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Analysis of DSSS – CDMA System for Varying Number of Users

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Abstract
Performance of Direct sequence spread spectrum code division multiple Access (DSSS – CDMA) under the presence of multiple users is addressed in this Engineering report. A system model for DSSS – CDMA, Quasi-orthogonal spreading code is developed. This Engineering report shows that as more access the system simultaneously, the noise level and hence the error rate increases, only gradual does the system degrade to the point of an unacceptable error rate increases, only gradual does the system degrade to the point of an unacceptable error rate. This property makes it more desirable than frequency Division multiple Access and Time Division multiple Access in cellular network that most have a fixed number of users.

1.0 INTRODUCTION:

Following the success of cellular telephone services in the 1990s, the technical community has turned its attention to data transmission. Direct sequence spread spectrum code division multiple access (DSSS CDMA) is a system for which all users transmit in the same bandwidth (channel) simultaneously. In this transmission technique, the frequency spectrum of data-signal is spread using a pseudo random code which is unique to each user. This is the reason that a receiver which has knowledge about the code of the intended transmitter is capable of selecting the desired signal. Quasi-orthogonal codes cause self interference, which degrade the performance in most CDMA systems.

This report looks at the problem of interference resulting from the presence of multiple users in the same channel. The purpose of this work is to model and analyze a CDMA system while observing its response of a user 1 to change in the number of users. There has been little previous work on this topic. Some things that have been investigated include hear-far problem, accurate power control, tight synchronization analyse. We have taken a more general look at DSSS CDMA. Unlike most of the work done on this topic, our research is focused on the transmission of data as opposed to that of voice.

1.1 Code Division Multiple Access

CDMA is a form of spread-spectrum, a family of digital communications techniques that have been used in military applications for years. Originally there were two motivations for using CDMA: either to resist enemy efforts to jam the communications or to hide the fact that communication was even taken places.

The use of CDMA for civilian mobile radio applications was proposed 40 years ago, but did not take place till recently. In March 1992, the Telecommunications Industry Association (TIA) established the TR-45.5 subcommittee with the charter of developing a spread-spectrum digital cellular standard. In the July of 1993, the TIA gave its approval to the CDMA is 95 standard [1]. The system involved multiplying the required data with another data stream with a much higher data rate known as a spreading code; this widened the bandwidth required for the transmission, spreading it over a wide frequency band. Only when the original spreading code was used in the reconstruction of the data, would the original information be reconstituted. It was reasoned that by having different spreading codes, a multiple access system could be created for use in mobile phone system. In order to prove that the new system was viable a consortium was set up and Qualcomm was joined by US network operators Nynex and America Ameritech (1990) to develop the first experimental code division multiple access (CDMA) system.

Later the team was expanded as Motorola and AT & T (now incent joined to bring their resources to speed development. As a result the new standard was published as 15-95 in 1995 under the auspices of the cellular Telecommunications industry Association (CTIA) and the telecommunications industry Association (TIA). As a part of CDMA an organization called the CDMA Development. Group (CDG) was formed from the founding network and manufacturers. Its purpose is to promote CDMA and envolve the technology and standards, although today most of the standards work is carried out by 3GPP2.

1.2 Direct Sequence Spread Spectrum (DSSS)

In this technique, the PRN is applied directly to data entering the carrier modulator. The modulator therefore sees a much larger bit rate, which corresponds to the chip rate of the PRN sequence. The result of modulating an RF carrier with such a code sequence is to produce a direct-sequence modulated spread spectrum with $(C \text{ Sin } x)/x)^2$ frequency spectrum, centered at the carrier frequency. The main lobe of this spectrum (null to null) has a bandwidth twice the clock rate of the modulating code, and the side lobes have null-to-null bandwidths equal to the codes' clock rate. Illustrated below is the most common type of direct-sequence-modulated spread spectrum signal.

Direct-sequence spectra vary somewhat in spectral shape, depending on the actual carrier and data modulation used. Below is binary phase shift keyed (BPSK) signal, which is the most common modulation type used in direct sequence systems.

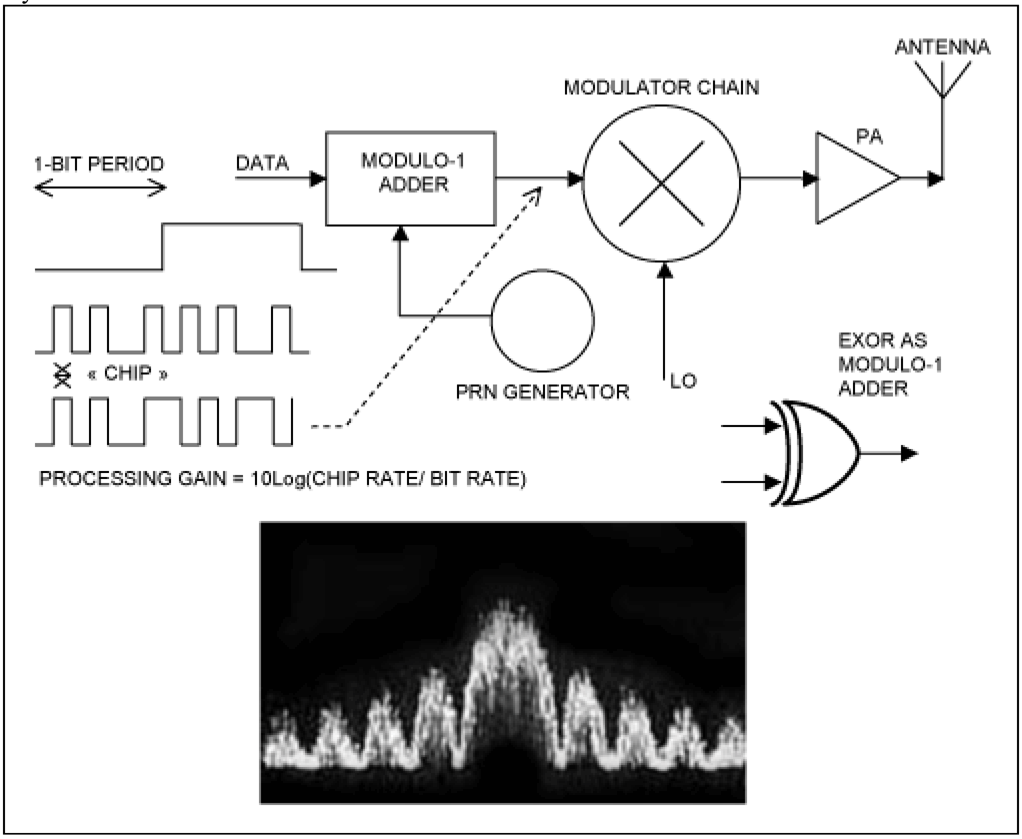

Figure 1.0: Spectrum – Analyzer of a DSSS Signal

1.3 Frequency Hopping Spread Spectrum (FHSS)

This method does exactly what its name implies; it causes the carrier to hop from frequency to frequency over a wide band according to a sequence defined by the PRN. The speed at which the hops are executed depends on the data rate of the original information, but one can distinguished between fast frequency Hopping (FFHSS) and low frequency Hopping (LFHSS). The latter method (the most common) allows several consecutive data bits to modulate the same frequency FFHSS, on the other hand, is characterized by several hops within each data bit. The transmitted spectrum of a frequency hopping signal is quite different from that of direct sequence system. Instead of a $(\sin x)/x)^2$ – shaped envelop, the frequency hopper's output is flat over the band of frequencies used (see below).

The band width of a frequency hopping signals is simply N time the number of frequency slots available, when N is the bandwidth of each hop channel.

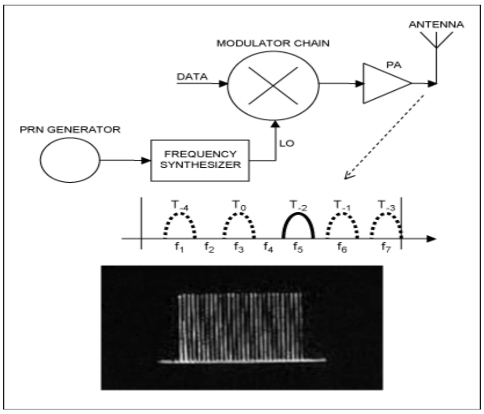

Figure 2.0: Spectrum Analyzer of a FHSS Signal

2.0 SPREAD SPECTRUM

Different SS (spread spectrum) technique are available, but all have one idea in common: the key (also called code or sequence) attached to the communication channel. The manner of inserting this code defines precisely the SS technique in question. The term "spread spectrum" refers to the expansion of signal band width, but several orders of magnitude in some cases, which occurs when a key is attached to the communication channel.

The formal definition of SS is more precise: spread spectrum is an RF communication system in which the base band signal bandwidth is intentionally spread over a larger bandwidth by injecting a higher frequency signal. As a direct consequence, energy used in transmitting the signal is spread over a wider bandwidth and appears as noise. The ratio (in dB) between the spread baseband and the original is processing gain. Typical SS processing gains run from 1odB to 60dB. To apply an SS technique, simply inject the corresponding SS code somewhere in the transmitting chain before the anterria. (That injecting is called the spreading operation) the effect is to diffuse the information in a (anger bandwidth, conversely, you can remove the SS code dispreading operation) at a point in the receival. The effect of a dispreading operation is to reconstitute the information in its original bandwidth. Obviously, the same code must be known in advance at both ends of the transmission channel (in some circumstances, it should be known only by those two parties).

2.1 Benefit of Spread Spectrum

There are many benefits to spread-spectrum technology. Resistance to interference is the most important advantage. Intentional or unintentional interference and jamming signal are rejected because they do not contain the spread spectrum key. Only the desired signal, which has key, will be seen at the receiver when the dispreading operation is exercised.

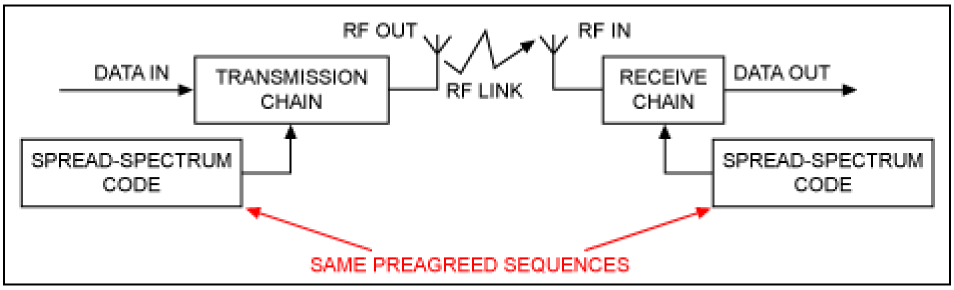

Fig. 3.0: A Spread Spectrum Communication System

2.2 Bandwidth Effect of Spreading Operation

Spread the signal energy over a wide frequency bandwidth.
SS modulation is applied on top of a conventional modulation such as BPSK or directed conversion. One can demonstrate that all other signals not receiving the SS code will stay as they are, unspread.

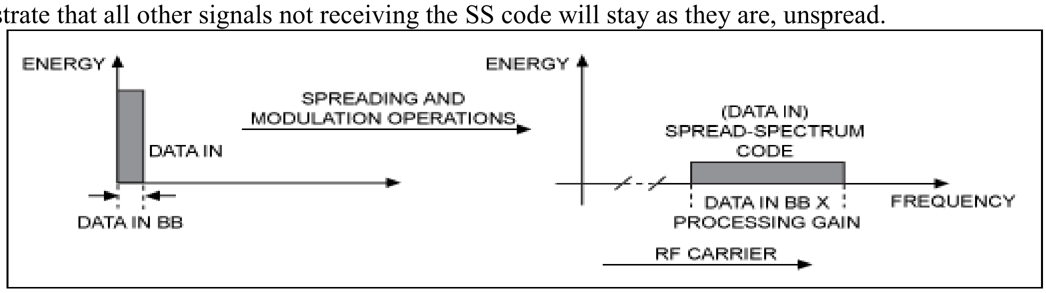

Fig 4.0: Spreading Operation

2.3 DSSS – CDMA System for a varying number of Users

% user accessing the system
User 1 = [1000110]
User 2 = 110100]
User 3 = [100100]
User 4 = [100010]
% to convert the binary sequence to bipolar NRZ format
Length user 1 = length (user 1);
Length user 1 = Length (user 1);
Length user 3 = Length (user 3);
Length user length (user 4)
User 1 = [100110] fori = 1 length user 1

If user 1 (i) = 0
User 1 (i) = 1;
end.

3.0 Summary and conclusions

When this work was initially started, the goal was to provide new insight into the understanding of DSSS – CDMA. This was not geared toward any system in particular. O system specific parameters were used in this work. Some very important result was obtained. We have learned that CDMA systems undergo a gradual degradation in signal to noise ratio as the number of users is increased.

4.0 REFERENCES

[1] CDMA Development Group (1999) CDMA Technology <htt://www.edg.org/framstech.html.
[2] Clark, George C. Jr. Cam. J Bibb Error – Correction coding for digital communications, plenum Press NY. 1981 p. 38.
[3] Clark, George C. Yr. Cam. J.B. Error-Correction coding for digital communication plenum Press.NY 1981 p. 219.
[4] CDMA Online (1999), CMDA online <http//wwwedmaonline
[5] Farugue, Saleh (1996) Cellular mobile Systems Engineering Norwood. MA Artech House.
[6] Famolari, David Parameter Optimization of CDMA System. Thesis Rutgers University, NJ January 1999.
[7] Peter E. Bandsbacher and Jeeffrey L. Kearns, "Transmission Parameter Selection and Adaptive packet-Radio Network Tactical Communication Conference. 1990 Vol 1, p.51-68, 1990.
[8] Metric System corporation (1999) Spread Spectrum http://www.metricsystem.com/technology.htm1.com>.
[9] Lee, W. (1991, May) Overview of Cellular CDMA. IEEE Transaction on Vehicle Technology, 04, 291-302.
[10] Thomas M. Cover and Joy A. Thomas, Elements of Information Theory.John Wiley and sons 1991.