CSC412 Computer Networks

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Computer Networks

The **Internet** is a computer network that interconnects computing devices: **hosts / end systems**

Hosts are divided into two categories: 1. Clients (users)
2. Servers (distributors)

A network transfers data from one host to another host via a medium.

- **Electromagnetic waves** require time varying signal energy

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electricity --> magnetism --> electricity
```

Laptops / computers have an omni-directional antenna (**Network Card**) that converts between digital and electromagnetic waves.

Hosts access the Internet through **Internet Service Providers (ISPS)** which in itself a network of packet switches and communication links

Signals travel in a straight line whereas wires bend. Reflection allows the electromagnetic signal to bend in the wire.

Signal strength at a distance r from source is about `1 / r^2` . If too far away, signal will be repeated.

Analog Communications: V(t) (velocity of propagation w.r.t time) occupies a continuous value, `V(t) = (0, V_max)`

Computer Communications is digital in binary (0s and 1s)

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Digital <------network card------> E.M.
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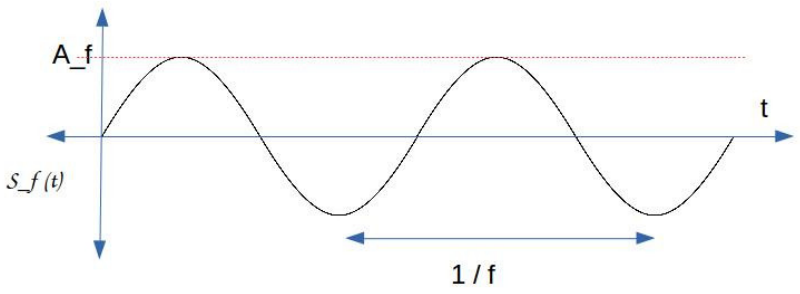
Modulation

Data Representation

Data is represented as a time-varying signal ($S_t(t)$).



Upper limit = line capacity = bandwidth limited medium

$S_f(t) = A_f * \sin(2 * pi * f * t + theta_f)$

Time-varying Signal is the summation of all frequency components

$$r(t) = \int_0^\infty S(t)dt$$

What is Modulation?

In radio communication, a radio signal is "modulated" so that it can be transmitted over long distances. In other words, the radio signal (input signal) is added with a carrier signal.

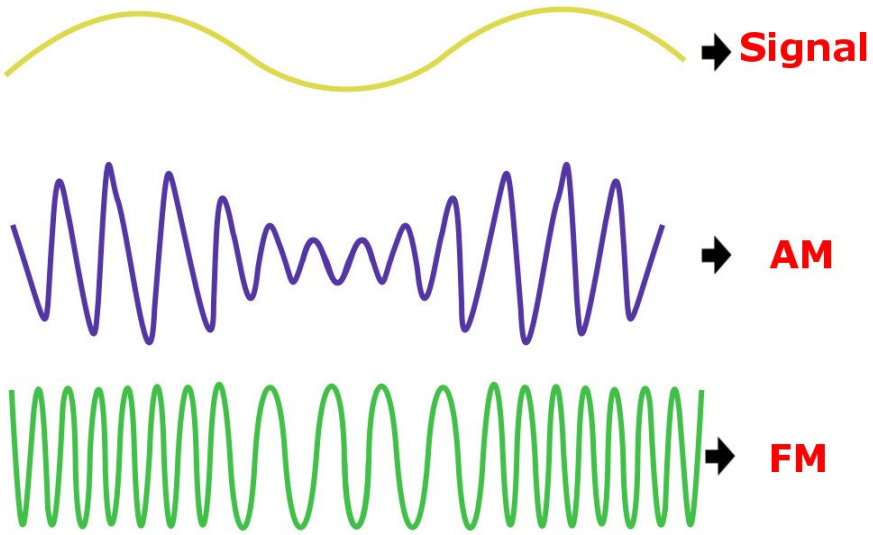
$$\text{Modulated Signal} = S(t) * S_c(t)$$

A **carrier signal** has a constant amplitude and frequency.

$$S_c(t) = A_c * \sin(2 * \pi * f_c + \theta_c)$$
$$f_c >> f_m$$

A radio signal usually has a very low frequency.

Analog modulation comes in 3 types:
1. Amplitude Modulation (AM)
2. Frequency Modulation (FM)
3. Phase Modulation

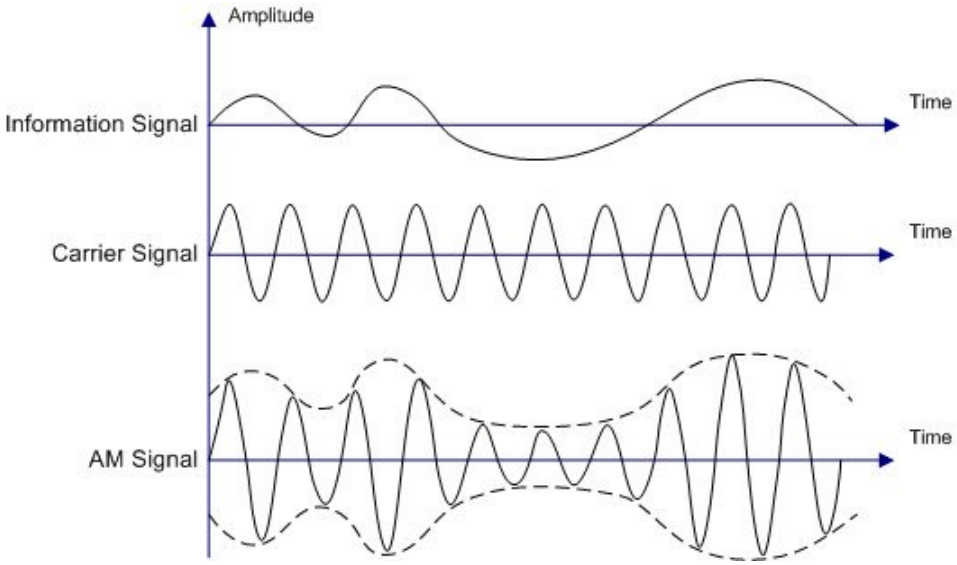


Noise $n(t)$ adds onto the signal received and therefore there are peak detectors at the receiver.

$$S(t) * S_c(t) + n(t)$$

Amplitude Modulation

The amplitude of $S_c(t)$ is modified as per $S(t)$.

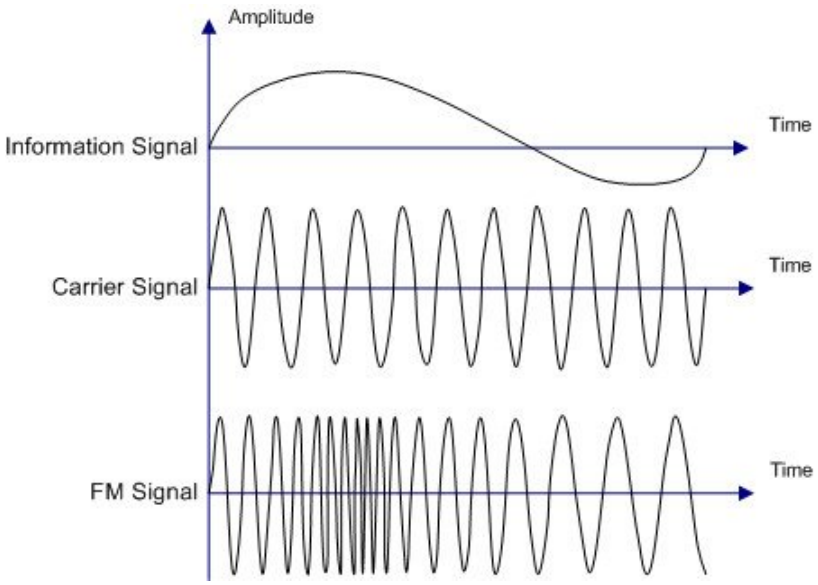


The amplitude of the carrier wave is modified proportionally according to the input signal.

- When the input signal has a low amplitude, the amplitude of the carrier wave is decreased and vice-versa.

Frequency Modulation

The frequency of $S_c(t)$ is modified as per S(t).



The frequency of the carrier wave is modified proportionally according to the amplitude of the input signal.

> **NOTE** FM has a better transmission quality than AM.

Circuit Switching

Packet Switch

In packet switched networks, resources are *not reserved*!

- A session's messages use the resources on demand and as a consequence may have to wait (queue) for access to a communication link.

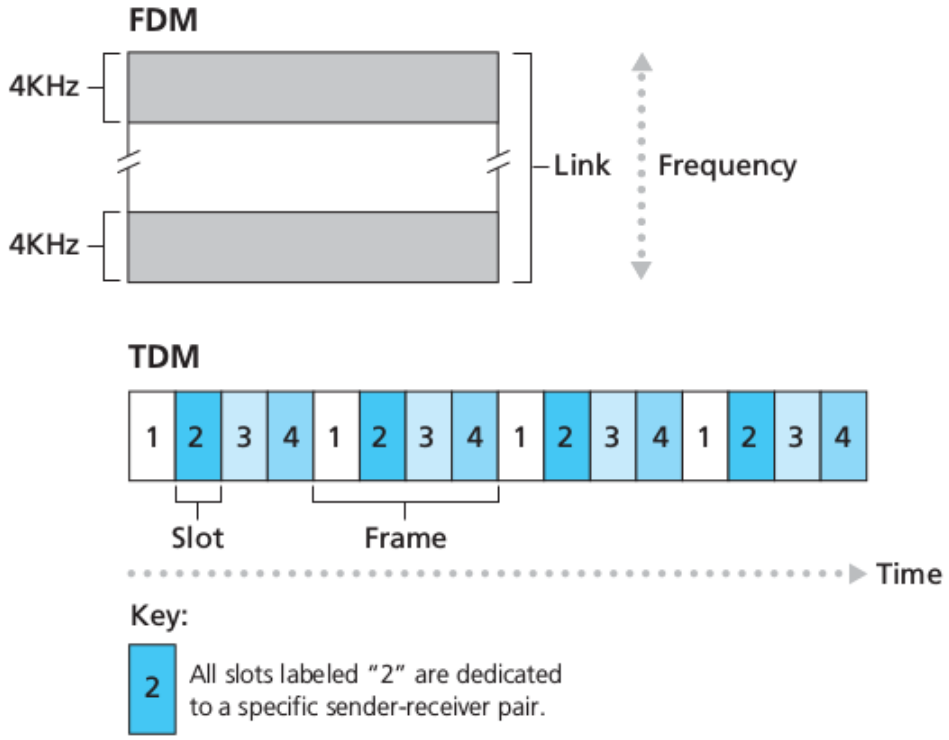
Circuit Switch

In circuit switched network, the resources needed along a path (buffer, link transmission rate) to provide for communication between the end systems are *reserved* for the duration of the communication session between the end systems.

Example:
Traditional telephone networks must establish a connection between the sender and the receiver (*bona fide* connection) and maintain the connection state for the duration of the call. This connection is a **circuit**.
When the network establishes the circuit, it also reserves a constant transmission rate in the network's links.

Multiplexing

A circuit in a link is implemented with either:
1. Frequency-division multiplexing (FDM)
2. Time-division multiplexing (TDM)



Frequency-Division Multiplexing (FDM)

The frequency spectrum of a link is divided up among the connections established across the link.

The link dedicated a frequency band to each connection for the duration of the connection.

The width of the band is called **bandwidth**.

- FM radio stations use FDM to share the frequency spectrum between 88 MHz and 108 MHz with each station being allocated a specific frequency band.

Time-Division Multiplexing (TDM)

Time is divided into frames of fixed duration, and each frame is divided into a fixed # of time slots.

When the network establishes connection across the link, the network dedicates one time slot in every frame to this

connection to transmit the connection's data.

Layers of Abstraction

Table 1. Seven-Layer ISO OSI Reference Model

Application
Presentation
Session
Transport
Network
Data Link
Physical

Presentation: doest not alter content but interpret

Session: set up context for communication

Transport: deliver content

Link: transport interface

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