Computer Networks
Chapter 1: Introduction

CSC 249
January 25, 2018

Introduction

- What is the Internet?
- Define network edge: hosts, access net, physical media
- Define the network core & Internet structure
- First glimpse at the 'layers' of the Internet
- Thoughts on Internet security

Basic Network Questions

- What are some basic questions you have for this course?

What Are Applications We Use?

1.
2.
3.
4.
5.
6.
7.
8.
9.
10.

What are (core) Internet Tasks?

1.
2.
3.
4.
5.
6.
7.
8.
9.
10.

How Organize (Group) These Tasks?

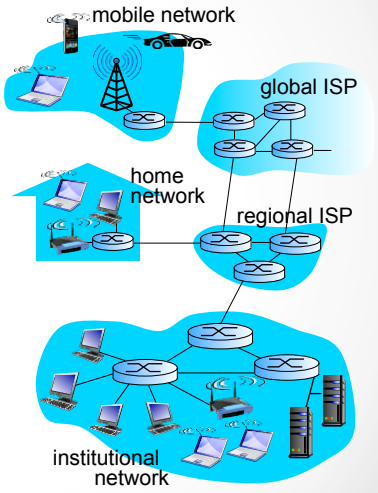
1.
2.
3.
4.
5.

Network Structure:

1) network edge: hosts = clients and servers

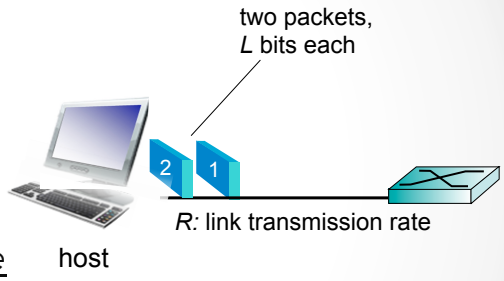
2) access networks, physical media: wired, wireless communication links

3) network core:
- interconnected routers
- network of networks



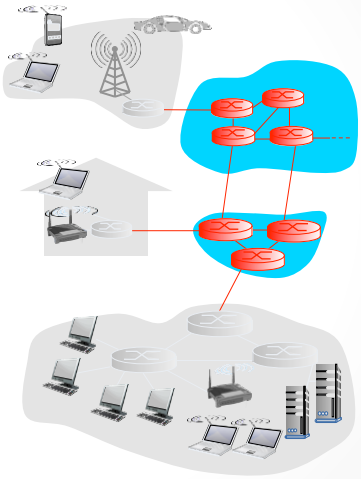
Network Edge Host: sends *packets* of data

To send information:
- The host starts the application message
- Breaks the message into *packets*, of length *L* bits
- Transmits the packet into the Internet, *to the correct destination*



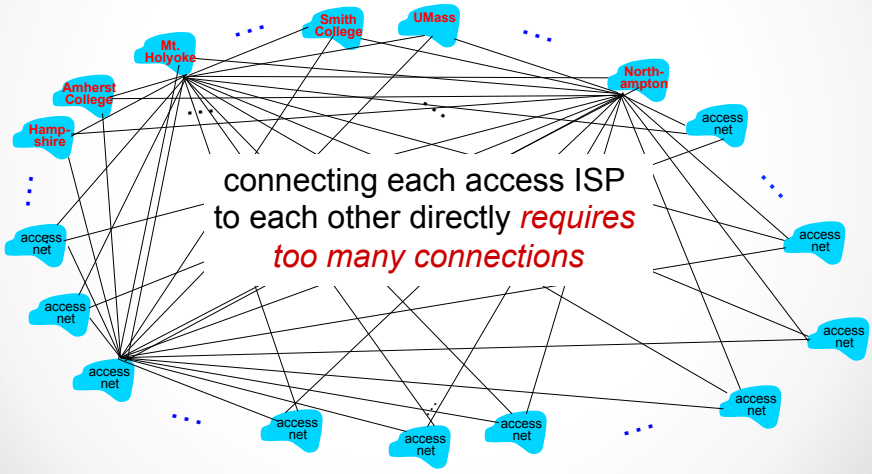
The network core

- A 'mesh' of interconnected routers

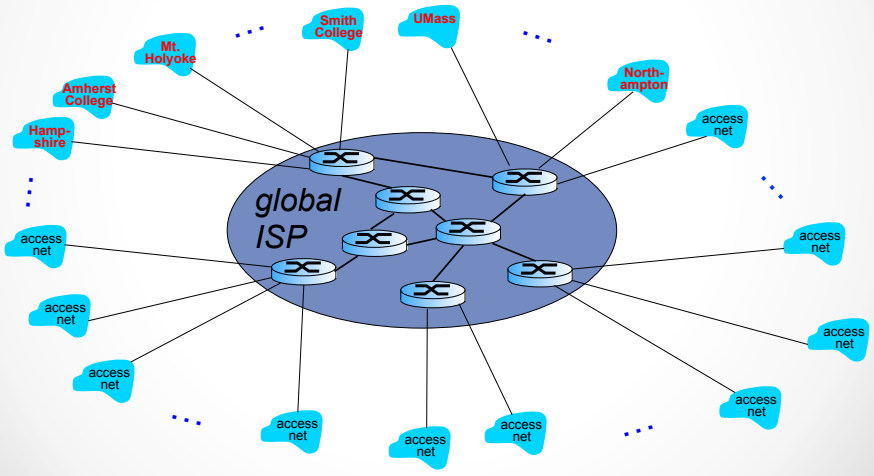


Internet structure: network of networks

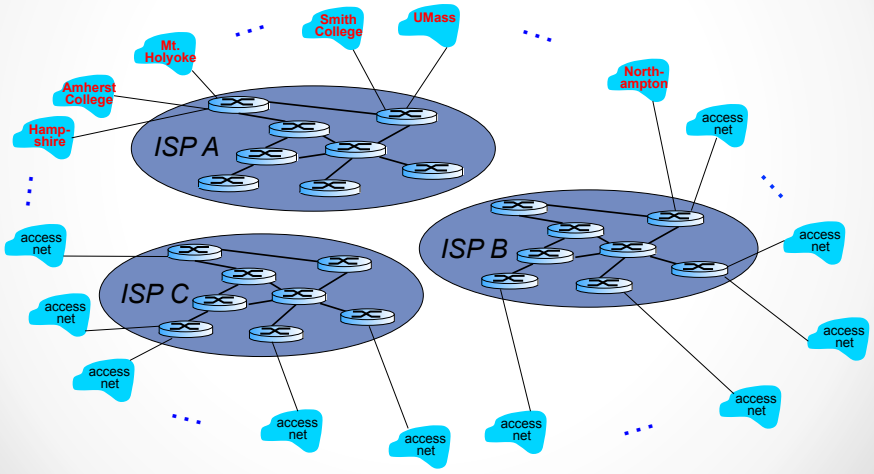
Question: given *millions* of access ISPs, how to connect them together?



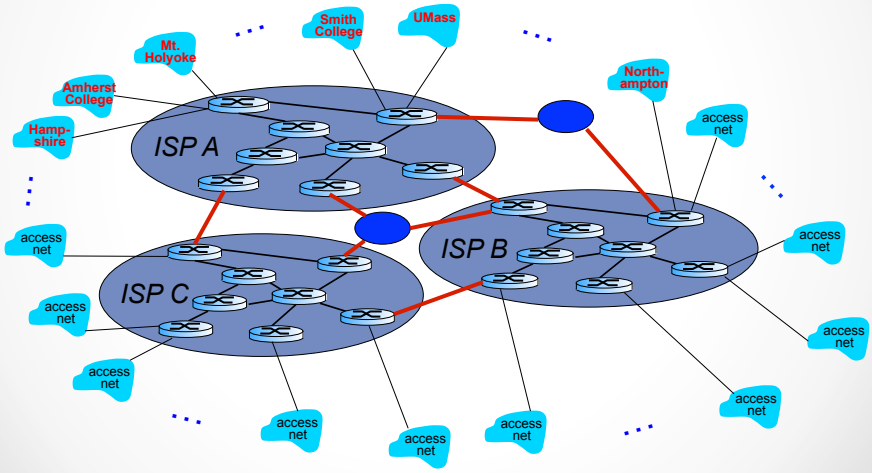
Internet structure: network of networks



Internet structure: network of networks

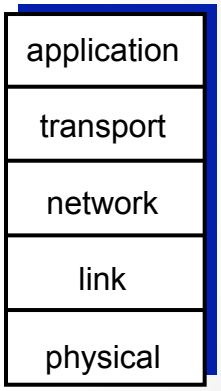


Internet structure: network of networks



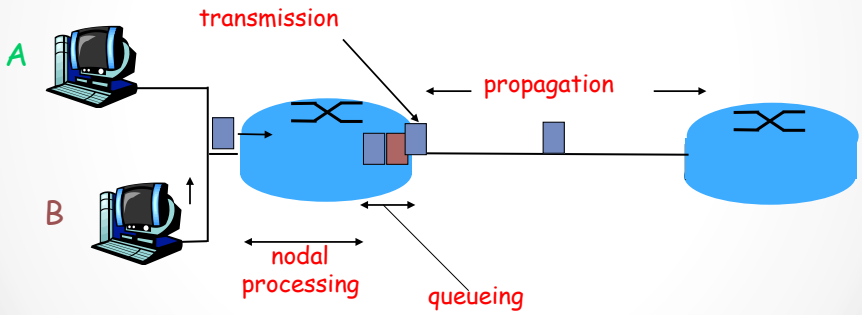
* Internet protocol stack (layers) *

- *Layer 1 (doll 1) – application:*
  - web browsing, email
- *Layer 2 – transport:* data transfer
- *Layer 3 – network:* routing from source to destination
- *Layer 4 – link:* single hop data transfer
- *Layer 5 – physical:* (electrical signals)



Four sources of packet delay

We will return to these concepts throughout the semester.



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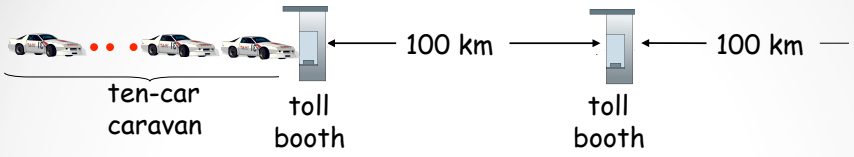
Caravan analogy



- Car ~ bit; caravan ~ packet
- Toll booth takes 8 sec to service car (processing time)
- Cars "propagate" at 100 km/hr
- Q: How long until the caravan is lined up before 2nd toll booth?

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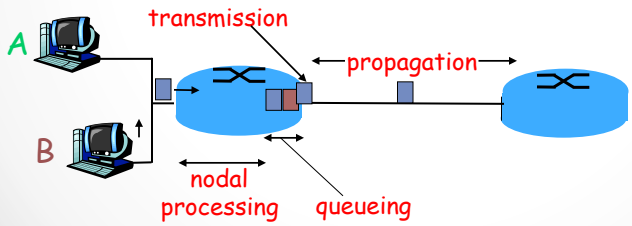
Four sources of packet delay

1. nodal processing

- Read & interpret packet header
- Error checking
- Determine which output link to use

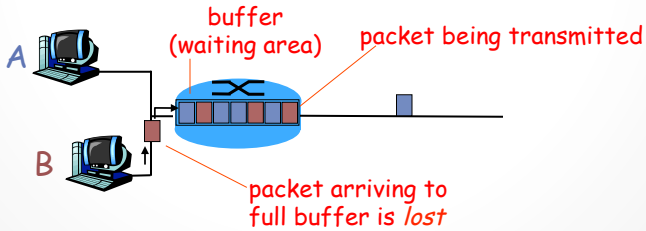
2. queuing

- Time waiting at a router for transmission
- Depends on congestion level of router (how many packets are already in the router RAM)



Queuing Delay & Packet Loss

- A queue, a "buffer" in a router (a portion of memory), has finite capacity
- A packet arriving to a full queue is dropped (aka lost)
- A lost packet may be retransmitted, or not → Reliability

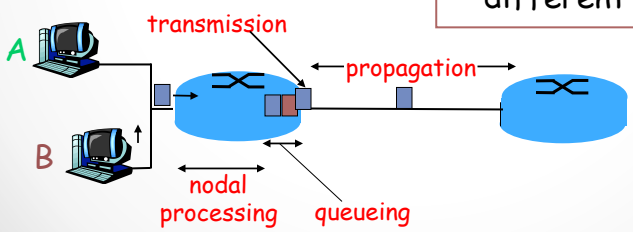


Four sources of packet delay

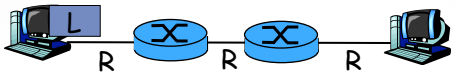
3. Transmission delay:
- R = link bandwidth (bps)
- L = packet length (bits)
- time to send bits into link = L/R

4. Propagation delay:
- d = length of physical link
- s = propagation speed in medium (~$2x10^8$ m/sec)
- propagation delay = d/s

Note: s and R are *very* different quantities!



Packet Switching: store-and-forward



- It takes L/R seconds to transmit (push out) a packet of L bits on to a link at R bps
- *Store and Forward:* entire packet must arrive at router before it will be transmitted on to the next link
- delay = 3L/R (assuming zero propagation delay)

Example:
- L = 7.5 Mbits
- R = 1.5 Mbps
- transmission delay = ? seconds

Moving Fast Through Lines!

- http://blog.mrmeyer.com/2009/what-i-would-do-with-this-groceries/
  - Still Image
- http://blog.mrmeyer.com/2009/good-morning-america/
  - Video (4' 30")

Nodal packet delay

$$d_{nodal} = d_{proc} + d_{queue} + d_{trans} + d_{prop}$$

- d_{proc} = processing delay
  - typically a few microsecs or less
- d_{queue} = queuing delay
  - depends on congestion
- d_{trans} = transmission delay
  - = L/R, significant for low-speed links
- d_{prop} = propagation delay
  - a few microsecs to hundreds of msecs
  - = d/s

Chapter 1 – what to read

- Read through entire chapter, but…
- Section 1.3
  - Emphasize 1.3.1 over 1.3.2
- Section 1.4 – Delay, Loss
  - Know this in detail, including the calculations
  - … In order to *really* know the various sources of delay, and some causes of packet loss
- Section 1.5 – the Layers
  - We will spend all semester on these layers
  - Be *sure* to start internalizing this structure

Summary

- Review
  - New terms and definitions, including
    - Message; packet; frame; bit …
- Begin internalizing "the layers"
  - How do the layers communicate with each other?
    - How do they work together to become the Internet?
- What are the sources of delay?
  - How do we determine and/or calculate these?

Course Administration

- Current events discussions
  - Net Neutrality – semester project
  - Security issues
  - Privacy of our personal data
  - Reliability of the Internet
  - The future of the internet
- Course webpage
  - www.science.smith.edu/~jcardell/Courses/CSC249
  - Course objectives
  - Grading
  - * Schedule *

Course Assignments

- Homework problems from text plus one programming assignment (Python)
  - Homework due on THURSDAY at start of class
  - Self-corrected
- Wireshark labs (packet sniffer)
  - Also due Thursday mornings
  - Self-corrected
- Project – Net Neutrality
- Participation
- Mid-term exam (in-class)
- Final exam (take home)

Homework

- Self-grading on a scale of 0 to 3
- Attempt every problem
- Full credit for attempting and then self-correcting with identifying conceptual errors

CSC 249: Computer Networks Homework Self-Grading

CSC 249 HW number _____

Name: _____ **Date:** _____

The students I worked with on this homework are:

_____

My self-assigned grade is: **0** **1** **2** **3**

(include all the information above this line on every homework submitted)

I. HOMEWORK FORMAT
   a. Include your name on everything you hand in
   b. Homework problems should be *neatly* written or typed
   c. Include a brief statement of the problem being answered, so that anyone would be able to know what problem you are solving
      i. For example: Prob 1: Packet Delay

II. The purpose of the homework problems is to give you the chance to practice what you are learning. You are encouraged to work together to better understand the concepts. However, you will learn more if you also make a first attempt entirely on your own. A first attempt means you read each question and write something down, even if you are pretty sure it is not correct. If you do not know how to solve the problem, write down concisely what you *do know* related to the problem, and what you think you would use to help solve the problem.

II. To best learn from your own mistakes, you will also be the one to correct your own homework first. When correcting your work, try to determine ***why*** you made an initial mistake (e.g., a conceptual misunderstanding? new vocabulary?...). Clearly make corrections, as needed, for *every* question, and *make your corrections in a different color ink than your original work.*

V. Suggest a grade (based on the rubric below) The instructor will verify your work and assign a final grade (0-3) for each homework set.

Grading Rubric for final, self-corrected assignment
0 = Little or no work completed.
1 = Some steps were attempted and these were mostly completed with answers.
2 = All or almost all steps were attempted with full answers.
3 = All steps were attempted with full answers. Most were solved correctly or have been fully corrected (**error identified, conceptual misunderstanding explained and corrected**).

Note that full credit requires correcting your assignment, as needed, AND: identifying errors, identifying your conceptual misunderstanding that led to the error with a brief phrase, and providing the corrected answer.

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Wireshark Labs

- Wireshark, a packet sniffer, is on the Macs on the 2nd floor computer room, Ford Hall (though buggy…)
- It is free to download and put on your own computer
- Make sure it will open for you before the first lab assignment is due.

For the Wireshark Labs, submit a ONE-PAGE professional memo that is *guided* by the lab handout

Include:

- Your name
- An informative memo title
- A brief statement of the learning objective of the lab
  - For the first lab, this could be simply to become familiar with the basic functions of Wireshark…
  - For subsequent labs you need to think about this objective more deeply
- The questions in the lab with your results and answers ***in an appendix*** as relevant to support results and conclusions in the body of the 1-page memo
  - For the Wireshark labs it may be a good idea to include a couple of screen shots of the Wireshark window and/or information pasted from sections of the Wireshark window into your lab write-up.
- A brief concluding statement which must include
  - What you learned, as related to computer networks and networking theory that we are discussing this semester. This must be something that reveals that you are learning networking material.
  - ** *State what you learned from the lab* **

Net Neutrality Project

- Semester long investigation of the issues surrounding net neutrality.
- Start reading now, for homework 2
  - Readings posted on the course webpage
  - And/or your own readings
- Objective will be to understand
  - Benefits and drawbacks in terms of:
  - Technical understanding and issues
  - Concerns for industry, consumers, politicians

Introduction: summary

- Internet overview
- Network structure: network edge, core, access network
- Defining a protocol?
- Performance: loss, delay, throughput
  - Read in chapter, and we will use throughout the semester
- Layering, service models
- Security & Privacy