ISM 50 - Business Information Systems

Lecture 16

Instructor: John Musacchio
UC Santa Cruz
November 14, 2006

Class announcements

- Reading for Thursday (Nov 16):
  - Akamai Case
- Student Presentations Thursday (Nov 16)
  - Victoria Tam (akamai case)
  - Andrew Director (Business Paper)

Student Presentations

- Dan PhamBusiness Paper)
- Jess Chung (Business Paper)

Standardization

Purpose of a standard?

- Allow products or services from different suppliers or providers to be interoperable

Scope of a standard

Included:

- interfaces (physical, electrical, information)
- architecture (reference model)
- formats and protocols (FAP)
- compliance tests (or process)

Excluded:

- implementation
- (possibly) extensions

Reference model

Decide decomposition of system

- where interfaces fall

Defines the boundaries of competition and ultimately industrial organization

- competition on the same side of an interface
- complementary suppliers on different sides
- hierarchical decomposition at the option of suppliers
- (possibly) optional extensions at option of suppliers

Some issues

Once a standard is set

- becomes possible source of industry lock-in; overcoming that standard requires a major (~10x?) advance
- may lock out some innovation

In recognition, some standards evolve

- IETF, CCITT (modems), MPEG
- backward compatibility

Types of standards

de jure

- Sanctioned and actively promoted by some organization with jurisdiction, or by government

de facto

- Dominant solution arising out of the market
- Voluntary industry standards body

Industry consortium

Common or best practice

Examples?

Examples

de jure

- GSM, ISDN Telephone interface

de facto

- Microsoft Windows API (Application Programming Interface)
- Intel Pentium instruction set,

Voluntary industry standards body

- IEEE (Institute of Electrical and Electronic Engineers)
- IETF (Internet Engineering Task Force

Industry consortium

- W3C (World Wide Web Consortium)
- SET (Secure Electronic Transactions)

Best practice

- Windowed GUI

The changing process

- As technology and industry move more quickly, the global consensus standards activity has proven too unwieldy
  - e.g. ISO
- "New age" standards activities are more informal, less consensus driven, a little less political, more strategic, smaller groups
  - e.g. OMG, IETF, ATM Forum, WAP

Programmable/extensible approaches for flexibility

- e.g. XML, Java

Reasons for change

- From government sanction/ownership to market forces
  - Increasing fragmentation
  - Importance of time to market

Greater complexity

- Less physical/performance constraint for either hardware or software

Lock-in

(Particularly open) standards reduce consumer lock-in

- Consumers can mix and match complementary products

Increase supplier lock-in

- Innovation limited by backward compatibility
- e.g. IP/TCP, x86, Hayes command set

Aside: Network Effects

- The value of owning some products goes up if lots of other people have it too.
  - Examples?
- This phenomenon is called "network effects"
- How do standards influence network effects?

Network effects

Standards can harness network effects to the industry advantage

- Revenue = (market size) x (market share)

Increases value to customer

Increases competition

- Only within confines of the standard
- But forces customer integration or services of a system integrator

Why standards?

de jure are customer driven to reduce confusion and cost

de facto standards are sometimes the result of positive feedback in network effects

Customers and suppliers like them because they

- increase value
- reduce lockin

Governments like them because they

- promote competition in some circumstances
- May believe they can be used to national advantage

Approaches

Consensus

- ISO

Collaborative design

- MPEG

Competitive "bake off"

- IETF

Coordination of vendors

- OMG

Open vs. Proprietary Standards

- Open standard – a standard that is well documented, unencumbered by intellectual property rights and restrictions, and available to any vendor.
- What are the advantages?
- What are the disadvantages?

Why companies participate

Pool expertise in collaborative design

- e.g. MPEG

Have influence on the standard

Get technology into the standard

- Proprietary, with expectation of royalties
- Non-proprietary

Reduced time to market

Standards applied to Business Processes?

- Can you standardize business processes?

- Yes!:
  - ISO 9000
    - A set of standardized business processes for Quality Management.
    - Supports TQM (Total Quality Management)
  - RosettaNet
    - A set of standardized business processes, and accompanying standardized data interfaces/formats for conducting e-business.

Markup languages

Definition

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

Example: HTML

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

Super Widget

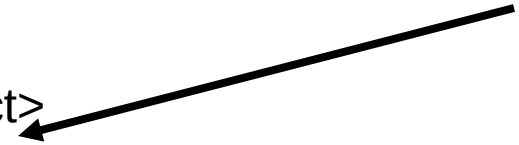
Widgets Incorporated

123456789

$300

Example: XML

Tags Emphasize what the things *mean* rather than how to *format* their Presentation.



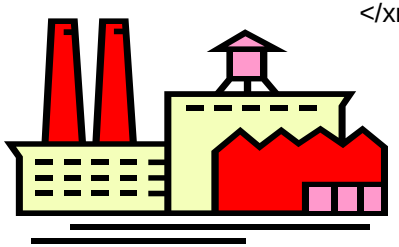
```
<xml>
<product>
<model>  Super Widget  </model>
<make>  Widgets Incorporated</make>
<sku>   123456789  </sku>
<price>  $300 </price>
<\product>
</xml>
```

XML in Ecommerce example

```
<xml>
<product>
<model>  Super Widget  </model>
<make>  Widgets Incorporated</make>
<sku>   123456789  </sku>
<price>  $300 </price>
<\product>
</xml>
```

Stuff4U

Super Widget	$300
Amazing Gadget	$500



Supplier

Product info From each Supplier sent in XML

Stuff4U

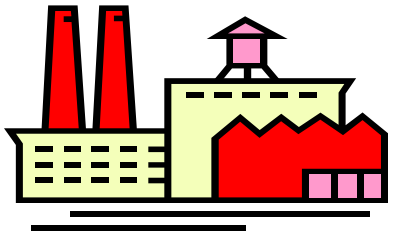
Retailer

Consumer

XML in ecommerce example 2

XYZ
Manufacturing

```
<xml>
<product>
<model>  Super Widget  </model>
<make>  Widgets Incorporated</make>
<sku>   123456789  </sku>
<price>  $300 </price>
<\product>
</xml>
```

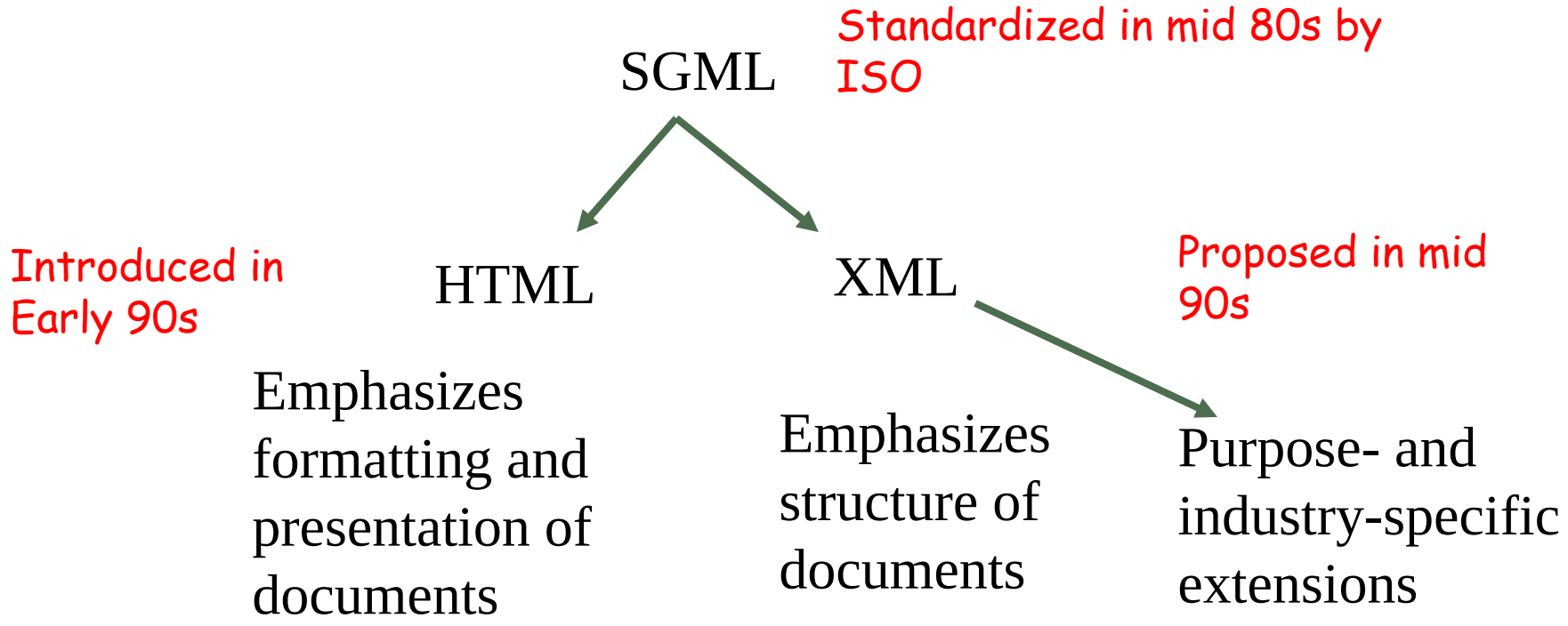


Supplier

Product info
From each
Supplier sent in
XML

Super widget recognized and managed by SCM software.

Family lineage



Networks

What are some examples of communications networks?

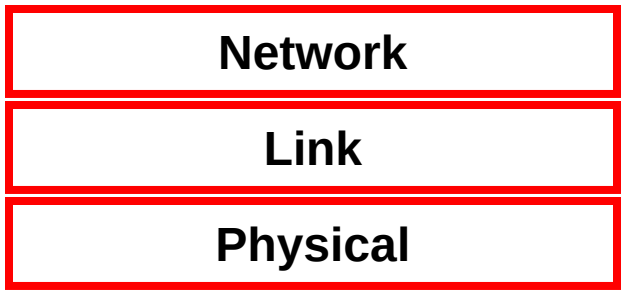
- Public Telephone Network
- Internet
- LANs (Local Area Networks)

What does a network do?

1) Transport data from one host to another.

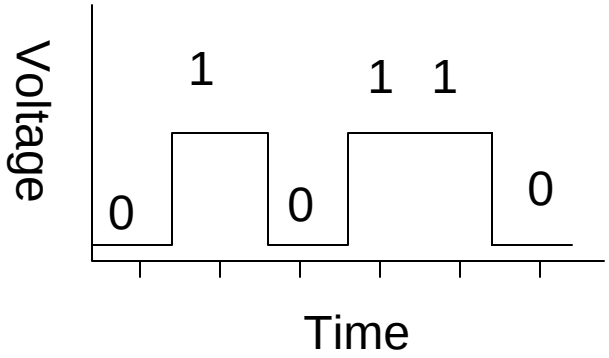
Network Architecture

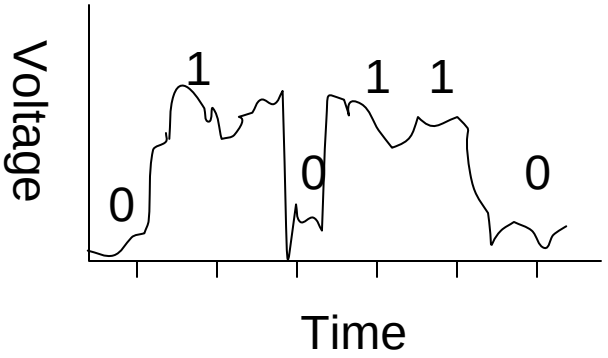
- Network architectures are layered
- Each layer
  - uses the services of the layers below
  - To offer more advanced services to layer above
- Allows layers to be designed independently
- We will talk about 3 layers next…

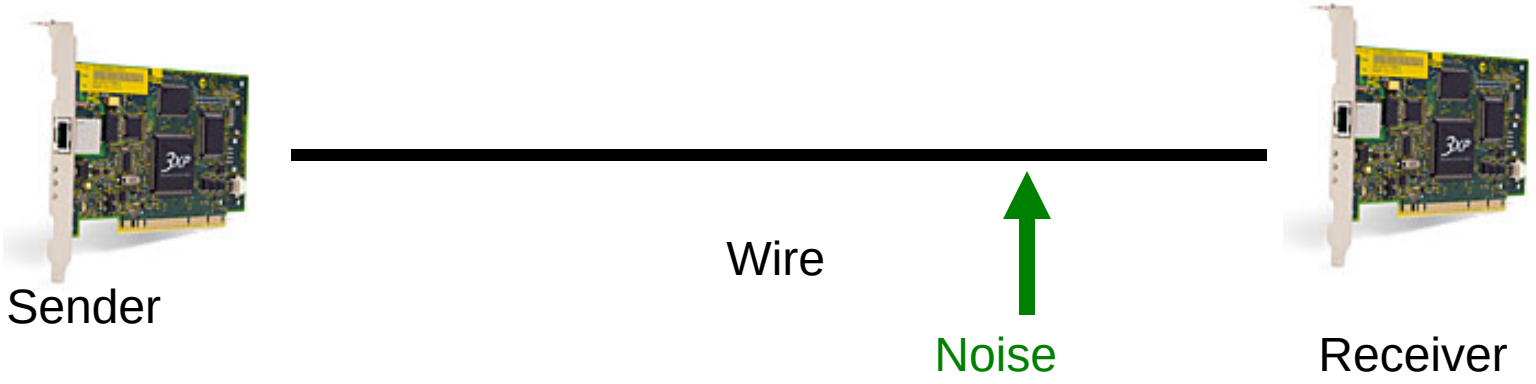


Physical Layer: Convey bits over a wire

Bits: 010110…







Physical layer

- Other schemes for mapping a bit sequence to a physical sequence are possible.
  - These are called *modulation* schemes

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
  - 0101010101010111010 and 101010101011010
  - Concatenate them and send them as a sequence?
- How can the receiver tell where the new frame begins?

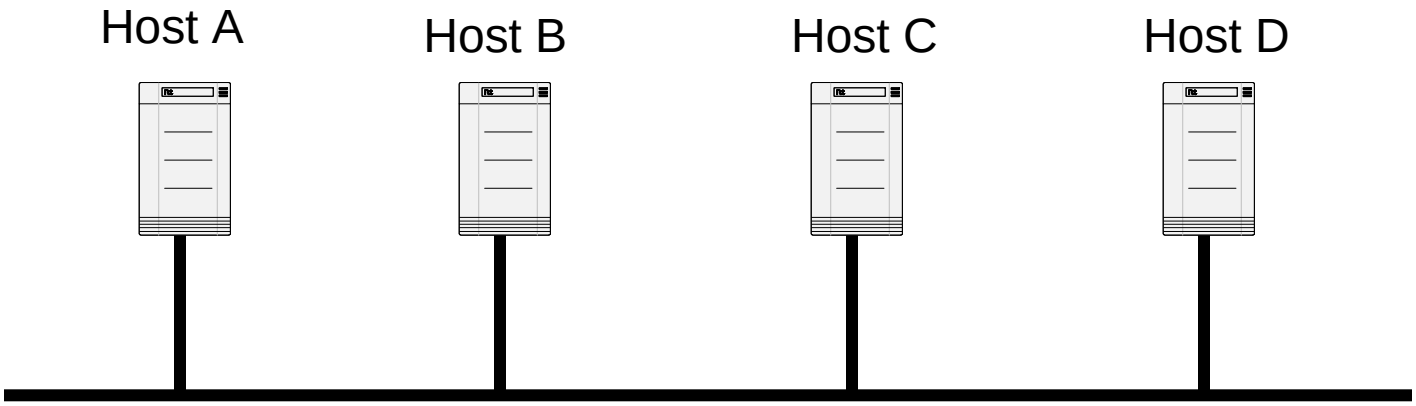
- Solution: insert a special sequence at the start of frame: for example: 01111110

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.

More Link Layer.. -- Ethernet

Want to allow multiple hosts to *share a link*

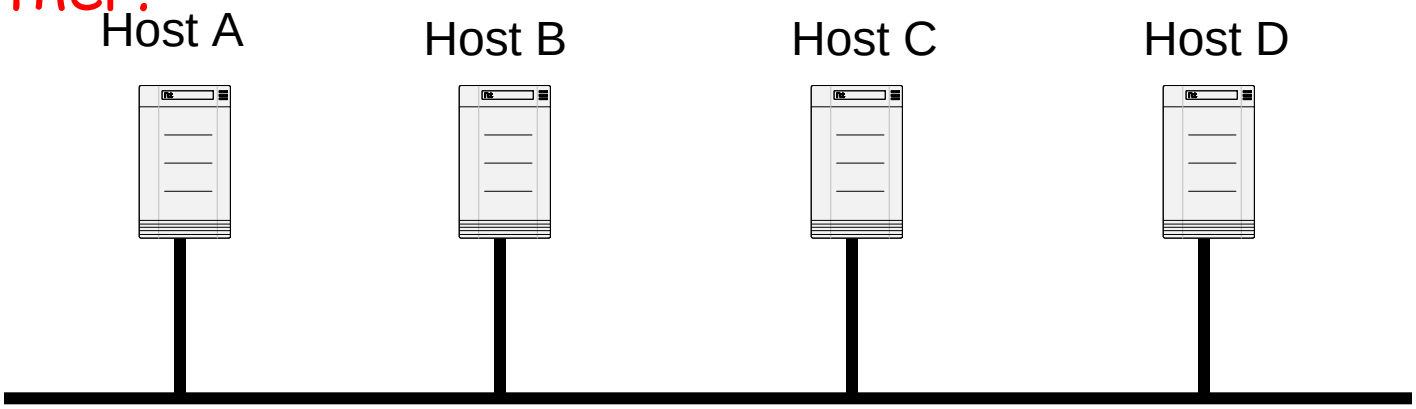


How do they avoid talking at the same time?

- 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

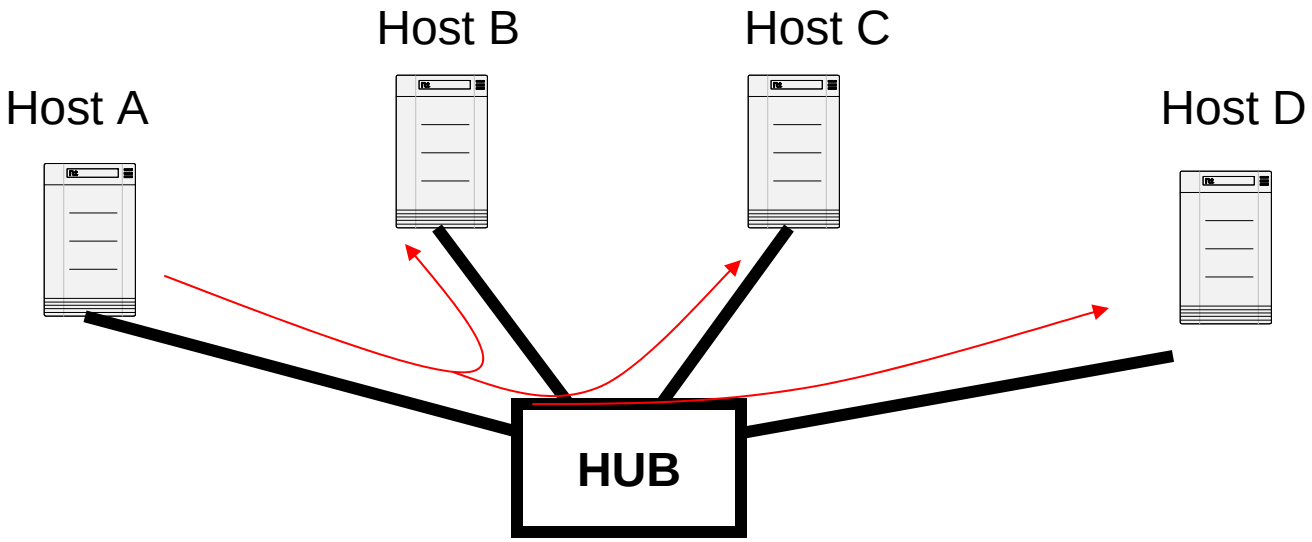
Ethernet Continued

- How do the hosts on this Ethernet identify each other?



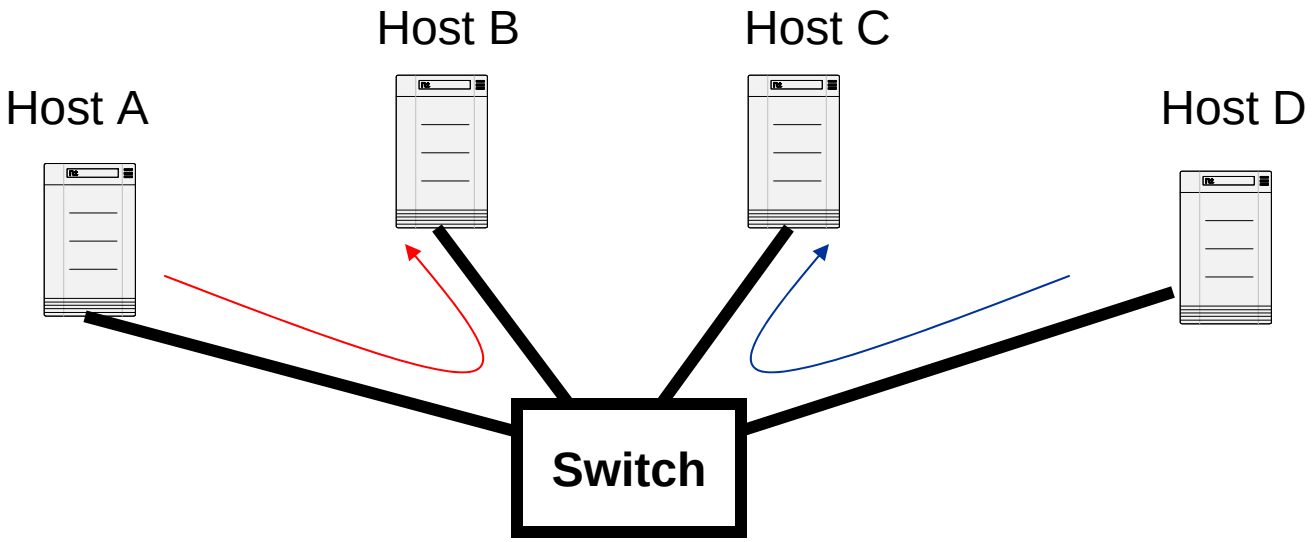
- Each host (actually each interface)
  - has a globally unique *MAC address*
  - Cannot be changed

Ethernet Hub



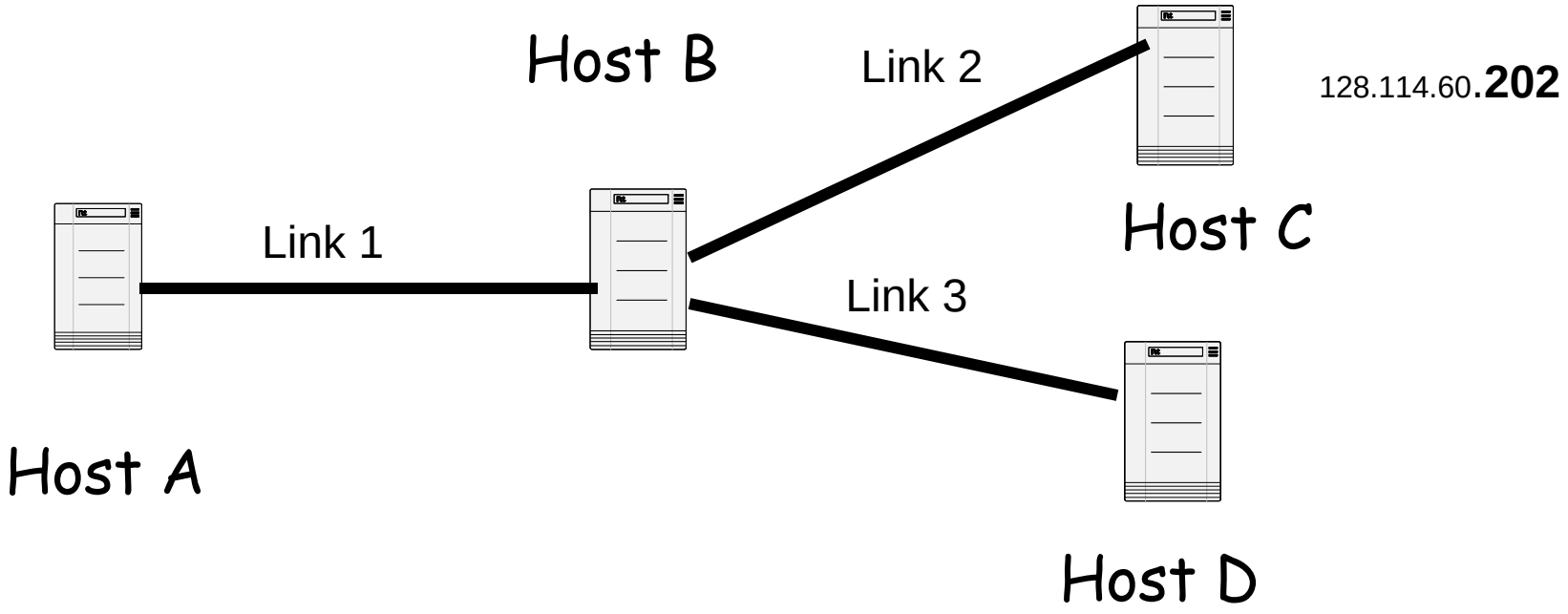
- Hub broadcasts packets on a link to all others
- As if all hosts connected to single link
  - We say it is a Single collision domain
- Only one host can talk at a time

Ethernet Switch



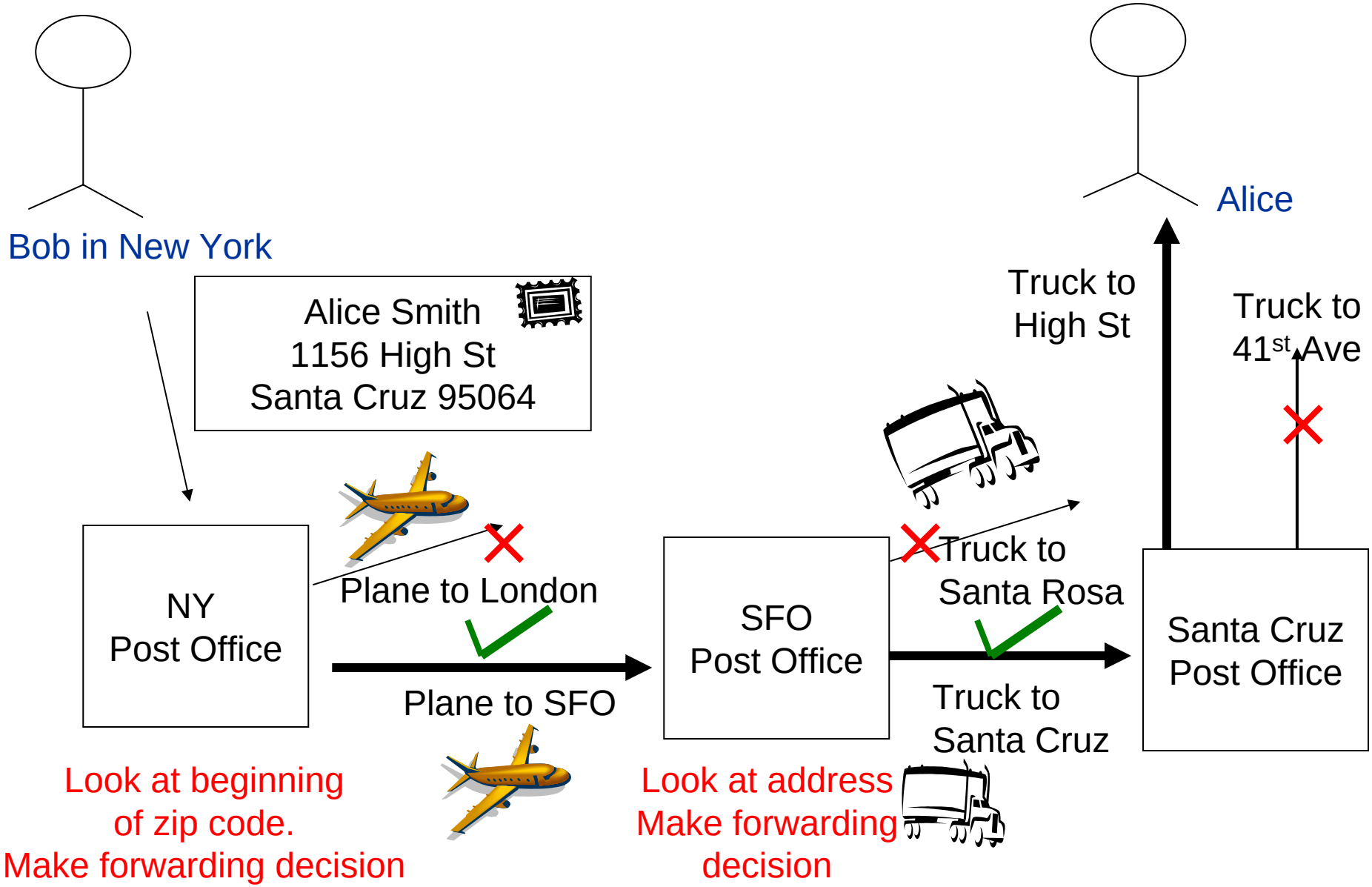
- If switch knows where the destination is
  - Switch forwards an incoming frame to destination only.
  - Otherwise, it broadcasts it to everyone.
- Thus, parallel conversations possible.

Network Layer

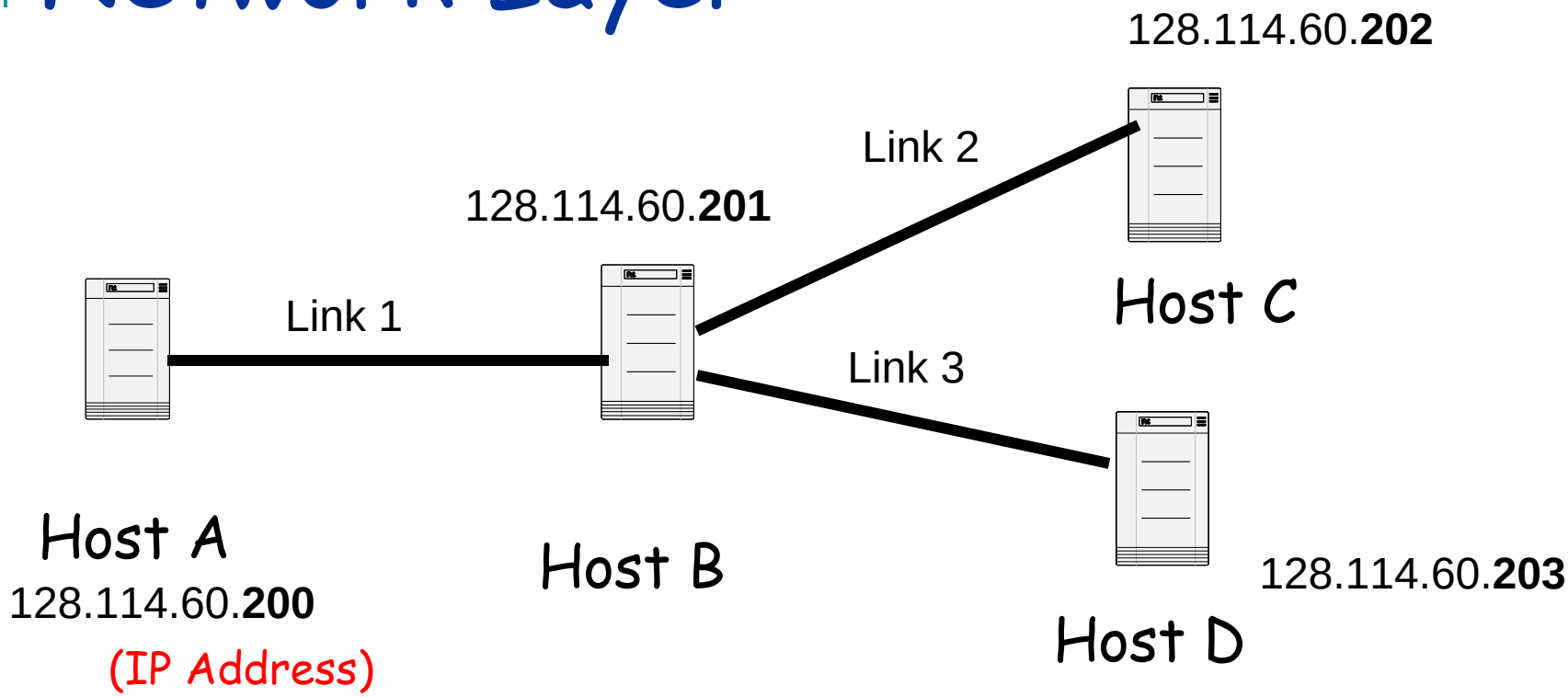


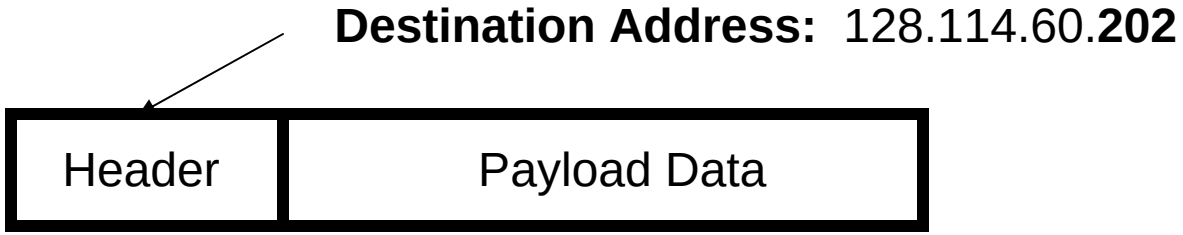
- *A wants to send some data to C*
  - Suppose A knows C's address
- *A sends a packet towards C*
  - A marks his packet with C's Address (an *IP Address*)

Post Office Analogy

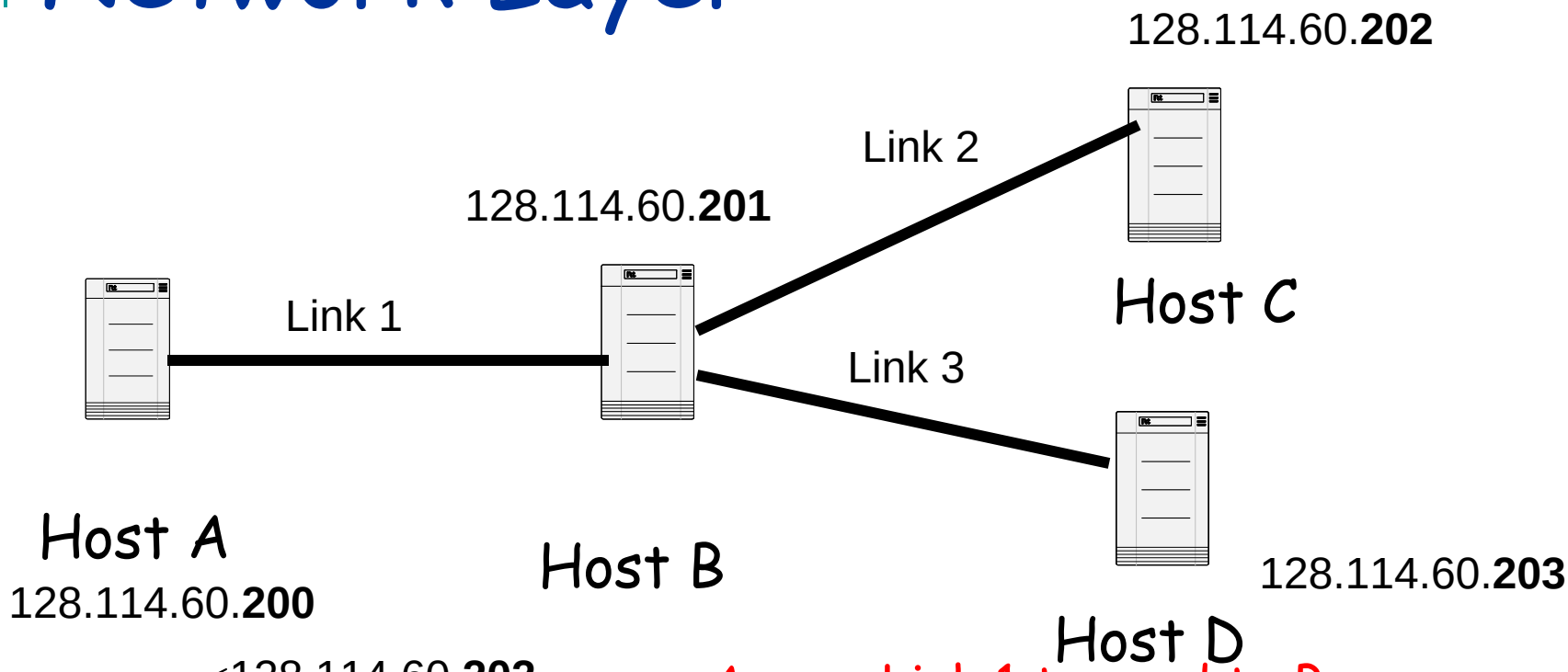


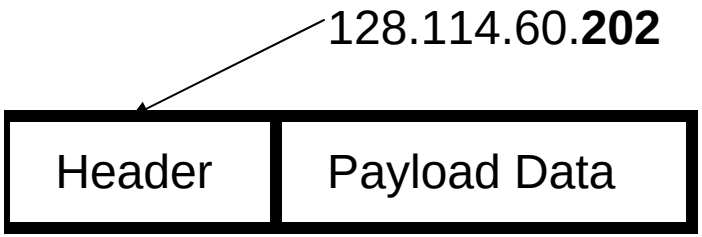
Network Layer





Network Layer

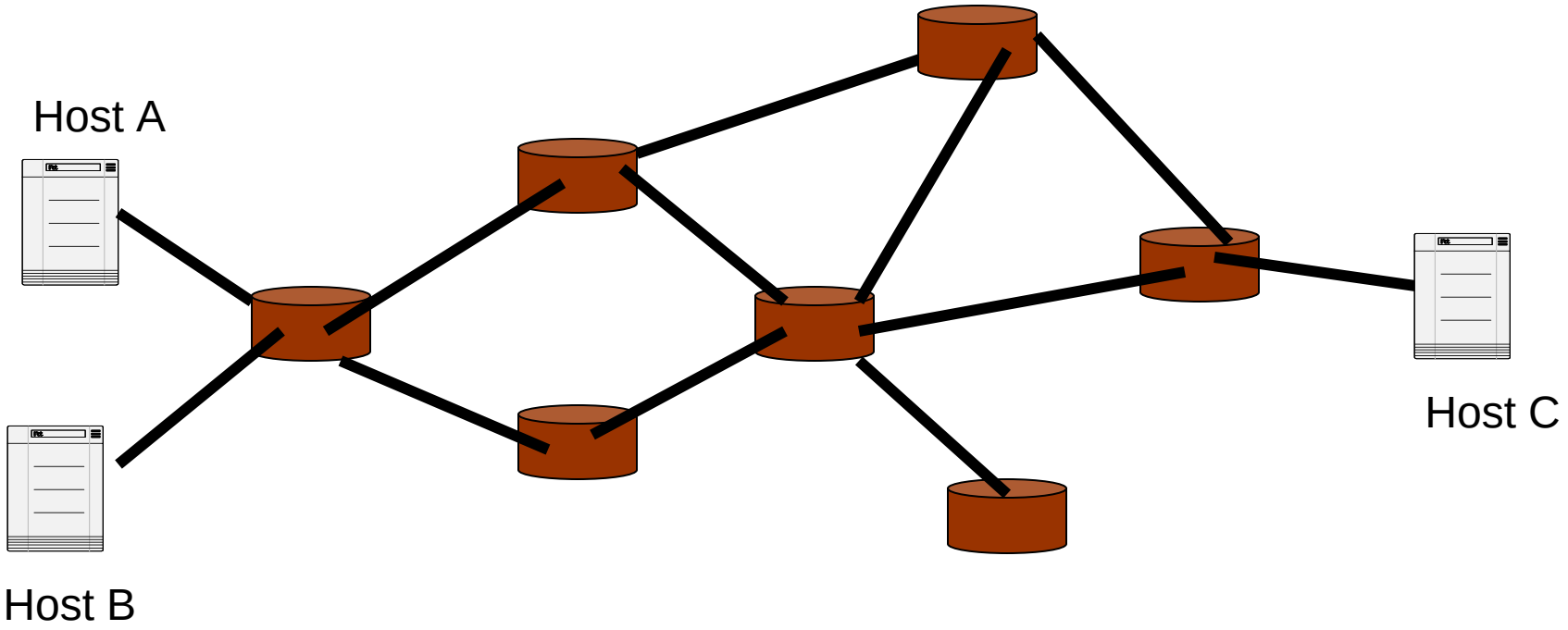




- A uses Link 1 to send to B
- B looks at
  - Packet Header
  - Routing Table

Address	Next Hop
128.114.60.202	Link 2
128.114.60.203	Link 3

Routing in the Internet



Many feasible paths from source to destination.

Routing

Routing

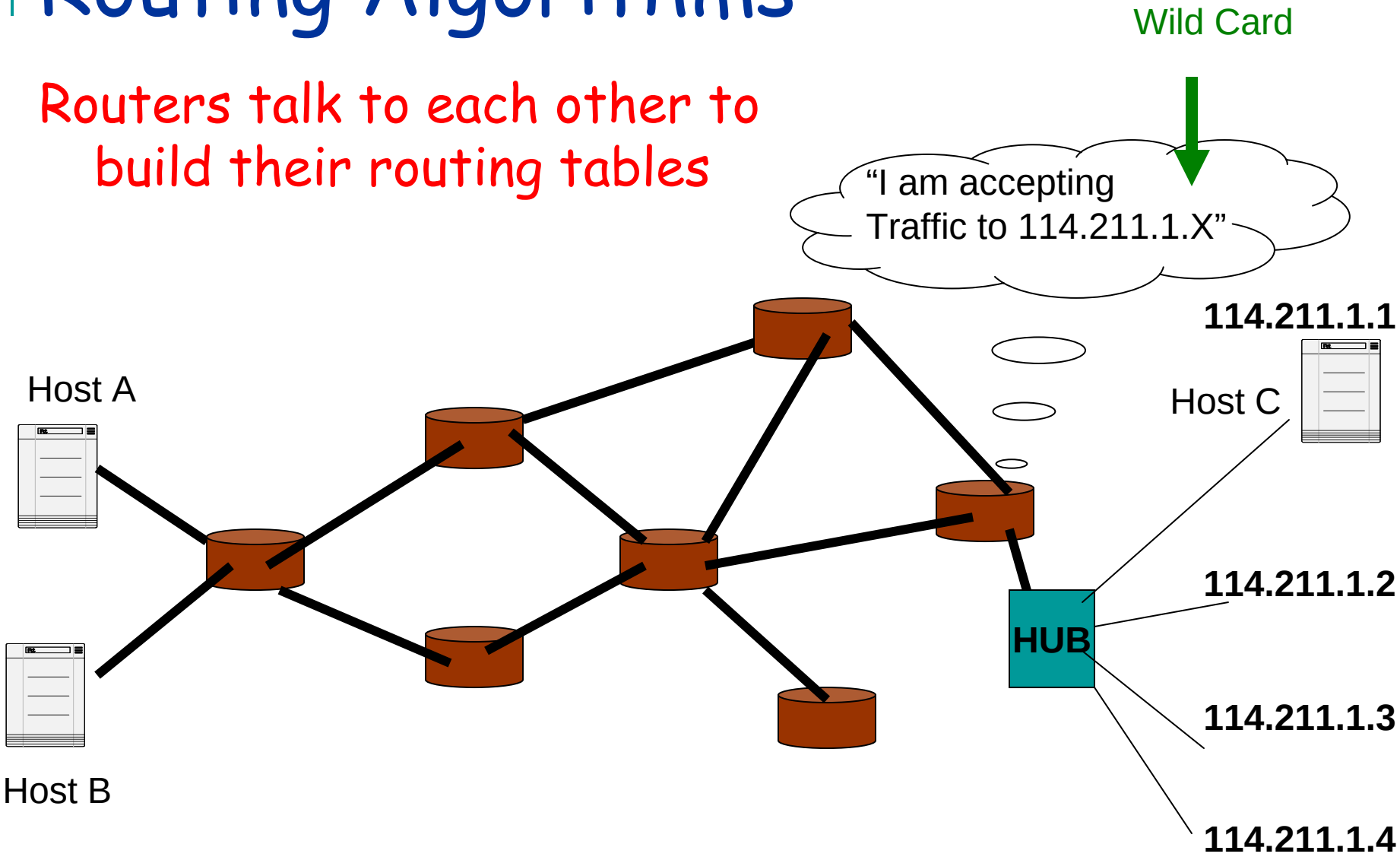
- Updating the routing table
- Objective: each packet gets closer to destination

Packet forwarding

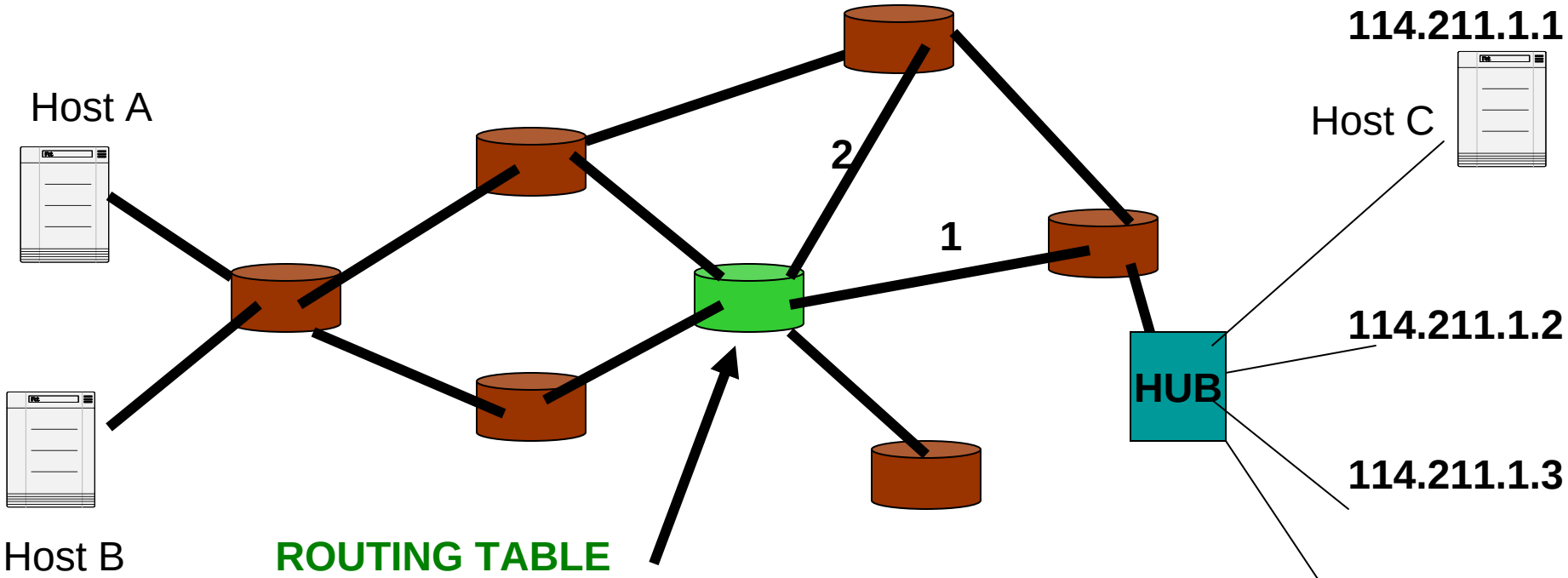
- Transmitting each packet on the appropriate output link
- Based on routing table

Routing Algorithms

Routers talk to each other to build their routing tables



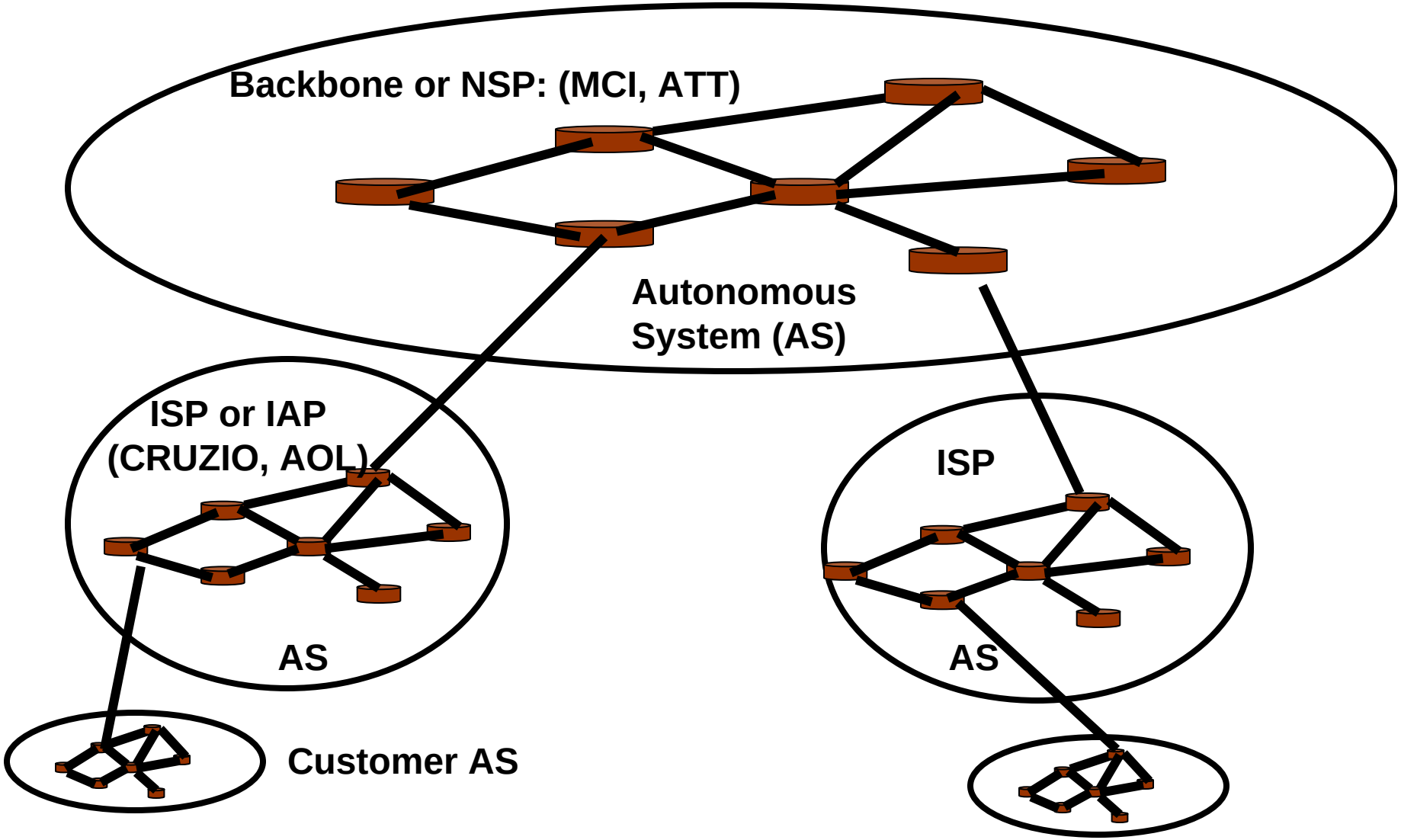
Routing Table has Wild Cards



ROUTING TABLE

114.211.1.X	**Link 1**
200.261.19.X	**Link 2**

Internet Routing is Hierarchical



Routing Concerns

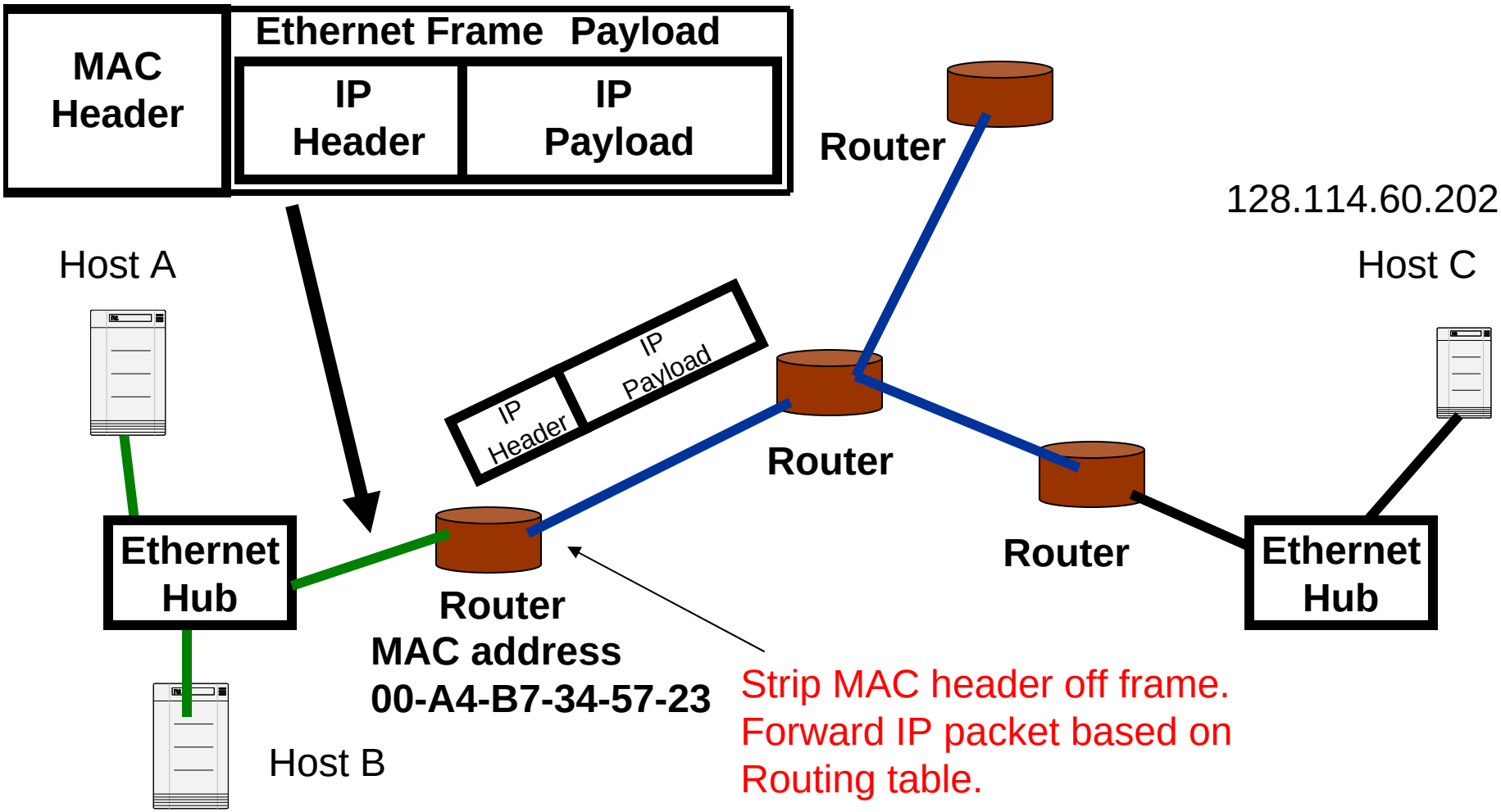
- Long routes
- Circular routes
- Hijacking routes
- Route flapping

IP Addresses vs Mac Addresses

- Hierarchical
  - The beginning bits tell you which network the host is on
  - Ex: UCSC addresses start with 128.114.X.X
  - The last bits tell you which host of the network
- Changeable
  - Changes with location of Host
- 4 bytes
- Only 4.2 billion

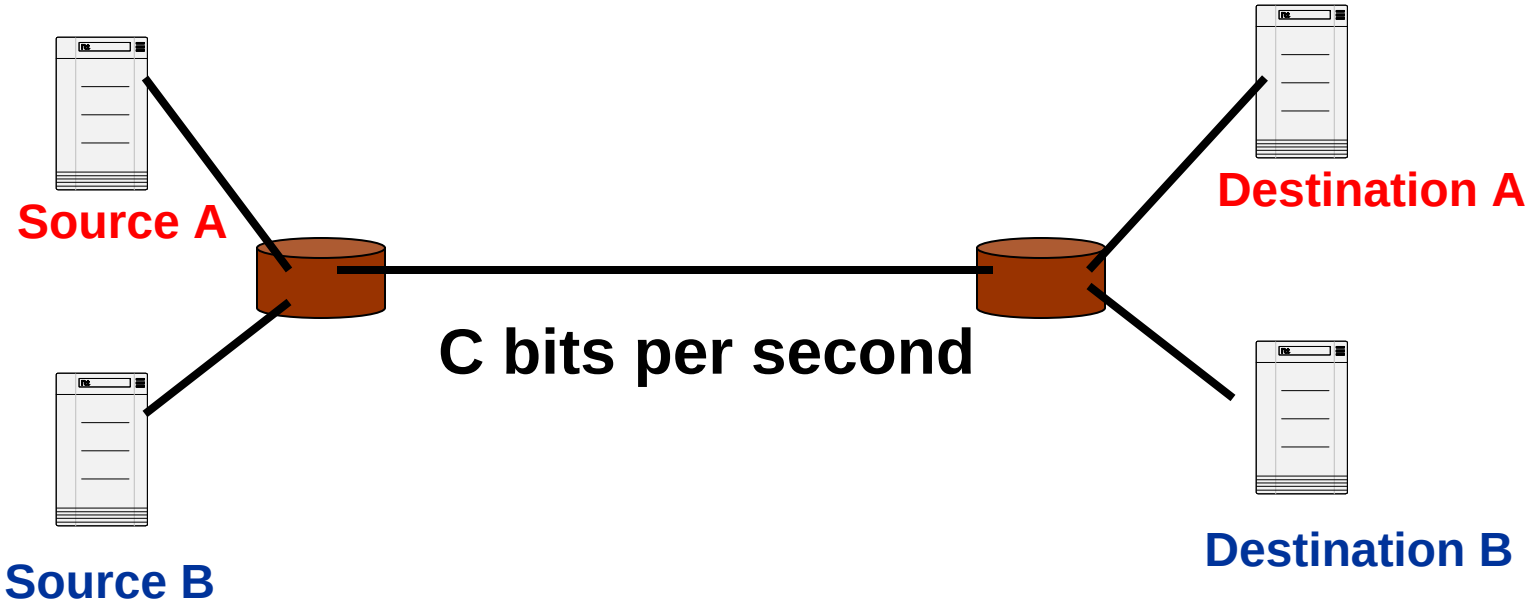
- Not Hierarchical
  - Beginning bits tell nothing useful
- Not Changeable
- 6 bytes
- 281 Trillion

Link and Network Layer Interaction



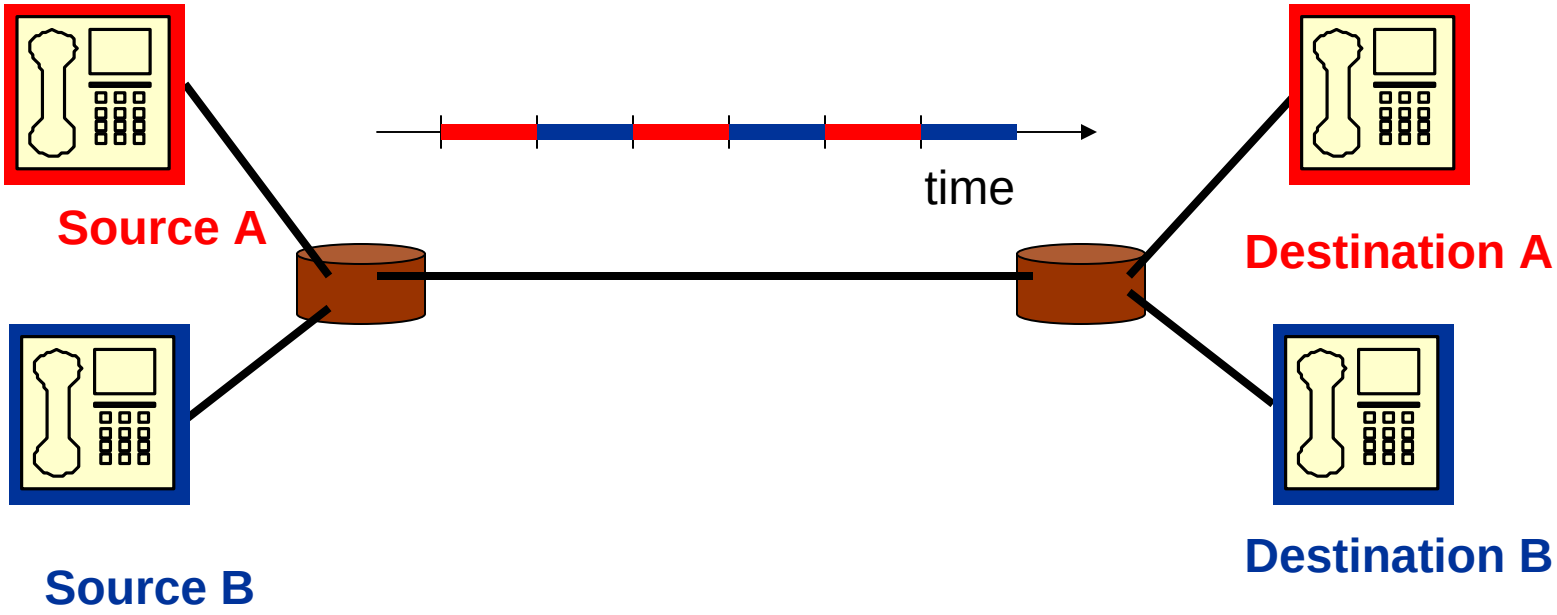
Issues In Networking

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



Issues In Networking

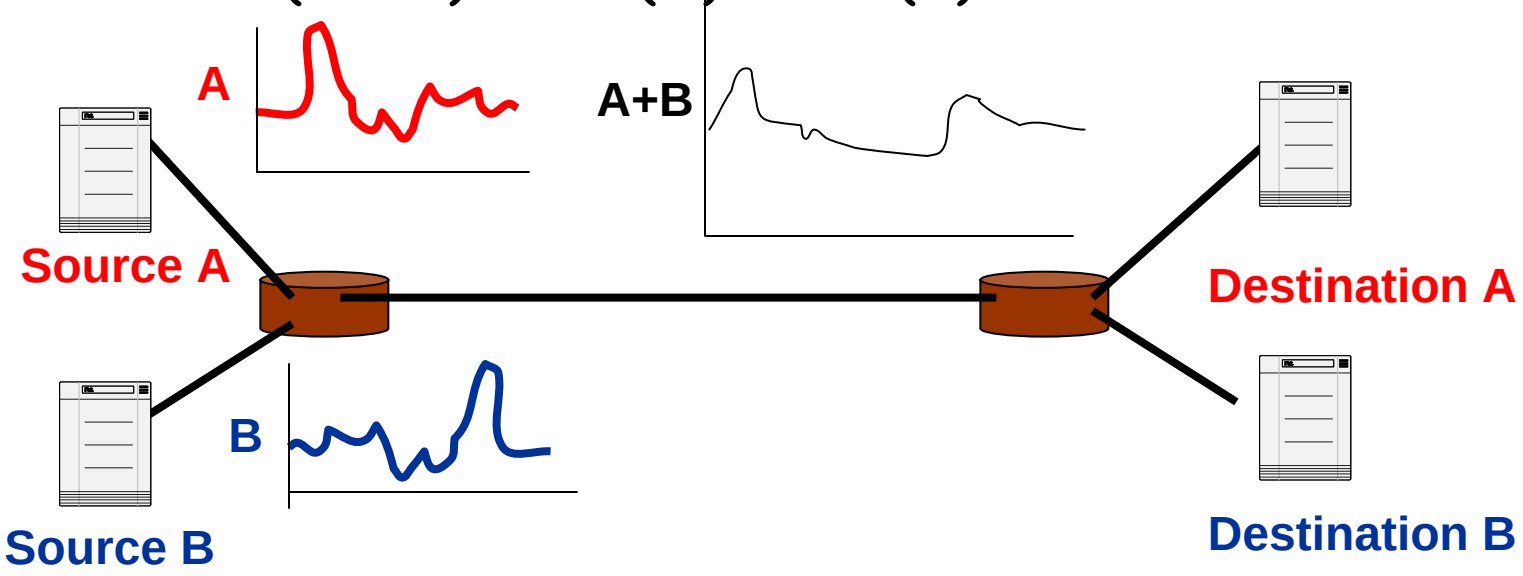
- Time Division Multiplexing
  - gives each connection the use of the link a fixed fraction of time
  - Fixed fraction of resources reserved for each connection
  - Technology called ***circuit switching***.



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

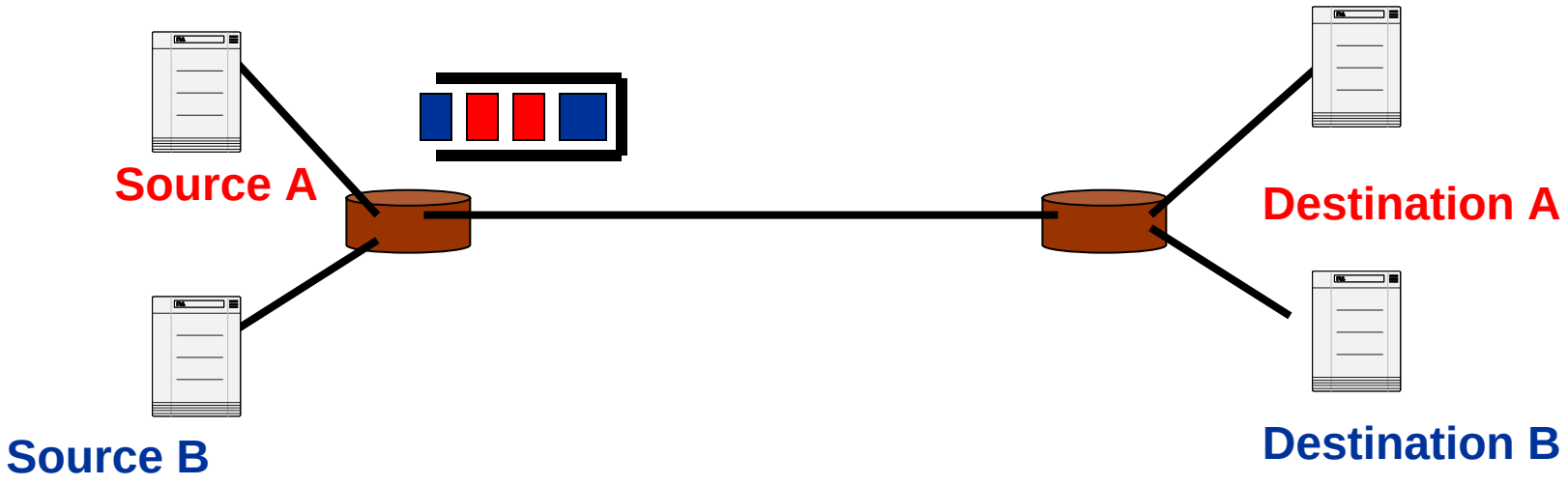
Issues In Networking

- Statistical Multiplexing
  - Link shared in such a way that connections are not assigned fixed fraction of Link.
  - A and B unlikely to offer peak rate at the same time.
    - max(A+ B) < max(A) + max(B)



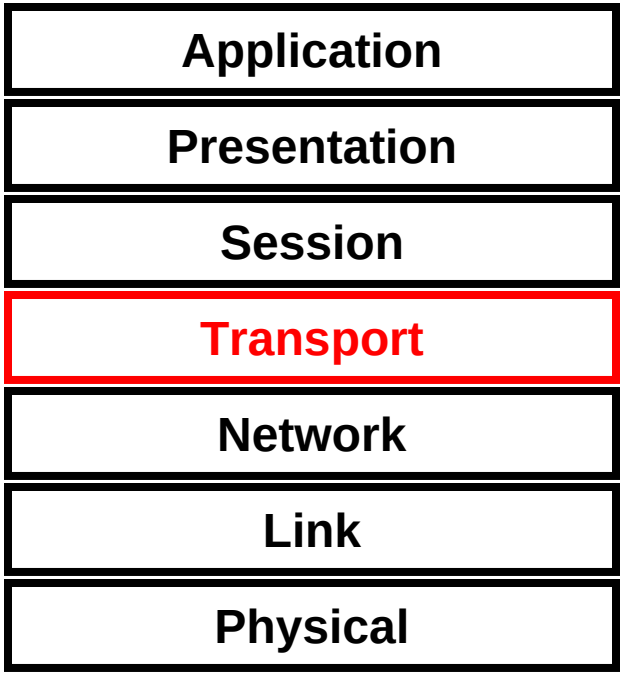
Statistical Multiplexing

- Because resources aren't reserved. It's possible offered load too high.
- Packets are put into a queue.
- If offered load remains too high, queue will fill up and overflow.



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



Transmission Control Protocol (TCP)

ACK

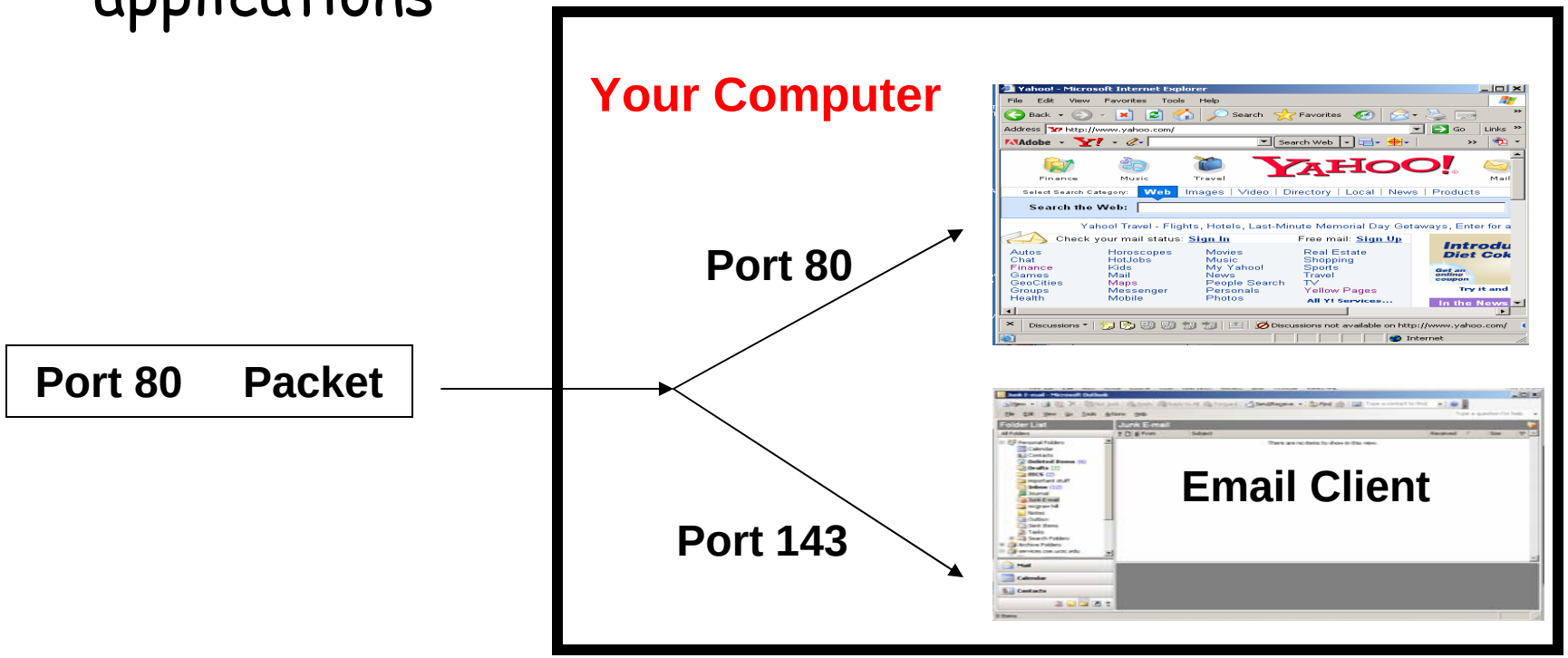
Packet 2

- 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

TCP cont'd

IP Header	TCP Header	Payload

- TCP port numbers
  - TCP Header has a "port" number field
  - Helps host sort out how to route packets to applications



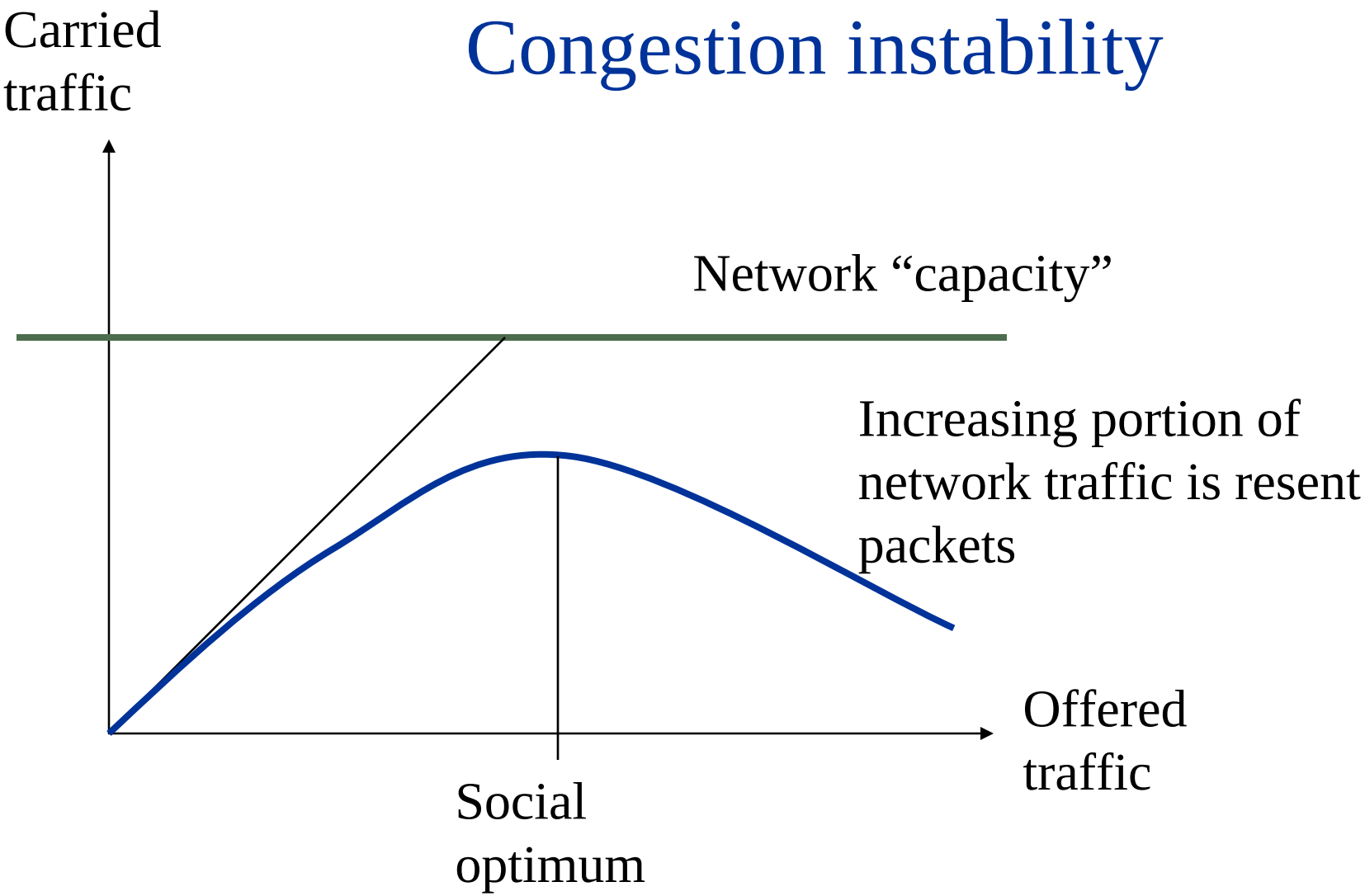
UDP

- For some applications packet retransmissions are not worthwhile
  - Why?
- For those applications, we use UDP
- UDP is a transport protocol that
  - Does not do retransmissions
  - Does not do congestion control

Network congestion

- Traffic can overload links
  - Failure of statistical multiplexing
- Congestion must be limited in some fashion

Congestion instability

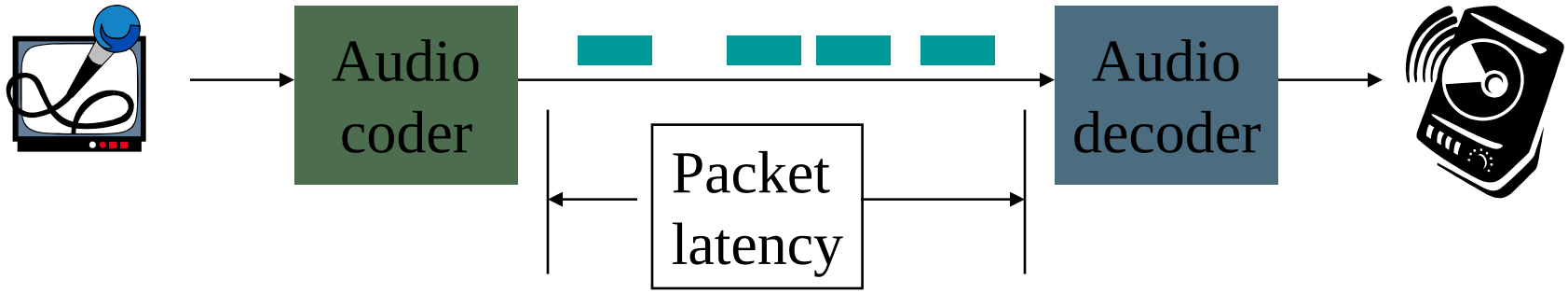


Congestion Control

- 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

Quality of Service (QoS) -metrics

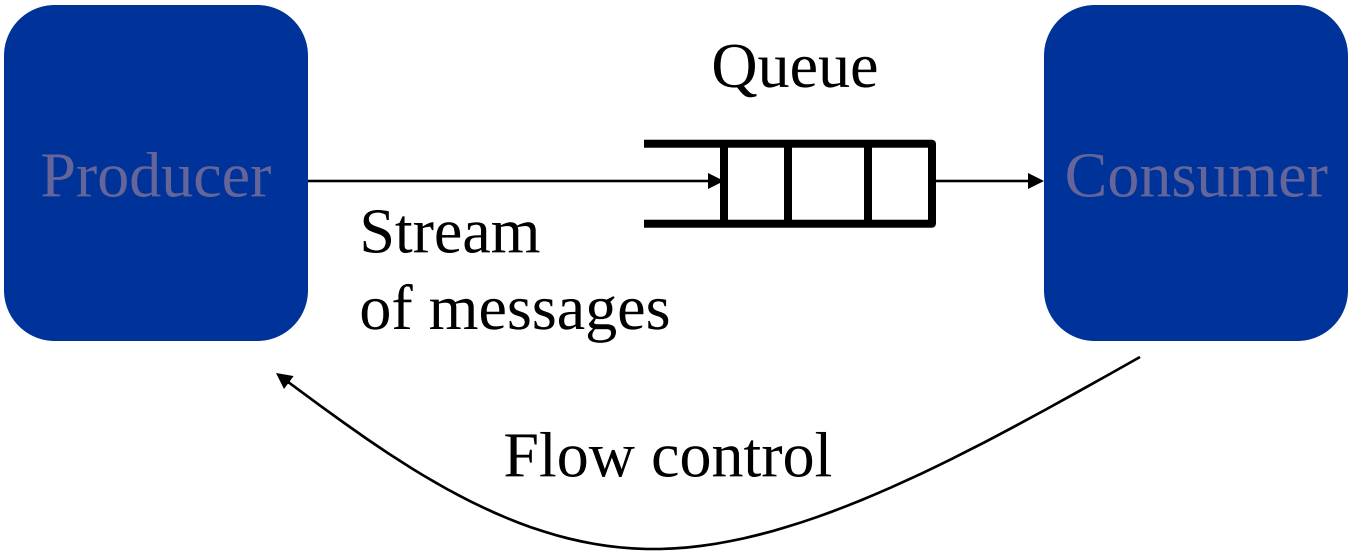


- Latency – the time it takes a packet to travel from a sender to receiver.
- Throughput – the rate of the connection in bps.
- Loss – the fraction of packets that get lost.
- Jitter – How much the latency varies over time.

Achieving QoS

- Increase the capacity of the network a lot
- TDMA instead of statistical multiplexing
  - That way traffic from one connection does not effect the quality of another
  - But, we lose the benefits of statistical multiplexing.
- Priority Scheduling?
  - Analogy: first class check-in vs. coach check-in

Flow control vs Congestion Control



Receiver has to have a way to tell producer to slow down!

Flow control is when the sender adjusts his send rate so as not to overwhelm the receiver.

Pricing Today

End User

- Flat Rate most common
  - pays an ISP a flat rate per month
  - does not depend on use

Pricing Alternatives

- Usage based pricing
  - Charge some amount per megabit sent.
  - Those that use more thus, pay more.
  - This is done today for the phone network, as well as data connections over cell phones.
  - Advantages?

Pricing Alternatives

- QoS based pricing
  - Pay a high price for guaranteed QoS
    - Guaranteed throughput, low loss and latency.
  - Pay a lesser price for not-guaranteed (best effort) service.
  - Advantages:
    - QoS costs provider more, so user should pay more.
    - Might improve provider revenue.
    - Benefits users who need QoS guarantees.
  - Disadvantages
    - Complexity.

Pricing Alternatives

Congestion Pricing

- Idea studied a lot in research community,
  - Pay more when links are congested.
  - This gives an incentive to reduce usage
  - If fined grained enough, congestion prices could be an alternative to TCP congestion control.
  - Some proposed schemes allow users with greater needs to outbid those with less need.

Congestion Pricing

Advantages?

- More revenue for provider
- Allows users with sensitive applications to pay more to get the service they require.

Disadvantages?

- Complexity
  - This is why it has not caught on.

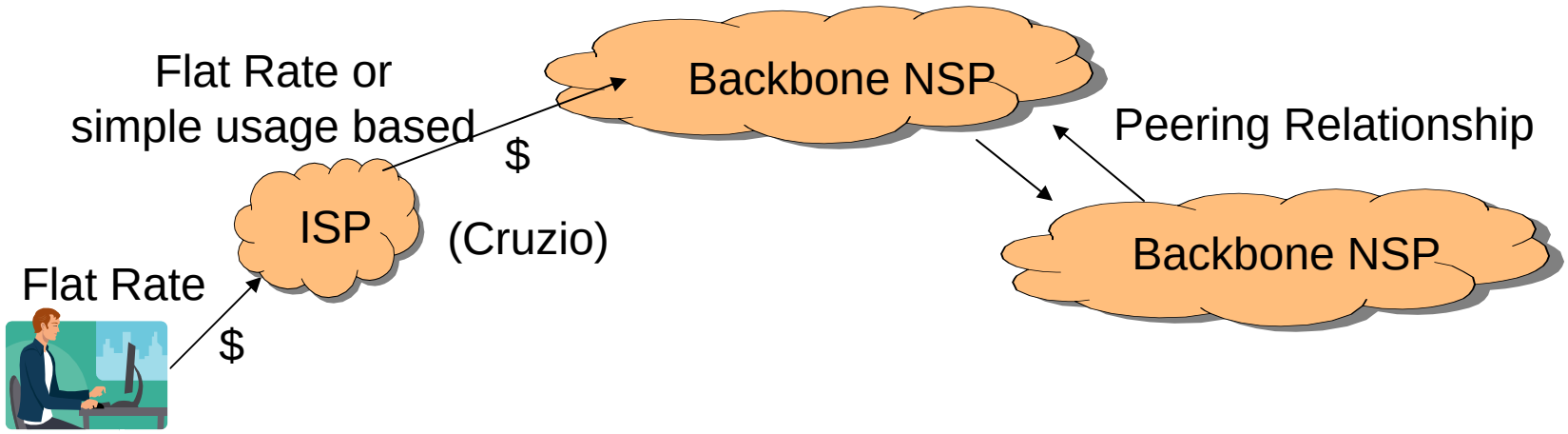
Cost based Pricing?

What are the difficulties with this?

Large Fixed Costs.

Small marginal costs.

Pricing within the Internet



- Customer pays an ISP
  - Often Flat Rate per month
- ISP pays a backbone AS
  - Often just flat rate, dependent on access link speed.
  - Sometimes based on total usage
- Backbone NSPs peer with each other
  - Often for free if they exchange comparable amounts of traffic.
- Overall…
  - Internet billing today is much more course grained than telephone billing.

Domain Names

IP addresses are inconvenient for people

- 32 bits hard to remember
- 128 bits very hard to remember

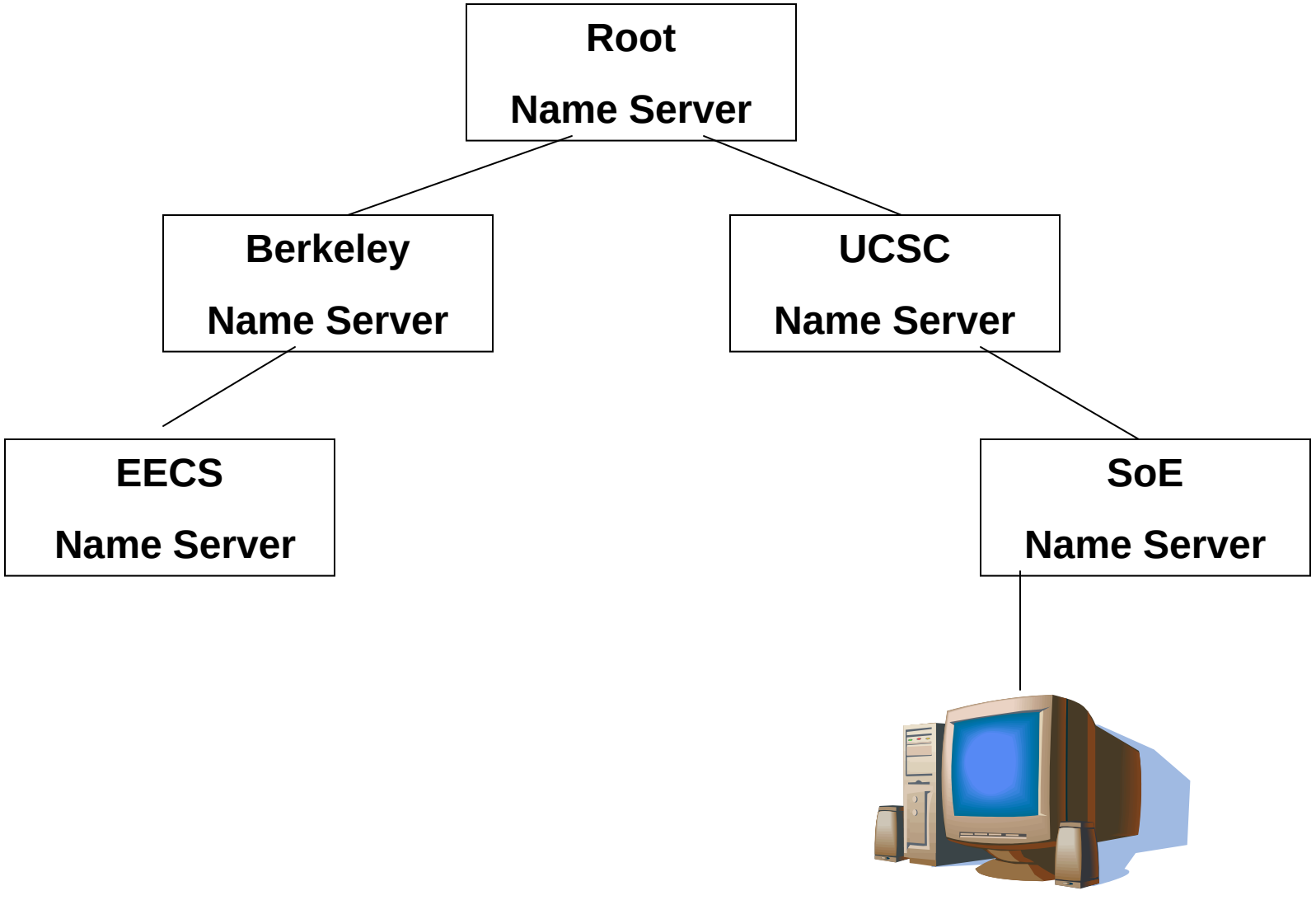
Domain names

- 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

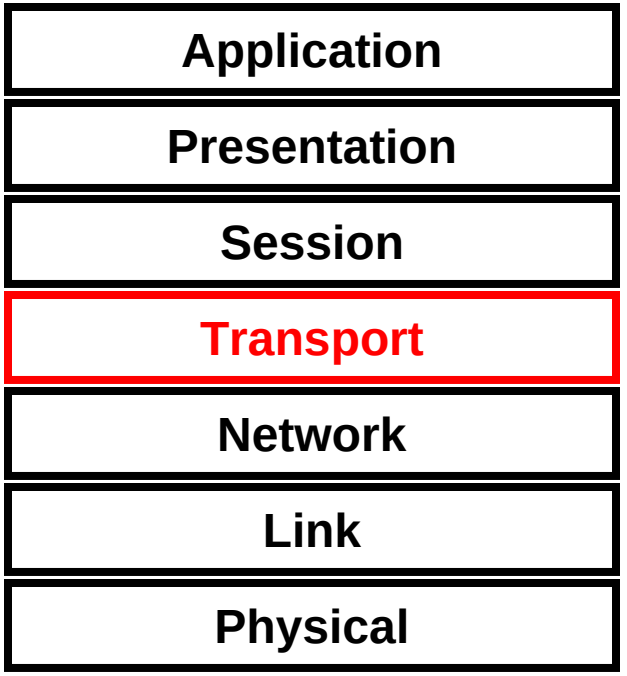
- Maximize "wild cards" and distribute address administration

Names hierarchical in administration

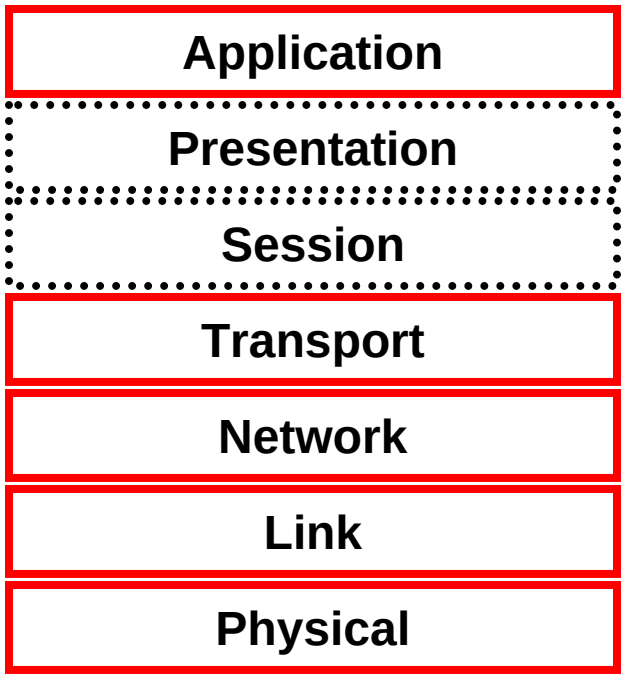
- Single administered organizations often distributed topologically (e.g. ibm.com)

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



OSI Layers



Internet Explorer, Outlook Email, Real Player, …

TCP, UDP

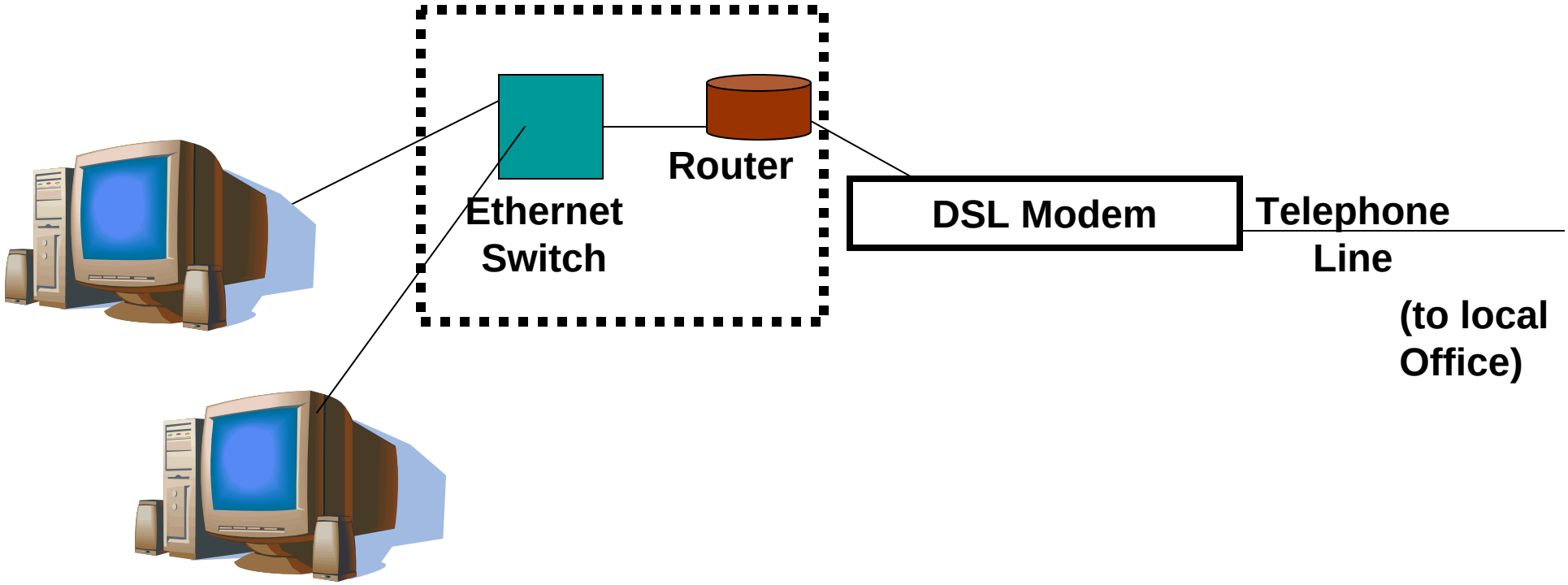
Internet Protocol (IP), …

Ethernet, Wi-Fi, SONNET, …

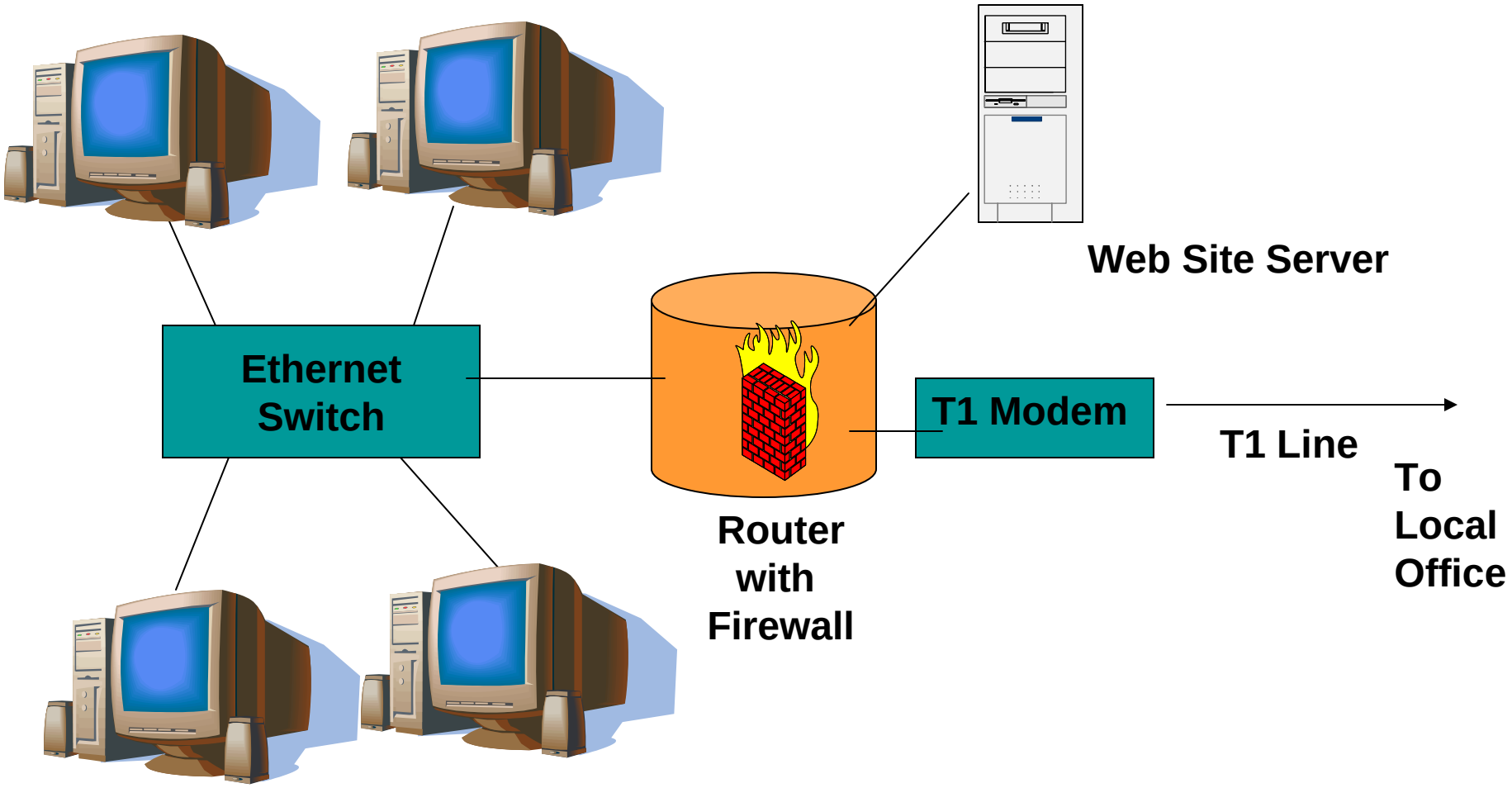
Modulation Schemes: QAM, OFDM, etc…

Some Typical Topologies

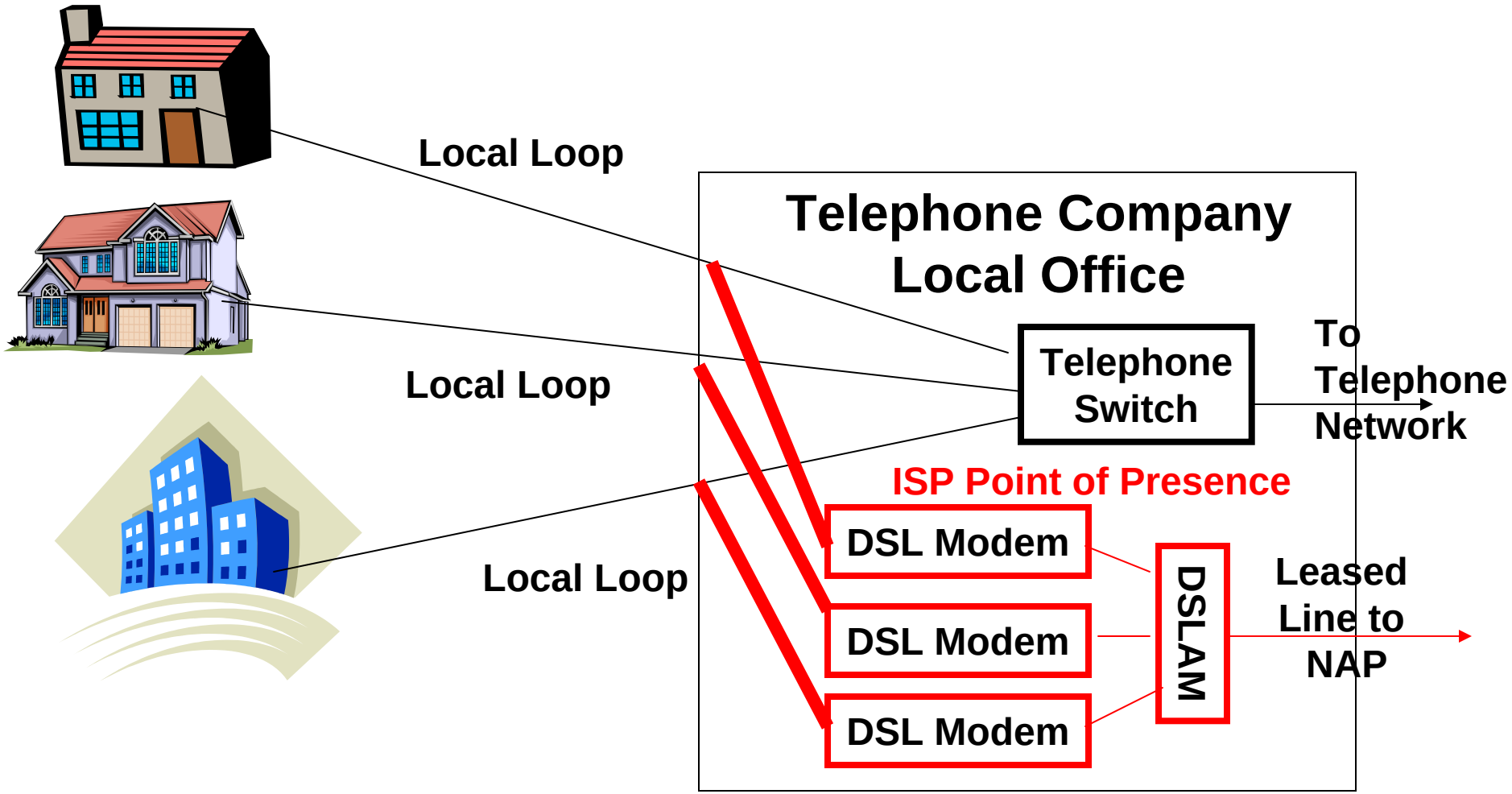
Home Network



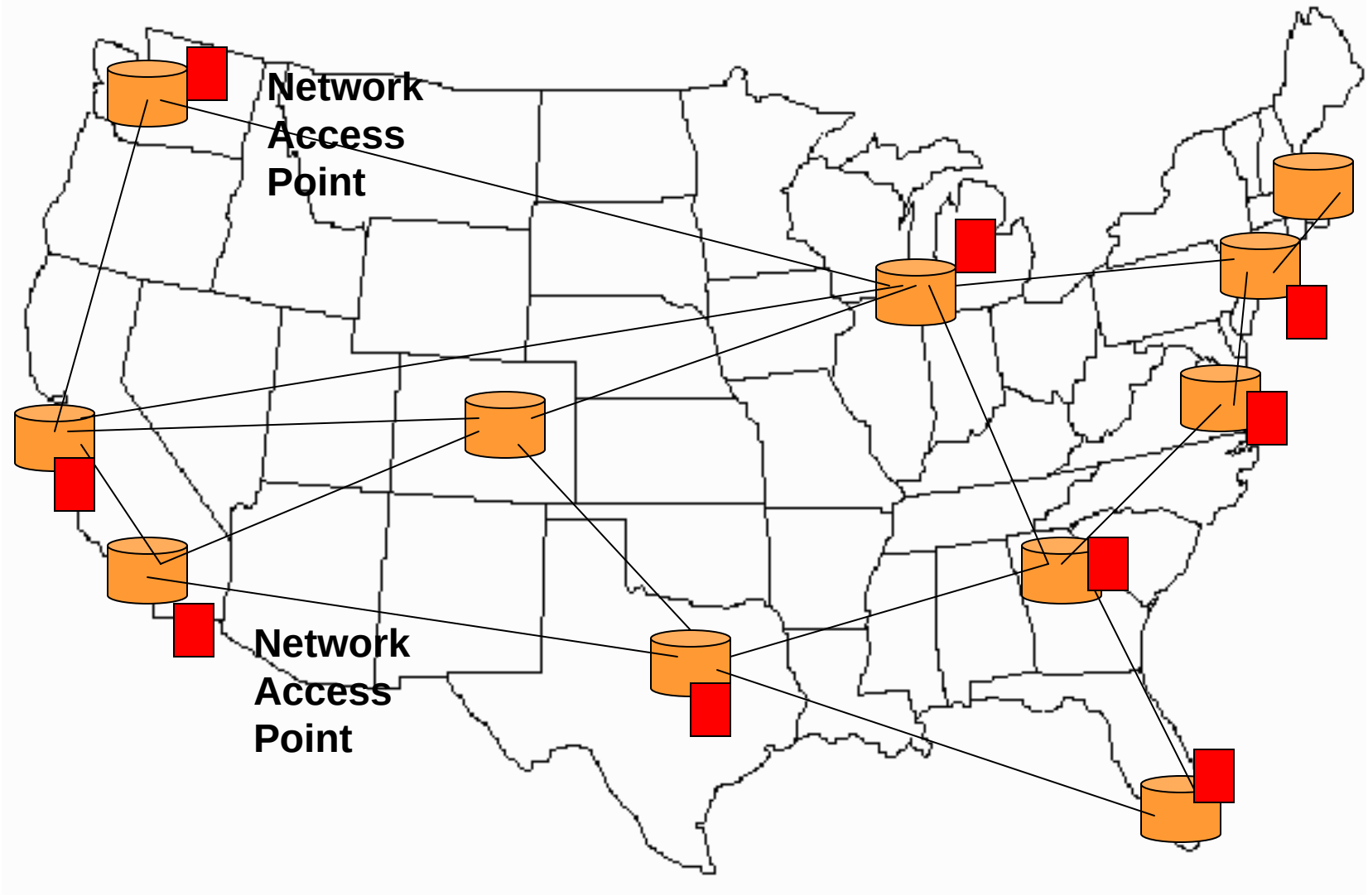
Small/Medium Business



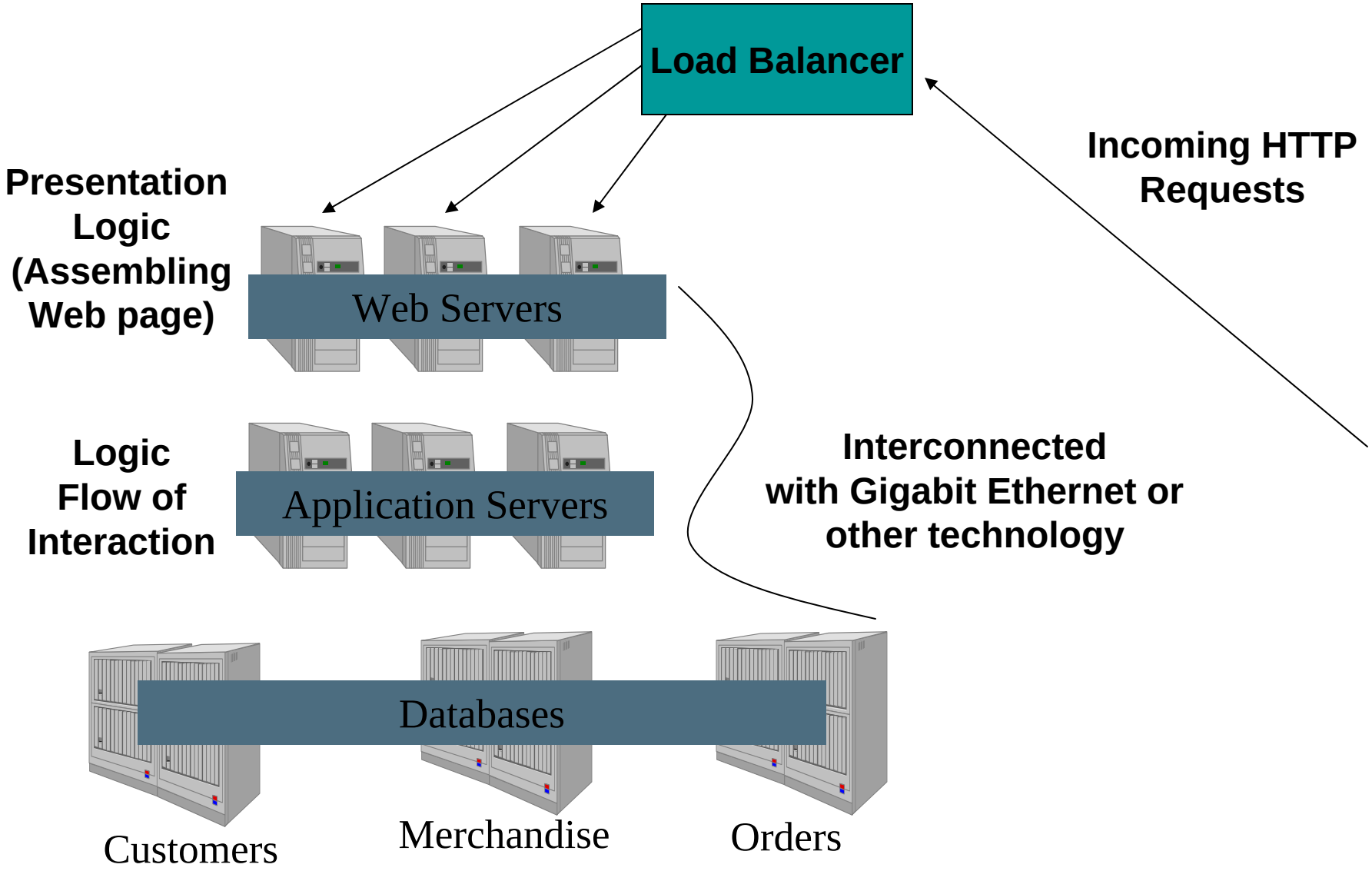
ISP Topology



Network Service Provider



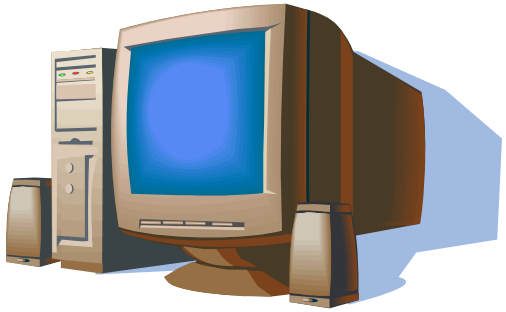
Large E-Business



Web Caching

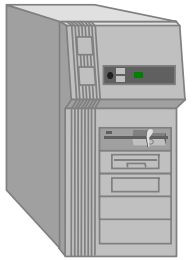
- Speed up web page loading by storing previously seen components locally

http://www.ucsc.edu



Cache on Hard Drive

Web server



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Web Caching can also Happen at

Proxy Server at ISP