dump.node0"
0 node2 "cp /usr/local/dump.dmp /proj/DDoSImpact/exp/bell/data/dump.node2"
1 "pause"
0 node0 "cp /usr/local/ttcp.out /proj/DDoSImpact/exp/bell/data"
1 "pause"
0 node0 "cp /usr/local/tmeas.out /proj/DDoSImpact/exp/bell/data/tmeas.out.node0"
0 node3 "cp /usr/local/tmeas.out /proj/DDoSImpact/exp/bell/data/tmeas.out.node3"
0 node1 "cp /usr/local/tmeas.out /proj/DDoSImpact/exp/bell/data/tmeas.out.node1"
```

Measurement and Integration

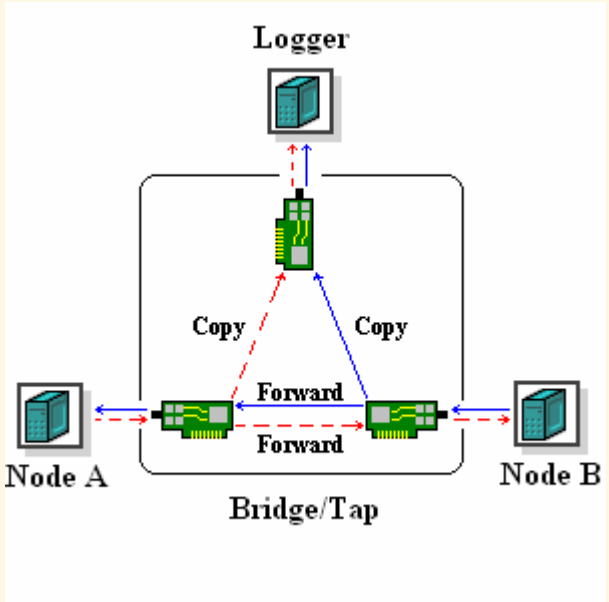
- Measurement of systems statistics at different points in the network can yield an understanding of what events are occurring in the entire network
- A tool based on a 1 second timer records CPU, PPSin, PPSout, BPSin, BPSout, RTO, Memory. The collected logs (plus routing logs) are aggregated and used to plot graphs via a collection of scripts
- TCP congestion window can be recorded on a per connection basis by reading the system files. Alternatively, it can be estimated from *tcpdump* files using *tcptrace*
- The data can also be displayed by the ESVT upon experiment completion, allowing easy graphical examination





Link Monitor

- An easy way to monitor links is to run tcpdump and drop counters on individual PCs
  - Tcpdump requires additional CPU processing
  - Drop counters are not always accurate, as they depend on the driver accuracy
- A software solution similar to a delay node can be placed on a link between two nodes
  - Two monitors can be used to find out what was dropped by comparing traffic in and traffic out
  - High traffic volumes require the tap/logger to be much faster than the test nodes
  - Extensive tests have shown that the tap can keep up with 148 Kpps, but tcpdump cannot



Future Work

- Short term:
  - Finalize and integrate tool suites
  - Add configuration options to tool suites
  - Further investigate ability to obtain/infer more complex BGP policies – perhaps through PREDICT
- Longer term:
  - Better understand scale down problem
  - Understand interaction between topology/routing policies and attacks/defenses