Asynchronous and Synchronous Transmission

- **The transmission of a stream of bits from** one device to another across a transmission.

- Transmit using cooperation and agreement between the two sides.

- **Synchronization:**

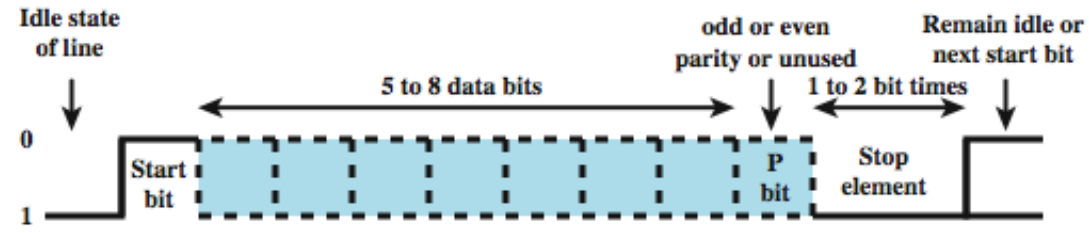
  The receiver must know the rate at which bits are being received so that it can sample the line at appropriate intervals to determine the value of each received bit.

- Two types: Asynchronous and synchronous

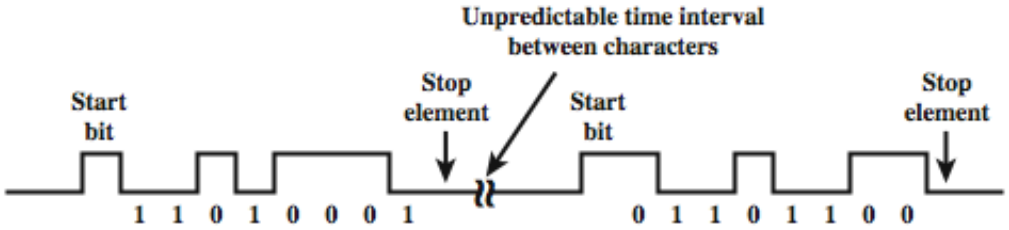
Asynchronous - Behavior

- In **asynchronous transmission**, each character of data is treated independently.
- Data are transmitted one character at a time.
- Each character begins with **a start bit** that alerts the receiver that a character is arriving.
- The receiver samples each bit in the character and then looks for the beginning of the next character.
- Works well for long blocks of data.
- Simple and cheap but requires an overhead of two to three bits per character.

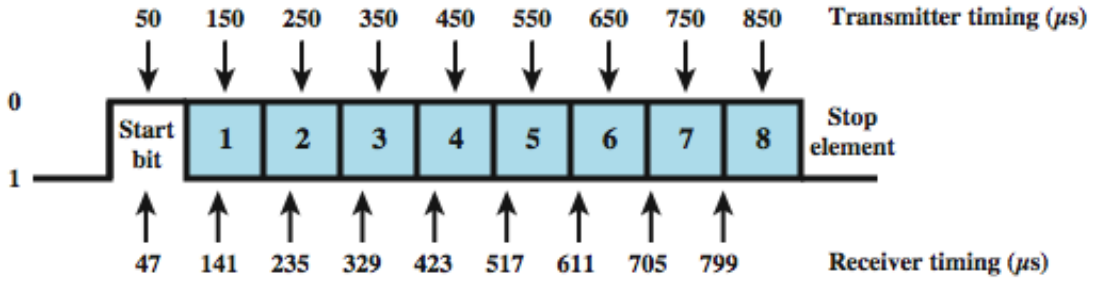
Asynchronous Transmission



(a) Character format



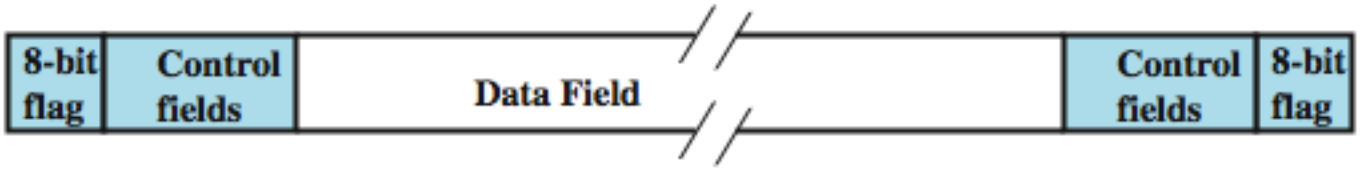
(b) 8-bit asynchronous character stream



(c) Effect of timing error

Synchronous Transmission

- For large blocks, **synchronous transmission** is used.
- Each block of data is formatted as a frame that includes a starting and an ending flag (preamble and post amble).
- Stream of bits 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.
- More efficient (lower overhead) than asynchronous.



About Channel Capacity

- Channel Capacity

  The maximum rate at which data can be transmitted over a given communication path, or channel, under given conditions

Shannon Capacity Formula

- Equation: $C = B\log_2(1+\mathrm{SNR})$

- Represents theoretical maximum that can be achieved
- In practice, only much lower rates achieved
  - Formula assumes white noise (thermal noise)
  - Impulse noise is not accounted for
  - Attenuation distortion or delay distortion not accounted for

Nyquist Bandwidth

- For binary signals (two voltage levels)
  - $C = 2B$
- With multilevel signaling
  - $C = 2B \log_2 M$
    - M = number of discrete signal or voltage levels

Signal-to-Noise Ratio

- Ratio of the power in a signal to the power contained in the noise that's present at a particular point in the transmission
- Typically measured at a receiver
- Signal-to-noise ratio (SNR, or S/N)

$$(SNR)_{\text{dB}} = 10\log_{10}\frac{\text{signal power}}{\text{noise power}}$$

- A high SNR means a high-quality signal, low number of required intermediate repeaters
- SNR sets upper bound on achievable data rate