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(54) **Title**: SYSTEM AND METHOD FOR DISTRIBUTING CONNECTIVITY IN A NETWORK

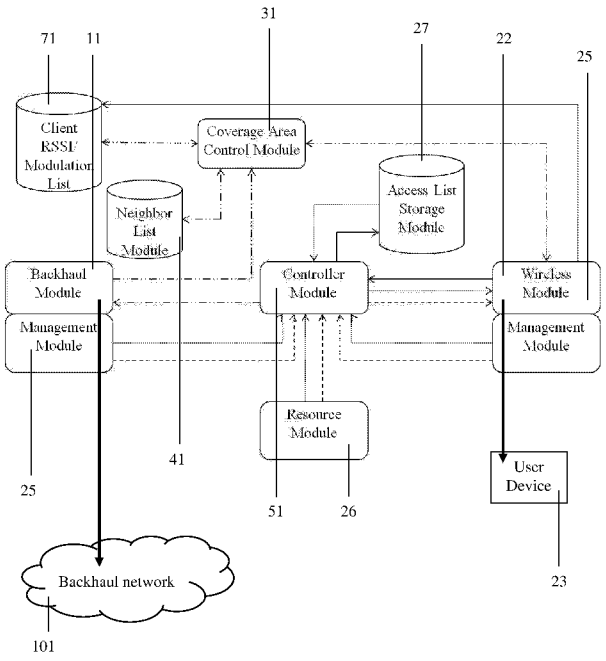


Figure 1

(57) **Abstract**: The present invention generally relates to a system and method for distributing connectivity in a network, more particularly the present invention relates to a system and method for distributing connectivity in a wireless network. The system comprising at least a backhaul module (11) for connecting and transmitting packets from at least a connection module to at least a backhaul network (101), at least a wireless module (22) for providing network access to at least a user device connecting to at least an access point, at least a management module (25) in association with said at least a backhaul module (11) and said at least a connection module for measuring and determining network connectivity of said at least an access point, at least resource module (26) for measuring resources of said at least an access point and determining utilization of the resources, and at least an access list storage module (27) for storing at least a list of at least a user device media access control addresses.

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SYSTEM AND METHOD FOR DISTRIBUTING CONNECTIVITY IN A NETWORK

TECHNICAL FIELD

The present invention generally relates to a system and method for distributing connectivity in a network, more particularly the present invention relates to a system and method for distributing connectivity in a wireless network.

BACKGROUND OF INVENTION

In wireless network connection systems, it is possible to have a plurality of wireless access points that provide connectivity to a plurality of user devices, and each user is able to connect to any one of the subscribed plurality of access points for establishing network connections. However, each access point is capable of providing network connectivity to a predetermined number of user devices, before overloading occurs.

In the event any one of the user device exceeds the predetermined number of user devices that can be connected to a particular access point, the user device can suffer from network connectivity problems, thus causing the user device from being disconnected from the subscribed wireless network. More often than not, the user device remains disconnected from the wireless network until the access point reduces its load. Such limitation contributes unfavourable experiences to the user.

US 7,162,250 B1 discloses a computer network connectivity and wireless networking, more particularly the prior art relates to a cellular wireless access infrastructure, where individual wireless devices use a set of access point devices as gateway nodes to connect to a backbone network, for addressing the issues of overloading in an access point by comparing overload statuses with neighbouring access points, and controlling the transmit power of the access points to expand or shrink the coverage are to accommodate the overload.

US 8,463,272 B2 discloses a wireless communication system that includes a plurality of base stations. More particularly, the prior art pertains to a base station, and to a technology

for managing base stations, for addressing the problem of heavy load by adjusting the power transmission. US 7,215,677 B2 discloses load balancing in a wireless local area network (LAN) and, more particularly the prior art pertains to a system and a method for balancing load among access points.

The aforementioned prior arts however fail to address the overloading conditions in a manner with minimal resources, and accelerated execution time.

SUMMARY OF INVENTION

The present invention aims to provide a system and a method for overcoming overloading conditions in an access point by distributing network connectivity of at least a user among a set of wireless access points, such that the network connectivity can be evenly distributed among said set of wireless access points.

It is an object of the present invention to provide a system for distributing connectivity in a network, wherein the system comprising at least a backhaul module, at least a wireless module, at least a queue overflow measurement module, at least resource measurement module, and at least an access list storage module.

It is another object of the present invention to provide a system for distributing connectivity in a network, wherein the system comprising at least a coverage area control module for updating said at least an access point overload status in at least a neighbour list module, and notifying said at least a wireless module to adjust coverage area for distributing network connectivity.

It is yet an object of the present invention to provide a system for distributing connectivity in a network, wherein the system comprising at least a neighbour list module for storing in any combination of said at least a list of configured neighbouring, said at least an access point, or respective overload statuses.

It is a further object of the present invention to provide a system for distributing connectivity in a network, wherein the system comprising a controller module for receiving triggers from said at least a queue overflow measurement module and at least a resource

measurement module for determining overload condition of said at least an access point and for instructing at least a connection module to enable or disable at least an access list and service set identifications, and for notifying neighbours of said at least an access point of any change in overload status.

It is yet another object of the present invention to provide a method for distributing connectivity in a network, wherein the method comprising the steps of determining overloading conditions, and controlling coverage area of at least an access point for distributing network connectivity to a plurality of user devices.

The present invention therefore provides a system and methods for distributing connectivity in a network to address the overloading conditions in a manner with minimal resources, and accelerated execution time, which will be described in further detail in the following description.

BRIEF DESCRIPTION OF DRAWINGS

Figure 1 illustrates a schematic representation of the system for distributing connectivity according to the present invention.

Figure 2 illustrates a process flow of the method for distributing connectivity according to the present invention.

Figure 3 illustrates a process flow of the method for distributing connectivity according to the present invention.

Figure 4 illustrates a process flow of the method for distributing connectivity according to the present invention.

Figure 5 illustrates a process flow of the method for distributing connectivity according to the present invention.

DETAILED DESCRIPTION OF EMBODIMENTS

Described below are preferred embodiments of the present invention with reference to the accompanying drawings. Each of the following preferred embodiments describes an example not limiting in any aspect.

Referring to Figure 1, the figure illustrates a schematic representation of the system for distributing connectivity in a network, wherein the system comprising at least a backhaul module (11) for connecting and transmitting packets to at least a backhaul network (101) from at least a connection module, at least a wireless module (22) for providing network access to at least a user device (23) connecting to at least an access point, at least a management module (25) in association with said at least a backhaul module (11) and said at least a connection module for measuring and determining network connectivity of said at least an access point, at least a resource module (26) for measuring utilization of resources of said at least an access point and determining in an event the utilization of the resources exceeds a predetermined threshold, and at least an access list storage module (27) for storing information of at least a user device, preferably but not limited to media access control addresses.

According to the present invention, said at least a backhaul module (11) is the physical interface of said at least an access point that connects to a network, a backhaul network (101), at the back-end of said at least an access point, hence said at least a backhaul module (11) provides connectivity and control features of said at least an access point to at least a user device (23).

In the preferred embodiment of the present invention, said at least a connection module is the physical interface of said at least an access point that provides connectivity and serves at least a user device (23) associated to said at least an access point. Accordingly, said at least a management module (25) resides at said at least a backhaul module (11) and said at least a connection module, and said at least a management module (25) is responsible to determine overflow in outgoing and incoming queues.

In the preferred embodiment of the present invention, said at least a resource module (26) measures available resources of said at least an access point. These resources include

information of a central processing unit, memory, storage, interruption requests and etcetera.

The preferred embodiment of the system in accordance to the present invention controls transmit power of said at least an access point, such that the system determines overload condition of said at least an access point and distributes network connectivity coverage among a plurality of access points to assist in maintaining connectivity of said at least a user device, so as to achieve balanced load distribution among a plurality of said at least an access point.

The balanced load distribution among a plurality of said at least an access point is achieved by at least a coverage area control module (31) for updating said at least an access point overload status in at least a neighbour list module (41), and notifying said at least a wireless module (22) to adjust coverage area for network connectivity. The preferred embodiment of the present invention comprises said at least a neighbour list module (41) for storing information of any one or a combination of said at least a list of configured neighbours of said at least access point, said at least an access point, or respective overload statuses.

In the preferred embodiment of the present invention, said at least a coverage area control module (31) is responsible for updating neighbours of said at least access point on the overload status in said at least a neighbour list module (41) and notifying said at least a wireless module (22) to increase the coverage area via enabling lower modulation schemes or increasing transmit power.

The preferred embodiment of the present invention further comprises at least a controller module (51) for receiving triggers from said at least a management module (25) and at least a resource module (26) for determining overload condition of said at least an access point, instructing said at least a connection module to enable or disable at least an access list and service set identifications, and notifying neighbours of said at least an access point of any change in overload status.

In the preferred embodiment of the present invention, said at least a controller module (51) is responsible for determining list of at least a user device (23) in a particular said at least an access point and updating an Access Control List (ACL) in at least an access list storage

module (27). In the similar context, said at least a controller module (51) is also responsible for receiving triggers from said at least a management module (25) and said at least a resource module (26). Based on the triggers, said at least a controller module (51) either enables or disables the Access Control List (ACL) and service set identifiers and notifying the neighbours of said at least an access point of any changes to the overloaded state.

By configuring said at least an access point with the modules shown in Figure 1 according to the preferred embodiment of the present invention, the achieved effect would be that said at least a controller module (51) would be aware of any breach in status of said at least an access point that could trigger performance degradation. This will then allow said at least a controller module (51) to enable the Access Control List (ACL) so that at least a user device (23) will not be able to connect to said at least an access point.

Further, said at least a controller module (51) will instruct said at least an access point to hide its service set identifiers (SSID) so that said at least a user device (23) will not be able to determine the existence of said at least an access point and said at least a controller module (51) will notify said at least a coverage area control module (31) or the neighbours of said at least an access point of the overload status. If the network setup uses preferably but not limited to a Wireless LAN controller (WLC), the controller would then forward the trigger to the configured neighbours of said at least an access point.

The neighbours of said at least an access point, upon receiving the trigger would adjust the transmit power or supported modulation schemes to expand the network connectivity coverage area so that said at least a user device (23) in the vicinity of the overloaded said at least an access point would be able to connect to another under loaded said at least an access point.

If the overloaded said at least an access point exits the overload condition, said at least a controller module (51) would remove the Access Control List (ACL), start broadcasting the service set identifiers (SSID) in its beacons and forward a trigger to the Wireless LAN controller (WLC) or neighbours of said at least an access point. The neighbours of said at least an access point depending on status of said at least a user device (23), would reduce the coverage area by either reducing the transmit power or by disabling the lower modulation schemes.

Referring to Figures 2 to 5 with the aid of Figure 1, Figures 2 to 5 illustrate process flows of the method for distributing connectivity in a network according to the present invention.

The preferred method of the present invention comprising the steps of first, initializing individual overload state by at least a controller module (51) to a predetermined value for determining overload status, then initializing status of a plurality of said at least an access point in at least a neighbour list module (41) by at least a coverage area control module (31) to a predetermined value for indicating overload status, then periodically monitoring status of said at least an access point and comparing current status with previously cached status, then determining a status change of said at least an access point, updating overload state with new overload status if a status change is detected by said at least a controller module (51), notifying a plurality of said at least an access point from the at least a neighbour list module (41) of the change, adjusting of coverage areas depending upon network situation, and enabling or disabling of access control list, preferably known as Access Control List (ACL).

Further, the preferred method for adjusting network connectivity coverage areas depending upon network situation comprising the steps of receiving notifications from neighbours of said at least an access point by said at least a coverage area control module (31), determining whether said received notification indicates an overloaded state, and updating the new overloaded state notification in said at least a neighbour list module (41), determining overload state of said at least an access point, notifying at least a wireless module (22) by said at least a coverage area control module (31) to manipulate coverage area of said at least an access point by adjusting transmit power of said at least an access point, verifying if there is any user device with low received signal strength indication by said at least a coverage area control module (31), and notifying said at least a wireless module (22) by said at least a coverage area control module (31) to manipulate the coverage area of said at least an access point by adjusting transmit power.

Fundamentally, the operation of the preferred system of the present invention comprises at least 3 phases, which are the initialization phase, an overloaded access point phase, and an under loaded access point phase.

Initialization Phase

Upon boot of the system, at least a management module, access list storage module, controller module, resource module, and coverage are controller module are activated, and a configured neighbour list is updated with the configured neighbours of at least an access point and their overload status is set to "not overloaded". The controller module sets its own state to "not overloaded". This process is illustrated in Figure 2.

Overloaded Phase

Referring to Figure 3, the figure illustrates the process flow during the overloaded phase. Initially, at least a controller module (51) checks for at least a user device (23) that is connected to at least an access point. In the event of unfamiliar said at least a user device (23) connects said to at least an access point, said at least a controller module (51) preferably extracts, but not limited to Media Access Control address and stores in an Access Control List (ACL) inside at least an access list storage module (27).

The preferred system of the present invention comprises at least a management module (25) and at least a resource module (26) for maintaining an upper and lower threshold limits.

In the overloaded phase and as the number of said at least a user device (23) connecting to a particular of said at least an access point increases such that the upper threshold limit is reached at either said at least a management module (25) or said at least a resource module (26), the upper threshold is breached. When an upper threshold is breached at either said at least a management module (25) or said at least a resource module (26), the modules trigger said at least a controller module (51).

In the preferred embodiment of the present invention, said at least a controller module (51) then fetches the Access Control List (ACL) from at least an access list storage module (27) and transmits instructions to enable at least a connection module.

Also, said at least a controller module (51) instructs said at least a connection module to hide its service set identifiers (SSID) and not to accept any new connections, then said at least a controller module (51) updates its own status to "overloaded", and said at least a

controller module (51) then sends an "overloaded" notification to the Wireless LAN controller (WLC) or the configured neighbours of said at least an access point.

In the preferred embodiment of the present invention, at least a coverage area control module (31) of the neighbours of said at least an access point, upon receiving the trigger updates of the overload field of the overloaded said at least an access point in the neighbour list to "overloaded". If the overloaded said at least an access point is the only said at least an access point in the neighbour list that is overloaded, said at least a coverage area control module (31) of the neighbours of said at least an access point instructs said at least a connection module to increase its coverage area. The coverage area can be increased by increasing the transmit power. It can also be increased by re-enabling lower modulation schemes if it was not enabled earlier. If there is already said at least an access point in an overloaded state in its neighbour list, the neighbours of said at least an access point will not change its coverage area size.

Under Loaded Phase

Referring to Figure 4 and Figure 5, the figures illustrate the process flow during the under loaded phase in the preferred embodiment of the present invention.

In the under loaded phase according to the present invention and as at least a user device (23) disconnects from at least an access point, lower threshold limit is breached. When the lower threshold limit is breached, at least a management module (25) and at least a resource module (26) trigger at least a controller module (51). Said at least a controller module (51) then instructs at least an access moduke to unload Access Control List (ACL) and unhide service set identifiers (SSID). Said at least a connection module is then configured to accept new connections. Said at least a controller module (51) updates its own status to "not overloaded" and sends a "not overloaded" notification to the Wireless LAN controller (WLC) or the configured neighbours of said at least an access point.

In the preferred embodiment of the present invention, said at least a coverage area control module (31) of the neighbours of said at least an access point, upon receiving the trigger, updates said at least an access point overload status to "not overloaded" in the neighbour list. If there are no more neighbours of said at least an access point in its list that are in the

"overloaded" state, Said at least a coverage area control module (31) will instruct said at least a connection module to reduce the coverage area. The coverage area can be reduced by lowering the transmit power or by disabling lower modulation schemes. If there are said at least an access point in the neighbour list that are in overloaded state or wireless user devices of the neighbours of said at least an access point with low RSSI (received signal strength index), the neighbours of said at least an access point will not reduce its coverage area.

In as much as the present invention is subject to many variations, modifications and changes in detail, it is intended that all matter contained in the foregoing description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

CLAIMS

1. A system for distributing connectivity in a network comprising;

at least a backhaul module (11) for connecting and transmitting packets from at least a connection module to at least a backhaul network (101);

at least a wireless module (22) for providing network access to at least a user device (23) connected to at least an access point;

at least a management module (25) in association with said at least a backhaul module (11) and said at least a connection module for measuring and determining network connectivity of said at least an access point;

at least a resource module (26) for measuring utilization of resources of said at least an access point and determining in an event the utilization of the resources exceeds a predetermined threshold; and

at least an access list storage module (27) for storing information of said at least a user device (23);

characterized in that the system controls transmit power of said at least an access point, such that the system determines overload condition of said at least an access point and distributes network connectivity coverage among a plurality of access points to maintain connectivity of said at least a user device (23).

2. A system according to claim 1, wherein the system further comprises at least a coverage area control module (31) for updating said at least an access point overload status in at least a neighbour list module (41).

3. A system according to claim 1, wherein the system further comprises at least a coverage area control module (31) for notifying said at least a wireless module (22) to adjust coverage area for network connectivity.

4. A system according to claim 1, wherein the system further comprises at least a neighbour list module (41) for storing information of any one or a combination of said at least a list of configured neighbouring of said at least access point, said at least an access point, or respective overload statuses.

5. A system according to claim 1, wherein the system further comprises at least a controller module (51) for receiving triggers from said at least a management module (25) and at least a resource module (26) for determining overload condition of said at least an access point.

6. A system according to claim 1, wherein the system further comprises at least a controller module (51) for instructing said at least a connection module to enable or disable at least an access list and service set identifications.

7. A system according to claim 1, wherein the system further comprises at least a controller module (51) for notifying neighbours of said at least an access point of any change in overload status.

8. A system according to claim 1, wherein said at least an access list storage module (27) stores information of media access control addresses of said at least a user device.

9. A method for distributing connectivity in a network in the system of claim 1 comprising the steps of:

initializing individual overload state by at least a controller module (51) to a predetermined value for determining overload status;

initializing status of a plurality of said at least an access point in at least a neighbour list module (41) by at least a coverage area control module (31) to a predetermined value for indicating overload status;

periodically monitoring status of said at least an access point;

comparing current status with previously cached status;

determining a status change of said at least an access point;

updating overload state with new overload status if a status change is detected by said at least a controller module (31);

notifying a plurality of said at least an access point from the at least a neighbour list module (41) of the change;

adjusting of coverage areas depending upon network situation; and

enabling or disabling of access control list.

10. A method according to claim 9, wherein the adjusting of coverage areas comprising the steps of:

receiving notifications from neighbours of said at least an access point by said at least a coverage area control module (31);

determining whether said received notification indicates an overloaded state, and updating the new overloaded state notification in said at least a neighbour list module (41);

determining overload state of said at least an access point;

notifying at least a wireless module (22) by said at least a coverage area control module (31) to manipulate coverage area of said at least an access point by adjusting transmit power of said at least an access point;

verifying if there is any user device with low received signal strength indication by said at least a coverage area control module (31);

notifying said at least a wireless module (22) by said at least a coverage area control module (31) to manipulate the coverage area of said at least an access point by adjusting transmit power.

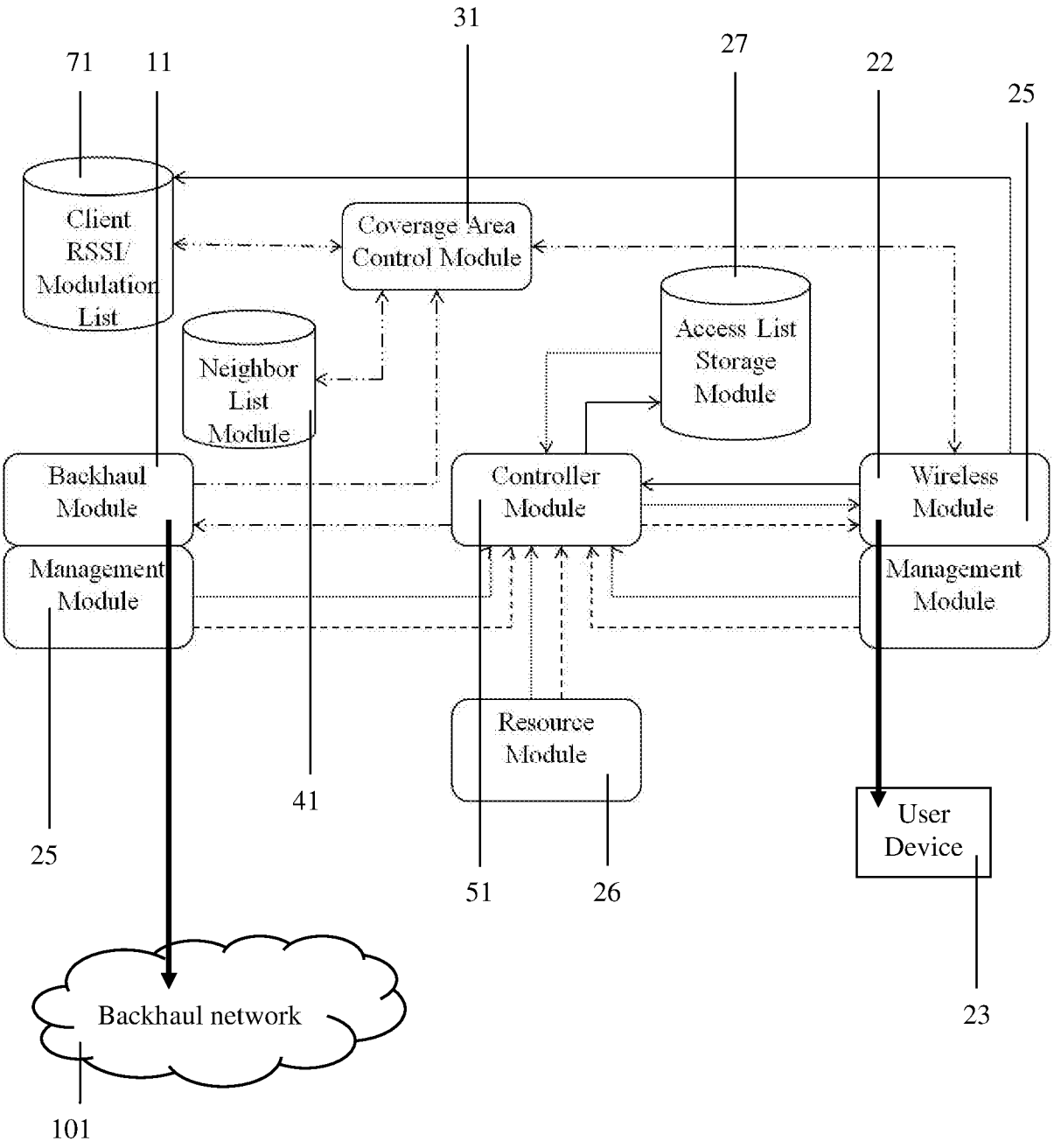

31
27
22
25
71
11
Client RSSI/ Modulation List
Coverage Area Control Module
Access List Storage Module
Neighbor List Module
Backhaul Module
Controller Module
Wireless Module
Management Module
Management Module
Resource Module
41
25
51
26
User Device
Backhaul network
101
23

Figure 1

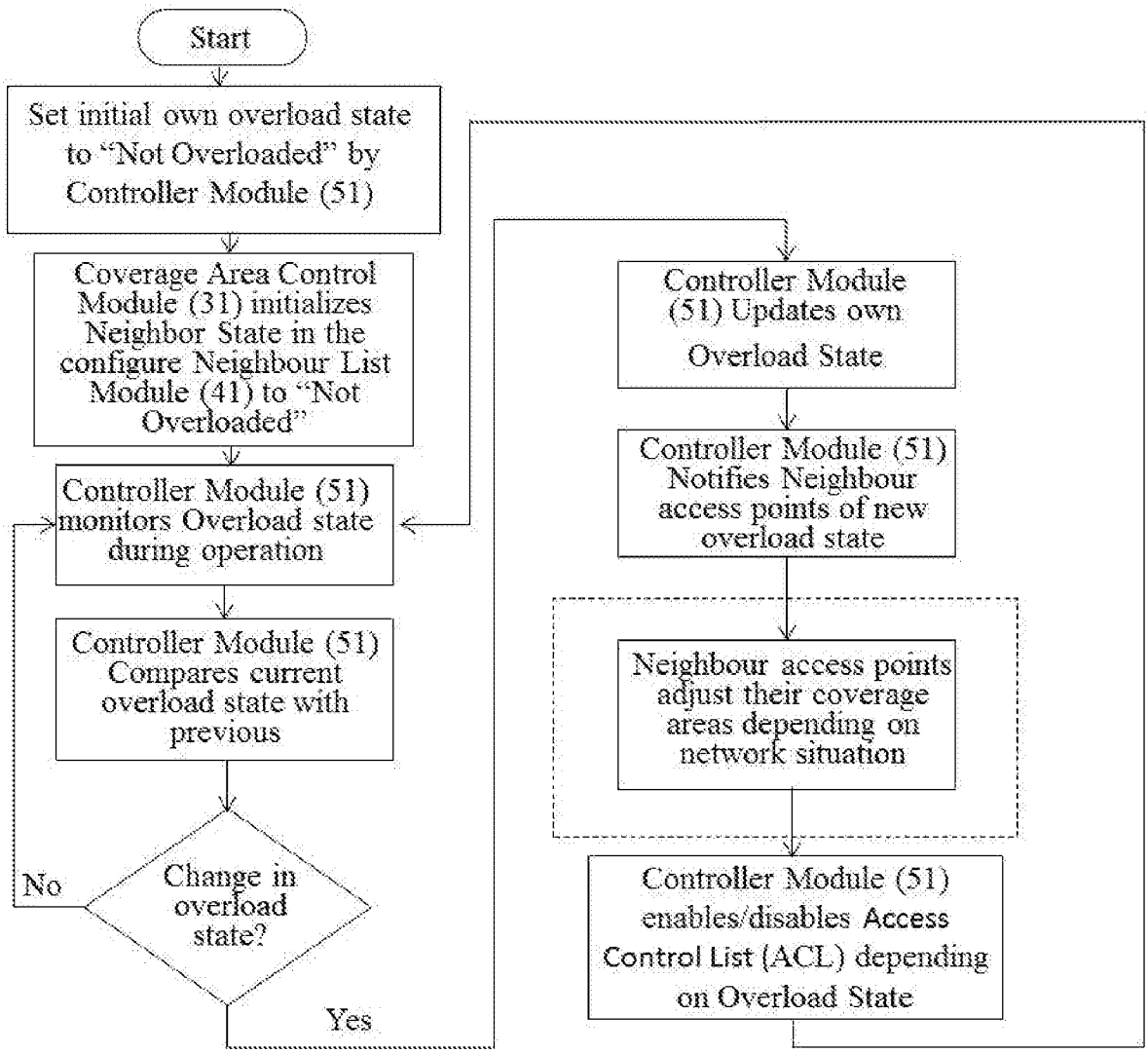

Start
Set initial own overload state to "Not Overloaded" by Controller Module (51)
Coverage Area Control Module (31) initializes Neighbor State in the configure Neighbour List Module (41) to "Not Overloaded"
Controller Module (51) monitors Overload state during operation
Controller Module (51) Compares current overload state with previous
Change in overload state?
No
Yes
Controller Module (51) Updates own Overload State
Controller Module (51) Notifies Neighbour access points of new overload state
Neighbour access points adjust their coverage areas depending on network situation
Controller Module (51) enables/disables Access Control List (ACL) depending on Overload State

Figure 2

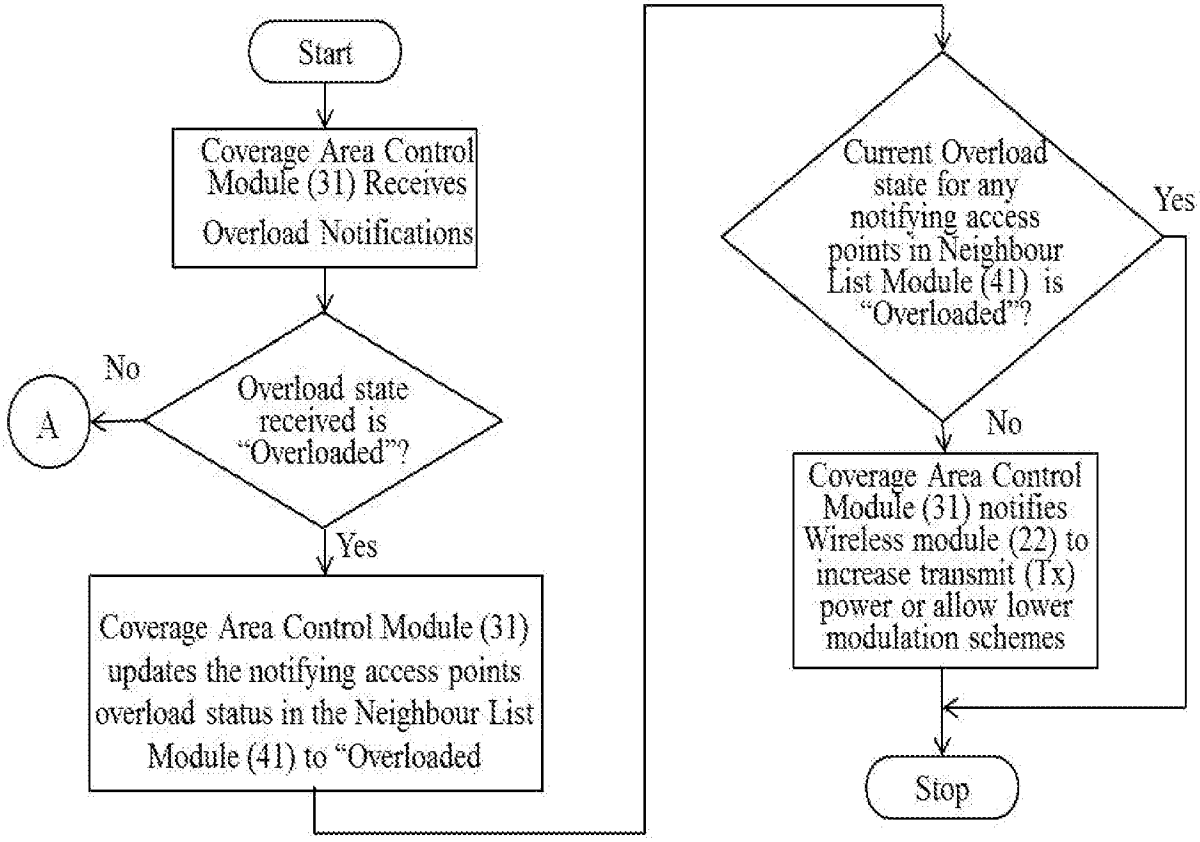

Start
Coverage Area Control Module (31) Receives Overload Notifications
Overload state received is "Overloaded"?
No
A
Yes
Coverage Area Control Module (31) updates the notifying access points overload status in the Neighbour List Module (41) to "Overloaded
Current Overload state for any notifying access points in Neighbour List Module (41) is "Overloaded"?
Yes
No
Coverage Area Control Module (31) notifies Wireless module (22) to increase transmit (Tx) power or allow lower modulation schemes
Stop

Figure 3

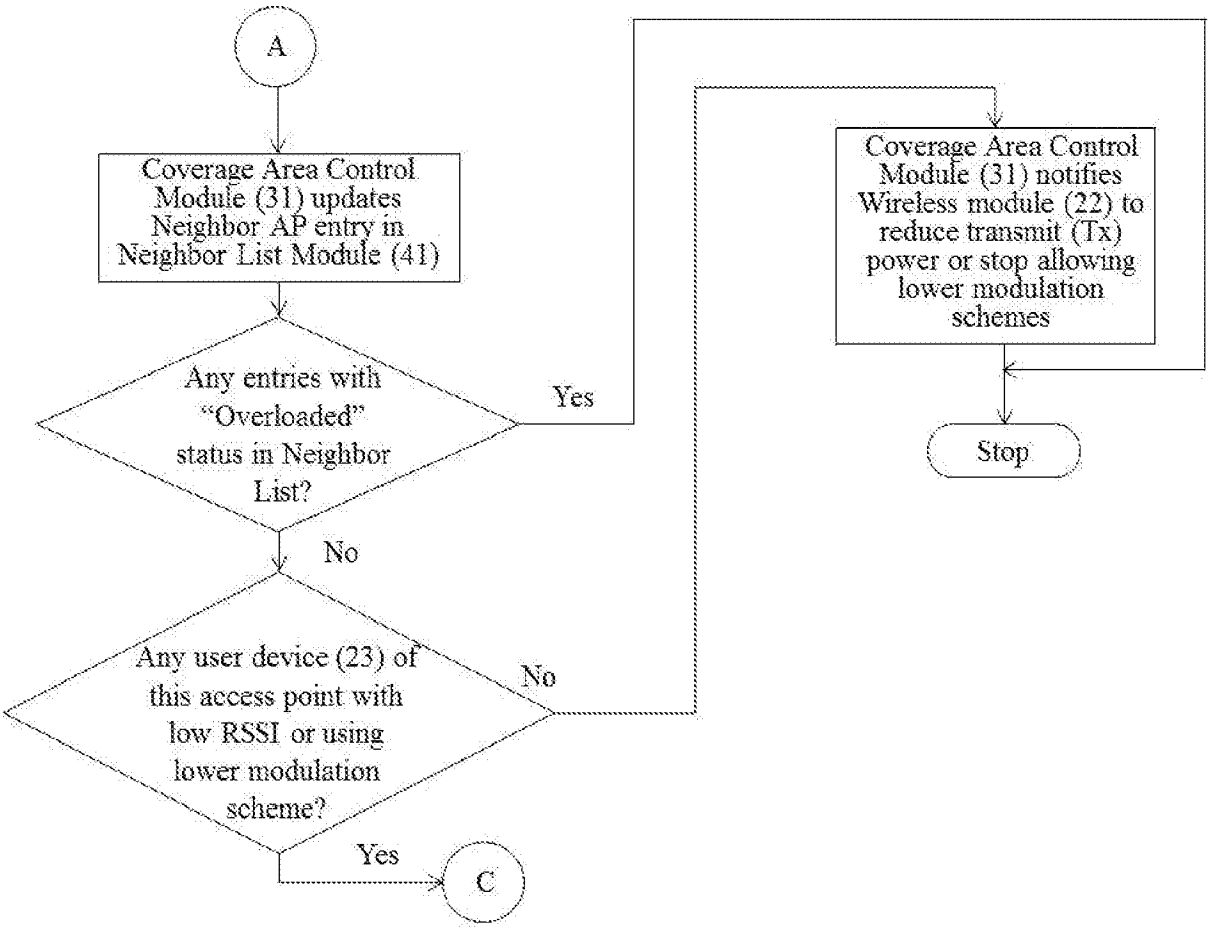

A
Coverage Area Control Module (31) updates Neighbor AP entry in Neighbor List Module (41)
Any entries with "Overloaded" status in Neighbor List?
Yes
No
Any user device (23) of this access point with low RSSI or using lower modulation scheme?
No
Yes
C
Coverage Area Control Module (31) notifies Wireless module (22) to reduce transmit (Tx) power or stop allowing lower modulation schemes
Stop

Figure 4

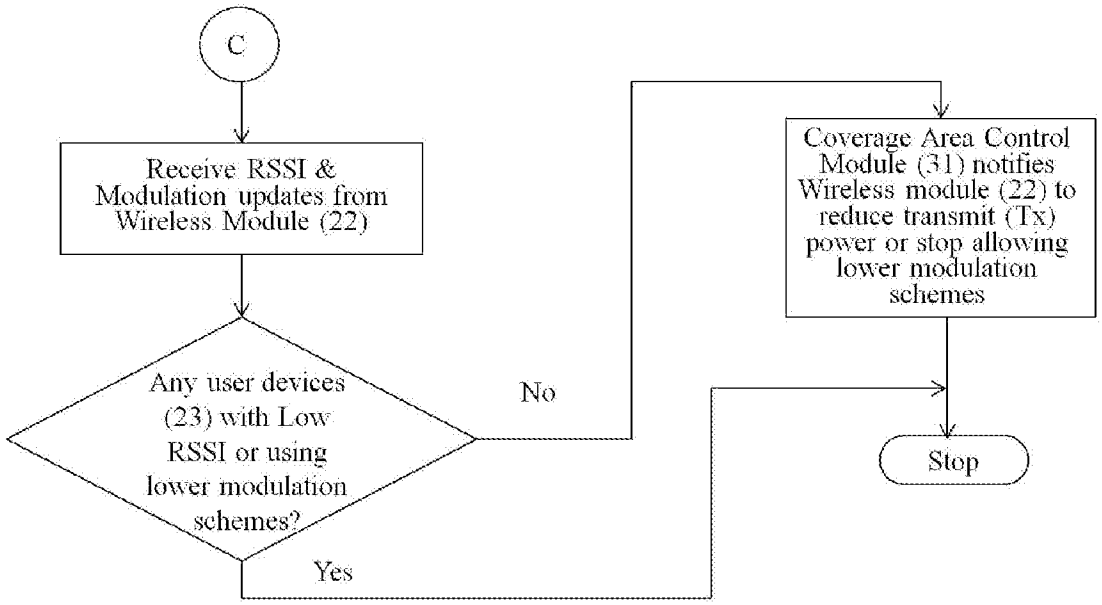

C
Receive RSSI & Modulation updates from Wireless Module (22)
Any user devices (23) with Low RSSI or using lower modulation schemes?
No
Yes
Coverage Area Control Module (31) notifies Wireless module (22) to reduce transmit (Tx) power or stop allowing lower modulation schemes
Stop

Figure 5

INTERNATIONAL SEARCH REPORT

International application No.
PCT/MY2015/050027

A. CLASSIFICATION OF SUBJECT MATTER

Int.Cl. H04W16/08(2009.01)i, H04W48/06(2009.01)i, H04W92/12(2009.01)i

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)

Int.Cl. H04W4/00-99/00

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

Published examined utility model applications of Japan 1922-1996
Published unexamined utility model applications of Japan 1971-2015
Registered utility model specifications of Japan 1996-2015
Published registered utility model applications of Japan 1994-2015

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2004/0229621 A1 (INTERNATIONAL BUSINESS MACHINES CORPORATION) 2004.11.18, [0021], [0025], [0036], [0042]-[0046],[0049],[0052] & WO 2004/105420 A1 & KR 10-2006-0005362 A & CN 1792108 A	1-10
Y	US 2010/0285812 A1 (HITACHI, LTD.) 2010.11.11, [0026]-[0040],[0048]-[0060] & JP 2010-263513 A	1-10
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☑ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

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International application No.
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C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 2013/107418 A1 (HUAWEI TECHNOLOGIES CO., LTD.) 2013.07.25, Abstract & US 2014/0349704 A1 & EP 2800414 A1 & CN 103220717 A	1-10
A	WO 2005/069519 A1 (INTERDIGITAL TECHNOLOGY CORPORATION) 2005.07.28, Abstract, Fig. 9 & JP 2007-518361 A & US 2005/0153690 A1 & EP 2053884 A2 & NO 20063591 A & MX PA06007826 A & KR 10-2006-0096105 A & CN 1906868 A & TW 200524315 A & AR 47376 A	1-10
A	WO 2011/149083 A1 (KYOCERA CORPORATION) 2011.12.01, Abstract, claim 5 & JP 2011-250213 A & US 2013/0072201 A1	1-10