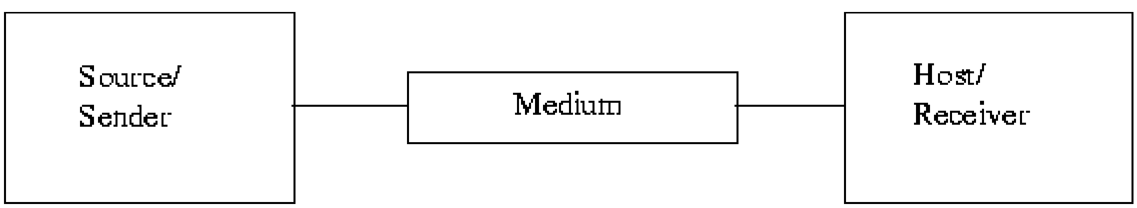
Data Communication

Data communications (DC) is the process of using computing and communication technologies to transfer data from one place to another, and vice versa. It enables the movement of electronic or digital data between two or more nodes, regardless of geographical location, technological medium or data contents.

Components of data communication

Data communication is a process of transferring data electronically from one place to another. Data can be transferred by using different medium. The basic components of data communications are as follows:

- Message
- Sender
- Receiver
- Medium/ communication channel
- Encoder and decoder



Message

The message is the data or information to be communicated. It may consist of text, number, pictures, sound, video or any a combination of these.

Sender

Sender is a device that sends message. The message can consist of text, numbers, pictures etc. it is also called source or transmitter. Normally, computer is use as sender in information communication systems.

Receiver

Receiver is a device that receives message. It is also called sink. The receiver can be computer, printer or another computer related device. The receiver must be capable of accepting the message.

Medium

Medium is the physical path that connects sender and receiver. It is used to transmit data. The medium can be a copper wire, a fiber optic cable, microwaves etc. it is also called communication channel.

Encoder and decoder

The encoder is a device that converts digital signals in a form that can pass through a transmission medium. The decoder is a device that converts the encoded signals into digital form. The receiver can understand the digital form of message. Sender and receiver cannot communicate successfully without encoder and decoder.

Data representation

There are two basic representation types for native data, namely, analog and digital.

Examples of analog and digital data representations

As shown in the diagram,

Analog data is continuous & can take infinite set of values. In the diagram, the data takes a wide set of voltage values (v) at different points of time (t). Examples of analog data are audio from a speaker, video output from a camera etc.

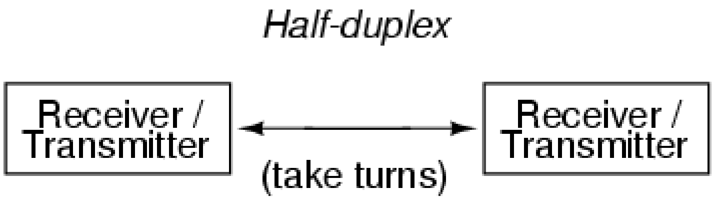
Digital data is discrete and not continuous. It cannot take an infinite set of values and it only takes a finite set of values. In the diagram above, the data takes only two voltage values (+v and -v) at different points of time (t). Examples of digital data include Text files (finite set of characters), binary representation (in 0s and 1s) of any data like that used in computer arithmetic, bitmap file etc, digitally converted audio, video data, digital images, pictures, digital movie etc.

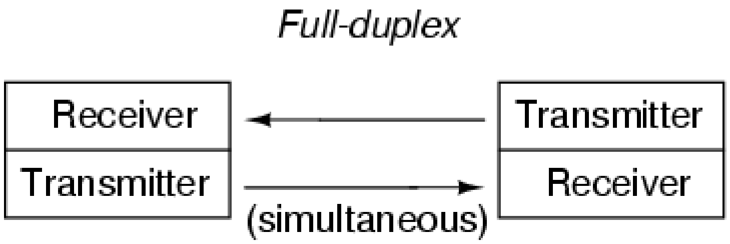
Data Flow

Buses and networks are designed to allow communication to occur between individual devices that are interconnected. The flow of information, or data, between nodes, can take a variety of forms:

With simplex communication, all data flow is unidirectional: from the designated transmitter to the designated receiver. BogusBus is an example of simplex communication, where the transmitter sent information to the remote monitoring location, but no information is ever sent back to the water tank. If all we want to do is send information one-way, then simplex is just fine. Most applications, however, demand more:

With duplex communication, the flow of information is bi-directional for each device. Duplex can be further divided into two sub-categories:





Half-duplex communication may be likened to two tin cans on the ends of a single taut string: Either can may be used to transmit or receive, but not at the same time. Full-duplex communication is more like a true telephone, where two people can talk at the same time and hear one another simultaneously, the mouthpiece of one phone transmitting the the earpiece of the other, and vice versa. Full-duplex is often facilitated through the use of two separate channels or networks, with an individual set of wires for each direction of communication. It is sometimes accomplished by means of multiple-frequency carrier waves, especially in radio links, where one frequency is reserved for each direction of communication.

Distributed processing

Distributed processing is a setup in which multiple individual central processing units (CPU) work on the same programs, functions or systems to provide more capability for a computer or other device. Originally, conventional microprocessors involved just one CPU on a chip. As microprocessor engineering evolved, manufacturers discovered that to speed up processes, more than one processor could be combined on a single unit. Many modern processors involve a multi-core design, such as a quad-core design pioneered by companies like Intel, where four separate processors offer extremely high speeds for program execution and logic.

Distributed processing also can be used as a rough synonym for parallel processing, in which programs are made to run more quickly with multiple processors. With the strategy of including more than one processor on a microprocessor chip, hardware users also can string multiple computers together to implement parallel processing with applications known as distributed processing software.

The distributed processing concept goes along with Moore's law, which posits that the number of transistors on an individual integrated circuit (IC) doubles every two years. As this theory has largely proven correct over the last four decades, engineering strategies like distributed processing also have added to the speed of logical devices for some amazing advances in the ability of computers to perform functional tasks.

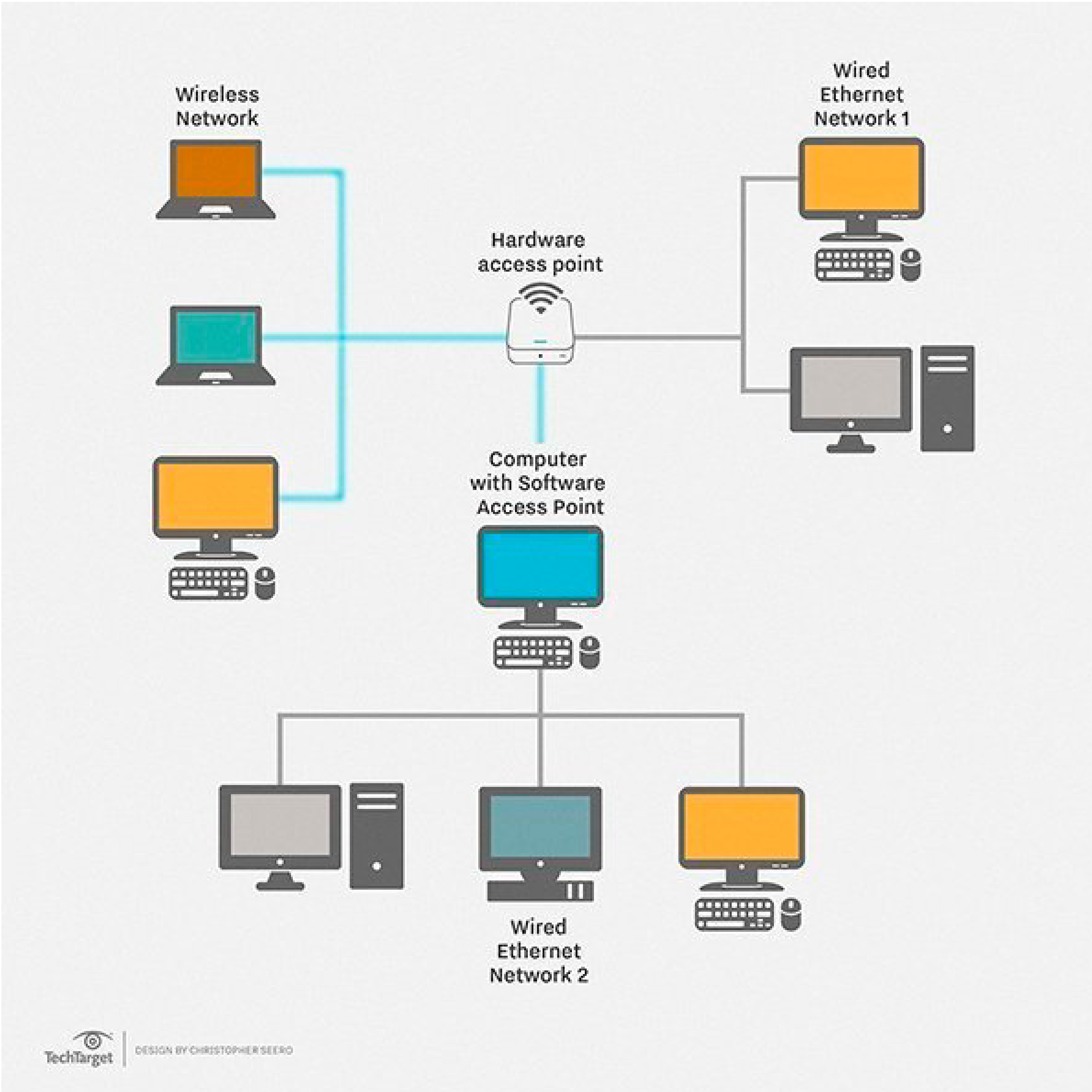
Physical structures

The physical layout of devices on a network. Every LAN has a topology, or the way that the devices on a network are arranged and how they communicate with each other. The way that the workstations are connected to the network through the actual cables that transmit data -- the physical structure of the network -- is called the physical topology. The *logical topology*, in contrast, is the way that the signals act on the network media, or the way that the data passes through the network from one device to the next without regard to the physical interconnection of the devices.
A network's logical topology is not necessarily the same as its physical topology. For example, twisted pair Ethernet is a logical bus topology in a physical star topology layout. While IBM's Token Ringis a logical ring topology, it is physically set up in a star topology.

Network Category

A local area network (LAN) is a group of computers and associated devices that share a common communications line or wireless link to a server. Typically, a LAN encompasses computers and peripherals connected to a server within a distinct geographic area such as an office or a commercial establishment. Computers and other mobile devices use a LAN connection to share resources such as a printer or network storage. local area network may serve as few as two or three users (for example, in a small-office network) or several hundred users in a larger office. LAN networking comprises cables, switches, routers and other components that let users connect to internal servers, websites and other LANs via wide area networks.

Ethernet and Wi-Fi are the two primary ways to enable LAN connections. Ethernet is a specification that enables computers to communicate with each other. Wi-Fi uses radio waves to connect computers to the LAN. Other LAN technologies, including Token Ring, Fiber Distributed Data Interface and ARCNET, have lost favor as Ethernet and Wi-Fi speeds have increased. The rise of virtualization has fueled the development of virtual LANs, which allows network administrators to logically group network nodes and partition their networks without the need for major infrastructure changes.



Typically, a suite of application programs can be kept on the LAN server. Users who need an application frequently can download it once and then run it from their local device. Users can order printing and other services as needed through applications run on the LAN server. A user can share files with others stored on the LAN server; read and write access is maintained by a network administrator. A LAN server may also be used as a web server if safeguards are taken to secure internal applications and data from outside access.

In some situations, a wireless LAN, or Wi-Fi, may be preferable to a wired LAN connection because of its flexibility and cost. Companies are assessing WLANs as primary means of connectivity as the number of smartphones, tablets and other mobile devices proliferates.

Metropolitan Area Network (MAN)

A metropolitan area network (MAN) is similar to a local area network (LAN) but spans an entire city or campus. MANs are formed by connecting multiple LANs. Thus, MANs are larger than LANs but smaller than wide area networks (WAN).

MANs are extremely efficient and provide fast communication via high-speed carriers, such as fiber optic cables. A MAN is ideal for many kinds of network users because it is a medium-size network. MANs are used to build networks with high data connection speeds for cities and towns.The working mechanism of a MAN is similar to an Internet Service Provider (ISP), but a MAN is not owned by a single organization. Like a WAN, a MAN provides shared network connections to its users. A MAN mostly works on the data link layer, which is Layer 2 of the Open Systems Interconnection (OSI) model.

Distributed Queue Dual Bus (DQDB) is the MAN standard specified by the Institute Of Electrical And Electronics Engineers (IEEE) as IEEE 802.6. Using this standard, a MAN extends up to 30-40 km, or 20-25 miles.

WAN (wide area network)

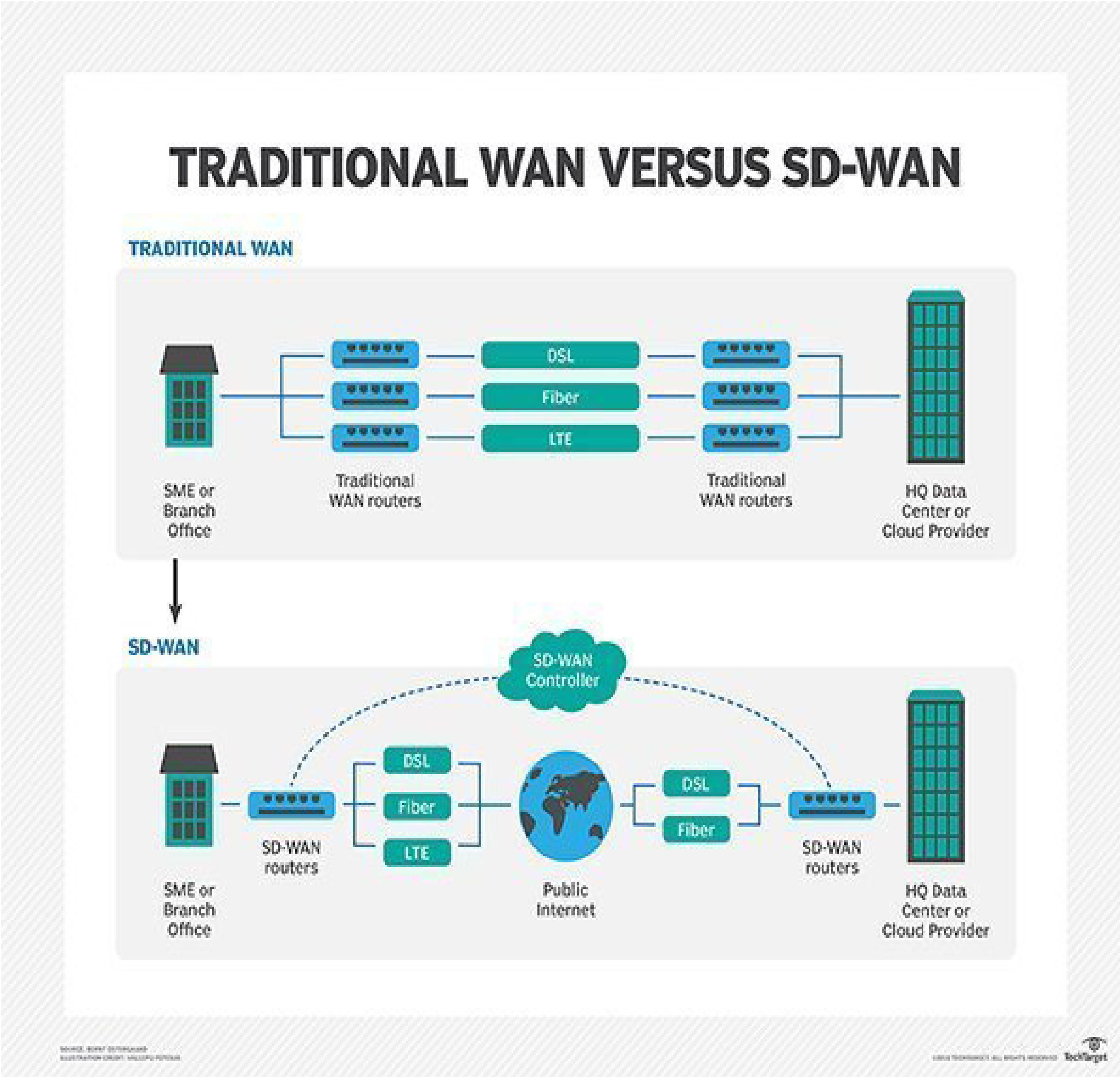
A wide area network (WAN) is a geographically distributed private telecommunications network that interconnects multiple local area networks (LANs). In an enterprise, a WAN may consist of connections to a company's headquarters, branch offices, colocation facilities, cloud services and other facilities. Typically, a router or other multifunction device is used to connect a LAN to a WAN. Enterprise WANs allow users to share access to applications, services and other centrally located resources. This eliminates the need to install the same application server, firewall or other resource in multiple locations, for example. A virtual private network (VPN) facilitates connectivity between WAN sites. An IPsec VPN is more commonly used in continuously open site-to-site connections, such as those between branch offices and headquarters locations. An SSL VPN is often the preferred choice for enabling remote access for individual users because the data transmitted from users across the WAN is encrypted. Direct fiber optic links are also used to connect sites on a WAN – and they almost always offer greater performance, reliability and security than VPNs, but they are cost-prohibitive for most enterprises to procure and operate.

Types of WAN connections

WAN connections can include wired and wireless technologies. Wired WAN services can include multiprotocol label switching, T1s, Carrier Ethernet and commercial broadband internet links. Wireless WAN technologies can include cellular data networks like 4G LTE, as well as public Wi-Fi or satellite networks.

WANs over wired network connections remain the preferred medium for most enterprises, but wireless WAN technologies, based on the 4G LTE standard, are gaining traction.

WAN infrastructure may be privately owned or leased as a service from a third-party service provider, such as a telecommunications carrier, internet service provider, private IP network operator or cable company. The service itself may operate over a dedicated, private connection -- often backed by a service-level agreement -- or over a shared, public medium like the internet. Hybrid WANs employ a combination of private and public network services.



Software-defined WAN (SD-WAN) is designed to make hybrid WAN architectures easier for enterprises to deploy, operate and manage. Using a combination of virtualization, application-level policies and network overlays, on-site SD-WAN devices, software platforms or customer premises equipment (CPE) perform two functions:

They aggregate multiple public and private WAN links.

They automatically select the most optimal path for traffic, based on real-time conditions.

The latter function has historically required network managers to manually reconfigure their networks any time they wanted to shape the direction of traffic over multiple routes.

Data & Signals

Analogue Signals and Digital Data

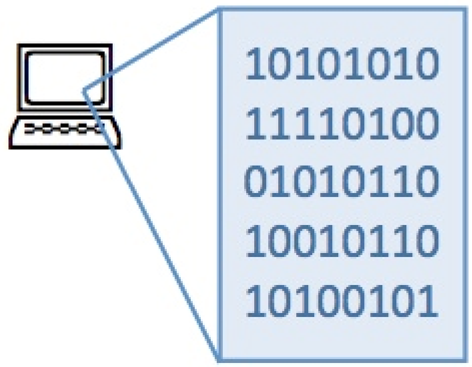
An analogue signal is one which has a value that varies smoothly. It is easiest to understand this by looking at an example:

The sound waves that your mouth produces when you speak are analogue - the waves vary in a smooth way. These waves can be converted into an electrical signal by a microphone. This electrical signal is also analogue:

Computers (and most other modern electronic devices such as cameras, mobile phones, etc.) are 'digital' devices because they process data in the form of numbers (digits).

Computer **software** is a collection of **numeric codes**which tell the computer what to do

- Text that you type into a computer is stored as **numeric codes**
- **Images** inside a computer are stored as **numeric values**(different values for different coloured pixels)



Everything stored and processed inside a computer is a number(digital).

Computers are unable to process analogues signals because they are digital devices. For digital devices such as computers, to work with analogue devices, conversion is required...

Analog Signal

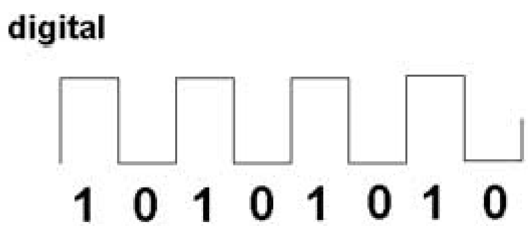
An analog signal is a continuous wave denoted by a sine wave (pictured below) and may vary in signal strength (amplitude) or frequency (time). The sine wave's amplitude value can be seen as the higher and lower points of the wave, while the frequency (time) value is measured in the sine wave's physical length from left to right.

There are many examples of analog signals around us. The sound from a human voice is analog, because sound waves are continuous, as is our own vision, because we see various shapes and colors in a continuous manner due to light waves. Even a typical kitchen clock having its hands moving continuously can be represented as an analog signal.

Analog signal represented as a sine wave

Digital Signal

A **digital signal** - a must for computer processing - is described as using binary (0s and 1s), and therefore, cannot take on any fractional values. As illustrated in the graphic below, digital signals retain a uniform structure, providing a constant and consistent signal. Because of the inherent reliability of the digital signal, technology using it is rapidly replacing a large percentage of analog applications and devices. For example, the wristwatch, showing the time of day, with its minute, hour, and sweeping second hands, is being replaced by the digital watch, which offers the time of day and other information using a numerical display. A typical digital signal is represented below. Note the equally dispersed 1s and 0s.



Digital signal with binary

Periodic and Non-Periodic Signal

A signal which repeats itself after a specific interval of time is called periodic signal.
A signal which does not repeat itself after a specific interval of time is called aperiodic signal.
A signals that repeats its pattern over a period is called **periodic signal**,

A signal that does not repeats its pattern over a period is called aperiodic signal or non periodic. Continuous time signals are said to be periodic.Get over in limited time called aperiodic or non periodic...

Both the Analog and Digital can be periodic or aperiodic. but in data communication periodic analog sigals and aperiodic digital signals are used.

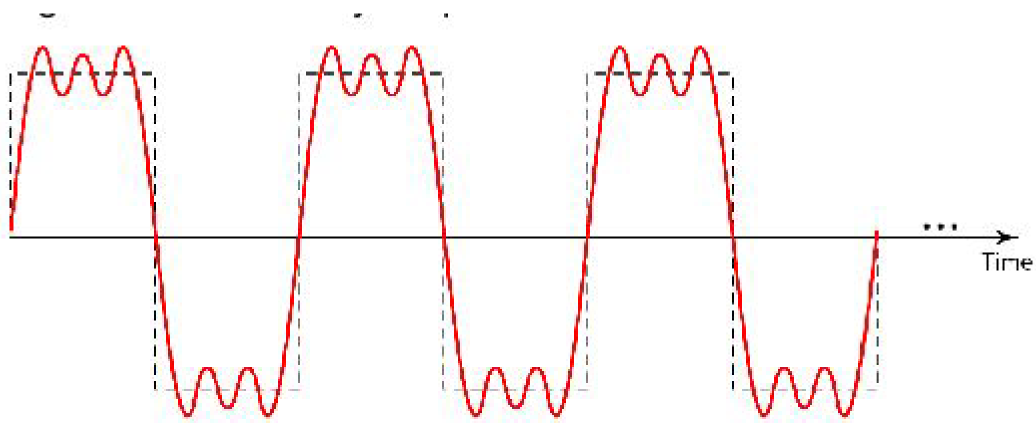
bit rate

In digital telecommunication, the bit rate is the number of bits that pass a given point in a telecommunication network in a given amount of time, usually a second. Thus, a bit rate is usually measured in some multiple of bits per second - for example, kilobits, or thousands of bits per second (Kbps).

Bit Length :-The Bit Length is the distance of one Bit occupies on the transmission medium.

Digital signal as a composite analog signal

A single-frequency sine wave is not useful in data communications; we need to send a compositesignal, a signal made of many simple sine waves.

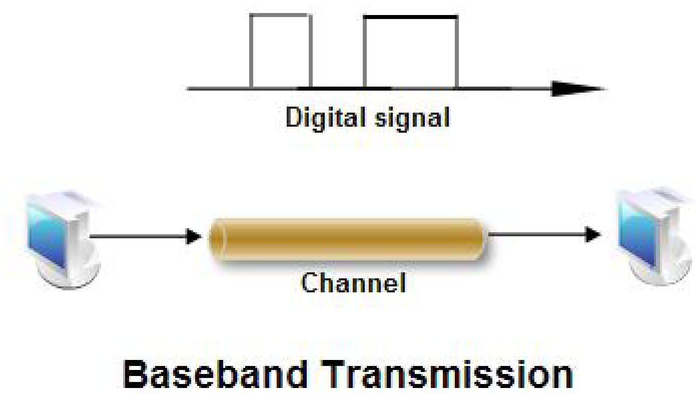


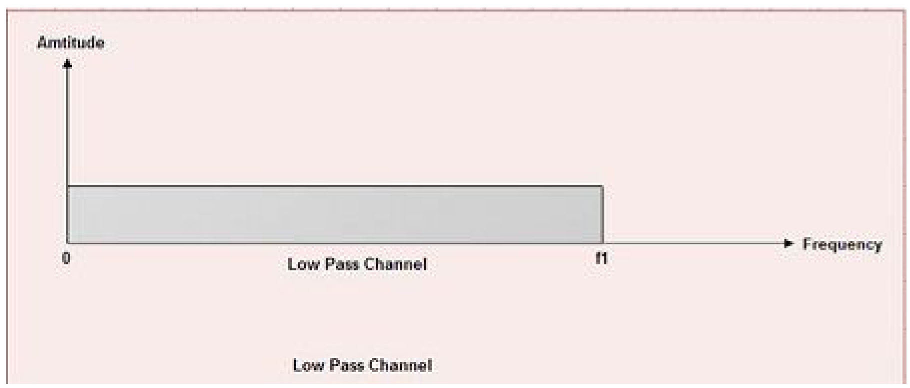
transmission of digital signals

There are two different approaches for the transmission of digital signals: baseband transmission and broadband transmission.

Baseband transmission

Baseband transmission means sending a digital signal over a channel without changing the digital signal to an analog signal.



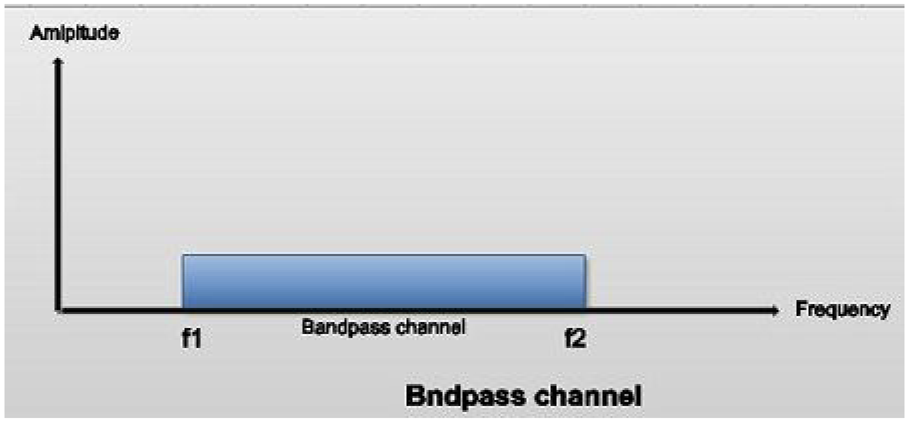


Baseband transmission requires low pass channel for transmission. A low pass channel is a channel whose bandwidth starts from zero.

Broadband Transmission

Broadband transmission means sending a digital signal over a channel after changing the digital signal to analog signal i.e. it requires modulation.

Broadband transmission can use bandpass channel. A bandpass channel is a channel whose bandwidth does not start from zero. A bandpass channel is more available than a lowpass channel.



If the available channel is bandpass, we cannot send the digital signal directly to the channel, it must be converted to an analog form before transmission.

Attenuation

Attenuation is a general term that refers to any reduction in the strength of a signal. Attenuation occurs with any type of signal, whether digital or analog. Sometimes called loss, attenuation is a natural consequence of signal transmission over long distances. The extent of attenuation is usually expressed in units called decibels (dBs). If Ps is the signal power at the transmitting end (source) of a communications circuit and Pdis the signal power at the receiving end (destination), then Ps > Pd. The power attenuation Apin decibels is given by the formula:

$$Ap = 10 \log10(Ps/Pd)$$

Attenuation can also be expressed in terms of voltage. If Av is the voltage attenuation in decibels, Vs is the source signal voltage, and Vd is the destination signal voltage, then:

$$Av = 20 \log10(Vs/Vd)$$

In conventional and fiber optic cables, attenuation is specified in terms of the number of decibels per foot, 1,000 feet, kilometer, or mile. The less the attenuation per unit distance, the more efficient the cable. When it is necessary to transmit signals over long distances via cable, one or more repeaters can be inserted along the length of the cable. The repeaters boost the signal strength to overcome attenuation. This greatly increases the maximum attainable range of communication.

Distortion is the alteration of the original shape (or other characteristic) of something. In communications and electronics it means the alteration of the waveform of an information-bearing signal, such as an audio signal representing sound or a video signal representing images, in an electronic device or communication channel. Distortion is usually unwanted, and so engineers strive to eliminate or minimize it. In some situations, however, distortion may be desirable. For example, in FM broadcasting and noise reduction systems like the Dolby system, an audio signal is deliberately distorted in ways that emphasize aspects of the signal that are subject to electrical noise, then it is symmetrically "undistorted" after passing through a noisy communication channel, reducing the noise in the signal. Distortion is also used as a musical effect, particularly with electric guitars