

# Internet

CPE 401 / 601  
Computer Network Systems

slides are modified from **Dave Hollinger** and **Daniel Zappala**

# Network

" ... communication system for connecting end-systems"

End-systems a.k.a. "hosts"

PCs, workstations

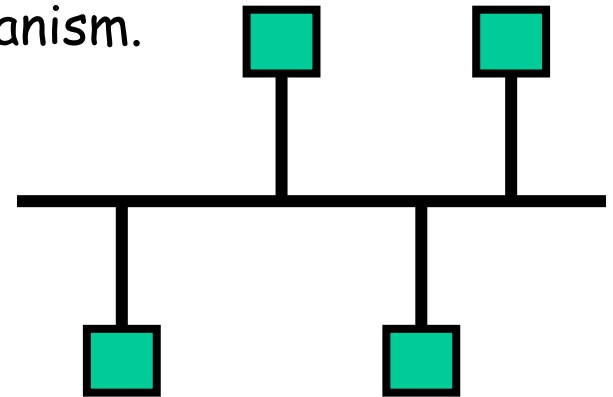
dedicated computers

network components

# Multiaccess vs. Point-to-point

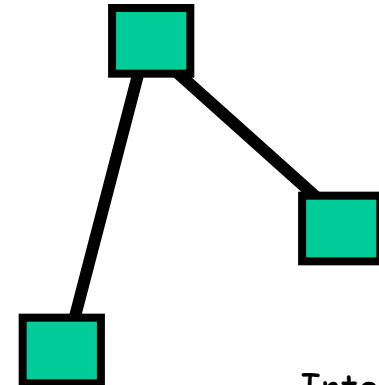
## ❑ Multiaccess means shared medium.

- ❖ many end-systems share the same physical communication resources (*wire, frequency, ...*)
- ❖ There must be some arbitration mechanism.



## ❑ Point-to-point

- ❖ only 2 systems involved
- ❖ no doubt about where data came from !



# LAN - Local Area Network

- ❑ connects computers that are physically close together ( < 1 mile).
  - ❖ high speed
  - ❖ multi-access
  
- ❑ Technologies:
  - ❖ Ethernet 10 Mbps, 100Mbps
  - ❖ Token Ring 16 Mbps
  - ❖ FDDI 100 Mbps

# WAN - Wide Area Network

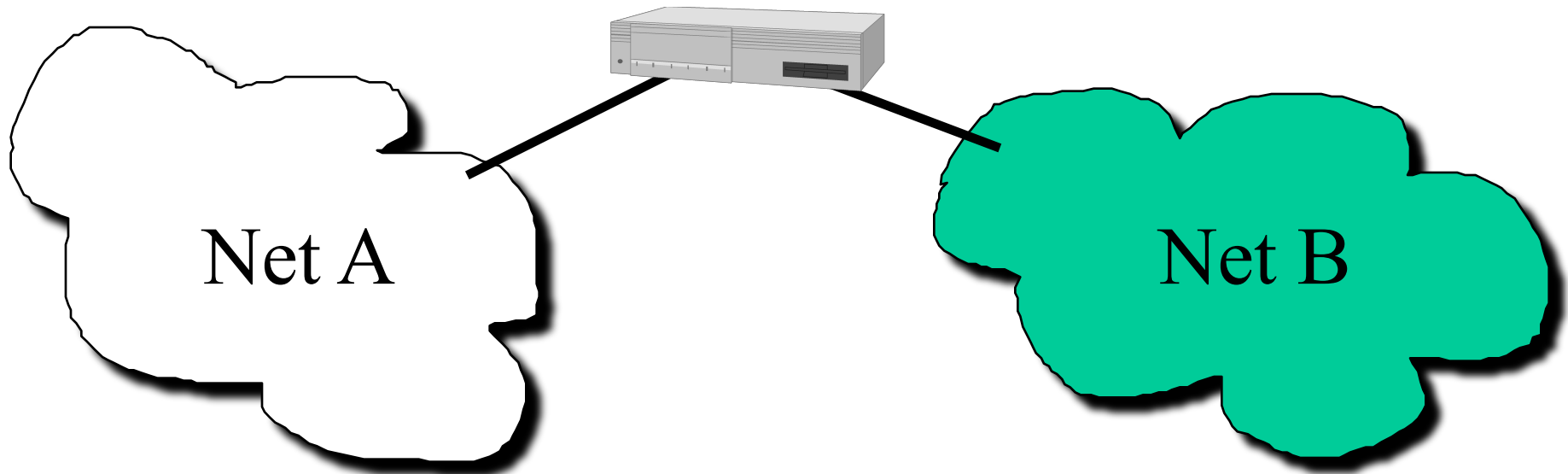
- connects computers that are physically far apart. "long-haul network".
  - ❖ typically slower than a LAN.
  - ❖ typically less reliable than a LAN.
  - ❖ point-to-point
  
- Technologies:
  - ❖ telephone lines
  - ❖ Satellite communications

# MAN - Metropolitan Area Network

- Larger than a LAN and smaller than a WAN
  - example: campus-wide network
  - multi-access network
  
- Technologies:
  - ❖ coaxial cable
  - ❖ microwave

# Internetwork

- ❑ Connection of 2 or more distinct (possibly dissimilar) networks.
- ❑ Requires some kind of network device to facilitate the connection.



# The Internet



PC



server



wireless laptop



cellular handheld



access points



wired links

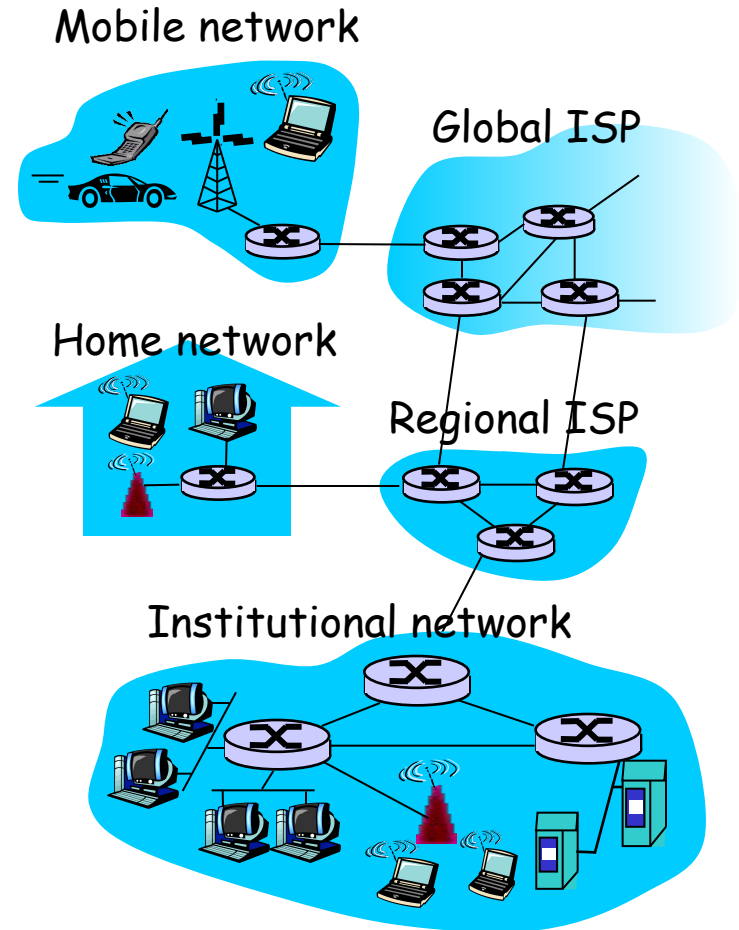


router

- millions of connected computing devices:  
*hosts = end systems*
  - ❖ running *network apps*

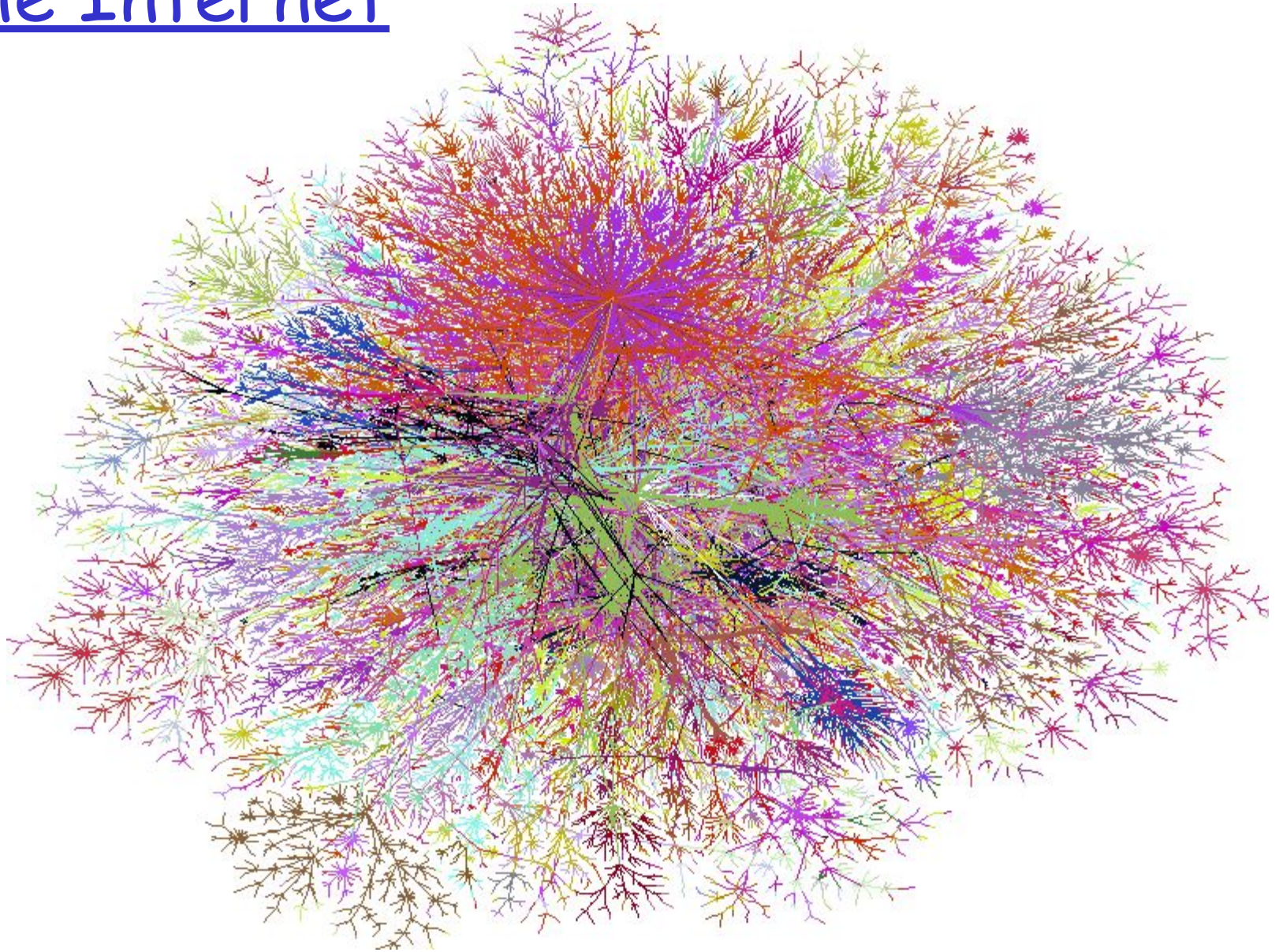
- *communication links*
  - ❖ fiber, copper, radio, satellite

- *routers:*  
forward packets  
(chunks of data)



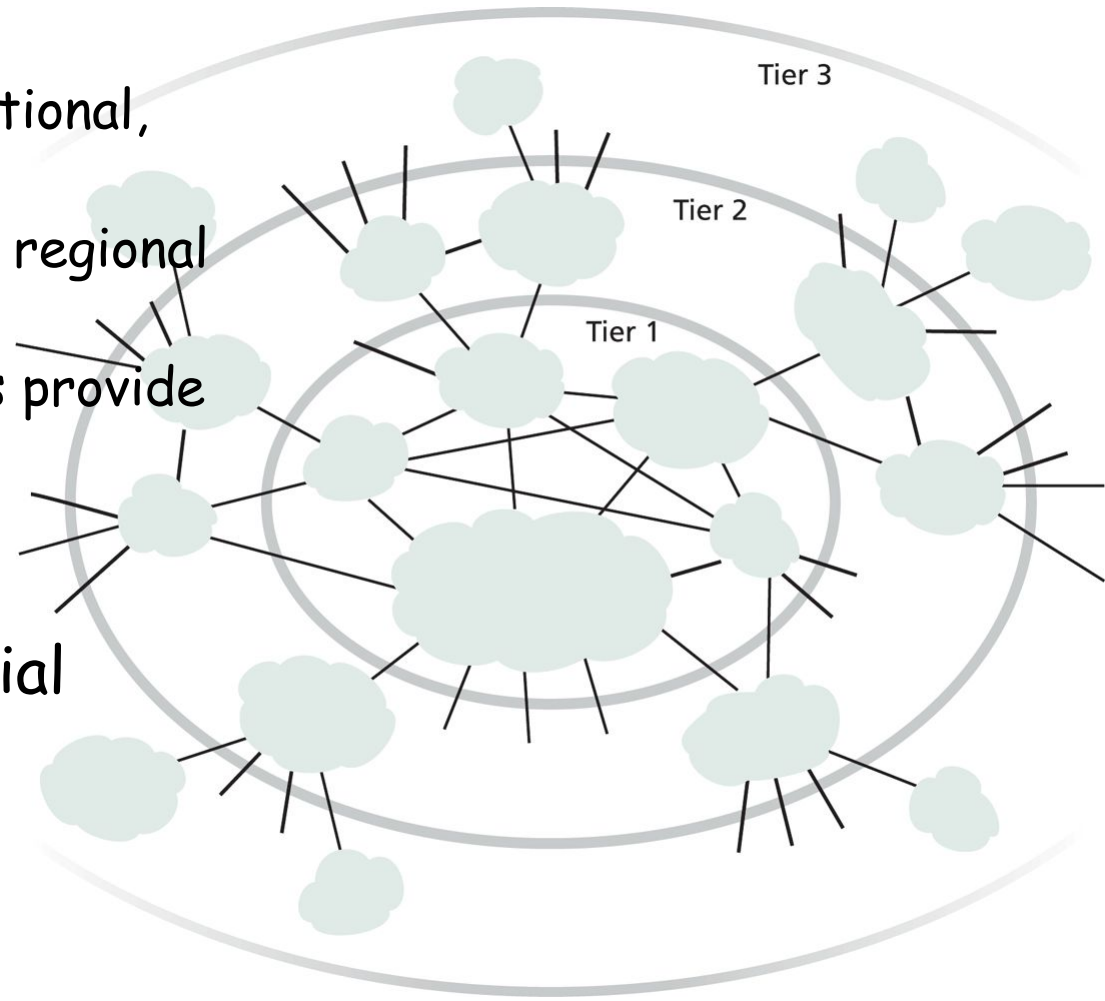


# The Internet



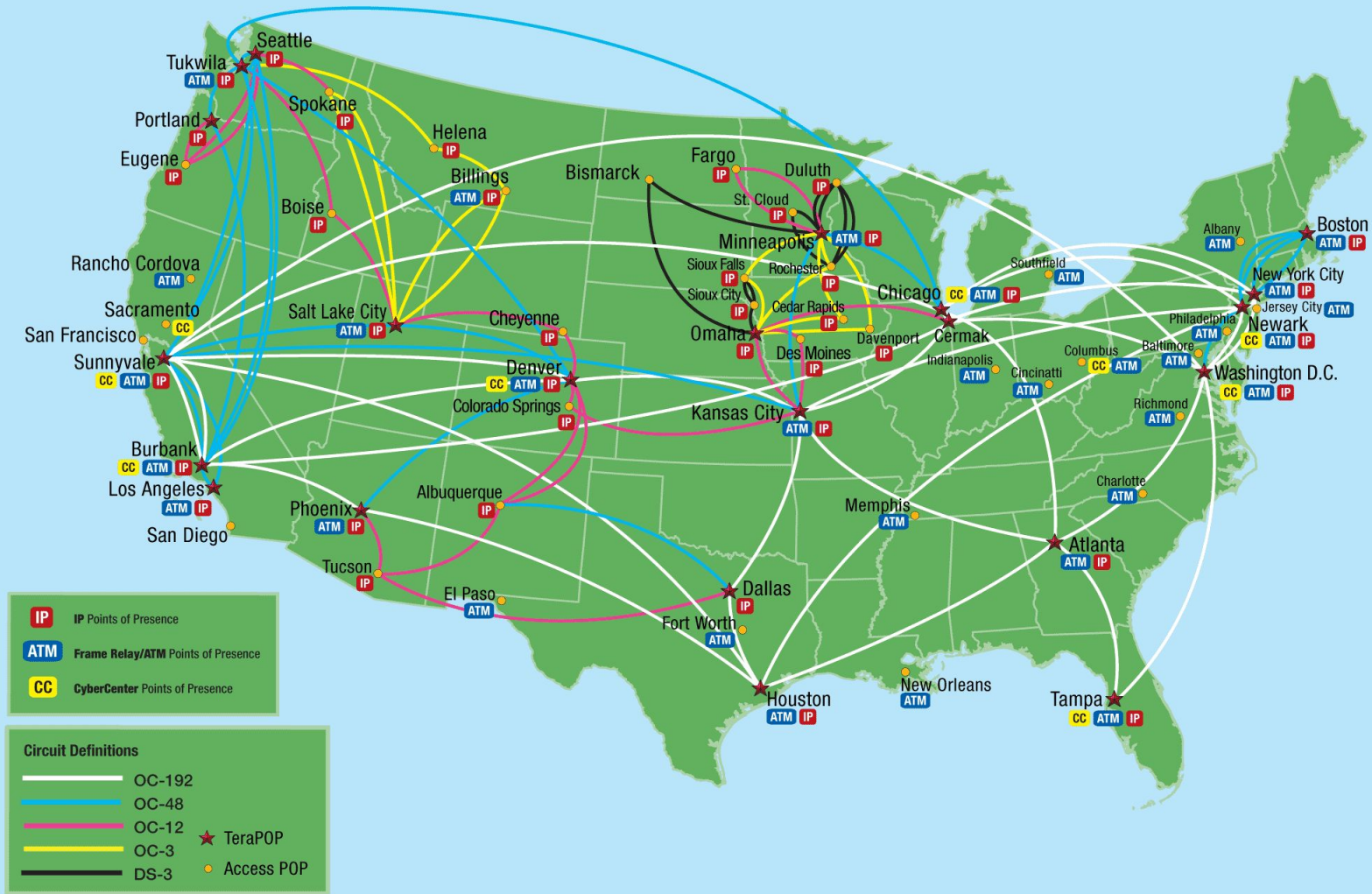
# A Network of Networks

- ❑ roughly hierarchical
  - ❖ Tier-1 ISPs provide national, international coverage
  - ❖ Tier-2 ISPs provide regional coverage
  - ❖ Tier-3 and lower levels provide local coverage
- ❑ any tier may sell to business and residential customers
- ❑ any ISP may have a link to any other ISP (not strictly hierarchical)





# Qwest® iQ Networking™ Map



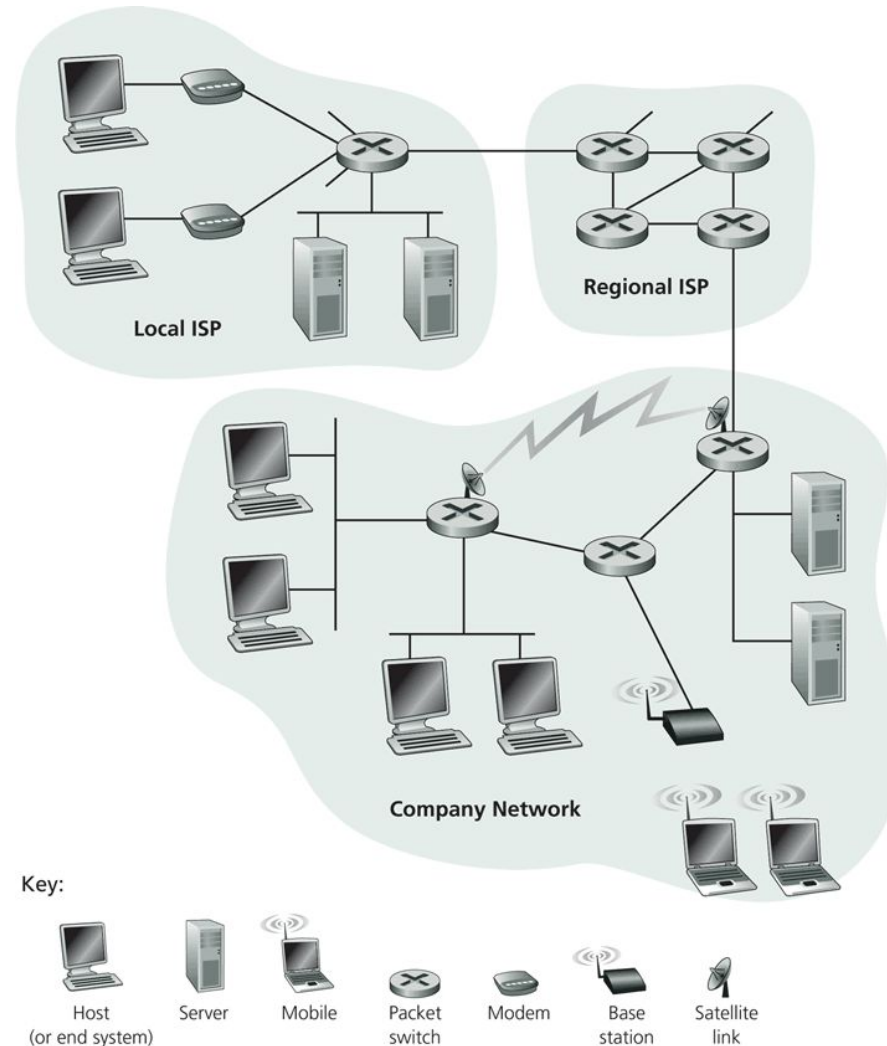
This map is an approximate representation of network coverage, and is not a guarantee of network or service availability. Coverage is subject to change. Copyright ©2006 Qwest. All Rights Reserved.

As of February 2006  
BM030604

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# Many Different Internet Service Providers

- ❑ Each network is independent
- ❑ Interoperability requires using Internet standards: IP, TCP
  - ❖ the Internet is global and must run these standards
  - ❖ your private intranet can do whatever you want it to do



# Internet Design Goals

- ❑ primary goal: interoperability among existing networks
  - ❖ a network of networks
  - ❖ obey administrative boundaries
- ❑ secondary goals
  - ❖ fault tolerance
  - ❖ multiple transport protocols
  - ❖ support a variety of networks
  - ❖ distributed management
  - ❖ cost effective, low effort for host attachment, accountability
- ❑ first three were more important, so remaining four did not receive as much attention
- ❑ no mention of security

# Internet Design Principles

- ❑ minimal assumptions about services network should support
  - ❖ ability to send packets
  - ❖ no reliability or security
  
- ❑ end-to-end principle
  - ❖ keep the core of the network as simple as possible,
  - ❖ put complex functionality at the edges
  - ❖ *exception*: significant performance improvement

# Network Models

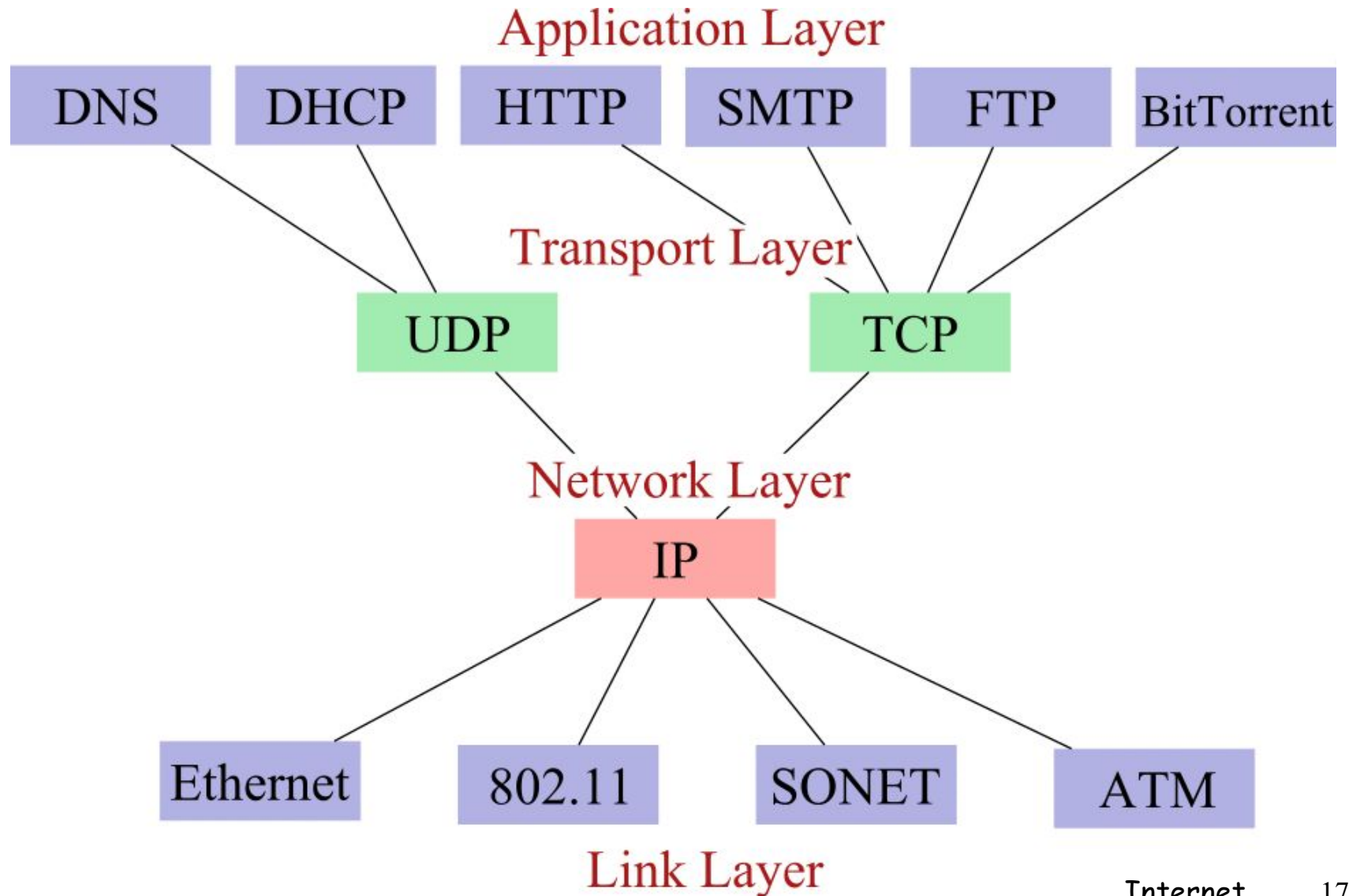
- ❑ Using a formal model allows us to deal with various aspects of Networks abstractly.
- ❑ We will look at a popular model (OSI reference model).
- ❑ The OSI reference model is a *layered* model.

# Layering

- ❑ Divide a task into pieces and then solve each piece independently (or nearly so).
- ❑ Establishing a well defined interface between layers makes porting easier.
- ❑ Major Advantages:
  - ◆ Code Reuse
  - ◆ Extensibility



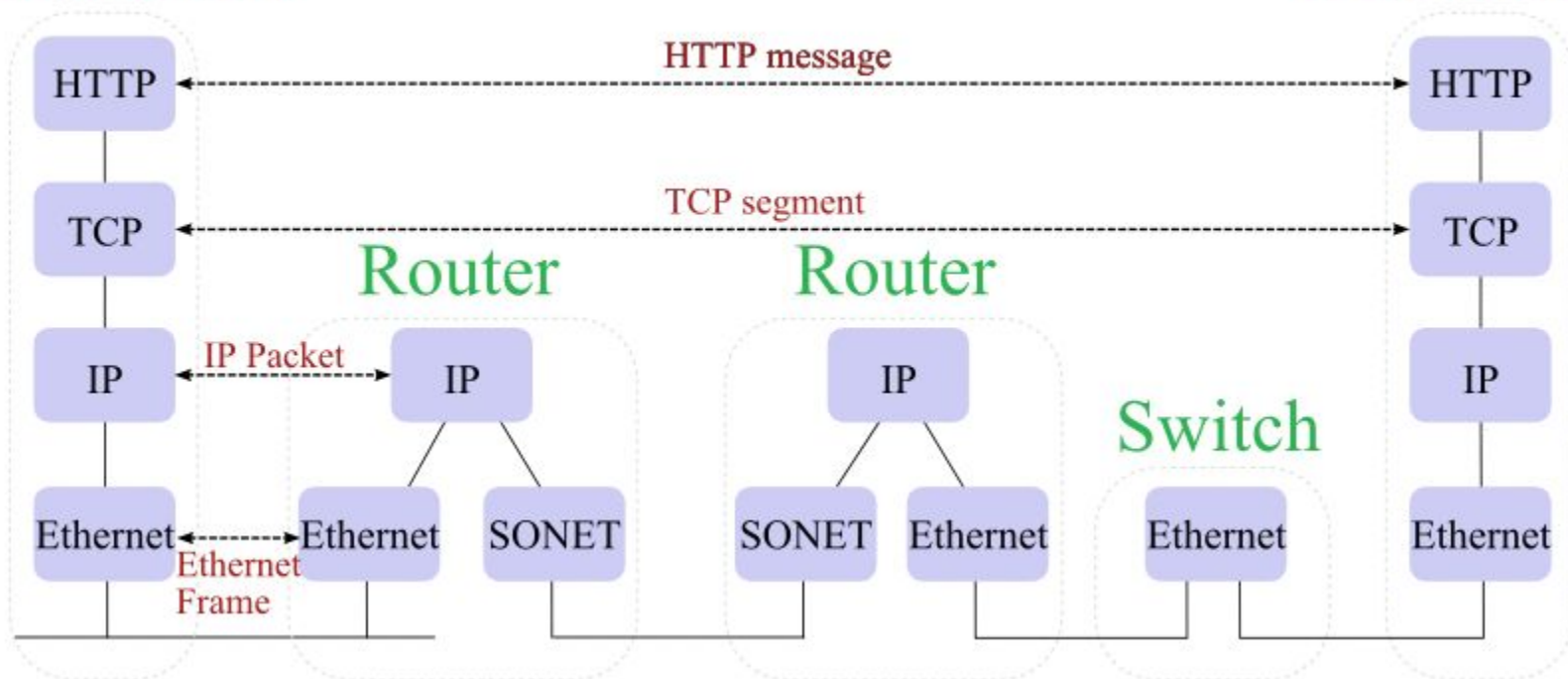
# The Internet Hourglass



# The Internet at each Hop

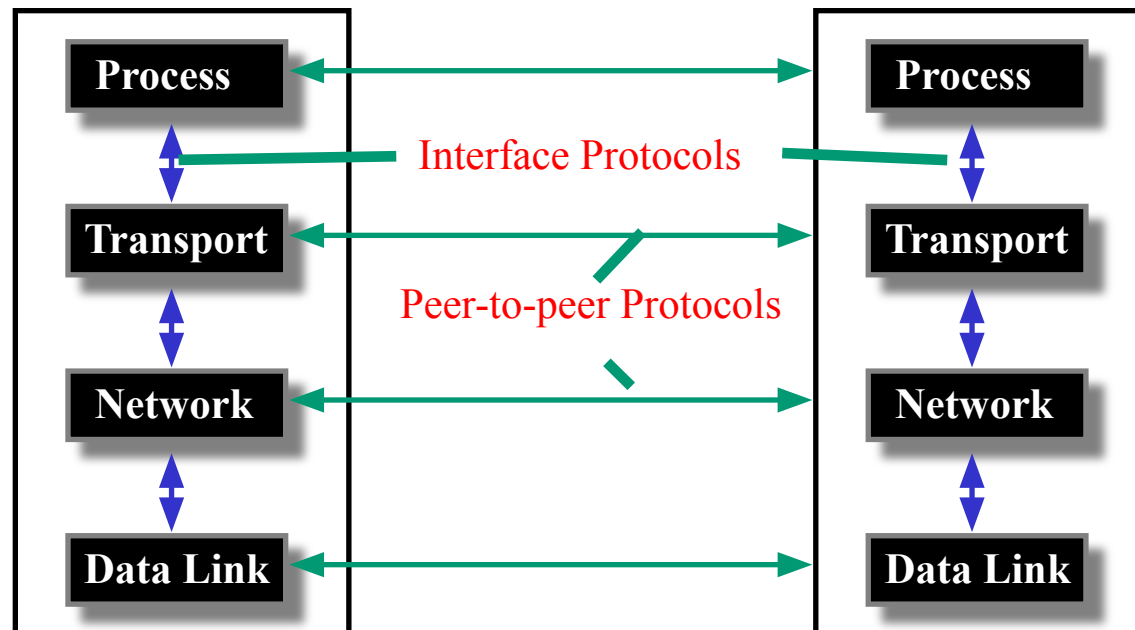
Web Client

Web Server



# Interface and Peer-to-peer Protocols

- ❑ Interface protocols describe communication between layers on the same endpoint.
- ❑ Peer-to-peer protocols describe communication between peers at the same layer.



# What's a protocol?

## human protocols:

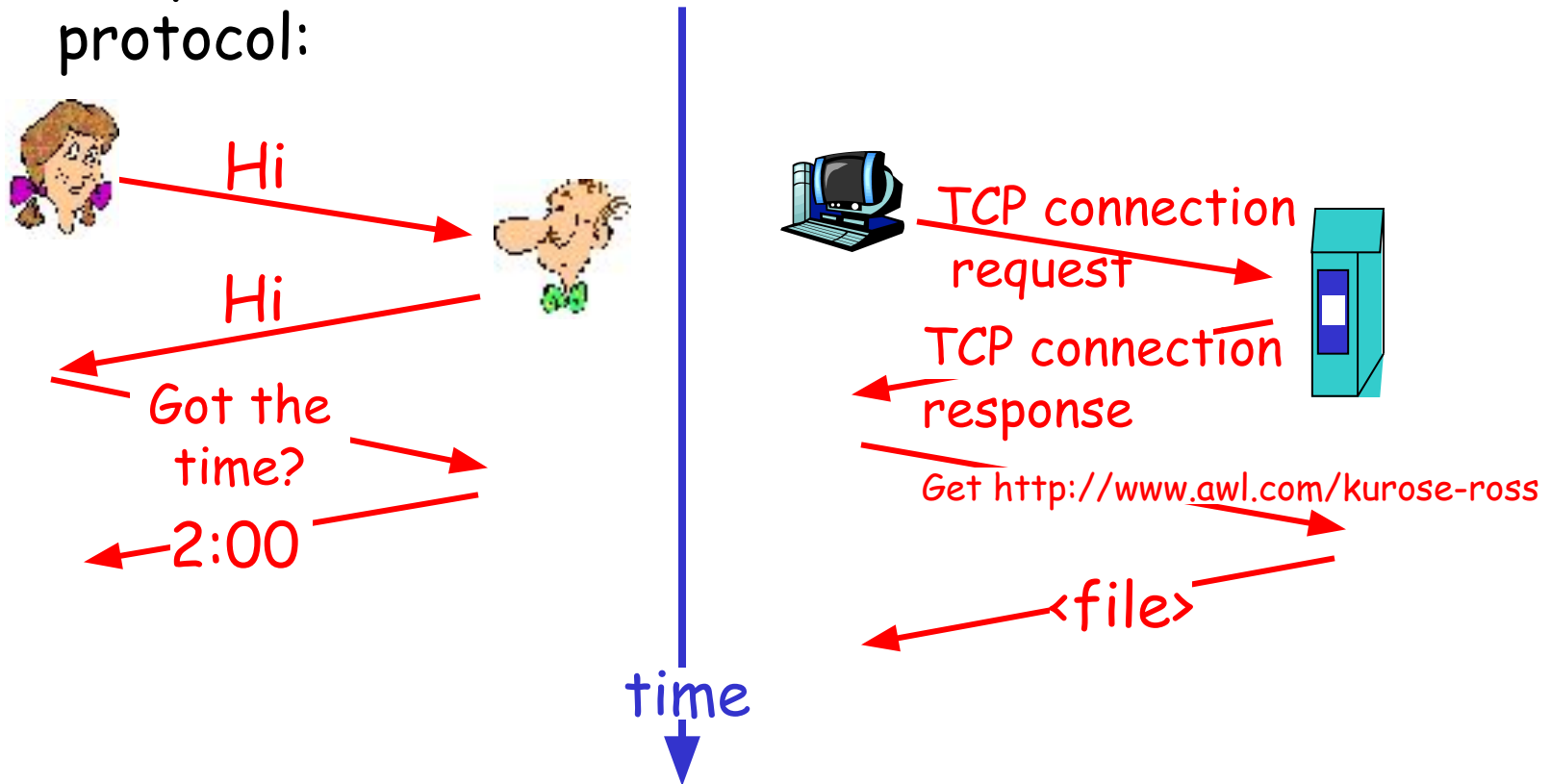
- ❑ "what's the time?"
  - ❑ "I have a question"
  - ❑ introductions
- ... specific msgs sent
- ... specific actions taken  
when msgs received, or  
other events

## network protocols:

- ❑ machines rather than humans
- ❑ all communication activity in Internet governed by protocols

# What's a protocol?

a human protocol and a  
computer network  
protocol:



Q: Other human protocols?

# Protocol

- ❑ An agreed upon convention for communication.
  - ❖ both endpoints need to *understand* the protocol.
- ❑ Protocols must be formally defined and unambiguous!
- ❑ Protocols define
  - ❖ format,
  - ❖ order of msgs sent and received among network entities,
  - ❖ actions taken on msg transmission, receipt
- ❑ We will study lots of existing protocols and perhaps develop a few of our own.

# Programs & Processes

- ❑ *A program is an executable file.*
- ❑ *A process or task is an instance of a program that is being executed.*
- ❑ *A single program can generate multiple processes.*

# Client - Server

- ❑ *A server is a process - not a machine !*
- ❑ *A server waits for a request from a client.*
- ❑ *A client is a process that sends a request to an existing server and (usually) waits for a reply.*



# Client - Server Examples

- ❑ Server returns the time-of-day.
- ❑ Server returns a document.
- ❑ Server prints a file for client.
- ❑ Server does a disk read or write.
- ❑ Server records a transaction.

# Servers

- ❑ Servers are generally more complex (more interesting).
- ❑ Basic types of servers:
  - ◆ *Iterative* - server handles one client at a time.
  - ◆ *Concurrent* - server handles many clients at a time.
- ❑ We will study the differences later.

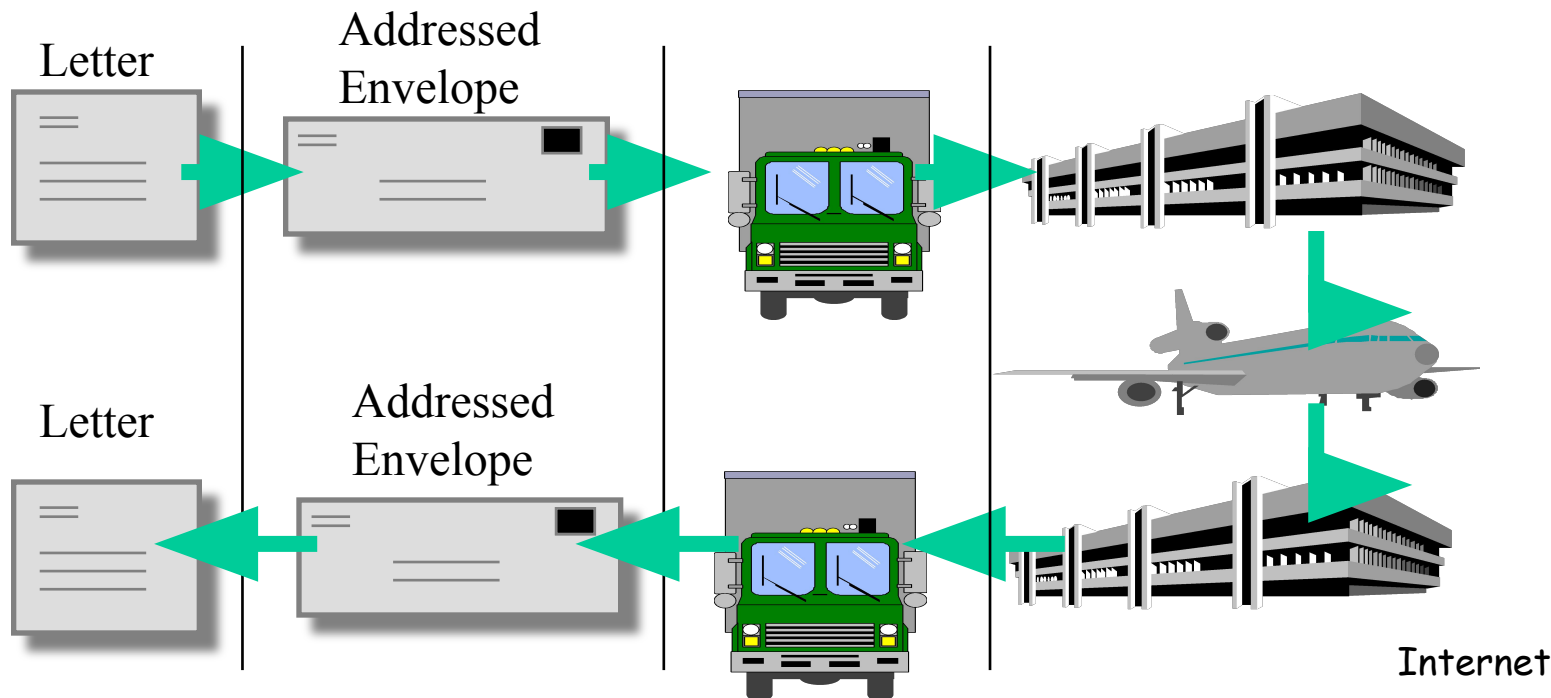
# Thought Exercise

- ❑ Come up with an example of a layered system.
- ❑ Describe the interface and peer-to-peer protocols for your example.



# Layering Example: Federal Express

- ❑ Letter in envelope, address on outside
- ❑ FedX guy adds addressing information, barcode.
- ❑ Local office drives to airport and delivers to hub.
- ❑ Sent via airplane to nearest city.
- ❑ Delivered to right office
- ❑ Delivered to right person



# Layered Software Systems

- ❑ Network software
- ❑ Operating systems
- ❑ Windowing systems

# Unix is a Layered System

