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/AWS 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 on Blackboard
Project

• One project with one mid-term checkpoint
• Build a networked system
• Individual project

• 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

<table>
<thead>
<tr>
<th>Component</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exams</td>
<td>40%</td>
</tr>
<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: M230-330

• TA: Alireza Ansaripour
  – Expert in networking
  – Office hour: R3-4
Communication

• Teams for discussions
• Personal message for private matters
  – Examples...
• Emails MUST have COSC6377 in the subject if you MUST send email.
• Do not use Teams personal message to the instructor or the TA unless it is an emergency
• Check course website regularly

http://www2.cs.uh.edu/~gnawali/courses/cosc6377-s22/
Logistics

• In-person instruction
• Lectures will be available also on Teams
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: 5 billion users
  – Tomorrow: more users, computers, things, …

• Near-constant innovation
  – Apps: Web, P2P, social networks, virtual worlds
  – Links: optics, WiFi, cellular, 5G, …
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>[Graph showing growth over time with milestones and doubling every time]</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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!
But, What *is* Networking?
A Plethora of Protocol Acronyms?

- BGP
- ARP
- HTTP
- DNS
- PPP
- OSPF
- DHCP
- TCP
- UDP
- SMTP
- FTP
- SSH
- MAC
- RIP
- NAT
- CIDR
- VLAN
- VTP
- WAP
- SACK
- SNMP
- RED
- IP
- ICMP
- HTTP
- IMAP
- IGMP
- HIP
- ECN
- SIP
- ARP
- RED
- IP
- ICMP
- MPLS
- BFD
- RTCP
- RTP
- RTSP
- TLS
- NAT
- STUN
- BGP
- RTP
- RTSP
- PLAN
- LISP
- LDP
- LLDP
- OSPF
- RIP
- SMTP
- FT
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>'359a4e4-56000-4d/5c680'</td>
</tr>
<tr>
<td>Accept-Ranges</td>
<td>bytes</td>
</tr>
<tr>
<td>Content-Length</td>
<td>352255</td>
</tr>
<tr>
<td>Connection</td>
<td>Close</td>
</tr>
<tr>
<td>Content-Type</td>
<td>application/vnd-microsoft-program</td>
</tr>
</tbody>
</table>
A Ton of Tools?

arpwatch  tcpdump
traceroute  wget
nslookup  trat
ping  snort
ipconfig  ipperf
rancid  bro
whois  mrtg
nmap  ntop
dig  net-snmp
arpwatch  ntop
rancid  mrtg
dig  net-snmp
arpwatch  net-snmp
dig  ping
nmap  ping
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
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?
Wireless

• Wireless networks are pervasive
• Mobile, phones, IoT devices
• 5G
Online services at scale

• Internet-scale networking
• Cloud
• Data centers
• Content distribution
Back to the two questions

Why are you taking this course?

What do you want to do?
Will I learn anything useful?

• Architect data communication
  – IoT
  – Online software
  – Apps on different platforms
  – Information consumption and production

• Some general skills
  – Presentation
  – Project formulation
  – Checkpoints
  – Code review
Project Ideas

• Study Wireless, Internet, ... adoption, use
• Extend existing technology
• Explore new and popular ideas
  – IoT
  – Blockchain
• 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 3-5 lectures per week
• Discuss the material in the class
• Grab lectures from:
  http://www2.cs.uh.edu/~gnawali/courses/cosc4377-s12/