Traffic Shaping in Wireless Mesh Network

Ratika Sachdeva#1, Aashima Singla#2

# Student Masters of Technology, Department of CSE, Sri Guru Granth Sahib World University
Fatehgarh Sahib, Punjab, India

Abstract – Wireless mesh networks (WMNs) consist of mesh routers and mesh clients, where mesh routers have minimal mobility. A WMN is dynamically self-organised and self-configured, with the nodes automatically establishing and maintaining mesh connectivity. The integration of WMNs with various existing wireless networks such as cellular, wireless sensor, Wi-Fi, WiMAX, WiMedia networks, etc can be accomplished through the gateway and bridging functions in the mesh routers. WMNs have attracted considerable interest in recent years as a convenient, flexible and low-cost alternative to wired communication infrastructures in many contexts. Designing efficiency of WMNs has become a major task for network operators. Furthermore, earlier deployments of WMN have been linked to number of problems (traffic causing considerable frame losses and higher delays). In WMNs, admission control is deployed to efficiently control different traffic loads and prevent from overloaded network. RCAC uses to achieve the high resources utilization by providing lower blocking probabilities in traffic-load environment while satisfying quality-of-service (QoS) constraints in terms of PLP and end-to-end delay. In this paper, the traffic shaping in wireless mesh networks has been discussed.

Keywords- Wireless Mesh Networks, Admission control, Quality of service (QoS).

I. INTRODUCTION

WIRELESS Mesh Networks (WMNs) are emerging as a promising solution for the fourth-generation wireless systems, high-capacity, providing flexible wireless back-haul over a geographical areas. Wireless Mesh Networks (WMNs) consist of mesh routers and mesh clients. A Wireless Mesh Network is dynamically self-configured and self-organized with the nodes automatically. Each node can also operate as a router and forwarding packets on the behalf of others nodes. In WMNs, the users can get online anywhere anytime. The WMN router contains additional functionalities of gateway and repeater. Mesh clients can also work as a router but it cannot support gateway or bridge functions. Mesh clients have only one wireless interface but the hardware and software platforms for mesh clients are much simpler than mesh routers. In WMNs, Access points (APs) provide internet access to the mesh clients by forwarding traffic to the mesh routers until a mesh gateway is reached. However, several challenges still remain in the WMNs such as scalability, security, network integration, and self-organization and self-configured and traffic control. Fig. 1 shows the infrastructure of WMNs.

I (A) Issues in Wireless Mesh Networks

1) Radio Techniques
To enhance the performance of a wireless radio and control by higher layer protocols, more never radio technologies such as reconfigurable radios, frequency agile/cognitive radios and even software radios have been used in wireless communication.

2) Scalability
Communication protocols suffer from scalability issues as when the size of network increases, the network performance decreases.

3) Mesh Connectivity
Mesh connectivity is required for MAC and routing protocols and for this, network self-organization and topology control algorithms are needed.

4) Broadband and QoS
In order to increase the performance of WMNs, most applications of network are with various QoS requirements such as end-to-end transmission delay and fairness, per node throughput and packet loss ratios must be considered.

5) Compatibility and Inter-Operability
It is an essential feature for WMNs to support network access for both conventional and mesh clients. WMNs need to be backward compatible with the clients nodes; otherwise, motivation of WMNs will be significantly compromised.
WMNs mesh routers have the capability of inter-operation among heterogeneous wireless network.

6) Security

Many security solutions have been proposed for wireless LANs, but they are still not ready for WMNs. There is no public key scheme used in the WMNs due to the distributed architecture. Most of the security solutions are still not matured to be practically implemented. These new security schemes are such as encryption algorithms to security key distribution, secure MAC and routing protocols, intrusion detection and security monitoring. To increase the security of WMNs, two strategies are needed to be implemented. Either to develop security mechanism into network protocols such as secure protocols and MAC protocols or to discover security monitoring and response systems to detect attacks, monitor service disruption and react very quickly to attacks. Security attacks may occur simultaneously from different protocol layers.

7) Ease of Use

In WMNs, the protocols must be designed to provide the sense of power management, self organization, dynamic topology control, robust to temporary link failure and fast subscription/user-authentication procedure.

I (B) Capacity of Wireless Mesh Networks

The capacity of WMNs is concerned to many factors such as network architecture, network topology, traffic pattern, network node density, number of channels used for each node, transmission power level and node mobility. To enhance the capacity of ad hoc network, nodes should only communicate with nearby nodes. For this, two important schemes are suggested as:

- Throughput capacity can be improved by deploying relaying nodes.
- Nodes need to be clustered.

However, several challenges still remain in the WMNs performance terms such as throughput and delays match the performance of a wired network. Due to wireless interference and congestion causing packet losses and higher delays, network performance is highly affected. The most important aspects of performance degradation of WMNs, e.g. high latency or low throughput, due to the bad planned wireless networks. Performance problems occur due to many reasons: traffic slow down, multi-path interference or badly configured client/AP. These problems degrade the overall throughput of the network.

But a well planned and optimized wireless network can often provide good capacity and throughput in the same infrastructure cost. MAC and routing protocols are of great help in increasing efficiency. It also improve the capacity and flexibility of wireless networks by using multiple channels, some techniques are based on the radio techniques and which has been proposed, these are directional and smart antenna, multi-radio/multi channel systems and MIMO systems. Moreover, the probability of packet collision can be reduced because of traffic mitigation in each channel. It depends on what and how to optimize, these contributions classify into two broad classes, fixed-topologies based to aim at better exploiting and using the network resources; they increase the channel spatial and temporal reuse or routing protocols with possible admission control mechanisms. On the other hand, unfix-topologies based approaches are divided into further two groups. Partial design approach that attempts to optimize the network performance by selecting the position and depends on the type of mesh node either mesh router or mesh gateway. On the other hand, design from scratch: it requires many factors and these are clients coverage, optimal placement of MGs so that we get better throughput from the channels and less delay/congestion and an optimal number of channels/radio per node.

II. FIXED-TOPOLOGIES BASED APPROACHES

One step towards the performance of the wireless systems can be greatly increase by using multi-channel. We can reduced the probability of the packet congestion because traffic being control in each channel. Two neighbouring nodes can communicate with each other if they are assigned in same channel. A number of MAC protocols for multi-channel transmission in WMNs is proposed by many numerous research. Research efforts from the globe have addressed the problems routing and channel assignment in the multi-channel WMNs.

Dynamic channel assignment and routing techniques in multiple channels WMNs is proposed by Raniwala et al. [2]. In this, they measures the traffic flows through each channel and calculate the bandwidth in different links of each path and find the MG node for load-balancing route. For this, they divide the each channel load and then compute the bandwidth available to any link. The three routing matrices are used for compute the total cost for final tree. The hop count is not used
for balancing network load; it indicates the number of hops between a WMNs node and MG node. The MG link capacity indicates the capacity of the uplink MG root of a tree to the wired network. The path capacity is more common than the other two metrics, as the bottleneck of a path can be any other link on the path instead of always being link.

Routing in multi-radio multi-hop wireless systems is proposed by Draves et al. [2]. The aim of this metric is to select a path which is having high-throughput between a source and a destination. The metric Weights combination based on Expected Transmission Time (WCETT) is stated as a combination of weights that assigned to each link based on the Expected Transmission Time. The author is performed experiments and concluded that a path is made up of hops on the different channels is well instead of a path where all hops are on the common channel because it creates interference problem consequences. They assume that benefit on the longer path and heavily loaded networks are limited than shorter paths. WCETT cannot avoid the problem of flow interference. The iWARE metric takes into consideration the inter-flow interference by estimating the average time the channel is busy because of transmissions from other interfering nodes and it also looks for link quality variation. To improve the performance, Jain et al. [2] conducted and concluded through study to show that the frame loss is another result of channel interference due to accumulative interference resulting from nodes that lying outside the silence range of transmitter. With the silence set of transmitter A is set of nodes that will find that the channel is busy in case A transmits.

III. PARTIAL DESIGN TOPOLOGIES

Partial design topologies comes under the unfixed-topologies based approaches. This is another method to achieve the better network performance is to optimize the placement of either MGs or client before network deployment. A proper setting of mesh gateways may lead less delay, less congestion and gives better throughput but if the distance and links capacity takes into determined. We taxonomy of partial design into two classes, namely fixed-gateways [2] and unfixed gateways [2].

A. Fixed Gateways

In the WMNs design, we focused on the problem of locations to optimally the place of APs and MRs under given set of positioned of MGs and also focused on the area coverage, set of connectivity and constraints.

Sen et al. [2] proposed a planning for the rural areas network to facilitate to the villages with given network connectivity from a wired node (landline node or a positioned MG). In this, authors solve the problem of cost which affected by the multi-hop network topology and antenna tower heights under the constraints of maximum throughput, power and interference. Author divide the problem into four sub-parts; and apply the solution technique to each part of the problem. These sub-parts of problems are: topology search, optimum height assignment, and antenna height and power assignment.

Chen & Chekuri [2] propose the plan for the urban areas and these authors consider the mesh routers that equipped with directional antennas from the mesh backbone. The placement of mesh gateways is already given. In this, author increase the amount of services a location can provide if it is deployed with router and maintain the cost and guarantee about a robust back bone. In this author uses the greedy-based algorithm for solving the problem of optimizing.

B. Unfixed Gateways

In this, the problem is related to locate the MGs and how to minimize the APs as well as MGs path length along with satisfying the demands of APs. The hop length of the communication paths, how much congestion can occur, the availability of bandwidth to and from the internet is determined by the MGs in the network. When demand per user increase and the number of users increase, it affects the network scalability. In the unfixed gateways, it is further categories into two schemes for the placement of MGs in the network. One scheme is clustering-based placement and another is non-clustering.

1) Clustering-based placement: In this scheme, when the network is divided into the clusters, then network is independently of the network size is send to each node nearby MGs within a fixed radius. Each node is bounded within the fixed distance or number of hops to reach MGs. It is further divided into sub sections whether it is depending on the tree structure clustering or not. The tree structure clustering techniques have number of benefits (e.g. Less routing overhead and efficient flow aggregation) but still they suffer with degradation – a tree topology uses smaller links where there are at least two nodes with two or more paths between them. In this case redundant paths are used if one path is fails. The tree structure is restricted under the link capacity constraints. Large number of MGs increases and thus may increase the network cost. This technique consists of using a recursive algorithm for dividing the network into clusters and bounded radius under relay load and under some cluster constraints.

Fig. 3. (a) Initial network (b) tree based topology (c) mesh topology [2]

In the Non-Treel based clustering, network partitioning is not major problem. But the clustering solution becomes more
difficult to implement because of the capacity and connectivity constraints and QOS requirements. Heuristics approaches are used to solve this problem of MGs placement under non-tree based clustering.

2) Non-clustering based placement: Li et al. [2] study that the MGs placement according to the grid based method for throughput optimization in WMNs. Author decide that how to place the MGs in the mesh infrastructure. The basic idea behind this proposes solution is to sort the link in order to achieve the optimal throughput. In this study author uses the greedy approach for each link. They decide to place K MGs in order to achieve better throughput in the grid based method than in fixed schemes.

IV. ROUTING ON CLIQUES ADMISSION CONTROL ALGORITHM

In WMNs, admission control is deployed to efficiently control different traffic loads and prevent the network from the overload. Admission control is one of the mechanisms that must be deployed to provide the QOS. An admission of new user is accepted if sufficient resources are available. We propose a distributed admission control mechanism for WMNs, routing cliques admission control (RCAC). RCAC accepts the clique (user) request while predefined the thresholds of packet loss probability and end-to-end delay satisfying. This mechanism helps to avoid the congestion. In RCAC consider two QOS parameters in WMNs: 1) packet loss 2) end-to-end delay in multichannel and multiradio WMNs. The first parameter packet loss probability is the major objective of RCAC is to prevent a high load from overloading the WMN and degrading the quality of service. Admission control mechanism limits the overflow of probability to very small values. The end-to-end delay is the second QOS parameter which is satisfied by the RCAC.

Before accepting a flow, RCAC calculates whether the delay of the selected route is lower than the threshold value. We describe the operations and interactions among CHs in processing for flow requests. When CH receives a request from a node then determines that 1) whether there is enough bandwidth for flow and satisfies the loss probability 2) whether CHs delay is smaller than delay threshold than it will accept the request of node for transmit and forward to the next hop CH toward the destination CH otherwise reject the request. Otherwise, a transit CH computes the sum of its delay and delay included the delay in the request; if accumulated delay is smaller than delay threshold, if it determines sufficient bandwidth to flow and satisfy the low threshold, then it propagates the request, pass the accumulated delay to next-hop CH. Each transit CH repeats this step until it reaches the destination CH. After reaching the destination, it carries the similar process. If response is positive, then it sends “commit” towards the source CH [see fig. 4 (a)]. Source CH uses the timer. If it expires before receiving the “commit” then source CH assumes that the flow request is rejected and informs the user. [see fig. 4(b)]. The CHs involved in the flow request setup “conditionally” commit the network resources only after receiving “commit”. In the second phase “commit” moves towards the source CH if the resources are still available, otherwise it sends reject towards the destination [see fig. 4(c)]. When the source CH receives “commit”, it sends accept to the user. If source CH receives reject then it releases the resources conditionally committed and forwards “reject” towards the destination [see fig 4(d)].

V. CONCLUSION

In this paper, the relevant research contributions in the open literature dealing with the efficiency of WMNs have been surveyed. We classify these contributions by carefully discussing their strengths and weaknesses. We conclude a new admission control scheme based on the cliques. Author considered two QoS parameters PLP and end-to-end delay in the design of RCAC. In the further work, we plan to add more admission control to minimize the blocking probability while satisfying a constraint on packet loss that it should not exceed the given threshold value. RCAC can be extended to handle different types of traffic.

REFERENCES


