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MODULE 3

Transmission Modes: Parallel and Serial Transmission, Asynchronous, Synchronous, Isochronous Transmission Multiplexing - TDM, FDM, WDM - Spread spectrum-The concept of spread spectrum – frequency hopping spread spectrum – direct sequence spread spectrum – code division multiple access

Transmission Modes:

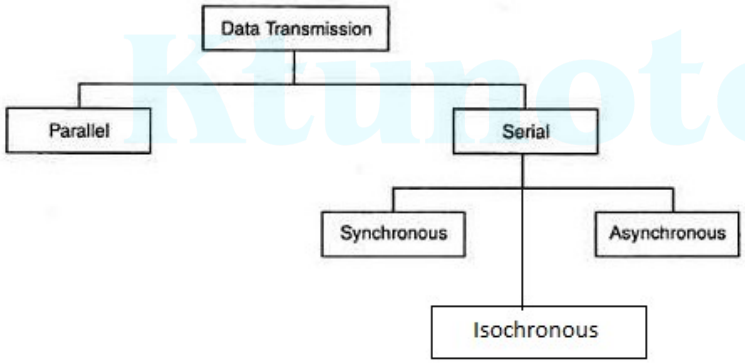
Data Transmission

- refers to the process of transferring data between two or more digital devices.
- Data is transmitted from one device to another in analog or digital format.

Data is transferred in the form of bits between two or more digital devices. There are two methods used to transmit data between digital devices:

Serial data transmission: sends data bits one after another over a single channel.

Parallel data transmission: sends multiple data bits at the same time over multiple channels.



Parallel Transmission

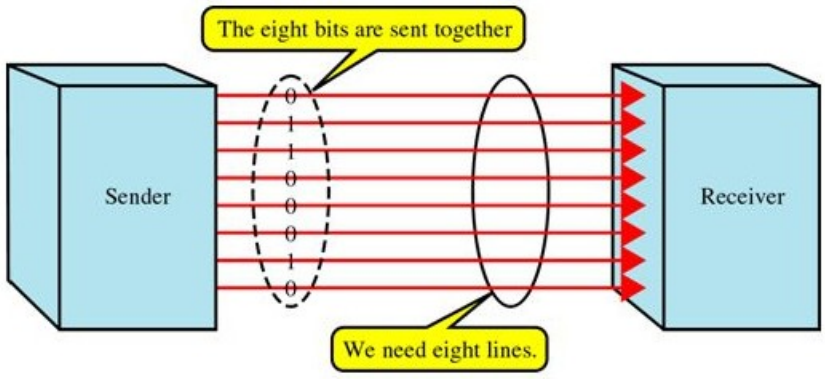
•Multiple bits are sent with each clock-tick

•„n‟ bits in a group are sent simultaneously.

•„n‟wiresare usedto send „n‟bits at one time

.•Each bit has its own wire

.•Typically, the 8 wires are bundled in a cable with a connector at each end



Advantage:

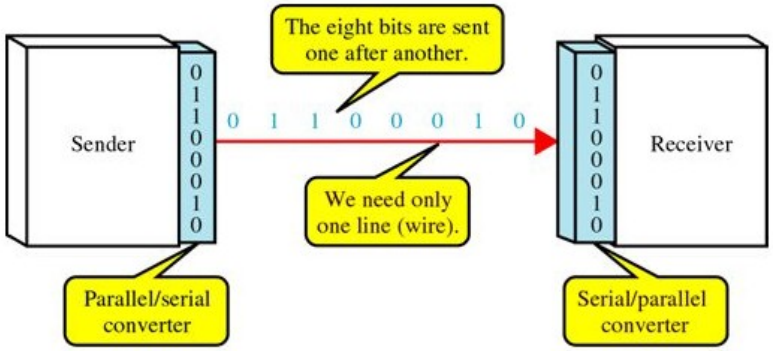
Speed: Parallel transmission can increase the transfer speed by a factor of n over serial transmission.

Disadvantage:

Cost: Parallel transmission requires n communication lines just to transmit the data-stream. Because this is expensive, parallel transmission is usually limited to short distances.

Serial Transmission

- One bit is sent with each clock-tick using only a single link
- One bit follows another



Advantage:

Cost: reduces cost by a factor of n.

Disadvantage:

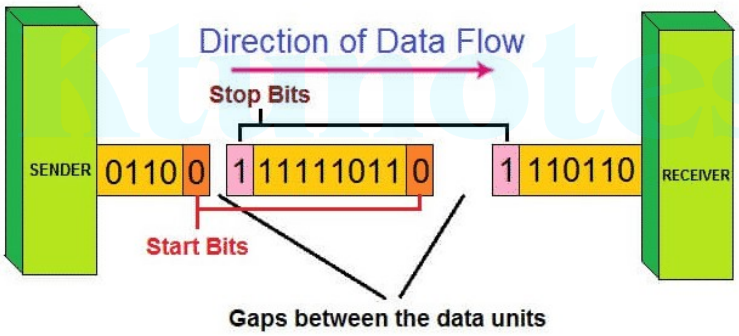
Since communication within devices is parallel, following 2 converters are required at interface
i) Parallel-to-serial converter

ii) Serial-to-parallel converter.

Three types of serial transmission: asynchronous, synchronous, and isochronous

Asynchronous Transmission

- Asynchronous transmission is so named because the timing of a signal is not important
- Prior to data transfer, both sender & receiver agree on pattern of information to be exchanged
- Normally, patterns are based on grouping the bit-stream into bytes.
- The sender transmits each group to the link without regard to a timer.
- As long as those patterns are followed, the receiver can retrieve the info. without regard to a timer.
- There may be a gap between bytes
- We send
  → 1 start bit (0) at the beginning of each byte
  → 1 stop bit(1) at the end of each byte.
- Start bit alerts the receiver to the arrival of a new group.
  Stop bit lets the receiver know that the byte is finished.
- Here, the term asynchronous means "asynchronous at the byte level".
  However, the bits are still synchronized& bit-durations are the same

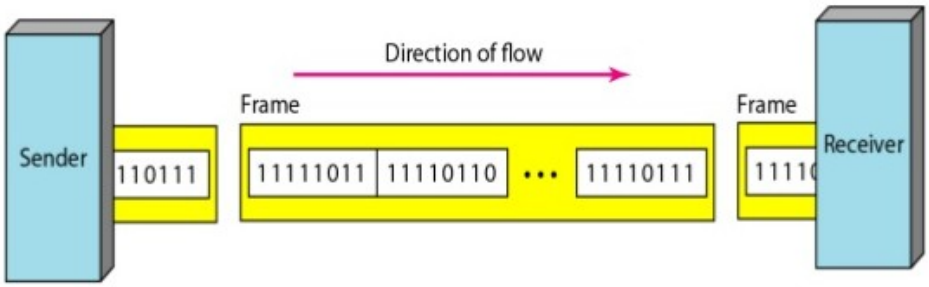


Advantages:
1) Cheap &effective.
2) Useful for low-speed communication

Disadvantage:
1) Slower than synchronous transmission. (Because of stop bit, start bit and gaps)

Synchronous Transmission

- We send bits one after another without start or stop bits or gaps
- The receiver is responsible for grouping the bits.
- The bit-stream is combined into longer "frames," which may contain multiple bytes.
- If the sender wants to send data in separate bursts, the gaps b/w bursts must be filled with a special sequence of 0s &1s(that means idle)



Advantages:

- Speed : faster than asynchronous transmission
- Useful for high-speed applications such as transmission of data from one computer to another

Isochronous

- Synchronization between characters is not enough; the entire stream of bits must be synchronized.
- isochronous data transfer system combines the features of an asynchronous and synchronous data transfer system.
- The isochronous transmission guarantees that the data arrive at a fixed rate.
- Transmits asynchronous data over a synchronous data link
- In real-time audio/video, jitter is not acceptable. Therefore, synchronous transmission fails.
- For example: TV images are broadcast at the rate of 30 images per second. The images must be viewed at the same rate.

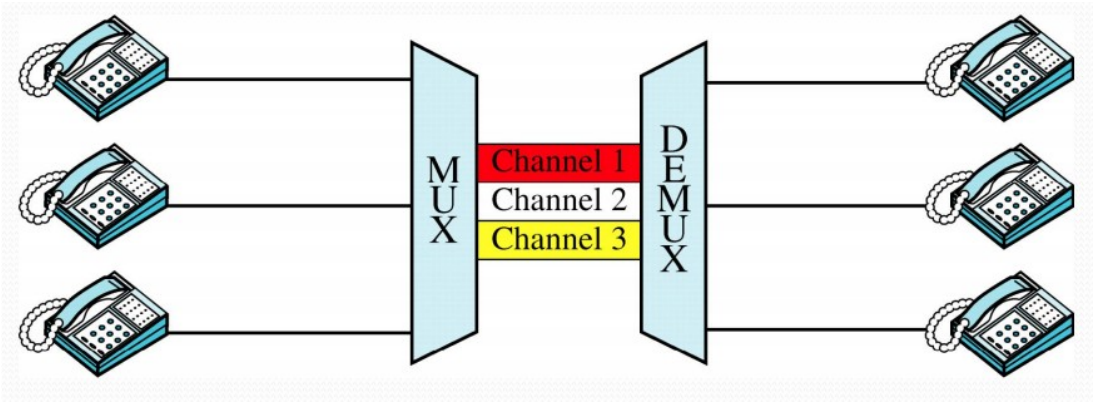
Multiplexing -TDM, FDM, WDM & DWDM Encoding techniques

- Multiplexing is the techniques that allows the simultaneous transmission of multiple signals across a single data link .
- As data and telecommunications use increases, so does traffic. The figure below shows the basic format of a multiplexed system.
- The lines on the left direct their transmission streams to a multiplexer (MUX), which combines them into a single stream (many-to one).
- At the receiving end, that stream is fed into a de-multiplexer (DEMUX), which separates the stream back into its component transmissions (one-to-many) and directs them to their corresponding lines.
- In the figure, the word link refers to the physical path.

- The word channel refers to the portion of a link that carries a transmission between a given pair of lines.
- One link can have many (n) channels.
- There are three basic multiplexing techniques:
    - frequency-division multiplexing,
    - wavelengthdivision multiplexing, and
    - time-division multiplexing.
- The first two techniques designed for analog signals, the third one is , for digital signals

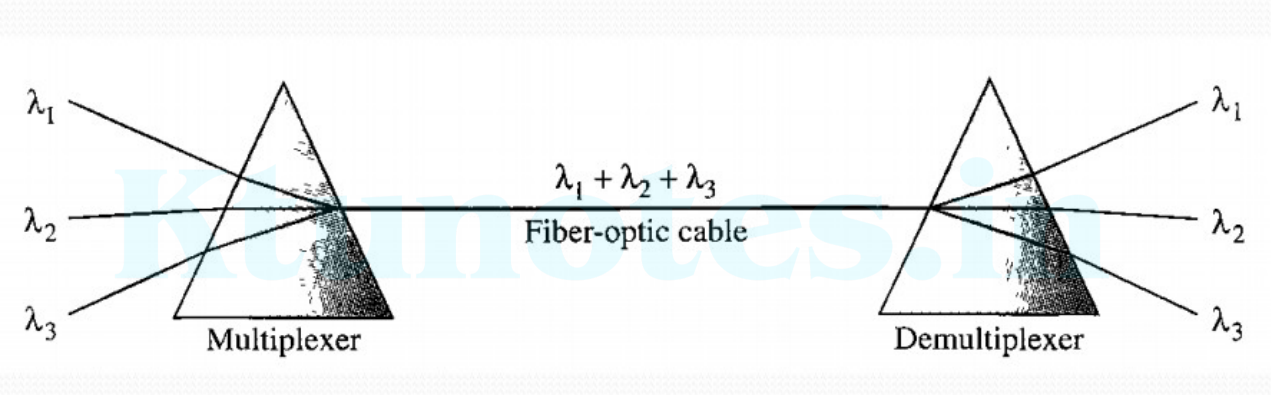
Frequency Division Multiplexing

- Useful bandwidth of medium exceeds required bandwidth of channel
- Each signal is modulated to a different carrier frequency
- Carrier frequencies separated so signals do not overlap (guard bands)
- e.g. broadcast radio
- Channel allocated even if no data



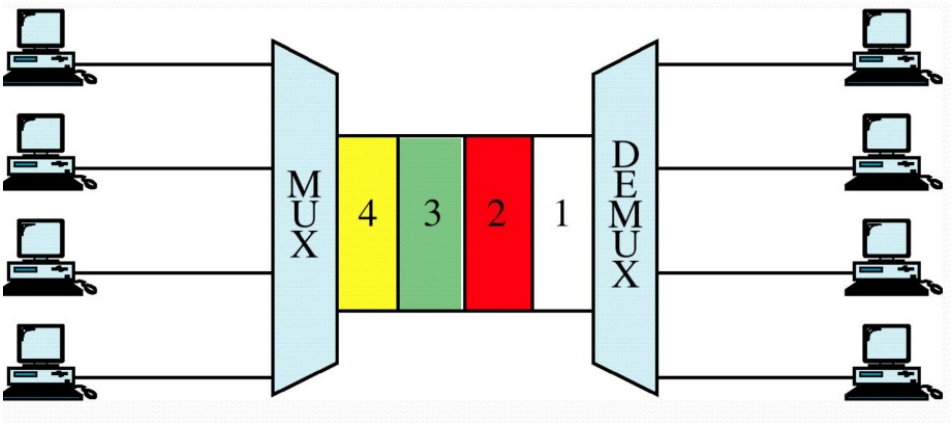
Wavelength Division Multiplexing

- WDM is an analog multiplexing technique.
- Working is same as FDM.
- In WDM different signals are optical or light signals that are transmitted through optical fiber.
- Various light waves from different sources are combined to form a composite light signal that is transmitted across the channel to the receiver.
- At the receiver side, this composite light signal is broken into different light waves by Demultiplexer.
- This Combining and the Splitting of light waves is done by using a PRISM.
- Prism bends beam of light based on the angle of incidence and the frequency of light wave.



Time Division Multiplexing

- It is the digital multiplexing technique.•
- Channel/Link is not divided on the basis of frequency but on the basis of time.
- Total time available in the channel is divided between several users.
- Each user is allotted a particular time interval called time slot or slice.
- In TDM the data rate capacity of the transmission medium should be greater than the data rate required by sending of receiving devices.

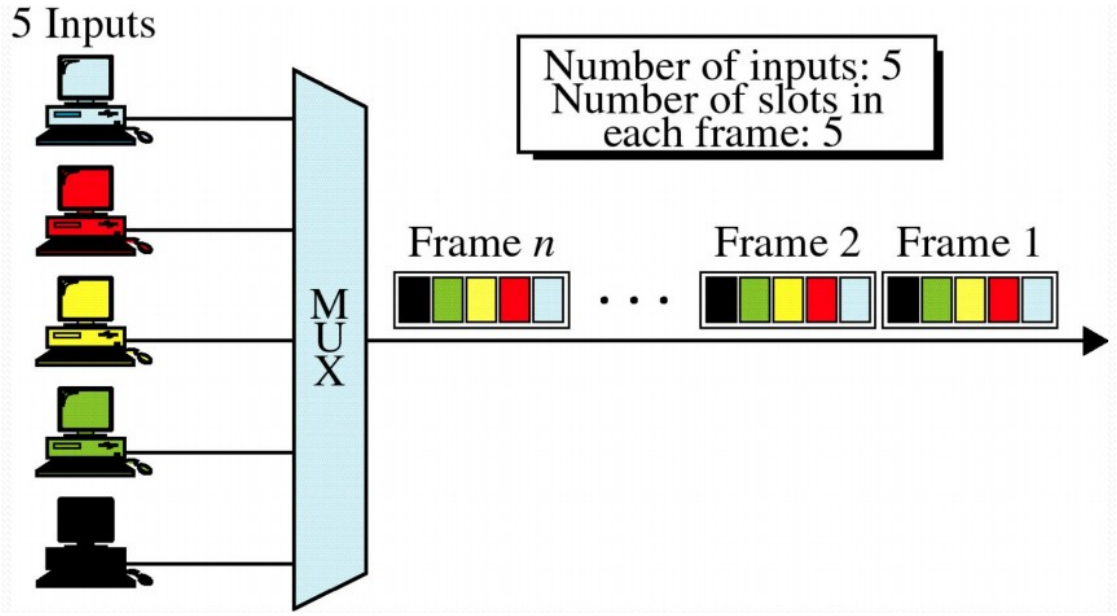


Types of TDM

- Synchronous TDM
- Asynchronous TDM

Synchronous TDM

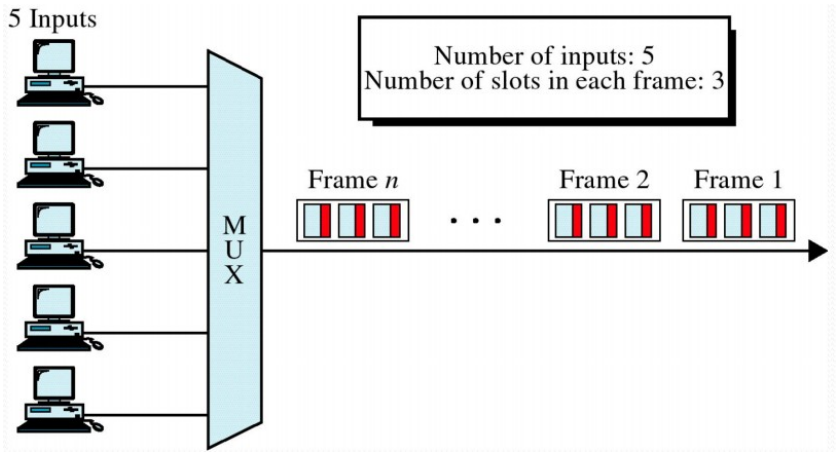
- Each device is given same Time Slot to transmit the data over the link, whether the device has any data to transmit or not.
- Each device places its data onto the link when its Time Slot arrives, each device is given the possession of line turn by turn.
- If any device does not have data to send then its time slot remains empty.
- Time slots are organized into Frames and each frame consists of one or more time slots.
- If there are n sending devices there will be n slots in frame.



Asynchronous TDM

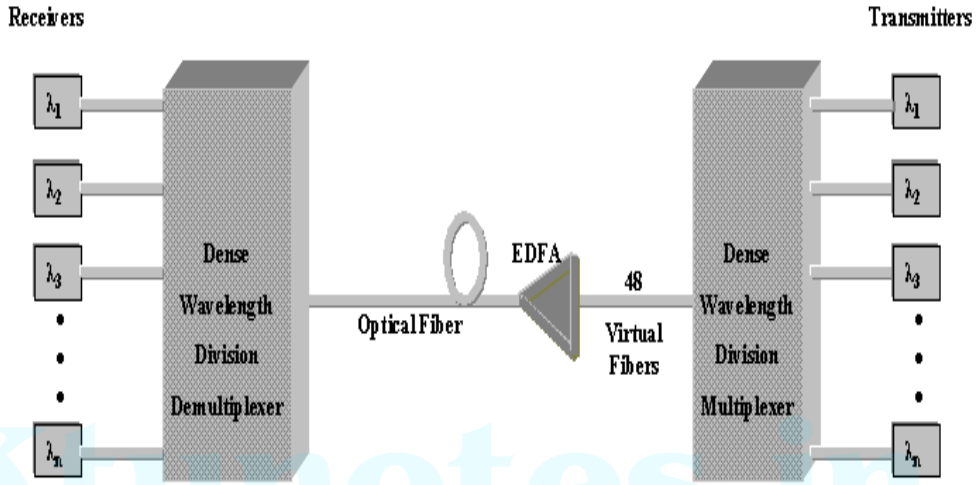
- Also known as Statistical Time Division multiplexing.
- In this time slots are not Fixed i.e. slots are Flexible.
- Total speed of the input lines can be greater than the capacity of the path.
- In ASTDM we have n input lines and m slots i.e. m less than n (m<n)

- Slots are not predefined rather slots are allocated to any of the device that has data to send.



DWDM

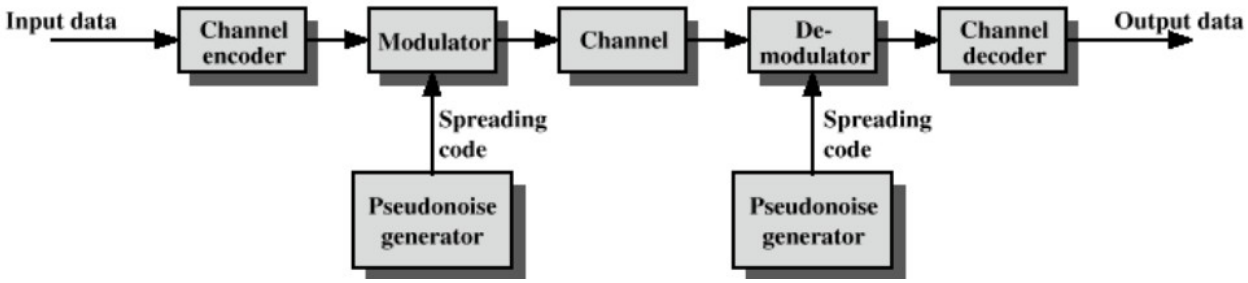
- It transmits multiple data signals using different wavelengths of light through a single fiber.
- Incoming optical signals are assigned to specific frequencies within a designated frequency band.
- The capacity of fiber is increased when these signals are multiplexed onto one fiber
- Transmission capabilities is 4-8 times of TDM Systems with the help of Erbium doped optical amplifier.



Spread spectrum

The concept of spread spectrum

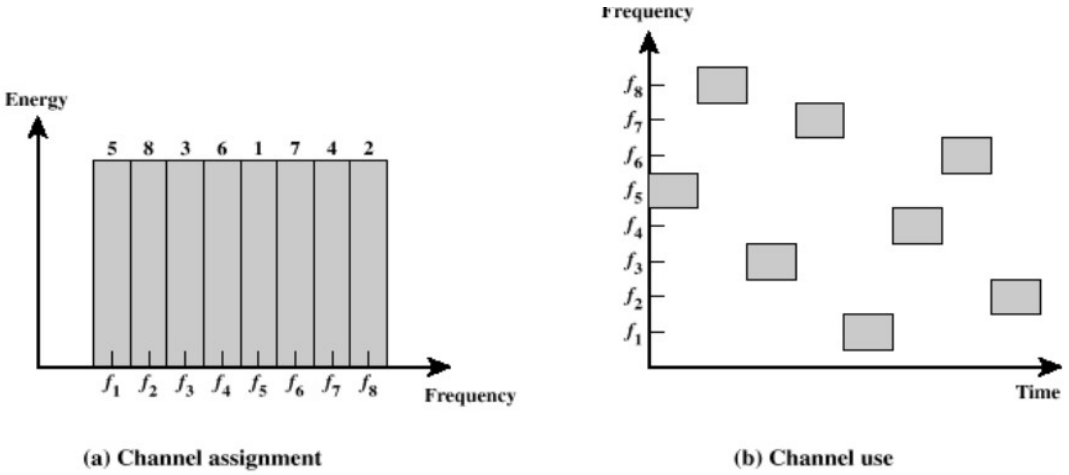
- Input is fed into a channel encoder
  - Produces analog signal with narrow bandwidth
- Signal is further modulated using sequence of digits
  - Spreading code or spreading sequence
  - Generated by pseudonoise, or pseudo-random number generator
- Effect of modulation is to increase bandwidth of signal to be transmitted
- On receiving end, digit sequence is used to demodulate the spread spectrum signal
- Signal is fed into a channel decoder to recover data



Frequency Hoping Spread Spectrum (FHSS)

- Signal is broadcast over seemingly random series of radioθ frequencies
    - A number of channels allocated for the FH signal
    - Width of each channel corresponds to bandwidth of input signal
- Signal hops from frequency to frequency at fixed intervals
    - Transmitter operates in one channel at a time
    - Bits are transmitted using some encoding scheme
    - At each successive interval, a new carrier frequency is selected

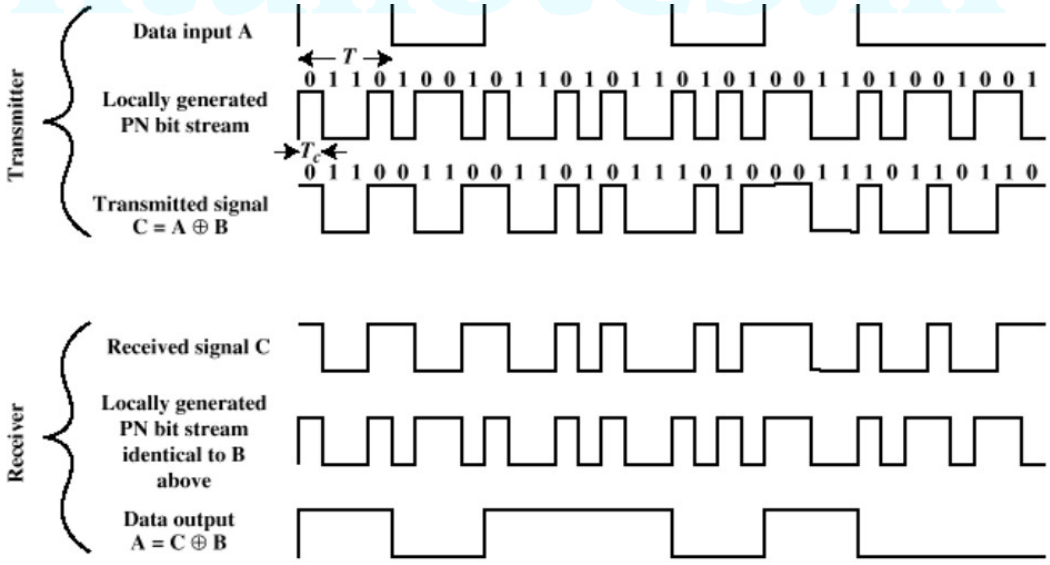
- Channel sequence dictated by spreading code
- Receiver, hopping between frequencies in synchronization with transmitter, picks up message
- Advantages
        - Eavesdroppers hear only unintelligible blips
        - Attempts to jam signal on one frequency succeed only at knocking out a few bits



(a) Channel assignment (b) Channel use

Direct Sequence Spread Spectrum (DSSS)

- Each bit in original signal is represented by multiple bits in the transmitted signal
    - Spreading code spreads signal across a wider frequency band
- Spread is in direct proportion to number of bits used
- One technique combines digital information stream with the spreading code bit stream using exclusive-OR



Code-Division Multiple Access (CDMA)

Basic Principles of CDMA

D = rate of data signal o Break each bit into k chips

Chips are a user-specific fixed pattern

Chip data rate of new channel = kD

Code Division Multiple Access (CDMA) is a sort of multiplexing that facilitates various signals to occupy a single transmission channel. It optimizes the use of available bandwidth. The technology is commonly used in ultra-high-frequency (UHF) cellular telephone systems, bands ranging between the 800-MHz and 1.9-GHz.

How Does CDMA Work?

CDMA allows up to 61 concurrent users in a 1.2288 MHz channel by processing each voice packet with two PN codes. There are 64 Walsh codes available to differentiate between calls and theoretical limits. Operational limits and quality issues will reduce the maximum number of calls somewhat lower than this value.

In fact, many different "signals" baseband with different spreading codes can be modulated on the same carrier to allow many different users to be supported. Using different orthogonal codes, interference between the signals is minimal. Conversely, when signals are received from several mobile stations, the base station is capable of isolating each as they have different orthogonal spreading codes.

The following figure shows the technicality of the CDMA system. During the propagation, we mixed the signals of all users, but by that you use the same code as the code that was used at the time of sending the receiving side. You can take out only the signal of each user.