NS-2: A Free Open Source Network Simulator

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Simulation

Definition

A simulation imitates the behaviour of a system.

- Simulate when actual system is too:
  - Expensive, dangerous or time consuming to study
  - Complicated to model analytically
- Many areas use simulation:
  - Aerospace engineering
  - Electronic circuit design
  - Structural design
  - Computer networks!

Demo: A simple network simulation

Example

We want to connect Place 0 to Place 1 with a network cable. We know how much data we will be sending on the cable. What should be the minimum bandwidth if we are not to lose data?

- In the above case, we do not *really* need a simulation, since the calculation is simple.
- But, there can be more involved cases!
- Simulation environment: NS
- Visualization: NAM

NS - The Network Simulator

- Started as variant of REAL simulator (1989)
- Main participants:
  - VINT project at LBNL
  - Xerox PARC
  - UCB
  - USC/ISI
- Development funded by DARPA, NSF
- Significant contributions from user community
  - UCB Deadelus project
  - CMU Monarch project
  - Sun Microsystems
- Many contributions from all around the world that are not part of the distribution

NS - Basics

- NS is a discrete-event based simulator.
- A network is composed from:
  - Nodes
  - Links
  - Agents
  - Demo: building a simple network with NAM editor
- Examples of events:
  - An agent sends a packet
  - A node moves to another place
  - A link fails

NS: Internal Organization

- NS uses a *split programming* approach
- C++ when speed is required
  - Processing packets Implementing algorithms

  OTcl for combining components and configuration
  - Specifying a simulation

NS: Overview of a Simulation

1. Specify network configuration in an OTcl script
2. Specify traffic
3. Any other events at network components
4. Run NS
5. NS writes a log of events to a *trace file*
6. Analyze trace file for events of our interest.
7. Optionally, use a network visualizer like NAM

NS is used in . . .

- Research
- Education
- Network emulation
  - Introducing simulator elements into a real network
- Network protocol implementation
  - AODV-UU - simulator code formed basis for actual implementation

NS in networks research

- Papers at networking conferences routinely use NS for simulations
- Published research using NS in many areas of networking:
  - TCP
  - QoS
  - Scheduling in routers
  - Multimedia
  - Multicast
  - Internet Traffic Modeling
  - Web Caching
  - Wireless Sensor Networks
  - Mobile Ad hoc networks
  - Satellite Networks
  - Wi-Fi Networks

NS for teaching Computer Networks

- Homework assignments involving NS
  - Available on request for faculty from NS web page
- NAM animations to illustrate concepts in classroom
  - Small repository of instructional animations
  - Demo: Teaching TCP/IP with NS/NAM
- Possible class project: Develop scripts as teaching aid for textbook

TCP over IP

- IP - Internet Protocol
  - Demo: IP is best-effort, robust
- TCP - Transmission Control Protocol
  - Reliable, in-order delivery of packets
  - Demo: Stop and wait, sliding window, slow start

Installation

- `ns-allinone` contains the source for all of NS's components
- `ns-allinone-2.28.tar.gz` should be in the directory where you want to install NS
- `> tar -zxvf ns-allinone-2.28.tar.gz`
- `> cd ns-allinone-2.28`
- `> ./install`

Setting paths

- `> export LD_LIBRARY_PATH=$HOME/ns-allinone-2.28/otcl-1.9:$HOME/ns-allinone-2.28/lib:$LD_LIBRARY_PATH`
- `> export TCL_LIBRARY=$HOME/ns-allinone-2.28/tcl8.4.5/library:$TCL_LIBRARY`
- `> export PATH=$HOME/ns-allinone-2.28/bin:$PATH`

Running NS

- `> cd ns-2.28/ns-tutorial/examples/`
- `> ns example1a.tcl`
- Similarly, try running `example1b.tcl` and modifying it to get packet drops as demonstrated earlier.

Resources

- NS web page - `http://www.isi.edu/nsnam/ns/`
- NAM web page - `http://www.isi.edu/nsnam/nam/`
- NS for teaching - `http://www.isi.edu/nsnam/ns/edu/`
- Marc Greis' tutorial - a good place to start - `http://www.isi.edu/nsnam/ns/tutorial/`
- NS by Example - `nile.wpi.edu/NS/`
- NS for Beginners - `http://www-sop.inria.fr/maestro/personnel/Eitan.Altman/COURS-NS/n3.pdf`