9.4. Synchronization:

It is the process of timing the serial transmission to properly identify the data being sent. There are two most common modes:

Synchronous transmission:

Synchronous transmission relies on a single pulse-clock available at both transmitter and receiver. Blocks of characters or bits are transmitted. To prevent timing drift between transmitter and receiver, their clocks must somehow be synchronized. The sharing of this clock may be achieved in several ways.

Firstly, the common clock may originate from a clock generator distinct from both source and destination and be transmitted separately to each. This referred as master clock.

Another possibility is to provide a separate clock line between transmitter and receiver; this is called a pilot clock. The clock is produced by a generator at the transmitter and is then sent to the receiver.

The last approach called self-synchronization, were relay on timing being carried in the data signal itself. This can be done by using signal elements that provide "events" in the flow of data to which the receiver can synchronize. For example for digital signals, this can be achieved with biphase encoding.

Another level of synchronization is required to allow the receiver to determine the beginning and the end of a block of data.

- With character-oriented transmission, the frame begins with one or more "synchronization characters". The synchronization character usually called SYN, is a unique bit pattern that signals the receiver that this is the beginning the block.

- With bit-oriented transmission, a special bit pattern signals the beginning of the block. In bit-oriented transmission, this preamble is eight bits long and is referred to as a flag.

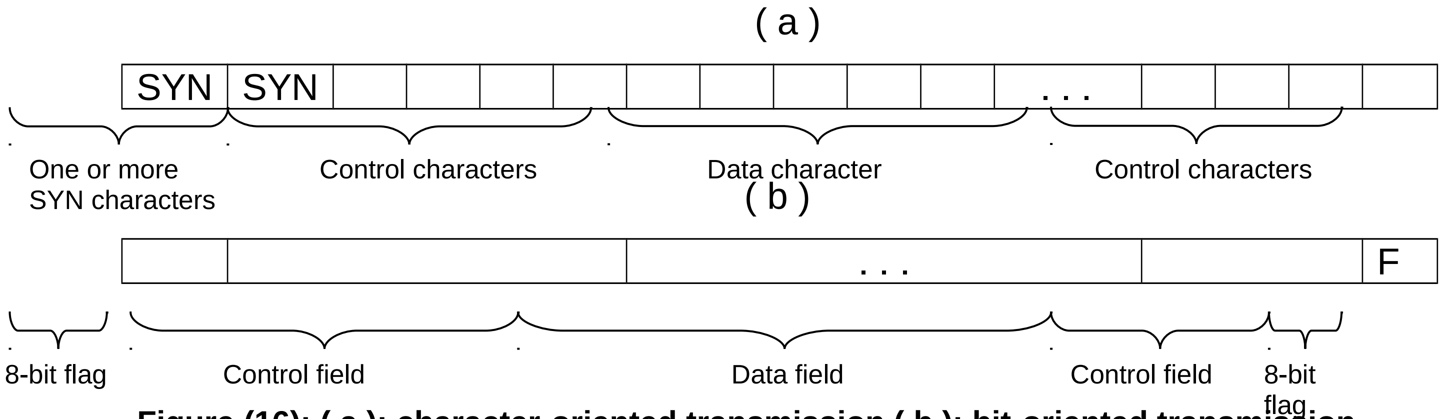

Figure (16): (a): character-oriented transmission,(b): bit-oriented transmission

Asynchronous transmission:

In Asynchronous transmission, data transmitted one character maintained within each character. The receiver has the opportunity to resynchronize at the beginning of each new character. The most prevalent form of asynchronous serial communication is an old technique called start-stop. In start-stop, the transmission process is character-oriented and data is sent in small blocks called envelops (frames) each of which carries a single character of between 5 and 8 bits. The receiver and the transmitter attempt to synchronize at the beginning of each envelop using the following technique.

1. Idle state: when no character is being transmitted in the line between transmitter and receiver is in an “idle” state. The definition of idle is equivalent to the signaling element for binary “1”.
2. Start bit: the beginning of the character is signaled by a start bit with a value of binary “0”.
3. Data bits: a fixed number of data bits (from 5 to 8) plus sometimes, a parity bit for the character are sent at the rate of one every T second (T is the duration of ordinary bit).

4. Stop bit: the last bit of the character is followed by a stop bit, which is a binary “1”. A minimum length for the stop bit is specified and this is usually 1, 1.5, 0r 2 times the duration of an ordinary bit.

After sending the requisite number of stop bits, the transmitter may immediately begin a new character with a new start bit. This represents the maximum rate at which data can be sent using start-stop transmission and is known Cadence rate.

Asynchronous transmission involves more overhead than synchronous (with start and stop bits needed for every envelop) and tend to be operated at lower clock speeds. It used for low-volume communications, such as between a computer and terminal or a computer and a printer, unlike synchronous transmission the receiver in start-stop does not attempt to maintain constant synchronization with the transmitter, it does extract clocking information from the incoming signal using the falling edges of the start bits.

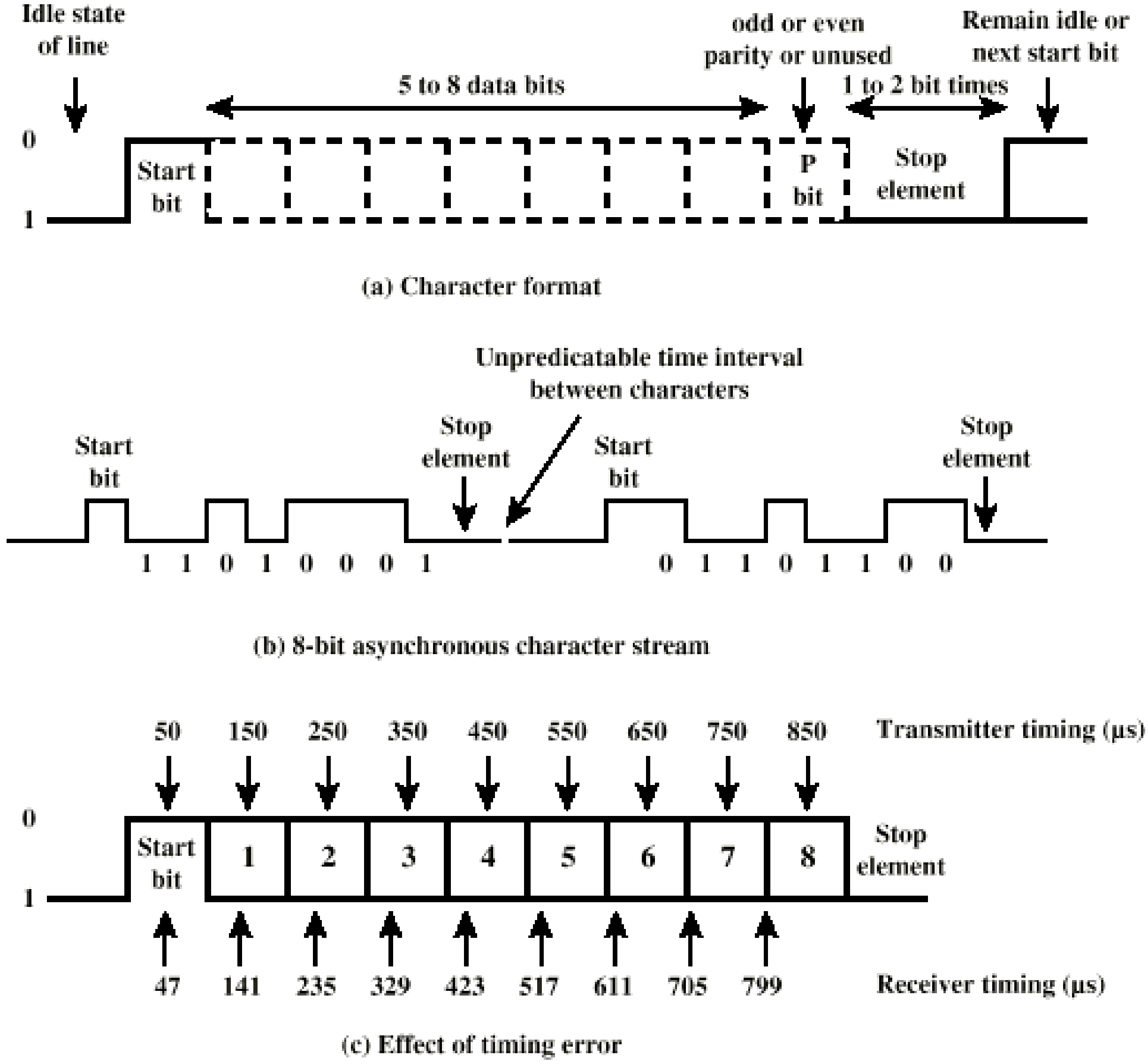

Figure (17): Asynchronous transmission

10. Modulated Digital Transmission:

The basic techniques that are used to modulate the digital Baseband signals are:

1. **Amplitude Shift Keying (ASK):** is essentially suppressed-carrier AM applied to a unipolar NRZ Baseband signal. Two binary numbers (0,1) represented by two different amplitudes of the carrier wave, used to transmit digital data over optical fiber.
2. **Frequency Shift Keying (FSK):** equivalent to applying FM to a binary Baseband polar or unipolar NRZ signal uses two binary numbers (0,1)

represented by two different frequencies of the carrier wave. Less susceptible to error than ASK. Commonly used for high frequency radio.

3. **Phase Shift Keying (PSK):** is equivalent to applying PM to a binary polar or unipolar signal, and uses two binary numbers (0,1) represented by phase shift of the carrier wave. More efficient and noise resistant than FSK.
4. **Differential Phase Shift Keying (DPSK):** the phase of the carrier signal is shifted to represent data, and phase shifted relative to previous transmission rather than some reference signal. Not that DPSK is a self-synchronizing code, with a detection-timing event in each signal element, and is suitable for synchronous transmission.
5. **Quadrature Phase Shift Keying (QPSK):** Because of its superior noise immunity, PSK (and DPSK) may be extended to 4-level signaling (4 phase changes). The number of phase can be increased further at the cost of reduced resistance to noise. The great advantage of multilevel signaling is the more bits can be carried by each signal element. Each signal element (phase shift) represents two bits.
6. **Quadrature Amplitude Modulation (QAM):** in channels of restricted bandwidth, where multilevel signaling is high desirable. The simplest is 16-level QAM, which uses a Quadrature combination of two 4-level amplitude modulated waveforms, giving 16 levels in all and permitting the transmission of 4 bits per signal element. Modern V. 32 and V. 34 modems can use QAM with up to 128 levels, transmitting 7 bits with every signal element (1 of bits is redundant and used for error control using a technique called Trellis coding). It stand to reason that QAM transmissions especially those with very large numbers of levels will not be as robustly immune to noise as those of ordinary PSK or QPSK, and can only be used on lines where noise levels are low.

11. Data flows:

There are three ways for data transfer in communication links:

1. **Simplex:** the link is to be working in a simplex, if it permits to pass the data in one direction only and in all time (e.g., radio or TV transmission).
2. **Half duplex:** the link is to be working in Half-duplex, if it permits to transfer the data in two directions but only once at a time. In half-duplex, users can transmit and receive data but cannot do both simultaneously (police radio).
3. **Full duplex: the link is to be working in a full duplex, if it permits to transfer the data in both directions simultaneously (e.g., telephone). This mode is clearly easier then the half-duplex but the cost may be significant over long distance.**