



Spread Spectrum Wireless Technology

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Introduction

Analog mobile phones (Advanced Analog Phones System) are called first generation mobile communications systems. The second generation mobile communications systems—such as Global System for Mobile Communication (GSM), Code Division Multiple Access (CDMA) and IS-136—use digital technology to achieve better performance, quality, security, and spectral efficiency. Third generation (3G) mobile communications systems are expected to provide high quality global roaming capability for voice, data, Internet browsing, and multimedia applications.

Proposed 3G technology will utilize some form of spread spectrum technology in the converging wireless communication, data communication and Internet standards.

Spread spectrum, first developed by the military, became increasingly popular largely due to its interference tolerance and co-existence capabilities. Today spread spectrum outside the military-only realm, ranges from digital cellular phones and wireless PCs (for wide-area wireless applications) to wireless LANs (for local-area wireless data transmission).

This paper presents a multi-code technology, an improvement over CDMA.

What is Spread Spectrum?

Spread spectrum is a type of modulation that spreads data transmission across the available frequency band, in excess of the minimum bandwidth required to send the information. Spreading the data across the frequency spectrum makes the signal resistant to noise, interference and eavesdropping. Spread spectrum modulation schemes are commonly used with personal communication devices such as digital cellular phones, as well as with wireless local area networks.

Why Spread Spectrum?

Spread Spectrum has many different unique properties that cannot be found in any other modulation technique. Below outlines the advantages and disadvantages for a typical spread spectrum system. Bear in mind that these came about because of the nature of spread spectrum, not because they are direct attributes.

Advantages:

- Has the ability to eliminate or alleviate the effects of multipath interference;
- Can share the same frequency band (overlay) with other users;
- Provides privacy due to unknown random codes;
- Involves low power spectral density since signal is spread over a large frequency band.

Disadvantages:

- Bandwidth inefficient;
- Implementation is somewhat complex.

Types of Spread Spectrum Techniques

Two of the most popular techniques that provide spectrum spreading in a spread spectrum system are direct sequence and frequency hopping.

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Direct Sequence Spread Spectrum (DSSS)

This is probably the most widely recognized form of spread spectrum. A Direct Sequence Spread Spectrum transmitter converts an incoming data (bit) stream into a symbol stream where each symbol represents a group of one or more bits. Using a phase-varying modulation technique such as quadrature phase-shift keying (QPSK), the DSSS transmitter modulates or multiplies each symbol with a noise-like code called pseudorandom noise (PN) sequence. This is called a “chip” sequence. The multiplication operation in a DSSS transmitter artificially increases the used bandwidth based on the length of the chip sequence.

Frequency Hopping Spread Spectrum (FHSS)

As the name implies, the FHSS hops from narrow band to narrow band within a wide band. More specifically, FHSS radios send one or more data packets at one carrier frequency, hop to another frequency, send more data packets and continue this hop-transmit sequence. The hopping pattern or sequence appears random but is actually a periodic sequence tracked by sender and receiver. FHSS systems can be susceptible to noise during any one hop but typically can achieve transmission during other hops within the wideband.

Code Division Multiple Access

There are several unique properties that arise as a result of the pseudorandom noise sequence and the wide bandwidth that results from spreading. One of these is code division multiplexing. By assigning a given code to a single receiver or a group of receivers, they may be addressed individually or by group away from other receivers assigned a different code. Codes can also be chosen to minimize interference between groups of receivers by choosing ones that have low cross correlation properties. In this manner, more than one signal can be transmitted at the same time on the same frequency. CDMA is implemented via these codings. CDMA, commonly known as a cellular telephony technology, assigns a single code to each user in the network. The problems with CDMA are:

1. The “near-far” problem: a transmitter “near” the receiver sending a different code than the receiver’s desired code produces in the receiver a signal comparable with that of a “far” transmitter sending the desired code; and
2. Synchronization of the receiver and the transmitter is complex (especially if the receiver does not know in advance which code is being transmitted).

Multi-code Direct Sequence Spread Spectrum

Multi-code Direct Sequence Spread Spectrum (MC-DSSS), Wi-LAN’s patented technology (United States patent number 5,555,268) is a spectrally efficient spread spectrum modulation technique that assigns up to N DSSS codes to a single user where N is the number of chips per DSSS code. These N DSSS codes are all orthogonal. In other words, MC-DSSS enables multiple CDMA codes to be assigned to a single user in a CDMA network, thus increasing throughput. Conventional systems with a single user using three codes not only triple

the throughput but also triple the cost of having three full transceivers. In MC-DSSS implementation, the information on all codes can be decoded in a single transformation. The implementation of MC-DSSS has the following advantages:

1. It does not require the stringent synchronization DSSS requires: conventional DSSS systems required synchronization to within a fraction of a chip whereas MC-DSSS requires synchronization to within two chips;
2. It does not require the stringent carrier recovery DSSS requires: conventional DSSS requires the carrier at the receiver to be phase locked to the received signal whereas the MC-DSSS does not require phase locking the carriers. Commercially available crystals have sufficient stability for MC-DSSS; and
3. It is spectrally efficient.

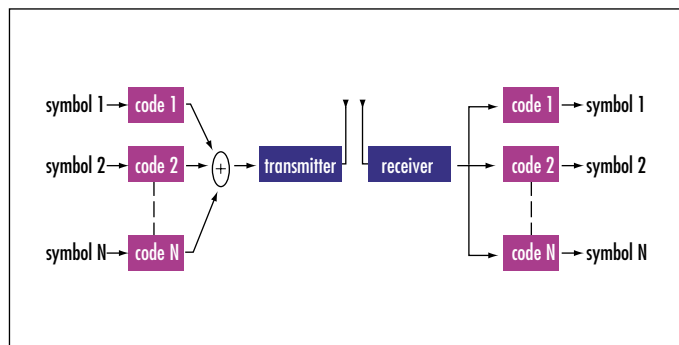


Figure 1. Implementation of MC-DSSS.

Summary

In the 21st century, we can expect to see the convergence of the Internet, wireless communications, and data communications. This convergence of services will revolutionize personal communications.

In October 1999, Wi-LAN filed an intellectual property (IP) statement with the International Telecommunication Union (ITU) offering to make MC-DSSS patented technology available for licensing on fair, reasonable and non-discriminatory terms. The IP statement targeted the ITU’s International Mobile Telecommunications (IMT-2000) standard, which is the foundation for 3G mobile radio networks, including cellular phones.

The IMT-2000 Initiative, the idea for a 3G wireless initiative, was driven by consumer demands for both mobile voice and data services that enable computing and Internet access irrespective of location.

Wi-LAN's IP statement is based on the company's belief that the IMT-2000 proposals under consideration for 3G standardization use Wi-LAN's MC-DSSS technology. The ITU received ten proposals for 3G systems, including Wi-LAN's MC-DSSS technology. Of the proposals received, all or most are based on CDMA technology.

Wi-LAN's MC-DSSS technology enables multiple CDMA codes to be assigned to a single user in a CDMA network, thus increasing throughput. Various proposed 3G standards use multiple codes per user.

MC-DSSS is a major improvement over CDMA and is the best technology choice for proposed 3G standards now being established.

