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 2:30-3:30pm or by appointment
  - EBU3b 3114

- **TA:** Bhanu Vattikonda
  - Office hours Thursdays 9:30-10:30am EBU3b B225

- **Course Web page**
  - 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 materials taught through class lecture, 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 lectures, readings, project
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 publication

- We will post a list of project ideas on the Website
  - You can review old lists as well while you wait

- Several milestones to keep you on track
  - Topics of interest due Jan 20\textsuperscript{st}
  - Teams formed January 22\textsuperscript{nd}
  - Project proposal due February 3\textsuperscript{th}

- Final exam period will be a mini conference
  - Each group 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 phone, 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=1KB)
    » $\frac{M}{R}=1\text{ms}$, $D \approx 5\text{us}$
  - 155 Mbps cross country ATM link (M=1KB)
    » $\frac{M}{R} = 50\text{us}$, $D \approx 40-100\text{ms}$

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

- $R \times D$ 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
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.
Internet Protocol Suite

The Hourglass Model

Applications
Transport
Data Link
Physical

"Thin Waist"

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

2.4Ghz Radio
DS/FH Radio
(1-11Mbps)

802.11b Wireless Access Point

Cat5 Cable (4 wires)
100Base TX Ethernet
100Mbps

Ethernet switch/router

To campus backbone

62.5/125um 850nm MMF
1000BaseSX Ethernet
1000Mbps

CSE 222A – Lecture 1: Course Introduction
**Link Layer (e.g. Ethernet)**

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

www.google.com
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)

Local DNS server (132.239.51.18)

What’s the address for www.google.com

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
...

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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)
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 site
  - http://www.cs.ucsd.edu/classes/wi15/cse222A-a

- Read P&D Chapters 1 & 2

- Read and review Saltzer, Reed, and Clark ‘84
  - Submit review in HotCRP

- Start thinking about term project ideas/groups
  - Suggestions will be available on the web soon