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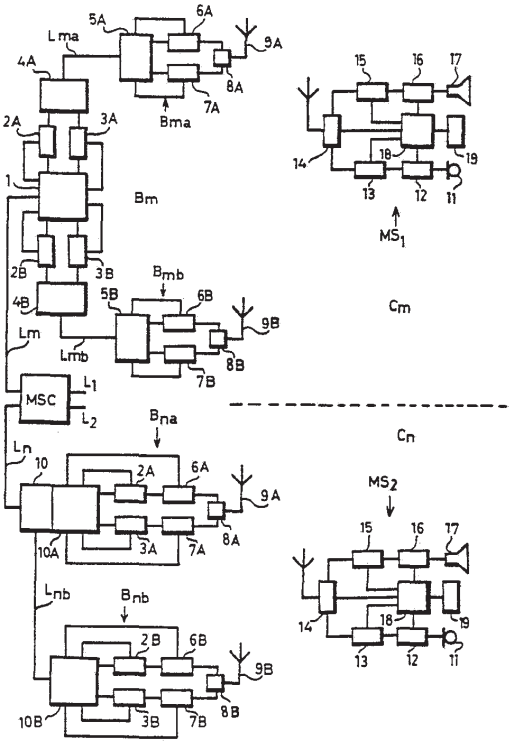
(54) Title: CELLULAR DIGITAL MOBILE RADIO SYSTEM WITH PLURAL BASE STATION TRANSMITTERS AND METHOD OF TRANSMITTING INFORMATION IN SUCH A SYSTEM

(57) Abstract

The invention relates to a cellular digital mobile radio system including base stations (B_m, B_n) and mobile stations (MS_1, MS_2) with transmitters and receivers. The invention also relates to a method of transmitting message information digitally between mobile and base stations in such a system. In accordance with the invention, at least two base station transmitters (B_{ma}, B_{mb}, B_{na}, B_{nb}) at a given transmitting distance from each other are assigned to each of certain cells (C_m, C_n) within a restricted geographical area. The base station transmitters which are assigned to the same cell transmit digitally modulated radio signals within the same frequency range at least partially simultaneously to the mobile stations of the cell. The radio signals from different base station transmitters associated with the same cell are digitally modulated with the same message information to the mobile stations in the cell. Different base station transmitters (9A, 9B) preferably transmit the digitally modulated radio signals with the same message information to a given mobile station with a given mutual transmission time shift. Here, the transmission time shift is selected individually for each mobile station, such that corresponding digitally modulated radio signals with the same message information to a given mobile station from different base station transmitters arrive practically simultaneously at the mobile station.



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Cellular digital mobile radio system with plural base station transmitters and method of transmitting information in such a system

TECHNICAL FIELD

The present invention relates to mobile radio systems. More specifically the invention relates to a digital, cellular, mobile radio system. The invention also relates to a method of transmitting information digitally to and from mobile stations in a cellular mobile radio system.

BACKGROUND ART

The mobile radio systems that were first taken into common use were of analogue type, i.e. message information was transmitted in analogue form to and from mobile stations by transmitting and receiving analouge-modulated radio signals. In such systems it is known to have two or more base station transmitters at a distance from each other simultaneously transmitting radio signals within the same frequency range and modulated with the same message information to the mobile stations. Such mobile radio systems are described in EP 0040731 and EP 0072479, as well as in the two publications: NTG-Fachberichte, Bewegliche Funkdienste, Vorträge der NTG-Fachtagung vom 25. bis 27 November in Munich, "GLEICHKANALFUNKSYSTEME FüR DIE FREQUENZÖKONISCHE VERSORGUNG GROSSER GEBIETE" Berndt Heynisch pp 41-46, VDE-VERLAG GmbH, Berlin, Elektrizitätswirtschaft, Jg. 80(1981), Heft 6, pp 187-198 "Quasissynchroner Gleichwellenfunk-ein Gleichkanalfunk-Verfahren zur Erhöhung der Erreichbarkeit in Mobilfunknetzen.

In known systems of the kind in question here, it is known to transmit message information from a central station or exchange to the base station transmitters either via cables or radio signals. It is also known to have equalisers in the fixed part of the mobile radio system for equalising differences in propagation time and attenuation in transmission from the exchange to the base station transmitters. The equalisers can be at the exchange and/or at the base station transmitters. The object of the equalisers is that irrespective of position in relation to the exchange the base station transmitters shall transmit the radio signals simultaneously, and modulated with the same message information.

Digital mobile radio systems in which message information is transmitted digitally to and from mobile stations by transmission and reception of digitally modulated signals have been proposed in US 4675863 and "Digital Mobile Telephone System Using TD/FDMA Scheme", Kota Kinoshita, Masaharu Hata and Kenkichi Hirade, IEEE TRANSACTIONS ON VEHICULAR TECHNOLOGY, VOL. VT-31, NO.4, NOVEMBER 1982, pp 153-157.

It has been proposed to have adaptive equalisers in mobile radio stations in digital radio systems, whereby multi-path propagation of radio signals can be used to improve signal quality, instead of the multipath propagation acting as noise. Among the publications on adaptive equalisers in digital mobile radio systems can be mentioned: "Multi-path Equalization for Digital Cellular Radio Operation at 300 k. bit/s". K Raith, J-E Sjternvall and J Uddenfeldt, 36th IEEE Vehicular Technology Conference, pp 268-272, Dallas, Texas, USA May 1986. "Radio Test Performance of a Narrowband TDMA System", J-E Stjernvall, B. Hedberg, and S Ekmark, IEEE Vehicular Conference, Tampa, Florida, USA, June 1987, RADIO TEST PERFORMANCE OF A NARROWBAND TDMA SYSTEM-DMS 90, J-E Stjervall, B. Hedberg, K Raith, T Bäckström and R Lofdahl.

DISCLOSURE OF INVENTION

In mobile radio systems there are problems due to reflections and radio shadows from natural obstacles such as rocks and hills, as well as structures such as buildings. These problems are especially troublesome in transmitting information requiring great accessibility/reliability and high transmission speed. In particular the problems may become large in certain urban environments where the propagation conditions for radio signals can vary heavily within a small geographic area, while radio traffic is intensive at the same time. Up to now attempts have been made to solve these problems by having adaptive equalisers in the mobile stations and small cells with specially selected positioning of the base station transmitters. In areas with much traffic it is, however, a desire to be able to select the size of the cells and their positions in the mobile radio system cell plan in an optimum way with respect to the traffic handling capacity of the system. Reducing the cell size and selecting the positions of the small cells to avoid radio shadows thus involves a complication. Another complication resulting from the reduction of cell size to below what is necessary for reasons of capacity is that the number of handovers increases.

The object of the invention is to solve the above-mentioned problems and complications, and to provide a method and a cellular digital mobile radio system which are also suitable for transmitting information requiring great accessibility/reliability and high transmission speed.

What is distinguishing for a method and a digital cellular mobile radio system in accordance with the invention, and particularly preferred embodiments thereof is disclosed in the independent and dependent claims. Somewhat simplified, it may be said that according to the invention there are utilised at least two base station transmitters for each of a plurality of cells, these transmitters being at a distance from each other and at least partially simultaneously transmitting radio signals within the same frequency range digitally modulated with the same message information to the mobile stations in the cell. The digital modulation is changed with a modulation time interval which is adapted to the greatest transmitting distance between two base station transmitters serving the same cell in an area. The mobile stations have adaptive equalizers for reconstructing the digital modulation in the transmitted signals from the signals received during a reception time interval, which is also adapted to the greatest transmitting distance between two base station transmitters serving the same cell in an area.

In a preferred embodiment of a method in accordance with the invention, the digitally modulated signals are transmitted with the same message information to a given mobile station with a given, mutual transmission time shift from the different base stations. The transmission shift is then selected such that it counteracts the difference in arrival time for the signals from the different base station transmitters to this mobile station.

In each mobile station, there is preferably estimated the arrival time shift between the digitally modulated radio signals with the same message information from the different base station transmitters. Information about the estimated arrival time shift at the respective mobile station is transmitted from there to at least one base station transmitter. This estimated arrival time shift is utilised at the base station for selecting the transmission time shift for at least one base station transmitter. A transmission time shift is thus obtained individually for each affected mobile station, and which is adjusted for this

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