COS 461: Computer Networks

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Spring 2014

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

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

How does the design of the Internet support growth and foster innovation?

The Internet is a Tense Place

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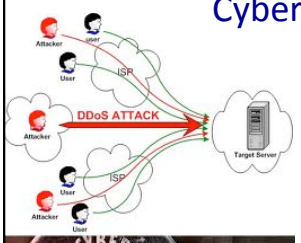
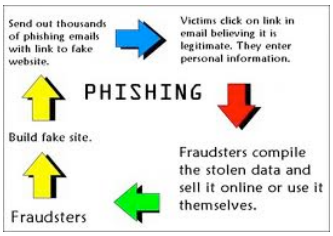
Cyber Attacks





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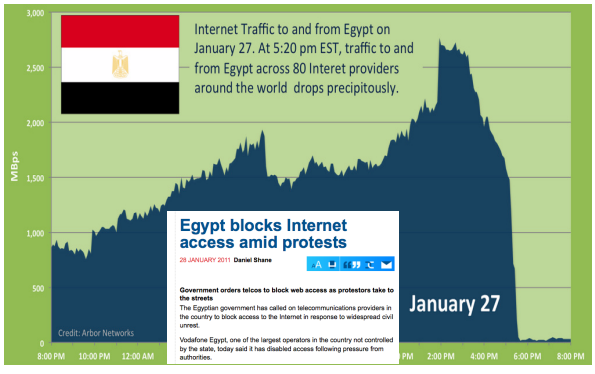
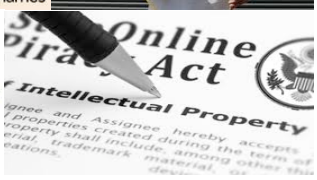
Internet Traffic to/from Egypt (2011)



Stop Online Piracy Act (SOPA)



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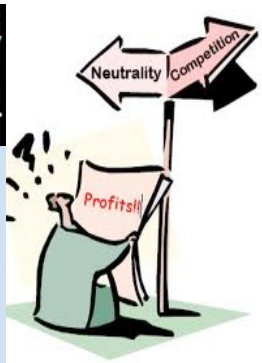
Network Neutrality

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…



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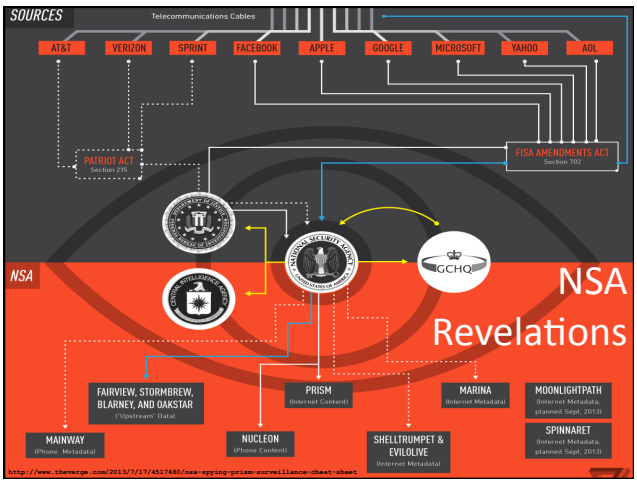

How does the design of the Internet create or exacerbate these tensions?

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What *is* the Internet?

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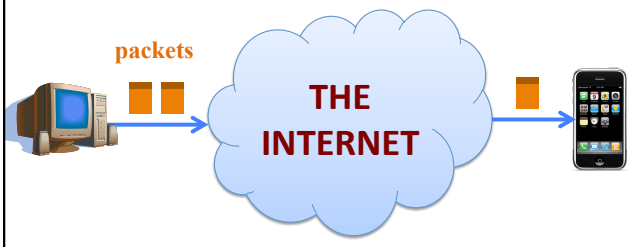
I Can Haz Wikipedia

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"



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Power at the Edge

End-to-End Principle

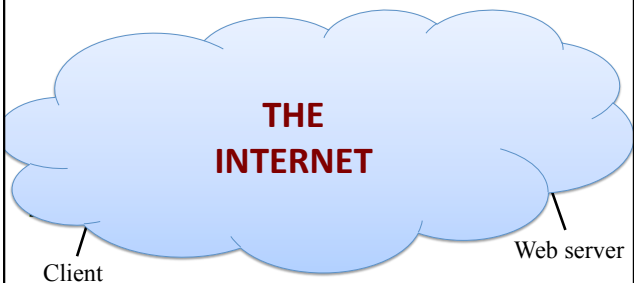
Whenever possible, communications protocol operations should be defined to occur at the end-points of a communications system.

Programmability

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

And end hosts became powerful and ubiquitous….

"A Network of Networks"



- How do you name?
- How do you find a name?

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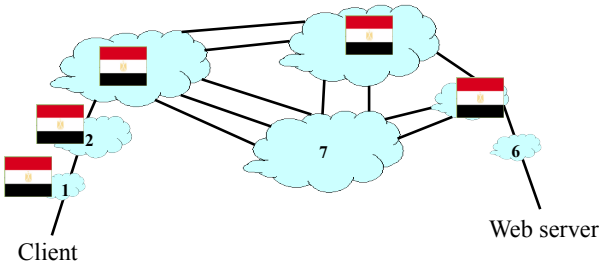
Announcing a Route



"Egypt is in this direction"

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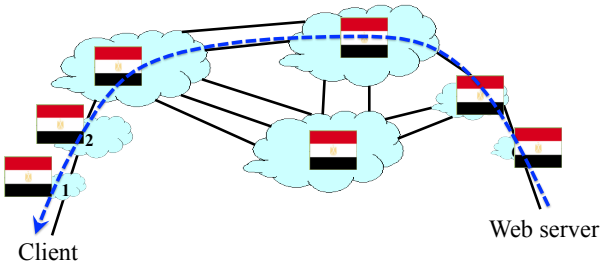
Forwarding Traffic



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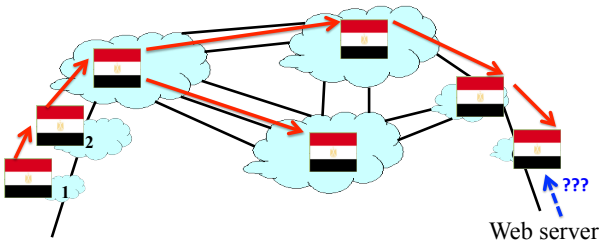
Withdrawing a traffic route



"Egypt is not in this direction"

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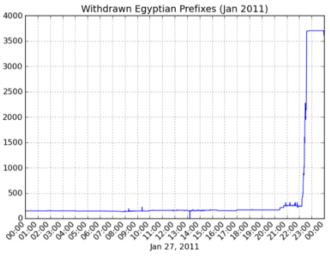
renesys | blog

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

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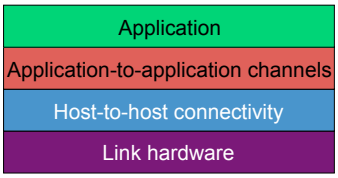
Abstraction through Protocol Layering

- 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



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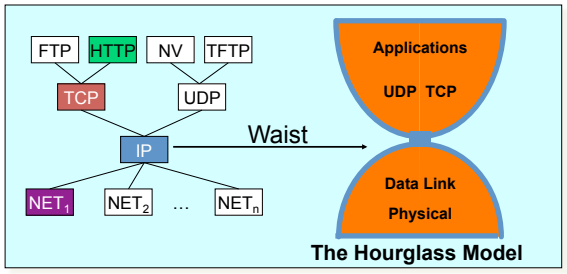
The Internet Protocol Suite



The "narrow waist" facilitates interoperability

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Example: HyperText Transfer Protocol

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

Request

Response

```
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
```

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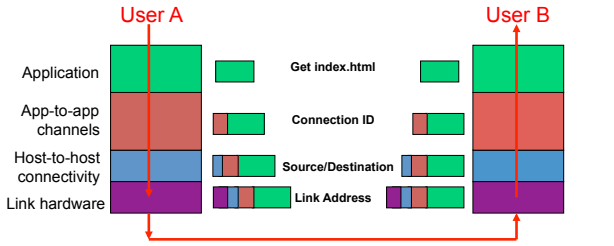
Layer Encapsulation in HTTP



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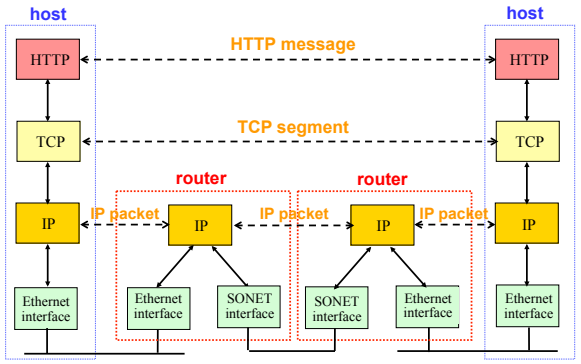
End Hosts vs. Routers



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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 scare resources among competing parties
  - Memory, link bandwidth, wireless spectrum, paths

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Course Organization

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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

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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

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meClickers: Quick Surveys

Growth/innovation vs. create/exacerbate tensions

- Does Internet design prevent misuse?

  Networks are assigned unique IP address blocks from a central authority ("IANA"): Princeton has 128.112.*
  - A. Network can only announce assigned addresses
  - B. Networks can spoof any address

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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

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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

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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, & Rudolf

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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

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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.

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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

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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?

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