Performance Evaluation of Routing Protocols in MANETs Under FTP Traffic Applications

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Abstract

Mobile Ad-hoc Networks (MANETs) have already opened a new point of view in the field of wireless networks, which includes hundreds and thousands of nodes. The wireless nodes are communicating without the need of any kind of neither infrastructure like the base stations or routers, nor centralized administration. Wireless nodes are free of moving anytime, anywhere. Therefore, MANETs need to have dynamic routing protocols. The MANET routing protocols are divided into several different categories such as Proactive, Reactive, and Hybrid. There arenumerous performance metrics are used to compare the routing protocols. Each of them has its own attributes and well for specific area such as throughput, jitter, packet delivery ratio, average number of hops, route discovery time, and end-to-end delay, etc. In this paper, two well known routing protocols including OLSR and AODV were evaluated using the OPNET 17.1 simulator under the medium load traffic size in FTP protocol. The Random Waypoint mobility model is used as pattern of mobility. As performance metrics the average throughput and average network load are examined in different number of nodes, file sizes, and node speeds.

Keywords

MANETs, Routing Protocols, Network Metrics, OPNET 17.1

I. Introduction

During this decade, wireless network has become very famous in the area of communication. Considering this, wireless networks are also being used in all places such as military application, industrial application, and even in personal networks (e.g. laptop, mobile phone, MP3 player, personal digital assistance, and personal computer). These nodes can be located in cars, ships, airplanes, or with people having small electronic devices [1]. Ad-hoc networks classified into proactive, reactive, hierarchical, geographical, power aware, multicast, geographical multicasting, security and others. However, the main categories are the first three ones [2]. These categories are based on the applications, which are widely considered in Ad-hoc networks. In addition, there is another category for Ad-hoc networks base in the area that it is running, i.e. Mobile Ad-hoc Networks (MANETs), Wireless Mesh Networks (WMNs), Wireless Sensor Networks (WSNs) [3, 4, 5]. The main categories are called by other names as proactive (on-demand), reactive (table driven), and hierarchical (hybrid) [11, 14]. In the table driven approach, each router is able to contain one or more routing table together. Routing tables are absent when it needs on-demand routing protocols. In the on demand, route request starts to establish a route when it needs the route [12-13]. This paper focuseswe uses the OLSR and AODV MANETs protocols to analyze the performance of routing protocols using the OPNET simulatorversion 17.1 [15]. In order to evalauet the performance in the experimental part, we used FTP medium traffic.

The rest of the paper is organized as follows. Section II provides a short literature review of MANET routing protocols more specifically on OLSR and AODV. Section III describes the experimental environment. Section IV provides the experimental results and discussions. Section V concludes the paper.

II. Literature Review

The Optimized Link State Routing (OLSR)is a proactive (table-driven) routing protocol i.e. frequently exchanges topology information with other nodes of the network [6]. This protocol is optimization of traditional link state protocol developed for MANETs. Minimizing the required number of control packets transmission makes control packets size short, which are the OLSR accountabilities. The main goal of OLSR is to organize the control traffic overhead in the network with the help of Multipoint Relays (MPRs) [7]. The MPR idea is the key concept behind the OLSR protocol. It is basically a node's one-hop neighbors in the network. The MPR technique is used for route calculation between the source and the destination in a network. Furthermore, the MPRs support a mechanism for flooding the control traffic by minimizing the number of packet transmissions. However, they are to be involved in another task when the information of link state is announced in the network. The task includes announcements for the link-state information for their MPR selectors, and then provides the shortest paths to all destinations in MANET. The MPRs are allocated from the one-hop adjacent nodes with symmetric or bi-directional connection, so it is possible to stay away from the hardships of experience during the packet transmission over a uni-directional link by deciding the path through the multipoint relays.

The Ad-hoc On-demand Distance Vector Routing (AODV) [8-9] discovers the new algorithm in operation of Ad hoc networks.In this protocol, every node works as a separate router and when it needs a route, it starts to establish or obtain a route for itself. The AODV does not require universal periodic routing advertisements because it is loop free route even when the link fails. Due to this fact, it requires just on the whole bandwidth, which is reachable to the mobile nodes. Note that, it is substantially less than those protocols, which are required for such advertisements. AODV does not work with active paths neither maintains any routing information nor joins in any periodic routing table exchanges. The nodes in AODV do not have to discover and maintain the route to others nodes up to the time they want to make communication.

III. Modellingof MANETs in OPNET and Simulation Setup

In order to deploy a MANET, there is a need to design a virtual network environment. In this study, the OPNET Modeler version 17.1 is used, which supports AODV, DSR, GRP, OLSR, and TORA routing protocols in total. In all scenarios, all mobile devices use IP address version 4.The results obtained during the simulation are depicted through a number of scenarios. In our simulation study, there are three types of different scenarios based on the number of nodes, different file (data) sizes, and speeds as performed with performance metrics average throughput [10] and average end-to-end delay for AODV and OLSR routing protocols.The simulation parameters used in the experimental study depicted in different Tables 1-3.

Table 1: General Simulation Parameters

Network Parameters	Values
Routing Protocols	AODV, OLSR
Packet (File) Size	512, 1024, 2048, 4096 bytes
MANET size	1 km * 1 km
Mobile Nodes	100, 80, 60, 40, 20
Speed (m/s)	5, 30, 50
Mobility Traffic Type	Medium load Ftp traffic
Mobility Model	Random Waypoint

Table 2: Wireless Parameters

Network Parameters	Values
Wireless LAN MAC address	Auto assigned
BSS identifier	Auto assigned
Physical characteristics	Extended Rate PHY (802.11g)
Data rate (bps)	11 Mbps
Channel settings	Auto assigned
Transmit power(W)	0.005
Rts threshold (bytes)	None
Fragmentation threshold (bytes)	None
CTS-to-self option	Enabled
Short retry limit	7
Long retry limit	4
AP beacon interval (seconds)	0.02
Max receive lifetime (seconds)	0.5
Buffer size (bits)	256000
Large packet processing	Drop

Table 3: Profile Configuration Parameters

Network Parameters	Values
Pause time (seconds)	Constant (100)
Start time (seconds	Constant (0)
Start time offset	Constant (0)
Duration	End of profile
Start time (seconds)	Uniform (100,300)
Duration	End of simulation

A set of simulations were done for each protocol by various number of nodes. The results were obtained in the form of graphs and all graphs were displayed as sample mean of 5 runs.

IV. Experimental Results and Analysis

A. Investigation of Different Number of Nodes

In first scenario was prepared in which there were 20, 40, 60, 80 and 100 mobile nodes from the object palette window of OPNET Modeler 17.1 and pasted all of them in the workspace window and routing protocols AODV and OLSR were used individually. After the processes of inserting application configuration and profile configuration from object palette to workspace window, the settings had to be done according to the requirements. FTP file size set to 512 bytes. In the first scenario the maximum node speed was set to 5 m/s.

Reactive protocols have much end-to-end delay due to broadcasting the routing request by source nodes for whole network and keep them waiting for responses. AODV is always searching about new routes when it needs (on demand method), thus it doesn't save whole routes in the network and also unable to preserve the unused routes in the network. The benefit of this strategy is low controlled traffic. However, overall average end-to-end delay increases in network because the files are waiting in buffer, up until they will be sent by new routes. In addition, AODV maintains only one route per destination in its routing table [16].

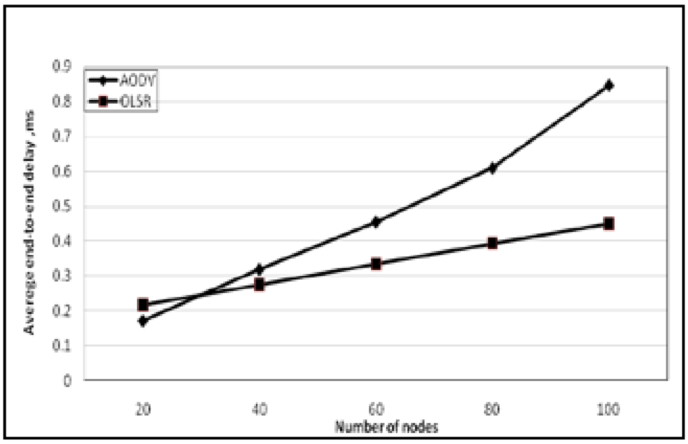

Fig. 1: Average End-to-End Delay Versus Number of Nodes with File Size 512 Bytes and Maximum Node Speed 5 m/s

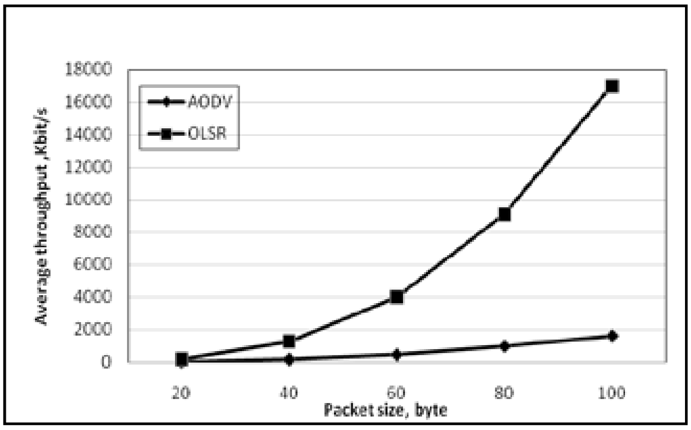

Fig. 2: Average Throughput Versus Number of Nodes with File Size 512 Bytes and Maximum Node Speed 5 m/s

OLSR protocol has low end-to-end delay because of several reasons; using low latency of route discovery process, keeping whole neighbor tables and maintaining track of other nodes available through of them, and not showing the failure link until associated MPR transfer its topology information to other nodes across the network. Stands to these reasons OLSR works efficiently when the number of nodes increases. OLSR protocol maintains and updates routing tables regularly so; it is efficient and has low latency [17].

By considering this scenario figures which were fixed 512 byte file size, 5 m/s maximum speed for each nodes and different number of nodes; When the number of mobile nodes increases then the data which is needed to deliver to the specific destination has to pass from many mobiles, so it increases end-to-end delay in and make it excessive and also when the number of nodes with high traffic is increased, the cache of routes make the end-to-end delay gets worse.

B. Investigation of Different File Sizes

In the second set of simulations numbers of nodes were fixed with 40 and 100 where file size was changed as 512,1024, 2048 and 4096 bytes. All other parameters remained the same as the first scenario.

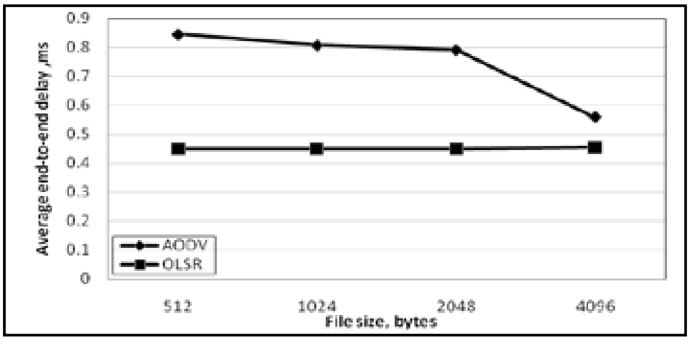

Fig. 3: Average End-to-End Delay Versus Different File Size with 100 Nodes and Maximum Node Speed 5 m/s

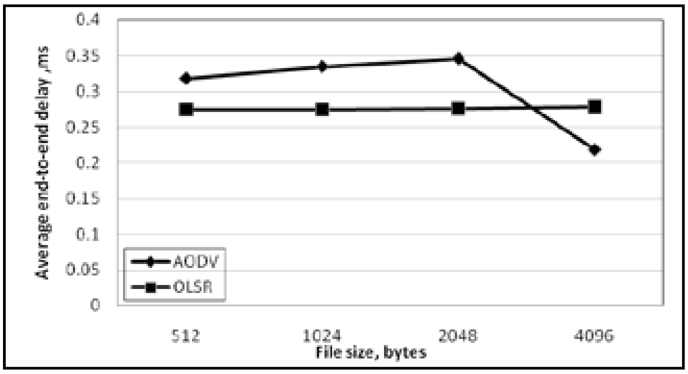

Fig. 4: Average End-to-End Delay Versus Different File Size with 40 Nodes and Maximum Node Speed 5 m/s

Normally in the AODV; there are not many packets in the buffer that should wait for the transmission on the route but the loss rate of the packet are increase with the increase of file size because they were sent on the old routes and it need more time to send the file with large size. Thus AODV requires periodic update of information but exhibit reasonable average end-to-end delay. Due to AODV characteristic (used hop-by-hop routing mechanism and eliminates the source routing overhead in the network) when the file size increases the average-end-to-end delay will be decreased. Resulting show this affect more when the file size become more. AODV is admirable, when the goal is to achieve more throughputs regardless of the incremental file size. AODV was used hop-by-hop routing mechanism and eliminates the source routing overhead in the network. Besides of that, the availability of multiple route information in AODV makes it easy to produce the highest amount of throughput in the network.

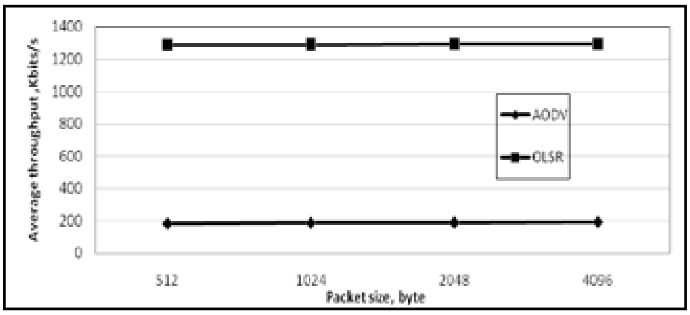

Fig. 5: Average Throughput Versus Different File Size With 40 Nodes and Maximum Node Speed 5 m/s

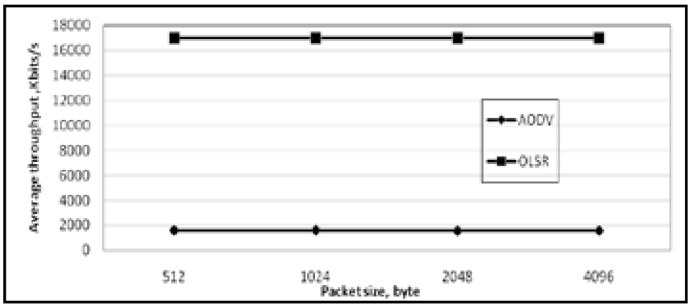

Fig. 6: Average Throughput Versus Different File Size with 100 Nodes and Maximum Node Speed 5 m/s

In OLSR with the help of MPR there is continues maintaining information and updating routing, as result reduction of routing overhead. This makes OLSR protocol independent in the network traffic in receiving more data packets [18].

In medium traffic environment by notice second scenarios figures which the file size was changed to 512, 1028, 2048 and 4096 byte OLSR shows better throughput than AODV also the lowest end-to-end delay time. Here for AODV to find an optimal fresh path due to frequent broadcasting of route re-initialization and RRQ message also because of using destination sequence number for every RRQ, they increase the efficiency of the link without needing to execute the large routing table every time.

C. Investigation of Different Node Speeds

In this set of simulations, the effect of different node speeds (5 m/s, 30m/s and 50 m/s) to routing protocols with fix number of nodes (100) was observed. All of the remaining parameters are the same as the previous scenario.

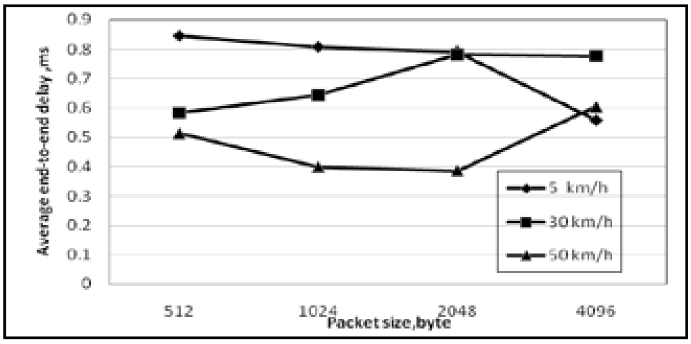

Fig. 7: Average End-to-End Delay Versus File Size with 100 Nodes for AODV Protocol with Different Node Speeds

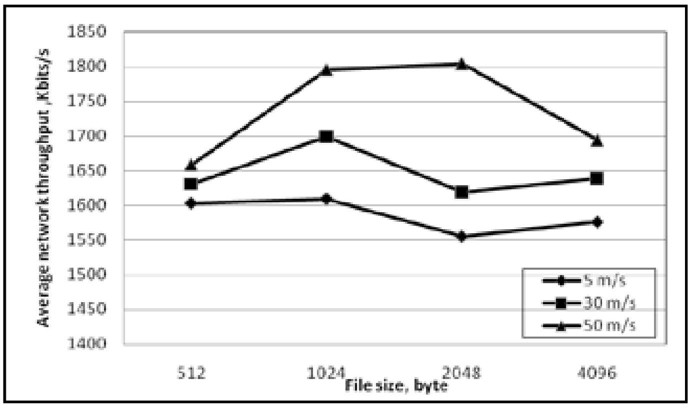

Fig. 8: Average Throughput Versus File Size with 100 Nodes for AODV Protocol With Different Node Speeds

Nodes speed is played a high role in determining the performance metrics of routing protocols. It should be noted that, when the nodes

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speed increases, more packets are dropped due to unavailable routes.The performance of AODV is found to be increased as the network topology stays constant for a low speed network with the lower mobility rate. Even when the speed increases, AODV is slightly affected. Routing tables are more frequently updated in response to topology changes in the network that is shown in fewer packet drops and less performance degradation. AODV operates the on-demand routing strategy. It is unable to keep the unused routes in the network. Instead, AODV is always searching about new routes when it needs (on-demand method) thus it doesn't save whole routes in the network also unable to preserve the unused routes in the network.This strategy usually generates less control traffic. However, overall average end-to-end delay increases in network because filesare waiting in buffer, up to they will be sent by new routes.

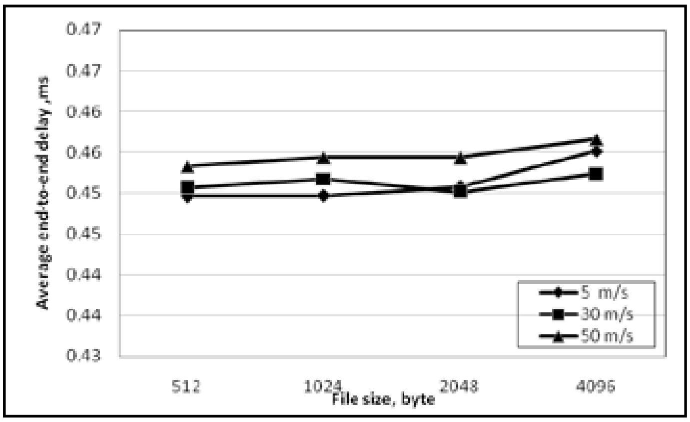

Fig. 9: Average End-to-End Delay Versus File Size with 100 Nodes for OLSR Protocol with Different Node Speeds

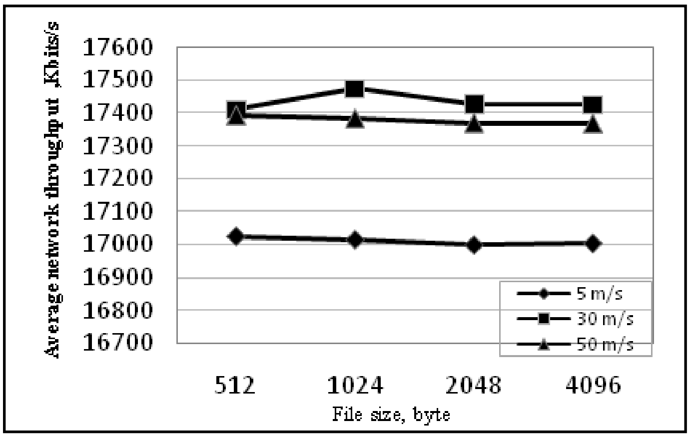

Fig. 10: Average Throughput Versus File Size with 100 Nodes for OLSR Protocol with Different Node Speeds

OLSR protocol to maintain consistent paths, it updates its routing table frequently. Thus mobility of nodes shows less impact over the performance of OLSR protocol. OLSR can detect link failure sooner than AODV protocol, so fewer packets are dropped when the speed increases. By exchange of periodical routing updates between nodes even in the absence of data, OLSR shows the highest average network throughput.

In high mobility scenarios in the third part, OLSR also shows better throughput than AODV with different file size and speed. Since OLSR without saving all the nodes parts maintains one hop and two hop neighbors, it becomes more impressive in link update process. In addition, OLSR minimizes the traversal of control message by multipoint relays and decreasing the average end-to-end delay compared to AODV.OLSR is well suited for small and large size network with high mobility. It also performs better at low node mobility in large network. AODV performs well in medium sized networks under high traffic load. In respect of average end-to-end delay and average throughput, OLSR has shown better performance than AODV.OLSR exhibited very low end-to-end delay in all scenarios. AODV had an improved end-to-end delay when network grows but when the speed increases it did not have obvious effect on end-to-end delay. It can be concluded that MANET could have dynamic number of nodes connectivity in mobility, in general, when the number of nodes is higher, AODV would be avoided. With increase in the number of nodes and due to mobility, throughput performance of AODV is minor affected. It is important to realize that OLSR has better throughput performance, as it is shown in all figures, comparing to AODV.

IV. Conclusion

In this study from proactive category Optimized Link State Routing (OLSR) and from reactive category Ad-hoc On-demand Distance Vector (AODV) are evaluated using OPNET simulator under the medium load traffic size in FTP protocol.

In this work, a number of simulation experiments are performed by using OPNET (version 17.1) simulator to determine and evaluate the performance of mobile ad hoc networks. Random waypoint mobility model is used as pattern of mobility. As performance metrics average throughput and average end-to-end delay are examined in different number of nodes, file sizes and node speeds. In the first part of simulation the number of nodes is varied from 20 to 100 with file size 512 bytes and node speed 5m/s. The file size is changed from 512 bytes to 4096 bytes in the second scenario with the other fixed attributes of the first scenario; and in the last scenario the speed was used as 5 m/s, 30 m/s and 50 m/s with the file size varying from 512 bytes to 4096 bytes using 100 nodes in the network.

According to the simulation results and observations a number of conclusions are drawn as follows. In general, proactive protocols perform better in case of average throughput and average end-to-end delay. OLSR seems to be well as it exhibits lower end-to-end delay and highest throughput. The OLSR delay has very minor changes when the numbers of nodes increases.

The OPNET version 17.1 supports six MANET routing protocols only. It does not support other protocols for instance LDR and ZRP. So, different protocols from different classifications could be implemented in OPNET. In addition to this, suggesting for the future research is to develop a modified version of the selected routing protocols which could consider different aspects of routing protocols such as rate of higher route establishment with lesser route breakage and any weakness of the used protocols could be improvised.

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