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(54) Title: METHOD FOR SURROGATE MONITORING RADIO ACCESS POINTS

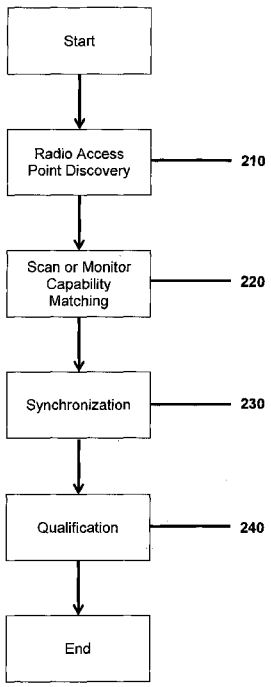

FIGURE 2

(57) Abstract: The present invention relates to a method for surrogate monitoring on-air- information of a plurality of radio access points that are co-located by using an independent monitoring radio. In general, the monitoring radio performs scanning or monitoring of on-the-air information, specifically time variant parameters and time invariant parameters, specified by and on behalf of the radio access points in order to significantly free the resources required by the said radio access points to perform their normal operation. According to the present invention, the radio access points must be within the scanning vicinity of the monitoring radio and registered with a central manager, which can be determined by the step of radio access points discovery (210). Further, the present invention introduces steps of scan or monitor capability matching (220), synchronization (230), and qualification (240) to select, determine, and register the time variant parameters and time invariant parameters in a surrogate monitoring list, which is to be used by the monitoring radio as a reference to perform the scan or monitor task.

WO 2014/084713 A1

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METHOD FOR SURROGATE MONITORING RADIO ACCESS POINTS

TECHNICAL FIELD OF THE INVENTION

The present invention relates generally to a method for surrogate monitoring radio access points, and more particularly to a method for surrogate monitoring on-air-information of a plurality of radio access points that are co-located.

BACKGROUND OF THE INVENTION

The conventional method to monitor on-the-air information for a group of radio access points is by using a simple network management protocol (SNMP) to query each radio access point for the desired information on a fixed interval or on a demand basis.

Such approach is challenging due to a couple of reasons. The first one being resource intensive. The conventional way requires a central entity to continuously poll a radio access point or a group of radio access points to report data in a periodically manner back to the central entity. This, in turn, allows the central entity to get a real-time or timely network status information to support critical collective decision making function, such as selection of a channel for each access point.

Apart from the above, another challenge faced by the conventional method would be the hardware/software constraint. The conventional method requires each radio access point to perform a periodic scanning. To do that each radio access point needs to be in scan mode from time to time in accordance with a certain schedule. This is practically challenging. Furthermore, the radio access point only sees a single channel at a time during operation and hence, it has limited view of the network neighborhood.

US publication no. 2010/0278117 A1 discloses a channel management system in a wireless network that includes a master radio and a surrogate radio. The

master radio performs data communication with one or more clients on a first channel in the wireless network, and the surrogate radio simultaneously scans other channels in the wireless network. A channel manager determines if a channel switch is needed, and subsequently the data communication is switched to a second channel based on the scanning of the other channels. This prior art proposes a surrogate radio to scan other radio channels while the master radio maintains the data communications. However, the system of this particular prior art does not comprise methods to discover co-located radio access points from the air, perform scan or monitor capability matching between the master radio and the surrogate radio, and perform synchronization and qualification of parameters that are to be scanned or monitored by the surrogate radio on behalf of the master radio. The prior art assumes that the radio signals received by the master radio as well as the surrogate radio are having the same level, or equal in terms of properties.

US patent no. 5,185,860 discloses a computer network node discovery system that provides a general way of discovering network elements, or nodes, connected to a computer network, and a specific algorithm for discovering nodes connected to a TCP/IP network, using the SNMP protocol available within the TCP/IP network software. Some nodes on a network, called discovery agents, can convey knowledge of the existence of other nodes on the network. The network discovery system queries these agents and obtains the information they have about other nodes on the network. It then queries each of the obtained nodes to determine if that node is also a discovery agent. In this manner, most of the nodes on the network can be discovered. However, one major disadvantage of the prior art is that the traditional SNMP is used to discover and manage the radio access points, which in turn leads to the well known challenges of resource intensive and hardware/software constraint.

US patent no. 8,019,851 B2 discloses a system, method and computer program product for intelligent discovery of network information from multiple information gathering agents adapted to discover information concerning the network. The discovery agents each have an associated discovery capability. Based on

consideration of the agent discovery capabilities, discovery assignments are computed and network discovery is performed according to the assignments so as to reduce discovery poll overhead. Similar to the disadvantage of US patent no. 5,185,860 as discussed above, this prior art is also using traditional SNMP method to discover and manage radio access points, which leads to the issues of resource intensive and hardware/software constraint.

In light of the above, it therefore has become the aim of the present invention to overcome the above-identified technical issue by providing a method for surrogate monitoring on-air-information of a plurality of radio access points that are co-located by using an independent monitoring radio.

SUMMARY OF THE INVENTION

The present invention is directed to a method for surrogate monitoring on-the-air information of a plurality of radio access points that are co-located by using an independent monitoring radio.

In general, the communications between the radio access points and the monitoring radio are managed by an element called central manager, wherein the said communications, on the whole, determine the possibility and capability of the monitoring radio to execute the monitoring task on behalf of the radio access points and establishing this unique relationship between the monitoring radio and the radio access points. With the support of the monitoring radio, the central manager can therefore make a better collective decision, such as selection of optimum channels to be allocated to radio access points, based on the neighbor network conditions.

According to the present invention, it is essential to ensure that each of the co-located radio access point is within the scanning vicinity of the monitoring radio in order to register each radio access points with the central manager for surrogate monitoring service. This can be accomplished by a first step of radio access points discovery. Initially, each radio access point retrieves its own

wireless radio interface information and sends it together with a request for surrogate monitoring service to the central manager. Upon receiving the request, the central manager will instruct the monitoring radio to scan for each radio access point based on the wireless radio interface information, and proceeds to register the radio access points in a candidate list upon confirmation that the radio access points are indeed within the scanning vicinity of the monitoring video.

Thereafter, a second step of scan or monitor capability matching is carried out. Fundamentally, this particular step is to determine the capability of each radio access points and the monitoring radio in scanning or monitoring parameters, and to verify that the monitoring radio is indeed able to scan or monitor the parameters specified by each radio access points. At the start, the central manager requests each radio access point registered in the candidate list to provide parameters that are to be scanned or monitored. The central manager then proceeds to request each radio access point and the monitoring radio to perform a local scan or monitor capability premised on the provided parameters. Based on the local scan or monitor capability results, the central manager searches for parameters that are matching, and registers the same in a parameter list.

Then, a third step of synchronization is performed to essentially further decide on the matching parameters that are to be scanned or monitored, and also to decide on data sampling criteria. Subsequently, the central manager instructs each radio access points and the monitoring radio to perform a local scan on themselves based on the selected matching parameters and the selected data sampling criteria, and revert to the central manager with the processed data of the local scan results.

With the processed data, the central manager is then able to execute a fourth step, namely qualification, that includes the central manager to perform a correlation test on the said processed data, and proceeds to rate the same based on the correlation test. Next, the central manager compares the rating

against a qualification policy, and proceeds to register the selected matching parameters that are associated with the rating that has passed the qualification policy in a surrogate monitoring list. Lastly, the central manager instructs the monitoring radio to scan or monitor the parameters registered in the surrogate monitoring list on behalf of each registered radio access point, and instructs each registered radio access point to resume its normal operating mode.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 illustrates a general scenario of the method in accordance with the present invention;

Figure 2 illustrates a flow chart of the overall method in accordance with the present invention;

Figure 3 illustrates a flow chart of the step of radio access points discovery;

Figure 4 illustrates a flow chart of the step of scan or monitor capability matching;

Figure 5 illustrates a flow chart of the step of synchronization; and

Figure 6 illustrates a flow chart of the step of qualification.

DETAILED DESCRIPTION OF THE INVENTION

The above mentioned and other features and objects of this invention will become more apparent and better understood by reference to the following detailed description. It should be understood that the detailed description made known below is not intended to be exhaustive or limit the invention to the precise form disclosed as the invention may assume various alternative forms. On the contrary, the detailed description covers all the relevant modifications and alterations made to the present invention, unless the claims expressly state otherwise.

The core aspect of the present invention relates to a method for surrogate monitoring on-the-air information of a plurality of radio access points that are co-located by using an independent monitoring radio. In other words, the monitoring radio is provided only for the sole purpose of implementing the action of scanning or monitoring on-the-air information (otherwise also known as a set of particular parameters) specified by and on behalf of the radio access points, which also may turn out to be the scanning or monitoring capability of the said radio access points. This, in turn, results in a substantial increase of free resources for the radio access points to perform their actual original tasks as they do not have to convert to scanning mode from time to time to scan or monitor on-the-air information.

Apart from the monitoring radio, it is introduced in the method according to the present invention an element that manages the communication between the radio access points and the monitoring radio, namely central manager. The term 'communications' used herein, on the whole, means the exchange of information between the radio access points and the monitoring radio for the purposes of (a) determining the possibility and capability of the monitoring radio to execute the monitoring task of a set of particular parameters specified by and on behalf of the radio access points, and (b) establishing this unique surrogate relationship between the monitoring radio and the radio access points.

It is shown in Figure 1 a general scenario in line with the core aspect of the present invention, wherein the scenario comprises a plurality of radio access points, namely radio access point 1, radio access point 2, and radio access point 3 (110) for providing wireless network connections to wireless devices. The radio access points (110) may further comprise a local monitoring data repository for storing local monitoring data, a wireless radio interface such as WLAN interface, and a wired interface such as Ethernet interface.

Further, the scenario comprises a monitoring radio (130), which is also a radio access point, for scanning or monitoring on-the-air information (also known as a

set of particular parameters) specified by and on behalf of the radio access points (110), grasping the network activity information of the radio access points (110) and their neighborhood radio access points, namely neighborhood radio access point A and neighborhood access point B (120).

The scenario further comprises an intelligent gateway (140) connected to the radio access points (110) and the monitoring radio (130), in which a central manager is located for managing the communications between the radio access points (110) and the monitoring radio (130). The central manager may communicate with the monitoring radio (130) by using any well known internal messaging protocol or network protocol. Similarly, the central manager may communicate with the radio access points (110) by using any proprietary protocol such as SNMP. The intelligent gateway (140) may further comprise a webserver for generating and providing a graphical user interface for the use of a system administrator, and a dynamic host configuration protocol (DHCP) server for configuring the wireless devices (e.g. assigning IP addresses to the wireless devices) so that they can communicate on an IP network. The monitoring radio (130) as mentioned above may be residing inside or outside the intelligent gateway (140). In Figure 1, for example, the monitoring radio (130) is located outside the intelligent gateway (140).

Still referring to Figure 1, the cluster of three radio access points (110) are co-located in such a way that they are within the scanning vicinity of the monitoring radio (130). The term 'co-located' used herein means that the radio access points (110) are nearby to each other and they can be scanned and detected by the monitoring radio (130). The monitoring radio (130) is situated closely to the radio access point 3 (110), and therefore, both the nodes are likely to scan and detect the same neighbor radio access points A and B (120). Similarly, the radio access points 1 and 2 (110) may scan and detect the same neighbor radio access points (not shown in the figure), which is different from the radio access point 3 (110). Before the intervention of the present invention, each of the radio access points (110) is required to convert to scanning mode from time to time to scan or monitor on-the-air information, and compiles and stores its own

information of neighborhood radio access points (120) in the local monitoring data repository. Nonetheless, with the detailed method presented hereinafter, the monitoring task can now be delegated to the monitoring radio (130).

The general outline of the present invention is illustrated in Figure 2. The method comprises four main steps, namely radio access points discovery (210), scan or monitor capability matching (220), synchronization (230), and qualification (240).

The first step (210) will become apparent by referring now to Figure 3. The ultimate aim of this step (210) is to register the radio access points in a candidate list (213). Initially, the method requires each of the radio access points to retrieves its own wireless radio interface information such as MAC address (211). Subsequently, the retrieved information is sent to the central manager together with a request for surrogate monitoring service (211). Upon receiving the request, the central manager proceeds to extract the wireless radio interface information, and instructs the monitoring radio to scan for each radio access point based on the extracted information (212). If the radio access points can be scanned and detected by the monitoring video, the central manager will register the radio access points in the candidate list (213), and send a confirmation message to the registered radio access points (214). In the event that the radio access points cannot be discovered by the monitoring radio, the central manager will reject the surrogate monitoring service (215), and therefore terminating the operation.

The second step (220) will become apparent by referring now to Figure 4. The ultimate aim of this particular step (220) is to determine and match the scanning or monitoring capability of each radio access points and the monitoring radio. Continues from the first step (210), the central manager requests each radio access point registered in the candidate list to provide on-the-air information, specifically parameters, to be scanned or monitored (221). The parameters in this case can be categorized into two groups. The first one being time variant parameters such as received signal strength indication (RSSI), signal-to-noise ratio (SNR), modulation and coding scheme (MCS), transmitted or received

frames, bit error rate, frame error rate, and the like; whereas the second one being time invariant parameters such as service set identifier (SSID), type of radio access point, MAC address, mode of operation, operating radio channel number, and the like. In practice, these time invariant parameters may actually change according to time but in a less frequent manner. Therefore, it is not necessary to subject them to the third step and the fourth step of the present invention. Consequently, the central manager requests each radio access points and the monitoring radio to perform a local scan or monitor capability based on the provided parameters (222) (223). The central manager then compares the results of local scan or monitor capability of each radio access points with the results of local scan or monitor capability of the monitoring radio, searching for matching parameters (224), which are then registered in a parameter list (225). If the central manager is unsuccessful in identifying matching parameters, it will proceed to terminate the whole operation.

The third step (230) will become apparent by referring now to Figure 5. The central manager then further selects the matching parameters, which are registered in the parameter list, that are to be scanned and monitored (231). Preferably, time variant parameters are selected. In this preferred example, the time variant parameters are required to be smoothened by using moving average algorithm before they are being used by the central manager. Along with this particular selection (231), the central manager also selects data sampling criteria (232) such as start time, time interval, number of sample, number of batches, smoothing configurations, and the like. After that, the central manager proceeds to instruct each radio access points and the monitoring radio to perform a local scan based on the selected matching parameters and the selected data sampling criteria (233), and to process data obtained from the said local scan (234). Further, it is critical to synchronize the parameters scan time instance to ensure consistency between each of the radio access points and the monitoring radio.

The fourth step (240) will become apparent by referring now to Figure 6. The central manager performs a correlation test on each of the processed data (241),

wherein the test involves measurement of correlativity between two parameters (in the form of processed data) by using well known techniques. In this instance for example, Pearson Product Moment Correlation (or Pearson's correlation for short) technique can be used to qualify the level of correlation between different parameters (in the form of processed data). Next, the central manager gives a rating to each processed data based on the results of the correlation test (242). In a preferred example, rating system such as high, medium, or low system can be introduced to ease the decision making process, instead of using index number system between 0 and 1, or 1 and 100. The obtained rating is then being used by the central manager for comparing against a qualification policy (243). Subsequently, the central manager proceeds to register the selected matching parameters that are associated with the rating that has passed the qualification policy in a surrogate monitoring list (244).

After the registration (244), the central manager instructs the monitoring radio to scan or monitor the parameters registered in the surrogate monitoring list on behalf of each radio access point (245), and further instructs each radio access point to resume its normal operating mode (246). In the circumstance that the rating does not pass the qualification policy, the central manager will terminate the whole operation.

CLAIMS

1) A method for surrogate monitoring on-the-air information of a plurality of radio access points that are co-located by using an independent monitoring radio comprises the steps of:

a) radio access points discovery (210) that further comprises the steps of;

i) each radio access point retrieves its own wireless radio interface information such as MAC address (211);

ii) each radio access point sends a request for surrogate monitoring service to a central manager (211);

iii) the central manager receives the request for surrogate monitoring service and extracts the wireless radio interface information (212);

iv) the central manager instructs the monitoring radio to scan for each radio access point based on the wireless radio interface information (212);

v) the central manager registers each radio access points in a candidate list (213) and send a confirmation message to each registered radio access points (214) upon successful scanning by the monitoring radio;

b) scan or monitor capability matching (220) that further comprises the steps of;

i) the central manager requests each radio access point in the candidate list to provide parameters to be scanned or monitored (221);

ii) the central manager requests each radio access point to perform a local scan or monitor capability based on parameters to be scanned or monitored (222);

iii) the central manager requests the monitoring radio to perform a local scan or monitor capability based on the parameters to be scanned or monitored (223);

iv) the central manager compares the results of local scan or monitor capability of each radio access point with the monitoring radio to search for matching parameters (224);

v) the central manager registers the matching parameters in a parameters list (225);

c) synchronization (230) that further comprises the steps of;

i) the central manager selects matching parameters, which are registered in the parameters list, to be scanned or monitored (231);

ii) the central manager selects data sampling criteria (232);

iii) the central manager instructs each radio access points and the monitoring radio to perform a local scan based on the selected matching parameters and the selected data sampling criteria (233);

iv) the central manager instructs each radio access points and the monitoring radio to process data obtained from their own local scan (234);

d) qualification (240) that further comprises the steps of;

i) the central manager performs a correlation test on each of the processed data (241);

ii) the central manager gives a rating to each processed data based on the results of the correlation test (242);

iii) the central manager compares the rating against a qualification policy (243);

iv) the central manager proceeds to register the selected matching parameters that are associated with the rating that has passed the qualification policy in a surrogate monitoring list (244);

v) the central manager instructs the monitoring radio to scan or monitor the parameters registered in the surrogate monitoring list on behalf of each registered radio access point (245);

vi) the central manager instructs each registered radio access point to resume its normal operating mode (246).

2) A method in accordance with claim 1, wherein the parameters include time variant parameters such as received signal strength indication (RSSI), signal-to-noise ratio (SNR), modulation and coding scheme (MCS), transmitted or received frames, bit error rate, frame error rate, and the like.

3) A method in accordance with claim 1, wherein the parameters include time invariant parameters such as service set identifier (SSID), type of radio access point, MAC address, mode of operation, operating radio channel number, and the like

4) A method in accordance with claim 1, wherein the data sampling criteria includes start time, time interval, number of sample, number of batches, smoothing configurations, and the like.

5) A method in accordance with claim 1, wherein the preferred matching parameters to be selected by the central manager during the step of synchronization (230) is time variant parameters.

6) A method in accordance with claim 1, wherein the step of radio access points discovery (210) further comprises the step of terminating the operation upon unsuccessful scanning of the radio access points by the monitoring radio by having the central manager to reject the request for surrogate monitoring service (215).

7) A method in accordance with claim 1, wherein the step of scan or monitor capability matching (220) further comprises the step of terminating the operation upon unsuccessful searching of matching parameters.

8) A method in accordance with claim 1, wherein the step of qualification (240) further comprises the step of terminating the operation when the rating has not passed the qualification policy.

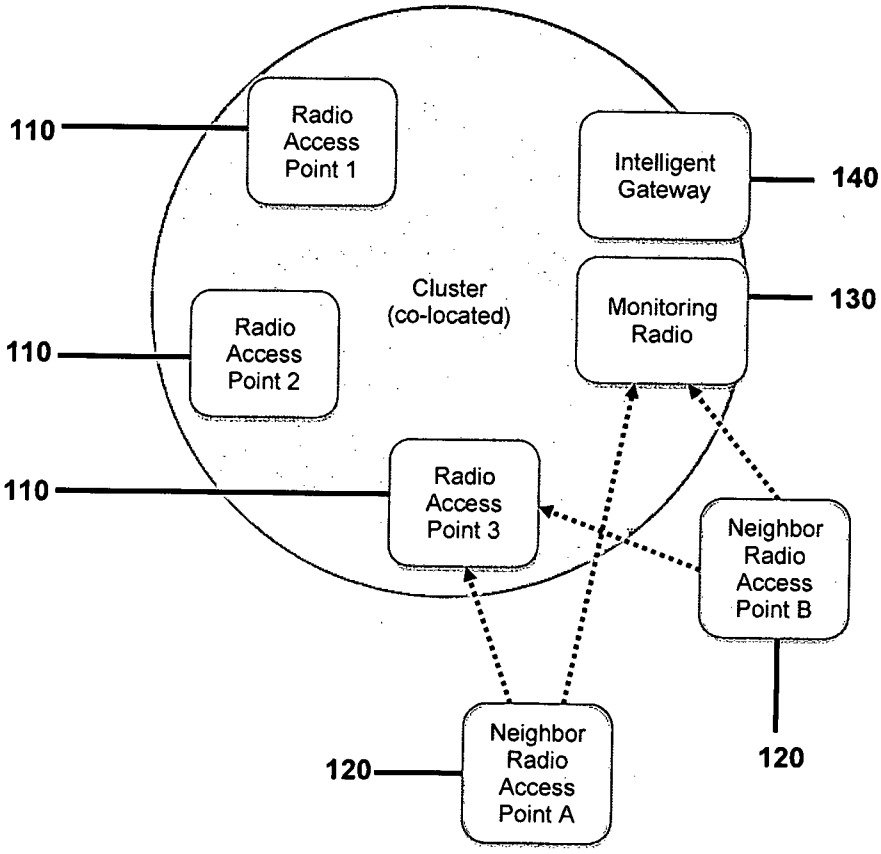
110
Radio Access Point 1
Intelligent Gateway
140
Cluster (co-located)
Monitoring Radio
130
110
Radio Access Point 2
110
Radio Access Point 3
Neighbor Radio Access Point B
120
Neighbor Radio Access Point A
120

FIGURE 1

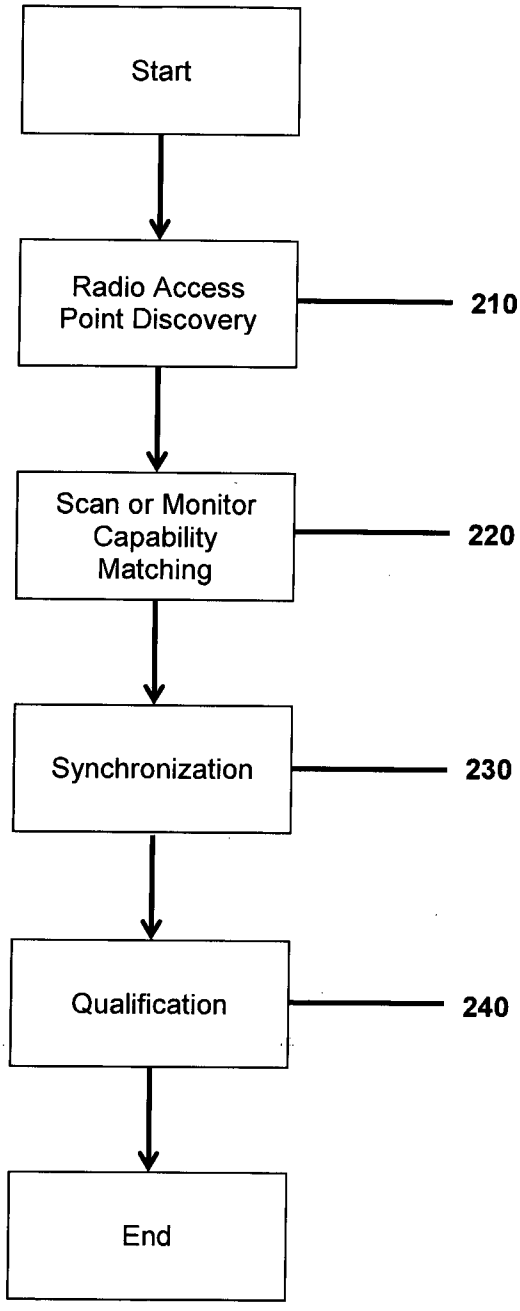
Start
Radio Access Point Discovery
210
Scan or Monitor Capability Matching
220
Synchronization
230
Qualification
240
End

FIGURE 2

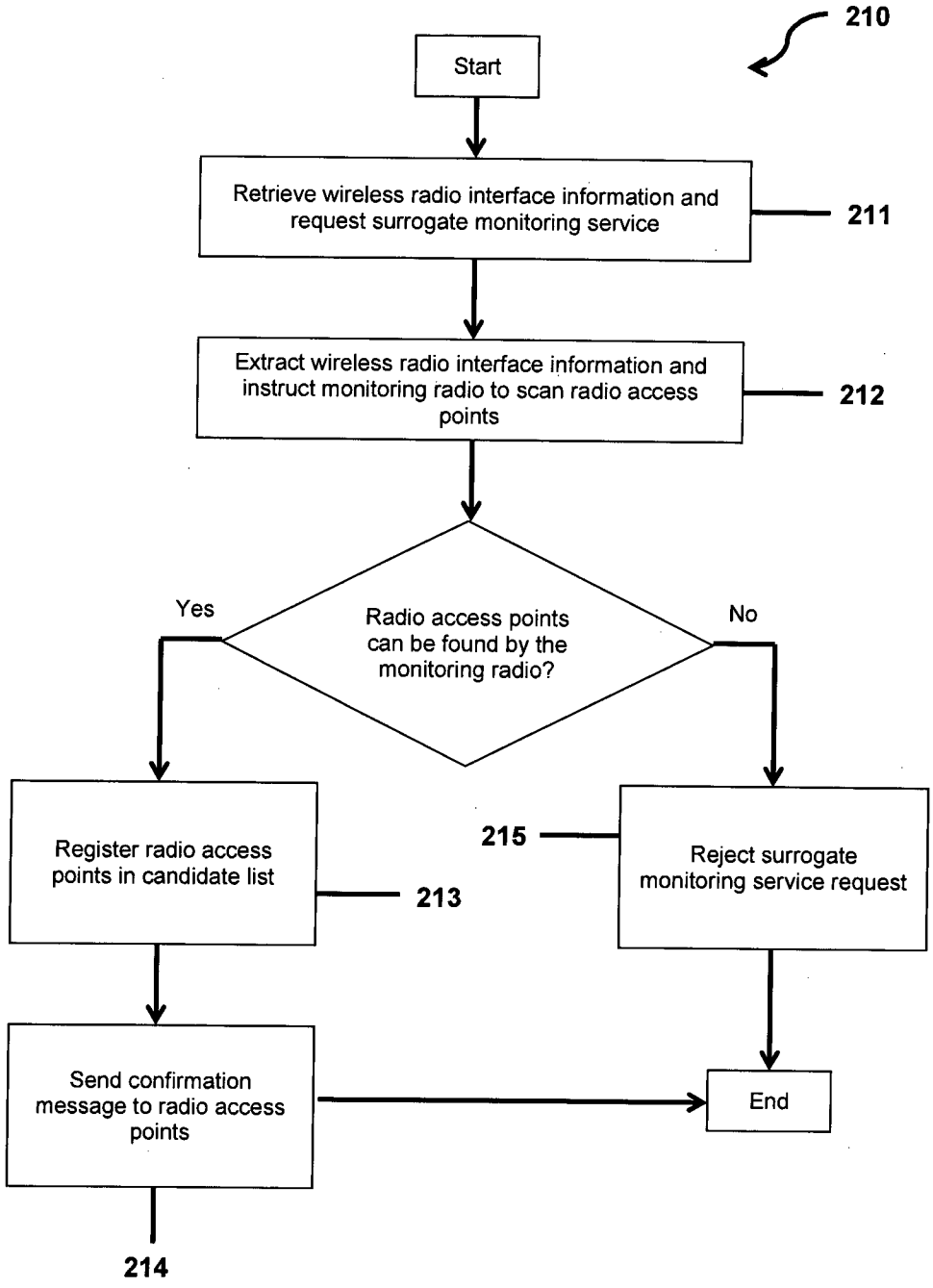
210
Start
Retrieve wireless radio interface information and request surrogate monitoring service
211
Extract wireless radio interface information and instruct monitoring radio to scan radio access points
212
Radio access points can be found by the monitoring radio?
Yes
No
Register radio access points in candidate list
213
215
Reject surrogate monitoring service request
Send confirmation message to radio access points
End
214

FIGURE 3

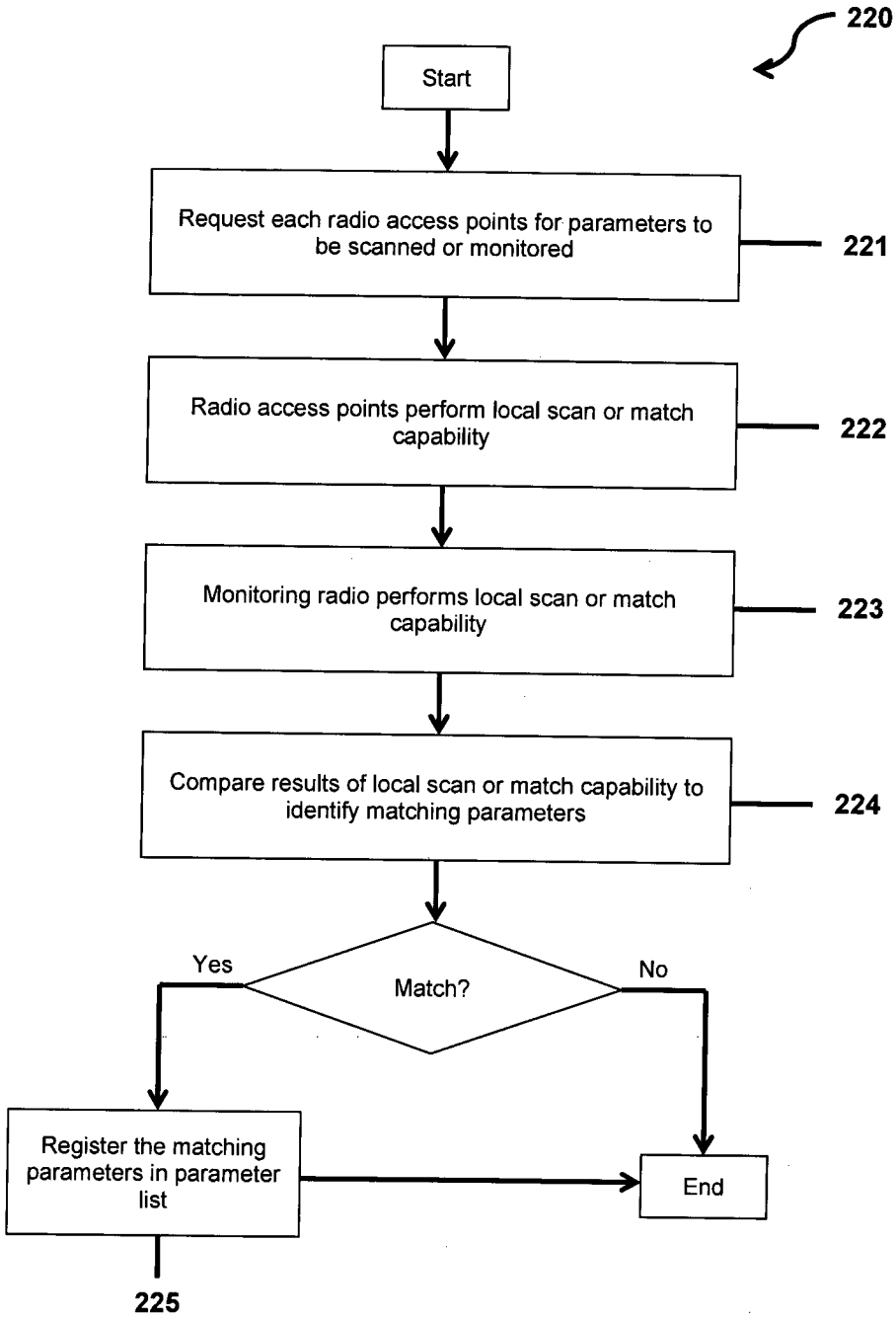
220
Start
Request each radio access points for parameters to be scanned or monitored
221
Radio access points perform local scan or match capability
222
Monitoring radio performs local scan or match capability
223
Compare results of local scan or match capability to identify matching parameters
224
Match?
Yes
No
Register the matching parameters in parameter list
End
225

FIGURE 4

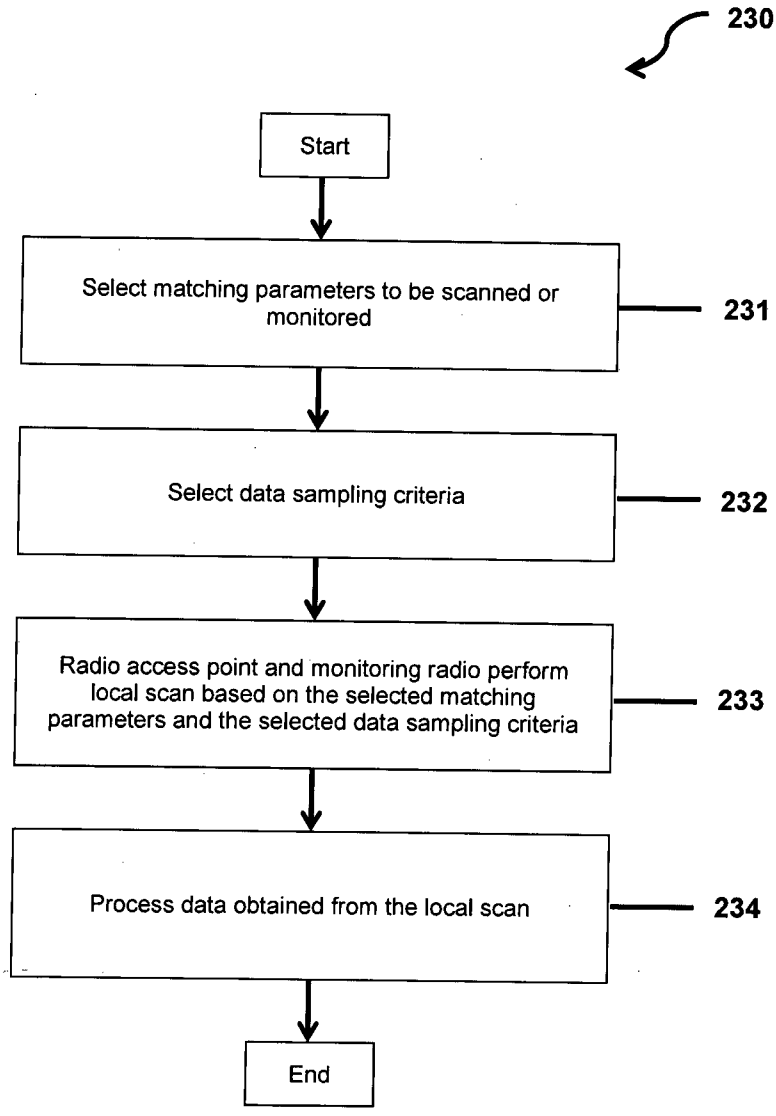
230
Start
Select matching parameters to be scanned or monitored
231
Select data sampling criteria
232
Radio access point and monitoring radio perform local scan based on the selected matching parameters and the selected data sampling criteria
233
Process data obtained from the local scan
234
End

FIGURE 5

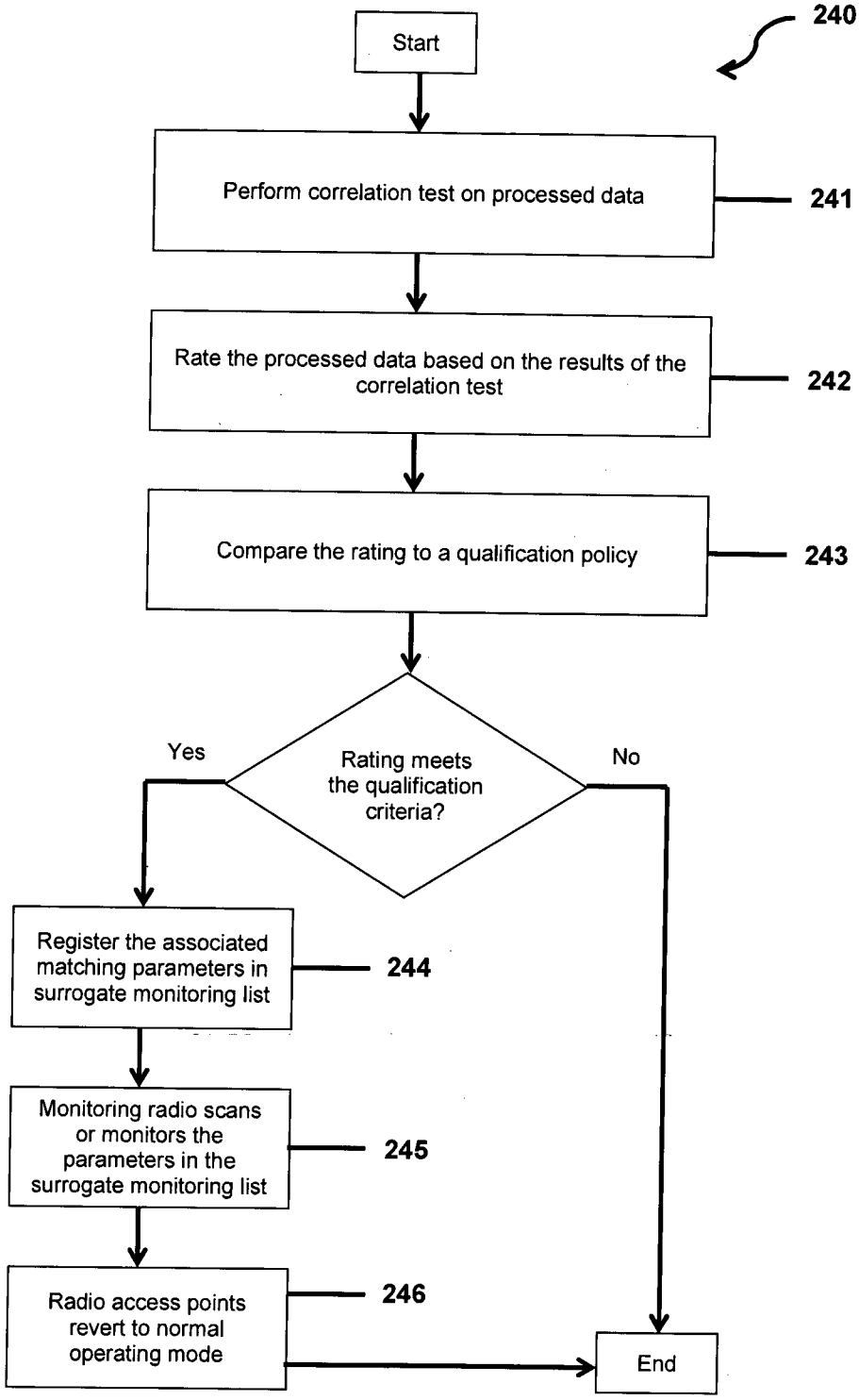
240
Start
Perform correlation test on processed data
241
Rate the processed data based on the results of the correlation test
242
Compare the rating to a qualification policy
243
Rating meets the qualification criteria?
Yes
No
Register the associated matching parameters in surrogate monitoring list
244
Monitoring radio scans or monitors the parameters in the surrogate monitoring list
245
Radio access points revert to normal operating mode
246
End

FIGURE 6

INTERNATIONAL SEARCH REPORT

International application No
PCT/MY2013/000202

A. CLASSIFICATION OF SUBJECT MATTER
INV. H04W24/02 H04L12/24
ADD.

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)
H04W 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 practicable, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2010/278117 A1 (SHARMA PUNEET [US] ET AL) 4 November 2010 (2010-11-04) cited in the application abstract paragraphs [0009], [0011] - [0027]	1-8
A	US 2005/003827 A1 (WHELAN ROBERT J [US]) 6 January 2005 (2005-01-06) paragraphs [0009], [0016] - [0027], [0068], [0115] - [0119]	1-8
A	US 2007/087696 A1 (D BONTA JEFFREY [US] ET AL) 19 April 2007 (2007-04-19) abstract paragraphs [0014], [0017], [0018], [0021] - [0023]	1-8

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

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"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

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1

INTERNATIONAL SEARCH REPORT

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