

# 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

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## Today and Next

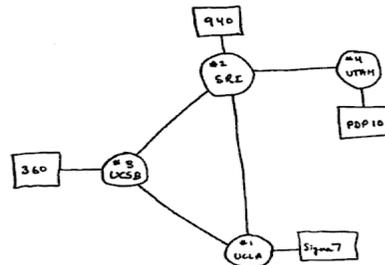
- A brief overview of the Internet
- Two things
  - The design philosophy of the Internet (“The Design Philosophy of the DARPA Internet Protocols” by David Clark): today
  - Transport & application layers: next lecture
- Obviously can’t replace a networking course; this should be just a recap for you.
- 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.

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## What Is the Internet?

- 1969

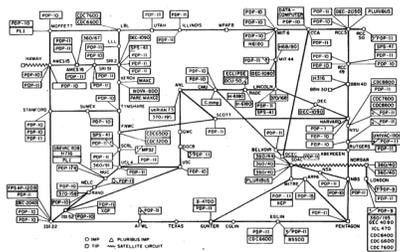


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## What Is the Internet?

- 1977

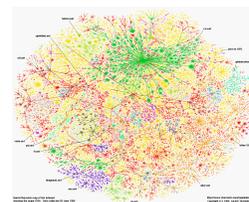


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## What Is the Internet?

- Now



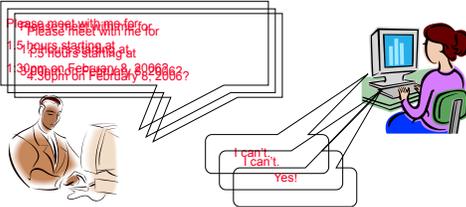
- A network of networks
- The fundamental goal of the original designers: interconnecting different networks by designing common protocols

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## Detour: What is a Protocol?

- Example: making an appointment



- Well...I think we need a better way...

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## 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.

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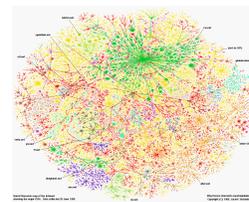
## Detour: What is a Protocol?

- 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.

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## Returning back: What Is the Internet?



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

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## CSE 486/586 Administrivia

- PA 1 is out. Please try it yourself.
  - We're deciding API 19 vs. API 21. Stay tuned.
- Please use Piazza; all announcements will go there.
  - Signup link: <http://piazza.com/buffalo/spring2016/cse486586>
  - Anonymous/private posting: generally questions are beneficial to the whole class; please consider posting it publicly first.
  - All announcements will be posted there.
- Please come to my office during the office hours!
  - Give feedback about the class, ask questions, etc.
- 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.

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## 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?

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## 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.

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## How to Interconnect?

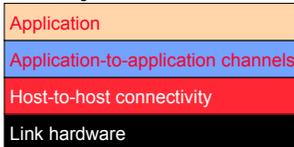
- There were **many types of networks** based on **various physical media**.
  - Coax, radio, satellite, etc.
- The original designers wanted to interconnect those somehow.
- A potential solution
  - Designing a “multi-media” network (e.g., via physical signal translator for various physical media)
- 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)

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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
- “The” computer science approach
  - ISA, OS, networking...



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## 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.

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## 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?

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## 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

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## Acknowledgements

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  - Indranil Gupta at UIUC
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