

(19) World Intellectual Property Organization
International Bureau



(43) International Publication Date
30 March 2006 (30.03.2006)

PCT

(10) International Publication Number
WO 2006/033685 A2

(51) International Patent Classification:
G06K 9/34 (2006.01)

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(21) International Application Number:
PCT/US2005/019828

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(22) International Filing Date: 6 June 2005 (06.06.2005)

(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SM, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
0414225.3 25 June 2004 (25.06.2004) GB

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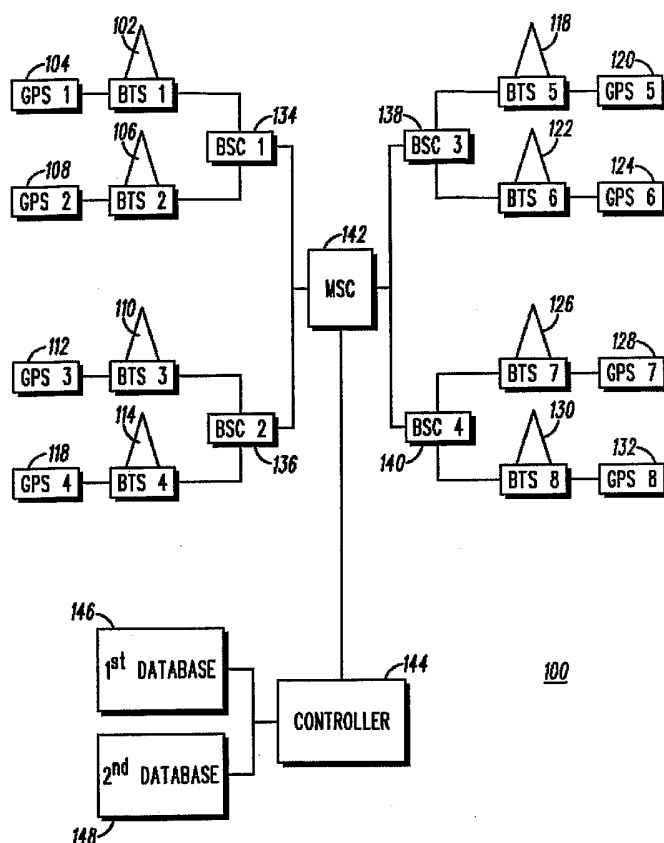
(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI,

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[Continued on next page]

(54) Title: WIRELESS COMMUNICATIONS NETWORK AND METHOD OF DETERMINING ADJACENCY OF SITES IN A WIRELESS COMMUNICATIONS NETWORK



(57) Abstract: A wireless communications network (100) comprising a plurality of sites, each of which is served by a base transceiver station (102, 106, 110, 114, 118, 122, 126, 130). The base transceiver stations (102, 106, 110, 114, 118, 122, 126, 130) are connected with other elements of infrastructure (134 - 142) and at least one of said base transceiver stations (102) comprises means (104) for determining its geographical location. Said base transceiver station (102) is adapted to be moved from a first geographical location to a second geographical location. A first database (146) is configured to store location data of said base transceiver stations (102, 106, 110, 114, 118, 122, 126, 130). The network (100) further comprises a controller (144) configured to receive location data from the at least one base transceiver station (102) and from the first database (146) and to determine adjacency of sites.

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FR, GB, GR, HU, IE, IS, IT, LT, LU, MC, NL, PL, PT, RO,
SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN,
GQ, GW, ML, MR, NE, SN, TD, TG).

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.

Published:

— *without international search report and to be republished
upon receipt of that report*

**WIRELESS COMMUNICATIONS NETWORK AND METHOD OF DETERMINING
ADJACENCY OF SITES IN A WIRELESS COMMUNICATIONS NETWORK**

5 **Field of the Invention**

The present invention relates to a wireless communication network, in general, and in particular, to a method of determining adjacency of sites in a wireless communications network.

10

Background of the Invention

In a cellular communication system (like for example the Global System for Mobile communication (GSM) and
15 TETRA (TErrestrial Trunked RAdio)), a geographical region is divided into a number of cells each of which is served by a base transceiver station. One base transceiver station, also termed as Base Transceiver Station (BTS) with a switching infrastructure is referred as a node of
20 the network. The switching infrastructure supporting BTS may be shared with other BTSS. The system infrastructure in a TETRA system is generally referred to as a switching and management infrastructure (SwMI), which substantially contains all of the communication elements apart from the
25 Mobile Stations (MSs). This includes base transceiver stations (BTSS) connected to a conventional public-switched telephone network (PSTN) through base station controllers (BSCs) and mobile switching centres (MSCs). In geographical terms reference to a node is a reference
30 to an area served by one BTS, and in network terms reference to a node is a reference to the infrastructure equipment required to support one or more BTSS. A remote

unit referred also as subscriber or mobile station (MS) or communication unit is served via a radio communication link by the BTS of the cell within which the remote unit is operating.

5

One of the basic advantages of the cellular communications systems is that subscriber may move from one geographical location to another one while receiving services from the network. To provide seamless service there are regions of overlapping coverage between base transceiver stations. As the subscriber moves from area served by a first base transceiver station towards area served by a second base transceiver station it enters the region of overlapping coverage. Within the region of overlapping coverage the subscriber changes the serving base transceiver station. This is known as cell reselection or handover.

The communication link from a BTS to a subscriber is generally referred to as a downlink communication channel. Conversely, the communication link from a subscriber to a BTS is generally referred to as an up-link communication channel.

To enable communication between two handsets operating in two different cells a fixed network interconnects the base transceiver stations. The fixed network is operable to route data between any two base transceiver stations and this way allows for communication between these two remote handsets. In addition, the fixed network may comprise gateway functions for interconnecting to external networks such as the Public Switched Telephone Network (PSTN). This

allows subscribers to communicate with landline
telephones and other communication terminals connected by
a landline. Additionally the fixed network is adapted to
perform functions required for managing a conventional
5 cellular communication network including routing data,
admission control, resource allocation, subscriber
billing, mobile station authentication etc.

The TETRA communications system may be used as a
10 public cellular communication system. However a principal
application of TETRA communication systems is for use by
are organizations or groups such as emergency services.
Special functions and services implemented in the TETRA
system make this system especially suitable for services
15 like police, emergency, fire rescue or others. One of
such features provided by TETRA system, which is
especially useful for the emergency services is
controlling group calls as well as managing the
membership of these groups. Other features and services
20 provided by TETRA include, push-to-talk channel
allocation, broadcast calls etc. In addition to trunked
mode operation wherein remote units communicate via a
base transceiver station, TETRA provides for the
possibility of communication directly between remote
25 units without participation of the infrastructure. This
is known as Direct Mode Operation (DMO).

A deployable or ad-hoc network may be considered as
one in which the topology of the network and number of
30 nodes which together offer service to mobile users
changes from time to time. The connections between these
nodes also change in number and topography from time to

time, either together with or independently of changes in the nodes. Nodes may be added or may be taken away.

5 In such deployable networks it is necessary for the infrastructure to know the adjacencies of the base transceiver station sites in order to aid subscriber handover when roaming between base transceiver stations. In networks known in the art the adjacency information is configured manually based on the knowledge of topology of
10 the radio system. However if the base transceiver stations are moved from one location to another, e.g. in military communications network, then the update of adjacencies is complicated and time consuming.

15 A need therefore exists for a method of controlling and identifying location information of base transceiver stations in a communications network, particularly when the network is required to be operational irrespective of reconfiguration processes.

20

Summary of the Invention

According to a first aspect of the present invention there is provided a wireless communications network as claimed in claim 1.

25

According to a second aspect of the present invention there is provided a method of determining adjacency of sites in a wireless communications network as claimed in claim 16.

30

The present invention beneficially allows for:

- re-configuration of the network's control channels after moving at least one of the Base Stations between two different locations;
- quick and automatic configuration of newly
5 deployed network;
- automatic re-configuration of the network's adjacent channel configuration for broadcast on the control channels after moving at least one of the Base Transceiver Stations between two
10 different locations;
- automatic prediction of interference between newly deployed and existing Base Transceiver Stations and mechanism for changing the transmit/receive frequencies of the Base
15 Transceiver Stations accordingly.

Brief description of the drawings

The present invention will be understood and
20 appreciated more fully from the following detailed description taken in conjunction with the drawings in which:

FIG. 1 is a diagram illustrating a wireless
25 communications network in one embodiment of the present invention;

FIG. 2 is a diagram illustrating portion of a
wireless communications network in one embodiment of the
30 present invention;

FIG. 3 is a diagram illustrating portion of a wireless communications network in one embodiment of the present invention;

FIG. 4 is a flow chart illustrating a method of determining adjacency of sites in a wireless communications network in one embodiment of the present invention.

Description of an embodiment of the invention

The following description focuses on an embodiment of the invention applicable to a TETRA cellular communication system. However, it will be appreciated that the invention is not limited to this application but may be applied to many other communication systems (e.g. APCO Project 25 or GSM and other digital and analogue communication systems).

With reference to FIG. 1 through FIG. 3 a wireless communications network 100 (e.g. deployable or ad-hoc communications network) in one embodiment of the present invention is shown. For the sake of clarity the diagram illustrating embodiment of the network 100 depicted on FIG. 1 is simplified. The network 100 comprises a plurality of sites, each of which is served by a base transceiver station 102, 106, 110, 114, 118, 122, 126, 130. These base transceiver stations 102, 106, 110, 114, 118, 122, 126, 130 are connected with other elements of infrastructure like Base Station Controllers 134 - 140 or Mobile Switching Centres 142. All elements of infrastructure are connected by means of so called backbone network. Depending on particular embodiment the

backbone network can be a fixed wireline network or network based on radio links or a combination of wireline and radio links.

5 In one embodiment at least one of said base transceiver stations 102, 106, 110, 114, 118, 122, 126, 130 comprises means 104 for determining its geographical location. However in alternative embodiments every base transceiver station in the network 100 has said means for
10 determining its geographical location. In one embodiment, the means for determining geographical location is a Global Positioning System (GPS) unit 104, 108, 112, 116, 120, 124, 128, 132. The primary function of the GPS unit in the base transceiver station is providing
15 synchronization with other elements of the network. For said synchronization a very accurate time signal received by the GPS unit is used.

 In deployable or ad-hoc networks said base
20 transceiver stations 102, 106, 110, 114, 118, 122, 126, 130 are adapted to be moved from one geographical location to other geographical location. In the simplest case only one base transceiver station 102 is moved from a first location to a second location. Moving base
25 transceiver stations or deploying network in new locations is especially useful in communication networks used by special services, like police, fire fighters, etc. It may happen that they will need communication network in a place where it was not necessary before
30 (e.g. in places of big events when a huge group of people gathers in remote place for limited period of time).

The network 100 further comprises a first database 146 configured to store location data of said base transceiver stations 102, 106, 110, 114, 118, 122, 126, 130. The location data consist of coordinates of the base transceiver stations. Another element of the network 100 is a controller 144 which is configured to receive location data from the at least one base transceiver station 102 and from the first database 146 and to determine adjacency of sites based on the received data. Determining how sites are adjacent to each other is necessary to configure control channels and to eliminate interference and correct coverage of area of the site. To meet this objective said controller 144 is adapted to update 213 the infrastructure with determined adjacency data and said infrastructure is adapted to adjust its settings in response to said adjacency data.

In one embodiment said infrastructure configures control channels to transmit the adjacency data to Mobile Stations. The Mobile Stations need these data to know which frequencies should search on for possible BTS to roam to. The adjacency information is also used for changing frequencies of signals transmitted by the BTSs (on RF channels, i.e. control channels and traffic channels) in a way that interference between signals transmitted by the BTSs is avoided.

In the simplest case the adjacency is determined only on the basis of location data of the base transceiver stations 102, 106, 110, 114, 118, 122, 126, 130. However in alternative embodiments topography of the area is also considered. In these alternative embodiments

the controller 144 is configured to obtain topographical data from a second database 148.

There are many possible embodiments that provide
5 access to the second database 148. The second database 148 may be:

- 1) a separate unit of the network's 100 infrastructure and accessed by the controller 144 via the backbone network;
- 10 2) integrated with the first database 146;
- 3) incorporated in the controller 144 (separately or integrated with the first database 146);
- 4) independent and remote from the network 100 and accessed by the controller 144 via internet or other
15 network.

The network 100 is configured in a way that if the second database 148 is not available or does not contain topographical data of required area the controller 144
20 determines adjacency based only on the location data provided by the base transceiver stations 102, 106, 110, 114, 118, 122, 126, 130 to the first database 146.

In one embodiment the controller 144 is a computing
25 device operably connected to a Base Station Controller 134 - 140. Alternatively it can be connected to a Mobile Switching Centre 142 or be implemented as a stand-alone device operably connected to the backbone network (network that interconnects the communication network's
30 infrastructure).

In yet another embodiment the controller 144 is a computing device integrated with a Base Station Controller 130 - 140 or a Mobile Switching Centre 142.

5 If the location of the base transceiver station has changed significantly since the last time the location was determined, the location is transmitted to the controller 144 where the locations of all base transceiver stations are stored and/or processed.

10

The distance between base transceiver stations' locations can then be determined by the controller 144 based on simple calculations on the longitude/latitude stored for each base transceiver station.

15

The determination, of which base transceiver stations are adjacent to each other, can then be made based on the distance between the base transceiver stations. This could be any base transceiver station
20 closer than a given (configurable) distance (for example less than 10 km apart) or a specific number of the closest base transceiver stations (for example the three closest).

25

In a trunking radio system (like a TETRA system) every base transceiver station broadcasts information about adjacent base transceiver stations. This is done for mobility management in order for the individual Mobile Stations to know which frequencies to search on
30 for possible base transceiver stations to roam to. The actual roaming is done following the air interface protocol and trunking standard. In order for the individual base transceiver stations to know which

adjacent base transceiver stations to broadcast information about, the base transceiver stations needs to know the adjacency information. This controller 144 informs all the base transceiver stations about their
5 current adjacencies. In an alternative implementation the base transceiver stations are configured with information about the possible adjacencies and with a keep-alive protocol (like polling) that determines the current operation of the possible adjacent base transceiver
10 stations.

With reference to FIG. 4 a method of determining adjacency of sites in a wireless communications network 100 (e.g. deployable or ad-hoc communications network) in
15 one embodiment of the present invention is shown. The method comprises the step of deploying a first base transceiver station in a second geographical location. This deployment may be a result of building a new network or reconfiguration of the existing network 100 where said
20 reconfiguration involves moving at least one, 102, of the base transceiver stations from a first geographical location to a second geographical location. When the base transceiver station 102 is deployed in a second location said GPS unit 104 determines its geographical coordinates
25 using GPS data. In alternative embodiment said coordinates are determined, based on GPS data, in the base transceiver station 102.

In the next step said coordinates are transmitted
30 206 from said first base transceiver station 102 to a first database 146, wherein said first database 146 is used for storing location data of base transceiver stations of said network 100.

Next, in said controller 144, adjacency of sites is determined 212 using data from said first database 146. In one embodiment in addition to the location coordinates
5 from the first database 146 said controller 144 obtains topographical data from a second database 148.

When the adjacency is determined 212 said controller 144 updates 213 the infrastructure with said determined
10 212 adjacency data. It is important that the infrastructure adjusts its settings in response to said adjacency data. In one embodiment, in the step of adjustment the infrastructure, to avoid interference, changes frequency 214, 216 of RF channels provided in
15 said sites, in response to said adjacency data.

In summary the invention provides a communication network having base transceiver stations with means for determining geographical coordinates of the base
20 transceiver station and for determining adjacency of sites on the basis of said coordinates and in consequence for configuration of the control channels in the sites of the network 100 in such a way that information on adjacent sites is transmitted on the control channel.
25 This information is used by individual Mobile Stations in order to know which frequencies to search on for possible BTS to roam to. The adjacency information is also used for changing frequencies of signals transmitted by the BTSs in a way that interference between signals
30 transmitted by the BTSs is avoided.

Claims

1. A wireless communications network (100) comprising:
a plurality of sites, each of which is served by a
5 base transceiver station (102, 106, 110, 114, 118, 122,
126, 130), wherein said base transceiver stations (102,
106, 110, 114, 118, 122, 126, 130) are connected with
other elements of infrastructure (134 - 142) and at least
one of said base transceiver stations (102) comprises
10 means (104) for determining its geographical location,
wherein said base transceiver station (102) is adapted to
be moved from a first geographical location to a second
geographical location;
a first database (146) configured to store location
15 data of said base transceiver stations (102, 106, 110,
114, 118, 122, 126, 130);
a controller (144) configured to receive location
data from the at least one base transceiver station (102)
and from the first database (146) and to determine
20 adjacency of sites.
2. The network (100) according to claim 1,
wherein said controller (144) is configured to
obtain topographical data from a second database (148);
25 wherein said controller comprises said first
database and said second database integrated (150) into
one unit of said controller (144); and
wherein said controller (144) is a computing device
operably connected or integrated a) to a Base Station
30 Controller (134 - 140), b) to a Mobile Switching Centre

(142) or c) to a network that interconnects the network's infrastructure as a stand-alone device.

3. The network (100) according to claim 1, wherein said
5 means (104) for determining geographical location is a GPS unit.

4. The network (100) according to claim 1, wherein said
controller (144) is adapted to update the infrastructure
10 with determined adjacency data.

5. The network (100) according to claim 2 wherein said
infrastructure, in response to said adjacency data is
adapted to at least one of a) to adjust its settings, b)
15 to configure control channels, provided in said sites in
such a way that information on adjacent sites is
transmitted on the control channel, and c) to change
frequency of RF channels of said base transceiver
stations (102, 106, 110, 114, 118, 122, 126, 130).

20

6. A method of determining adjacency of sites in a
wireless communications network (100) comprising the
steps of:

25 deploying a first base transceiver station in a second
geographical location;

determining coordinates (204) of said second
geographical location;

30

transmitting (206) said coordinates from said first
base transceiver station (102) to a first database

(146) for storing location data of base transceiver stations of said network;

in said controller (144), determining adjacency (212)
5 of sites using data from said first database.

7. The method according to claim 6, wherein said controller (144) updates (213) the infrastructure with determined (212) adjacency data.

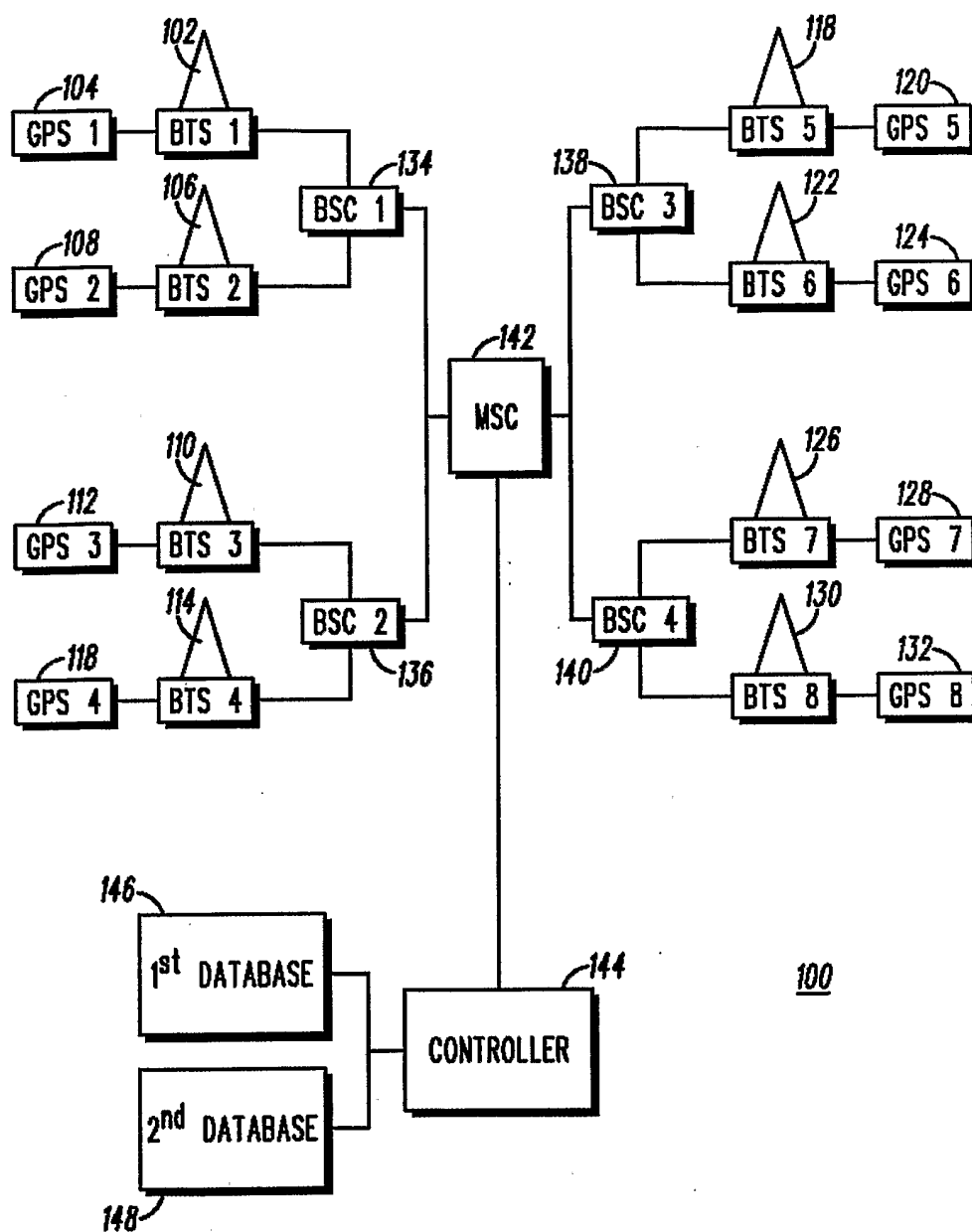
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8. The method according to claim 7, wherein said infrastructure in response to said adjacency data performs at least one of a) adjusts its settings, b) configures control channels (216) provided in said sites
15 in such a way that information on adjacent sites is transmitted on the control channel, and c) changes frequency (214, 216) of RF channels of said Base Transceiver Stations.

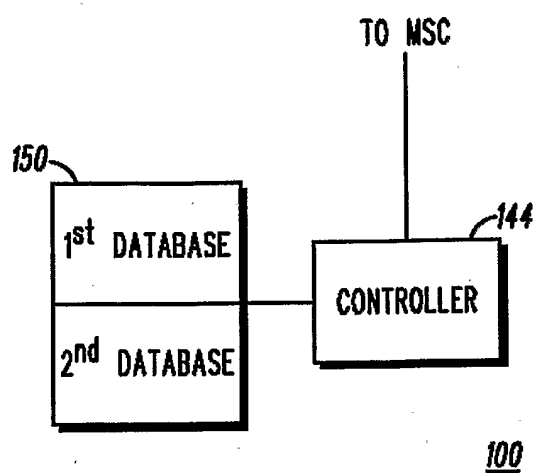
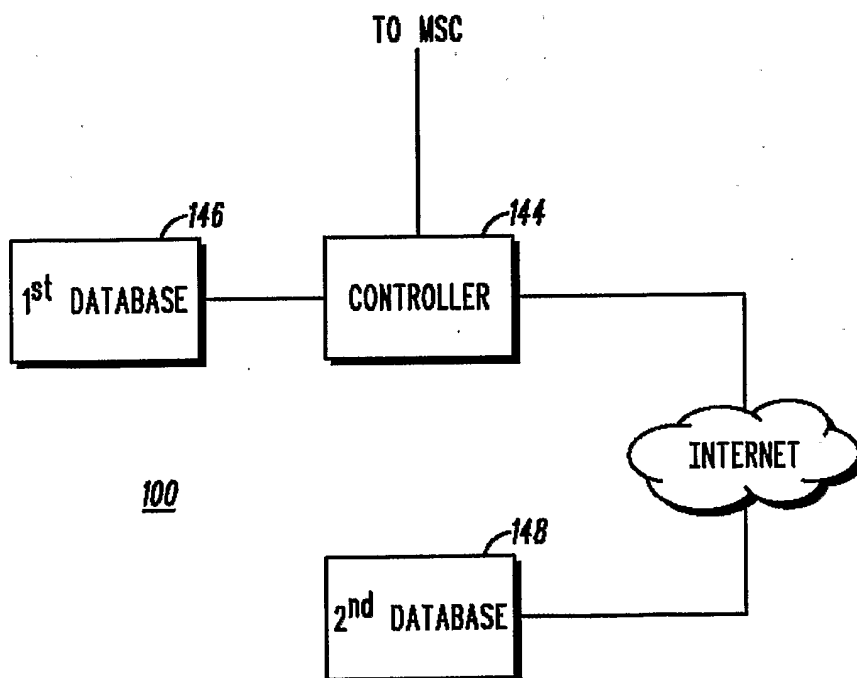
20 9. The method according to claim 6, wherein said controller (144) obtains topographical data from a second database (148).

10. The method according to claim 6, wherein said first
25 base transceiver station is deployed in the second geographical location after moving (202) from a first geographical location.

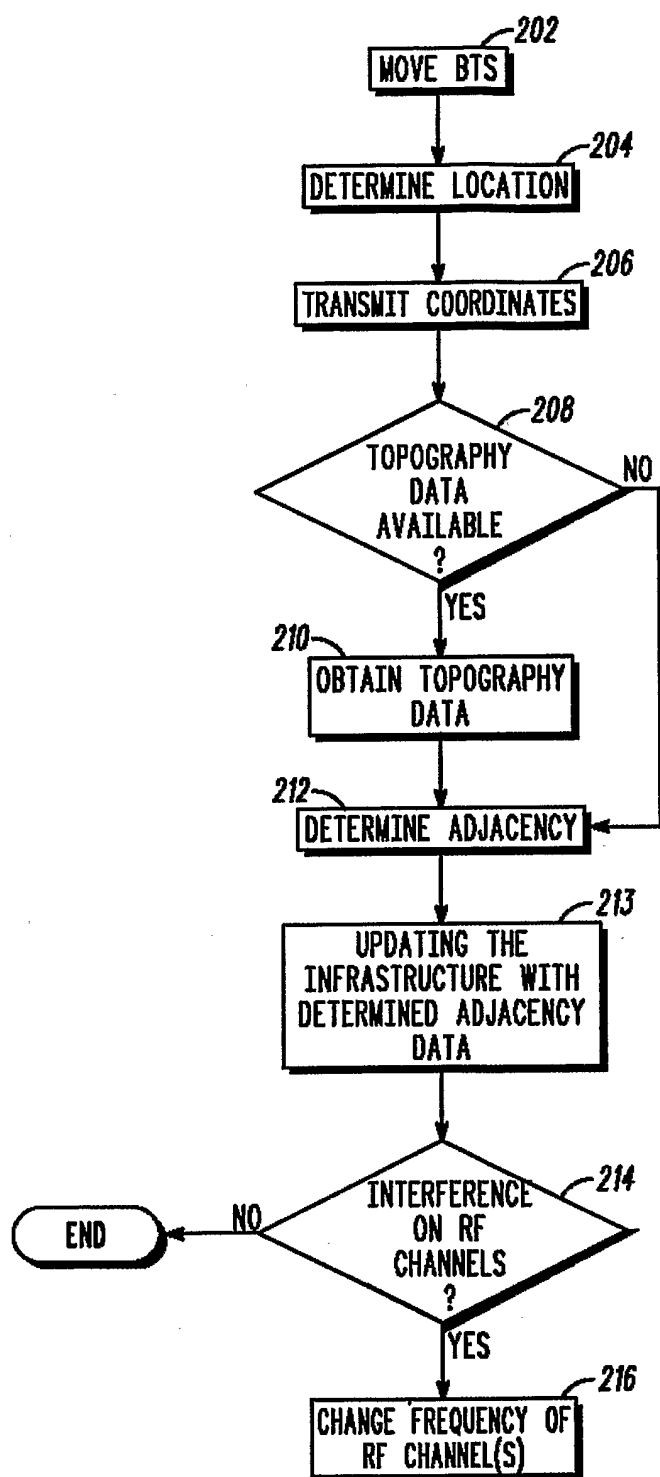
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**FIG. 1**

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**FIG. 2****FIG. 3**

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**FIG. 4**