

TIM 50 - Business Information Systems

Lecture 18

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Outline

- Announcements
- Markup Languages
- Networks
- Student Presentations
- Akamai Case

Announcements

- Reading
 - Messerschmitt Ch 10.1 -10.2
 - American Airlines

Markup languages

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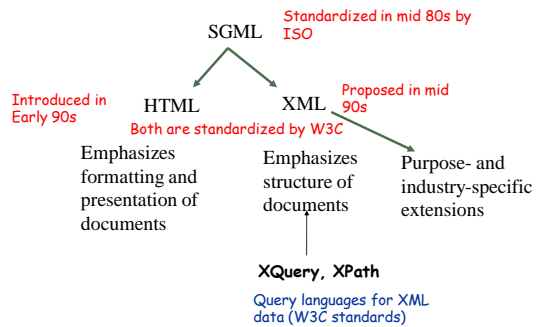
Documents and XML

- Enterprises create/store/exchange documents
- When using DBMS, documents are stored in their entirety
 - BUT their internal structure is not visible
- The WWW as a communication medium
 - Non-traditional database
 - Billions of documents stored/exchanged
 - Need for identifying/processing documents' internal structure

Markup Languages

- A *markup language* describes the structure of a document
 - Based on tags
 - **Tags** denote structural elements like sections, subsections, figures, etc
- Internationally standardized, so application independent

Family lineage



Example: HTML

```
<html>
<h1> Super Widget </h1>
<h2> Widgets Incorporated</h2>
<em> 123456789 </em>
<br>
<p> $300</p>
</html>
```

Super Widget

Widgets Incorporated

123456789

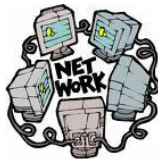
\$300

Networks

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What are some examples of communications networks?

- Public Telephone Network
- Internet
- LANs (Local Area Networks)



What does a network do?

- Transport data from one host to another
 - Host allocation
 - Routing
- Millions of users/applications/hosts share the same network
 - Resource sharing
 - Congestion control

Network Architecture

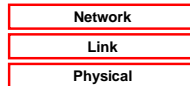
Network architectures are layered

Each layer

- uses the services of the layers below
- To offer more advanced services to layer above

Allows layers to be designed independently

We will talk about 3 layers next...



Link Layer

Make a **Frame** link out of a bit link

- Instead of endless sequence of 1s and 0s, we want distinct "packages" of data that are separate from each other

Say we want to send 2 Frames with data

- 010101010111010 and 101010101011010
- Concatenate them and send them as a sequence?

How can the receiver tell where the new frame begins?

Solution: insert a special sequence at the start of frame: for example: 01111110

Link Layer (cont'd)

Also does error detection/correction

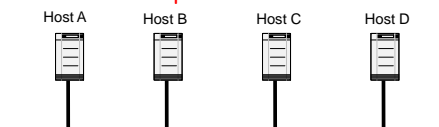
- Insert extra information the helps the receiver to determine if the data has been corrupted.
- Example: parity bit
 - Sender adds a 1 or zero to end of data so number of ones is always odd
 - 10011 or 10000
 - If receiver counts an even number of ones, than it knows the data was corrupted.

Error Detection

- **Simple parity** bit scheme problem?
 - Cannot detect if two or any even number of bits were modified during the transmission.
- **CRC (for cyclic redundancy code):** more sophisticated error detection code
 - sending node: calculates the CRC bits (typically 32 bits) from the previous bits in the packet
 - receiving node: performs the same calculation and compares the result with the error detection bits in the packet;
 - if they differ, the receiving node knows that some error occurred and it discards the corrupted packet.

More Link Layer.. -- Ethernet

Want to allow multiple hosts to share a link



How do they avoid talking at the same time?

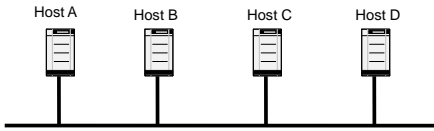
Don't transmit if you hear another host transmitting

If there is a collision, stop wait a random amount of time, and try again

This is a **Medium Access Control (MAC)** Protocol

Ethernet Continued

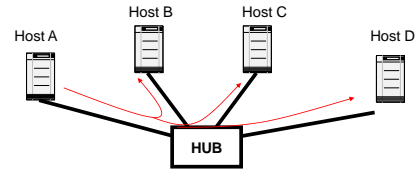
How do the hosts on this Ethernet identify each other?



Each host (actually each interface)

- has a globally unique *MAC address*
- Cannot be changed

Ethernet Hub

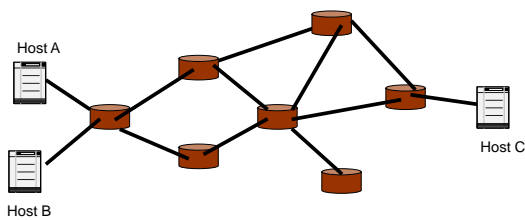


Hub broadcasts packets on a link to all others
As if all hosts connected to single link

- We say it is a Single collision domain

Only one host can talk at a time

Routing in the Internet



Many feasible paths from source to destination.

Recall: three ways of locating things(Ch.11)

Name

- "John Smith"

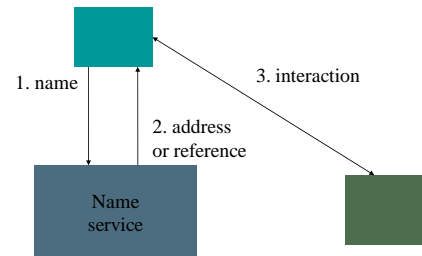
Address

- "1156 High St., Santa Cruz, CA"

Reference

- "Postmaster of UCSC, Santa Cruz, CA"

Name services



E.g. Map a host name (URL) to its IP address

Domain Names

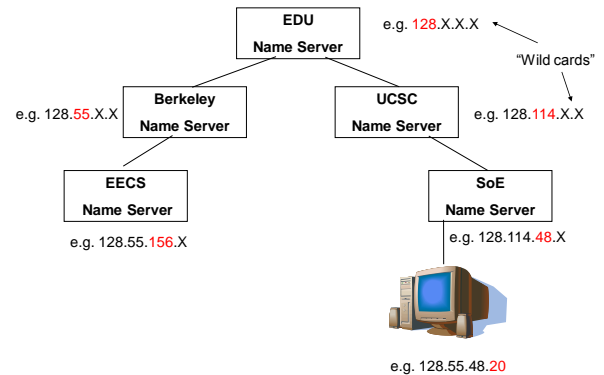
IP addresses are inconvenient for people

- e.g. 128.55.156.273
- 32 bits hard to remember
- 128 bits very hard to remember

Domain names

- e.g. argus.eecs.berkeley.edu
- Easier to remember than IP addresses
- However, we need some way of mapping domain names to IP addresses.

Domain Name System (DNS)



Hierarchy in Addresses vs. Names

Addresses hierarchical in topology

- Maximize "wild cards" and distribute address administration

Names hierarchical in administration

- Single administered organizations often distributed topologically (e.g. ibm.com)

Routing

Routing

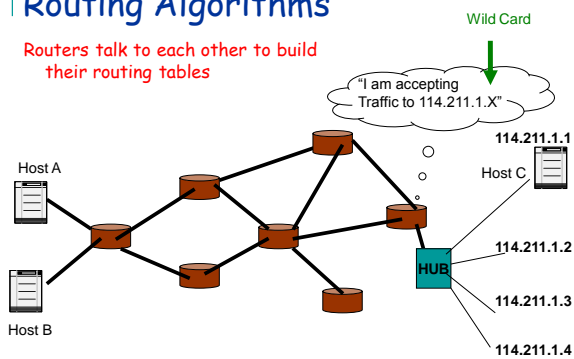
- Updating the routing table
- Objective: each packet gets closer to destination

Packet forwarding

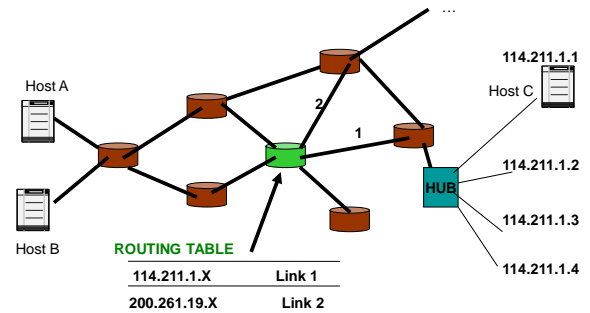
- Transmitting each packet on the appropriate output link
- Based on routing table

Routing Algorithms

Routers talk to each other to build their routing tables

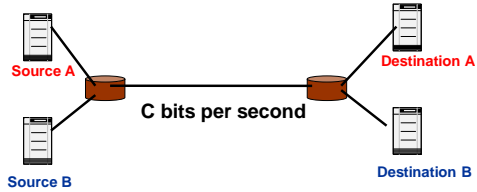


Routing Table has Wild Cards



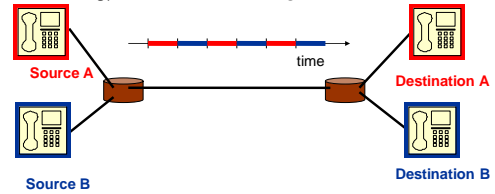
Issues In Networking

- **Sharing of Limited Resources**
 - How Should A and B share a link with limited bit rate?



Issues In Networking

- **Time Division Multiplexing**
 - gives each connection the use of the link a fixed fraction of time
 - Fixed fraction of resources reserved for each connection
 - Technology called *circuit switching*.



- **Problem**
 - When A is silent, A's fraction of link goes unused.

Transport Protocols

The Internet is unreliable

- It will make a "best effort" to get your packet to its destination

Packets can be lost because of

- Congestion
- Link errors
- Routing problems

Application
Presentation
Session
Transport
Network
Link
Physical

Transmission Control Protocol (TCP)



ACK



Packet 2

Retransmit mechanism for reliability

- Receiver sends acknowledgements to sender
- If a packet is lost, source fails to get ACK, and then retransmits.

Congestion control

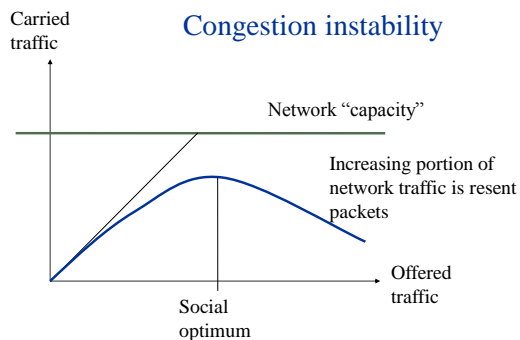
- If congestion perceived (by lost packets)
- Source reduces its send rate
 - When loss, sender reduces send rate by half
 - Otherwise slowly increases

Network congestion

Traffic can overload links

- Failure of statistical multiplexing

Congestion must be limited in some fashion



Congestion Control

When networks are congested, certain sessions (Source-destination pairs) should reduce offered rates.

- Today all TCP sessions slow down when they detect packet losses.
- UDP sessions do not slow down.

What are some alternative strategies?

- Have those whose applications aren't as sensitive slow down more?
 - How would we know which are less sensitive

kb, mb and others...

We count in base 10 by powers of 10:

$$10^1 = 10, 10^2 = 10 \times 10 = 100, 10^3 = 10 \times 10 \times 10 = 1000,$$

$$10^6 = 1000000$$

Computers count by base 2:

$$2^1 = 2, 2^2 = 2 \times 2 = 4, 2^3 = 2 \times 2 \times 2 = 8, 2^{10} = 1024, 2^{20} = 1048576$$

So in computers, the following units are used:

Unit Equivalent

1 kilobyte (KB) 1,024 bytes

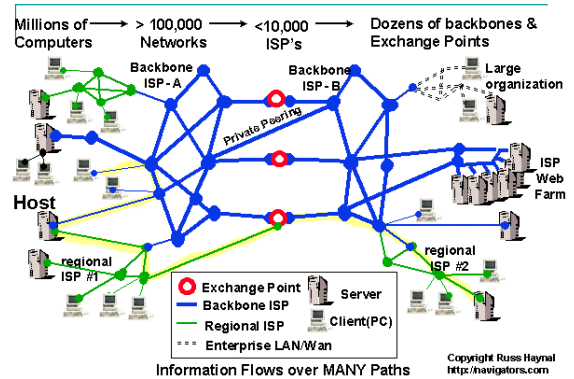
1 megabyte (MB) 1,048,576 bytes (1,024*1,024)

1 gigabyte (GB) 1,073,741,824 bytes

1 terabyte (TB) 1,099,511,627,776 bytes

1 petabyte (PB) 1,125,899,906,842,624 bytes

Akamai Case (cont'd)



Source: www.navigators.com

Bottlenecks in the Internet architecture

- **First mile**
 - Web and application server performance
 - Router and Switch capacity.
- **Peering**
 - Dumping traffic on other NSPs
- **Last mile**
 - IAP's router or modem capacity
 - Limited transmission rates
 - Older computers
- **Backbone**
 - Many routers for data to go through (17 to 20 routers)

2 major problems:

- **loss of packets (information)**
- **slow connections**

Freeflow

- Deployed in 1999
- Akamai Infrastructure
 - 13000 servers in 954 networks by 2001
- Customers
 - Large Commercial Websites

Competition

- Hosting firms (substitute)
 - Exodus
- Other CDNs
 - Sandpiper, Adero, Mirror Image
- Content Alliances
 - Akamai's competitors banded together to share networks

Akamai Case

- How did Akamai differentiate from its competitors after the dot-com recession of 2000?
- Was it a successful move? Was it a costly decision for Akamai? Why?

2001 Market Changes

Bad

- Dot-coms bust
- Customers leave
 - "churn rate goes to 22% per quarter"

Good

- Hosting firms go bust (exodus)
- Some CDN competitors go bust.
- Competing CDN alliances mired in problems

EdgeSuite

- Assemble and Present dynamic pages at edges rather than just deliver heavy objects
- Pricing - higher than old service
- Soon EdgeSuite dominated revenue