SYSTEMS AND METHODS FOR USING CODE SPACE IN SPREAD-SPECTRUM COMMUNICATIONS

CLAIM OF PRIORITY UNDER 35 U.S.C. §119 AND 35 U.S.C. §120

The present Application for Patent is a continuation and claims priority to patent application Ser. No. 10/783,771 filed Feb. 20, 2004 which claims priority to Provisional Application No. 60/452,790 filed Mar. 6, 2003, and Provisional Application No. 60/470,770 filed May 14, 2003, and are assigned to the assignee hereof and hereby expressly incorporated by reference herein.

BACKGROUND

1. Field

The present invention relates generally to telecommunications systems, and more specifically to systems and methods for using direct-sequence codes to spread data over a broad frequency spectrum.

2. Background

Wireless communication technologies are rapidly advancing, and wireless communication systems are utilized to provide a larger and larger portion of the communications capacity that is currently available to users. This is true despite the additional technological impediments that are faced in implementing a wireless communication system, as compared to a wireline system.

One type of wireless communication system comprises a cellular CDMA (code division multiple access) system that is configured to support voice and data communications. This system may have multiple base stations that communicate via wireless channels with multiple mobile stations. (The base stations are also typically coupled via wireline networks to various other systems, such as a public switched telephone network.) Each base station communicates with a set of mobile stations that are within a sector corresponding to the base station.

CDMA refers generally to a form of direct-sequence spread-spectrum communication. Spread-spectrum communication techniques are generally characterized by several features. One of these features is the fact that the spread-spectrum signal occupies much greater bandwidth than the minimum bandwidth that is actually necessary to send the transmitted data. The use of greater bandwidth provides a number of benefits, including greater immunity to interference and tolerance of access by multiple users. Another of the characterizing features is the fact that the spreading of the signal over greater bandwidth is accomplished by means of a spreading code that is independent of the data being transmitted. Another characterizing feature is the fact that the spread-spectrum receiver synchronizes itself with the spreading code in order to recover the transmitted data. The use of independent candidates and synchronous reception by receivers allows multiple users to utilize the system (and the same bandwidth) at the same time.

CDMA can be used to transmit various types of data, including digitized voice data, ISDN channels, modem data, and the like. This data is typically transmitted on one or more traffic channels and these traffic channels are combined and transmitted as a single CDMA channel. The traffic channels are typically selected to be orthogonal to each other so that interference from the other traffic channels is minimized. The steps involved in the transmission of a CDMA channel consist generally of error-control coding, interleaving, and modulating the data of each traffic channel, spreading each traffic channel by a code that produces orthogonal sequences of code channel symbols, combining the code channel symbols of the different traffic channels, covering the combined code channel symbols with a pseudorandom code at the chip rate, and filtering, amplifying, and transmitting the signal at the CDMA carrier frequency. Receiving the CDMA channel transmission consists generally of receiving and amplifying the signal, mixing the received signal with a local carrier in order to recover the spread-spectrum signal, generating a pseudorandom code identical to that used in transmission, correlating the signal with the pseudorandom code in order to extract the combined code channel symbols, correlating the sequence of combined code channel symbols with the orthogonal code for each traffic channel, and demodulating, deinterleaving, and error-control-decoding each traffic channel.

In one type of CDMA system, referred to as cdma2000, the particular codes that are utilized to spread the traffic channels comprise sequences that are known as Walsh codes. Walsh codes are useful in CDMA systems because, for example, these codes are orthogonal and therefore minimize interference between the other traffic channels from that user. The Walsh codes spread the sequences of modulated symbols on the traffic channels to obtain sequences of modulated symbols at up to the chip rate. The current cdma2000 system with a chip rate of 1,228,800 chips per second uses Walsh codes of 2^n symbols where n=2 to 7. A Walsh code of length 2^n uses a fraction $1/2^n$ of the total available Walsh space. For example, a length-4 Walsh code uses one fourth of the total Walsh space and all of the longer length Walsh codes derived from that length-4 Walsh code cannot be used to provide orthogonal sequences. Low-rate traffic channels with low modulation symbol rates can use long Walsh codes that only use a small fraction of the Walsh space without exceeding the maximum spread modulation symbol rate of 1,228,800 symbols per second. However, with high traffic channel data rates, short Walsh codes that use a large fraction of the Walsh space must be used. To obtain the best possible performance with high traffic channel data rates, it is important to use the Walsh space efficiently. The low-rate reverse link traffic channels that are currently defined for cdma2000 only utilize about one fourth of the available Walsh space and the Walsh space that they use is all derived from the same length-4 Walsh code. The cdma2000 system uses the remaining three fourths of the Walsh space for typically high-rate traffic channels. However, the cdma2000 system doesn't make the best use of this three fourths of the Walsh space at its highest data rates. When even higher data rates are used, there is an even more important need in the art for systems and methods for making maximum use of the remaining three fourths of the Walsh space, so that the additional Walsh space can be efficiently utilized to achieve the best possible system performance. This is true for cdma2000 systems, as well as for other types of wireless spread spectrum communication systems that use other types of codes.

A problem with efficiently using the available unused Walsh space is that the Walsh codes only use fractions of $1/2^n$ of Walsh space. So an approach for using three fourths of the Walsh space must be determined. One approach is to just use half of the Walsh space with a length-2 Walsh code. However, this would result is a lower data rate or a higher error-control code rate for the code channel, which is undesirable. Another approach would be to multiplex the high data rate traffic channel onto three length-4 Walsh codes. However, this results in a higher than necessary peak-to-average power ratio for the resulting Walsh spread traffic channel.