

2024
2023

INTRODUCING DATA COMMUNICATIONS

A tour of advanced networking concepts

Instructor



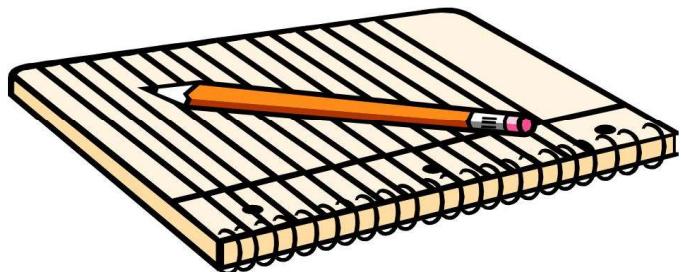
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Objectives

- Upon Completion of this chapter, you will be able to :
- Understanding architecture of network
- Know basic conception of LAN and WAN
- Grasp ISO OSI reference model

Course Contents

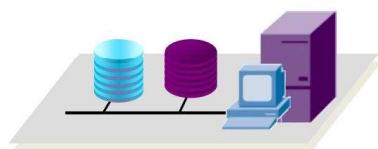
- Network Overview
- OSI Reference Model



Computer Network



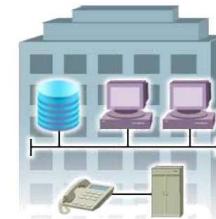
HQ.



Server



IP Hotel

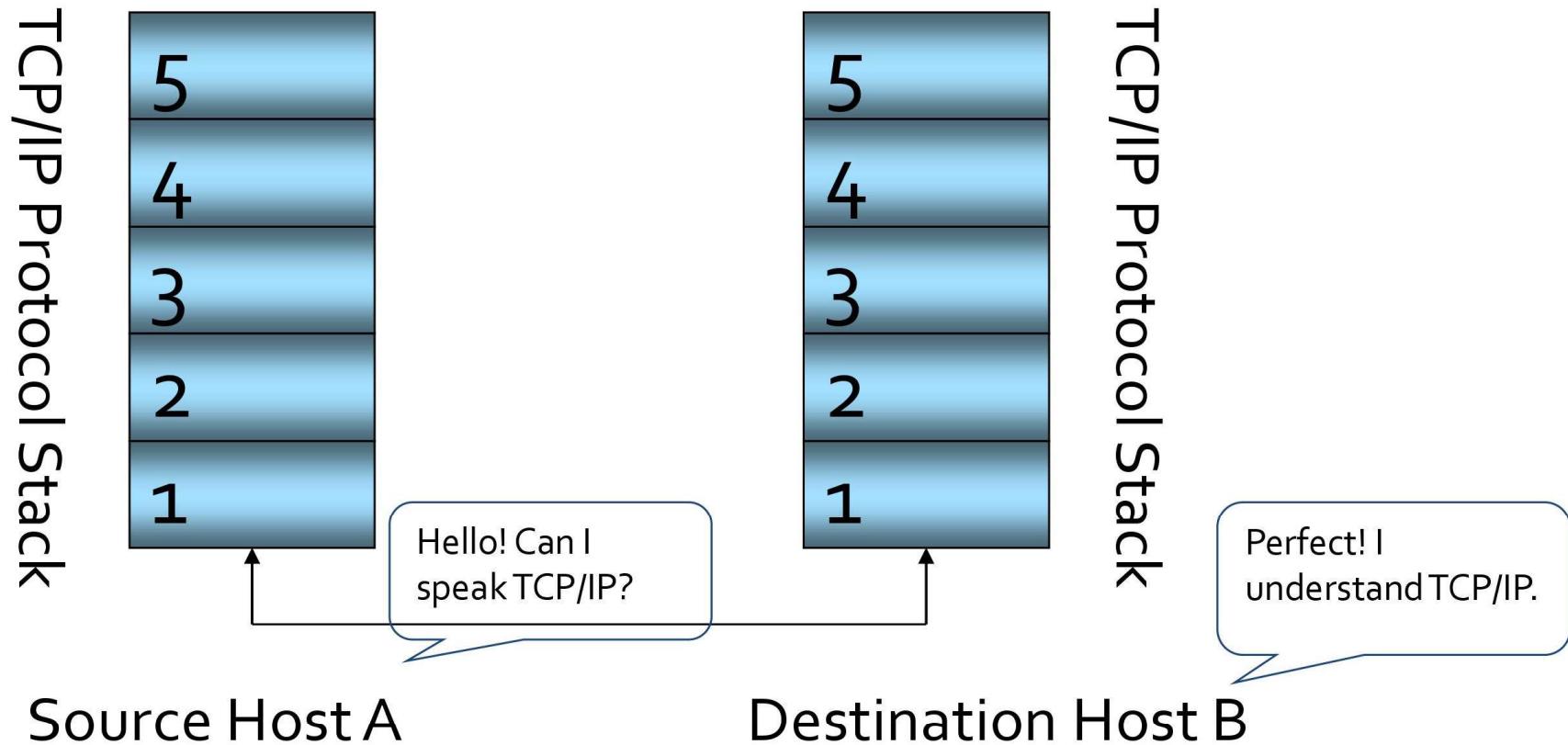


Intranet



Wireless

Network Protocols



- Network protocols are formal descriptions of equipment communication rules.

LAN Definition

- **Definition of LAN:**
 - ➔ It usually refers to the collection of the computer, printer, modem or other equipment that can be interconnected through some medium within several kilometers.
- **Characteristics:**
 - ➔ Short distance, low delay, high bandwidth and reliable transmission.
- **Standard:**
 - ➔ It describes the regulation of the protocol and sets the simplest performance collection.

Common Equipment of LAN

- Design Objective of LAN:
 - ➔ Run in a limited geographical area
 - ➔ To connect PCs or workstations in local area
 - ➔ High bandwidth and low delay
 - ➔ Provide local service



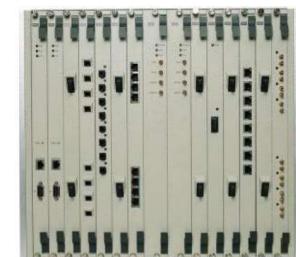
HUB



Switch



Router



ATM Switch

WAN (Wide Area Network)

- WAN:
 - Provide data communication service in a wide area.
- Classification of WAN:
 - PSTN: Public Switched Telephone Network
 - ISDN: Integrated Services Digital Network
 - DDN: Digital Data Network
 - X.25: Public Packet Switched Network
 - Frame Relay
 - ATM: Asynchronous Transfer Mode

WAN Switching Mode

- **Circuit switch:** circuit switch based on the telephone network
 - ➔ **Advantage:** low delay and transparent transmission
 - ➔ **Disadvantage:** low ratio of network resources utilization
- **Packet switch:** store and forward with packet as the unit
 - ➔ **Advantage:** multiplex
 - ➔ **Disadvantage:** Low real-time performance

Bandwidth and Delay

- **Definition of bandwidth:** describes the information volume of the network data transmitted from one node to any other
 - ➔ node at a fixed time.
 - ➔ Bandwidth of the Ethernet: 10M, 100M and 1000M etc.;
 - ➔ Various types of service bandwidth of WAN
 - ➔ Delay: time of inter-node data transmission

Standardization Organization

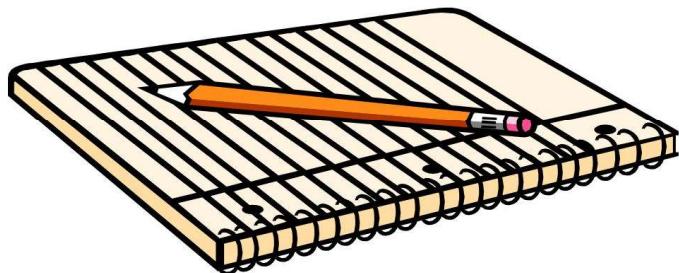
- International Organization for Standardization (ISO)
 - Institute of Electrical & Electronic Engineers (IEEE)
 - America National Standard Institute (ANSI)
 - Electronic Industries Association/Telecom Industries Association (EIA/TIA)
 - International Telecom Union (ITU)
 - INTERNET Action Board (IAB)



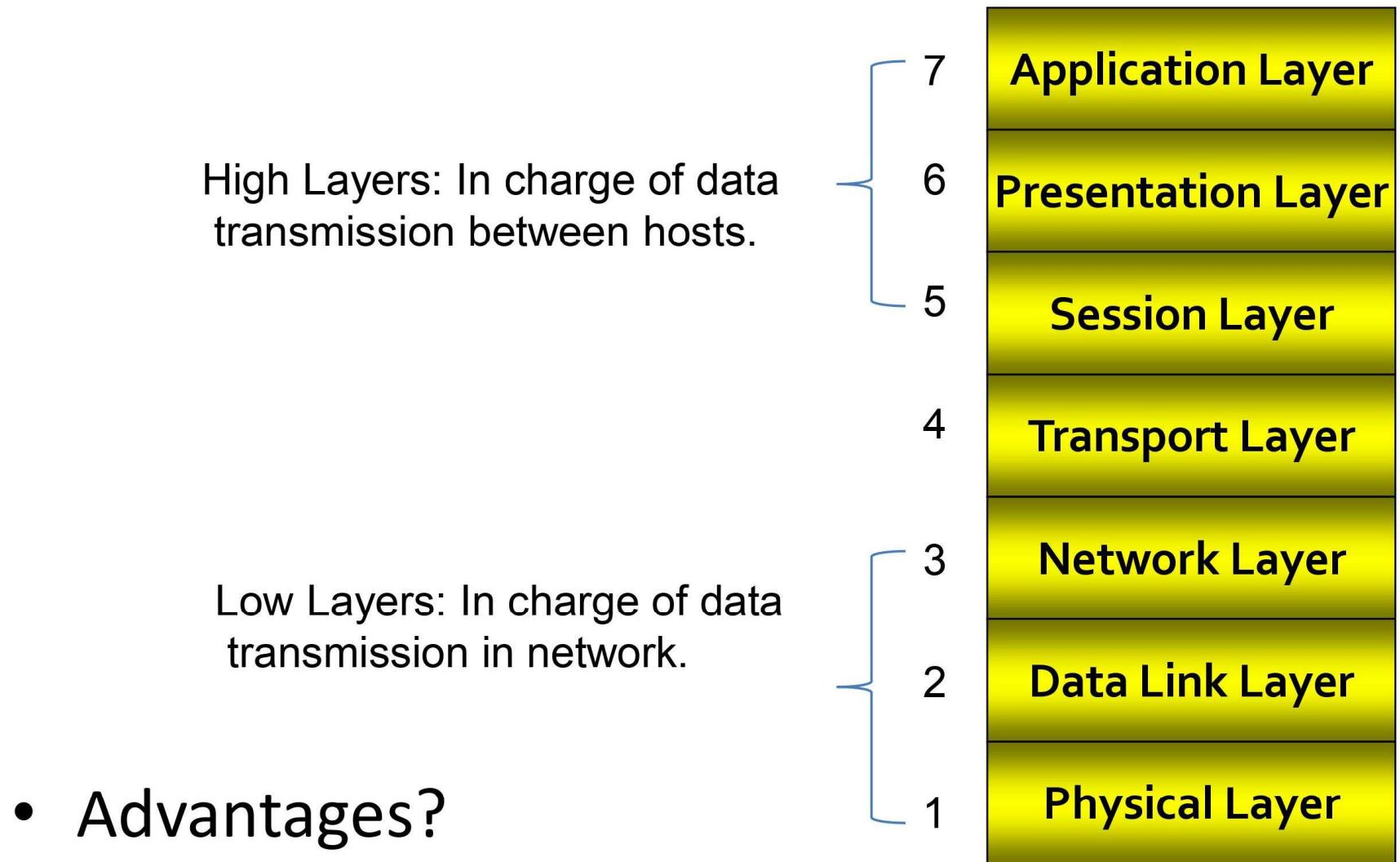
Course Contents

● Network Overview

● OSI Reference Model

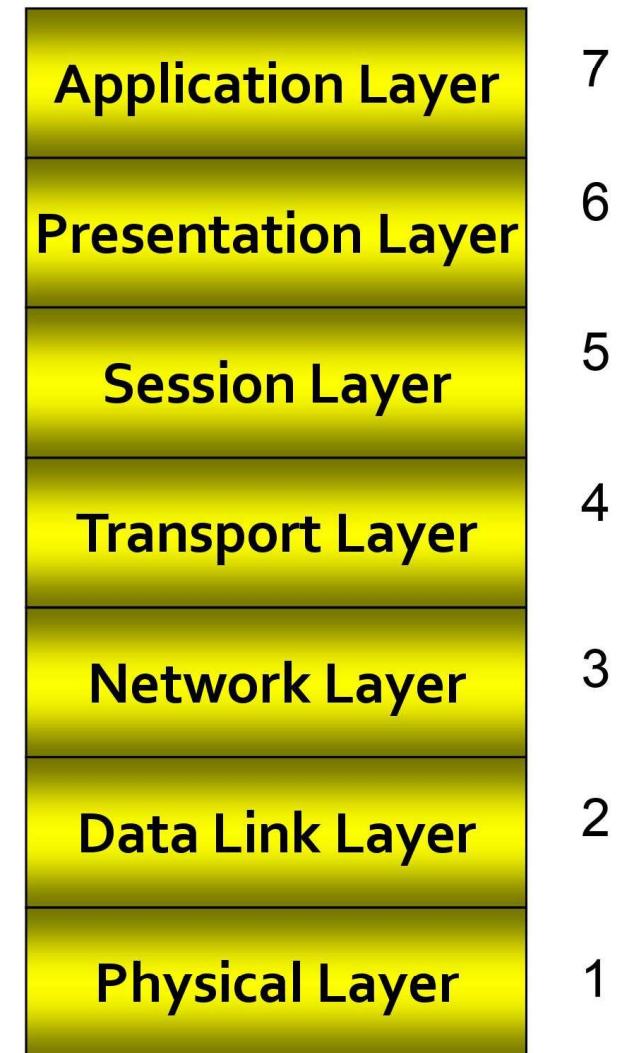


OSI Reference Model

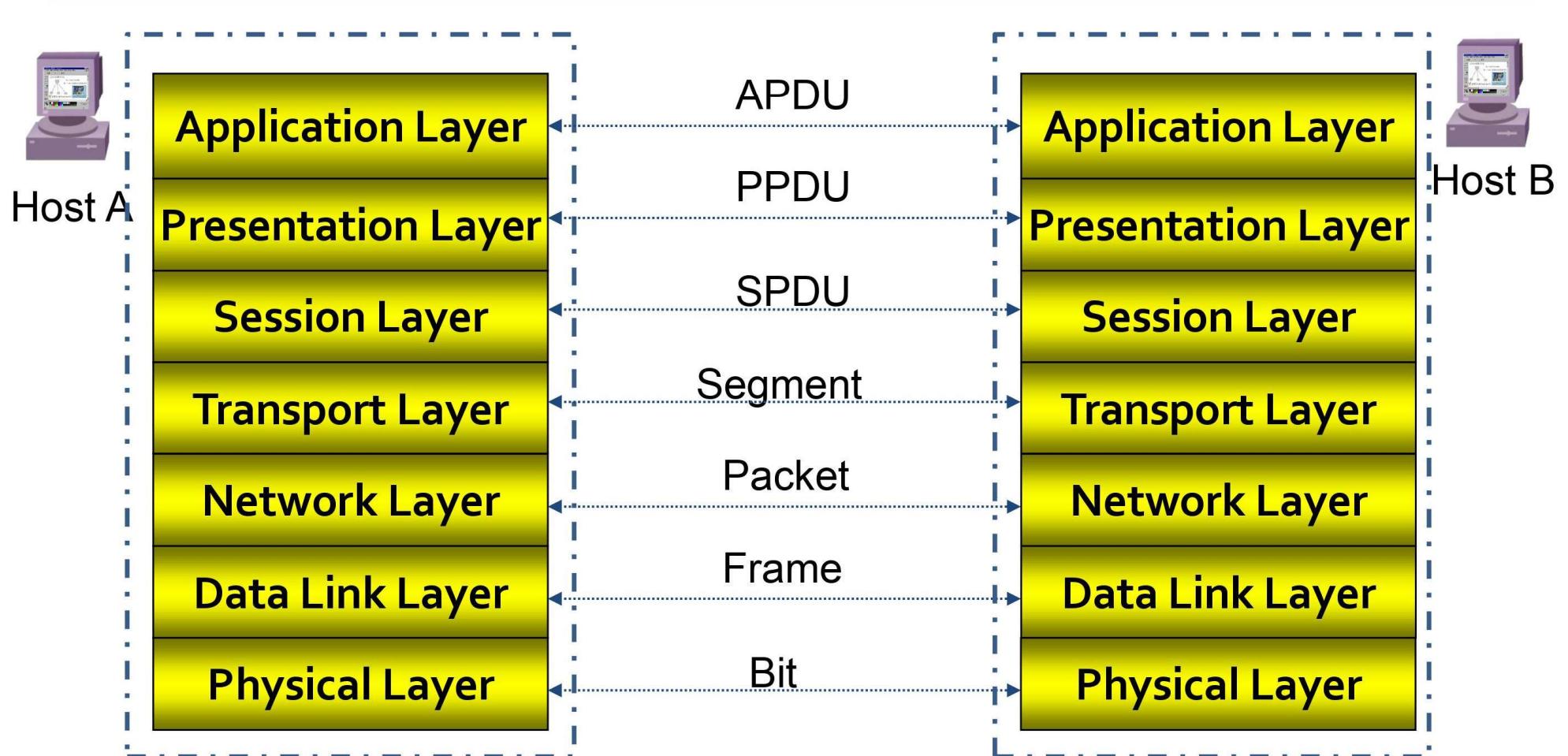


Function of the 7 Layers

- Provide communications between applications.
- Deal with data format problems.
- Establish, maintain and manage sessions.
- Establish, maintain and manage end to end connection.
- Addressing and routing.
- Provide link medium access and link management.
- Bit flow transmission.

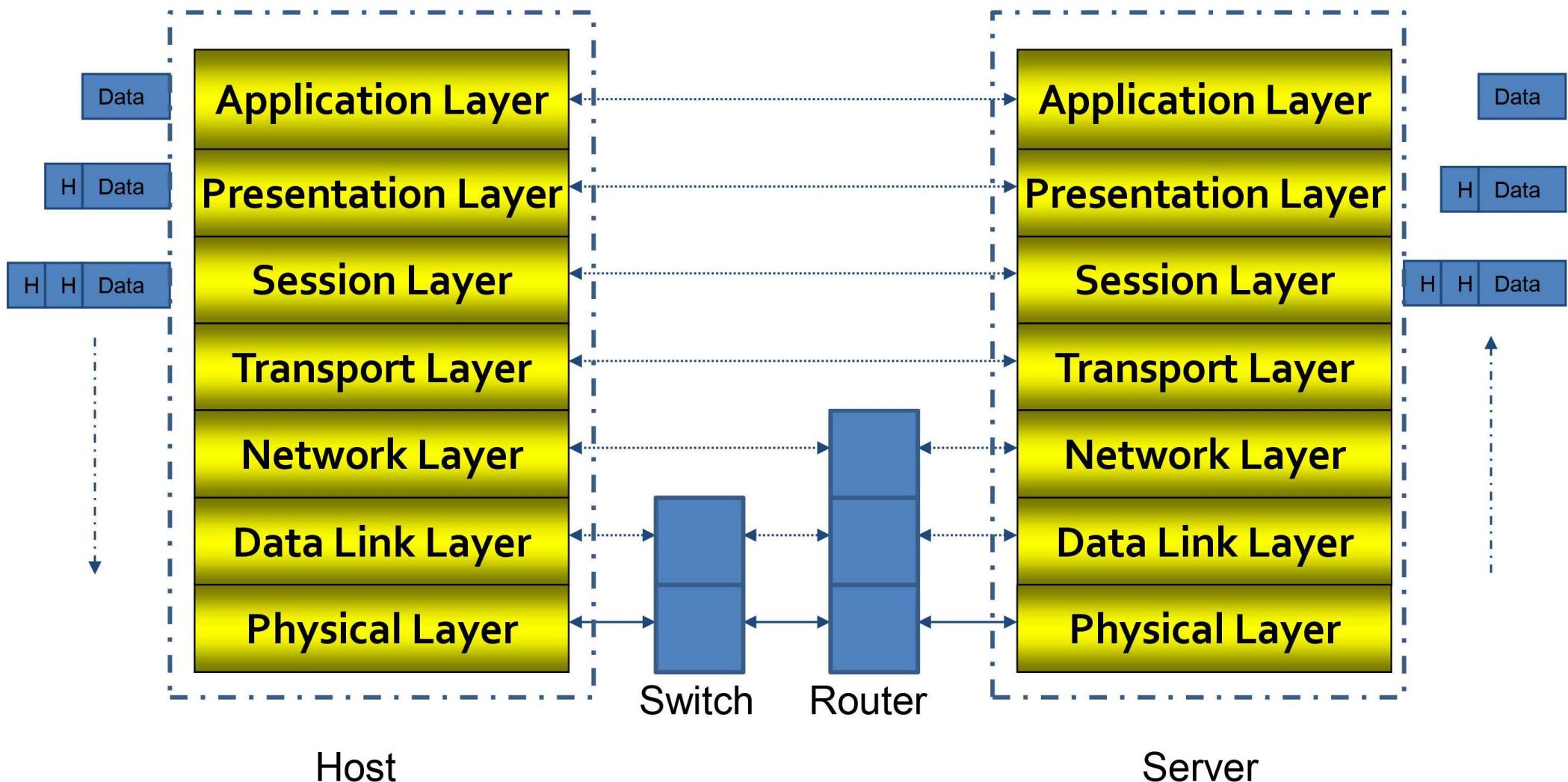


Peer Communication



- Every layer communicates with its peer through the services provided by the lower layer.

Data Encapsulation



- Data encapsulation and de-capsulation process.

Physical Layer

- **Physical layer:** defines the voltage, interface,
→cable standard and transmission distance etc.
- **Physical layer cable:**
 - Twisted pair : UTP , STP
 - Coaxial cable: thin, thick
 - Fiber
 - Wireless radio: WLAN

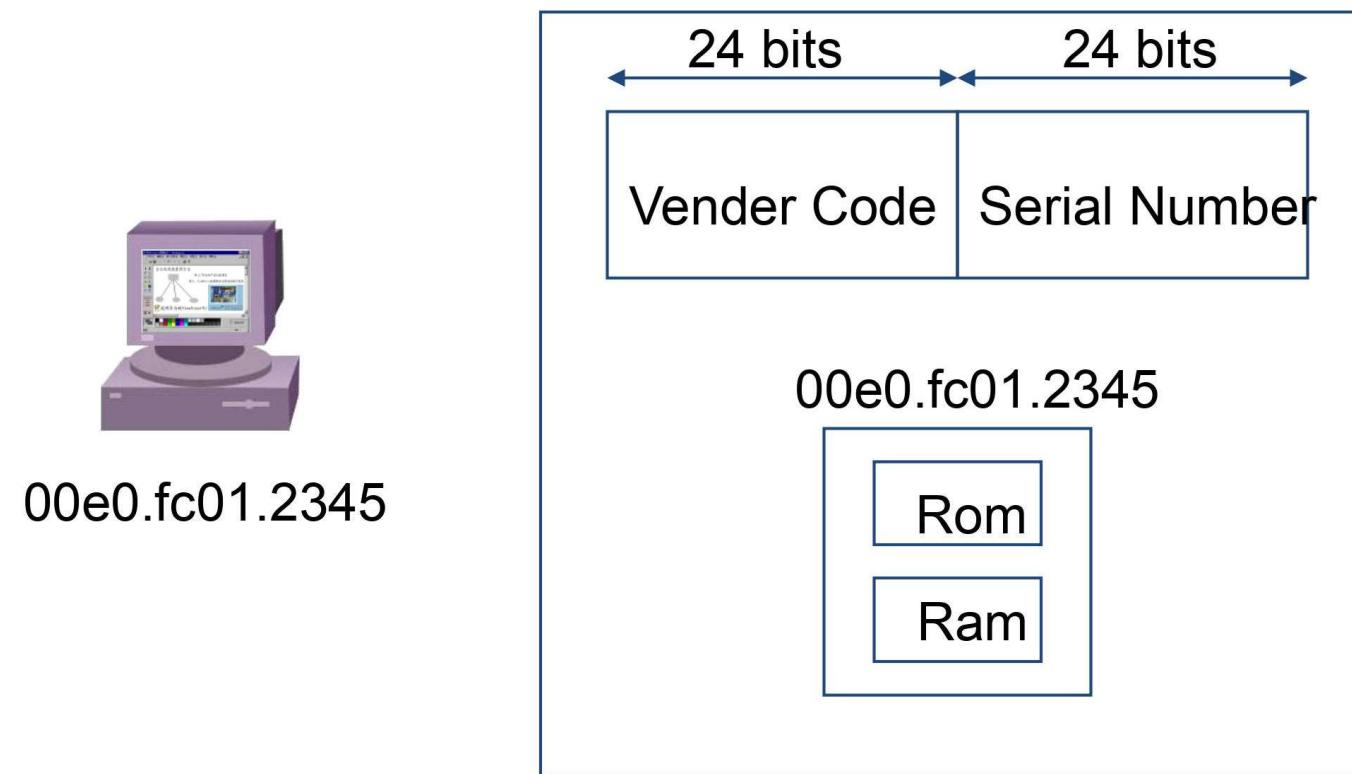
Physical Layer

- LAN and Physical Layer
 - Cable standard: 10Base-T, 100Base-T and 1000Base-SX etc.;
 - Network equipment: repeater and hub etc.
- WAN and Physical Layer
 - DTE equipment: router and terminal host etc.;
 - DCE equipment: WAN switch and Modem etc.;
 - Common interface: RS-232, V.24 and V.35 etc.

Data Link Layer

- Data Link Layer divided into two sub-layer:
 - ➔ The LLC sub-layer
 - ➔ The MAC sub-layer
- The Function of Data Link Layer:
 - ➔ Physical address definition
 - ➔ Network topology
 - ➔ Link parameter
 - ➔ Error verification
 - ➔ Physical media access
 - ➔ Flow control (optional)

MAC/Physical Address



- MAC address is composed of 48 bits.

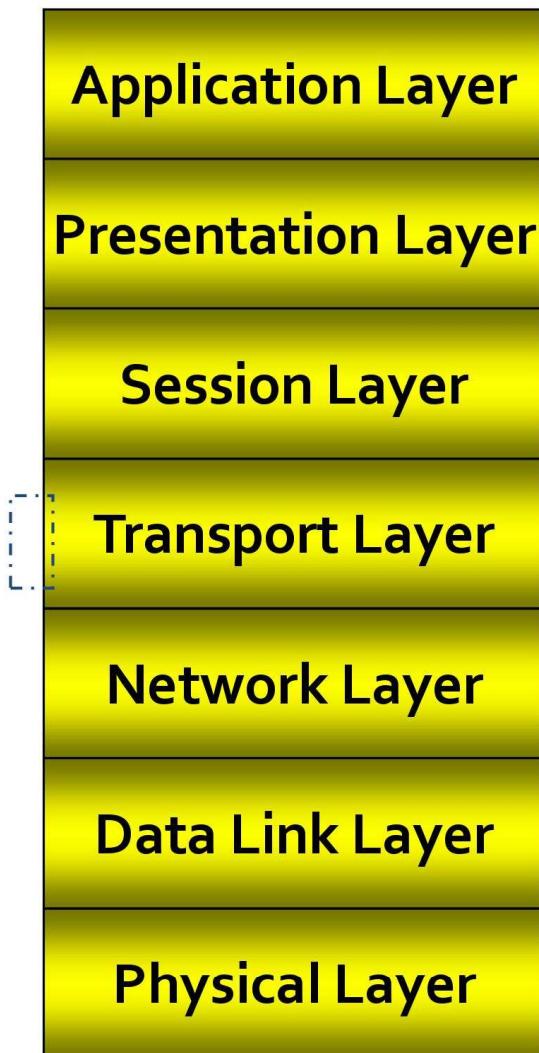
LAN and Data Link Layer

- IEEE802 Standard: the most popular LAN standard nowadays
 - IEEE802.1 Common LAN Conceptions
 - IEEE802.2 Definition of LLC Sub-Layer
 - IEEE802.3 Ethernet Standard
 - IEEE802.4 Token Bus Network
 - IEEE802.5 Token Ring Network
- Ethernet switch

WAN and Data Link Layer

- WAN data link layer standard:
 - ➔ HDLC
 - ➔ PPP
 - ➔ ISDN
 - ➔ Frame Relay
- WAN data link layer equipment
 - ➔ Modem and ISDN terminal adaptor
 - ➔ CSU/DSU and WAN switch

Network Layer



⇒ Addressing and Routing

Network Addresses

IP Address

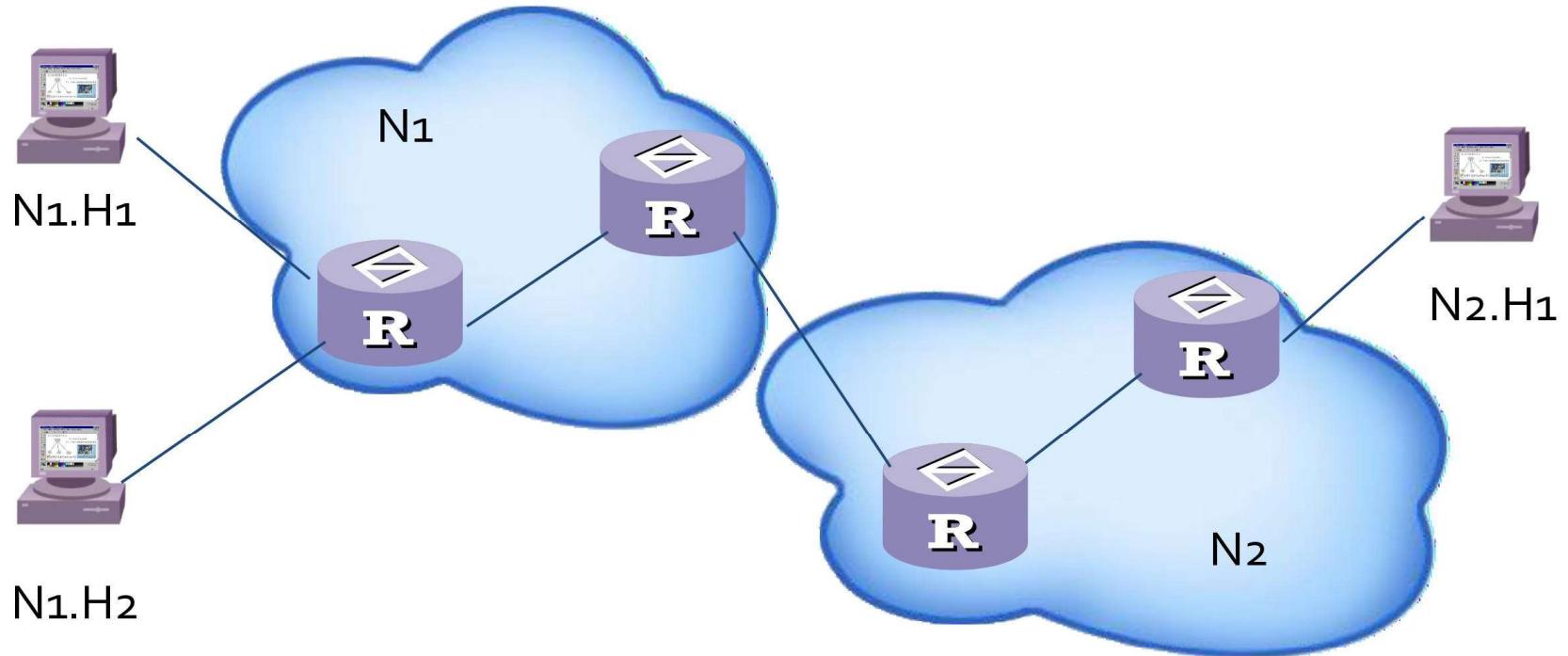
Network Address	Host Address
10.	8.2.48

IPX Address

Network Address	Host Address
1ACEB0B1.	0000.0C00.6E25

- The network layer address is composed of two parts: the network address and the host address, which is globally unique.

Routed Protocol and Routing Protocol

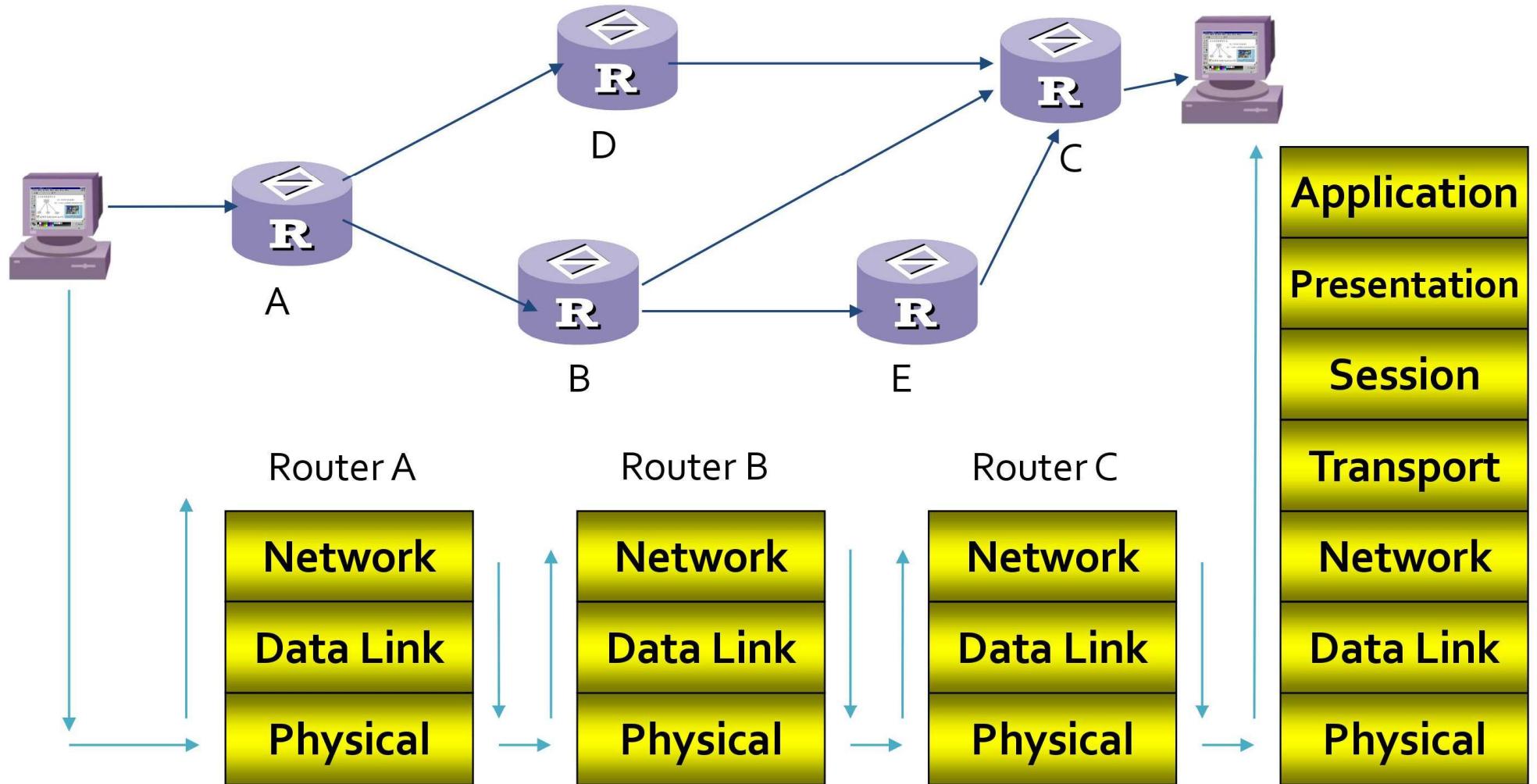


- Routed protocol: IP, IPX, etc;
- Routing protocol: RIP, OSPF, IS-IS, BGP, etc;

Connection-oriented and Connectionless service

- **Connection-oriented service:** suitable for delay sensitive application
 - set up connection
 - data transmission
 - disconnection
- **Connectionless service:** suitable for delay permitted application
 - unnecessary to set up connection
 - dynamically resources allocation

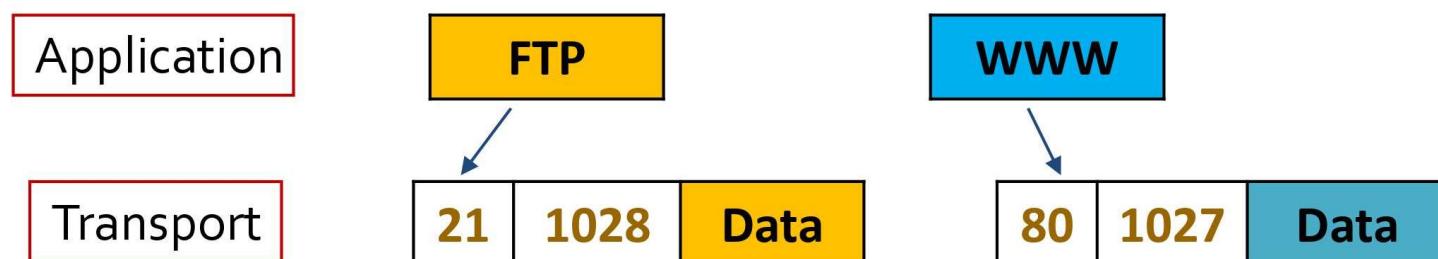
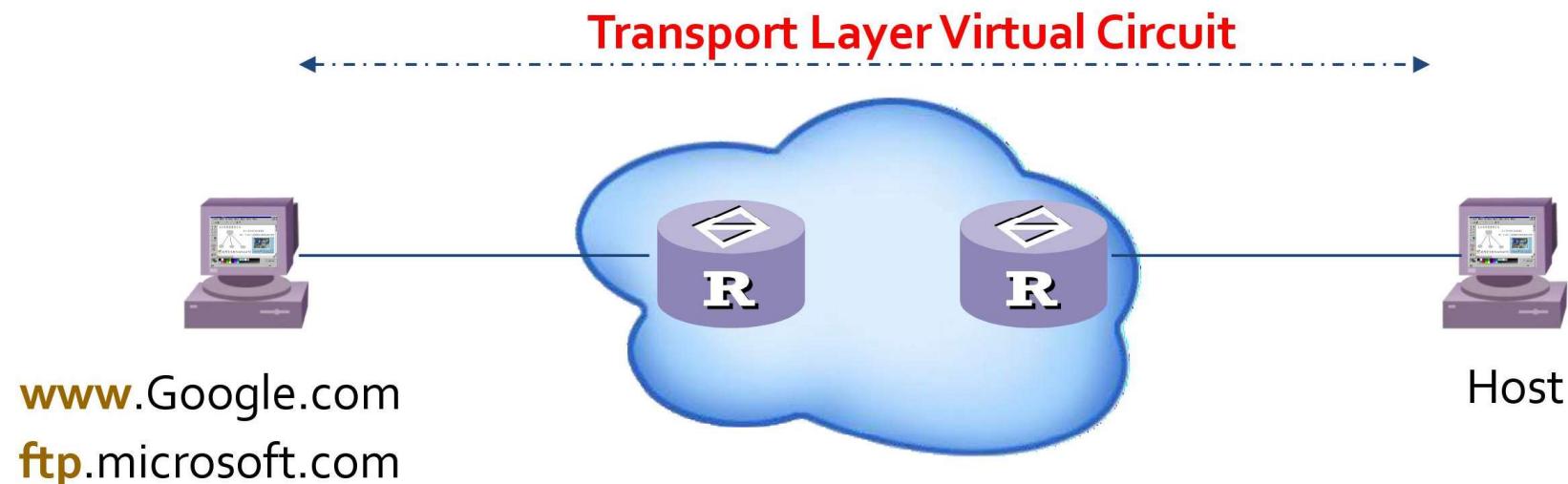
Network Layer Protocol Operation



Transport Layer

- The Function of Transport layer:
 - ➔ segment upper layer data
 - ➔ set up end to end connection
 - ➔ transmit data from end to end
 - ➔ ensure the reliability of the data transmission
- Transport layer protocol:
 - ➔ TCP, UDP for TCP/IP stack
 - ➔ SPX for IPX/SPX stack

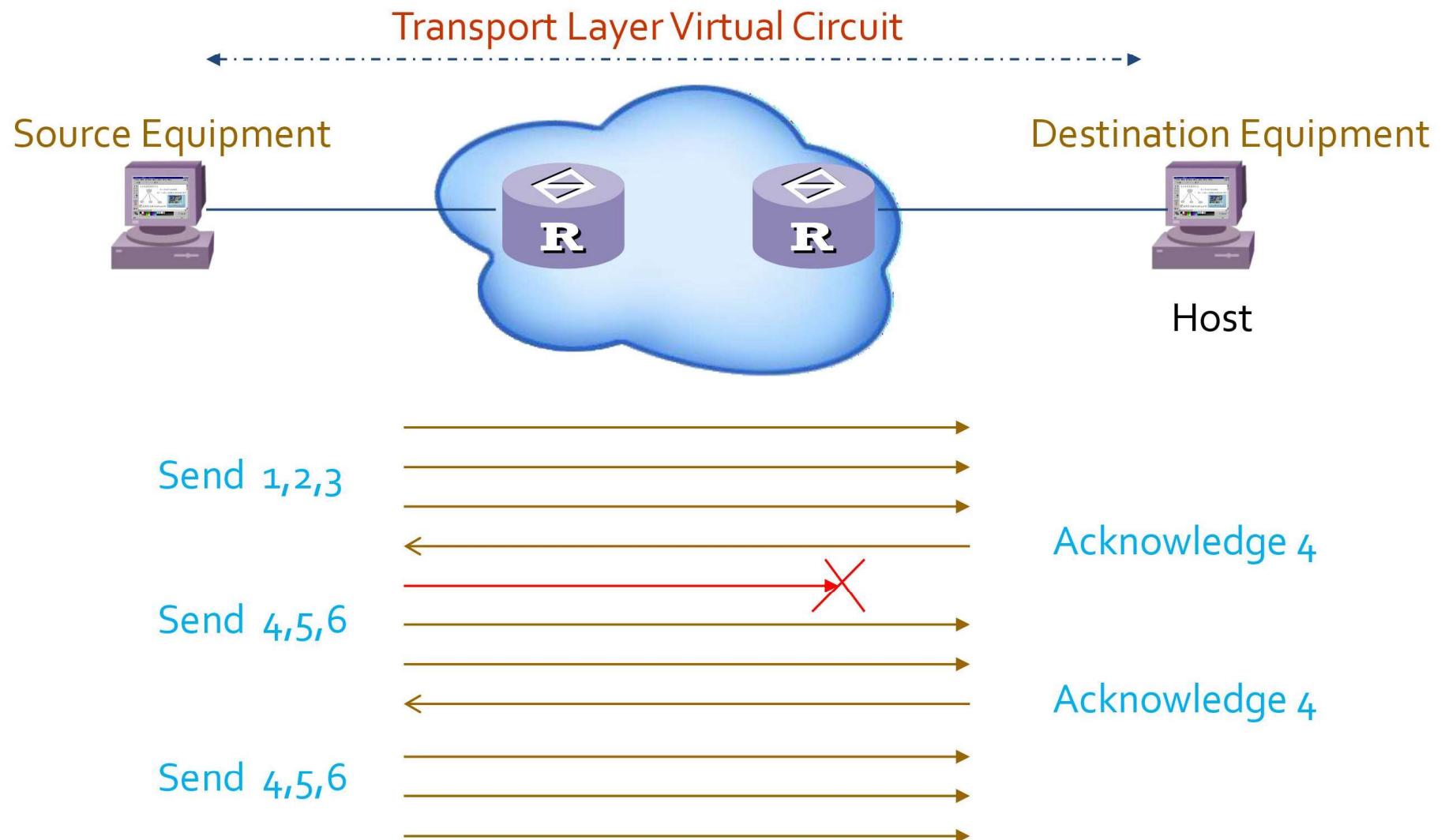
End to End Communication



Flow Control

- Three method of flow control:
 - ➔ Buffering: burst data buffered, forward when idle.
 - ➔ Source quench message: send the source quench message by ICMP
 - ➔ windowing: use to control how many data be sent at one time

Acknowledgment Technology



Upper Layer

- Session layer protocol:
→SQL, NFS and RPC etc.;
- Presentation layer protocol:
→ASCII, MPEG and JPEG etc.;
- Application layer protocol:
→Word processing, mail and electronic table etc.

Summary

- Basic knowledge of Computer network
- WAN , LAN, and their equipments.
- Topology of the networks
- OSI Reference Module
- The feature of every layer



Thank you!

Chapter 2

TCP/IP

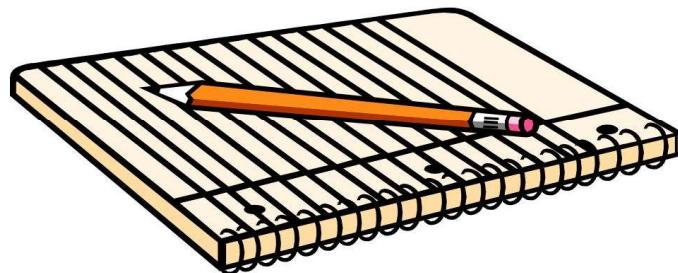
Objectives

TCP/IP

- Upon Completion of this chapter, you will be able to :
- Describe TCP/IP and OSI Reference Model
- Describe function of layers of TCP/IP

Course Contents

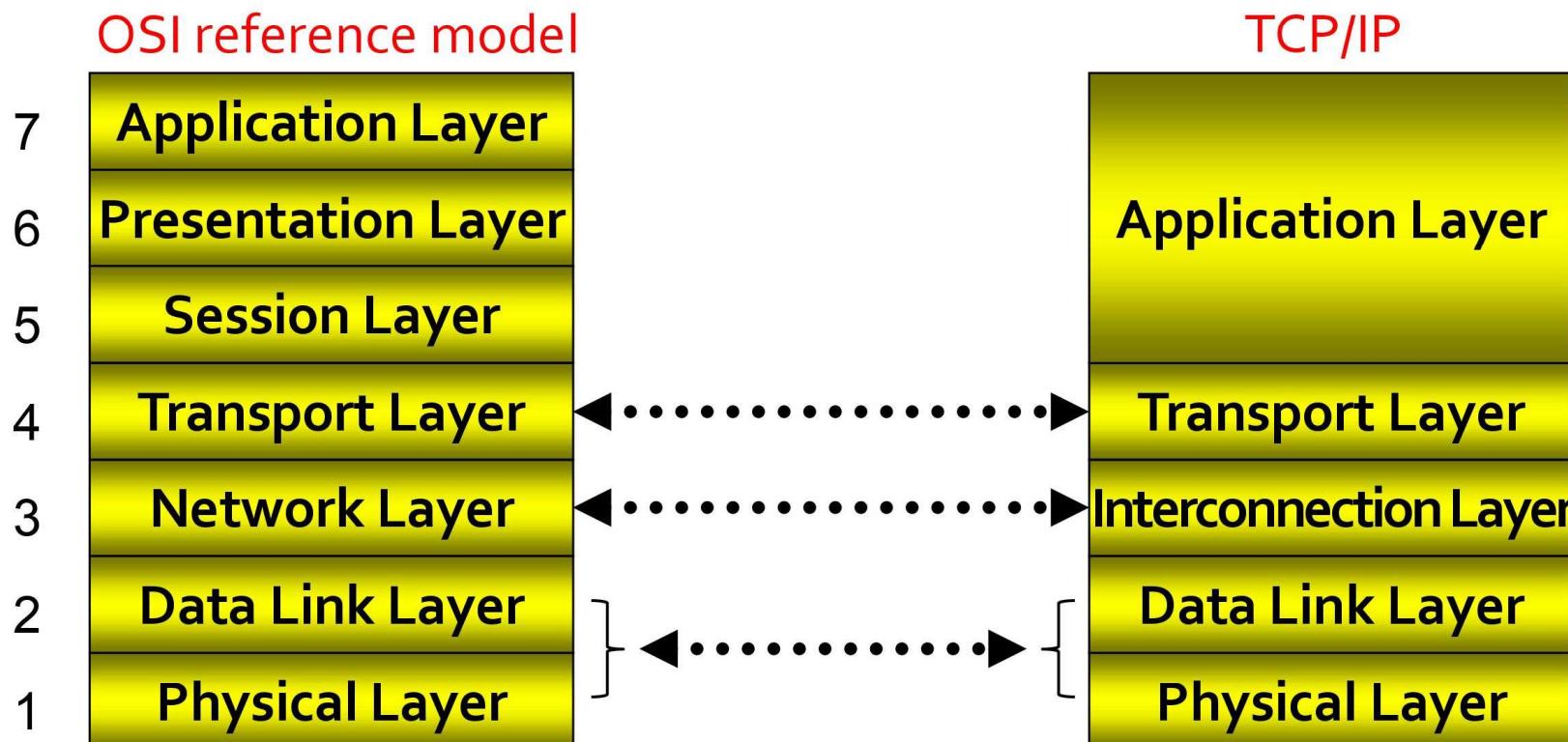
TCP/IP



TCP/IP and OSI Model

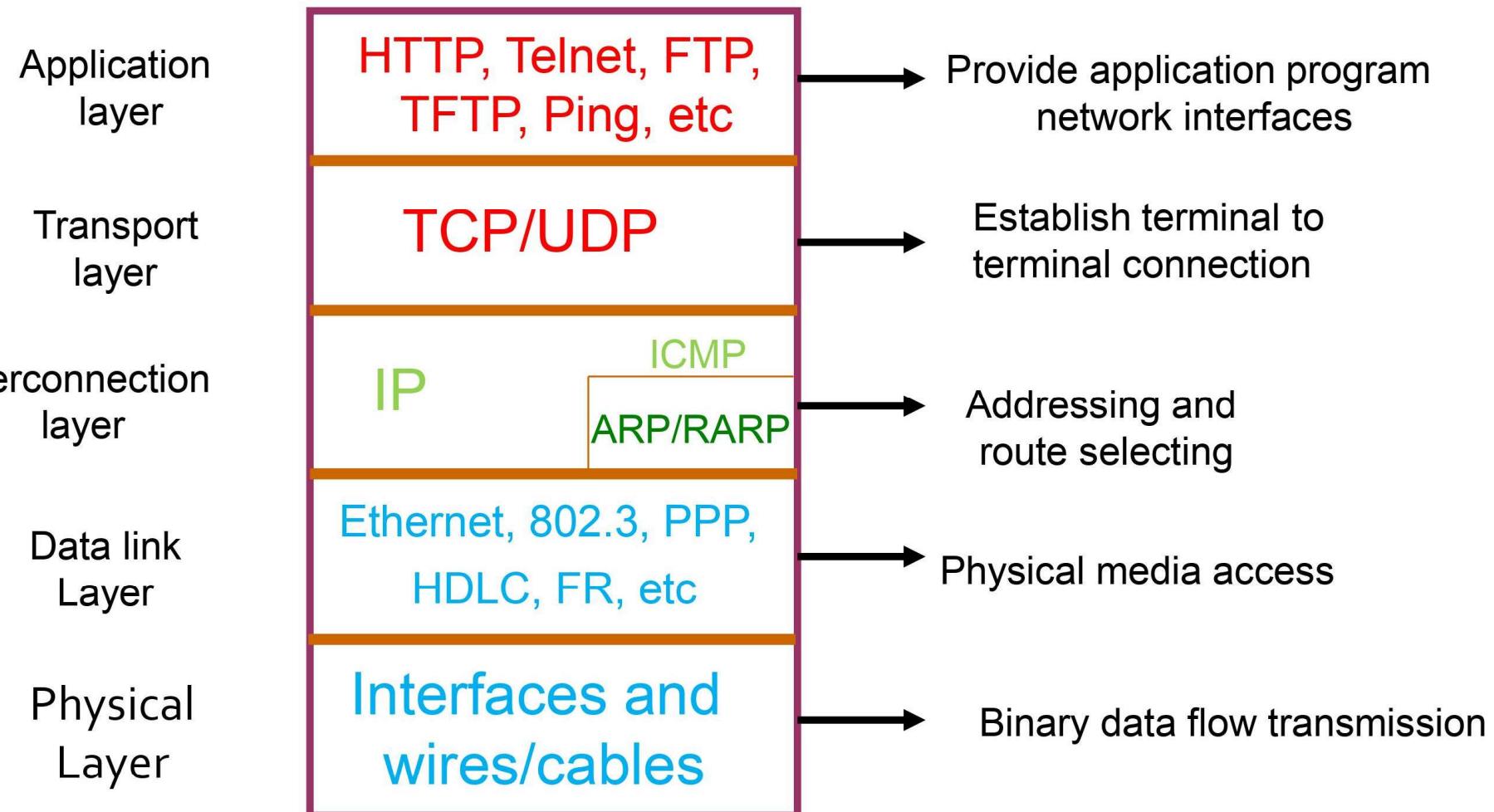
TCP/IP

- TCP/IP has simple hierarchical design
- In clear corresponding relations with OSI reference model.



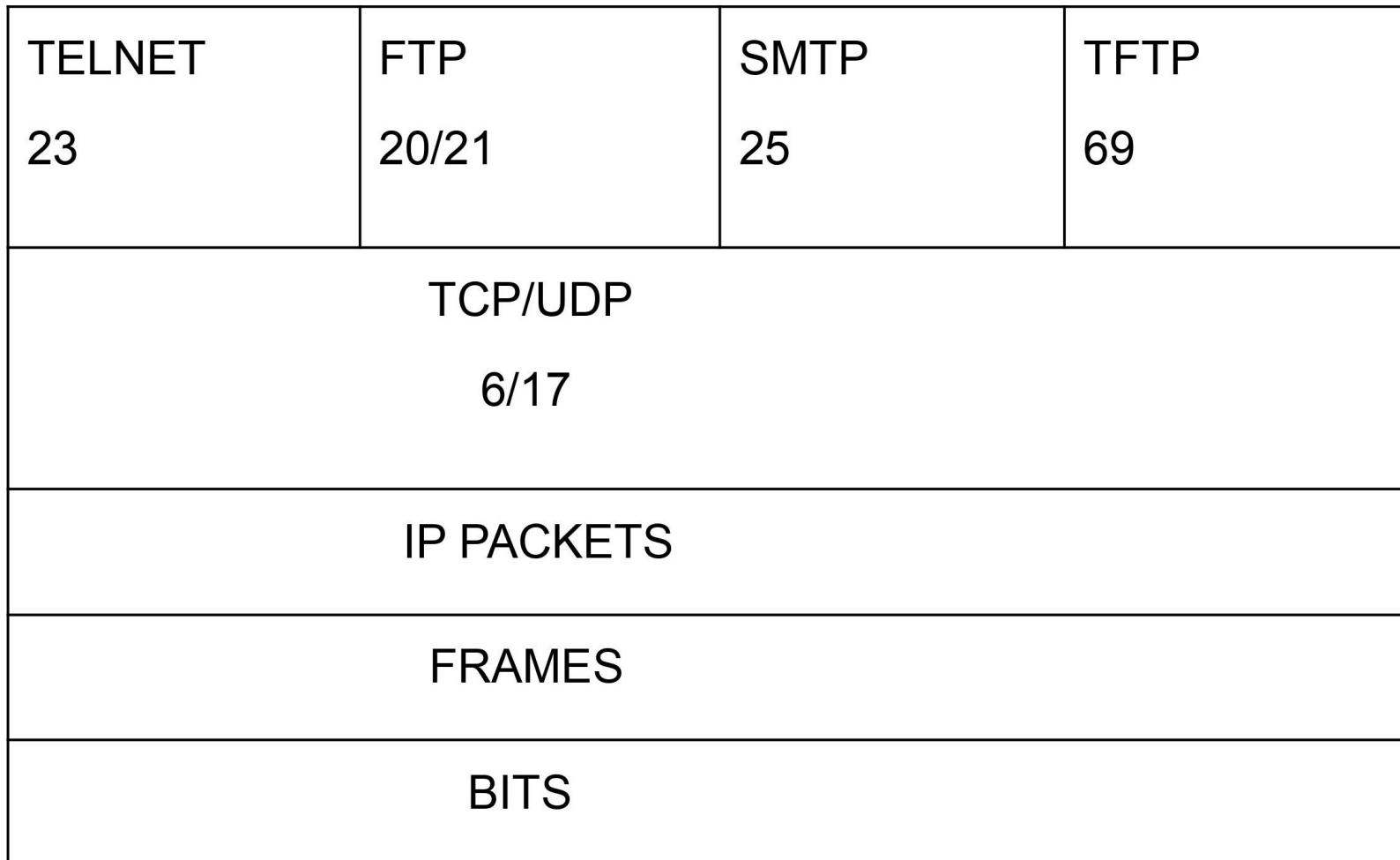
TCP/IP Protocol Stack

TCP/IP



Data Encapsulation

TCP/IP



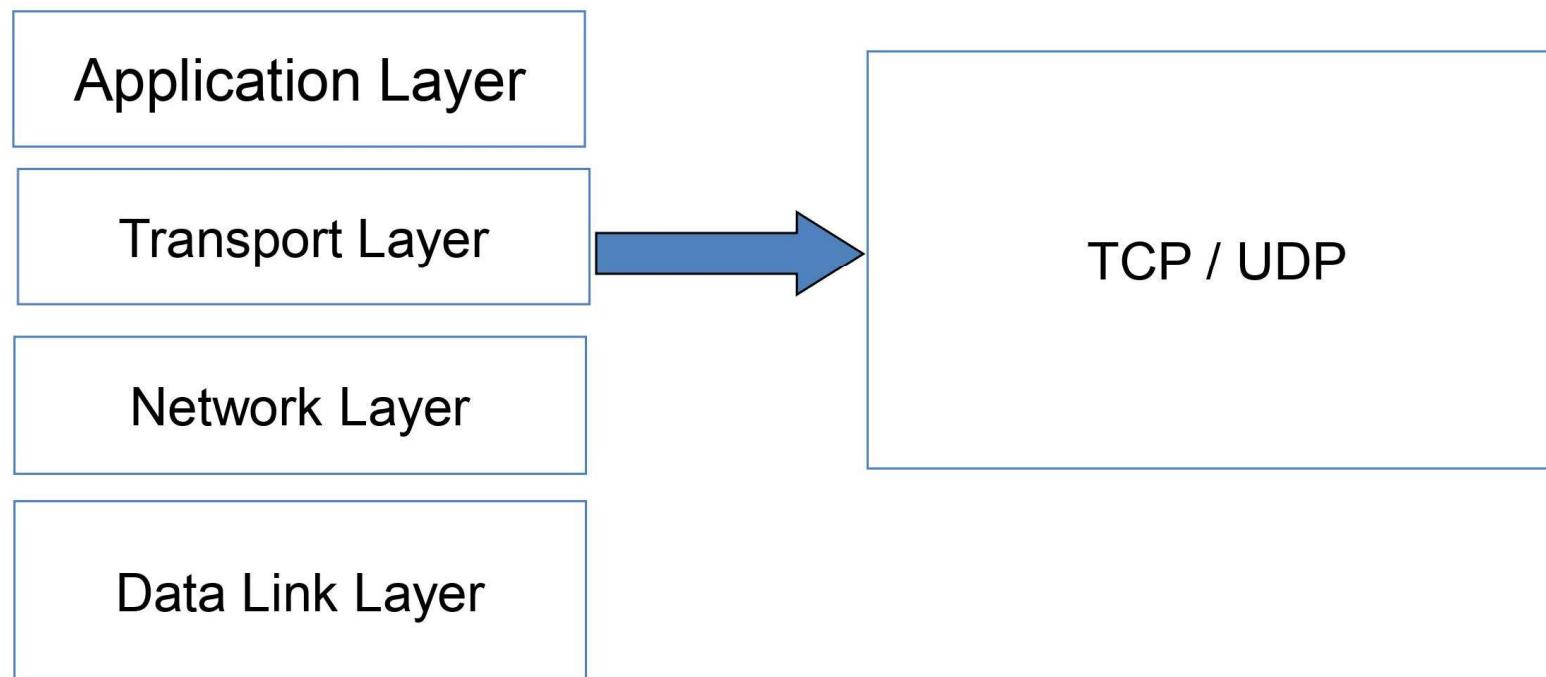
Application Layer

TCP/IP

- File transfer
 - FTP, TFTP
- Mail service
 - SMTP, POP3
- Network management
 - SNMP, Telnet, Ping, Tracert
- Network service
 - HTTP, DNS, WINS

Transport Layer Overview

TCP/IP



TCP/UDP Header Format

TCP/IP

0	8	16	24	31
16 bits source port	16 bits destination port			
16 bits UDP length	16 bits UDP checksum			
Data				

UDP header format

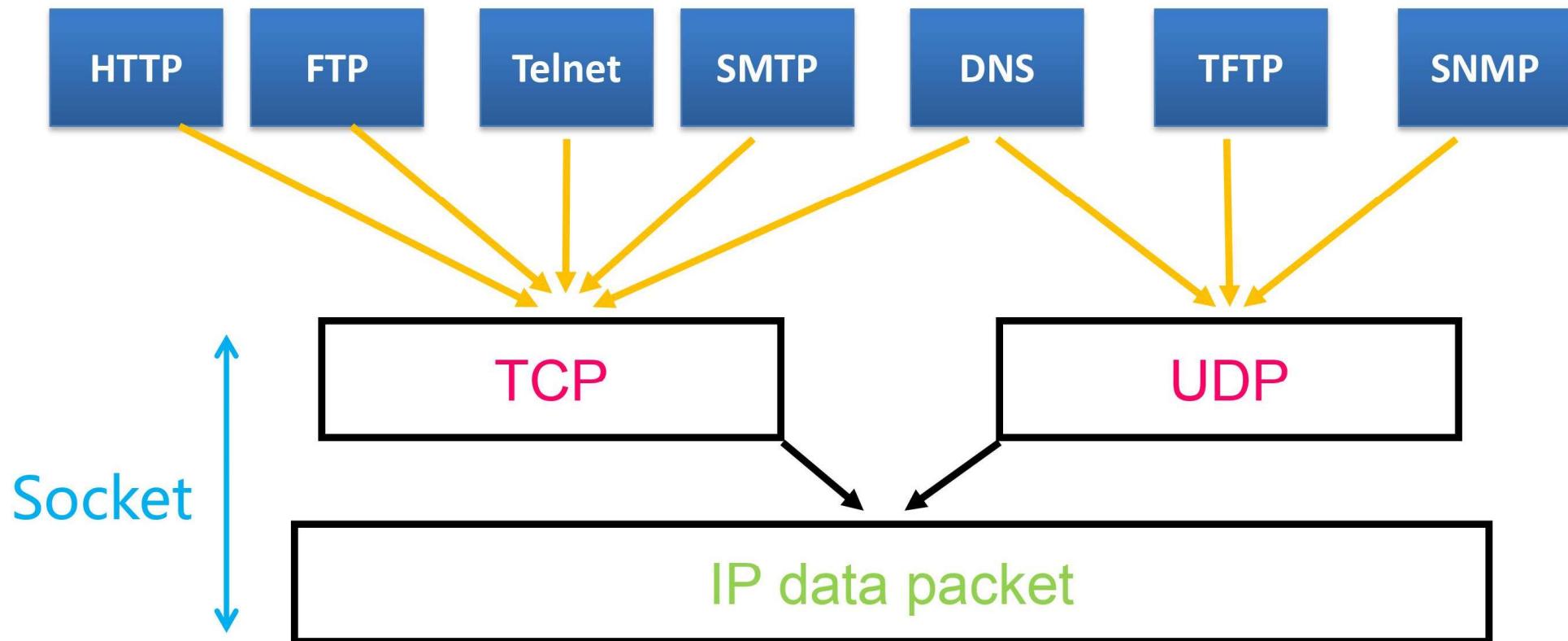
0	8	16	24	31						
16 bits source port	16 bits destination port									
32 bits sequence number										
32 bits acknowledge number										
offset	Reserved(6 bits)	C R G	A C K	P S H	R S T	S Y N	F I N	16 bits window size		
16 bits TCP checksum			16 bits urgent pointer							
Options										
Data										

TCP header format

Port Number

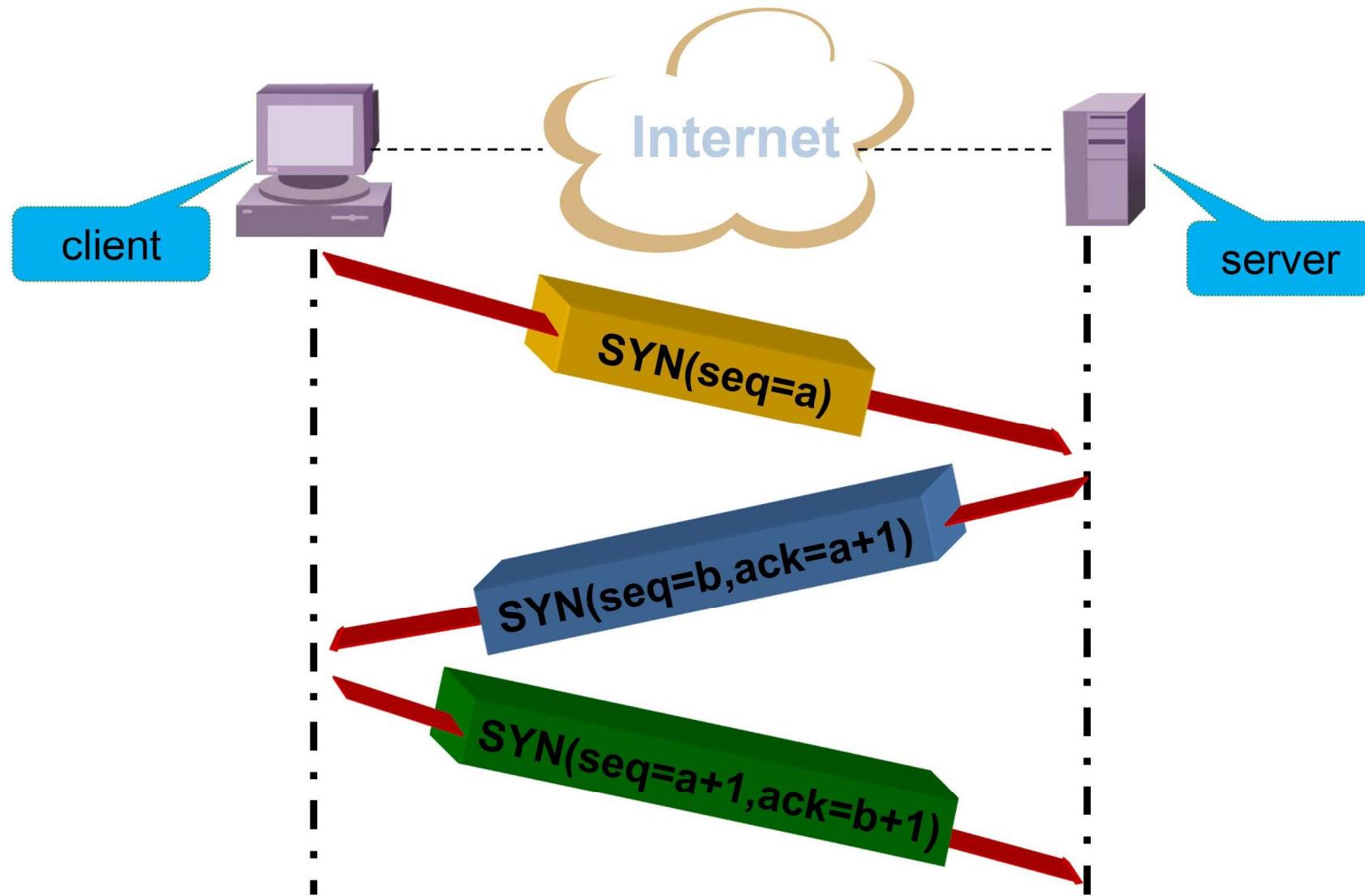
TCP/IP

- TCP protocol uses port numbers to mark and distinguish various application programs.



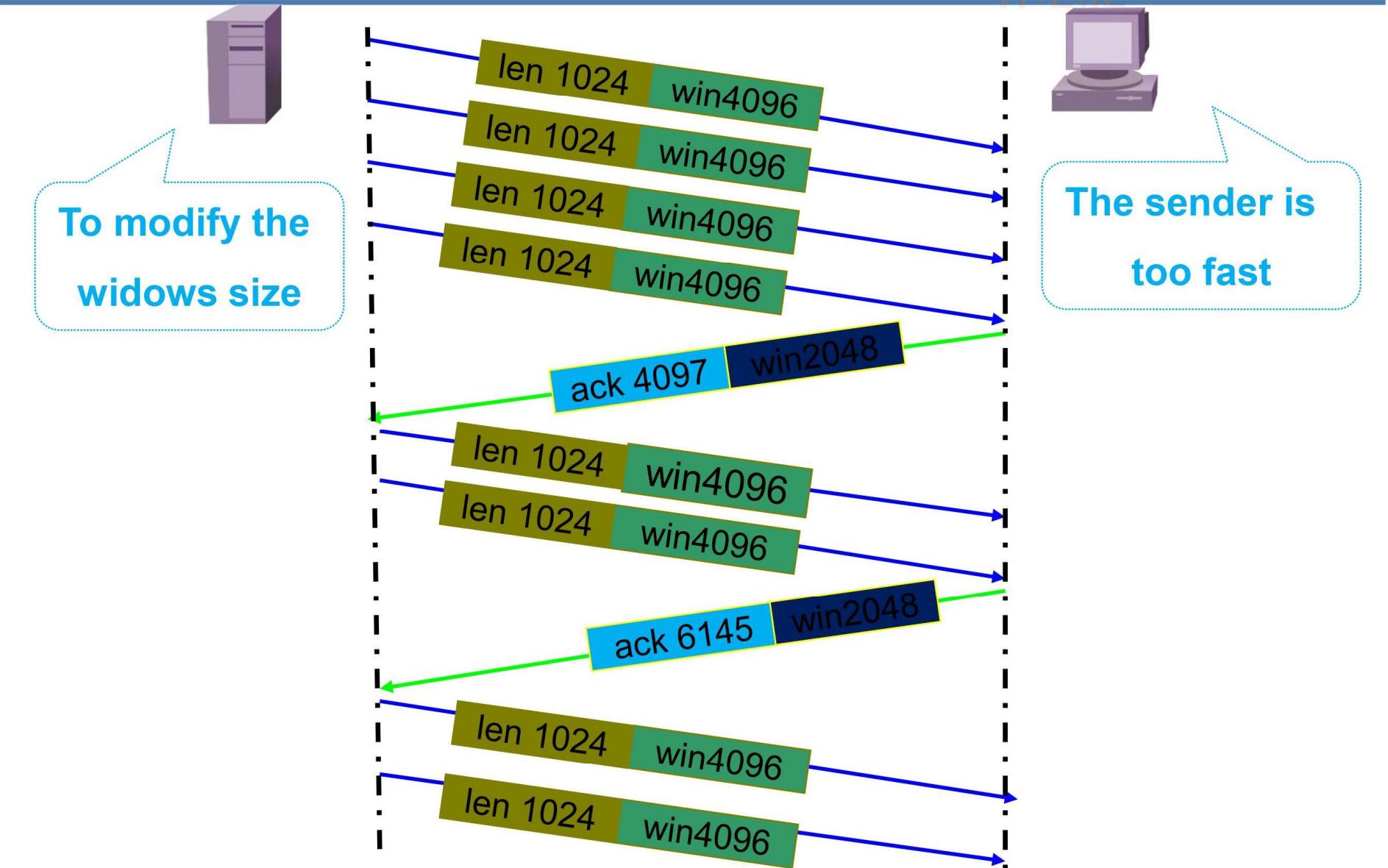
TCP Connection

TCP/IP



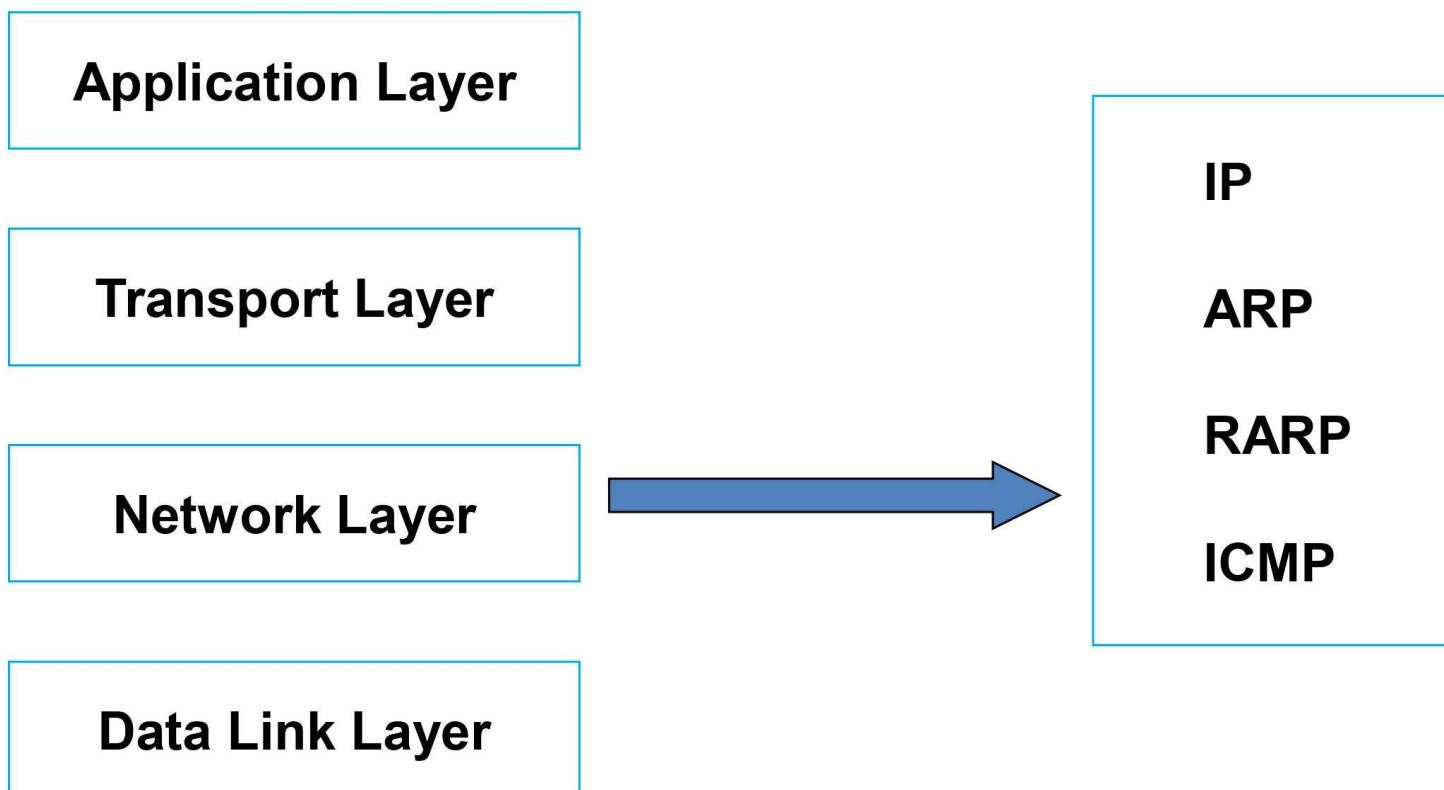
Slide Window

TCP/IP



Network Layer Overview

TCP/IP



IP Header Format

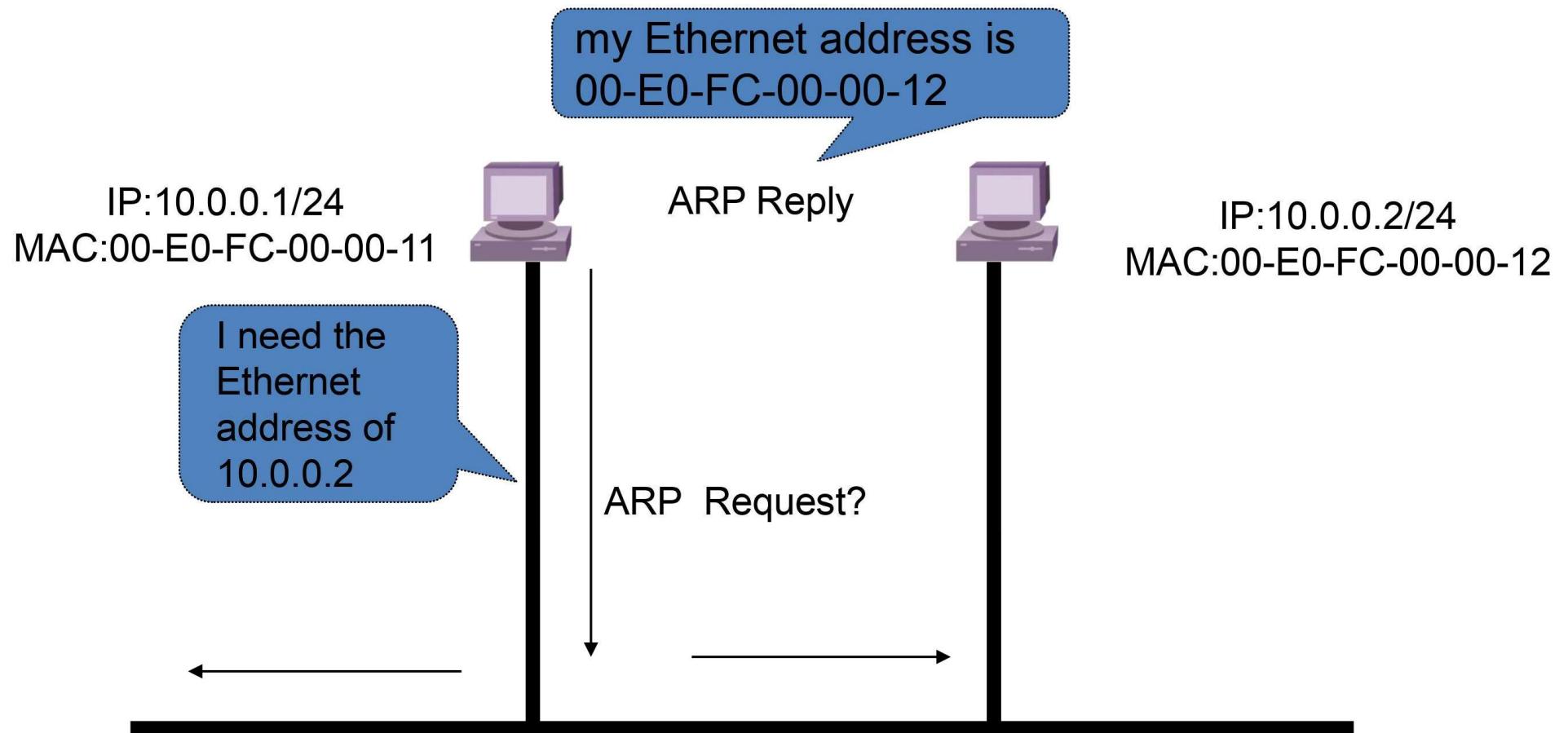
TCP/IP

0 4 8 16 31

Version	Message length	Service type	Total length			
Identification		Flag	Chip offset			
Time to live	Protocol	Message header checksum				
Source IP address						
Destination IP address						
IP options						

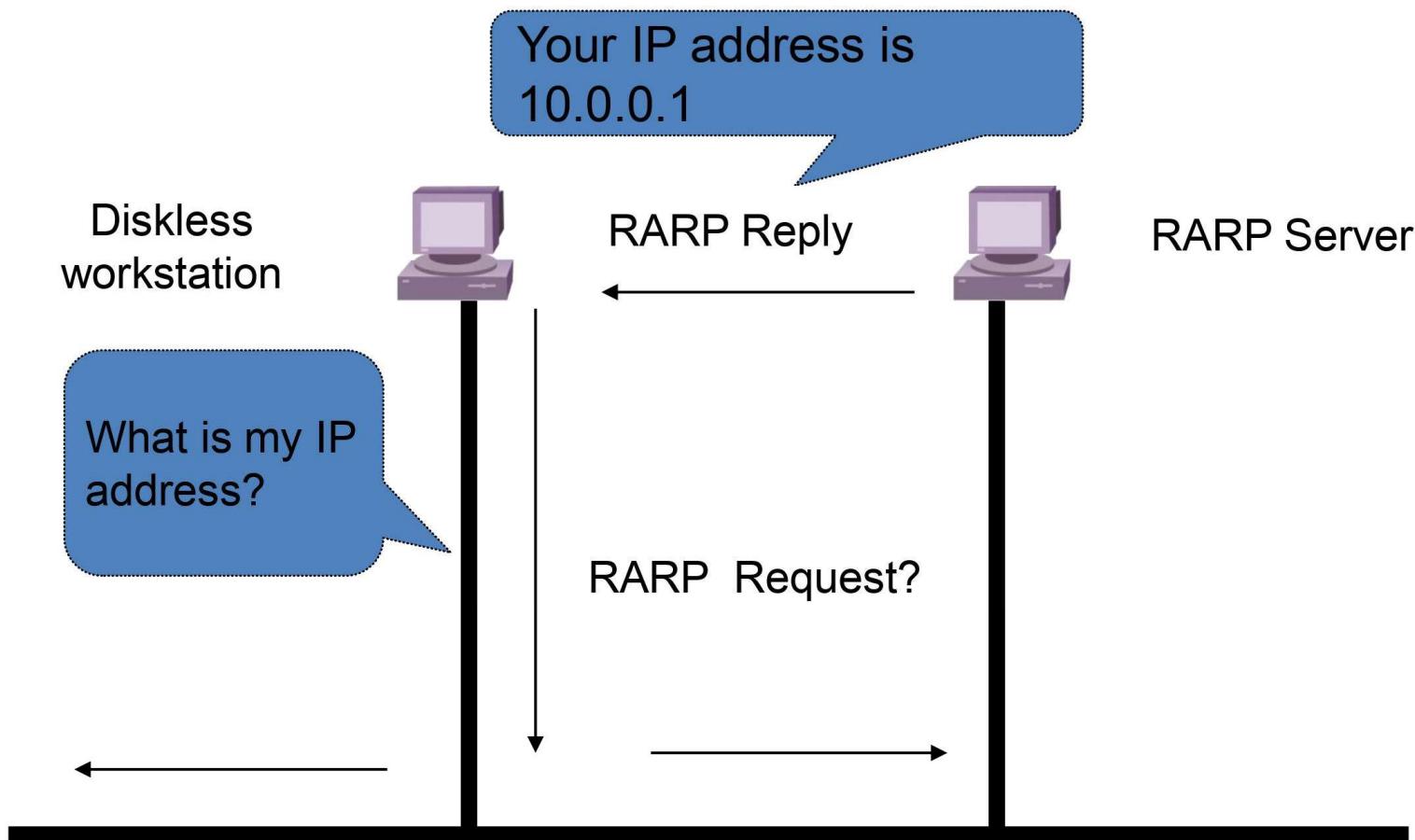
ARP

TCP/IP



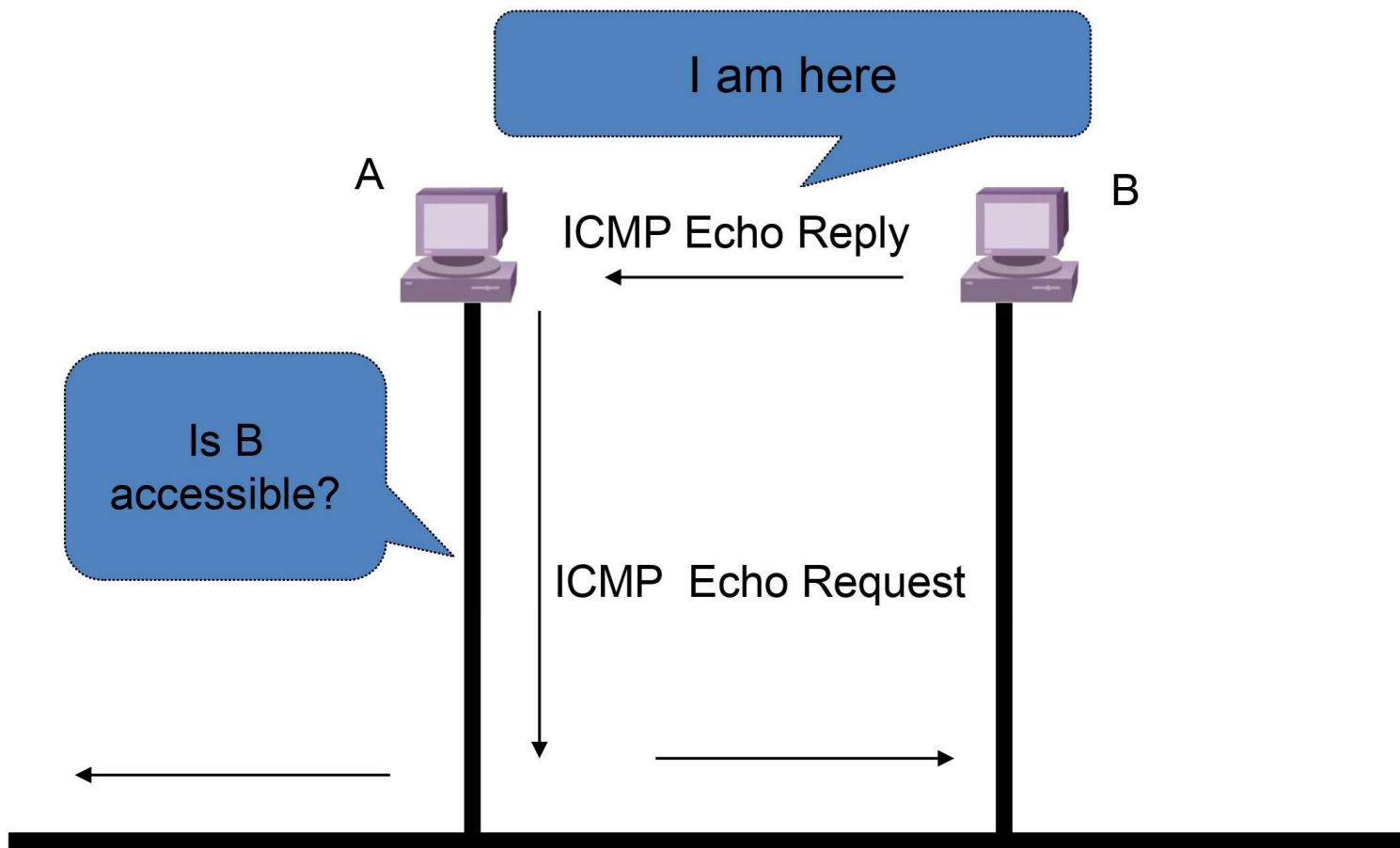
RARP

TCP/IP



ICMP

TCP/IP



Summary

TCP/IP

- TCP/IP stack and OSI reference model
- Protocols of TCP/IP stack



Thank you!

Chapter 3

Interfaces and cables

Objectives

Interfaces and cables

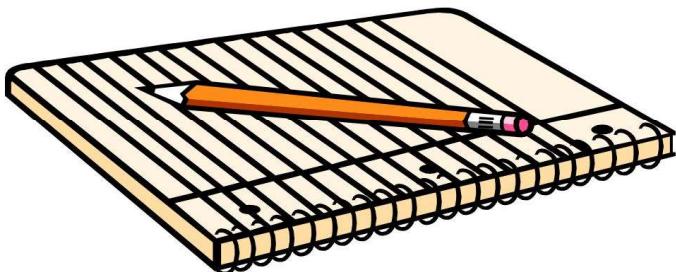
Upon Completion of this chapter, you will be able to :

- Understand general network structure
- Common LAN interface and its features
- Common WAN interface and its features
- Common optical interface and features

Course Contents

Interfaces and cables

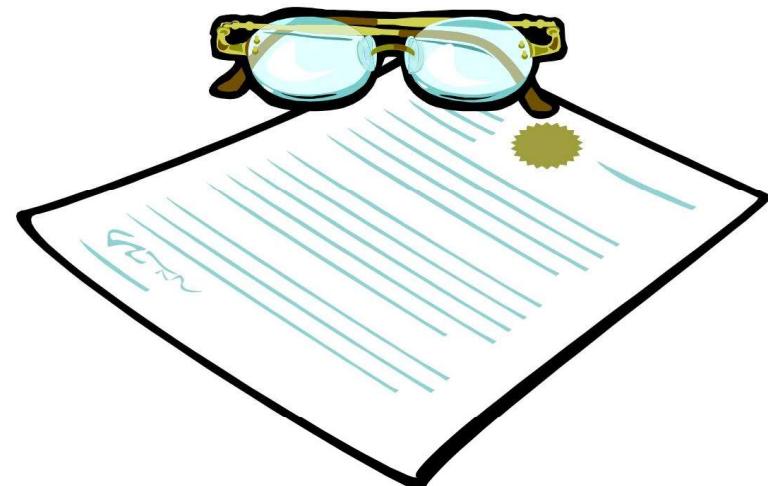
- LAN Interface and Cables
- WAN Interface and Cables



Common LAN types

Interfaces and cables

- **Ethernet**
- **Token Bus**
- **Token Ring**
- **FDDI**
-



Common LAN types

Interfaces and cables

- **10M Ethernet (Standard Ethernet)**
- **100M Ethernet (Fast Ethernet)**
- **1000M Ethernet (Gigabit Ethernet)**

100M Ethernet Interfaces

Interfaces and cables

- 100Base-TX :
 - The physical medium uses category 5 or above twisted pair
 - Max. network segment length 100 m
- 100Base-FX :
 - The physical medium uses single-mode optical fiber, max. network segment length 10 km, and multi-mode optical fiber with max. network segment length 2000 m

1000M Ethernet Interfaces

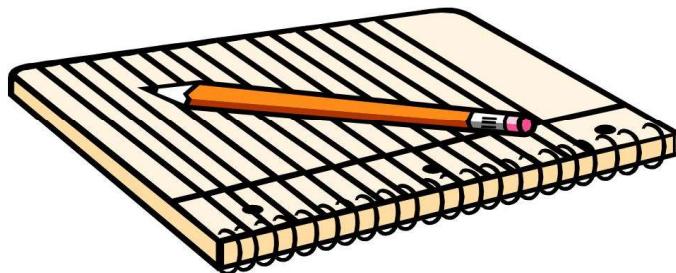
Interfaces and cables

- 1000Base-T :
 - The physical medium uses category 5 or above twisted pair with max. network segment length 100m
- 1000Base-F :
 - The physical medium uses single-mode optical fiber, multi-mode optical fiber with max. network segment length 500m

Course Contents

Interfaces and cables

- LAN Interface and Cables
- WAN Interface and Cables



WAN

Interfaces and cables

- Narrowband WAN

- PSTN

- ISDN

- DDN

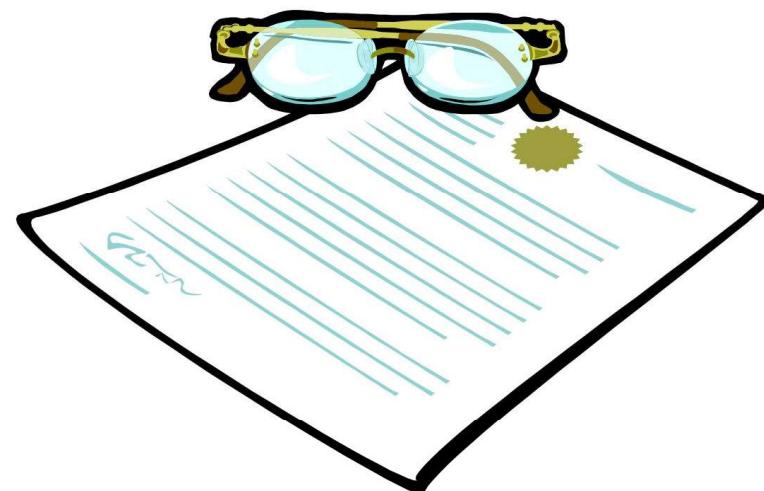
- Frame relay

- X.25

- Broadband WAN

- ATM

- SDH



Asynchronous & Synchronous Serial Interfaces

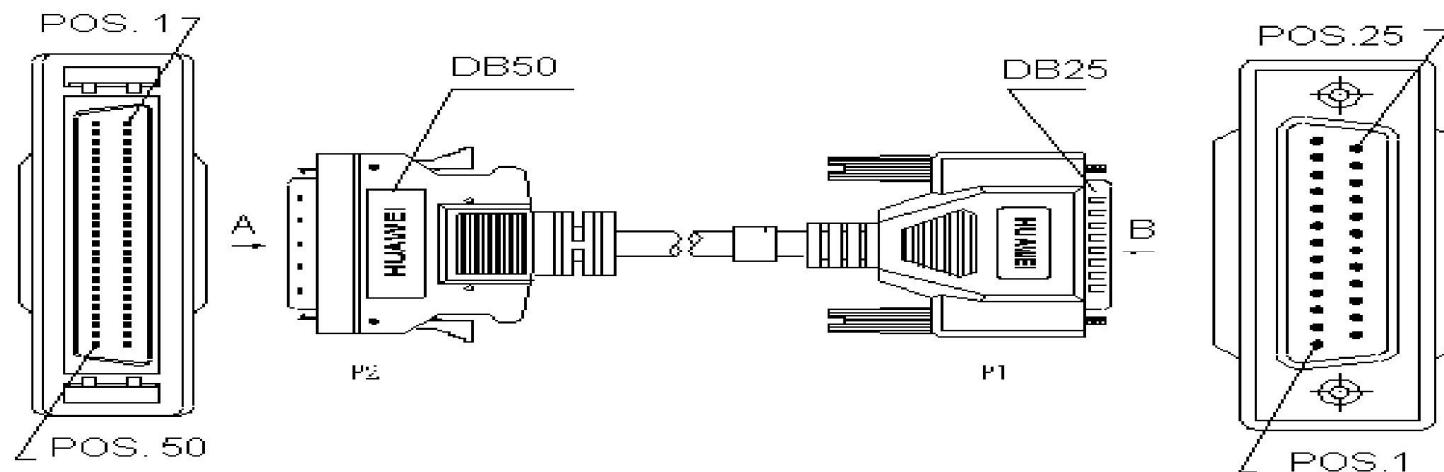
Interfaces and cables

- **Async. serial interface**
 - ➔ Two kinds of async. serial ports: sync/async serial interface set as async. serial interface and dedicated async. serial interface
 - ➔ Can be set as dedicated or dialup mode, usually dialup mode
- **Sync. serial interface**
 - ➔ Can work in DTE or DCE mode
 - ➔ Can be connected to several types of cables
 - ➔ Supports several link-layer protocols
 - ➔ Supports IP and IPX
 - ➔ The "show interface serial" command can be used to show information of the sync. serial interface

Mechanical Features of V.24

Interfaces and cables

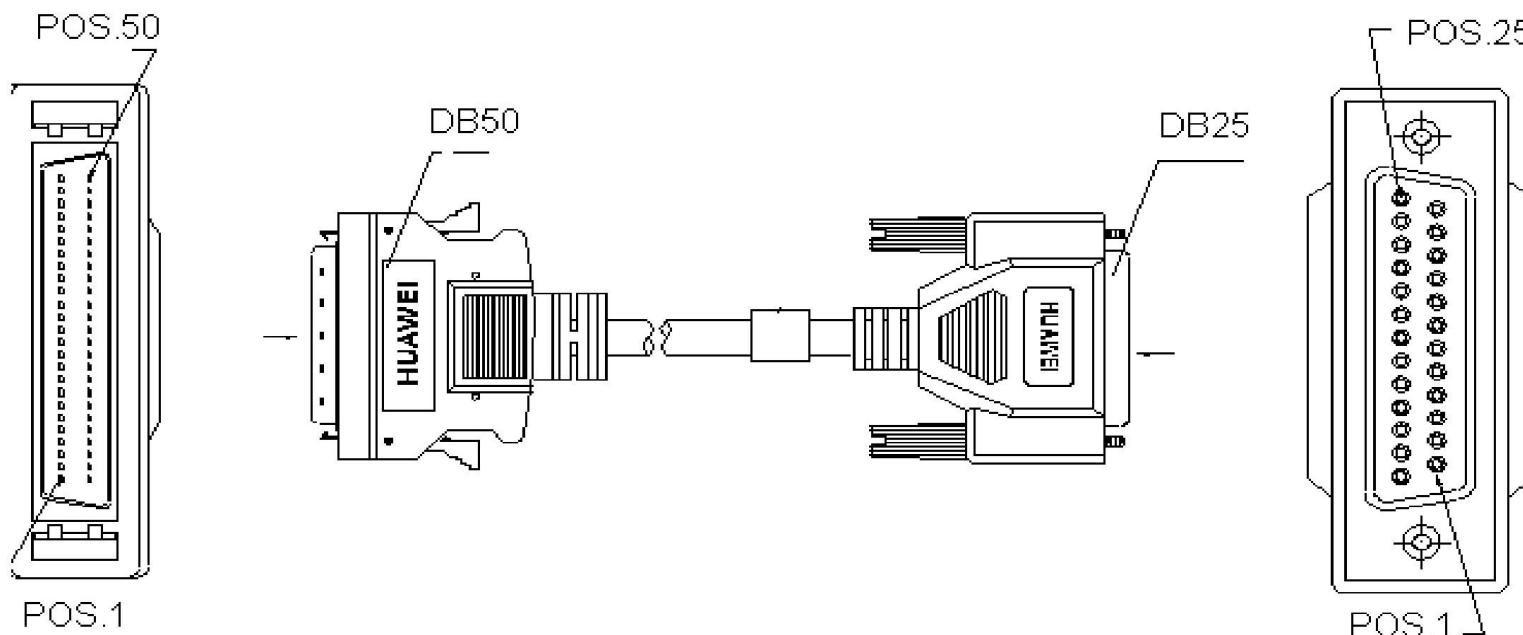
- DB50 (router side)--DB25 (external network side)
- Can work in sync./async. mode
- Max. transmission rate in async. mode is 115200bps
- Max. transmission rate in sync. mode is 64000bps



Mechanical Features of V.24

Interfaces and cables

→ DB50 (router side)--DB25 (external network side)



V.24 Features

Interfaces and cables

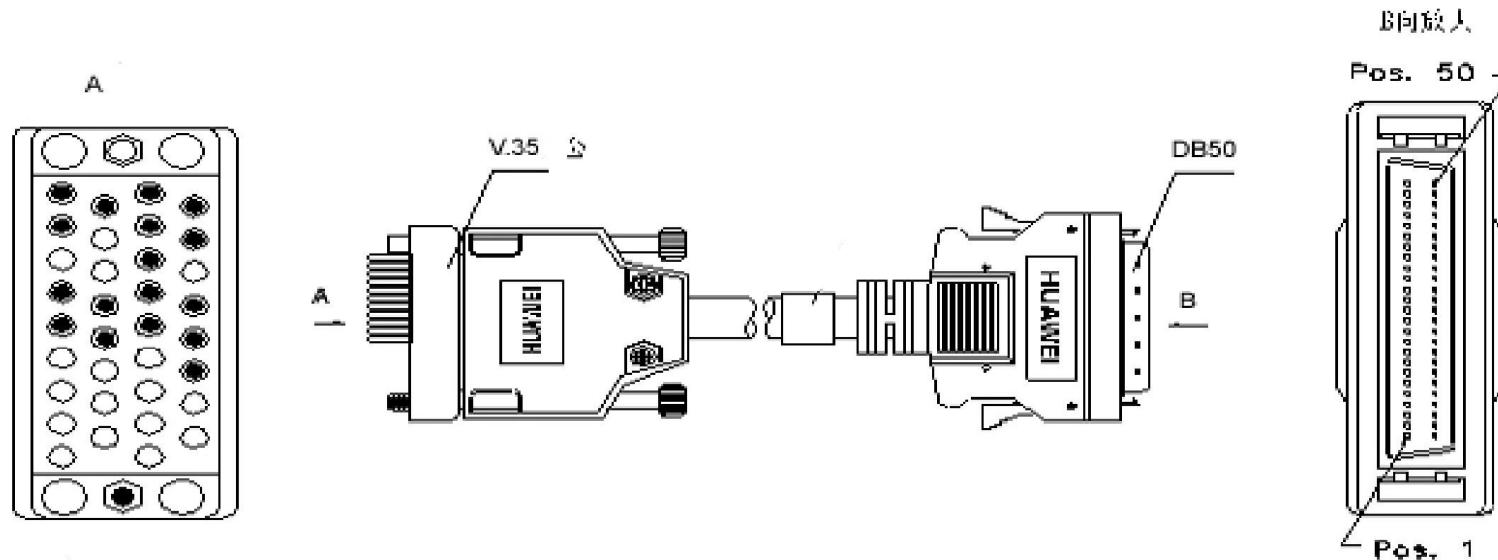
- Those that use V.24 in a router include WAN, AUX, 8AS, and Console
- Conforms to standard RS-232: $\pm 12V$
- Transmission speed and distance

Baud rate (bps)	Max. transmission (meters)
2400	60
4800	60
9600	30
19200	30
38400	20
64000	20
115200	10

Mechanical Features of V.35

Interfaces and cables

- DB34(external network side)--DB50 (router side)
- DTE side is a 34-pin plug
- DCE side is a 34-hole plug



V.35 Features

Interfaces and cables

- Control signals conform to RS-232 standards: $\pm 12V$
- Data and clock conforms to V.35 standards: $\pm 0.5V$
- Max. transmission rate in synchronous mode: 2048000 bps
- EIA/TIA-V.35 transmission rate and distance

Baud rate (bps)	Max. transmission (meters)
2400	1250
4800	625
9600	312
19200	156
38400	78
56000	60
64000	50
2048000	30

Composition of the Optical Communication System

Interfaces and cables

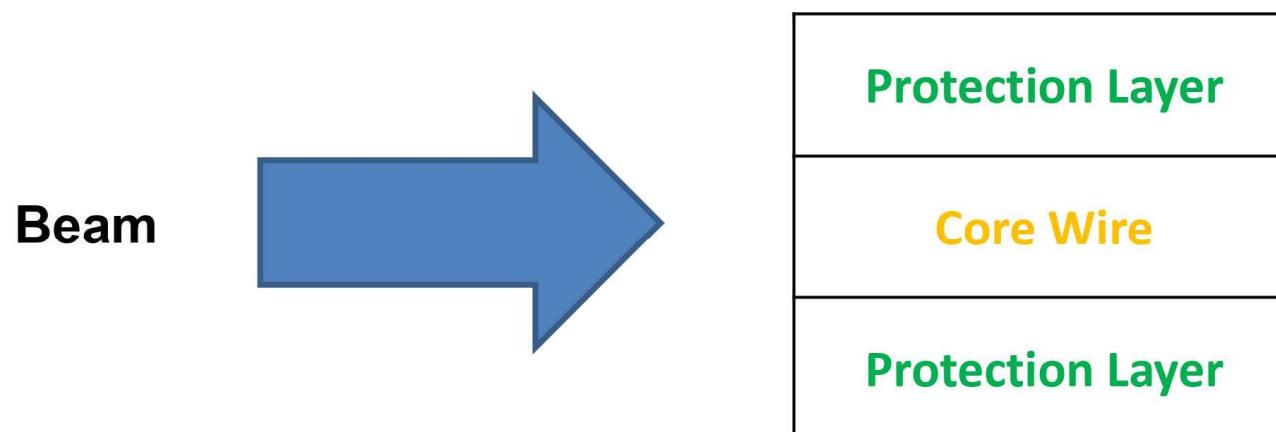
- Optical source is the source of optical wave generation
- Optical fibers are the media to transmit optical waves.
- Optical transmitter produces optical beams, transforms the electrical signals into optical signals, and transmits them into the fiber.
- Optical receiver receives the optical signals from the fiber, transforms them into electrical signals, and decodes them for further processing.



Optical Fiber

Interfaces and cables

- The center of the optical fiber is the glass core for optical transmission
- The core is coated with glass jacket whose refractive index is lower than the core to protect the core
- It is coated with one more plastic jacket to protect the glass jacket



Optical Cables

Interfaces and cables

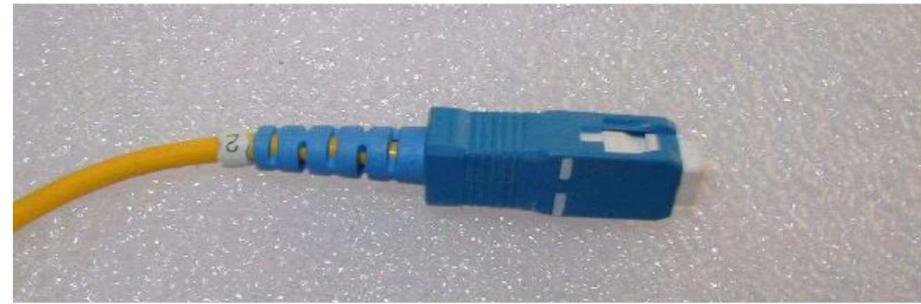
- The optical cable is one of the most efficient transmission medium. It has the following advantages:
 - ➔ Broad frequency band
 - ➔ Good electro-magnetic insulation
 - ➔ Low attenuation
 - ➔ Large interval between repeaters

Common Optical Fiber Plug

Interfaces and cables



FC-PC tail fiber plug



SC-PC tail fiber plug



ST-PC tail fiber plug



FC/PC-SC/PC tail fiber plug

Summary

Interfaces and cables

- Common cables in LAN: twisted pair and optical cable
- Features of different twisted pairs and optical cables
- synchronous port and asynchronous port
- Physical and transmission features of V.24 and V.35
- Introduction to optical fiber and features of optical interface



Thank you!