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Load Balancing Techniques in Wireless Networks

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Abstract—*Communication in wireless network is the most popular technology because of its easy installation and low overhead. Access points are responsible for communication between users in wireless networks. These access points have limited amount of resources like bandwidth and power. If utilization of access points by its associated users increases the upper threshold value defined by access point then access point is said to be over-utilized. Balancing the loads between these access point increases reliability, performance of wireless network and reduces response time. In this paper a survey is done using various load balancing techniques and approaches in wireless networks.*

Keywords:—*Access points, load balancing, wireless network.*

1. INTRODUCTION

Wireless network is a network in which there are number of nodes connected with each other without any physical connection. Element of wireless networks are mesh node gateways, mesh router and clients. In wireless network a user can be connected because wireless network is capable in establishment and configuration of connections automatically [1]. Advantage of wireless network is easy installation, low cost, robustness, reliability, user mobility and lack of complexity. It may be established in home networking, organizations, hospitals, education institutions, military areas etc.

Now a days internet is growing because of the number of user is increasing rapidly which are accessing the internet more and more. As the users increase it directly affect

the efficiency of ISP by which users access the internet. An Internet Service Provider (ISP) is a node which is connected with users via router in which a group of user become connect in any particular region. And ISP has a job to provide proper service of access of internet to the all users fulfilling their bandwidth demands. Each ISP provides an amount of bandwidth to which a group of users can access. It may be possible that in any region number of users may vary from other region or area. If in any area, users are accessing more than upper threshold bandwidth so ISP may get over-loaded. And if users are consuming less bandwidth so it may be under-utilized. The task is to balance the utilization of bandwidth between ISPs is called as load balancing.

Load Balancing is a term in which few amount of load of any over-utilized ISP is shifted to an underutilized ISP so that all ISP may work efficiently [2]. Here meaning of load may be bandwidth, power consumption, link load, node load, number of users connected to a link or number of users connected to a node. Power consumption is utilization of battery power of mobile devices like laptops, cellphones, tablets etc. Link load is a term in which total loads on a link requested by the number of users connected to that particular link is calculated separately. Node load is defined as the load requested by all the links associated with that particular node. All of these parameters can be balanced between the nodes in wireless networks.

Classification of Load Balancing techniques:

Load balancing techniques [3] are classified as static load balancing and another dynamic load balancing. Static load balancing works on the information gathered in previous stages and dynamic load balancing works on current data traffic. Further classification of load balancing techniques is shown in figure 1.
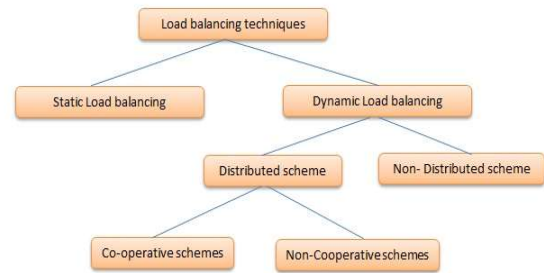

Figure 1: Classification of Load Balancing Techniques

2. LITERATURE REVIEW

Many authors have proposed different load balancing techniques for wireless stub and autonomous networks. In the literature review part few of such techniques are discussed. In wireless networks access points (APs) handle client connection. Whenever load of the network increases it simply means access points (ISP) will be overloaded and they may slow down in exchanging messages between client and network and client (User) services will also suffer in such cases. Some of the useful load balancing techniques is discussed below –

Fuzzy Based Load Balancing Scheme [3]

In this scheme for every access point number of clients is scanned at regular interval of time. And the performance of access points and quality of service (QoS) are measured cyclically. All this information captured is given as input to fuzzy controller. And every parameter will have a value and membership; because some client will specify the traffic type, signal quality and other parameters also. So some client will generate real traffic and some will generate non real traffic. Depending on these parameters priorities will be assigned. With the help of information provided by the network, fuzzy controller makes decision about the movement of a client to an access point which has fewer loads. All the parameters like packet loss, message propagation delay are considered to evaluate performance of access point and finally load will be distributed on the basis of fuzzy logic applied to fuzzy controller. It is shown in figure 2.
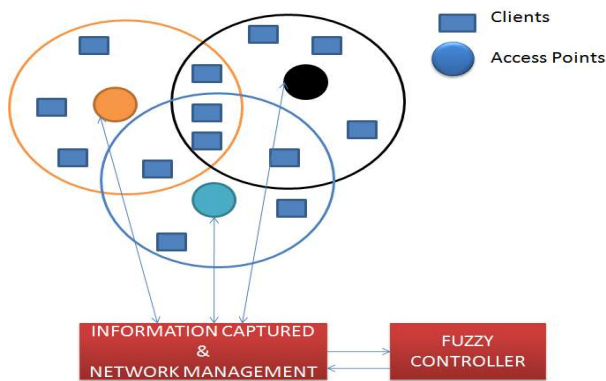
Figure 2: Fuzzy Based Load Balancing [3]

Non-dominated-sorting-genetic-algorithm-II (NSGA-II) Based Multi objective Load Balancing Scheme [2]

In a stub network some group of users assigned to an internet service provider downloads the internet traffic more than the upper threshold value assigned by each ISP causing node overloaded and some group of users downloads the internet traffic less than the lower threshold value causing node under loaded. This problem is handled by reassignment of users from one link to another link in the network. NSGA-II approach is used here to solve three objectives: load balancing, minimizing the number of users reassigned and minimizing the intra domain cost.

Packet Loss Rate Prediction Based Load Balancing Scheme [4]

In this paper packet loss rate is predicted over all available networks and their paths. This information is used for routing of proportion of data packets over various available paths. NS2 is used in this paper. As a result this technique minimizes the packet loss rate and performs well in terms of packet delay.

Hybrid Routing Based Load Balancing Scheme [5]

This paper presents a hybrid routing approach for balancing loads using multiple traffic matrices. Here destination based and explicit routing both are used to achieve better results. This approach is scalable and complexity is low. Compared to pure explicit routing this approach reduces forwarding

entries. This approach reduces the number of resources and shows better results compared to pure explicit routing.

Association Control of Access Point Based Load Balancing Scheme [6]

In this scheme incoming traffic is routed intelligently across the available access points so that load balancing is occasionally required. Here one user can be assigned to multiple access points in first stage and then depending upon integral solution user is assigned to a final access point where available bandwidth can be used efficiently. In this approach load is balanced keeping bandwidth availability fair to all clients and access points. This approach uses Max-Min fair bandwidth allocation scheme. This approach focuses on Quality of service and energy consumption of the system and keeps the load balanced. But as before assigning the access points several analysis is done this scheme offers delay in service.

Distributed Load Balancing Scheme [7]

In this paper authors describe a distributed load balancing scheme which can be applied for real-time traffic, where the first scope is to achieve Quality of Service (QoS) requirements. Network nodes may not be same in industrial scenarios, because some devices can have some different type of requirements that request. The solution shown in [6] shows that each and every access point which is connected with backbone can communicate with the network controller. This approach shows the same problem as in centralized load balancing algorithm.

Cluster Based Load Balancing Scheme [8]

In this technique few nodes are chosen as cluster nodes that has maximum transmission power. These nodes are called gateway nodes. These gateway nodes act as cluster heads. Here load balancing is performed between the gateway nodes. Load equalization is considered to create balanced clusters. Energy is distributed between clusters and load imbalance is avoided. In this paper first it is

shown that a case in which loads on all sensor nodes are equal is solvable in a polynomial time. And after that it is proved that problem is NP hard. And a 3/2 approximation algorithm is proposed.

Scheduling Based Load Balancing Scheme [9]

Optimal scheduling algorithm is used in wireless sensor network in scheduling based load balancing technique. Information is gathered by cluster heads. Packets are forwarded to base stations with minimum loss probability. Time slot is determined for packet forwarding for the node. A scheduling algorithm is proposed to implement this objective. Here Optimal scheduling algorithm is used for packet forwarding. Real life process is monitored for a time interval. Algorithm guarantees load balancing in a polynomial time.

Load Balancing through Multiple Gateways [10]

Here loads are balanced among various gateways in wireless networks. Here switching is used between gateways. Depending upon the average queue length load is switched. There are two modules in this load balancing scheme, one is gateway discovery module and another one is load balancing module. Load balancing is performed after gateway discovery module. Gateway for a mesh router is determined in Gateway discovery module and load is balanced among gateways in load balancing module.

Distributed Algorithm for Load Balancing between Gateways [11]

In this technique flow is reroute from highly congested gateway to the gateways which is less congested. In this technique a mesh network is partitioned into multiple domains. A domain is set of routers that receive network traffic. A specific maximum capacity is assigned to each and every domain if the load in domain exceeds the maximum capacity then the domain is said to be overloaded. Flow from over utilized gateway to under-utilized gateway is handled by gateway itself. Effect of interference is also taken into account. It is shown in figure 3.
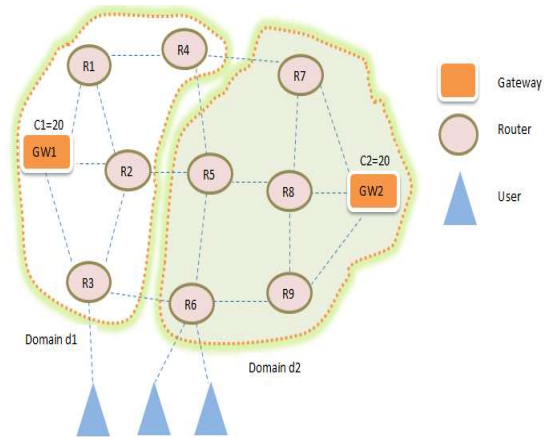

Figure 3: Mesh Network is divided into Domains for Load Balancing [11]

Load Aware Routing Based Load Balancing Scheme [12]

In this paper a dynamic adaptive load aware routing technique is proposed in which the load aware metric is used to balance the unbalanced links. AODV protocol is extended with load aware matrix (LAM) to design an on demand routing algorithm. LAM is used for balancing unbalanced links. Using this technique latency, packet loss ratio is reduced and flow balancing is achieved and hence network throughput is increased.

Interference-Aware routing algorithm based Load-Balancing Scheme [13]

In this paper intra-flow interference and inter-flow interference is taken into consideration for load balancing. Load balance factor is used to balance the loads of links. Link with fewer loads is chosen to route the information. NS3 is used to implement it and results shows the performance of network is increased after using this approach.

Routing Protocol based Load-Balancing Scheme [14]

Problem with the direct diffusion technique is that this technique is not aware with the current status of nodes and network

status. And that's why direct diffusion technique is unable to find the best path to transmit the data from source to destination. This paper tried to overcome disadvantages of direct diffusion technique by choosing shorter and healthier paths with a new network aware protocol. This protocol collects information about all the available paths from source to destination and this information is used to select the best path.

Multipath Routing based Load-Balancing Scheme [15]

In this paper multipath routing is used to avoid bottleneck to reduce the power consumption of batteries. Proposed multipath routing is explained in three phases in the paper. They are path creation phase, path selection phase and data transmission phases. Here access points automatically selects path of very less load and data is transmitted through this load. Hence load is distributed through various paths and life of battery is increased.

Delay Aware based Load-Balancing Scheme [16]

Mobile device can be connected to more than one node for the transmission of data traffic through multiple paths. It increases data rate and reliability. In this paper author has proposed an approach to split the traffic among all available paths accurately and without reordering packets end to end delay is reduced. This algorithm aims to minimize data traffic splitting error and end to end delay.

Load-balancing over Heterogeneous Wireless Networks [17]

Here load balancing algorithm is based on selection of access network. In this algorithm real time network traffic is taken into account. Network traffic is also classified for multimedia data i.e. for audio, video or text data. This algorithm is compared with the classic network selection technique in which traffic type is not classified. Results shows that both quality of service and load balancing is

improved using this approach compared to the classic network selection technique.

Load-Balanced Multipath Routing in Mobile Ad Hoc Networks [18]

In this paper author has proposed a routing scheme to balance the loads for multiple available paths in mobile ad hoc networks. Here first of all multiple paths is determined for a pair of source and destination nodes and estimated time is calculated to route the data packets along such paths. Once time to route the packet is estimated then data packet is distributed along these paths. Here the basic idea to transmit the packet along such available paths is that the number of data packets routed through a particular path should be inversely proportional to the estimated time taken to send the data packet through this path. Using this strategy of load balancing the overall routing time for all available paths is minimized. Here instead of calculating number of hops, routing time is calculated in the route discovery phase. In this phase all available paths are also determined if exits.

Load Balancing In Wireless Mesh Networks Using Modified RED Algorithm [19]

In this paper concepts of multipath gateways are used and this concept is combined with the multiple queue concepts at each gateway. Arrival of real time data traffic at each gateway queue is prioritized and hence quality of service is improved. Proposed scheme is suitable for real time scenario. Requirements of quality of service are achieved and loads are balanced between gateways. This algorithm is simulated with network simulator 2 (NS2) and simulation results are compared with existing solutions and it is found that the proposed scheme is more efficient than the existing standard algorithm.

Delay-Based Load-Balancing Algorithm [20]

This paper presents a delay based routing algorithm for load balancing in which the concepts of physical layer capacity is

combined with estimated congested value of MAC layer.

Routing matrix for end to end delay calculates estimated congestion value at MAC layer and physical layer. This matrix is used to determine the high capacity link. And after it data is forwarded through this link. Thus this algorithm determines a link with high capacity and low congestion. MATLAB is used to simulate the algorithm and results shows that this algorithm shows better results for packet loss and average delay.

Load Balancing for Multi radio Wireless Mesh Network [21]

This paper presents a load balanced multi hop routing protocol. It determines many paths from source to destination node through number of intermediate nodes based on proposed congestion aware matrix. Here load balancing is performed by utilizing the queue at different interfaces of nodes. Proposed technique diverts data traffic from congested area to all the possible ways and hence data transmission is maintained. Proposed algorithm is simulated with NS2 and results shows that this algorithm has better for throughput and end to end delay for high traffic density.

3. CONCLUSION

In this paper a survey is done using various load balancing techniques applied on the wireless networks. It is concluded that load balancing in wireless networks having overlapped domains and access points is NP-Hard problem. So met heuristics should be applied to balance load in quick time. And intelligent routing is also an efficient solution for load balancing of network traffic.

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