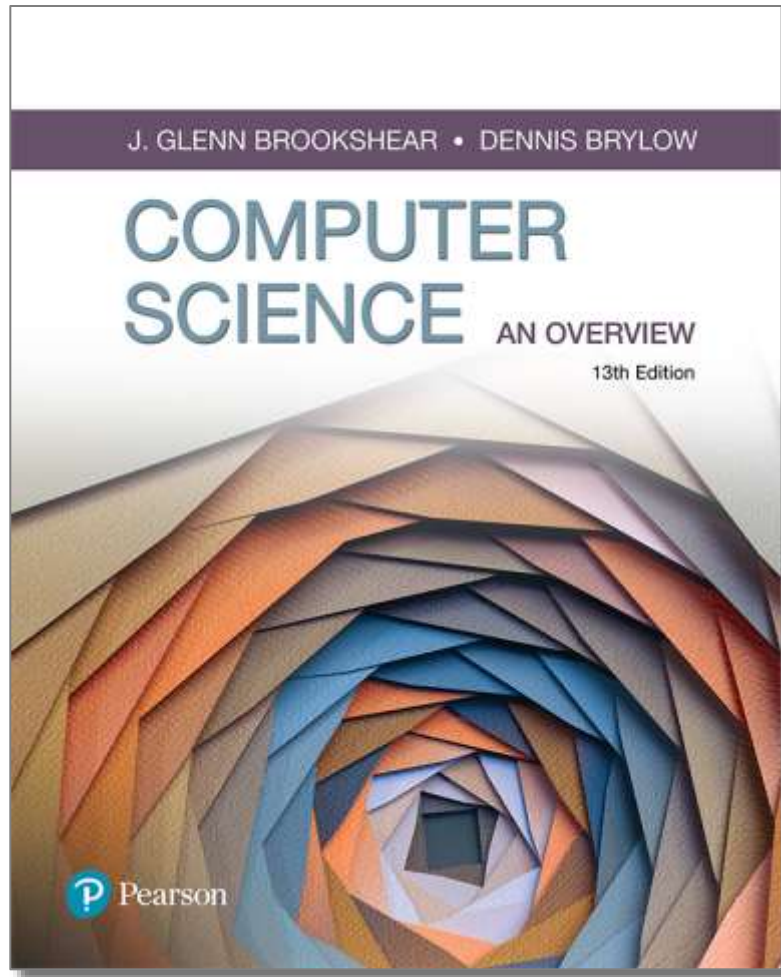


# Computer Science An Overview

13<sup>th</sup> Edition



## Chapter 4

Networking and  
the Internet

# Chapter 4: Networking and the Internet

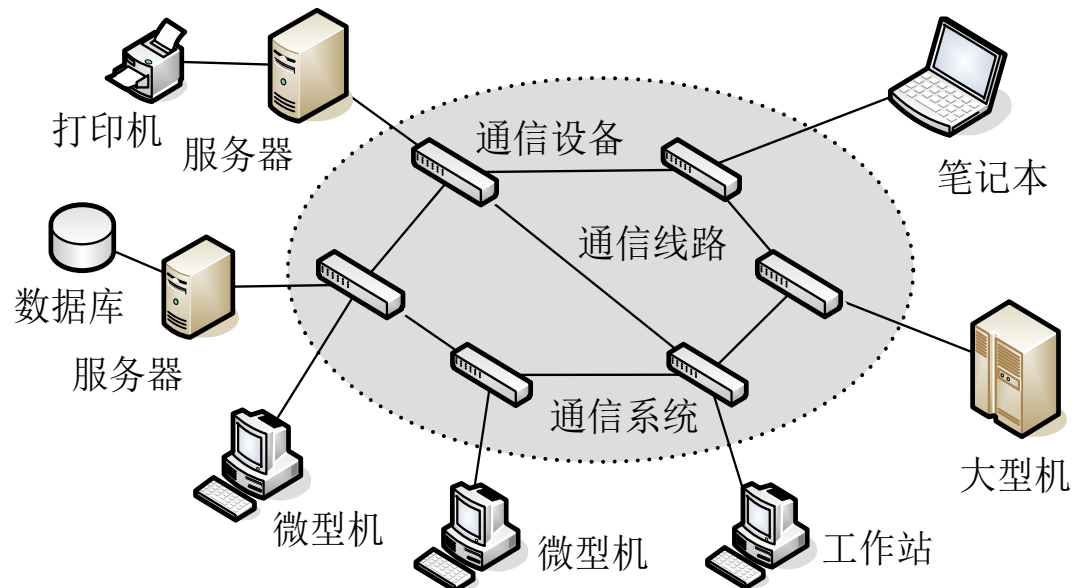
- 4.1 Network Fundamentals
- 4.2 The Internet
- 4.3 The World Wide Web
- 4.4 Internet Protocols
- 4.5 Simple Client Server
- 4.6 Security

# 4.1 Network Fundamentals

- Network Software allows users to exchange information and share resources
  - Content
  - Software
  - Data storage facilities
- Network software has evolved into a network-wide operating system

# What is a computer network?

- How many devices? 2 or more
- Connected
- Sharing resources



# Element of a computer network

- Sender / Receiver
- Messages (signal)
- Media
- Protocol (rules)

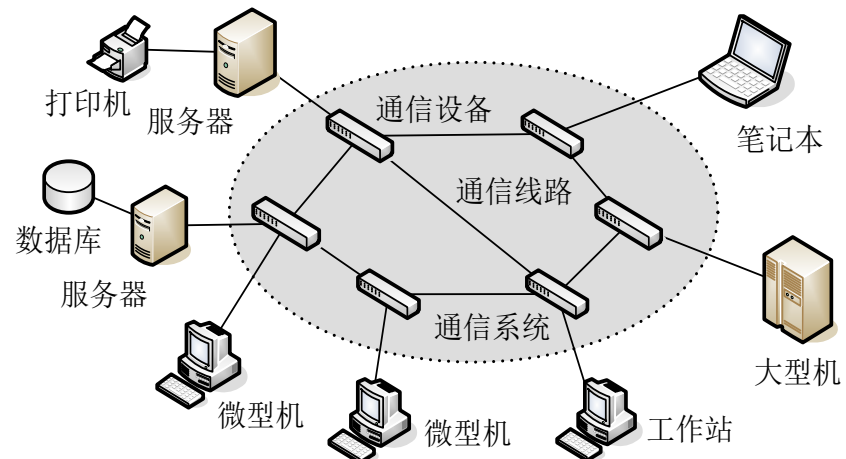
# What is the computer network ?

**A computer network**, often simply referred to as a network, is a collection of hardware components and computers interconnected by communication channels that allow sharing of resources and information

Network techniques:

Communication

Computer science



# What are the functions of the network?

➤ **Data communication**

**e.g. email, e-businness, etc.**

➤ **Resource-sharing**

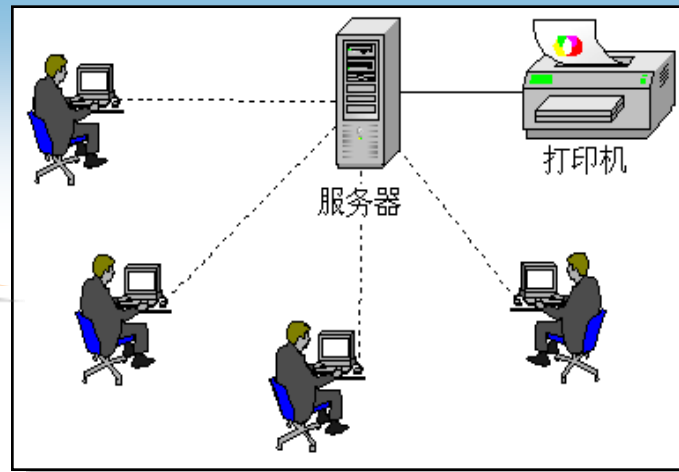
**e.g. share the hardware, software and data resource**

➤ **Distributed processing**

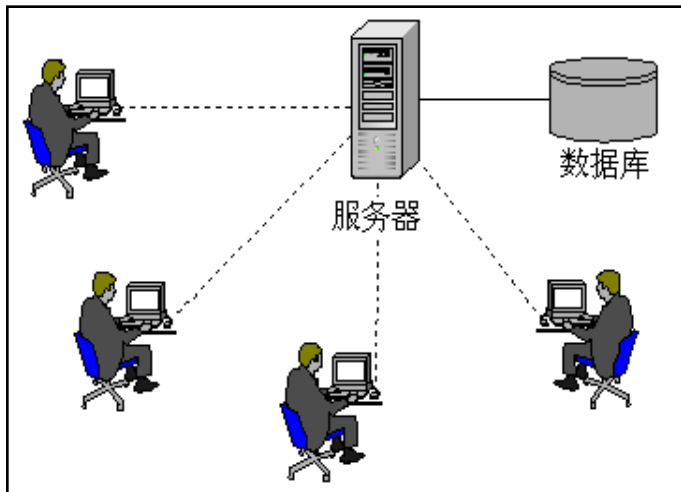
**Divide the complicated problem into sub problems to process**

# Resource sharing

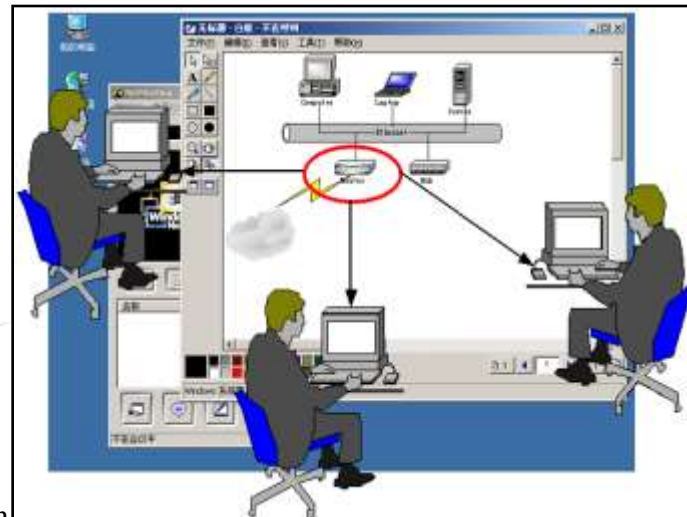
Hardware



Data



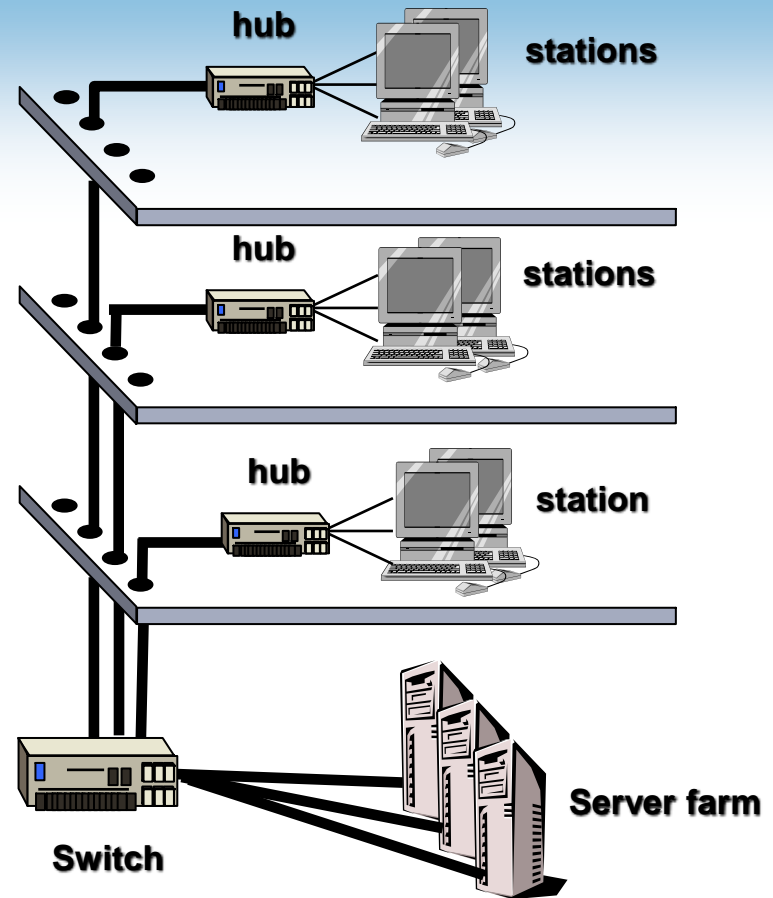
Software

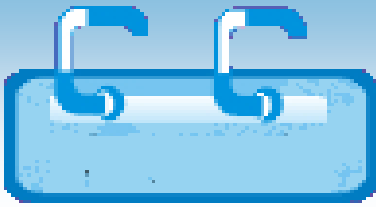




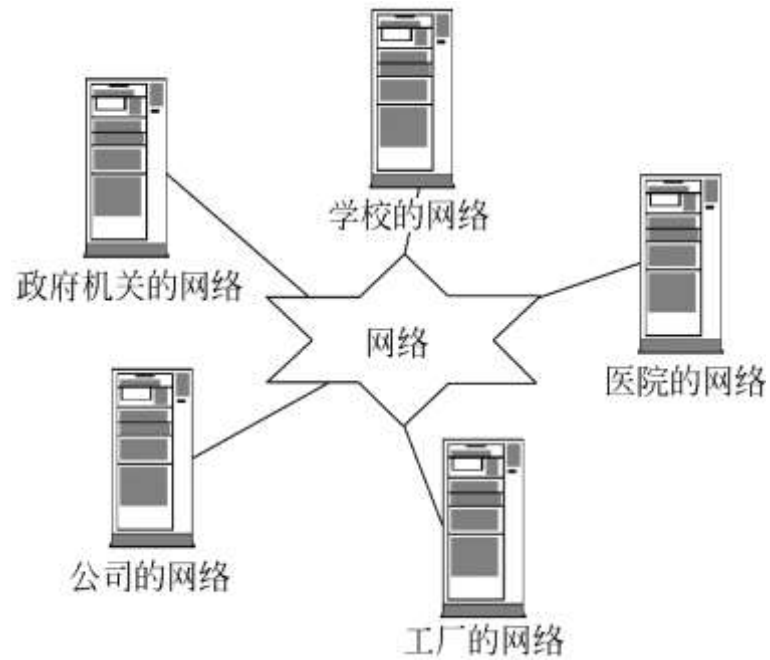
# Network Classifications

- Scope
  - Personal Area Network (short-range)
  - Local Area Network (building/campus)
  - Metropolitan Area Network (community)
  - Wide Area Network (greater distances)
- Ownership
  - Closed versus open
- Topology (configuration)
  - Bus (Ethernet)
  - Star (Wireless networks with central Access Point)



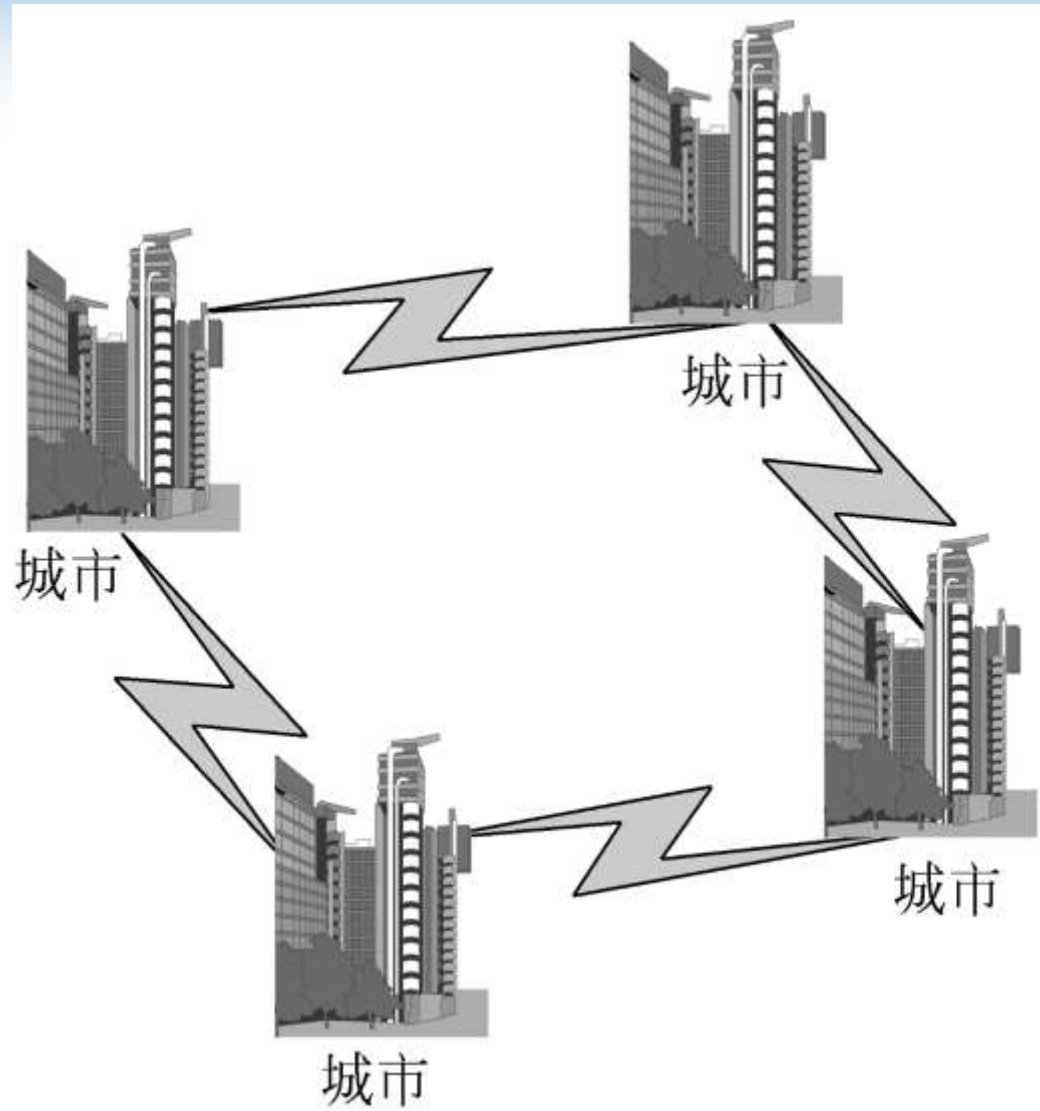


**MAN**

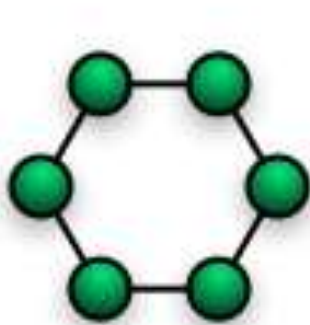




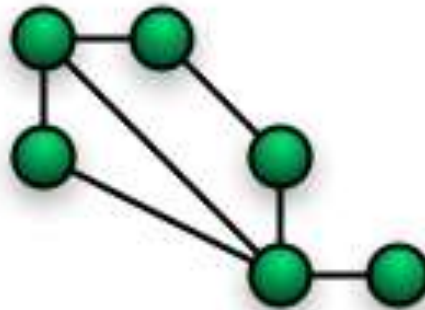
**WAN**



# Various topologies



Ring



Mesh



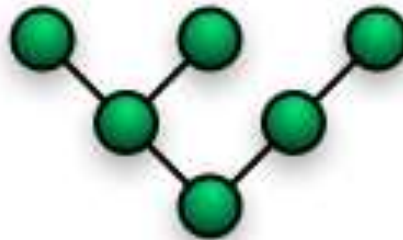
Star



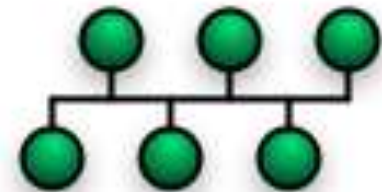
Fully Connected



Line



Tree

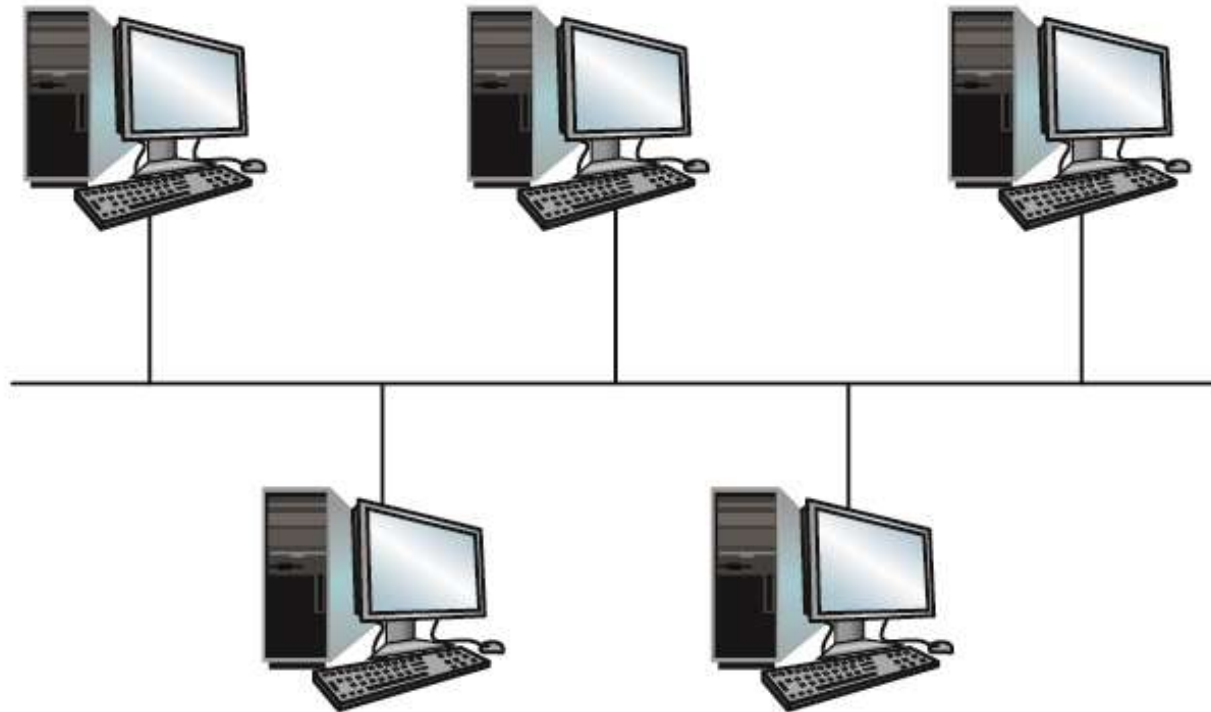


Bus

Wikipedia

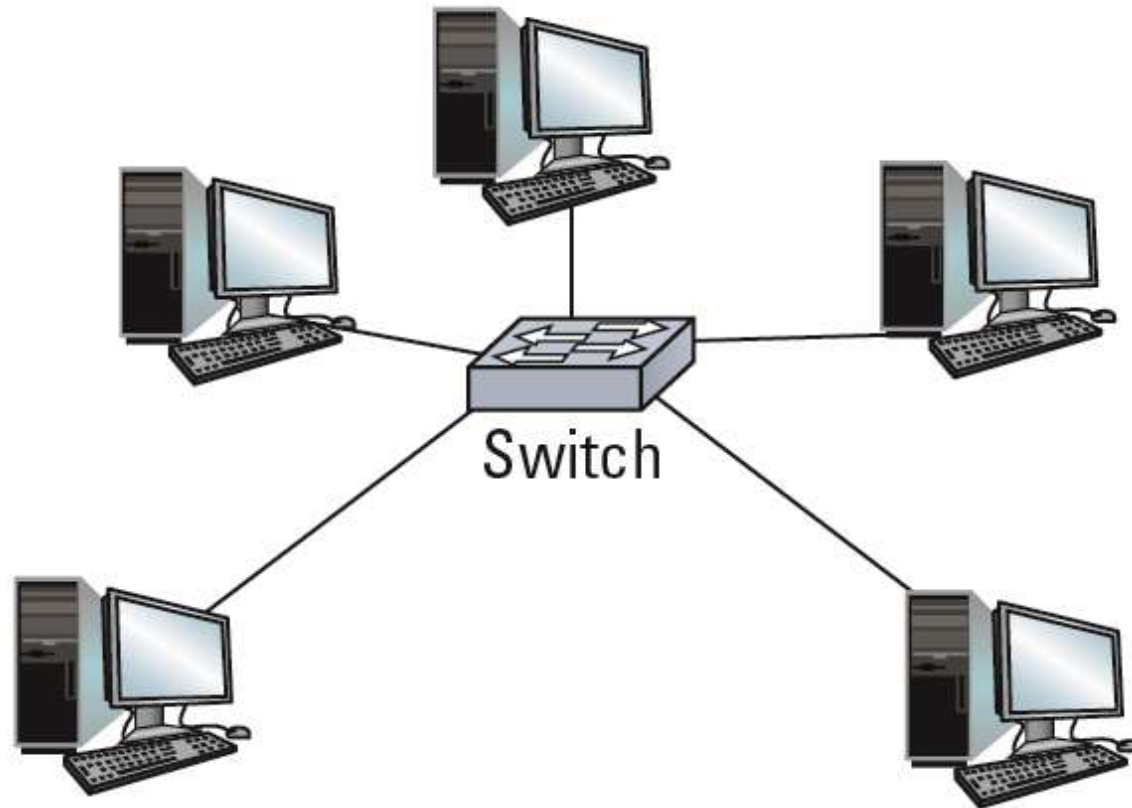
# Figure 4.1 Two popular network topologies (1 of 2)

a. Bus



# Figure 4.1 Two popular network topologies (2 of 2)

## b. Star



# Network Topologies

- Topology - Physical and logical network layout
  - Physical – actual layout of the computer cables and other network devices
  - Logical – illustrates how data flows within a network, regardless of its physical design.
  - Common topologies:
    - Bus, ring, star, mesh and wireless



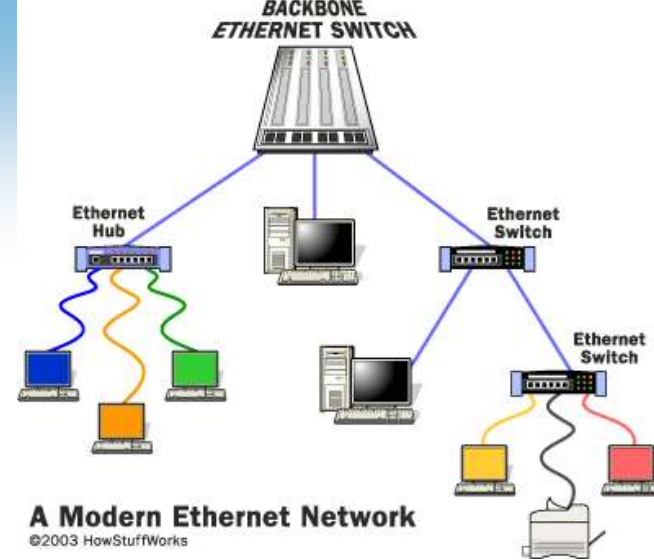
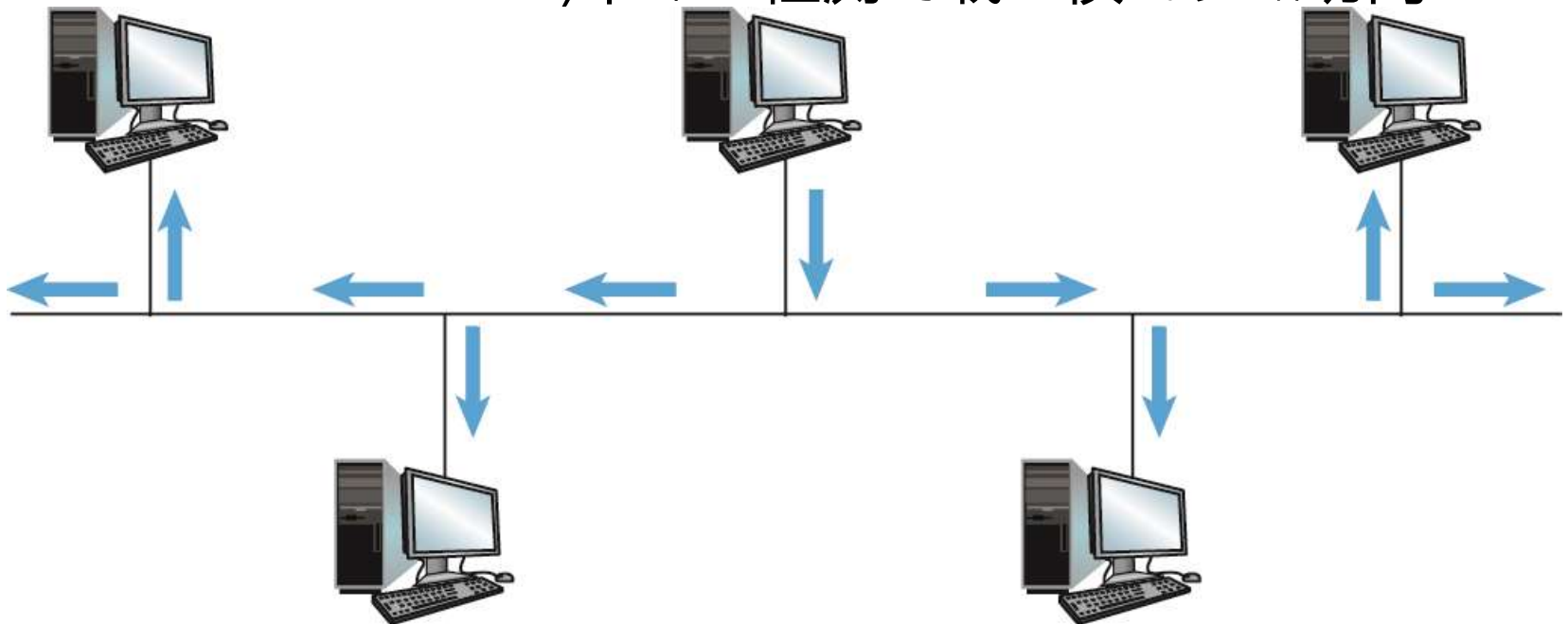
# Protocols

- Rules by which activities are conducted on a network
  - Example: Coordinating the transmission of messages between computers
    - Need to avoid all machines transmitting at the same time
- Allows vendors to build products that are compatible with products from other vendors

# Topology

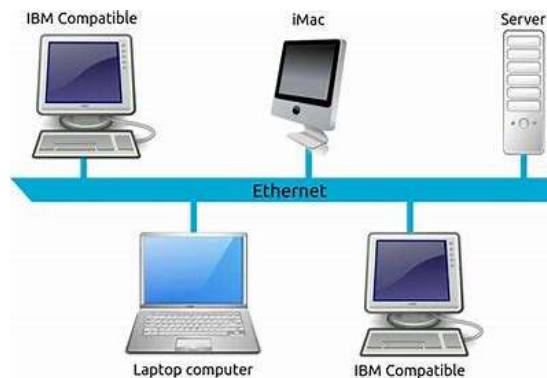
- Bus

- Ethernet (以太网)
- Protocol: CSMA/CD (Carrier Sense, Multiple Access with Collision Detection) 带冲突检测的载波侦听多路访问



# Ethernet

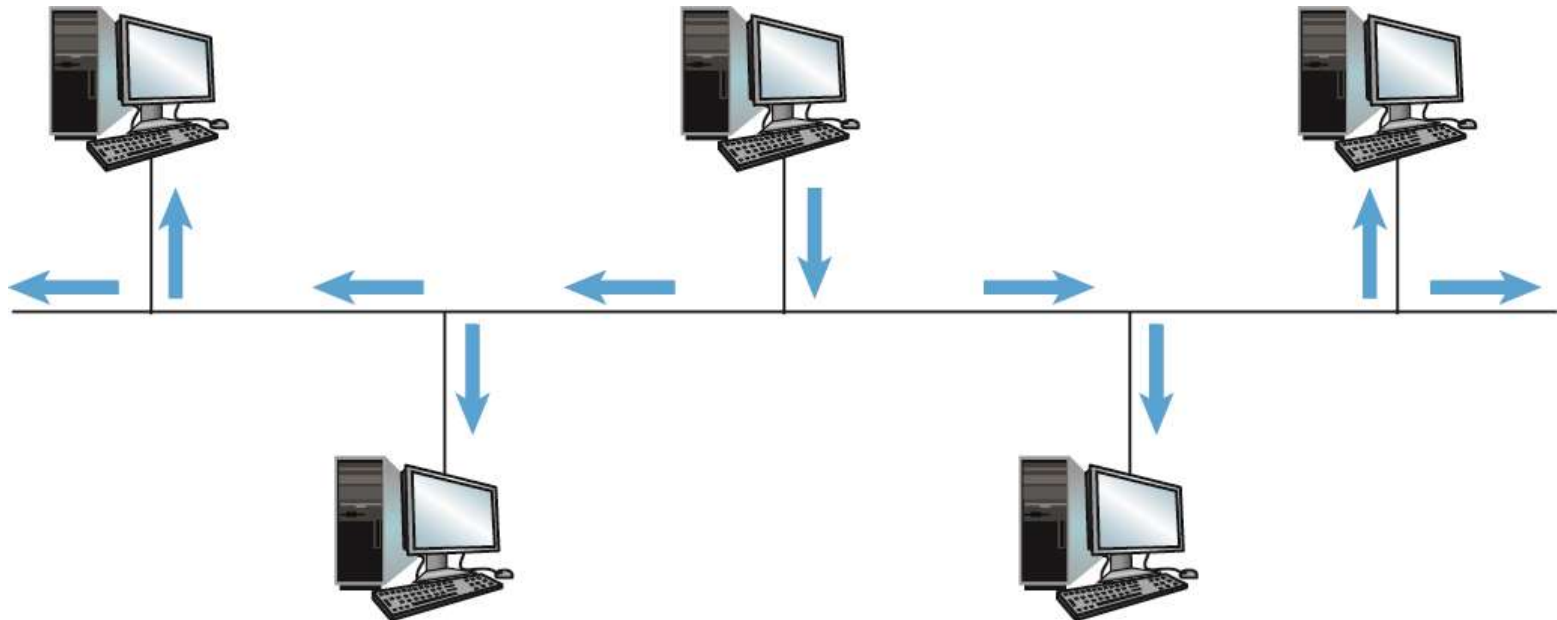
- Ethernet is a system for connecting a number of computer systems to form a local area network, with protocols to control the passing of information and to avoid simultaneous transmission by two or more systems



Bus topology

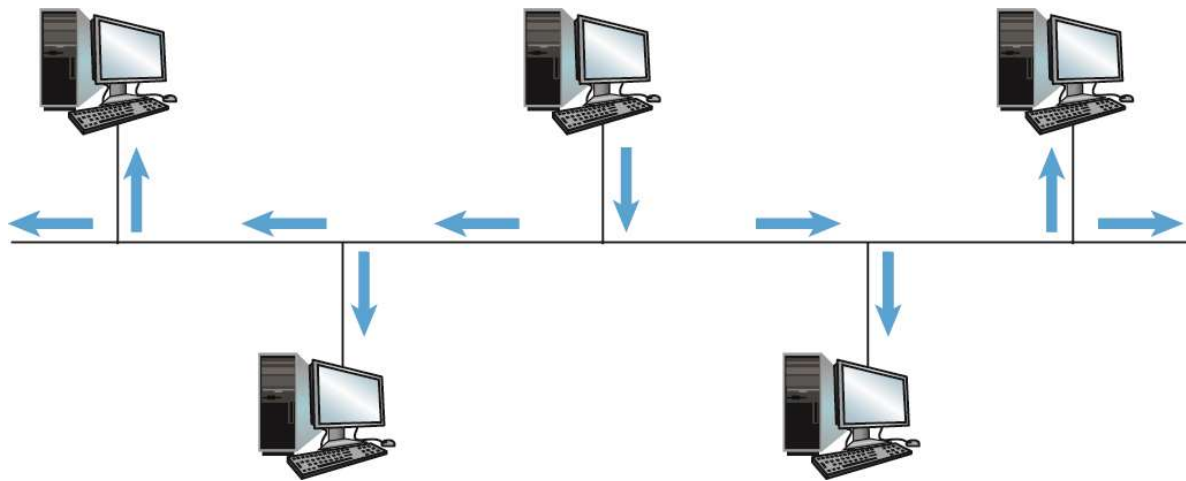
# CSMA/CD

- Protocol: CSMA/CD (Carrier Sense, Multiple Access with Collision Detection) 使用载波监听多路访问及冲突检测技术



# CSMA/CD

- Protocol: CSMA/CD (Carrier Sense, Multiple Access with Collision Detection)使用载波监听多路访问及冲突检测技术

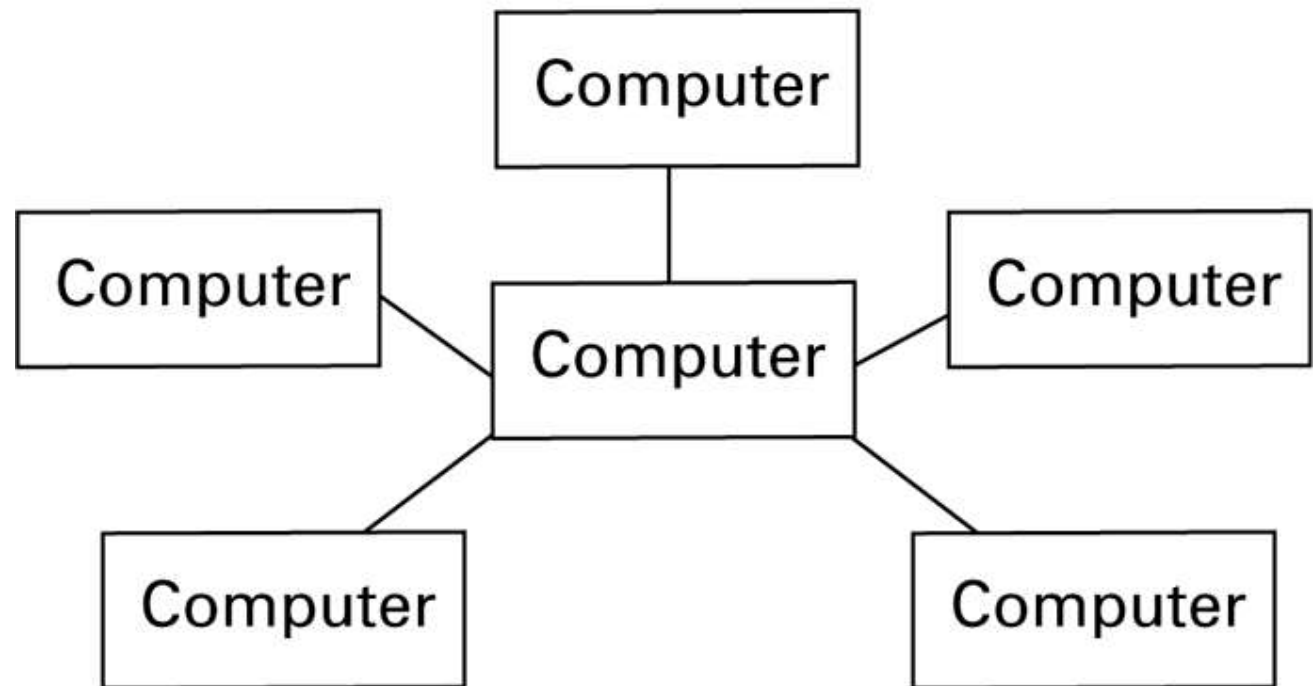


载波监听是指每个站点在发送前和发送中都必须不停地检测信道，在发送前检测信道是为了获得发送权，在发送中检测信道是为了及时发现发送的数据是否发生了碰撞。站点要发送数据前先监听信道，只有信道空闲才能发送，碰撞检测（Collision Detection）就是边发送边监听，如果监听到了碰撞，则立即停止数据发送，等待一段随机时间后，重新开始尝试发送数据。

CSMA/CD 的工作流程可简单概括为“先听后发，边听边发，冲突停发，随机重发”。

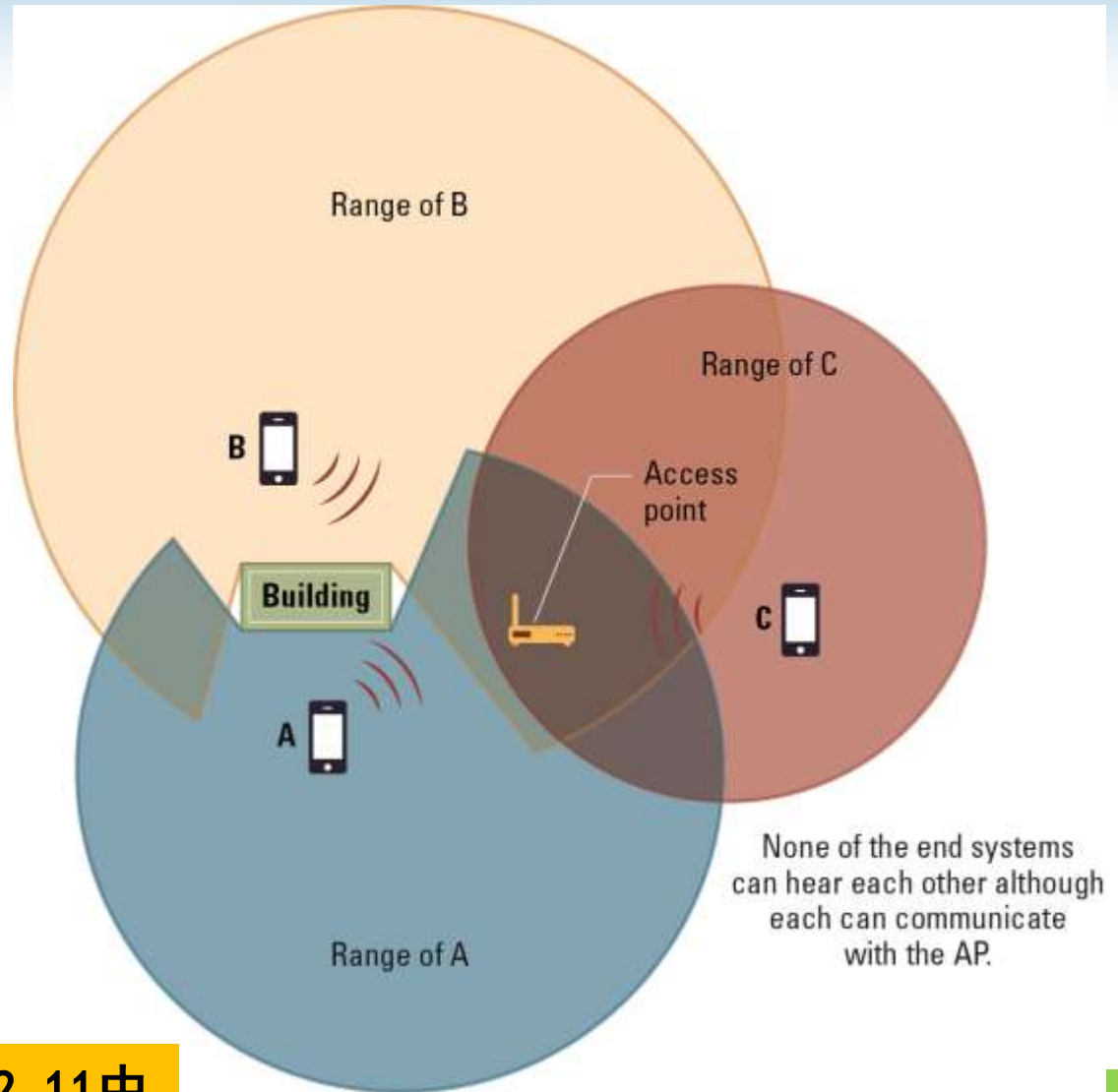
# Topology (logical)

- Star
  - Wireless
  - Protocol: CSMA/CA带冲突避免的载波侦听多路访问



# CSMA/CA带冲突避免的载波侦听多路访问

- Carrier Sense, Multiple Access with Collision Avoidance
  - Used in WiFi
  - Hidden terminal problem
  - Wait with priority
  - confirmation



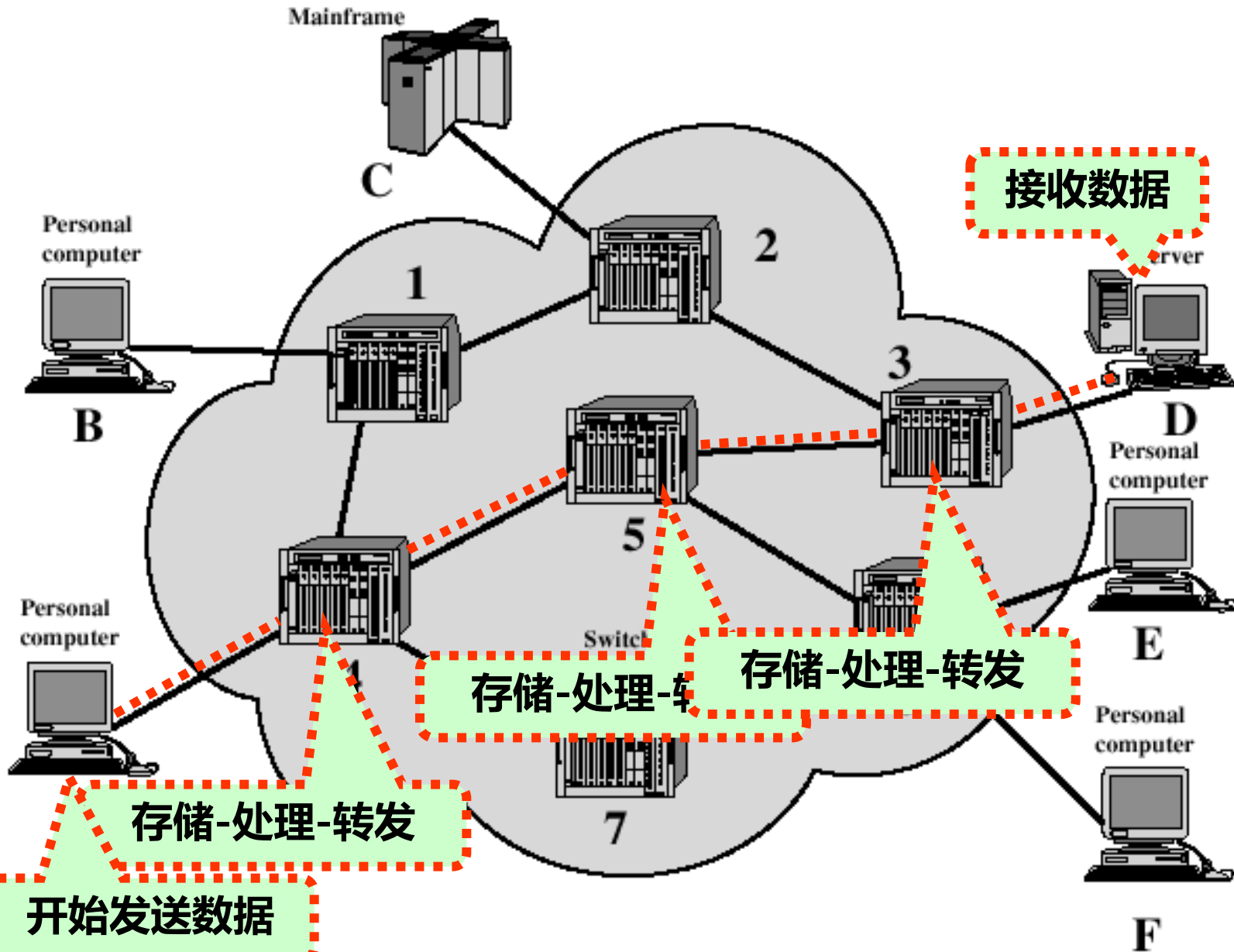
CSMA/CA的很多策略是IEEE802.11中定义的协议下标准化的，通常称为无线保真（WiFi）

Hidden terminal problem  
隐蔽终端问题

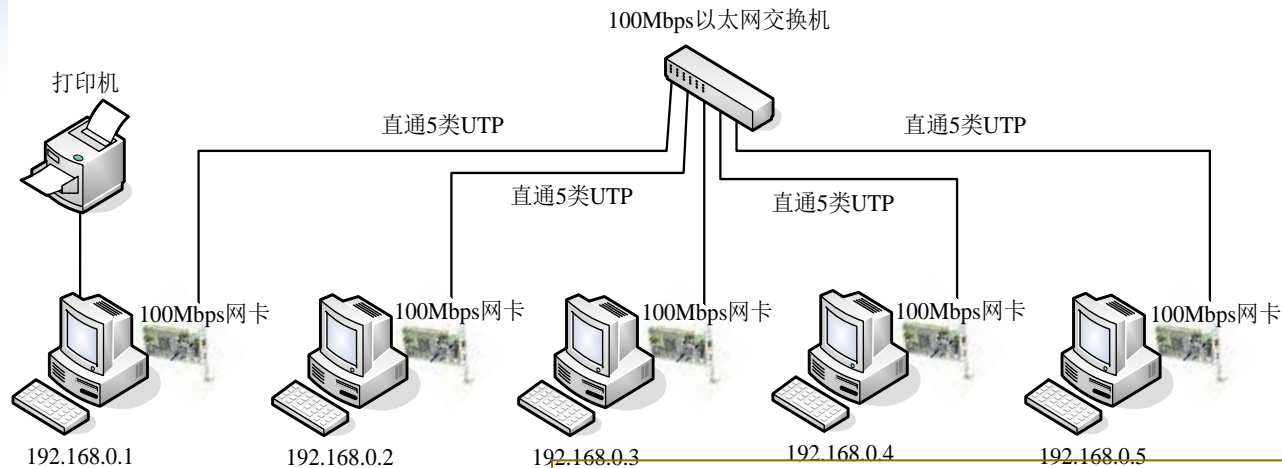
- 网络拓扑可以根据通信子网中通信信道类型分为两类：
  - 点到点线路通信子网（如：星型）
  - 广播信道通信子网（如：总线型）



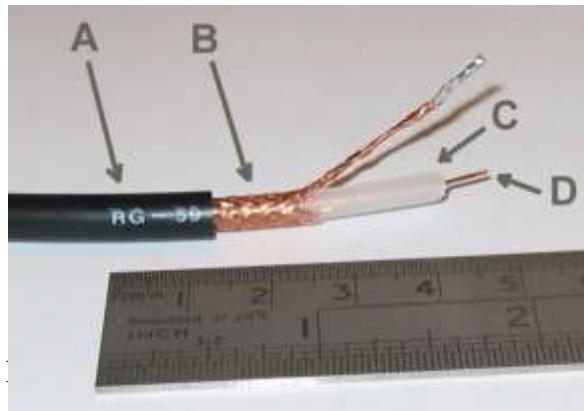
# 点到点式网络



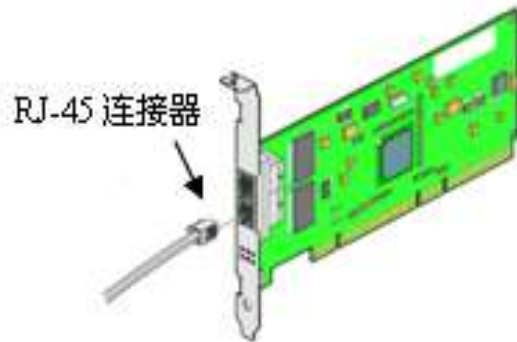
# Build a local area network



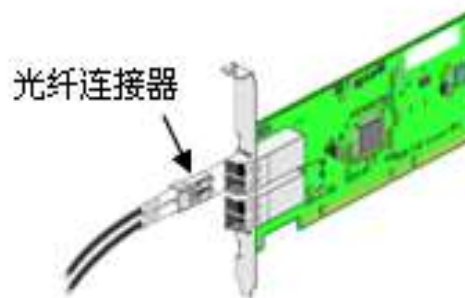
**Components :**  
**Switch**  
**Network adapter**  
**Network communication wires**



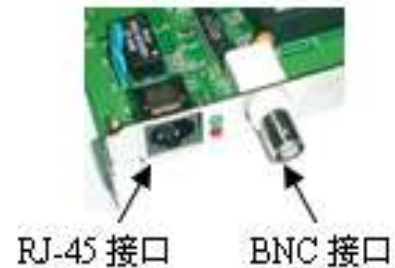
# Network Adapter



(a) RJ-45 接口网卡



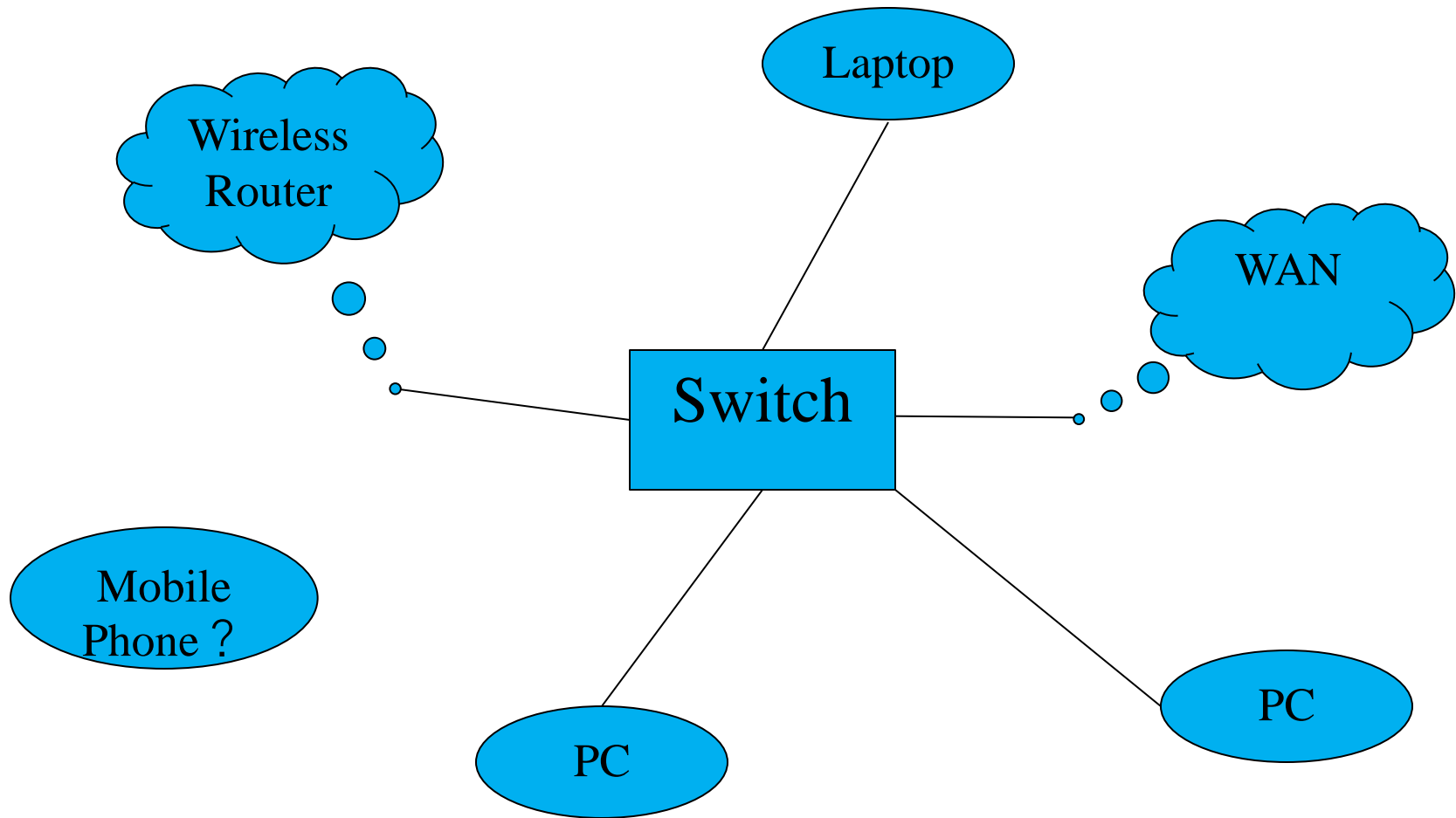
(b) 光纤接口网卡



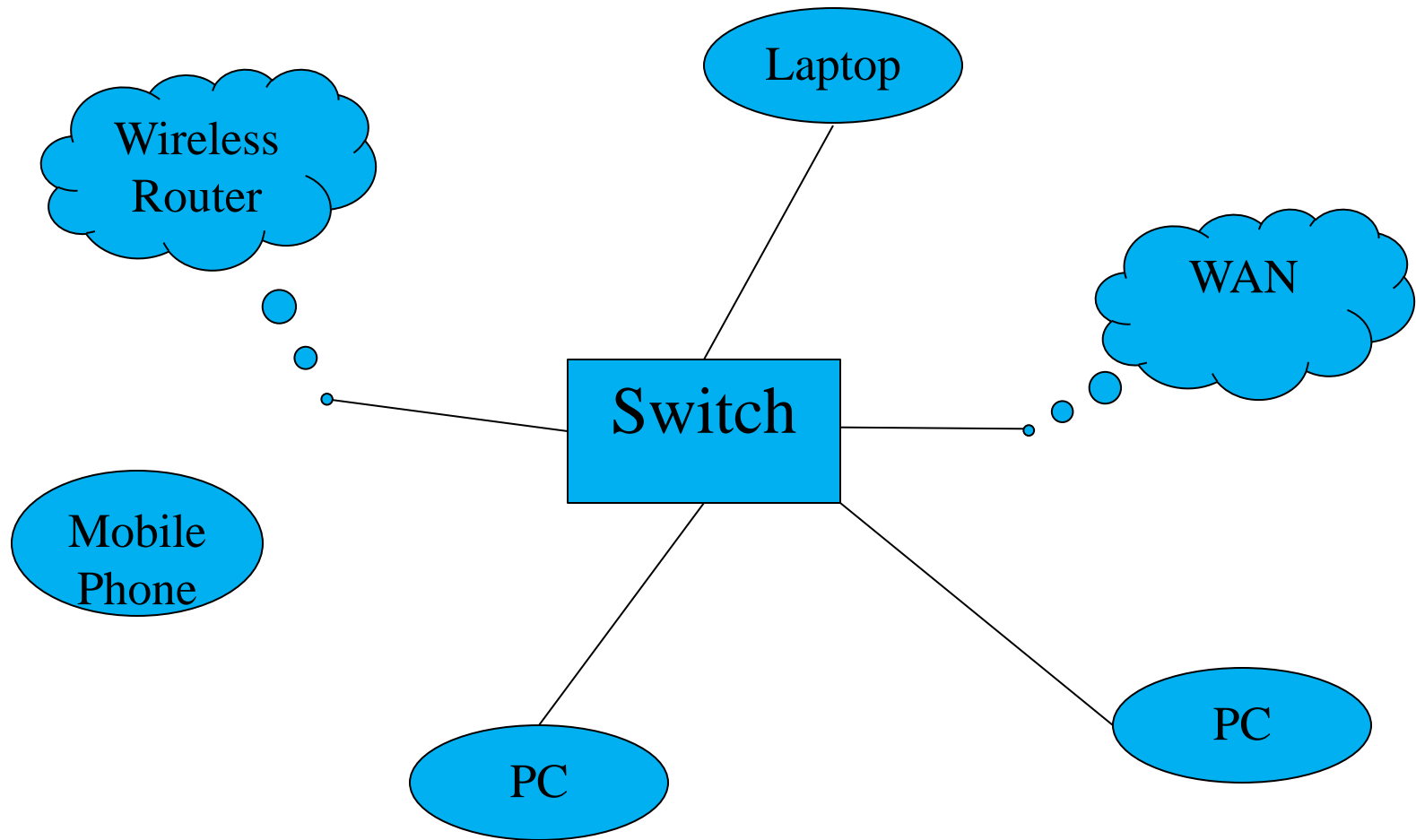
(c) 双接口网卡



# How to build a LAN?



# How to build a LAN?



# Connecting Networks

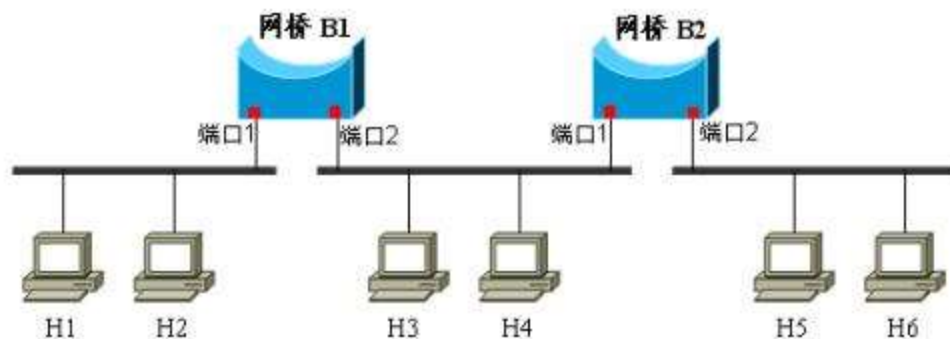
- **Repeater:** Extends a network
- **Bridge:** Connects two compatible networks
- **Switch:** Connect several compatible networks
- **Router:** Connects two incompatible networks resulting in a network of networks called an **internet**

# Connecting Networks

- **中继器 (Repeater)**：网络物理层上面的连接设备。适用于完全相同的两类网络的互连，通过对数据信号的重新发送或者转发，来扩大网络传输的距离，是两个原始总线间简单地来回传送信号



- **网桥 (Bridge)**：也叫桥接器，是连接两个局域网的一种存储/转发设备，要检查每条报文的目的地址，并且当该报文的目的地址是另一边的计算机时才将其在线路上传输



- **交换机(Switch)**

扩大网络的器材，能为子网络中提供更多的连接端口，以便连接更多的计算机



- **路由器(Router)**

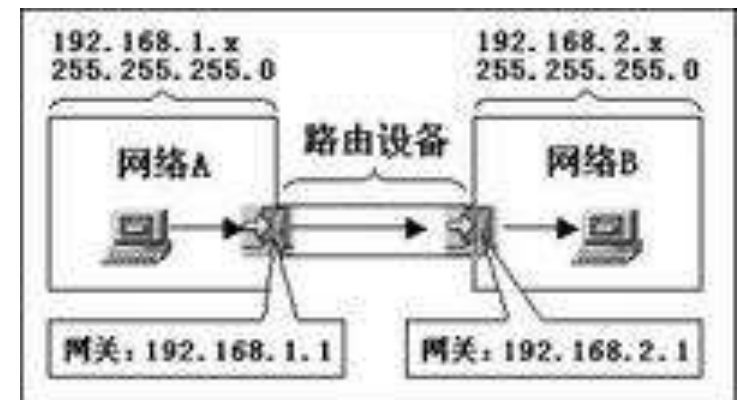
连接因特网中各局域网、广域网的设备，它会根据信道的情况自动选择和设定路由，以最佳路径，按前后顺序发送信号





- **网关(gateway)**

- 复杂的网络互连设备，仅用于两个高层协议不同的网络互连。是一种充当转换重任的计算机系统或设备。在使用不同的通信协议、数据格式或语言，甚至体系结构完全不同的两种系统之间，网关是一个翻译器。与网桥只是简单地传达信息不同，网关对收到的信息要重新打包，以适应目的系统的需求。



# Hub (集线器)

- the *simplest* of these devices
- **cannot filter data** so data packets are sent to all connected devices/computers
- **Bandwidth of each port: Total bandwidth / W (numbers of ports)**

**Bandwidth 带宽**：发送信号中含有的有效成分的**频率范围**。  
在数据系统中，**带宽**用比特每秒（b/s）来度量

**Bandwidth**：10M bps 100M bps 1000M bps



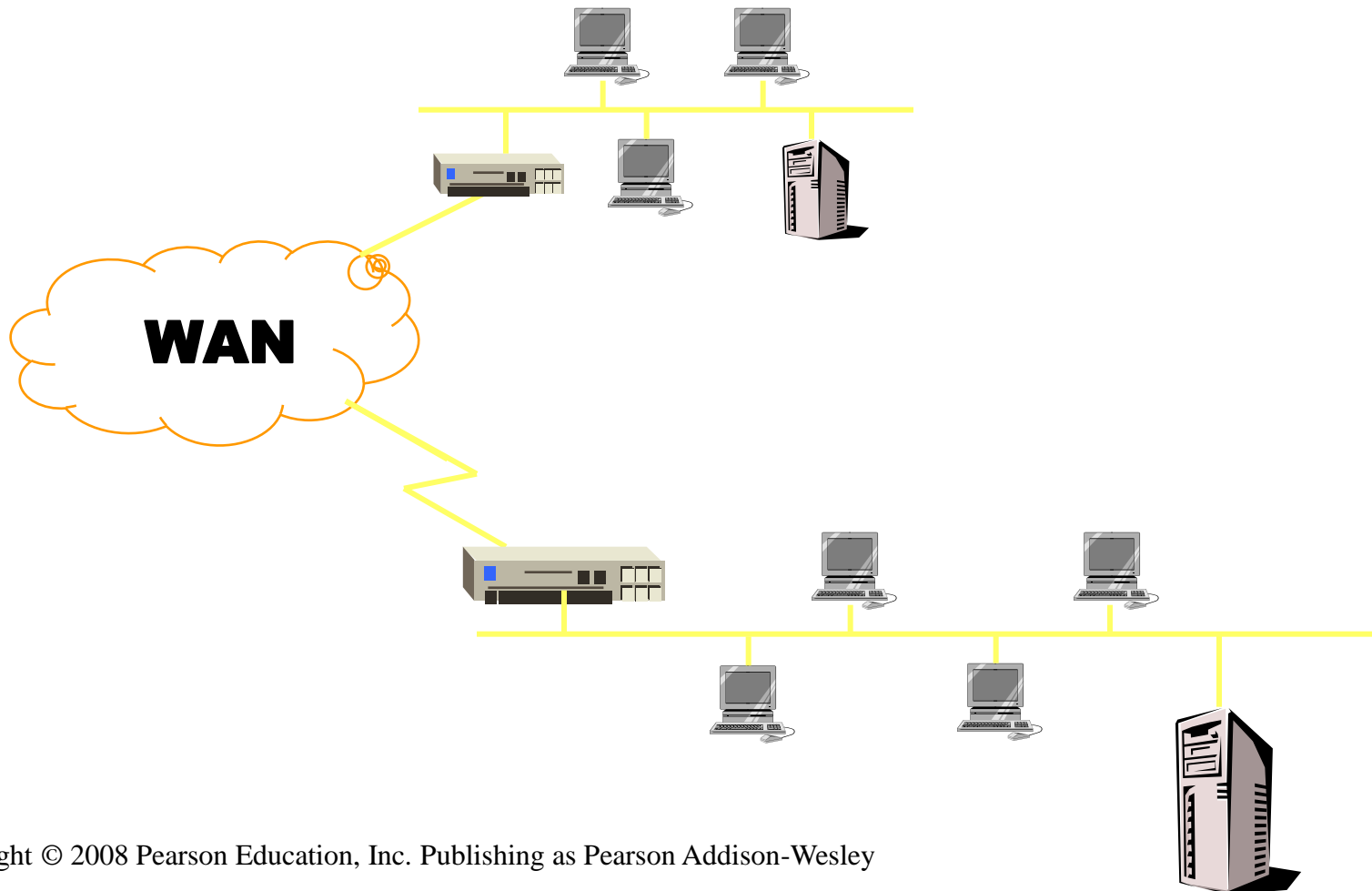
# Switch(交换机)

- ***maintains a MAC address table  
(网络设备的物理地址表)***
- ***filters traffic on the LAN***
- ***looks at the destination of the packet before forwarding***
- **Each port: Total bandwidth**



# Router

**A router is a device that forwards data packets between computer networks**

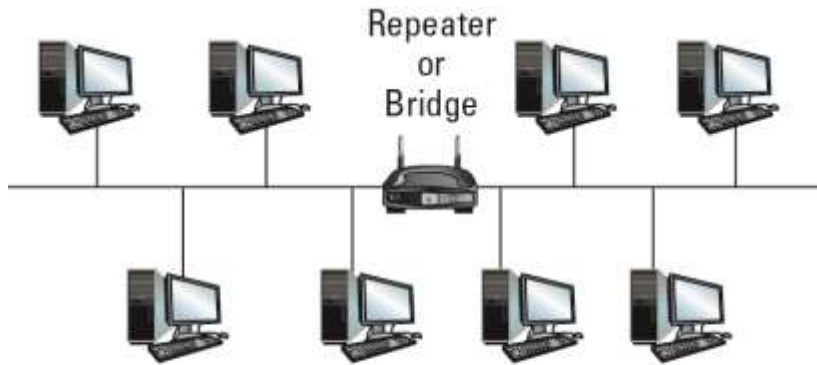


# Router

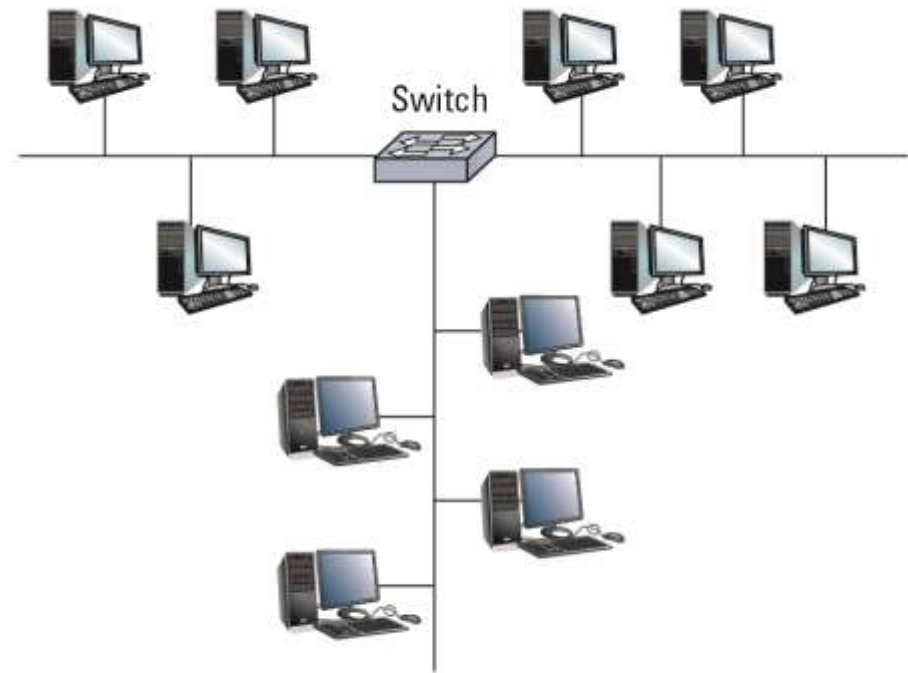
- *uses the IP address to forward packets*
- *forward packets based on software*
- *support different WAN technologies* but switches do not
- Wireless Routers have ***Access Point built in***



# Figure 4.4 Building a large bus network from smaller ones

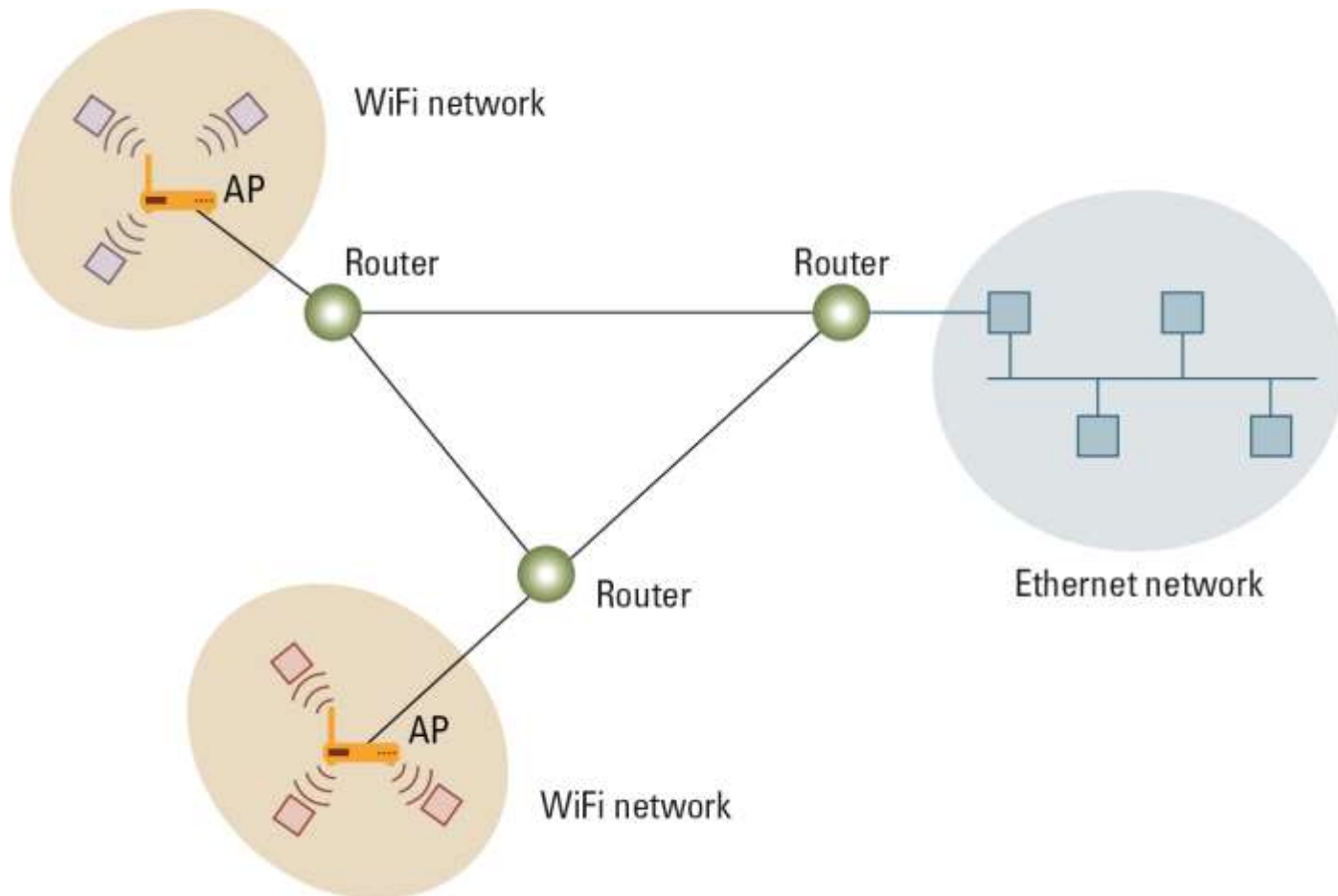


**a.** A repeater or bridge connecting two buses



**b.** A switch connecting multiple buses

# Figure 4.5 Routers connecting two WiFi networks and an Ethernet network to form an internet

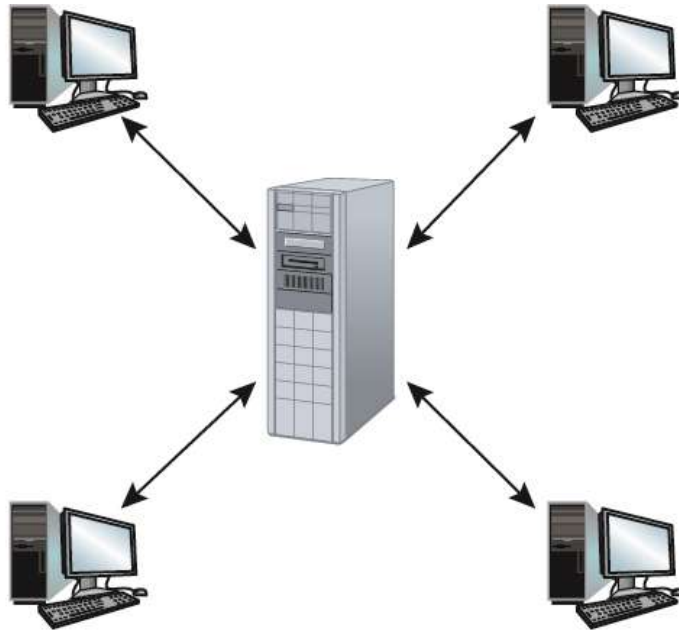


# Methods of Process Communication

- Client-server
  - Many clients, one server (executing continuously)
  - Clients make requests of other processes
  - Server satisfies requests made by clients
- Peer-to-peer (P2P)对等网
  - Two processes communicating as equals
  - Processes execute on a temporary basis



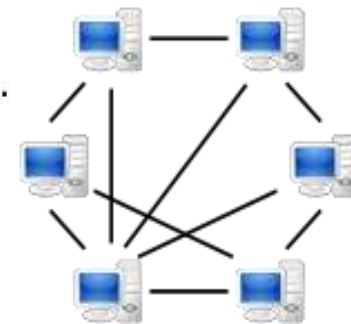
# Figure 4.6 The client/server model compared to the peer-to-peer model



**a.** Server must be prepared to serve multiple clients at any time.



**b.** Peers communicate as equals on a one-to-one basis.



# 对等网

- 通常是由**计算机**组成的**工作组**
- **计算机**无主从之分
- 网上任意**节点**既可以作为**网络服务器**，也可以作为**工作站**
- 任一台**计算机**均可**同时**兼作**服务器**和**工作站**，也可只作其中之一
- **对等网**除了共享文件之外，还可以共享打印机

P2P网络最常见的用途之一是文件共享。用户可以通过P2P网络共享和下载文件，而无需借助中央服务器。这种方式可以提供更快速的下载速度，因为文件可以同时从多个节点下载。比如：BitTorrent和eMule

# Server/Client



## (Server)

**A computer or computer program that manages access to a centralized resource or service in a network.**

## (Client)

**Common computers**

## Working styles

**(Client/Server, C/S)**

**(Browser/Server, B/S)**

## **C/S** : Client/Server(客户机/服务器)结构

- 任务合理分配到Client端和Server端
- 降低了系统的通讯开销
- 充分利用两端硬件环境的优势

## **B/S** : Browser/Server(浏览器/服务器)结构

- 用户界面完全通过WWW浏览器实现
- 一部分事务逻辑在前端实现
- 主要事务逻辑在服务器端实现

# Distributed Systems

- Systems units that execute as processes on different computers
  - Cluster computing
    - Independent computers work closely together instead of a single, much larger machine
  - Grid computing
    - Millions of home PCs (not connected to each other) work on a complex problem
  - Cloud computing
    - Provide services, hide the details

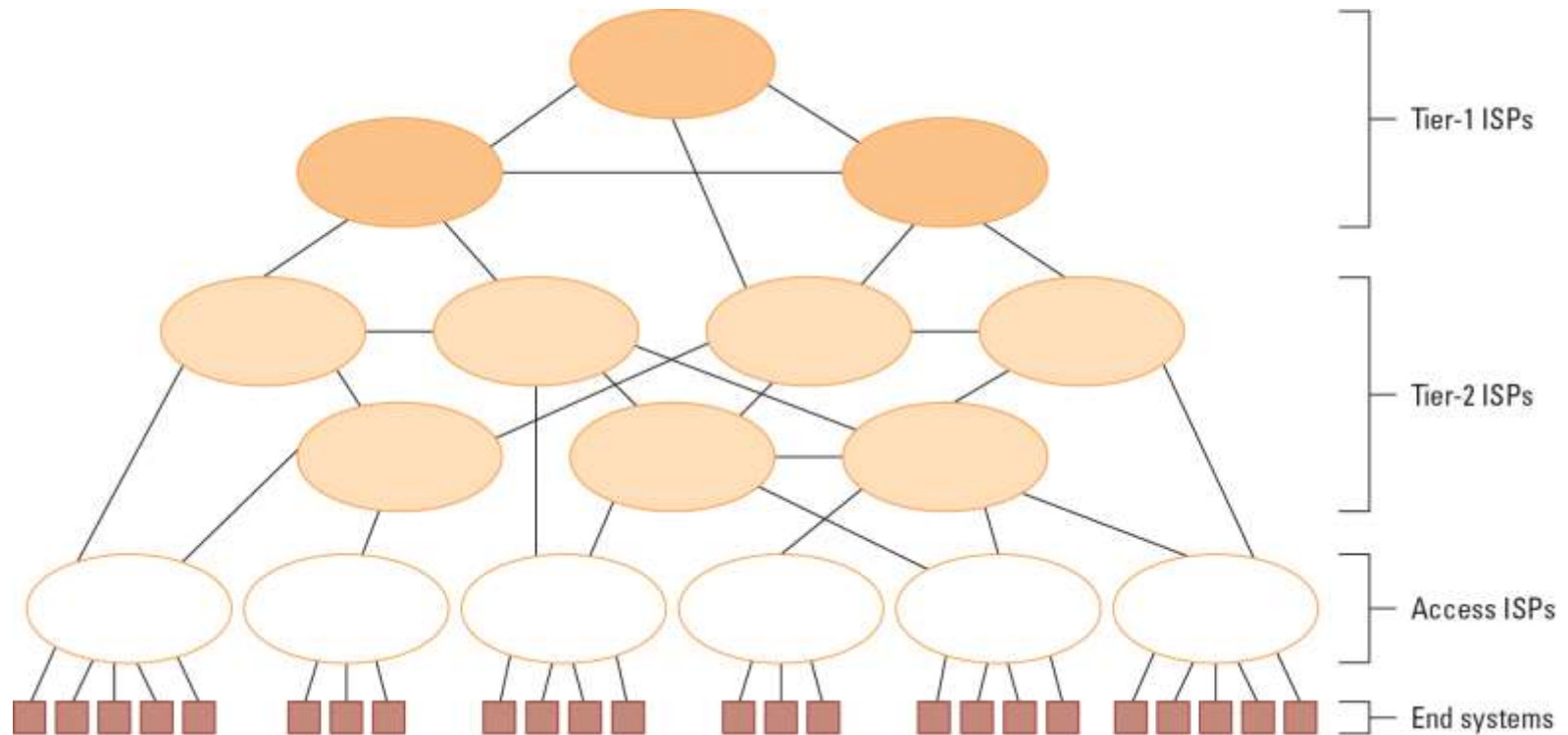
•**Cluster computing:** 通常由几十到几百个紧密连接的计算机节点组成，这些节点位于同一个局域网内（LAN）或至少在相近的地理位置。集群中的节点通常具有相同的硬件配置和操作系统。

•**Grid computing:** 可以覆盖更广泛的地理范围，可能包含数千甚至数万个节点，这些节点可能分布在不同的地理位置，并通过广域网（WAN）连接。网格中的节点可能有不同的硬件配置和操作系统。

## 4.2 The Internet

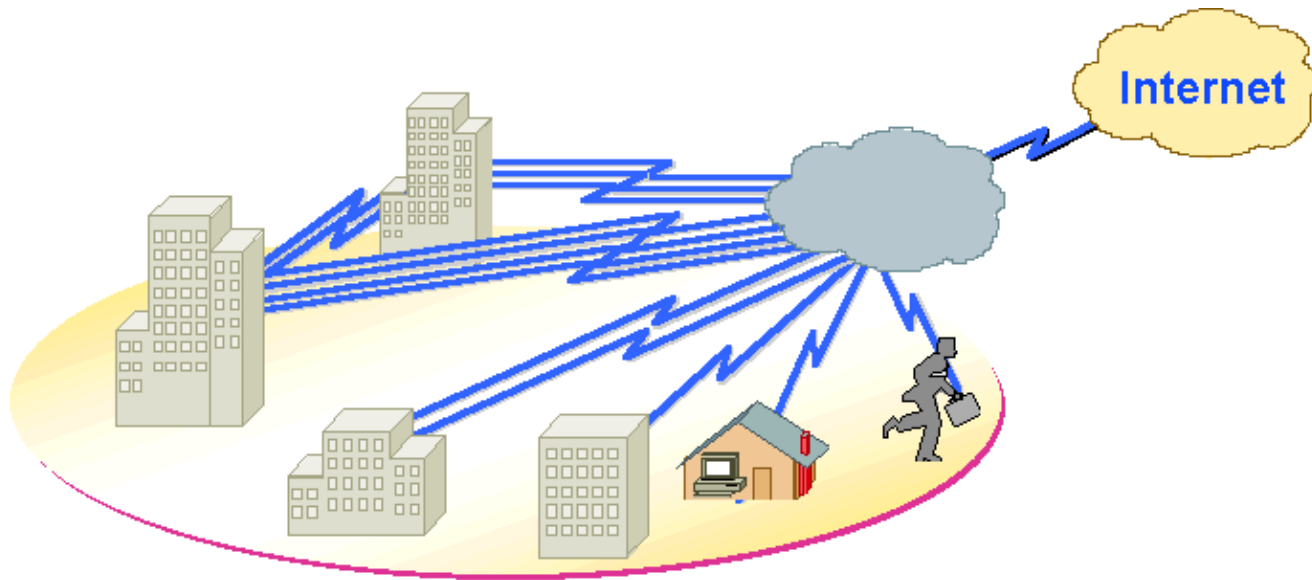
- The Internet is an internet that spans the world
  - Original goal was to link a variety of networks into a connected system unaffected by local disasters
  - Today, it is a commercial undertaking that links a worldwide combination of PANs, LANs, MANs, and WANs involving millions of computers

# Figure 4.7 Internet Composition



# Internet access technology

- **ISP**: An **Internet service provider (ISP)** is a company that provides access to the Internet.





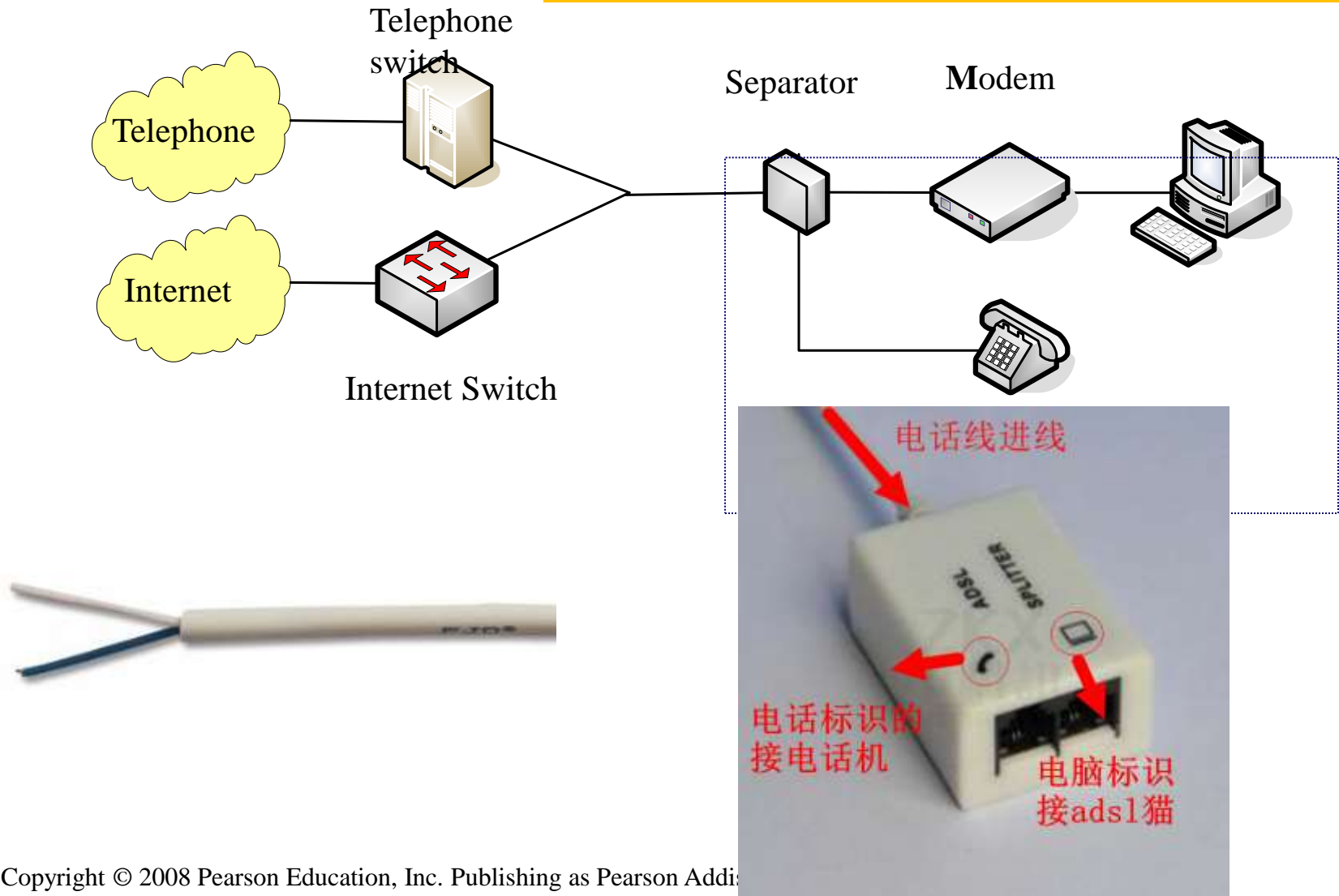
# Internet Architecture

- Internet Service Provider (ISP)
  - Tier-1 (Internet backbone) (中国电信, 中国移动)
  - Tier-2
- Access or Tier-3 ISP: Provides connectivity to the Internet
  - Hot spot (wireless)
  - Telephone lines
  - Cellular
  - Cable/Satellite systems

# ADSL宽带

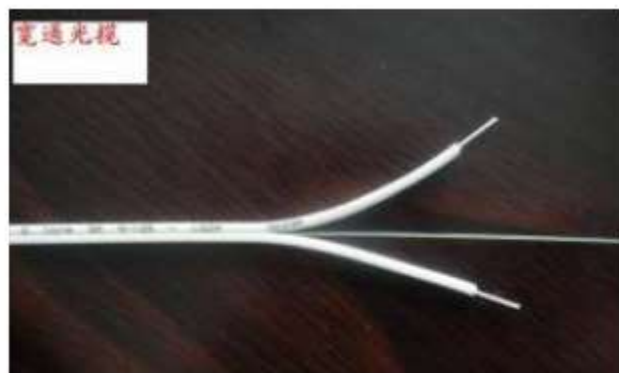
宽带是指传输速度高的网络接入方式

ADSL以铜质电话线为传输介质的传输技术组合

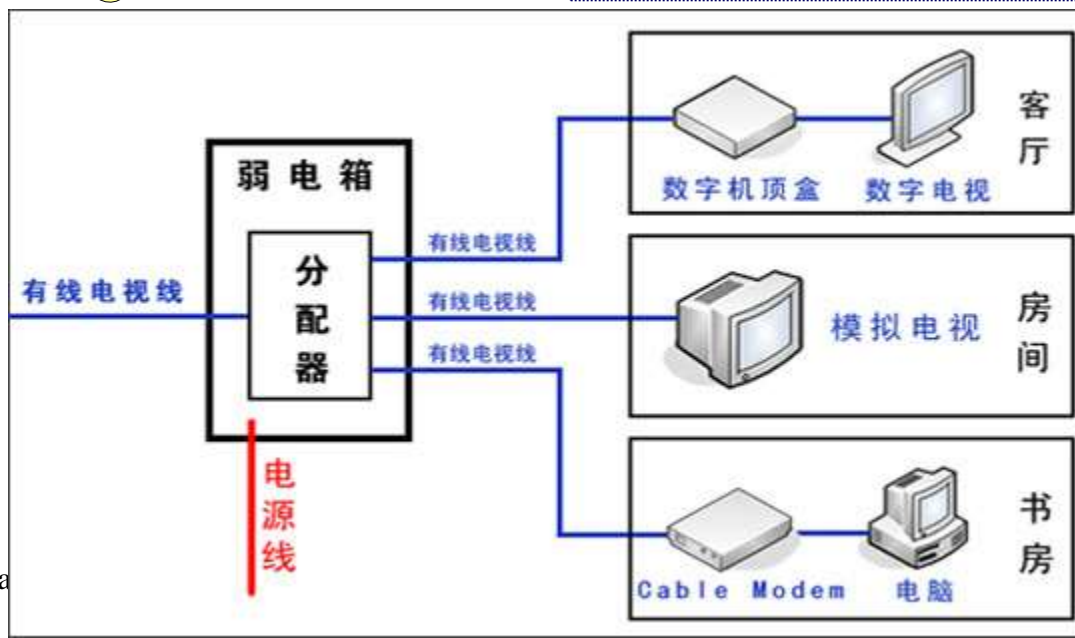
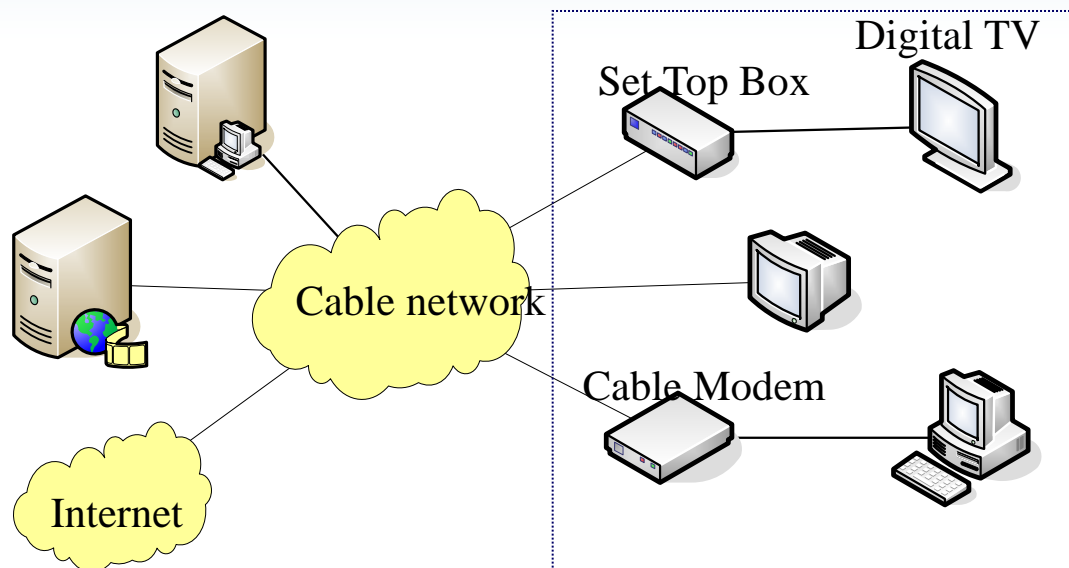


# 光纤宽带（速度快）

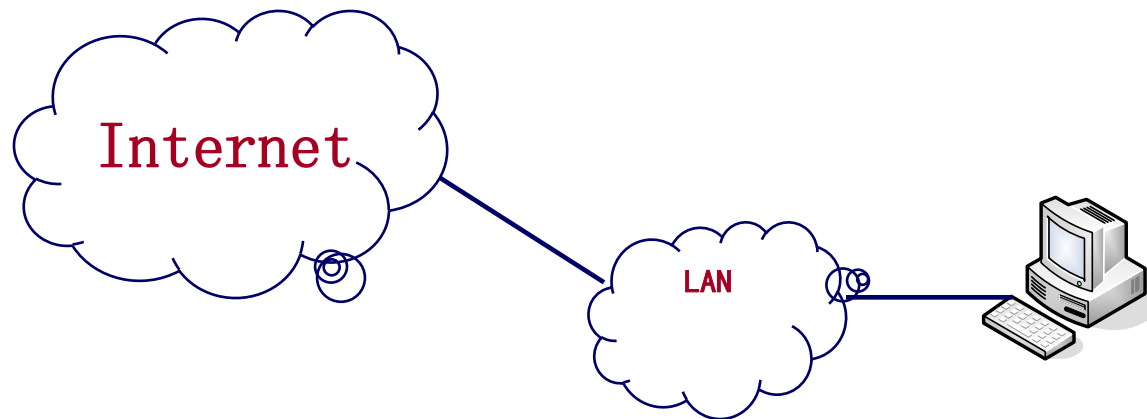
传输介质为光纤，通过光猫把光信号转换成网络信号。



# 有线电视

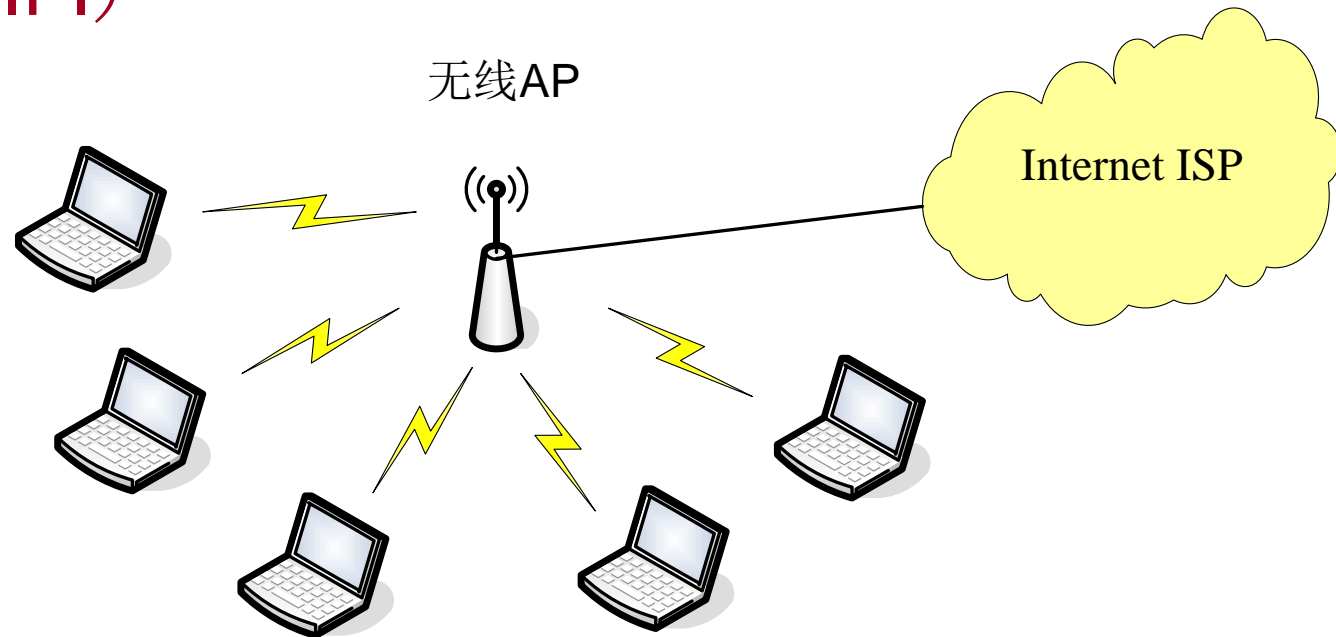


# LAN



# Wireless connection

- 通过移动电话上网：GPRS, CDMA, 3G, 4G, 5G
- 通过无线局域网WLAN：以无线AP和无线网卡来构建（WIFI）



# Internet Addressing

- IP address: pattern of 32 or 128 bits often represented in dotted decimal notation
- Mnemonic address:
  - Domain names (mu.edu)
  - Top-Level Domains
    - .org, .gov, .com, .mil, .net, .au, .ca, .biz, ....
- Domain name system (DNS)
  - Name servers
  - DNS lookup

# Internet Corporation for Assigned Names & Numbers (ICANN)

- Allocates blocks of IP addresses to ISPs who then assign those addresses within their regions.
- Oversees the registration of domains and domain names.