4.3 Code Division Multiple Access (CDMA)

In CDMA, the narrowband message signal is multiplied by a very large bandwidth signal called the spreading signal.

The spreading signal is a pseudo-noise code sequence that has a chip rate which is orders of magnitudes greater than the data rate of the message.

All users use the same carrier frequency and may transmit simultaneously as shown in figure 2.2.1.

Each user has its own pseudorandom code word which is approximately orthogonal to all other code words.

The receiver performs a time correlation operation to detect only the specific desired codeword. All other code words appear as noise due to decorrelation. The receiver needs to know the codeword used by the transmitter.

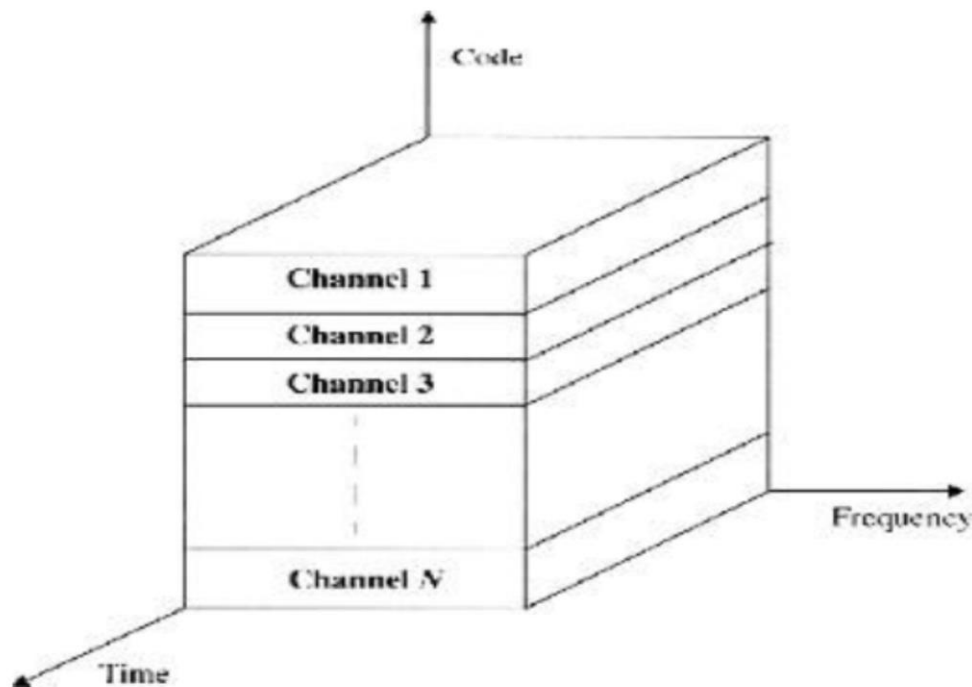Each user operates independently with no knowledge of the other users.

Fig 2.2.1: CDMA

[Source : "Wireless communications" by Theodore S. Rappaport,Page-406]

Near-far problem:

The near-far problem occurs when many mobile users share the same channel.

In general, the strongest received mobile signal will capture the demodulator at a base station.

In CDMA, stronger received signal levels raise the noise floor at the base station demodulators for the weaker signals, thereby decreasing the probability that weaker signals will be received.

The power of multiple users at a receiver determines the noise floor after decorrelation.

Power control:

Provided by each base station in a cellular system and assures that each mobile within the base station coverage area provides the same signal level to the base station receiver. This solves the problem of a nearby subscriber.

Over powering the base station receiver and drowning out the signals of far away subscribers.

Power control is implemented at the base station by rapidly sampling the radio signal strength indicator (RSSI)levels of each mobile and then sending a power change command over the forward radio link.

Features of CDMA:

Many users of a CDMA system share the same frequency. Either TDD or FDD may be used. Unlike TDMA or FDMA, CDMA has a soft capacity limit.

Increasing the number of users in a CDMA system raises the noise floor in a linear manner. Thus, there is no absolute limit on the number of users in CDMA.

Multipath fading may be substantially reduced because the signal is spread over a large spectrum. Channel data rates are very high in CDMA systems.

Consequently, the symbol (chip) duration is very short and usually much less than the channel delay spread. Since PN sequences have low autocorrelation, multipath which is delayed by more than a chip will appear as noise.

A RAKE receiver can be used to improve reception by collecting time delayed versions of the required signal.

Since CDMA uses co-channel cells, it can use macroscopic spatial diversity to provide soft handoff. Soft handoff is performed by the MSC, which can simultaneously monitor a particular user from two or more base stations.

The MSC may choose the best version of the signal at any time without switching frequencies.

Self-jamming is a problem in CDMA system.

Self-jamming arises from the fact that the spreading sequences of different users are not exactly orthogonal, hence in the despreading of a particular PN code, non- zero contributions to the receiver decision statistic for a desired user arise from the transmissions of other users in the system.

The near-far problem occurs at a CDMA receiver if an undesired user has a high detected power as compared to the desired user.