Lecture 1:
Course Introduction

CSE 222A: Computer Communication Networks
Alex C. Snoeren
Lecture 1 Overview

- Class overview
  - Expected outcomes
  - Structure of the course
  - Policies and procedures

- A brief review of undergrad networking
  - High-level concepts
  - An end-to-end example
Logistics

- Instructor: Alex C. Snoeren
  - Office hours Tuesdays 11-12pm or by appointment
  - EBU3B 3114

- TA: Siva Radhakrishnan
  - Office hours Wed 1-3pm EBU3B B240A

- Course Web page:
  - http://www.cs.ucsd.edu/classes/wi13/cse222A-a/
  - Piazza is only for Q&A
Prereqs

- Undergrad networking course (e.g., CSE123)
  - You are welcome to take the course without prior background,
  - But, several parts of the course will be especially challenging
    » You are responsible for doing the extra reading on your own
    » Peterson & Davie are your friends—our undergrad textbook

- Systems programming experience
  - The term project will likely require significant implementation
  - This course will not teach you systems programming. The TA will help, but you need to learn it on your own if you don’t already know it.
Expected Outcomes

- This course *will* teach you about network architecture
  - We will cover some classic literature for background
  - Focus mostly on recent developments in the field

- This course *will not* teach you the fundamentals
  - Layering, signaling, framing, MAC, switching, routing, naming, Internetworking, congestion control, router design, etc.
  - Take the undergrad course for the basics

- Similarly, we will not cover Web/Cloud services
  - CSE223B covers distributed systems design, the “cloud,” etc.
  - You *will be able to* pick this up on your own with Google
CSE 222A Class Overview

- Course material taught through class lectures, paper readings, and term project
  - Lectures are *interactive*—attendance is crucial to success

- Course grade based upon:
  - Daily paper reviews
  - In-class quiz at end of term (based on lectures/readings)
  - Term project with paper and presentation

- Piazza discussion forums
  - The place to ask questions about lecture, papers, project, etc.
  - My first time using it, so please let me know if it’s broken!
Textbook

Paper reviews

- Written critique of each assigned reading
  - Submitted in advance of each class through an automated conference review system (HotCRP)
  - What are the biggest contributions of the paper?
  - What are the main shortcomings/issues with the work?
  - What are the implications of the described work?

- You should read others’ reviews
  - Help you see other points of view
  - Available after you submit your review

- Graded on a 3-point scale
  - Our expectations will go up as the term progresses
Term Project

- Group project; teams of 2-3 people
  - Your chance to explore what networking research is like
  - The very best projects can—and do—result in publications

- List of project ideas on course Website
  - Will be posted shortly

- Several milestones to keep you on track
  - Topics of interest due Jan 22nd.
  - Teams formed January 24th.
  - Project proposal due February 5th.

- Final exam period will be a mini conference
  - You will prepare a report and a presentation
Grading

- Paper reviews: 15%
- Quiz: 35%
- Project: 40%
- Participation: 10%
  - Attendance and engagement in class discussion is crucial
Questions

- Before we start the material, any questions about the class structure, contents, etc.?
Networking in One Slide

- **Protocols & Layering**
  - Manage complexity by decomposing the tasks
  - Standardizing syntax and semantics to support interoperability

- **Naming**
  - Agreeing on how to describe a host, application, network, etc.

- **Switching & Routing**
  - Deciding how to get from here to there
  - Forwarding messages across multiple physical components

- **Resource Allocation**
  - Figuring out how to share finite bandwidth, memory, etc.
A “Simple” Task

- Send information from one computer to another

- Endpoints are called **hosts**
  - Could be computer, iPod, cell Iphone, etc.

- The plumbing is called a **link**
  - We don’t care what the physical technology is: Ethernet, wireless, cellular, etc.
Measures of success

- How fast?
  - Bandwidth measured in bits per second
  - Often talk about KBps or Mbps – Bytes vs bits

- How long was the wait?
  - Delay (one-way or round trip) measured in seconds

- How efficiently?
  - Overhead measured in bits or seconds or cycles or…

- Any mistakes?
  - Error rate measured in terms of probability of flipped bit
How long to send a message?

- Transmit time $T = \frac{M}{R} + D$
  - 10 Mbps Ethernet LAN ($M=1$KB)
    - $\frac{M}{R}=1$ms, $D \sim=5$us
  - 155 Mbps cross country ATM link ($M=1$KB)
    - $\frac{M}{R} = 50$us, $D \sim= 40-100$ms

- Where are the bits in the mean time?
  - In transit inside the network

- $R\cdot D$ is called the **bandwidth delay product**
  - How many bits can be “stored” be stored in transit
  - Colloquially, we say “fill the pipe”
Is Not Really So Simple

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Layering: A Modular Approach

- Sub-divide the problem
  - Each layer relies on services from layer below
  - Each layer exports services to layer above

- Interface between layers defines interaction
  - Hides implementation details
  - Layers can change without disturbing other layers

- Interface among peers in a layer is a protocol
  - If peers speak same protocol, they can interoperate
Protocol Standardization

- Communicating hosts speaking the same protocol
  - Standardization to enable multiple implementations
  - Or, the same folks have to write all the software

- Internet Engineering Task Force
  - Based on working groups that focus on specific issues
  - Produces “Request For Comments” (RFCs)
    - Rough consensus and running code
    - After enough time passes, promoted to Internet Standards

- Other standards bodies exist
  - ISO, ITU, IEEE, etc.
TCP/IP Protocol Stack

Application Layer

Transport Layer

Network Layer

Link Layer

host

host

HTTP

TCP

IP

SONET

Ethernet interface

router

router

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Encapsulation

HTTP
TCP
IP
Ethernet interface

Payload

Headers

HTTP
TCP
IP
Ethernet interface
Internet Protocol Suite

The Hourglass Model

Applications
Transport
Data Link
Physical

FTP
HTTP
NV
TFTP
TCP
UDP
IP
NET_1
NET_2
...
NET_n

“Thin Waist”
Physical layer

- 802.11b Wireless Access Point
- Cat5 Cable (4 wires)
  - 100Base TX Ethernet, 100Mbps
- Ethernet switch/router
- 2.4Ghz Radio
  - DS/FH Radio (1-11Mbps)
- To campus backbone

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Link Layer (e.g. Ethernet)

- Break message into frames
- Media Access Control (MAC)
  - Can I send now? Can I send now?
- Send frame

Receiver
Connecting links

- **Routers/Switches**: moves bits between links
  - *Circuit switching*: guaranteed channel for a session (Telephone system)
  - *Packet switching*: statistical multiplexing of independent pieces of data (Internet)
Putting this all together

- **ROUGHLY**, what happens when I click on a Web page from UCSD?

```
My computer

?  Internet

www.google.com
```

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Web request (HTTP)

- Turn click into HTTP request

GET http://www.google.com/ HTTP/1.1
Host: www.google.com
Connection:keep-alive
...
Name resolution (DNS)

- Where is www.google.com?

My computer (132.239.9.64)

What’s the address for www.google.com

Local DNS server (132.239.51.18)

Oh, you can find it at 66.102.7.104
Data transport (TCP)

- Break message into packets (TCP segments)
- Should be delivered reliably & in-order

```
GET http://www.google.com HTTP/1.1
Host: www.google.com
Connection:keep-alive
...
```
Global Network Addressing

- Address each packet so it can traverse network and arrive at host

My computer
(132.239.9.64)

www.google.com
(66.102.7.104)

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Resource Allocation: Queues

- Sharing access to limited resources
  - E.g., a link with fixed service rate
- Simplest case: first-in-first out queue
  - Queue/serve packets in the order they arrive
  - Drop packets when the queue is full
- Anybody hear of “Network Neutrality”?
For Next Class…

- Browse the course web
  - http://www.cs.ucsd.edu/classes/sp13/cse222A-a/

- Read P&D Chapters 1 and 2

- Read and review Saltzer, Reed, and Clark ’84
  - Submit review in HotCRP – available by tomorrow

- Start thinking about term project ideas/groups
  - Suggestions available later this week