

CSE 123b Communications Software

Winter 2002

Lecture 1: Introduction & Review

Stefan Savage

Class Overview

- Course Material
 - Class lectures, textbook readings, and handouts
- Course Assignments
 - Homework questions from book and handouts
 - » Handed out on Tuesday due the following Tuesday
 - Potentially a small number of programming projects
- Exams
 - Midterm and Final
 - I will be explicit about what is covered in each

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Some hints

- Come to lecture
 - Yes, I will distribute the slides online, and yes the material is in the book
 - However, lecture materials are the basis for exams
- Do the homework
 - You will have a hard time with the exams without doing the homework
 - Its 25% of your grade (easily the difference between an A and C)

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Some hints (2)

- Ask questions
 - In class, via e-mail and at office hours
 - Inevitably you won't understand something... that's my fault, but you need to help
- Start assignments early
 - There is a statistical relationship between when you start and what grade you get.
- Sleep

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Administrativa

- Web page
<http://www-cse.ucsd.edu/classes/sp02/cse123B/>
- Textbook
Computer Networks: A Systems Approach (2nd ed) by Peterson and Davie
- Discussion section
 - M 9:05-0:55 CENTR 109
- TA's
 - John Paul Fryckman & Sanjeev Bansal
- Mailing list & office hours (TBA)

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Course material

- The key aspects of modern computer networks and network services
 - Reliable communication
 - Congestion control
 - Routing (intradomain and interdomain)
 - Mobility, Naming
 - Address translation, Time synchronization
 - Web service, caching, load balancing, CDNs
 - Peer-to-peer networks
 - Security
 - ???

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We will not cover

- Queuing theory
- Signals
- Hardware design
- Switching design
- Physical/data link layers

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Overall goals

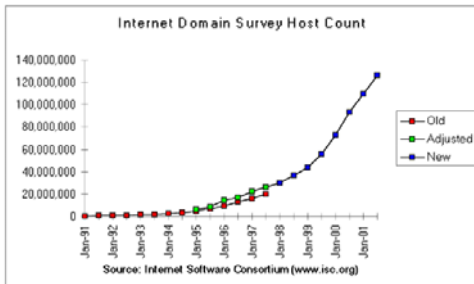
- Understand how to **large scale, heterogeneous distributed networks are built**
 - Fundamental problems
 - Established design principles
 - Standard Internet protocols and implementations

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Large scale?



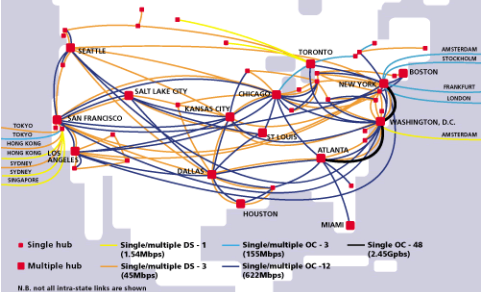
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Large scale? (2)

UUNET'S North American Internet Backbone



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Heterogeneous?

- Homogenous network: the telephone system
 - Designed for making phone calls
 - Known call duration distribution, bandwidth, service constraints, service model
- Homogenous network: the Internet
 - Supports E-mail, web, e-commerce, audio, video, multi-player games...
 - Few underlying assumptions – a strength and a weakness

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Distributed?

- Decentralized components
 - Must update/manage changes in state
- Long communication latency
 - Actions take time
- Partial failures
 - Must tolerate failures

“A distributed system is a system in which I can't do my work because some computer has filed that I've never even heard of”
– Leslie Lamport

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Some review

- Elementary components
- Circuit switching vs packet switching
- Basic network model/metrics
- Layering/protocols
 - Layering by example: fetching a Web page

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Network components

- **Hosts:** endpoints that communicate
 - e.g. workstation, server, PDA
- **Links:** transmission medium
 - e.g. Ethernet, 802.11b, FDDI
- **Routers/Switches:** moves bits between links
 - Circuit switching: guaranteed channel for a session (Telephone system)
 - Packet switching: statistical multiplexing of independent pieces of data (Internet)

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Circuit Switching

- Three phases
 1. circuit establishment (dial)
 2. data transfer (talk)
 3. circuit termination (hang up)
- If circuit not available: "Busy signal"
- Examples
 - Telephone networks
 - ISDN (Integrated Services Digital Networks)

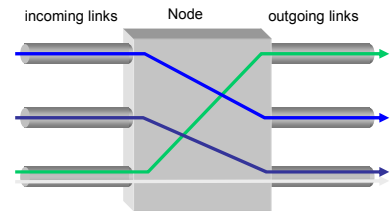
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Circuit Switching

- A node (switch) in a circuit switching network



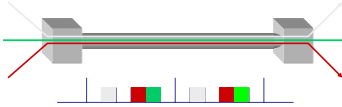
Slide courtesy Ion Stoica

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Circuit switching: time division multiplexing



- Time divided in frames and frames divided in slots
- Relative slot position inside a frame determines which conversation the data belongs to
- Needs synchronization between sender and receiver
- In case of non-permanent conversations
 - Needs to dynamic bind a slot to a conversation
 - How to do this?

Slide courtesy Ion Stoica

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Packet Switching

- Data is sent in a bundle of bit-sequences, called a packet.
- Packets have the following structure:



- » Header and Trailer carry control information (e.g., destination address, check sum)
- Each packet is passed through the network from node to node along some path (**Routing**)
- At each node the entire packet is received, stored briefly, and then forwarded to the next node (**Store-and-Forward Networks**)
- Typically no capacity is allocated for packets

Slide courtesy Ion Stoica

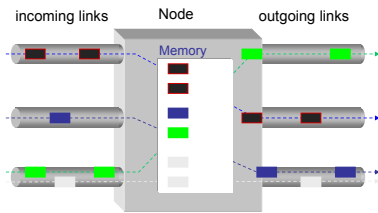
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Packet Switching

- A node in a packet switching network

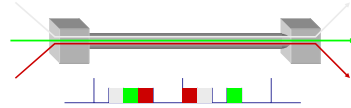


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Packet Switching: Statistical multiplexing



- Data from any conversation can be transmitted at any given time
- How to tell them apart?
 - use **header** to describe data

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Pro/cons of packet switching

- Efficiency
 - Can share network up to its capacity – no overhead for reserving bandwidth that is unused
 - Can support many different service types
- Low complexity
 - Don't need to maintain state about each "call"
- Harder to guarantee bandwidth/delay

We will focus on packet switching in this class

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Simple network model

Network is a pipe connection two computers



Basic Metrics

- Bandwidth, delay, overhead, error rate and message size

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Network metrics

- Bandwidth
 - Data transmitted at a rate of R bits/sec
- Delay or Latency
 - Takes D seconds for bit to propagate down wire
- Overhead
 - takes O secs for CPU to put message on wire
- Error rate
 - Probability P that message will not arrive intact
- Message size
 - Size M of data being transmitted

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How long to send a message?

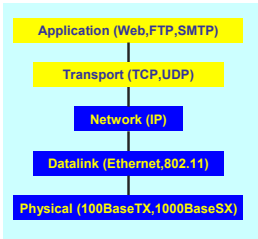
- Transmit time $T = M/R + D$
 - 10Mbps Ethernet LAN (M=1KB)
 - » $M/R=1\text{ms}$, $D \sim 5\mu\text{s}$
 - 155Mbps cross country ATM (M=1KB)
 - » $M/R = 50\mu\text{s}$, $D \sim 40\text{-}100\text{ms}$
- $R \cdot D$ is the "storage" of pipe
(also called *bandwidth delay product*)

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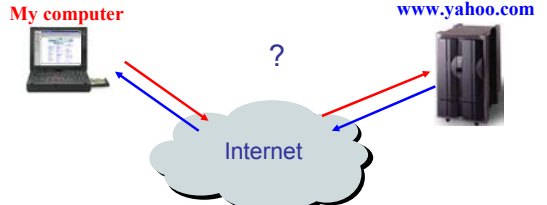
The Internet layering model



- So-called “hourglass” model
 - One network layer protocol
 - Significant diversity at other layers
- No presentation or session layers
- Implementations more important than interfaces

Layering by example...

- **ROUGHLY**, what happens when I click on a Web page from UCSD?



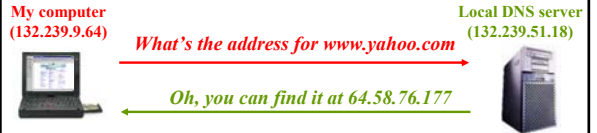
Application layer (HTTP)

- Turn click into HTTP request



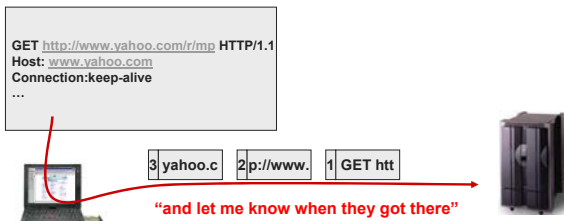
Application layer? Name resolution (DNS)

- Where is www.yahoo.com?



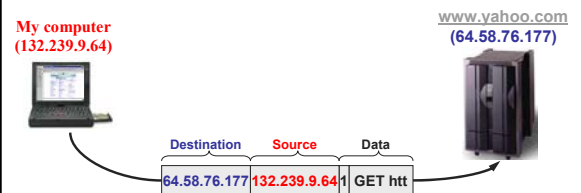
Transport layer (TCP)

- Break message into packets (TCP segments)
- Should be delivered reliably & in-order



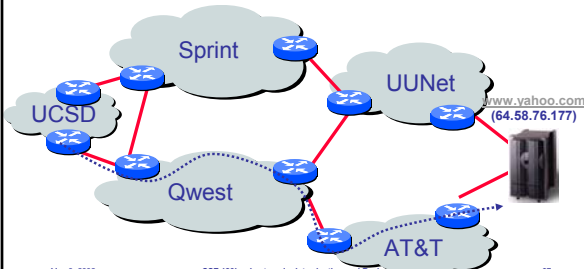
Network layer: IP Addressing

- Address each packet so it can traverse network and arrive at host



Network layer: IP Routing

- Each router forwards packet towards destination



Datalink layer (Ethernet)

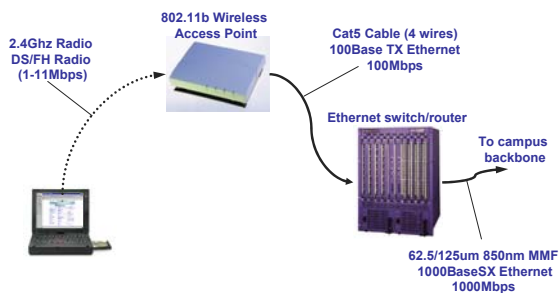
- Too boring for a picture (sorry)
- Break message into frames
- Media Access Control (MAC)
- Send frame

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Physical layer



Summary

- Packets switching is an efficient and simple architecture for data communications
 - Gives up guarantees on service
- Layering is a technique for managing complexity in systems
 - Encapsulate related functionality in a layer and provide an interface to upper and lower layers
 - A **model**: implementations do not necessarily respect layers
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For Next Time...

- Review Patterson&Davie Chap1
- Read Chap 4.1 - 4.1.4

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