Energy Efficient Load Diversion Strategy for Green WLANs

Ravneet Kaur[1], Jyotsna Sengupta[2]

[1]*Department of Computer Science, Punjabi University, Punjab, India*
[2]*Professor, Department of Computer Science, Punjabi University, Punjab, India*

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Abstract- *With the increasing demand of wireless services, users now demand good WLAN infrastructure for energy efficiency. But Traffic Overloading is one of the main obstacle to this. For this Load Diversion is one of the solutions for Green WLAN. Load Diversion can also be used to achieve significant energy savings. Providing necessary quality requirements like good throughput and minimum access delay are challenging tasks, this research improved the presently deployed strategies. In this improved strategy mesh topology is used in which all nodes are connected with each other by which every node can easily communicate with any other node and the path which is short and have less traffic load is used for communication and the second thing is that only those nodes are in active mode which want to communicate and the other nodes which are idle goes to sleep mode and a controller controls the whole procedure, by this the problem of traffic overloading decreases as well as energy consumption also decreases. Two scenarios for implementing existing strategy and improved strategy were created in the network simulation tool, NS2 to obtain the results. The results show that the performance of Energy-Efficient Load Diversion Strategy was better as compare to existing one.*

Key Words: Energy, Load balancing, Wireless Local Area Network, Traffic Overloading, Mesh Topology.

1. INTRODUCTION

Wireless LAN which use energy or power efficiently and provide a high speed internet access is a Green WLAN. A WLAN can be converted into a green WLAN when Resource on Demand (RoD) strategies and high density access points (APs) are deployed.

In a Wireless Local Area Network every link or node can carry a finite traffic. If the traffic increases beyond a limit, the network become busy and its speed also become low. This instant increase in the traffic above the limit is traffic overloading and it is also called congestion in network. When the users beyond the limit are connected to a network and access the same network than the traffic overloading occurs. Because of traffic overloading the degradation in performance will result and network becomes busy.

Sometimes, like in working hours in an office or in day time in university campus, when the number of users increases from the limit of AP, traffic overloading occurs by which the performance of network degrades. Network generates busy signal and users have to wait for their request to be fulfilled. Sometimes due to traffic overloading some critical problems also arises like breakdown. Traffic overloading wastes a lot of energy. A WLAN having this problem can't be a green WLAN, so this problem has to be removed for energy efficiency. Therefore, this problem of traffic overloading has to be prevented before its occurrence.

2. RELATED WORK

A comprehensive literature survey on different perspectives of traffic overloading problem in WLAN and how it can be minimized using various strategies.

For high density WLANs, Survey, Evaluate, Adapt and Repeat (SEAR) approach is used for load balancing by user and topology management. A SEAR central controller which creates list of users associated to each AP in the network. By using this list, SEAR central controller can know about the load of each AP. If any AP has the problem of traffic overloading then the central controller move the half of load from that AP to a new AP by which user can get better performance. [1]

Resource on Demand (RoD) strategy is for energy efficiency of the WLAN. Two policies used which are Association-Based Policy and Traffic Based Policy. In Association based policy, the APs are switched on or off according to the number of users associated with it. In Traffic based policy, the APs are switched on or off according to traffic flow. [2]

A Decentralized Adaptive Coordinated Resource Management (DACoRM), in which traffic overloading is managed using load balancing by implementing a combination of various topologies. [3]

Two dynamic load balancing methods i.e. Cell Breathing and Dynamic Load Balancing with Multi Agent Pseudo-tree Repair algorithm were compared and evaluated. [4]

A load balancing procedure having four phases are used, these phases are scanning phase, inform phase, decision phase, association or re-association phase. [5]

A two-level load balancing method, using an already proposed Received Signal Strength Indicator (RSSI) algorithm. In first level, the APs are either assigned to different channels or in the same channel according to received RSSI of the adjacent AP and the channel-location. In second level, the wireless station (WS) is assigned to all the available AP by using RSSI measurements, the number of already associated WS and by using some other quality measurements. [6]

For the throughput and energy efficiency in WLANs a three-fold contribution on the field of greening the future global network infrastructures firstly by providing an approximate analytical model to analyses the energy consumption of WLANs using some input parameters like, the number of stations present in WLAN, minimum contention window stations used on their first attempt and power consumed by AP during transmission, receiving, or sleeping by assuming that all stations have a fixed length of packet for transmission. Secondly, for minimizing the energy consumption they defined an optimal configuration strategy. In last they provided a comparison of energy minimization with throughput optimization. [7]

Based on insights from this literature survey a new load diversion strategy will be designed for an under-loading and energy efficient network.

3. IMPLEMENTATION AND RESULTS

Energy-Efficient Load Diversion Strategy as its name implies is a load diversion strategy whose main concern is about saving energy. As like existing strategy it also uses mesh topology because in this network model all nodes are connected with each and every other nodes of the network. In this the nodes which want to communicate are in active state and all other which are free goes to sleep mode by which energy saving is more. When a source node want to send data to a destination node, then these nodes became active for transmission. By this traffic load as well as energy consumption both decreases. This strategy can also be implemented in large scale networks and for that according to the number of nodes connected within the network a division of nodes into groups are done. Each group has equal number of nodes and its own central controller or cluster head which controls all the nodes of its group. Thus in this way a large scale network can also be handled by this improved strategy and no communication overhead occurs using this approach.

Therefore all the limitations or problems which occur in the existing load diversion strategy are tried to resolve in the improved load diversion strategy.

The simulation of the existing load diversion strategy and the improved load diversion strategy for traffic management in Wireless Local Area Networks have been shown in the form of graphs and to evaluate this simulation some performance metrics are also used.

3.1. Simulation Scenario

The first step of simulation is to create a simulation scenario that is equivalent to real world scenario. In this simulation, the wireless LAN consisted of several wireless stations and base station using wireless Mesh and Ring topology. All wireless stations are located such that every station is able to detect a transmission from any other station.

The simulation experiments are carried out using NS2 simulator.

3.2. Simulation Method

To compare the performance of existing strategy and improved strategy two scenarios were created; in first scenario the ring and mesh topology are implemented and the comparison of both were performed to find which one is best i.e. mesh topology and in second scenario, energy efficient mesh topology is implemented. Network environment factors which were used as a benchmark configured same for both scenarios. The performance evaluation is done by simulating both scenarios one by one in NS2 simulator and then comparing the graphs obtained.

3.3. Results

After choosing metrics, the simulation is done, and then results are gathered.

3.3.1. Analysis of Improved Load Diversion Strategy

In this load diversion strategy, mesh topology is used in which all nodes are connected with each other by which every node can easily communicate with any other node. This new improved strategy is energy efficient as compare to existing one. In this the nodes which want to communicate are in active state and all other which are free goes to sleep mode by which energy saving is more. When a source node want to send data to a destination node, then these nodes became active for transmission. By this traffic load as well as energy consumption both decreases. In the simulation, we assumed that each traffic class has the equal portion of the total data traffic in terms of the average number of packets generated per unit time. The results obtained for this improved load diversion strategy using 10, 20 and 30 nodes are as follows:

1. Packet Delivery Ratio (PDR):- Chart 1 shows the packet delivery ratio for the newly improved load diversion strategy. For the simulation, network model consists of 10, 20 and 30 nodes are used and while number of nodes are 10 the packet delivery ratio is 1 i.e. all data packet were sent and when the number of nodes increases the packet delivery ratio decreases.

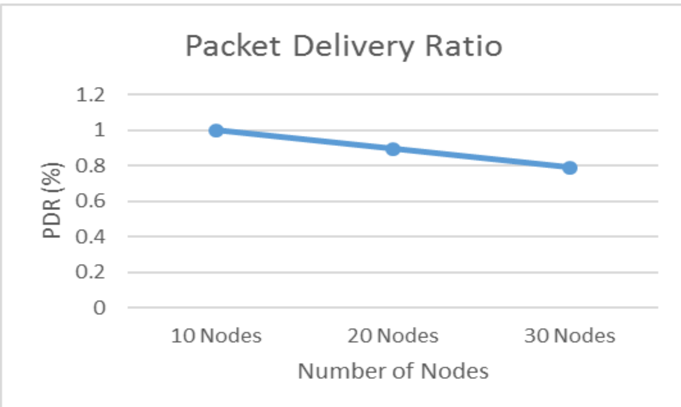

Chart -1: Packet Delivery Ratio

2. Throughput: - Throughput is the ratio of the total amount of data that a receiver receives from a sender to a time it takes for receiver to get the last packet. It is observed from Chart 2 that the throughput while using 10 nodes is less as compare to 20 nodes and the throughput while using 30 nodes is also a little bit less than throughput of 20 nodes.

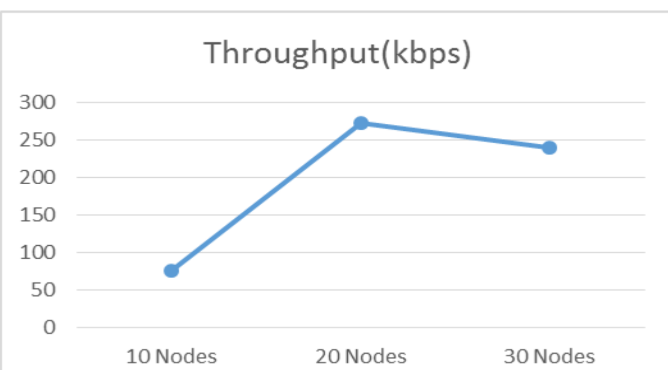

Chart -2: Throughput

3. End-to-End Delay: -Chart 3 shows the end-to-end delay of newly improved load diversion strategy. Delay means the time taken by a bit of data in a network to reach its destination. The less time it takes to reach its destination the chance of occurrence of congestion is also less.

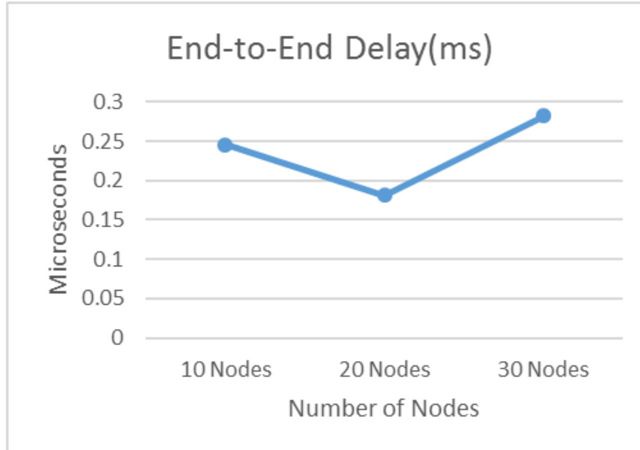

Chart -3: End-to-End Delay

4. Normalized Routing Load (NRL): -When the number of nodes increases the chance of increase in normalized routing load is also more as shown in Chart 4 that the normalized routing load of 30 nodes is more than the normalized routing load of 20 nodes and the normalized routing load of 20 nodes is more than the normalized routing load of 10 nodes.

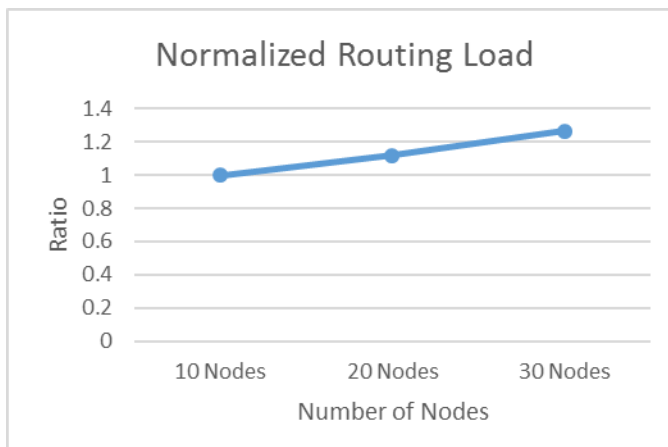

Chart -4: Normalized Routing Load

5. Energy Consumption: - During transmission how much energy is used is known as energy consumption. The total energy consumed in the transmission is shown in Chart 5 and it is observed form figure that when the number of active nodes is less consumption of energy is also less.

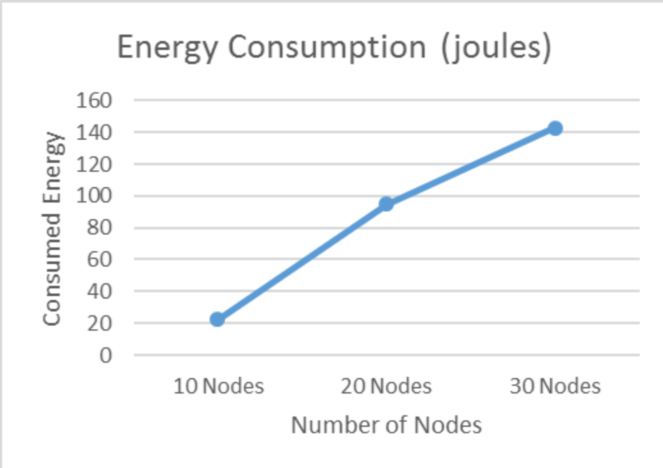

Chart -5: Energy Consumption

3.3.2. Comparative Analysis of Existing and Improved Load Diversion Strategy

The performance of both strategies is checked in terms of Throughput, Packet Delivery Ratio, End-to-End Delay and Normalized Routing Load. These four metrics are determining factors in terms of overall performance of both the strategies.

1. Packet Delivery Ratio (PDR)

The packet delivery ratio for both existing and improved strategy are shown in Chart 6 and from the chart it is clear that the packet delivery ratio of the improved load diversion strategy is always more in all cases whether the number of nodes are 10, 20 or 30.

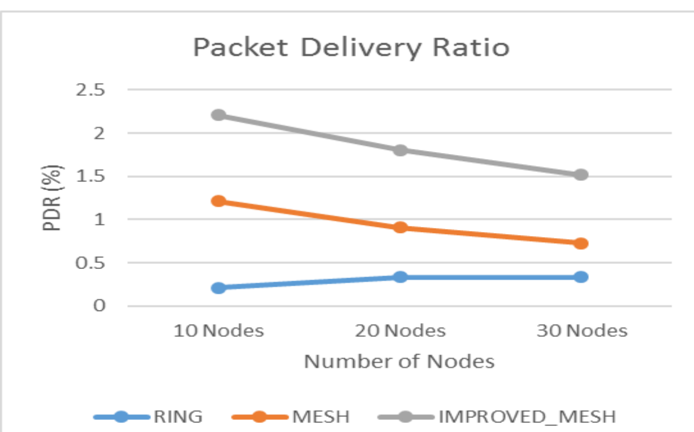

Chart -6: Packet Delivery Ratio

2. Throughput

In Chart 7 the throughput comparison of existing and improved strategy is shown from which it is observed that the improved one is much better than the existing one.

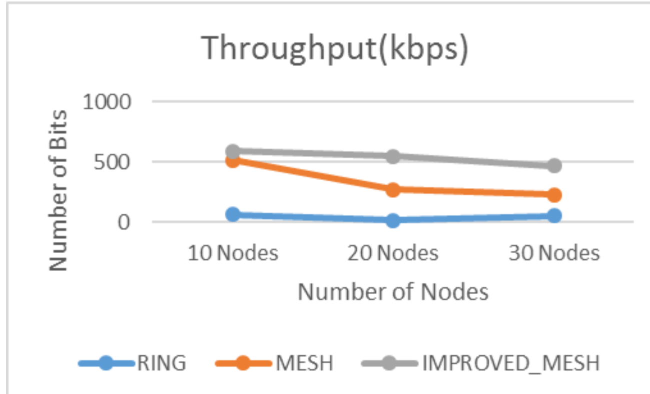

Chart -7: Throughput

3. End-to-End Delay

End-to-End Delay of both strategies are shown in Chart 8 and it is observed from the figure that the end-to-end delay of mesh topology model of improved strategy and existing strategy is almost similar.

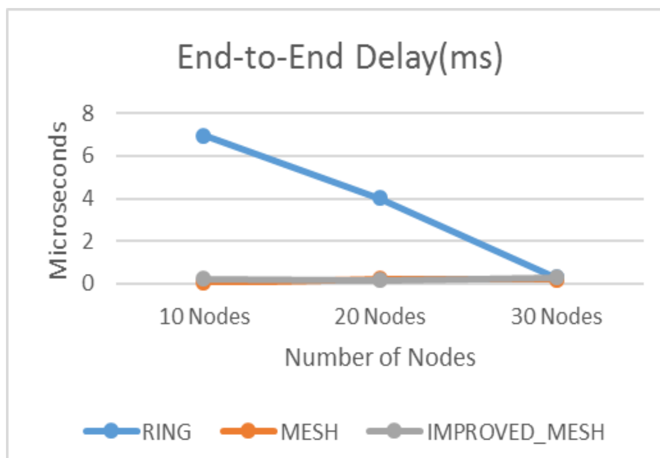

Chart -8: End-to-End Delay

4. Normalized Routing Load (NRL)

Normalized Routing Load of existing and improved load diversion strategy is shown in Fig. 9. While using 10 nodes the normalized routing load is same for both strategies but when the number of nodes increases the normalized routing load of improved strategy decreases as compare to existing strategy.

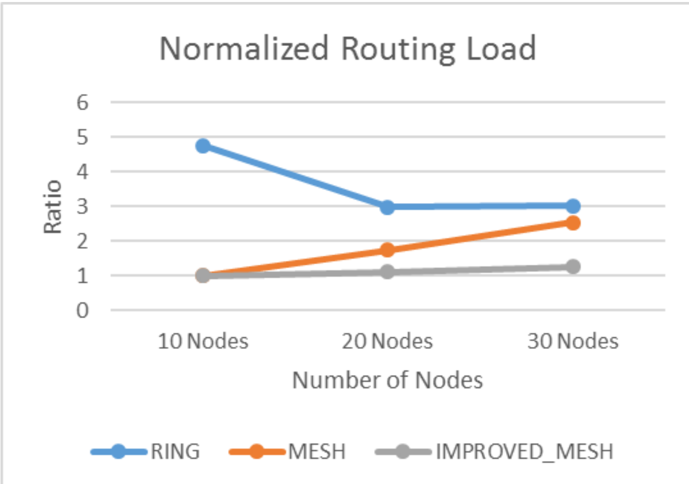

Chart -9: Normalized Routing Load

4. CONCLUSION AND FUTURE SCOPE

4.1. Conclusion

The results obtained from simulation show that Improved Load Diversion Strategy is energy-efficient and provides efficient mechanism for traffic engineering and hence provides quality of service to the wireless local area network. When the number of active nodes are more than the energy consumption is more so it is better to switch all the idle nodes into sleep mode for less energy consumption to make network more energy efficient.

4.2. Future Work

Future work may be done on large scale network and by making network more energy-efficient. Future work will focus on how energy consumption of large network can be decreased.

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