

# TCP/IP Basics

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## Objectives

- After completing this course, you will be able to:
  - ▣ Understand the TCP/IP hierarchical model.
  - ▣ Understand the IP addresses and IP routes.
  - ▣ Understand the Ethernet technology.
  - ▣ Understand the principles of the VLAN.



## Contents

1. Data Communication Overview
2. TCP/IP
3. LAN and WAN
4. VLAN

# What is Data Communication?

- According to the communication protocol, data information is transmitted between functional units by using a transmission technology, to implement information exchange between a computer and a computer, between a computer and a terminal, and between other data terminal devices.
- A data communication network is a network that provides data communication services.

# Data Communication Features

- Connectionless:
  - The communication does not have a unique and independent link.
- Packet switching:
  - Each packet has a destination address, source address, error control information, and so on, and has the ability to find a destination.

## Standardization organization

- ISO International Organization for Standardization
- IEEE Institute of Electrical and Electronics Engineers
- ANSI American National Standards Institute
- EIA Electronic Industries Alliance
- TIA Telecommunications Industry Association



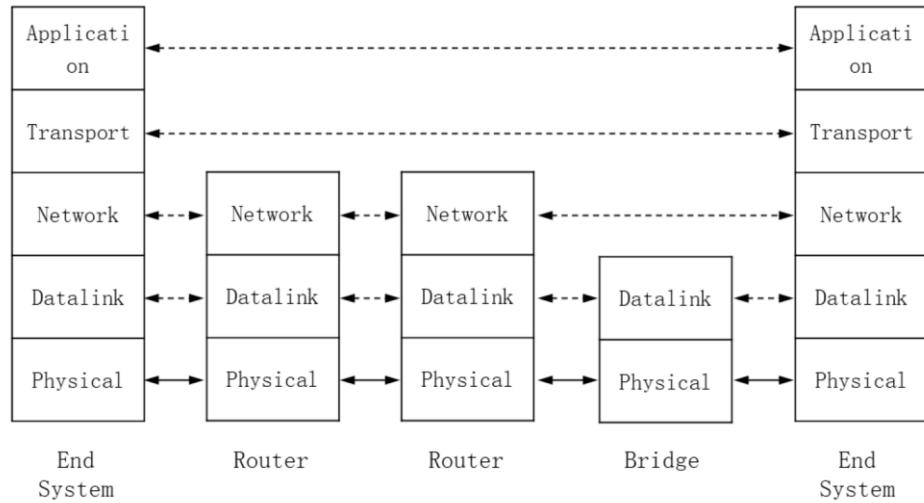
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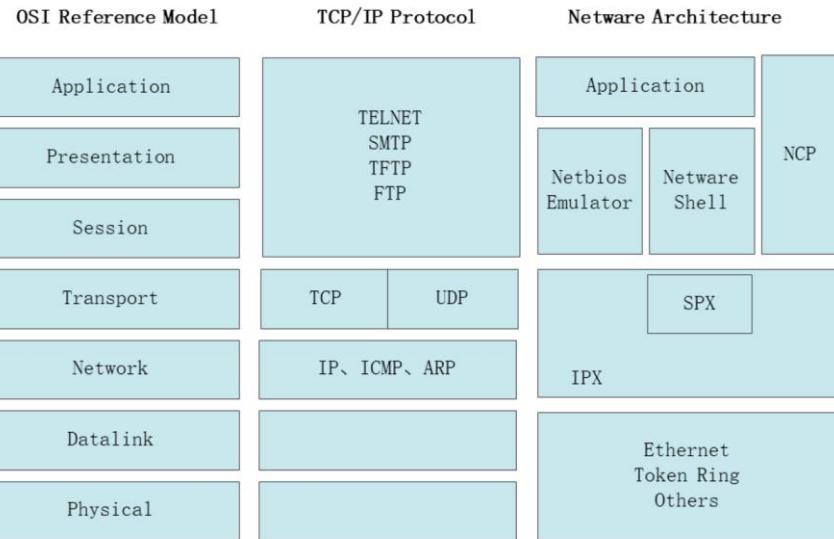
## What is TCP/IP?

- TCP/IP is a transmission control protocol/Internet protocol;
- Unlike the seven-layer OSI model, TCP/IP uses a simpler five-layer model.
- TCP/IP has become the standard for Internet interconnection.

# TCP/IP Layered Model



# OSI Model vs TCP/IP Model

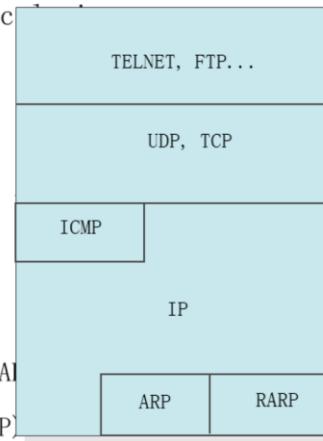


# TCP/IP Architecture (1)

- IP is one of the most important protocols in the TCP/IP system.

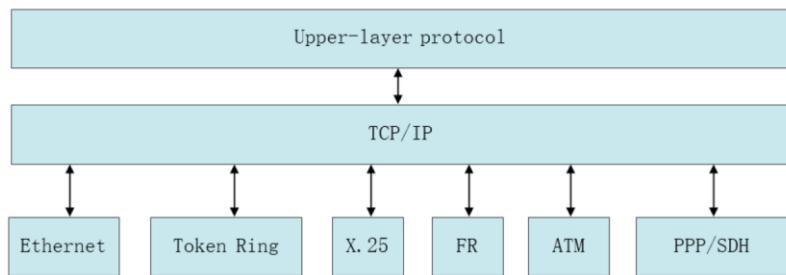
- The following protocols are used with IP protocol:

- Address Resolution Protocol (ARP)
- Reverse Address Resolution Protocol (RARP)
- Internet Control Message Protocol (ICMP)

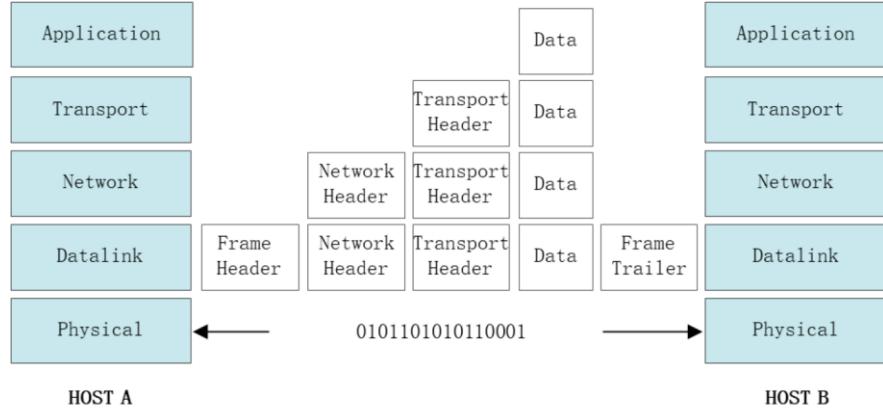


## TCP/IP Architecture (2)

- The IP protocol provides a globally unified addressing mode, which shields the differences between physical network addresses and makes route searching possible.
- The IP protocol provides a globally unified packet format, which shields differences in the network link layer and makes network interconnection possible.

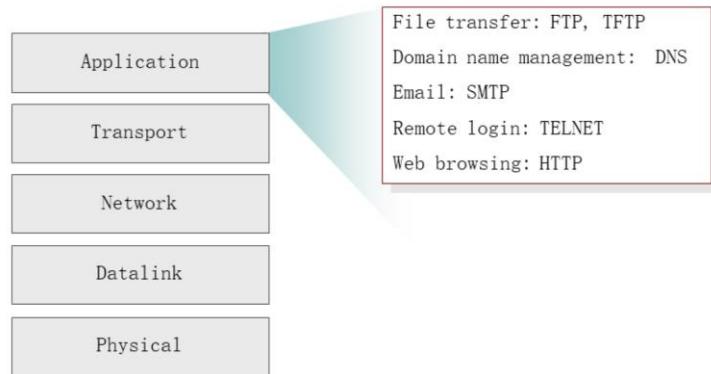


# Data Encapsulation



# The Function of Application Layer

- Provides network interfaces for applications.



# The Function of Transport Layer

- Data segmentation and data segment combination.
- Establishing an End-to-End Connection.
- The data segment is sent from one host to another host.
- (Optional) Ensure data transmission correctness.

# High Layer Application of TCP/UDP

- TCP application:
  - Connection-oriented transmission mode
  - Reliable transmission
  - Telnet, FTP and HTTP
- UDP application:
  - Connectionless transmission mode
  - Unreliable transmission
  - RIP, SNMP, RADIUS and VoD

# Transport Layer Port Number

- Data segment format at the transport layer
  - ▣ Port number range: 0 - 65535
    - 0 - 254              Public application
    - 255 - 1023          Allocated to each company
    - More than 1024      Random port number
  - The port number is used to identify the application program that the payload part belongs to.

Source Port No. (2 bytes)	Destination port No. (2 bytes)	.....	Application layer data
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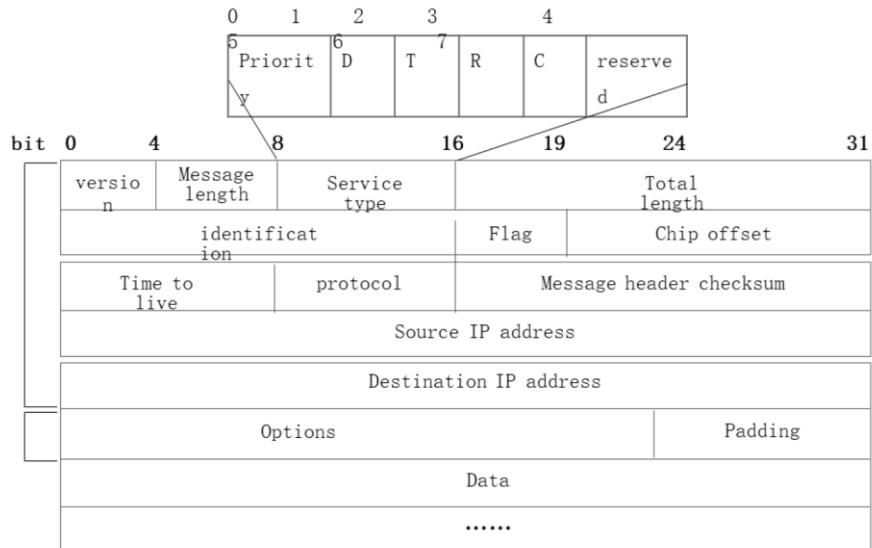
## Common Port Numbers

- 20 File Transfer Protocol [Default Data]
- 21 File Transfer Protocol [Control]
- 23 Telnet
- 25 Simple Mail Transfer Protocol
- 53 Domain Name Server
- 80 World Wide Web HTTP
- 119 Network News Transfer Protocol
- 161 SNMP
- 162 SNMP TRAP

# The Function of Network Layer

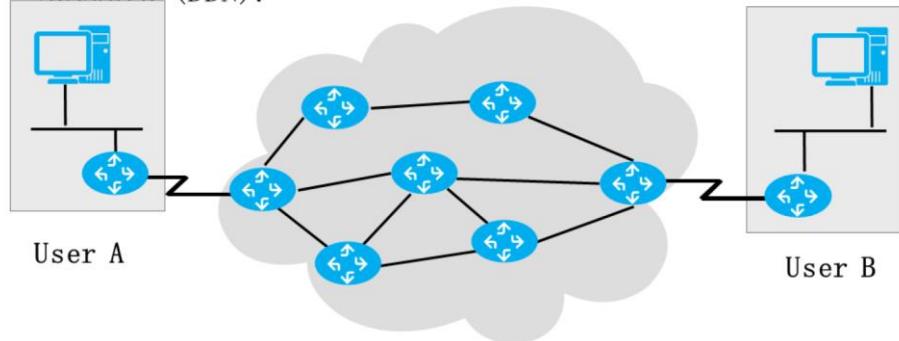
- Define the network address
- Route selection
- IP is implemented at the network layer

# IP Packet Format



## Functions of IP Addresses

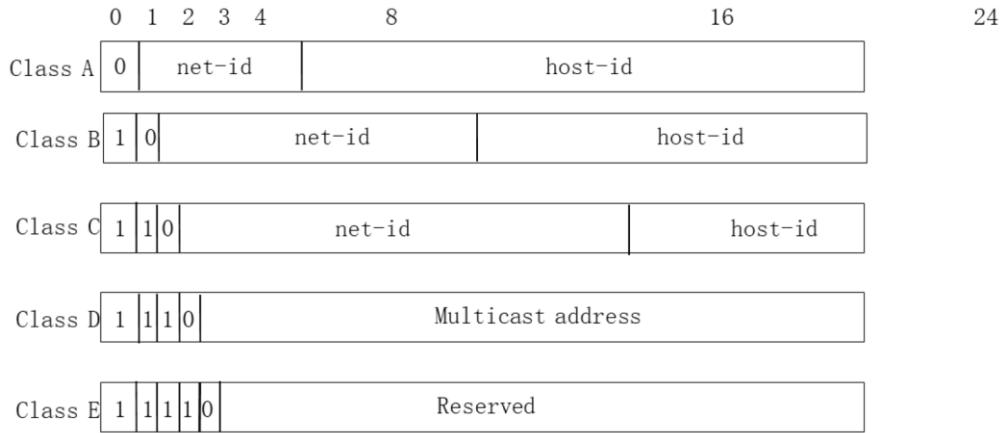
- Uniquely identifies a host on the network.
- The IP address is allocated by the network information center (NIC) of the National Defense Data Network (DDN).



## IP Address Format

- The IP address is a 4-byte 32-bit binary number, expressed in dotted decimal notation.
  - Example: 10000000. 00000001. 11111111. 11111110
  - The value is: 128. 1. 255. 254

# Classification of IP Address



## Reserved IP Address (1)

- All 0 network numbers
  - It indicates the current network itself or an unknown network.
- All 1 network numbers
- All 0 host numbers
  - Representing a network Segment
- All 1 host numbers
  - Indicates the broadcast address.

## Reserved IP Address (2)

- All 0 IP address, that is, 0.0.0.0
- The network address is 127.X.X.X., which is used for the local software echo test (loopback test).
- All 1 IP address, that is, 255.255.255.255, it indicates that the IP address is broadcast to all hosts on the network.

## Private IP Address

- Private IP addresses cannot be used on the Internet.

10. 0. 0. 0 — 10. 255. 255. 255  
172. 16. 0. 0 — 172. 31. 255. 255  
192. 168. 0. 0 — 192. 168. 255. 255

# IP Address Range

Address Type	Maximum Number of Networks	First Available Network Number	Last Available Network Number	Maximum Number of Hosts on Each Network
Class A	126	1	126	16777214
Class B	16382	128. 0	191. 255	65534
Class C	2097150	192. 0. 0	223. 255. 255	254

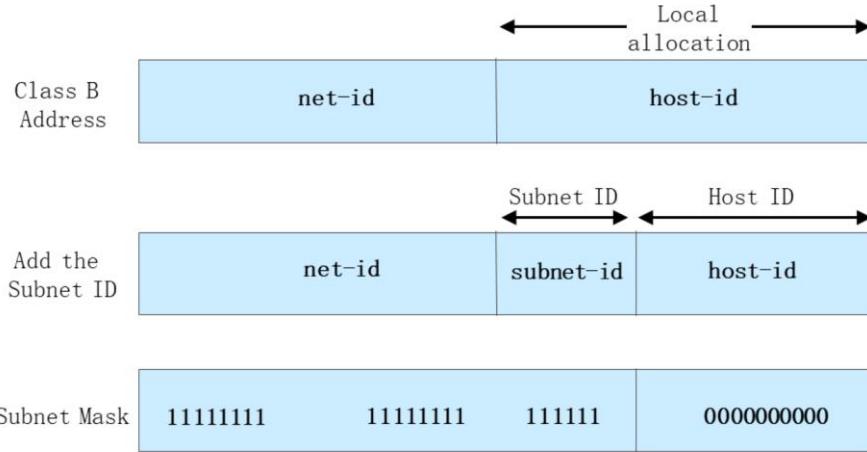
# Classful IP Address and Classless IP Address

- Classful IP address:
  - There are three types of net-id: 8, 16, and 24
- Classless IP address:
  - The net-id can be set to any value from 1 to 32.
- Advantages of classless IP addresses:
  - Flexible networking and easy management
  - Reducing the waste of IP addresses

## Subnet Mask

- The TCP/IP system requires a 32-bit subnet mask to indicate the length of the subnet number field.
- A subnet mask consists of a series of "1" and a series of "0":
  - The value 1 corresponds to the network number and subnet number fields.
  - The value 0 corresponds to the host number field.
  - "1" and "0" cannot overlap.

## Classless IP Address



# The Representation of the IP Address

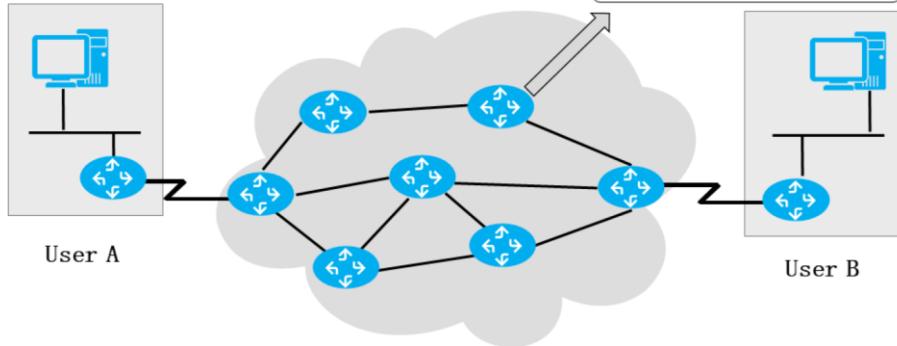
- IP address/subnet mask or IP address/subnet mask length
  - Example:
    - 128.1.0.1/255.255.0.0
    - 128.1.0.1/16
  
    - 192.2.2.2/255.255.224.0
    - 192.2.2.2/19

## Characteristics of IP Addresses

- IP addresses are hierarchical.
- The IP address is different from the phone number, which cannot reflect the geographical location of the host.
- When a host belongs to multiple networks, there are multiple IP addresses (such as routers). These IP addresses have different network/subnet parts.

## IP Route

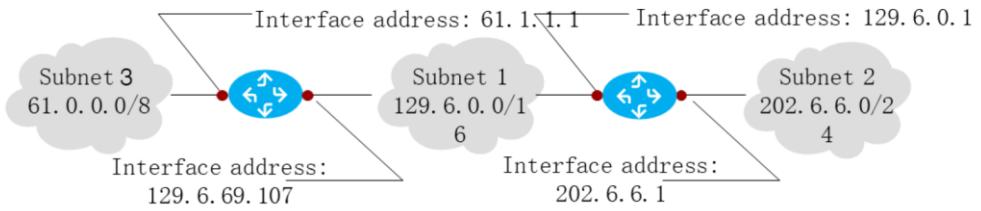
- The important function of the network layer is to forward the data packet to the destination host according to the destination IP address in the IP datagram.
- The device that completes this task is the **router**. Which path should be selected?



# Features and Functions of Routers

- As a router, it must meet the following requirements:
  - Two or more network layer interfaces are used for connecting different networks.
  - The protocol is implemented at least to the network layer.
- A router has the following functions:
  - Generate a routing table.
  - Forward data packets to other networks.

# Router Connection Example



## Routing Table on Router A

Destination Network Address	Destination Network Mask	Next Hop Address	Outbound Interface
202. 6. 6. 0	255. 255. 255. 0	129. 6. 0. 1	129. 6. 69. 107
129. 6. 0. 0	255. 255. 0. 0	129. 6. 69. 107	129. 6. 69. 107
61. 0. 0. 0	255. 0. 0. 0	61. 1. 1. 1	61. 1. 1. 1

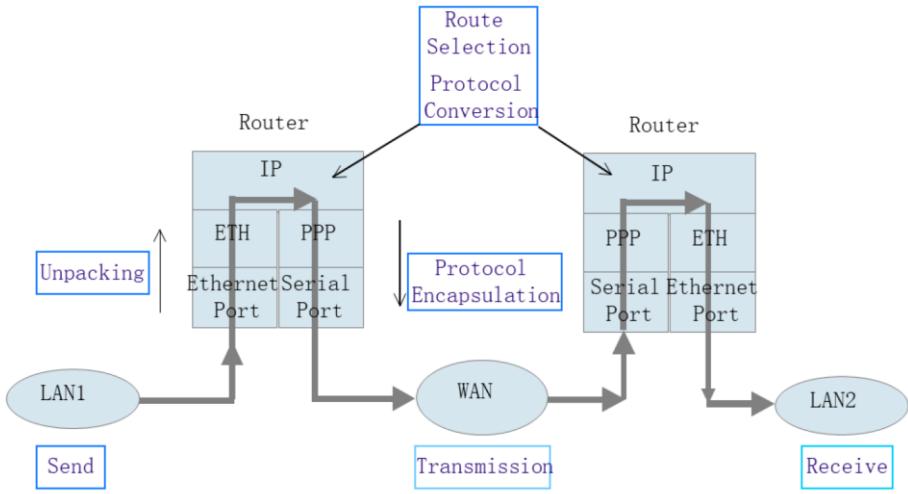
## Routing Table on Router B

Destination Network Address	Destination Network Mask	Next Hop Address	Outbound Interface
202.6.6.0	255.255.255.0	202.6.6.1	202.6.6.1
129.6.0.0	255.255.0.0	129.6.0.1	129.6.0.1
61.0.0.0	255.0.0.0	129.6.69.107	129.6.0.1

# Routing Table Generation Mode

- Static route:
  - The operator records the information one by one.
- Dynamic route:
  - Routing entries are generated by routing protocols.
  - Common routing protocols include OSPF and RIP.

# Working Process of A Router



# The Function of Data Link Layer

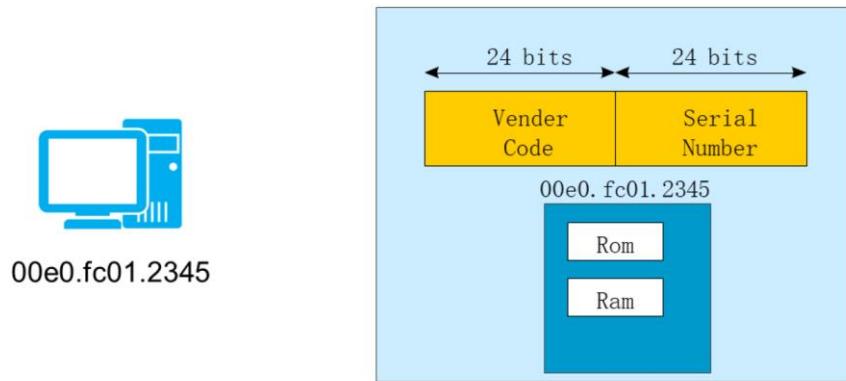
- The main function of the data link layer is to transmit data between the transmit end and the receive end through a physical medium.

## Physical Address (MAC Address) (1)

- A device on the network has a unique address, that is, a MAC address.
- A MAC address consists of 48bit, which is usually represented by a 12-digit hexadecimal number.
- The first six hexadecimal digits are distributed by the IEEE to determine the uniqueness of the vendor.
- The last six hexadecimal digits are managed by each vendor.

## Physical Address (MAC Address) (2)

- The first six digits of the MAC address of Huawei network products are 0x00E0FC.

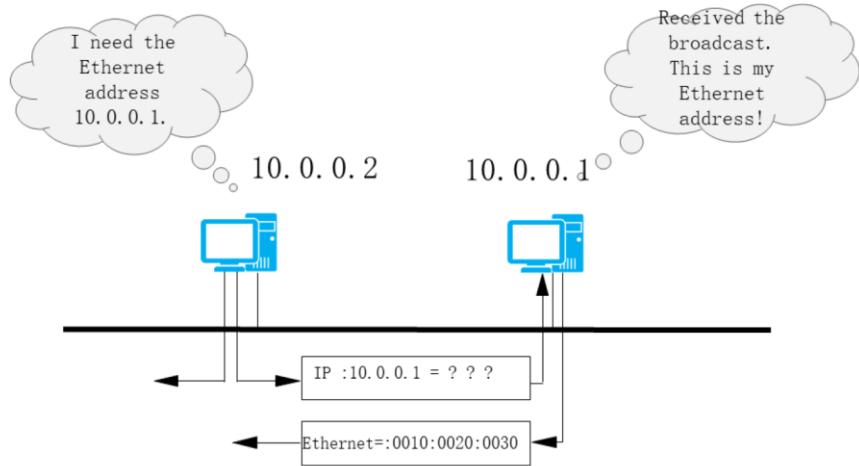


## Address Resolution Protocol (ARP) (1)

- The IP address is only the address of the host at the network layer. To send the data packets from the network layer to the destination host, you must know the physical address of the host.



## Address Resolution Protocol (ARP) (2)



# The Function of Physical Layer

- The physical layer defines the electrical and mechanical processes and functions to activate, maintain, and remove lines when the system is connected at both ends.
- The physical layer defines the following features:
  - Voltage level
  - Data transmission rate
  - Maximum transmission distance
  - Physical connection mode



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# Local Area Network (LAN) and Wide Area Network (WAN)

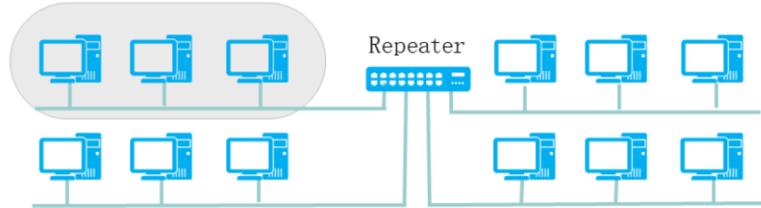
- Different coverage areas:
  - LAN: Facing limited geographical areas
  - WAN: Used for remote connection.
- Different speed:
  - LAN: 10 Mbit/s, 100 Mbit/s, 1000 Mbit/s
  - WAN: 64 kbit/s, 128 kbit/s, 384K, and 2 Mbit/s
- Different technologies

## What is Ethernet

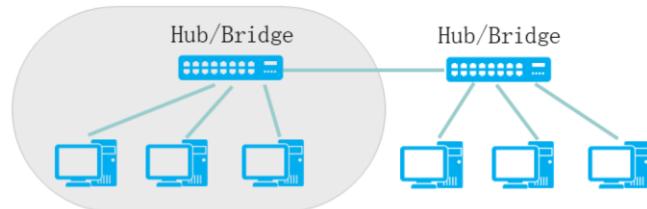
- Ethernet is a LAN implementation technology defined by IEEE Std 802.3. It is a part of the LAN/MAN standard.
- The 802.X protocol cluster defines the network access mode. The switching Ethernet and fast Ethernet technologies are called 802.X protocols.

# Physical Structure of the Ethernet

Bus type (early 10BASE2 and 10BASE5)



Star type (other Ethernet networks later than 10BASE-T)

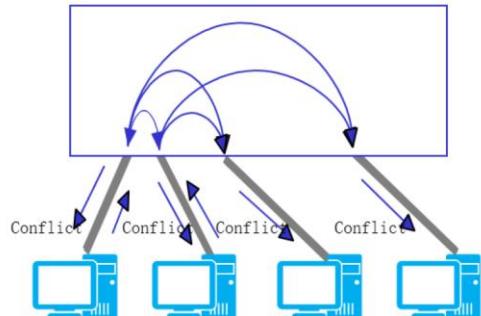


# Working Principles of the Ethernet - CSMA/CD

- CSMA/CD: Carrier sense and conflict detection
  - Carrier sense: Detection before sending
  - Conflict detection: Detection in the sending process
  - Rollback: Processing after a conflict is detected

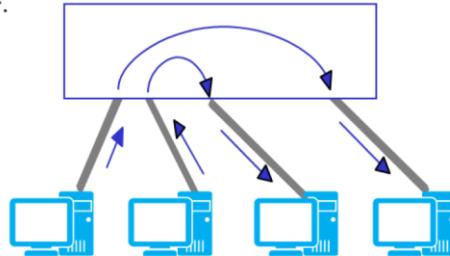
# Shared Ethernet

- Hub
- When any port receives a packet, it directly forwards the packet to all ports. Logically, it is a shared medium.
- If two or more ports receive packets at the same time, a conflict occurs. The DTE performs the CSMA/CD algorithm.
- Only one DTE can send packets at a time.



# Switched Ethernet

- Bridge (LAN SWITCH)
- Learning addresses based on the SA of the received packets and establishing the mapping between addresses and ports.
- After receiving the packet, the system queries the table according to the DA value of the packet and forwards the packet to a specific port.
- Multiple DTEs can transmit data at a certain time without interfering with each other.



# Shared Ethernet vs Switched Ethernet

	Shared Ethernet	Switched Ethernet
Topology Structure	Bus or star topology	star topology
Working Mode	Half-duplex	Full-duplex
Bandwidth	Shared media bandwidth	Exclusive media bandwidth
Device	Hub, Repeater	Bridge
Device Processing Layer	Physical layer	MAC layer
Main Technologies	CSMA/CD	Address learning and switching
Device Complexity	Simple	Complex

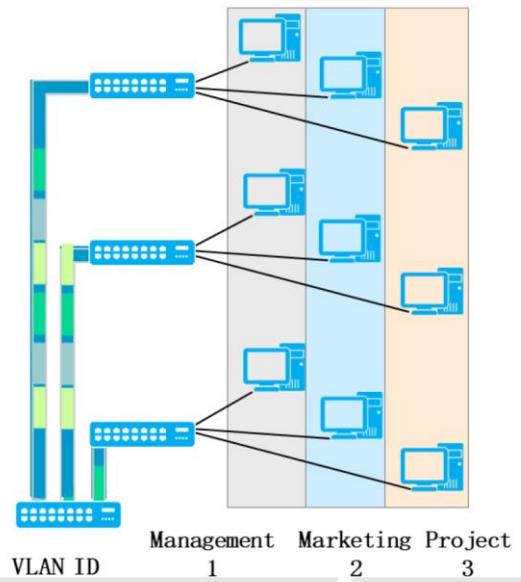


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# VLAN Definition

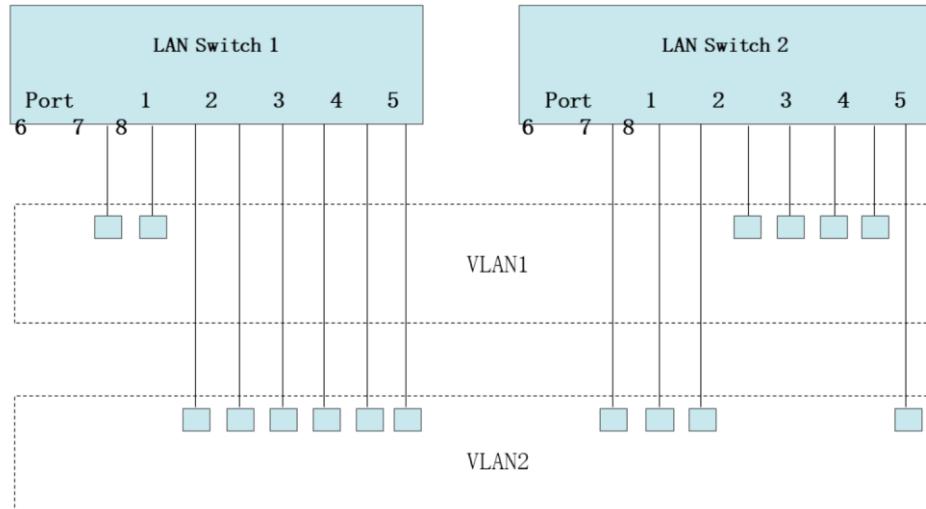
- A virtual local area network (VLAN) is a group of terminal groups that are logically divided from users and servers on different physical network segments. The functions and operations of a VLAN are similar to those of a traditional LAN.



## VLAN Division

- Divide VLANs based on ports.
- Divide VLANs based on MAC addresses.
- Divide VLANs based on network protocols:
  - Divide VLANs based on protocol types, such as IP VLAN and IPX VLAN.
  - Divide VLANs based on network layer addresses (such as IP addresses).
- Generally, VLANs are divided based on ports.

## Divide VLANs Based on Ports



## Advantages of VLAN

- Virtual Work Group
- Reduce the number of routes for broadcast capacity.
- Security

## Quiz

1. Which of the following IP addresses belong to class B? ( )
  - A. 192. 168. 1. 4
  - B. 8. 8. 8. 8
  - C. 172. 16. 23. 3
  - D. 172. 30. 1. 1
2. Which of the following statements about MAC addresses are correct? ( )
  - A. A device on the network has a unique address, that is, a MAC address.
  - B. The MAC address consists of 48bit, which is usually represented by a 12-digit hexadecimal number.
  - C. The MAC address is a logical address and can be configured as required.

- Answers:

1. CD.
2. ABD.



## Summary

- Functions of TCP/IP layers
- Functions and formats of IP addresses
- Functions of IP routes
- VLAN definition
- VLAN division mode
- Benefits of dividing a VLAN

**Thank You**

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