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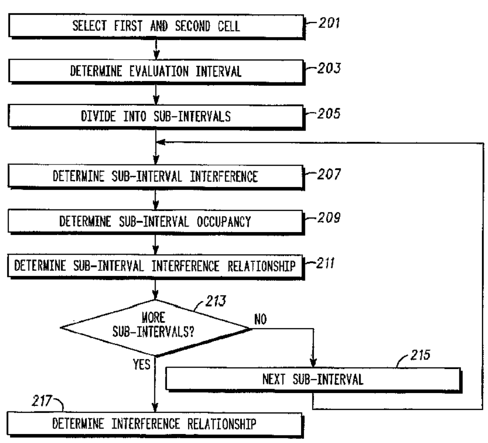
(54) Title: METHOD AND APPARATUS FOR DETERMINING AN INTERFERENCE RELATIONSHIP BETWEEN CELLS OF A CELLULAR COMMUNICATION SYSTEM



(57) Abstract: The invention relates to a system for determining an interference relationship between cells of a cellular communication system comprising at least a first cell and a second cell. A method comprises the step of dividing (205) an evaluation interval into a plurality of sub-intervals. For each sub interval, the method proceeds to determine (209) a sub-interval simultaneous occupancy related to the correlation between communication in the first and second cell. The sub-interval simultaneous occupancy is determined from an occupancy of each of the first cell and the second cell. A sub-interval potential interference is then determined (209) in response to the interference characteristics in each sub-interval. An interference relationship is subsequently determined from the sub-interval potential interferences and the sub-interval simultaneous occupancies. The interference relationship provides a measure of the impact of interference between the first and second cell suitable for frequency planning.

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METHOD AND APPARATUS FOR DETERMINING AN INTERFERENCE RELATIONSHIP BETWEEN CELLS OF A CELLULAR COMMUNICATION SYSTEM

Field of the invention

The invention relates to a method and apparatus for determining an interference relationship between cells of a cellular communication system and in particular for determining an interference relationship suitable for frequency planning.

Background of the Invention

FIG. 1 illustrates the principle of a conventional cellular communication system 100 in accordance with prior art. A geographical region is divided into a number of cells 101, 103, 105, 107 each of which is served by base station 109, 111, 113, 115. The base stations are interconnected by a fixed network which can communicate data between the base stations 109, 111, 113, 115. A mobile station is served via a radio communication link by the base station of the cell within which the mobile station is situated. In the example of FIG. 1, mobile station 117 is served by base station 109 over radio link 119, mobile station 121 is served by base station 111 over radio link 123 and so on.

As a mobile station moves, it may move from the coverage of one base station to the coverage of another, i.e. from one cell to another. For example mobile station 125 is initially served by base station 113 over radio link 127. As it moves towards base station 115 it enters a region of overlapping coverage of the two base stations 113 and 115 and within this overlap region it changes to be supported by base station 115 over radio link 129. As the mobile station 125 moves further into cell 107, it continues to be supported by base station 115. This is known as a handover or handoff of a mobile station between cells.

A typical cellular communication system extends coverage over typically an entire country and comprises hundreds or even thousands of cells supporting thousands or even millions of mobile stations. Communication from a mobile station to a base station is known as uplink, and communication from a base station to a mobile station is known as downlink.

The fixed network interconnecting the base stations is operable to route data between any two base stations, thereby enabling a mobile station in a cell to communicate with a mobile station in any other cell. In addition the fixed network comprises gateway functions for interconnecting to external networks such as the Public Switched Telephone Network (PSTN), thereby allowing mobile stations to communicate with landline telephones and other communication terminals connected by a landline. Furthermore, the fixed network comprises much of the functionality required for managing a conventional cellular communication network including functionality for routing data, admission control, resource allocation, subscriber billing, mobile station authentication etc.

Currently, the most ubiquitous cellular communication system is the 2nd generation communication system known as the Global System for Mobile communication (GSM). GSM uses a technology known as Time Division Multiple Access (TDMA) wherein user separation is achieved by dividing frequency carriers into 8 discrete time slots, which individually can be allocated to a user. A base station may be allocated a single carrier or a multiple of carriers. One carrier is used for a pilot signal which further contains broadcast information. This carrier is used by mobile stations for measuring of the signal level of transmissions from different base stations, and the obtained information is used for determining a suitable serving cell during initial access or handovers. Further description of the GSM TDMA communication system can be found in 'The GSM System for Mobile Communications' by Michel Mouly and Marie Bernadette Pautet, Bay Foreign Language Books, 1992, ISBN 2950719007.

Currently, 3rd generation systems are being rolled out to further enhance the communication services provided to mobile users. The most widely adopted 3rd generation communication systems are based on Code Division Multiple Access (CDMA) wherein user separation is obtained by allocating different spreading and scrambling codes to different users on the same carrier frequency. The transmissions are spread by multiplication with the allocated codes thereby causing the signal to be spread over a wide bandwidth. At the receiver, the codes are used to de-spread the received signal thereby regenerating the original signal. Each base station has a code dedicated for a pilot and broadcast signal, and as for GSM this is used for measurements of multiple cells in order to determine a serving cell. An example of a communication system using this principle is the Universal Mobile Telecommunication System (UMTS), which is currently being deployed. Further description of CDMA and specifically of the Wideband CDMA (WCDMA) mode of UMTS can be found in 'WCDMA for UMTS', Harri Holma (editor), Antti Toskala (Editor), Wiley & Sons, 2001, ISBN 0471486876.

In order to optimise the capacity of a cellular communication system, it is important to minimise the impact of interference caused by or to other mobile stations. Thus, it is important to minimise the interference caused by the communication to or from a mobile station, and consequently it is important to use the lowest possible transmit power. As the required transmit power depends on the instantaneous propagation conditions, it is necessary to dynamically control transmit powers to closely match the conditions. For this purpose, the base stations and mobile stations operate power control loops, where the receiving end reports information on the receive quality back to the transmitting end, which in response adjusts it's transmit power. This ensures that the minimum transmit power necessary to ensure a given quality is used, and thus that interference caused by communication with each mobile station is minimised.

An important advantage of cellular communication systems is that, due to the radio signal attenuation with distance, the interference caused by communication within one cell is negligible in a cell sufficiently far removed, and therefore the resource can be reused in this cell. In GSM systems, carrier frequencies are therefore reused in other cells in accordance with a frequency plan. Frequency planning is one of the most important optimisation operations for a cellular communication system in order to maximise the communication capacity of the system. The frequency planning typically considers a vast number of parameters including propagation characteristics, traffic profiles and communication equipment capabilities.

Specifically, known frequency planning methods rely heavily on interference estimations between different cells. Automatic frequency planning methods have been developed wherein potential cross-interference and resulting carrier to interference ratios are determined for different possible frequency allocations. Typically, an interference level is determined as the interference caused to a communication between a mobile station and a base station in one cell by a potential communication between a mobile station and base station in a different cell. Conventionally, the interference is determined from propagation predictions based on calculated and measured propagation characteristics.

However, these interference values and carrier to interference ratios do not reflect the true impact on the performance of the communication system as they do not consider the relationship between the caused interference and the quality of service parameters provided by the communication system.

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