The New NS2 Emulation Facility

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- NS2 is the simulation vehicle for the VINT project:
  - USC/ISI: Deborah Estrin, Mark Handley, John Heideman, Ahmed Helmy, Polly Huang, Satish Kumar, Kannan Varadhan, Daniel Zappala
  - LBNL: Kevin Fall, Sally Floyd
  - UCBerkeley: Elan Amir, Steve McCanne
  - Xerox PARC: Lee Breslau, Scott Shenker
- **VINT is currently funded by DARPA through mid-1999**

ns2 Architecture

- Discrete-event C++ simulation engine
  - scheduling, timers, packets
- Based on ns1 (S. McCanne and V. Jacobson)
- Split Otcl/C++ object "library"
  - protocol agents, links, nodes, classifiers, routing, error generators, traces, queuing, math support (random variables, integrals, etc)
- separate visualization tool ("Nam")
- used on many UNIXes, tested on Windows

Supported Components

- Protocols:
  - tcp (2modes + variants), udp, ip, rtp/rtcp, SRM, 802.3 MAC, 802.11 MAC
- Routing
  - global topology map, classifiers
  - static unicast, dynamic unicast (distance-vector), multicast
- Queueing and packet scheduling
  - FIFO/drop-tail, RED, CBQ, WRR, DRR, SFQ
- Topology: nodes, links Failures: link errors/failures
- **Emulation: plug simulator into live network**

New Emulation Facility
(note: *still under active development*)

- Generic which "tap" live networks
  - inject received packets into simulation
  - emit packets on to live network
  - associated with a "network object"
- Network Objects
  - Raw IP and UDP/IP network object
    - send/receive raw IP packets or UDP/IP
    - IP multicast support
  - pcap network object
    - send/receive link-layer frames
    - use tcpdump/pcap filtering language

Sample Environment

Proxy ARP for Laptop

DHCP for address/routing

Internet

Emulation Machine

Laptop
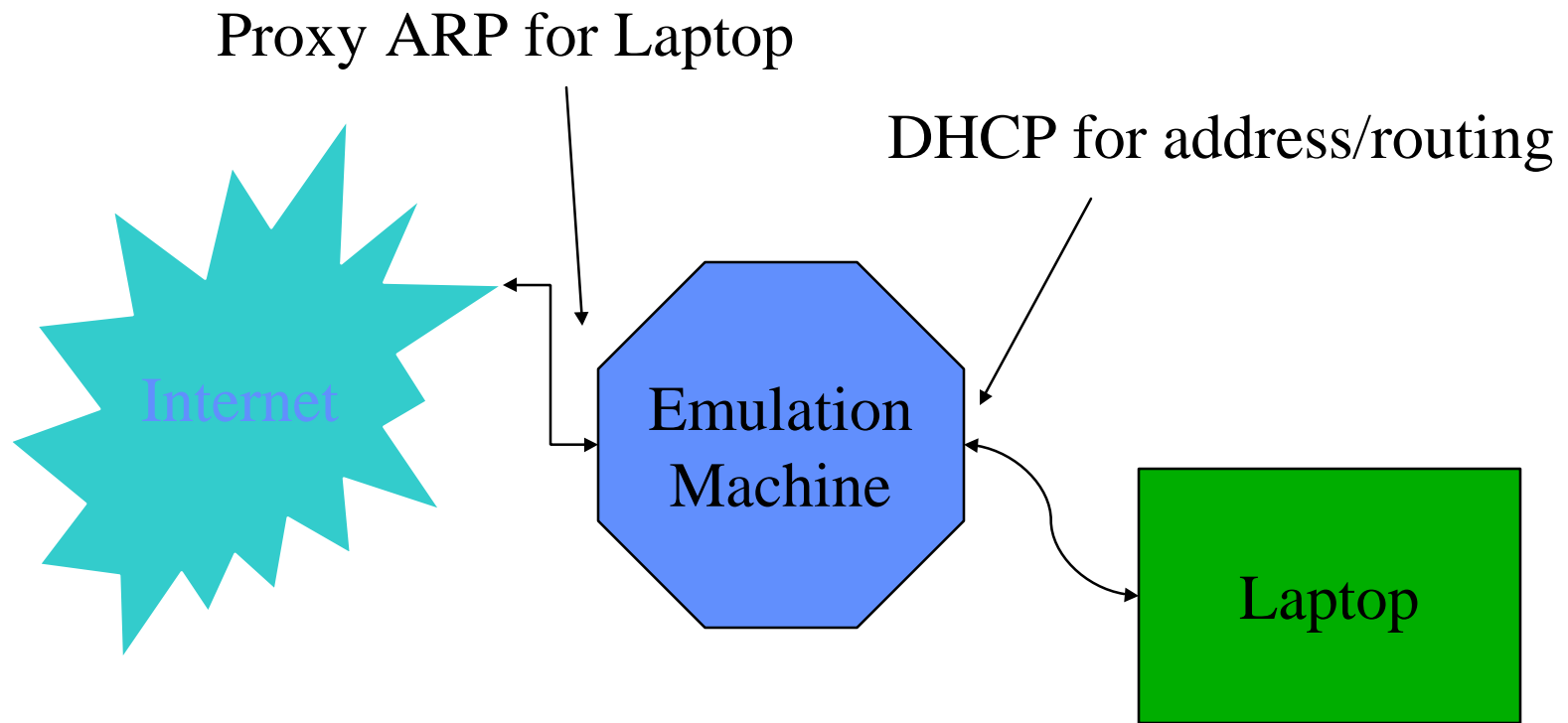
Emulation Machine
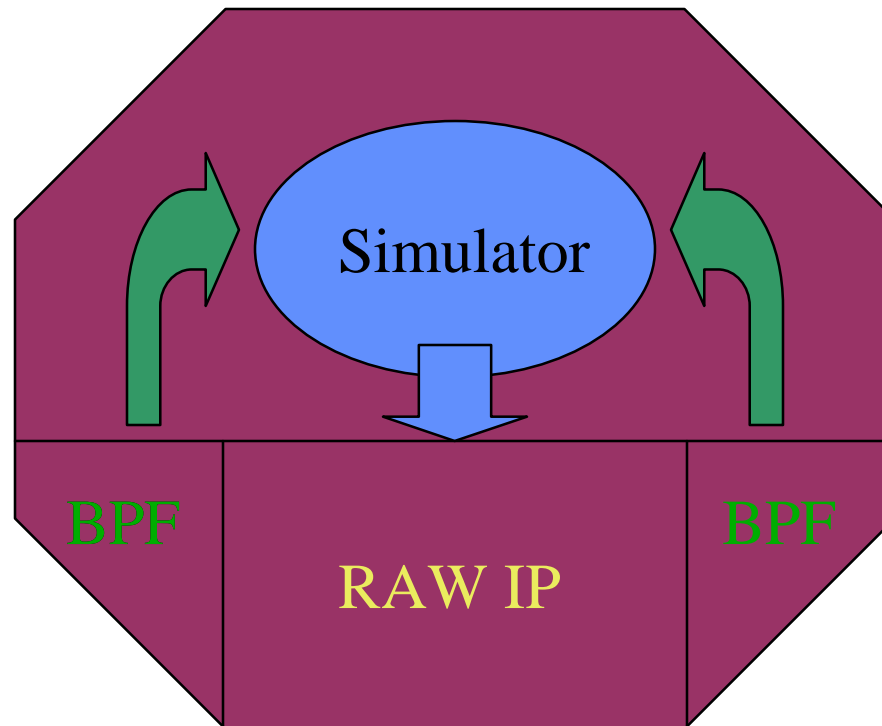
Sample Script

```
set ns [new Simulator]
$ns use-scheduler RealTime
set me [exec hostname]
set bpf0 [new Network/Pcap/Live]
$bpf0 set promisc_ true
set ipnet [new Network/IP]
set nd0 [$bpf open readonly fxp0]
$ipnet open writeonly
set filt "(not ip host $me)"
$bpf0 filter $filt
set a0 [new Agent/Tap]
$a0 network $bpf0
set n0 [$ns node]
$ns attach-agent $n0 $a0
```

TCP Results (10 packet periodic drop)
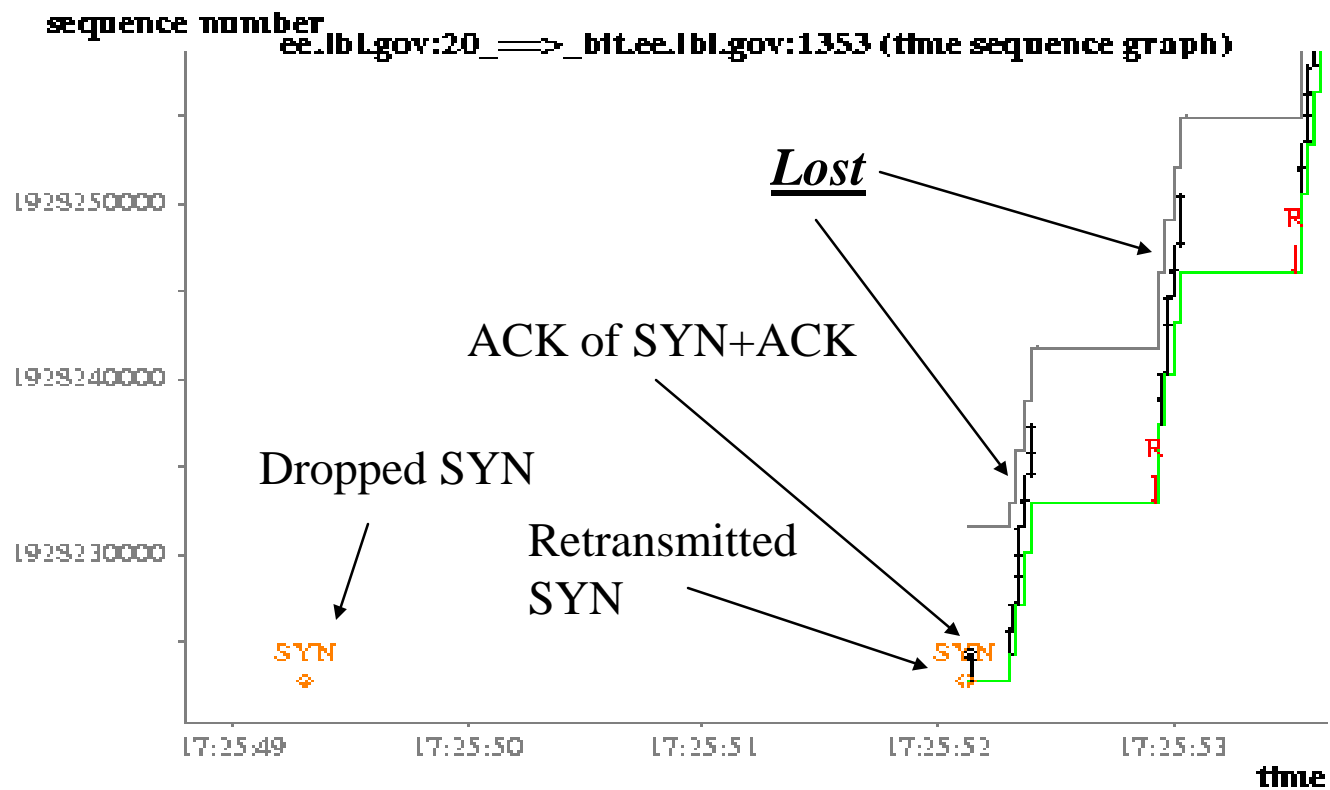
Relevance to TCP-IMPL

- Rich multi-protocol simulation environment
- Modular structure easily extended
- Traffic and error generation

Additional Information

- ## Web pages:
    - http://www-mash.cs.berkeley.edu/ns
    - http://netweb.usc.edu/vint
    - http://www.ito.darpa.mil/Summaries96/E247--USC_ISI.html
    - http://www.ito.darpa.mil/Summaries97/E243_0.html

- ## Mailing list:
    - majordomo@mash.cs.berkeley.edu
    - "subscribe ns-users"