CSE 486/586 Distributed Systems
The Internet in 2 Hours: The First Hour

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Recap

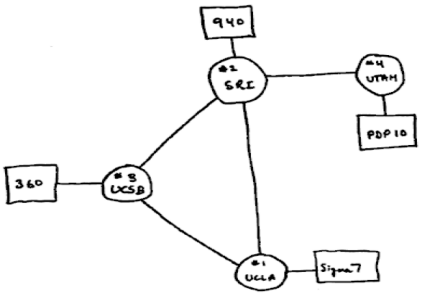
- Please make an effort to come to every class.
- Please do the work yourself and get permissions for other sources. Also, acknowledge them.
- Please check if you have the background by doing PA1 all by yourself.
- This course will expect:
  - Good work ethics
  - Independence
  - Respect for others
- This course is about:
  - Introducing common problems that arise when building a distributed system
  - Discussing algorithms, architectures, and abstractions that solve those problems
  - Practicing how to adapt those algorithms and concepts

Today and Next

- A brief overview of the Internet
- Two things
  - The design philosophy of the Internet ("The Design Philosophy of the DARPA Internet Protocols" by David Clark): today
  - Transport & application layers: next lecture
- Obviously can't replace a networking course; this should be just a recap for you.
- Why teach these?
  - Because I want to ;-)
  - If there's no network, there's no distributed system.
  - Not just that: the design of the Internet is a great example of designing a solid distributed system.

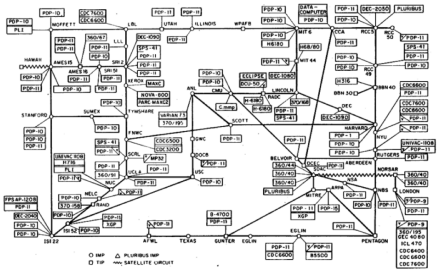
What Is the Internet?

- 1969



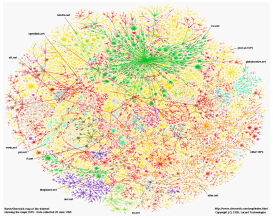
What Is the Internet?

- 1977



What Is the Internet?

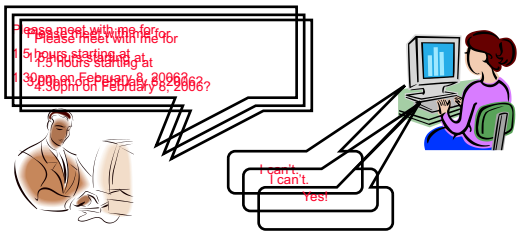
- Now



- A network of networks
- The fundamental goal of the original designers: interconnecting different networks by designing common protocols

Detour: What is a Protocol?

- Example: making an appointment



- Well…I think we need a better way…

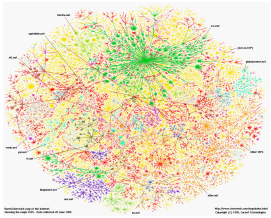
Detour: What Is a Protocol?

- Bob: When are you free to meet for 1.5 hours during the next two weeks?
- Alice: 10:30am on Feb 8 and 1:15pm on Feb 9.
- Bob: Book me for 1.5 hours at 10:30am on Feb 8.
- Alice: Yes.

Detour: What is a Protocol?

- An agreement between entities in communication
  - Two things: 1) syntax, 2) semantics
- Syntax
  - What language?
  - What's the time format? Granularity?
  - Etc.
- Semantics
  - If broken into pieces, how do you reassemble?
  - If a msg gets lost, what do you do?
  - If you get a msg, what do you do?
  - Etc.

Returning back: What Is the Internet?



- A network of networks
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CSE 486/586 Administrivia

- PA 1 is out. Please try it yourself.
- Please use Piazza; all announcements will go there.
  - Signup link: http://piazza.com/buffalo/spring2019/cse486586
  - Anonymous/private posting: generally questions are beneficial to the whole class; please consider posting it publicly first.
  - All announcements will be posted there.
- Use good coding styles.
  - Use the Android code style guideline posted on Piazza.
- After-class questions
  - Will answer them outside. There's a class right after this one.

Building the Internet

- Why care?
  - Now: you might be just doing what's given to you.
  - Later: you will likely *define* what you want to do and do it.
- Internet as a case study of a distributed system
  - Put a designer's hat on for a moment.
- Questions to think about:
  - Why? i.e., why do we want to connect computers?
  - What is the ideal outcome? i.e., what do we want?
  - How do we do that?

Why and What

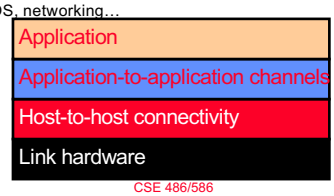
- Why
  - "The whole can be greater than the sum of its parts"
- What
  - Internet communication must continue despite loss of networks or gateways.
  - The Internet must support multiple types of communications service.
  - The Internet architecture must accommodate a variety of networks.
  - The Internet architecture must permit distributed management of its resources.
  - The Internet architecture must be cost effective.
  - The Internet architecture must permit host attachment with a low level of effort.
  - The resources used in the Internet architecture must be accountable.

How to Interconnect?

- There were many types of networks based on various physical media.
  - Coax, radio, satellite, etc.
- The original designers wanted to interconnect those somehow.
- A potential solution
  - Designing a "multi-media" network (e.g., via physical signal translator for various physical media)
- Solution chosen?
  - Hint: "All problems in computer science can be solved by another level of indirection." --- David Wheeler
  - Connecting by layering with packet switching
  - (We will not cover packet switching vs. circuit switching)

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
- "The" computer science approach
  - ISA, OS, networking…



Challenges in Layering

- What to put on top of physical networks?
- Assumption (for the sake of the discussion):
  - Packet switching (a conversation is divided into smaller units called packets).
- Basic things for enabling a conversation between remote hosts:
  - Addressing (where do I send a msg?)
  - Routing (how do I reach that address?)
- Most importantly, survivability
  - Protection of a conversation *as long as* there's a physical path between entities communicating and they are alive.
- What are some of the threats that disrupt a conversation?
  - Packet loss, out-of-order delivery, duplicate packets, etc.

We Must Ask Ourselves…

- In a conversation, there are two components involved
  - Hosts
  - Network
- So, one more question: where do we want to put the functionalities? More specifically, what would be a good network/host division of labor?
- Addressing and routing?
  - Yeah, probably in the network
- What about conversation protection mechanisms?
  - The network or hosts?

Summary

- The Internet
  - A network of networks
  - A case study as a distributed system
- Protocol
  - An agreement between multiple parties
  - Syntax & semantics
- Design a system
  - Why, what, and how
- The Internet
  - Connecting by layering

Acknowledgements

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  - Mike Freedman and Jen Rexford at Princeton