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Techniques For Load Balancing In Wireless Lan's

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ABSTRACT: *Optimal load allocation strategies are proposed for a wireless sensor network which is connected in a star topology. The load considered here is of arbitrarily divisible kind, such that each fraction of the job can be distributed and assigned to any processor for computation purpose. Divisible Load Theory emphasizes on how to partition the load among a number of processors and links, such that the load is distributed optimally. Its objective is to partition the load in such a way so that the load can be distributed and processed in the shortest possible time. The existing strategies for both star and bus topologies are investigated. The performance of the suggested strategy is compared with the existing ones and it is found that it reduces the overall communication and processing time if allocation time is considered in the previous strategies. Wireless communications is one of the most active areas of technology development..Many mechanisms have been studied aimed at resolving load imbalance among access points (APs),(Ffig.1) which is a key issue in Wireless LANs (WLANs); meanwhile, cell breathing (CB), first appearing in cellular networks, provides another method in controlling coverage scale to realize load balance. In this paper, we present a new load balancing algorithm through power management based on cell breathing. Through establishing a centralized operation agent (COA), the load status of all the APs is monitored and power management is implemented accordingly, thus it avoids repetitive operations and extra management message consumption between APs in the distributive manner. Simulation results show that our algorithm can find a near optimal solution and improve the fairness as well as the performance of the whole network effectively. The IEEE 802.11 standards offer performance nearly comparable to that of Ethernet. In addition, they provide scalability, mobility, flexibility and relative ease of integration of wireless access. A WLAN is a flexible data communications system that can either replace or extend a wired LAN where cost is an issue or running cables between floors or different rooms on the same floor is not feasible. Examples of structures that are difficult to wire are warehouses, historic buildings, and manufacturing facilities. A WLAN basically consists of one or more wireless devices connected to each others in a peer-to-peer manner or through APs, which in turn are connected to the backbone network providing wireless connectivity to the covered area. Fig.1 shows a typical layout of a WLAN with two APs . . The main thing behind this is load balancing is to reduce the execution time of the load and to make sure that all the resources present in the system are utilized optimally Load balancing Features in their device drivers, AP firm wares, and WLAN cards. In these solutions, APs broadcast their load levels to users via modified beacon messages and each user chooses the least-loaded AP.*

Keywords*:Load balancing, WLAN, Min-Max Load balancing, Load, Access point, cell breathing, persistent, round robin, etc.*

INTRODUCTION

Large-scale WLAN deployment is popular in locations, such as conferences, university campuses, and airports, as well as metropolitan areas due to their low cost and ease of deployment [1]. A WLAN is made up of multiple Access Points (APs) with overlapping cells to provide a wide coverage and offer high transmission rates. In current implementations, each user associates with an AP with the strongest signal strength. However, recent studies have shown that this simple approach leads to inefficient association of mobile stations (STAs) to available APs [2]–[1]. Uneven distribution of user loads among APs increases congestion and packet loss, and reduces throughput. These results in inefficient medium utilization, and occasionally, network collapse. Therefore, AP selection has been an important issue in WLANs. Along with the development of wireless technologies, free access to the Internet and other networks brings huge popularity in Wireless LAN (WLAN) research. However, the client stations in WLAN tend to be concentrated at some places, called hot points area, and stay in centralized time duration. Although a hot spot is served by overlapping APs, the client stations (STAs) are only associated with the AP that provides the strongest power signal. As a result, this may cause load imbalance among neighboring APs, hence impacting the overall performance of the network, the utility of the available resources and the usage fairness of different APs.

The traditional load balancing with load unit migration from one processing element to another when load is light on some processing elements and heavy on some other processing elements. Load balancing is a technique used to distribute load on server to increase performance and speed of work designated to particular server. There are various techniques that can be used to accomplish load balancing task with the help of different types of computer hardware and software components. Many approaches have been proposed to solve the loadImbalance problem in WLAN. Several load balancingschemes by means of controlling WLAN cells size.one is to reduce the mostcongested AP and the other is to find the min-max solution. A new distributed algorithm is allowing APs to adjust their coverage rangeaccording to its own and the neighboring load conditions. Itgives a better balance in the network, but requires every AP toknow a complete list of the load information on adjacent APs,bringing a lot of exchange overheads.In this paper, we present a novel power control algorithmfor load balancing in IEEE 802.11 WLANs with cell breathing(CB). A centralized operation agent (COA) is designed tocollect the load information of all APs and manage their respective coverage area sizes from overall network level, so asto control the load distribution among APs. APs report theirload status and related information to COA periodically, andadjust their transmission power level of the beacon packets dueto COA arrangementsApplication of load balancing is used by different companies that conduct huge business transactions using internet. It is normally done to ensure that all their clients are able toconduct business activities with ease and accuracy. Load balancing improves the performance of server due to distributed load and is used for busy and large networks .Without balancing load in busy networks it is very difficult to satisfy the entire request issued to server. Organization into the web services or online business normally makes use of load balancing technique and engages two web servers (or more servers accordingly). If one of the web server gets overloaded or goes off, in that case alternate server activates and access the requested load. Load balancing is done by assigning particular service time for each process in order to ensure that several requests are handled without causing traffic. In other words, specific time is assigned to each process in the server for its execution and the process no more stay in the server once service time extends. Once load balancer works actively, service time reduces for each process reduces.

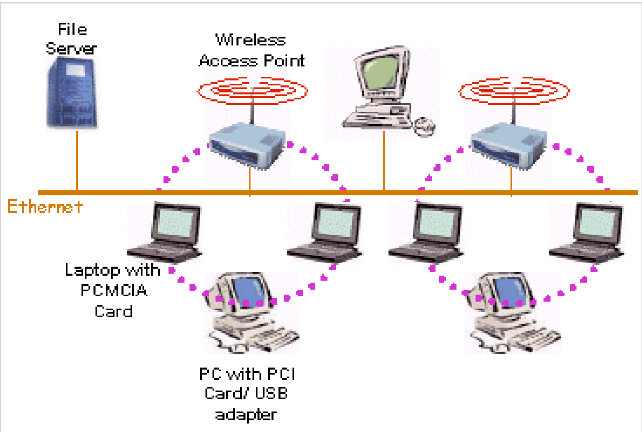

Fig 1: WLAN with two APs

Load balancing is particularly useful for parallel and distributed systems where we have to share the workload to get the maximum throughput from the System.Most distributed systems are characterized by the distribution of both physical and logical features. The architecture of a distributed system is generally modular in nature. Most of the distributed systems support different types and numbers of processing elements. The system resources like hardware, software, data, user software and user data are distributed across the system. An arbitrary number of system and user processes can be executed on various machines in the system. Factors to consider when selecting a machine for process execution include the availability of resources and itsoptimal use. In a distributed system environment, a load balancing algorithm seeks the least busy machine. At the same time, the load balancing algorithm must not overload the system. Ideally, the load balancing algorithm selects the machine for process execution based on available information about all the resources present in the system. Cell breathing is conceptually adopted from CDMAcellular networks. The cells will shrink or expand theircoverage area based on local load condition by adjustingtransmission power of the base station [1]. In IEEE 802.11WLANs, the coverage of an AP is determined by its beaconpackets reaching scale. Therefore, adjusting the transmissionpower of beacon packets could change the covering users. Butthis will not affect the actual data packets transmission power.For the stations located at the overlapping area of several APs,when APs change beacon packets transmission power, whichindicates that cell breathing happens, the station may have tochange its connected AP. Note that station will choose the APwith the strongest beacon packets signal.The problem that we study is the load distribution among access points in the most client way. The standard way to connect wireless hosts (laptops, net books, smart phones, etc.)To access points is to connect to the access point with the strongest signal. This is a very good way to acquire the best bit rates possible, but it's not the optimal way to distribute the load among the available access points.

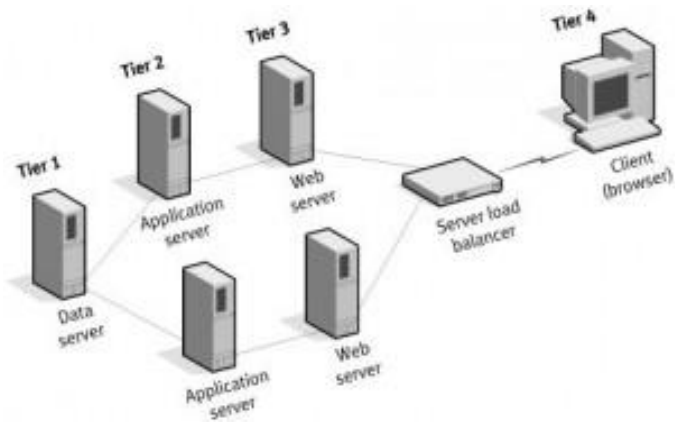

Fig 2: clients connected with server

A WLAN can be configured in two basic modes:

• **Peer-to-peer (ad hoc mode)-** This mode consists of two or more PCs equippedwith wireless adapter cards, but with no connection to a wired network, as shown in Figure 3. It is usually used to quickly and easily set up a WLAN where noinfrastructure is available, such as a convention center or offsite meeting location.

• **Client/Server (infrastructure networking)-** This mode consists of multiple stations(Laptops, PDAs, PCs) linked to a central hub that acts as a bridge to the resourcesof thewired network, as shown in Figure 4

Fig 3: Peer-to-Peer Wireless Configuration

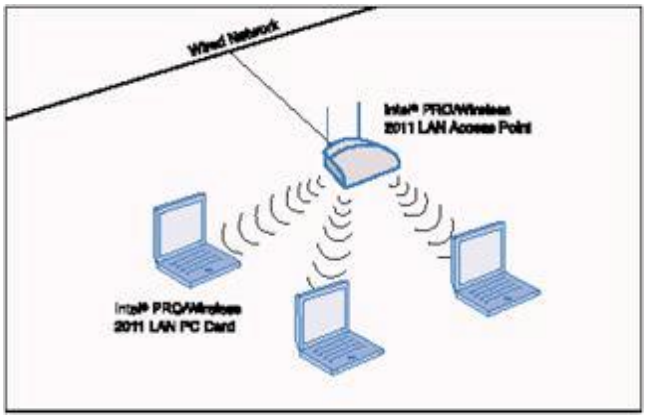

Fig 4: Client/Server Wireless Configuration

Our network model consists of *S* APs, *U* STAs and a COA, as shown in Fig.5. A set of stations are controlled by asingle AP, which is the coordination point in a cell. All APs aredirectly connected to the COA through wired lines. Every APreports to the COA periodically while COA monitors the loadstate of each AP and changes respective transmission powerlevel when necessary.

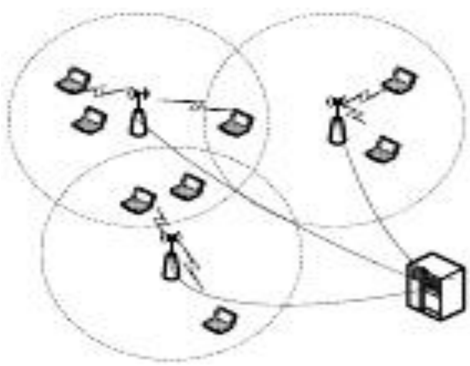

Fig 5. Network model.

The power level of an AP is denoted by $\{P_k \mid k \in [0, K]\}$,where the minimal level is *P min*= *P0*and the maximal oneis *P max*= *P k*. Considering the operation convenience, the owerlevel is grouped into (K+ 1) levels, where *K* is an integerand variable in terms of accuracy requirements. We assumethat the AP distribution is deployed in such a way that thecoverage areas of neighboring APs are overlapped, so thatevery STA can connect to at least one AP even when all APsare transmitting at the minimal power level $_{min\ 0} P = P$. WhenCOA detects the load imbalance of the network which existsfor a certain period of time, it triggers load balancing algorithmto find out the optimal adjustment of each AP and implementthe power assignment solution.All the calculation of the algorithm is done in COA.Therefore, it is necessary to give detailed description of theCOA functions. Fig.6 shows the function modules of COA.Through the input interface, COA collects all updatedinformation of each AP and deals with it in the informationcollection and disposal module. When load balancingalgorithm is triggered, the module of load balancing algorithmstarts up its execution. The optimal result of power assignmentis passed to the module of power assignment implementationand the relative disposal is realized in this module. The APneeded to adjust its power is notified through output interface.In many situations, the deployment of a single AP is not enough to provide therequired connectivity. As an example, large facilities, such as an office complex, auniversity campus, hospitals, large buildings or warehouses generally require manycooperating APs in order to provide the required services to the end users.Services in the WLAN environment should be designed in order to achievemaximum coverage and throughput. AP placement, channel assignment and loadbalancing should be carefully examined to maximize coverage and throughput.

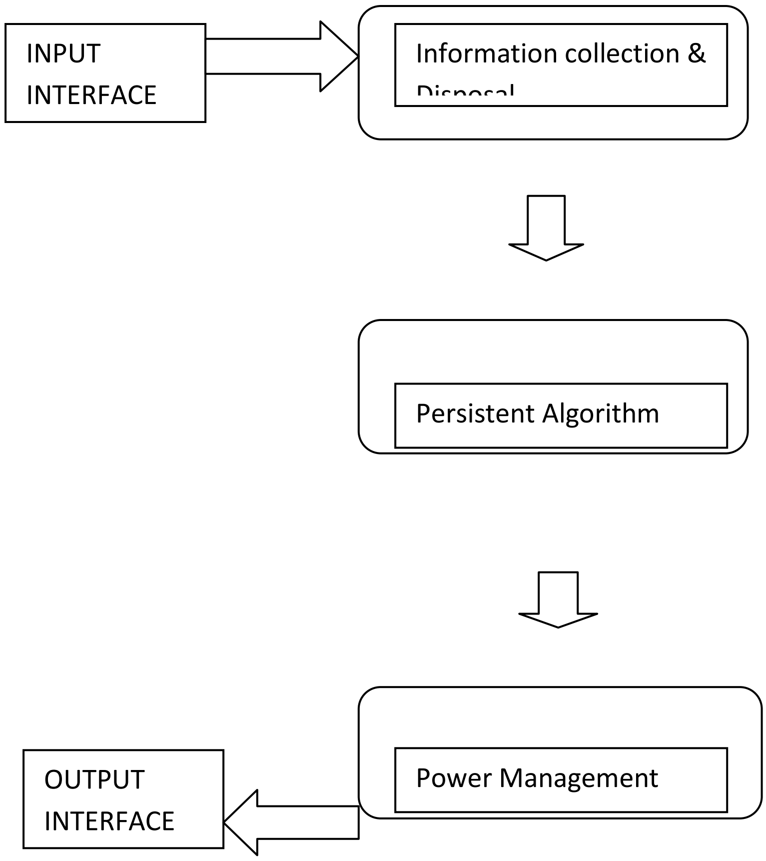

Fig 6. COA function modules.

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NAP = (bwuser * Nuser * %activity) / (%effeciency*rateassociation)

Where *NAP* is the number of APs needed to provide the required capacity,

*bwuser*is thebandwidth required per user,

Nuser is the number of users in the area, *%activity* is thefraction of time the users are active, *%efficiency*is the channel efficiency defined as theratio of actual-rate over association-rate which is *rate association*. Equation is used forlarge coverage areas that require high bandwidth with uniformly distributed users. If asmall amount of bandwidth is needed for a large coverage area, then the number of APscane be determined by the following equation,

NAP = Ctotal / CAP

Where *Ctotal* is the total area to be covered, and *CAP* is the coverage area of a single APbased on maximum power.

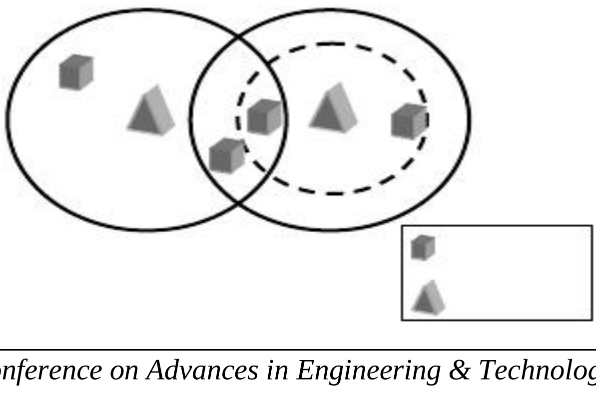
In WLANs, cell breathing can be implemented by controlling the transmission power of an AP's beacon packets. Note that we do not change the transmission power of data packets to avoid degrading clients' performance. More specifically, when data packets reduces, the AP may see higher data packet losses, or even adapt to a lower sending rate, both of which degrade the client's performance. In comparison, changing the transmission power of beacon packets only affect how clients associate with APs, and does not affect the loss rate or sending rate of data packets, which matches our goal well. Finding the appropriate power assignment at APs toautomatically achieve loadbalancing is a challenging problem.To our knowledge, the cell breathing algorithms proposed for cellular networks are based on local heuristics, and do not provide performance guarantees In this we develop power control Algorithms for the following two cases: (i) APs are able to adjust Their power to any level (continuous-power assignment), and (ii) APs are able to adjust their power to only some discrete power levels (i.e., discrete-power assignment). when client demands are homogeneous (i.e., all clients have the same demand), we can alwayscompute such a power assignment - we can set the powers of all APs in such a way that after all the clients choose their AP based on RSSI, either all the clients can be served by the APs or all the APs are fully utilized. For heterogeneous demands (i.e., clients can have different demands), we apply the same approach, and prove that it can completely satisfy at least N − K clients, where N is the number of clients, and K is the number of APs (Note that K is often much smaller than N in practical scenarios). For discrete-power assignment, we develop a greedy algorithm. The high level idea of our algorithm is as follows. We start by setting the powers of all APs to the highest value, and then we choose the best power configuration resulting from iteratively decreasing the power of overloaded APs. This approach is intuitive and easy to implement. Moreover, it only requires knowledge of APs' load, which is easy to Obtain. We show that if there exists a power assignment such that each AP has capacity to accommodate the demands assigned to it, our algorithm can find the solution in a polynomial time. In addition, we consider two extensions to the above algorithms: (1) dynamic adjustment of APs' power in response to changes in clients' load while limiting the number of hand-offs, and minimizing APs' transmission power to reduce interference.

II. LOAD BALANCING STRATEGIES

The idea we want to apply has been used previouslyin Cellular networks. It is based on taking advantage ofoverlapping areas between neighboring cells, i.e. areasunder coverage of more than one base station (see fig.1). Thus, mobile stations in overlapping areas are able` to reach several base stations, and when requiring anyservice, the system can decide to offer it through thebase station with more available channels.The concept of load in traditional circuit-switchedcellular networks is limited to reckoning the number ofactive calls. Then, load balancing mechanisms try tobalance this number among all the cells, since the loadthat each active user contributes with is always thesame. But the appearance of packet-switched radionetworks, such as WLANs, forced that concept toevolve given that the load contributed by each uservaries depending on the services requested. Therefore,new load metrics are needed, which take into account packet level information. In the following we willdiscuss other important issues raised by the loadbalancing needs in WLANs and suggest how to applyfuture IEEE 802.11k mechanisms to facilitate the implementation of known load balancing techniques in IEEE 802.11 WLANs.

III. CELL BREATHING

Cell Breathing techniques consist on dynamically modifying cell dimensions by increasing or reducing transmitted power. In CDMA networks cell breathing is a side effect producing the cell coverage to shrink when supporting more users, but applying optimal strategies, this could become a benefit for load balancing techniques. The concept of cell breathing for load balancing in WLANs is explained: a highly congested AP reduces its coverage radius so farthest1 stations lose connectivity and try to roam to less loaded APs. An under-utilized AP may increase its transmitted power in order to expand its coverage so new users will roam to it, thus reducing its neighbors' load. In the example of fig.3, station *1* is attached to AP *A*, the rest of stations are associated with AP *B*. If all stations have the same behavior, *B* is supporting a higher load than *A*. Then *B* reduces its transmitted power so that station *2* looses connectivity with *B* and associates with *A*. Now we have a balanced network.



______ Coverage before ------Coverage after cell-breathing

Fig 7: Load balancing with cell breathing

IV. TYPES OF LOAD BALANCING ALGORITHMS

The basic idea of a load balancing is to equalize loads at all computers by transferring loads to idle or heavily loaded computers. Load balancing algorithms can broadly be classified into three categories.

- Static algorithms
- Dynamic algorithms
- Adaptive algorithms
- Persistent algorithm

1. Static Algorithms:

In static algorithms, load balancing decisions are hard-wired in the algorithm using a priori knowledge of the system. The overhead entailed in static algorithms is almost nil.

2. Dynamic Algorithms:

Dynamic algorithms use system state information (the loads at nodes) to make load balancing decisions. Dynamic algorithms have t he potential to outperform the static algorithms, since they are able to exploit the short term fluctuations in the system to improve performance. But they incur overhead in the collection, storage and analysis of system state.

3. Adaptive Algorithms:

Adaptive algorithms are a special class of dynamic algorithms which adapt their activities by dynamically changing the parameters of the algorithm to suit the changing system state. Our results show the algorithms are effective for improving throughput. Under high load, the improvement is up to 50% for uniform client distributions, and up to an order of magnitude for non uniform distribution of clients' locations.

4. Persistence Algorithm:

Another load balancing technique is *Persistent load balancing* technique. This load balancing technique does not make any use of software or hardware node and the customer is allowed to select their respective server and get services from that server. This process is very transparent and useful from client point of view as it discloses the presence of multiple servers at the backend. This technique assigns each new client with different set of server on a round robin allocation basis. This process of load balancing ensures that each new client is assigned with specific server and no server is overloaded with particular client.Load balancing with persistence allows you to distribute client requests across multiple servers and optimize resource utilization. Load balancers improve server fault tolerance and end-user response time. In a scenario with a limited number of servers providing service to a large number of clients, a server can become overloaded and degrade server performance. Load balancing is used to prevent bottlenecks by forwarding the client requests to the servers best suited to handle them. Thus Load balancers are logically located between the client and the server farm. Load balancing is used to manage traffic flow to the servers in the server farm. Load Balancing can be performed on HTTP, HTTP, SSL, FTP, TCP, SSL_TCP, UDP, SSL_BRIDGE, NNTP, DNS, ANY, SIP-UDP, DNS-TCP, and RTSP. Load balancing uses a number of algorithms, called load balancing methods, to determine how to distribute the load among the servers.

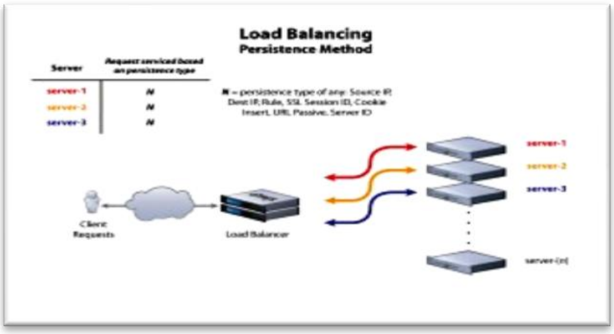


Fig 8: Load balancing with Persistent Method

Persistence connections means all the requests from one client are connected to one web server. In a simple one web server setup, all the web page requests from the clients are connected to the single web server. Persistent connections are not an issue here but overloading and server crashes are.A more elaborate system uses a simple load director and an array of web servers as a web farm In this setup the load is distributed to the servers within the farm. The load is evenly distributed but the connections between a particular client and server are not assured. With each new request, the load direction may assign a different server to service the client. For web applications that require persistent connections, WebMux™ offers fast and efficient algorithm that setup a virtual fixed connection between a specific client and server.

V. LOAD BALANCING TECHNIQUES FOR WEB SERVERS.

1. Round-Robin load balancing:

Round-robin is one of the simplest scheduling algorithms for processes in an operating system, which assigns time slices to each process in equal portions and in order, handling all processes without priority. Round-robin scheduling is both simple and easy to implement, and starvation-free. Round-robin scheduling can also be applied to other scheduling problems, such as data packet scheduling in computer networks. The name of the algorithm comes from the round-robin principle known from other fields, where each person takes an equal share of something in turn.

2. Persistent Round-Robin load balancing:

Persistent Round Robin is similar to round robin load balancing, except for each visiting client, they will stay with the same server till they log off, or till the inactivity timer expires.

3. Weighted Round-robin load balancing:

Weighted round robin take counts the server capacity. For more powerful servers, the weight can be higher. The older or less powerful servers, the weight can be lower. WebMux will load balance based on the weight on each server.

4. Persistent Weighted Round-robin load balancing:

To keep the user session stick to the same server, WebMuxsupports the persistent weighted round robin load balancing method. This is a layer 4 method. Same client will stay with the same server during the time of visiting. The persistent timeout is based on the user's inactivity, which can be adjusted in the "setup" screen.

5. Least Connections load balancing:

Since 1998, WebMux supports a least connections method that distributing visitors to a site to multiple servers based on the number of connections already on a server. WebMux distributes new connections to the server has least connections based on a few factors.

6. Persistent Least Connection load balancing:

Persistent least connection is a load balancing method that WebMux has been using since 1998. It will keep the same client session with the same server, until the client sign off, or the inactivity timer expires. The persistent is actually against the least connection, so the result may not be the most desirable.

7. Weighted Least Connections load balancing

WebMux allows user set a weight to each server, so that new and old servers can serve the same site/farm together. The weight is preferrable minimum normalized number. The weight is served by WebMux from one server to another, so the smallest weight is desirable.

8. Persistent Weighted Least Connections load balancing

This is also a load balancing method WebMux supporting since 1998. Although both persistent and weight algorithms are against the least connection algorithm, WebMux still tries to sending the connections to servers based on all three factors.

9. Weighted Fast Response load balancing

WebMux distribute the load to servers based on the weight and the server response time. Although this method sounding really good, but to achieve the best result based on server response, one must consider also the server resources.

10. Cookie Persistent load balancing

WebMux supports load balancing in layer 7 protocols. One of the layer 7 Protocol is the cookie based load directing, also called cookie persistent. WebMux will track the cookie server placed into the browser, thus same client will always send to the same server till the cookie expires.

VI. CONCLUSION

In this section, we study how to simultaneously maximize system throughput and minimize APs' power. Power minimization is helpful to reduce interference among different APs. The demand for more capacity and better coverage in a WLAN environment has been increasing steadily for the last few years. However, the assigned channels in the IEEE 802.11 WLAN are fixed (14 frequency channels).The power adjustment of each AP is implemented under the monitor of COA, which provides efficient management and reduces the cooperation complexity between APs and its users compared to the distributed manner. Researchers have been actively investigating how to efficiently utilize the available channels by implementing different techniques and algorithms such as, better placement algorithms for APs, load-balancing on APs, and assigning non-overlapping channels (frequencies) to adjacent APs to minimize interference. Dynamic load balancing is a technique that improves coverage areas of APs and capacity provisioning in a WLAN environment. Unlike other load balancing techniques give the optimal performance as time progresses. Part of our future work includes research on the transmission power control aimed at reducing the power consumption as well as improving the utilization of overall network resources in the infrastructure WLANs.

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