Topic #01
Today’s Objectives

• Introduction--networking knowledge check

• Course syllabus

• History
Why are you here?
Networking Status Check

• What does anyone know about:
  – History of the Internet?
  – Internet architecture/structure?
  – Protocols that are used?
Why is Networking Hard?
Why is Networking Hard?

• LARGE…
  – millions and millions of computers all connected together
  – spread over a wide geographical area

• Devices are heterogeneous
  – Some large, fast, and well-connected
  – Others are small, power-constrained, and mobile
  – Different devices are made the world over

• Networks do things computers generally don’t like
  – Communication is more prone to errors and delay
  – Computers do exactly what they are programmed to do and must be programmed to deal with all possible scenarios
Check List of What We Will Study

• Organized by layers (OSI stack)
  – Starting next class

• Based on looking at protocols (what is a protocol?)
  – What they do, how they work, and their specifications

• Also look at the context in which these protocols work
  – Limitations of the environment and equipment
  – The types of techniques (classes of algorithms) that can be used

• Always with an eye towards practical aspects
  – What is coming into existence/use today
  – Changing what is done today tends to research (grad school)

• And there is always next quarter(s): cs176b, cs176c
• **Syllabus**
  - One of the few pieces of paper I’ll hand out.
  - The rest of what you need is online on Gauchospace.

• **Description/Objectives/Mission**
  - First of a three course series on networking
    - Principles/Network Programming/Special Topics
  - Designed so that if you only take the first course, you will have exposure to the important components. So more than just a concepts course—it will have programming and network packet tracing.
  - Designed to be conceptual and functional
Course Information

• **Lecture**
  – 20 lectures total
  – 17 topics
  – 2 review/catch-up days (or travel days)
  – 1 in-class midterm

• **Discussion:** First discussion section is October 2\textsuperscript{nd}
  – Review class concepts
  – Receive additional details about homework assignments
  – More time for questions
  – Receive graded assignments
Course Content

• **Course Web Site:** Using GauchoSpace
  – Everyone is already enrolled, log on and follow instructions
  – *Critical* for getting course material, turning in assignments, and getting updates

• **Course Material:** Suggest using Kurose (v6, v5, v4, or v3), but really, any source is fine
  – Plus some papers, you’ll see these on GauchoSpace

• **Other Materials**
  – As a “functional” course, you will often have to look beyond the textbook to supplement your understanding
  – Networking courses are taught all over the US and the world
Syllabus Notes (cont’d)

• Lecture notes are posted online
  – Will generally have them posted 24 hours before class
  – I go through and do updates and add/subtract material
  – Good idea to print lecture notes and use as the basis for tracking what is happening in class and writing further notes

• Lecture style
  – Combo of PPT and board

• Warning: posted lecture notes can be alluring
  – Provides (another) good excuse not to come to class—but be careful.
TAs: Large Enough for Four!

Johan Henkens
Max Hinson
Michael Agun
Smruthi Manjunath
People Information

• Johan will largely handle HW#1
• Michael and Smruthi will handle HW#2A, HW#2B, and help grade the midterm and final
• Max will largely handle HW#3

• Still working on scheduling who will lead the discussion sections
  – My goal is one TA will lead all three discussion sections for a given week
  – Won’t be possible all of the time given scheduling conflicts
Grading

• 40%: Homeworks
  – 10%: Homework #1
  – 6%: Homework #2A
  – 6%: Homework #2B
  – 18%: Homework #3
  – About due dates: all are due Sunday at 11:59pm

• 25%: Midterm Exam

• 35%: Final Exam
Homeworks

- **Homework Details**
  - HW#1
    - Some practical programming experience—ties in with sockets
    - Important that you learn to learn how to transmit/receive data
    - This will be hard for some!!
  - HW#2s
    - Straightforward problem/solution, exercise-based
    - Necessary/important to re-enforce class concepts
    - Two, so HW#2A and HW#2B
  - HW#3
    - Big picture of how protocols fit together
    - Low-level details of how the protocols work
    - Fit it all together into how communication takes place
    - NOTE: HW#3 is worth 3x more than other homeworks
A Bit of History
The Birth of the Internet

• Until the early 1960s, there was radio, television and telephone communications

• Early 1960s: a major shift in thinking about data communications
  – circuit switching was not suitable for computer communications
  – May 1961, Leonard Kleinrock introduced the idea of packet switching
  – Paul Baran introduced an idea called “distributed communication”, in which each communication node was connected to several other communication nodes - precursor to switching
  – Donald Davies in Britain introduces the terms “packet” and “packet switching”
1961-1972: Early Packet-Switching

- Fundamental advances in computer networking, satellite communications and lasers and optical fibers
- Birth of the ARPANET: the first computer network to use packet switching
  - funded by US Advanced Research Projects Agency (ARPA)
  - tasked to connect computing sites at universities and research institutions across the country
  - Interface Message Processors (IMPs): early packet switches, the fundamental component of the early ARPANET
FIGURE 6.1 Drawing of September 1969 (Courtesy of Alex McKenzie)
UCSB is Famous!

- First IMP installed in Sept 1969 at UCLA (Leonard Kleinrock’s research group)
- Second IMP installed at Stanford Research Institute (SRI)
- Third IMP installed at UCSB!! – Thanks to Glenn Culler, Professor Emeritus of Electrical Engineering
- Fourth installed at University of Utah
1972-1980: Internetworking

- The ARPANET becomes a network of networks
  - First connectivity protocol: Network Control Protocol (NCP)
- October 1972: First public demonstration of the ARPANET
  - usage begins to skyrocket
- 1973: Metcalfe’s PhD thesis proposes Ethernet
  - early version of TCP/IP
- 1979: ARPAnet has 200 nodes

Cerf and Kahn’s internetworking principles:
- minimalism, autonomy - open architecture networking
- best effort service model
- stateless routers
- decentralized control
define today’s Internet architecture
Early 1990s: Evolution of the Web

• Early 1990’s: ARPAnet decommissioned

• Early 1990s: Web
  – HTML, HTTP: Tim Berners-Lee
  – 1994: Mosaic, later Netscape
Late 1990s, 2000’s: Commercialization and New Applications

- **1991**: NSF lifts restrictions on commercial use of NSFnet (decommissioned, 1995)

- **1995**: Internet becomes a “network of networks”

- **Mid 1990s**: Commercialization

- **Late 1990s**: More apps
  - instant messaging, P2P file sharing
  - network security becomes critical
  - 50 million hosts, 100 million+ users
  - backbone links running at Gbps

Internet became a “network of networks”
“Network of Networks”

• There was no longer a single backbone

• Any service provider could try to get customers
  – Would need to build their own network
  – Would need to connect their customers together and to other customers
    • Some didn’t at first: CompuServe, GEnie, AOL

• Just like the organization of the telephone system or the mail system
  – Comm have to be “routed” through multiple networks
  – So now…
How Do Networks Exchange Data?

• Point-of-Presence (PoP)
  – the edge of an ISPs network
  – think from an ISPs point-of-view
    • inside looking out

• Traffic exchange points
  – Point where ISPs peer to exchange traffic
  – Called lots of things
    • Network Access Point (NAP)
    • Metropolitan Area Exchange (MAE)
    • Internet eXchange Point (IX or IXP)
1990, 2000’s (Part 2): Trying to Think About Research

- Internet2: A new kind of backbone
  - Started in October 1996
  - 34 research universities started, now 100s
  - Goal was to repeat the success of NSFNet

- Functional goals: create and support advanced apps
  - focus on developing new network services
  - focus on enabling new network-based applications

- Structure
  - campus networks
  - “gigapops”: high-speed points-of-presence
  - backbone (and then inter-connected backbone)

- At the end of the day, “Internet2” is just another one of the networks in the “network of networks.”
Key Transitions

• Birth of the Internet and the early years
  – Up to the early 1970s

• Evolution of internetworking principles and the ARPAnet
  – Early 1970s to early 1990s

• NSFnet
  – 1985 - 1995

• Modern Internet
  – 1995 to present

• Experimental networks
  – Late 1990s to present
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