Experimentation through simulation

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Outline

1. Experimentation

2. ns-3: decreasing cost
What is experimentation?

- Physical testbeds:
  - Cluster of ethernet networked machines
  - Set of laptops with wireless cards, on a desktop
  - Set of wireless motes in backpacks
  - Planetlab, ORBIT, Onelab, Emulab, ...

- Simulation:
  - ns-2, ns-3, nctuns, omnetpp etc.

- Emulation:
  - Coupling of simulation with physical testbeds or real world
The need for experimentation

You have designed a brand new algorithm (say, TCP Reno):
- Must explore parameter space
- Must verify that, once deployed, it won’t kill your network,
- Must perform a couple of performance measures
- Must verify that it works!
What is hard about experimentation

- Reproducibility: scientific methodology means that you must publish reproducible results
- Configuration: large scale experiments require a lot of configuration
- Instrumentation: need to gather data about the behavior of the experiment to figure out what happened
- Fidelity: did the experiment really capture the effects you are really interested in?
Simulation vs testbeds

- Simulation is:
  - Reproducible,
  - Easy to configure,
  - Easy to instrument,
  - Potentially unrealistic

- Testbeds are:
  - Potentially more realistic than simulation,
  - More or less reproducible (often less),
  - Hard to configure,
  - Very hard to instrument
The ideal workflow

1. A great idea,
2. Thorough simulation,
3. Thorough testbed experimentation,
4. Small-scale deployment,
5. Large-scale deployment
The ideal workflow

- Bright Idea
- Real World
- Simulation
- Modelization
- Implementation
- Experimentation
- Validation
Outline

1. Experimentation

2. ns-3: decreasing cost
Open source GPLv2 licensed
Website: http://www.nsnam.org
  - Code repository
  - Bug tracker
  - Mailing lists
  - Wiki
Simulation code and models in C++, python bindings
Releases: June 2008, Sept 2008, Dec 2008, ...
The key issue: cost of experimentation

- Simulation:
  - cost of model validation
  - cost of model implementation
- Cost of transition from simulation to testbed experimentation
- Cost of transition from testbed experimentation to deployment
Minimizing impedance mismatch

ns-3 model architecture close to real-world:
- multi-interface nodes
- real ip addressing
- socket API
- device API
- packets use on-the-wire buffer format
- natively support emulation
Experimentation through simulation

### Topology modelization

- **Node**: represents CPU+RAM+I/O
- **NetDevice**: represents network card plugged in Node I/O. Encapsulate layer 1+2.
- **Channel**: represents communication medium between a set of network cards
- **Socket**: communication endpoint above layer 2
- **Application**: generate or receive traffic to or from a set of sockets
Topology Modelization
Write once, run everywhere

- POSIX socket application:
  - can be run in simulation (ns-3-simu)
  - can be run in testbed
  - can be deployed

- Kernel network stack:
  - can be run in simulation (ns-3+nsc)
  - can be run in testbed
  - can be deployed
A typical experiment

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Experimentation through simulation
The need for testbeds and simulators
Experimentation is hard and costly
ns-3 attempts to minimize the cost of experimentation
ns-3 is open source: get it and play with it
Shameless plug

We are hiring: positions available to work on ns-3:
- master-level internships
- post-doctoral positions
- junior and senior engineers

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Questions?

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