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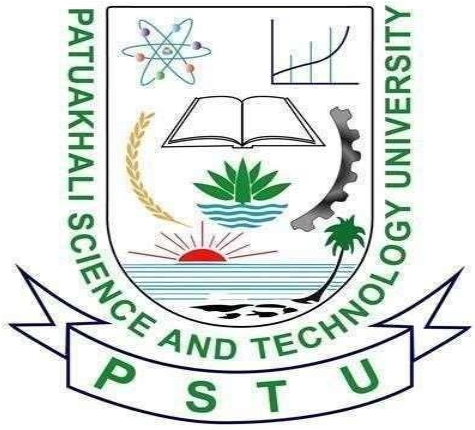

Course Code : CCE-211

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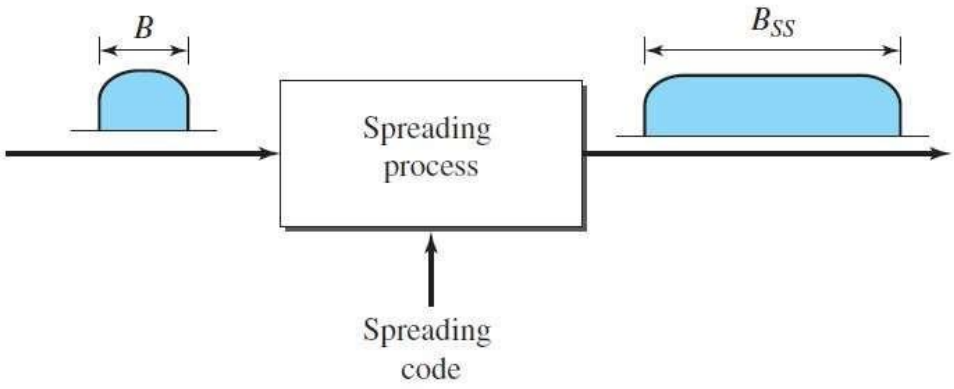
Spread spectrum

Spread spectrum is a method used in telecommunication and signal processing to spread the bandwidth of a signal over a broader range than the original signal.

If we say about the bandwidth, is expends the main bandwidth with larger bandwidth. Like it is covering the main data with an protective envelope.

But how does the bandwidth expand?

Ans: There is a spreading code that helps to expand the bandwidth. But there is no relationship between the main bandwidth and the spreading code. It just expands the main bandwidth.



Why should we use Spread spectrum?

Ans:

Resistance to Interference: Spread spectrum signals are more resilient to interference, both intentional (such as jamming) and unintentional (such as background noise). The spread signal is spread out across a wider bandwidth, making it less susceptible to narrowband interference.

Security: Spread spectrum communication can provide increased security by making it difficult for unauthorized users to intercept the signal. This is especially true for techniques like Frequency Hopping Spread Spectrum (FHSS), where the

transmitter and receiver synchronize their frequency hopping patterns using a predetermined sequence.

There are two techniques of spread spectrum. One is FHSS and DSSS.

Frequency Hopping Spread Spectrum (FHSS)

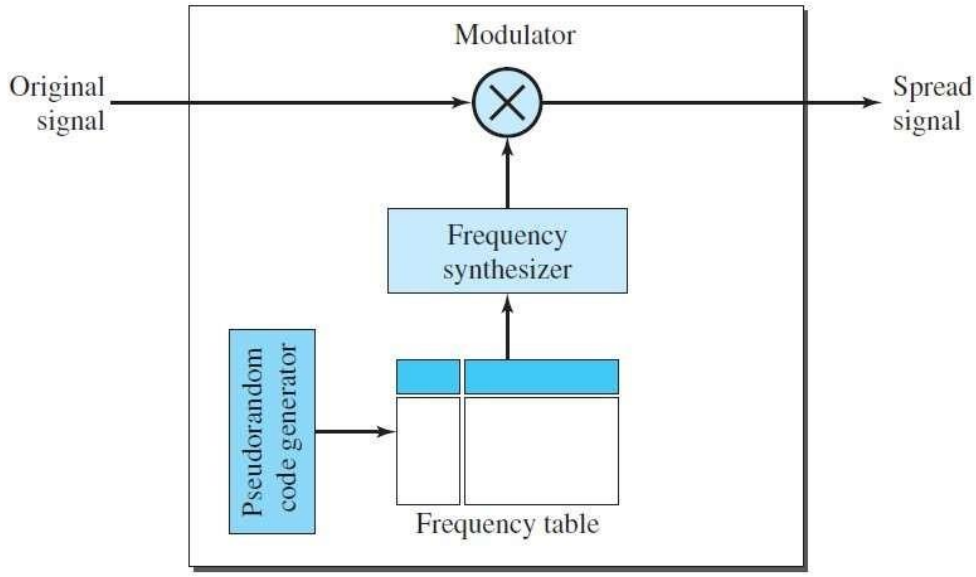
In this technique, FHSS uses M different carrier frequencies. But the question is how the carrier frequencies are generated and what is the connection between main data with carrier frequencies. There is a term modulator and Frequency synthesizer.

Frequency synthesizer: Frequency synthesizer mainly generates the carrier frequency. And pass it to modulator. We are not using the main bandwidth. The carrier frequencies are sent to the receiver. We will generate many carrier frequencies randomly so that the 3rd party user can't use the data at a time.

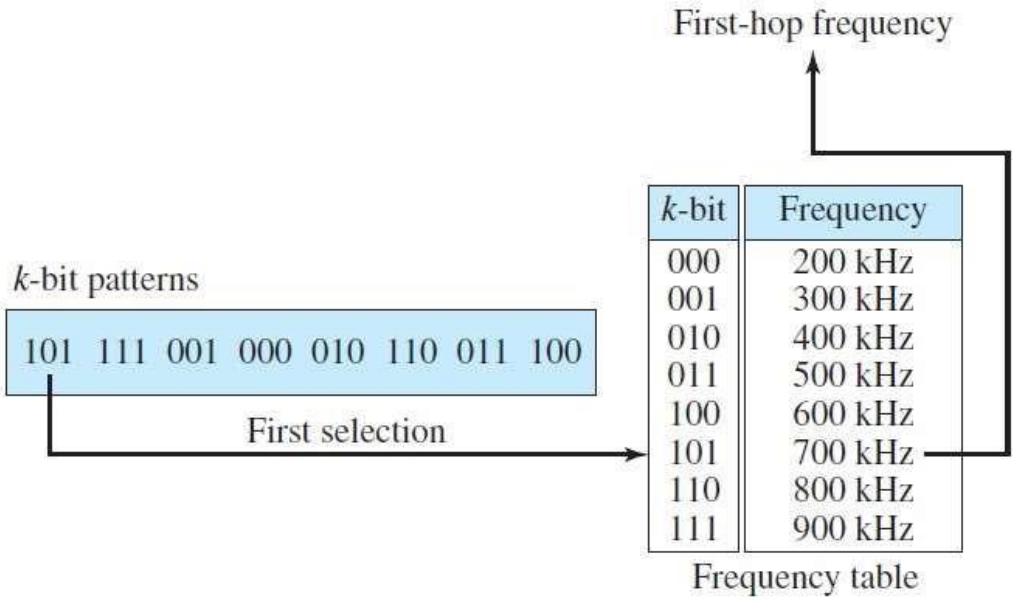
Modulator: This mixes the Carrier frequencies with the main bandwidth and produces a spread signal. So, the main signal can't be recognized anymore.

Pseudorandom code generator: It generates the bit patterns for the bandwidth and sends to Frequency table.

Frequency table: All the frequency randomly allocated in it. So, that the frequency synthesizer uses the frequency randomly.

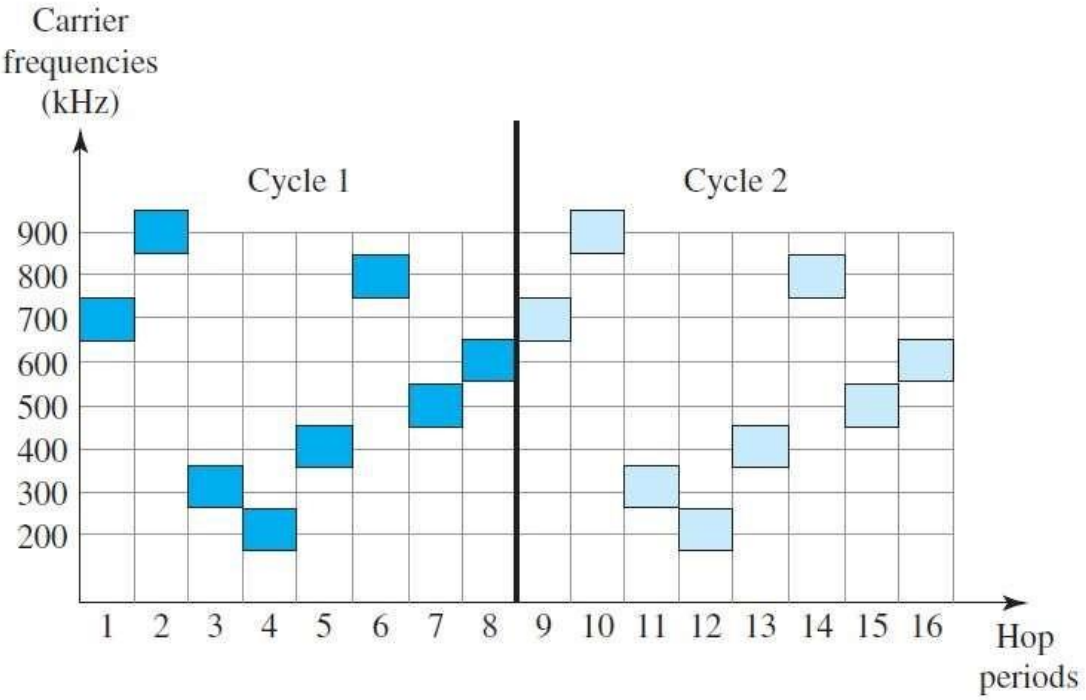


First the Original signal is sent to modulator. Pseudorandom code generator generates the random bits for random frequencies allocated in frequency table. The randomly selected bit is sent to frequency synthesizer. The synthesizer generates the carrier frequency and sends to modulator. Modulator mixes the original signal with the carrier frequency. Then the final signal is the spread signal.



In the frequency table there is the bit and allocated frequency for it. Pseudorandom code generator generates the bit pattern. For example, it generates the bit pattern 101,111,001,000,010,011,100. First the 101 is called and it carries 700KHz.This frequency is then sent to frequency carrier. Then the 111 bits is called with 900 KHz.

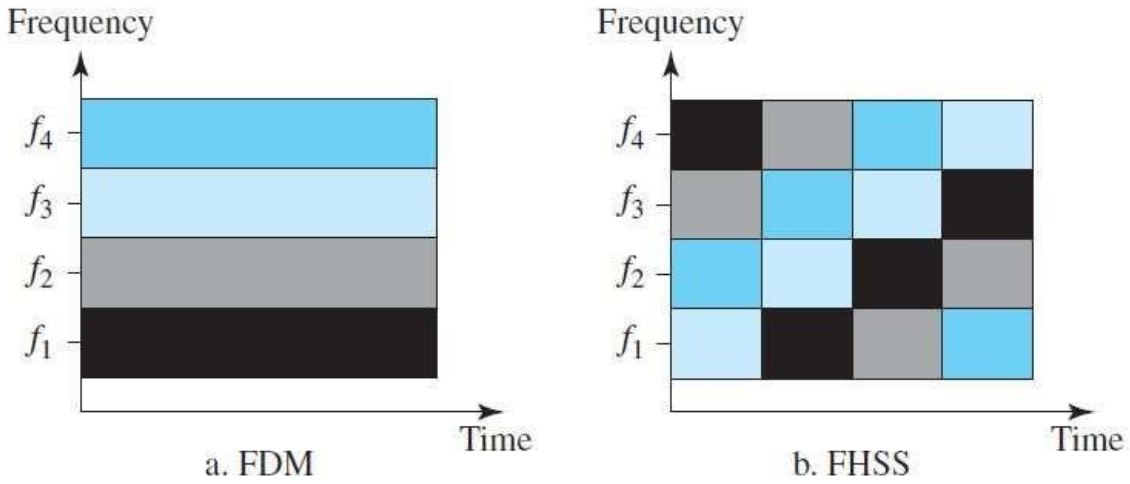
It can be shown that this scheme can accomplish the previously mentioned goals. If there are many k-bit patterns and the hopping period is short, a sender and receiver can have privacy.



If the first cycle of frequency is completed, it repeats the sequence again in long run. If there are 8 carrier frequencies the bits will be generated for per frequency $\log_2 8=3$ bits.

What is the difference between FDM and FHSS?

Ans:



Frequency Division Multiplexing (FDM):

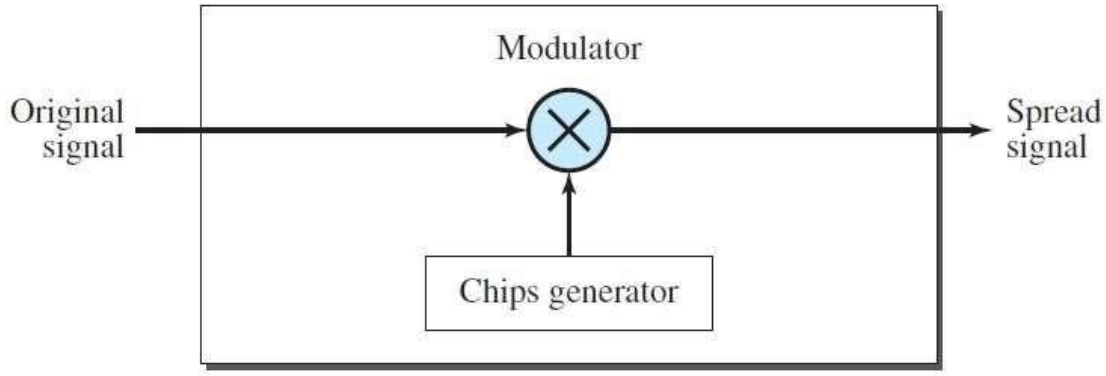
1. FDM is a multiplexing technique where multiple signals are combined for transmission over a single communication channel.
2. In FDM, each signal is allocated a separate, non-overlapping frequency band within the channel.
3. The combined signal consists of the individual signals modulated onto their respective carrier frequencies.
4. FDM is typically used in wired communication systems, such as cable television and some older telephone systems, where multiple signals need to be transmitted simultaneously over a shared medium.

Frequency Hopping Spread Spectrum (FHSS):

1. FHSS is a spread spectrum technique used to transmit a single signal over a wide bandwidth by rapidly switching the carrier frequency.
2. In FHSS, the transmitter and receiver hop between different frequencies according to a predetermined sequence.
3. The hopping sequence is synchronized between the transmitter and receiver to ensure proper reception of the signal.
4. FHSS offers advantages such as increased resistance to interference, improved security, and reduced susceptibility to jamming.
5. FHSS is commonly used in wireless communication systems, such as Bluetooth and some types of Wi-Fi, as well as in military applications where security and robustness are essential.

Direct sequence Spread Spectrum (DSSS)

Direct Sequence Spread Spectrum (DSSS) is a spread spectrum modulation technique used in digital communication systems. Unlike Frequency Hopping Spread Spectrum (FHSS), which rapidly changes the carrier frequency, DSSS spreads the signal over a wider bandwidth by multiplying it with a pseudorandom noise code sequence, known as a spreading code or spreading sequence.

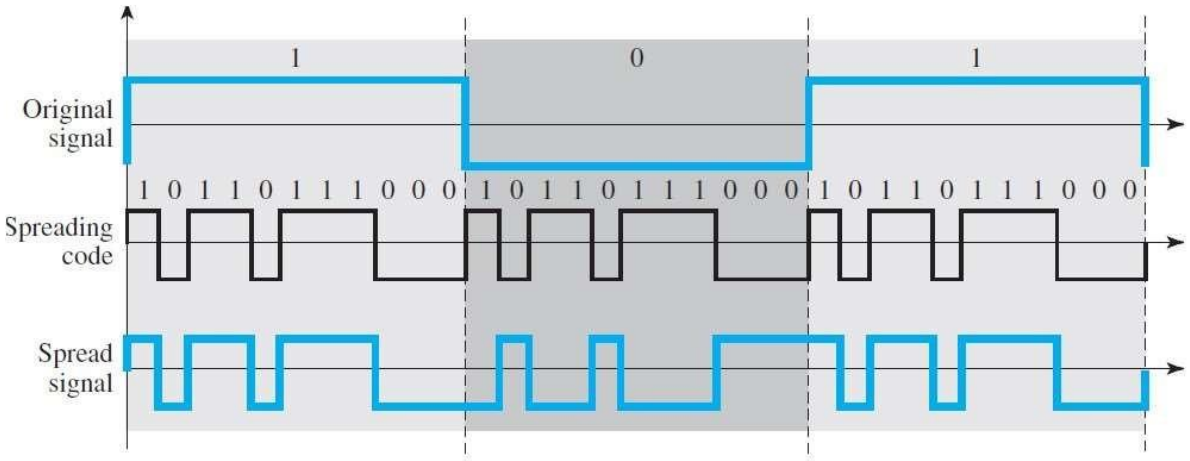


Spreading: The original digital data signal is modulated by multiplying it with a spreading code. This spreading code is a binary sequence with a much higher data rate than the original data signal.

Bandwidth Expansion: The spreading process expands the bandwidth of the signal. The spreading code effectively "spreads" the signal energy over a wider frequency range.

Transmission: The spread signal is transmitted over the communication channel.

Reception: At the receiver, the received signal is correlated with the same spreading code used at the transmitter.



Spreading Code: In your example, the spreading code is a sequence of 11 chips with the pattern 10110111000. This spreading code is applied to the original data signal.

Bandwidth Expansion: The spreading process expands the bandwidth of the signal. Since each chip of the spreading code corresponds to one bit of the original signal, the rate of the spread signal is 11 times the rate of the original signal.

Bandwidth Requirement: Because the spread signal has a higher data rate, it requires a wider bandwidth for transmission. The bandwidth of the spread signal is 11 times larger than the bandwidth of the original signal.