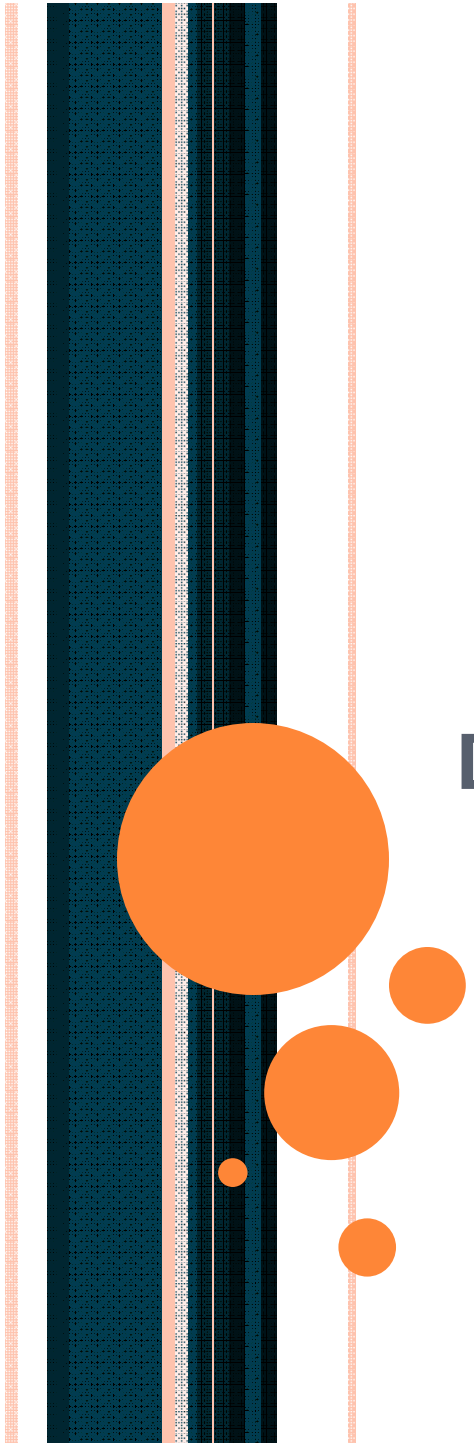

Data Communication

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- Parallel and Serial Data Transmission
- Asynchronous Serial Transmission
- Synchronous Serial Transmission
- Data Communication Terminology
  - Channel, baud rate, bits per second, bandwidth
- Protocols
  - Asynchronous and synchronous protocols
- Data Multiplexing
  - Time division multiplexing and frequency division multiplexing
- Modems

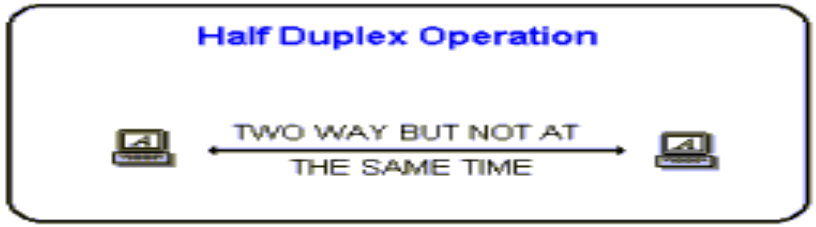
Data Transmission

- **Data transmission** is the transfer of data from point-to-point often represented as an electromagnetic signal over a physical point-to-point or point-to-multipoint communication channel
- A communication channel refers to the medium used to convey information from a sender (or transmitter) to a receiver, and it can use fully or partially the medium.
- Examples of channels: copper wires, optical fibbers or wireless communication channels.

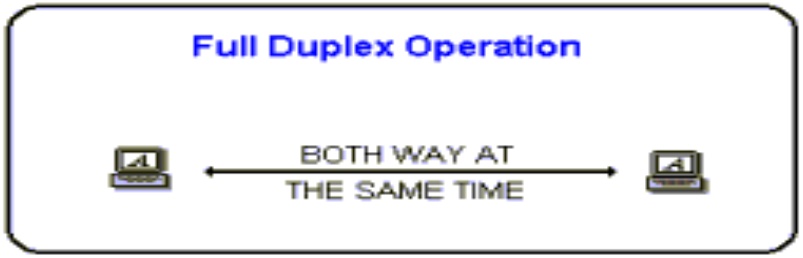
Data Communication Channels

- **Simplex**

- **Half Duplex**

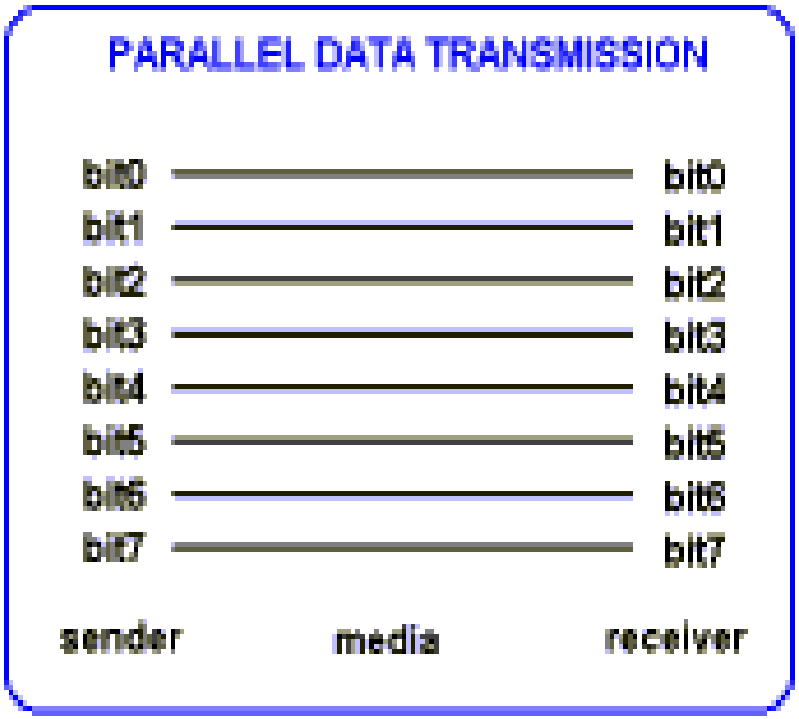


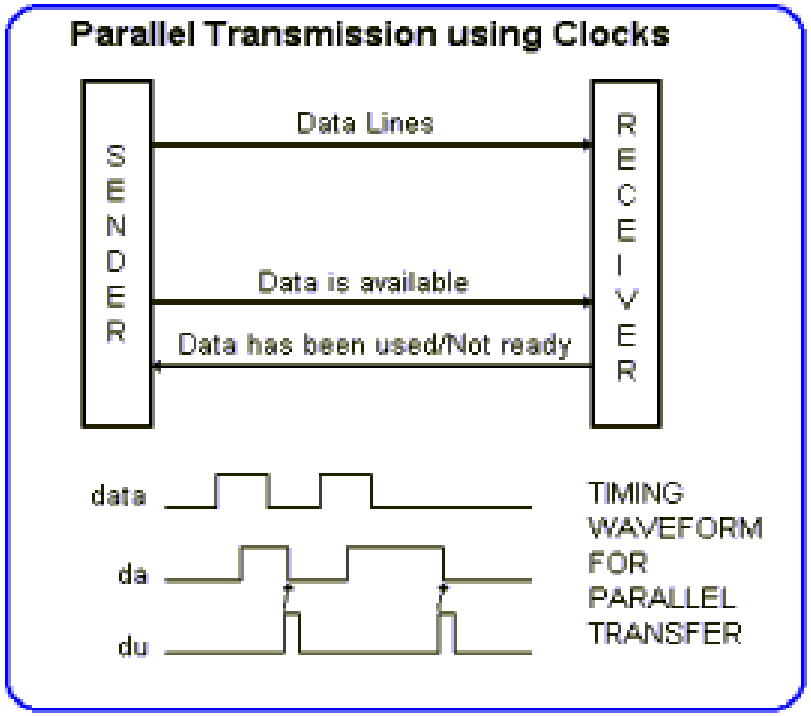
- **Full Duplex**



PARALLEL AND SERIAL DATA

- Data may be transmitted between two points in two different ways. Lets consider sending 8 bits of digital data (1 byte)
- Parallel transmission





Serial

- There are two types of serial transmission, essentially having to do with how the clock is embedded into the serial data
  - Asynchronous serial transmission
  - Synchronous serial transmission

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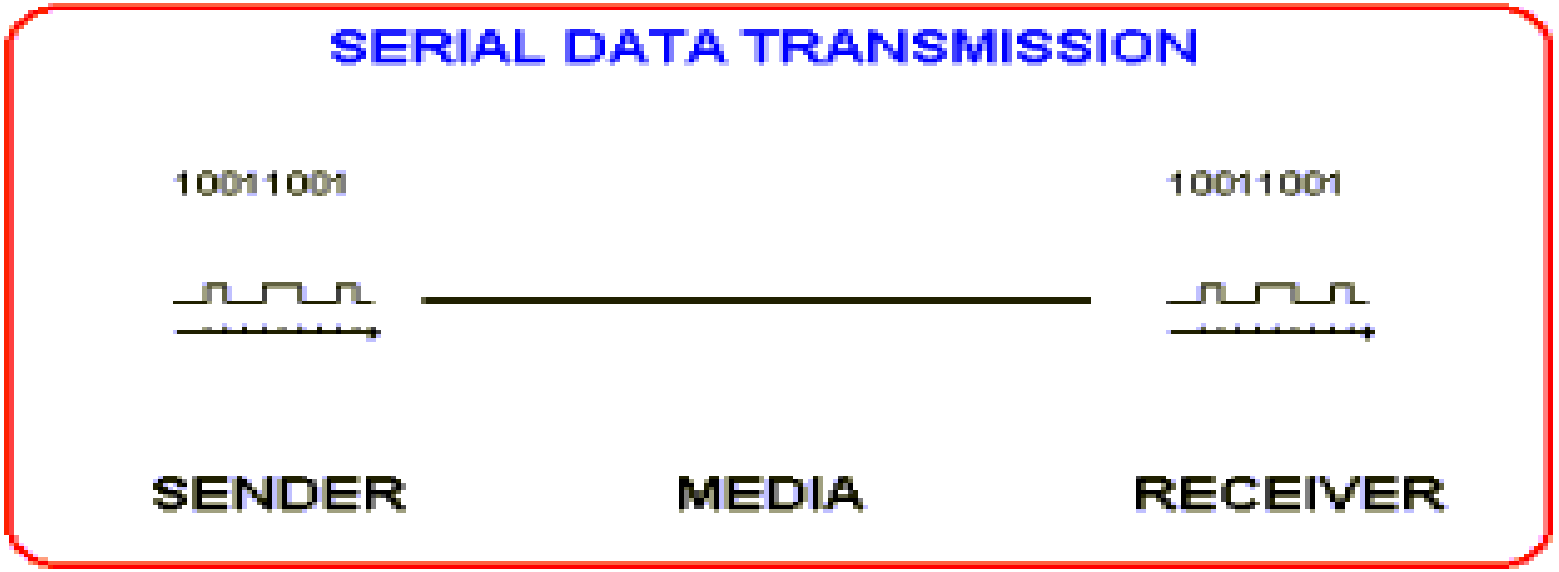
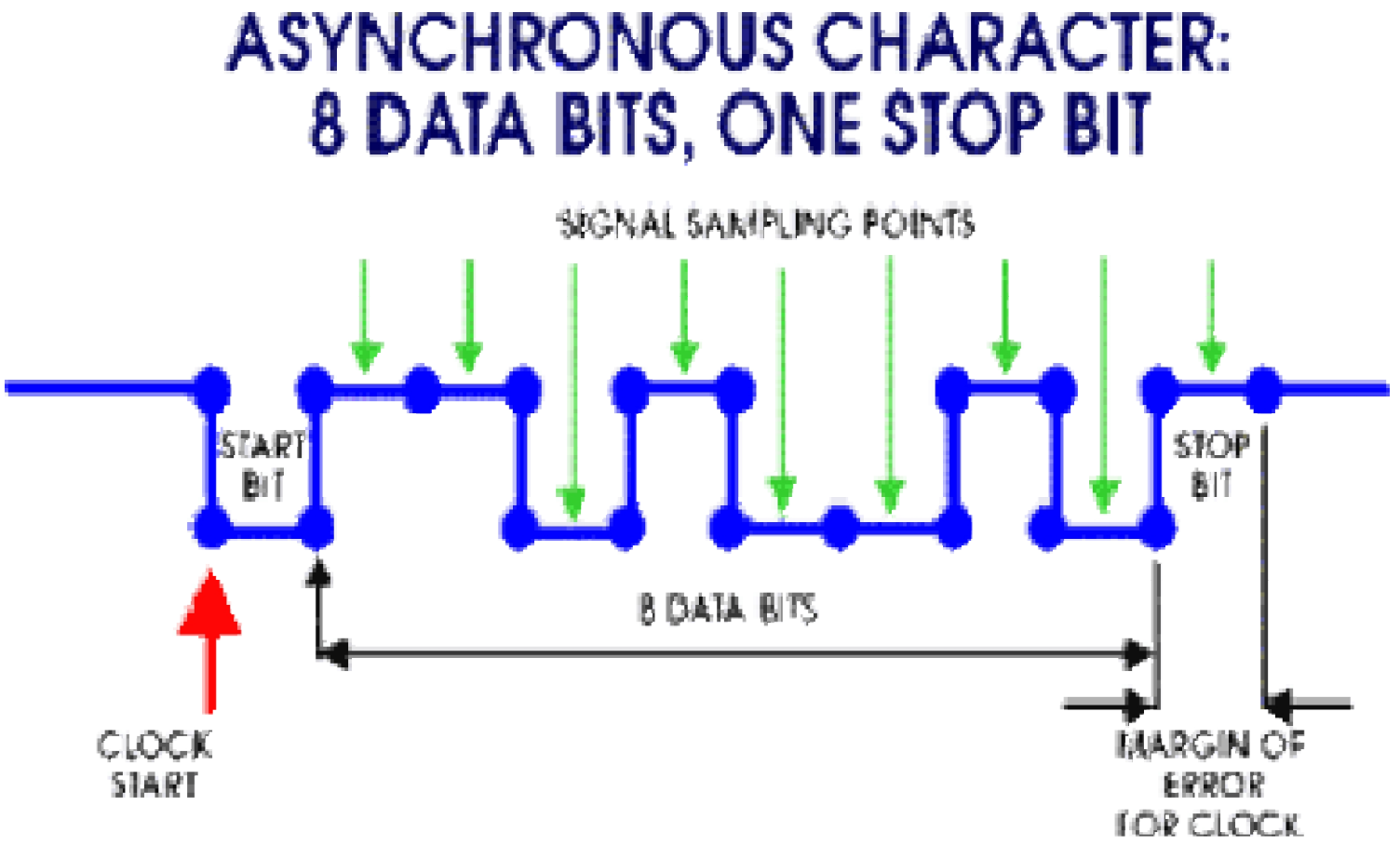


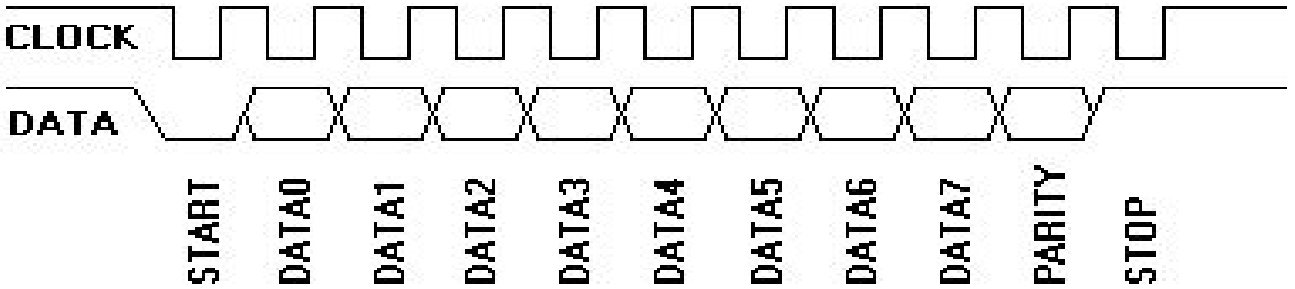
Asynchronous Serial Transmission (RS232 Example)



Synchronous Serial Transmission (PS2 Example)

Data is transmited 1 byte at a time:

- 1 start bit. This is always 0.
- 8 data bits, least significant bit first.
- 1 parity bit (odd parity - The number of 1's in the data bits plus the parity bit always add up to an odd number. This is used for error detection.).
- 1 stop bit. This is always 1.
- 1 acknowledge bit (host-to-device communication only)



Synchronous Serial Transmission

- In fast speed synchronous communications, data is not sent in individual bytes, but as frames of large data blocks. Frame sizes vary from a few bytes through 1500 bytes for Ethernet.
- The clock is embedded in the data stream encoding, or provided on separate clock lines such that the sender and receiver are always in synchronization during a frame transmission. Most modern WAN framing is built on the High-Level Data Link Control (HDLC) frame structure. An HDLC frame has the following general structure
- The **flag** is a sequence 01111110 which delimits the start of the frame. A technique known as bit stuffing is used to insert additional zeros into the data so that a flag sequence never appears anywhere but at the start and end of a frame. These extra bits are "unstuffed" again by the receiver.

Data Communication Terminology

- **Channel**
  - A channel is a portion of the communications medium allocated to the sender and receiver for conveying information between them.
- **Baud Rate**
  - Baud rate is the same as symbol rate and is a measure of the number of line changes which occur every second. Each symbol can represent or convey one (binary encoded signal) or several bits of data. For a binary signal of 20Hz, this is equivalent to 20 baud (there are 20 changes per second).
- **Bits Per Second**
  - This is an expression of the number of data bits per second. Where a binary signal is being used, this is the same as the baud rate. When the signal is changed to another form, it will not be equal to the baud rate, as each line change can represent more than one bit (either two or four bits).
- **Bandwidth**
  - Bandwidth is the frequency range of a channel, measured as the difference between the highest and lowest frequencies that the channel supports.

DATA MULTIPLEXING

- A multiplexer is a device which shares a communication link between a number of devices (users).
- Rather than provide a separate circuit for each device, the multiplexer combines each low speed circuit onto a single high speed link. The cost of the single high speed link is less than the required number of low speed links.
- It does this by time or frequency division.

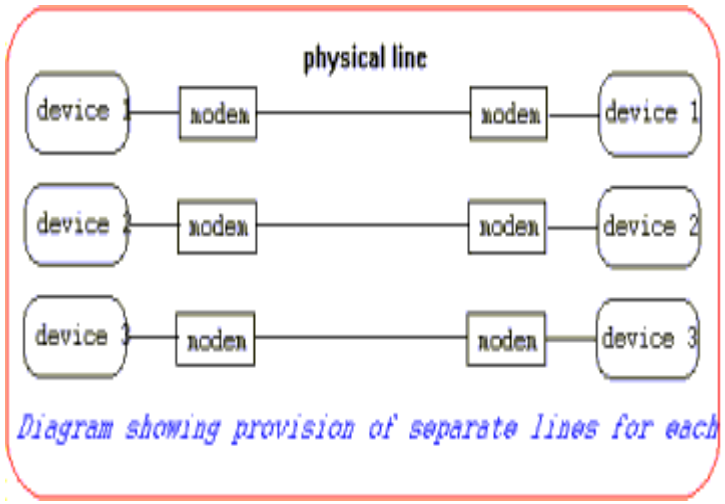


Diagram showing provision of separate lines for each c.

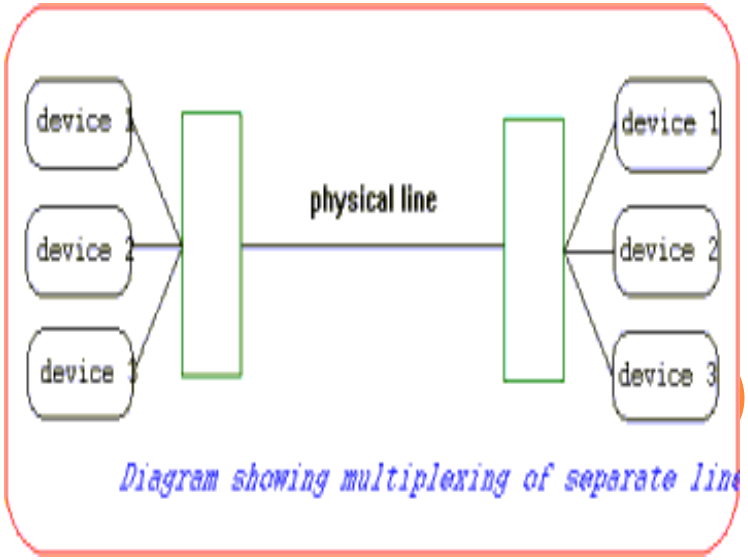


Diagram showing multiplexing of separate line

Time Division Multiplexing

- In time division, the communications link is subdivided in terms of time.
- Each sub-circuit is given the channel for a limited amount of time, before it is switched over to the next user, and so on
- In the picture bellow it can be seen that each sub-channel occupies the entire bandwidth of the channel, but only for a portion of the time

Time Division Multiplexing

Frequency Division Multiplexing

- In frequency division multiplexing, each sub-channel is separated by frequency (each sub-channel is allocated part of the bandwidth of the main channel)
- The speed or bandwidth of the main link is the sum of the individual sub-channel speeds or bandwidth.