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(54) **LOAD BALANCING APPARATUS AND METHOD IN WIRELESS NETWORK HOTSPOTS**

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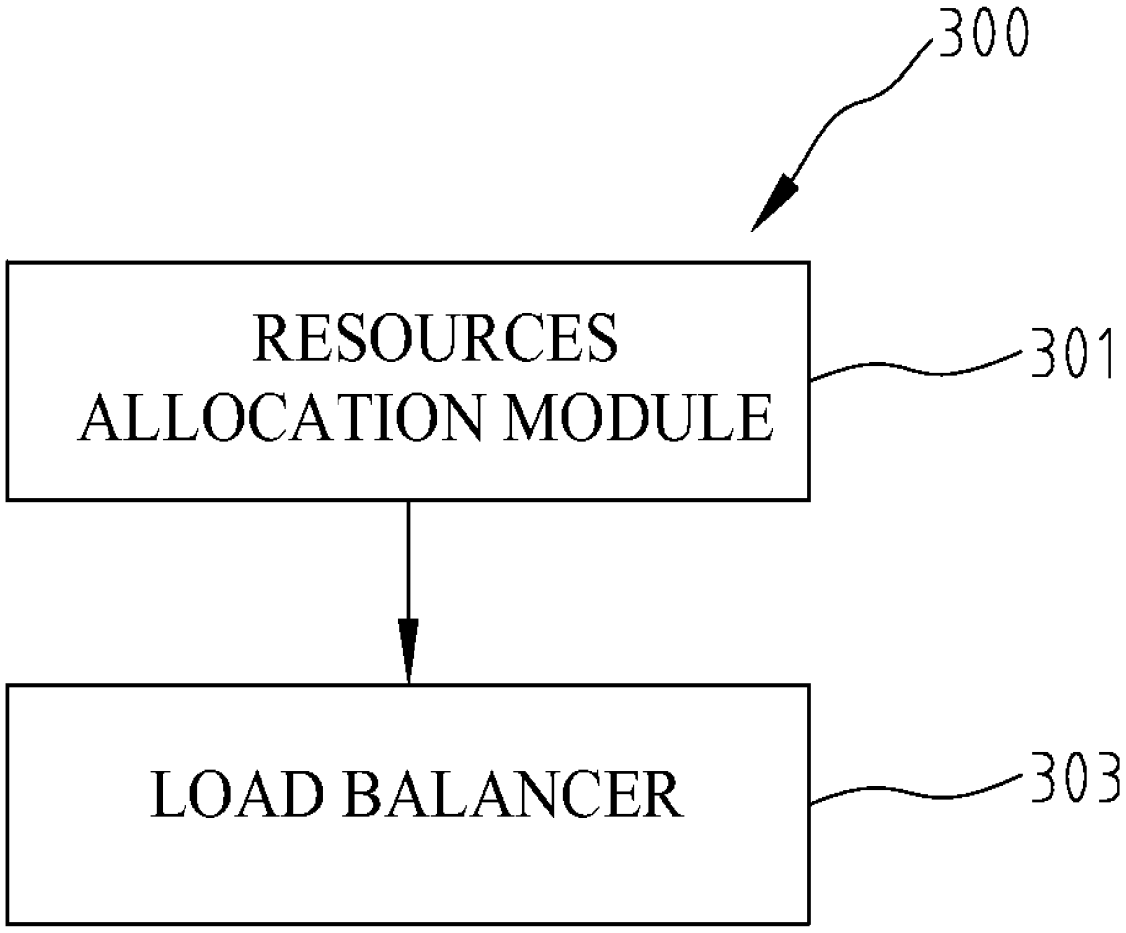
(57) **ABSTRACT**

Disclosed is a load balancing apparatus and method in wireless network hotspots, which comprises a resource allocation module and a load balancer. The resources reallocation module establishes the resources module and the relationship between access points (APs) and STAs in the wireless network hotspots, and seeks possible load balance shift paths (LBSPs). From these possible LBSPs, an LBSP is selected. Based on the selected LBSP, the load balancer reallocates network resources and dynamically arranges the load among the APs in the wireless network hotspots. This invention can be applicable to a centralized or a decentralized wireless communication system.



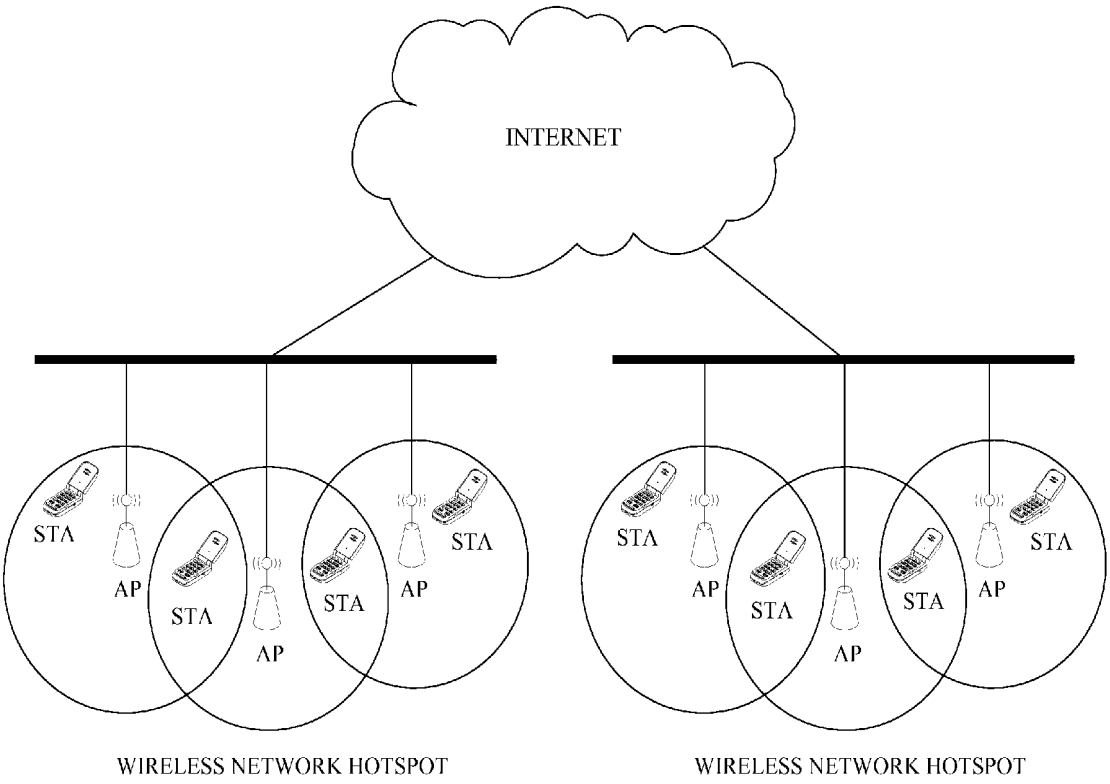


FIG. 1 (PRIOR ART)

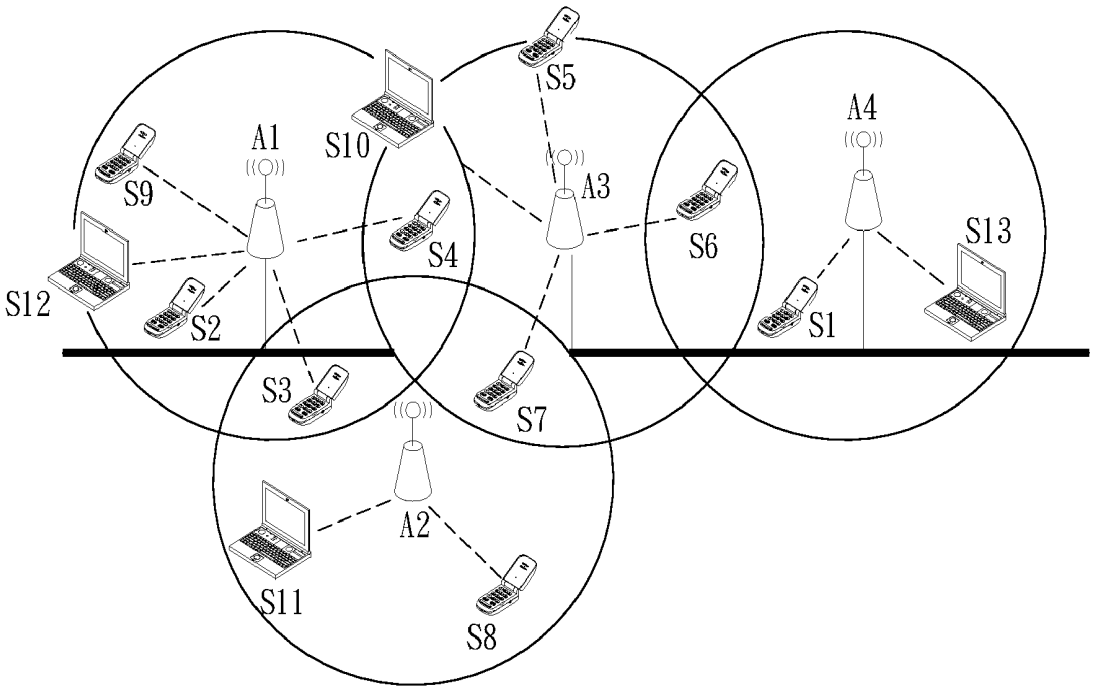


FIG. 2 (PRIOR ART)

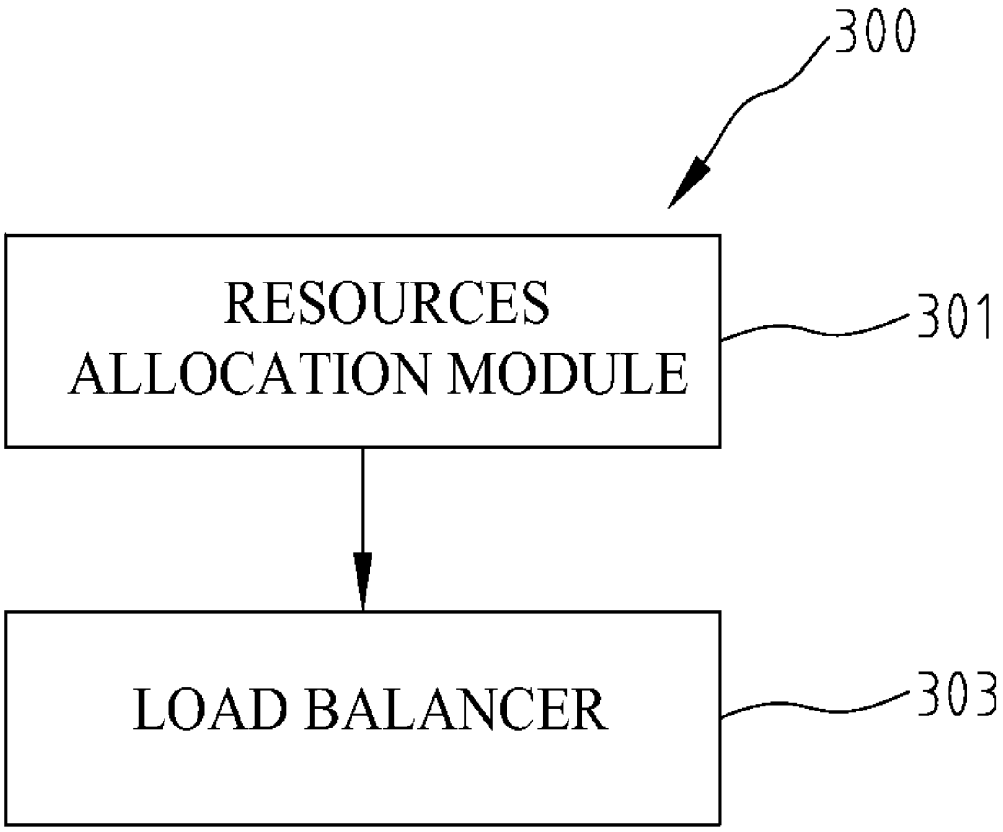


FIG. 3

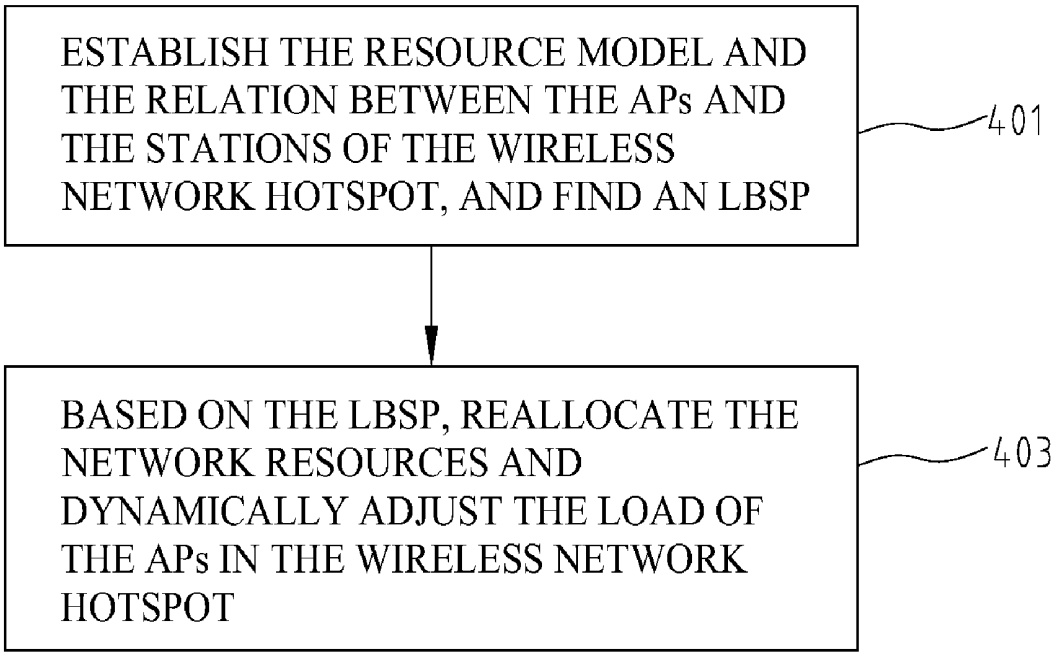

ESTABLISH THE RESOURCE MODEL AND THE RELATION BETWEEN THE APs AND THE STATIONS OF THE WIRELESS NETWORK HOTSPOT, AND FIND AN LBSP
401
BASED ON THE LBSP, REALLOCATE THE NETWORK RESOURCES AND DYNAMICALLY ADJUST THE LOAD OF THE APs IN THE WIRELESS NETWORK HOTSPOT
403

FIG. 4

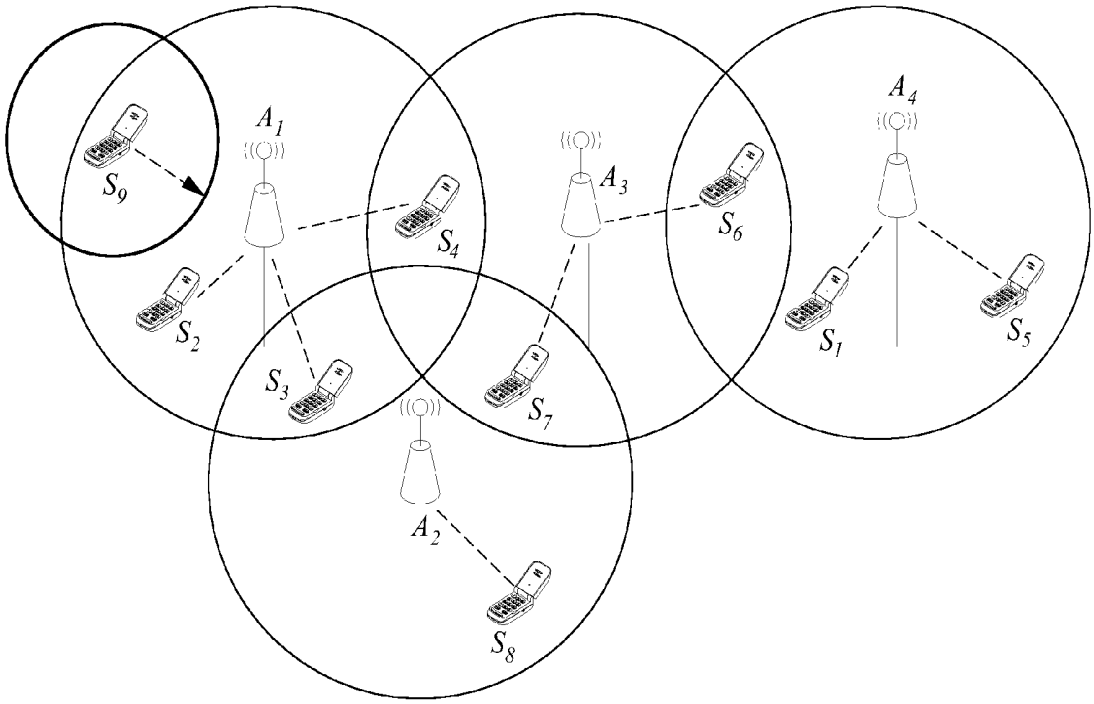


FIG. 5A

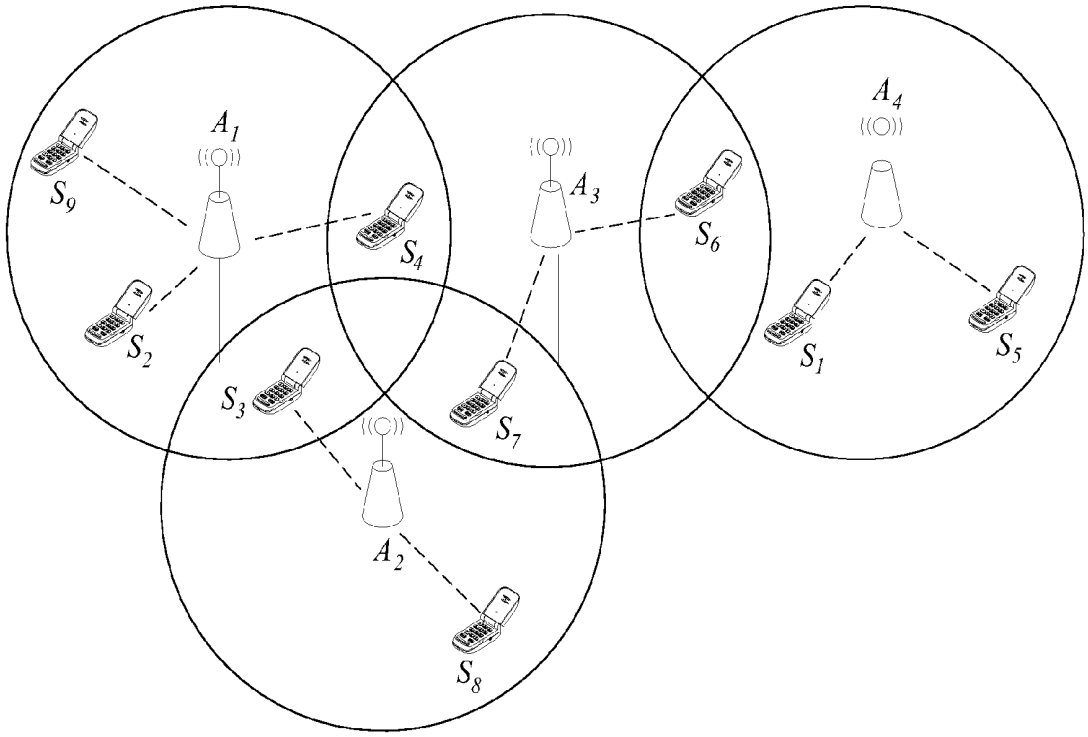


FIG. 5B

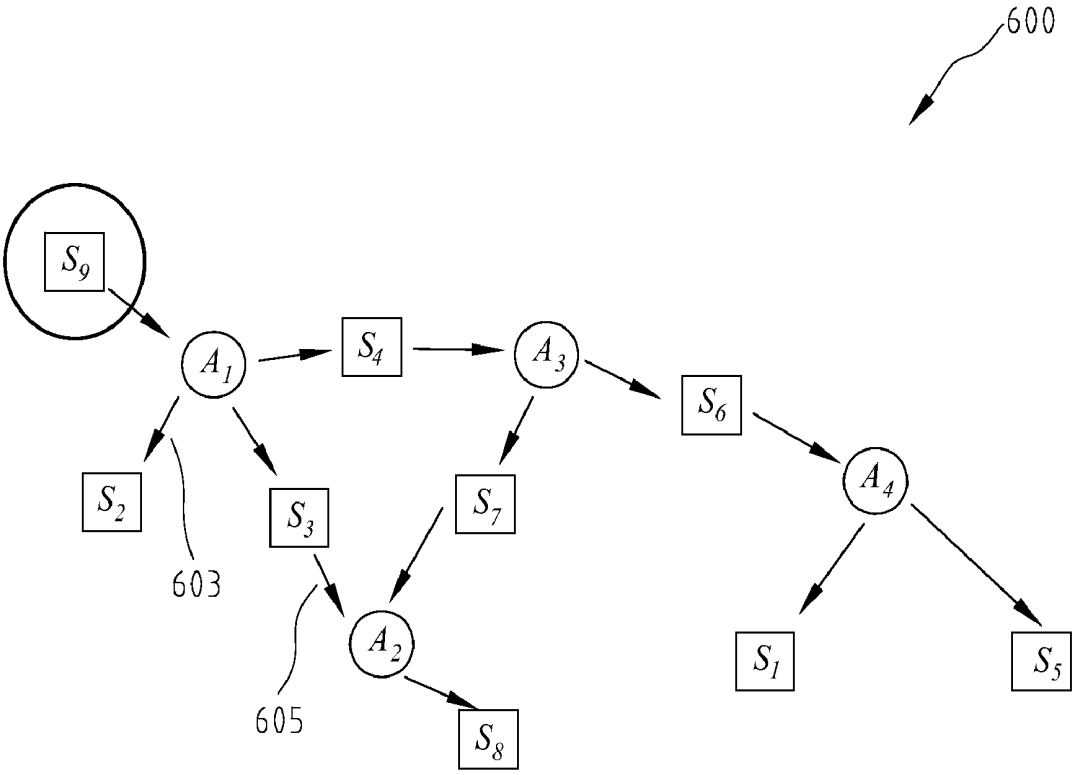


FIG. 6A

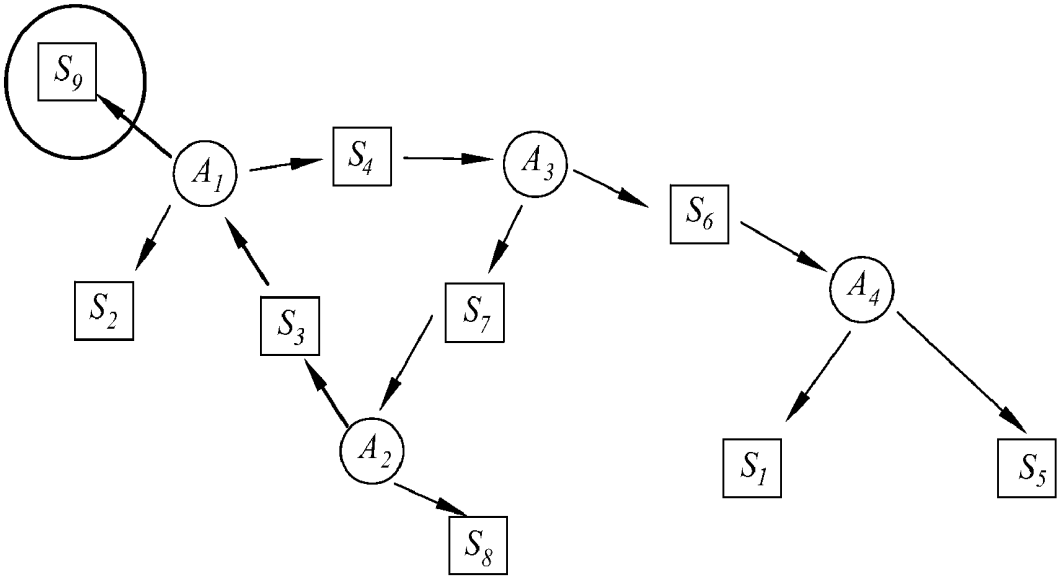


FIG. 6B

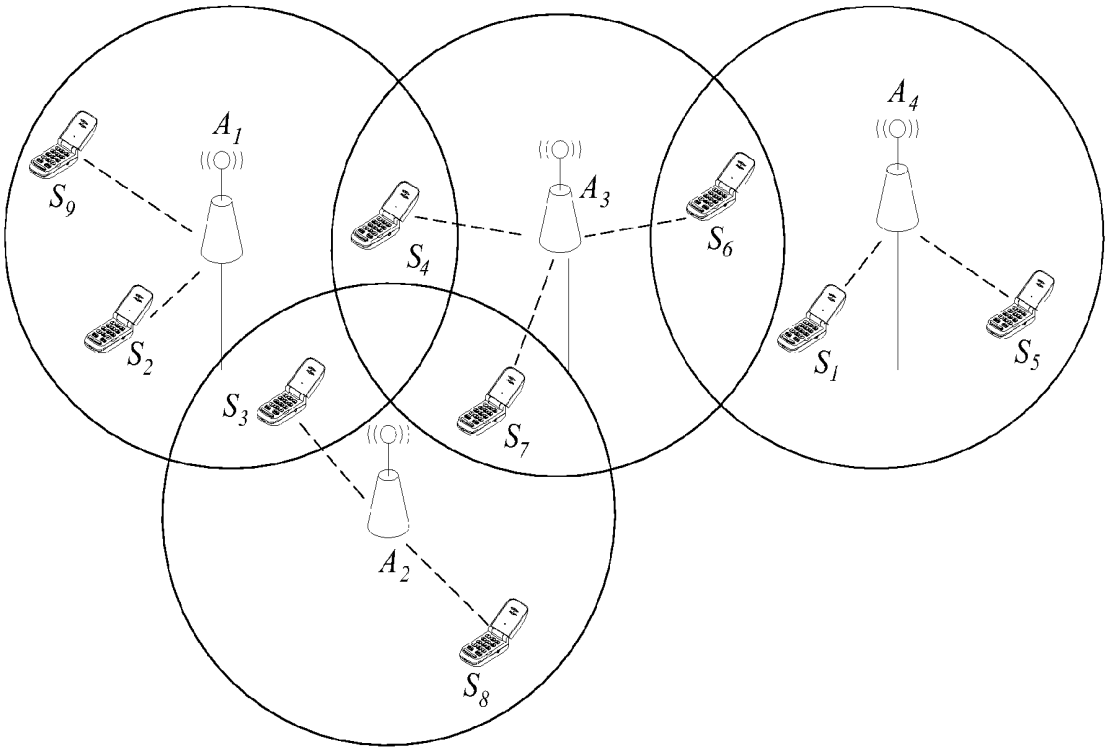


FIG. 7A

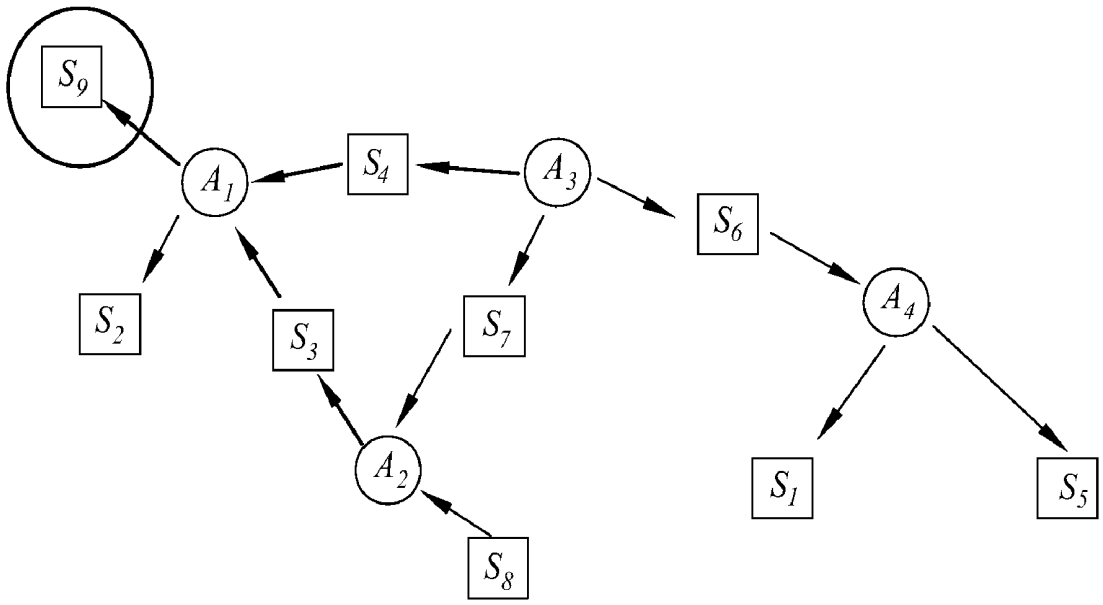


FIG. 7B

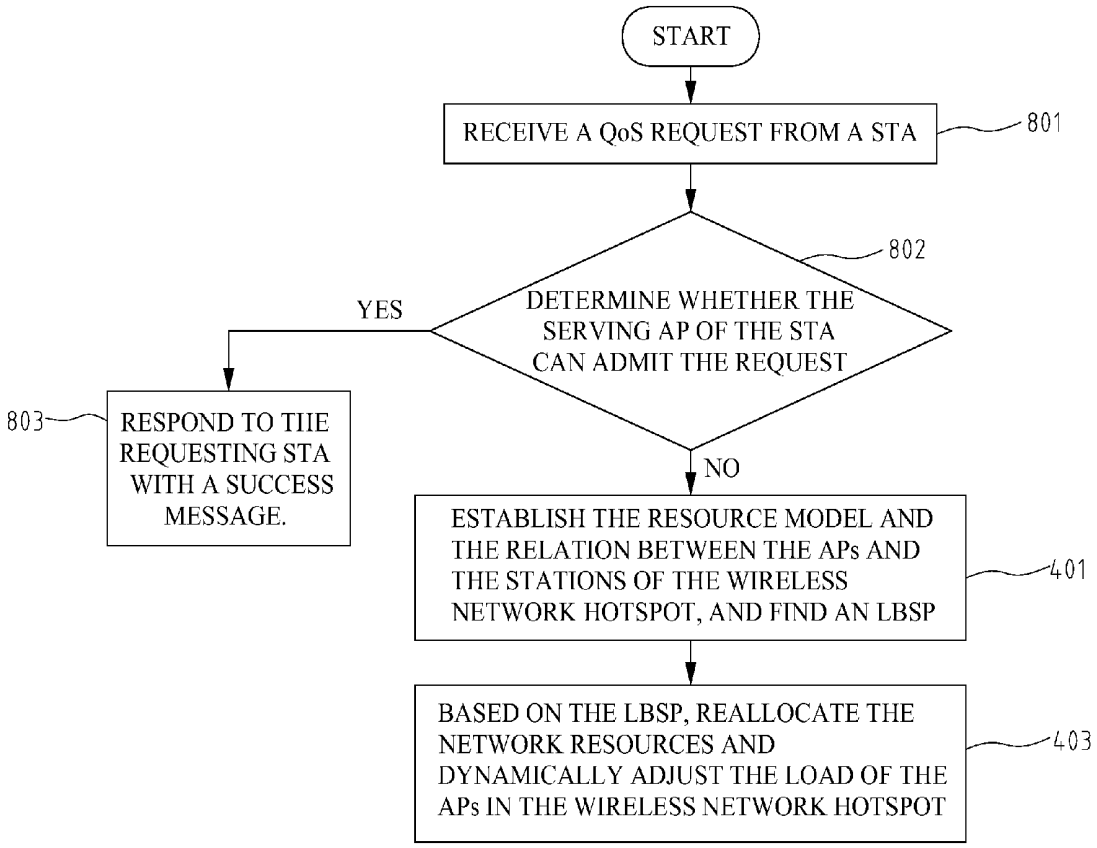

START
RECEIVE A QoS REQUEST FROM A STA
801
802
DETERMINE WHETHER THE SERVING AP OF THE STA CAN ADMIT THE REQUEST
YES
NO
803
RESPOND TO TIIE REQUESTING STA WITH A SUCCESS MESSAGE.
ESTABLISH THE RESOURCE MODEL AND THE RELATION BETWEEN THE APs AND THE STATIONS OF THE WIRELESS NETWORK HOTSPOT, AND FIND AN LBSP
401
BASED ON THE LBSP, REALLOCATE THE NETWORK RESOURCES AND DYNAMICALLY ADJUST THE LOAD OF THE APs IN THE WIRELESS NETWORK HOTSPOT
403

FIG. 8

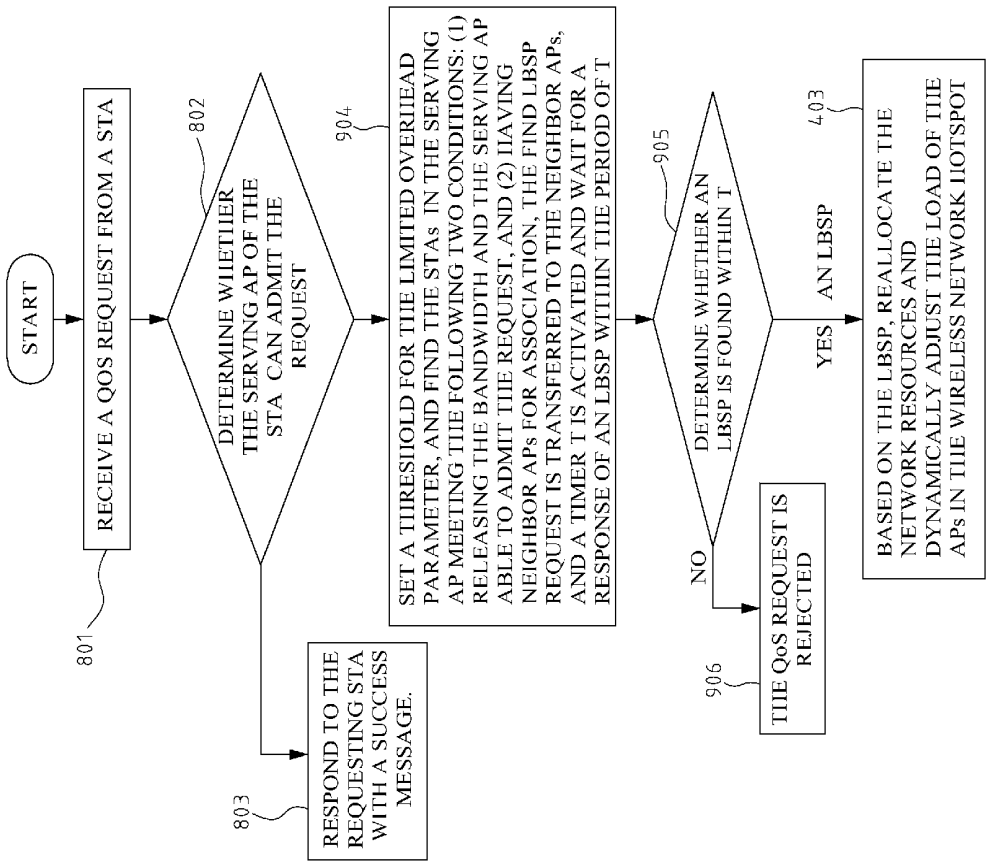

START
RECEIVE A QOS REQUEST FROM A STA
801
DETERMINE WHETHER THE SERVING AP OF THE STA CAN ADMIT THE REQUEST
802
RESPOND TO THE REQUESTING STA WITH A SUCCESS MESSAGE.
803
SET A THRESHOLD FOR THE LIMITED OVERHEAD PARAMETER, AND FIND THE STAs IN THE SERVING AP MEETING THE FOLLOWING TWO CONDITIONS: (1) RELEASING THE BANDWIDTH AND THE SERVING AP ABLE TO ADMIT THE REQUEST, AND (2) HAVING NEIGHBOR APs FOR ASSOCIATION, THE FIND LBSP REQUEST IS TRANSFERRED TO THE NEIGHBOR APs, AND A TIMER T IS ACTIVATED AND WAIT FOR A RESPONSE OF AN LBSP WITHIN THE PERIOD OF T
904
DETERMINE WHETHER AN LBSP IS FOUND WITHIN T
905
NO
THE QoS REQUEST IS REJECTED
906
YES
AN LBSP
403
BASED ON THE LBSP, REALLOCATE THE NETWORK RESOURCES AND DYNAMICALLY ADJUST THE LOAD OF THE APs IN THE WIRELESS NETWORK HOTSPOT

FIG. 9

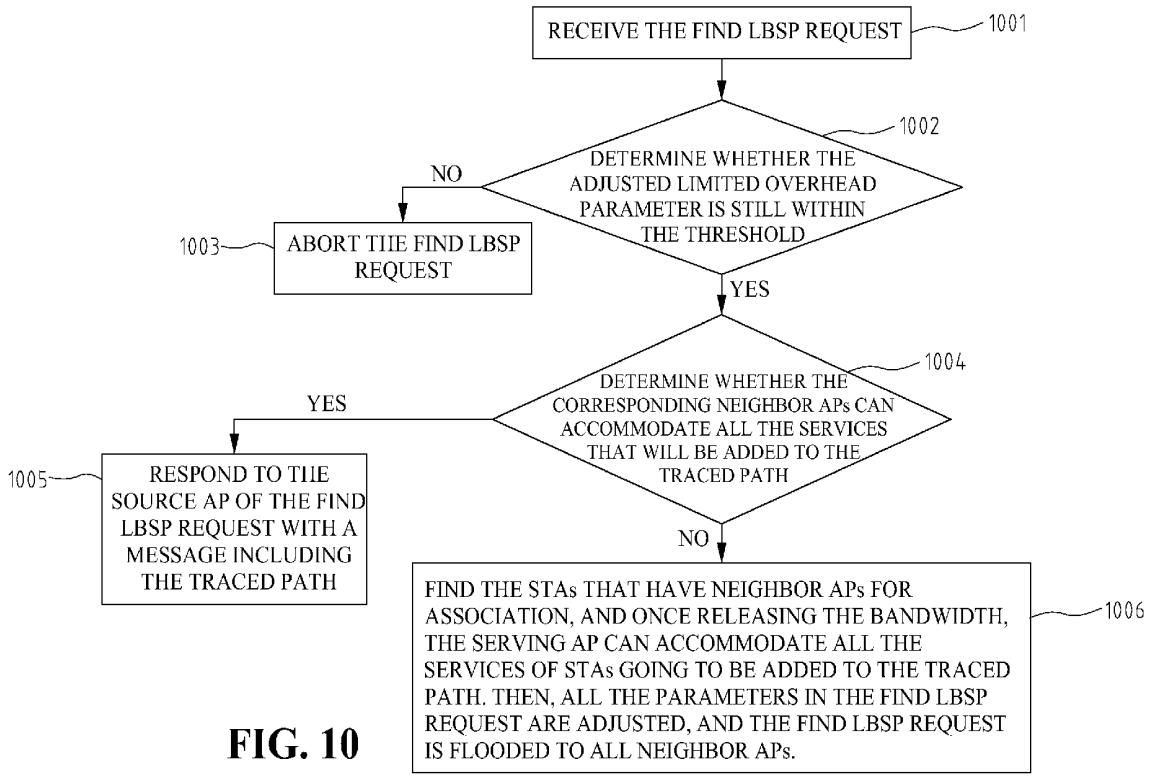

RECEIVE THE FIND LBSP REQUEST
1001
1002
DETERMINE WHETHER THE ADJUSTED LIMITED OVERHEAD PARAMETER IS STILL WITHIN THE THRESHOLD
NO
1003
ABORT TIIE FIND LBSP REQUEST
YES
1004
DETERMINE WHETHER THE CORRESPONDING NEIGHBOR APs CAN ACCOMMODATE ALL THE SERVICES THAT WILL BE ADDED TO THE TRACED PATH
YES
1005
RESPOND TO TIIE SOURCE AP OF THE FIND LBSP REQUEST WITH A MESSAGE INCLUDING THE TRACED PATH
NO
FIND THE STAs THAT HAVE NEIGHBOR APs FOR ASSOCIATION, AND ONCE RELEASING THE BANDWIDTH, THE SERVING AP CAN ACCOMMODATE ALL THE SERVICES OF STAs GOING TO BE ADDED TO THE TRACED PATH. THEN, ALL THE PARAMETERS IN THE FIND LBSP REQUEST ARE ADJUSTED, AND THE FIND LBSP REQUEST IS FLOODED TO ALL NEIGHBOR APs.
1006

FIG. 10

LOAD BALANCING APPARATUS AND METHOD IN WIRELESS NETWORK HOTSPOTS

FIELD OF THE INVENTION

[0001] The present invention generally relates to an apparatus and method for load balancing in the wireless network hotspots.

BACKGROUND OF THE INVENTION

[0002] The wireless local area network (WLAN) technology and construction have grown rapidly in recent years. The wireless network is the most important technology for the mobile Internet service. The wireless network is designed as an extension of the Ethernet, and is suitable for best-effort services, such as e-mail and web browsing. But as the real-time media applications, such as voice over IP (VoIP), video streaming, grows popular, a higher demands on the network efficiency is required to guarantee an acceptable quality of service (QoS).

[0003] The conventional development is mostly focusing on improving the bandwidth efficiency of a single access point. Many wireless resources management techniques are proposed. However, in a wireless network hotspot, the load balancing problems among the access points (APs) and the overall capacity are not fully discussed.

[0004] FIG. **1** shows a schematic view of a conventional wireless network hotspot system structure. As shown in FIG. **1**, the wireless network hotspot system includes three parts: Internet, distributed system, and WLAN hotspot.

[0005] A wireless network hotspot includes many APs and stations (STAs), and has the following three functions. The first is the admission control unit, through which the APs can determine whether sufficient resources are available for supporting the QoS request. Many admission control techniques can achieve such a function, such as the reference admission control mechanism of IEEE802.11e specification. The second is the radio measurement and management facilities, through which the APs can request the connected STAs to measure the radio, and reports the measurement to the APs. Hence, the APs can know the information of the neighboring APs. There are several radio measurement and management techniques, such as IEEE802.11k specification. The third is the fast handoff. The STAs and APs can use the fast handoff technique of IEEE802.11r specification or related techniques.

[0006] As shown in FIG. **1**, the coverage areas of the APs in a wireless network hotspot usually overlaps with one another. When a wireless network STA is in the network entry stage, a plurality of APs can be detected. The STA usually selects the AP with the best received signal strength indicator (RSSI) to associate with and establish the connection. Then, the STA will occupy some AP resources, such as bandwidth and AP buffer, for service. However, this type of STA-centric network association and service request will lead to the load unbalance among the APs in the wireless network hotspot so that the bandwidth can not be effectively utilized. For wireless multimedia service, such as voice over WLAN (VoWLAN), that demands high quality service, this is an important issue.

[0007] The STAs can establish a non-QoS connection or a QoS connection with the AP. When a non-QoS connection is established, such as FTP, e-mail, wed browsing, the so-called best effort (BE) and background (BK) services, the AP does not guarantee the quality of the non-QoS services. When a QoS connection is established, such as voice (VO) or video (VI) connection, the quality of service is guaranteed by the AP. Because the AP must provide QoS guarantee, the majority of bandwidth resources of an AP is allocated to the QoS connections, for example, 80% vs. 20% allocation for QoS and non-QoS, respectively.

[0008] FIG. **2** shows a schematic view of a conventional wireless network load system. As shown in FIG. **2**, an STA **S3** in the network entry stage detects APs **A1**, **A2**, and selects an AP with best signal, for instance, **A1**, for association. When a second STA **S9** tries to establish a QoS connection, such as VO or VI connection, **S9** issues a QoS connection request to **A1**. **A1** uses admission control unit to determine whether the request can be admitted. As the QoS bandwidth of **A1** is fully occupied, the request from **S9** cannot be admitted.

[0009] In other words, the conventional STA-centric network association mechanism may lead to load unbalance among APs, and results in poor bandwidth utilization.

[0010] U.S. Pat. No. 6,574,474 disclosed a method for the STA to select the AP association based on the AP signal strength and load condition so as to achieve load balancing in the wireless network.

[0011] U.S. Pat. No. 6,574,477 disclosed a method for load balancing two APs of a single cell. U.S. Pat. No. 6,069,871 disclosed a cellular wireless communication system for multi-carriers. When an STA requests a connection with a base station (BS), a method for searching for a neighbor BS will be provided if the requested BS does not have sufficient resource to provide the connection. The neighbor BS must have sufficient resource to provide the QoS to the requesting STA. International Publication WO 2004/004226 disclosed a method that, in a wireless network, when the bandwidth resource of an AP is below the threshold, the AP searches for a neighbor AP with sufficient bandwidth so that the bandwidth of the neighbor AP will not be below the threshold after providing the service to the STA. All these techniques are specific mechanism activated under specific condition, instead of general solution.

[0012] It is imperative to provide a load balancing technique to improve the bandwidth utilization of a wireless network system.

SUMMARY OF THE INVENTION

[0013] Examples of the present invention may provide a load balancing apparatus and method in wireless network hotspots. The apparatus includes a resource allocation module and a load balancer. The wireless network hotspots include a plurality of APs and a plurality of STAs.

[0014] When an AP cannot admit a QoS request of an STA, the resources allocation module first establishes the resource model and the relation among the AP and the STA of the wireless network hotspot, and finds a load balance shift path (LBSP). Based on the LBSP, the load balancer reallocates the network resources, and dynamically adjusts the loads of a plurality of APs in the wireless network hotspot to improve the bandwidth utilization of the overall wireless network.

[0015] When more than one LBSP are found, a plurality of selection schemes can be used to select the LBSP, for example, the LBSP with the least resource consumption cost

after the load balancing, or the shortest LBSP. It is also possible to use multiple LBSPs for load balancing operation to achieve the QoS request.

[0016] The present invention may be suitable to both centralized and decentralized wireless communication systems. In the centralized wireless communication system, a directed graph, i.e., the relation between AP and the STA in the wireless network hotspot, is used to find the LBSP and adjust the load of the APs to achieve load balancing. In the decentralized communication system, where the information of APs and the STAs are scattered in each AP, the information must be exchanged among the APs without a centralized server to achieve the load balancing.

[0017] The foregoing and other objects, features, aspects and advantages of the present invention will become better understood from a careful reading of a detailed description provided herein below with appropriate reference to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0018] FIG. **1** shows a schematic view of a conventional wireless network hotspot.

[0019] FIG. **2** shows a schematic view of loads of a conventional wireless network.

[0020] FIG. **3** shows a schematic view of a load balancing apparatus for wireless network hotspot of the present invention.

[0021] FIG. **4** shows a flowchart of the operation of the apparatus of FIG. **3**.

[0022] FIG. **5**A shows an example of before load balancing.

[0023] FIG. **5**B shows an example of FIG. **5**A after load balancing.

[0024] FIG. **6**A shows a resource allocation graph of the example in FIG. **5**A.

[0025] FIG. **6**B shows the resource allocation graph of the example in FIG. **5**B.

[0026] FIG. **7**A shows an LBSP sub-graph after load balancing of the present invention.

[0027] FIG. **7**B shows a resource allocation graph of FIG. **7**A.

[0028] FIG. **8** shows a flowchart of the load balancing operation of the present invention in a centralized wireless communication system after receiving a QoS request.

[0029] FIG. **9** shows a flowchart of the load balancing operation of the present invention in a decentralized wireless communication system after receiving a QoS request.

[0030] FIG. **10** shows a flowchart of the operation of the present invention after receiving a find LBSP request.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0031] FIG. **3** shows a schematic view of a load balancing apparatus of wireless network hotspot of the present invention, where the hotspot includes a plurality of APs and STAs. As shown in FIG. **3**, a load balancing apparatus **300** includes a resources allocation module **301** and a load balancer **303**. When an AP cannot admit a QoS request of an STA, for example, the available bandwidth of an AP is below a threshold, or does not have a sufficient bandwidth, load balancing apparatus **300** performs the dynamic load balancing operation, as shown in FIG. **4**.

[0032] Resources allocation module **301** first establishes the resource model and the relation between the APs and the STAs of the wireless network hotspot, and finds an LBSP, as shown in step **401** of FIG. **4**. Based on the LBSP, load balancer **303** reallocates the network resources and dynamically adjusts the load of the APs in the wireless network hotspot to improve the bandwidth utilization of the overall wireless network, as shown in step **403**.

[0033] The following describes how the resource model between the APs and the STAs is established. A wireless network hotspot includes N APs. For simplicity, all the APs are assumed to be identical, where Ai is the i-th AP in the model, Ci is the bandwidth efficiency of Ai, where Ci is between 0 and 1. Ci=1 implies that the bandwidth of Ai is fully occupied, and Ai has no further bandwidth to provide services to an STA.

[0034] Sj is the j-th STA, and connects to Ai of the wireless network hotspot at the speed of Rij Kbps, for example, IEEE802.11b providing the STA with 1 Mbps, 2 Mbps, 5 Mbps, and 11 Mbps connection. Assuming Sj needs the nj service connections, and the k-th service connection is at the speed of r_k. When Ai admits the nj service connections, Ai allocates $rate_j/Rij$ resources to these service connections, where $rate_j=\Sigma_{k=1}^{nj} r_k$.

[0035] The following describes how the two relations between the APs and the STAs of the wireless network hotspot are established. The first relation is the coverage area relation between the APs and the STAs, and the second relation is the service relation between the APs and the STAs.

[0036] When some Sj performs wireless network channel scanning and finds Ai, Sj adds Ai to its scan list. Therefore, $p_{i,j}$ defines the coverage area relation between an AP and an STA.

$$p_{i,j} = 1, \text{ when } Ai \text{ in } Sj \text{ scan list;}$$

$$= 0, \text{ otherwise.}$$

[0037] If Sj issues a QoS request to Ai, and obtains the admission for connection, $q_{i,j}$ defines the service relation between an AP and an STA.

$$q_{i,j} = 1, Ai \text{ is the serving } AP \text{ for } Sj, \text{ and } Ai \text{ supports } QoS \text{ for } Sj;$$

$$= 0, \text{otherwise.}$$

[0038] The above two relations can be obtained from the serving AP or through periodic or non-periodic measurement requests to the STAs.

[0039] When Sj needs more resources for new services, and the serving AP cannot admit the request, the load balancing method of the present invention is activated to adjust the load of the APs to accommodate the QoS request of Sj.

[0040] FIGS. **5**A and **5**B show a working example of the dynamic load balancing of the present invention, where FIG. **5**A is the relation between AP and STA of a wireless network hotspot before the load balancing, and FIG. **5**B shows the relation after the load balancing.

[0041] Referring to FIG. **5**A, for simplicity, the APs are assumed to have the uniform bandwidth in their coverage areas, and the two neighboring APs use different wireless network channels. Each AP at most supports three wireless network phones, where S**1**-S**8** are connected to A**4**, A**1**, A**1**, A**1**, A**4**, A**3**, A**3**, and A**2**, respectively. When S**9** requests for wireless network phone connection to A**1**, the loaded A**1** cannot admit the service request to S**9**. With the present invention, the serving AP of S**3** is changed from A**1** to A**2**, and then A**1** will have available bandwidth for serving S**9**. FIG. **5**B shows the relation between the AP and the STA after the load balancing operation.

[0042] The present invention is applicable to both centralized and decentralized wireless communication systems. In the centralized wireless communication system, a centralized server owns all the information about the APs and the STAs. The present invention uses a directed graph, i.e., directed resource-allocation graph, to describe the relation between the APs and the STAs of the wireless network hotspot, and find the LBSP. Then, the centralized server is used to balance the load of the APs to achieve load balancing of the wireless network.

[0043] In the decentralized communication system, where the information of APs and the STAs are scattered in each AP, the present invention uses information exchange to adjust the load among APs to achieve load balancing of the wireless network. Without the use of a centralized server, the cost can be further reduced. The following describes the present invention applied in a centralized and a decentralized wireless communication system, respectively.

[0044] In a centralized wireless communication system, the present invention uses a directed resource-allocation graph to describe the relation between the APs and the STA, and the loads on the APs. This directed resource-allocation graph includes a plurality of nodes and edges. The nodes represent the APs and the STAs. The edges include a plurality of assignment edges and claim edges. FIG. **6**A shows the resource-allocation graph of FIG. **5**A. Using FIG. **6**A as an example, the following describes the resource-allocation graph.

[0045] As shown in FIG. **6**A, an edge **603** from A**1** to S**2** is represented by (A**1**, S**2**) to indicate that A**1** is serving S**2**. Edge **603** is an assignment edge. That is, $p_{1,2}=1$, and $q_{1,2}=1$. An edge **605** from S**3** to A**2** is represented by (S**3**, A**2**) to indicate that A**2** is in the scan list of S**3** but not serving S**3**. Edge **605** is a claim edge. That is, $p_{2,3}=1$, and $q_{2,3}=0$. The only exception is a claim edge from S**9** to A**1** represented by (S**9**, A**1**) to indicate that S**9** is requesting service from A**1**.

[0046] Through resource-allocation graph **600**, the relation between APs and STAs can be easily understood. In a centralized wireless communication system, the resource model between the APs and the STAs of the wireless network hotspots established by resources allocation module **301** of the present invention is the resource allocation graph.

[0047] As mentioned, when S**9** requests to A**1** for wireless network phone service, and A**1** is unable to admit the request, the load balancing apparatus of the present invention can be activated to find an LBSP and adjust the loads of APs to accommodate S**9**'s request.

[0048] When more than one LBSP is found, many path selection solutions can be used to select an LBSP, for example, path that spends the minimal resources, shortest path, i.e., path that minimizes migration overhead. In the present invention, three paths can be found using resource-allocation graph: {(S**9**,A**1**), (A**1**,S**4**), (S**4**, A**3**), (A**3**, S**6**), (S**6**, A**4**)}, {(S**9**, A**1**), (A**1**, S**4**), (S**4**, A**3**), (A**3**, S**7**), (S**7**, A**2**)}, {(S**9**, A**1**}, (A**1**, S**3**), (S**3**, A**2**)}.

[0049] If the path that spends the minimal resources is selected, all the edges on the LBSP must be assigned a weight Wij. For an assignment edge, Wij=−Rij. For a claim edge, Wij=Rij. By adding all the weights of the edges on a path, the weight of an LBSP is calculated, and the LBSP with the minimal weight is selected.

[0050] If the shortest path is adopted, {(S**9**, A**1**), (A**1**, S**3**), (S**3**, A**2**)} will be selected.

[0051] Once the LBSP is selected, for example, {(S**9**, A**1**), (A**1**, S**3**), (S**3**, A**2**)}, the direction of the edges on the LBSP must be reversed; that is, assignment edge **603** becomes claim edge **605**, and vice versa. Therefore, the path {(S**9**, A**1**), (A**1**, S**3**), (S**3**, A**2**)} is reversed into {(A**1**, S**9**), (S**3**, A**1**), (A**2**, S**3**)}. In this case, S**9** is served by A**1**. FIG. **6**B shows the resource allocation graph of FIG. **5**B after the load balancing operation.

[0052] The above example uses an LBSP to achieve the admission of the QoS request. The LBSP sub-graph approach can also be used. That is, a plurality of LBSPs can be used together to achieve the load balancing and admission of the QoS request. The following describes the LBSP sub-graph approach using FIG. **6**B.

[0053] When S**9** request for QoS connection to A**1**, A**1** must obtain the bandwidths of S**3** and S**4** to satisfy the S**9**'s request. Therefore, a plurality of LBSPs must be selected to migrate S**3** and S**4** to neighbor APs, A**3** and A**3** respectively, to satisfy the request. This is the LBSP sub-graph, as shown in FIG. **7**A.

[0054] FIG. **7**B shows the resource allocation graph, where the LBSP sub-graph is to reverse the {(S**9**, A**1**), (A**1**, S**3**), (S**3**, A**2**), (A**1**, S**4**), (S**4**, A**3**)) to {(A**1**, S**9**), (S**3**, A**1**), (A**2**, S**3**), (S**4**, A**1**), (A**3**, S**4**)}. That is, S**3** is migrated to A**2**, and S**4** is migrated to A**3**.

[0055] The above two examples show how the present invention is applied to a centralized wireless communication system. The central server owns all the related information of APs and STAs, and the load balancing after the finding of LBSP is also performed by the central server. However, the centralized wireless communication system requires the extra hardware cost of the central server.

[0056] FIG. **8** shows a flowchart of the load balancing operation in a centralized wireless communication network after receiving the QoS request. As shown in FIG. **8**, step **801** is to receive a QoS request from an STA. Step **802** is to determine whether the serving AP of the STA can admit the request. If yes, take step **803** to respond to the requesting STA with a success message. If not, take step **401** to establish the resource model and relation between the APs and the STAs of the wireless network hotspot, and then find an LBSP for the serving AP to accommodate the requesting STA. Finally, step **403** is to re-allocate network resources and balance the lads of APs according to the LBSP, using such as IEEE802.11r fast handoff technique, to improve the bandwidth utilization of the overall wireless network.

[0057] As mentioned, when the resource mode and the relation between the APs and STAs are established, all the possible LBSPs are found, and if there is more than one LBSp, several path selection solutions can be used to select the path, such as path that spends the minimal resources, shortest path, i.e., path that minimizes migration overhead.

In addition, a plurality of LBSPs can be selected together to balance the load to accommodate the QoS request.

[0058] Because the centralized wireless communication network requires a central server, the present invention also provides a load balancing method for decentralized wireless communication network. The related information of APs and the STAs are scattered in each AP in a decentralized wireless communication system, and all the findings of the LBSP must be accomplished through information exchange between APs. This method includes the use of flooding to transfer the LBSP finding request to the neighbor AP to find a LBSP.

[0059] FIG. **9** shows a flowchart of the load balancing operation in a decentralized wireless communication network after receiving the QoS request. As shown in FIG. **9**, after step **802**, if the resource of the serving AP does not allow the AP to admit the request, step **904** is used to replace step **401**.

[0060] Step **904** is to set a threshold for the limited overhead parameter, and find the STAs in the serving AP meeting the following two conditions: (1) releasing the bandwidth and the serving AP able to admit the request, and (2) having neighbor AP for association. Then, the find LBSP request is transferred to the neighbor APs, and a timer T is activated. Finally, the next step is to wait for a response of an LBSP within the period of T.

[0061] According to the present invention, the find LBSP request includes the traced path, limited overhead parameter, threshold of the limited overhead parameter, and corresponding QoS parameters, and so on. The traced path includes the ID information of the APs and the STAs on the path. The limited overhead parameter may include the limits on the additional bandwidth, or the number of APs searched.

[0062] After the timer T is expired, if neighbor APs respond, the traced path included in the response is selected. If more than one response is received, a path selection solution is used to select a path, and take step **403** following the selected path.

[0063] As shown in step **905**, if an LBSP is found within T, the last AP on the path includes the response of the traced path, and following step **403**, which is described earlier. If no response is received by AP within T, the request is rejected, and a failure message is issued to the STA, as shown in step **906**.

[0064] It is worth noticing that the T must set to effectively solve the problem of over-time in finding the LBSP. FIG. **10** shows a flowchart of the present invention after receiving a find LBSP request.

[0065] As shown in FIG. **10**, step **1001** is for the neighbor APs to receive the find LBSP request. Step **1002** is to adjust the limited overhead parameter, and determine whether the adjusted limited overhead parameter is still within the threshold. If not, take step **1003** to abort the find LBSP request. Otherwise, take step **1004** to determine whether the corresponding neighbor AP can accommodate all the services of STAs that will be added to the traced path. If so, take step **1005** to respond to the source AP of the find LBSP request with a message including the traced path. The source AP is the first AP of the traced path. Otherwise, take step **1006**.

[0066] Step **1006** is to find the STAs that have neighbor APs for association, and once releasing the bandwidth, the serving AP can accommodate all the services of STAs going to be added to the traced path. Then, all the parameters except the limited overhead parameters in the find LBSP request are adjusted, for example, adding itself and corresponding STAs to traced path, and updating the QoS parameter of the corresponding STAs. Finally, the find LBSP request is transferred to all neighbor APs.

[0067] Similarly, an AP receiving the find LBSP request will follow the above flowchart, and so on, until the LBSP is found or the limited overhead parameter exceeds the threshold. This method can effectively solve the problem of over-time in finding the LBSP, and prevents finding the path that the migration overhead is too much.

[0068] Although the present invention has been described with reference to the preferred embodiments, it will be understood that the invention is not limited to the details described thereof. Various substitutions and modifications have been suggested in the foregoing description, and others will occur to those of ordinary skill in the art. Therefore, all such substitutions and modifications are intended to be embraced within the scope of the invention as defined in the appended claims.

What is claimed is:

1. A load balancing apparatus for wireless network hotspot, said wireless network hotspot having a plurality of access points (APs) and a plurality of STAs, applicable when any said AP unable to admit a quality of service (QoS) request of any said STA, said apparatus comprising:

a resources allocation module, for establishing a resources model and relation between said APs and said STAs, and finding a load balancing shift path (LBSP); and

a load balancer, for re-allocating network resources and dynamically adjusting the loads of said APs based on said LBSP.

2. The apparatus as claimed in claim **1**, wherein said apparatus is applicable to a centralized wireless communication system.

3. The apparatus as claimed in claim **1**, wherein said apparatus is applicable to a decentralized wireless communication system.

4. The apparatus as claimed in claim **2**, wherein said resources allocation module further includes a directed resource allocation graph to describe the resource model and the relation between said APs and said STAs of said wireless network hotspot.

5. The apparatus as claimed in claim **4**, wherein said directed resource allocation graph further includes:

a plurality of nodes, representing said plurality of APs and said plurality of STAs; and

a plurality of edges, consisting of a plurality of assignment edges and a plurality of claim edges, said assignment edge indicating an AP serving an STA, and said claim edge indicating an AP being in a scan list of an STA, but said AP not serving said STA, or an STA is requesting service from its serving AP.

6. A load balancing method for wireless network hotspot, said wireless network hotspot having a plurality of access points (APs) and a plurality of STAs, said method being activated when any said AP unable to admit a quality of service (QoS) request of one of said plurality of STAs, said method comprising the steps of:

establishing a resource model and relation between said plurality of APs and said plurality of STAs, and finding a load balancing shift path (LBSP); and

reallocating network resources and dynamically adjusting the load of said plurality of APs according to said LBSP.

7. The method as claimed in claim **6**, wherein said method is applicable to a centralized wireless communication system.

8. The method as claimed in claim **6**, wherein said method is applicable to a decentralized wireless communication system.

9. The method as claimed in claim **6**, wherein said method uses a fast handoff technique to dynamically adjust the loads of said plurality of APs.

10. The method as claimed in claim **6**, wherein said method finds possible LBSPs before deciding said LBSP.

11. The method as claimed in claim **6**, wherein said relation between said APs and said STAs comprises a coverage area relation between said plurality of APs and said plurality of STAs, and a service relation between said plurality of APs and said plurality of STAs.

12. The method as claimed in claim **6**, wherein said method uses two techniques to find said LBSP, first being path that spends the minimal resources, and second being shortest path, that is the path that minimizes migration overhead.

13. The method as claimed in claim **6**, further including the following steps before said establishing resource model and relation between said plurality of APs and said plurality of STAs:

receiving said QoS request from said STA;

determining whether the serving AP of said STA able to admit said QoS request; and

responding a success message to said STA, if able to admit said QoS request.

14. The method as claimed in claim **7**, wherein said method owns information of said plurality of APs and said plurality of STAs through a central server, finds said LBSP and dynamically adjusts said load balancing among said plurality of APs through said central server.

15. The method as claimed in claim **8**, wherein said method floods a find LBSP request to neighbor APs to find said LBSP.

16. The method as claimed in claim **8**, wherein after said QoS request being received, the serving AP of said STA, when unable to admit said QoS request, performs the following steps of:

setting a threshold for the limited overhead parameter, and finding the STAs in said serving AP meeting the two conditions of releasing the bandwidth and said serving AP able to admit said request, and having neighbor APs for association; transferring said find LBSP request to said neighbor APs;

waiting for a response of said LBSP within a period of T; and

rejecting said QoS request if no said response of said LBSP being responded.

17. The method as claimed in claim **15**, wherein said find LBSP request further includes the information of a traced path, a limited overhead parameter, a threshold for said limited overhead parameter, and a plurality of corresponding STA QoS parameters.

18. The method as claimed in claim **17**, wherein said method performs the following steps after receiving said find LBSP request:

if said neighbor APs are able to admit said QoS request, and said limited overhead parameter are within a range of said threshold, responding to source AP of said find LBSP request;

finding the STAs of said neighbor APs, and once said STA releasing its bandwidth, said serving AP able to accommodate all the services of STAs going to be added to the traced path; and

adjusting all the parameters in said find LBSP request and transferring said find LBSP request to all neighbor APs corresponding to said STA.

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