Introduction to Networking Protocols and Architecture

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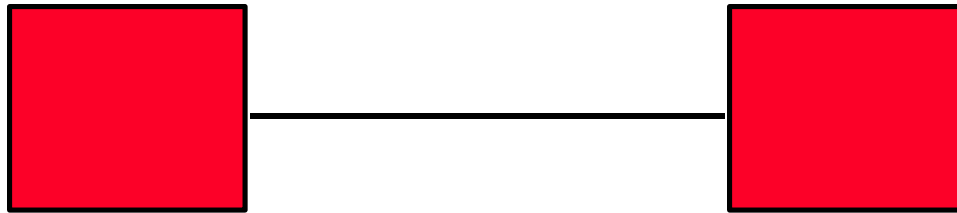These slides are available on-line at:

http://www.cis.ohio-state.edu/~jain/cis677-00/

Overview

❑ Data Comm vs Networking vs Distributed Systems

❑ Types of Networks

❑ Protocol Layers: OSI and TCP/IP Models

❑ Connection-oriented vs connectionless

❑ Layered packet format

Data Communication vs Networking

❑ Communication: Two Nodes. Mostly EE issues.

❑ Networking: Two or more nodes. More issues, e.g., routing
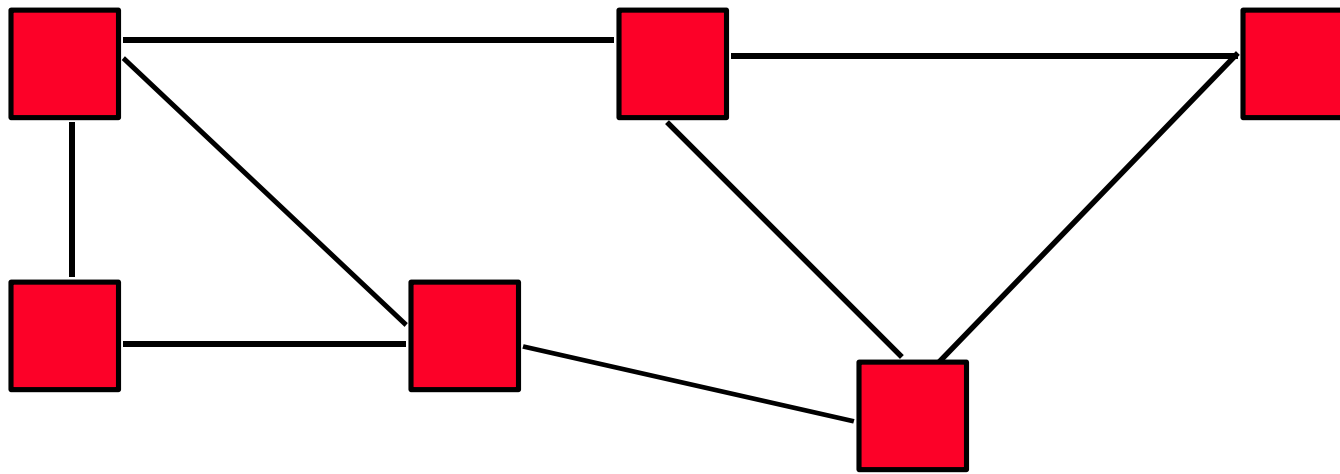
Distributed Systems vs Networks

❑ Distributed Systems:
  ❑ Users are unaware of underlying structure.
    E.g., trn instead of \n\bone\0\trn
  ❑ Mostly operating systems issues.
  ❑ Nodes are generally under one organization's control.
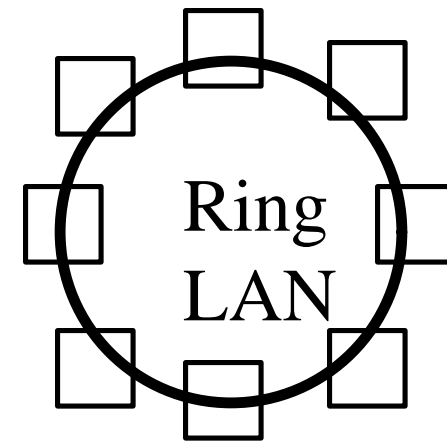❑ Networks: Users specify the location of resources.
  http:\\www.cis.ohio-state.edu\~jain\
  ❑ Nodes are autonomous.

Server
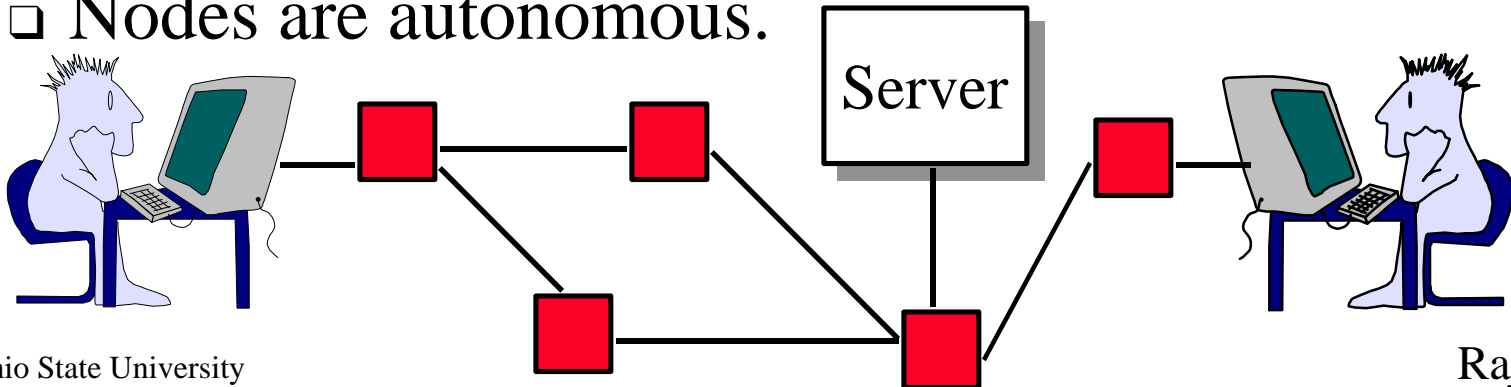
Types of Networks

❑ Point to point vs Broadcast

WAN   Bus LAN

Ring LAN
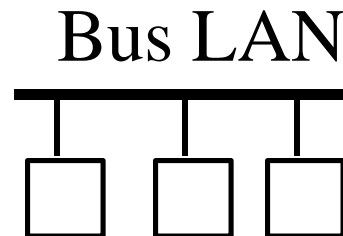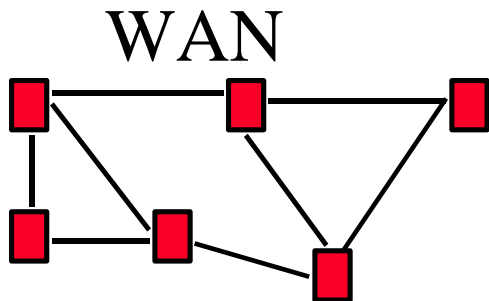
❑ Circuit switched vs packet switched
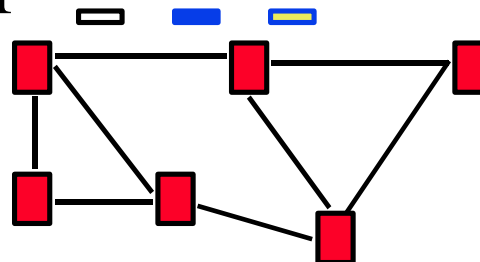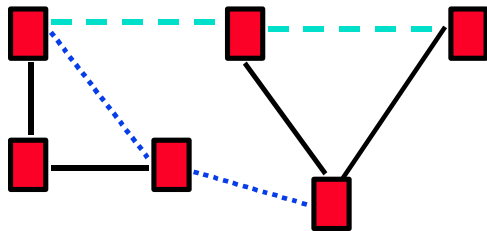
❑ Local Area Networks (LAN) 0-2 km,
   Metropolitan Area Networks (MAN) 2-50 km,
   Wide Area Networks (WAN) 50+ km

Protocol Layers

❑ Problem: Philosophers in different countries speak different languages. The Telex system works only with English.

I believe there is a God!

Philosopher
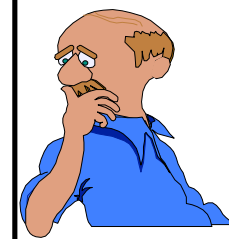
Translator

Secretary

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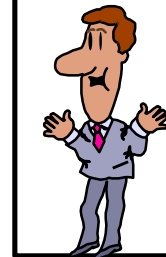
Design Issues for Layers

❑ Duplexity:
    ❑ Simplex: Transmit or receive

$$\longrightarrow$$
$$\longleftarrow$$

    ❑ Full Duplex: Transmit and receive simultaneously
    ❑ Half-Duplex: Transmit and receive alternately

❑ Error Control: Error detection and recovery
❑ Flow Control: Fast sender

ISO/OSI Reference Model

	Layer	Description
3	Application	File transfer, Email, Remote Login
	Presentation	ASCII Text, Sound
	Session	Establish/manage connection
2	Transport	End-to-end communication: TCP
	Network	Routing, Addressing: IP
1	Datalink	Two party communication: Ethernet
	Physical	How to transmit signal: Coding
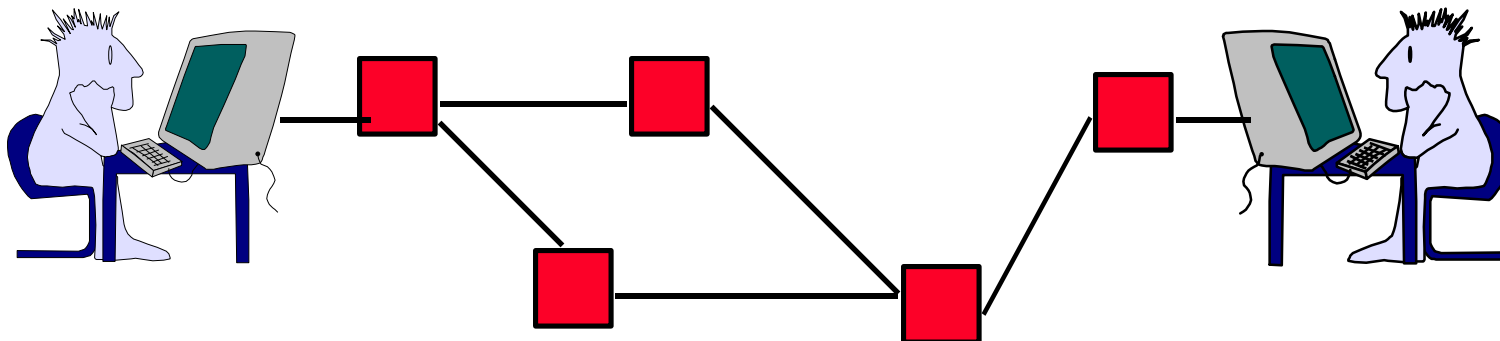
Layering

FTP	Telnet	Web	Email
Trans Control Prot		User Datagram Prot	
Internet Protocol		Novell Netware (IPX)	
Ethernet		Token Ring	
Copper		Fiber	

← Same Interfaces

❑ Protocols of a layer perform a similar set of functions
❑ All alternatives for a row have the same interfaces
❑ Choice of protocols at a layer is independent of those of at other layers. E.g., IP over Ethernet or token ring
❑ Need one component of each layer ⇒ Null components

Interfaces and Services
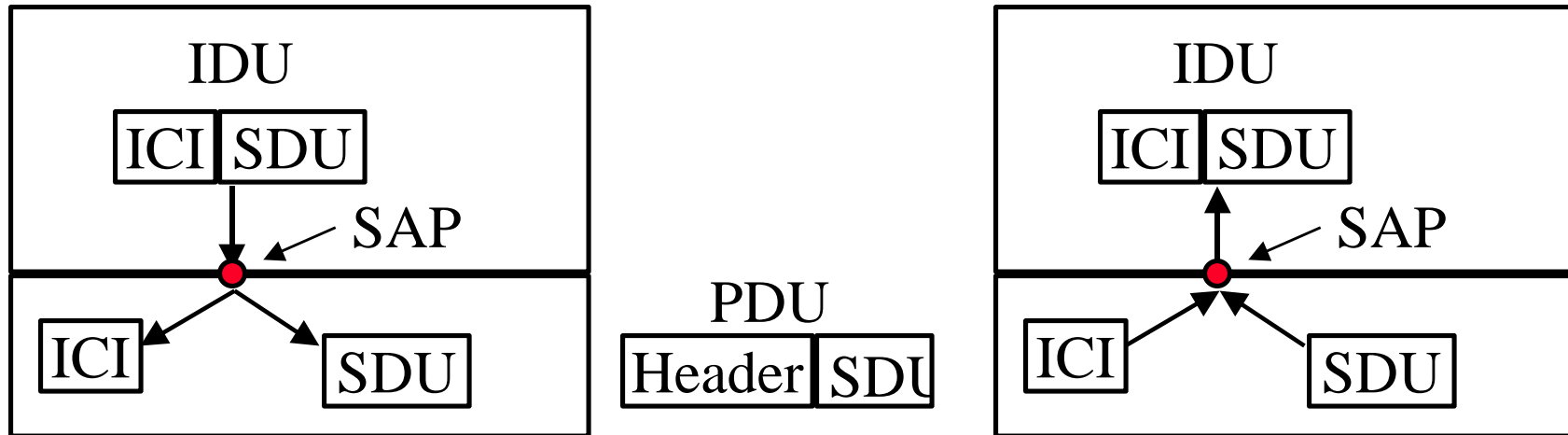
- ❑ IDU = Interface Data Unit = ICI + SDU
- ❑ ICI = Interface Control Information
- ❑ SDU = Service Data Unit
- ❑ PDU = Protocol Data Unit = Fragments of SDU + Header or Several SDUs + Header (blocking)
- ❑ SAP = Service Access Point

Protocol Data Unit (PDU)

Application	APDU, Message	Application	
Presentation	PPDU	Presentation	
Session	SPDU	Session	
Transport	TPDU	Transport	
Network	NPDU, Packet	Network	
Datalink	DPDU, Frame	Datalink	
Physical	PhPDU, Frame	Physical	

Service Data Unit (SDU)

Application

↓ PSDU

Presentation

↓ SSDU

Session

↓ TSDU

Transport

↓ NSDU

Network

↓ DSDU

Datalink

↓ PhSDU

Physical
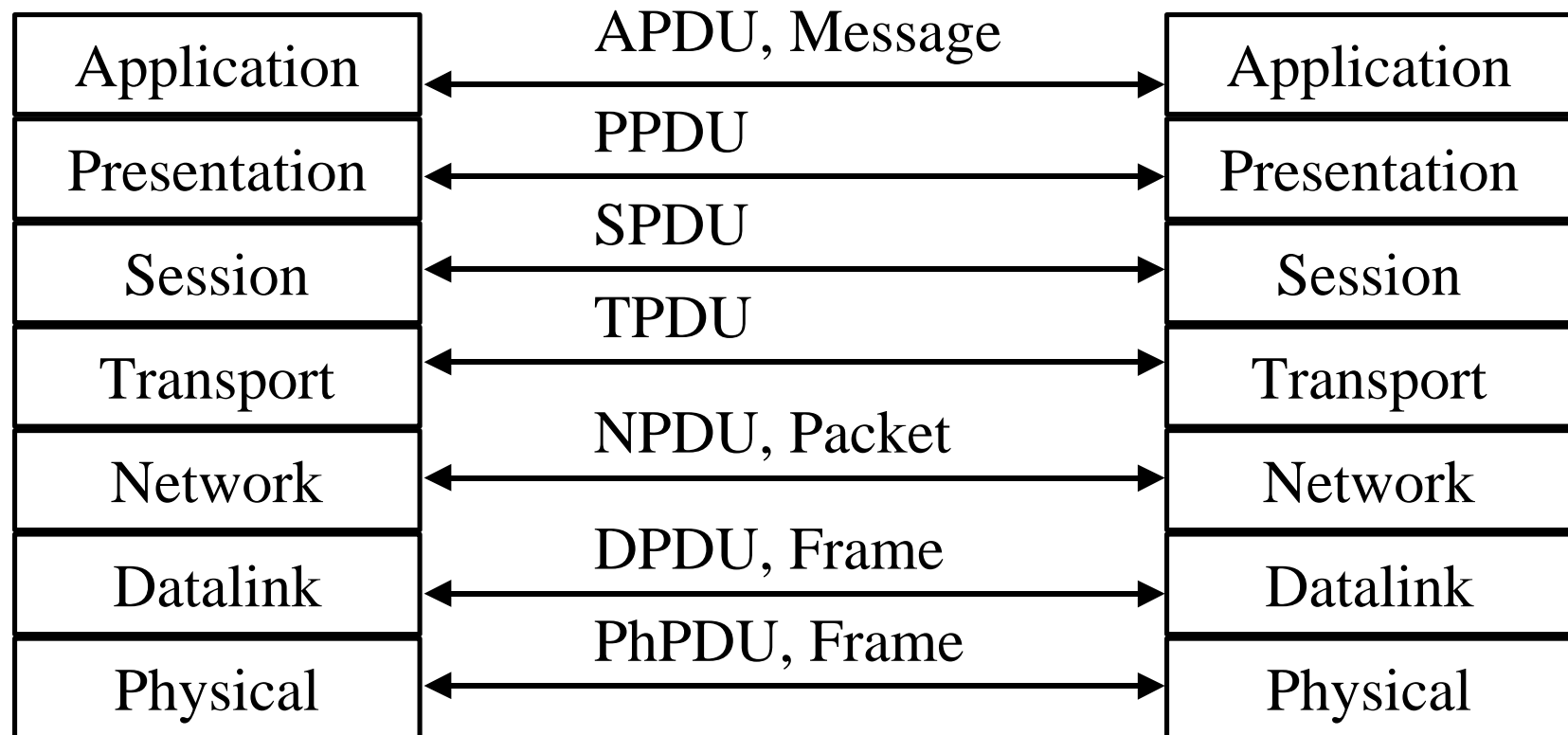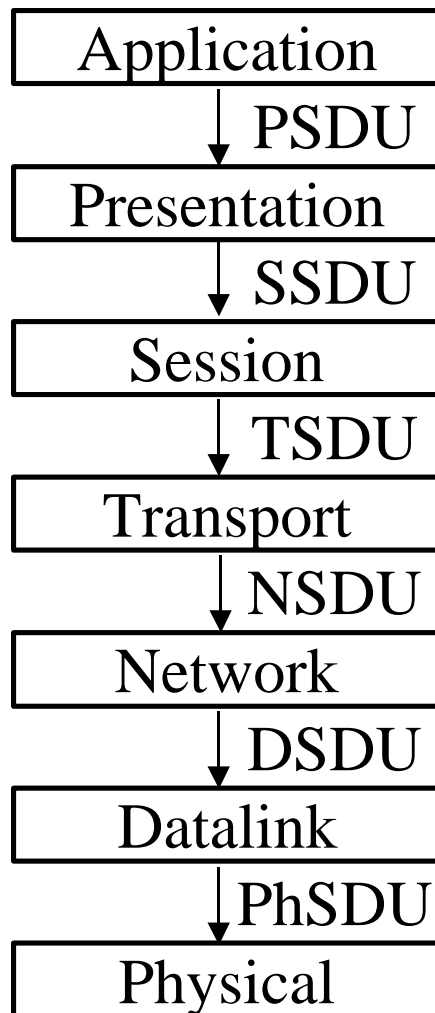
Connection-Oriented vs Connectionless
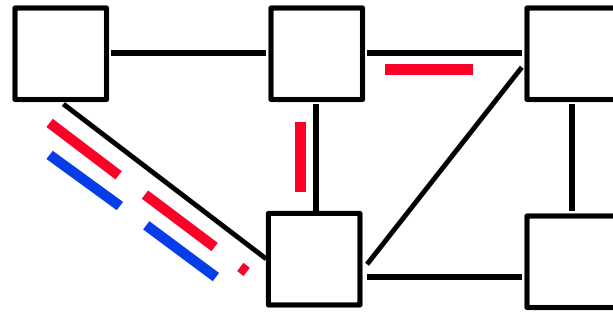
- Connection-Oriented: Telephone System
  - Path setup before data is sent
  - Data need not have address. Circuit number is used.
  - Virtual circuits: Multiple circuits on one wire.
- Connectionless: Postal System. Also known as datagram.
  - Complete address on each packet
  - The address decides the next hop at each routing point

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Types of Services

```
                          Types of Services
                                 |
                 _____|_____
                |                                 |
        Connection-oriented                   Datagram
                |                                 |
          _____|_____                    _____|_____
         |             |                  |             |
      Reliable    Unreliable           Reliable    Unreliable
         |                                 |
     ____|____                         ____|____
    |         |                       |         |
 Message    Byte                 Acknowledged  Request-Reply
 Sequence   Stream
```
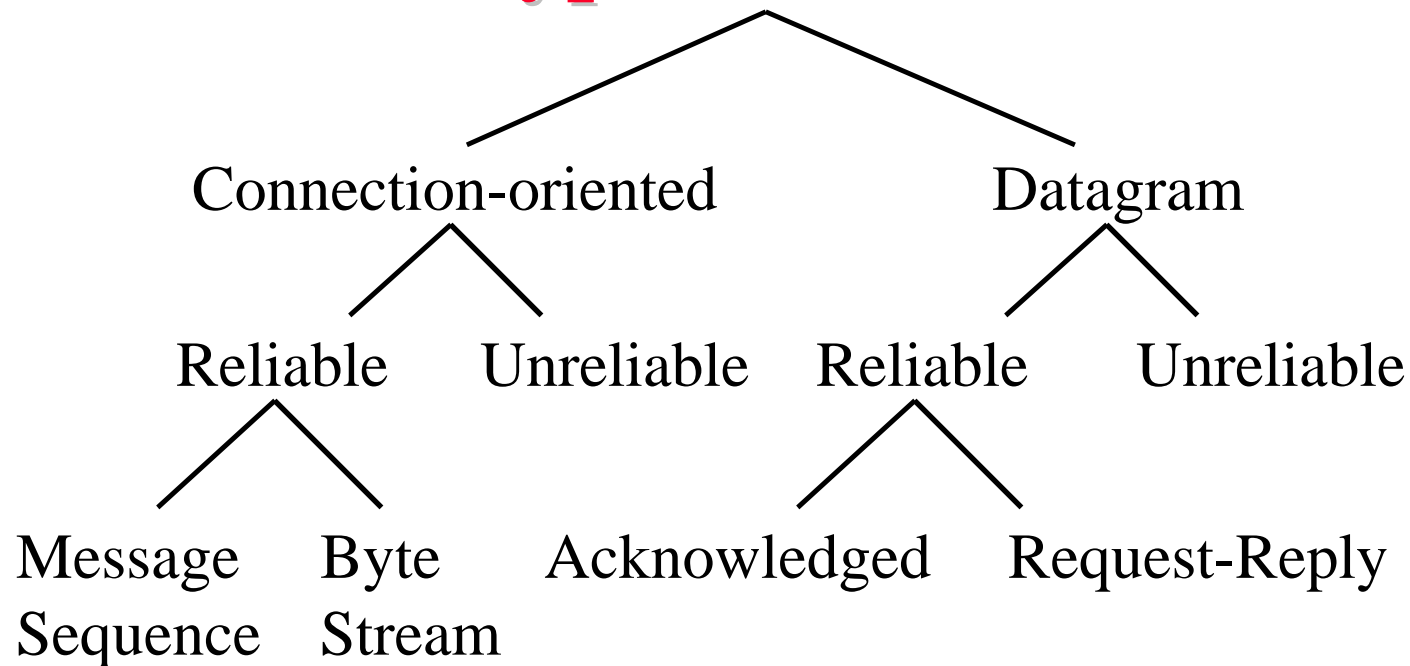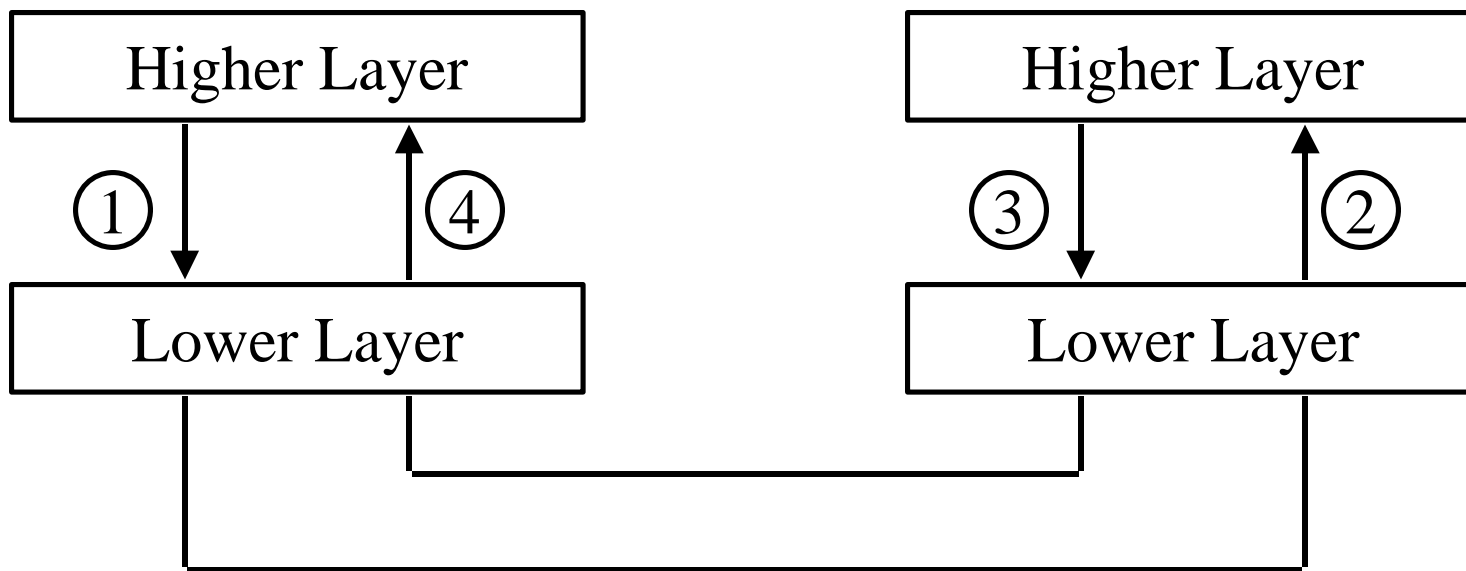
- ❏ Byte streams: user message boundaries are not preserved
- ❏ Request-reply: The reply serves as an acknowledgement also
- ❏ Message oriented or byte oriented approach can be used for unreliable connection-oriented communication

Service Primitives

❑ Indication = Interrupt

Higher Layer		Higher Layer
① ④		③ ②
Lower Layer		Lower Layer

1. Request   3. Response
2. Indication   4. Confirm

Unconfirmed service: No confirmation or response

TCP/IP Reference Model

❑ TCP = Transport Control Protocol

❑ IP = Internet Protocol (Routing)

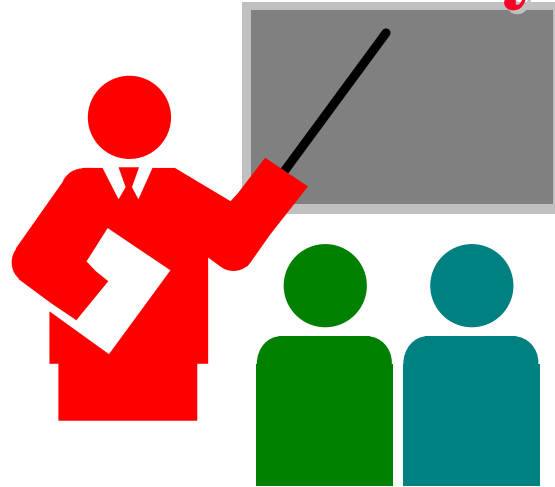| TCP/IP Ref Model	TCP/IP Protocols			OSI Ref Model
Application	FTP	Telnet	HTTP	Application
				Presentation
Transport	TCP		UDP	Session
				Transport
Internetwork	IP			Network
Host to Network	Ether net	Packet Radio	Point-to-Point	Datalink
				Physical

OSI vs TCP Reference Models

- ❏ OSI introduced concept of services, interface, protocols. These were force-fitted to TCP later
  $\Rightarrow$ It is not easy to replace protocols in TCP.

- ❏ In OSI, reference model was done before protocols. In TCP, protocols were done before the model

- ❏ OSI: Standardize first, build later
  TCP: Build first, standardize later

- ❏ OSI took too long to standardize. TCP/IP was already in wide use by the time.

- ❏ OSI become too complex.

- ❏ TCP/IP is not general. Ad hoc.

Layered Packet Format

❑ Nth layer control info is passed as N-1th layer data.

	FTP Header	FTP Data

	TCP Header	TCP Data

	IP Header	IP Data

Ethernet Header	Ethernet Data	Ethernet Trailer
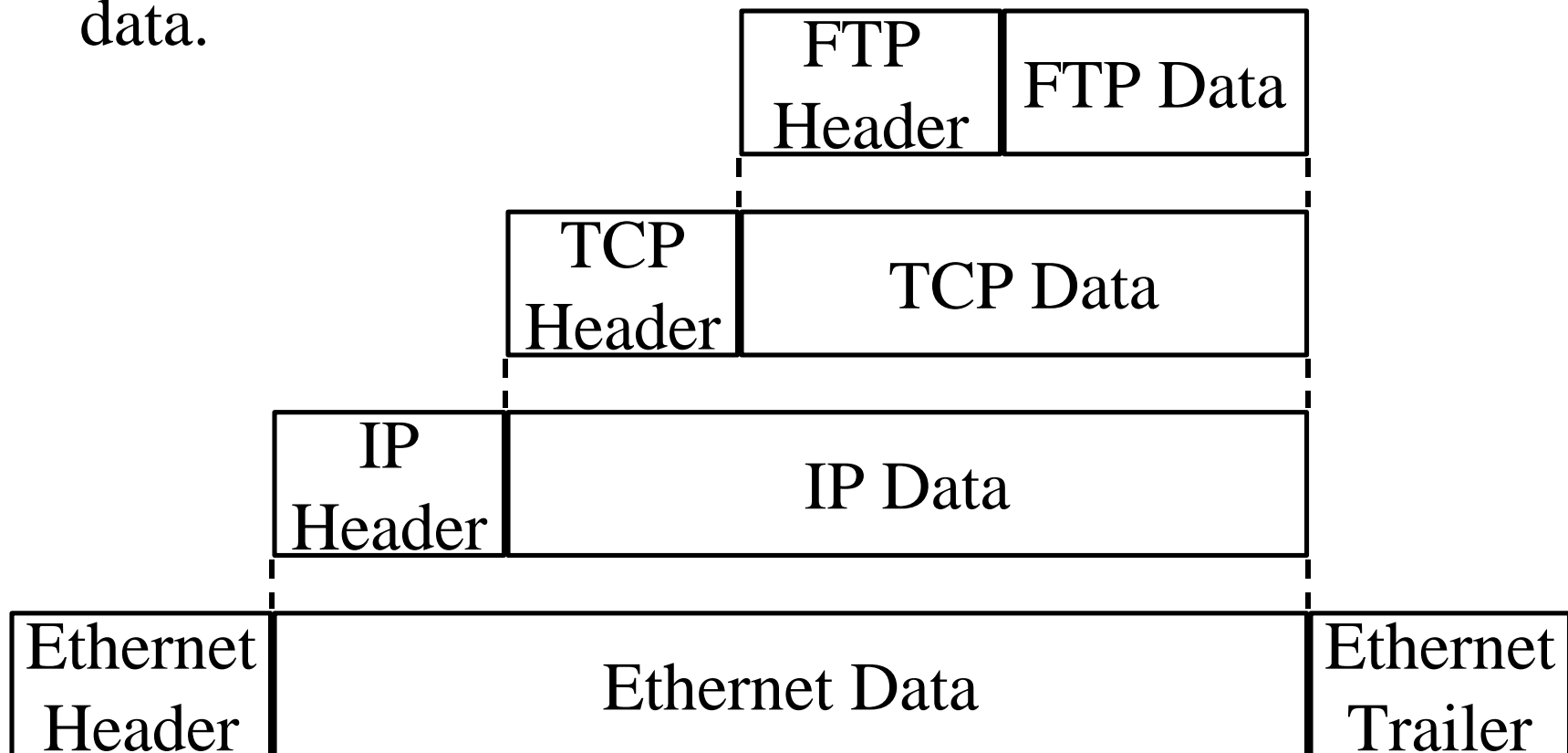
Summary

- ❑ Communication, Networks, and Distributed systems
- ❑ ISO/OSI's 7-layer reference model
- ❑ TCP/IP has a 4-layer model
- ❑ PDU, SAP, Request, Indication

Reading Assignment

❑ Read Sections 1.4, 1.5, Appendix 1A, 1B, Sections 2.2, and 2.3 of Stallings 6th Edition

  ❑ 1.4 Protocols and Protocol Architecture

  ❑ 1.5 Standards

  ❑ Appendix 1A: Standards organizations

  ❑ Appendix 1B: Internet Resources

  ❑ 2.2 OSI

  ❑ 2.3 TCP/IP

Homework

❑ Visit www.ietf.org and find the titles of RFC1 and RFC137

❑ Check newsgroup comp.protocols.tcp-ip and list any one of the current issues being discussed there

❑ Submit answers to Problems 2.4 and 2.7 of Stallings 6th Edition

   ❑ Problem 2.4: Communications between France and China

   ❑ Problem 2.7: Segmentation and Blocking