CS 352
Internet Technology

Lecture 1, Spring 2020
http://www.cs.rutgers.edu/~sn624/352
Srinivas Narayana
About us: Management

• Professor: Srinivas Narayana
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  • [srinivas.narayana@rutgers.edu](mailto:srinivas.narayana@rutgers.edu)
  • 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 sections 5, 6, and 7
• TAs for each section will be announced shortly
• Course info
• Piazza: will be accessible from class Sakai site
Class etiquette

• Cell phones in off position

• Please, 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
The Internet is an exciting place
The Internet has transformed everything

- How we communicate with other humans
- How we learn and acquire knowledge
- How we transact and do business
- How we entertain ourselves
- How we govern ourselves
- How war is conducted (!)

- **Internet Technology** is the study of how the Internet (and other inter-networks) are designed: all parts of it.
  - The Internet is an example of a computer network
What is a network, anyway?

• Carrier of information between two or more entities

• Entities may be hosts: your laptop, cell phone, etc.

• Entities may also be devices in the middle of the network
  • For example, your WiFi router

• In this course, we will typically refer to communicating entities as *endpoints*

• The interconnection between entities is any physical medium capable of carrying information
  • copper wire, lasers (over optic fibre), microwave, cable (coax), satellite link, wireless link (cellular, 802.11, bluetooth)
A single link multiple access network

- Send bits of data in *packets* or *frames*
- How do we differentiate among many receivers?
- Every host as a link level *address*: also called a *MAC* address
- Packets have a destination address on them

- However, can’t have every computer in the world on the same link!
A single link multiple access network

- Even on a single link, you need to worry about a few things:
  - Converting digital data to physical signals over the medium (encode/decode)
  - How do we decide who speaks? *(medium access control)* problem
  - Detecting and correcting errors
A multi-link network

- Connect multiple links via *routers*
- Need to figure out how to move packets from one host to another host
- Known as the *routing* problem
- How should packets be routed from endpoint A to endpoint B?
Multi-link networks provide no guarantees

• Packets may be lost, corrupted, reordered, on the way to the destination
  • Best effort delivery

• Advantage: The network becomes very simple to build
  • Don’t have to make it reliable
  • Don’t need to implement any performance guarantees
  • Don’t need to maintain packet ordering
  • Almost any medium can deliver individual packets
    • RFC 1149: “IP Datagrams over Avian Carriers”

• The early Internet thrived since (transient) disruptions are okay
Sending data into a multi-link network

• How quickly should endpoints send data into a network?

• Known as the congestion control problem

• Congestion control algorithms at source endpoints react to remote network congestion

• Key question they answer: How to vary the sending rate?
What about guarantees?

• How should endpoints provide guarantees to applications?

  • **Transport** software on the endpoint is in charge of implementing guarantees on top of an unreliable network
    • Reliability
    • Ordered delivery
    • Packet delay not exceeding 50 ms?
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
How 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
Internet evolution

And ours
Internet growth

1995
35MM+ Internet Users
0.6% Population Penetration

2014
2.8B Internet Users
39% Population Penetration

2018:
3.6B users

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 Craigslist Youtube
2010-now Airbnb Netflix Spotify

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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
1.8 B youtube users
Scale of Web apps

- 2.23 B active users
- > 1 B iPhones
- 300 M iPads

3.5 B searches/day
Transforming the economy

• Mobile payment
  • Venmo, square, paytm

• Marketplaces and resource platforms
  • Uber, Airbnb, WeWork

• Cryptocurrencies
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
Just dancing and listening, to video, tweets, selfies, and share
Impact of the Internet on society

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

• The bad
  • Internet addiction, gossip, distraction, …

• The ugly
  • Phishing, fraud, trolling, cyberbullying

• The Internet is a mirror of society
Course Administration
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

• Take-home quizzes (20%)
  • Due every Tuesday night at 10 PM on Sakai

• 2 Mid-terms (15% each)
  • No notes or cheat sheets allowed
  • No electronic devices other than analog calculators allowed. No cell phones

• Final (20%)
  • 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

• Three programming projects
• Work in the same group of two students throughout semester
  • Only change groups with the discretion of instructor
• Programs and short write-up required
• Background needed to get started
  • Python (211, 214 level)
    • Comfortable using data structures (tuples, arrays, dictionaries)
  • Unix (login, permissions, gcc)
Programming assignments

• Hand-in projects 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

• I encourage you to study and prepare in groups  
  • Share materials: it’s helpful for everyone
• All written & programmed work you turn in must be your own
• Please, no cheating on projects and exams  
  • We reserve the right to…  
    • Run code similarity detectors on the projects & code review  
    • Scrutinize exams for copying  
  • It’s much easier to just do the right thing

• Department academic integrity policy  
  • [https://www.cs.rutgers.edu/academics/undergraduate/academic-integrity-policy](https://www.cs.rutgers.edu/academics/undergraduate/academic-integrity-policy)
  • Please read and acknowledge your awareness of this policy
Help, Accommodations, and such

- Reasonable accommodations will be provided
  - Challenges, care duties, …

- Please don’t hesitate to reach out to me
  - Earlier the better
Questions?

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