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Throughput Analysis of Proactive and Reactive MANET Routing Protocols

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Abstract:

MANET is considered a collection of wireless mobile nodes that are capable of communicating with each other without the use of a network infrastructure or any centralized administration.A number of ad hoc routing protocols have been developed during the time, but none of these is able to produce efficient routing of packets in large number of nodes due to their own limitations. In this paper, we presented our observations regarding the comparison of the three MANET routing protocols, Ad hoc On Demand Distance Vector (AODV), Dynamic Source Routing (DSR) and Optimized Link State Routing (OLSR) by using* different web based applications such as HTTP, FTP, E-mail and Video conferencing. *The simulation is done by using OPNET Modeler 14.0 simulator by taking throughput as performance metric. In case of throughput OLSR outperforms AODV and DSR.

Keywords: - MANET, DSR, HTTP, FTP, E-mail, OPNET.

I. INTRODUCTION

In last three decades, wireless network has grown enormously. Although, wireless network has eased the information sharing and communication but we have to setup static links before we can start the communication between two systems. This form of network is known as infrastructured network. These networks can only work in the environment where a fixed infrastructure exists. This motivates the need of infrastructureless networks which are known as *ad hoc* networks. Ad-hoc means "for one specific purpose only" [1]. Hence, these networks are formed when needed. All available nodes are aware of all other nodes within range. The entire collection of nodes is interconnected in many different ways. The topology of such networks changes very rapidly because the nodes in ad hoc network are mobile and independent of each other. This makes the routing very difficult. The widespread adaptation of ad hoc networks has produced the challenge of scalability. The scalability performance of the network depends on the routing protocol used in the network. A routing protocol is responsible for delivering the packet from source to destination. In this paper, we have analyzed and compared three widely used routing protocols namely AODV, DSR and OLSR based on different web applications. Throughput is chosen as the performance metric.

The rest of the paper is organized as follows: Section II presents the definition of MANET, Routing and protocol classification. Overview of three protocols used in the study is presented in Section III. Section IV describes the simulation environment and performance metric and then the results are presented in Section V. Finally, Section VI concludes the paper.

II. MOBILE AD-HOC NETWORK (MANET)

MANET [1] is a collection of wireless mobile nodes forming a temporary/short-lived network without any fixed infrastructure where all nodes are free to move arbitrarily and where all the nodes configure themselves. The nodes in a MANET can be of varying capabilities. Mobile phones, laptop computers and Personal Digital Assistants (PDAs) are some examples of nodes in ad-hoc networks.

2.1 Routing In MANETs

To facilitate communication within the network a routing protocol is used to discover routes between nodes. The goal of the routing protocol is to have an efficient route establishment between a pair of nodes, so that messages can be delivered in a timely manner.

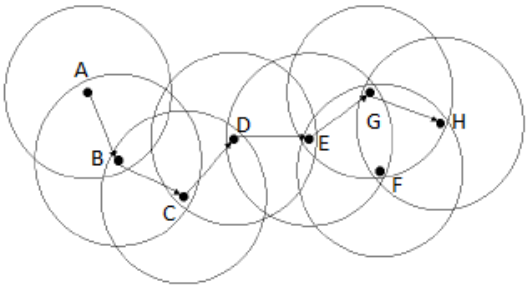

Figure1. Routing in MANETs

Routing in MANETs As shown in Fig. 1, route is created between nodes A and H using a number of intermediate nodes. This is called multi-hop routing. Bandwidth and power constraints are the important factors to be considered in current wireless network because multi-hop ad-hoc wireless relies on each node in the network to act as a router and packet forwarder. This dependency places bandwidth, power computation demands on mobile host to be considered while choosing the protocol for the nodes. Routing protocols used in wired network cannot be used for mobile ad hoc networks because of node mobility [2].

2.2 Classification of Routing Protocols

Many protocols have been proposed for MANETs. These protocols can be mainly divided into two categories.

- Reactive/On-demand Routing Protocols
- Proactive/Table-driven Routing Protocols

A. Reactive/On-demand Routing Protocols

In reactive or On-demand protocols, the routing information is maintained only for active routes. That is, the routes are determined and maintained by a node only when it wants to send data to a particular destination. A route search is needed for every unknown destination. Therefore, the communication overhead is reduced at expense of delay due to route research. Some reactive protocols are Ad hoc On-Demand Distance Vector (AODV), Temporally Ordered Routing Algorithm (TORA) and Dynamic Source Routing (DSR). But here we'll discuss only AODV and DSR as we have simulated these two protocols from reactive category [2].

B. Proactive/Table-driven Routing Protocols

In proactive or table-driven routing protocols, the routing tables are used. Each node maintains up-to-date routing information to every other node in the network in the routing tables. Routing information is periodically transmitted throughout the network in order to maintain routing table consistency. However, for highly dynamic network topology, the proactive schemes require a significant amount of resources to keep routing information up-to-date and reliable. Some highly used proactive routing protocols are Optimized Link State Routing (OLSR), Destination Sequenced Distance Vector (DSDV) and Wireless Routing Protocol (WRP) [2].

III. DESCRIPTION OF AODV, TORA AND OLSR

A. Ad hoc On-Demand Distance Vector (AODV)

The AODV joins the mechanism of DSDV and DSR. The hop-by-hop routing and sequence number of DSDV and on-demand mechanism of route discovery and route maintenance from DSR are combined in AODV [3].

Route Discovery[3]: In this when the route is present in cache, route discovery is not used. Otherwise the RREQ which contains the last known sequence number, is flooded in network. The intermediate nodes store the reverse route to source. When destination gets the RREQ, it sends back RREP that contains number of hops to it and most recent sequence number. All intermediate nodes that forward the RREP backward build a forward path. Because of the hop-by-hop nature of AODV the nodes store only the next hop instead of entire route.

Route Maintenance[3]: To maintain routes the nodes check link status of their next hop neighbour in active routes. The node, detecting a link break sends a route error (RERR) message to each of its upstream neighbour to invalidate this route and the neighbours forward it further. Consequently, these nodes propagate the RERR to their predecessor nodes. This process continues until the source node is reached. When RERR is received by the source node, it can either stop sending the data or reinitiate the route discovery mechanism by sending a new RREQ message if the route is still required.

B. Dynamic Source Routing (DSR)

DSR is a simple and efficient routing protocol designed specifically for use in multi-hop wireless ad hoc networks of mobile nodes. The protocol is composed of the two main mechanisms of "Route Discovery" and "Route Maintenance".

Route Discovery [4]: Whenever a source node desires a route to a destination node. First, the source node searches its route cache for a valid route to the destination. If the source finds a valid route to destination, it uses this route to send its data packets by putting the route into packet's header. If cache doesn't have valid route, it initiates the route discovery process by broadcasting a route request (RREQ) message. The route request message contains the address of the source and the destination, and a unique identification number. The intermediate nodes put their address on the header and forward the packet. When the destination node gets the request message it has the whole hop sequence of path. Then it sends back the route reply (RREP) message which contains the proper hop sequence.

Route Maintenance [4]: It is used to handle route breaks. When a node encounters a transmission problem at its data link layer, it removes the route from its route cache and generates a route error message which is sent to each originator node that has sent a packet routed over the broken link. The originator node removes this link from its route cache. If one route cache contains another source route, the node sends the packet using this route. Otherwise, it will initialize a new Route Request. Acknowledgment messages are used to verify the correct operation of the route links.

C. Optimized Link State Routing (OLSR)

The OLSR [5] is the proactive link-state routing protocol optimized for the MANETs. In this two types of messages are used: Hello and Topology Control (TC) messages, to discover and then distribute link state information throughout the network. The nodes use Hello messages for sensing these changes in neighbourhood and gather the information about its neighbours and link status. Now to communicate with the distant nodes TC messages are used by flooding process. Each node chooses a set of nodes as MPRs (Multi Point Relays). Nodes select MPRs such that there is a path to each of its 2-hop neighbours via a node selected as an MPR. These MPR nodes then source and forward TC messages that contain the MPR selectors. TC message contains address of its originator and MPR set of that node. The nodes will receive a partial topology graph and shortest path algorithm is applied on this graph to find optimal path.

IV. SIMULATION SETUP

4.1 Simulator

The simulation is performed using the OPNET (Optimized Network Engineering Tool) Modeler 14.0 simulator. OPNET is a discrete event network simulator that provides virtual network communication environment. OPNET Modeler 14.0 is chosen because it is one of the leading environments for network modeling and simulation. It offers easy graphical interface. This tool is highly reliable, robust and efficient. It supports large number of built-in industry standard network

4.2 Simulation Parameters

This simulation study focuses on the performance of routing protocols with increase in the number of nodes. The performance comparison is evaluated based on the different web application with increase in the number of nodes. But in this paper, I have show only simulation results with 100 nodes.

Therefore, twelve simulation scenarios consisting of nodes 100 are considered for three routing protocols AODV, TORA & OLSR. Different web traffic is generated using the Application and Profile Configuration. Table 1 shows the simulation parameters used in this study. The speed of the nodes is set to 5 meters/sec. We have chosen random waypoint mobility model as this assures that mobile nodes are configured with mobility. Buffer size is set to 1024000 bits as heavy browsing is used for traffic generation.

Table1. Simulation Parameters

Attribute	Value
Maximum Simulation Time	150 sec
Interface Type	Wireless(ad-hoc)
Network Area	500*500 meters 700*700 meters 900*900 meters
Mobility Model	Random Way Point
Data Rate(bps)	11Mbps
Transmit Power(W)	0.020
Buffer Size(bits)	1024000
No. of Nodes	100
Protocols	DSR, AODV, OLSR
Traffic Generation Application	HTTP, FTP, Email, VIDEO CONFERENCING

4.3 Performance Metrics

a) **Throughput**: - The average rate at which the data packet is delivered successfully from one node to another over a communication network is known as throughput. The throughput [6] is usually measured in bits per second (bits/sec). Throughput= (number of delivered packet *packet size)/total duration of simulation

V. RESULTS AND DISCUSSIONS

The performance comparison is made between three routing protocols AODV, DSR and OLSR by using throughput.

A. Network Throughput

Network Throughput is calculated for all three routing protocols for 100 nodes.

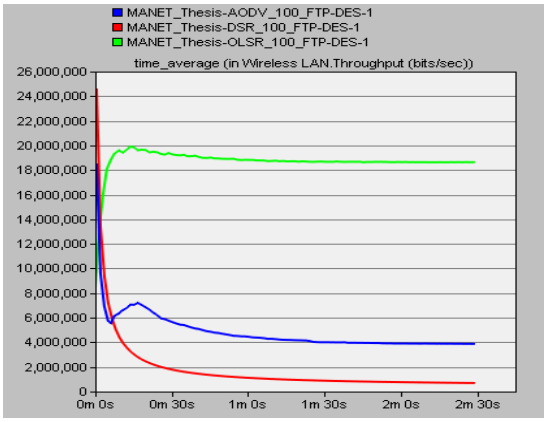

Fig. 2: Network Throughput for 100 nodes (DSR, AODV and OLSR) with FTP Traffic.

The figures 2 to figure 5 ,the simulation results for AODV, DSR, and OLSR protocols over HTTP, FTP and Email and Video Conferencing heavy traffic shows that the throughput for the routing protocol. It is observed that the throughput increases for simple HTTP, FTP and Email and video conferencing traffic.

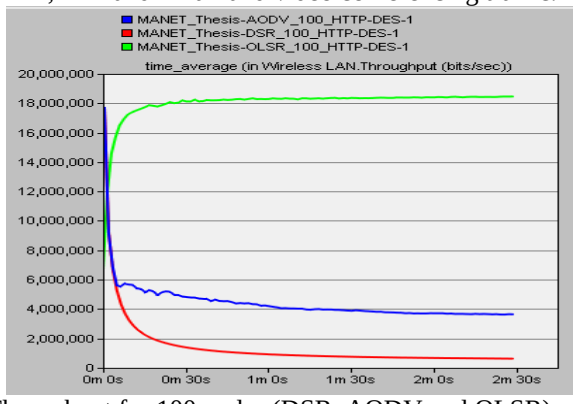

Fig. 3: Network Throughput for 100 nodes (DSR, AODV and OLSR) with HTTP Traffic.

Throughput of DSR is very less than that of AODV and OLSR.AODV performed decently in terms of throughput .AODV discovers multiple routes from source to destination so there are always the chances of finding an optimal route. AODV tends to reduce the control traffic overhead at the cost of increased latency in finding new routes. The Hello messages, which are responsible for the route maintenance, are also limited so that they do not create unnecessary overhead in the network.

OLSR is higher than that of the reactive routing protocols AODV, DSR in case of HTTP, FTP and Email and video conferencing traffics; it is because the OLSR protocol is independent of the traffic and network density compared to AODV, DSR protocols. OLSR reduce the control overhead forcing the MPR to propagate the updates of the link state. But the drawback of this is that it must maintain the routing table for all the possible routes, so there is no difference in small networks, but when the number of the mobile hosts increase, then the overhead from the control messages also increases. The OLSR protocol work most efficiently in the dense networks.

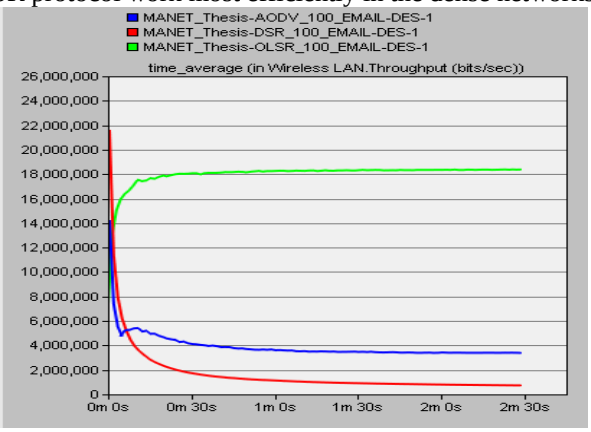

Fig. 4: Network Throughput for 100 nodes (DSR, AODV and OLSR) with EMAIL Traffic.

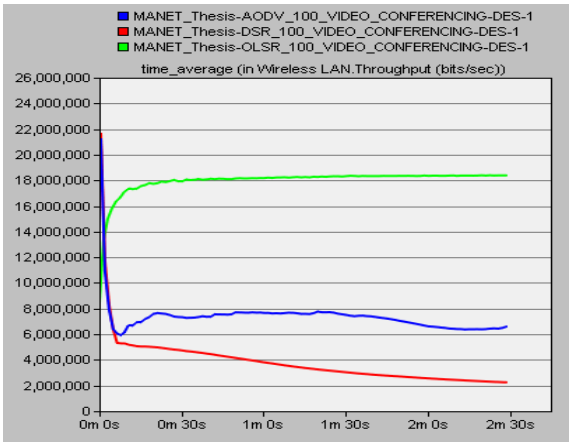

Fig. 5: Network Throughput for 100 nodes (DSR, AODV and OLSR) with VIDEO_CONFERENCING Traffic.

VI. CONCLUSION

In this paper the performance analysis of routing protocols AODV, DSR and OLSR protocols in MANET have been investigated. The investigation considers the impact of scalability, mobility and network. HTTP, FTP and Email and Video Conferencing heavy traffic load on different types of routing protocols is taken. In the performance assessment throughput are adopted for the whole scenarios considered. The simulation using OPNET consider different scenarios that attempt to cover all of the aspects on network evaluation required. From this paper, In the case of throughput, the throughput of DSR is very less than that of AODV and OLSR. But, the throughput of OLSR is higher than that of the reactive routing protocols AODV, DSR; it is because the OLSR protocol is independent of the traffic and network density compared to AODV, DSR protocols.

The simulation results according to web application conclude that throughput is highest in HTTP and lowest in video conf and Email.

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