Introduction to NS-2

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Outline

- NS-2 Internals
- Installation + Usage
- Troubleshooting
- Resources
- Q & A
What is the core of NS-2

- Discrete-event driven network simulation
- Object Oriented
- NS-2 is an extended Tcl (OTcl) interpreter
- NS-2 is written in C++ and OTcl
  - OTcl = Tcl + OO
  - C++ implements the code that executed frequently
  - OTcl configures the system
Platforms

- Most UNIX and UNIX-like systems
  - FreeBSD or *BSD
  - Linux
  - Sun Solaris
  - HP, SGI

- WINDOWS
  - Under Cygwin
Components of NS-2 package

- Tcl/TK: ns-2 is an extended Tcl interpreter
- OTcl: Object Tcl
- TclCL: Tcl with classes library
- NS-2
- nam-1: Network Animator
- xgraph: Plotting and Graphing
- And more....
NS-2 architecture

(picture from www.wikipedia.org)
## Pros & Cons

- Free
- Almost all network components are implemented
- Active contributions from researchers
- Easy to modify and/or add new functions
- Unreliable
- No technical support
- Hard to troubleshoot
- Unrealistic abstraction/model
- Contains bugs
LINKING OTCL AND C++
OTcl and C++: The Duality

(picture from www.wikipedia.org)
OTcl Linkage

set tcp [new Agent/TCP]

static class TcpClass : public TclClass {
    public:
        TcpClass() : TclClass("Agent/TCP") {}
        TclObject* create(int, const char*const*) {
            return (new TcpAgent);
        }
} class_tcp:
OTcl Linkage (III)

**bind()**: link C++ member variables to Otcl object variables

- **C++**
  ```cpp
  TcpAgent::TcpAgent() {
    bind("window_", &wnd_);
  }
  // bind_time(), bind_bool(), bind_bw()
  ```

- **Otcl**
  ```tcl
  $tcp set window_ 200
  ```

You must set the initial values of variants in 
~ns-2.34/tcl/lib/ns-default.tcl
OTcl Linkage (II)

**Command()**

- **Otcl**
  
  ```
  $tcp advance 10
  ```

- **C++**
  
  ```
  int Agent::command(int argc, const char*const* argv)
  {
      if (argc == 3) {
          if (strcmp(argv[1], "advance") == 0) {
              int newswq = atoi(argv[2]);
              return (TCL_OK);
          }
      }
      return (Agent::command(argc, argv));
  }
  ```
How ns-2 works

Register Event

Event Queue

Target object
Event (Packet)
Time

Deque

Scheduler

Dispatch

Object A

Dispatch

Object B
An Example

Wireless Channel

A

CBR

Transport

Network

LL

IFQ

MAC

NetIF

Scheduler

B

CBR Sink

Transport

Network

LL

IFQ

MAC

NetIF
Download Ns-Allinone

- Latest stable version: 2.34 (June 17, 2009)
- Download ns-allinone
  - http://www.utdallas.edu/~sara.arbabyazd/ns2
  - http://sourceforge.net/projects/nsnam/

Faster download on campus!
Installation

- ssh cs1.utdallas.edu
- wget http://www.utdallas.edu/~sara.arbabyazd/ns2/ns-allinone-2.34.tar.gz
- tar -zxf ns-allinone-2.34.tar.gz
- cd ns-allinone-2.34
- ./install
Please put /home/ryan/ns2/ns-allinone-2.34/bin:/home/ryan/ns2/ns-allinone-2.34/tcl8.4.18/unix:/home/ryan/ns2/ns-allinone-2.34/tk8.4.18/unix into your PATH environment; so that you'll be able to run itm/tclsh/wish/xgraph.

IMPORTANT NOTICES:

(1) You MUST put /home/ryan/ns2/ns-allinone-2.34/otcl-1.13, /home/ryan/ns2/ns-allinone-2.34/lib, into your LD_LIBRARY_PATH environment variable.
   If it complains about X libraries, add path to your X libraries into LD_LIBRARY_PATH.
   If you are using csh, you can set it like:
   setenv LD_LIBRARY_PATH <paths>
   If you are using sh, you can set it like:
   export LD_LIBRARY_PATH=<paths>

(2) You MUST put /home/ryan/ns2/ns-allinone-2.34/tcl8.4.18/library into your TCL_LIBRARY environmental variable. Otherwise ns/nam will complain during startup.

After these steps, you can now run the ns validation suite with——

```
cd ns-2.34; ./validate
```

For trouble shooting, please first read ns problems page http://www.isi.edu/nsnam/ns/ns-problems.html. Also search the ns mailing list archive
for related posts.
Environment Configuration

- Add environment variables
- nano ~/.bash_profile

```bash
export PATH=$PATH:/home/ryan/ns2/ns-allinone-2.34/bin:/home/ryan/ns2/ns-allinone-2.34/tcl8.4.18/unix:/home/ryan/ns2/ns-allinone-2.34/tk8.4.18/unix
export LD_LIBRARY_PATH=$LD_LIBRARY_PATH:/home/ryan/ns2/ns-allinone-2.34/otcl-1.13: /home/ryan/ns2/ns-allinone-2.34/lib
export TCL_LIBRARY=$TCL_LIBRARY: /home/ryan/ns2/ns-allinone-2.34/tcl8.4.18/library
```

- source ~/.bash_profile
Usage

- NS-2 Source code: ns-allinone-2.34/ns-2.34
  - C++ portion of NS-2
  - To rebuild NS-2 after modifying
    - `cd ns-allinone-2.34/ns-2.34`
    - `make all`

- Create an experiments directory
  - `mkdir ~/ns2_experiments`
  - `cd ~/ns2_experiments`
  - `wget http://www.utdallas.edu/~sara.arbabyazd/ns2/example2.tcl`
  - `ns example2.tcl`

If you change a header file (.h) run “make clean” first.
Demonstration (Contd.)

Scenarios:

- n0 sends packets to n5 at 0.5 second
- n1 sends packets to n5 at 2.5 second
- Link (n0,n4) is down at 3.0 second
- n0 redirects packets through n2
- Which cause congestion, some packets are dropped
- At 4.0 second, n1 stops
- Things get back to normal after that
## Trace File Format

<table>
<thead>
<tr>
<th>Event</th>
<th>Abbreviation</th>
<th>Type</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal Event</td>
<td></td>
<td>%g %d %d %s %d %s %d %d.%d %d.%d %d %d</td>
<td>double</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Int</td>
<td>Source Node</td>
</tr>
<tr>
<td></td>
<td></td>
<td>int</td>
<td>Destination Node</td>
</tr>
<tr>
<td></td>
<td></td>
<td>string</td>
<td>Packet Name</td>
</tr>
<tr>
<td></td>
<td></td>
<td>int</td>
<td>Packet Size</td>
</tr>
<tr>
<td></td>
<td>r: Receive</td>
<td>string</td>
<td>Flags</td>
</tr>
<tr>
<td></td>
<td>d: Drop</td>
<td>Int</td>
<td>Flow ID</td>
</tr>
<tr>
<td></td>
<td>e: Error</td>
<td>Int</td>
<td>Source Address</td>
</tr>
<tr>
<td></td>
<td>+: Enque</td>
<td>Int</td>
<td>Destination Address</td>
</tr>
<tr>
<td></td>
<td>-: Deque</td>
<td>Int</td>
<td>Sequence Number</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Int</td>
<td>Unique Packet ID</td>
</tr>
</tbody>
</table>

Ex: r 0.026198 0 4 rtProtoDV 6 ------ 0 0.2 4.1 -1 11
d 3.00771 0 4 cbr 500 ------ 1 0.0 5.0 54 95
Troubleshooting

☑ Problem while installing
  - Check known errors

☑ Program crashes/Tcl complains
  - Check tcl files for errors

☑ Unexpected results
  - Use gdb or any debug tool

☑ Hidden problem
  - Slice & dice the trace log

☑ TA does not fix your problems 😊
Resource

- http://www.isi.edu/nsnam/ns/
- **Manual & Tutorial**
  - http://www.isi.edu/nsnam/ns/ns-documentation.html
- **Mailing List**
  - http://www.isi.edu/nsnam/ns/ns-lists.html
- **Tcl**
- **OTcl**
  - http://bmrc.berkeley.edu/research/cmt/cmtdoc/otcl/tutorial.html
- **tclCL**
- **Slides:** http://www.utdallas.edu/~sara.arbabyazd/ns2