# UART / USART

- UART stands for Universal Asynchronous Receiver / Transmitter.
- USART stands for Universal Synchronous/Asynchronous Receiver / Transmitter.
- It is hardware control protocol based on wired system.
- It is **serial**/parallel protocol and asynchronous due to no clock line.
- Used for transferring data b/w two systems using a single data line.
- Send one bit at a time.
- Used for reliable communication over long distance.
- Supports Simplex, Half Duplex and Full Duplex.
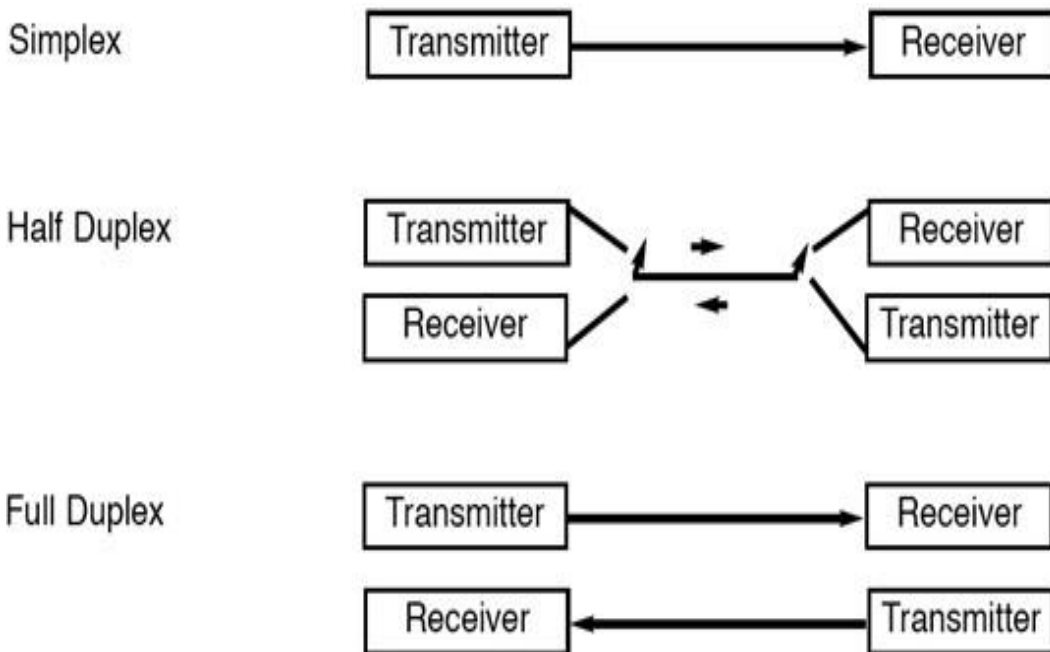
- **Parallel:**
    - Grabs the full one-byte (8 bits) data and send it using 8 separate data lines.
    - Printers and hard disk use parallel ports.
    - Not suitable for longer distance (cost of cable and synchronization difficulties).
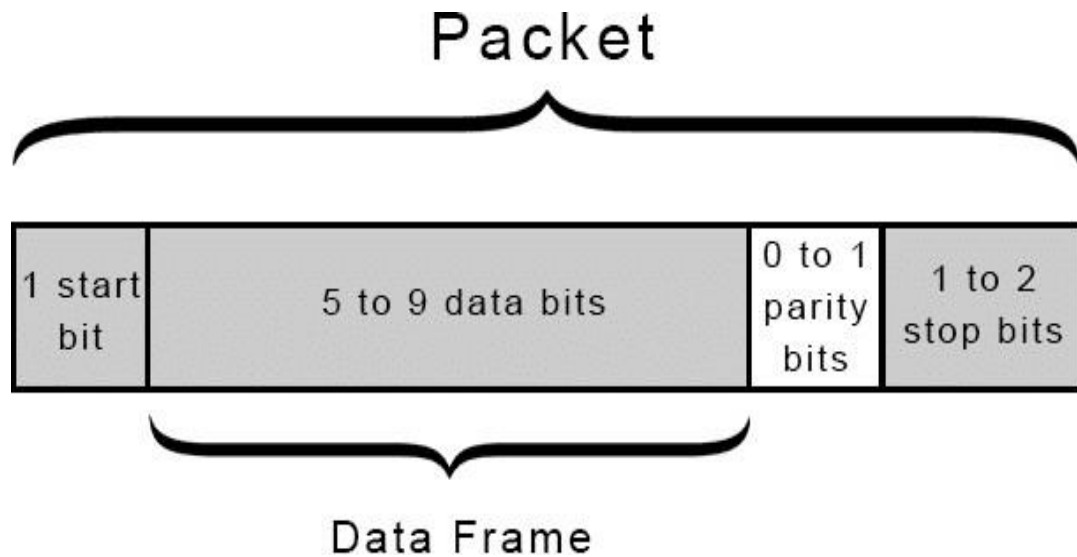   - More data pins thus more expensive.

Parallel Communication
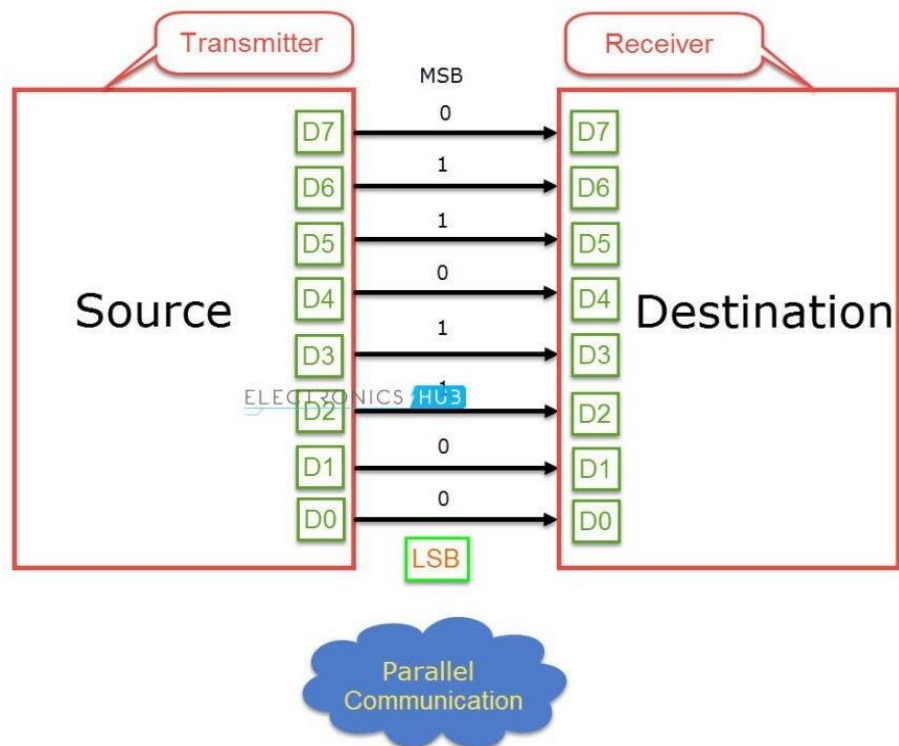
- **Serial:**
    - Single Line
    - Cheaper
    - Suitable for longer distances.

Serial Communication

- **Frame Format:**

Packet

Data Frame
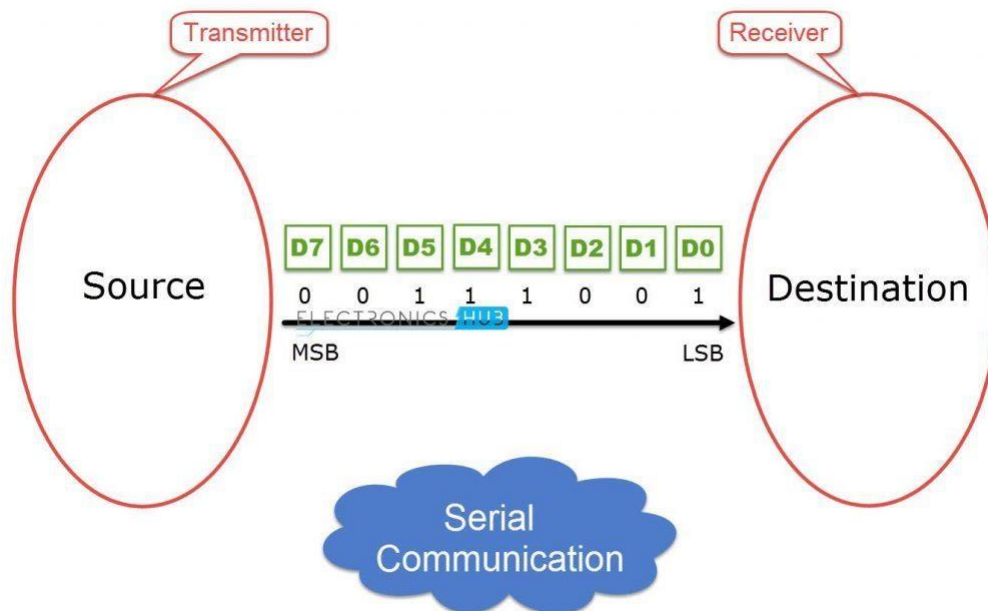
- **Start Bit:** Start bit is a synchronization bit that is added before the actual data. Start bit marks the beginning of the data packet. Usually, an idle data lines i.e. when the data transmission line is not transmitting any data, it is held at a high voltage level (logic 1). In order to start the data transfer, the transmitting UART pulls the data line from high voltage level to low voltage level (from 1 to 0). The receiving UART detects this change from high to low on the data line and begins reading the actual data. Usually, there is only one start bit.

- **Stop Bit:** The Stop Bit, as the name suggests, marks the end of the data packet. It is usually two bits long but often only one bit is used. In order to end the transmission, the UART maintains the data line at high voltage (logic 1).

- **Parity Bit:** Parity allows the receiver to check whether the received data is correct or not. Parity is a low – level error checking system and comes in two varieties: Even Parity and Odd Parity. Parity bit is optional, and it is not that widely used.

- **Data Bits:** Data bits are the actual data being transmitted from sender to receiver. The length of the data frame can be anywhere between 5 and 9 (9 bits if parity is not used and only 8 bits if parity is used). Usually, the LSB is the first bit of data to be transmitted (unless otherwise specified).

- **Baud Rate:**

  - The speed at which the data is transmitted is mentioned using Baud Rate. Both the transmitting UART and Receiving UART must agree on the Baud Rate for a successful data transmission.
  - Baud Rate is measured in bits per second. Some of the standard baud rates are 4800 bps, 9600 bps, 19200 bps, 115200 bps etc. Out of these 9600-bps baud rates is the most commonly used one.

- **General Overview:**

Wires Used	2
Maximum Speed	Any speed up to 115200 baud, usually 9600 baud
Synchronous or Asynchronous?	Asynchronous
Serial or Parallel?	Serial
Max # of Masters	1
Max # of Slaves	1

- **Advantage:**

  - Requires only two wires for full duplex data transmission (apart from the power lines).
  - No need for clock or any other timing signal.
  - Parity bit ensures basic error checking is integrated into the data packet frame.

- **Disadvantage:**

  - Size of the data in the frame is limited.
  - Speed for data transfer is less compared to parallel communication.
  - Transmitter and receiver must agree to the rules of transmission and appropriate baud rate must be selected.