Course Goals

• Overview of the basics
• Principles and Philosophies
• Read research papers
• Hands-on experience with networked systems
Prerequisites

• Undergraduate level networking/OS course
• Some systems programming
• Familiar with Linux environment
• Access to a Linux environment
  – Use department server
  – Use your own machine
• Willingness to catch up if you don’t have these experiences
Structure

• Lectures
• Paper discussions
• Homework
• Project
• Exams
• Class participation
Homework

• Several short assignments
• Concepts and calculations
• Some hands-on (incl. programming) work
• Allowed to discuss with other students, but you should turn in your own hw
• Submit online
Project

• One project with intermediate checkpoints
• Build a networked system

• Possible to propose your own project
  – Strongly encouraged for PhD students
  – Talk to the instructor
Exams

• No final exam!
• Open notes
• In-class scheduling
Grades

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<tbody>
<tr>
<td>Exams</td>
<td>40%</td>
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<tr>
<td>Homework</td>
<td>15%</td>
</tr>
<tr>
<td>Project</td>
<td>40%</td>
</tr>
<tr>
<td>Class Participation</td>
<td>5%</td>
</tr>
</tbody>
</table>

• It is possible to get a C or lower grades
• No incompletes
Readings

• No required textbook
• Recommended texts
  – Computer Networks: A Systems Approach
  – Computer Networking: A Top-Down Approach
• Research papers
• Standards
• Wikipedia
Academic Honesty

• The work you turn in should be yours

• Acknowledge
  – Group discussions
  – Internet sources

• Plagiarism results in an F
Course Staff

• Instructor: Omprakash Gnawali
• Office Hours: TR 230-330
• TA: Milad Heydariaan
Communication

• Send questions and answers to Piazza
• Emails MUST have COSC6377 in the subject
• Check course website and Piazza regularly

http://www2.cs.uh.edu/~gnawali/courses/cosc6377-f18/
Some Questions

• How difficult is this course?
• What is the workload?
• Will I learn anything useful?
• Any other questions?
Why are you taking this course?

What do you want to do?
The Internet: An Exciting Time

• One of the most influential inventions
  – A research experiment that escaped from the lab
  – … to be a global communications infrastructure

• Ever wider reach
  – Today: 3 billion+ users
  – Tomorrow: more users, computers, things, …

• Near-constant innovation
  – Apps: Web, P2P, social networks, virtual worlds
  – Links: optics, WiFi, cellular, WiMax, …

With thanks to Jennifer Rexford
Transforming Everything

• The ways we do business
  – E-commerce, advertising, cloud computing, ...
• The way we have relationships
  – E-mail, IM, Facebook, virtual worlds, online dating
• How we think about law
  – Interstate commerce? National boundaries?
• The way we govern
  – E-voting and e-government
  – Censorship and wiretapping
• The way we fight
  – Cyber-attacks, including nation-state attacks
Internet Growth Occurring in Accelerating Waves

<table>
<thead>
<tr>
<th>“Fixed” computing (you go to the device)</th>
<th>Mobility / BYOD (the device goes with you)</th>
<th>Internet of Things (age of devices)</th>
<th>Internet of Everything (people, process, data, things)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td>Doubles every (?) years 50B things</td>
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<td></td>
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<td>10B</td>
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<td>Doubled every 1.4 years</td>
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<td>200M</td>
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<td>Doubled every 1.3 years</td>
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Source: Cisco IBSG, 2012

Cisco
The Study of Networking is Cool

• Tangible, relates to reality
  – Can measure/build things
  – Can truly effect far-reaching change in the real world

• Inherently interdisciplinary
  – Well-motivated problems + rigorous solution techniques
  – Interplay with policy, economics, and social science

• Widely-understood impact
  – Can discuss technologies with your grandfather!
The Study of Networking is Cool

- Young, relatively immature field
  - Great if you like to make order out of chaos
  - Tremendous intellectual progress is still needed
  - You can help decide what networking really is
- Defining the problem is a big part of the challenge
  - Recognizing a need, formulating a well-defined problem
  - … is at least as important as solving the problem…
- Lots of platforms for building your ideas
  - Programmability: Click, OpenFlow, NetFPGA
  - Routing software: Quagga, XORP, and Bird
  - Testbeds: Emulab, PlanetLab, Orbit, GENI, …
  - Measurements: RouteViews, traceroute, Internet2, …
But, What *is* Networking?
A Plethora of Protocol Acronyms?
A Heap of Header Formats?

HTTP Response Header

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>HTTP Status Code:</td>
<td>HTTP/1.1 200 OK</td>
</tr>
<tr>
<td>Date:</td>
<td>Thu, 27 Mar 2008 13:37:17 GMT</td>
</tr>
<tr>
<td>Server:</td>
<td>Apache/2.0.55 (Ubuntu) PHP/5.1.2</td>
</tr>
<tr>
<td>Last-Modified:</td>
<td>Fri, 21 Mar 2008 13:57:30 GMT</td>
</tr>
<tr>
<td>ETag:</td>
<td>&quot;358a4e4-56000-ddf5c680&quot;</td>
</tr>
<tr>
<td>Accept-Ranges:</td>
<td>bytes</td>
</tr>
<tr>
<td>Content-Length:</td>
<td>352256</td>
</tr>
<tr>
<td>Connection:</td>
<td>close</td>
</tr>
<tr>
<td>Content-Type:</td>
<td>application/x-msdos-program</td>
</tr>
</tbody>
</table>
A Big Bunch of Boxes?
A Ton of Tools?

traceroute  nslookup  ping  ipconfig  rancid  whois  tcpdump  wget  ndt  iperf  dummynet  syslog  snort  bro  ntop  mrtg  nmap  wget  dig  net-snmp  ping  wireshark  ***
But, That Doesn’t Say What Networking Really Is

Or, What Will This Course is About
Nor does that...
We want to understand how the Internet works

Technical issues (protocols, architectures…)

Non-technical topics you will encounter (net-neutrality, access, rights…)
Internet as human right?

Politics

Business
Free Internet Access

“1.5 million people access the Internet via Google's free Wi-Fi at 19 Indian railway stations”

mashable.com

Facebook also had Free Internet initiatives.
Types of things we will study
Internet Architecture

• How to
  – Design and manage protocols
  – That can be used and combined in many ways
  – To do many things
• Definition and placement of function
  – What to do, and where to do it
• The “division of labor”
  – Across multiple protocols and mechanisms
  – Across components (hosts, routers, administrators)
• Goal: search for general principles
  – Of protocol design, evaluation, and composition
Congestion

• How to know how much traffic is being used for what purpose?
• How to ensure we can service the competing traffic demand sharing the infrastructure
• How to design applications to run “fast”
Reliability

• How reliable is the Internet?
• How can we measure different aspects of reliability in networking?
• What causes it to break?
Security

• How secure is the Internet?
• Security challenges in the Internet (DDoS, bots, etc.)
• Technologies to make Internet secure and their limitations

• How to make your application secure?
Back to the two questions

Why are you taking this course?

What do you want to do?
Project Ideas

• Study Wireless, Internet, ... adoption, use
• Extend existing technology
• Create impact using Internet or Wireless
  – Low-resource setting (edu, health, etc.)
  – Access to information
Plan for next four weeks

• Rapid review of undergraduate material
  – Understand how the basic building blocks work
• Watch lectures/read slides from COSC4377
  – Cover approx. 5 lectures per week
• Discuss the material in the class
• Grab lectures from:
  http://www2.cs.uh.edu/~gnawali/courses/cosc4377-s12/