(54) Title: REMOTE CONTROL OF ADJUSTABLE ANTENNAS

(57) Abstract: This invention relates to a mobile communication network control system (1) and a method of operating same. The control system (1) comprises a plurality of control units (5), each of which is associated with at least one antenna, and a control node server. The control system further comprises an accessible database (9) with orientation data relating to the antennas stored thereon. Each of the antennas have means to adjust the orientation of the network antenna and means to measure the orientation of the antenna associated therewith. In use, a command may be sent from a remote user device (13, 15, 17, 19) to the control node (5) via the control server (7) to alter the orientation of an antenna. Once the re-orientation is complete, the accessible database (9) is updated and the user device (13, 15, 17, 19) is informed of the new orientation of the antenna (3).
For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.
**Introduction**

This invention relates to a mobile communication network control system for use with a mobile communication network, the mobile communication network comprising a plurality of network antennae, each of the network antennae having means to adjust the orientation of the network antenna associated therewith and means to measure the orientation of the network antenna associated therewith, the control system comprising a plurality of control nodes, each control node being associated with at least one network antenna and each control node having means to communicate with both the means to adjust the orientation of the network antenna and the means to measure the orientation of the network antenna. This invention further relates to a method of operating such a mobile communications network.

Mobile communication networks have become increasingly popular over the last number of years. These mobile communication networks facilitate mobile telephony communications and other wireless communication technologies. Mobile communication networks have grown exponentially in recent times to a position where they are fast becoming the largest carrier of communications, challenging the traditional fixed line networks. One particularly relevant advance that has had a significant impact on mobile communication networks has been the advent of 3G mobile telephone technology, superseding the existing 2G systems. The introduction of 3G telephony, which may operate at higher frequencies than previous technologies, has led to an increased density of radio frequency (RF) cells in most areas to cater for the demand. This has also led to a significant increase in the traffic passing through the mobile communication networks. In order to handle this volume of traffic, it is most important for the mobile network operators to be able to monitor and control their networks in a simple and efficient manner.

Furthermore, in many jurisdictions there is significant competition between mobile network operators for customers and quality of service provided by the network operator is often of paramount importance to the customers when deciding which
mobile operator they will use. Quality of service is essentially the coverage and reliability of the network experienced by the users when communicating using the network. Therefore, it is highly desirable for the mobile network operators to be able to provide enhanced quality of service to their customers. In order to be able to provide improved quality of service to their customers, it is important that the mobile communication network operators can optimise the RF cells in their network as much as possible. One manner in which the RF cells may be optimised is implemented by controlling the size of the RF cell. The size of the RF cell may be adjusted by tilting the antennae or its azimuth associated with that cell and accordingly, increasing or decreasing the RF field produced by the cell. In this way, customers complaining of poor coverage in a particular area, such as in the vicinity of their homes, can contact the mobile communication network operator and request that the network operator increases the signal strength in their area. The mobile communication network operator may achieve this by adjusting the tilt of the RF cell antennae in the vicinity of the customer's home to increase the RF field and improve the coverage in that area.

There are however numerous obstacles to providing this enhanced level of service to the customers. First of all, tilting of an antenna is by no means a trivial matter. Until now, there have been essentially two methods of adjusting the tilt of an antenna, physical tilt and electrical tilt. The first method, physical tilt, comprised sending a rigging crew to the site of the appropriate antenna mast and sending a rigger up the mast to mechanically adjust the tilt of the antenna. This is undesirable as the rigging crews are generally expensive to employ and there are safety risks to the riggers. Furthermore, once the tilt angle has been adjusted physically, the network operator must then test the RF field in the area in question and if the RF field is still insufficient, they may have to revisit the antennae mast one or more times in order to achieve a suitable level of RF field in that area. Furthermore, changing the coverage of one RF cell can have a knock-on effect throughout the network and may necessitate changing other adjacent RF cells to compensate for the first RF cell that was altered. This is often seen as a cumbersome and time consuming process.

The second method of adjusting the tilt of the antenna uses a variable electrical tilt (VET)/remote electrical tilt (RET) method. This method uses an electronic or electrical device connected to the antenna to tilt the antenna. A cable is run directly from the
electrical device on the mast to a control unit in a base station, or the signal and power are sent modulated on the existing RF cable to the antenna where it is demodulated. In order to adjust the tilt of the antenna the service personnel have to access the base station and adjust the tilt using the electrical device in the base station. This so-called VET/RET method is seen as useful as it obviates the need for a rigger to climb a mast and physically adjust the antenna. Furthermore, the mobile communication network operator can install the antennae and optimise them at a later stage without the need for expensive rigging crews. However, there are some difficulties with this VET/RET method.

First of all, in order to adjust the angle of tilt of the antenna an engineer must access the electrical device connected to the antenna in the base station. Typically, the engineer will interface with the electrical equipment via a laptop and make any necessary adjustments. However, many of the base stations are located on private property and it is necessary to arrange a suitable time with the owners of the property to obtain access to those base stations. This can often take several days to arrange which is inconvenient and does not allow the network operator to provide a sufficient level of service to the customer. Furthermore, the base stations are often inaccessible during normal working hours thereby increasing the cost of adjusting any antenna associated with the base station. A further difficulty of the VET/RET method is that once the adjustments have been made by the engineer he must still then travel to the location where the complaint about RF field strength was made and take an RF field strength measurement. If the field strength is still inadequate, he must return to the base station, connect to the electronic device once again and repeat the adjustment procedure. This may require numerous visits to the base station by the engineer or a team of engineers. Once again, this is time consuming and relatively difficult to perform.

Another problem with the known mobile communication networks is that the precise orientation of each of the antennae in the network is not known. Measurements of each antenna orientation may be taken when the antennae is installed but over time the orientation of the antennae are often adjusted and accurate records of the antennae orientation are seldom kept. Furthermore, changes to the orientation of the antennae can happen over time due to, for example, subsidence of the mast or other
environmental conditions that can cause a change in the orientation of the antennae. This makes control of the network a significant challenge as the network operator rarely knows the precise status and actual orientation of all the antennae in their network.

It is an object of the present invention to provide a mobile communication network control system and method that overcome at least some of these difficulties that are both simple to operate, efficient in use and allow improved control of the mobile communication network by the network operator.

**Statements of Invention**

According to the invention there is provided a mobile communication network control system for use with a mobile communication network, the mobile communication network comprising a plurality of network antennae, each of the network antennae having means to adjust the orientation of the network antenna associated therewith and means to measure the orientation of the network antenna associated therewith, the control system comprising a plurality of control nodes, each control node being associated with at least one network antenna and each control node having means to communicate with both the means to adjust the orientation of the network antenna and the means to measure the orientation of the network antenna, characterised in that:

the control system further comprises a control node server located remote from the control nodes, the control nodes each having means to communicate with the control node server, the control node server having means to receive antenna orientation data from the control nodes and means to transmit antenna orientation data to the control nodes to cause re-orientation of the antenna associated with the control node.

By having such a control system, the operator of the mobile communication network may gain access to each of the antennae in the network via their control nodes and alter the tilt of the antennae from a remote control node server. It is no longer necessary to send rigging crews up telecommunications masts or engineers
out to base stations in order to adjust the tilt and orientation of the antennae. This is seen as particularly useful as customer complaints may be handled in an extremely quick manner with the minimum of difficulty and in less time than was previously the case. Furthermore, by having such a system, the mobile communication network operator may carefully monitor their network and the positions of each of the antennae and easily adjust their network if and when desired. Another advantage of the present invention is that the system and the control nodes in particular may be retrospectively fitted into existing mobile networks and may be configured to operate with a range of disparate devices in the legacy system. Perhaps most advantageously, the network operator will have a current and up to date view of the actual orientation and status of each of the antennae in their network which will enable them to make decisions concerning the antennae orientation with greater accuracy and simplicity.

In one embodiment of the invention there is provided a control system in which the control node server further comprises an accessible database having data including actual orientation data relating to each antenna stored thereon. By having an accessible database with data relating to each antenna stored thereon, it is possible for the mobile communication network operator to carefully monitor the condition and state of each of the antennae located in their network. Furthermore, the network operator will be able to determine the precise orientation of an antenna in the network at a given moment in time rather than relying on out of date records of the antenna orientation. By having all this information stored in a central location, it is possible to provide a coherent strategy for the mobile communication network and control the mobile communication network in a more comprehensive manner.

In another embodiment of the invention there is provided a control system in which the control node server has means to verify with the control node when an orientation change has been made to an antenna, and on verification of the orientation change, update the antenna data relating to that antenna stored in the accessible database. By having such a system, it is possible to keep the information relating to the antennae in the database up-to-date and verify when the tilted antenna has been altered. This alteration will be reflected in the database only
once it has actually been made so that the status of the network is kept current at all times.

In a further embodiment of the invention there is provided a control system in which the control node server is provided with a web interface to allow access to the control node server over the World Wide Web. This is seen as particularly preferred. By having a web interface, it is possible for an engineer or other authorised individual with the appropriate access permissions to connect to the control node server via the world wide web. Once they have connected to the control node server over the world wide web they may then control the tilt angle of the various antennae. It is envisaged therefore that if an alteration of RF field strength is required at a particular location, the engineer may travel to that exact location and from that location may alter the tilt angle of one or more antennae from nearby telecommunication masts without having to travel to the actual base stations. Therefore, having adjusted the tilt angle of one or more antennae, they are in position at the test location and may carry out RF field strength calculations at that location. If the adjustments made were insufficient to increase the RF field to an adequate level, the engineer may further alter the tilt of one or more antennae until a suitable RF field is achieved. This will significantly speed up the process of adjusting the mobile network and responding to customers complaints.

In one embodiment of the invention there is provided a control system in which each control node is provided with one of an Ethernet and a GPRS interface to allow communication with the control node server. In another embodiment of the invention there is provided a control system in which each control node is provided with an Antenna Interface Standards Group (AISG) interface for communication with an antenna. Alternatively, each control node may be provided with a 3GPP interface for communication with an antenna.

In a further embodiment of the invention there is provided a control system in which at least one of the control nodes is associated with a plurality of antennae. In this way, it is possible to connect the control node to more than one antenna and it is therefore possible to adjust more than a single antenna through each control node. This reduces the number of control nodes significantly that are required thus
reducing the cost of the base stations. This is seen as particularly preferred as due to the implementation of 3G technology and the subsequent increase in the number of base stations required, the cost of the individual base stations and the associated equipment is becoming more of a factor. By being able to reduce the cost of the base stations, it is therefore possible to significantly reduce the cost of the total network. Most base stations will have three antenna sectors per base station and it is envisaged that all three may be connected to a single control node.

In one embodiment of the invention there is provided a control system in which the control node server and the plurality of control nodes are connected by way of wide area network (WAN).

In another embodiment of the invention there is provided a control system in which the accessible database has one or more of the control node identifiers, antenna identifiers, antenna settings, antenna locations and antenna logs stored thereon.

In a further embodiment of the invention there is provided a control system in which the accessible database has optimised settings for each of the antennae stored thereon. Preferably, the optimised settings for the antennae further comprise time-based optimised antennae settings. Preferably, the control node server has means to access the optimised antenna settings stored in the accessible database and apply those settings to the antennae. By having time-based optimised antennae settings, it is possible to adjust the angle of the antennae in the mobile communication network at a particular time of day so that sufficient signal strength is provided in a particular area. For instance, it may be decided that between the hours of 8.00am and 6.00pm a higher level of RF field should be provided in the main business district and diverted from the surrounding residential areas which will be less populous at that time thereby requiring less coverage. Similarly, it may be decided to increase the RF field around a football stadium before, during or after a match has taken place.

In one embodiment of the invention there is provided a control system in which the mobile communication network comprises a plurality of base stations and there is provided only one control node in each base station.
In one embodiment of the invention there is provided a control system in which the control node has a microprocessor with firmware to communicate with the antenna through a first protocol and with the control node server through a second protocol. Preferably, the second protocol further comprises XML scripts.

In one embodiment of the invention there is provided a control system in which each control node has an incorporated website. This is seen as particularly useful as it will enable updating and alteration of the control nodes in a very simple and efficient manner. Each node essentially has its own web site which is used to configure the node and the antenna when they are being configured/installed on the site. The other web site, which is used by the engineers to optimise the mobile network, is generated by the server based on the database only. In theory, the system could be configured so that the user could surf each of the independent web sites. However, any changes to the settings would not be centrally held unless data was sent from the control node to the control node server on a change to the antenna orientation being made. The data in the database may be exported to optimisation and simulation packages to facilitate maintenance and control of the network components.

In a further embodiment of the invention there is provided a control system in which each control node further comprises a 3-port Ethernet switch. It is envisaged that the control node may have additional equipment powered thereby. For example, it is envisaged that a camera may be installed in the base station and powered in this manner. Furthermore, it is envisaged that the control node may have a USB interface or other such similar interface for connection to a computing device such as a laptop, PDA, mobile phone, PC or other such computing device. Preferably, a number of USB interfaces will be provided to allow a number of devices to be simultaneously connected to the control node.

In one embodiment of the invention there is provided a control system in which the control node has an alarm input/output for base station security. In another embodiment of the invention there is provided a control system in which the control node server has means to periodically communicate with each of the control nodes.
In one embodiment of the invention there is provided a control system in which the system has means to monitor other mast head devices. In this way the system can monitor other devices such as an amplifier which can have its gain adjusted over AISG. Also, some of these devices have a tendency to fail in such a way that greatly affects the gain of the cell. In such circumstances, the system has an email interface that can be configured to warn service engineers of breakdowns such as these.

In another embodiment of the invention there is provided a method of operating a mobile communications network, the mobile communications network comprising a control node server, an accessible database, a plurality of control nodes and a plurality of network antenna, each of the network antenna having means to adjust the orientation of the network antenna associated therewith and means to measure the orientation of the network antenna associated therewith, each control node being associated with at least one network antenna and having means to communicate with both the means to adjust the orientation of the network antenna and the means to measure the orientation of the network antenna, the control nodes each having means to communicate with the control node server, characterised in that the method comprises the steps of:

1. the control nodes obtaining actual antenna orientation data relating to the network antenna associated therewith;
2. the control node server communicating with each of the control nodes and obtaining the actual orientation data relating to each of the network antennae;
3. the control node server storing the actual orientation data relating to each of the network antennae in the accessible database for viewing by authorised individuals.

By having such a method, an authorised individual may review the actual status of the mobile network and determine the precise orientation of one or more antennae
in the network at a given time. This has great advantages as the individual may thereafter control the network in a more comprehensive manner.

In a further embodiment of the invention there is provided a method in which the method further comprises the steps of:

- an authorised individual transmitting a network antenna orientation adjustment command to one of the control nodes;

- the control node causing the means to adjust the orientation of the network antenna to apply the new orientation to the antenna and the control node thereafter confirming the new antenna orientation with the means to measure the orientation of the network antenna; and

- the control node transmitting the new measured antenna orientation to the accessible database.

In this way, the data on the network in the accessible database is kept up to date and therefore the individuals reviewing the status of a particular antenna will be able to see the changes from the accessible database once the changes have been made. This will facilitate the engineers in the field when they are making changes to the equipment as they will be able to determine the precise effect of any changes that they have made.

In one embodiment of the invention there is provided a method in which the step of the control node transmitting the new measured antenna orientation to the accessible database further comprises the control node transmitting the new measured antenna orientation to the control node server and the control node server updating the accessible database with the new antenna orientation.

In another embodiment of the invention there is provided a method in which the method further comprises the steps of:

- an authorised individual transmitting a network antenna orientation
adjustment command to the control node server;

the control node server forwarding the orientation adjustment command onwards to the control node associated with that network antenna;

the control node causing the means to adjust the orientation of the network antenna to apply the new orientation to the antenna and the control node thereafter confirming the new antenna orientation with the means to measure the orientation of the network antenna;

the control node transmitting the new measured antenna orientation to the control node server; and

the control node server updating the accessible database with the new antenna orientation.

This is seen as a particularly preferred implementation of the present invention due to the fact that changes may be instructed remotely by an engineer in the field and these changes are routed through the control node server. The control node server is responsible for updating the changes in the accessible database and ensuring that the accessible database is kept up to date. Furthermore, only when the actual change has been made will the accessible database be updated thereby ensuring that the database is a true representation of the mobile network status at a given time.

In a further embodiment of the invention there is provided a method in which the method comprises the initial configuration steps of:

the control node contacting the control node server; and

the control node server responding to the control node and instructing the control node not to contact the control node server unless contacted by the control node server.
In this way, the control node essentially starts off as a client to the control node server but then changes to the function of a computer server in the normal understanding of the term. In other words, the control node receives requests for information from there on in from the control node server rather than sending information to the control node server in the manner of a normal client to the control node server.

In one embodiment of the invention there is provided a method in which the control node server additionally instructs the control node to contact the control node server when the control node is experiencing an alarm condition. In another embodiment of the invention there is provided a method in which the means to measure the orientation of the network antenna detecting a change in the orientation of the network antenna constitutes an alarm condition and the control node contacts the control node server when a change in the orientation of the network antenna is detected. In a further embodiment of the invention there is provided a method in which the data in the accessible database is viewed using a suitable web browser.

Detailed Description of the Invention

The invention will be more clearly understood from the following description of some embodiments thereof, given by way of example only, with reference to the accompanying drawings, in which:

Fig. 1 is a diagrammatic representation of a mobile communication network control system according to the invention;

Fig. 2 is a diagrammatic representation of an alternative construction of mobile communication network control system according to the invention; and

Fig. 3 is a diagrammatic representation of a control node in a base station connected to a plurality of antennae.
Referring to the drawings and initially to Fig. 1 thereof there is shown a mobile communication network control system, indicated generally by the reference numeral 1, for use in a mobile communication network 2 comprising a plurality of network antennae 3. The mobile communication network control system 1 comprises a plurality of control nodes 5 (only two of which are shown). The network antennae 3 each have means to adjust the orientation of the network antenna associated therewith (not shown) and means to measure the orientation of the network antenna associated therewith (not shown). Each control node 5 is associated with a network antenna 3, and each control node 5 has means to communicate with the associated network antennas means to adjust the orientation of the network antenna and the means to measure the orientation of the network antenna.

The mobile communication network control system 1 further comprises a control node server 7, the control node server 7 having means to communicate with each of the control nodes 5 to transmit and receive antenna orientation data to and from the control nodes. Similarly, each of the control nodes 5 has reciprocating communication means (not shown) to allow communication of antenna orientation data to and from the control node server 7. The control node server 7 further comprises an accessible database 9 having data relating to each antenna stored thereon including actual orientation data relating to each antenna. The accessible database 9 also has data relating to the individual control nodes 5 stored thereon. The control node server 7 further comprises a web interface (not shown) so that the control node server 7, the accessible database 9 and each of the control node 5 and associated antennae 3 may be accessed via the world wide web 11 by a suitable device such as a laptop 13, a mobile phone 15, a PDA 17 or a PC 19.

In use, an operator of the mobile communication network control system 1 who wishes to alter the tilt of an antennae 3 uses either the control node server 7 directly or accesses the control node server 7 via the world wide web using one of the laptop 13, the mobile communication device 15, the PDA 17 or the PC 19 and initiates communications with the control node 5 connected to the antenna 3. If necessary, the operator may access the database 9 to determine which antenna must be adjusted and which control node 5 is connected to that antenna. The
operator sends a signal from the control node server 7 via a TCP/IP link 20. Alternatively, an Ethernet 22 or a GPRS (not shown) interface could be used for communication using TCP over Ethernet or GPRS protocols between the control node server 7 and the control node 5. Once the control node 5 has been accessed, the operator then uses the control node to instruct the means to adjust the positioning of the antenna 3 to alter the tilt of the antenna 3. The means to alter the positioning of the antenna may comprise an AISG interface, a 3GPP interface or other such suitable interface. Once the antenna 3 has been moved into the appropriate position, the position is verified by the means to measure the orientation of the network antenna and a signal is sent from the antenna 3 to the control node 5 and then via communication link 20 to the control node server 7 where the control node server 7 writes the new antenna orientation data to the accessible database 9 thereby updating the antenna status in the database. This may be seen as a simple screen refresh of a web page through web interface (not shown). The operator, if accessing the control node server 7 over the world wide web and located at the point where it is desired to alter the RF signal, uses test apparatus (not shown) to monitor the RF field strength at that location and then either confirms that the signal strength is sufficient or causes the antenna to be moved once again in order to achieve sufficient RF field strength.

Referring to Figure 2 of the drawings there is shown a diagrammatic representation of an alternative construction of mobile communication network control system according to the invention, indicated generally by the reference numeral 31, where like parts have been given the same reference numerals as before. Figure 2 shows the typical sequential method steps used in altering the orientation of an antenna. In step 32, an authorised user at a laptop 13 sends an antenna orientation change request to the control node server 7. In step 33, the control node server 7 transmits the request onwards to the appropriate antenna, in this case Antenna # 2. The base station, control node and antenna are represented diagrammatically in this case by a single block 34. The control node associated with Antenna # 2, on receipt of the request from the control node server, sends a message to the means to alter the orientation of the antenna and the antenna is re-oriented in step 35 and the means to measure the orientation of the antenna sends a signal to the control node indicating the new orientation of the antenna. In step 37, the control node
associated with Antenna # 2 sends a signal back to the control node server 7 indicating that the change to the antenna has been made. The control node server thereafter sends a command to accessible database either through the network 11 as indicated by the arrow 39 or directly as indicated by arrow 41. The accessible database is updated accordingly with the new orientation information of the antenna and the records are up to date. Once the records are up to date, this will be conveyed to the user at the laptop 13 by refreshing the web page that they are viewing the status of the antenna on in step 43.

It will be understood that various modifications to the foregoing could be made without deviating from the spirit of the invention. For example, the database may be a standalone database accessible only by the control node server 7 or alternatively the user may have a view of the database independent of the server 7 through a separate web interface. Indeed, it may be possible to view the database and/or the control server through a private network other than the world wide web if deemed preferable. Similarly, if the commands are not able to be executed for a particular reason, an error command and if necessary a brief explanation may be transmitted to the user of the system. What is important is the fact that the information may be controlled centrally and furthermore a record of all changes to the antennae is kept centrally.

Referring to Figure 3 of the drawings, there is shown a diagrammatic representation of a control node 5 in a base station 21 connected to a plurality of antennae 3. The control node 5 in this case is connected to three antenna 3. Typically, an antenna mast is divided into three sections, each of which having an antenna associated therewith. Electronic circuitry 51 is provided adjacent the antennae 3 to measure the orientation of the antenna and furthermore to allow re-orientation of the antennae. The control node 5 comprises a separate control unit 53 that has been retrospectively fitted to allow communication with both the base station existing equipment 55 and the electronic circuitry 51. In this way, the system may be configured to operate with existing systems thereby allowing a retrofit of the system and method according to the invention.
It is envisaged that there will be provided a control node in each base station 21. Preferably, each control node will be connected to a plurality of antennae 3 and the control node server and the plurality of control nodes will be connected by a wide area network (WAN). It is further envisaged that the database 9 may store one or more of the control node identifiers, the antennae identifiers, the antenna settings, the antenna locations and the antenna logs to facilitate manipulation of each of the antennae in the network by an operator. Furthermore, it is envisaged that the database may have optimised settings of the antennae which may be time-based optimised settings and the control node server may have means to access the optimised antennae settings stored in the accessible database 9 and apply those settings to the antennae 3. In this way, the antenna may be adjusted automatically at certain times of day or under certain conditions such as climatic conditions and the like.

It is envisaged that the mobile communication network may communicate using TCP/IP protocol and it is further envisaged that the control node may have a microprocessor with firmware so that the control node may communicate with each of the antennae through an AISG interface or similar such interface and with the control node server through a second protocol, preferably XML scripts. The communication network may also be a company intranet accessible from the outside world with appropriate permissions. In an ideal embodiment, each control node will have an incorporated website so that the node provides an intuitive interface to that control node to allow a simple and efficient alteration of that node setting and/or the settings of the antennae associated therewith. It is envisaged that the control node may be provided with a 3-port Ethernet switch and additional equipment may be connected to the control node and powered therefrom. Each control node may further be provided with a USB interface or a similar such interface for direct connection to either a laptop or other computing device. The USB port is used for local communication to the AISG/3GPP bus using specialist communication software and is used during commissioning and the like procedures.

In order to monitor the control nodes, it is envisaged that the control node server will periodically communicate with each of the control nodes in order to determine
their exact tilt angles if changed locally and status so that alarms may be generated should a control node or antenna become inoperable or if there is a problem experienced with one or more control nodes in the mobile communication network. Finally, it is envisaged that the control node server may further comprise a web server so that the control node server may be accessed via the world wide web. The web server will ideally operate using Microsoft (Registered Trademark) IIS with standard HTML pages. This is seen as a particularly simple implementation of mobile communication network control system to use. In certain embodiments, other systems may also be allowed to access the data in the database for reporting, monitoring and/or other requirements.

In the embodiments described, each control node 5 device has a built in POE (Power over Ethernet) port for easily attaching cameras and the like for security and other purposes, e.g. head cameras for police and local authorities that allow the operator to sell mast area and bandwidth for extra revenue. The individual devices also have a method of updating their firmware automatically by the server detecting the nodes firmware version and sending appropriate updates if deemed necessary. Each device may be provided with a temperature sensor for detecting overheating in the base station cabinet due to air-conditioning failure thereby assisting in the prevention of overheat shutdown. Furthermore, each device may be provided with adjustable mounting brackets that adjust for the various mounting requirements of the node and an inbuilt power converter for converting to the -48V +24V ASG requirements.

It is envisaged that the present invention may also operate in the presence of firewalls, for example if the antenna base station is located in a private house or business establishment with such a firewall in place. Typically, firewalls prevent external communications coming in to a system. Furthermore, the router built in to the base station that the node is connected to may have a firewall built in to the system which would prevent receipt of external communications. However, the present invention obviates this difficulty by initiating the connection from the base station to the server. This is carried out on initial plug in of the device. Essentially, the device hunts for the server and once communication is made, the device no longer transmits to the server unless requested to do so or required to so in the
event of an emergency condition. By making the node go offline and waiting for Communications from the control node server, the communication overhead and computation overhead required by the control node server is significantly reduced. In this way, bandwidth is reserved for these communications which is counter-intuitive in normal applications.

In this specification the terms "comprise, comprises, comprised and comprising" or any variation thereof and the terms "include, includes, included and including" or any variation thereof are considered to be totally interchangeable and they should be afforded the widest possible interpretation.

The invention is in no way limited to the embodiments hereinbefore described but may be varied in both construction and detail within the scope of the claims.
Claims

1. A mobile communication network control system (1) for use with a mobile communication network (2), the mobile communication network (2) comprising a plurality of network antennae (3), each of the network antennae having means to adjust the orientation of the network antenna associated therewith and means to measure the orientation of the network antenna associated therewith, the control system (1) comprising a plurality of control nodes (5), each control node being associated with at least one network antenna and each control node having means to communicate with both the means to adjust the orientation of the network antenna and the means to measure the orientation of the network antenna, characterised in that:

   the control system (1) further comprises a control node server (7) located remote from the control nodes (5), the control nodes each having means to communicate with the control node server (7), the control node server having means to receive antenna orientation data from the control nodes and means to transmit antenna orientation data to the control nodes to cause re-orientation of the antenna associated with the control node.

2. A control system (1) as claimed in claim 1 in which the control node server (7) further comprises an accessible database (9) having data including actual orientation data relating to each antenna (3) stored thereon.

3. A control system (1) as claimed in claim 2 in which the control node server (7) has means to verify with the control node (5) when an orientation change has been made to an antenna (3) and on verification of the orientation change, update the antenna data relating to that antenna (3) stored in the accessible database (9).

4. A control system (1) as claimed in any preceding claim in which the control node server (7) further comprises a web server and a web interface to allow access to the control node server over the world-wide web.
5. A control system (1) as claimed in any preceding claim in which each control node (5) is provided with one of an Ethernet and a GPRS interface to allow communication with the control node server.

6. A control system (1) as claimed in any preceding claim in which each control node (5) is provided with an AISG interface for communication with an antenna.

7. A control system (1) as claimed in any of claims 1 to 5 in which each control node (5) is provided with a 3GPP interface for communication with an antenna.

8. A control system (1) as claimed in any preceding claim in which at least one of the control nodes (5) is associated with a plurality of antennae.

9. A control system (1) as claimed in any preceding claim in which the control node server (7) and the plurality of control nodes (5) are connected by way of wide area network (WAN).

10. A control system (1) as claimed in claim 2 in which the accessible database (9) has one or more of the control node identifiers, antenna identifiers, antenna settings, antenna locations and antenna logs stored thereon.

11. A control system (1) as claimed in any preceding claim in which the accessible database (9) has optimised settings for each of the antennae stored thereon.

12. A control system (1) as claimed in claim 11 in which the optimised settings for the antennae further comprise time-based optimised antenna settings.

13. A control system (1) as claimed in claim 11 or 12 in which the control node server (7) has means to access the optimised antenna settings stored in the accessible database and apply those settings to the antennae (3).
14. A control system (1) as claimed in any preceding claim in which the mobile communication network (2) further comprises a plurality of base stations (21) and there is provided only one control node (5) in each base station.

15. A control system (1) as claimed in any preceding claim in which the control node (5) has a microprocessor with firmware to communicate with the hardware associated with the antenna (3) through a first protocol and with the control node server (7) through a second protocol.

16. A control system (1) as claimed in claim 15 in which the second protocol further comprises XML scripts.

17. A control system (1) as claimed in any preceding claim in which each control node (5) has an incorporated website.

18. A control system (1) as claimed in any preceding claim in which each control node (5) further comprises a 3-port Ethernet switch.

19. A control system (1) as claimed in any preceding claim in which each control node (5) has additional equipment connected thereto and powered thereby.

20. A control system (1) as claimed in any preceding claim in which the control node (5) has an interface for direct connection to a computing device.

21. A control system (1) as claimed in any preceding claim in which the control node (5) has an alarm input/output for base station security.

22. A control system (1) as claimed in any preceding claim in which the control node server (7) has means to periodically communicate with each of the control nodes.

23. A method of operating a mobile communications network (2), the mobile communications network (2) comprising a control node server (7), an
accessible database (9), a plurality of control nodes (5) and a plurality of network antenna (3), each of the network antenna (3) having means to adjust the orientation of the network antenna associated therewith and means to measure the orientation of the network antenna associated therewith, each control node (5) being associated with at least one network antenna (3) and having means to communicate with both the means to adjust the orientation of the network antenna and the means to measure the orientation of the network antenna, the control nodes (5) each having means to communicate with the control node server (7), characterised in that the method comprises the steps of:

the control nodes (5) obtaining actual antenna orientation data relating to the network antenna (3) associated therewith;

the control node server (7) communicating with each of the control nodes (5) and obtaining the actual orientation data relating to each of the network antennae (3);

the control node server (7) storing the actual orientation data relating to each of the network antennae in the accessible database for viewing by authorised individuals.

24. A method as claimed in claim 23 in which the method further comprises the steps of:

an authorised individual transmitting a network antenna (3) orientation adjustment command to one of the control nodes (5);

the control node (5) causing the means to adjust the orientation of the network antenna (3) to apply the new orientation to the antenna and the control node (5) thereafter confirming the new antenna orientation with the means to measure the orientation of the network antenna; and

the control node (5) transmitting the new measured antenna orientation to
the accessible database (9).

25. A method as claimed in claim 24 in which the step of the control node (5) transmitting the new measured antenna orientation to the accessible database (9) further comprises the control node (5) transmitting the new measured antenna orientation to the control node server (7) and the control node server (7) updating the accessible database (9) with the new antenna orientation.

26. A method as claimed in claim 23 in which the method further comprises the steps of:

an authorised individual transmitting a network antenna (3) orientation adjustment command to the control node server (7);

the control node server (7) forwarding the orientation adjustment command onwards to the control node (5) associated with that network antenna (3);

the control node (5) causing the means to adjust the orientation of the network antenna (3) to apply the new orientation to the antenna and the control node (5) thereafter confirming the new antenna orientation with the means to measure the orientation of the network antenna;

the control node (5) transmitting the new measured antenna orientation to the control node server (7); and

the control node server (7) updating the accessible database (9) with the new antenna orientation.

27. A method as claimed in any of claims 23 to 26 in which the method comprises the initial configuration steps of:

the control node (5) contacting the control node server (7); and
the control node server (7) responding to the control node (5) and instructing the control node (5) not to contact the control node server (7) unless contacted by the control node server (7).

28. A method as claimed in claim 27 in which the control node server additionally instructs the control node (5) to contact the control node server (7) when the control node is experiencing an alarm condition.

29. A method as claimed in claim 28 in which the means to measure the orientation of the network antenna detecting a change in the orientation of the network antenna constitutes an alarm condition and the control node (5) contacts the control node server (7) when a change in the orientation of the network antenna is detected.

30. A method as claimed in any of claims 23 to 29 in which the data in the accessible database is viewed using a suitable web browser.
A. CLASSIFICATION OF SUBJECT MATTER
INV. H01Q3/00 H04Q7/36 H04L12/24

According to International Patent Classification (IPC) or to both national classification and IPC.

B. FIELDS SEARCHED
Minimum documentation searched (classification system followed by classification symbols)
H01Q H04Q H04L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and where practical search terms used)
EPO-Internal , WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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<th>Relevant to claim No</th>
</tr>
</thead>
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<td>A</td>
<td>EP 1 026 778 A (LUCENT TECHNOLOGIES INC [US]) 9 August 2000 (2000-08-09) abstract; figure 1</td>
<td>1-30</td>
</tr>
</tbody>
</table>

Further documents are listed in the continuation of Box C

See patent family annex

'A' Special categories of cited documents 'A' document defining the general state of the art which is not considered to be of particular relevance
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Date of the actual completion of the international search
2 August 2007

Date of mailing of the international search report
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Kahl, Marcus
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<tr>
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<th>Patent family member(s)</th>
<th>Publication date</th>
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</thead>
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<td></td>
<td></td>
<td>DE 60028466 T2</td>
<td>28-12-2006</td>
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<td></td>
<td>DK 1067626 T3</td>
<td>09-10-2006</td>
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<tr>
<td></td>
<td></td>
<td>US 6239744 B1</td>
<td>29-05-2001</td>
</tr>
<tr>
<td>EP 1026778 A</td>
<td>09-08-2000</td>
<td>BR 0000293 A</td>
<td>19-12-2000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CA 2296988 A1</td>
<td>01-08-2000</td>
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<td></td>
<td>CN 1264257 A</td>
<td>23-08-2000</td>
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<tr>
<td></td>
<td></td>
<td>ID 27123 A</td>
<td>01-03-2001</td>
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<td></td>
<td></td>
<td>JP 3492967 B2</td>
<td>03-02-2004</td>
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<td>JP 2000269723 A</td>
<td>29-09-2000</td>
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<td></td>
<td>KR 20000057836 A</td>
<td>25-09-2000</td>
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<td></td>
<td>US 6549529 B1</td>
<td>15-04-2003</td>
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<tr>
<td></td>
<td></td>
<td>AU 6859898 A</td>
<td>22-10-1998</td>
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<tr>
<td></td>
<td></td>
<td>CA 2284177 A1</td>
<td>08-10-1998</td>
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<td>CN 1258416 A</td>
<td>28-06-2000</td>
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<td></td>
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<td>07-12-1999</td>
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