Performance comparison of MANET Routing Protocols under FTP Traffic

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Abstract— **Mobile AdHoc networks (MANET) is a network of mobile nodes such as laptops interfacing without centralized infrastructure. Each individual node in MANET must be able to act as a host, generating application traffic and as a router which carries out network control and routing protocol.**

The performance of proactive and reactive routing protocols is studied under specific application traffic beside the original network traffic which is more similar to real situations. There are various routing protocols exist for MANET. This paper will study and compare the performance of three routing protocols Optimized link state routing protocol (OLSR), which is a proactive protocol, Dynamic Source Routing Protocols (DSR) and AdHoc-On-Demand Vector Routing protocol (AODV) .Both AODV and DSR are reactive protocols .The comparison between the performance of these routing protocols, based on the performance metric of throughput , End-to-End delay and routing traffic overhead will be evaluated by using Opnet Simulation package under different scenarios and under identical loads and environment conditions. File Transfer Protocol (FTP) is used as the application traffic where a number of nodes receive data file from the same source node (WLAN FTP Server) with different data for each destination node. The finding of the study is that the type of traffic load in the network is the most important factor on the performance of MANET routing protocols regardless of the mobility model employed by the nodes

Index Terms— **AODV; DSR; FTP;.OLSR**

I. INTRODUCTION

As the field of wireless networks has witnessed an accelerated growth in all it aspects, Mobile AdHoc networks have emerged as a major area of research for both the academic and industrial sectors [1].This growth has been motive by the rapid growth of different wireless devices. A mobile ad hoc network is an autonomous collection of mobile devices (laptops, smart phones, sensors, etc.) that communicate with each other over wireless links and cooperate in a distributed manner in order to provide the necessary network functionality in the absence of a fixed infrastructure [1].Nodes that are located within each other send range can directly communicate, otherwise intermediate nodes will act as a router and relay data packets to their destinations. High rate of topological change, due to the fact that every node can enter or leave the network at any time, limited bandwidth and energy-constrains are considered to be the main challenges in MANET designing and routing [3].the routing protocol should be able to cope with dynamic changes of MANET and keep up-to-date routing paths to all nodes in the network or be able to find them when need arises.

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MANET can operate in stand-alone fashion or it can be connected to the internet. Many studies have been conducted in the area of MANET protocol performance comparison and in most of these studies the type of traffic considered are not related to specific application [3]. In this paper we will compare the performance where a varying number of nodes need to receive large data files from one common source node (server). In order to achieve this, File Transfer Protocol (FTP) is used. Although there is a trend towards HTTP for downloads, FTP is still a candidate for use in modern applications for Internet of Things or Smart Cities [3]

II. RELATED WORK

In [3] the performance of AODV, DSR, and OLSR has been evaluated under FTP traffic. Many scenarios has been implemented and the study concluded that OLSR outperformed AODV and DSR in terms of routing traffic overhead, normalized load routing and End-to-End Delay. They concluded that the type of the traffic load in the network plays an important role on the performance and operation of the most popular routing protocols used in MANETs, regardless of the mobility model employed by the relay nodes. In [4] the performance of AODV, DSR and TORA has been evaluated under varying number of nodes and FTP Traffic. Two scenarios have been implemented (20 nodes and 40 nodes).the study concluded that DSR outperform AODV and TORA in term of delay, throughput and network load. In [5] the paper evaluated the performance of AODV and DSR protocols to transfer multimedia data over MANET. Performance of these routing protocols is evaluated under different metrics such as network load, throughput and end-to-end delay. During the simulation they have changed network size. They concluded that AODV perform better than DSR under high mobility and varying network size.

In [6], DSR, AODV and OLSR are compared in terms of throughput, good put, routing load and end-to-end delay, by varying network load, number of flows, network size and mobility. The paper concludes that proactive routing protocols have better performance than reactive Routing protocols. In [7], DSDV, AODV and DSR are compared in terms of packet delivery ratio, throughput, and end-to-end delay and routing overhead by varying packet size, time interval between packet sending, and mobility of nodes

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III. REVIEW OF ROUTING PROTOCOL IN MANET

Routing in mobile ad hoc networks is quite different from conventional routing in wired networks. A dynamic routing protocol is needed for mobile ad hoc network to function properly in a rapidly changing network topology

Types of Routing in MANET

Based on how routing information is acquired, routing protocols in MANET can be divided into proactive routing, reactive routing and hybrid routing [2].

Proactive (table – driven) routing:-

This type of protocol maintain fresh lists of destinations and their routes by periodically distributing routing tables throughout the network so that a source can find a route immediately when it need it .The main disadvantages of proactive are slow reaction on dynamic changes and respective amount of data for maintenance. Optimized Link -State Routing Protocol (OLSR) is an example of proactive routing protocols in MANET.

Reactive (on – demand) routing:-

This type of protocols finds the routes on demand by flooding the network with route request packets. Higher latency time in route finding and excessive flooding which can lead to network clogging, are the main disadvantages of this routing approach. Ad hoc On Demand Distance Vector (AODV) is an example of this type of protocol.

Hybrid

This type of protocol combines the advantages of proactive and reactive routing. Zone Routing Protocol (ZRP) is an example of a hybrid protocols. Proactive is used by anode to establish routing to it is closest neighbors (Within 2 hop radius) and reactive is used by anode if communication is desired with another node that is outside of it is closest neighbors radius

IV. OVERVIEW OF AODV, DSR AND OLSR

A. ADHOC ON-DEMAND VECTOR ROUTING PROTOCOL (AODV)

AODV [8] is an On Demand routing protocol and thus only initiate a route discovery when needed. Neighbor nodes learn about each other's either by broadcast or a HELLO messages. When a broadcast is received by neighbors nodes each node update it is routing table information to include the broadcasting node. When anode never sends a broadcast to it is neighbors within the hello interval, it broadcast only to the neighbors nodes a HELLO message. HELLO message contains the identity of the node and it is sequence number. When a node wants to send a packet it first checks for the address of destination in it is routing table if address exist it start sending packets otherwise it will start a route discovery process by broadcasting a route request packet (RREQ). The RREQ message consists of the following information: source IP, destination IP, source sequence number and destination sequence number which are used to determine the freshness of the route and to prevent routing loops[10], the broadcast identifier which is used to avoid the problem of duplicate packets in broadcasting and the hops count .All the nodes that receive the RREQ packets check if they have any packet with the same broadcast identifier and same source IP address if they do, they will discard the packets to avoid duplicate packets. When receiving a non-duplicate packet the nodes create a back way pointer towards the source. When the destination node receives the RREQ; it sends a route reply packet RREP to the source node by unicast in the reverse path .When an intermediate node discovers an active links disconnection or change of topology caused by node movement it sends a route error message (RERR) to the affected nodes. The source node will re-initialize Route discovery process if it is still need that route. In brief AODV uses three types of control messages RREQ, RREP and RERR to implement route discovery and maintenance processes.

B. DYNAMIC SOURCE ROUTING PROTOCOL (DSR)

The DSR [9] Protocol is a simple, efficient and on-demand routing protocol designed specifically for use in multihop wireless ad hoc networks of mobile nodes. The key distinguishing feature of DSR is the use of source routing. That is, the sender knows the complete hop-by-hop route or the complete ordered list of nodes through which the packet must pass to the destination. These routes are stored in a route cache. The data packets carry the source route in their packet header [10]

DSR protocol composed of two mechanism Route discovery and Route maintenance. Route discovery is the mechanism by which a source node obtains a source route to a destination. Route maintenance is the mechanism by which a source node while routing packets to a destination is able to detect any changes in the network. If the network topology changed due to mobility of nodes then the source node can either attempt to use any route it happens to know about the destination node or invoke a route discovery mechanism to find a new route to destination. Route discovery and maintenance mechanisms are issued only on-demand.

If a route to a destination node is unknown for a source node it initiates a **route discovery** mechanism to dynamically determine that route.

Route discovery mechanism floods the network with route request packets (RREQ). Each node receiving a RREQ rebroadcasts it, unless it is the destination or it has a route to the destination in its route cache. Such a node
replies to the RREQ with a route reply(RREP) packet that is routed back to the original source. The route carried back by the RREP packet is cached at the source for future use [10]

Route maintenance mechanism works as follows if any link on a source route is broken; the source node is notified using a route error(RERR) packet. The source removes any route using this link from its cache. A new route discovery process must be initiated by the source node, if this route is still needed [10] Implementation of DSR and source routing results in a loop-free packet routing ,eliminate the need for updating routing information in the passed-by nodes and allow caching of information by nodes that forwarding or overhearing packets in them for their own future use

C. OPTIMIZED LINK-STATE ROUTING PROTOCOL(OLSR)

Optimized link state routing (OLSR) protocol [11] is a proactive (table – driven) protocol designed specifically for mobile wireless Ad hoc network (MANET). OLSR is a modification and improvement of the pure link state routing, while in pure link state routing the entire link with neighbor nodes are declared and flooded in the entire network, OLSR reduce the overhead of network floods through the use of Multipoint Relay (MPR). MPRS refer to the selected routers (Nodes) that can forward broadcast messages during the flooding process. The use of multipoint relay minimize the overhead of flooding messages in the network by reducing redundant retransmission in the same region .Each node in the network selects a set of nodes in it is symmetric one-hop

neighborhood , which may retransmit it is message . This selected set is called MPR of that node. Neighbors of anode N which are not it is MPR set receives message but don't retransmit broadcast messages received from node N. This reduce overhead since in classical flooding mechanism, every node retransmit each message it receives the first time .Each node selects it is MPR set from among it is one – hop symmetric Neighbors. MPR set is selected such that it covers in terms of radio signal all symmetric two –hop nodes. Once each node's MPR set is selected, routing paths within the network can be determined and because of OLSR proactive nature, each node maintains a route to every other node in the network. Nodes in OLSR sends control messaged periodically and it can sustain the loss of some packets from time to time so reliable transmission is not required .OLSR works in a completely distributed manner and no central entity is required. OLSR carries out hop by hop routing which means that each node in the network uses it is recent information to route a packet. OLSR has three functions: packet forwarding, neighbor sensing, and topology discovery [11]. Packet forwarding and neighbor sensing mechanisms provide routers with information about the neighbors and offer an optimized way to flood messages in the OLSR network using MPRs. The neighbor sensing operation allows routers to diffuse local information in the whole network. Topology discovery is used to determine the topology of the entire network and to construct the routing tables. OLSR is particularly suitable for large and dense networks as the optimization done using MPR is works well in this context. OLSR also supports node mobility that can be traced thought it is local control messages.

V. Simulation Setup

To carry out the simulation two scenarios have been created and analyzed for varying numbers of node. The first scenario consists of 20 nodes and the second scenario consists of 50 nodes. The second scenario has high node density and more congested than the first. The simulation environment is 1000mx1000m and one WLAN server is configured with FTP server application in each scenario.FTP file size is set to 1000 byte and inters request time to 20 seconds

TABLE I
Simulation Parameters

Parameter	Value
Simulator	Opnet 17.5
Protocol Studied	AODV,DSR and OLSR
Simulation time	1h
Simulation Area	1000mx1000m
Transmission Range	250m
Node Mobility Model	Random Way Point
Bandwidth	1Mbps
Application	FTP
Numbers of relay Node	20,50
File size (constant)	1000bytes

Performance Metrics Parameters

Three important performance metrics of AdHoc routing protocols are evaluated [10]

Average End-to-End delay

The packet End-to-End delay is the amount of time it takes a packet to exit from a source until it reaches it is destination. This includes all possible delays caused by buffering during route discovery latency, queuing at the interface queue, retransmission delays at the MAC, propagation and transfer times [10].End-to-End delay is expressed in Seconds. End-to-End delay is important because some applications are delay sensitive. End-to-end delay assesses the ability of the routing protocols in terms of efficient use of the network resources

Throughput

Throughput can be defined as the ratio of the total data that reaches a receiver from the sender. It is expressed as bytes orbits per second. Throughput can be affected by many factors such as limited bandwidth, network topology changes, and unreliable communication between nodes

Routing Traffic Overhead

It is defined as the total number of routing control packets transmitted over the network, which is expressed in bits per second or packets per second.

The amount of routing traffic increases as the network grows. This parameter measures the scalability of the protocol, and thus the network

VI. Simulation Results and Observations

The results of the simulations of the 20-Nodes and 50-Nodes networks and the observation made from the graph are discussed below

Average End-to-End delay

The figures below (Fig 1 and Fig2) show the delay in all protocol studied in the 20-node and 50-node scenarios. We note that OLSR has the least End-To-End delay and this is due to its proactive nature.AODV performs approximately near to OLSR in the two scenarios while DSR got the higher delay and this is due to it is Source routing mechanism. It is also observed that the results in the two scenarios are approximately equals and this prove that the type of traffic load in MANETs is the most important factor in routing protocols performance. Fig 3 combines the two results.

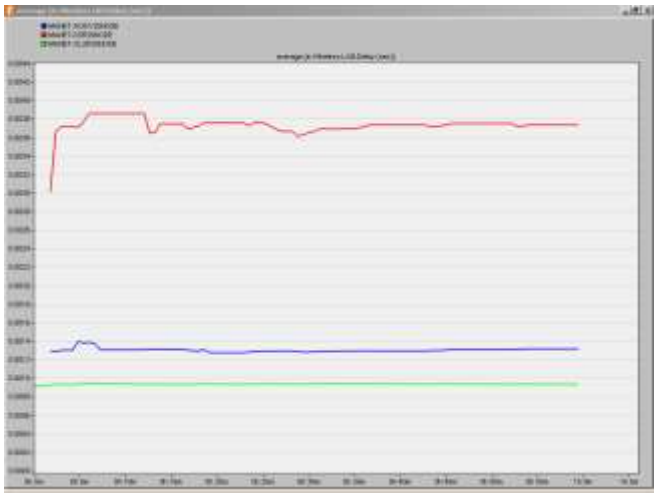

Fig 1 Average End-to-End delay in 20 Nodes

Fig 2 Average End-to-End delay in 50 Nodes

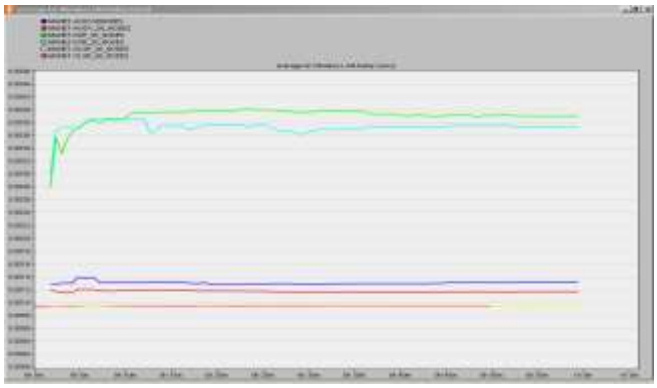

Fig 3 Average End-to-End delay in 50 Nodes and 20 Nodes

Throughput

From the figures below it is noted that OLSR has the highest throughput because it is a proactive routing protocol and it discovers routes before attempting to send any data. AODV and DSR maintain approximately the same throughput

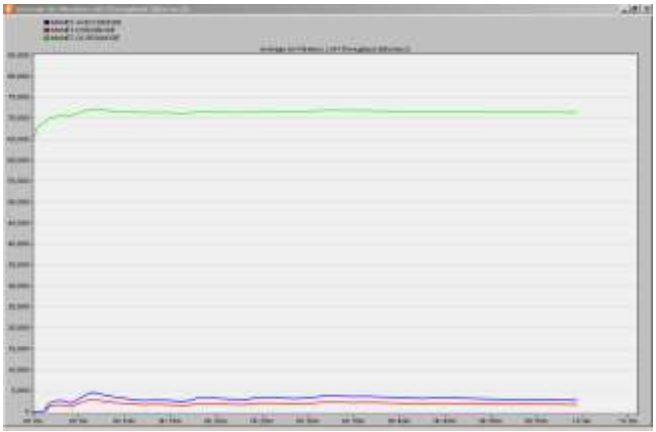

Fig 4 Average in throughput for 20 Nodes

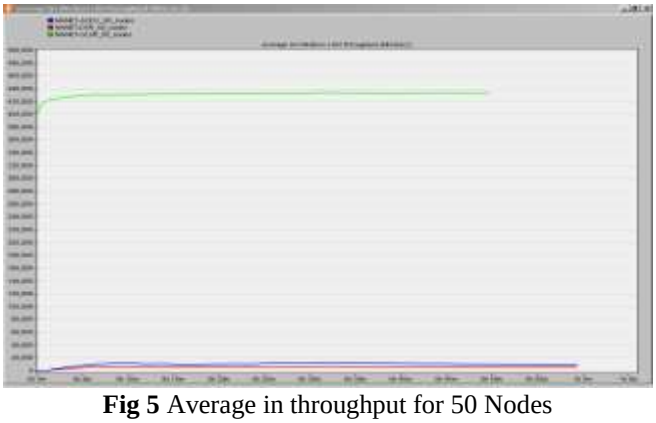

Fig 5 Average in throughput for 50 Nodes

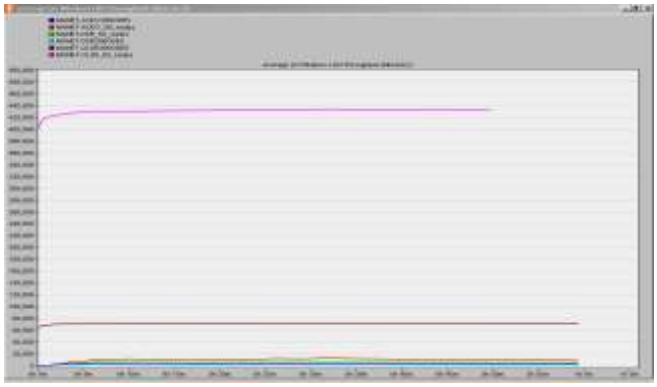

Fig 6 Average in throughput for 50 and 20 Nodes

Routing Traffic Overhead

Routing traffic overhead is an important factor in AdHoc networks routing protocols. The figures below show the results of comparison of AODV, DSR and OLSR. As can be noted from the figure OLSR has much larger routing traffic overhead compared to AODV and DSR and the result is expected because OLSR will try to maintain route to all nodes in the network which explains it is Proactive approach, on the other hand, AODV and DSR are reactive and on demand routing protocols which will only initiate route discovery on demand and their routing traffic overhead.

Figure 7: Average routing traffic sent 20-Node scenario

Figure 8: Average routing traffic sent 50-Node scenario

VII. CONCLUSION

In this paper the performance of AODV, DSR and OLSR have been investigated. In our scenarios we used FTP traffic and we compared the simulation results of the three

protocols under FTP traffic. Although OLSR has the best performance of all three protocols in terms of throughput and Average End-to-End Delay, it produces significantly more overhead traffic to maintain updated routing tables. DSR has poor performance in contrast to AODV and OLSR in all metrics considered in this study. Finally, AODV has adequate performance and in the same time keeps the overhead traffic rather low in contrast to OLSR. Overall, OLSR performs better than AODV and DSR, but it is not the best choice in case we need to keep overhead traffic low. In future we will further investigate the performance of routing protocols by introducing other types of traffic (e.g. Http-E-mail) and implementing more complex scenarios and more metric.

REFERENCES

[1] K. Subir, and G, Basavargia AdHoc Mobile Wireless networks Principles, protocols and Applications Taylor & Francis Group .USA 2008

[2] E. M. Royer Mobile AdHoc Networking IEEE Press 445 Hoes Lane Piscataway, New Jersey page 315

[3] Dimitra Kampitakia, Anastasios A. [2014] "Simulation study of MANET routing protocols under FTP traffic" Economides Published by Elsevier Ltd 2014

[4] O.O. Omitola (2015). Performance Evaluation of Routing Protocols in MANETs using Varying Number of Nodes and Different Metrics. Afr J. of Comp & ICTs. Vol 8, No. 2. P 83-90.

[5] Abdullah et al "The Impact of Reactive Routing Protocols for Transferring Multimedia Data over MANET," Journal of Zankoy Sulaimani-Part A, vol. 4, no. 16, 2014

[6] M barushimana, C.; Shahrabi, A., Comparative Study of Reactive and Proactive Routing Protocols Performance in Mobile Ad Hoc Networks, *Advanced Information Networking and Applications Workshops, 2007, AINAW '07. 21st International Conference on* , vol.2, no., pp.679,684, 21-23 May 2007

[7]Tuteja, A.; Gujral, R.; Thalia, S., Comparative Performance Analysis of DSDV, AODV and DSR Routing Protocols in MANET Using NS2, *Advances in Computer Engineering (ACE), 2010 International Conference on* , vol., no., pp.330,333, 20-21 June 2010

[8] C. E. Perkins and E. M. Royer Ad hoc on-demand distance vector routing. In *Proceedings of the 2nd IEEE Workshop on Mobile Computing Systems and Applications*, pages 90–100, Feb 1999

[9] D. B. Johnson and D. A. Maltz, "Dynamic Source Routing in Ad-Hoc Networks," Mobile Computing, ed. T. Imielinski and H.Korth, Kluwer Academic Publishers, 1996, pp. 153-181

[10] Perkins, C.E.; Royer, E.M.; Das, S.R.; Marina, M.K., Performance comparison of two on-demand routing protocols for ad hoc networks, *Personal Communications, IEEE* , vol.8, no.1, pp.16,28, Feb 2001

[11] T. Clausen, P. Jacquet, A. Laouiti, P. Muhlethaler; A. Qayyum, and L. Viennot. "Optimized Link State Routing Protocol," in *Proceedings of IEEE INMIC*, Lahore, Pakistan, December 2001