Graduate Network Assignments with GENI

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Introduction

We will discuss four things today:

- The state of networking coursework at Purdue pre-GENI
- How GENI infrastructure relates to that coursework
- Two specific assignments centered around GENI resources
- Challenges in developing and supporting GENI coursework

Computer Networking Courses at Purdue

- Undergraduate: Junior/Senior for the Systems/Security tracks
  Typical projects:
  Chat, VoIP, P2P file sharing applications

Computer Networking Courses at Purdue

- Graduate:
  Introduction to networking (Kurose-Ross text + papers + online resources)
  Typical projects:
  - Web server/client, simple TCP, simple routing protocol
  - Small project of student's choice
- Special topics and advanced courses (mostly papers + online resources)
  Project(s), typically of student's choice

Resources We Used

Typical undergrad/grad programming assignments involve 3-4 machines in the same lab

Small scale limits testing/evaluation that can be conducted

Projects selected by student (groups) have used:

- Data analysis (e.g., RouteViews)
- Simulators
- Small local testbeds (e.g., MAP, sensor motes)
- Emulab
- DETER
- PlanetLab
- ORBIT

Expanding Horizons with GENI

Even at a large University, external resources can be critically valuable.

- Huge testbed environments (Emulab, DETER, *etc.*)
- Internet-distributed infrastructure (PlanetLab)
- Heterogeneous resources
- …

GENI provides all of this in one package.

GENI Assignments

We have designed graduate networking assignments that take advantage of GENI resources to provide a more complete experience.

- Internet datapaths via PlanetLab nodes
- Emulated links via ProtoGENI delay nodes
- Intelligent switching via OpenFlow switches

Philosophy

Students do not necessarily have much “real world” experience.

Start them off easy with emulated networks and predictability.

Then, introduce them to the wild and woolly Internet.

Assignments

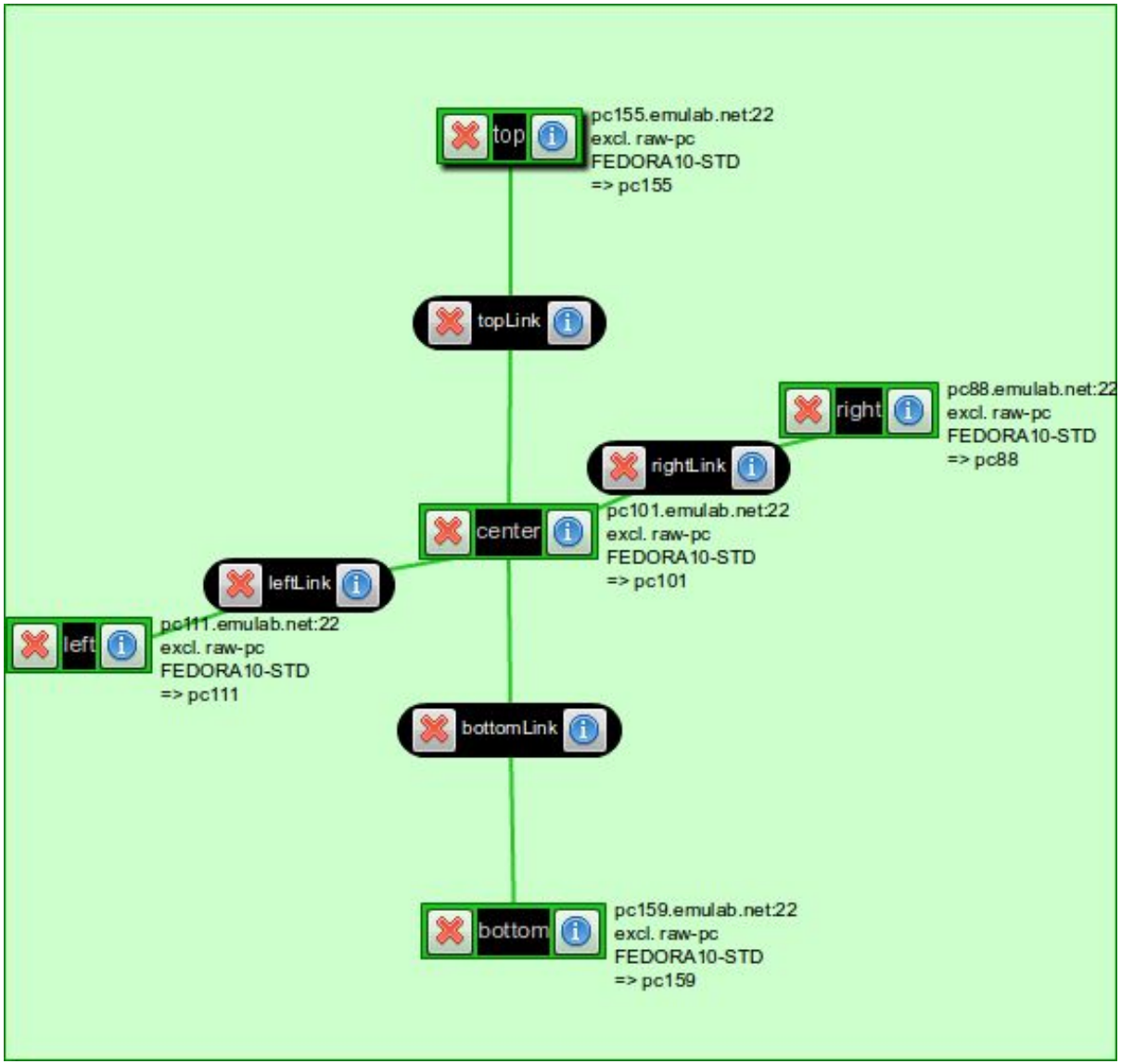
We will discuss two assignments here:

- TCP Congestion Control
- OpenFlow Networking

TCP Congestion Control

Students learn about congestion control by doing.

- Explore goodput, fairness, convergence
- Learn about loss and delay effects
- Implement a modified NewReno loss recovery
- Compare their algorithm to NewReno and CUBIC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TCP_exp

Two algorithmic changes from NewReno:

During slow start,

$$cwnd = cwnd + \min(2 \times N, 2 \times SMSS)$$

Entering loss recovery,

$$ssthresh = \max(3 \times FlightSize/4, 3 * SMSS)$$

OpenFlow

Students learn about OpenFlow by implementing an OpenFlow controller.

- Understand the OpenFlow protocol
- Explore the relationship between controller and device
- Push against the limitations of flow management
- Implement a distributed control loop

Firewalling with OpenFlow

Student controllers examine only the first packet of a flow.

Wildcards, TCP semantics, and OpenFlow timers manage traffic at the switch.

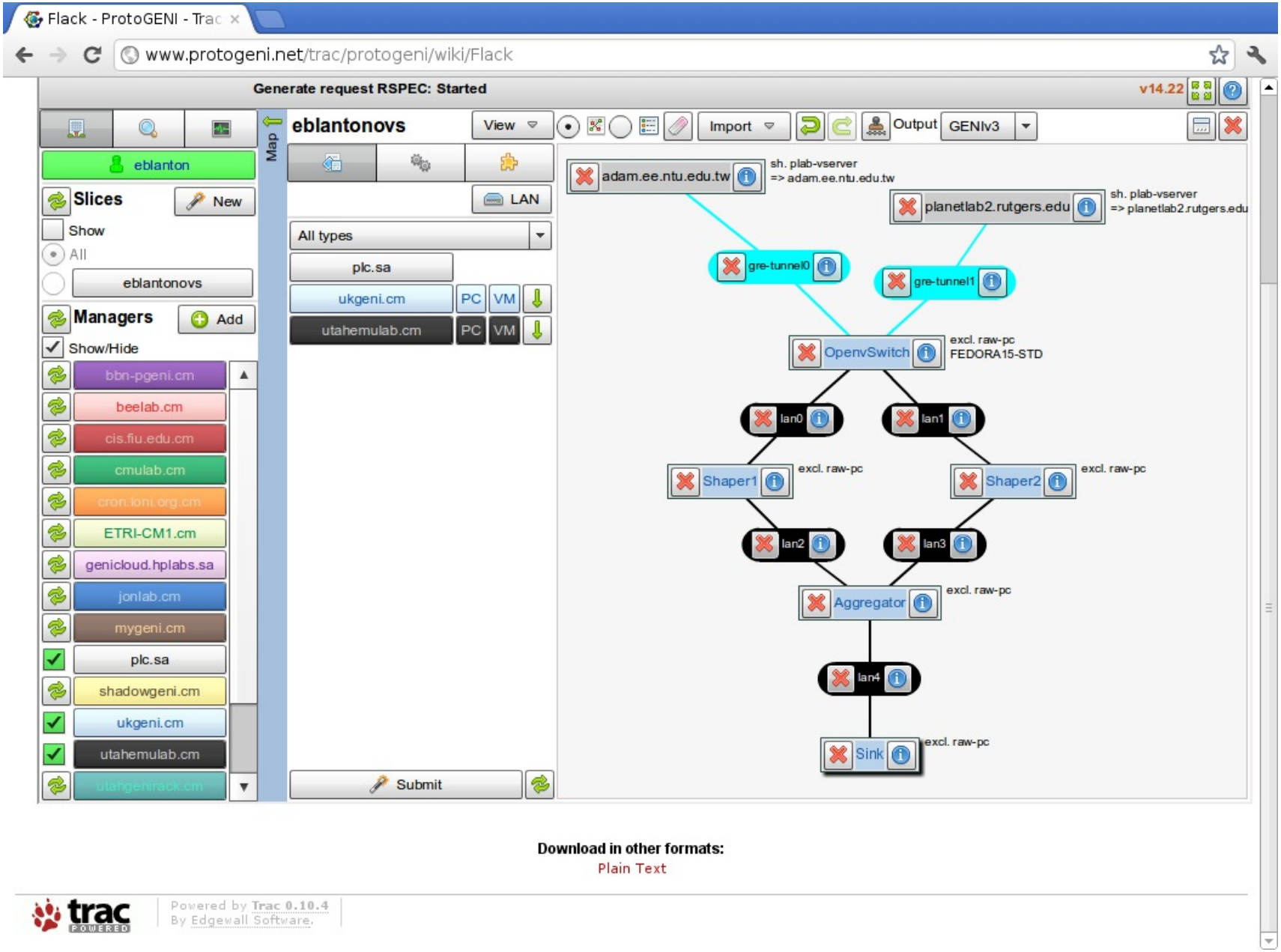
The complete implementation is tiny; the goal is an introduction to OpenFlow and related concepts.

Dynamic Load Balancing

Students develop an OpenFlow controller to load balance between dissimilar paths.

"Balance" is determined by empirical measurement.

Student controllers try to achieve high utilization with minimal queuing delays.


Flack - ProtoGENI - Trac
www.protogeni.net/trac/protogeni/wiki/Flack
Generate request RSPEC: Started
v14.22
eblantonovs
View
Import
Output
GENIv3
Map
eblanton
Slices
New
Show
All
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Aggregator
excl. raw-pc
lan4
Sink
excl. raw-pc
Download in other formats:
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trac
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By Edgewall Software.

Assisting Instructors

The Usual Suspects

- Objectives
- Prior knowledge
- Effort required
- GENI Overhead

GENI Overhead

Much of the time spent developing our assignments is in assessing GENI-related effort.

We try to provide instructor guidance on using GENI and assisting students with GENI.

GENI-specific pitfalls to be aware of, GENI resource constraints, *etc.*

Pitfalls? Constraints?

What sort of pitfalls have we encountered?

- Differing behavior across aggregates
- Stale or incomplete documentation (getting better!)
- Bugs in management software
- Changing versions over time

Questions

Thank you for your attention.

`http://groups.geni.net/geni/wiki/ScalableMonitoring`