COS 461: Computer Networks

Mike Freedman

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Lectures: MW 10-10:50am in CS 104

Lead Preceptor: Dr. Sandra Batista
Preceptors: Marcela Melara, Scott Erickson

http://www.cs.princeton.edu/courses/archive/spr14/cos461/

The Internet is an Exciting Place

Internet growth

<table>
<thead>
<tr>
<th>World Regions</th>
<th>Internet Users (Dec 31, 2000)</th>
<th>Internet Users (June 30, 2012)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asia</td>
<td>114 M</td>
<td>1077 M</td>
</tr>
<tr>
<td>Europe</td>
<td>105 M</td>
<td>519 M</td>
</tr>
<tr>
<td>North America</td>
<td>108 M</td>
<td>274 M</td>
</tr>
<tr>
<td>Latin America / Caribbean</td>
<td>18 M</td>
<td>255 M</td>
</tr>
<tr>
<td>Africa</td>
<td>5 M</td>
<td>167 M</td>
</tr>
<tr>
<td>Middle East</td>
<td>3 M</td>
<td>90 M</td>
</tr>
<tr>
<td>Oceania / Australia</td>
<td>8 M</td>
<td>24 M</td>
</tr>
<tr>
<td>World Total</td>
<td>361 M</td>
<td>2406 M</td>
</tr>
</tbody>
</table>

How does the design of the Internet support growth and foster innovation?
The Internet is a Tense Place

Cyber Attacks

Stop Online Piracy Act (SOPA)
Network Neutrality

FCC Rules Against Comcast P2P Throttling
The U.S. Federal Communications Commission has ordered Comcast to stop interfering with peer-to-peer traffic on its broadband network...

http://www.theverge.com/2013/7/17/4517480/nsa-spying-prism-surveillance-cheat-sheet

How does the design of the Internet create or exacerbate these tensions?

What is the Internet?
I Can Haz Wikipedia

The Internet is the worldwide, publicly accessible network of interconnected computer networks that transmit data by packet switching using the standard Internet Protocol (IP).

It is a "network of networks" that consists of millions of smaller domestic, academic, business, and government networks, which together carry various information and services.

http://en.wikipedia.org/wiki/Internet

"Best-Effort Packet Delivery Service"

Power at the Edge

**End-to-End Principle**
Whenever possible, communications protocol operations should be defined to occur at the end-points of a communications system.

**Programmability**
With programmable end hosts, new network services can be added at any time, by anyone.

And end hosts became powerful and ubiquitous....
Announcing a Route

“Egypt is in this direction”

Forwarding Traffic

Withdrawing a traffic route

“Egypt is not in this direction”

Egypt Leaves the Internet
By James Cowie on January 27, 2011 7:56 PM

At 22:34 UTC (00:34am local time), Renesys observed the virtually simultaneous withdrawal of all routes to Egyptian networks in the Internet’s global routing table. Approximately 3,500 individual BGP routes were withdrawn, leaving no valid paths by which the rest of the world could continue to exchange Internet traffic with Egypt’s service providers. Virtually all of Egypt’s Internet addresses are now unreachable, worldwide.
Central concepts in networking

Abstraction through Protocol Layering

- **Modularity**
  - Each layer relies on services from layer below
  - Each layer exports services to layer above
- **Interfaces**
  - Hides implementation details
  - Layers can change without disturbing other layers

The Internet Protocol Suite

The “narrow waist” facilitates interoperability

Example: HyperText Transfer Protocol

```
GET /courses/archive/spr13/cos461/ HTTP/1.1
Host: www.cs.princeton.edu
User-Agent: Mozilla/4.03

HTTP/1.1 200 OK
Date: Mon, 4 Feb 2013 11:09:03 GMT
Server: Netscape-Enterprise/3.5.1
Last-Modified: Mon, 2 Feb 2013 19:12:23 GMT
Content-Length: 21
CRLF

Site under construction
```
Key Concepts in Networking

- **Naming**
  - What to call computers, services, protocols, ...
- **Layering**
  - Abstraction is the key to managing complexity
- **Protocols**
  - Speaking the same language
  - Syntax and semantics
- **Resource allocation**
  - Dividing scarce resources among competing parties
  - Memory, link bandwidth, wireless spectrum, paths

Course Organization
What You Learn in This Course

- Knowledge: how the Internet works, and why
  - Protocol stack: link, network, transport, application
  - Resource allocation: congestion control, routing
  - Applications: Web, P2P, VoIP, ...
  - Networks: enterprise, cloud, backbone, wireless, ...

- Insight: key concepts in networking
  - Naming, layering, protocols, resource allocation, ...

- Skill: network programming (in precept!)
  - Many nodes are general-purpose computers
  - Can innovate and develop new uses of networks

meClickers: Quick Surveys

Growth/innovation vs. create/exacerbate tensions

- Does Internet design prevent misuse?
  A. Individual endpoints can only use addresses given to them when connect to the network
  B. Individual end-points can “spoof” any IP address

meClickers: Quick Surveys

Growth/innovation vs. create/exacerbate tensions

- Does “Internet” provide reliable packet delivery?
  A. Yes, that’s necessary for protocols like HTTP that require in-order streams
  B. No, packets may be arbitrary dropped or reordered
Learning the Material: People

- Lecture: Mike Freedman
  - Slides available online at course Web site

- Precepts
  - Sandra Batista (Lead), Marcela Melara, Scott Erickson

- Main Q&A forum: www.piazza.com
  - Graded on class participation: so ask and answer!
  - No anonymous posts or questions
  - Can send private messages to instructors

Learning the Material: Books

- Required textbook
  - Computer Networks: A Systems Approach (5th edition), by Peterson and Davie
  - Okay to use the 4th edition

- Books on reserve
  - Networking textbooks
    - Computer Networking: A Top-Down Approach Featuring the Internet, by Kurose and Ross
    - Computer Networks, by Tanenbaum
  - Network programming references
    - TCP/IP Illustrated, Volume 1: The Protocols, by Stevens
    - Unix Network Programming, Volume 1: The Sockets Networking API, by Stevens, Fenner, & Rudoff

Grading

- Four assignments (12% each)
  - 95% 3 hours, 80% 2 days late, 25% >7 days late
  - One free late day (we’ll figure which one is best)
  - Only failing grades I’ve given are for students who don’t / try to do assignments

- Two exams (45% total)
  - Midterm exam before spring break (20%)
  - Final exam during exam period (25%)

- Class participation (7%)
  - In lecture, precept, and Piazza

Policies: Write Your Own Code

Programming is an individual creative process. At first, discussions with friends is fine. When writing code, however, the program must be your own work.

Do not copy another person’s programs, comments, README description, or any part of submitted assignment. This includes character-by-character transliteration but also derivative works. Cannot use another’s code, etc. even while “citing” them.

Writing code for use by another or using another’s code is academic fraud.
0th Assignment

- Learning how to use network sockets
  - Part of class participation grade only
  - On website, navigate -> Assignments -> Assignment 0
  - Due February 13
- Perform assignments inside Virtual Machine
  - Can then have similar environment on laptop, fishbowl machines, for our testing
  - Requires you have VirtualBox installed
  - We will be sending instructions for getting VM shortly

Conclusions

- Internet
  - Diverse, ever-changing applications
  - ... communicating over a network of networks
  - ... using multiple layers of protocols
- Wednesday lecture
  - Links: how do two computers communicate?
- Friday precept
  - Sockets: how do two applications communicate?