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
Structure

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

• 3-4 homeworks
• Concepts
• Calculations
• Some hands-on work
• Allowed to discuss with other students, but you should turn in your own writeup
• Submit through Moodle
Project

• One project with an intermediate checkpoint
• Build a networked system

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

- No final exam!
- The second exam will cover topics not covered by the first exam
- Open notes
- In-class scheduling
### Grades

<table>
<thead>
<tr>
<th>Component</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exams</td>
<td>40%</td>
</tr>
<tr>
<td>Homeworks</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
  – UNIX Network Programming
• 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: TBD
• We may have pseudo TAs
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-s14/
Some Questions

• How difficult is this course?
• What is the workload?
• Will I learn anything useful?
• Any other questions?
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, …
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</th>
<th>Mobility / BYOD</th>
<th>Internet of Things</th>
<th>Internet of Everything</th>
</tr>
</thead>
<tbody>
<tr>
<td>(you go to the device)</td>
<td>(the device goes with you)</td>
<td>(age of devices)</td>
<td>(people, process, data, things)</td>
</tr>
</tbody>
</table>

- Doubled every 1.3 years
- Doubled every 1.4 years
- Doubles every (?) years
- **50B things**

Source: Cisco IBSG, 2012
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-read papers
  - Many of the most cited papers in CS are in networking
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;353a4e4-56000-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?

- Router
- Switch
- Switched Router
- Load balancer
- Scrubber
- Repeater
- Gateway
- Intrusion Detection System
- Bridge
- Route Reflector
- Deep Packet Inspection
- NAT
- Firewall
- Hub
- DHCP server
- Packet shaper
- WAN accelerator
- DNS server
- Base station
- Packet sniffer
- Proxy
A Ton of Tools?

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

Or, What Will This Course Be About?
One Take on Defining Networking

• 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
Plan for next four weeks

• Review of undergraduate material
• 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/