CS 352
Internet Technology

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http://www.cs.rutgers.edu/~sn624/352-S19
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About us: Management

• Professor: Srinivas Narayana
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  • Office hours: CoRE 312, Thursdays 10 am -- noon or by appointment
  • Class: Wed 10.20 – 11.40 AM and Fri 3.20 – 4.40 PM TIL 232

• Recitation section 5: Bala Murali Komanduri bk455@scarletmail.rutgers.edu
  • Thursday 12.15 —1.10 PM LSH-B267

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  • Thursday 8.55 – 9.50 AM LSH-B115

• Course info
  • http://www.cs.rutgers.edu/~sn624/352-S19/

• Piazza: accessible from class Sakai site
Class etiquette

• Cell phones in off position

• No FB status updates, texting, selfies in class

• If you need to surf while in class (I prefer you do not), do not disturb your neighbors

• Stop me anytime to ask questions

• Try to learn as much as you can in class
What is a Network?

- Carrier of information between 2 or more entities

- Interconnection may be any medium capable of communicating information:
  - copper wire
  - Lasers (optic fibre)
  - Microwave
  - Cable (coax)
  - satellite link
  - Wireless link (cellular, 802.11, bluetooth)

- Examples: Ethernet, 802.11(WIFI), cable modem, cellular
A single link network

- Send bits of data in packets or frames
- Need to worry about errors, how to convert bits into signals and vice versa
A single link multiple access network

- Send bits of data in packets or frames
- Need to worry about errors, how to convert bits into signals and vice versa
- In addition, how to differentiate among many receivers?
- Every host as a link layer address: MAC address
- Packets or frames will have destination address
- However, can’t have every computer in the world on the same link!
A multi-link network

- Connect multiple links via routers
- Need to figure out how to route packets from one host to another host
Components of a network

- **Link**
  - Communication links for transmission

- **Host**
  - Computer running applications of end user

- **Router**
  - Computer for routing packets from input line to another output line

- **Gateway**
  - A device directly connected to two or more possibly different networks (serves as an access point), provides access

- **Network**
  - A group of hosts, links, routers capable of sending packets among its members
Why are networks useful?

• Availability of resources
  • Resources become available regardless of user location

• Performance and load sharing
  • Ex: Move work to the least loaded machine

• High reliability
  • Alternative sources for the same data (multiple copies)

• Human-to-human communication!
  • Ex: telephone (voice over IP), text messaging
What is Internet Technology?

• What is an internet?
  • Network of networks

• What is the Internet?
  • A global internet based on the IP protocol
  • Network to network – adopt a common language

• What does “Internet technology” refer to?
  • Architecture, protocols, and services
Internet growth

Mobile Phones: in 1995 80 M, now 5 B
Evolution of Internet Applications

1992
ftp
web

1996
chat
Games
IM
Yahoo!

2000
news
Blog
Search

2004
Music
itunes
Games
search

2008
Wikipedia
Craiglist
Youtube

2010-now

Evolution of Internet Applications
Web evolution

• Web 1.0
  • Read-only web
  • Content ➔ Users
  • Yahoo, google, daily targum

• Web 2.0
  • Read-write web
  • Content ➔ Users and Users ➔ Content
  • Blog, wikipedia, facebook, twitter, youtube

• Web 3.0
  • Contextual web
  • Personalized, location dependent
  • Apps on your phone get organized (ex: weather, maps); Google NOW

• Web 4.0
  • Devices will be connected as first class objects: refrigerator, car, fitbit, thermostat, …
  • Prediction-Machine learning
Content is exploding

HD quality video: 2G to 4G / hour

Source: Mary Meeker Internet trends Presentation
Video =
Mobile Adoption Climbing...

1.8 B youtube users
Transforming the economy

• Mobile payment
  • Venmo, square, paytm

• Shared resource platforms
  • Uber, Airbnb, WeWork
Just dancing and listening, to video, tweets, selfies, and share

Source: Mary Meeker Internet trends Presentation
Scale of Web apps

- Facebook: 2.23 B active users
- Apple: > 1 B iPhones, 300 M iPads
- Google: 3.5 B searches/day
Impact of the Internet on People

• Access to remote information
  • HW assignments from my server
  • Stock quotes from financial web site
  • News, wikipedia, google

• Person to person and group communication
  • email, whatsapp, blogs, fb, twitter, instagram, snapchat

• Interactive entertainment
  • video clips (youtube), movies (netflix), music (itunes, spotify), games

• Online commerce
  • Amazon, Ebay, hotels
Impact of the Internet on Society

• The good
  • Access to information, services, e-commerce, productivity

• The bad
  • Gossip, distraction, Internet addiction, chat room

• The ugly
  • Phishing, fraud, trolling, cyberbullying

• The Internet is a mirror of society
Internet Players

• Users of applications
  • Everyone (mom and pop, kids) to get something done
• Network Designers
  • Protocol design and implementation
  • Performance, cost, scale
• Internet Service Providers
  • Administrators and ISPs (AT&T)
  • Management, revenue, deployment
• Market/businesses on the Internet
  • Consumer to consumer (ebay), Business to consumer (amazon, netflix), Business to business (alibaba, importers.com,21food.com), Consumer to business (hotjobs, monster), Govt to C, Govt to B, etc.
Internet service providers (ISPs)

• Local ISPs: Tier 3 (cablevision)
• Regional ISPs: Tier2 (internap)
• Global ISPs: Tier 1 (Verizon, Sprint, AT&T, level 3, century link, Deutsche Telekom, NTT) provide access to the entire internet; connect ISP to other ISPs
• Peering ISPs
  • Have a mutual relationship about forwarding traffic of each others customers (no $ involved)
• Transit ISPs
  • Provides access to all reachable customers ($$ involved)
Local and tier-3 ISPs are customers of higher tier ISPs connecting them to the rest of the Internet.
ISPs connected via Exchanges

• Flatter Internet
• Business models among, content provider, transit providers, and customers
• Net Neutrality
Types of Networks in an Internet

• Local area networks (LAN)
  • Privately owned, within building
  • High speed, broadcast, Ethernet
    • 2 to 100 Mbps

• Wide area networks (WAN)
  • Spans a large area
  • Point-to-point, high speed fiber lines
    • Long delays but very high speed links
    • Several Gbps
Types of Networks (cont’d)

• Wireless networks
  • Hosts connected by radio or infrared links
  • Local area and wide area
  • Satellite networks
Google WAN

Figure 1: B4 worldwide deployment (2011).
Microsoft WAN
Historical perspective

• Late 1960’s: ARPAnet (4 nodes)
• Early 1970’s: Aloha net, ethernet, multiple access problem
• Mid-to-late 1970’s: TCP/IP, 4.2BSD
• 1980’s to early 1990’s: early internet growth, e-mail & file transfer dominant, NSFNET
• Mid 1990s: NSFnet handed over to commercial service providers, WWW explodes
• Late 90s, business models using the internet; dot-com boom and bust
• Early to mid 2000s, Web 2.0, Facebook, google, Wikipedia
• Future: “Embedded networks”, 5 to 10 billion devices waiting to be networked, media convergence, ubiquitous RFID tags
Course Goals

• Understand the basic design principles of computer networks

• Understand how the Internet works
  • Services, protocols, and architectures

• Text: “Computer networking, a top-down approach,” by James Kurose and Keith Ross
Course Assessments

- Sakai quizzes (15%)
  - 6 of them, can drop lowest grade

- 2 Mid-terms (15% each)
  - No electronic devices, notes, or cheat sheets allowed

- Final (25%)
  - You must notify me at least 2 weeks before the final if you need to take the makeup!

- Project (30%)
  - Part 1 (10%)
  - Part 2 (10%)
  - Part 3 (10%)
  - You may not dispute a grade before 24 hours or after 7 days of receiving it
Programming assignments

• Single long project
  • Broken into three parts
• Can work in a group of 2
• Both program and write-up required
• Background needed to get started:
  • C or Python (211, 214 level)
    • Comfortable using data structures (dictionaries, vectors, trees)
  • Unix (login, permissions, gcc)
Programming assignments

• Each phase of the code feeds into the next phase
• Make improvements for next phase of the assignment
• Hand-in via sakai
  • Failure to meet the deadline will result in a zero for all team members. No exceptions.
• You must turn in all projects to pass this course
Academic integrity

• No cheating on projects and exams
  • Run code similarity detectors on the projects & code review
  • Scrutinize exams for copying

• Department academic integrity policy
  • https://www.cs.rutgers.edu/academic-integrity/introduction
  • Please read and acknowledge your awareness of this policy