Performance Evaluation and Optimization of DSR Routing Algorithm over 802.11 based Wireless Mesh Network

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Abstract— DSR Protocol offers a very effective routing mechanism in Wireless Mesh Networks. But the performance deteriorates when network is subjected to large amount of traffic. In this paper we have proposed modifications in DSR protocol, wherein congestion in the network is controlled by reducing the RREQ packet retransmission by the source node, and reducing the number of dropped packets by managing buffer space. Simulations done of Qualnet Network Simulator shows significant improvement in throughput, and reduction in number of packets dropped, and jitter.

Keywords- DSR Protocol, Buffer, Average end-to-end Delay, RREQ Retransmission, Throughput, Wireless Mesh Network, Qualnet

I. INTRODUCTION

A) WMN

Wireless Mesh Networks are being touted as the next big thing in the evolution of computer networks. WMN cater to a wide variety of applications ranging from Natural Disaster Management to On-Ground Military Communication to VOIP applications. Unlike Wireless LAN, mesh networks are self-configuring systems wherein each Access Point can relay messages to other nodes on behalf of others.

Moreover, in regular Wireless Local Area Networks, the Access Point has to be wired to the infrastructure (e.g. some wired backbone). This limitation is overcome by Wireless Mesh Networks, where Access Points can be connected to the rest of the network by wireless radio links only. Other key advantages of\ WMNs include ease of installation, lesser setup cost, automatic connection initialization among nodes, network flexibility, and automatic discovery of newly added nodes, redundancy, and self-healing reliability. These characteristics make a Wireless Mesh Network, a great solution in situations where, there is a need for a network which is quick to setup and easy to maneuver around.

There are two types of algorithms which are used Wireless Mesh Networks for routing of packets from source to destination. These are

- Proactive Routing Algorithms: These use information stored in routing tables to route a packet from source to destination.
- Reactive Routing Algorithms: In this, no routing table is maintained and whenever a node decides to send a packet, a new path is discovered then and there only.

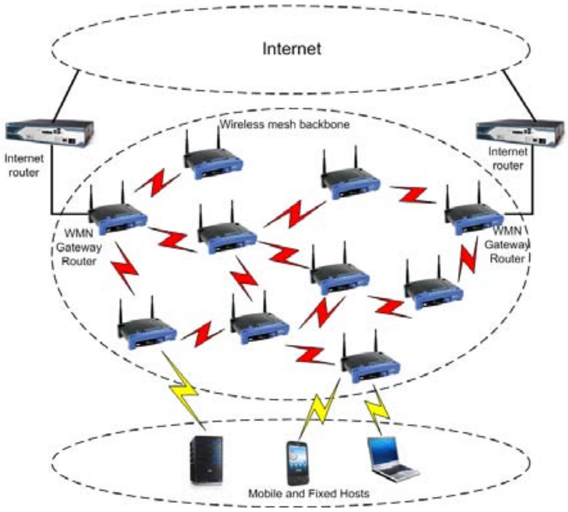

Figure 1. Wireless Mesh Network

B) DSR ROUTING PROTOCOL

The Dynamic Source Routing (DSR) Protocol is a source-routed on-demand routing protocol [1]. DSR is a reactive (On demand) routing protocol, unlike OLSR and DSDV, which are proactive (table driven) in nature.

DSR protocol is based on the concept of source routing. When a node wants to send data and there is no route to the destination currently available in its route cache, it broadcasts a route request packet, which contains the destination address and a route record. The route record records the passed nodes address. When the request is received by the destination or an intermediate node that knows the route to the destination, a route reply is sent back to the source node via the recorded route.

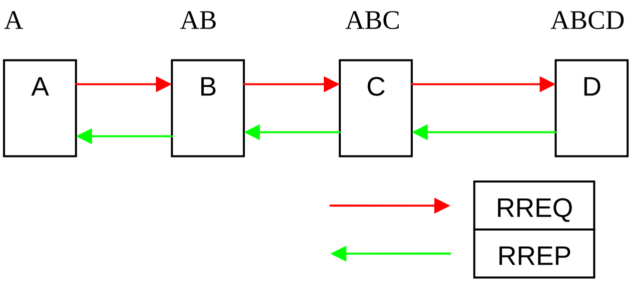

Figure 2. DSR Routing Algorithm

DSR protocol uses flooding technology to sends the Route Request (RREQ) packets [1]. Each RREQ packet consists of source node address (Sid), destination node address (Did) and the unique request sequence-number (Request ID). The structure of the RREQ packet is shown in Figure.3 as follows

Sid	Did	Route Record	Request ID

Figure 3. RREQ Packet Header

II. PROBLEM FORMULATION

The DSR (Dynamic Source Routing) routing algorithm is a reactive mesh routing algorithm, which means that no routing table exists. When a node wants to send a data packet to some other node, it must initiate some steps to find the most suitable path between itself and the destination node. It does so by flooding the network with RREQ (Route Request) packets. Initially the source node sends this RREQ packet to its immediate neighbours. The neighbouring node receives the RREQ packet and replies back with RREP (Route Reply) packet if it has a path available to the destination node. If, however, it does not have the path, it simply forwards the received RREQ packet to its neighbours. In this way whole of network is flooded with these RREQ packets.

This event takes place every time a node wishes to send a packet to some other node, and does not have the path available to do so., and it continues to broadcast till it receives a reply packet. Due to this flooding of RREQ packets, a lot of network resources are used up in path finding only, which results in the congestion of the network, which further results in problems like delay, reduced throughput, jitter and increased dropped packets.

Another problem arises due to multiple transmissions of various RREQ and RREP packets over the network. It becomes difficult to handle such large number of packets, and hence some packets are dropped. Due to this route discovery time increases, which reduces the efficiency of the network.

This paper relates to finding the solutions to the above mentioned problems by controlling the flooding of network with RREQ packets.

III. RELATED WORK

Brief survey of literature in area related to the wireless mesh network has been conducted and summarized as below.

According to [1], WMN is a dynamically self-organized and self-configured, with the nodes in the network automatically establishing an ad hoc network and maintaining the mesh connectivity. It can be built up based on existing technologies. Based on various experiments on WMNs proves that the performance of WMNs is still far below the expectations due to lack of scalability and the security.

[2] In this work, an initial variant of a 802.11s simulation model for the QualNet simulator is described. The tool builds on the existing QualNet 802.11 model by adding capabilities suitable for mesh networking. In the first set of simulations the effect on the throughput due to a different configuration for the timer present in the finite state automation was analyzed.

In [3] Testbed for the deployment of a real wireless multihop network utilizing WMN technology based on Microsoft MCL has created various experiments are performed to access the functioning of testbed and to evaluate the performance of heterogeneous flows over it. Experiments say that time to download the file increase linearly with the number of hops the flow has to traverse.

In [4] the capability of backhaul networking in Wireless Mesh Network is measure to support various types of traffic. The backhaul networking needs capacity, throughput, latency, and reach guarantee. Therefore, the mechanism of CSMA/CA must be enhanced if it is to be running in wireless mesh networks.

In [5] Wireless Mesh Network is based on low cost commodity hardware have a great potential for public safety and disaster recovery applications. The key characteristics of WMNs are good match for the requirements of public safety communication. The robustness and fault tolerance combined with the rapid deployment and self-configuration capability are crucial features for PSDR communications.

In [6] Ye Yan, Hua Cai and Seung-Woo Seo worked on an analytical traceable stochastic models to characterize the average delay and throughput performance in wireless mesh Network. The analytical model takes into account the mesh router density, the random packet arrival process, the degree of locality of traffic and the collision avoidance mechanism of the IEEE802.11

In [7] Tsai-Wei and Hung-yun hsieh investigate the impact when multiple wireless mesh networks overlap in service area. They find that in a system with multiple wireless mesh networks in overlap, if no form of coordination across different domains is present, individual mesh networks will suffer from significant capacity degradation. Results show that if proper interworking between overlapping mesh networks is provided, significant performance gain can be obtained.

In [8] Security is considered as one of the most critical parameter for the acceptance of Wireless Mesh Network. To ensure the security of WMNs various major security concern should be follows such as confidentiality, Integrity, Availability, Authenticity, Non-repudiation, Authorization, Anonymity etc.

The work in [9] Security is the vital problem in the design of Wireless Mesh Network. Appropriate measures should be taken to avoid security threats. Various possible attack types which can effect networks are, Tempering, Pretending, Forging, Resource depletion attack, wormhole attack, blackhole attack and Rushing attack.

IV. PROPOSED SOLUTION

The problem of congestion can be solved by reducing the RREQ packet retransmission by the source node. This will help reduce congestion in the network and factors like throughput and end-to-end delay, will have positive effects on them. We intend to make modifications in DSR routing algorithm, present in Qualnet Network Simulator to achieve this task.

The second problem of dropped packets can be solved by increasing the buffer size of the protocol. With increased buffer size, the packets which were to be dropped will be place in buffer space instead, and the same can be retransmitted at a later stage. Qualnet simulator provides with the option of implementing and modifying buffer space.

V. EXPERIMENTAL SETUP

This section deals with the detailed description of experimental scenario that has been setup to evaluate various traffic parameters of Wireless Mesh Network. We have built our WMN test bed using QualNet Network Simulator. QualNet is a network modeling tool, which is used to model wired and wireless networks. It uses simulation and emulation to predict the behavior and performance of networks to improve their design, operation and management. To implement the 802.11s functionality in the simulation model, we have used 2 Mesh Point Portals, 3 Mesh Assess Points, 4 Mesh Clients are used. These all are connected to each other using wireless component. The designed scenario is shown in figure 4 below.

Figure 4. Qualnet Scenario

A Constant Bit Rate (CBR) traffic link is initiated between Node 1 and Node 4. CBR data is transmitted after the interval of 1 millisecond having the packet size of 512 bytes. Values for different parameters are given in the table below.

TABLE I. SCENARIO PARAMETER VALUES

Parameter	Value
Data	CBR Traffic
Routing Protocol	DSR
Simulation Time	15 Seconds
Total No of Packets Sent	10000
Packet Size	512 Bytes
Max Buffer Packets	50 (Unmodified)
Max Buffer Size	0Bytes (Unmodified)
Transmission Interval	1millisecond

All Mesh Point Portals and Mesh Access Points are connected in Ad-hoc mode, whereas Mesh clients are connected to mesh access points in infrastructure mode. DSR Routing protocol is used to analyze the different traffic parameters. Distance among the nodes has been chosen so that non-neighboring nodes cannot communicate directly with each other.

VI. RESULTS

The purpose of this experiment is to check the functioning of our scenario and to evaluate the performance of wireless Mesh network after the proposed modifications. The above mentioned scenario was run for 15 seconds. Total of 10000 CBR packets were to be transmitted at interval of 1ms, starting from 0 seconds. At time t=3 seconds the route is broken, by generating a fault in the AP1 interface. The protocol then searches for an alternate route, through AP3,and transmission starts again. During the time route was not available packets were lost, due to non-availability of route. Mean number of packets lost during this time in original setup was 548. In the modified scenario, in which buffer was implemented, mean number of packets dropped were reduced to 513. Fig 5 show the original and modified results after buffer implementation.

The second parameter which was checked was throughput. In the original scenario, the mean throughput was 57390 bps. In the modified scenario mean throughput was improved to 61398 bps. This was done by reducing the number of RREQ packets being retransmitted by the source node. This helped in reducing the congestion in the network, thus improving the efficiency of the network. Fig. 6 shows the comparison between original and modified throughput values.

The only downside to modification we have made is in the end-to-end delay in packet arrival. The average mean end-to-end delay in the original scenario was found to be 1.29 seconds. But in the modified scenario, the mean end-to-end delay increased to 1.39 seconds. This was mainly due to the implementation of buffer. Fig 7 shows the end-to-end delay in the two scenarios.

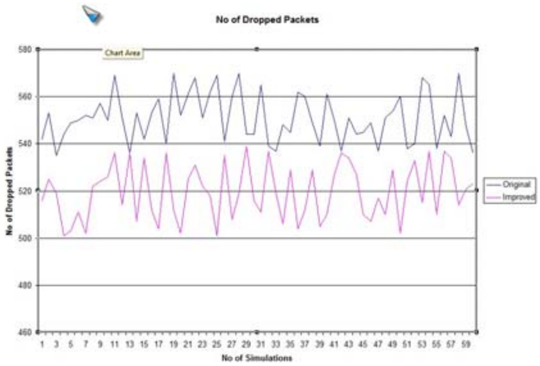

Figure 5 Dropped Packets

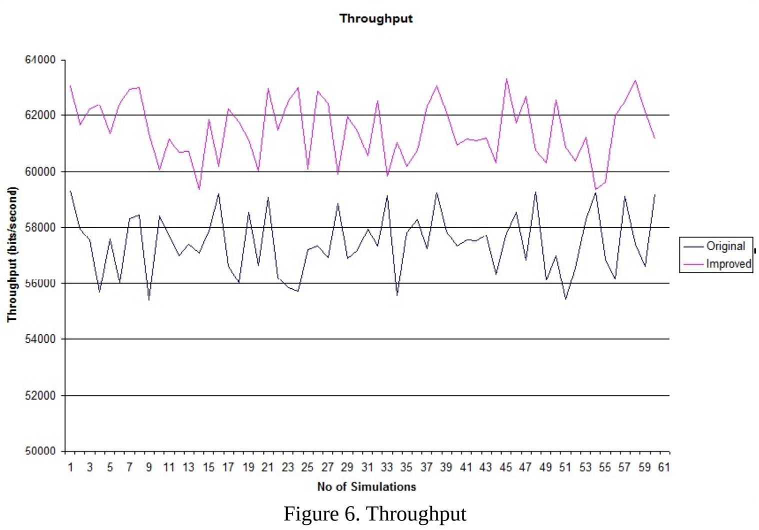

Figure 6. Throughput

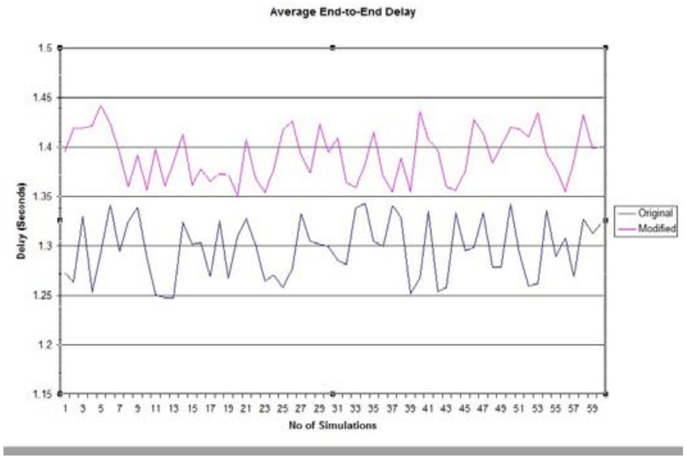

Figure 7 Average End-to-End Delay

VII. Conclusion

A Wireless Mesh Network scenario was developed in order to analyze and enhance the performance of various traffic parameters using DSR routing protocol and CBR traffic was used. A scenario was developed in Qualnet having 2 Mesh Point Portals (MPP), 3 Mesh Access Points (MAP) and 4 Mesh Clients. It was observed that by increasing the buffer space in a network, number of dropped packets could be reduced significantly. Also, by reducing the number of RREQ packets, we were able to improve upon throughput. But the downside to this proposed solution was increased end-to-end delay. We can conclude that there is a tradeoff between number of dropped packets and delay. If we decrease the number of dropped packets with help of buffer, then average end-to-end delay will increase. But we can certainly improve upon the throughput by reducing the retransmission of RREQ packets.

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