

Education Experiences with GENI

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Computer Science & Electrical Engineering
University of Missouri – Kansas City

March, 15th 2017

GENI GEC 25



UNIVERSITY OF MISSOURI-KANSAS CITY



Nov. 2011

With Deep Medhi



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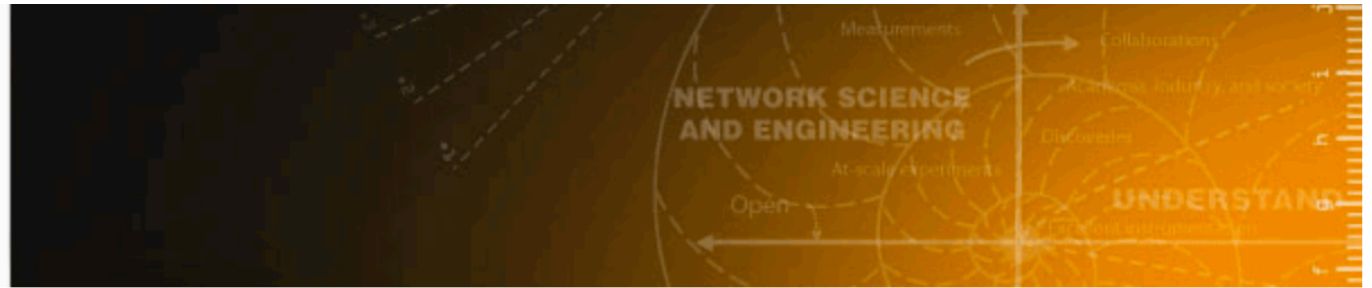
GEC12 Agenda

General

Day	Time	Topic	Location	Leader	Links
Wed	7:30 am - 4:30 pm	Registration			
Wed	noon - 4:30 pm	GPO "Office Hours" (by appt only)	<i>upon request</i>	GPO	more info
Wed	5:30 - 7:30 pm	Demo & Networking Event	UMKC Student Union	GPO	more info
Thu	7:30 am - 5:30 pm	Registration			

Plenary Sessions

Day	Time	Topic	Location	Leader
Thur	8:30 - 9:30 am	Plenary Session: GENI Updates		Chip Elliott, C
Thur	9:30 - 10:00 am	Break		
Thur	10:00 - noon	Plenary Session: US Teri		Carl Tappan



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Project Number

1595

Project Title

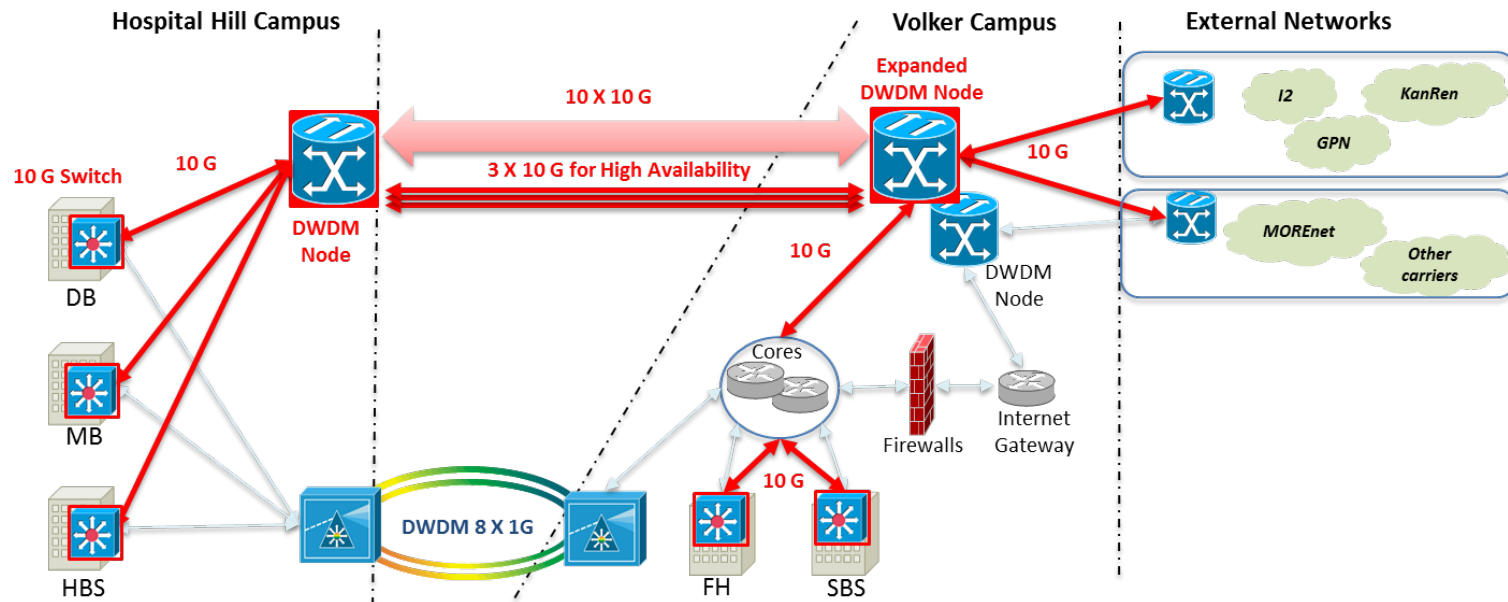
Great Plains Environment for Network Innovation
a.k.a. GpENI

Technical Contacts

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Co-I: Andrew Scott, Lancaster University, ✉ acs@comp.lancs.ac.uk

CC* DNI

- CC*DNI Networking Infrastructure: Data Driven Research-Wise Network Infrastructure Upgrade (“DaRWiN”)



CC* DNI

Benefited Research Activity	Location	DaRWiN Usages
End-to-end campus network performance management	Computer Science and CIO, <i>Volker Campus</i>	Network management research along with perfSONAR over Science DMZ
Large data movement service research	Computer Science , <i>Volker Campus</i>	Dedicated large data transfer testing & external research collaboration
Chemical fingerprinting and sequencing research	School of Biological Sciences , <i>Volker Cam.</i>	Visualization, cloud access & hosting outside collaboration
Computational physics and electronic structure research	Physics , <i>Volker Campus</i>	HPC, education, & external access
Human Balance and Ambulation research	Mechanical Engineering , <i>Volker</i>	Data sharing & external collaboration
vivaCT40 scanning system research	School of Dentistry , <i>Hospital Hill Campus</i>	Data storage, regional core access, & external collaboration
Confocal Microscope Core research	School of Dentistry , <i>Hospital Hill Campus</i>	Data center access & external collaboration
Muscle Biology Research Group (MUBIG) research	School of Nursing , <i>Hospital Hill Campus</i>	Inter-campus data sharing & external data access and collaboration
Biomedical data analysis projects	School of Medicine , <i>Hospital Hill Campus</i>	Visualization, education, & external data access and collaboration

security
computing
performance modeling
software-defined traffic
management **Network**
protocols **Internet-of-Things**
measurement **algorithms**
analysis **Data** **networks**
systems storage
Cloud

Courses Benefited

Semester	Course Name	Enrollments
Fall 2011	CS 5520 Network Architecture-I	28 (grad)

Spring 2014	CSEE 5110 Network Architecture-I	62 (grad)
Fall 2014	CSEE 5110 Network Architecture-I	58 (grad)
Fall 2014	Cloud Computing	15 (grad)
Spring 2015	CSEE 5110 Network Architecture-I	67 (grad)
Fall 2015	CSEE 5110 Network Architecture-I	93 (grad)
Fall 2015	Cloud Computing	36 (grad)
Spring 2016	CSEE 5110 Network Architecture-I	68 (grad)
Fall 2016	CSEE 5110 Network Architecture-I	64 (grad)
Spring 2016/2017	CS 423 Client Server Programming	15 (undergrad) 30 (undergrad)

UMKC Courses Benefited So Far

- CSEE 5110 Network Architecture-I
- CS 5525 Cloud Computing
- CSEE 5113 Network Routing (GpENI)
- CS 423 Client Server Programming

- > 15 Course Offerings
- Total > 600 students

Thanks GENI-GPO/Community!

- TA Webinar trainings
- Summer camps
 - 6 students (including 3 female students)
- Summer interns
 - 2
- Vic Thomas, talk at CANSec, UMKC – introducing GENI for networking and security research, Spring 2015

Class Introduction of GENI

- TA runs a 1hr tutorial in the classroom to demonstrate concepts
 - Lab zero
 - Students are encouraged to bring their laptop
- Project
 - **Groups** of 2~3
 - Resource availability issues
 - Computer Science **Electrical Engineering**

Example Projects

- TCP client and server programs
 - Chat program
 - Similar to google hangout and skype chat
 - Multiple clients, echo server
 - File transfer

More Example Project: Understanding the Performance of Data Transfer Protocols

- Explore TCP performance
 - Compare with UDP-based data transfer protocol
- Vary network conditions
 - Bandwidth, delay, and loss

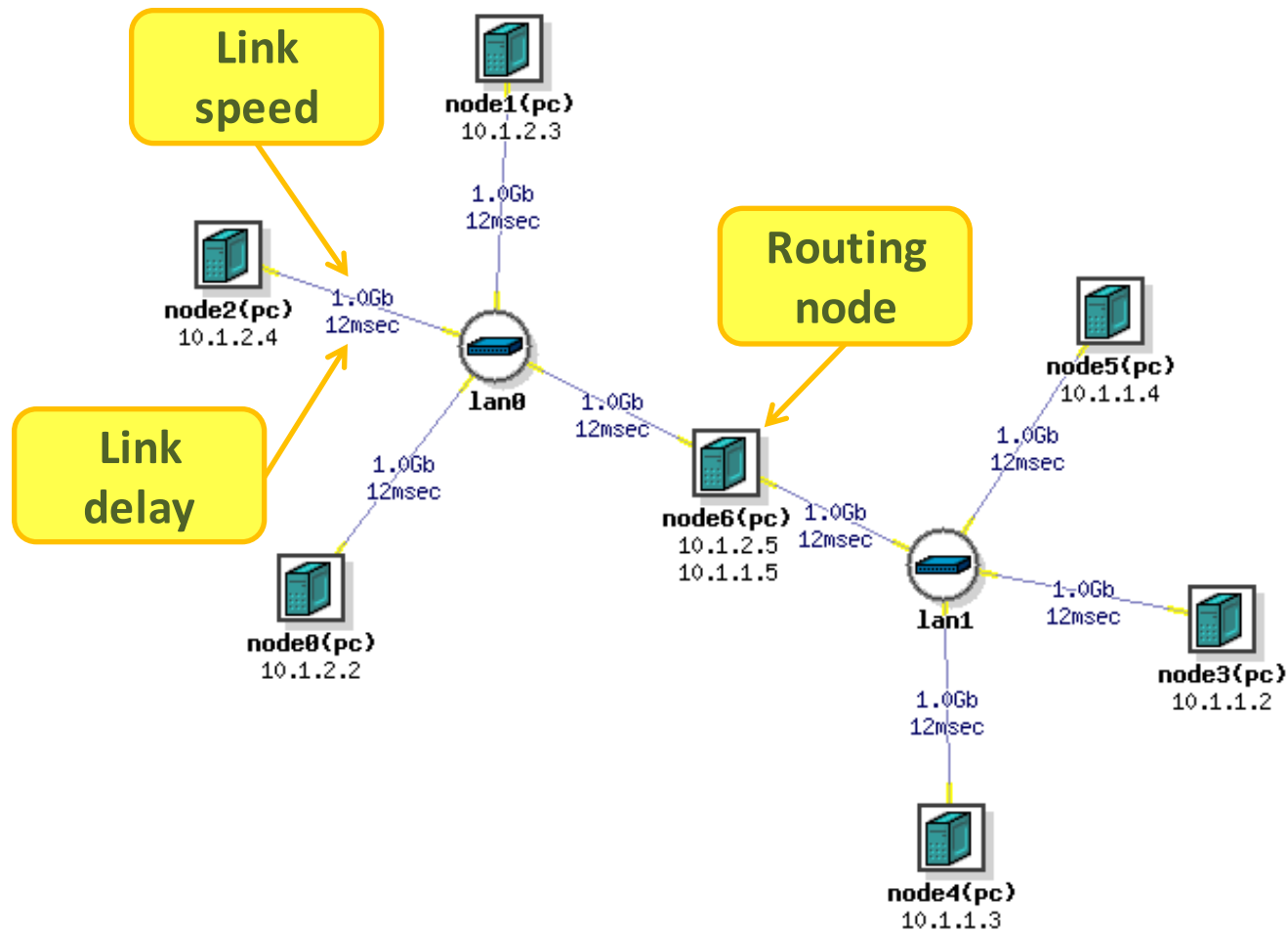
Background

- Understanding TCP is essential in networking course
- TCP underutilize network bandwidth over high bandwidth networks especially with long delays
- UDT: UDP-based Data Transfer (Gu et.al)
 - UDP-based application-level protocol
 - Transfer bulk data
 - Reliability and congestion control mechanisms on top of UDP

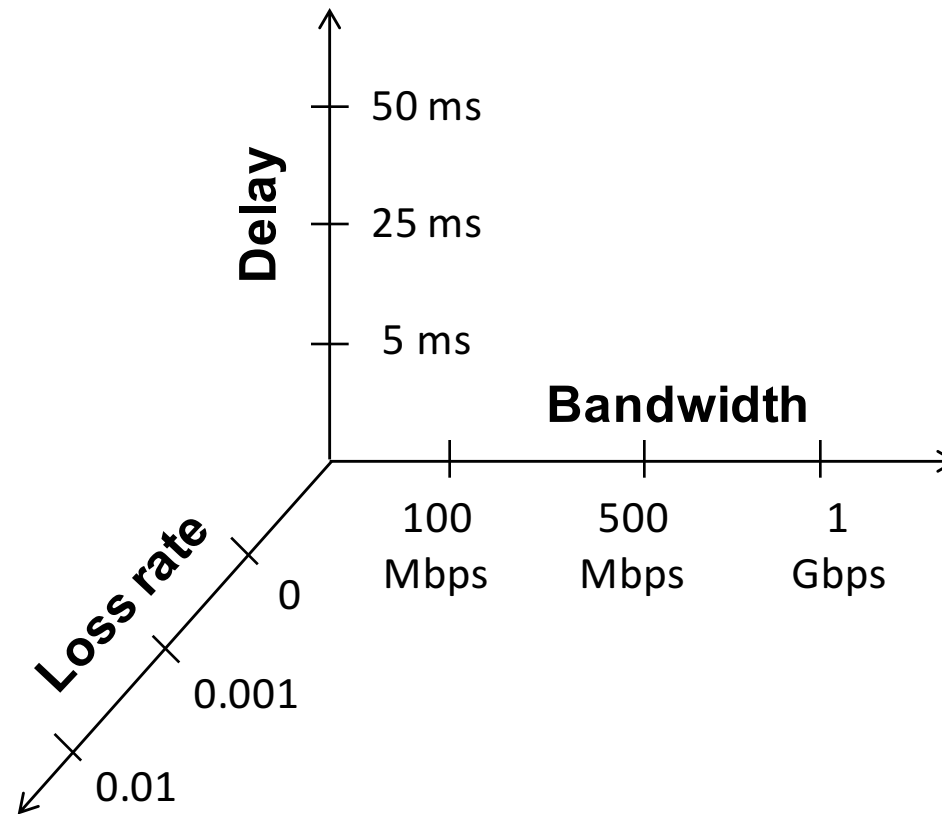
TCP vs. UDT

TCP	UDT
<ul style="list-style-type: none">• Window-based• Slow-start and AIMD• Three duplicate ACKs or timeout event• Throughput $\sim 1/RTT, 1/v(\text{loss rate})$	<ul style="list-style-type: none">• Rate-based (regardless of RTT)• ACK, ACK2, and NAK (avoids duplicate ACKs)• Decrease sending rate by negative feedback• Increase if there is only positive feedback

Topology

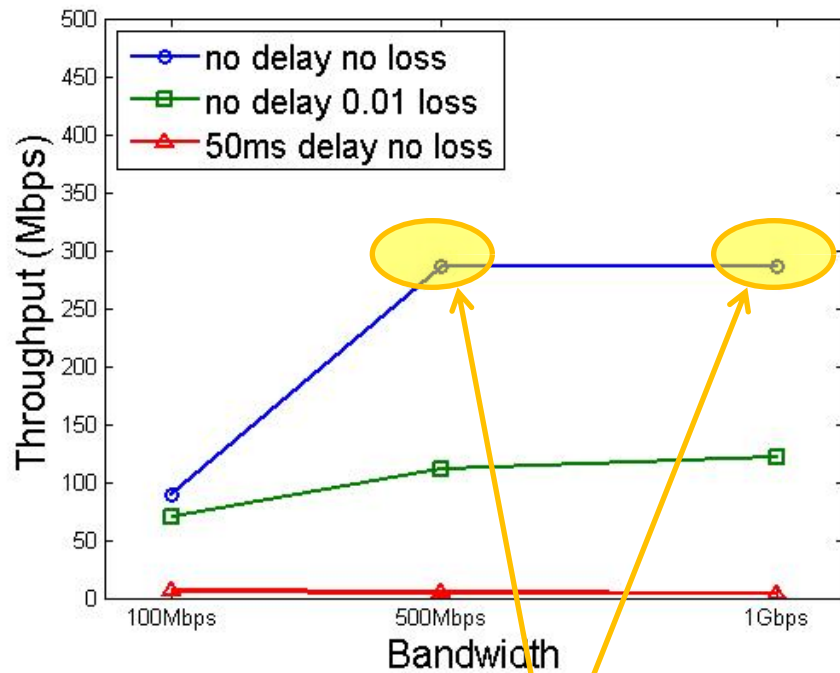


Varied Network Settings



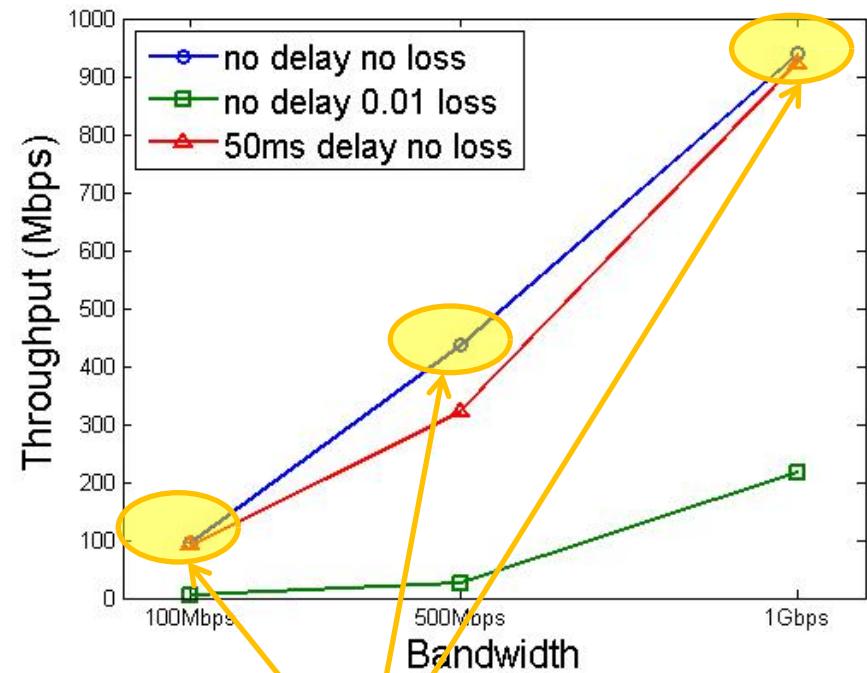
Throughput: Under Varied Bandwidth

TCP



Remain at lower throughput

UDT



Reach almost the full network capacity

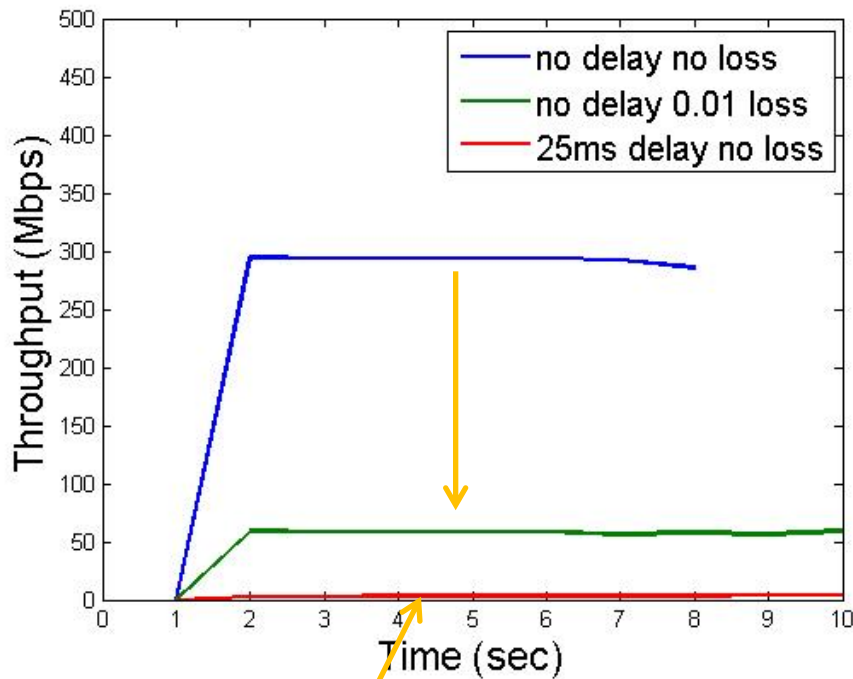
(No cross traffic)

Throughput: Time Series

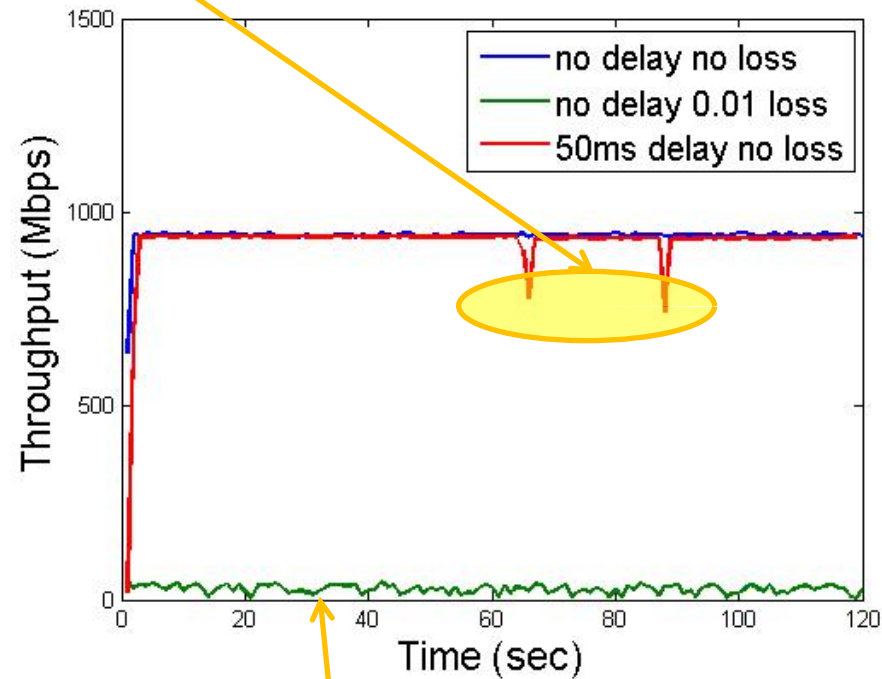
TCP

UDT is sensitive to loss

UDT



Crucial impact on delay

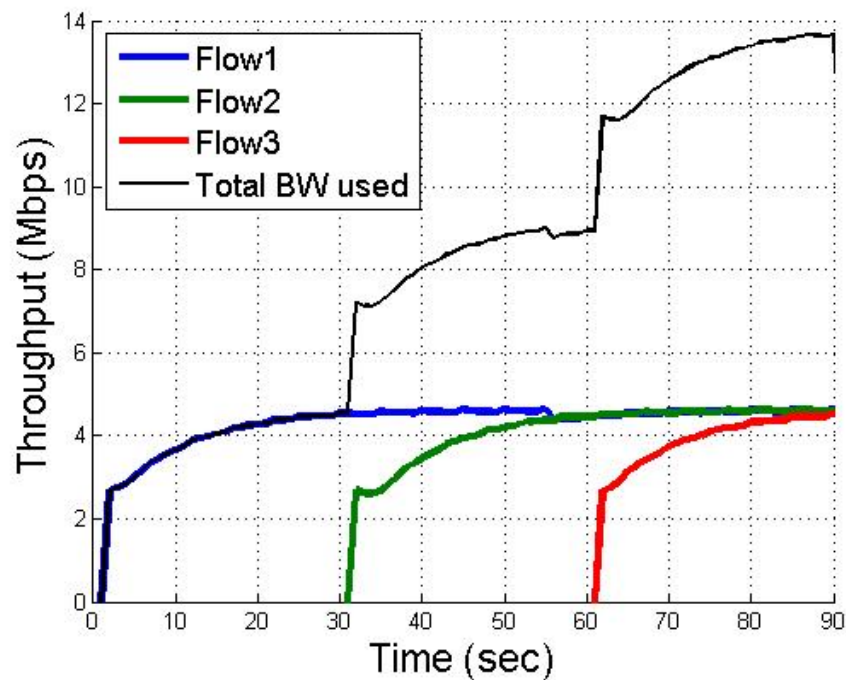


Performance degrade large with loss

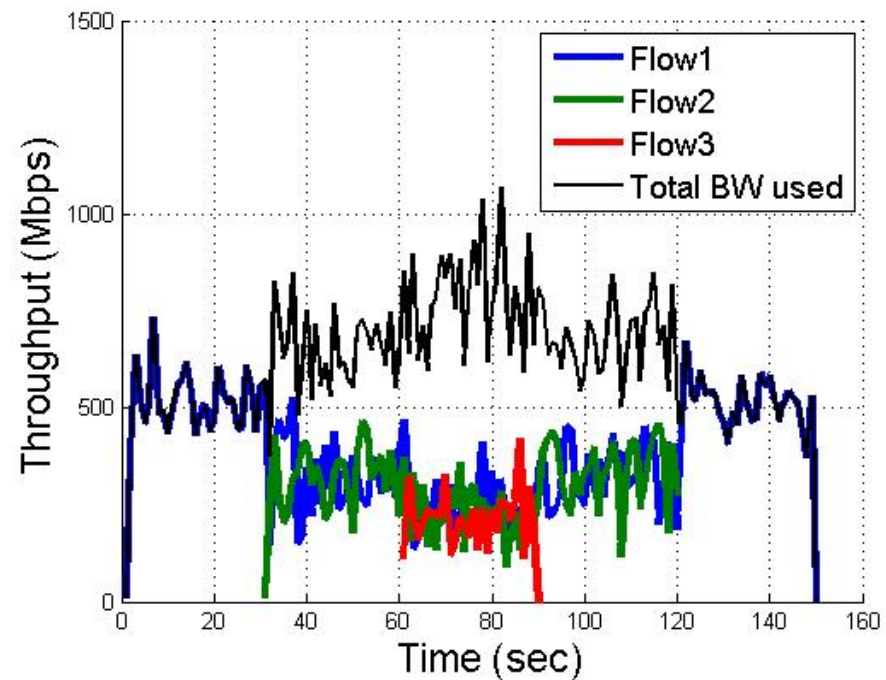
(BW=1Gbps)

Fairness

TCP



UDT



Both of the protocols permit fairness among the flows

Summary

- Computer networking course project
 - Compare TCP and UDP-based data transfer protocol
 - **Virtual laboratory of GENI have offered students an invaluable and deep learning experience!**
- Performance result
 - TCP throughput suffers in high bandwidth
 - UDT quickly reach and stay at almost the full network capacity

Cloud Computing Course

- **Course Projects**
 - Cloud performance comparison
 - Deploying cloud based services
 - SDN related
 - ...
 - Cloud building from scratch (OpenStack)
- **CloudLab**
 - Introduction only in fall 2015
 - But plan to use it in fall 2017

Invaluable Educational Experiences!

- Being able to control network conditions
- Being able to use a remote machine(s)!
- Alternative Cloud Example
 - Community Cloud
 - cf. commercial public/private cloud
 - Being able to build a cloud (CloudLab)
- Overcoming the issue of limited resource of a university
- Seeing the research efforts beyond the current Internet
 - BBN in Internet history, Internet2, Future Internet



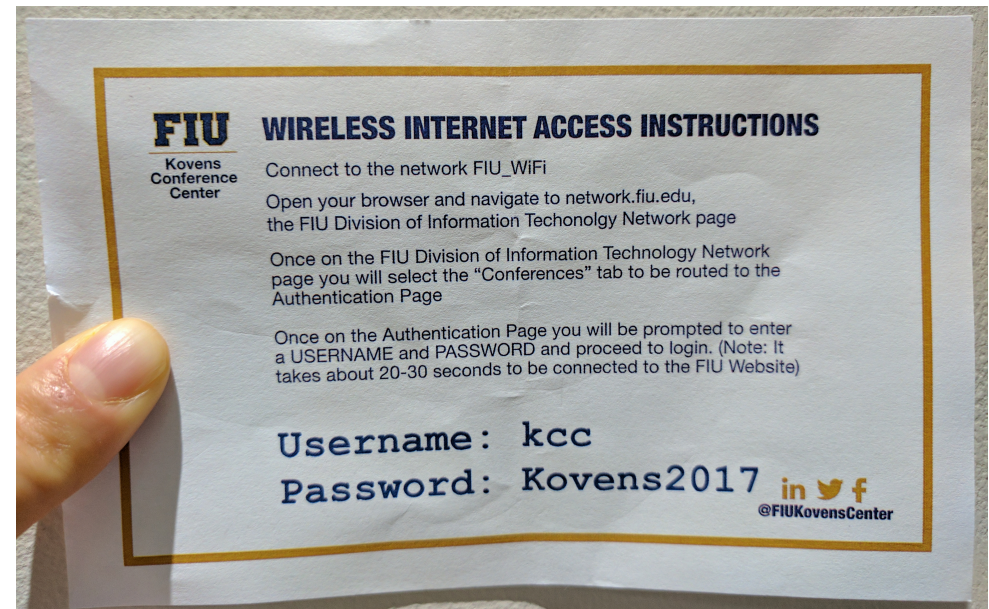
Great Improvements

- GENI Portal, wiki, Aggregate
 - University login
- Many class project examples
 - Diverse courses
 - Networking
 - Security
 - Cloud Computing
- Many educational activities
 - TA webinar training
 - Student camps
 - GEC, Workshops (GRW, GREE)
 - Monthly webinar
 - ...



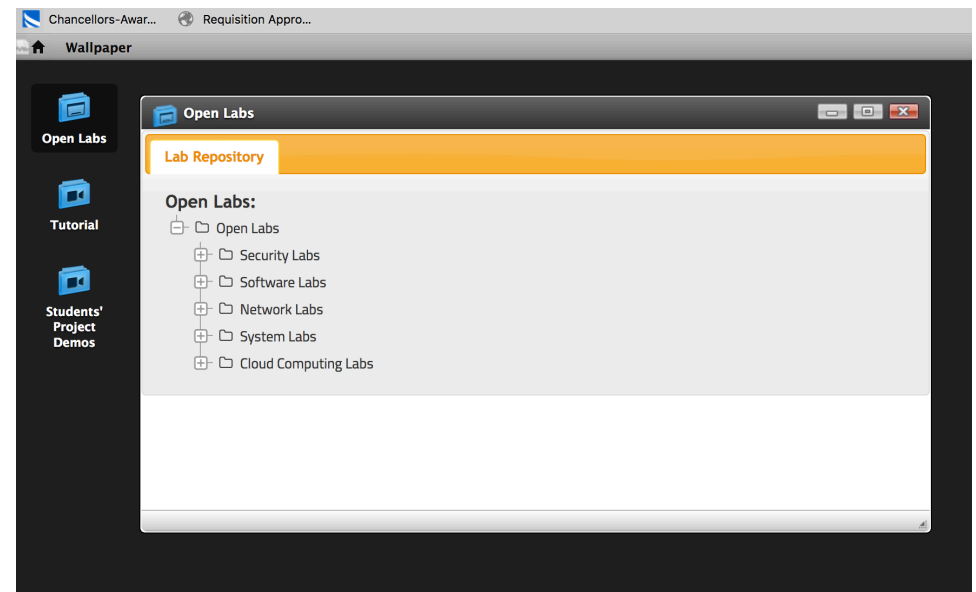
Suggestions...

- Availability
- Reliability/Stability
- Less Changes...
- User Friendliness
/Complexity
 - Non CS courses
 - CS courses!



Suggestions...

- Availability
- Reliability/Stability
- Less Changes
- User Friendliness
 - Non CS courses
 - CS courses!
 - Perhaps completely web-based environment...



**Thanks GENI -
GPO/NSF & Community!**



IEEE Core Smart Cities

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/ Home / IEEE Selects Municipalities Kansas City, Missouri, United States of America, and Casablanca, Morocco to Engage in IEEE Smart Cities Initiative

IEEE SELECTS MUNICIPALITIES KANSAS CITY, MISSOURI, UNITED STATES OF AMERICA, AND CASABLANCA, MOROCCO TO ENGAGE IN IEEE SMART CITIES INITIATIVE

Kansas City and Casablanca smart city project leaders to meet representatives of first three IEEE Core Smart Cities at IEEE Smart City Conference Guadalajara, Mexico, 25-28 October

PISCATAWAY, N.J., USA, 21 October 2015 – IEEE, the world's largest professional organization dedicated to advancing technology for humanity, today announced the selection of Kansas City, Missouri, USA, and Casablanca, Morocco as its newest municipalities to engage as IEEE Core Smart Cities. Kansas City and Casablanca were selected from more than 15 applicants as the cities that provided the most compelling evidence they are well positioned to utilize the resources offered through the IEEE Smart Cities Initiative and by demonstrating plans to invest human and financial capital into their project.

Project representatives for Kansas City and Casablanca have been invited to attend an integration workshop in Guadalajara, Mexico during the first [IEEE Smart City Conference](#), 25-28 October, to meet and learn from the experiences of representatives of the three first IEEE Core Smart Cities: Guadalajara, Mexico; Trento, Italy; and Wuxi, China. The two cities will kick-off their activities in the coming months.

IEEE International Smart Cities Conference (ISC2) 2018 in Kansas City



IEEE International Conference on Communications

20-24 May 2018 // Kansas City, MO USA

Communications for Connecting Humanity

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WELCOME TO IEEE ICC 2018!

Kansas City, MO is proud to host and welcome IEEE ICC back to the US after 15 years.

IEEE ICC 2018 will be held at the Sheraton Kansas City Hotel located in the heart of the Crown Center complex home to many shopping, dining and entertainment destinations.

Themed "Communications for Connecting Humanity," the conference will offer five full days of original paper presentations, tutorials, workshops, keynotes, demonstrations, industry panels and social events designed to further career opportunities and the in-depth understanding of the latest communications advancements worldwide.