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?

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

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
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