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(71) Applicant *(for all designated States except US)*: NOKIA TELECOMMUNICATIONS OY [FI/FI]; Mäkkylän puistotie 1, FIN-02600 Espoo (FI).

(72) Inventors; and
(75) Inventors/Applicants *(for US only)*: KESKITALO, Ilkka [FI/FI]; Rantapolku 1N2, FIN-90940 Jääli (FI). KIEMA, Arto [FI/FI]; Erkkilänkatu 8 As 2, FIN-24280 Salo (FI). SAVUSALO, Jari [FI/FI]; Valtatie 73 A 16, FIN-90500 Oulu (FI). SIIRA, Anne [FI/GB]; 6 Napoleon Avenue, Farnborough, Hampshire GU14 8LY (GB). KÄRKKÄINEN, Ari [FI/FI]; Sarkamäki, FIN-79999 Varkaus (FI). UOLA, Risto [FI/FI]; Nummikatu 19 B 5, FIN-90100 Oulu (FI). KÜHN, Ingo [DE/FI]; Puutarhakatu 14 As 5, FIN-90100 Oulu (FI). HOTTINEN, Ari [FI/FI]; Koulukatu 33-35 B 4, FIN-90100 Oulu (FI). JOLMA, Petri [FI/FI]; Hintantie 78 A 3, FIN-90650 Oulu (FI).

(74) Agent: TEKNOPOLIS KOLSTER OY; c/o Oy Kolster Ab, Iso Roobertinkatu 23, P.O. Box 148, FIN-00121 Helsinki (FI).

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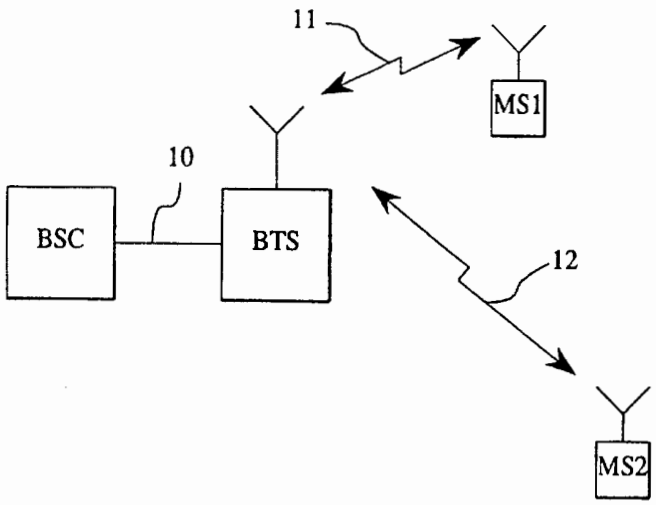

(57) Abstract

The invention relates to a CDMA cellular radio system, comprising in each cell at least one base station (BTS) connected to the mobile stations (MS1, MS2) in the cell, in which system a data signal of each user generated with a given bit rate is multiplied by a spreading code generated with a bit rate considerably higher than the bit rate of the data signal, the ratio between the data signal and the spreading code forming the spreading ratio of the connection, and in which system signals multiplied by the spreading codes of several users are transmitted on the same frequency band. To improve the quality of a connection between a mobile station and a base station, the spreading ratio of the connection between the base station (BTS) and the mobile station (MS1, MS2) is adjusted during the connection on

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Method of increasing signal quality by adjusting the spreading ratio in a COMA cellular radio system

The invention relates to a CDMA cellular radio system, comprising in each cell at least one base station connected to the mobile stations in the cell, in which system a data signal of each user generated with a given bit rate is multiplied by a spreading code generated with a bit rate considerably higher than the bit rate of the data signal, the ratio between the data signal and the spreading code forming the spreading ratio of the connection, and in which system signals multiplied by the spreading codes of several users are transmitted on the same frequency band.

CDMA is a multiple access method, which is based on the spread spectrum technique, and which has been applied recently in cellular radio systems, in addition to the prior FDMA and TDMA methods. CDMA has several advantages over the prior methods, for example spectral efficiency and the simplicity of frequency planning.

In FDMA, users are distinguished from one another by means of frequency; each data signal of the user has a dedicated frequency band. In TDMA, the frequency band is divided into successive time slots, and the data signal of each user is transmitted in its own recurrent time slot. In the case of combined FDMA/TDMA, several such frequency bands may be in use.

In CDMA, the narrow-band data signal of the user is modulated by a pseudorandom sequence, called the spreading code, having a broader band than the data signal. In connection with modulation, the signal spreads to a relatively wide band. In known test systems, bandwidths such as 1.25 MHz, 10 MHz and 50 MHz have been used. The spreading code consists of a number

of bits. The bit rate of the spreading code is much higher than that of the data signal, and the bits of the spreading code are called chips to distinguish them from data bits and data symbols. Each data symbol of the user is multiplied by the chips of the spreading code. The narrow-band data signal thus spreads to the frequency band to be used. The ratio between the bit rate of the spreading code and the bit rate of the data signal is called the spreading ratio of the CDMA system.

Each user has a separate spreading code. The data signals of several users are transmitted simultaneously on the same frequency band. Correlators provided in the receivers are synchronized with a desired signal, which they recognize on the basis of the spreading code, and they restore the band of the signal to its original bandwidth. Signals arriving at the receiver and containing the wrong spreading code do not correlate in an ideal case, but retain their wide band and appear thus as noise in the receivers. The spreading codes used by the system are preferably selected in such a way that they are mutually orthogonal, i.e. they do not correlate with each other.

A typical feature of a cellular radio environment is that a signal propagating between a user and a base station does not propagate along a single straight path from the transmitter to the receiver but along several paths varying in length, depending on the properties of the environment. This kind of multipath propagation occurs even though there were direct line of sight between the base station and the mobile station. This multipath propagation is mainly due to the reflections of the signal from the surrounding surfaces. Signals propagating along different paths have different transmission delays, and so they differ in phase on arriving at the receiver.

Generally speaking, spreading codes are not orthogonal with all possible delay values. Signals with different delays therefore interfere with the detection of other signals. Users thus interfere with each other, and this is called multiple access interference. CDMA is an interference-limited system. The effect of multiple access interference increases with the number of system users, which degrades the signal-to-noise ratio of connections. In view of the capacity of the CDMA system, the optimum situation at the base station is when all signals arrive at the base station with the same signal-to-noise ratio. For this purpose, the CDMA system utilizes power control. The transmit power used by the mobile stations is controlled according to each situation. Thus, for example when a mobile station moves further away from the base station, it increases its transmit power so that the level of the signal received at the base station would not deteriorate.

There may, however, occur situations in the CDMA system where the deterioration of signal quality cannot be compensated for by power control. This occurs for example if the mobile station is already transmitting with its highest power. When the connection deteriorates, it is not possible to increase the power any more. Another such situation occurs when the mobile station is located at the border of the cell. Thus the signal it is transmitting interferes with the neighbouring cell, and an increase in power is disadvantageous to the entire system. In particular, if the system utilizes the so-called hard handover, i.e. the mobile station breaks its connection with the previous base station before a connection is established to the new base station, interference to the cell of the new base station is strong before the handover. In addition, if the traffic load in the cell is heavy, an

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