Analytical Study and Performance Comparison of various Routing Protocols

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Abstract— a wireless ad-hoc network is a collection of mobile nodes that makes a multi hop autonomous system without any fixed infrastructure. The nodes use service of other nodes in the network to transmit packet to the destination nodes. This paper contain the study of three MANET routing protocol given by various researchers. In this paper, we have also studies the comparison of the performance of the DSR, AODV, and OLSR routing protocols. We have analyzed the performance of protocols in different traffic load including end to end delay, throughput, and video packet delay variation and routing traffic overhead. A Simulation result shows that in the case of file transfer with TCP connection, OLSR acts better in terms of end to end delay and upload response time, but with high routing overhead. In the case of the video transfer with UDP connection, AODV acts better in terms of throughput, delay variation, end to end delay and have low routing traffic.

Key words: DSR, OLSR, AODV, MANET

I. INTRODUCTION

A wireless Ad Hoc network is a collection of mobile nodes that from a dynamic autonomous network. Wireless Ad-Hoc network does not rely on preexisting infrastructure such as base station or access point [4]. In wireless ad-hoc network each node act as a router as well as source node for sending data. Mobile network can be classified in to infrastructure and Mobile Ad-Hoc Network (MANET) according to their dependence on fixed infrastructure. MANET can follow the dynamic topology where node can join or leave the network at any time. Mobile Ad Hoc Networks (MANETs) consist of nodes that change position frequently. To accommodate the changing topology special routing algorithms are needed. For relatively small networks flat routing protocols may be sufficient. However, in larger networks either hierarchical or geographic routing protocols are needed. There is no single protocol that fits all networks perfectly. The protocols have to be chosen according to network characteristics, such as density, size and the mobility of the nodes. An ad hoc wireless network should be able to handle the possibility of having mobile nodes, which will most likely increase the rate at which the network topology changes. Accordingly the network has to be able to adapt quickly to changes in the network topology. This implies the use of efficient handover protocols and auto configuration of arriving nodes. Application of the MANET, it use in establishing survivable, efficient and dynamic communication for emergency rescue operations, disaster relief efforts, and military networks. They may be also used as hybrid infrastructure extensions and in fixed infrastructure operations [8].

In this paper I have reviewed 3 MANET protocols namely DSR, OLSR and AODV. I have also studied the performance and then checked out the comparison of these three protocols. The organization of the paper is as following, in section 2 I will explain the MANET routing protocol and its subparts. Section 3 I have explain the Ad-Hoc on Demand Distance Vector (AODV) routing protocol. Section 4 I have explain the Dynamic Source Routing (DSR) protocol. Section 5 I have explain the Optimized Link State Routing (OLSR) protocol. Section 6 contains the study of comparison of these protocols and the Section 7 contains the conclusion about the study I have done so far.

II. MANET ROUTING PROTOCOLS

In MANET there are different criteria for designing and classifying routing protocol. Based upon this criteria a routing protocol is classified into three groups, which are proactive (Table-Driven), reactive (On-Demand), and hybrid.

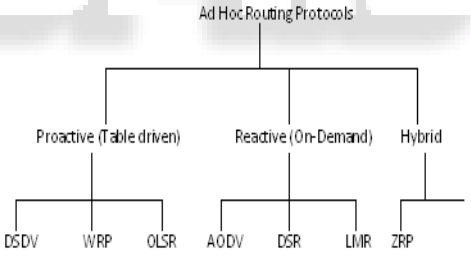

Fig. 1: Ad-Hoc routing protocol

A. Proactive (Table-Driven) Routing Protocols

Proactive routing protocol is also known as Table Driven routing protocol will actively determine the layout of the network [2, 3]. In proactive routing protocol, each node continuously evaluate route to each reachable nodes and each node periodically distributes routing tables throughout network. In proactive routing protocol each node continuously maintains up-to-date routing information to every other node, routing table contain the latest information about routes to any nodes in network. Therefore source node get routing path immediately if it need one. Proactive routing protocols work best in network when node has a low mobility or node transmit the data frequently. In proactive protocols route to every other node in ad-hoc network is always available. Proactive routing protocols are mostly based on LS (Link State). When source node wants to send

packet to destination node and if there is no route is available on that time route discovery operation is performed. In route discovery operation, source node broadcast route request (RREQ) packet. When the destination node receive the RREQ packet a route reply (RREP) packet is created and forward to the source node. Every node usually uses hello messages to notify its existence to its neighbors. So that link state to the next hop in active route can be monitored. DSDV, WRP, OLSR are example of proactive routing protocol.

B. Reactive (On-Demand) Routing Protocols

Reactive routing protocol is also known as on-Demand routing protocols [2, 3]. If there is no communication in network, reactive routing protocol does not maintain any route information or route activity. This protocol takes lazy approach to route. They do not maintain their update in routing table with latest routing topology. This type of protocol creates routes only when requested by source node. When node requires a route to destination, it initiates a route discovery process with in the network. If node sends to packet to the destination or other node then this protocol search for the route in on-demand manner and establish connection to receive or transmit the packet in network. Normally route discovery can be occurring by flooding in route request packets throughout the network. However, discovering a new route "from scratch" on demand is costly and bad routes are detected at the cost of the packet drops. Main advantage of the reactive routing protocol is less control overhead. Thus reactive routing protocol has better scalability than proactive routing protocols. DSDV, DSR are example of the reactive routing protocols.

C. Hybrid Routing Protocols

Hybrid routing protocol is combined of the proactive routing protocols and reactive routing protocols. The basic idea behind hybrid routing protocols is to use proactive routing mechanisms in some areas of the network at certain times and reactive routing for the rest of the network. The proactive operations are restricted to a small domain in order to reduce the control overheads and delays. The reactive routing protocols are used for locating nodes outside this domain, as this is more bandwidth-efficient in a constantly changing network. ZRP, ORP are example of the hybrid routing protocols.

III. AD-HOC ON DEMAND DISTANCE VECTOR ROUTING (AODV)

AODV routing protocol is one of the best reactive routing protocol [2]. AODV ensures loop free route even while repairing broken links. In AODV, following type of message [1] type defined which are RREQ, RREP and RREP. RREQ message contains <source_addr, source sequence#, broadcast id, dest_addr, dest sequence#, hop count > fields [5, 6]. When source node wants to send the packet to specific destination node but does not know the valid route to it, then it initiate Path Discovery operation by broadcasting RREQ packet to its neighbor. This request is then forwarded to its neighbor until intermediate node with a "fresh enough" route to destination is located. RREP message contains <source_addr, dest_addr, dest_sequence#, hop_cnt, lifetime> fields. When RREQ packet request reach to an intermediate node, it responds by route reply (RREP) packet that unicast to its neighbor which first received the RREQ packet and route back along the reverse path [17]. When the link in active path is broken or node move from their place in network and topology change the intermediate node that discover this link breakage propagates an RREP packet that contains unreachable destination IP address and unreachable sequence number, Then source node re initialize the path discovery if it still desire path [15].

IV. DYNAMIC SOURCE ROUTING (DSR)

Dynamic Source Routing (DSR) protocol is the class of reactive protocols [1, 14] and allow to nodes to dynamically discover a route across multiple network hope to any destination. DSR is one of the most on demand routing protocol that is based on concept of source routing [2]. That means each routed packet must carry a complete and ordered list of its header through which the packet pass. DSR originally developed by Johnson, Maltz and Broch. DSR use no periodic routing messages, thereby reducing network bandwidth overhead, conversing battery power and avoiding large routing updates through the ad-hoc network. In DSR, there are following the mode of the basic operation which is Route Discovery and Route Maintenance [5]. When source node wish to send packet to a destination node, it obtain the source route by route discovery mechanism in which source node broadcast a RREQ packet. Every node receives this RREQ packet, search through its route cache for route to the requested destination [12]. If no route is found it forward the RREQ further and add its own address to the recorded hop sequence. This request propagates through network until either the destination or a node with a route to a destination [17].When sender detects that network topology has changed so it can no longer use its route to its destination on that time Route Maintenance mechanism use. This might happen because a host listed in source route, move out of the wireless transmission range or is turn off its route making unusable. Route maintenance is mechanism that uses Route Error packet and acknowledgments [15]. When route maintenance detects a problem with a route in use, a route error packet is sent back to the source node. When this error packet is received, the hop in error is removed from this hosts route cache, and all routes that contain this hop are truncated at this point. Advantage of DSR is that it does not need to periodically flood the network for updating the routing tables like table-driven routing protocols do.

V. OPTIMIZED LINK STATE ROUTING (OLSR)

Optimized Link State routing protocol is one of the most proactive routing protocol [2]. OLSR is an optimization version of a pure link state protocol [15]. OLSR exchange the topology information to other node in network periodically. OLSR has a periodically nature so it create a large no of overhead. To reduce the overhead in network OLSR uses Multi Point Relay (MPR) [5]. OLSR uses two type of control message which are Hello message and Topology Control message. Hello message is use to find out the information about the link status and host's neighbors. With the Hello message the MPR Selector set is constructed which describes which neighbor has chosen this host act as

MPR and form of this information the host can calculate its own set of the MPRs. Topology Control message is use to broadcast information about own advertised neighbor which include at least MPR selector list. Only the Multi Point Relay can forward the Topology Control message. Topology Control messages are broadcast periodically. In MANET mobility cause topology change and this cause link breakage. In OLSR, after detecting the broken link, a source node is not notified immediately but rather it notified by its intermediate node broadcast its next packet.

VI. COMPARISON

In order to evaluate the performance of ad-hoc routing protocols, fig 2 shows that all protocol has sent all the FTP traffic, but at a different delay with different time that are shown in fig 3. Fig 3 shows the average TCP delays, in first four minutes, the distance between the source and destination is one hop and delay is low. After movement of the mobile node, TCP delay in both OLSR scenarios is dramatically increased. Fig 4 shows the upload response time of routing protocol. In which, a proactive routing protocol OLSR generate better upload response time compare to reactive routing protocol AODV and DSR. Fig 5 shows the sent routing traffic in FTP scenario and in source node for all routing protocols. In figure it is clear that, in both OLSR scenarios, routing traffic is very dense and causes a large overhead in the network and AODV send less routing traffic than DSR routing protocols. Fig 6 shows the throughput of MPEG4 video in AODV, fig 7 shows the throughput of MPEG4 video in DSR and fig 8 and 9 shows the throughput of MPEG4 video for both OLSR routing protocol. It can be seen that throughput of both reactive protocol AODV, DSR is better than proactive routing protocol OLSR. In the case of delay variation in MPEG4 movie transfer, Fig 10 shows that AODV has packet delay variation are almost to zero compare to other routing protocol. Fig 11 shows that MPEG4 video packet end to end delay. In this fig it is clear that AODV routing protocol has less video packet end to end delay compare to other routing protocols.

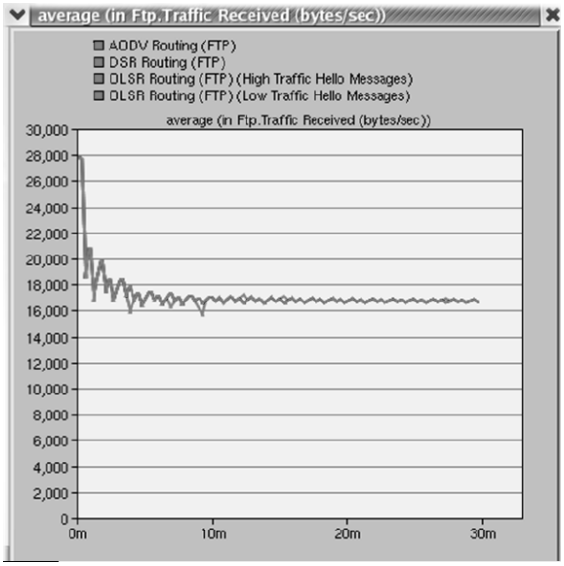

Fig. 2: Average FTP traffic received

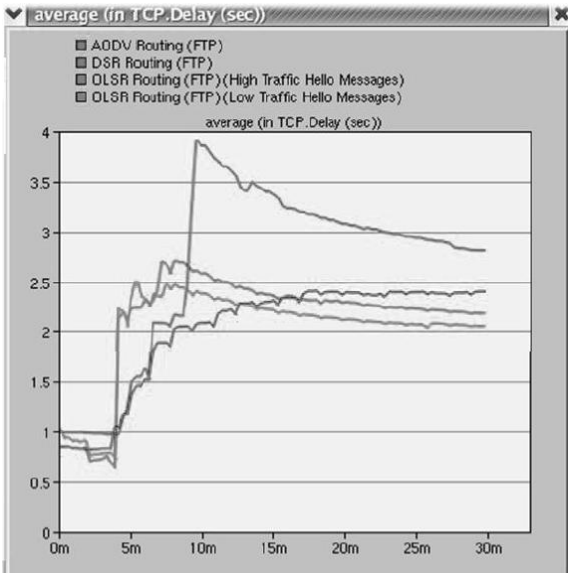

Fig. 3: Average TCP delay

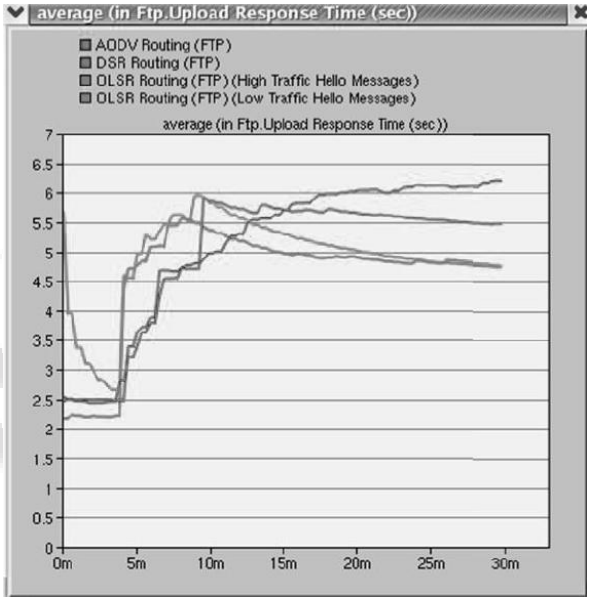

Fig. 4: Upload response time

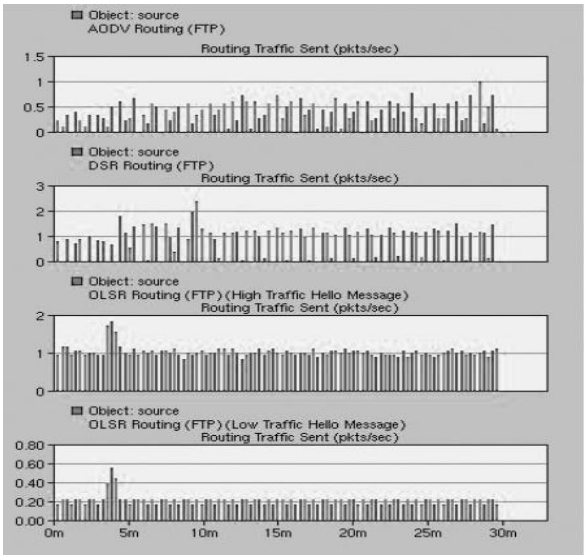

Fig. 5: Routing traffic sent in FTP scenario

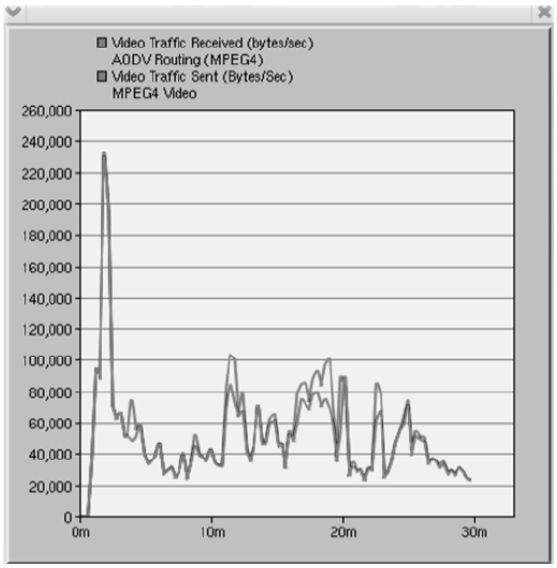

Fig. 6: MPEG 4 video traffic in AODV

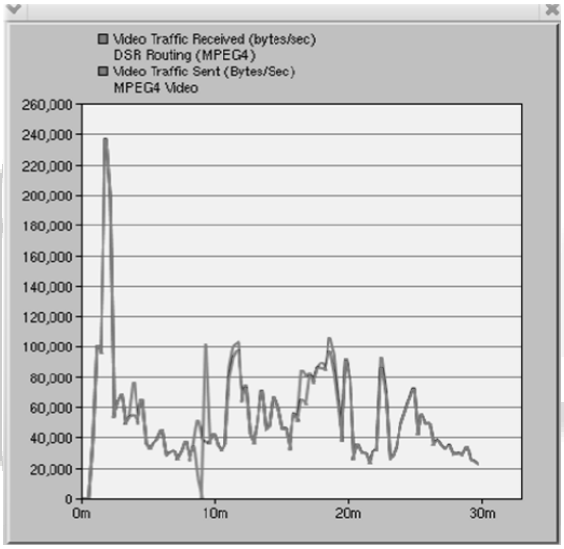

Fig. 7: MPEG 4 video traffic in DSR

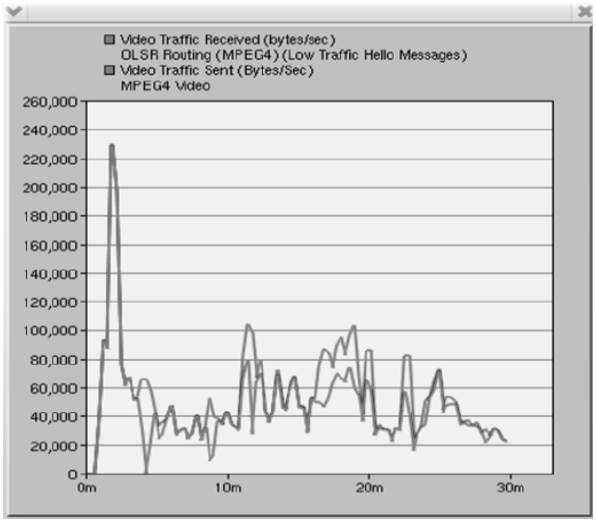

Fig. 8: MPEG 4 video traffic in OLSR (Hello message with every 1's)

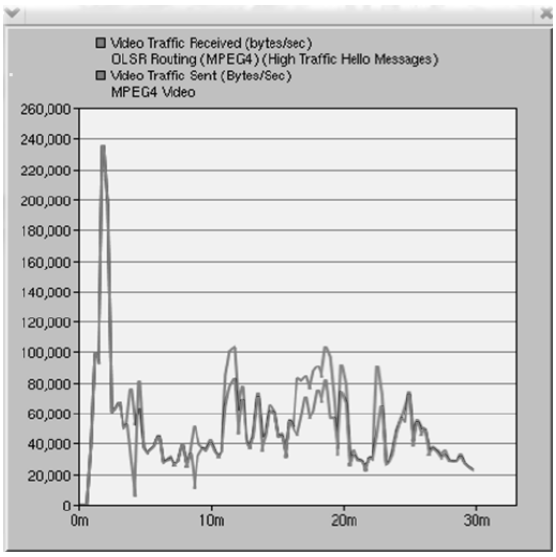

Fig. 9: MPEG 4 video traffic in OLSR (Hello message with every 5's)

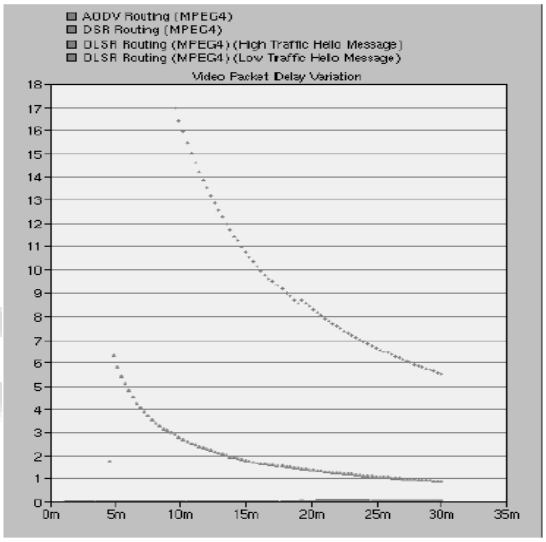

Fig. 10: MPEG 4 video packet delay variation

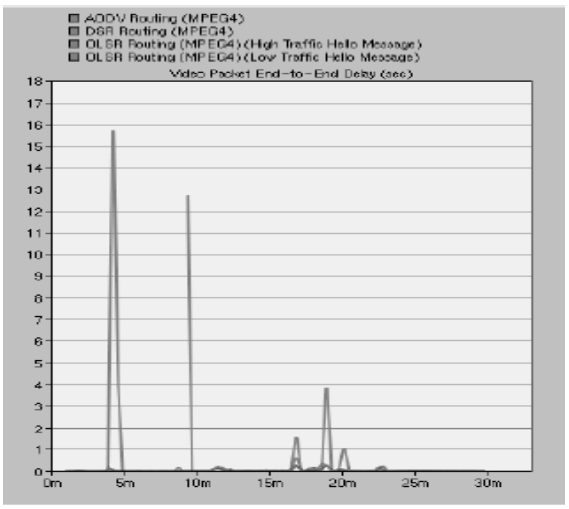

Fig. 11: MPEG 4 video packet end to end delay

VII. CONCLUSIONS

In this paper we have compared the performance of three routing protocol in wireless ad hoc network. The conclusion that, In the case of File transfer scenario, all the protocol had similar result. But major different was routing traffic overhead and delay. If we consider delay factor was important than OLSR performed better in FTP. If we consider routing traffic overhead factor was important than AODV performed better. In MPEG4 scenario, AODV performed better in the case of packet delay and delay variation together with good throughput and low routing overhead. In feature work you can try to compare the other routing protocols.

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