CANCELLATION OF PILOT AND UNWANTED TRAFFIC SIGNALS IN A CDMA SYSTEM

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates generally to digital communications. More specifically, the invention relates to a system and method which cancels the global pilot signal and unwanted traffic signals from a received code division multiple access signal thereby removing them as interferers prior to decoding.

Description of the Prior Art

Advanced communication technology today makes use of a communication technique in which data is transmitted with a broadened band by modulating the data to be transmitted with a pseudo-noise (pn) signal. The technology is known as digital spread spectrum or code divisional multiple access (CDMA). By transmitting a signal with a bandwidth much greater than the signal bandwidth, CDMA can transmit data without being affected by signal distortion or an interfering frequency in the transmission path.

Shown in Figure 1 is a simplified, single channel CDMA communication system. A data signal with a given bandwidth is mixed with a spreading code generated by a pn sequence generator producing a digital spread spectrum signal. The signal which carries data for a specific channel is known as a traffic signal. Upon reception, the data is reproduced after correlation with the same pn sequence used to transmit the data. Every other signal within the transmission bandwidth appears as noise to the signal being despread.

For timing synchronization with a receiver, an unmodulated traffic signal known as a pilot signal is required for every transmitter. The pilot signal allows respective receivers to synchronize with a given transmitter, allowing despreading of a traffic signal at the receiver.

In a typical communication system, a base station communicates with a plurality of individual subscribers fixed or mobile. The base station which transmits many signals, transmits a global pilot signal common to the plurality of users serviced by that particular base station at a higher power level. The global pilot is used for the initial acquisition of an individual user and for the user to obtain signal-estimates for coherent reception and for the combining of multipath components during reception. Similarly, in a reverse direction, each subscriber transmits a unique assigned pilot for communicating with the base station.

Only by having a matching pn sequence can a signal be decoded, however, all signals act as noise and interference. The global pilot and traffic signals are noise to a traffic signal being despread. If the global pilot and all unwanted traffic signals could be removed prior to despreading a desired signal, much of the overall noise would be reduced, decreasing the bit error rate and in turn, improve the signal-to-noise ratio (SNR) of the despread signal.

Some attempts have been made to subtract the pilot signal from the received signal based on the relative strength of the

pilot signal at the receiver. U.S. Patent No. 5,224,122 to Brackert discloses a spread-spectrum noise canceler which cancels a portion of spread-spectrum noise signal in the received signal by generating an estimated signal by spreading the known signal. Subsequently, the known signal is processed out of the received spread-spectrum signal by subtracting the estimated signal from the demodulated form of the received spread-spectrum signal. Where the estimated signals is generated based on the amplitude and the phase information of the known signals received from a base station in a primary serving cell, and the amplitudes information from the noise of multipath signal and the noise signal from a secondary serving cell. WO 98 43362 to Yellin et al. discloses a CDMA noise canceler by detecting at least one noisy user signal from a spread-spectrum signal and removing the noise of pilot signal and its interference effect the particular user signal. However, the strength value is not an accurate characteristic for calculating interference due to the plurality of received signals with different time delays caused by reflections due to terrain. Multipath propagation makes power level estimates unreliable.

There is a need to improve overall system performance by removing multiple noise contributors from a signal prior to decoding.

Summary of Invention

According to the first aspect of the invention, there is provided an apparatus for code division multiple access (CDMA) wireless communication comprising: a receiver configured to receive a CDMA signal that includes a desired traffic signal and a second signal, the desired traffic signal being spread with a desired traffic spreading code and the second signal being spread with a second spreading code; means for generating a second signal cancellation component including means for generating a second signal strength by despreading the CDMA signal based on the second spreading code; means for generating a second signal cancellation factor by selectively combining the second signal spreading code and the desired traffic spreading code; and means for combining the second signal strength and the second signal cancellation factor to generate the second signal cancellation component; means for generating a despread desired traffic signal by despreading the CDMA signal based on the desired traffic spreading code; and means for combining the despread desired traffic signal and the second signal cancellation component to cancel second signal noise from the despread desired traffic signal.

According to the second aspect of the invention, there is provided an apparatus for code division multiple access (CDMA) wireless communication comprising: a receiver configured to receive a CDMA signal that includes a desired traffic signal and a plurality of other known signals, the desired traffic signal being spread with a desired traffic spreading code and each of the other known signals being spread with a respective known spreading code; means for generating respective known signal cancellation components including for each respective known signal: means for generating a respective signal strength by despreading the CDMA signal based on the respective known spreading code; means for generating a respective known signal cancellation factor by selectively combining the respective known spreading code and the desired traffic spreading code; and means for combining the respective known signal strength and the respective known signal cancellation factor to generate the respective known signal cancellation component;

means for generating a despread desired traffic signal by despreading the CDMA signal based on the desired traffic spreading code; and means for combining the despread desired traffic signal and the respective known signal cancellation components to cancel pilot signal noise from the despread desired traffic signal.

According to the third aspect of the invention, there is provided a method of code division multiple access (CDMA) wireless communication comprising: receiving a CDMA signal that includes a desired traffic signal and a second signal, the desired traffic signal being spread with a desired traffic spreading code and the second signal being spread with a second spreading code; generating a second signal cancellation component including generating a second signal strength by despreading the CDMA signal based on the second spreading code; generating a second signal cancellation factor by selectively combining the second signal spreading code and the desired traffic spreading code; and combining the second signal strength and the second signal cancellation factor to generate the second signal cancellation component; generating a despread desired traffic signal by despreading the CDMA signal based on the desired traffic spreading code; and combining the despread desired traffic signal and the second signal cancellation component to cancel second signal noise from the despread desired traffic signal.

According to the fourth aspect of the invention, there is provided a method for code division multiple access (CDMA) wireless communication comprising: receiving a CDMA signal that includes a desired traffic signal and a plurality of other known signals, the desired traffic signal being spread with a desired traffic spreading code and each of the other known signals being spread with a respective known spreading code; generating respective known signal cancellation components including for each respective known signal: generating a respective signal strength by despreading the CDMA signal based on the respective known spreading code; generating a respective known signal cancellation factor by selectively combining the respective known spreading code and the desired traffic spreading code; and combining the respective known signal strength and the respective known signal

cancellation factor to generate the respective known signal cancellation component; generating a despread desired traffic signal by despreading the CDMA signal based on the desired traffic spreading code; and combining the despread desired traffic signal and the respective known signal cancellation components to cancel pilot signal noise from the despread desired traffic signal.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a simplified block diagram of a prior art, CDMA communication system.

Figure 2A is a detailed block diagram of a B-CDMA™ communication system.

Figure 2B is a detailed system diagram of a complex number multiplier.

Figure 3A is a plot of an in-phase bit stream.

Figure 3B is a plot of a quadrature bit stream.

Figure 3C is a plot of a pseudo-noise (pn) bit sequence.

Figure 4 is a block diagram of a global pilot signal cancellation system according to the present invention.

Figure 5 is a block diagram of an unwanted traffic signal(s) cancellation system according to the present invention.

Figure 6 is a diagram of a received symbol p_o on the QPSK constellation showing a hard decision.

Figure 7 is a block diagram of a combined pilot and unwanted traffic signal cancellation system according to the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The preferred embodiments will be described with reference to the drawing figures where like numerals represent like elements throughout.

A B-CDMA™ communication system 17 as shown in Figure 2 includes a transmitter 19 and a receiver 21, which may reside in either a base station or a mobile user receiver. The

transmitter 19 includes a signal processor 23 which encodes voice and nonvoice signals 25 into data at various bit rates.

By way of background, two steps are involved in the generation of a transmitted signal in a multiple access environment. First, the input data which can be considered a bi-phase modulated signal is encoded using forward error-correcting coding (FEC) 27. One signal is designated the in-phase channel I 33x. The other signal is designated the quadrature channel Q 33y. Bi-phase modulated I and Q signals are usually referred to as quadrature phase shift keying (QPSK).

In the second step, the two bi-phase modulated data or symbols 33x, 33y are spread with a complex, pseudo-noise (pn) sequence 35I, 35Q using a complex number multiplier 39. The operation of a complex number multiplier 39 is shown in Figure 2B and is well understood in the art. The spreading operation can be represented as:

$$(x+jy) \times (I+jQ) = (xI-yQ) + j(xQ+yI) \qquad \text{Equation (1)}$$
$$= a+jb.$$

A complex number is in the form $a+jb$, where a and b are real numbers and $j^2=-1$. Referring back to Figure 2a, the resulting I 37a and Q 37b spread signals are combined 45a, 45b with other spread signals (channels) having different spreading codes, multiplied (mixed) with a carrier signal 43,

and transmitted 47. The transmission 47 may contain a plurality of individual signals.

The receiver 21 includes a demodulator 49a, 49b which mixes down the transmitted broadband signal 47 with the transmitting carrier 43 into an intermediate carrier frequency 51a, 51b. A second down conversion reduces the signal to baseband. The QPSK signal 55a, 55b is then filtered 53 and mixed 56 with the locally generated complex pn sequence 35I, 35Q which matches the conjugate of the transmitted complex code. Only the original signals which were spread by the same code will be despread. All other signals will appear as noise to the receiver 21. The data 57x, 57y is coupled to a signal processor 59 where FEC decoding is performed on the convolutionally encoded data.

As shown in Figures 3A and 3B, a QPSK symbol consists of one bit each from both the in-phase (I) and quadrature (Q) signals. The bits may represent a quantized version of an analog sample or digital data. It can be seen that symbol duration t_s is equal to bit duration.

The transmitted symbols are spread by multiplying the QPSK symbol stream by the complex pn sequence. Both the I and Q pn sequences are comprised of a bit stream generated at a much higher frequency, typically 100 to 200 times the symbol rate. One such pn sequence is shown in Figure 3C. The complex pn sequence is mixed with the symbol bit stream producing the digital spread signal (as previously discussed).

The components of the spread signal are known as chips having a much smaller duration t_c.

When the signal is received and demodulated, the baseband signal is at the chip level. When the I and Q components of the signal are despread using the conjugate of the pn sequence used during spreading, the signal returns to the symbol level.

The embodiments of the present invention are shown in Figures 4, 5 and 7. The global pilot signal cancellation system 61 embodiment is shown in Figure 4. A received signal r is expressed as:

$$r = \propto c_p + \beta c_t + n \qquad \text{Equation (2)}$$

where the received signal r is a complex number and is comprised of the pilot strength $\propto$ multiplied with the pilot code c_p, summed with the traffic strength β multiplied with the traffic code c_t, summed with random noise n. The noise n includes all received noise and interference including all other traffic signals. To cancel the global pilot signal from the received signal r, the system 61 must derive the signal strength of the pilot code $\propto$ where:

$$\propto \neq \beta \qquad \text{Equation (3)}$$

since the global pilot is transmitted at a higher power level than a traffic signal.

When the received signal r is summed over time, Equation (2) becomes:

$$\Sigma r = \alpha \Sigma c_p + \beta \Sigma c_\ell + \Sigma n. \qquad \text{Equation (4)}$$

Referring to Figure 4, the received baseband signal r is input 63 into the pilot signal cancellation system 61 and into a pilot despreader 65 which despreads the pilot signal from the received signal r. First mixer 67 despreads the received signal r by multiplying with the complex conjugate c_p^* 69 of the pilot pn code used during spreading yielding:

$$\Sigma r c_p^* = \alpha \Sigma c_p c_p^* + \beta \Sigma c_\ell c_p^* + \Sigma n c_p^*. \qquad \text{Equation (5)}$$

A complex conjugate is one of a pair of complex numbers with identical real parts and with imaginary parts differing only in sign.

The despread pilot signal 71 is coupled to a first sum and dump processor 73 where it is summed over time. The first sum and dump 73 output O_{sd1} is:

$$O_{sd1} = \alpha L + \beta \Sigma c_\ell c_p^* + \Sigma n c_p^* \qquad \text{Equation (6)}$$

where L is the product of the pilot spreading code c_p and the complex conjugate of the pilot spreading code c_p^* summed over L chips.

The sum and dump 73 output O_{sd1} is coupled to a low pass filter 75. The low pass filter 75 determines the mean value for each signal component. The mean value for pilot-traffic cross-correlation is zero and so is the mean value of the noise n. Therefore, after filtering 75, the second and third terms in Equation (6) become zero. The low pass filter 75 output O_{lpf} over time is:

$$O_{lpf} = \propto L. \qquad \text{Equation (7)}$$

The low pass filter 75 output O_{lpf} is coupled to a processing means 77 to derive the pilot code strength $\propto$. The processing means 77 calculates $\propto$ by dividing the low pass filter 79 output O_{lpf} by L. Thus, the processing means 77 output O_{pm} is:

$$O_{pm} = \propto. \qquad \text{Equation (8)}$$

The pilot spreading code c_p^* complex conjugate generator 69 is coupled to a complex conjugate processor 79 yielding the pilot spreading code c_p. The pilot spreading code c_p is input to a second mixer 81 and mixed with the output of a traffic spreading code c_t^* complex conjugate generator 83. The resulting product from the second mixer 81 output is coupled to a second sum and dump processor 85. The output O_{sd2} of the

second sum and dump processor 85 is $\sum c_p c_t^*$ and is combined with $\propto$ at a third mixer 87. The third mixer 87 output 89 is $\propto \sum c_p c_t^*$.

The received signal r is also despread by traffic despreader 91. The traffic despreader 91 despreads the received signal r by mixing the received signal r with the traffic code c_t^* complex conjugate generator 83 using a fourth mixer 93 yielding:

$$\Sigma r c_t^* = \propto \Sigma c_p c_t^* + \beta \Sigma c_t c_t^* + \Sigma n c_t^*. \qquad \text{Equation (9)}$$

The traffic despreader 91 output 95 is coupled to a third sum and dump 97. The third sum and dump 97 output O_{sd3} over time is:

$$O_{sd3} = \Sigma r c_t^* = \beta L + \propto \Sigma c_p c_t^* + \Sigma n c_t^* \qquad \text{Equation (10)}$$

where L is the product of the traffic spreading code c_t and the complex conjugate of the traffic spreading code c_t^* summed over L chips.

The third sum and dump 97 output O_{sd3} is coupled to an adder 99 which subtracts the third mixer 87 output 89. The adder 99 output O_{add} is:

$$O_{add} = \beta L + \propto \Sigma c_p c_t^* + \Sigma n c_t^* - \propto \Sigma c_p c_t^*. \qquad \text{Equation (11)}$$

Thus, the pilot canceler 61 output O_{add} is equal to the received signal r minus the pilot signal simplified below:

$$O_{add} = \beta L + \Sigma n c_t^*. \qquad \text{Equation (12)}$$

The invention uses a similar approach to cancel unwanted traffic signal(s) from a desired traffic signal. While traffic signals are interference to other traffic signals just as the global pilot signal is, unwanted traffic signal cancellation differs from global pilot signal cancellation since a traffic signal is modulated by the data and is therefore dynamic in nature. A global pilot signal has a constant phase, whereas a traffic signal constantly changes phase due to data modulation.

The traffic signal canceler system 101 embodiment is shown in Figure 5. As above, a received signal r is input 103 to the system:

$$r = \psi d c_d + \beta c_t + n \qquad \text{Equation (13)}$$

where the received signal r is a complex number and is comprised of the traffic code signal strength ψ multiplied with the traffic signal data d and the traffic code c_d for the unwanted traffic signal to be canceled, summed with the desired traffic code strength β multiplied with the desired traffic code c_t, summed with noise n. The noise n includes all received noise and interference including all other traffic

signals and the global pilot signal. To cancel the unwanted traffic signal(s) from the received signal r, the system 101 must derive the signal strength of the unwanted traffic code ψ to be subtracted and estimate the data d, where:

$$\psi \neq d \neq \beta. \qquad \text{Equation (14)}$$

When the received signal r is summed over time, Equation 13 can be expressed as:

$$\Sigma r = \psi d \Sigma c_d + \beta \Sigma c_t + \Sigma n. \qquad \text{Equation (15)}$$

Referring to Figure 5, the received baseband signal r is input 103 into the desired traffic signal despreader 91 which despreads the desired traffic signal from the received signal r. Desired traffic signal mixer 93 mixes the received signal r with the complex conjugate c_t^* of the desired traffic pn code used during spreading. The despread traffic signal is coupled to a sum and dump processor 97 and summed over time. The sum and dump 97 output O_{sd3} is:

$$O_{sd3} = \Sigma r c_t^* = \beta L + \psi\, d \Sigma c_d c_t^* + \Sigma n c_t^*. \qquad \text{Equation (16)}$$

The traffic signal canceler system 101 shown in Figure 5 includes n unwanted traffic signal cancelers 115_1-115_n. An

exemplary embodiment includes 10 (where n=10) unwanted traffic signal cancelers 115_1-115_{10}.

Each unwanted traffic signal canceler 115_1-115_n comprises: an unwanted traffic signal despreader 139_1-139_n that includes a first mixer 117_1-117_n and an unwanted traffic signal code generator 119_1-119_n; second 133_1-133_n mixer, first 121_1-121_n and second 123_1-123_n sum and dump processors, a hard decision processor 125_1-125_n, a low pass filter 127_1-127_n, a processing means 129_1-129_n, third mixer 131_1-131_n, a conjugate processor 135_1-135_n, an adjustable amplifier 137_1-137_n, and a desired traffic signal code generator 83.

As above, the received signal r is input 103 into each unwanted traffic canceler 115_1-115_n. The unwanted traffic signal despreader 139_1-139_n is coupled to the input 103 where the received signal r is mixed 117_1-117_n with the complex conjugate c_{dI}^*-c_{dn}^* of the traffic pn sequence for each respective unwanted signal. The despread 139_1-139_n traffic signal is coupled to a first sum and dump processor 121_1-121_n where it is summed over time. The first sum and dump 121_1-121_n output O_{sdIn} is:

$$O_{sdIn} = \Sigma r c_{dn}^* = \psi\, dL + \beta \Sigma c_\ell c_{dn}^* + \Sigma n c_{dn}^*. \qquad \text{Equation (17)}$$

where L is the product of the unwanted traffic signal spreading code c_{dn} and c_{dn}^* is the complex conjugate of the unwanted traffic signal spreading code.

The first sum and dump 121_1-121_n output O_{cdln} is coupled to the hard decision processor 125_1-125_n. The hard decision processor 125_1-125_n determines the phase shift ϕ in the data due to modulation. The hard decision processor 125_1-125_n also determines the QPSK constellation position d that is closest to the despread symbol value.

As shown in Figure 6, the hard decision processor 125_1-125_n compares a received symbol p_o of a signal to the four QPSK constellation points $x_{1,1}$, $x_{-1,1}$, $x_{-1,-1}$, $x_{1,-1}$. It is necessary to examine each received symbol p_o due to corruption during transmission 47 by noise and distortion, whether multipath or radio frequency. The hard decision processor computes the four distances d_1, d_2, d_3, d_4 to each quadrant from the received symbol p_o and chooses the shortest distance d_2 and assigns that symbol d location $x_{-1,1}$. The hard decision processor also derotates (rotates back) the original signal coordinate p_o by a phase amount ϕ that is equal to the phase corresponding to the selected symbol location $x_{-1,1}$. The original symbol coordinate p_o is discarded.

The hard decision processor 125_1-125_n phase output ϕ is coupled to a low pass filter 127_1-127_n. Over time, the low pass filter 127_1-127_n determines the mean value for each signal component. The mean value of the traffic-to-traffic cross-correlation and also the mean value of the noise n are

zero. Therefore, the low pass filter 127_1-127_n output O_{lpfn} over time is:

$$O_{lpfn} = \psi L. \qquad \text{Equation (18)}$$

The low pass filter 127_1-127_n output O_{lpfn} is coupled to the processing means 129_1-129_n to derive the unwanted traffic signal code strength ψ. The processing means 129_1-129_n estimates ϕ by dividing the filter 127_1-127_n output O_{lpfn} by L.

The other hard decision processor 125_1-125_n output is data d. This is the data point d corresponding to the smallest of the distances d_1, d_2, d_3, or d_4 as shown in Figure 6. Third mixer 131_1-131_n mixes the unwanted traffic signal strength ψ with each date value d.

The unwanted traffic signal spreading code complex conjugate generator c_{d1}^*-c_{dn}^* is coupled to the complex conjugate processor 135_1-135_n yielding the unwanted traffic signal spreading code c_{d1}-c_{dn} and is input to the second mixer 133_1-133_n and mixed with the output of desired traffic signal spreading code complex conjugate generator c_i^*. The product is coupled to the second sum and dump processor 123_1-123_n. The second sum and dump processor 123_1-123_n output O_{sd2n} is $\sum cd_n c_i^*$ and is coupled to variable amplifier 137_1-137_n. Variable amplifier 137_1-137_n amplifies the second sum and dump

processor 123_1-123_n output O_{cd2n} in accorance with the third mixer 131_1-131_n output which is the determined gain.

The variable amplifier 137_1-137_n output 141_1-141_n is coupled to an adder 143 which subtracts the output from each variable amplifier 137_1-137_n from the output of the desired traffic signal despreader 105. The output O is:

$$O = \beta L + \psi d \Sigma c_d c_t^* + \Sigma n c_t^* - \psi d \Sigma c_d c_t^*. \qquad \text{Equation (19)}$$

The adder 143 output O (also the unwanted traffic canceler system 101 output) is equal to the received signal r minus the unwanted traffic signals simplified below:

$$O = \beta L + \Sigma n c_t^* \qquad \text{Equation (20)}$$

where the noise n varies depending on the amount of traffic signals subtracted from the received signal.

Another embodiment 145 cancelling the global pilot signal and unwanted traffic signals is shown in Figure 7. As previously discussed, the unwanted traffic cancellation system 101 includes the desired traffic signal despreader 91 and a plurality of unwanted traffic signal cancelers 115_1-115_n. The traffic cancellation system is coupled in parallel with the pilot cancellation system 61 previously described, but without a desired traffic singal despreader. A common input 147 is coupled to both systems 101, 61 with a common adder 149 which

is coupled to the outputs O, O_{add} from both systems 101, 61. The pilot and unwanted traffic signals are subtracted from the desired traffic signal yielding an output 151 free of interference contributions by the pilot and plurality of transmitted traffic signals.

While specific embodiments of the present invention have been shown and described, many modifications and variations could be made by one skilled in the art without departing from the principle and scope of the invention. The above description serves to illustrate and not limit the particular form in any way.

CLAIMS:

1. An apparatus for code division multiple access (CDMA) wireless communication comprising:

a receiver configured to receive a CDMA signal that includes a desired traffic signal and a second signal, the desired traffic signal being spread with a desired traffic spreading code and the second signal being spread with a second spreading code;

means for generating a second signal cancellation component including

means for generating a second signal strength by despreading the CDMA signal based on the second spreading code;

means for generating a second signal cancellation factor by selectively combining the second signal spreading code and the desired traffic spreading code; and

means for combining the second signal strength and the second signal cancellation factor to generate the second signal cancellation component;

means for generating a despread desired traffic signal by despreading the CDMA signal based on the desired traffic spreading code; and

means for combining the despread desired traffic signal and the second signal cancellation component to cancel second signal noise from the despread desired traffic signal.

2. The apparatus of claim 1 where the second signal is a pilot signal and the second signal spreading code is a pilot spreading code wherein:

the means for generating the second signal strength generates a pilot signal strength and includes:

a first despreader means configured to produce a despread pilot signal component by despreading the received CDMA signal with a complex conjugate of the pilot spreading code;

a low pas filter configured to perform low-pass-filtering of the despread pilot signal component; and

a divider configured to divide the output of the low-pass-filter to produce the pilot signal strength;

the means for generating the second signal cancellation factor generates a pilot signal cancellation factor and includes a multiplier configured to multiply the pilot spreading code and a

complex conjugate of the desired traffic spreading code;

the means for combining the pilot signal strength and the pilot signal cancellation factor generates a pilot signal cancellation component and comprises a multiplier;

the means for generating a despread desired traffic signal includes a second despreader means configured to despread the received CDMA signal with a complex conjugate of the desired traffic spreading code; and

the means for combining the despread desired traffic signal is configured to combine the desired traffic signal and the pilot signal cancellation component to cancel pilot signal noise from the despread desired traffic signal and comprises a subtractor.

3. The apparatus of claim 2 wherein:

the means for generating the pilot signal strength includes a sum and dump processor configured to sum the despread pilot signal component over time in advance of low pass filtering by the low pas filter;

the means for generating the pilot signal cancellation factor includes a sum and dump processor configured to sum a product of the pilot spreading code and a complex conjugate of the desired traffic spreading code over time to produce the cancellation factor; and

the means for generating the despread desired traffic signal includes a sum and dump processor configured to sum the received CDMA signal after despreading with complex conjugate of the desired traffic spreading code over time to generate the despread desired traffic signal.

4. An apparatus for code division multiple access (CDMA) wireless communication comprising:

a receiver configured to receive a CDMA signal that includes a desired traffic signal and a plurality of other known signals, the desired traffic signal being spread with a desired traffic spreading code and each of the other known signals being spread with a respective known spreading code;

means for generating respective known signal cancellation components including for each respective known signal:

means for generating a respective signal strength by despreading the CDMA signal based on the respective known spreading code;

means for generating a respective known signal cancellation factor by selectively combining the respective known spreading code and the desired traffic spreading code; and

means for combining the respective known signal strength and the respective known signal cancellation factor to generate the respective known signal cancellation component;

means for generating a despread desired traffic signal by despreading the CDMA signal based on the desired traffic spreading code; and

means for combining the despread desired traffic signal and the respective known signal cancellation components to cancel pilot signal noise from the despread desired traffic signal.

5. The apparatus of claim 4 wherein:

each means for generating a respective known signal strength includes:

a first despreader means configured to produce a despread pilot signal component by despreading the received CDMA signal with a complex conjugate of the respective known spreading code;

a low pas filter configured to perform low-pass-filtering of the despread respective known signal component; and

a divider configured to divide the output of the low-pass-filter;

each means for generating a respective known cancellation factor includes a multiplier configured to multiply the respective known spreading code and a complex conjugate of the desired traffic spreading code; and

the means for generating a despread desired traffic signal includes a second despreader means configured to despread the received CDMA signal with a complex conjugate of the desired traffic spreading code; and

the means for combining the despread desired traffic signal and the respective known cancellation components to cancel known signal noise from the despread desired traffic signal comprises a subtractor device.

6. The apparatus of claim 5 wherein:

each means for generating a respective known signal strength includes a sum and dump processor configured to sum the despread respective known signal component over time in

advance of low pass filtering by the low pas filter;

each means for generating a respective known cancellation factor includes a sum and dump processor configured to sum a product of the respective known spreading code and a complex conjugate over time to produce the respective known cancellation factor; and

the means for generating the despread desired traffic signal includes a sum and dump processor configured to sum the received CDMA signal after despreading with complex conjugate of the desired traffic spreading code over time to generate the despread desired traffic signal.

7. The apparatus of claim 4 or 5 where one of the other known signals is a pilot signal that is spread by a pilot spreading code wherein:

the means for generating the signal strength for the pilot signal includes:

a first despreader means configured to produce a despread pilot signal component by despreading the received CDMA signal with a complex conjugate of the pilot spreading code;

a low pas filter configured to perform low-pass-filtering of the despread pilot signal component; and

a divider configured to divide the output of the low-pass-filter to produce the pilot signal strength;

the means for generating the signal cancellation factor for the pilot signal includes a multiplier configured to multiply the pilot spreading code and a complex conjugate of the desired traffic spreading code;

the means for combining the pilot signal strength and the pilot signal cancellation factor comprises a multiplier.

8. The apparatus of claim 7 wherein:

the means for generating the pilot signal strength includes a sum and dump processor configured to sum the despread pilot signal component over time in advance of low pass filtering by the low pas filter; and

the means for generating the pilot signal cancellation factor includes a sum and dump processor configured to sum a product of the pilot spreading code and a complex conjugate over time to produce the cancellation factor.

9. The apparatus of claim 4 or 5 where one of the other known signals is an unwanted traffic signal that is spread by an unwanted traffic signal spreading code wherein:

the means for generating the signal strength for the unwanted traffic signal includes:

a despreader means configured to produce a despread unwanted traffic signal component by despreading the received CDMA signal with a complex conjugate of the unwanted traffic signal spreading code;

a hard decision decoder configured to perform a hard decision on the despread unwanted traffic signal component to select a constellation point as an unwanted traffic symbol and rotate despread unwanted traffic signal component by a phase error to produce a phase output;

a low pass filter configured to perform low-pass-filtering of the phase output; and

a processor for dividing an output of the low pass filter and combining the result with the selected unwanted traffic symbol to produce the unwanted traffic signal strength;

the means for generating the signal cancellation factor for the unwanted traffic signal includes a multiplier configured to multiply the unwanted traffic signal spreading code and a complex conjugate of the desired traffic spreading code;

the means for combining the unwanted traffic signal strength and the unwanted traffic signal cancellation factor to generate the unwanted traffic signal cancellation component comprises an adjustable amplifier.

10. The apparatus of claim 9 wherein:

the means for generating the unwanted traffic signal strength includes a sum and dump processor configured to sum the despread unwanted traffic signal component over time; and

the means for generating the unwanted traffic signal cancellation factor includes a sum and dump processor configured to sum a product of the unwanted traffic signal spreading code and a complex conjugate over time to produce the unwanted traffic signal cancellation factor.

11. A method of code division multiple access (CDMA) wireless communication comprising:

receiving a CDMA signal that includes a desired traffic signal and a second signal, the desired traffic signal being spread with a desired traffic spreading code and the second signal

being spread with a second spreading code;

generating a second signal cancellation component including

generating a second signal strength by despreading the CDMA signal based on the second spreading code;

generating a second signal cancellation factor by selectively combining the second signal spreading code and the desired traffic spreading code; and

combining the second signal strength and the second signal cancellation factor to generate the second signal cancellation component;

generating a despread desired traffic signal by despreading the CDMA signal based on the desired traffic spreading code; and

combining the despread desired traffic signal and the second signal cancellation component to cancel second signal noise from the despread desired traffic signal.

12. The method of claim 11 where the second signal is a pilot signal and the second signal spreading code is a pilot spreading code wherein:

the generating the second signal strength generates a pilot signal strength and includes:

producing a despread pilot signal component by despreading the received CDMA signal with a complex conjugate of the pilot spreading code;

low-pass-filtering of the despread pilot signal component; and

dividing the output of the low-pass-filter to produce the pilot signal strength;

the generating the second signal cancellation factor generates a pilot signal cancellation factor and includes multiplying the pilot spreading code and a complex conjugate of the desired traffic spreading code;

the combining the pilot signal strength and the pilot signal cancellation factor generates a pilot signal cancellation component by multiplying;

the generating a despread desired traffic signal includes despreading the received CDMA signal with a complex conjugate of the desired traffic spreading code; and

the combining the despread desired traffic signal is by subtracting the pilot signal cancellation component to cancel pilot signal noise from the despread desired traffic signal.

13. The method of claim 12 wherein:

the generating the pilot signal strength includes summing the despread pilot signal

component over time in advance of low pass filtering;

the generating the pilot signal cancellation factor includes summing a product of the pilot spreading code and a complex conjugate of the desired traffic spreading code over time to produce the cancellation factor; and

the generating the despread desired traffic signal includes summing the received CDMA signal after despreading with complex conjugate of the desired traffic spreading code over time to generate the despread desired traffic signal.

14. A method for code division multiple access (CDMA) wireless communication comprising:

receiving a CDMA signal that includes a desired traffic signal and a plurality of other known signals, the desired traffic signal being spread with a desired traffic spreading code and each of the other known signals being spread with a respective known spreading code;

generating respective known signal cancellation components including for each respective known signal:

generating a respective signal strength by despreading the CDMA signal based on the respective known spreading code;

generating a respective known signal cancellation factor by selectively combining the respective known spreading code and the desired traffic spreading code; and

combining the respective known signal strength and the respective known signal cancellation factor to generate the respective known signal cancellation component;

generating a despread desired traffic signal by despreading the CDMA signal based on the desired traffic spreading code; and

combining the despread desired traffic signal and the respective known signal cancellation components to cancel pilot signal noise from the despread desired traffic signal.

15. The method of claim 14 wherein:

each generating a respective known signal strength includes:

producing a despread pilot signal component by despreading the received CDMA signal with a complex conjugate of the respective known spreading code;

low-pass-filtering of the despread respective known signal component; and

dividing the output of the low-pass-filter;

each generating a respective known cancellation factor includes multipling the respective known spreading code and a complex conjugate of the desired traffic spreading code; and

the generating a despread desired traffic signal includes despreading the received CDMA signal with a complex conjugate of the desired traffic spreading code; and

the combining the despread desired traffic signal and the respective known cancellation components to cancel known signal noise from the despread desired traffic signal is by subtracting.

16. The method of claim 15 wherein:

each generating a respective known signal strength includes summing the despread respective known signal component over time in advance of low pass filtering;

each generating a respective known cancellation factor includes summing a product of the respective known spreading code and a complex conjugate over time to produce the respective known cancellation factor; and

the generating the despread desired traffic signal includes summing the received CDMA signal after despreading with complex conjugate of the desired traffic spreading code over time to generate the despread desired traffic signal.

17. The method of claim 14 or 15 where one of the other known signals is a pilot signal that is spread by a pilot spreading code wherein:

the generating the signal strength for the pilot signal includes:

producing a despread pilot signal component by despreading the received CDMA signal with a complex conjugate of the pilot spreading code;

low-pass-filtering of the despread pilot signal component; and

dividing the output of the low-pass-filtering to produce the pilot signal strength;

the generating the signal cancellation factor for the pilot signal includes multiplying the pilot spreading code and a complex conjugate of the desired traffic spreading code;

the combining the pilot signal strength and the pilot signal cancellation factor is by multiplying.

18. The method of claim 17 wherein:

the generating the pilot signal strength includes summing the despread pilot signal component over time in advance of low pass filtering; and

the generating the pilot signal cancellation factor includes summing a product of the pilot spreading code and a complex conjugate over time to produce the cancellation factor.

19. The method of claim 14 or 15 where one of the other known signals is an unwanted traffic signal that is spread by an unwanted traffic signal spreading code wherein:

the generating the signal strength for the unwanted traffic signal includes:

producing a despread unwanted traffic signal component by despreading the received CDMA signal with a complex conjugate of the unwanted traffic signal spreading code;

performing a hard decision on the despread unwanted traffic signal component to select a constellation point as an unwanted traffic symbol and rotate despread unwanted traffic signal component by a phase error to produce a phase output;

low-pass-filtering the phase output; and

dividing an output of the low pass filter and combining the result with the selected unwanted traffic symbol to produce the unwanted traffic signal strength;

the generating the signal cancellation factor for the unwanted traffic signal includes multiplying the unwanted traffic signal spreading code and a complex conjugate of the desired traffic spreading code;

the combining the unwanted traffic signal strength and the unwanted traffic signal cancellation factor to generate the unwanted traffic signal cancellation component is by using an adjustable amplifier.

20. The method of claim 19 wherein:

the generating the unwanted traffic signal strength includes summing the despread unwanted traffic signal component over time; and

the generating the unwanted traffic signal cancellation factor includes summing a product of the unwanted traffic signal spreading code and a complex conjugate over time to produce the unwanted traffic signal cancellation factor.