Chapter 1: Introduction

Raj Jain
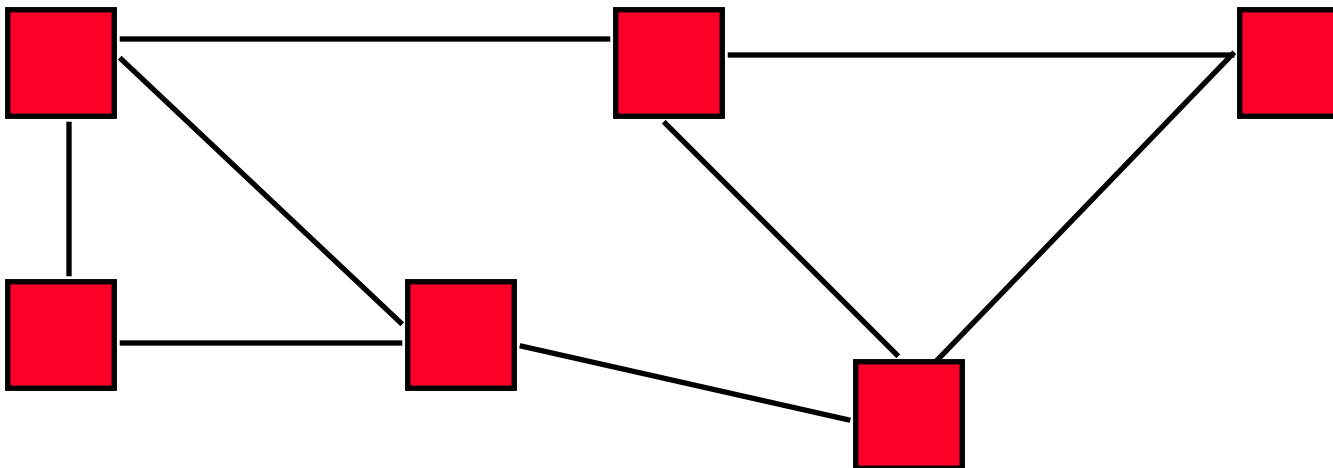
Raj Jain is now at
Washington University in Saint Louis
Jain@cse.wustl.edu
http://www.cse.wustl.edu/~jain/

Data Communication vs Networking

❑ Communication: Two Nodes. Mostly EE issues.
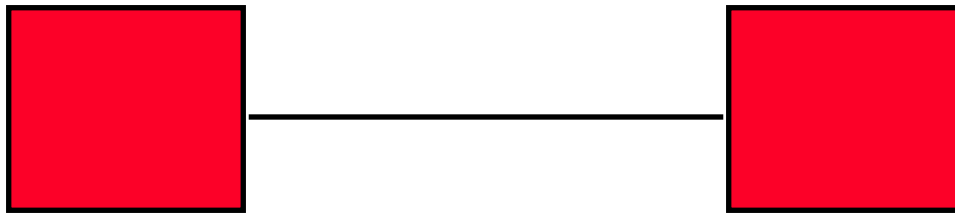
❑ Networking: Two or more nodes. More issues, e.g., routing

# 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
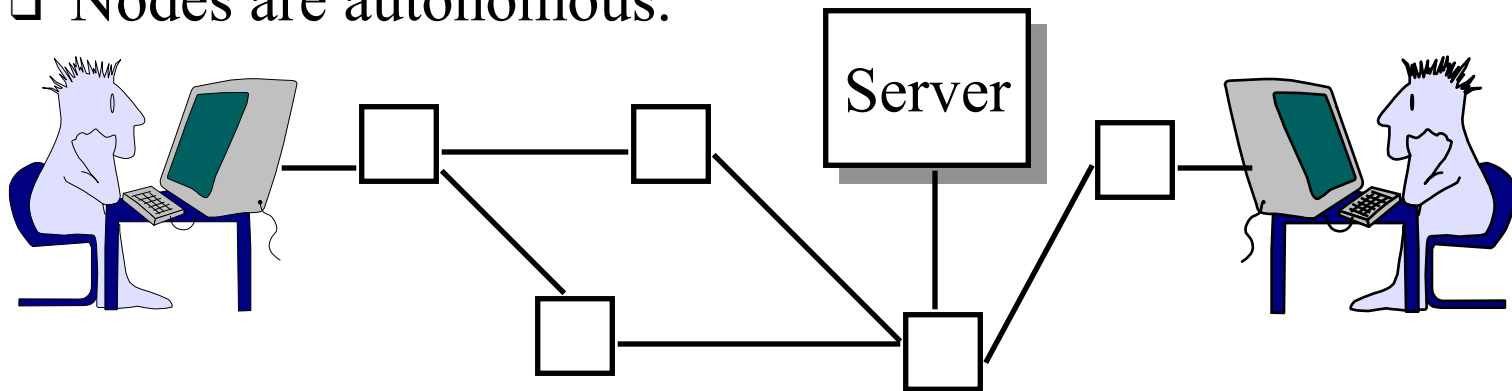
Types of Networks

❑ Point to point vs Broadcast

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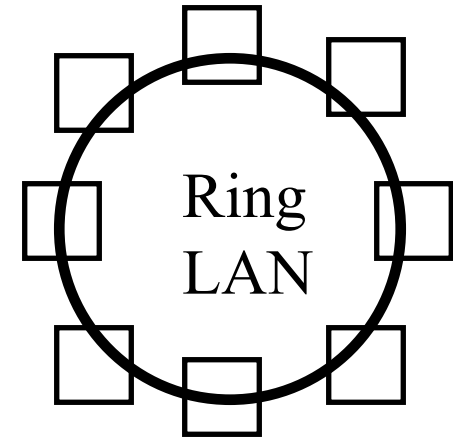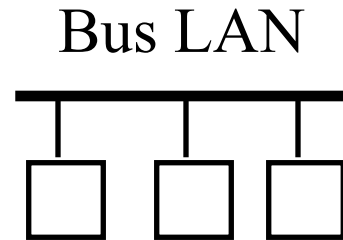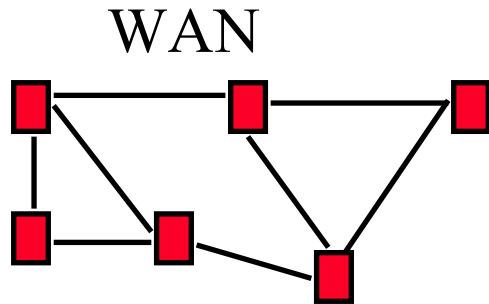
❑ Circuit switched vs packet switched
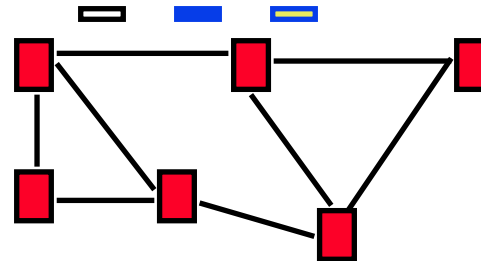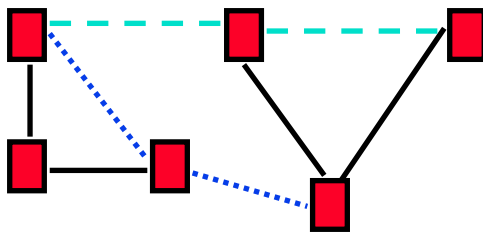
❑ Local Area Networks (LAN) 0-2 km, Metropolitan Area Networks (MAN) 2-50 km, Wide Area Networks (WAN) 50+ km

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
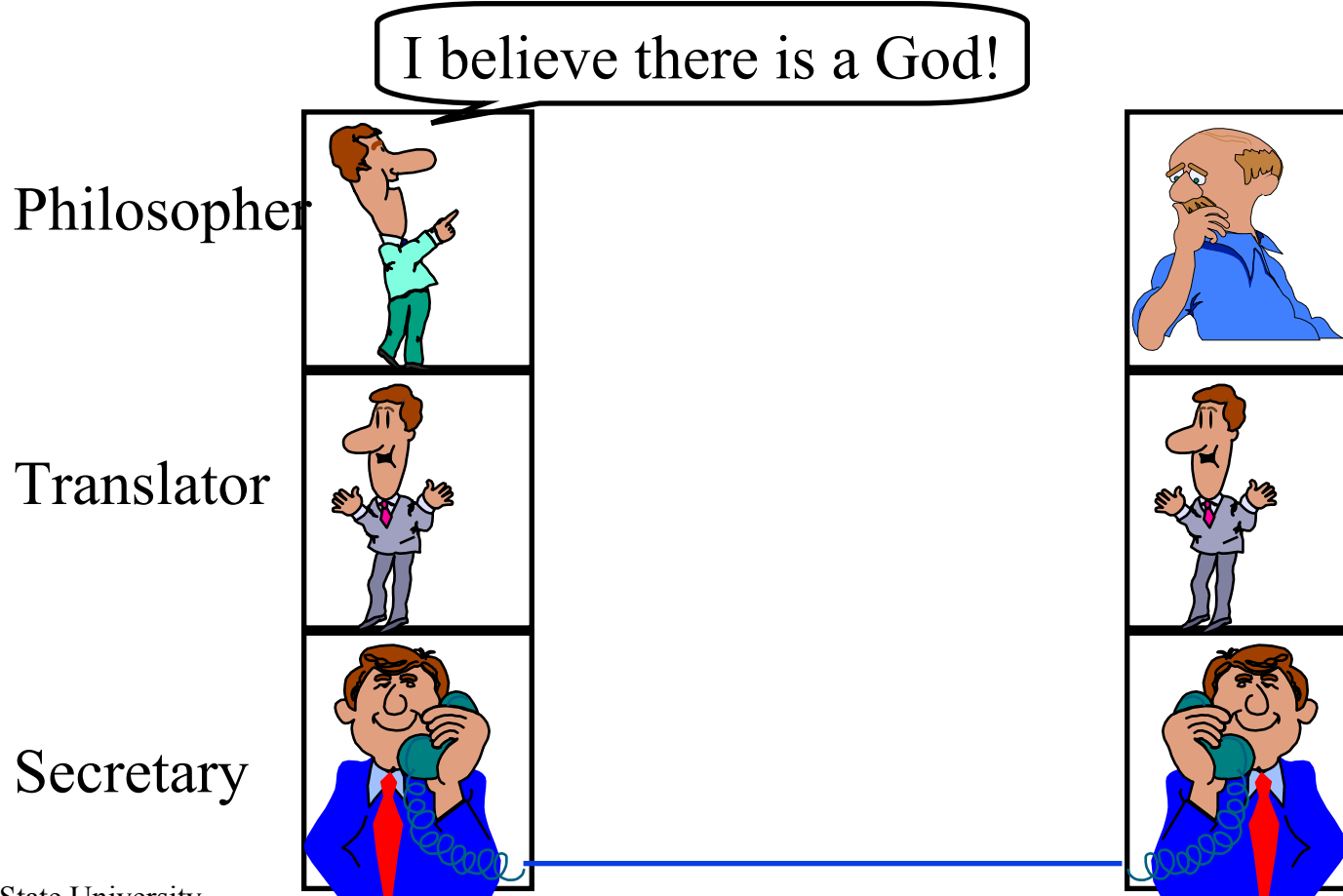
Design Issues for Layers

❑ Duplexity:

    ❑ Simplex: Transmit or receive
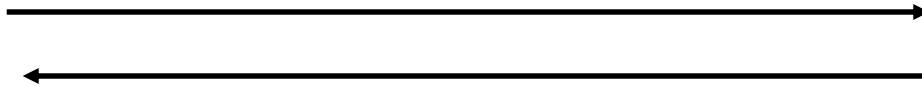
    ❑ Full Duplex: Transmit and receive simultaneously

    ❑ Half-Duplex: Transmit and receive alternately

❑ Error Control: Error detection and recovery

❑ Flow Control: Fast sender

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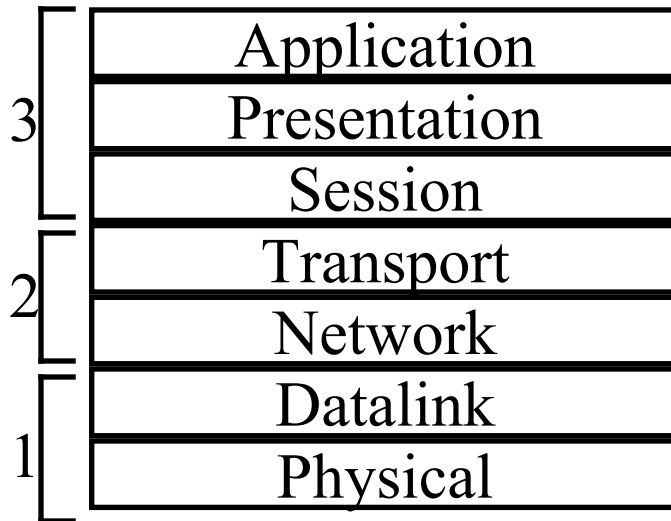
3	Application	File transfer, Email, Remote Login
	Presentation	ASCII Text, Sound
	Session	Establish/manage connection
2	Transport	End-to-end communication: TCP
	Network	Routing, Addressing: IP
1	Datalink	Two party communication: Ethernet
	Physical	How to transmit signal: Coding
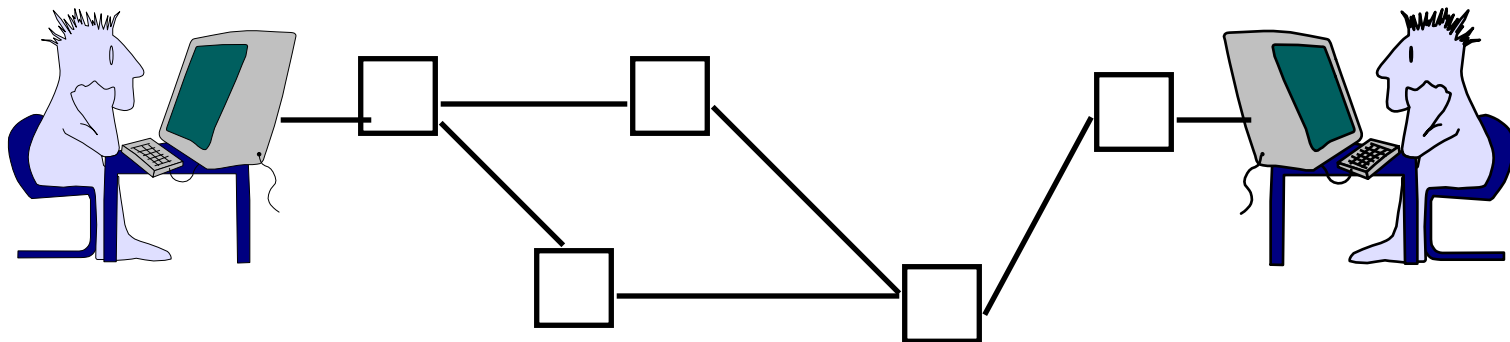
Layering

FTP	Telnet	Web	Email
TCP		UDP	
IP		IPX	
Ethernet		Token Ring	
Copper		Fiber	

← Same Interfaces

❑ Protocols of each layer have to perform a set of functions

❑ All alternatives for a row have the same interfaces

❑ Choice of protocols at each layer is independent of those of at other layers. E.g., IP works over Ethernet or token ring
   UDP = User Data Protocol, TCP=Transport Control Protocol

❑ Need one component of each layer $\Rightarrow$ Null components

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

Interfaces and Services
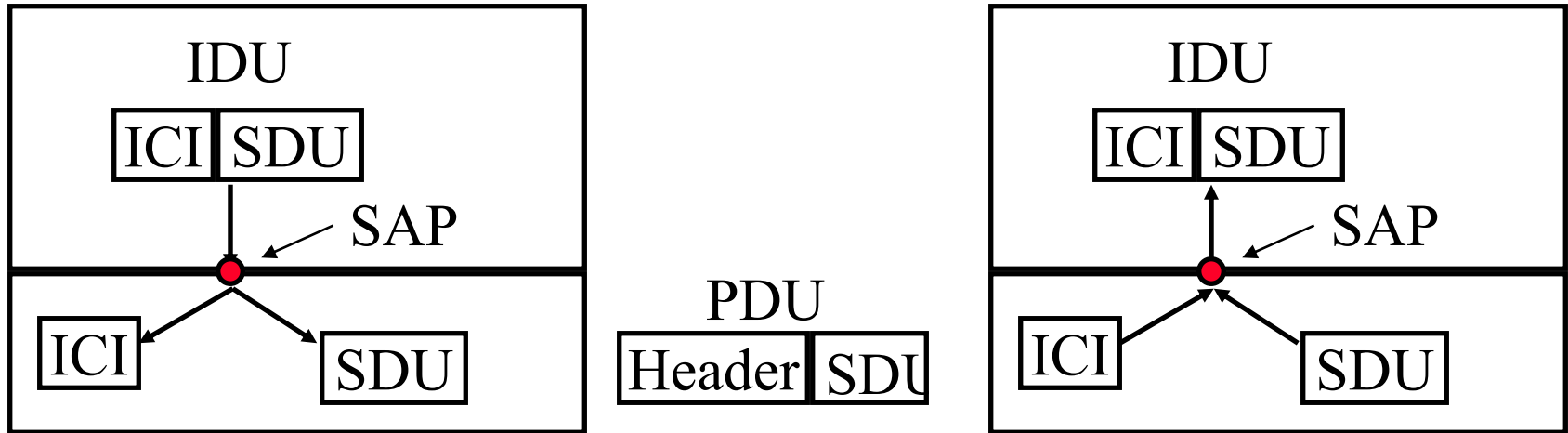
❑ IDU = Interface Data Unit = ICI + SDU

❑ 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     │
        └─────────────────┘
```
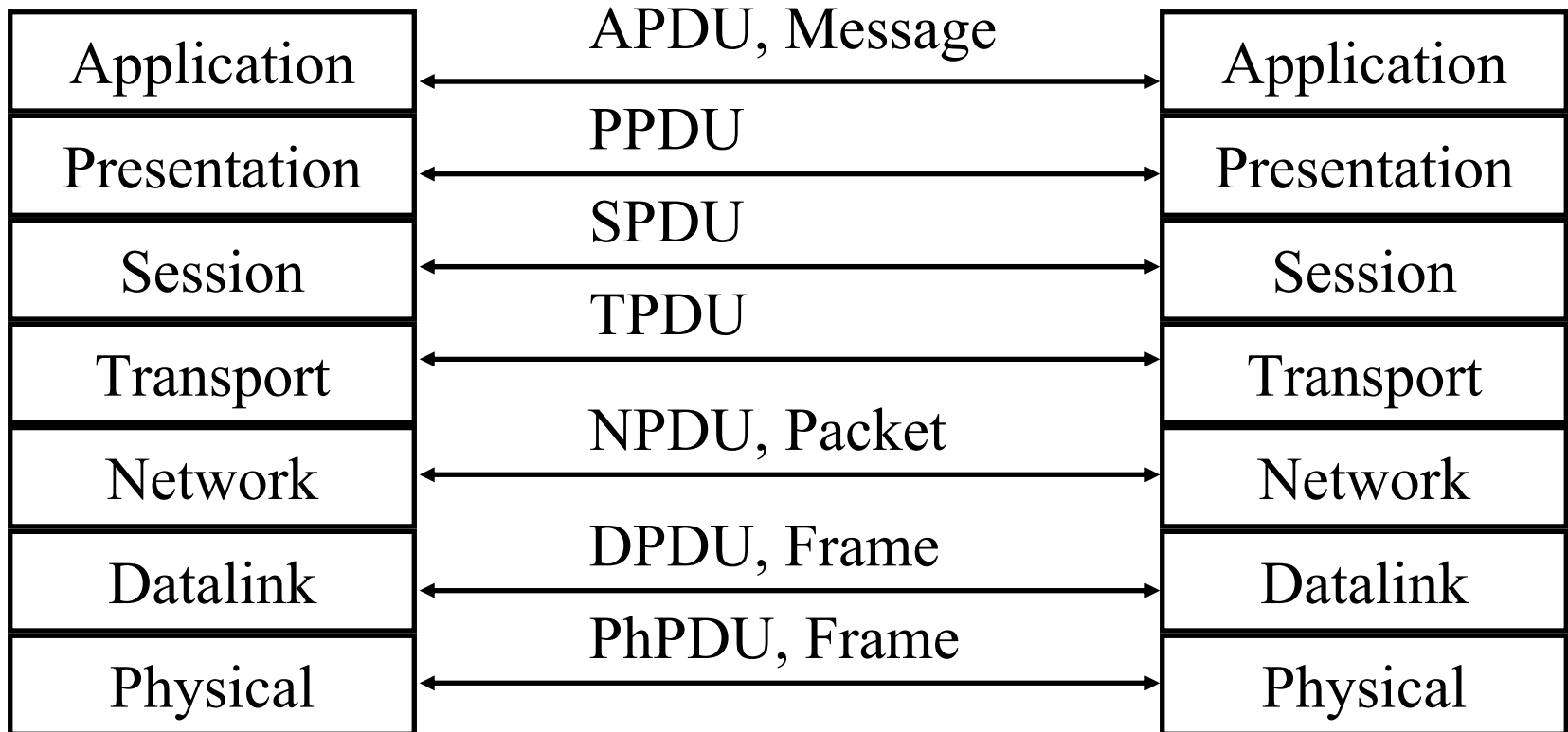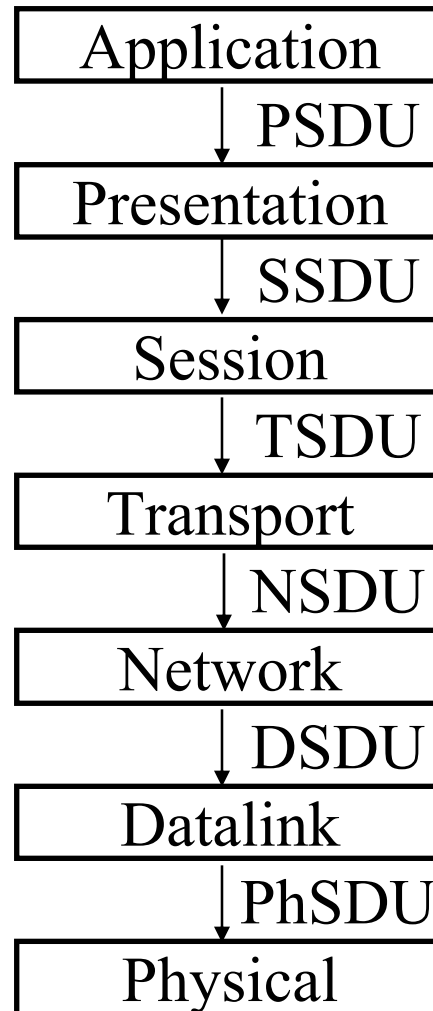
Connection-Oriented vs Connectionless
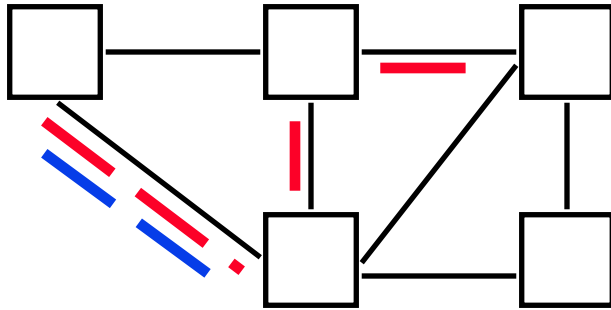
❑ Connection-Oriented: Telephone System

    ❑ Path setup before data is sent

    ❑ Data need not have address. Circuit number is sufficient.

    ❑ Virtual circuits: Multiple circuits on one wire.

❑ Connectionless: Postal System. Also known as datagram.

    ❑ Complete address on each packet

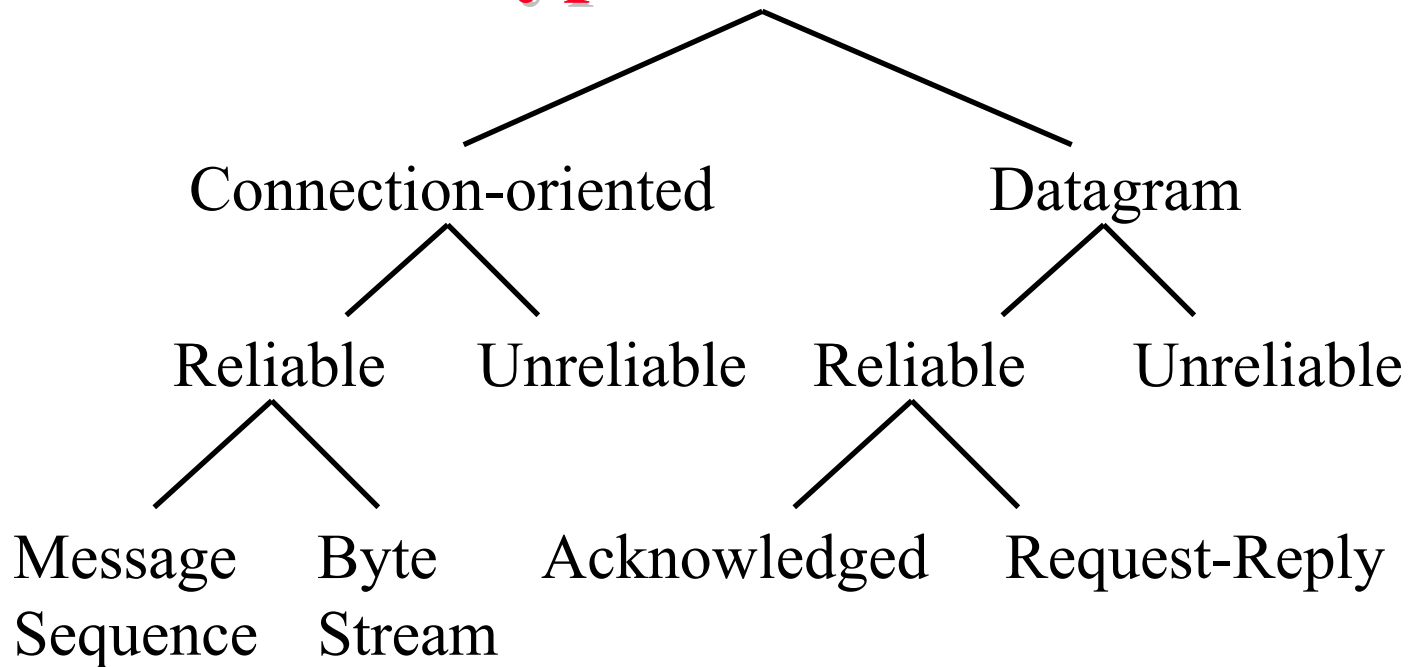   ❑ The address decides the next hop at each routing point

Types of Services

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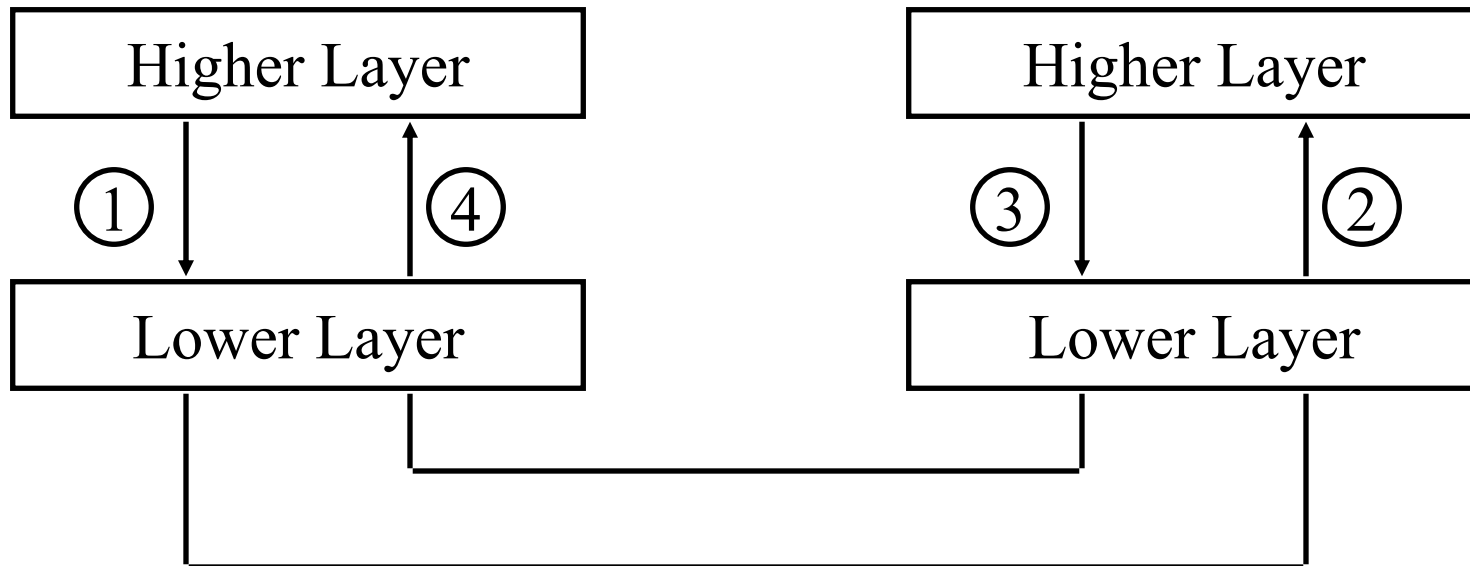
❑ Byte streams: user message boundaries are not preserved
❑ Request-reply: The reply serves as an acknowledgement also
❑ Message oriented or byte oriented approach can be used for unreliable connection-oriented communication

Service Primitives

❑ Indication = Interrupt

```
┌─────────────────────┐        ┌─────────────────────┐
│    Higher Layer     │        │    Higher Layer     │
└─────────────────────┘        └─────────────────────┘
      │        ↑                      │        ↑
     ①        ④                      ③        ②
      ↓        │                      ↓        │
┌─────────────────────┐        ┌─────────────────────┐
│    Lower Layer      │        │    Lower Layer      │
└─────────────────────┘        └─────────────────────┘
```

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

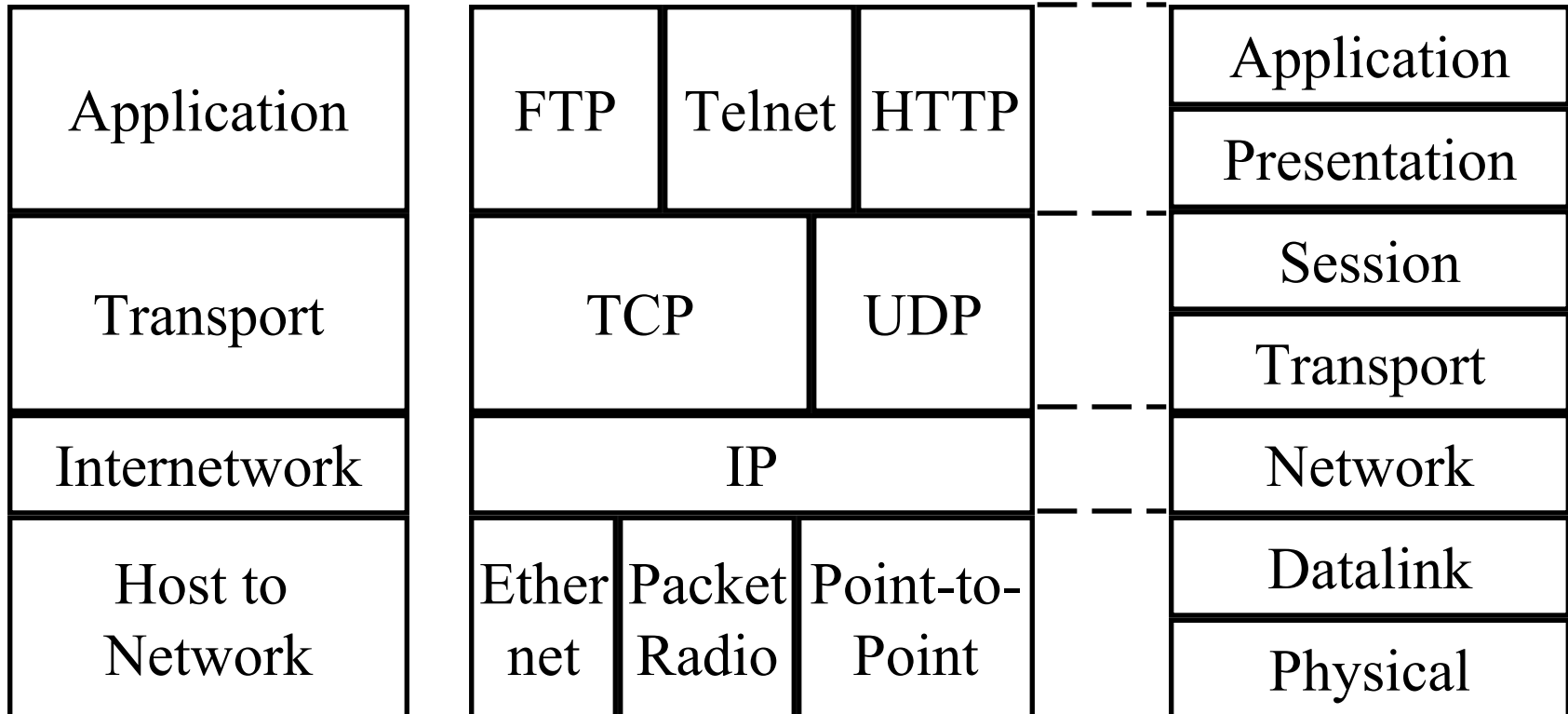Unconfirmed service: No confirmation or response

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.

Summary
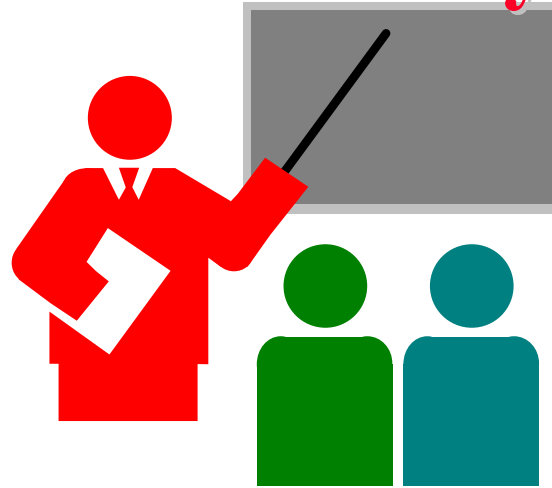
- Networking is growing exponentially

- 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 Chapter 1 of Tanenbaum, particularly, Sections 1.2-1.4

❑ Homework: Problems 9, 17