Lecture 1: Course Introduction

CSE 222A: Computer Communication Networks
George Porter

Thanks: Alex C. Snoeren, Mike Freedman, and Amin Vahdat
Lecture 1 overview

- Class overview and expectations
  - Expected outcomes
  - Structure of the course
  - Policies and procedures
- Pre-requisite quiz
- A brief review of undergrad networking
Logistics

- **Instructor:** George Porter
  - Office hours Mondays 1:00-2:00pm
  - EBU3b 3104

- **TAs:** Rahul Bhalerao and Yashar Asgarieh
  - Their office hours are on the course webpage

- **Course Web page**
Prerequisites

- Undergraduate networking (e.g., CSE 123)
  - 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
  - Term project will require significant programming effort
  - This course will not teach OS/systems programming
Expected outcomes

- This course will bring you up-to-date on recent trends in network design
  - We’ll cover classic and recent research papers to introduce you to new topics, and to put that material in historical context

- We won’t teach fundamentals
  - Layering, signaling, framing, MAC, switching, routing, naming, Internetworking, congestion control, router design, …
  - If these topics aren’t familiar to you, please take CSE 123

- We’re not going to cover cloud/web/REST/…
  - CSE 124/223B covers distributed systems
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:
  ❖ Reading papers, with periodic take-home quizzes
  ❖ In-class participation
  ❖ Term project with paper and poster presentation

● Piazza discussion forums
  ❖ The place to ask questions about lectures, readings, project

● CSE 222A “Slack” channel: interactive discussion
Textbook

  - 4th edition should be OK
  - You are responsible for everything in this book.
Term Project

- Group project; teams of 3 to 4 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 Oct 8th
  - Teams formed Oct 13th
  - Project proposal due Oct 22nd
- Final exam period will be a poster presentation
  - Each group will prepare a report and a poster
Grading

● 50% Project
● 40% Quizzes (in-class or take-home)
● 10% Class participation
  ◆ Attendance and engagement in class discussion is crucial
Questions?
In-class prerequisite quiz

- Designed so that you and I can get a sense of your preparation, background, and recall of CSE 123 knowledge
- This should be very easy!
  - If not, let’s talk…
- Note: You will receive a 100 if you complete this quiz
  - Only quiz like that this term
Undergrad review
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, cellphone, 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, $D \approx 5$us
  - 155 Mbps cross country ATM link ($M=1$KB)
    - $\frac{M}{R} = 50$us, $D \approx 40-100$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
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
Encapsulation

HTTP

TCP

IP

Ethernet interface

Payload

Headers

HTTP

TCP

IP

Ethernet interface
Internet Protocol Suite

The Hourglass Model

Applications
Transport
Data Link
Physical

"Thin Waist"

NET_1
NET_2
... 
NET_n

FTP
HTTP
NV
TFTP

TCP
UDP
IP

NET_1
NET_2
... 
NET_n

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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

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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
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/fa15/cse222A-a

- Read P&D Chapters 1 & 2

- Read Saltzer, Reed, and Clark ’84

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