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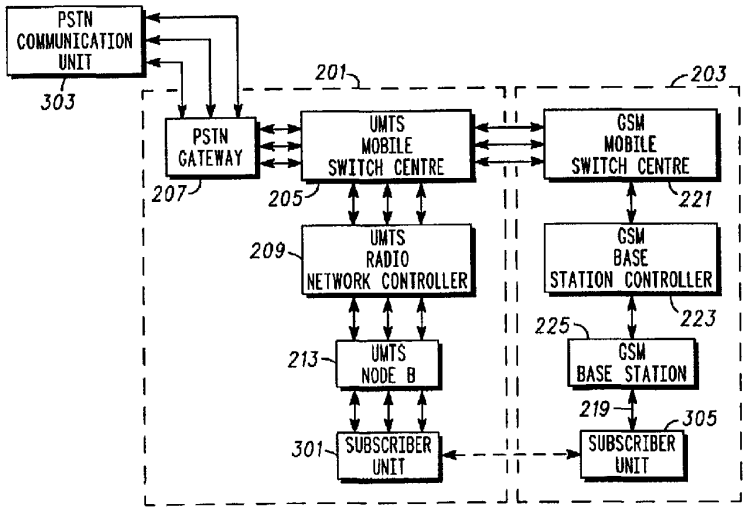
(54) **Title:** A METHOD AND APPARATUS FOR HANDING OVER A SUBSCRIBER UNIT BETWEEN CELLULAR COMMUNICATION SYSTEMS



(57) **Abstract:** The invention relates to handover of a subscriber unit (301, 305) from a first cellular communication system (201) to a second cellular communication system (203). The first communication system is for example a UMTS communication system supporting a plurality of connections, and the second communication system is for example a GSM communication system supporting only a single connection. The handover comprises forming a handover connection (219) to the subscriber unit (301, 305) through the second communication system and handing one of the connections under the first communication system over to this connection. Rather than dropping the remaining connections, they are entered into a holding state. After the handover, one of the connections on hold may be entered into an active state by associating the handover connection (219) with this connection.

WO 2004/036947 A1

A METHOD AND APPARATUS FOR HANDING OVER A SUBSCRIBER UNIT BETWEEN CELLULAR COMMUNICATION SYSTEMS

Field of the invention

The invention relates to a method and apparatus for handing over a subscriber unit between cellular communication systems and in particular to handovers from a third generation cellular communication system to a second generation cellular communication system.

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 101, 103, 105, 107. 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 if 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 111 and 113 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 hundred 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.

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 a UMTS CDMA communication system, the communication network comprises a core network and a Radio Access Network (RAN). The core network is operable to route data from one part of the RAN to another, as well as interfacing with other communication systems. In addition, it performs many of the operation and management functions of a cellular communication system, such as billing. The RAN is operable to support wireless user equipment over a radio link being part of the air interface. The RAN comprises the base stations, which in UMTS are known as Node Bs, as well as Radio Network Controllers (RNC) which control the Node Bs and the communication over the air interface.

Whereas the GSM system was originally developed with a view to mainly supporting voice services, UMTS has from the outset been developed to provide a wide plurality of different services including different voice communication services and data services. Different services can be set up having different characteristics and specifically with different Quality of Service parameters such as different delays, data rates, target error rates etc. Further, UMTS provides for a plurality of services and connections to be set up between different mobile stations.

The deployment of UMTS will initially be in islands of coverage wherein UMTS base stations provide coverage of selected areas and regions. However, it is expected that most UMTS systems will not provide full or extensive coverage for some time, and therefore it is planned that the gaps in UMTS coverage will be covered by 2nd Generation Systems such as GSM. Consequently, multimode mobile stations capable of operating with both GSM and UMTS are being developed as is handover methods between the two systems.

However, GSM provides limited services in comparison to UMTS and the handover methods therefore comprise reducing the services and quality of service provided to a user when handing over to GSM. Hence, the handover causes a reduced service level for a user therefore a system for handovers providing improved support of services, functionality and/or performance would be an advantage.

Summary of the Invention

Accordingly the Invention seeks to mitigate, alleviate or eliminate one or more of the above mentioned disadvantages singly or in any combination.

Accordingly, there is provided a method of handing over a subscriber unit from a first cellular communication system supporting a plurality of connections of the subscriber unit to a second cellular communication system; the method comprising the steps of: entering at least a first connection of said plurality of connections into a holding state; forming a handover connection to the subscriber unit through the second communication system; handing over a second connection of said plurality of connections to the second cellular communication system by associating the second connection with said handover connection; entering said at

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