Chapter 9

Transmission Modes
A Taxonomy of Transmission Modes

Transmission Mode

- Parallel
- Serial
  - Asynchronous
  - Synchronous
  - Isochronous
Parallel Transmission

- Parallel transmission allows transfers of multiple data bits at the same time over separate media.
- In general, parallel transmission is used with a wired medium that uses multiple, independent wires.

*each wire carries the signal for one bit, and all wires operate simultaneously*
Serial Transmission

single wire carries the signal for one bit at a time

hardware to convert between internal parallel and serial
Serial Transmission

• The hardware needed to convert data between an internal parallel form and a serial form can be straightforward or complex
  – depending on the type of serial communication mechanism
• In the simplest case, a single chip that is known as a Universal Asynchronous Receiver and Transmitter (UART) performs the conversion
• A related chip, Universal Synchronous-Asynchronous Receiver and Transmitter (USART) handles conversion for synchronous networks
Transmission Order: Bits and Bytes

- We use the term **little-endian** to describe a system that sends the LSB first
- We use the term **big-endian** to describe a system that sends the MSB first
- Either form can be used, but the sender and receiver must agree
Timing of Serial Transmission

• Serial transmission mechanisms can be divided into three broad categories (depending on how transmissions are spaced in time):

• **Asynchronous** transmission can occur at any time
  – with an  **arbitrary delay** between the transmission of two data items

• **Synchronous** transmission occurs continuously
  – with  **no gap** between the transmission of two data items

• **Isochronous** transmission occurs at regular intervals
  – with a  **fixed gap** between the transmission of two data items
Asynchronous Transmission

• It is asynchronous if the system allows the physical medium to be idle for an arbitrary time between two transmissions.
• The asynchronous style of communication is well-suited to applications that generate data at random
  – (e.g., a user typing on a keyboard or a user that clicks on a link)
• The disadvantage of asynchrony arises from the lack of coordination between sender and receiver
  – While the medium is idle, a receiver cannot know how long the medium will remain idle before more data arrives.
• Asynchronous technologies usually arrange for a sender to transmit a few extra bits before each data item
  – to inform the receiver that a data transfer is starting
  – extra bits allow the receiver to synchronize with the incoming signal
  – the extra bits are known as a preamble or start bits.
RS-232 Asynchronous Character Transmission

• Consider the transfer of characters across copper wires between a computer and a device such as a keyboard
  – each data item represents one character

• It is standardized by the Electronic Industries Alliance (EIA)
  • It has become the most widely used for character communication
  • Known as RS-232-C, and commonly abbreviated RS-232

• EIA standard specifies the details, such as
  – physical connection size (max cable length 50 feet long)
  – electrical details (range between -15v +15v)
  – the line coding being used
  – It can be configured to control the exact number of bits per second
  – It can be configured to send 7-bit or 8-bit characters
Synchronous Transmission

- A synchronous mechanism transmits bits of data continually
  - with no idle time between bits
  - after transmitting the final bit of one data byte, the sender transmits a bit of the next data byte
- The sender and receiver constantly remain synchronized
  - which means less synchronization overhead
- Compare the 8-bit characters on
- Each character sent using RS-232 requires an extra start bit and stop bit
  - meaning that each 8-bit character requires a minimum of 10 bit times, even if no idle time is inserted
- On a synchronous system
  - each character is sent without start or stop bit:
Synchronous Transmission

receiver must know how to group bits into bytes

<table>
<thead>
<tr>
<th>Start Frame</th>
<th>DATA up to 64,000 bits of data or 8K Bytes</th>
<th>End Frame</th>
</tr>
</thead>
</table>

Efficiency = \[
\frac{\text{# of Data bytes}}{\text{Total # of bytes transmitted}}
\]
Synchronous Transmission

Transmitter sends bits on falling edge of the clock
Receiver reads bits on rising edge of the clock

Clock

Data (e.g.: 61H)

Bits

0 1 1 0 0 0 0 1

Note: Many synchronous protocols send MSB first

http://www.eeherald.com/section/design-guide/esmod7.html
Asynchronous Transmission

Transmitter uses an internal clock when to determine when to send each bit.

Receiver detects the falling edge of the start bit and then uses its internal clock to read the following bits.

Data (61H)

Bits

Start bit | Bit 0 | Bit 1 | Bit 2 | Bit 3 | Bit 4 | Bit 5 | Bit 6 | Bit 7 | stop bit

1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0

Note: Asynchronous protocols send LSB first.
Isochronous Transmission

- Isochronous transmission
  - is designed to provide **steady bit flow** for multimedia applications
- Delivering such data at a steady rate is essential
  - because variations in delay known as **jitter** can disrupt reception (cause pops or clicks in audio/make video freeze for a short time)
- Isochronous network is designed to accept and send data at a fixed rate, **R**
  - Network interface is such that data must be handed to the network for transmission at exactly **R** bits per second
- For example, an isochronous mechanism designed to transfer voice operates at a rate of **64,000** bits per second
  - A sender must generate digitized audio continuously
  - A receiver must be able to accept and play the stream
Simplex, Half-Duplex, and Full-Duplex Transmission

- A communications channel is classified as one of three types: (depending on the direction of transfer)
  - Simplex
  - Full-Duplex
  - Half-Duplex
DCE and DTE Equipment

- Terms **Data Communications Equipment** (DCE) and **Data Terminal Equipment** (DTE) were originally created by AT&T
  - To distinguish between the communications equipment owned by the phone company and the terminal equipment owned by a subscriber
- The terminology persists: if a business leases a data circuit from a phone company
  - the phone company installs DCE equipment at the business
  - and the business purchases DTE equipment that attaches to the phone company’s equipment
DCE and DTE Equipment

• From an academic point of view, the concept behind the DCE-DTE distinction is not ownership of the equipment
  – Instead, it lies in the ability to define an arbitrary interface for a user

• If the underlying network uses synchronous transmission
  – the DCE equipment can provide either a synchronous or isochronous interface to the user’s equipment

• Figure 9.9 illustrates the conceptual organization

• Several standards exist that specify a possible interface between DCE and DTE
  – The RS-232 standard described in this chapter and the RS-449 standard proposed as a replacement can each be used
  – In addition, a standard known as X.21 is also available
DCE and DTE Equipment
DCE and DTE Equipment

The V Series
Recommendations from the ITU-TS include the most commonly used modem standards and other telephone network standards (next slide)
### V Series Standards

The V Series Recommendations from the ITU-TS include the most commonly used modem standards and other telephone network standards.

**Note:** V.32bis is very common / it uses Quadrature Amplitude Modulation used with dialup modems to maximize the transmission rate.

<table>
<thead>
<tr>
<th>Standard</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>V.22</td>
<td>Provides 1200 bits per second at 600 baud (state changes per second)</td>
</tr>
<tr>
<td>V.22bis</td>
<td>The first true world standard, it allows 2400 bits per second at 600 baud</td>
</tr>
<tr>
<td>V.32</td>
<td>Provides 4800 and 9600 bits per second at 2400 baud</td>
</tr>
<tr>
<td>V.32bis</td>
<td>Provides 14,400 bits per second or fallback to 12,000, 9600, 7200, and 4800 bits per second</td>
</tr>
<tr>
<td>V.32terbo</td>
<td>Provides 18,200 bits per second or fallback to 12,000, 9600, 7200, and 4800 bits per second; can operate at higher data rates with compression; was not a CCITT/ITU standard</td>
</tr>
<tr>
<td>V.34</td>
<td>Provides 28,800 bits per second or fallback to 24,000 and 19,200 bits per second and backwards compatibility with V.32 and V.32bis</td>
</tr>
<tr>
<td>V.34bis</td>
<td>Provides up to 33,600 bits per second or fallback to 31,200 or V.34 transfer rates</td>
</tr>
<tr>
<td>V.35</td>
<td>The trunk interface between a network access device and a packet network at data rates greater than 19.2 Kbps. V.35 may use the bandwidths of several telephone circuits as a group. There are V.35 Gender Changers and Adapters.</td>
</tr>
<tr>
<td>V.42</td>
<td>Same transfer rate as V.32, V.32bis, and other standards but with better error correction and therefore more reliable</td>
</tr>
<tr>
<td>V.90</td>
<td>Provides up to 56,000 bits per second downstream (but in practice somewhat less). Derived from the x2 technology of 3Com (US Robotics) and Rockwell's K56flex technology.</td>
</tr>
</tbody>
</table>

[http://searchnetworking.techtarget.com/dictionary/definition/what-is-V.xx.html](http://searchnetworking.techtarget.com/dictionary/definition/what-is-V.xx.html)
A **CSU/DSU** (Channel Service Unit/Data Service Unit) is a digital-interface device used to connect a Data Terminal Equipment device or DTE, such as a router, to a digital circuit (T1 or T3).

Simple Network Management Protocol (**SNMP**) is a UDP-based network protocol. It is used mostly in network management systems to monitor network-attached equipments.