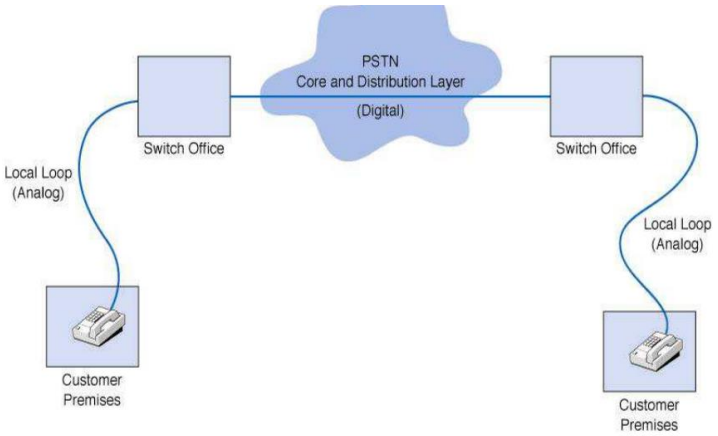
Chapter 1

Talk about traditional telephone networks for voice communications. Discuss the information infrastructure "Public Switched Telephone Network (PSTN)

Traditional telephone network was originally designed to carry voice signals using analog signals. Traditional telephone network works on circuit-switching technology, which setting up a dedicated channel (or circuit) between two points for the duration of the call. These telephony systems are based on copper wires carrying analog voice data over the dedicated circuits.

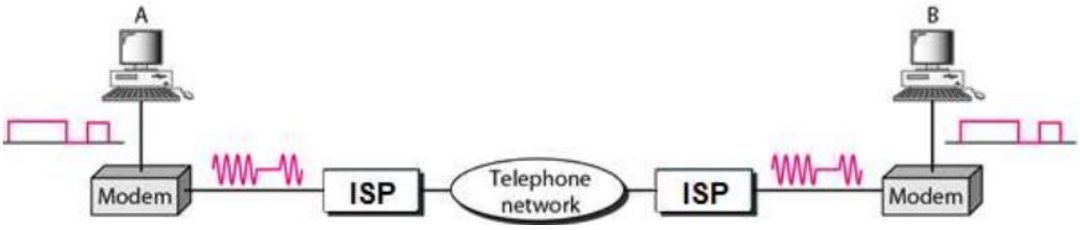
Today, the **Public Switched Telephone Network (PSTN)** can carry both analog and digital data. It is a network of computers and other electronic equipment that converts speech into digital data and provides a multitude of sophisticated phone features, data services, and mobile wireless access.

The connection between the customer premises equipment and the first telephone switch, called the local loop, is still analog.



2. Explain how to connect a home PC to Internet at a residential property.

A modem is a device enables a computer to transmit data over telephone lines. Computer systems understand digital data. To connect home PC to telephone systems, a modem is needed, the function of the modem is to modulate a digital data into an analog signal for transmission via analog medium, then demodulates the signal into digital for receiving information.



Simplified communications model

Functions of each component:

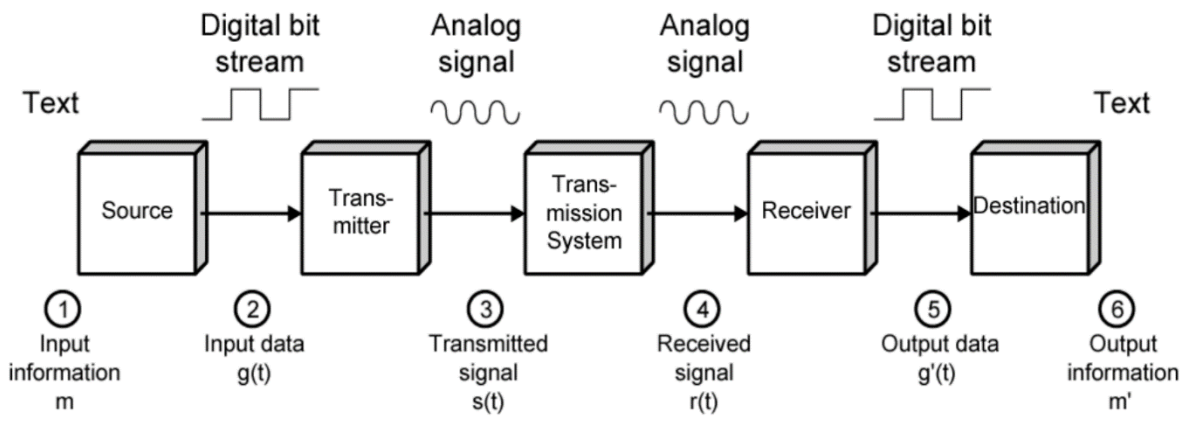
- Source: Generates (analog or digital) data to be transmitted.
- Transmitter: Converts data into transmittable electromagnetic signals.
- Transmission system: can be a single transmission line or a complex network.
- Receiver: Converts received signal into data.
- Destination: Takes incoming data.

Sending text over telephone lines

Signal in the form of electromagnetic wave propagated over a transmission medium. The signal is either analog or digital.

For signal transmission, it requires:

– the received message (m') as an exact copy of the original m.



What is a network?

A network is a set of devices (nodes) connected by communication links. A node can be a computer, printer, or any other device capable of sending and/or receiving data generated by other nodes on the network. Networks allow users to interact using e-mail, chat and video streaming

OSI model

Open Systems Interconnection (OSI) Model is a framework for computer network standards. Functions are partitioned into a hierarchical set of 7 layers.

Each layer performs a subset of the required communication functions and relies on the next lower layer to perform more primitive functions. Each layer provides services to the next higher layer. Changes in one layer should not require changes in other layers.

The 7 layers in OSI are:

Physical (Layer 1): is the physical interface between the device and transmission medium or network. It defines how individual bits are formatted to be transmitted through the network.

Data Link (Layer 2): relates to message delineation, error control and network medium access control.

Network: Internet Protocol (IP) (Layer 3): is responsible for making routing decisions.

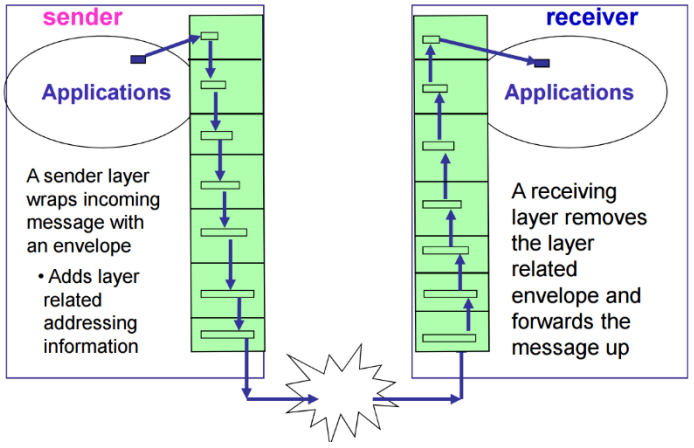
Transport: Transport Control Protocol (TCP) (Layer 4): deals with end-to-end issues. For instance, segmenting a message for network transport, as well as maintaining the logical connections between sender and receiver.

Session Layer (Layer 5): initiates, maintains and terminates each logical session.

Presentation Layer (Layer 6): formats data for presentation to the user. It also provides data interfaces, data compression and translation between different data formats.

Application Layer (Layer 7): is a set of utilities used by application programs.

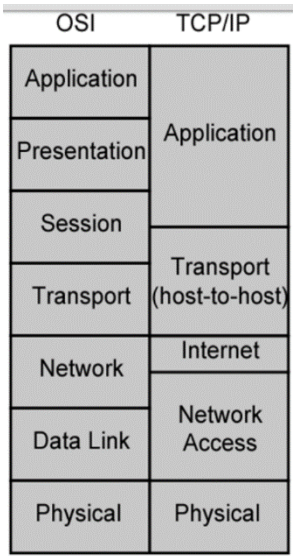
Message transmission using layers works in the following way: a sender layer wraps the incoming message with an envelope, and adds layer related addressing information. A receiving layer removes the layer related envelope and forwards the message up.



Protocols:

All communication activity in Internet is governed by protocols. Protocols are: sets of rules to define how to communicate at each layer and how to interface with adjacent layers. Key features of protocol are:

- Syntax: the format of the data blocks
- Semantics: control information for coordination and error handling.
- Timing: speed match and sequencing.



TCP/IP protocol

Transmission Control Protocol (TCP): TCP is implemented only in the end systems. It assures reliable transmission.

Internet Protocol (IP). IP is responsible for making routing decisions. It is in all the end systems and the routers.

TCP pass messages down to IP with specific instruction of destination. IP hands the message down to the network access layer with instructions of routing.

Control information is added as header on each layer:

• User data

• Add TCP header → TCP segment

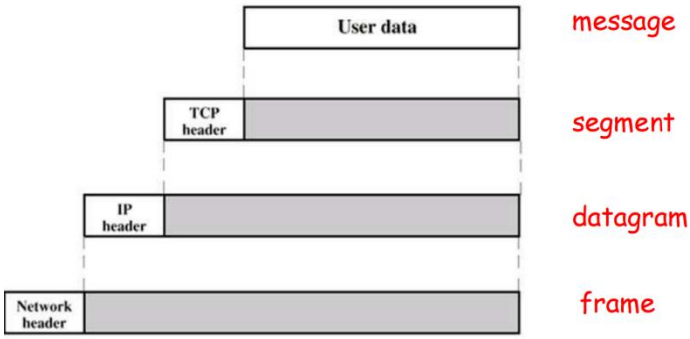
• Add IP header → IP datagram

• Add Network header → Network packet

Why is layering needed?

Layers help to deal with complex systems. Each layer implements a service via its own internal-layer actions: relying on services provided by layer below.

Each layer takes data from above, then adds header information to create new data unit; and passes new data unit to layer below.



Chapter 2: 4%

Data is defined as entities that convey meaning, or information.

Signals are electric or electromagnetic representations of data. A signals transmission medium carries either analog or digital signals.

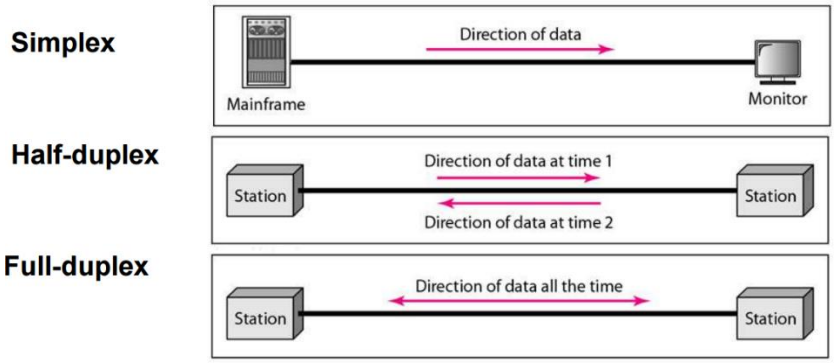
Data and signal

The type of data movement allowed on the channel comes in 3 forms, simplex, half-duplex and full-duplex.

Simplex: signal transmission in one direction.

Half-duplex: both stations transmit, but only one at a time.

Full-duplex: both stations may transmission simultaneously. The medium is carrying signals in both directions at the same time.



Discuss why modulation is needed in the radio communications systems?

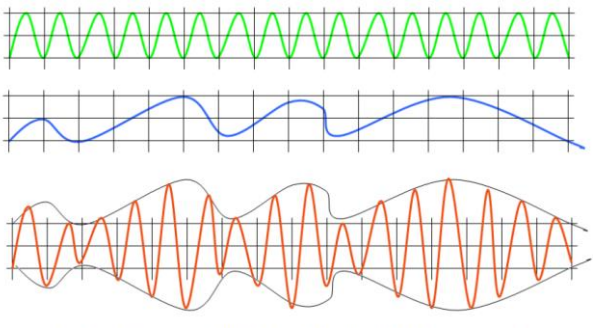
The purpose of radio communication is to transmit information (baseband) signals through a communication channel. Baseband is used to designate the band of frequencies representing the original signal as delivered by the input transducer. For instance, the voice signal from a microphone is a baseband signal.

A carrier wave has a frequency that is selected from an appropriate band in the radio spectrum.

Modulation is the process of impressing a low-frequency baseband signal onto a higher frequency carrier signal. There are two modulation techniques, Amplitude modulation, and frequency modulation. They are processes of varying the amplitude of the carrier wave in proportion to the amplitude of the baseband signal.

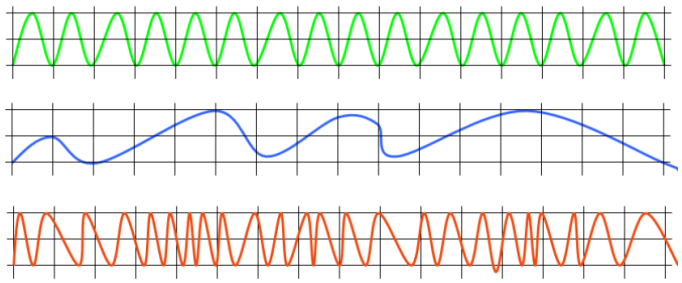
Explain how Amplitude Modulation (AM) and Frequency Modulation (FM) work.

Amplitude modulation(AM) The frequency of the carrier signals remain constant, which is the same with the modulated signal, while the amplitude varies.



(a). Carrier signal (in green); (b) Baseband signal (in blue); (c) Modulated signal (in brown).

Frequency Modulation (FM The amplitude of the carrier signal remains constant while frequency varies.



(b). Carrier signal (in green); (b) Baseband signal (in blue); (c) Modulated signal (in brown).

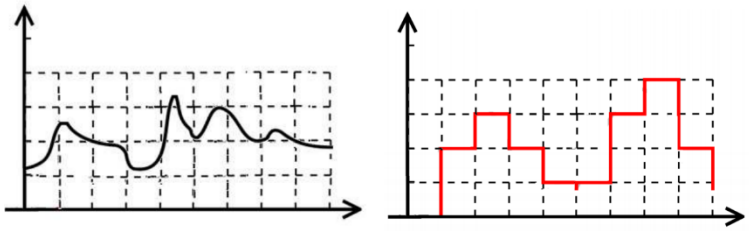
Demodulator extracts the original baseband signal from the received signal

The transmitter block in any communications system contains the modulator device. The receiver block in any communications system contains the demodulator device. If transmitting signals in wireless communication channel, we need to: shift the range of baseband frequencies to the frequency ranges suitable for transmission, and have a corresponding shift back to the original frequency range after reception.

Analog and digital

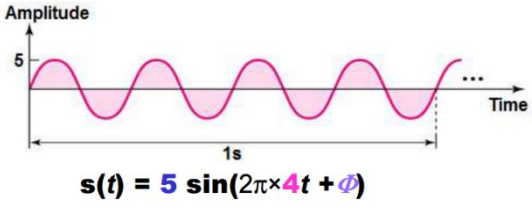
Analog data takes on continuous values, measured in hertz (Hz). This data varies smoothly over time, Example: audio, video, data sampled by sensor, etc.

Digital data takes on discrete values, measured in bit per second (bps). Maintains a constant level, then changes to another constant level. Example: Text, integers, etc.



Analog signals: sine waves

$S(x) = A \sin(\omega t + \Phi)$



A: the amplitude, the peak deviation of the function from zero.

$\omega = 2\pi f$, the angular frequency, the rate of change of the function argument in units of radians per second.

f: the frequency, the number of oscillations (cycles) that occur each second of time.

Φ: the phase, specifies (in radians) where in its cycle the oscillation is at t = 0.

T: period, the traveling time of one cycle. T = 1/f

Spectrum and bandwidth. What's the difference?

Spectrum: the range of frequency a signal contains.

Bandwidth: the width of the spectrum. Calculated by deducting lowest frequency from highest frequency.