计算机网络

7.

LAN WIRING AND EXTENSIONS

厦门大学软件学院

黄炜 助理教授

关于FTP整理

实验放到experiments下

删掉source

注意

今后实验更难

需提前准备

实验安排（改）

实验三 获取包的源和目标 MAC地址和IP地址

PART II   Packet Transmission

Ch 15 Wired LAN Technology (Ethernet and 802.3)

有线局域网技术
（以太网和802.3）

PART II   Packet Transmission

Ch 10 LAN Wiring, Physical Topology, and Interface Hardware

局域网布线、物理拓扑和接口硬件
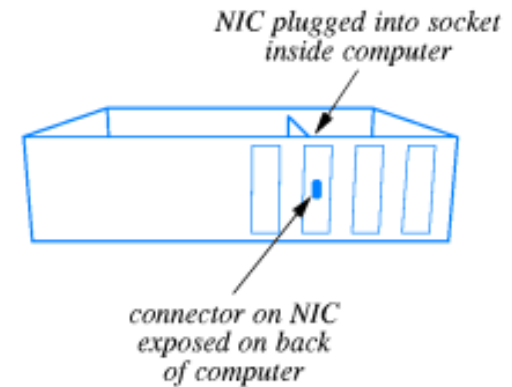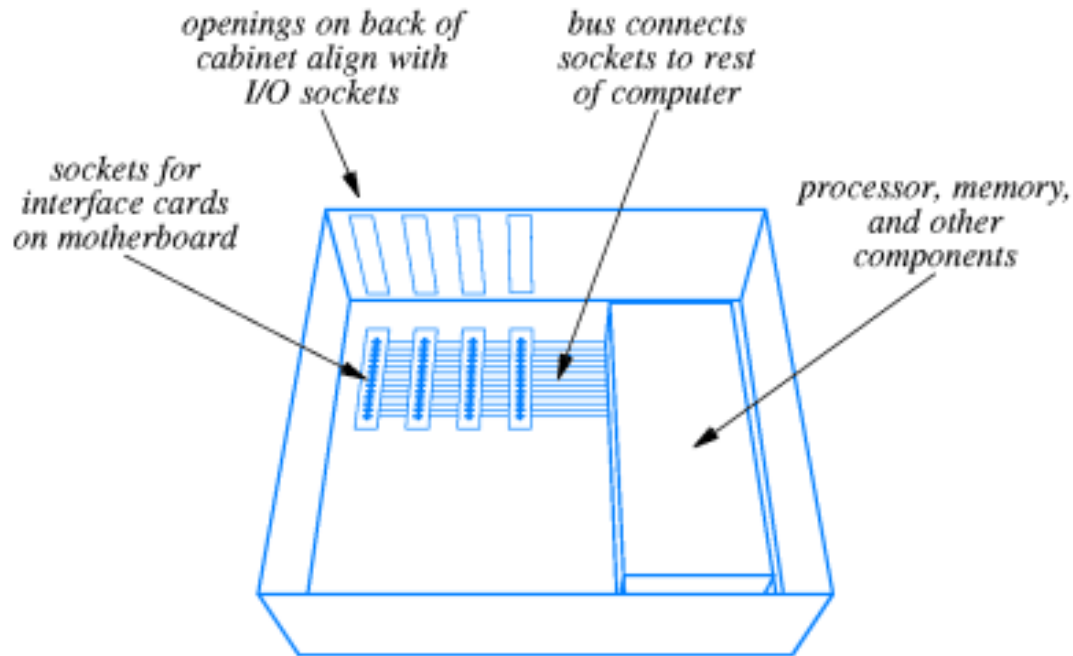
上节课遗留下的问题

10Base5/2/T/F
是神马东西

10.2 Speeds of LANs and Computer

- **Each network technology specifies a rate at which data must be sent.**

- **Many LANs operate at a rate so fast that a computer's CPU cannot process bits at network speed.**

- **The speed at which a network operates is usually fixed in the design---the speed does not depend on the CPU rates of the attached computers.**

10.3 Network Interface Hardware

openings on back of
cabinet align with
I/O sockets

bus connects
sockets to rest
of computer

sockets for
interface cards
on motherboard

processor, memory,
and other
components

NIC plugged into socket
inside computer

connector on NIC
exposed on back
of computer

10.2 The back of a computer with a NIC installed in one of the sockets. A cable attaches the exposed connector to the network.

Figure 10.1 The location of I/O sockets inside a typical computer. Each socket aligns with an opening in the back of the cabinet, and the computer's bus connects the socket to other major components such as the processor and memory.

NIC

- **The computer's CPU does not handle the transmission or reception of individual bits.**

- **A NIC connects a computer to a network, and handles all the details of packet transmission and reception.**

- **A NIC understands the electrical signals used on a network, the rate at which data must be sent or received, and the details of the network frame format.**

NIC

- **A NIC designed to be used with Ethernet cannot be used with a Token Ring network.**

- **A NIC designed to be used with a Token Ring cannot be used with an FDDI ring.**

- **Most NICs contain Direct Memory Access(DMA) circuit.**

- **A NIC functions like an I/O device.**

- **A NIC uses the computer's interrupt mechanism to inform the CPU.**

10.4 The Connection Between A NIC and A Network

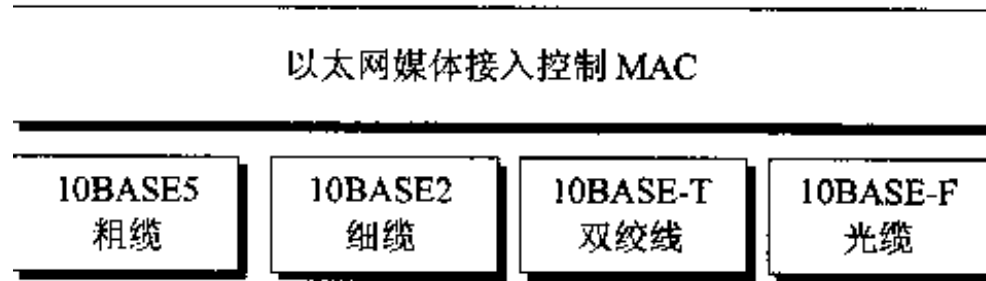- **The type of connection used between a NIC and a network depends on the network technology.**

以太网媒体接入控制 MAC

| 10BASE5 粗缆 | 10BASE2 细缆 | 10BASE-T 双绞线 | 10BASE-F 光缆 |

图 5-16 以太网的 4 种不同的物理层

名称	介质	最大长度/段	工作站数目/段	特点
10BASE5	粗同轴电缆	500m	100	适合于主干
10BASE2	细同轴电缆	200m	30	低廉的网络
10BASE-T	双绞线	100m	1024	易于安装和维护
10BASE-F	光纤	2000m	1024	远程工作站连接

10.5 Original Thick Ethernet Wiring

- **The shared medium consists of a thick coaxial cable.**

- **Each computer connected to the network requires a hardware device known as a transceiver (收发器).**

- **The cable connecting a NIC to a transceiver is known as an Attachment Unit Interface (AUI).**
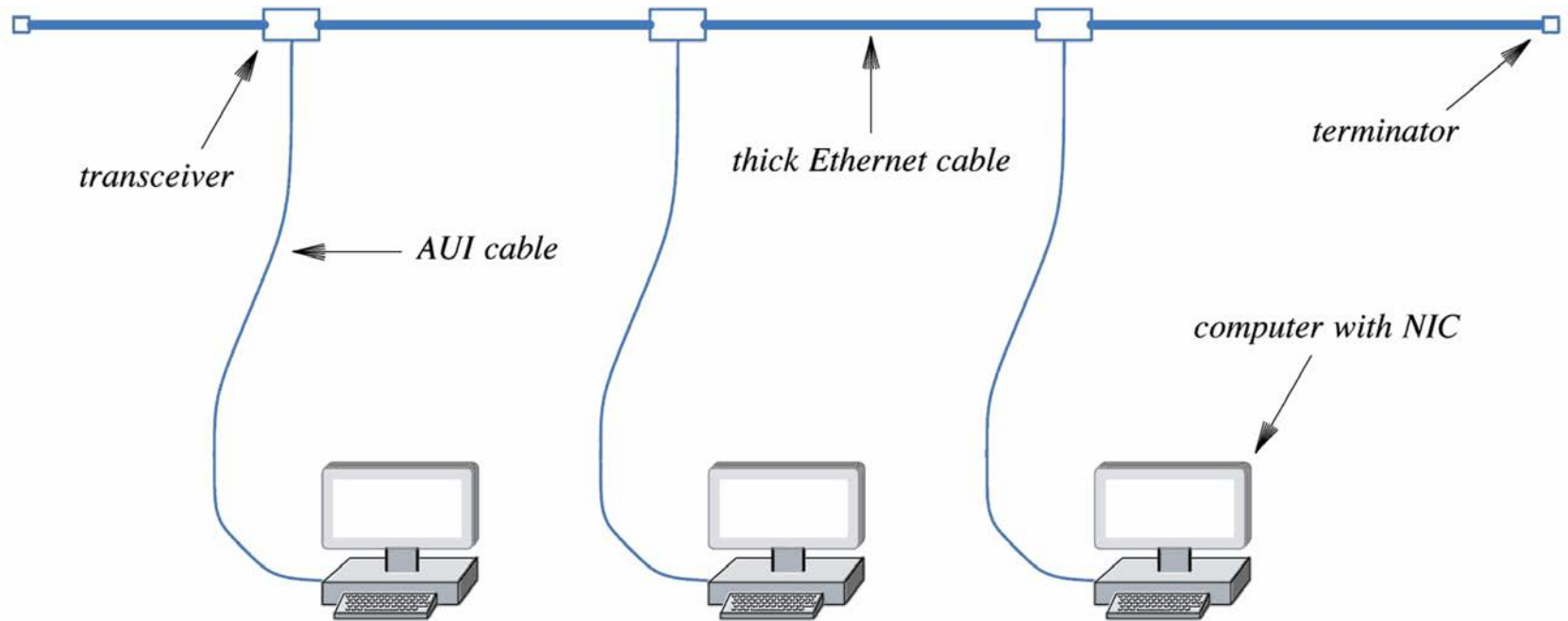
10Base5
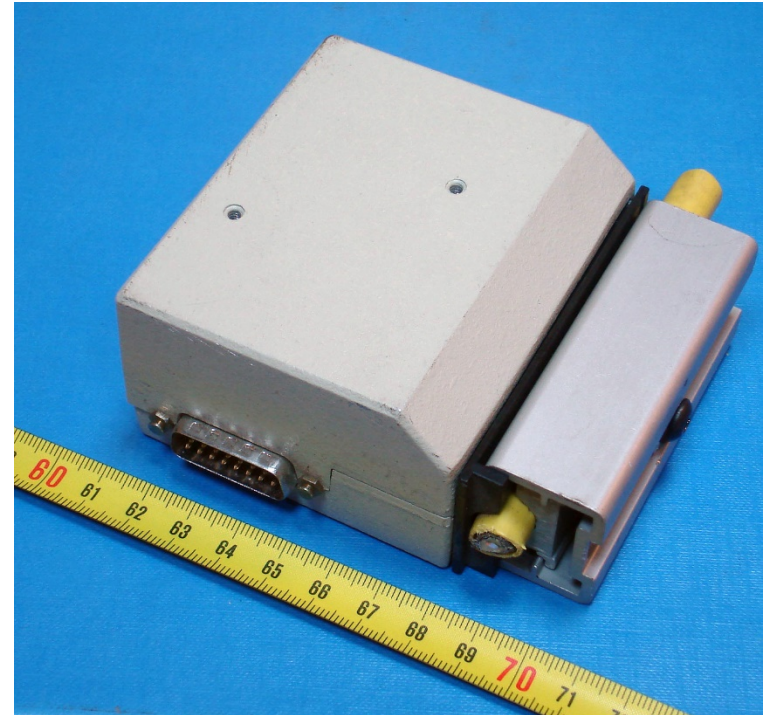
10Base5

- **Bus Topology**

Figure 15.4 Illustration of the original Thicknet Ethernet wiring.

transceiver

AUI cable

thick Ethernet cable

terminator

computer with NIC

10.6 Connection Multiplexing

- **A connection multiplexor allows multiple computers to attach to a single transceiver.**
  - A connection multiplexor is an electronic device designed to provide exactly the same signals as a conventional transceiver.
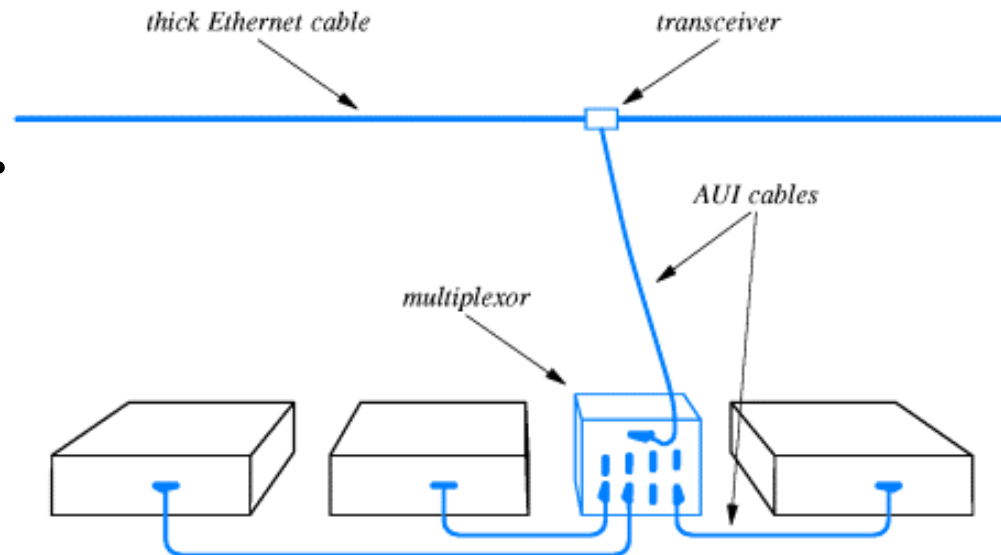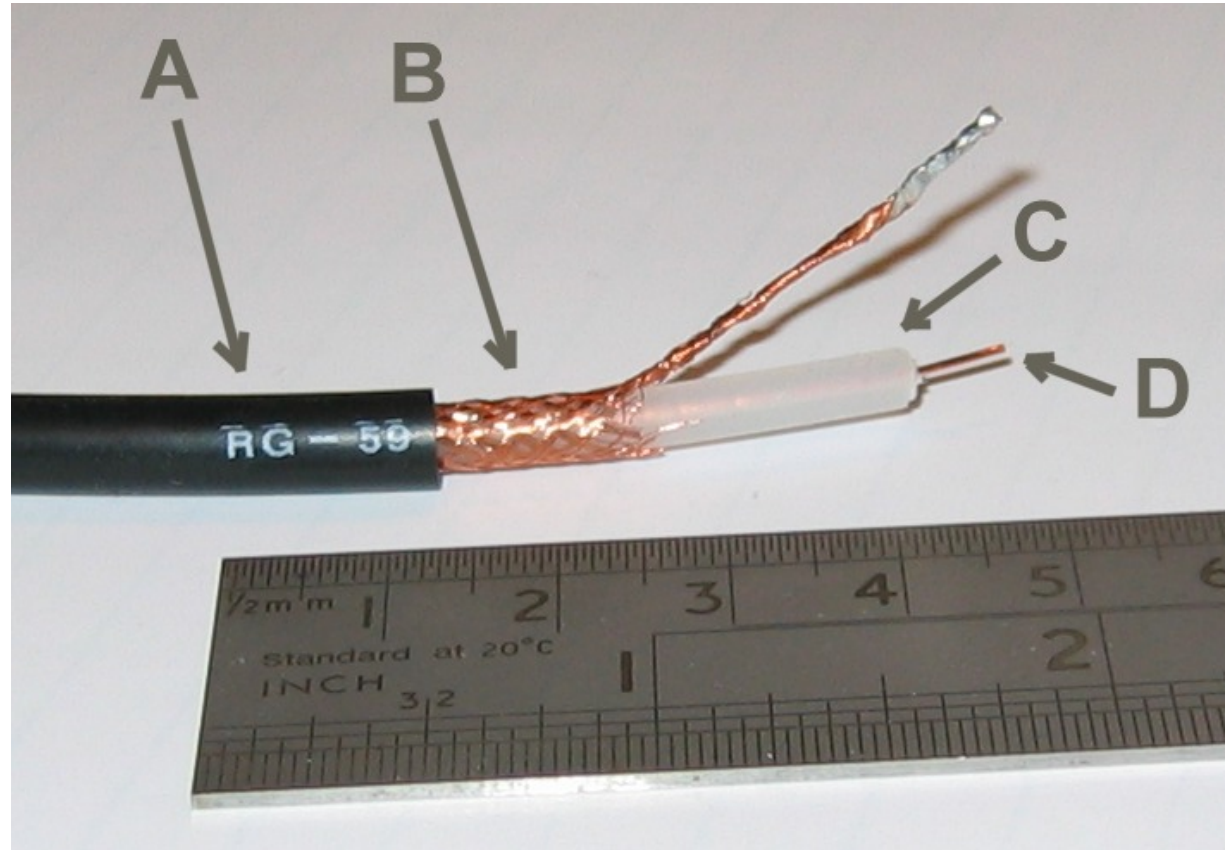
- **Formally called 10Base5.**

thick Ethernet cable   *transceiver*

AUI cables

multiplexor

Figure 10.4 A connection multiplexor. Although the multiplexor attaches to a single transceiver, multiple computers can connect to the multiplexor. Each computer operates as if it connects directly to a transceiver.

10.7 Thin Ethernet Wiring

- **Formally called 10Base2.**

- **Thinnet generally costs less.**

- **No external transceivers are needed.**

- **Thinnet does not use an AUI.**

- **Thinnet attaches directly to the back of each computer using a BNC connector.**
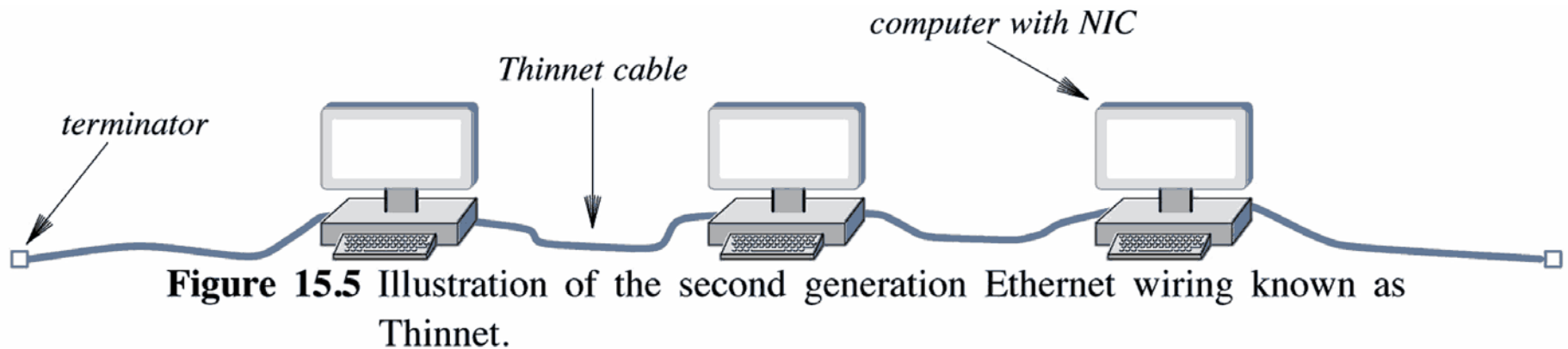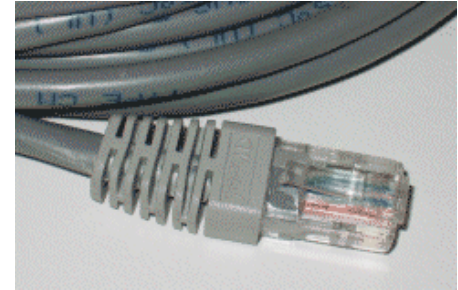
10Base2

10Base2

- **Bus Topology**

Figure 15.5 Illustration of the second generation Ethernet wiring known as Thinnet.

10.8 Twisted Pair Ethernet

- **Formally called 10BaseT.**

- **The 10BaseT does not use a coaxial cable.**

- **The 10BaseT uses an electronic device known as Enthernet hub.**

- **The connection between a computer and the hub uses twisted pair wiring with RJ-45 connectors.**
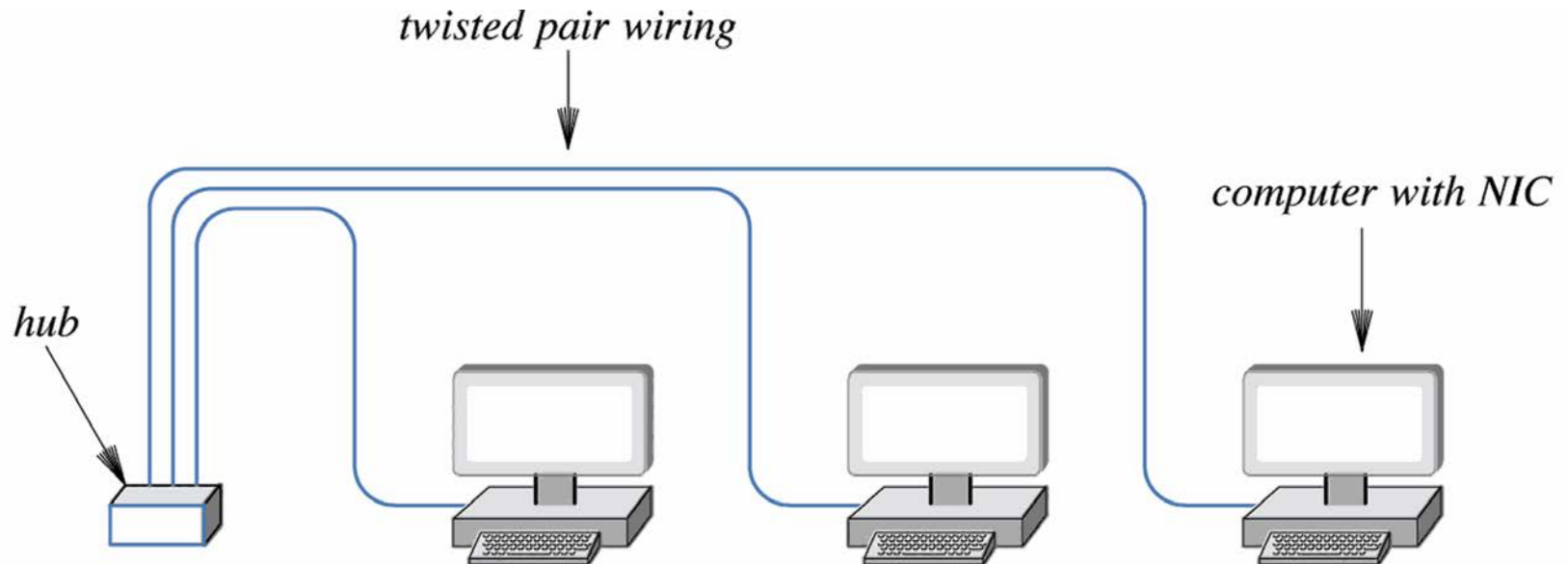
10Base-T

• **Star Topology**

Figure 15.6 Illustration of the third generation Ethernet using twisted pair wiring.
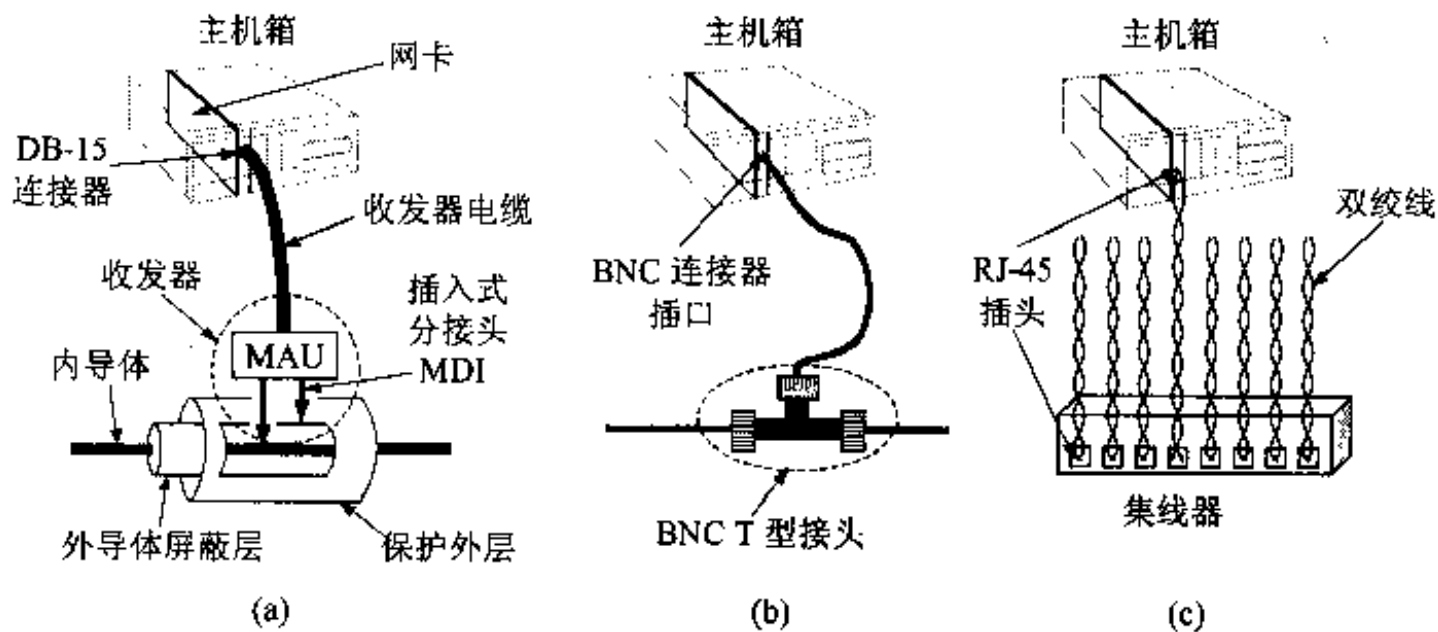
IEEE802.3 的三种接线方式

主机箱

网卡

DB-15 连接器

收发器电缆

收发器

插入式 分接头

内导体

MAU

MDI

外导体屏蔽层

保护外层

(a)

主机箱

BNC 连接器 插口

BNC T 型接头

(b)

主机箱

双绞线

RJ-45 插头

集线器

(c)

图 5-17 几种以太网的连接方法

10Base-F

20 milestones in Ethernet's first 40 years

15.11 Wiring in an Office Building

- **The styles of wiring used for LANs make little difference in a machine room or laboratory**

- **The type of wiring makes a major diff. in terms of**
  - **type; number of wires needed; the distance spanned; cost**

- **The three versions of Ethernet wiring illustrate the three principal forms that LANs use**

- **Fig. 15.7 depicts wiring on a floor of an office building**
  - **twisted pair Ethernet requires many individual cables to go between offices and a central point** (wiring closet)
  - **twisted pair Ethernet requires careful labeling of cables**

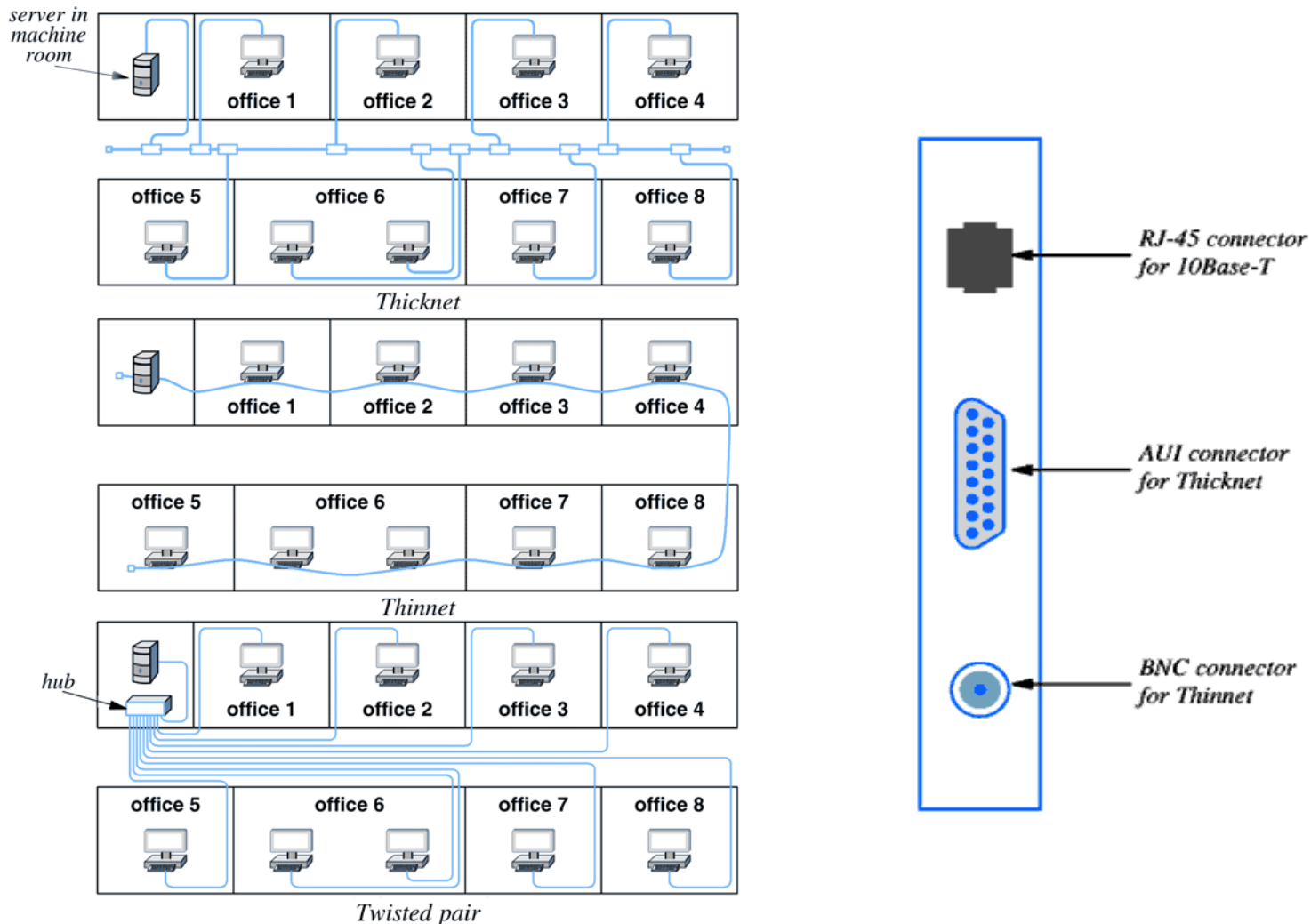# 10.9 Advantages and Disadvantages of Wiring Schemes

Figure 15.7 Illustration of various LAN wiring schemes that have been used in an office building.

10.10 The Topology Paradox 拓扑悖论

- **The 10BaseT wiring forms a star topology with the hub as the center of the star.**

- **A twisted pair Ethernet functions like bus, because all computers share a single communication medium.**

- **Physically, twisted pair Ethernet uses a star topology.**

- **Logically, twisted pair Ethernet function like a bus, and it is often called a star-shaped bus.**

10.11 Network Interface Cards and Wiring Schemes

- **A network interface must support a wiring scheme as well as a network technology.**

- **To make it possible to change wiring schemes without changing interface hardware, many network interface support multiple wiring schemes.**

- **Only one connector can be active at a time.**

Designation	Name	Data Rate	Cable Used
10BaseT	Twisted Pair Ethernet	10 Mbps	Category 5
100BaseT	Fast Ethernet	100 Mbps	Category 5E
1000BaseT	Gigabit Ethernet	1 Gbps	Category 6

Figure 15.8 Three types of twisted pair Ethernet, their data rates, and the cable used with each.

As the figure shows, the first version of twisted pair Ethernet was given the formal designation *10BaseT*,

10.12 Wiring Schemes and Other Network Technologies

- **Almost any network technology can support multiple wiring schemes, and the logical topology may differ from the physical topology.**
  - **The original LocalTalk wiring scheme uses transceivers.**
  - **Hub wiring is often used with a LocalTalk.**
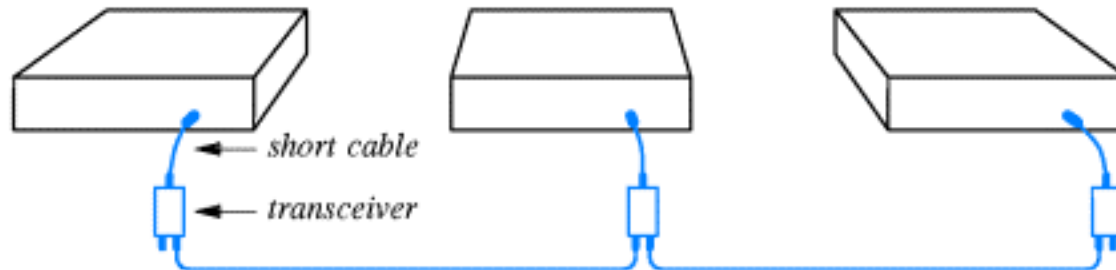 - **Hub wiring is often used with an IBM Token Ring.**

Figure 10.9 Three Macintosh computers connected with LocalTalk wiring. Each computer attaches to a transceiver with a short LocalTalk cable, and LocalTalk cables connect the transceivers. A LocalTalk transceiver with only one connection acts as a terminator for the bus.

建议自学

Ch 16 Wireless Networking Technologies

无线网络技术

16.2 A Taxonomy of Wireless Networks

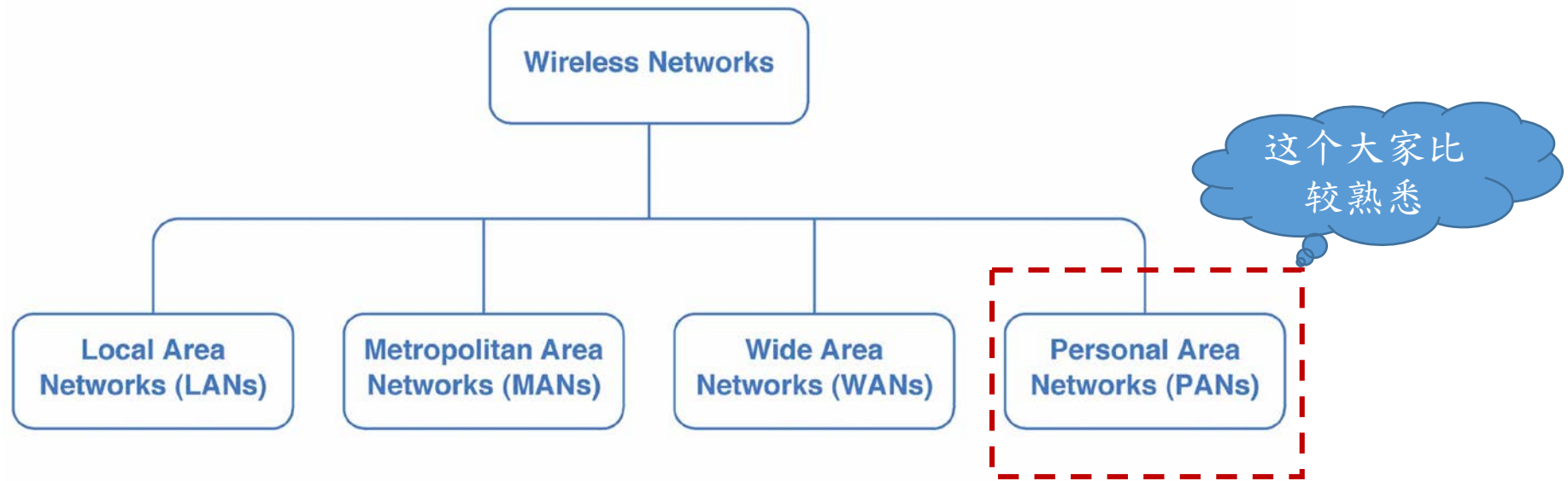Figure 16.1 A taxonomy of wireless networking technologies.

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16.3 Personal Area Networks (PANs)

Type	Purpose
Bluetooth	Communication over a short distance between a small peripheral device such as a headset or mouse and a system such as a cell phone or a computer
InfraRed	Line-of-sight communication between a small device, often a hand-held controller, and a nearby system such as a computer or entertainment center
ISM wireless	Communication using frequencies set aside for Industrial Scientific and Medical devices, an environment where electromagnetic interference may be present

Figure 16.2 Three basic types of wireless Personal Area Network technologies.

16.5 Wireless LAN Technologies and Wi-Fi

IEEE Standard	Frequency Band	Data Rate	Modulation Technique	Multiplexing Technique
original 802.11	2.4 GHz	1 or 2 Mbps	FSK	DSSS
	2.4 GHz	1 or 2 Mbps	FSK	FHSS
	InfraRed	1 or 2 Mbps	PPM	±none±
802.11a	5.725 GHz	6 to 54 Mbps	PSK or QAM	OFDM
802.11b	2.4 GHz	5.5 and 11 Mbps	PSK	DSSS
802.11g	2.4 GHz	22 and 54 Mbps	various	OFDM

Figure 16.4 Key wireless standards certified by the Wi-Fi Alliance.

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16.9 Overlap, Association, and 802.11 Frame Format

CTL	DUR	Address 1 (destination)	Address 2 (source)	Address 3 (dest. 2)	SEQ	Address 4	Payload (0 to 2312 bytes)	CRC
		↑	↑	↑		↑		
		AP or wireless computer's MAC	sender's MAC address	router's MAC address		used in ad hoc mode		
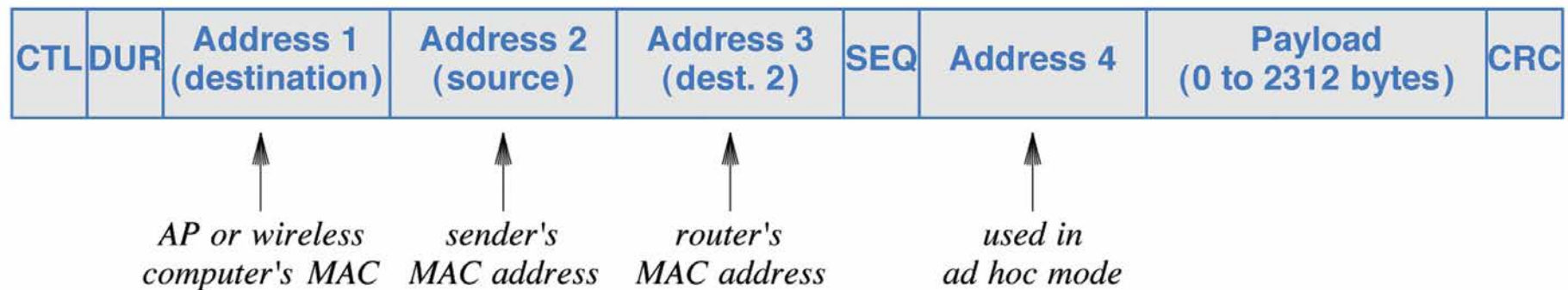
Figure 16.9   The frame format used with an 802.11 wireless LAN.

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其它名词

- 红外

- **Ad hoc**

- 蓝牙蜂窝技术

- 基站

一定要自学

这不是考纲不考纲的问题

你们都有机会部署单位的无线网络

不要泼狗血

PART II Packet Transmission

Ch 11 Extending LANs: Fiber Modems, Repeaters, Bridges, and Switches

局域网扩展：光纤调制解调器、中继器、网桥和交换机

从电压到电磁波

编码、编址、拓扑

冲突检测

山连着山，海连着海

全世界计算机，联合起来？

信号衰减、错误扩散

11.1 Introduction

- **Each LAN technology is designed for a specific combination of speed, distance, and cost.**

- **The designer specifies a maximum distance that the LAN can span,with typical LANs designed to span a few hundred meters.**

网络互联设备

Application
Presentation
Session
Transport
Network
Data link
Physical

Gateway

Router

Bridge

Repeater

Application
Presentation
Session
Transport
Network
Data link
Physical
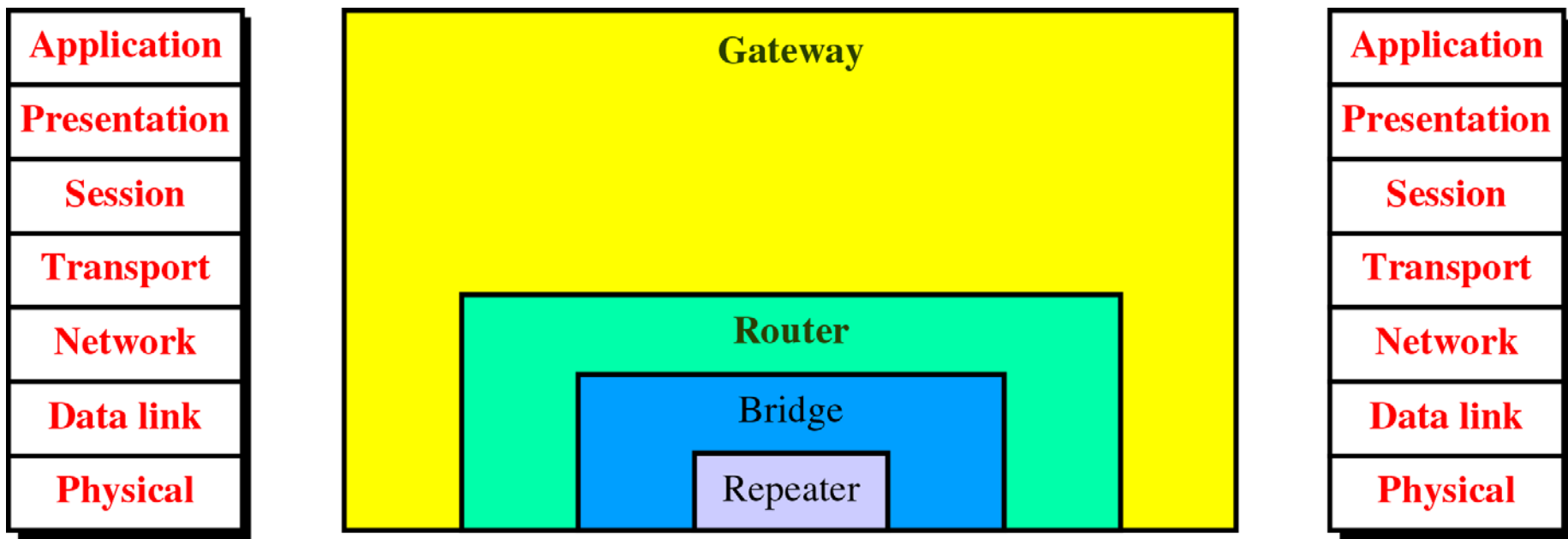
11.2 Distance Limitation and LAN Design

• **Distance limitation is a fundamental part of LAN designs.**

• **Engineers choose a combination of capacity, maximum delay, and distance that can be achieved at a given cost.**

• **To help save expense, LAN technologies usually use a shared communication medium.**

11.2 Distance Limitation and LAN Design

- **A LAN design must include a mechanism that guarantees each station fair access to the shared medium.**

- **Hardware is engineered to emit a fixed amount of electrical power, the signal can't reach arbitrarily far.**

- **LAN hardware is engineered for a fixed maximum length cable, The hardware will not work correctly over wire that exceed the bound.**

11.3 Fiber Optic Extensions

- **A pair of fiber modems and optical fibers can be used to provide a connection a computer and a remote LAN.**
  - **Because delays across fiber are low and bandwidth is high, the mechanism will operate correctly across distances of several kilometers.**
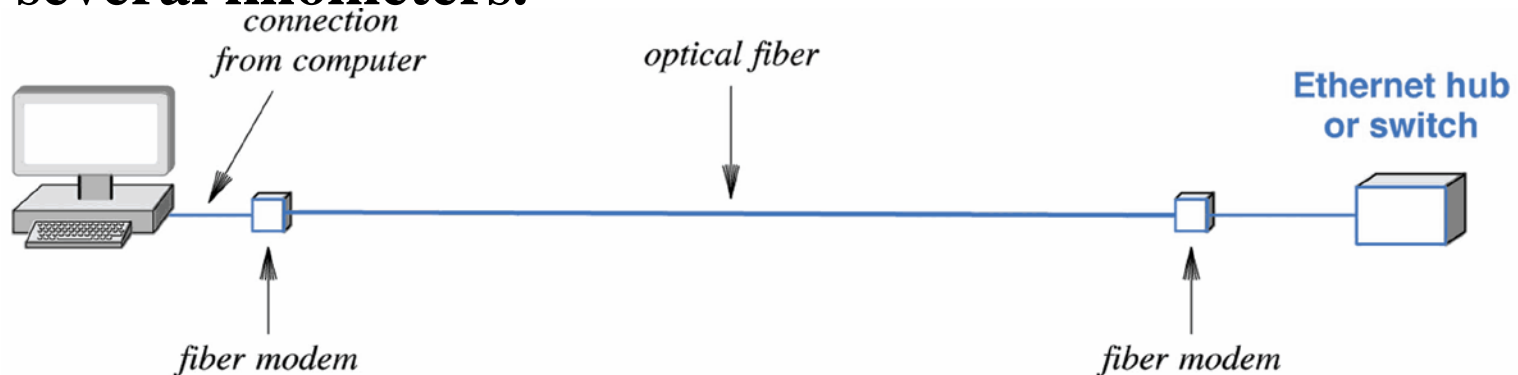
Figure 17.1 Illustration of fiber modems used to provide a connection between a computer and a remote Ethernet.

单工？半/全双工？
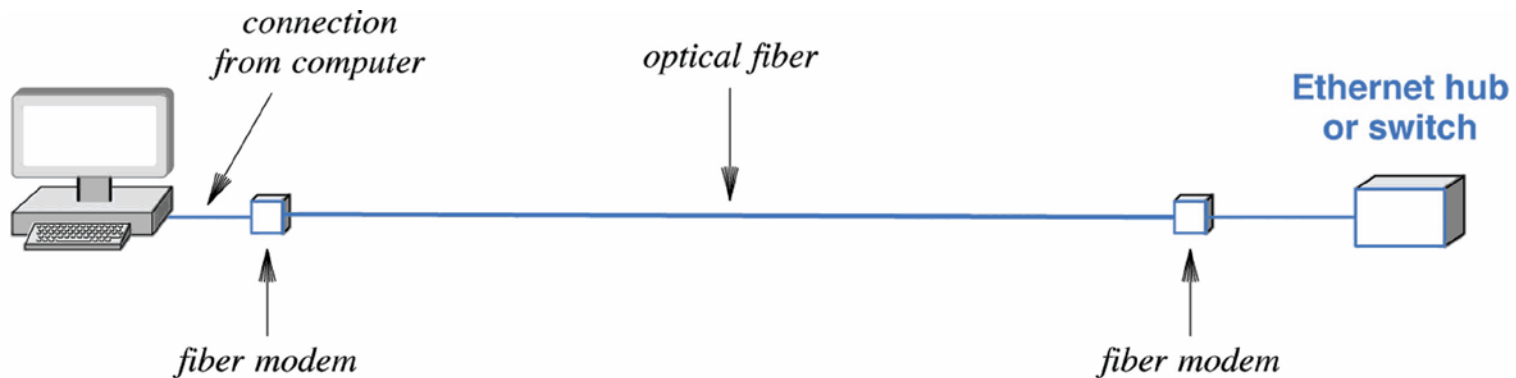
Figure 17.1 Illustration of fiber modems used to provide a connection between a computer and a remote Ethernet.

11.4 Repeaters 中继器

- **A repeater is usually an analog electronic device that continuously monitors electrical signals on each cable.**
  - **When it senses a signal on one cable, the repeater transmits an amplified copy on the other cable.**
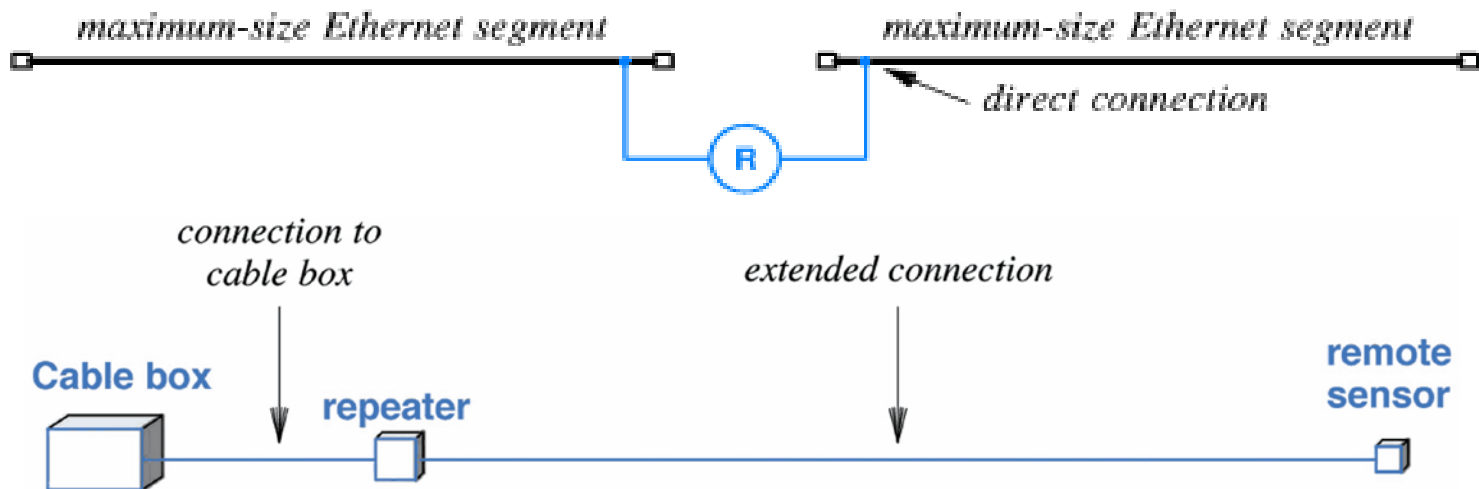
Figure 17.2 Illustration of an infrared sensor extended with a repeater.

11.4 Repeaters 中继器

- 网线的传输距离都是有限的，如果节点之间的距离太远，就需要在中间使用中继器(Repeater)来将信号放大后继续传输。网路上最多只能有：
  - 5个网段
  - 4个中继器器
  - 3个网段可以连接计算机
  - 2个网段只能用于扩展局域网的距离
  - 它们共同处于一个广播域

- 用交换机组网也要遵循这个原则。

中继器（1）

　　　　　　　　厦门大学软件学院 黄炜

中继器（2）
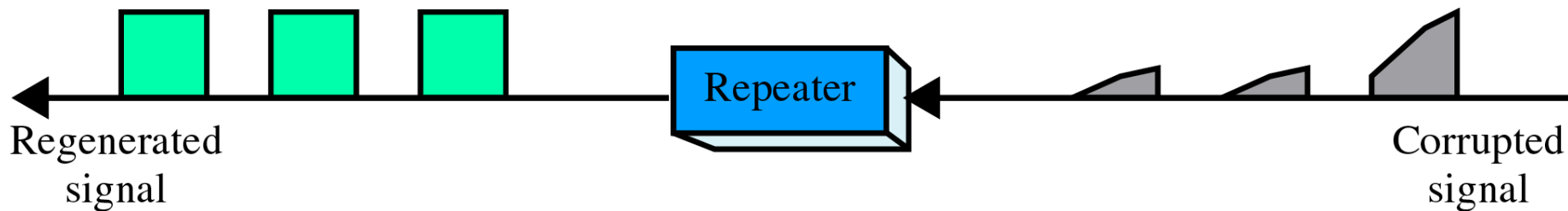
(a) Right-to-left transmission.
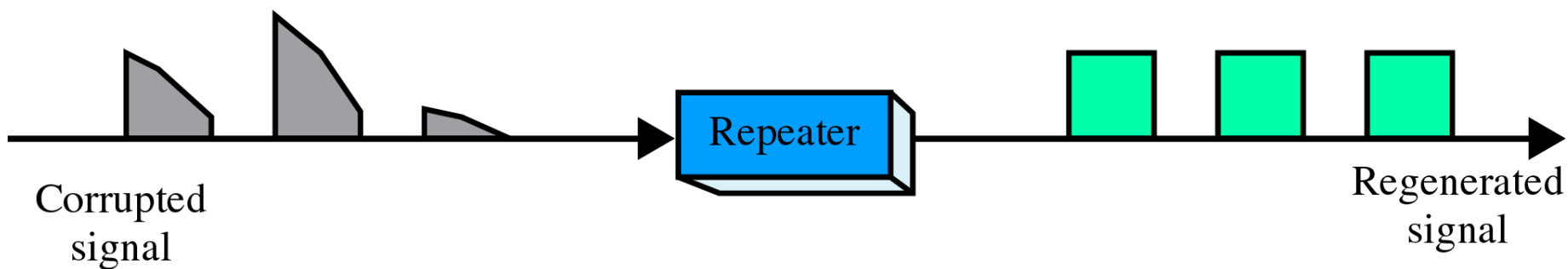
(b) Left-to-right transmission.

中继器

- **A repeater connects two Ethernet cables called segments, each of which has the usual termination.**

- **Repeaters do not understand the frame format, nor do they have physical addresses.**

- **Any pair of computers on the extended LAN can communication, the computers do not know whether a repeater separates them.**

中继器

- **The repeater attaches directly to the Ethernet cables and sends copies of electrical signals from one to other without waiting for a complete frame.**
- **A repeater does not distinguish between the signals that correspond to a valid frame and other electrical signals.**
- **If a collision or electrical interference occurs on one segment, repeaters cause the same problem to occur on all other segments.**

不要以为中继器是万能的

放大、失真、放大、失真

中继器

- **If more than four repeaters separate any pair of stations, the network will not operate correctly.**
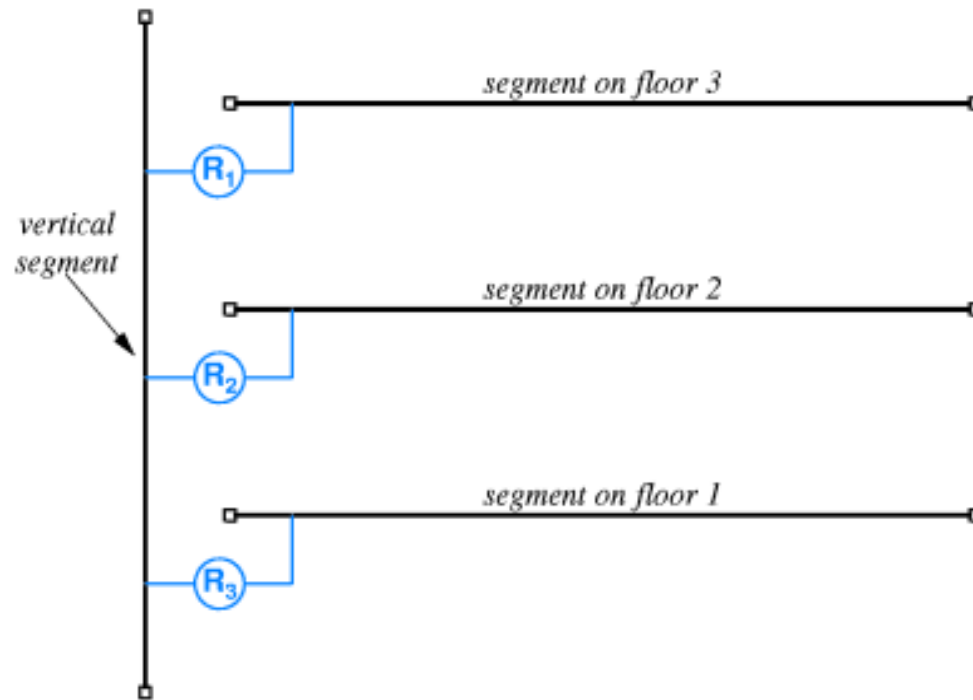
而且中继器是透明的

如果要阻断干扰，就要用……

11.5 Bridges网桥

- **A bridge is an electrical device that connects two LAN segments.**

- **A bridge handles complete frame and uses the same network interface as a conventional computer.**

- **The bridge listens to traffic on each segment in promiscuous mode (混合模式).**

- **When it receives a frame from one segment, the bridge verifies that frame arrived intact, and then forwards a copy of the frame to the other segment if necessary.**

网桥（1）

网桥（2）
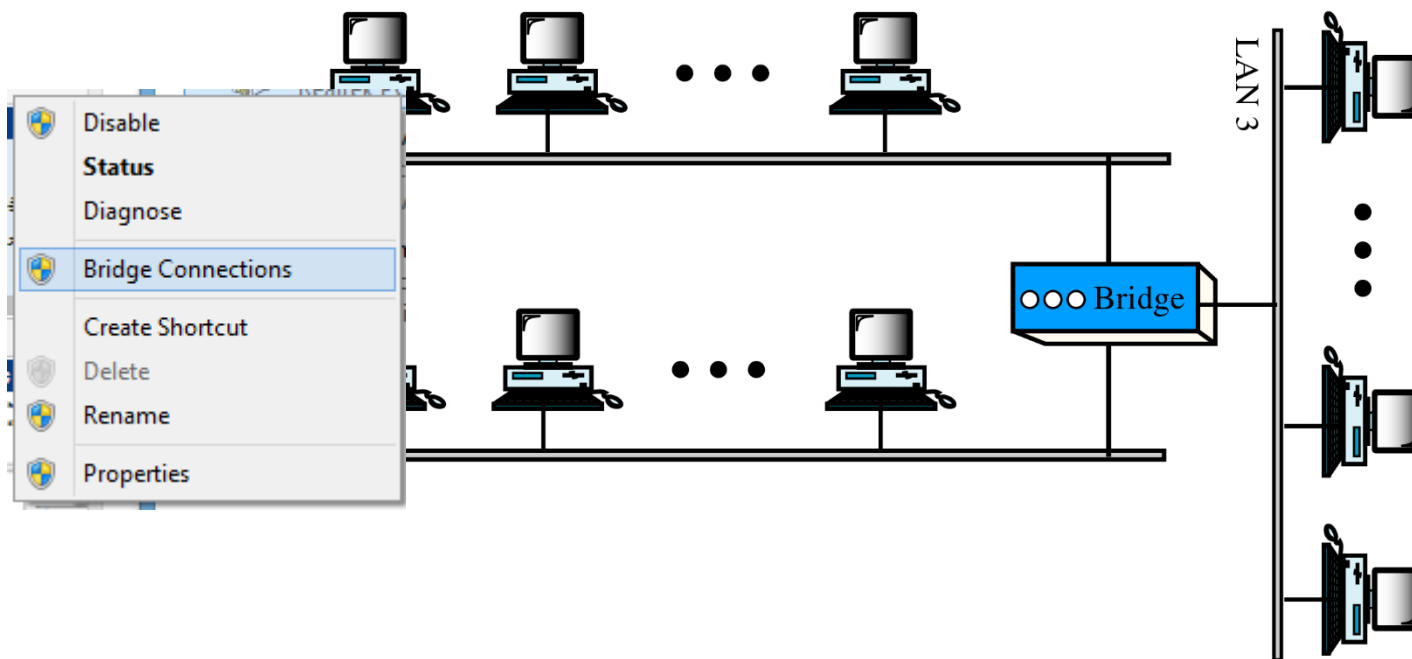
网桥

- 定义：

  − 网桥(bridge)用于连接两个局域网的一种互联设备。

- 功能：

  − 在不同的LAN之间进行互联；

  − 用于网段微化，有利于调节负载；

  − 对于802.3，可以扩展网络的物理距离；

  − 不同的网段之间进行隔离，有助于保密。

网桥
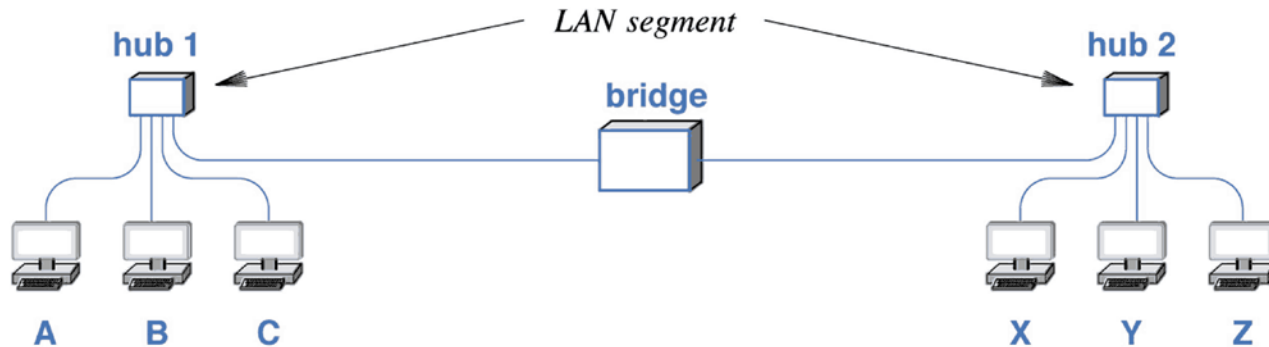
Figure 17.3 Illustration of six computers connected to a pair of bridged LAN segments.

- **Any pair of computers on the extended LAN can communication, the computers do not know whether a bridge separates them.**
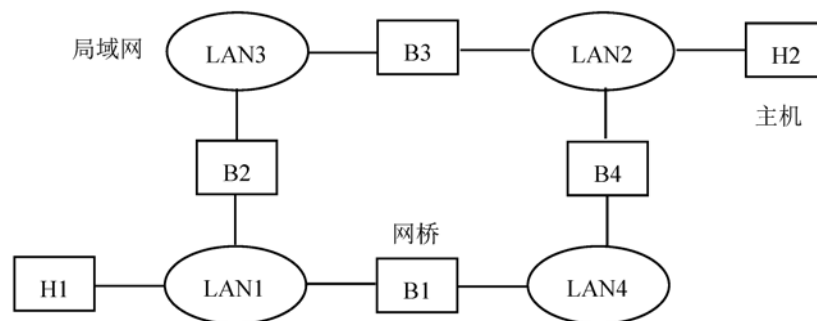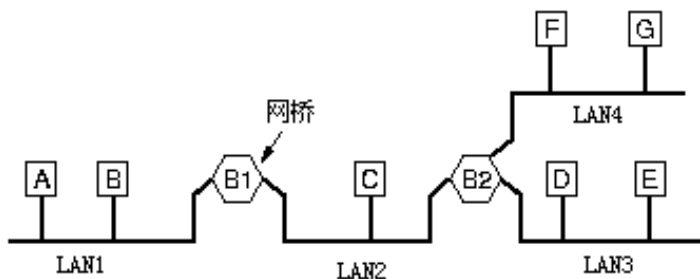
- **A bridge does not forward interference or other problems.**

网桥

- 工作原理：网桥接收一帧后的处理过程为：
  - 如果目的站点与源站点在同一个LAN中，则扔掉此帧；
  - 如果目的站点与源站点不在同一个LAN中，则通过某端口转发此帧；
  - 否则，将该帧扩散到除接收端口外的所有其他端口。
- 反向学习算法
  - 网桥根据反向传送的帧来填写转发表的地址记录
  - 学习(填表)－忘记－重新学习
- **Spanning Tree(802.1d)算法**
  - 用生成树来解决在帧扩散中所产生的广播风暴问题

网桥

- 网桥

- 可以设置并行的网桥
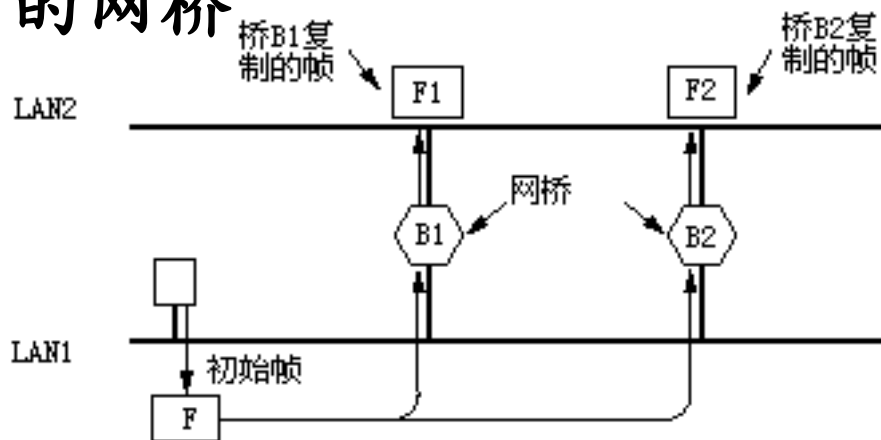
11.6 Frame Filtering 帧过滤

- **A typical bridge consists of a conventional computer with a CPU, memory, and two network interfaces.**

- **A bridge does not run application software, the CPU executes code from ROM.**

- **The most valuable function a bridge performs is frame filtering.**

- **When a frame arrives on a segment, the bridge extracts and checks the source address and the destination address.**

11.6 Frame Filtering 帧过滤

- **Most bridges are called adaptive or learning bridges because they learn the locations of computers automatically.**

Event	Segment 1	Segment 2	Frame Sent
Bridge boots	±	±	±
A sends to B	A	±	Both Segments
B sends to A	A, B	±	Segment 1 only
X broadcasts	A, B	X	Both Segments
Y sends to A	A, B	X, Y	Both Segments
Y sends to X	A, B	X, Y	Segment 2 only
C sends to Z	A, B, C	X, Y	Both Segments
Z sends to X	A, B, C	X, Y, Z	Segment 2 only

课本失误

Figure 17.4 Example of a learning bridge with computers A, B, and C on one segment and computers X, Y, and Z on another.

11.7 Startup and Steady State Behavior of Bridged Networks

- **When it first boots, a bridge does not know which computers attach to which LAN segment.**

- **If a computer did not send any frames, a bridge could not detect its location.**

- **In the steady state, a bridge forward each frame only as far as necessary**

11.8 Planning A Bridged Network

- **Bridge hardware is engineered to permit communication on separate segments at the same time.**

- **The design of a bridged network is parallelism: computers on one segment can communication at the same time as computers on another segment.**

- **A set of computers that interact frequently should be attached to the same segment.**

# 11.9 Bridging Between Buildings
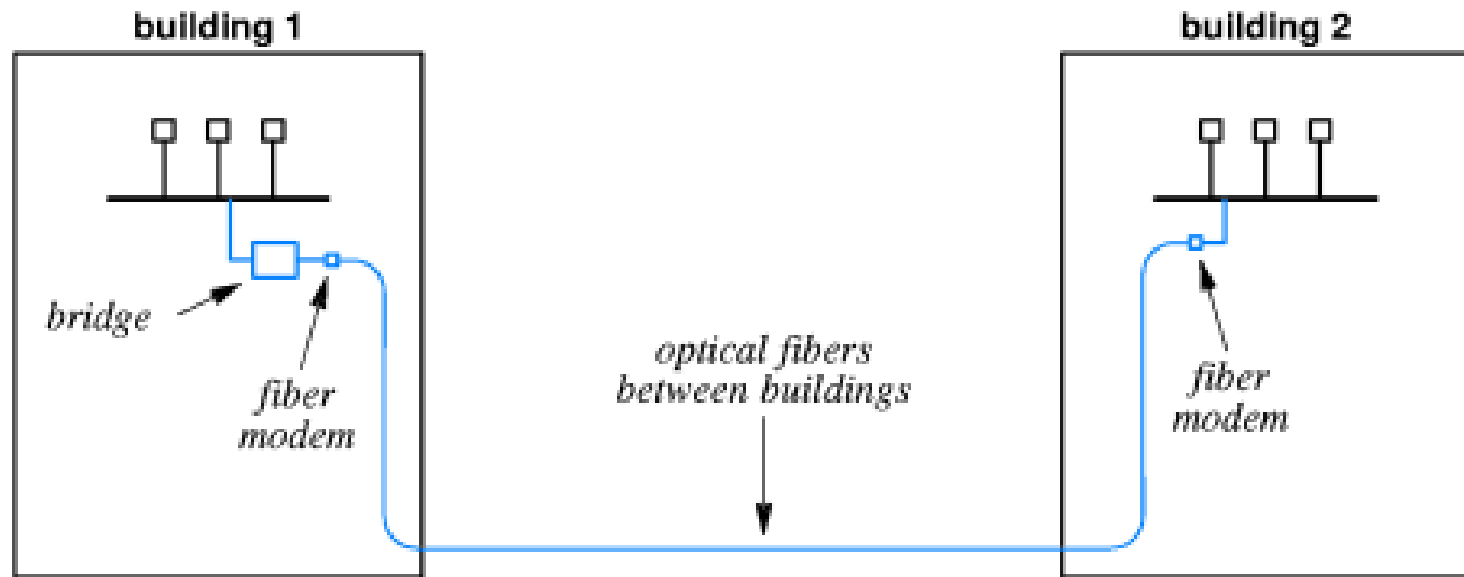
11.10 Bridging Across Longer Distances

- **In addition to filtering, bridge hardware used with long-distance connections must perform buffering**
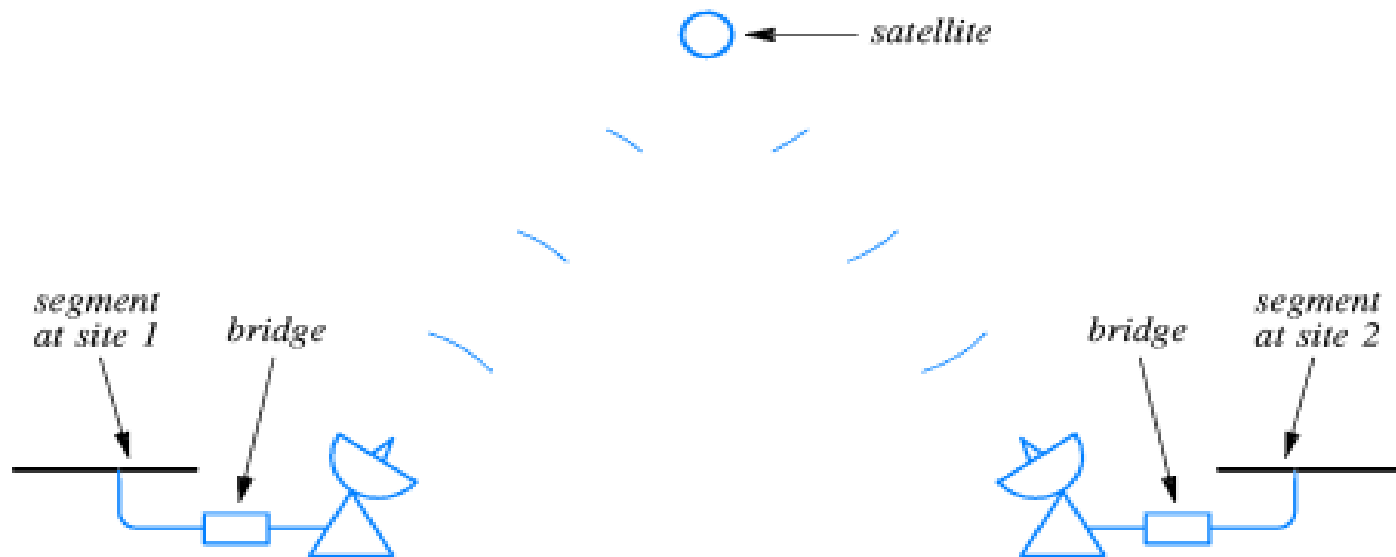
11.11 A Cycle of Bridges 网桥环

- **A bridge network can span many segments.**

- **One bridge is needed to connect each segment to the rest of the bridge network.**

- **A bridge always forwards a copy of a frame sent to broadcast address.**

- **Not all bridge can be allowed to forward broadcast frames,or a cycle of bridges introduces a problem.**
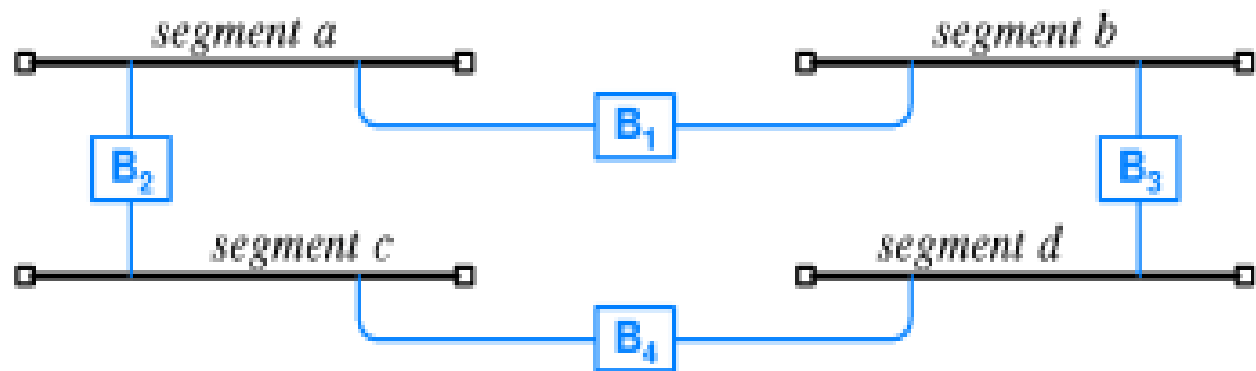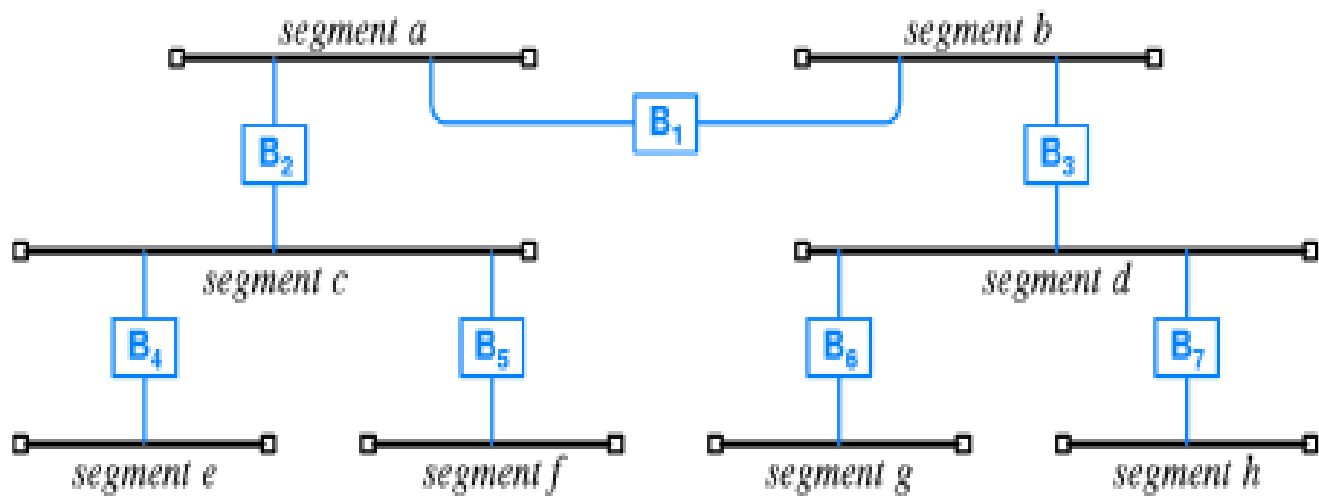
11.12 Distributed Spanning Tree

- **To prevent the problem of infinite loops,a bridged network must not allow both of the following condition to occur simultaneously:**

- **All bridge forward all frames.**

- **The bridged network contains a cycle of bridged segments.**

- **The bridges perform a computation known as the distribute spanning tree (DST分布生成树) algorithm to decide which bridges will not forward frames.**

- **After the DST algorithm completes, the bridges that agree to forward frames form a graph that does not contain any cycles (i.e., a tree).**

11.13 Switching 交换

- **A switched LAN consists of a single electronic device that transfers frames among many computers.**
- **A switch contains processors and a central interconnect.**
- **A processor looks up the address in an incoming frame, and then uses the interconnect to transfer the frame to the correct output port.**
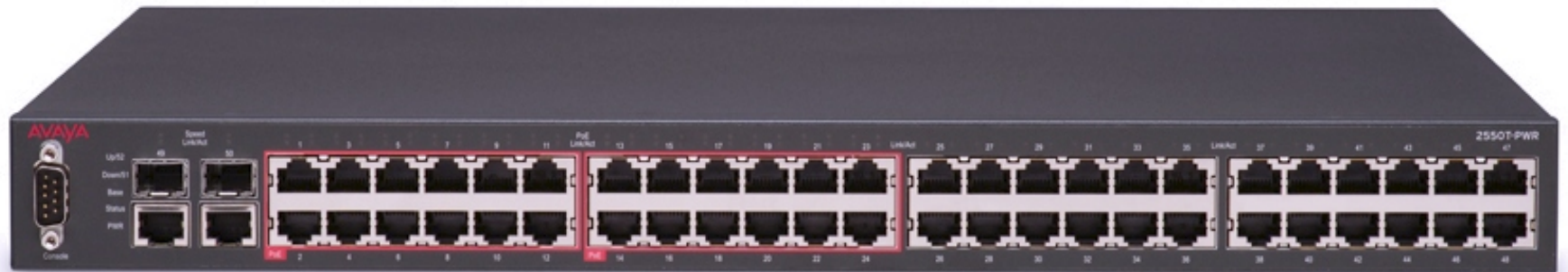- **In practice, a switch is not constructed from independent bridges**
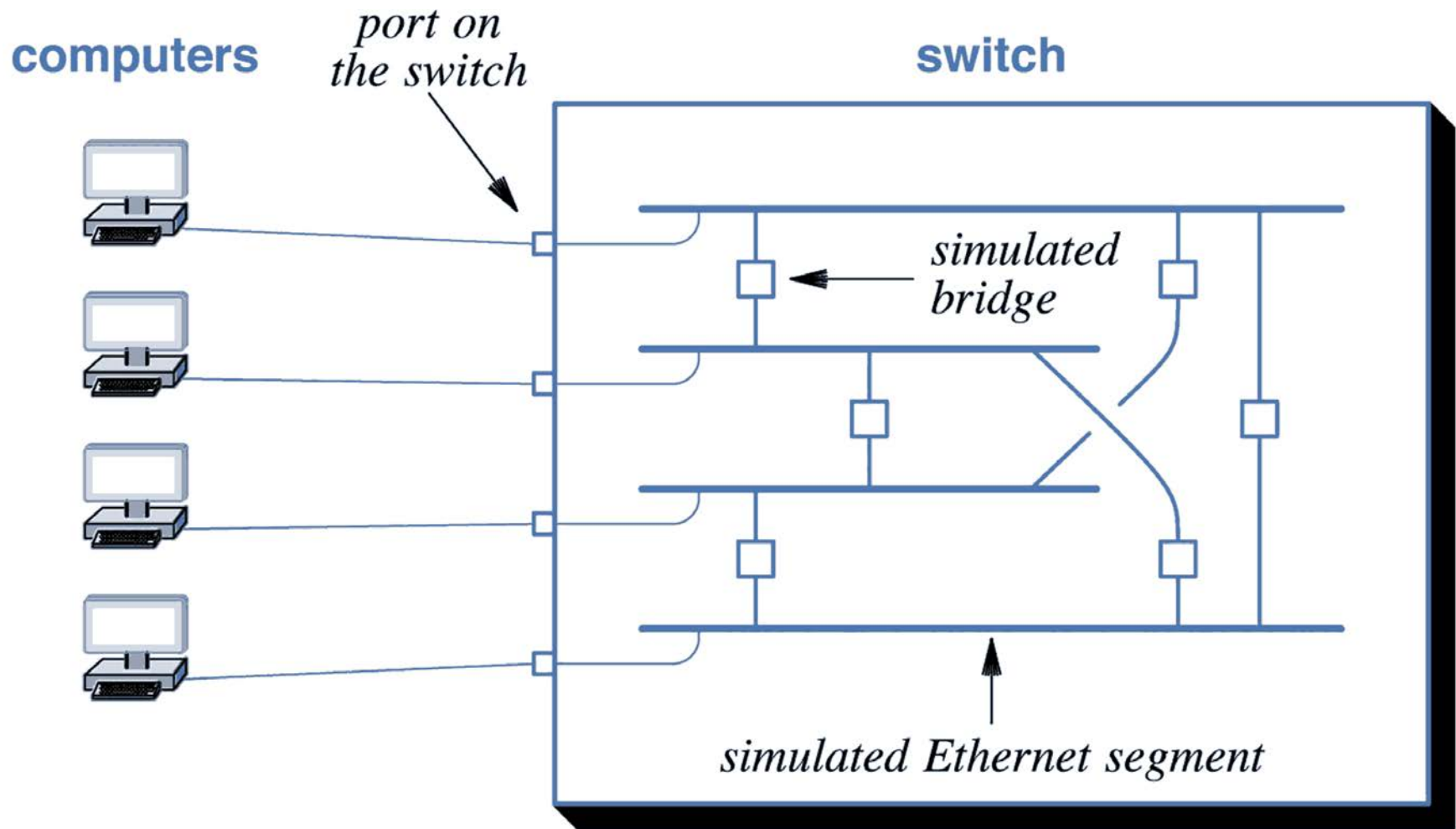
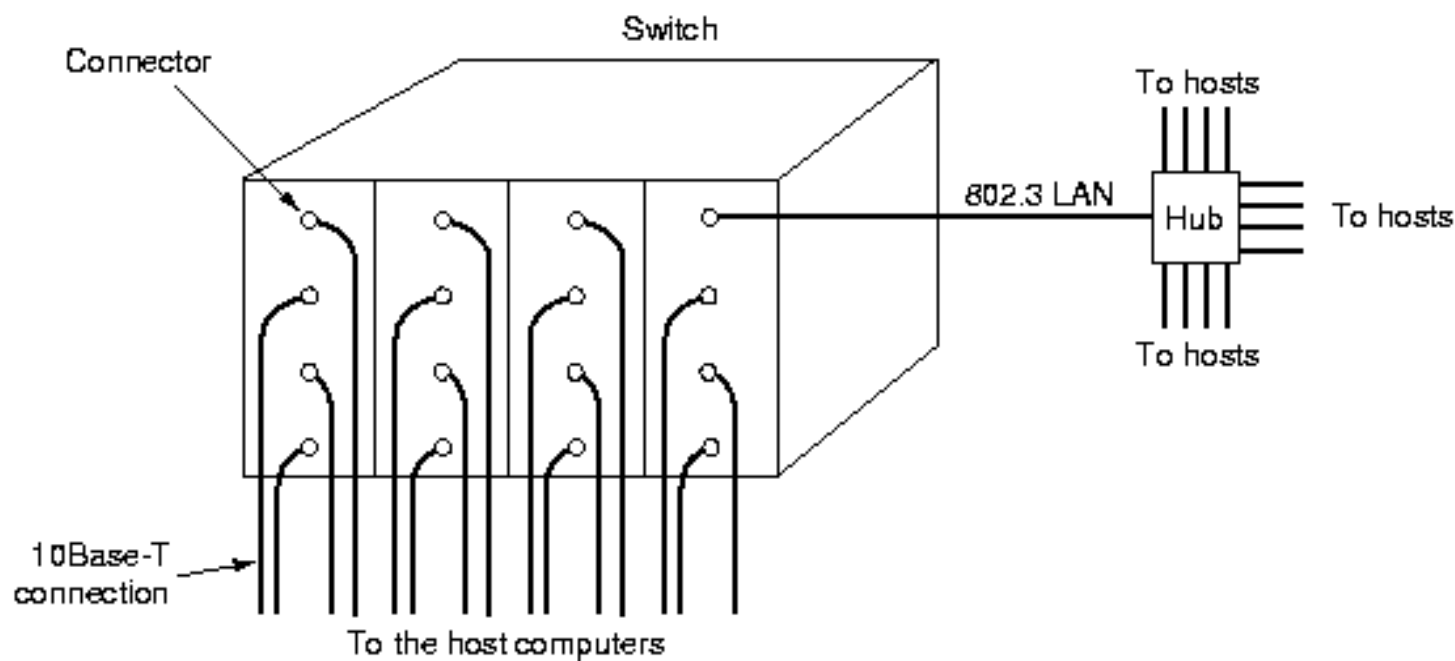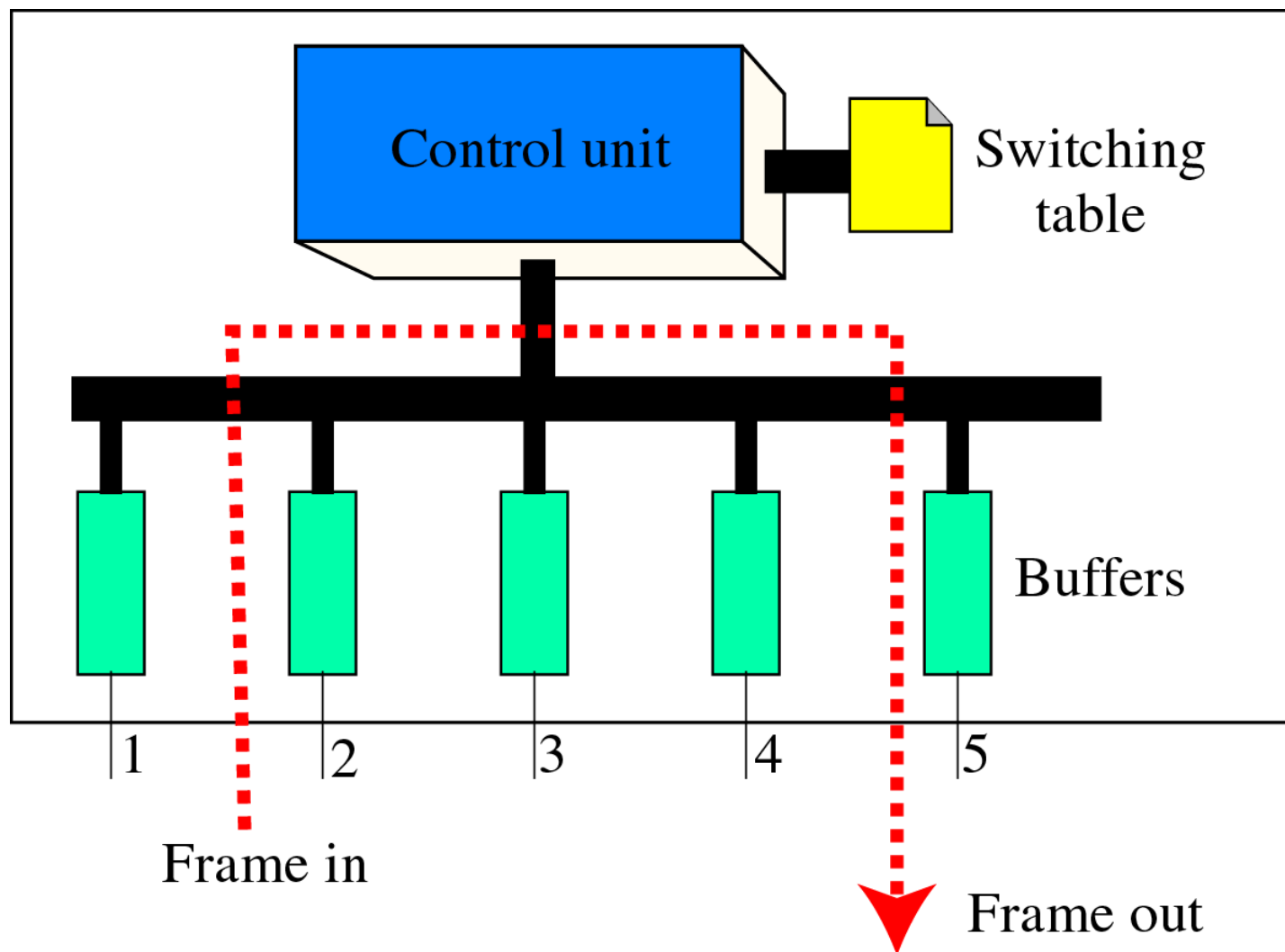**Figure 17.6** Conceptual organization of a switched LAN.

这只是个概念机而已

交换机带有中央结构单元

交换机

6.4 局域网交换机（LAN Switch）

交换机内部结构

11.14 Combining Switches and Hubs

- **Instead of connecting one computer to each port on a switch, the organization connects a hub to each port, and then connects each computer to one of the hubs.**
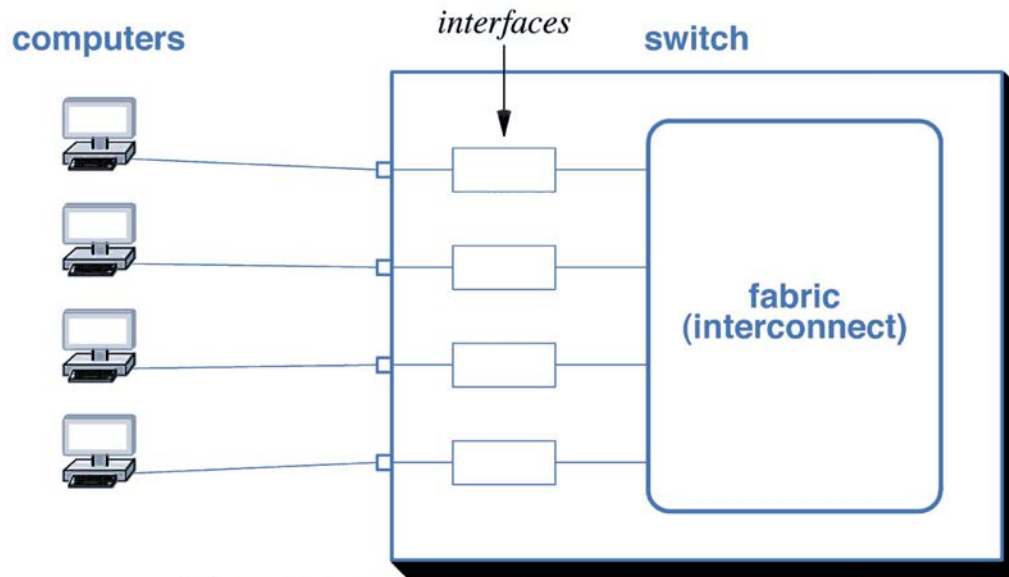

computers   *interfaces*   switch

fabric (interconnect)

Figure 17.7 Illustration of the architecture of a switch.

2~7 Layer Switchers

- **Layer 2**

- **Layer 3**

- **Layer 4**

- **Layer 7**

中继器、网桥、交换机

隔离冲突域？广播域？

很多设备已经不单卖了

但是概念深入人心

Principle will remain

路由器

网关

SNA

Gateway

NetWare
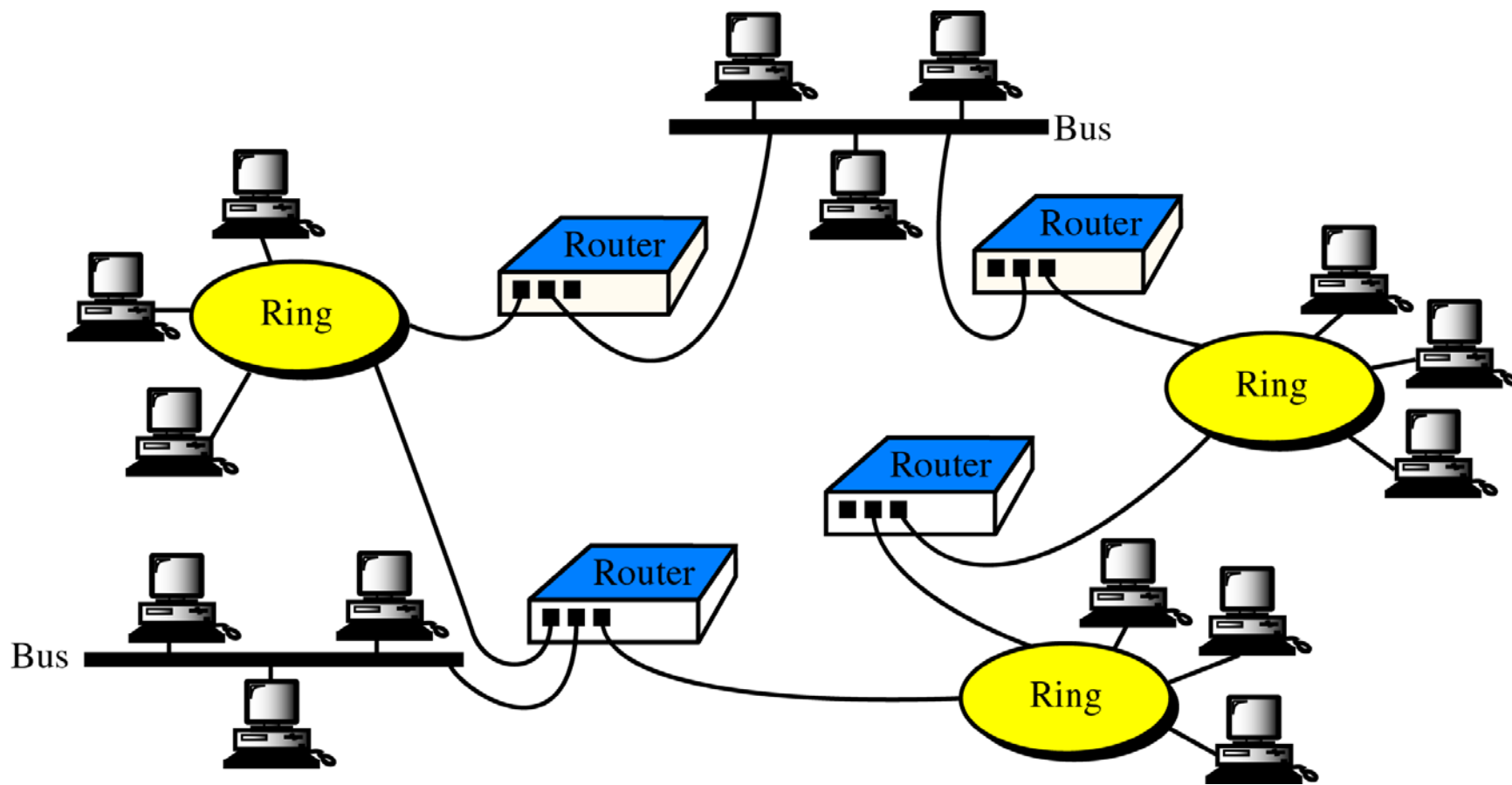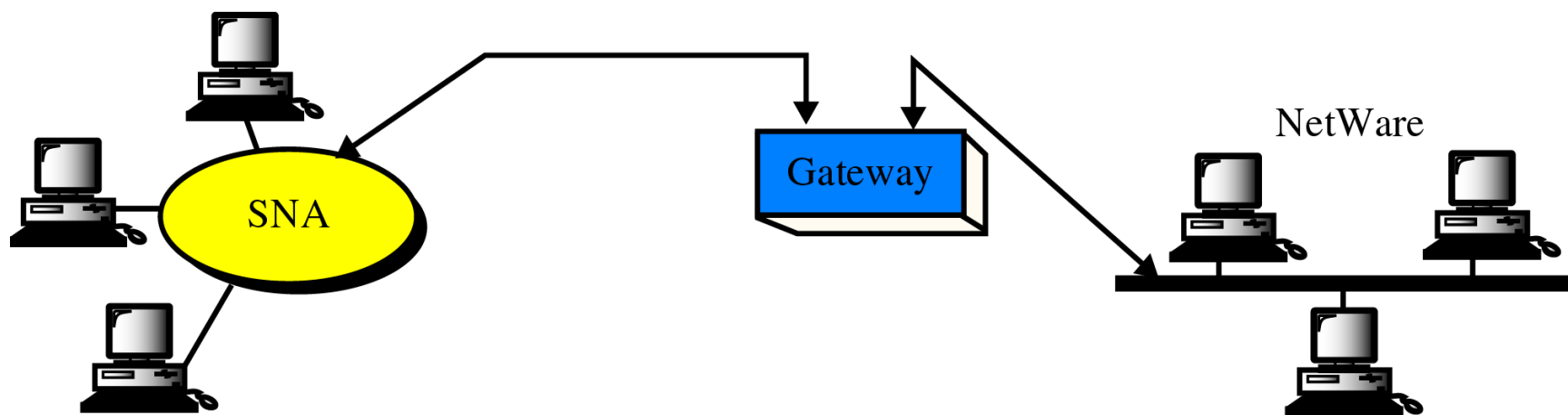
作业

- 详见FTP

- 往届作业

    - 简述中继器、网桥和交换机的作用与区别。

计算机网络

7. THANK YOU.

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