Unit 1 - Data Communications

Data Communication – Definition, Components, Types, Channels

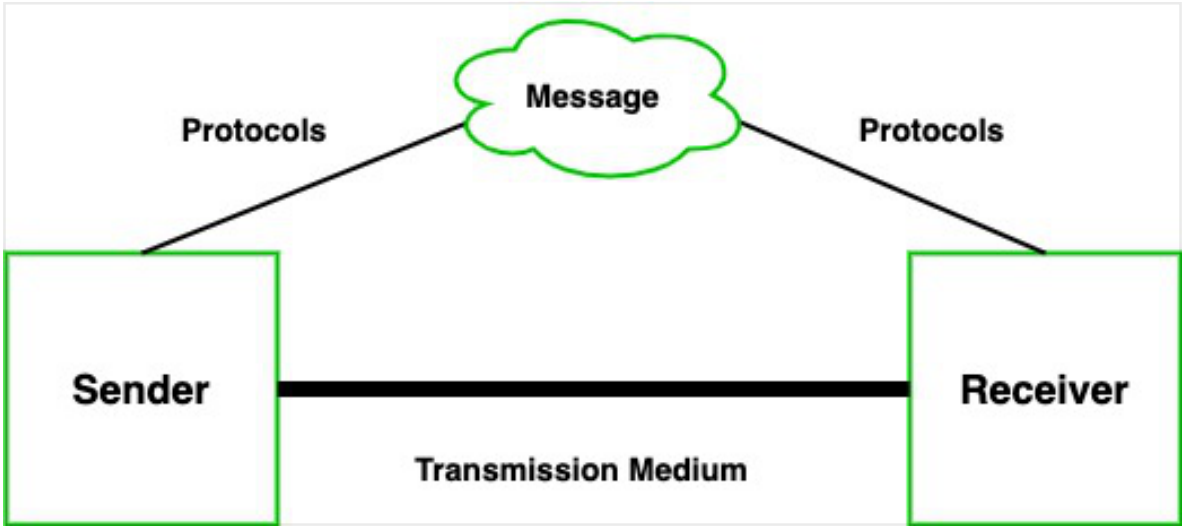
Transferring data over a transmission medium between two or more devices, systems, or places is known as data communication. Nowadays, computing and telecommunications depend heavily on this data transmission, which makes a variety of applications conceivable, including email, video chatting, the Internet, and many more things.

In this article, we will learn about Data communication, Definition, Components, Types, and Channels.

Components of Data Communication

A communication system is made up of the following components:

1. **Message:** A message is a piece of information that is to be transmitted from one person to another. It could be a text file, an audio file, a video file, etc.
2. **Sender:** It is simply a device that sends data messages. It can be a computer, mobile, telephone, laptop, video camera, or workstation, etc.
3. **Receiver:** It is a device that receives messages. It can be a computer, telephone mobile, workstation, etc.
4. **Transmission Medium / Communication Channels:** Communication channels are the medium that connect two or more workstations. Workstations can be connected by either wired media or wireless media.
5. **Set of rules (Protocol):** When someone sends the data (The sender), it should be understandable to the receiver also otherwise it is meaningless. For example, Sonali sends a message to Chetan. If Sonali writes in Hindi and Chetan cannot understand Hindi, it is a meaningless conversation.



Therefore, there are some set of rules (protocols) that is followed by every computer connected to the internet and they are:

- **TCP(Transmission Control Protocol)**: It is responsible for dividing messages into packets on the source computer and reassembling the received packet at the destination or recipient computer. It also makes sure that the packets have the information about the source of the message data, the destination of the message data, the sequence in which the message data should be re-assembled, and checks if the message has been sent correctly to the specific destination.

- **IP(Internet Protocol)**: Do You ever wonder how computer determines which packet belongs to which device. What happens if the message you sent to your friend is received by your father? Scary Right. Well! IP is responsible for handling the address of the destination computer so that each packet is sent to its proper destination.

Type of data communication
As we know that data communication is communication in which we can send or receive data from one device to another. The data communication is divided into three types:

1. **Simplex Communication:** It is one-way communication or we can say that unidirectional communication in which one device only receives and another device only sends data and devices uses their entire capacity in transmission. For example, IoT, entering data using a keyboard, listing music

using a speaker, etc.

2. **Half Duplex communication:** It is a two-way communication, or we can say that it is a bidirectional communication in which both the devices can send and receive data but not at the same time. When one device is sending data then another device is only receiving and vice-versa. For example, walkie-talkie.
3. **Full-duplex communication:** It is a two-way communication or we can say that it is a bidirectional communication in which both the devices can send and receive data at the same time. For example, mobile phones, landlines, etc.

Communication Channels

Communication channels are the medium that connects two or more workstations. Workstations can be connected by either wired media or wireless media. It is also known as a transmission medium. The transmission medium or channel is a link that carries messages between two or more devices. We can group the communication media into two categories:

- Guided media transmission
- Unguided media transmission

1. Guided Media: In this transmission medium, the physical link is created using wires or cables between two or more computers or devices, and then the data is transmitted using these cables in terms of signals. Guided media transmission of the following types:

1. Twisted pair cable: It is the most common form of wire used in communication. In a twisted-pair cable, two identical wires are wrapped together in a double helix. The twisting of the wire reduces the crosstalk. It is known as the leaking of a signal from one wire to another due to which signal can corrupt and can cause network errors. The twisting protects the wire from internal crosstalk as well as external forms of signal interference. Types of Twisted Pair Cable :

- **Unshielded Twisted Pair (UTP):** It is used in computers and telephones widely. As the name suggests, there is no external shielding so it does not protects from external interference. It is cheaper than STP.
- **Shielded Twisted Pair (STP):** It offers greater protection from crosstalk due to shield. Due to shielding, it protects from external interference. It is heavier and costlier as compare to UTP.

2. Coaxial Cable: It consists of a solid wire core that is surrounded by one or more foil or wire shields. The inner core of the coaxial cable carries the signal and the outer shield provides the ground. It is widely used for television signals and also used by large corporations in building security systems. Data transmission of this cable is better but expensive as compared to twisted pair.
3. Optical fibers: Optical fiber is an important technology. It transmits large amounts of data at very high speeds due to which it is widely used in internet cables. It carries data as a light that travels inside a thin glass fiber. The fiber optic cable is made up of three pieces:

1. **Core:** Core is the piece through which light travels. It is generally created using glass or plastic.
2. **Cladding:** It is the covering of the core and reflects the light back to the core.
3. **Sheath:** It is the protective covering that protects fiber cable from the environment.

2. Unguided Media: The unguided transmission media is a transmission mode in which the signals are propagated from one device to another device wirelessly. Signals can wave through the air, water, or vacuum. It is generally used to transmit signals in all directions. Unguided Media is further divided into various parts :
1. Microwave: Microwave offers communication without the use of cables. Microwave signals are just like radio and television signals. It is used in long-distance communication. Microwave transmission consists of a transmitter, receiver, and atmosphere. In microwave communication, there are parabolic antennas that are mounted on the towers to send a beam to another antenna. The higher the tower, the greater the range.
2. Radio wave: When communication is carried out by radio frequencies, then it is termed radio waves transmission. It offers mobility. It is consists of the transmitter and the receiver. Both use antennas to radiate and capture the radio signal.
3. Infrared: It is short-distance communication and can pass through any object. It is generally used in TV remotes, wireless mouse, etc.
Conclusion of Data Communication
A key component of modern technology, data transmission reduces the flow of information between networks, systems, and devices. To guarantee that data is sent exactly, quickly, and securely, it uses a variety of techniques and protocols.

Difference Between Analog And Digital Signal

The difference between analog signal and digital signal could be understood from the table given below:

Basis	Analog Signal	Digital Signal
Definition	Analog signals represent continuous variations in magnitude over time.	Digital signals are Discrete and quantized, with specific values.
Signal Type	Continuous waveforms	Discrete Signals
Processing	Requires complex processing for manipulation.	Easier to process and manipulate digitally.
Storage	Less efficient for storage due to continuous nature.	More efficient for storage due to discrete values.
Bandwidth	Typically requires more bandwidth.	Requires less bandwidth for transmission.
Examples	Analog audio signals, analog radio waves, Human voice, etc.	Digital audio signals, digital data streams, computers, etc.
Errors	Susceptible to noise and distortion	More resistant to noise and distortion
Circuit Component	Amplifiers, filters, continuous-wave oscillators	Microprocessors, binary counters, logic gates
Signal Values	Infinite range of values	Limited to discrete values
Conversion	No conversion required	Analog-to-digital conversion (ADC) required

Applications	Analog signals are used in electric fan, landlines, radio frequency communications, etc.	Digital signals are used in computers, smartphones, digital sensors, digital imagining, etc.

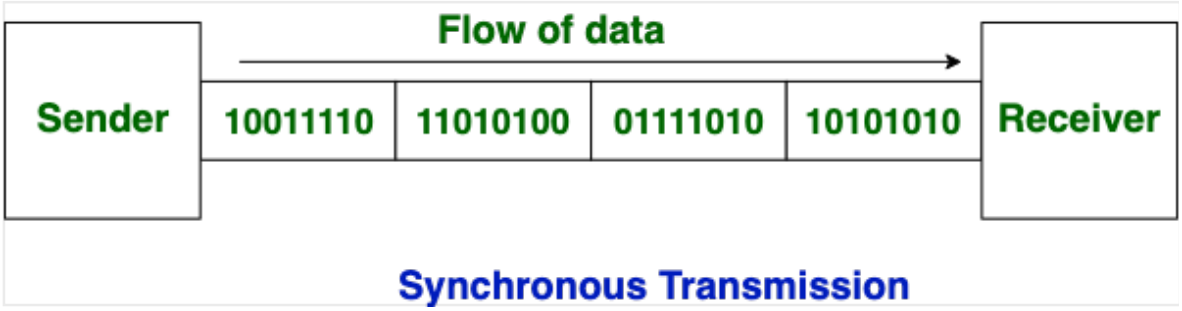
Difference Between Synchronous and Asynchronous Transmission

In the world of computers and communication, how information travels from one place to another can happen in different ways. Two common methods are synchronous and asynchronous transmission. In this article, we are going to discuss the difference between synchronous and asynchronous transmission in detail.
In this article, we are going to discuss Synchronous and Asynchronous Transmission and the key difference between Synchronous and Asynchronous Transmission.

What is Synchronous Transmission?
In Synchronous Transmission, data is sent in the form of blocks or frames. This transmission is the full-duplex type. Between sender and receiver, synchronization is compulsory. In Synchronous transmission, There is no time gap present between data. It is more efficient and more reliable than asynchronous transmission to transfer a large amount of data.

Both the sender and receiver are synchronized with a common clock signal. This means they operate at the same speed and know exactly when to send and receive data. Data is sent in a continuous stream, with each byte or chunk of data following the previous one without any gaps. It's efficient for sending large amounts of data quickly because there's less overhead (extra bits) needed to start and stop the transmission.

Example:
- Chat Rooms
- Telephonic Conversations
- Video Conferencing

- 

Synchronous Transmission

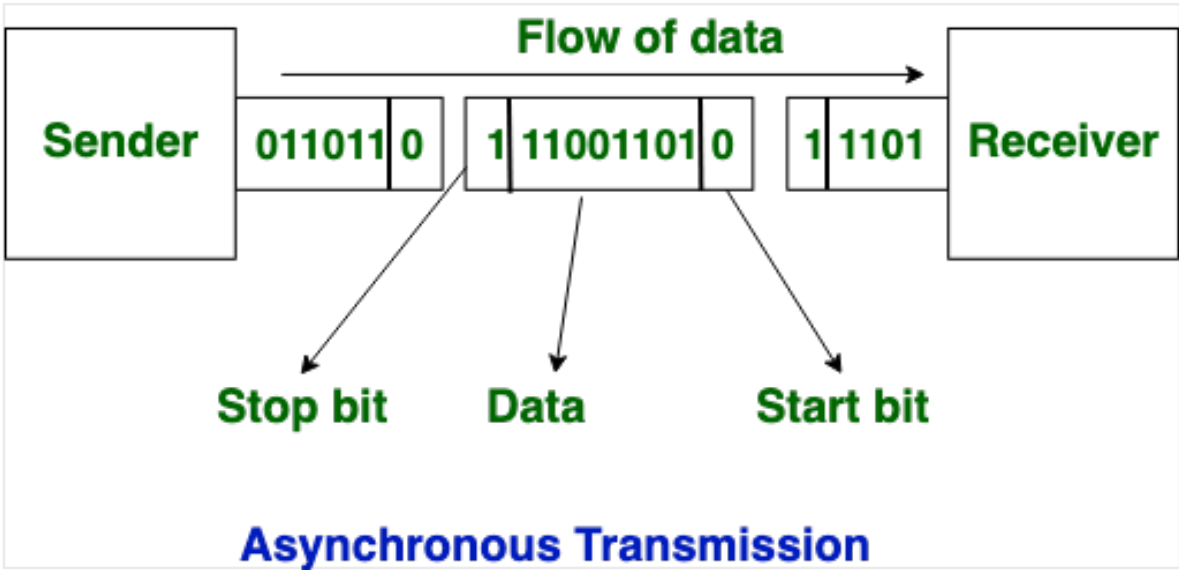
What is Asynchronous Transmission?

In Asynchronous Transmission, data is sent in form of byte or character. This transmission is the half-duplex type transmission. In this transmission start bits and stop bits are added with data. It does not require synchronization. **Asynchronous transmission** is like sending individual text messages without knowing exactly when the other person will read them.

The sender and receiver do not share a common clock signal. Instead, data is sent one byte or character at a time, with start and stop bits indicating the beginning and end of each byte. Each piece of data is sent independently, with gaps in between, allowing the receiver to process each byte as it arrives. It's flexible and simpler to implement, especially useful for communications where data is sent intermittently.

Example:

- Email
- Forums
- Letters

- 

Asynchronous Transmission

Difference Between Synchronous and Asynchronous Transmission

Now, let's see the difference between Synchronous and Asynchronous Transmission:

Synchronous Transmission	Asynchronous Transmission
In Synchronous transmission, data is sent in form of blocks or frames.	In Asynchronous transmission, data is sent in form of bytes or characters.
Synchronous transmission is fast.	Asynchronous transmission is slow.
Synchronous transmission is costly.	Asynchronous transmission is economical.
In Synchronous transmission, the time interval of transmission is constant.	In Asynchronous transmission, the time interval of transmission is not constant, it is random.
In this transmission, users have to wait till the transmission is complete before getting a response back from the server.	Here, users do not have to wait for the completion of transmission in order to get a response from the server.
In Synchronous transmission, there is no gap present between data.	In Asynchronous transmission, there is a gap present between data.
Efficient use of transmission lines is done in synchronous transmission.	While in Asynchronous transmission, the transmission line remains empty during a gap in character transmission.
The start and stop bits are not used in transmitting data.	The start and stop bits are used in transmitting data that imposes extra overhead.

Synchronous transmission needs precisely synchronized clocks for the information of new bytes.	Asynchronous transmission does not need synchronized clocks as parity bit is used in this transmission for information of new bytes.
Errors are detected and corrected in real time.	Errors are detected and corrected when the data is received.
Low latency due to real-time communication.	High latency due to processing time and waiting for data to become available.
Examples: Telephonic conversations, Video conferencing, Online gaming.	Examples: Email, File transfer,Online forms.

Conclusion

Both synchronous and asynchronous transmissions have their strengths and weaknesses, making them suitable for different types of applications. Synchronous transmission is efficient for high-speed, continuous data transfer, while asynchronous transmission offers simplicity and flexibility at the cost of some efficiency. Choosing between them depends on factors such as speed requirements, hardware complexity, and error tolerance in the communication system.

Difference Between Synchronous and Asynchronous Transmission – FAQs

Can both synchronous and asynchronous transmission be used together?

Yes, hybrid methods exist where synchronous and asynchronous techniques are combined to leverage their respective strengths in different parts of a communication system.

How does Synchronous Transmission Work?

In synchronous transmission, data is sent in blocks or frames. A shared clock signal between the sender and receiver ensures that both parties are in sync, allowing for a steady and continuous data flow.

How does Asynchronous Transmission Work?

In asynchronous transmission, each byte of data is sent

independently with start and stop bits. This way, the receiver knows when the data starts and ends, even without a shared clock signal.

When is Synchronous Transmission Used?
Synchronous transmission is often used in environments where high-speed data transfer is critical, such as in computer networks, mainframes, and high-speed communication channels.