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Performance Analysis of Quality of Services for AOMDV with Varying Mobility and Network Size

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Abstract*— Key challenge for mobile ad hoc networks is to achieve desired quality of service. The majority of the solutions proposed in literature until now have focused on throughput and average delay. Mostly the investigations are done with constant bit rate traffic. Many other metrics are used to quantify quality of services. This paper provides our investigation of quality of service parameters of ad hoc on demand multi path routing (AOMDV) protocol. This is an extensive study and evaluation of the quality of service issues for AOMDV. Also the effect of average delay on other parameters is analyzed. Our investigation is an attempt to evaluate AOMDV with respect to CBR and TCP traffic. Through the extensive simulation and analysis shows that that AOMDV performance drops with increasing mobility and network size.

***Keywords*— AOMDV, Mobile Ad Hoc Networks, Multi-path routing Protocol for MANET, QoS for MANET.**

I. INTRODUCTION

Achieving desired Quality of Services (QoS) in Mobile Ad-hoc networks (MANET) is the key challenge. This challenge is because of the dynamic nature of MANET. Characteristics of MANET are there are no fixed infrastructures, the nodes move at will. These characteristics make MANETs more complex and affect their performance in great manner. Dynamic topologies in MANET not only make routing difficult but also become prime hindrance in achieving desired QoS. Communication routes in MANETs are discovered either periodically or on-demand. Due to the additional overheads added in periodic discovery, On-demand route discovery is more efficient. Many MANET routing protocols discover single path when a node wants to communicate with other. The key concern with single path routing is; if any of the nodes on discovered route fails the route needs to be rediscovered. Route failure probability in MANET is more due to mobile nature of nodes and hence the route discovery needed very often. Multi-path routing protocols deal with the route failure problem quite well. Since there are multiple routes available between source and destination in multi-path routing protocols the route discovery needed only when all routes fails. This paper also focuses one of the on-demand multi-path routing protocols.

The majority of the solutions proposed in the literature until now have focused on providing QoS based on two metrics: throughput and delay. Of these, the more common is throughput. However, many other metrics are also used to quantify QoS. This work covers Mean node speed and number of connections. The remainder of this paper is structured as follows. Following section discuss multi-path routing protocol AOMDV for MANET. This is followed by a brief review of QoS and the QoS metrics affecting routing protocol performance is presented. Simulation experiment and results in order to analyze AOMDV routing protocol is described next. Last conclusion is presented.

II. AOMDV ROUTING PROTOCOL

In AOMDV multiple routes are discovered in single route discovery. AOMDV is primarily designed for highly dynamic ad hoc network where link failures and route breaks occur frequently. When single path on-demand routing protocol such as AODV is used in such networks, a new route discovery is needed in response to every route break. Each route discovery is associated with high overhead and latency. This inefficiency can be avoided by having multiple redundant paths available. Now, a new route discovery is needed only when all paths to the destination break [1].

AOMDV is multi-path extension of AODV. In AODV, a source initiates a route discovery when it needs a communication route to a destination. The source broadcast a route request (RREQ) with a unique sequence number so that duplicate requests can be discarded. Upon receiving the request, an intermediate node record previous hop and if it has a valid and fresh route entry to the destination in its routing table then sends a reply (RREP) back to the source else rebroadcast the RREQ. The nodes on reverse route towards source update their routing information. Duplicate RREP on reverse route is only forwarded if it contains either a larger destination sequence number or a shorter route found. In AOMDV each RREQ (respective RREP) arriving at node potentially defines an alternate path. Accepting such duplicate RREQs may lead to formation of routing loops [1,2,3,4,5]. AOMDV route update rules, applied locally at each node, play a key role in maintaining loop freedom and disjoint ness properties [4]. There are two types of disjoint paths: node-disjoint and link-disjoint. Node disjoint paths do not have any nodes in common except the source and the destination.

Whereas in link-disjoint paths do not have any common link. Note that link-disjoint paths may have common nodes [1] (See Fig.1).

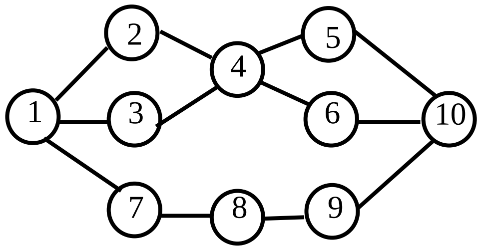

Fig.1. Source node1 and Destination10. Path 1-2-4-5-10 and 1-3-4-6-10 are link disjoint paths and not node disjoint as node 4 is common. Path 1-2-4-5-10 / 1-3-4-6-10 and 1-7-8-9-10 are link disjoint

To avoid any possibility of loop the "advertised hop count" is introduced. The advertised hop count of a node I for a destination D represent the maximum hop count of the multiple paths for D available at I. Alternate routes with hop count lower than the advertised hop count is accepted.

Advertised hop count mechanism establishes link-disjoint paths. To get node-disjoint paths following mechanism is used. When a node S floods RREQ packet in the network, each RREQ arriving at node I via a different neighbour of S or S itself, defines a node-disjoint path from I to S. In AOMDV this is used at intermediate nodes. Duplicate copies of RREQ are not immediately discarded. Each packet is examined to see if it provides node -disjoint path to source. For node-disjoint paths all RREQs need to arrive via different neighbours of the source. At the destination slightly different approach is used, the paths determined there are link-disjoint, and not nod-disjoint. In order to do this, the destination replies up to k copies of the RREQ, regardless of the first hops. The RREQ only need to arrive via unique neighbours [6].

III. QUALITY OF SERVICE ISSUES

The traditional best effort delivery network can not guarantee today's requirements. Networks are expected to provide guaranteed QoS. Providing better QoS in MANET is challenging due to following issues.

A. Node Mobility

MANET nodes move at will. This makes the topology dynamic. This means that topology information has a limited lifetime and must be updated frequently to allow data packets to be routed to their destinations. This updation means more routing overheads. Also due to the node mobility packet losses increase and end to end delay gets affected [3,5,7].

B. Lack of Central Control

The principal advantage of MANET is that it is deployed without planning in unknown terrains, hazardous conditions and its members can change dynamically. This makes it difficult to have any centralized control. Hence the controlling activities will be distributed among the nodes, which require lot of information exchange. This also adds up into the routing overheads [3,5,7].

Best effort routing does not provide any kind of QoS support during routing. Designing routing protocol to meet desired QoS is challenging. Following metrics are used to specify QoS for routing protocols in MANET.

1) *Throughput* : it reflects the data processing capacity of networks [8]. The number of packets delivered to the receiver provides the throughput of the network [3].

2) *Route Discovery frequency :* the total number of route discoveries initiated per second [1,4].

3) *Average end-to-end delay:* the end-to-end delay is averaged over all surviving data packets from the source to the destinations [9].

4) *Routing overhead :* It is defined as the percentage of control packets with respect to the received data packets. Each hop of any control packets is computed as a new control packet [10].

5) *Packet Delivery ratio:* the ratio of the data packets delivered to the destination to those generated by the source [3].

IV. SIMULATION SETUP

We study AOMDV performance using ns-2 [11] simulator. Our main objective is to perform extensive study and evaluate various QoS for AOMDV. AOMDV routing protocol is analysed extensively using network simulator (ns-2) version 2.34. Network Simulator is a discrete event simulator that provides substantial support for simulating wireless ad hoc networks. The IEEE802.11 is used as the medium access control (MAC) layer protocol in the simulation. The size of topology was set in a 1000 X 1000 grid. Multiple sources and destinations used. Constant bit rate (CBR) and transmission control protocol (TCP) traffics analysed with random Waypoint mobility model. CBR traffic commonly encompasses real time traffic. CBR traffic most effectively stresses a network as there are no control mechanisms to consider when flows are delayed or packet lost. TCP can be unsuitable for most real time applications because the protocol needs extra time to verify packets and request retransmission [12]. We have analysed the performance of AOMDV with CBR and TCP traffic types for varying mobility and network sizes. Also different numbers of sources and destinations are used. We have used 100 nodes for both CBR and TCP traffic. The simulation run time was set to 200s. Data packet size was set to 512 bytes [5,11].

V. RESULTS AND DISCUSSION

The main objective of the investigation was to analyze AOMDV performance with respect to varying mobility (mean node speed) and network size (number of connections). We have evaluated five key metrics throughput, Drop packet ratio (DPR) , average delay (Avg Delay) , route discovery frequency and routing overhead.

TABLE I
Mean Node Speed

Parameters	**Values**
Topology size	1000 X 1000
No of Nodes	100
No of Sources	Multiple
No of Destinations	Multiple
Packet size	512 bytes
MAC protocol	IEEE 802.11
Simulation time	200s
Traffic Types	CBR / TCP
Simulation run	200s for each mean node speed
Packet rate	1.0
Number of connections	50
Mean node speed	1, 2.5, 5, 7.5, 10

First we provide analysis of AOMDV performance for varying mobility (Mean Node Speed). When mean node speed varies, the packet rate is set to 1 packets/s and 50 number of connections are used. The simulation parameters are given in Table I. Simulation results for node mobility are depicted in Fig.2 to 6. In CBR traffic it is clear that with increase in mean node speed the throughput drops steadily and average delay increases slightly. The drop packet ratio, route discovery frequency and routing overhead shows rapid increase. The TCP traffic shows random behaviour

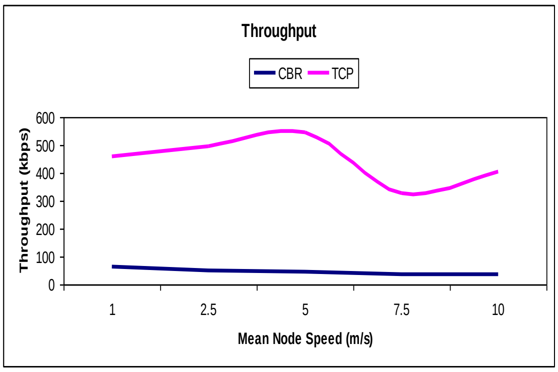

Fig. 2 Throughput with varying mobility

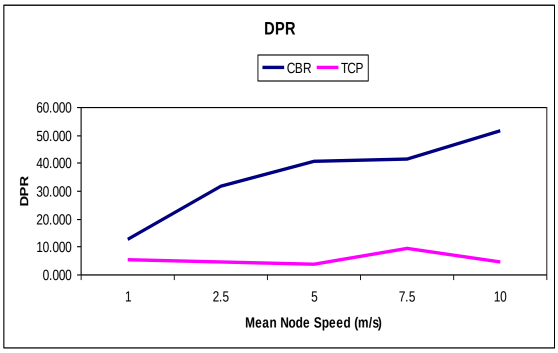

Fig. 3 Drop Packet Ratio with varying mobility

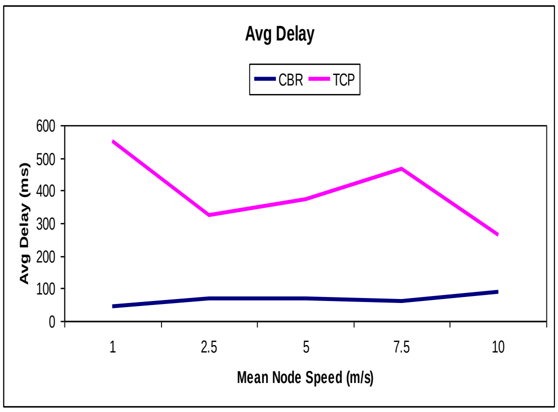

Fig. 4 Average delay with varying mobility

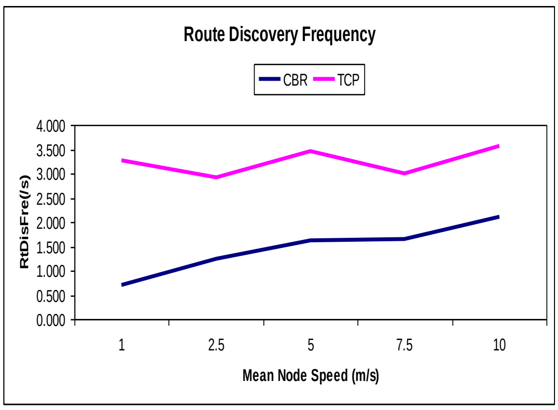

Fig. 5 Route Discovery Freq with varying mobility

Fig. 7 to 12 depicts behaviour of throughput, drop packet ratio and routing overhead with respect to average delay for varying mean node speed. In CBR traffic with increase in average delay the throughput drops and drop packet ratio and routing overhead increases. In TCP traffic the behaviour looks random.

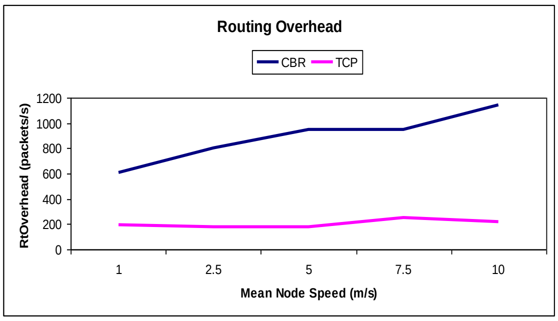

Fig. 6 Routing Overhead with varying mobility

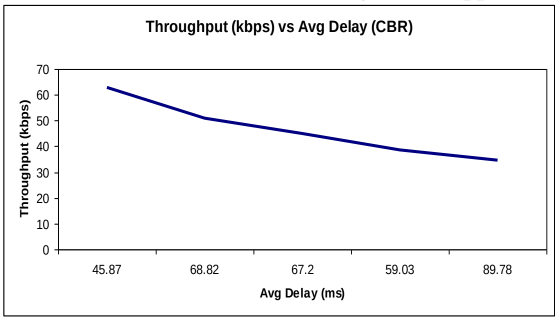

Fig. 7 throughput vs average delay with varying mobility (CBR)

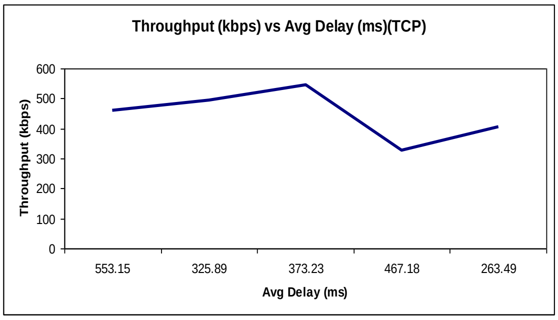

Fig. 8 throughput vs average delay with varying mobility (TCP)

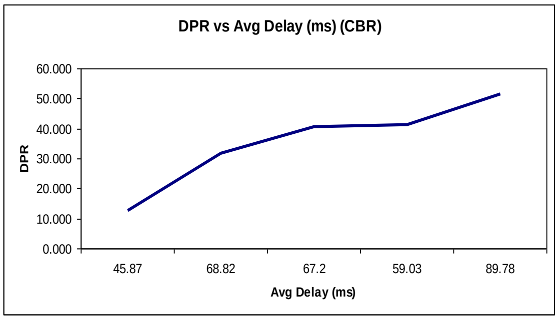

Fig. 9 DPR vs average delay with varying mobility (CBR)

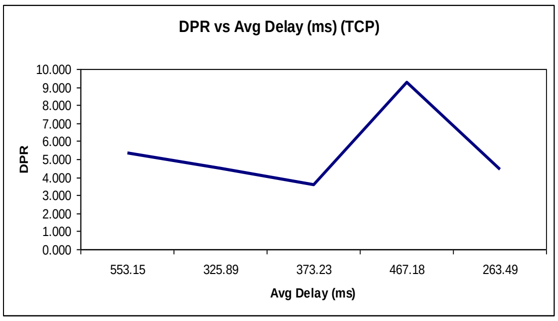

Fig. 10 DPR vs average delay with varying mobility (TCP)

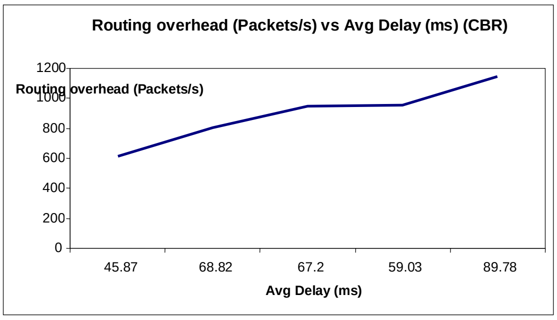

Fig. 11 Routing overheads vs average delay with varying mobility (CBR)

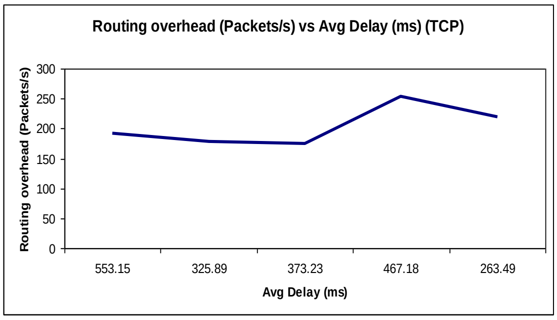

Fig. 12 Routing overheads vs average delay with varying mobility (TCP)

TABLE II: No. Of Connections

Parameters	**Values**
Topology size	1000 X 1000
No of Nodes	100
No of Sources	Multiple
No of Destinations	Multiple
Packet size	512 bytes
MAC protocol	IEEE 802.11
Simulation time	200s
Traffic Types	CBR / TCP
Simulation run	200s for each set of connections
Mean node speed	5
Packet rate	1.0
Number of connections	10, 30, 50, 70, 90

AOMDV investigation with varying network size is discussed here (Fig.13 to 23). The performance of AOMDV with varying numbers of connections with respect to CBR and TCP traffic is given below. When number of connections varies the packet send rates is set to 1 packets/s and mean node speed is set to 5 m/s. Simulation parameter details are provided in table II. When network size increases the throughput in TCP traffic initially increases and then start to drop whereas in CBR traffic the throughput increases with increase in number of connections. The Drop Packet ratio increases in both CBR and TCP traffic. Average Delay increases in CBR traffic and in TCP it drops. The route discovery frequency decreases in CBR with increase in number of connections whereas in TCP it increases slowly. Routing overheads increases with increase in number of connections in both traffic types.

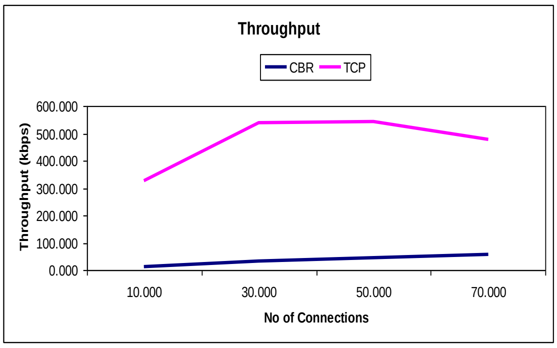

Fig. 13 Throughput with varying network size

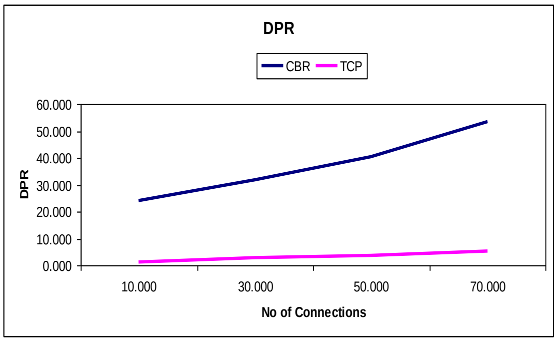

Fig. 14 Drop Packet Ratio with varying network size

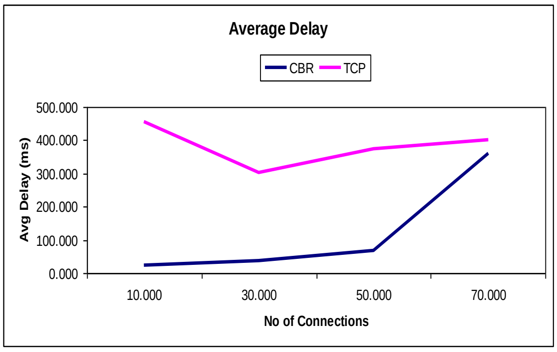

Fig. 15 Average delay with varying network size

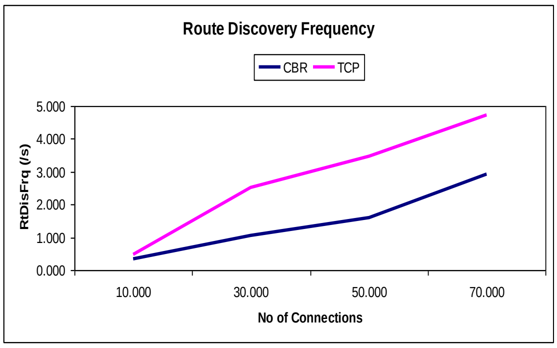

Fig. 16 Route Discovery Freq with varying network size

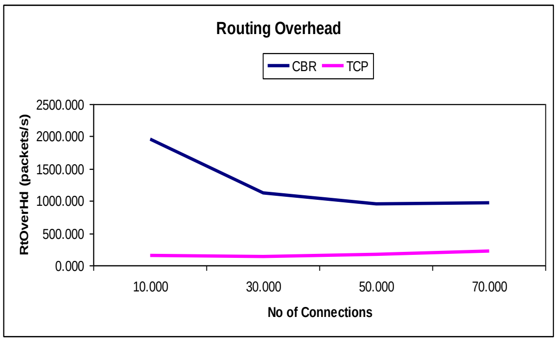

Fig. 17 Routing Overhead with varying network size

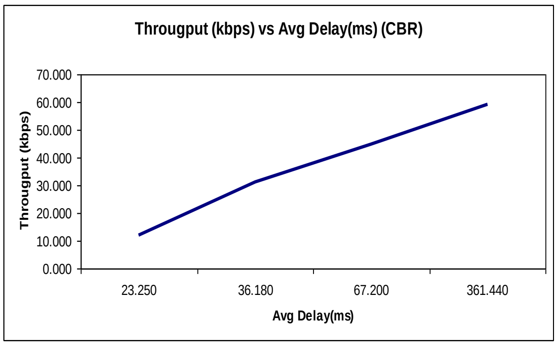

Fig. 18 throughput vs average delay with varying network size (CBR)

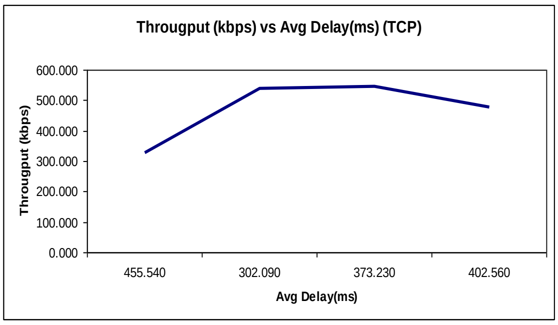

Fig. 19 throughput vs average delay with varying network size (TCP)

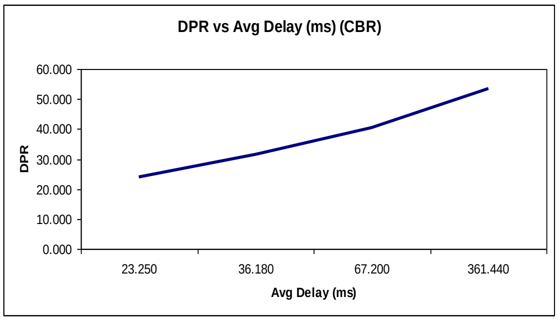

Fig. 20 DPR vs average delay with varying network size (CBR)

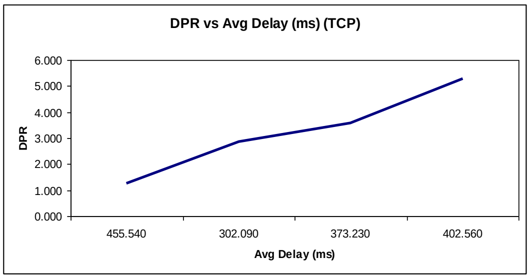

Fig. 21 DPR vs average delay with varying network size (TCP)

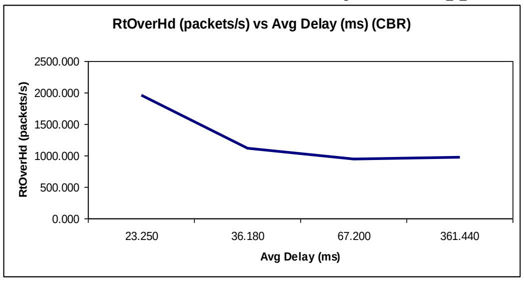

Fig. 22 Routing overheads vs average delay with varying network size (CBR)

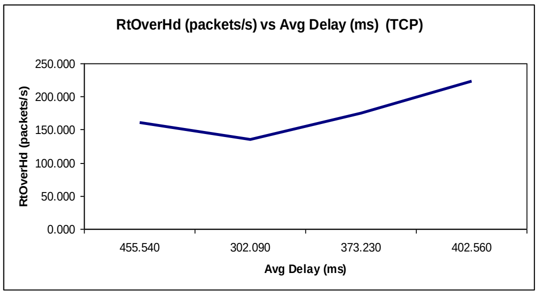

Fig. 23 Routing overheads vs average delay with varying network size (TCP)

VI. CONCLUSION

This paper is an attempt to investigate the multi-path routing protocol AOMDV for MANET. The extensive analysis is done to evaluate the performance of varies quality of service parameters. Also we have evaluated the effect of performance of one parameter on other. In [5] we show that with increase in offered load AOMDV performance degrades. In this paper we have presented our subsequent analysis of AOMDV. Through this extensive analysis we institute that AOMDV performance goes down with increase in mobility and network size. From this work we are able to show that AOMDV routing protocol is appropriate for MANETs where offered load, mobility and Network size are moderate.

Our future plan is to investigate more multi-path routing protocols and to provide extensive study of their QoS parameters and to investigate effect of average delay on other parameters.

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