Motivation

• Dissertation research:

An Investigation of the Effects of Application Workload Modeling and Path Characteristics on Network Performance
Number of Active Connections

- Same traffic input
- Same path characteristics
- Different application models
- **Very different outcomes!**

- **Modeling endpoint latencies** significantly affects the number of active connections in the network
Experimental Design

Different application workload models

Different Round Trip Time methods

Four performance metrics:
- Connection duration
- Response time
- Router queue length
- Active connections

Two traffic inputs: UNC and IBM

Two network environments: unconstrained and constrained
Research ➔ teaching

• Significant methodological advances in empirical networking research

• Built large-scale collaborative research testbeds, including the GENI infrastructure

• But these resources have yet to make their way into our classrooms and textbooks

• Why? ➔ we lack a coherent, shared view of best practices in networking research
Target students

• A second networking course for those who pursue:
  • a career in industry developing networking protocols and devices, or
  • an academic / research career in networking
• Focus: methodology of network experimentation
• Topic areas include network design, network measurements, data analyses, traffic modeling and generation, and network performance.
Course Design

• Learning experience with two primary goals:
  • Conceptual understanding of the various research methods used in empirical networking research, and
  • Grappling with the process of solving problems by performing two hands-on projects
Course Design

• Part I: Overview of key topics – protocol design, network architectures, congestion control, performance evaluations.

• Part II: Methodological issues pertaining to measurement, modeling, traffic generation, simulation and emulation, and basics of control theory.

• Part III: Project-based – two projects.
Projects - methodology

- Define the problem
- Design experiments
- Design the experimental testbed
- Identify methods of generating traffic
- Detail the process of running experiments
- Collect and analyze experimental data
- Write a brief report
Projects

• Laboratory project
  • Experiments on a testbed in a controlled environment.

• GENI-based project
  • Experiments using one of the GENI testbeds or a GENI cluster
GENI (Global Environment for Network Innovations)

- Support at-scale experimentation on shared, heterogeneous, highly instrumented infrastructure
- Enable deep programmability throughout the network, promoting innovations in network science, security, technologies, services and applications, and
- Provide collaborative and exploratory environments for academia, industry and the public to catalyze groundbreaking discoveries and innovation.
Laboratory Project - Controlled environment

- Design experiments
- Calibrate the network
- Traffic generation
- Variables in an experiment
- Measurement methodology
- Performance metrics
- Trade-offs
- Analyses and presentation of results
GENI-based Project – experiment in the “wild”

- Different learning experience
- Remotely controlled: reserve, configure, program, and operate distributed systems across the GENI clusters
- Wealth of network environments and infrastructure
GENI-based Project – experiment in the “wild”
Repository for educators

- Traffic datasets
- Tools for traffic generation
- Manuals for GENI cluster usage
- Pretested modules for network experimentation
Best practices in “experimental methods for networking research”

Teach such a course and write the textbook on it
Thank you!

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