CS311: Data Communication

Digital Data Communication

by

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Digital Transmission

- Serial Transmission: data are transferred over a single signal path, and signaling elements are sent down the line one at a time
  - E.g., Device to Device transmission via Wireless/Wired
- Parallel Transmission: data are transferred over a parallel set of lines
  - E.g, I/O devices, internal computer signal paths
- Each signaling element may be
  - Less than one bit: with Manchester coding
  - One bit: NRZ-L and FSK are digital and analog examples, respectively
  - More than one bit: QPSK

Transmitter-Receiver Time Synchronization

- Suppose that the sender simply transmits a stream of data bits.
- The sender has a clock that governs the timing of the transmitted bits.
- Let, data rate 1Mbps. So, one bit will be transmitted in every 1 μs as measured by the sender's clock.

- the receiver will attempt to sample the medium at the center of each bit time.
- So, sampling would occur once every 1 μs

- Hence, there will be a problem if the transmitter's and receiver's clocks are not precisely aligned.

- Let, there is a drift of 1%, i.e., the receiver's clock is 1% faster or slower than the transmitter's clock
- Then, the first sampling will be 0.01 of a bit time (i.e., 0.01 μs) away from the center of the bit (center of bit is 0.5 μs from beginning and end of bit)
- After 50 or more samples, the receiver may be in error.

Time Synchronization

- Two approaches are common for achieving synchronization
  - asynchronous transmission
    - strategy with this scheme is to avoid the timing problem by not sending long, uninterrupted streams of bits
    - data are transmitted one character at a time, where each character is five to eight bits in length
    - Timing or synchronization must only be maintained within each character
  - synchronous transmission
    - a block of bits is transmitted in a steady stream without start and stop codes
    - The block may be many bits in length
    - To prevent timing drift between transmitter and receiver, their clocks must somehow be synchronized
      - provide a separate clock line for sending clock from sender to receiver
      - embed the clocking information in the data signal. (E.g., Manchester or differential Manchester encoding)

Asynchronous Transmission

The definition of *idle* is equivalent to the signaling element for binary 1.

NRZ-L signaling is common for asynchronous transmission

The beginning of a character is signaled by a *start bit* with a value of binary 0

The final element is a stop element, which is a binary 1

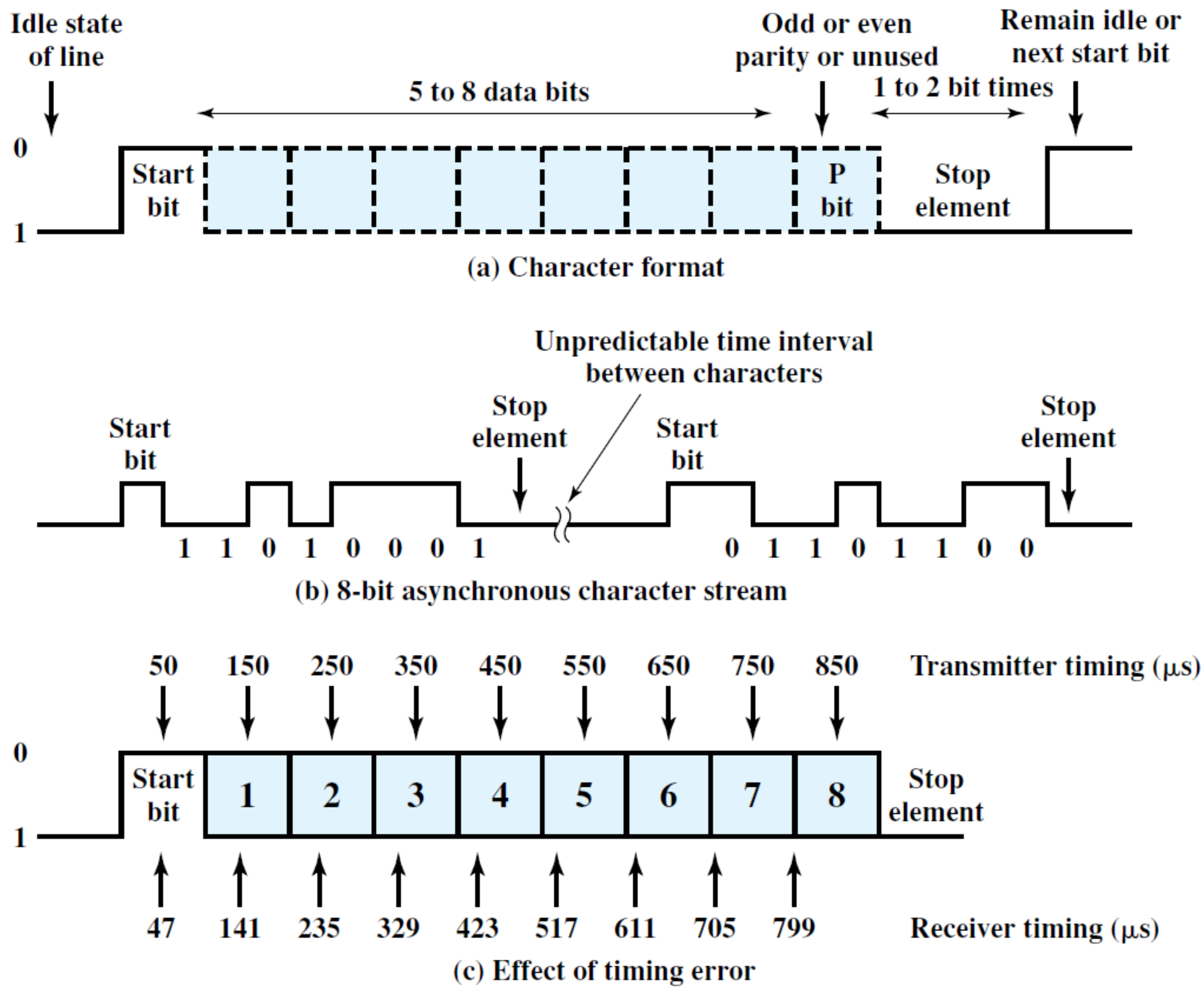


Figure 6.1 Asynchronous Transmission

Cont…

- Asynchronous transmission creates frame error.

- Frame error: the bit count may be out of alignment due to the cumulative timing error. If bit 7 is a 1 and bit 8 is a 0, bit 8 could be mistaken for a start bit.

- It is simple and cheap but requires an overhead of two to three bits per character

Synchronous Transmission

- Either provide a separate clock line
  - Applicable for short distance communication

- Or, embed the clock information in the data signal
  - Applicable for all
  - E.g. for Digital signal: Manchester / Differential Manchester encoding
  - E.g. for Analog signal: the carrier frequency itself can be used to synchronize the receiver based on the phase of the carrier.

- With synchronous transmission, there is another level of synchronization required, to allow the receiver to determine the beginning and end of a block of data.

- To achieve this, each block begins with a preamble bit pattern and generally ends with a postamble bit pattern.

- Asynchronous transmission requires 20% or more overhead. The control information, preamble, and postamble in synchronous transmission are typically less than 100 bits.

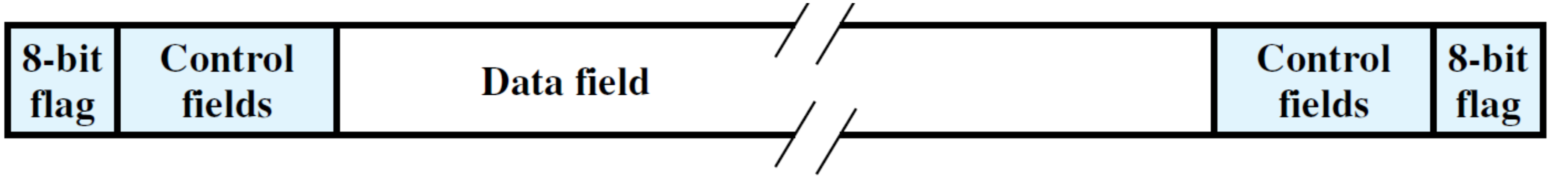


Figure 6.2 Synchronous Frame Format

Line Configurations

- Two characteristics that distinguish various data link configurations
  - Topology
  - half duplex / full duplex transmission
- The topology of a data link refers to the physical arrangement of stations on a transmission medium.
- With half-duplex transmission, only one of two stations on a point-to-point link may transmit at a time.
- For full-duplex transmission, two stations can simultaneously send and receive data from each other.
- With digital signaling, which requires guided transmission, full-duplex operation usually requires two separate transmission paths
- For analog signaling, it depends on frequency

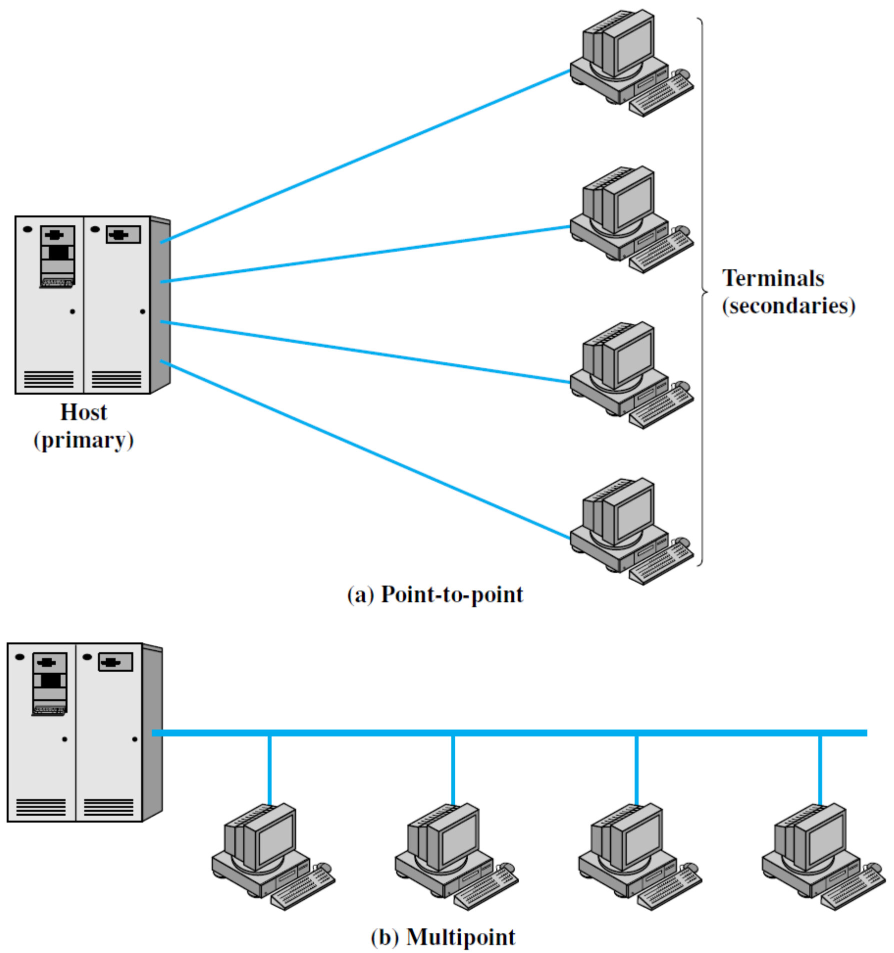
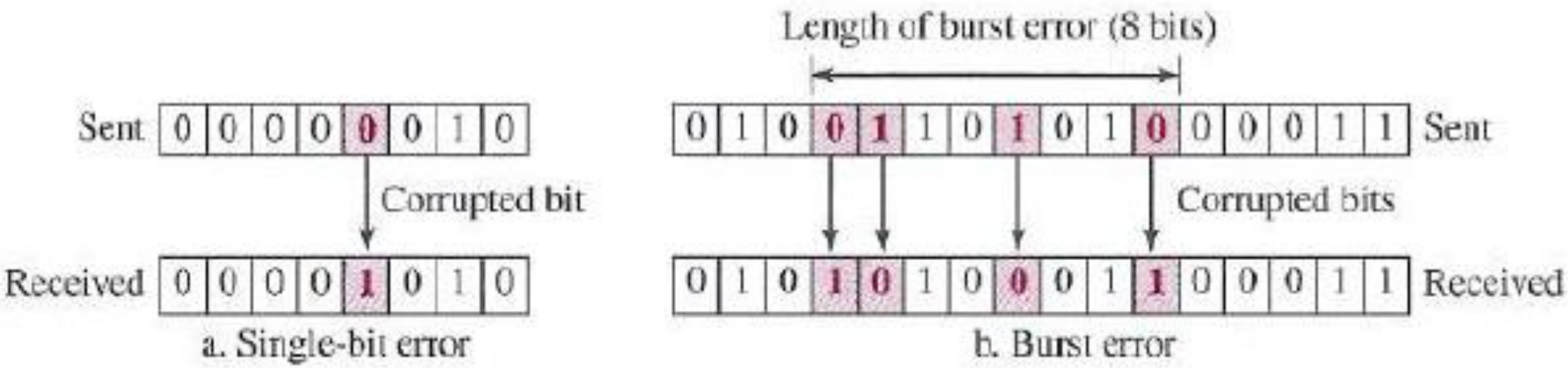


Figure 6.9 Traditional Computer/Terminal Configurations

Types of Error



- Single bit error
- Burst error / multibit error

- Reason: noise in the channel

Error Detection and Correction

- Objective:
  - System must guarantee that the data received are identical to the data transmitted

- Two Methods:
  1. If a frame is corrupted between the two nodes, it needs to be corrected (i.e. Detect and Correct error in PHY/MAC layers)
  2. Drop the frame and let the upper layer (e.g. Transport) protocol to handle it by retransmission

Thanks!

Figure and slide materials are taken from the following sources:

1. W. Stallings, (2010), Data and Computer Communications
2. NPTL lecture on Data Communication, by Prof. A. K. Pal, IIT Kharagpur
3. B. A. Forouzan, (2013), Data Communication and Networking