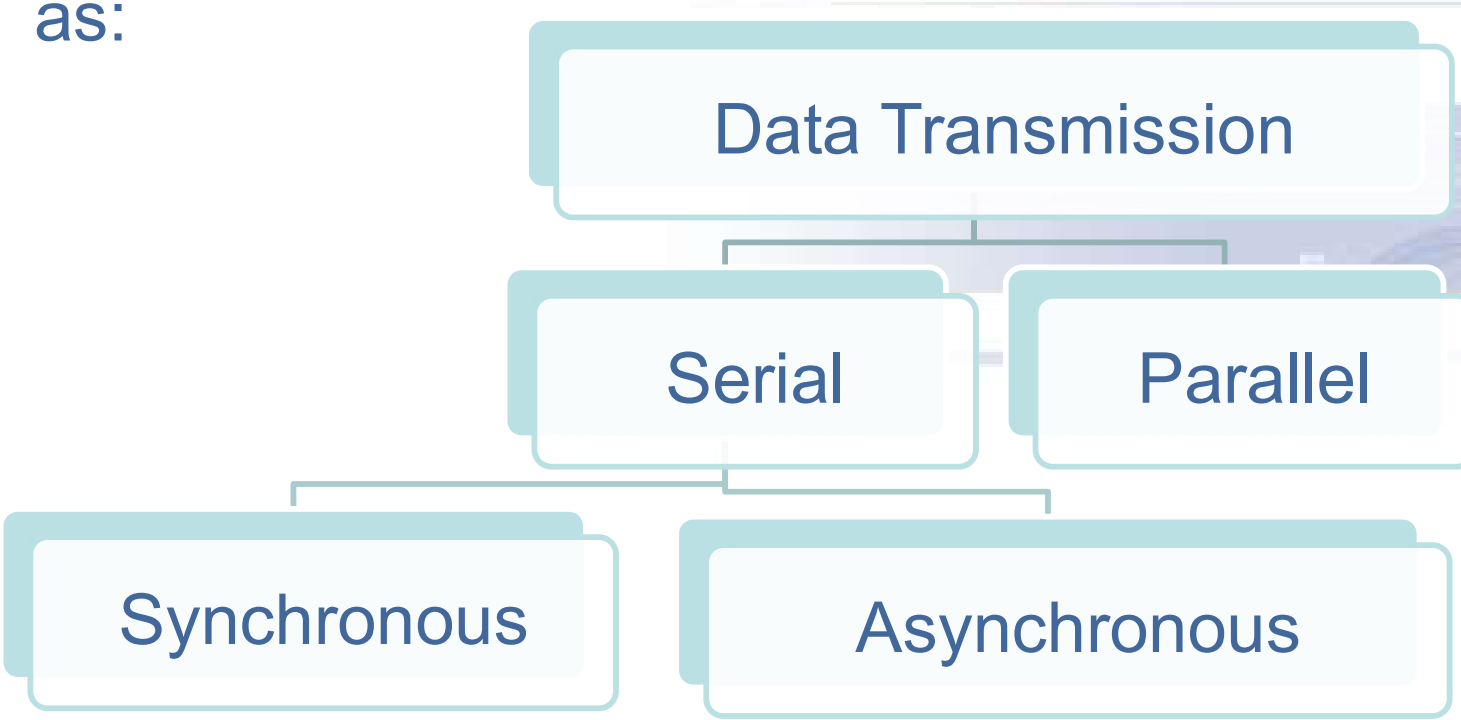
Unit- Two

Data Transmission

- Data Transmission Techniques- Parallel, Serial Transmission (Synchronous, Asynchronous and Isochronous Communication)
- Modes of Data Transmission
- Line Configuration
- Bit Rate/Baud Rate
- Transmission Channel
- Data Rate Limit - Shannon Capacity Theorem and Nyquist Bit Rate
- RS-232C (DTE-DCE, DTE-DTE)

Data Transmission Techniques

Data transmission is sending and receiving digital or analog data between multiple devices. While transmitting data we should be concerned with mutual understanding, co-operation and synchronization. Data transmission can be divided as:



Data Transmission Techniques

Types of transmission:

1) Serial Transmission

In serial transmission the data is transmitted bit by bits as a stream of 0's and 1's. Protocols are implemented for these types of transmission so that the communication takes place in a well-defined manner. The following key factors have to be observed regarding serial transmission.

- Timing Problem
- Error Detection
- Error Correction

Data Transmission Techniques

1) Serial Transmission

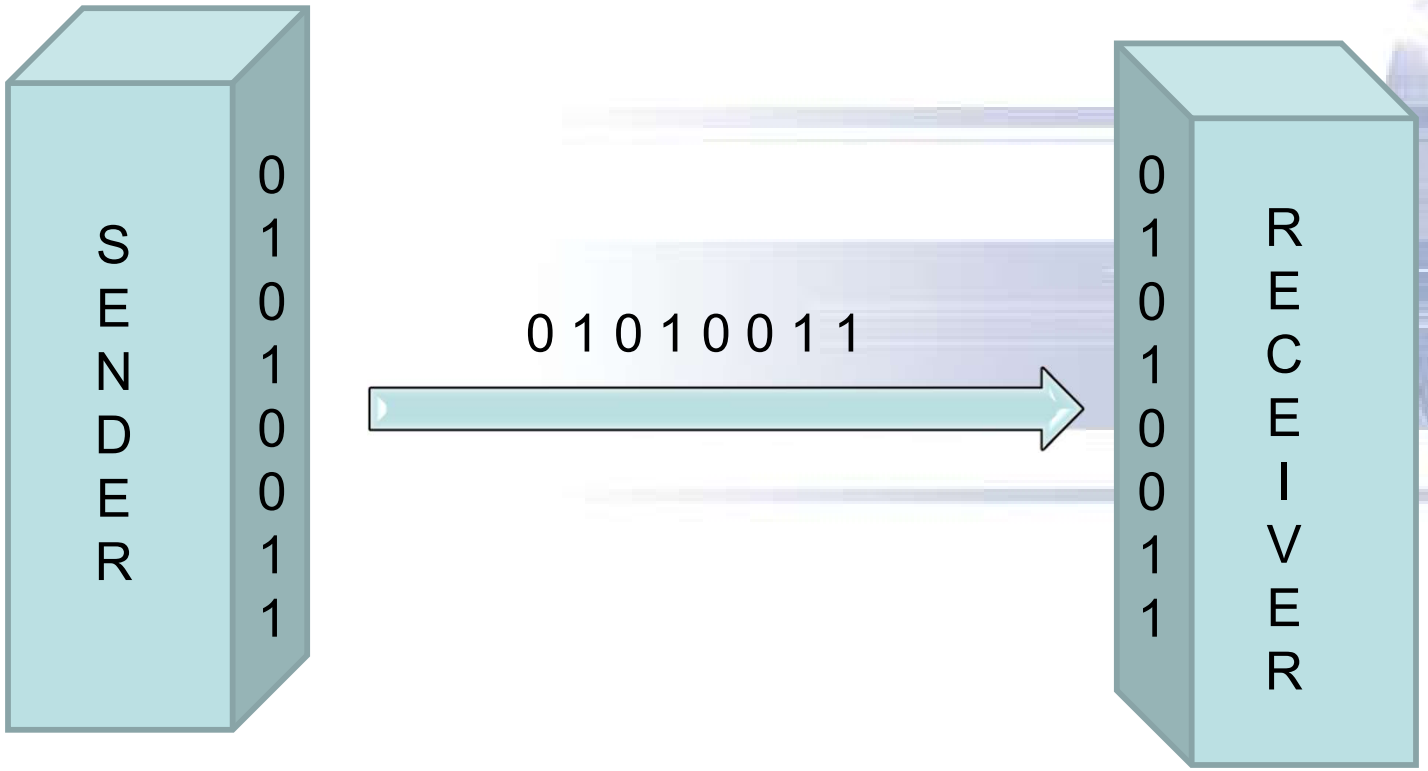


Fig: Serial Communication

Data Transmission Techniques

1) Serial Transmission

There are three approaches regarding transmission of serial data.

- Asynchronous Transmission

The term 'asynchronous' ,means it is asynchronous at frame level. In asynchronous transmission data is transferred character by character (frame by frame) and each character can be 5 to 8 bit long.

Characteristics:

- The bits of the character are transmitted beginning with the LSB.
- Each character begins with start bit i.e. 0s and stop bit 1s

Data Transmission Techniques

- Asynchronous Transmission

Characteristics:

- Data bits are usually followed by a parity
- Receiver samples each bit in the character and then looks for the beginning of the next character.

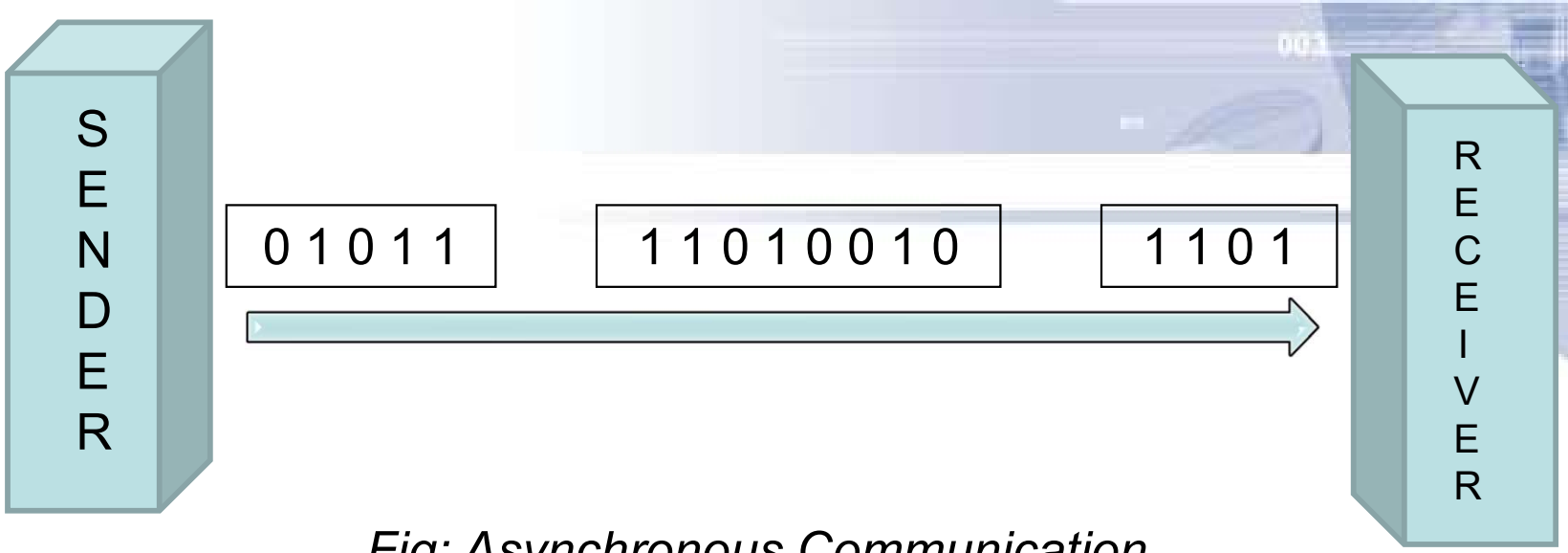


Fig: Asynchronous Communication

Data Transmission Techniques

- Asynchronous Transmission

Advantages:

- Simple and cheap
- Best for low speed communication

Disadvantages:

- Requires an overhead of two to three bits per frame.
- Time interval is unpredictable.

Data Transmission Techniques

1) Serial Transmission

There are three approaches regarding transmission of serial data.

- Synchronous Transmission

In this technique, a block of data in the form of bits stream is transferred without start / stop bits. The block can be any arbitrary length. In order to establish synchronization with remote computer the computer transmitter transmits synch pulse initially. When the receiver locks to the transmitter's clock frequency a block of data gets transmitted.

Data Transmission Techniques

- Synchronous Transmission

Characteristics:

- Block of data transmitted without start or stop bits.
- Initially synch pulses are transmitted.
- Good over short distance.
- Lower overhead than asynchronous so it becomes efficient.

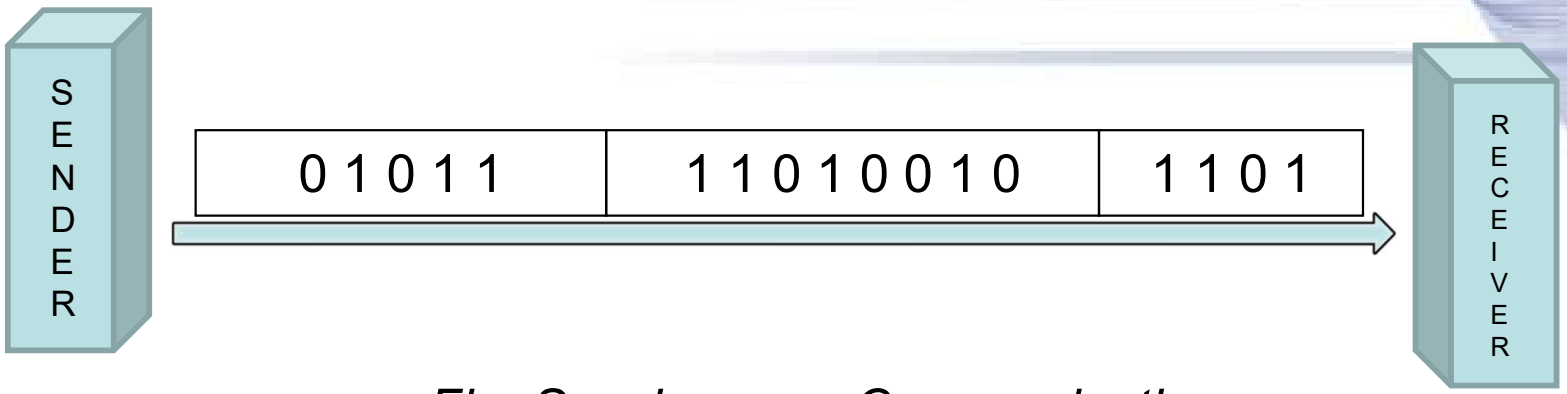


Fig: Synchronous Communication

Data Transmission Techniques

1) Serial Transmission

There are three approaches regarding transmission of serial data.

- Isochronous Transmission

An isochronous data transfer system combines the features of an asynchronous and synchronous data transfer system. An isochronous data transfer system sends blocks of data asynchronously, in other words the data stream can be transferred at random intervals.

Data Transmission Techniques

- Isochronous Transmission

Each transmission begins with a start packet. Once the start packet is transmitted, the data must be delivered with a guaranteed bandwidth. Isochronous data transfer is commonly used for where data must be delivered within certain time constraints, like streaming video.

Isochronous systems do not have an error detection mechanism (acknowledgment of receipt of packet) because if an error were detected, time constraints would make it impossible to resend the data.

Data Transmission Techniques

- Isochronous Transmission

Characteristics:

- Ensures no delay exists between frames.
- Complete bit stream has to be synchronized.
- Guarantees that data arrives at a fixed rate.
- Useful for real time communication.

Data Transmission Techniques

Types of transmission:

2) Parallel Transmission

When a number of bits are to be transmitted at once, then we use parallel transmission. In this technique, n-lines of channels are used to transfer n-bits of data. It is used to transfer data at faster rate and useful for shot distance.

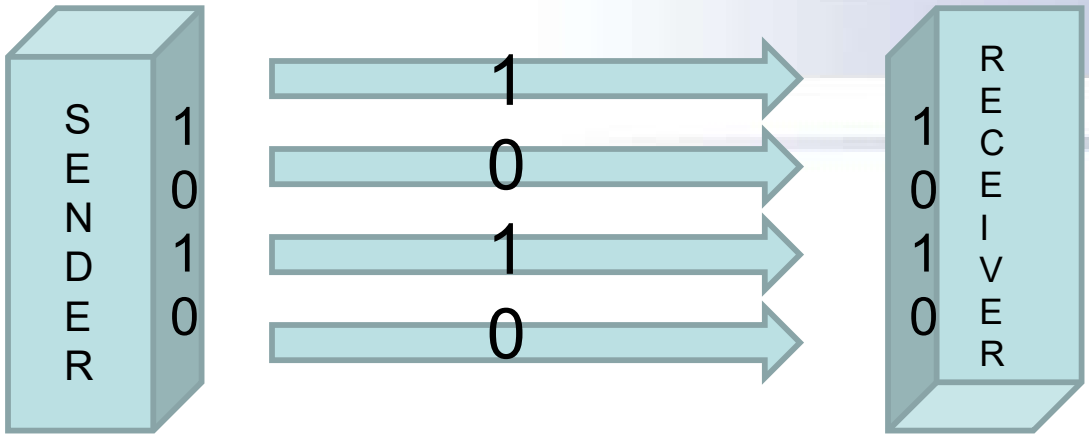


Fig: Parallel Transmission

Modes of Data Transmission

Communication of data between more than one terminals is called transmission. Communication can be simplex, half-duplex and full duplex.

1) Simplex:

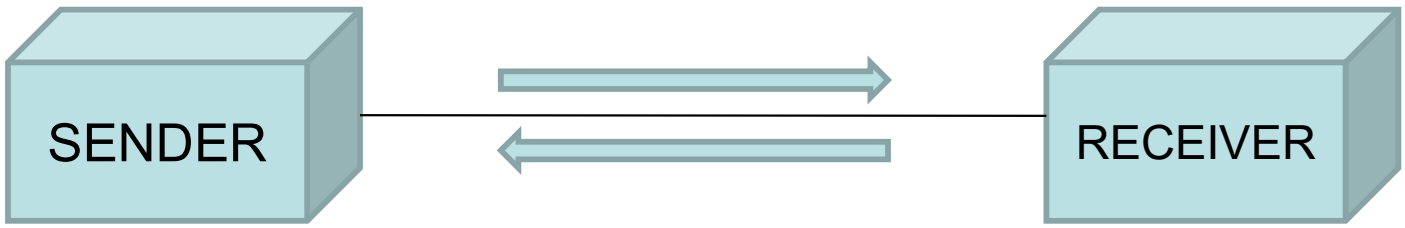
If communication is only in one way then it is called simplex. In this transmission, sender sends data but receiver cannot acknowledge to sender. For example: broadcasting information from radio, keyboards and monitors.

Modes of Data Transmission

Communication of data between more than one terminals is called transmission. Communication can be simplex, half-duplex and full duplex.

2) Half Duplex:

There are two way communication between transmitter and receiver, but only one side active at a time i.e. both stations can transmit the signal but only one at a time. For example: Walkie-Talkie

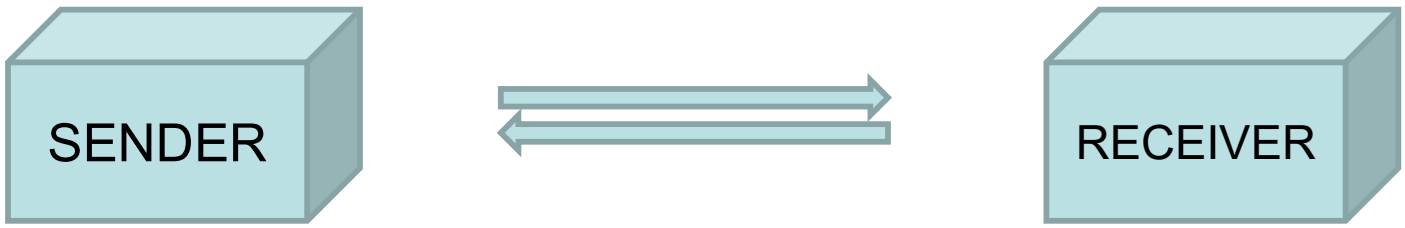


Modes of Data Transmission

Communication of data between more than one terminals is called transmission. Communication can be simplex, half-duplex and full duplex.

3) Full Duplex:

If transmission is possible in two ways at a time, then it is called full duplex. In full duplex, both stations may transmit the signal simultaneously. For example: Telephone N/W, Mobile communication, Satellite etc.



Line Configuration

Line configurations refers to the way by which two or more communication devices are attached to a link or network. A link is the physical communication path or way that transfer data from one device to another. There are following two ways of lines configurations:

1) Point-to-point Line Configuration
2) Multipoint Line Configuration

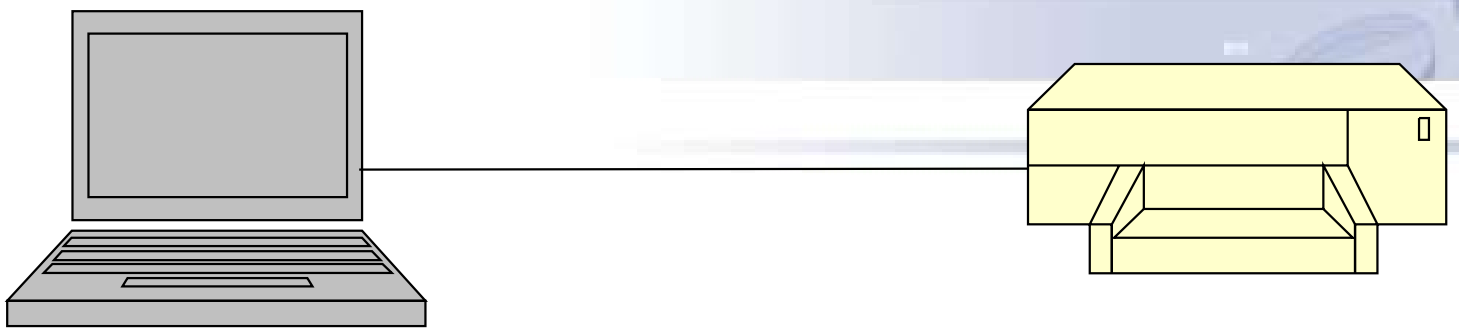
Point-to-Point Line Configuration

It provides link between two devices. The entire capacity of the channel is used for transmission between those two devices.

Line Configuration

Point-to-Point Line (P2P) Configuration

Most point to point line configuration use an actual length of wire or cable to connect the two ends. For example: a terminal or device and a computer, the connection between these link is point to point and called as line configuration.



Computer *Printer*

Fig: P2P Line Configuration

Line Configuration

Point-to-Point Line (P2P) Configuration

In P2P configuration, if each terminal has link to its corresponding device then the device or computer most have simplex mode of transmission such as computer to printer, radio broadcasting television signal transmission by a TV station etc.

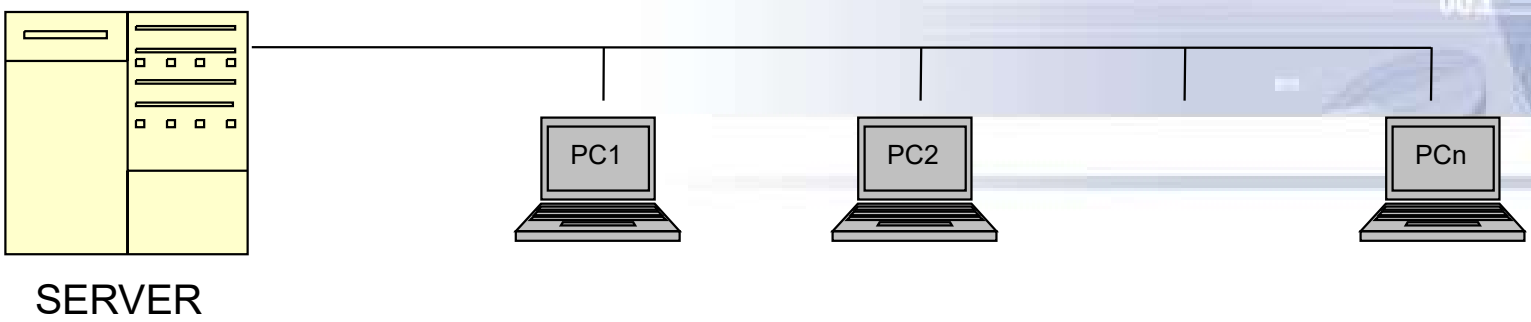
Multipoint Line Configuration

It is a configuration, in which more than two specific device shares a single link. Generally, multipoint techniques is used in local area network, cyber security, ISPs, telecommunication networks etc.

Line Configuration

Multipoint Line Configuration

Due to the use of single transmission line or link the cost is minimized, but sharing of some channel creates slow data transfer rate from transmitter to receiver or mainframe to other terminal in multipoint configuration.



Bit Rate/Baud Rate

Bit Rate

The no. of bits transmitted in one second is known as bit rate and is the measurement of capacity of the channel. Alternately, channel capacity is expressed in terms of bit per second.

Bit rate, as the name implies, describes the rate at which bits are transferred from one location to another. It measures how much data is transmitted in a given amount of time. It is commonly measured in bits per second (bps), kilobits per second (Kbps), or megabits per second (Mbps).

Bit Rate/Baud Rate

Bit Rate

Bit rate tells us how quickly data is transmitted from one location to another. For instance, a higher bit rate in music streaming will offer more audio details, resulting in better sound quality. Similarly, in video streaming, a higher bit rate translates to higher video quality and detail. Bit Rate cannot determine the bandwidth.

Bit Rate = baud rate x the number of bit per baud

Bit Rate/Baud Rate

Baud Rate

The rate at which the pattern of the original waveform changes is known as baud rate. It is the measurement of the signal changing its waveform or pattern for the transmission of signal from transmitter to receiver.

It counts how many times the state of a signal is changing. It is used to decide the requirement of bandwidth for transmission of the signal. It can determine the amount of bandwidth necessary to send the signal.

Baud Rate = bit rate / the number of bit per baud

Transmission Channel

The path through which the communication between any two parties or devices takes place is known as channel. The rate at which the data can be transmitted over a given communication channel under given condition is expressed in no. of bits per second.

The channel capacity is the maximum no. of bits per second passing through the channel. It depends upon data rate, bandwidth, noise and error rate.

The error rate is directly proportional to the data rate which means with every increase in data rate there is a increase in the error rate.

Transmission Channel

For reliable communication design limited bandwidth, channel capacity, minimum noise at error rate plays the most important factors or role in the data transmission. For channel capacity there are following two theorem are given:

1) Nyquist Theorem
2) Shannon's Theorem

Nyquist Theorem

For noise free channel data rate is proportional to the bandwidth of the signal. It is an important component of digital communication.

Transmission Channel

Nyquist Theorem

The Nyquist theorem defines the minimum sample rate for the highest frequency that you want to measure. It states that, “If the rate of signal transmission is twice of bandwidth then a signal with a frequency not greater than the bandwidth and is sufficient to carry the signal rate.” i.e. C = 2B

Nyquist Formula:

$C = 2B\log_2(m)$

Where,

C is Channel Capacity

m is no. of voltage levels or bits

B is bandwidth

Transmission Channel

Nyquist Theorem

Digital electronics can only work in discrete numbers. To convert an analog wave to a digital signal, it must be measured at a regular frequency, which is the sample rate. If the sample rate is too low, it will not accurately express the original signal and will be distorted, or show aliasing effects, when reproduced. If the sample rate is too high, it will needlessly take up extra storage and processing resources. The Nyquist theorem helps to find the perfect sweet spot where all the necessary information is recorded.

Transmission Channel

Shannon's Theorem

The Shannon channel capacity is a fundamental concept in information theory that defines the maximum rate at which information can be transmitted over a noisy channel without errors. It is measured in bits per seconds.

According to Shannon's theorem, the capacity of a channel for a signal with bandwidth (w) and signal to noise ratio is given by

$C = w\log_2(1+SNR)$

Where,

C is Channel Capacity

W is bandwidth

SNR is Signal to noise ratio

Transmission Channel

Shannon's Theorem

$$C = w\log_2(1+SNR)$$

Channel capacity increases linearly with bandwidth. This means that increasing bandwidth has a better return on investment than increasing SNR. However, bandwidth is limited by regulation, device capabilities, and channel conditions.

SNR is the relative strength of the signal energy as compared with the noise energy. It is a measure of the quality of a communication channel.

Transmission Channel

Shannon's Theorem

Shannon's channel capacity is a fundamental concept in information theory that provides an upper bound on the maximum rate of information that can be transmitted over a noisy channel. The original Shannon formula only considered the effects of noise, but modern communication channels are often subject to a variety of other challenges.

RS-232 Standard (DTE-DCE, DTE-DTE)

RS-232 Standard

It is a standard for serial communication. It formally defines the signal connection between data terminal equipment (DTE) such as computer terminal and data communication element (DCE) used in computer such as a modem. It is commonly used in computer serial port.

The main disadvantages or problem with RS-232 standard is that, it can only transfer data up to a distance of 50 ft. or 16.4m at the maximum rate of 20Kbps.

If transmission line is longer or the distance between two devices is higher, the signal is drastically reduced. For higher data rate and longer distance other standards can be used.

RS-232 Standard (DTE-DCE, DTE-DTE)

DTE

It stands for Data Terminal Equipment (DTE). It is the source and receiver's equipment which is generating the data stream. For example: PCs, terminals, End user devices etc.

DCE

The interface between the source and the medium, and the medium and the destination or receiver is called the Data Communication Equipment. It provides the interface from the DTE devise to the medium. For Examples: MODEM, Routers etc.