Emulation in ns

Presented by
Alefiya Hussain
What is Emulation

- Ability to introduce the simulator into a live network
- Application:
  - Allows testing real-world implementations
  - Allows testing simulated protocols
- Requirements
  - Scheduler support
  - Packet capture and generation capabilities
ns Tutorial 2002 3

Scheduler

- ns operates in virtual time using event-driven simulation
- Real-time scheduler
  - Does not advance the virtual clock to next event
  - Dispatches event at real-time
Emulation Objects

- Interface between ns and network traffic
- **Network Objects**
  - Access to live network via BPF and raw sockets
- **Tap Objects**
  - Conversion between ns and network packet formats

Capture: BPF

Inject: Raw socket
Modes of Operation

- Packet conversion leads to two modes of operation
- Opaque Mode
  Network packet fields are not interpreted by ns
- Protocol Mode
  - Network packet is interpreted
    - TTL values reflect hop count in simulator
  - Network packet fields are generated
    - Echo responder, TCP application
Opaque Mode

- Network packet is passed unmodified through simulator

<table>
<thead>
<tr>
<th>Source</th>
<th>Destination</th>
<th>Size</th>
<th>Data</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Ns packet contains a pointer to the network packet

Ns Tutorial 2002
Protocol Mode

- Network packet fields are generated by the simulator

Source
Destination
Size

The ns packet header is mapped onto the network packet header and visa versa.

Send/receive packets from ns
Network Packet

TCP Agent

Network Host A
TCP Application

Network Host B
Send/receive packets from application
Example: Setup

Goal: Make a ns TCP agent interact with a TCP server

A 192.168.1.1

- Disable IP forwarding
  `sysctl -w net.inet.ip.forwarding=0`
- Assign 10.0.0.1 and 6000 to TCP agent

B 192.168.1.2 port 8000

- Add route to dummy IP address
  `route add 10.0.0.1 192.168.1.1`
- Disable IP redirects
  `sysctl -w net.inet.ip.forwarding=0`

Switch
Example Script

set ns [new Simulator]
set entry_node [ns node]
set tcp_node [ns node]
set ns duplex-link entry_node \ tcp_node 10Mb 1ms DropTail
set tcp [new Agent/TCP/FullTcp]
set ns attach-agent tcp_node $tcp

Activate ns and Change to real-time scheduler
Create topology
Create TCP Agent
Example Script

```tcl
set capture_tap [new Agent/TCPTap];
set bpf [new Network/Pcap/Live];
set dev [bpf open readonly eth0]
set bpf filter "src 192.168.1.2 and src port 8000 
    and dst 10.0.0.1 and dst port 6000"
$capture_tap network $bpf;
$n s attach-agent Sentry_node $capture_tap;
$n s simplex-connect $capture_tap $tcp

set inject_tap [new Agent/TCPTap];
set ipnet [new Network/IP];
$ipnet open writeonly
$inject_tap network $ipnet;
$inject_tap advertised-window 512
$inject_tap extipaddr "192.168.1.2"
$inject_tap extport 8000
$n s attach-agent Sentry_node $inject_tap;
$n s simplex-connect $tcp $inject_tap
```

Capture & convert to ns format

Convert to network format & inject
Example Script

```
sn at 0.01 "tcp advance 1"
sn at 20.0 "exit 0"
sn run
```

```
start ns
```

TCP Server
(8000)

Switch

TCP Agent

BPF Raw Socket

A 192.168.1.1

B 192.168.1.2

TCP Server
(8000)

A 192.168.1.1

B 192.168.1.2

Switch
Applications

- Opaque Mode
  - Cross-traffic interaction leading to drop, delay and re-ordering of packets
  - End to end application testing
- Protocol Mode
  - Protocol and conformance testing
  - Evaluate effect of DDoS attacks
  - Wireless networks
Further Information

- [http://www.isi.edu/nsnam/ns/ns-emulation.html](http://www.isi.edu/nsnam/ns/ns-emulation.html)
- **Scripts ~ns/emulate**
  - **Opaque Mode:**
    - `em.tcl`
  - **Protocol Mode:**
    - `thrutcp.tcl`
    - `pingdemo.tcl`
    - `tcpemu.tcl`
- Fall K., *Network Emulation in the Vint/NS Simulator*, ISCC Jul 1999