Chapter 1

Uses of Computer Networks

Lesson 3

So far…

- Performance
  - Cannot grow indefinitely!
  - Bandwidth
  - Latency
- Design Issue for the Layers
  - Addressing
  - Error and Flow Control
  - Multiplexing
  - Routing

Today …

- The OSI Reference Model
- The TCP/IP Reference Model
- A Comparison of OSI and TCP/IP
- A Critique of the OSI Model and Protocols
- A Critique of the TCP/IP Reference Model
- Examples of Networks

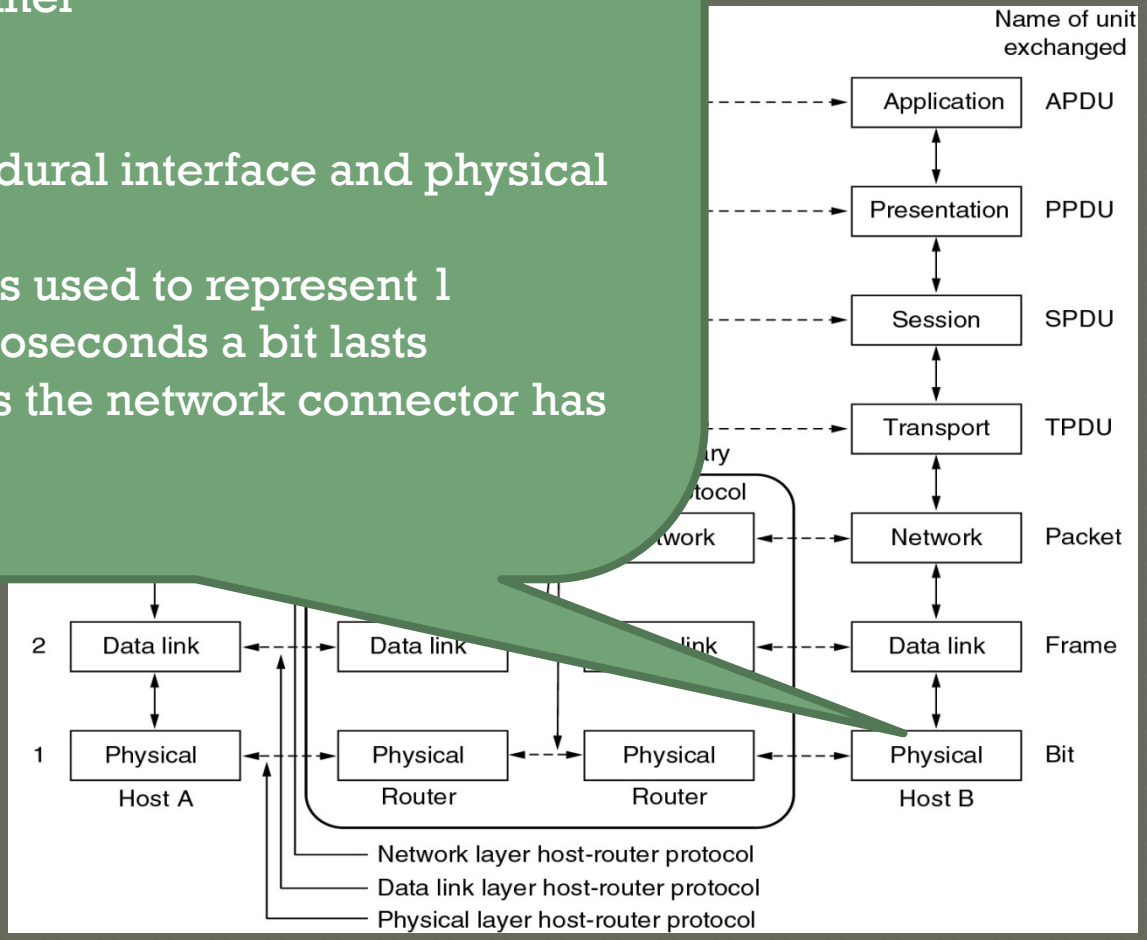
Physical Layer

Models

- Concerned about transmitting raw bits over a communication channel

Issue to deal:
Electrical and procedural interface and physical media transmission

- how many volts used to represent 1
- how many nanoseconds a bit lasts
- how many pins the network connector has
- etc….



The OSI reference model.

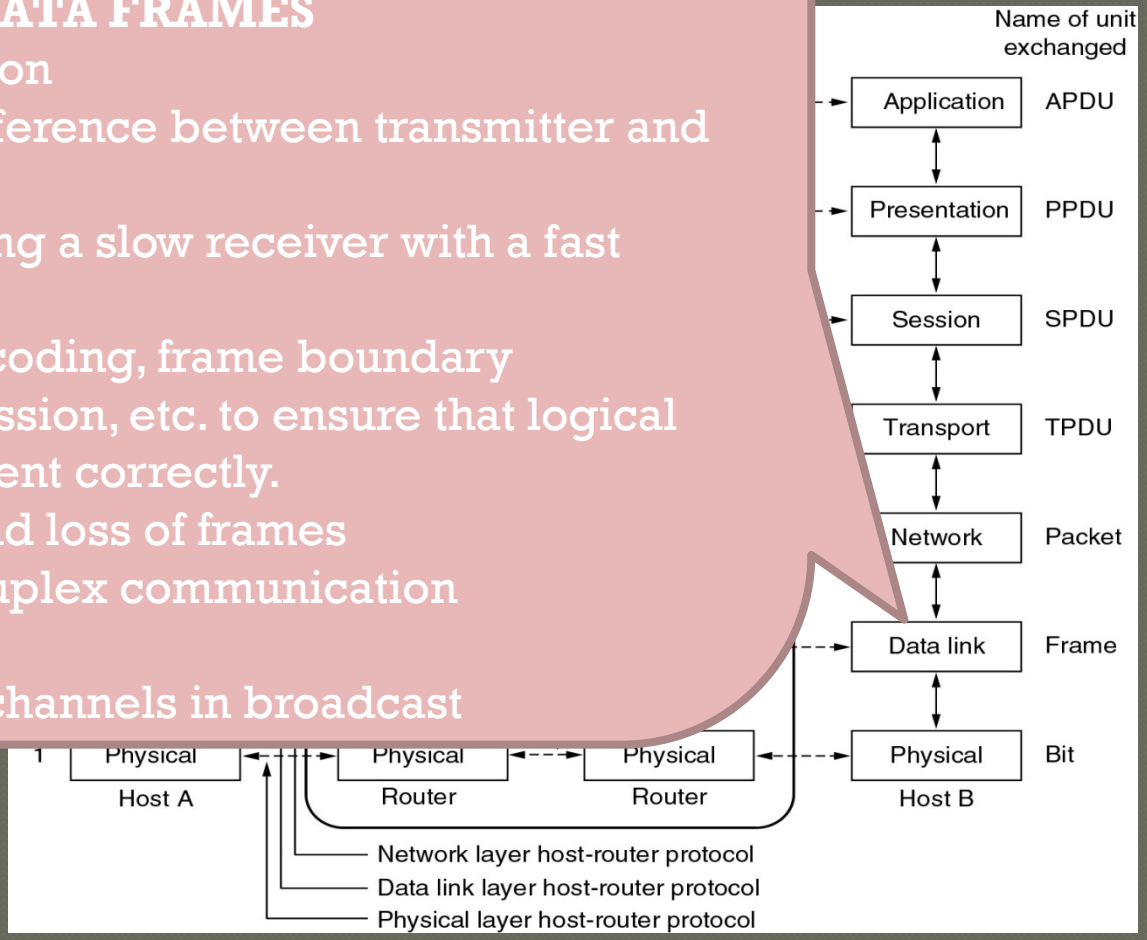
Data Link Layer

Concerned about transforming a raw transmission into a line free of errors

Issue to deal:

- Break the input data in **DATA FRAMES**
- take care of flow regulation
  - Deals with speed difference between transmitter and receiver
    - Ex. avoid drowning a slow receiver with a fast transmitter
  - Uses ack, special encoding, frame boundary delineation, retransmission, etc. to ensure that logical collection of bits are sent correctly.
  - Avoids duplication and loss of frames
  - Deals with half/full duplex communication
- handle errors
- control access to share channels in broadcast

The OSI reference model.



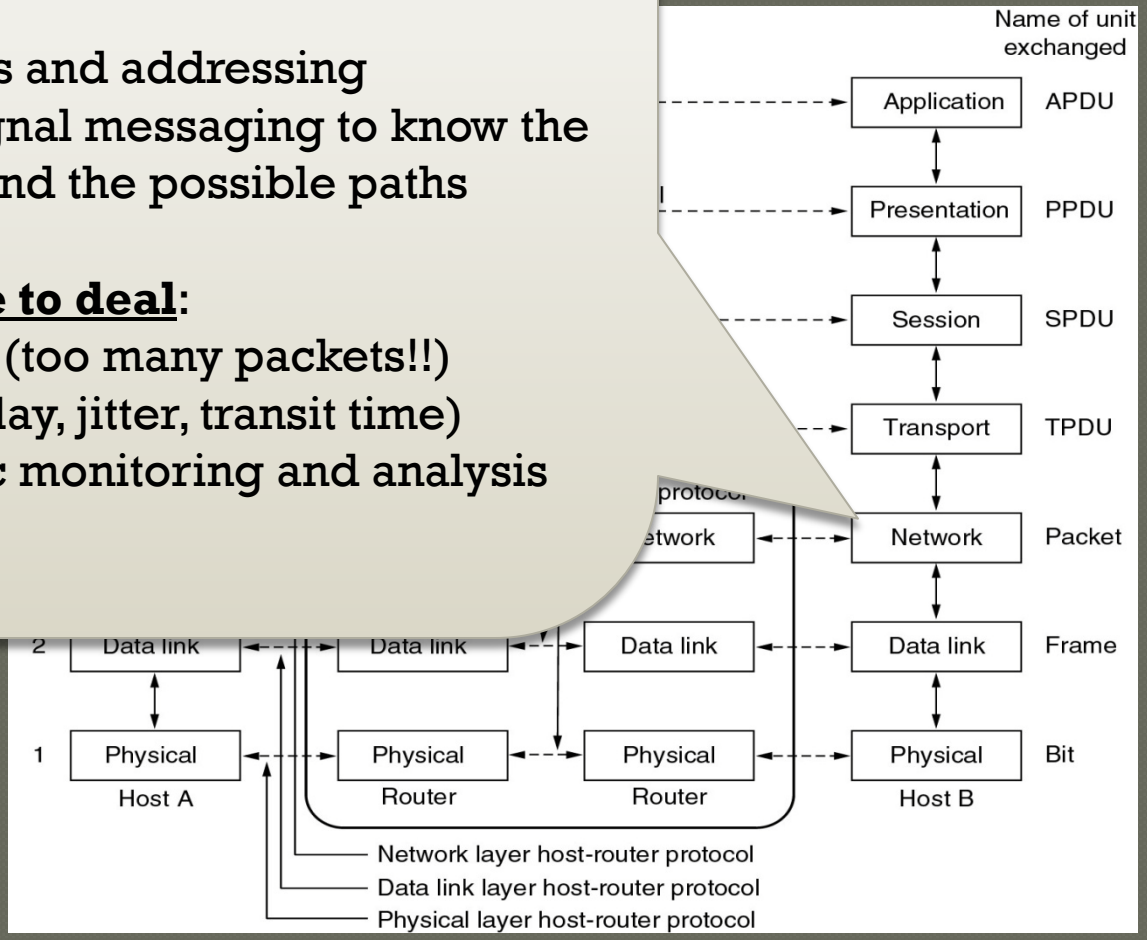
Network Layer

Concerned about how packets are routed from source to destination

- It uses route tables and addressing
- It uses various signal messaging to know the network topology and the possible paths

Issue to deal:

- Control of congestion (too many packets!!)
- Quality of service (delay, jitter, transit time)
- Used for billing, traffic monitoring and analysis



The OSI reference model.

Transport Layer

OSI reference model

ce Models

Concerned about splitting the data from above layer (if need be) and ensure that all the pieces arrive correctly at the destination

It is a real end-to-end layer

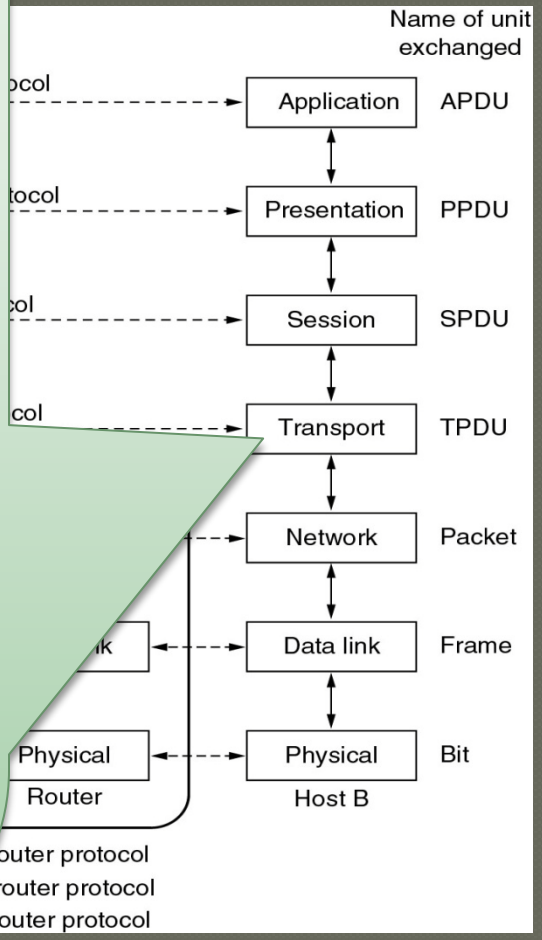
- It maintains
  1. multiple connection or multiplex
  2. the start and the end of the connection
- Identifies the application end-point who should received the data
- Ensure end-to-end flow control

Most popular type of transport connection:

1. Point-to-point - delivers messages in the order they are sent.

Other transport services:

1. do not guarantee the order of delivery
2. broadcast messages
3. Transport isolate messages

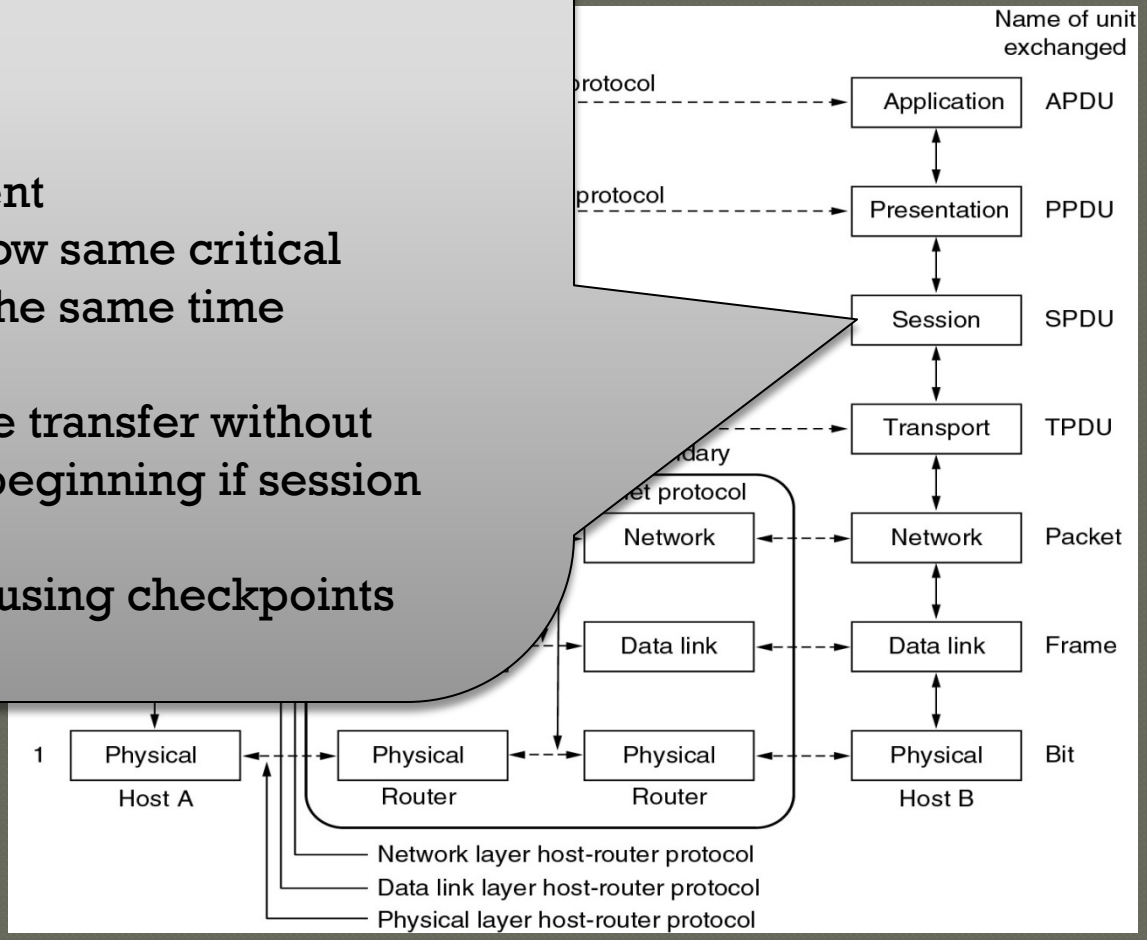


Session Layer

Concerned about establishing a session
Ex. Remote Login

Issue to deal:

- dialog control,
- token management
  - ex. do not allow same critical operation at the same time
- synchronization
  - ex. Restart file transfer without going to the beginning if session crashes
    - done by using checkpoints



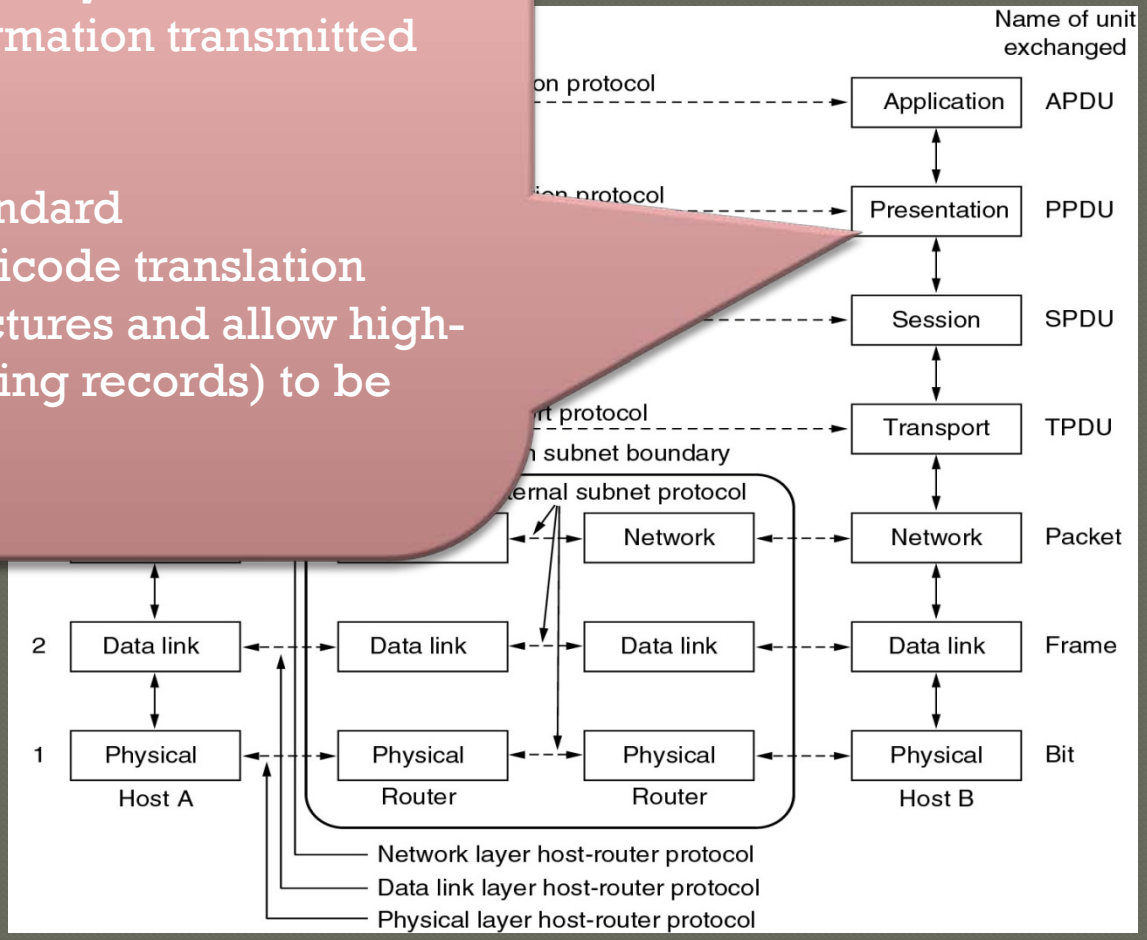
The OSI reference model.

Presentation Layer

Concerned about the syntax and the semantics of the information transmitted

Issue to deal:

- Encoding data in a standard
  ex. ASCII to Unicode translation
- manage the data structures and allow high-level records (e.g. banking records) to be define and exchanged



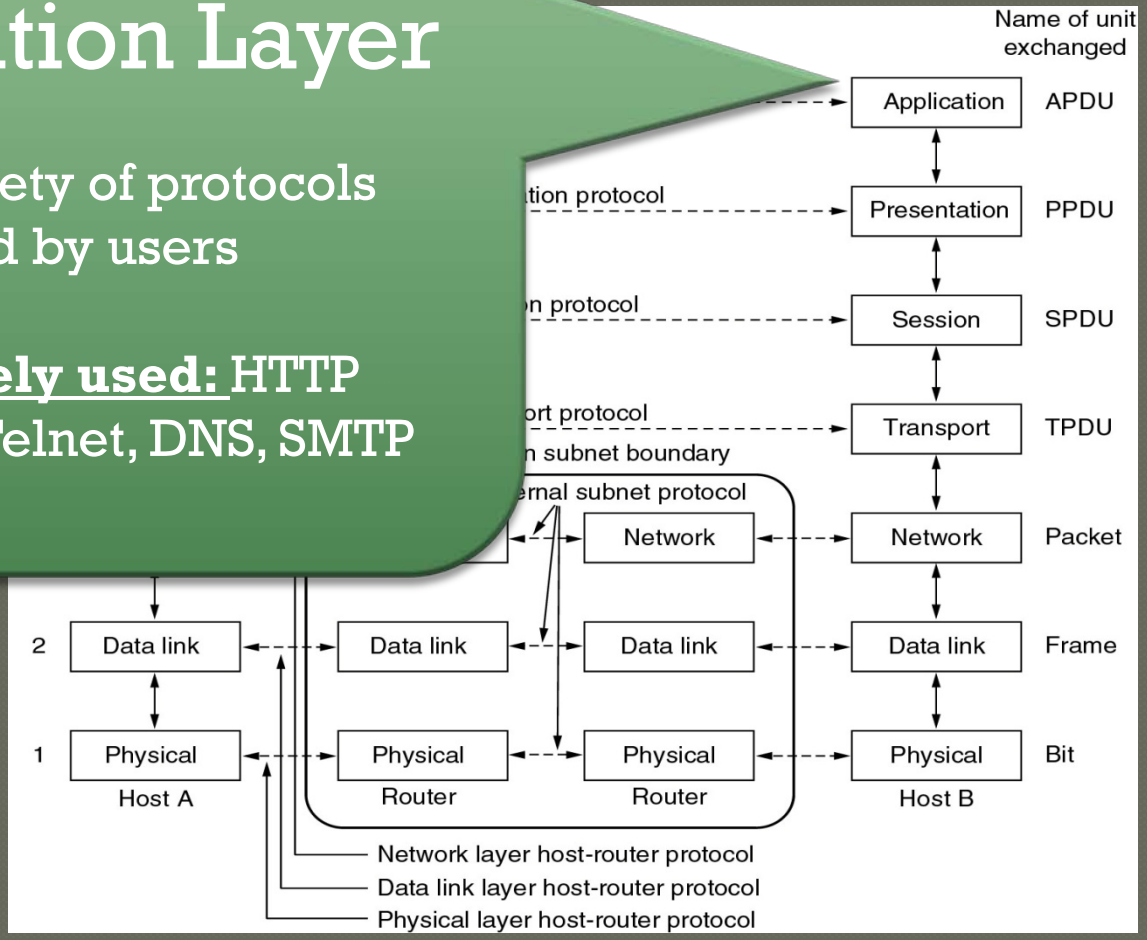
The OSI reference model.

Reference Models

Application Layer

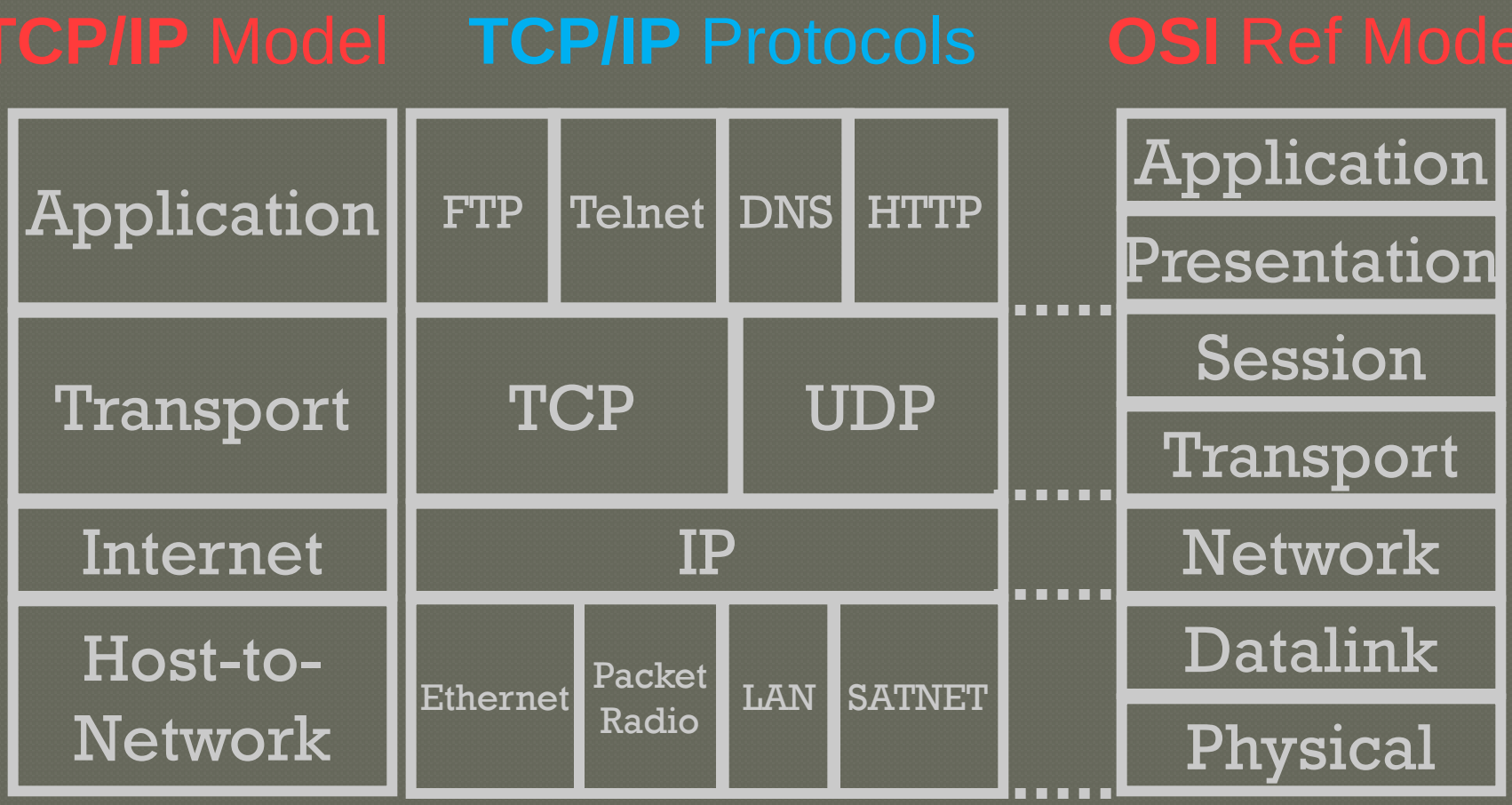
Contains a variety of protocols commonly used by users

Most widely used: HTTP
Other: FTP, Telnet, DNS, SMTP



The OSI reference model.

Reference Models for Layering



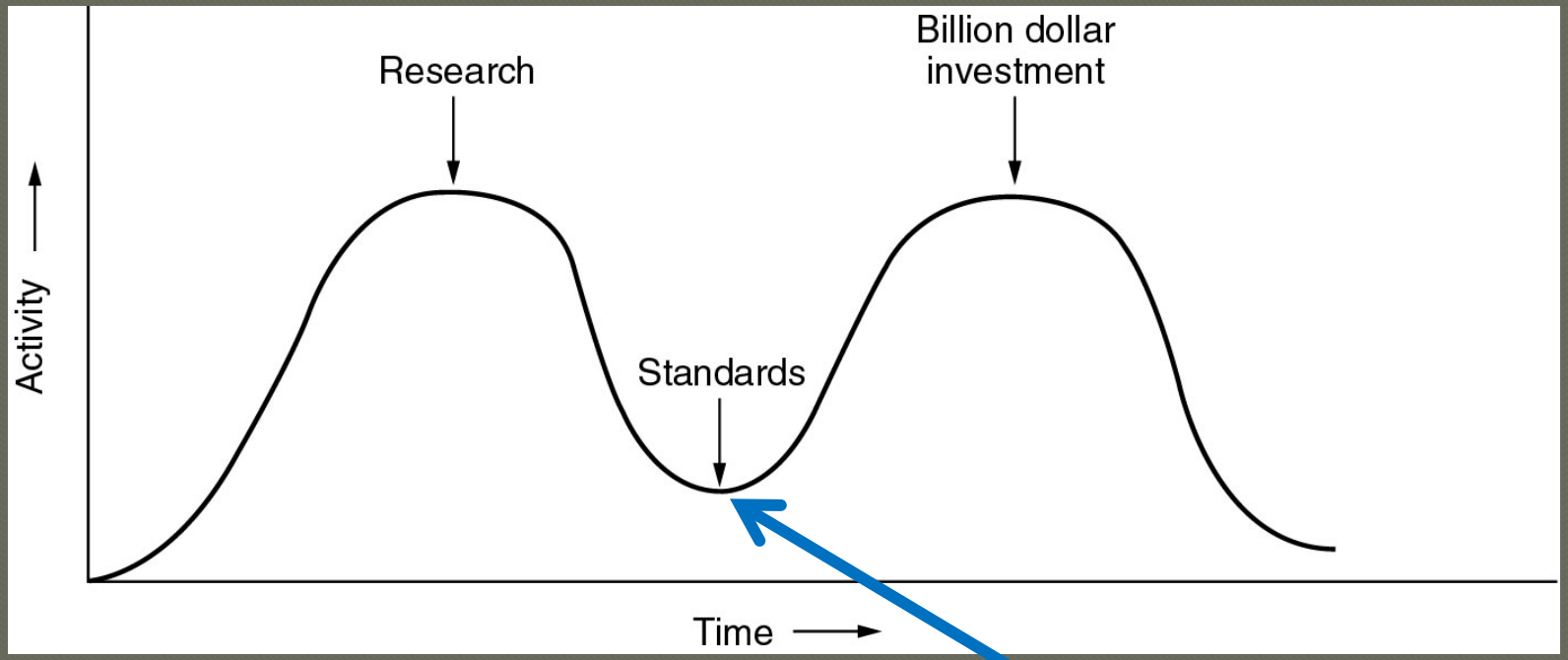
Comparing OSI and TCP/IP Models

- Concepts central to the OSI model
- Services
  - Tells what the layer does
- Interfaces
  - Tells the processes above it how to access it
- Protocols
  - …are the layer's own business

- Each layer performs some services for the layer above it
  - … and must be concerned about the layer below it.

Why OSI did not take over the world

- Bad Timing



Your SW must be ready here

Why OSI did not take over the world

- TCP/IP was already delivered when OSI protocols were available

- Bad technology
  - Two layers (session and presentation) are nearly empty
- Bad implementations
  - Huge, unwieldy and slow
- Bad politics
  - TCP/IP was offered under UNIX
  - Government participation in OSI was seen as lack of quality of the model

A Critique of the TCP/IP Reference Model

- Problems:
  1. Service, interface, and protocol not distinguished
  2. Not a general model
     - Ex. Describe Bluetooth is impossible
  3. Host-to-network "layer" not really a layer
     - It is an interface between network and data link layer
     - It does not distinguish between the physical and data link layers
  4. Minor protocols deeply entrenched, hard to replace

Hybrid Model

- The hybrid reference model to be used in the book and in the class.

5	Application layer
4	Transport layer
3	Network layer
2	Data link layer
1	Physical layer

Example Networks

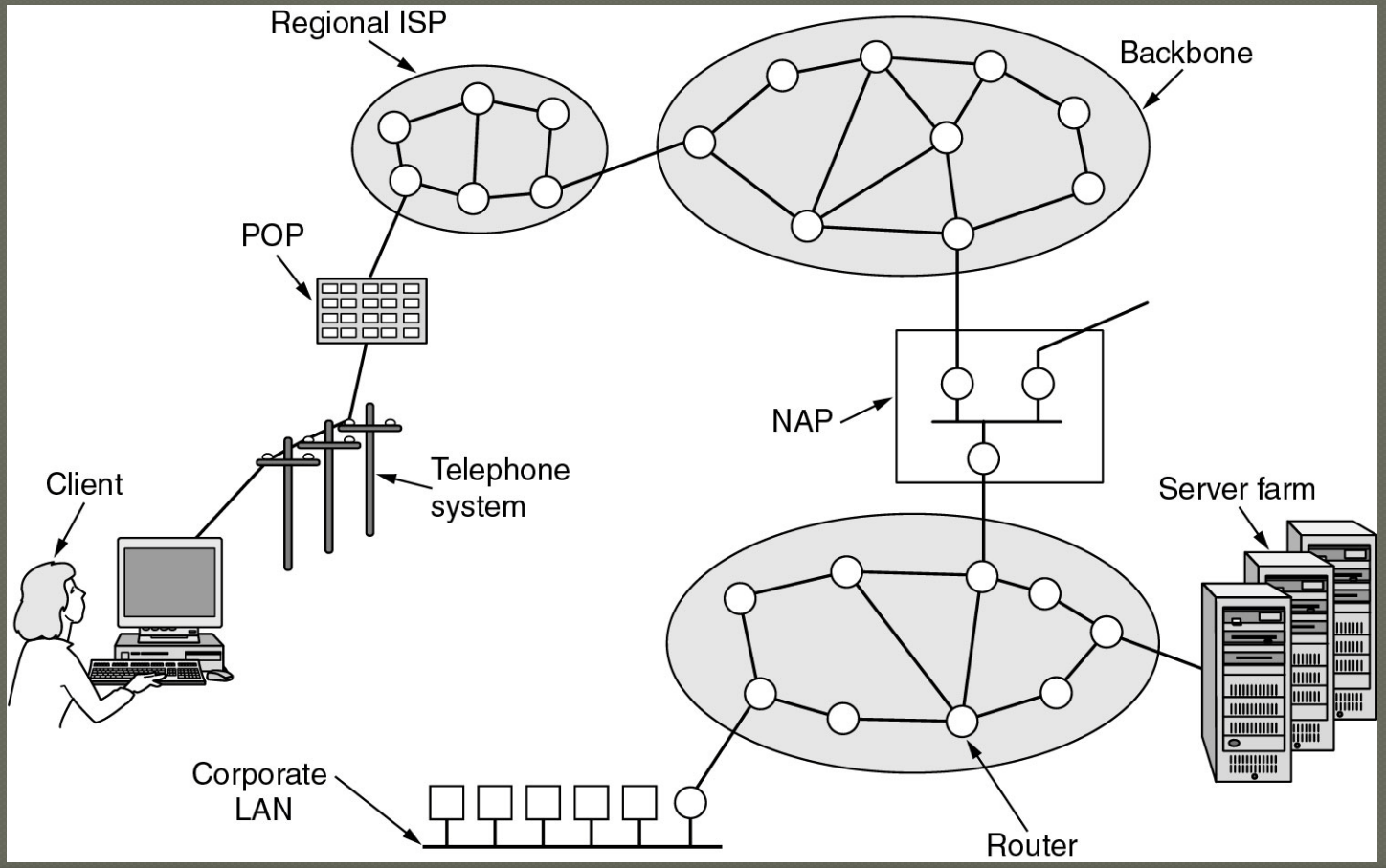
- The Internet
- Connection-Oriented Networks:
  X.25, Frame Relay, and ATM
- Ethernet
- Wireless LANs: 802:11

Internet Usage

- Traditional applications (1970 – 1990)
  - E-mail
  - News
  - Remote login
  - File transfer

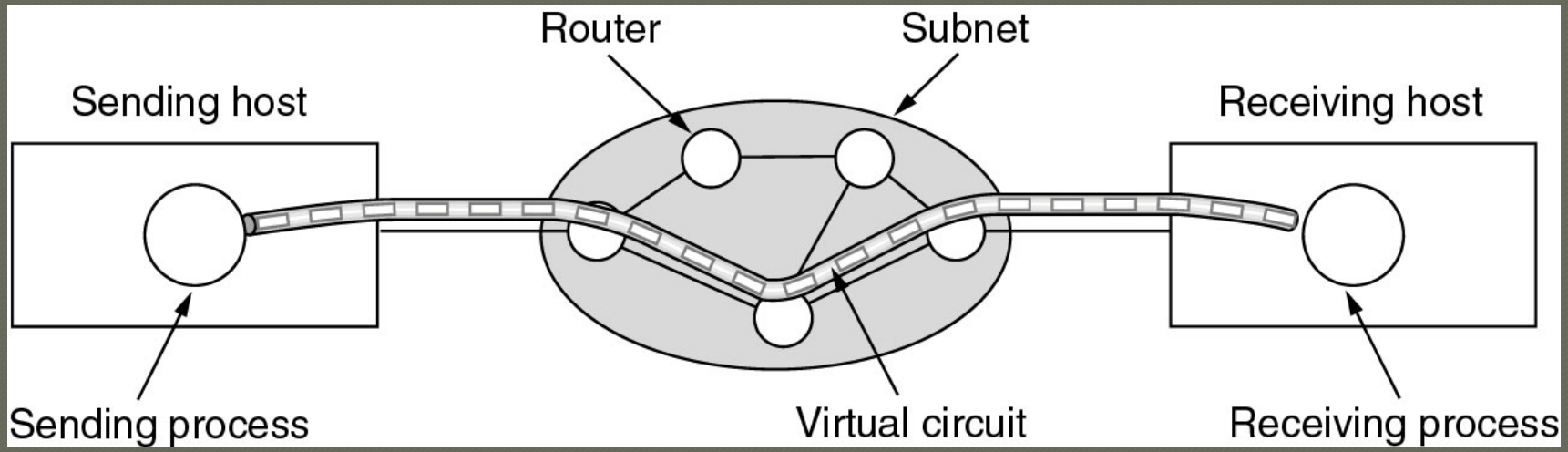
Architecture of the Internet

- Overview of the Internet.



ATM Virtual Circuits

- A virtual circuit.



Connection-oriented vs. Connenctionless

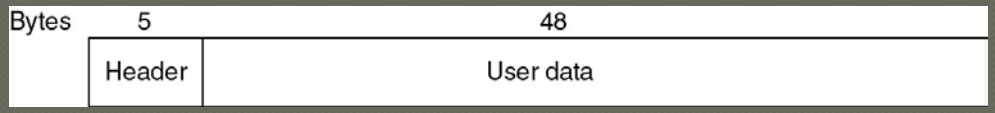
- Connection Oriented
  - Modeled after the telephone system
    - Establish the connection
    - Uses the connection
    - Release the connection
- Connectionless
  - Modeled after the postal system
    - Each message
      1. carries the full destination address
      2. is routed independently

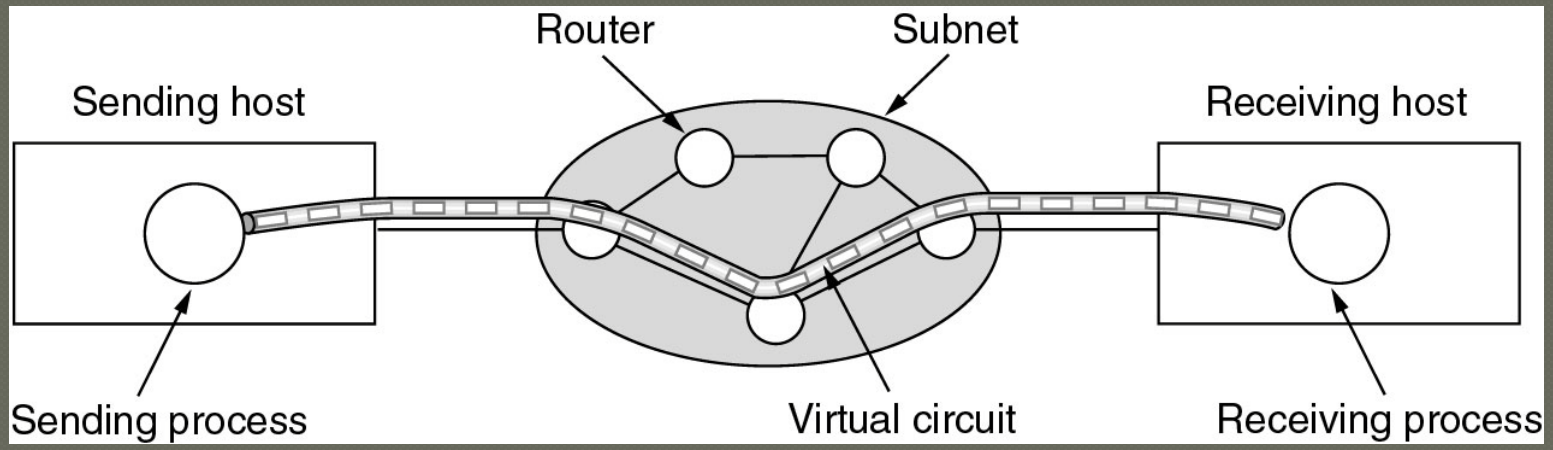
Connection-oriented vs. Connenctionless

- Not all the applications require connection
  - Unreliable connectionless service often called datagram service.
    - Junk E-mail
  - Acknowledged Service
    - Similar to registered mail (you get a return receipt)
  - Request-Reply
    - Similar to a database query

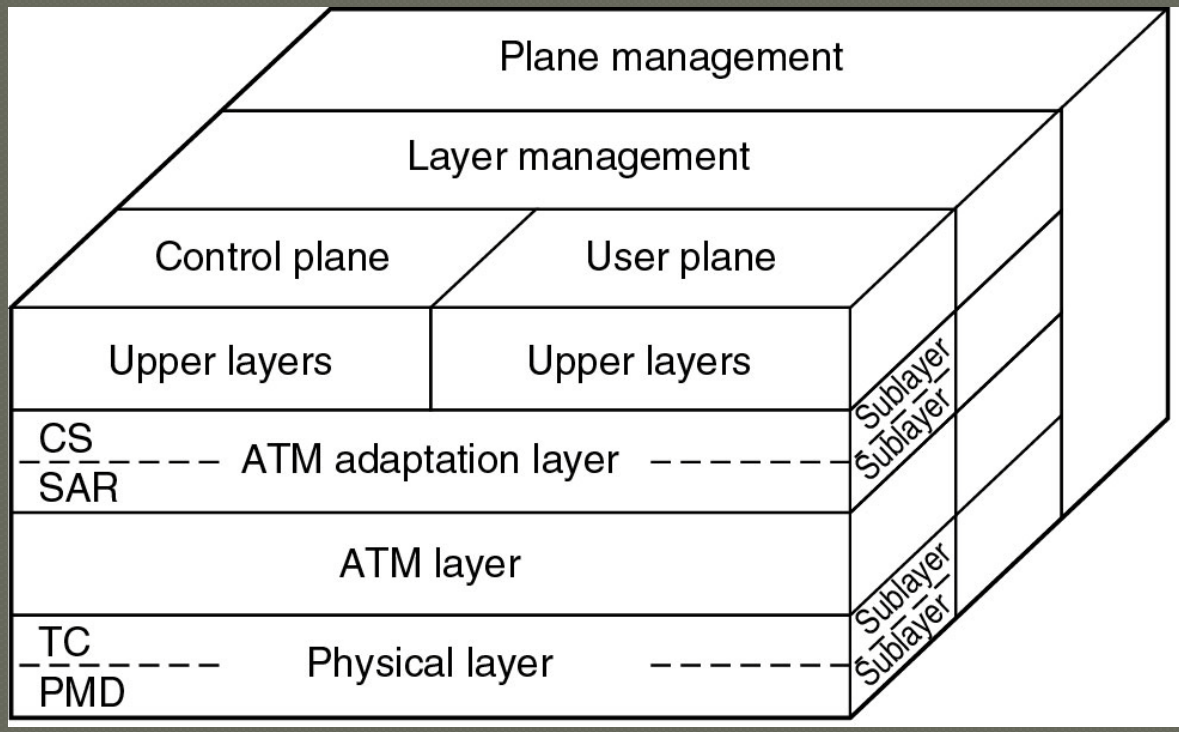
ATM Virtual Circuits

- A connection is called a virtual circuit.
- Most network support permanent virtual circuits between 2 hosts
- It transmits a fixed size packet called cell
- ATM cell





The ATM Reference Model



CS: Convergence sublayer

SAR: Segmentation and reassembly sublayer

TC: Transmission convergence sublayer

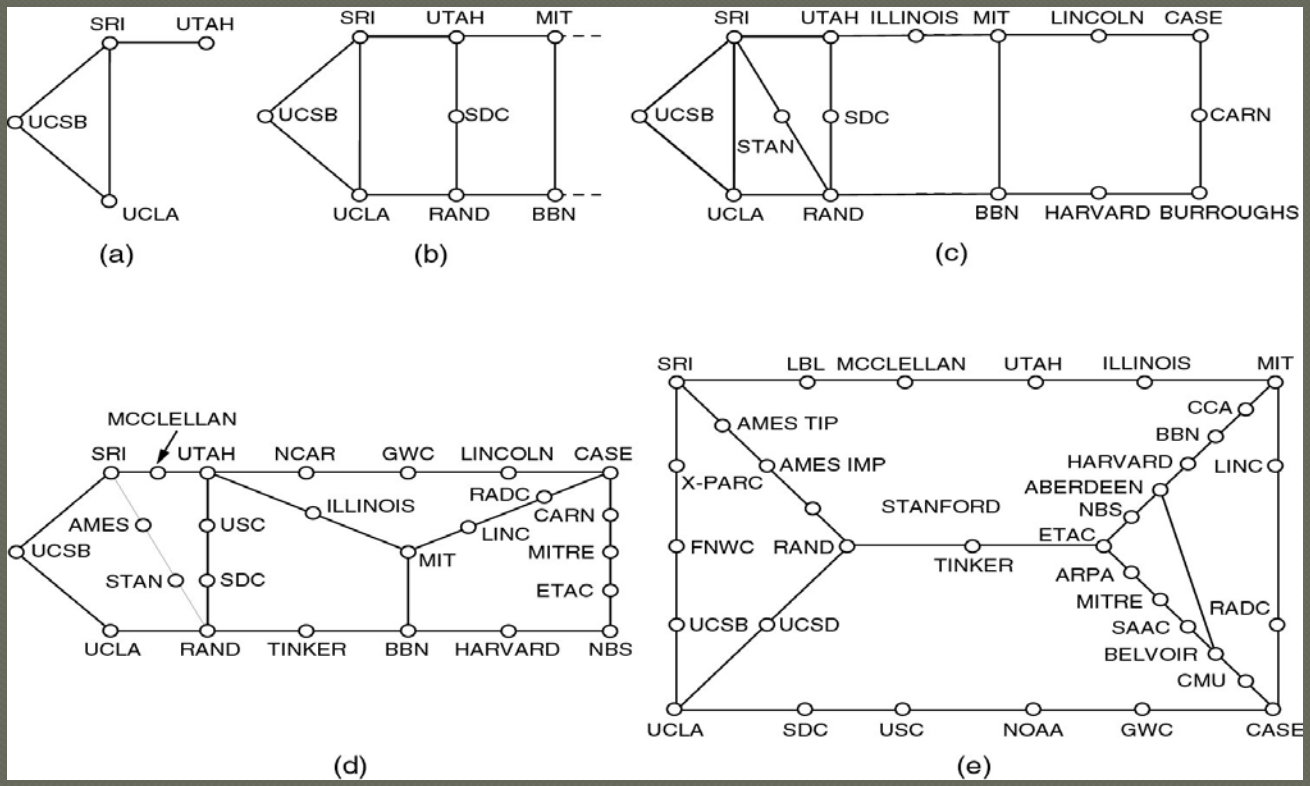
PMD: Physical medium dependent sublayer

The ATM Reference Model (2)

OSI layer	ATM layer	ATM sublayer	Functionality
3/4	AAL	CS	Providing the standard interface (convergence)
		SAR	Segmentation and reassembly
2/3	ATM		Flow control Cell header generation/extraction Virtual circuit/path management Cell multiplexing/demultiplexing
2	Physical	TC	Cell rate decoupling Header checksum generation and verification Cell generation Packing/unpacking cells from the enclosing envelope Frame generation
1		PMD	Bit timing Physical network access

The ATM layers and sublayers and their functions.

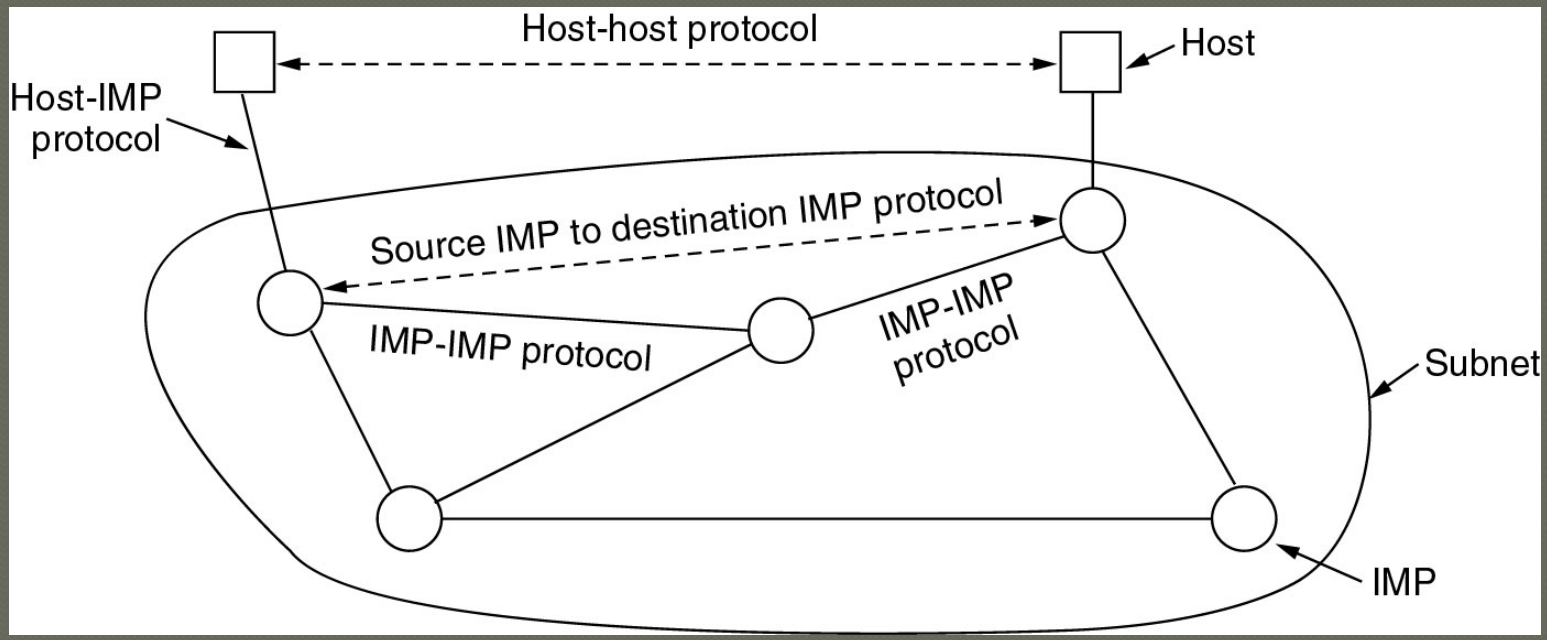
The ARPANET: The test bed for emerging technologies



- Growth of the ARPANET (a) December 1969. (b) July 1970.
- (c) March 1971. (d) April 1972. (e) September 1972.

The ARPANET (2)

- The original ARPANET design.
- Predecessor of TCP/IP
- It introduces the concept of packet switching



Example of Communication Services

- X.25 Network
- Frame Relay
- Distributed Queue Dual Bus (DQDB)
  - Used for MAN
- ATM
- Switched Megabyte Data Service (SMDS)

	X.25	Frame Relay	DQDB	ATM	SMDS
Connection Oriented	Yes	Yes	Yes	Yes	No
Speed (Mbps)	.064	1.5	45	155	45
Switched	Yes	No	No	Yes	Yes
Fixed-size payload	No	No	Yes	No	No
Multicasting	No	No	No	Yes	Yes

In Conclusion….

- The OSI Reference Model
  - Good model but never successful for several reasons
- The TCP/IP Reference Model
  - Not perfect, but was realized in a timely fashion
- The ATM Reference Model
  - Connection Oriented Network
  - Uses cells
- Examples of Networks
  - Internet
  - ARPANET
  - ATM
  - DQDB
  - X.25

Next Time…

We start Chapter 2

- The Physical Layer
- Assignment 1 issued today. Due by next class.