World Academy of Science, Engineering and Technology
International Journal of Electronics and Communication Engineering
Vol:5, No:5, 2011

Analysis of Delay & Throughput in MANET for DSR Protocol

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***Abstract*—**A wireless Ad-hoc network consists of wireless nodes communicating without the need for a centralized administration, in which all nodes potentially contribute to the routing process.In this paper, we report the simulation results of four different scenarios for wireless ad hoc networks having thirty nodes. The performances of proposed networks are evaluated in terms of number of hops per route, delay and throughput with the help of OPNET simulator. Channel speed 1 Mbps and simulation time 600 sim-seconds were taken for all scenarios. For the above analysis DSR routing protocols has been used. The throughput obtained from the above analysis (four scenario) are compared as shown in Figure 3. The average media access delay at node_20 for two routes and at node_20 for four different scenario are compared as shown in Figures 4 and 5. It is observed that the throughput will degrade when it will follow different hops for same source to destination (i.e. it has dropped from 1.55 Mbps to 1.43 Mbps which is around 9.7%, and then dropped to 0.48Mbps which is around 35%).

***Keywords*—**Throughput, Delay, DSR, OPNET, MANET, DSSS

I. INTRODUCTION

A wireless Ad-hoc network consists of wireless nodes communicating without the need for a centralized administration. A collection of autonomous nodes or terminals that communicate with each other by forming a multihop radio network and maintaining connectivity in a decentralized manner is called an ad hoc network. There is no static infrastructure for the network, such as a server or a base station. The idea of such networking is to support robust and efficient operation in mobile wireless networks by incorporating routing functionality into mobile nodes. Figure.1 shows an example of an ad hoc network, where there are numerous combinations of transmission areas for different nodes. From the source node to the destination node, there can be different paths of connection at a given point of time. But each node usually has a limited area of transmission as shown in Figure 1. by the oval circle around each node. A source can only transmit data to node *B* but *B* can transmit data either to *C* or *D*. It is a challenging task to choose a really good route to establish the connection between a source and a destination so that they can roam around and transmit robust communication. In this paper, OPNET simulator [3] has been used to simulate the network as proposed in Figure.2 in which 30 nodes have been taken for the analysis with four mode of operation as shown in Table1

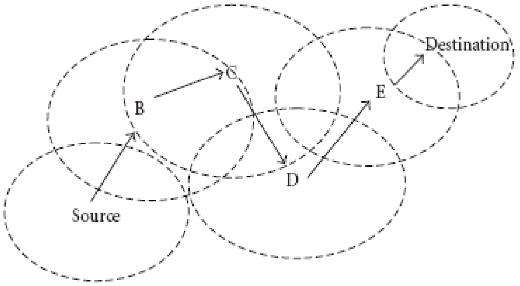

Fig. 1 Ad hoc networking example

TABLE I
DIFFERENT SCENARIO

Scenario	No. of Hopes	Route
First	Three	Between node_20 to node_1
Second	Five	Between node_20 to node_1
Third	Six	Between node_20 to node_1
Fourth	Seven	Between node_20 to node_1

The following system parameters are taken for the simulation of all the above scenario at channel speed 2 Mbps and simulation time 600 sim-seconds. The comparative studies of the simulation results for these parameters are also reported.
(i) Number of hops per route,
(ii) Delay,
(iii) Throughput,

DSR routing protocols proposed by [4,5,6] has been above analysis. We evaluated all available metrics supported by OPNET for this protocol. To the best of our knowledge, very few papers are reported in the literature, which compares the simulation results with different scenario reported in this paper. This work is the one of the major comprehensive performance evaluation of ad hoc routing protocols using OPNET Modeler. We also simulated this protocol under different loads (number of nodes in a network) and showed their corresponding performance differences.In Section-2, a summary of the Ad hoc routing protocols have been reported. The simulation software and the network simulation setup are described in section 3. In this paper the simulation results & conclusion has been reported in section 4 & 5 respectively.

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II. ADHOC ROUTING PROTOCOL

Most widely used routing protocols for wireless ad hoc networks used in OPNET simulator available till today are DSR[4,5,6], AODV, destination sequence distance vector (DSDV), and TORA ad hoc routing protocols. All these protocols are constantly being improved by IETF[1]. Since these protocols have different characteristics, the comparison of all performance differentials is not always possible. DSR routing protocols has been used for the present analysis.

A. Dynamic Source Routing (DSR)

DSR [4,5,6] uses source routing rather than hop-by-hop routing, with each packet to be routed carrying in its header the complete, ordered list of nodes through which the packet must pass. The key advantage of source routing is that intermediate nodes do not need to maintain up-to-date routing information in order to route the packets they forward, since the packets themselves already contain all the routing decisions. This fact, coupled with the on-demand nature of the protocol, eliminates the need for the periodic route advertisement and neighbor detection packets present in other protocols.

B. Basic Mechanisms

The DSR protocol consists of two mechanisms: Route Discovery and Route Maintenance. Route Discovery is the mechanism by which a node **S** wishing to send a packet to a destination **D** obtains a source route to **D**. To perform a Route Discovery, the source node **S** broadcasts a ROUTE REQUEST packet that is flooded through the network in a controlled manner and is answered by a ROUTE REPLY packet from either the destination node or another node that knows a route to the destination. To reduce the cost of Route Discovery, each node maintains a cache of source routes it has learned or overheard, which it aggressively uses to limit the frequency and propagation of ROUTE REQUESTs. Route Maintenance is the mechanism by which a packet’s sender **S** detects if the network topology has changed such that it can no longer use its route to the destination **D** because two nodes listed in the route have moved out of range of each other. When Route Maintenance indicates a source route is broken, **S** is notified with Table 2 Constants used in the DSR simulation. Time between retransmitted ROUTE REQUESTs (exponentially backed off) 500 ms Size of source route header carrying *n* addresses 4*n* + 4 bytes Timeout for nonpropagating search 30 ms Time to hold packets awaiting routes 30 s Max rate for sending gratuitous REPLYs for a route 1/s a ROUTE ERROR packet. The sender **S** can then attempt to use any other route to **D** already in its cache or can invoke Route Discovery again to find a new route. *Implementation Decision* Using the suggestions from the published description of DSR [4,5,6] we have optimized our implementation in a number of ways. Although the DSR protocol supports unidirectional routes, IEEE 802.11 requires an RTS/CTS/Data/ACK exchange for all unicast packets, limiting the routing protocol to using only bidirectional links in delivering data packets. We implemented DSR to discover only routes composed of bidirectional links by requiring that a node return all ROUTE REPLY messages to the requestor by reversing the path over which the ROUTE REQUEST packet came. If the path taken by a ROUTE REQUEST contained unidirectional links, then the corresponding ROUTE REPLY will not reach the requestor, preventing it from learning the unidirectional link route. In Route Discovery, a node first sends a ROUTE REQUEST with the maximum propagation limit (hop limit) set to zero, prohibiting its neighbors from rebroadcast it. At the cost of a single broadcast packet, this mechanism allows a node to query the route caches of all its neighbors for a route and also optimizes the case in which the destination node is adjacent to the source. If this no propagating search times out, a propagating ROUTE REQUEST is sent. Nodes operate their network interfaces in *promiscuous* mode, disabling the interface’s address filtering and causing the network protocol to receive all packets that the interface overhears. These packets are scanned for useful source routes or ROUTE ERROR messages and then discarded. This optimization allows nodes to learn potentially useful information, while causing no additional overhead on the limited network bandwidth. Furthermore, when a node overhears a packet not addressed to itself, it checks the unprocessed portion of the source route in the packet’s header. If the node’s own address is present, it knows that this source route could bypass the unprocessed hops preceding it in the route. The node then sends a gratuitous ROUTE REPLY message to the packet’s source, giving it the shorter route without these hops. Finally, when an intermediate node forwarding a packet discovers that the next hop in the source route is unreachable, it examines its route cache for another route to the destination. If a route exists, the node replaces the broken source route on the packet with the route from its cache and retransmits the packet. If a route does not exist in its cache, the node drops the packet and does not begin a new Route Discovery of its own. Table 2 lists the constants used in our DSR simulation.

TABLE II
CONSTANTS USED IN THE DSR SIMULATION

Time between retransmitted ROUTE REQUESTs (Exponentially backed off)	500m
Size of source route header carrying n addresses	4n+4Bytes
Timeout for nonpropagating search	30ms
Time to hold packets awaiting routes	30s
Max rate for sending gratuitous REPLYs for a route	1/s

III. SIMULATION SETUP

OPNET simulator is used to construct models for two different purposes: to study system behavior and performance. A network model may contain any number of communicating entities called nodes as shown in Figure 2. Node models consist of modules and connections. OPNET supports predefined statistics that are typically of interest in simulation studies [2,9].

A. Network Model Overview

In the present work the network model as proposed in Figure.2, consists of thirty nodes which includes an Application and a Profile Definition. The proposed network model and DSR protocol is taken for validation and comparison of throughput and delay.The channel speed of the WLAN is set to 2 Mbps and simulation time is taken 600 sim-sec. The Application and Profile Definition are used to define the type of traffic sent between the nodes. In this work, these are configured to send TCP traffic. The throughput between two nodes is measured by generating TCP packets from the one node and sending them to the another node. The throughput is calculated based on the time (sim-sec) and delay is calculated based on the distance. The simulation study consists of four scenarios as shown in Table 1.

B. Network Environment

The network environment parameters like area, Physical Characteristics, Packet Reception Power Threshold etc. are given in Table 3 The TCP parameter like Max^{m} ACK Delay(sec), Slow start initial count (MSS), Duplicate ACK Threshold etc. are given in Table 4.

IV. SIMULATION RESULT AND ANALYSIS

The simulations are carried out for throughput and delay for all the scenario as reported above in the Table 3-4 above. The variation in throughput in all the scenario are shown in Figure 3. All simulations run for 600 sim-seconds. The throughput obtained from the above analysis (four scenario) are compared as shown in Figure. 3.

TABLE III
SIMULATION ENVIRONMENT

Area	300m * 300m
Physical Characteristics	DSSS
Packet Reception Power Threshold	7.33 E-14
Buffer Size	25600
Fragmentation Threshold	1024
Data Rate	2 Mbps
Node Speed	10m/s

The average media access delay at node_20 for two routes and at node_20 for four different scenario are compared as shown in Figurers 4 and 5. The scale up network model consists of thirty nodes distributed randomly in a space of 300m x 300m. The channel speed of the wireless LAN is also set to 2 Mbps. In this network some of the nodes are fixed and some are moving with the speed of 10m/s. Figure. 2 is a snapshot of the proposed network model consider for simulation. The first set of scenarios deals with adding more relay nodes between source and destination.

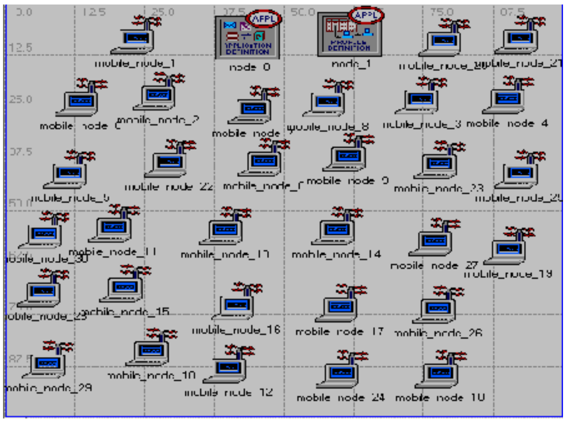

Fig. 2 Simulation setup for the proposed network

TABLE IV
TCP PARAMETER

Max^{m} ACK Delay(sec)	0.200
Slow start initial count (MSS)	4
Duplicate ACK Threshold	3
Fast Recovery	Reno
RTT Gain	0.125
Deviation gain	0.25
RTT Deviation Coefficient	4.0

The simulation results are obtained for the four scenario mentioned in Table 1. Figure. 3 shows a comparison of the average of the throughput the simulation time for comparison of four different scenarios as reported in Table 1. The top curve corresponds to the first scenario, where three hops exist between node_20 and node_1. The second curve relates to the second scenario. In this scenario five hops exist between node_20 and node_1. The third curve shows the results for the third scenario where six hops exist between node_20 and node_1. The bottom curve corresponds to the fourth scenario, where seven hops exist between node_20 and node_1. The graph in Figure. 4 shows the average throughput at node_30 for the two routes. It is clear from the graph in Figure. 3 that even though the number of hops in the second route (five hops) is less then the number of hops in the first route (six hops), the average throughput is smaller.The second set of scenarios deals with increasing the number of nodes trying to communicate simultaneously with one node. The graph in Figure. 3 shows the average throughput at node_20 for four different scenarios. The top curve corresponds to the scenario where only node_20 is communicating with node_1 (the average value is about 1.55Mbps). The second curve corresponds to the scenario where four nodes are trying to communicate simultaneously with node_20 (the average value is around 1.43Mbps). The third curve represents the average throughput for the scenario where five nodes are sending traffic simultaneously to node_20 (the value here is around 0.58Mbps). The bottom curve corresponds to the scenario where seven nodes are communicating simultaneously with node_20 (the average value here is around 0.46 Mbps). It is clear from the graph in Figure.3 that the more nodes are trying to communicate simultaneously with the same node the less the throughput will be. Also it is noticeable that the drop is linear (i.e. it has dropped from 1.55Mbps to 1.43 Mbps which is around 9.7%, and then dropped to 0.58Mbps which is around

35%).The graph in Figure. 4 shows the average delay at node_30 for the two routes The top curve indicate that average delay between source to destination corresponds to the five hops route, the bottom curve corresponds for the four hops route. To check the effect of the signal strength on the throughput, node_30 is going to move away from node_29 and try to connect to node_1 through node_27.

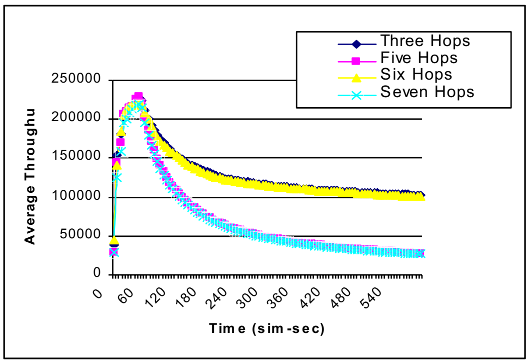

Fig. 3 Average throughput comparison between the four scenarios

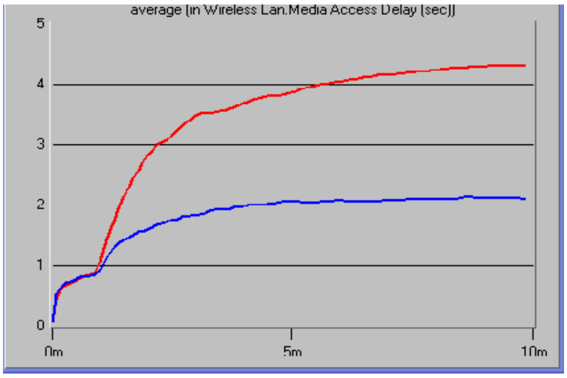

Fig. 4 Average Media Access Delay at node_20 for the two routes

It is clear from the graph in Figure. 4 that the number of hops in the second route (four hops) is less then the number of hops in the first route (five hops), the average delay is smaller. This is due to the fact that the signal quality between node_30 and node_29 is stronger than the one between node_30 and node_27. The second set (Figure.5) of scenarios deals with increasing the number of nodes trying to communicate simultaneously with one node.The graph in Figure. 5 shows the average delay at node_20 for four different scenarios. The top curve corresponds to the scenario where only node_20 is communicating with node_1 (the value here is around 4.2s). The second curve corresponds to the scenario where four nodes are trying to communicate simultaneously with node_1 (the value here is around 4.1s). The third curve represents the average throughput for the scenario where five hopes are sending traffic simultaneously to node_1 (the value here is around 2s). The bottom curve corresponds to the scenario where seven hopes are communicating simultaneously with node_1 (the average value here is around 1.8s). It is clear from the graph in Figure. 5 that the more nodes are trying to communicate simultaneously with the same node which results less the delay.

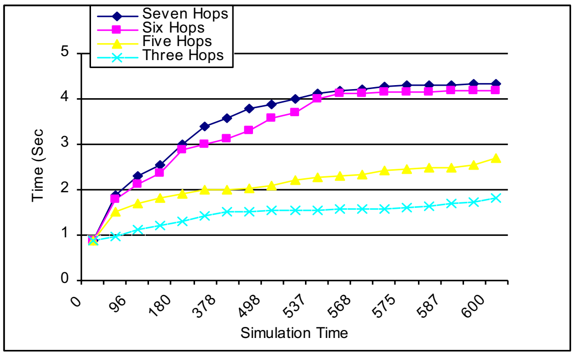

Fig. 5 Average delay at node_20 for four different scenarios

V. CONCLUSION

In this paper, the performance of wireless Ad-hoc networks has been studied through OPNET simulator and the results are compared. The results reported in this paper suggests a linear drop in the throughput at node_20 while moving towards node_27, with regard to the number of nodes that are trying to simultaneously connect to the same destination. This study has also shown that when the signal strength between source and destination is not strong enough, routing the traffic through an intermediary node can lead to higher values of throughput. In such a situation, the increased latency introduced by an intermediary node, needs to be noted.It has been observed that after the simulation throughput decreases as the no. of hopes increases as shown in Figure. 3. Communication between source to destination through 5 hops will decrease the throughput by 25.23%. Communication between source to destination through 6 hops will decrease the throughput by 40.45%. Communication between source to destination through 7 hops will decrease the throughput by 76.32%. Whereas delay increases when the no. of hops increases as shown in Figure. 5. Communication between source to destination through 5 hops will increases the delay by 22.14%. Communication between source to destination through 6 hops will increases the delay by 31.44%.Communication between source to destination through 7 hops will increases the delay by 36.24%.

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