计算机网络

# 2.


# LOCAL ASYNCHRONOUS COMMUNICATION (RS-232)

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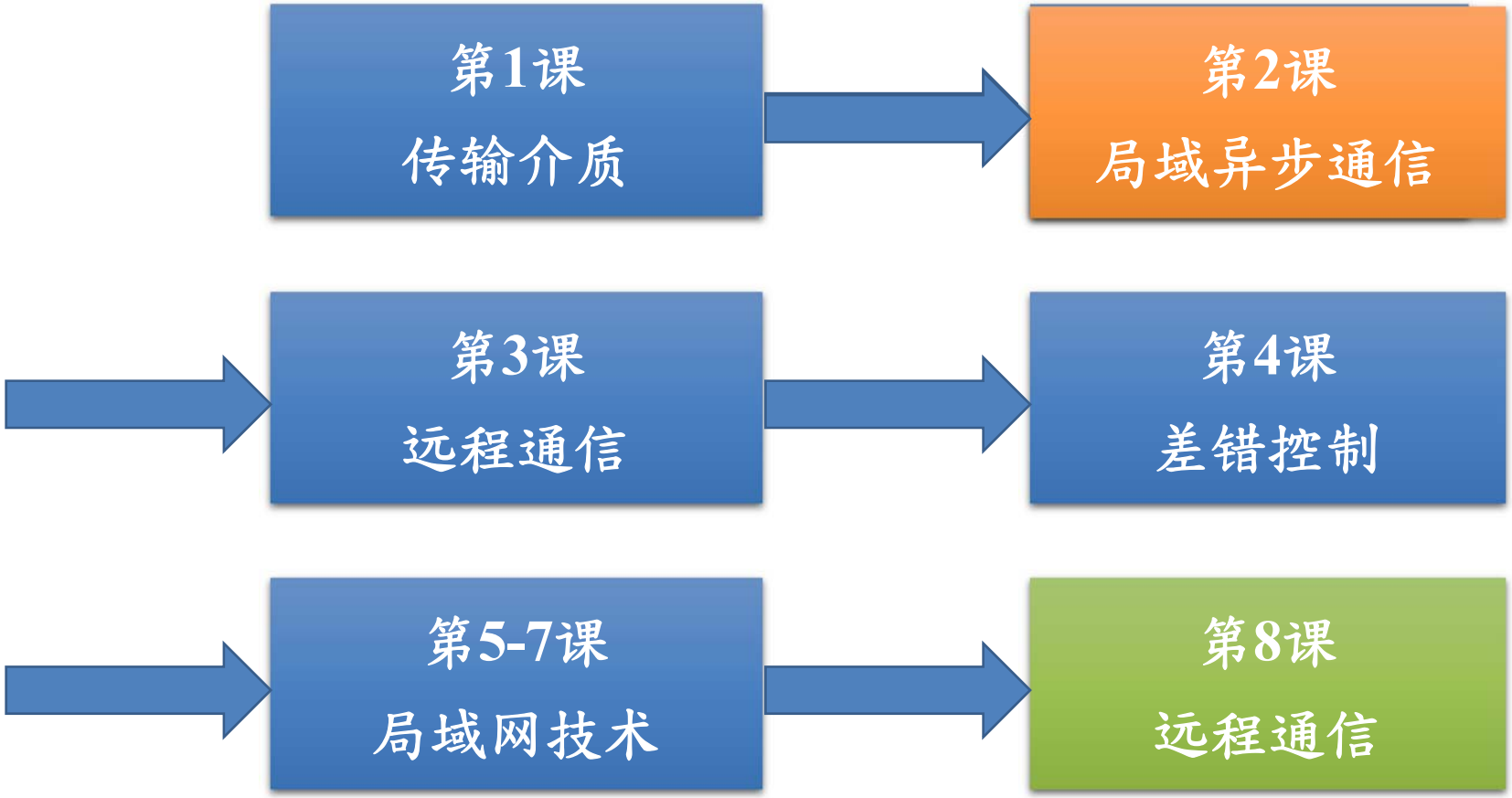
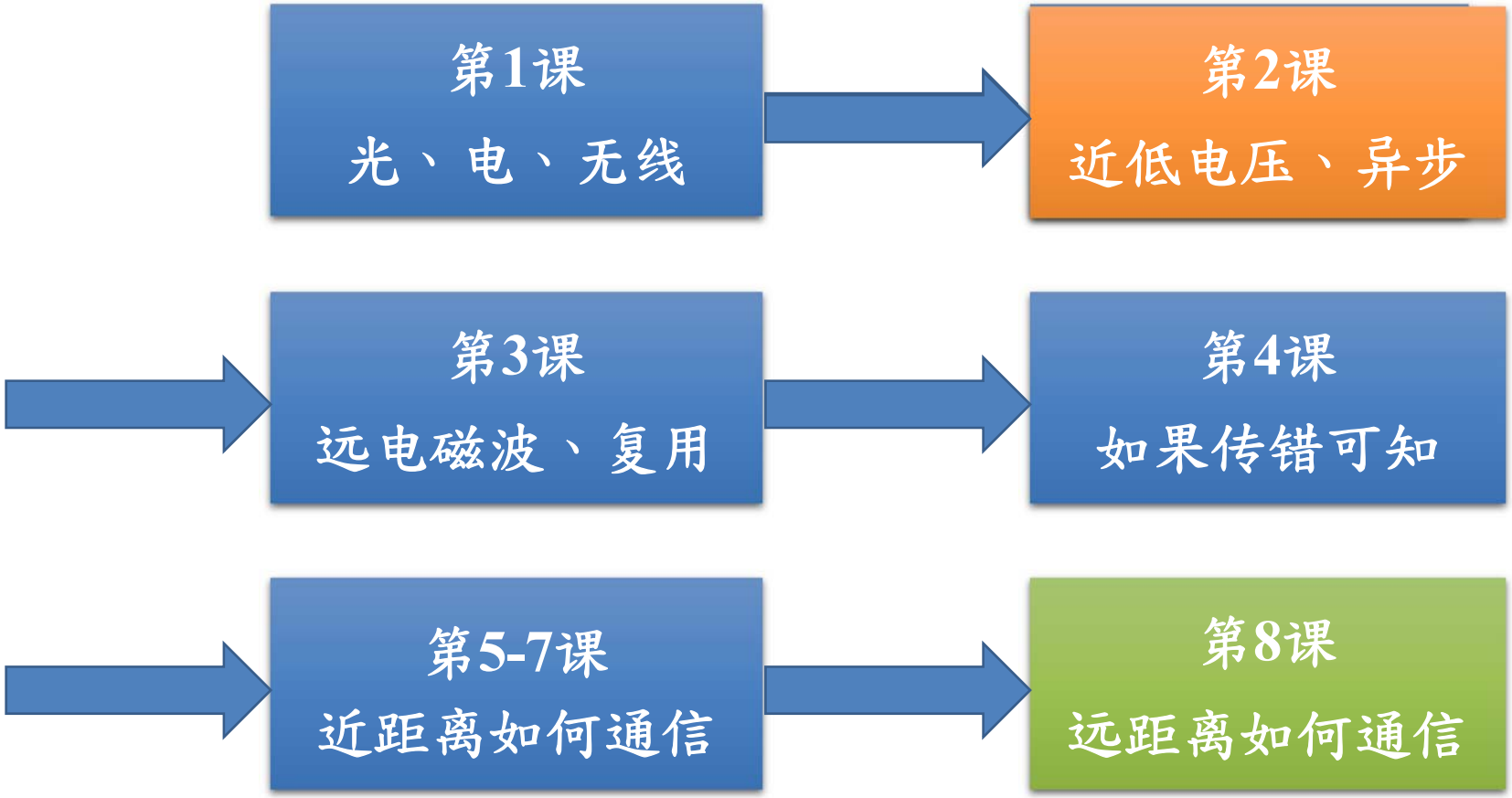
# Ch 5 Local Asynchronous Communication (RS-232)

# 局域异步通信


第1课
传输介质
第2课
局域异步通信
第3课
远程通信
第4课
差错控制
第5-7课
局域网技术
第8课
远程通信


第1课
光、电、无线
第2课
近低电压、异步
第3课
远电磁波、复用
第4课
如果传错可知
第5-7课
近距离如何通信
第8课
远距离如何通信

# RS-232

台式机上一般有2组 RS-232 接口

称为 COM1 和 COM2。

# 5.1 Introduction

- **Computers use binary digits (bits 位串) to represent data.**
- **Transmitting data across a network from one computer to another means sending bits through the underlying transmission medium.**
- **Communication systems use electric current, radio waves, or light to transfer information .**

# 传输的种类

# A Taxonomy (分类) of Transmission Modes

- The term transmission mode (传输模式) to refer to the manner in which data is sent over the underlying medium
- Divided into two fundamental categories:
  - Serial (串行) — one bit is sent at a time
    - Serial transmission is further categorized according to timing of transmissions
  - Parallel (并行) — multiple bits are sent at the same time

# A Taxonomy of Transmission Modes

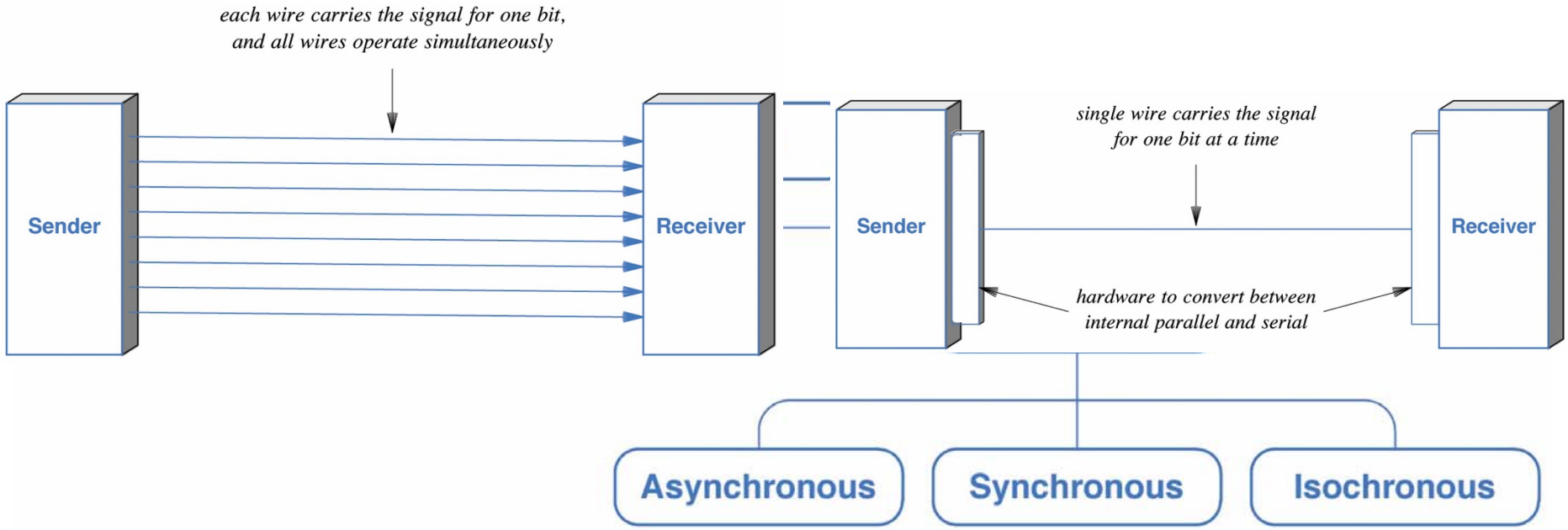



**Figure 9.1** A taxonomy of transmission modes.

# 多比特下的格式

## 端序、分组、同步异步

# Byte and Bit Order

- **Big-endian v.s. Little-endian 大端序 v.s. 小端序**
  - 字节和比特各有端序：什么是尾巴，什么是大小

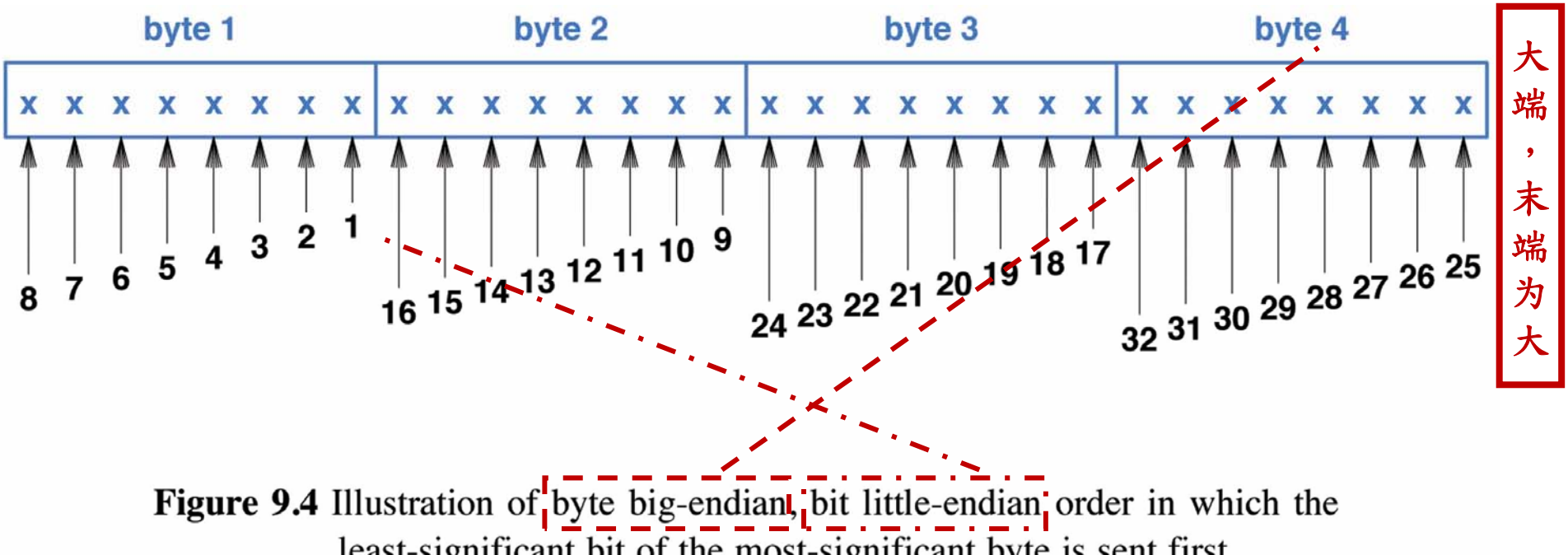



**Figure 9.4** Illustration of byte big-endian, bit little-endian order in which the least-significant bit of the most-significant byte is sent first.

# Byte and Bit Order

- 示例程序

```
typedef unsigned long DWORD;
typedef unsigned char byte;
int main(int argc, char* argv[]) {
        DWORD dw = 0x12345678;
        byte *pdw = (byte*)&dw;
        for (size_t i = sizeof(dw); i > 0; i--) {
                byte b = pdw[i-1];
                for (size_t j = 0; j < 8; j++) {
                        printf("%x", b & 1);
                        b = b >> 1;
                }
                printf(" ");
        }
        return 0;
}
```

输出：01001000 00101100 01101010 00011110

# 字节序举例

- 小端
  - IA架构的CPU是小端
- 大端
  - PowerPC 、SPARC和Motorola处理器是大端
  - JAVA的字节序是大端
  - Internet的网络字节序是大端

# 9.6 Timing of Serial Transmission

- Serial transmission mechanisms (串行传输机制) can be divided into 3 broad categories (on how trans. are spaced in time):
  - Asynchronous (异步) transmission can occur at any time
    - with an arbitrary delay (时延) between the trans. of two data items
  - Synchronous (同步) transmission occurs continuously
    - with no gap (间隔) between the transmission of two data items
  - Isochronous (等时) transmission occurs at regular intervals
    - with a fixed gap between the transmission of two data items

# 同步和异步通信

- 异步、同步、等时，哪个更好？
  - 没有绝对的最好，要看前提条件。

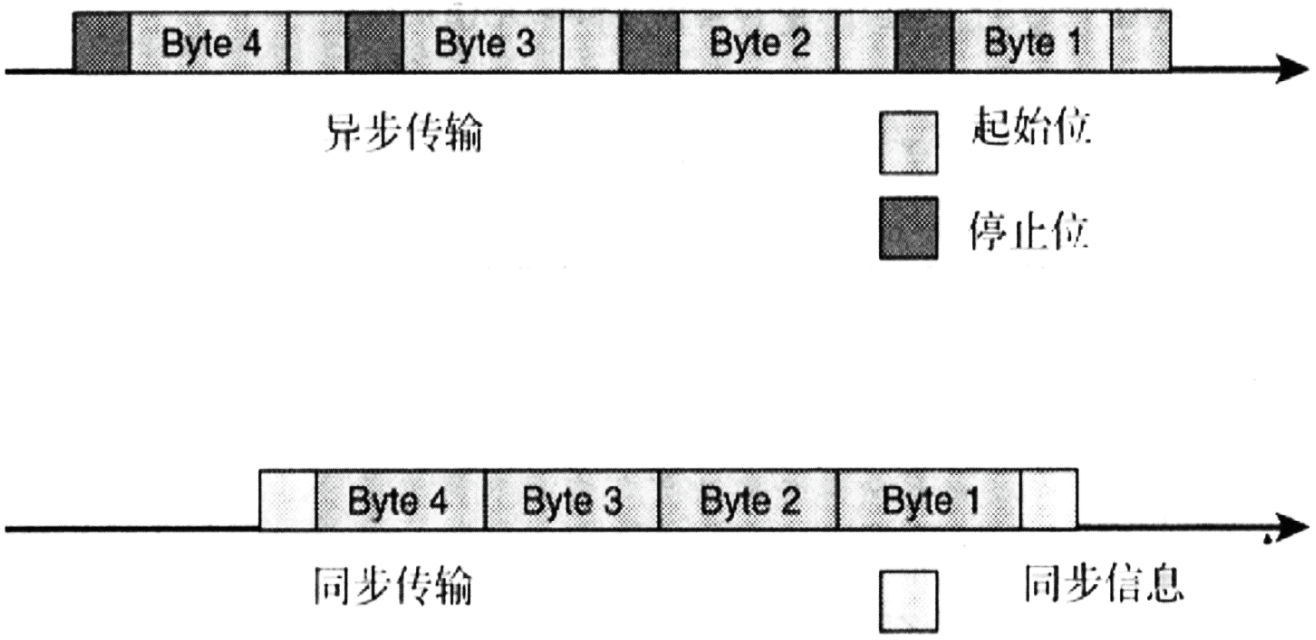



图17-6 异步与同步通信的比较

# Synchronous Transmission

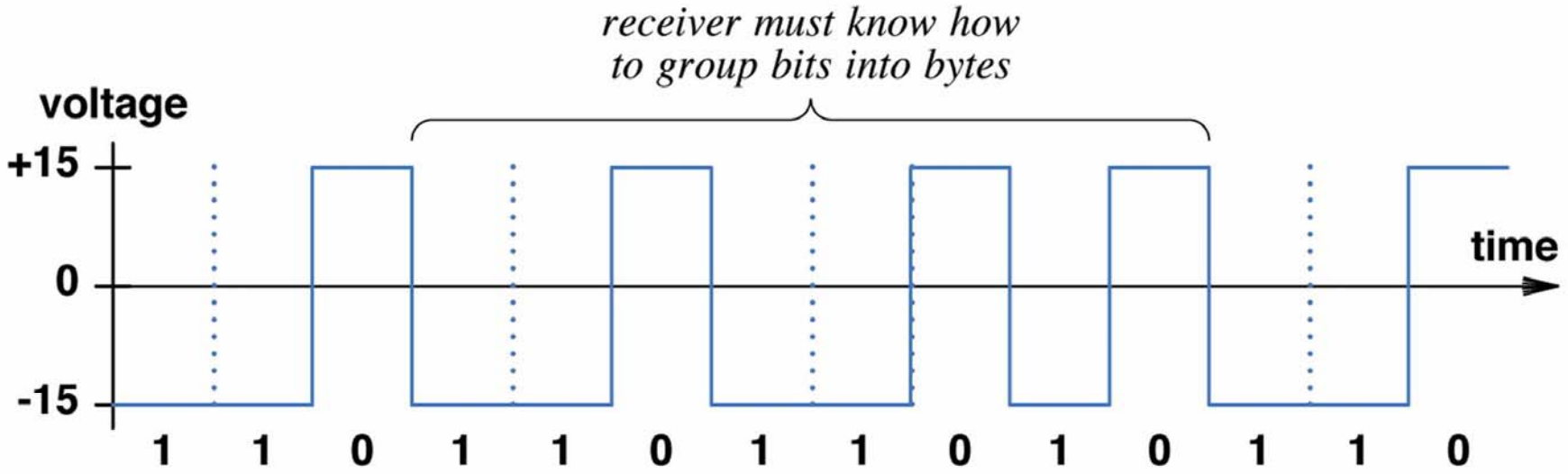



**Figure 9.6** Illustration of synchronous transmission where the first bit of a byte immediately follows the last bit of the previous byte.

# 5.2 The Need for Asynchronous Communication

- A communication is called asynchronous if a sender and receiver do not need to coordinate (协调) before data can be transmitted
- A sender can wait arbitrarily (任意地) long between transmissions and can transmit whenever data becomes ready.
- The receiver must be ready to accept data whenever it arrives.

- 如果发送器不发送使得接收器能决定每个比特开始和结束的信息，则硬件是异步的
- 接收器硬件应该被构造于接受和解释发送器信号

# 异步通信举例

# RS-232

# 5.3 Using Electric Current to Send Bits

- **Negative voltage might be used to represent a `1`, and positive voltage to represent a `0`.**

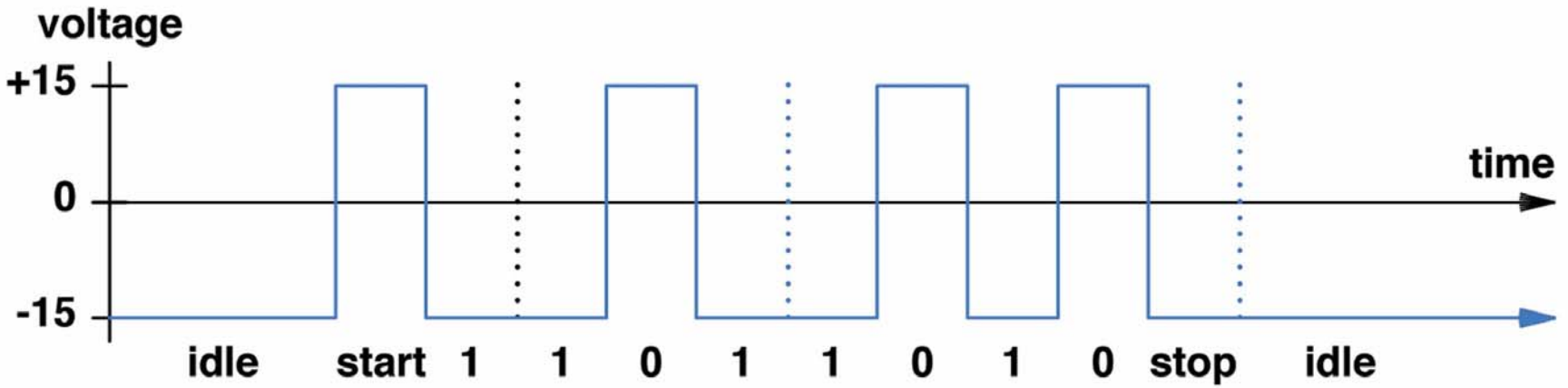



**Figure 9.5** Illustration of voltage during transmission of an 8-bit character when using RS-232.

# 负逻辑：来自 电传机

# Teleprinter

# 位(Bit)与电压

- 位是数据通信的基本数据单元
- 位的取值范围
  - {0,1}
- 通信数据的基本编码方式
  - 用不同的电压表示不同的位值。
    - 例如：0: [3v, 15v]; 1: [-15v, -3v]
  - 波形图：通信过程的电压曲线

# 同步通信和异步通信 (1)

- 同步(synchronous)通信
  - 数据发送方生成的数据中包含了有效数据的位置信息
  - 数据接收方根据有效数据的位置信息提取相应的有效数据
  - 通信的双方在开始通信之前必须完成协调工作，即必须进行同步处理
  - 数据基本单元保持顺序传输，对空数据必需填充对应的空单元

# 同步通信和异步通信 (2)

- 异步通信
  - 数据发送方不需要包含有效数据的位置信息
  - 数据接收方对接收的信息能够直接提取有效数据
  - 通信的双方不需要事先进行任何同步工作。

# RS-232

连线长度不能太长

小于50ft

# RS-232

电压范围

**−15V ~ +15V**

# RS-232

线路编码

负电压为1，正电压为0

# RS-232

电压变化

前导位，开始位，停止位

这么复杂

那就封装吧

# 9.10 Bytes, Blocks, and Frames

- If the underlying synchronous mechanism must send bits continually
  - What happens if a sender does not have data ready to send at all times?
  - The answer lies in a technique known as framing:
    - an interface is added to a synchronous mechanism that accepts and delivers a block of bytes known as a frame
  - To insure that the sender and receiver stay synchronized
    - a frame starts with a special sequence of bits
  - Most synchronous systems include an idle sequence (or idle byte)
    - that is transmitted when the sender has no data to send

# 9.10 Bytes, Blocks, and Frames

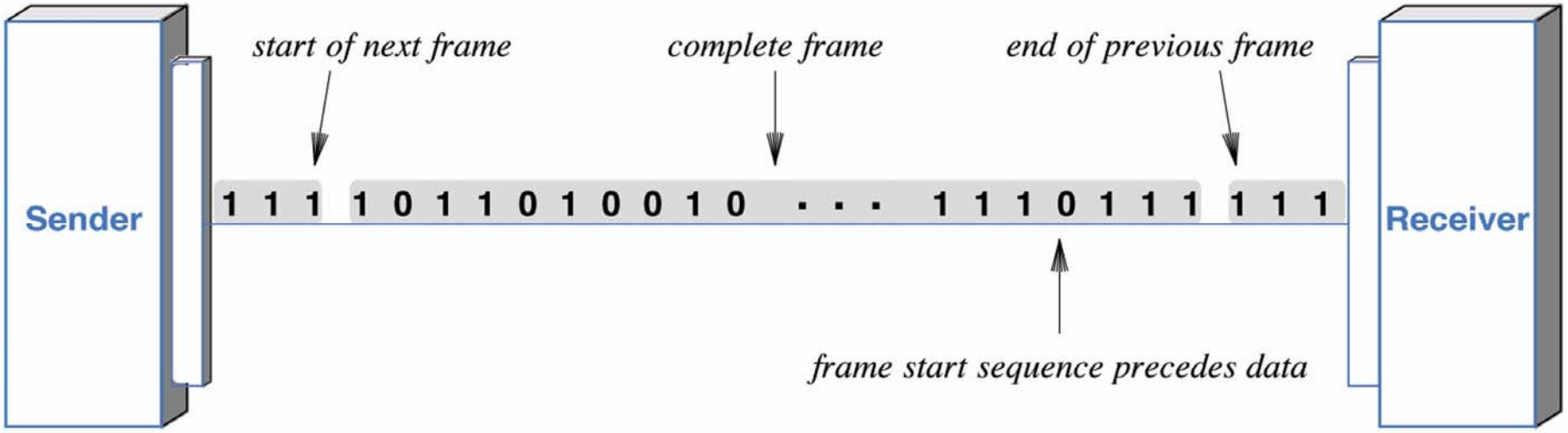



**Figure 9.7** Illustration of framing on a synchronous transmission system.

# 5.4 Standards for Communication

- How long should the sender hold a voltage (伏特) on the wire for a single bit?
- What is the maximum rate (速率) at which hardware can change the voltage?
- How can a customer know that transmitting hardware purchased from one vendor (供应商) will work correctly with receiving one from another vendor?
- Is there a way to send more data in the same amount of time?

# RS-232

- To ensure that communication hardware build different vendor will interoperate (互操作), the specification (规格) for communication systems are standardized.
- One particular standard produced by the EIA (Electronic Industries Association).
- EIA standard RS-232-C, which is commonly abbreviated RS-232.

# RS-232

- RS-232 is a popular standard used for serial (串行), asynchronous (异步) communication over short distances between a computer and a modem or ASCII terminal.
- RS-232 precedes (先于) each character with a start bit, follows each character with an idle (空闲) period at least one bit long (stop bit), and sends each bit in exactly the same length of time.

# RS-232通信标准

- 电子工业协会（ EIA ）
- RS-232异步串行通信接口
  - 对数据按照位进行序列化发送和接收
  - 发送方和接收方不需要进行同步操作
  - 数据值仅有0和1两种形式，不出现“空”状态
  - 7位作为一个发送单元

# RS-232通信标准 (续)

- 电子工业协会（ EIA ）
- RS-232异步串行通信接口
  - 对应每个数据单元，增加一个“0”作为开始位，“1”作为结束位
  - 接收方接收到有效数据开始位后，严格按照时间片顺序完成数据接收，直到接收完结束位为止

# RS-232的参数

## 波特率

# 5.5 Baud Rate Framing Errors

- **Technically, transmission hardware is rate in baud (波特), the number of changes in the signal per second that the hardware generates.**
- **For the simple RS-232 scheme presented, the baud rate is exactly equal to the number of bits per second.**

# 5.5 Baud Rate Framing Errors

- If the sending and receiving hardware are not configured to use the same baud rate, errors will occur because the receiver's timer will not wait an appropriate (适当) length of time for each bit.
- To detect errors, a receiver measures the vol. for each bit multiple times and compares the measurements. If the vol. don't all agree or if the stop bit doesn't occur exactly at the time expected, the receiver reports an error, called framing errors (帧错误).

# 波特率

- **Baud是波特，是码元传输速率的单位，1波特为每秒传送1个码元。**
  - 波特率：传输硬件介质中信号变化的速率，
  - 接口传输（发送/接收）位的速率，码元传输速率也称为调制速率，波形速率或符号速率。单位：**bps(bits per second)**
  - 波特与比特是两个不同的概念，比特是信息量的单位。
  - 若1个码元只携带1bit的信息量，则“比特/秒”和“波特”在数量上是相等的。

# 传输中断的实现

- 传输中断的实现
  - 发送方在发送完有效数据开始位后，发送“0”信息，超过有效数据结束位
  - 接收方接收到有效数据开始位后，严格按照时间接收数据，当有效数据结束位时间片到，仍然是“0”，接收方认为数据错误，产生中断信号

# 异步通信的模式

## 单工、半双工、全双工

# 5.6 Full Duplex Asynchronous Communication

- **Simultaneous transfer in two direction is known as full duplex (全双工) transmission.**
- **Transfer in single direction is known as half duplex(半双工) transmission or simplex (单工) transmission.**

# 单工、半双工和全双工

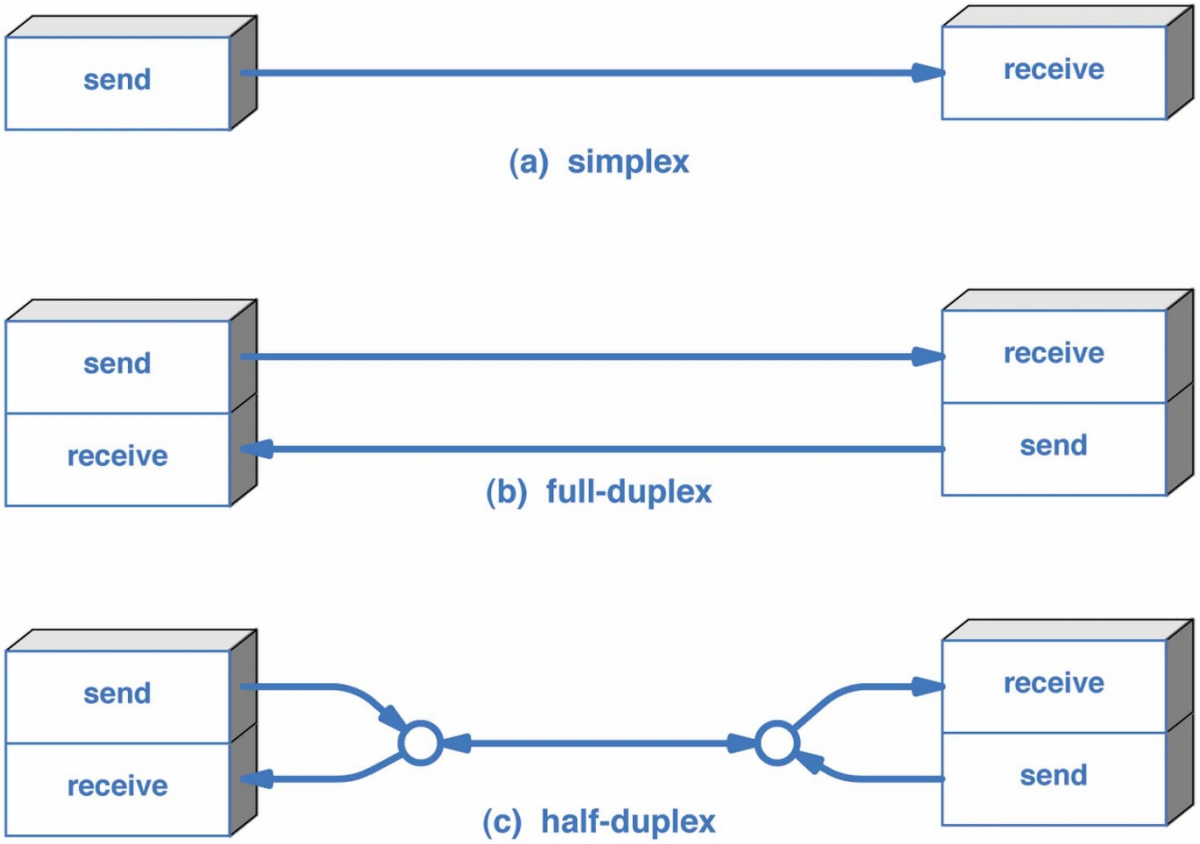
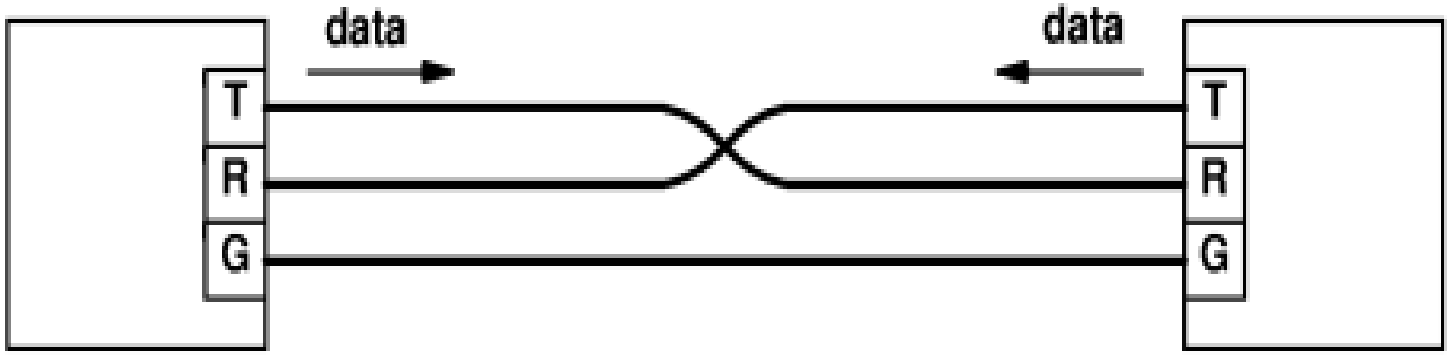



**Figure 9.8** Illustration of the three modes of operation.

# 单工、半双工和全双工

- **The minimal wiring required for full duplex RS-232 communication**




- **The ground wire connects directly from the ground on one device to the ground on the other, the other two wires cross: the wire connected to the transmitter on one device connects to the receiver on the other.**

# DCE和DTE

**Data Communication Equipment**

**Data circuit-terminating equipment**

数据通信设备（中文课本有误）

**Data Terminal Equipment**

数据终端设备

# DCE和DTE

- Technically, the two types of connectors are associated with Data Communication Equipment (DCE) and Data Terminal Equipment (DTE).
  - A cable that connects a computer to a modem has a wire from pin 2 to pin 2 and a wire from pin 3 to pin 3.
  - A cable used to connect two computers (i.e., two DCE devices) must have a wire from pin 2 to pin 3 and a wire from pin 3 to pin 2. The exchange is often called a 2-3 swap (2-3交换)

# DB-9

（2）RS232 串口通信基本接线方法

通信距离较近时（<15m）,可以用电缆直接连接标准 RS232 端口，最为简单且常用的是三线制接法，即信号地、接收数据和发送数据 3 脚相连。接线方法如图 2-2 所示。其他类型的串口，比如 DB-25 之间或 DB-9 与 DB-25 之间的连线，只要记住一个原则：接收数据针脚与发送数据针脚相连，彼此交叉，信号地对应相接就可以，如表 2-2 所示。

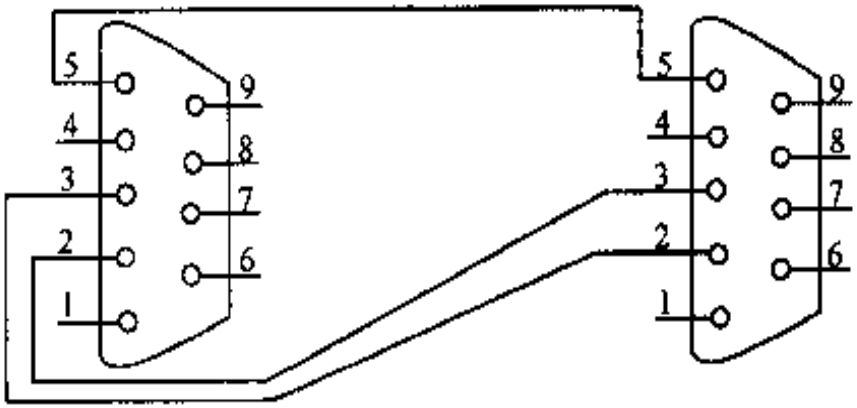



图 2-2　DB-9 基本连线图

# RJ-45接口

- 以10Mbps以太网的RJ-45接口为例：
  - 在UTP上以100Mbps或更高的信号速度运行的局域网将使用全部4对线。

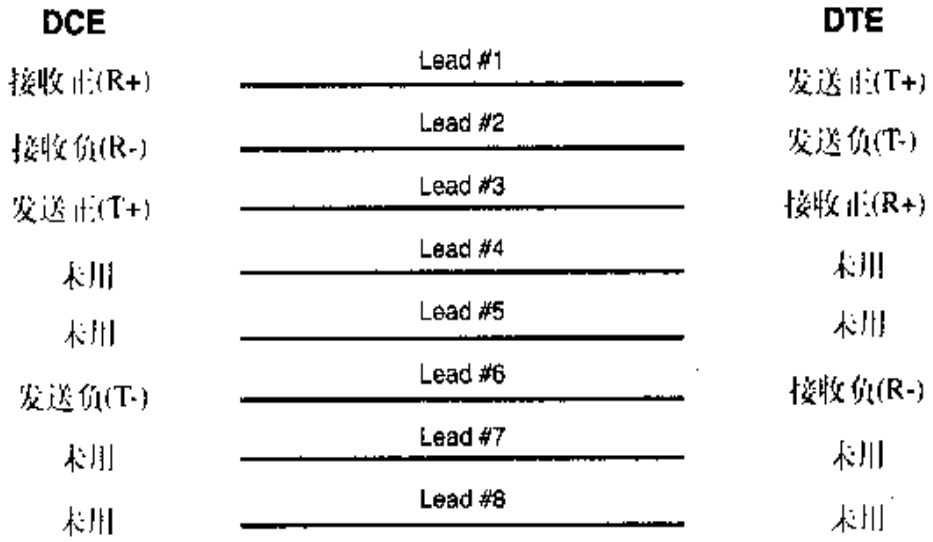



图3-10 DCE与DTE的连接

# DTE到DCE的通信

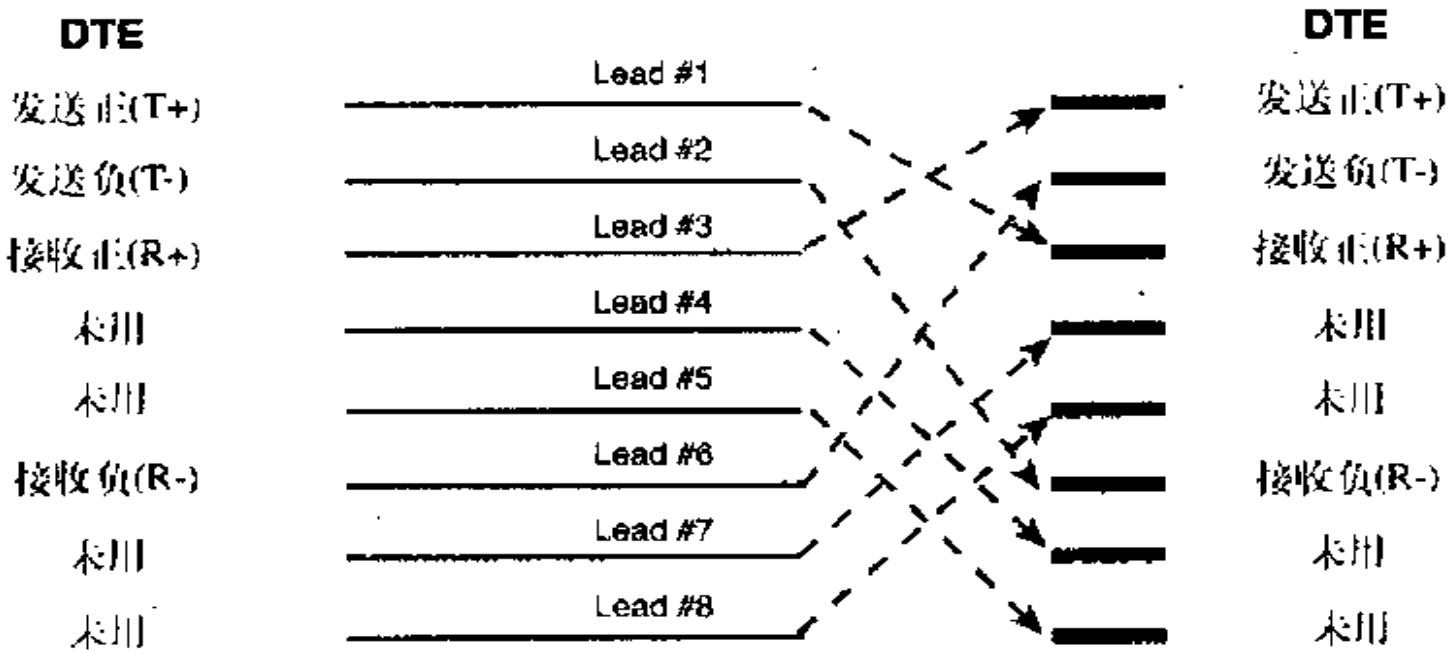



图3-11 DTE到DTE的交叉连线通信(RJ-45 10Base-T)

交叉电缆必须维持物理导线的极性，正负极电平必须保持分离。交叉的导线是从正极传送(T+)到正极接收(R+)，负极传送(T-)到负极接收(R-)。

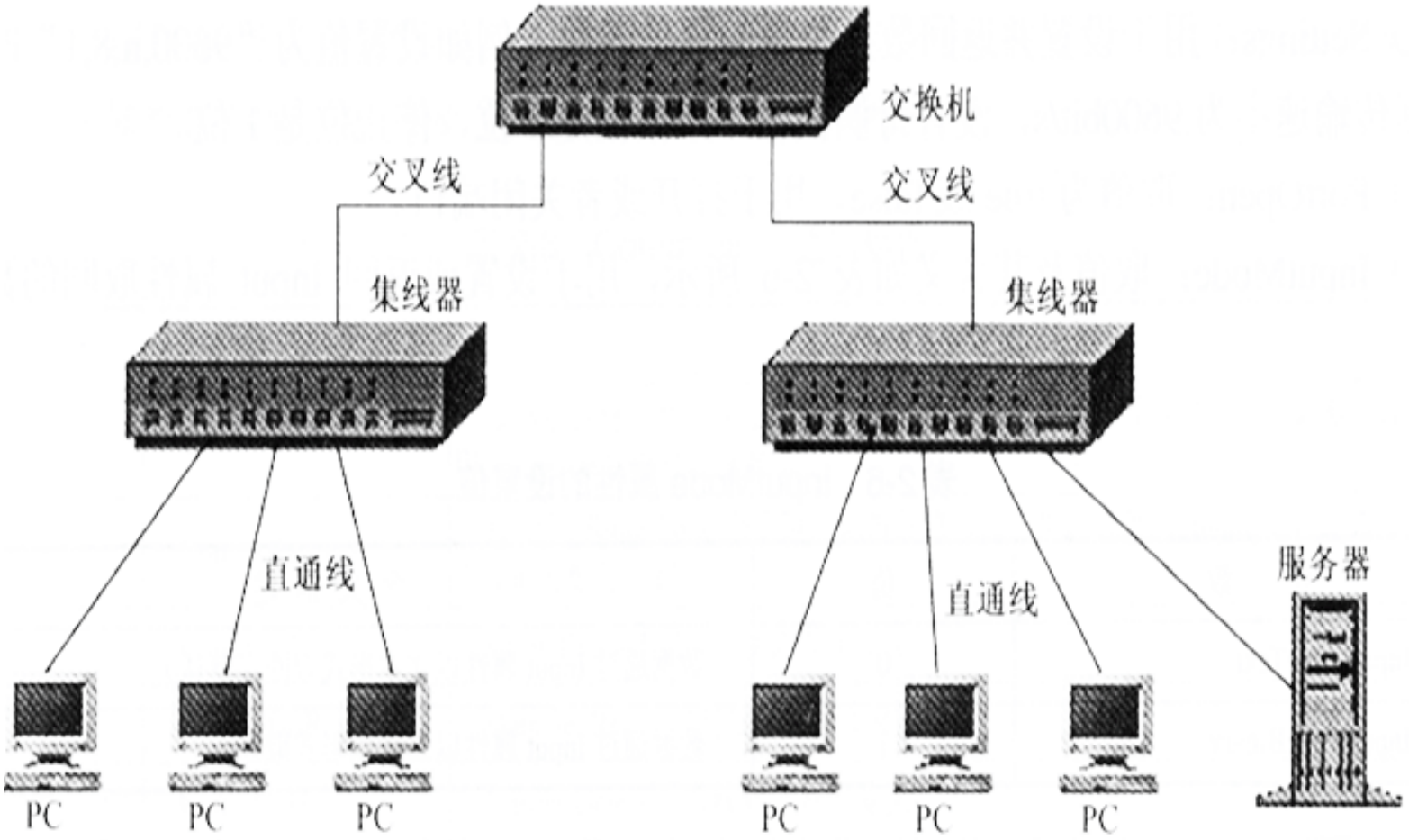


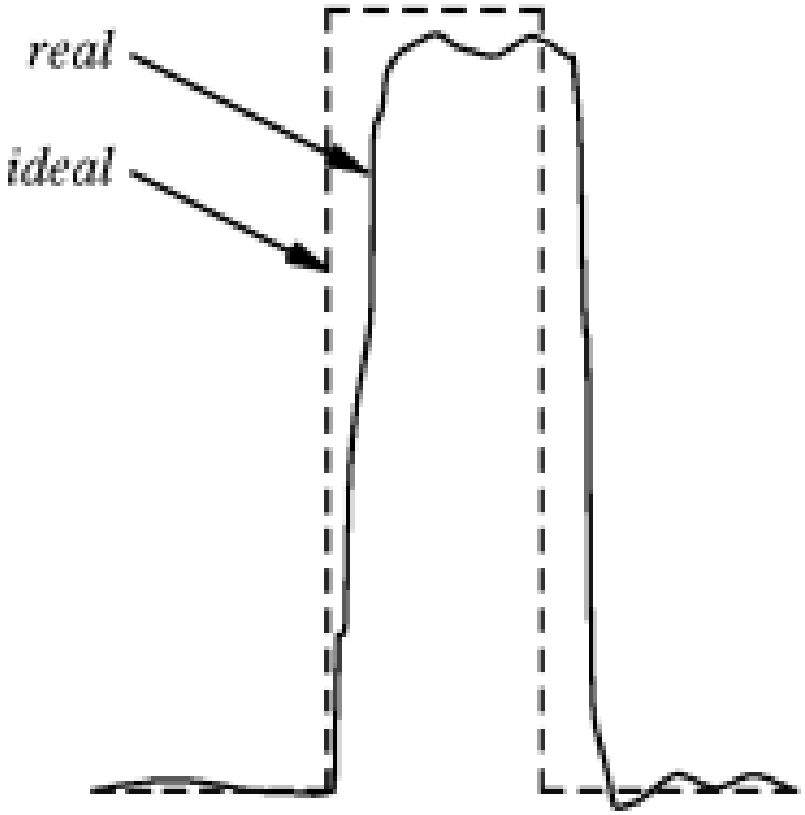

图 2-10　用 RJ45 连接的以太局域网结构图

# 带宽

## 信号频率度量

# 5.7 Limitations of Real Hardware

- **How fast can hardware transmit bits across a wire?**



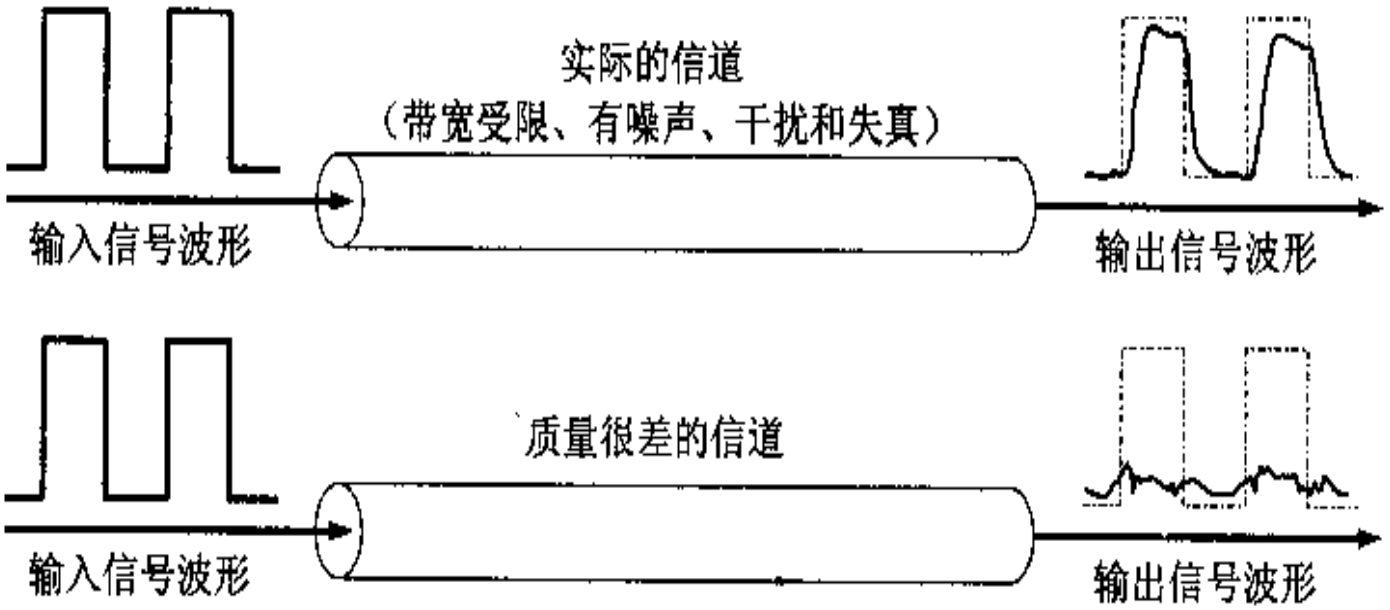



图 3-3　数字信号通过实际的信道和质量很差的信道时的输出波形

# The real world is not perfect.

- No electronic device can produce an exact voltage or change from one voltage to another instantly.
- No wire conducts electricity perfectly.
- As electric current travels down the wire, the signal loses energy.
- As a result, it takes a small time for the voltage to rise or fall, and the signal received is not perfect.

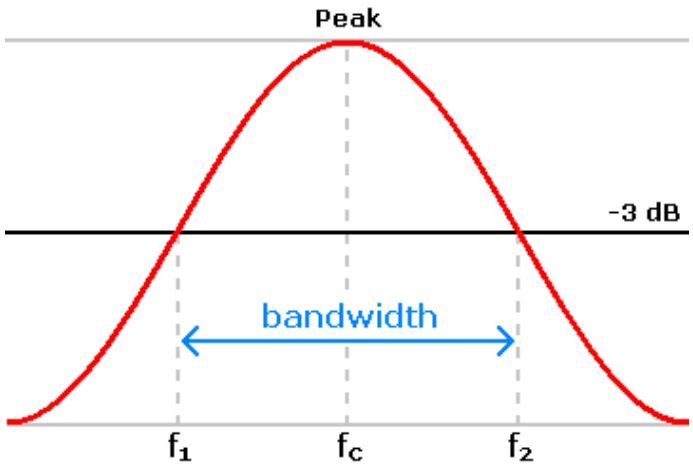
- **RS-232 recognizes that real hardware is imperfect.**
- **The standard does not specify that a receiver should measure the voltage exactly at the beginning of bit.**
- **The standard recommends taking samples during the middle of the time allocated to the bit.**

# 5.8 Hardware Bandwidth and the Transmission of Bits

- How fast can hardware transmit bits across a wire?
- Real hardware cannot change voltages instantly.
- Each transmission system has a limited bandwidth, which is the maximum rate that the hardware can change a signal.

# Bandwidth

- **Bandwidth is measured in cycles per second or Hertz.**
  - **Because bandwidth limitations arise from the physical properties of matter and energy, every physical transmission system has a finite bandwidth.**
  - **带宽的单位是波特率（baud），仅在二进制环境下为bps。**



# 两个重要的通信理论

# Nyquist's theorem

# Shannon's theorem

# Nyquist's (奈奎斯特) theorem

- **Nyquist's (奈奎斯特) theorem**
  - **defines relationship between hardware bandwidth and the theoretical maximum rate at which data can be sent.**
    - **For a trans. scheme like RS-232 that uses two values of voltage to encode data, Nyquist's theorem states that the max. data rate in bps that can be achieved over a trans. system of bandwidth $B$ is $2B$.**
  - **If the transmission system uses $K$ possible values of voltage instead of two, Nyquist's theorem states that the maximum data rate in bits per second, $D$, is: $D = 2B \log_2 K$**

# Bandwidth

- 带宽
  - 本来的意思是指某个信号具有的频带宽度。
  - 特定信号通常由许多不同的频率成分组成。一个信号的带宽是指该信号的各种不同频率成分所占据的频率范围。
  - 对于数字信道，“带宽”是指在信道上能够传送的数字信号的速率，即数据率或比特率，单位是b/s或bps。
  - 根据香农理论，因为带宽代表数字信号的发送速率，因此，带宽有时也称为吞吐量。

# 5.9 The Effect of Noise on Communication

- **Shannon's theorem (香农) extended Nyquist's work to specify the maximum data rate could be achieved over a transmission system that introduce noise.**

$$C = B \log_2\left(1 + \frac{S}{N}\right)$$

  - **where $C$ is the effective limit on the channel capacity in bits per second, $B$ is the hardware bandwidth, $S$ is the average signal power, and $N$ is the average noise power.**
  - **S/N is known as the signal-to-noise ratio (信噪比), which is measured in decibels (分贝dB):**

$$10 \log_{10} \frac{S}{N}$$

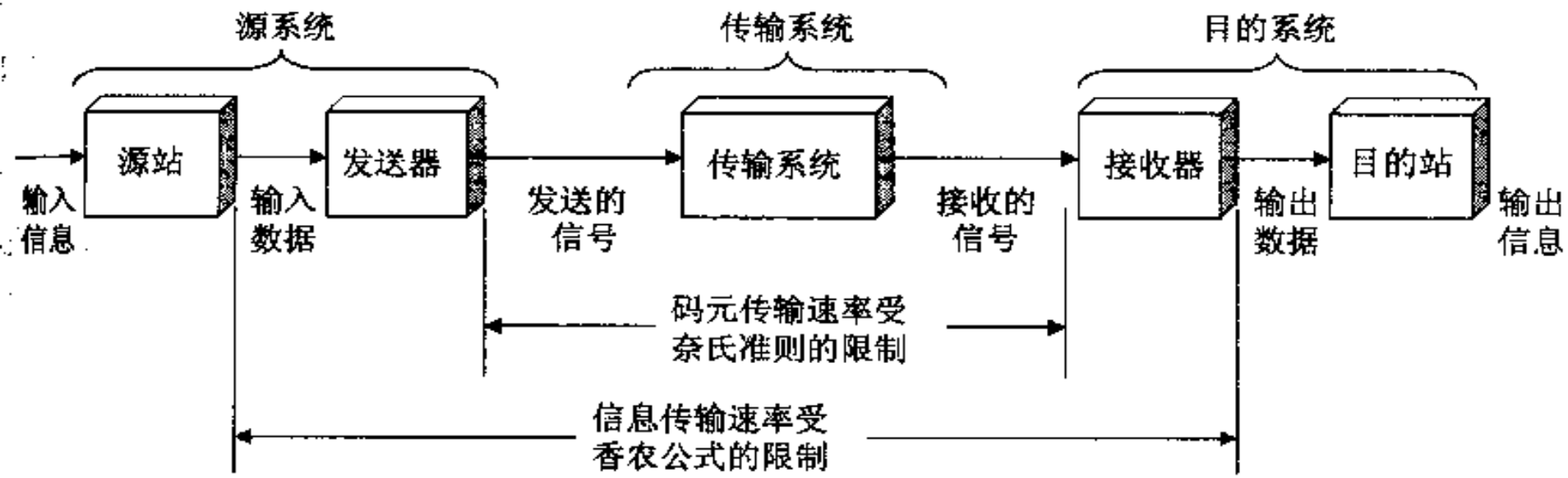



图 3-4　奈氏准则和香农公式在数据通信系统中的作用范围

# 5.10 Significance for Data Networking

- Nyquist's theorem encourages engineers to explore ways to encode bits on a signal because a clever encoding allows more bits to be transmitted per unit time.
- Shannon's theorem informs engineers that no amount of clever encoding can overcome the laws of physics that place a fundamental limit on the number of bits per second that can be transmitted in a real communication system.

- 奈奎斯特采样定理，是信息论，特别是通讯与信号处理学科中的一个重要基本结论。
  - 如果信号是带限的，并且采样频率大于信号带宽的2倍，那么，原来的连续信号可以从采样样本中完全重建出来。
    - 比如声音信号，由人类发出的声音信号中，频率超过5 kHz的成分通常非常小，因此以10 kHz的频率来采样这样的音频信号就足够了。

# 实验

- 请认真完成实验二
- 如果要开发一个视频网站，应使用何种串行传输？
  - CSDN：要使用socket进行视频传输,多对一传输,多个客服端一个服务器,多个客服端同时进行视频采集并发送给服务器,服务器端是使用同步还是异步机制进行数据的接收显示好呢?请高人指点一二,最好讲讲各自的优缺点.谢谢
- 建议有兴趣的同学编写服务器端和客户端，变换使用三种传输，验证是否满足三种传输的特点。

# 实验二

# RS-232双机互联编程

# 模拟RS-232

## 虚拟机

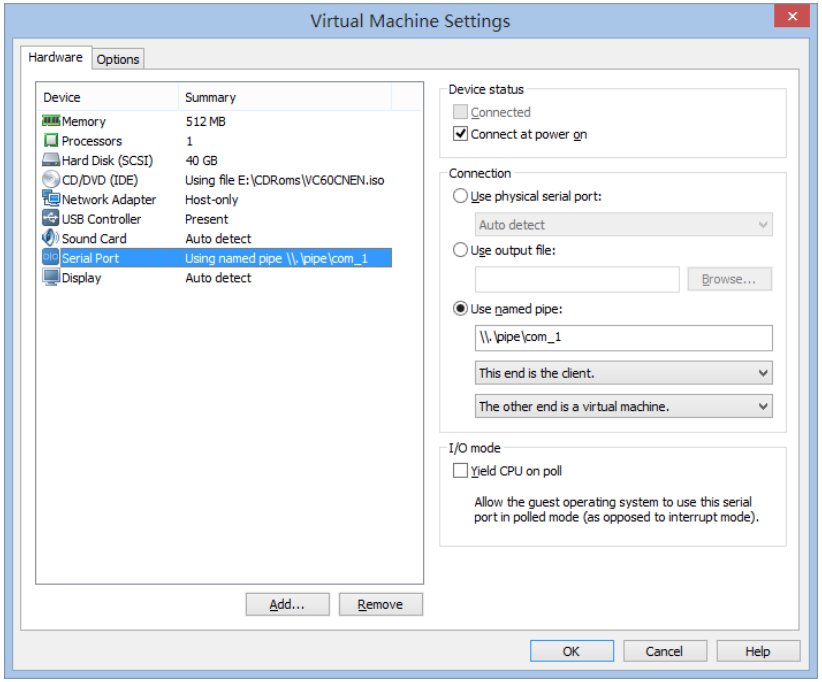
## 以VMWare为例

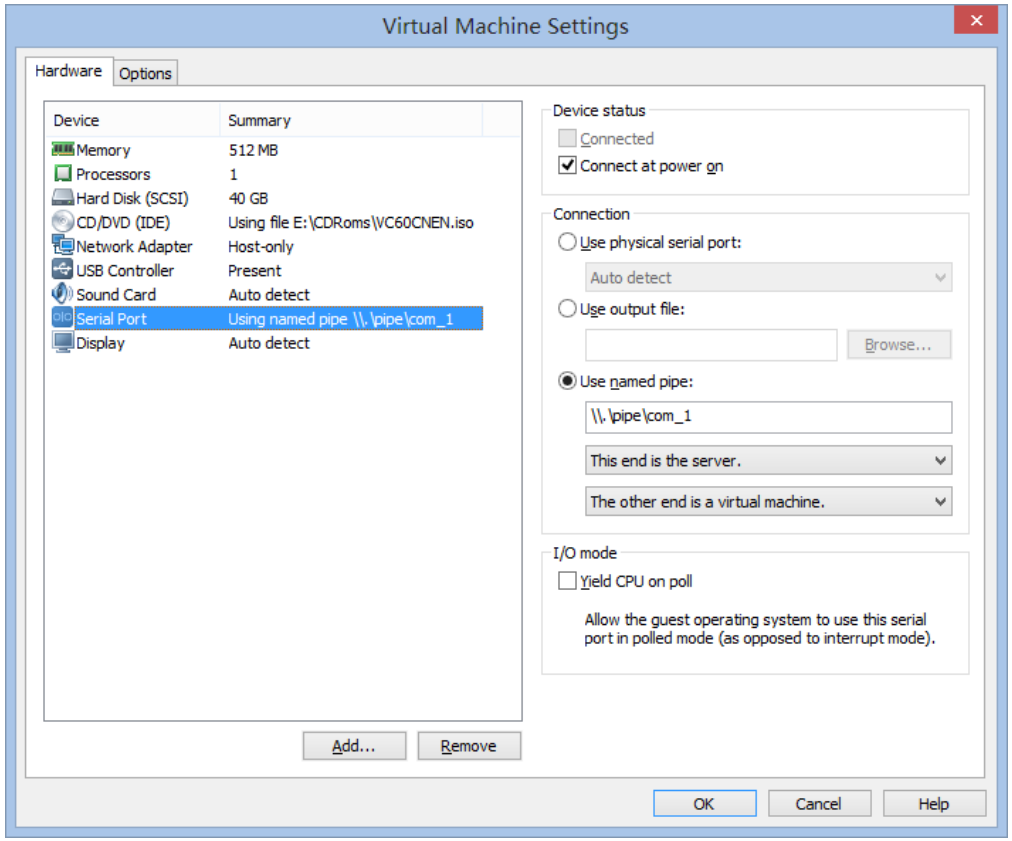
# VMWare配置

- 新建两台Windows XP虚拟机
- 新建串口（Serial Port）
  - 选择命名管道模式：Used Named Pipe
  - 选择相同的命名管道路径
  - 一台机器配置成服务器端，另一台配成客户端
    - This end is the server. This end is the client.
  - 选择对方端点为虚拟机
    - The other end is a virtual machine.

# VMWare

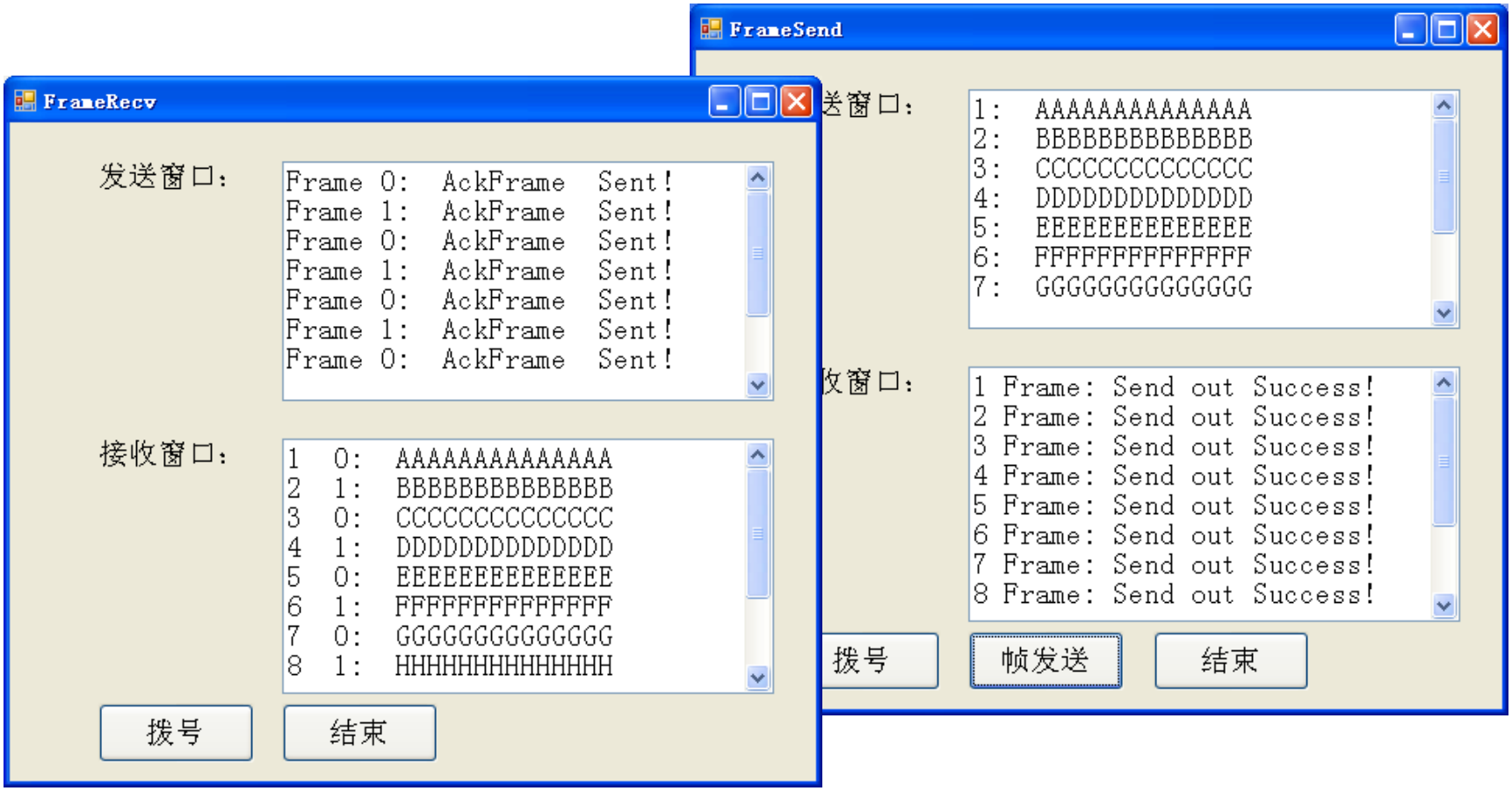
- 计算机网络实验课安排\网络实验教程参考程序源码\
  - \8.3FrameCommSend
  - \8.3FrameCommRecv



# 输出

- 建议不要只是build程序



# 作业

- 说明：课后作业详见FTP

计算机网络

# 2.


# THANK YOU.

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