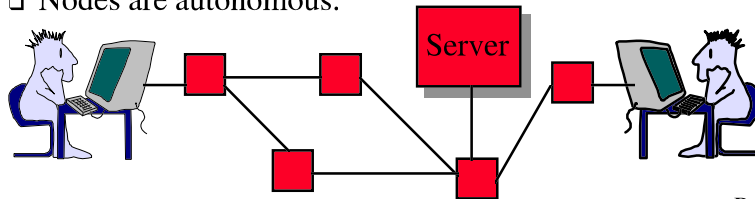


Distributed Systems vs Networks

- Distributed Systems:
 - Users are unaware of underlying structure.
E.g., trn instead of \\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.



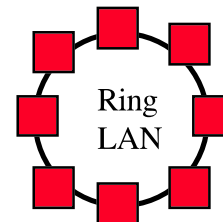
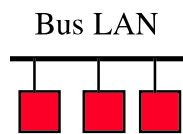
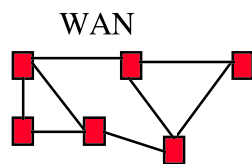
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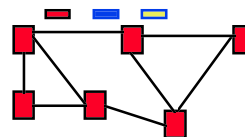
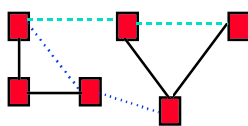
1B-3

Types of Networks

- Point to point vs Broadcast



- 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

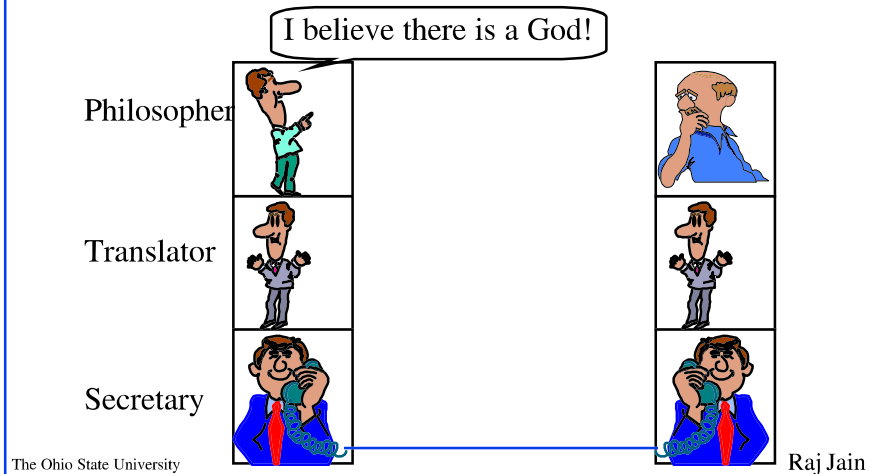
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1B-4

Protocol Layers

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



1B-5

Design Issues for Layers

- Duplexity:
 - Simplex: Transmit or receive
-
- The diagram shows two horizontal arrows. The top arrow points to the right, and the bottom arrow points to the left. This represents simplex communication where data flows in one direction.
- Full Duplex: Transmit and receive simultaneously
 - Half-Duplex: Transmit and receive alternately
 - Error Control: Error detection and retransmission
 - Flow Control: Fast sender

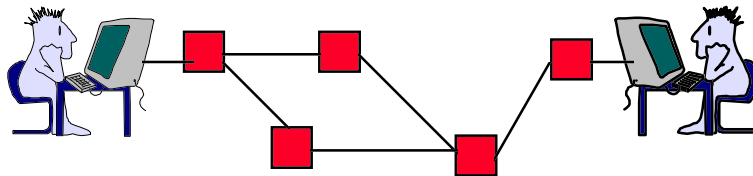
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1B-6

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

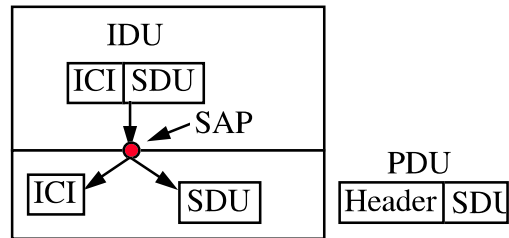


Layering

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

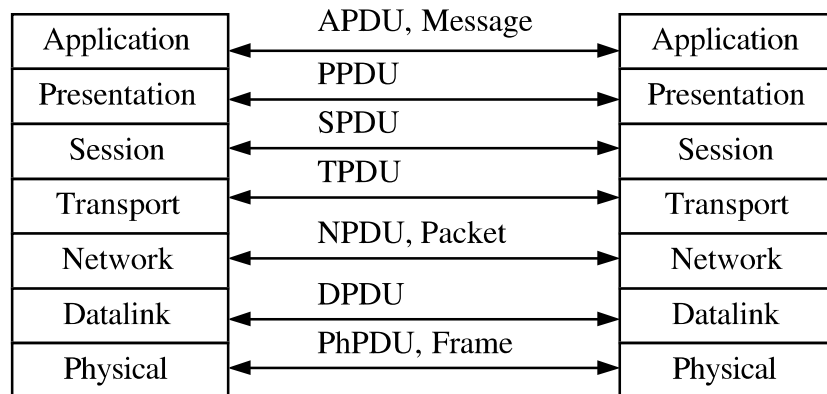
- Protocols of each layer have to perform a set of functions
- All alternatives for a row have the same interfaces
- Choice of protocols at each layer is independent of those of at other layers. E.g., TCP works over IP or IPX (Novell's IP)
UDP = User Data Protocol
- Need one component of each layer ⇒ Null components
- Nth layer control info is passed as N-1th layer data.

Interfaces and Services

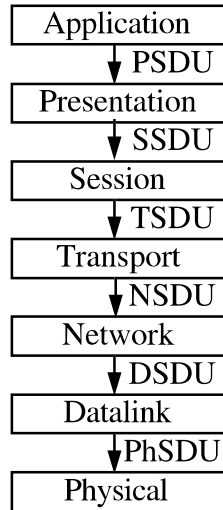


- ❑ IDU = Interface Data Unit = ICI + SDU
- ❑ ICI = Interface Control Information
- ❑ SDU = Service Data Unit
- ❑ PDU = Protocol Data Unit = Fragments of SDU + Header or Several SDUs + Header (blocking)

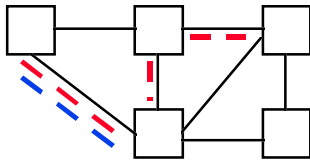
Protocol Data Unit (PDU)



Service Data Unit (SDU)

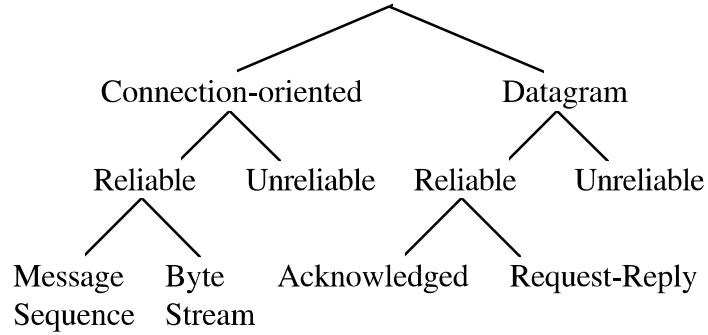


Connection-Oriented vs Connectionless



- ❑ 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

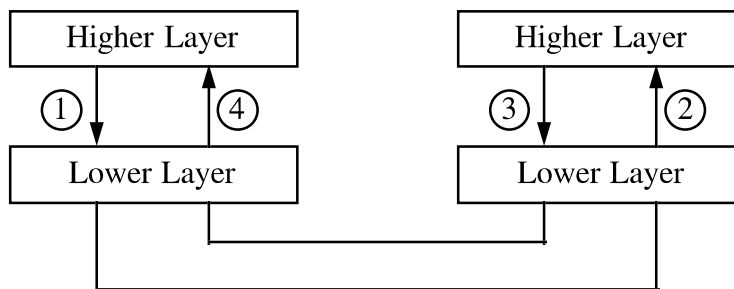
Types of Services



- Byte streams: user message boundaries are not preserved
- Request-reply: The reply serves as an acknowledgement also

Service Primitives

- Indication = Interrupt

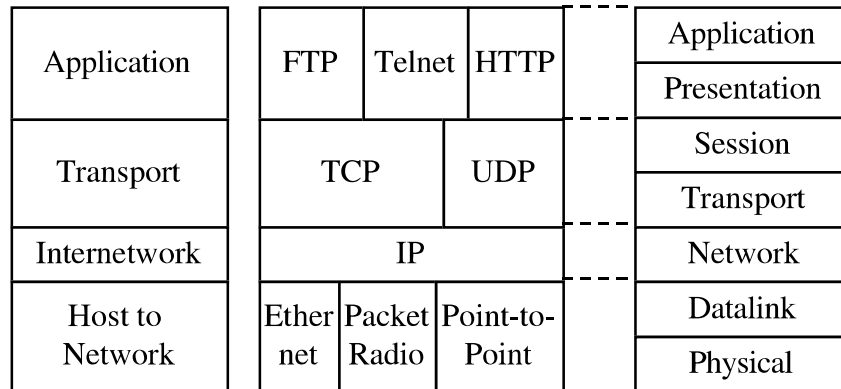


- | | |
|-----------------------|---------------------|
| 1. Connect.Request | 3. Connect.Confirm |
| 2. Connect.Indication | 4. Connect.Response |

Unconfirmed service: No confirmation or response

TCP/IP Reference Model

- ❑ TCP = Transport Control Protocol
- ❑ IP = Internet Protocol (Routing)



OSI vs TCP Reference Models

- ❑ OSI introduced concept of services, interface, protocols
These were force-fitted to TCP later
⇒ 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.