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Performance Comparison of MANET Routing Protocols using Traffic Models

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Abstract— A mobile ad-hoc network or MANET is a collection of mobile nodes sharing a wireless channel without any centralized control or established communication backbone. In this paper two reactive routing protocols AODV, AOMDV for mobile ad-hoc network are compared on the basis of PDF, NRL, Instant Jitter and Generation Throughput using different traffic models CBR, Pareto and Exponential. This comparative study with ns-2(version 2.35) shows that multipath protocol AOMDV has a better performance than single path protocol AODV in most of the conditions.

Keywords— MANET, AODV, AOMDV, PDF, NRL

I. INTRODUCTION

Wireless networks are being used everywhere due to the advancement in wireless technologies and their increase in affordability. A mobile ad-hoc network (MANET) is a collection of mobile nodes sharing a wireless channel without any centralized control or established communication backbone [11]. The wireless ad-hoc networks have self-organizing, self creating and self-administrating property. The nodes in an ad-hoc network can be any device which is capable of communicating with the nodes which are located in its transmission range. With all the nodes, they have no fixed routers. These nodes can act as both routers and end systems at the same time. When the nodes act as routers, they discover and maintain the routes to other nodes in the network [1,5]. It has a wide range of applications in battlefield, disaster relief, and classroom. Three types of routing protocols are used in MANET namely Proactive (e.g. OLSR, DSDV and WRP), Reactive (e.g. AODV, AOMDV, DSR etc.) and Hybrid. In table driven or proactive routing protocols up-to-date routing information of the network topology of all the nodes are preserved. It preserves the information about all the available paths in the networks even if these paths are not currently used. In on-demand or reactive routing protocols, the routes are created when they are required by the nodes. It uses the route discovery process. In this only the routes that are currently in use are maintained. Hybrid methods combine both reactive and proactive methods. In this paper, two reactive routing protocols AODV, AOMDV are evaluated on the basis of four performance metrics: Packet Delivery Fraction, Instant Jitter, Generation throughput, NRL using three different traffic models: CBR, Pareto, Exponential. The organization of the paper is as follows: in section II explains the routing protocols, in section III related work have been explained, section IV explains the performance metrics, traffic models and simulation, section V explains the simulation results and section VI includes the conclusion and future work.[10]

II. ROUTING PROTOCOLS IN MANETS

Two routing protocols are considered in this paper namely: AODV, AOMDV. Below is the explanation of both the routing protocols:

A. Ad-hoc On-demand Distance Vector Routing Protocol (AODV)

It is a single path and reactive routing protocol. AODV initiates the route discovery process whenever it has packets to send from source to destination using the control messages. AODV also called as on-demand protocol. It uses the various control messages:

RREQ: Route Request message is sent when a node needs to discover the route from source to destination.
RREP: Route Reply is a reply to the originating source and it is sent either by the intermediate node or destination node.
RERR: Route Error message is broadcasted for the broken links.
HELLO: This message is used for sending the connectivity information.[1]

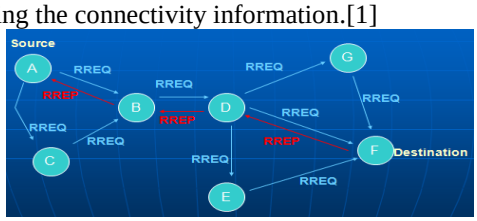

Fig 1. AODV Route discovery process

Fig.1 shows the example of message routing for AODV routing protocol. In this Fig, node 'A' wants to communicate with the node 'F' means node wants to send messages from source 'A' to destination 'F'. Node 'A' generates the Route Request (RREQ) message and forwards it to the neighbour's node. When it finds the route to the destination node then it generates the Route Reply (RREP) message back to the source node. Communication is started when the route is established between source 'A' and destination 'F'. [10]

B. Ad-hoc On-demand Multipath Distance Vector (AOMDV)

It is a multipath and a reactive routing protocol. It is extension to the AODV protocol for computing multiple loop free paths. Multipath routing is a technique gives the multiple alternate routes between source and destination. It discovers the multiple paths from source to destination in a single route discovery process. It consists of two components: Route update rule and a distributed protocol. Route update rule is used to establish and maintained the nodes and Distributed protocol is used to find the link-disjoint paths. It is used in highly dynamic network where link breakage occurs due to the high load on the network. After every link breakage or failure a route discovery process is needed in AODV routing protocol. When route discovery process is done after every link breakage then it gives the high overhead and latency. Thus having multiple paths may solve this problem. Route discovery process is used when all the routes from source to destination fail. The AOMDV attempts to use routing information. The advantage of using AOMDV is it allows the intermediate nodes to respond to RREQ, while it still choosing the disjoint paths[12]. In AOMDV when node S sends a RREQ (Route Request) message in the network, every RREQ reached at node I through the different neighbours of the S, or S itself, it defines a node disjoint path from path I to S. This is used at the intermediate nodes by AOMDV. During this process replicate copies of Route Request are formed and they are not instantly rejected. Every message is examined separately whether source is provided with the node-disjoint path or not. For node disjoint paths all route requests (RREQs) must be reached through the different neighbours of the source. The RREQs only need to arrive via unique neighbors.[1][5]

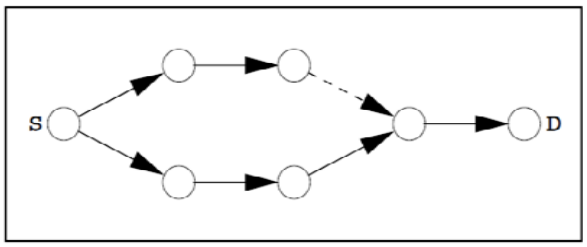

Fig 2. AOMDV

III. RELATED WORK

Shivendu Dubey and Prof. Rajesh Shrivastava [1] studied energy consumption using traffic models for AOMDV OLSR and AODV routing protocols. They found that AOMDV consumes less energy than OLSR and AODV with increasing number of nodes, average speed and send rate with CBR traffic, while AODV consumes less energy than OLSR and AOMDV with increasing pause time. In exponential and Pareto traffic, AODV consumes less energy than OLSR and AODV with increasing number of nodes, pause time, average speed and send rate. Juan Carlos Cano *et.al.* [2]developed number of protocols for minimizing energy consumption and analysed them under constant bit rate (CBR) traffic. J Hong *et.al.* [3] have compared two reactive protocols under on/off source traffic. They selected PDF, normalized routing overhead and average delay as the performance parameters. Al Maashri *et.al*. [4] have compared the energy consumption of various protocols under CBR traffic. Er.Deepinder Singh Wadhwa & Er.Tripatjot Singh Panag [5] compared the performance of AOMDV, AODV and DSDV routing protocols with NS2 (version 2.34) simulations show that AOMDV is able to achieve remarkable packet delivery fraction and almost similar throughput. Shrestha, F. Tekiner *et.al.* [6] used Random mobility and scalability aspects to analyse the performance of the AODV, OLSR and TORA routing protocol. OPNET modeller 14.5 is used for simulation. Throughput analysis of the selected protocols concluded TORA shows poor throughput than AODV and OLSR. AODV resulted in good efficiency over heavy traffic than OLSR and TORA.

Ashish K. Maurya, Dinesh Singh *et. al.* [7] evaluated performance of AODV, DSR and ZRP routing protocol with respect to pause time. AODV shows best performance when compared with DSR and ZRP in terms of packet delivery ratio and throughput. AODV delivers more than 60 percent of all CBR packets when network is presented as a function of pause time. Performance may vary by varying the network and can show different results when compared with different network scenarios. S. Sathish, K. Thangavel and S. Boopathi *et. al*. [8] presented a performance comparison of DSR, AODV, FSR and ZRP routing protocols for mobile Ad-hoc networks as a function of pause time. DSR shows best performance than AODV, FSR and ZRP in terms of packet delivery ratio and throughput as a function of pause time. FSR show lowest end-to-end delay and ZRP has less average jittering than DSR, AODV and FSR. DSR and AODV performed the worst in case of average jitter and ZRP performed the worst in case of throughput. Samir R. Das and Jiangtao Yan *et. al.* [9] evaluate several routing protocols for manet with respect to fraction of packets delivered, end-to-end delay, and routing load for a given traffic and mobility model. The proactive, shortest path protocols provide excellent performance in terms of end-to- end delays and packet delivery fraction, however, at the cost of higher routing load. The on demand suffers from suboptimal routes as well as worse packet delivery fraction because of more dropped packet data.

Ekta Nehra and Er. Jasvir Singh [10] compared the performance of AODV, TODV, OLSR and ABR on the basis of delay, network load and throughput using OPNET. It shows OLSR performs best among other protocols in case of network load and throughput. Said EL KAFHALI and Abdelkrim HAQIQ [11] compared the performance of AODV, DSR, DSDV routing protocols in terms of energy consumed due to packet type during transmission and reception of control packets.Sonal Dubey [12] analysed the performance metrics of OLSR, AOMDV & ZRP protocols in the VANET scenario.

IV. SIMULATION PARAMETERS, PERFORMANCE METRICS AND TRAFFIC MODELS

A. *Simulation Parameters*

TABLE I SIMULATION PARAMETERS

Parameter	Value
No of nodes	5,10,15,20,25,30,35,40,45,50,55,60,65,70, 75, 80,85,90,95,100
Traffic models	CBR, Pareto, Exponential
Channel type	Wireless
Routing Protocols	AODV, AOMDV
Node placement	Random
Pause time	Constant
Simulation time	2060 seconds
Antenna Model	Omni-directional
Radio Propagation Model	Shadow model

B. *Performance Metrics*

For comparing the three routing protocols using the four performance metrics i.e. Packet Delivery Fraction, Generation throughput, Instant Jitter, Normalized routing load. The description of the parameters are follow:

1) *Packet Delivery Fraction (PDF)*: It is defined as the ratio of packets received to packets send.[5]
2) *Generation throughput*: It is the no of packets received by all the destinations over the duration of simulations.[10]
3) *Instant jitter*: It is defined as the delay between the current packet and the next package. More is the delay worst is the performance of the protocol.[5]
4) *NRL*: It is defined as the ratio of the routing packets to the received packets.

C. *Traffic models*

Three traffic models used are:

1) *Constant Bit Rate (CBR)*: It generates traffic at deterministic rate. It is not an on/off traffic.[11]
2) *Pareto*: It is an on/off traffic.[11]
3) *Exponential*: It is also an on/off traffic. It generates traffic during on period [11].

V. RESULTS AND ANALYSIS

Following results have been obtained by comparing the AOMDV and AODV on the basis of four parameters with CBR, Pareto and Exponential:

A. *Comparison of AOMDV and AODV on the basis of PDF with CBR, Pareto, Exponential traffic*

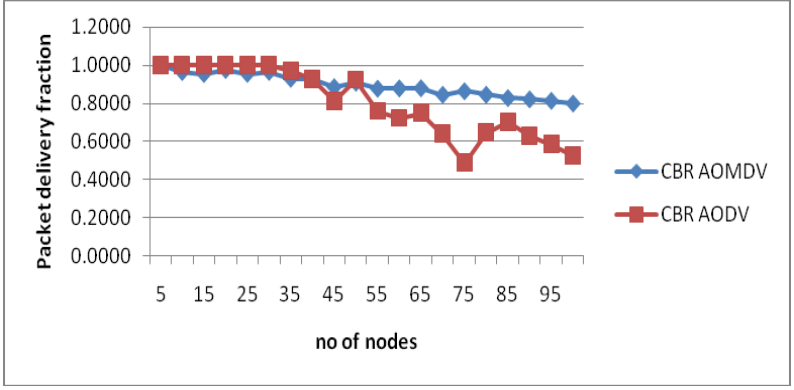

Fig 3. PDF versus no of nodes (CBR)

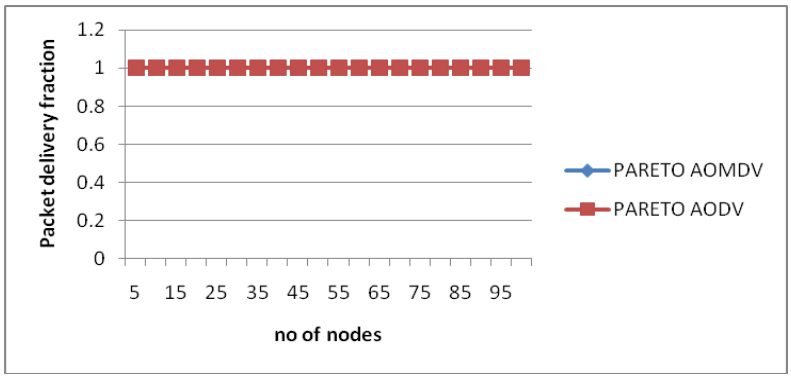

Fig 4. PDF versus no of nodes (Pareto)

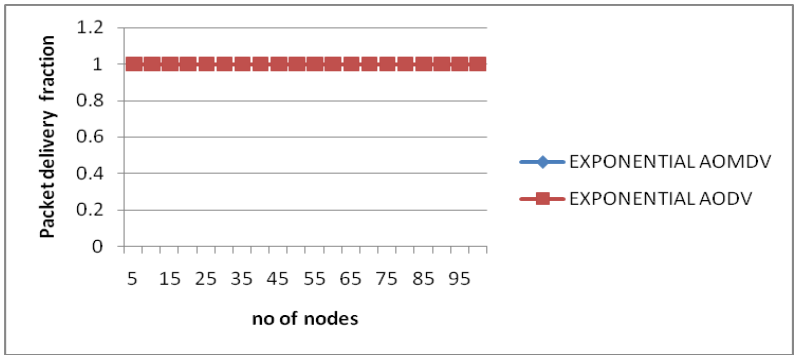

Fig 5. PDF versus no of nodes (Exponential)

The higher the value of PDF better would be the results. As seen in fig. 3, with less number of nodes, AOMDV and AODV show almost same performance but with the increase in no of nodes AOMDV performs better than AODV because AOMDV is a multipath routing protocol. There can be time delay at the node as AOMDV can find alternate node (route) if the current link has broken but AODV cannot be utilized in such a situation. As seen from the Fig 4, AOMDV and AODV show same performance for Packet Delivery Fraction with pareto on/off traffic from node 5 to 100.Fig.5 shows that both the routing protocols have constant performance for Packet delivery fraction from node 5 to 100 with Exponential on/off traffic.

B. Comparison of AOMDV and AODV on the basis of throughput with CBR, Pareto, Exponential traffic

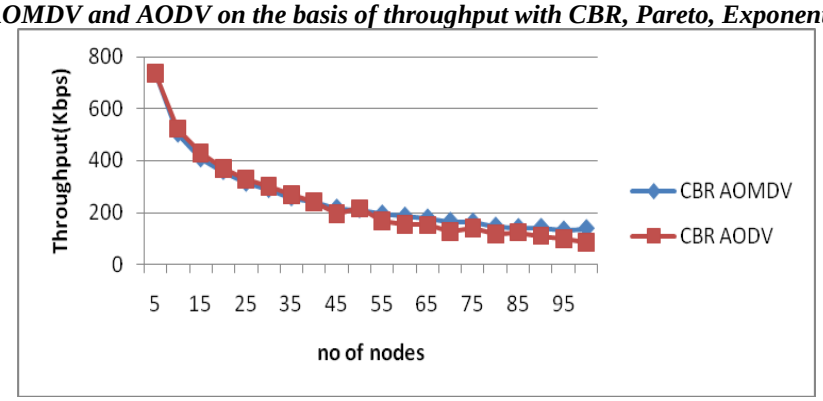

Fig 6. Throughput versus no of nodes (CBR)

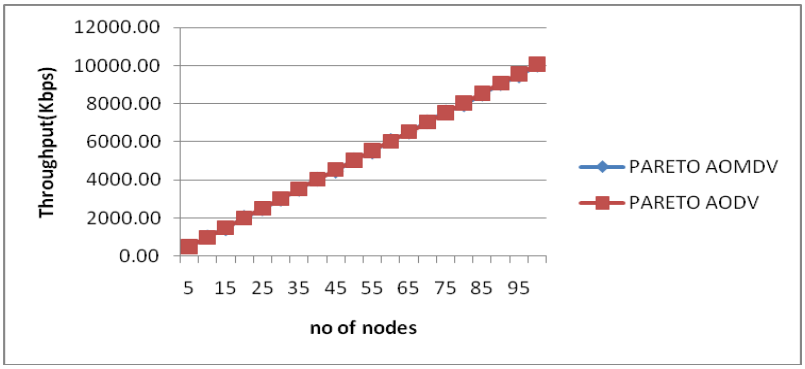

Fig 7. Throughput versus no of nodes (Pareto)

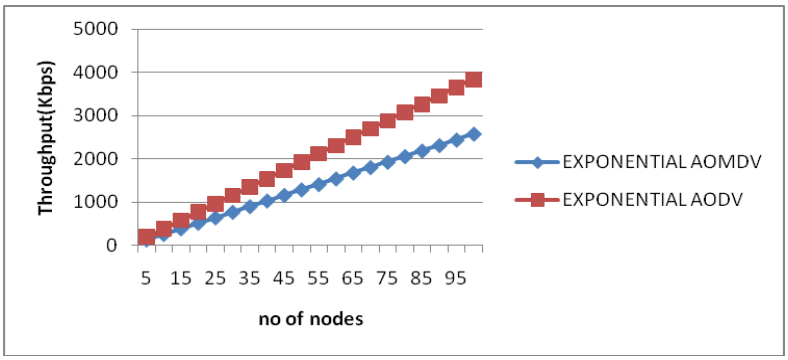

Fig 8. Throughput versus no of nodes (Exponential)

The Fig.6 shows the result of throughput of the two routing protocols with cbr traffic. The graph shows that no of nodes are in horizontal axis and throughput is in vertical axis. Initially in both routing protocols throughput is same but decreases with the increase in no of nodes and with no. of nodes more than 70, AOMDV shows the slightly much better performance than AODV. AOMDV has load balancing feature i.e. if load is more on one route then it transfers it to the alternate route so that more no of packets are delivered without any failure to the destination. Due to this feature AOMDV's performance is improved. As shown in Fig.7, when using pareto traffic for the comparison of AOMDV and AODV for throughput both the routing protocols have same performance .Throughput increases with the increase in the number of nodes for both the protocols. In Fig 8 with increase in the no of nodes, the performance of both the AOMDV and AODV becomes better but AODV performs better than AOMDV with exponential traffic.

C. Comparison of AOMDV and AODV on the basis of Instant jitter with CBR, Pareto, Exponential traffic

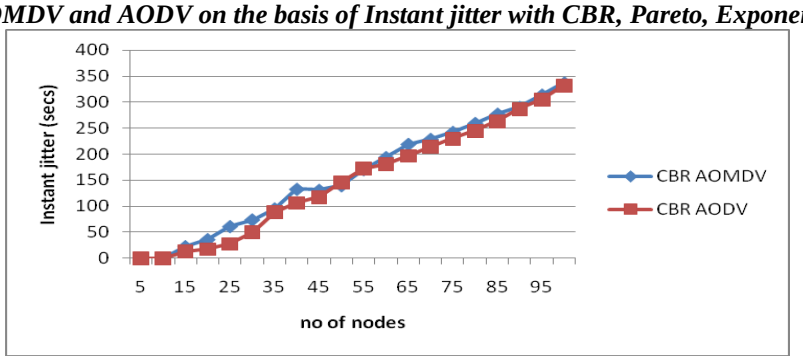

Fig 9. Instant jitter versus no of nodes (CBR)

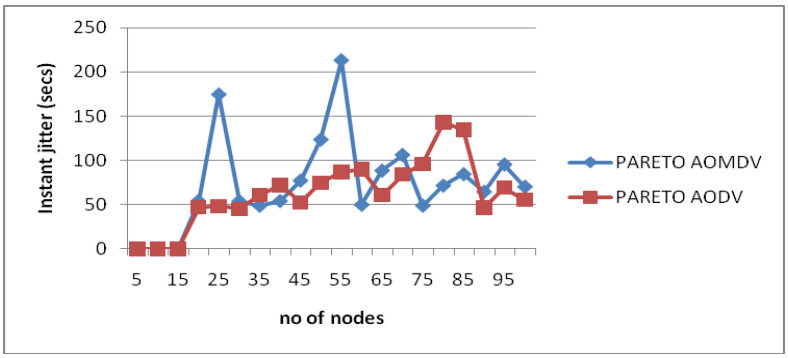

Fig 10. Instant jitter versus no of nodes (Pareto)

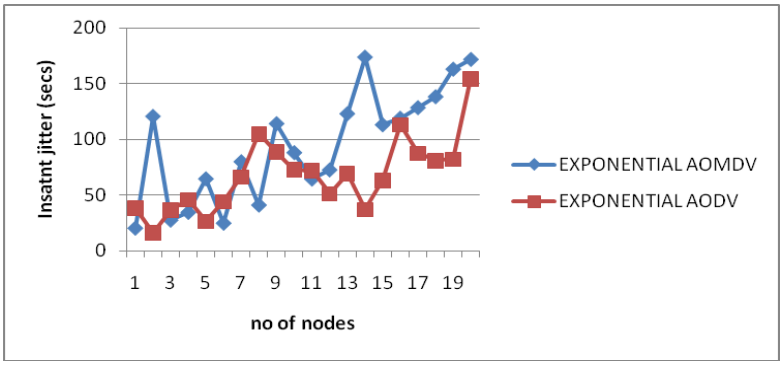

Fig 11. Instant jitter versus no of nodes (Exponential)

Instant jitter implies the delay in delivery of data packets. As observed from Fig 9, performance of AOMDV and AODV is almost similar with regard to instant jitter with cbr traffic. The Fig.10 shows that delay is same upto the node 15 for both the routing protocols but with the increase in the no of nodes after 15, there is abrupt rise and fall in delay for AOMDV. Thus AODV performs better than AOMDV which is a multipath routing protocol due to the possibility of congestion when selecting the multiple routes or when the link is broken. Fig.11 shows the abrupt rise and fall in the delay of the AOMDV and AODV with exponential traffic. AODV shows less delay than AOMDV. So, single path protocol performs better than multipath routing protocol with exponential traffic.

D. Comparison of AOMDV and AODV on the basis of NRL with CBR, Pareto, Exponential traffic

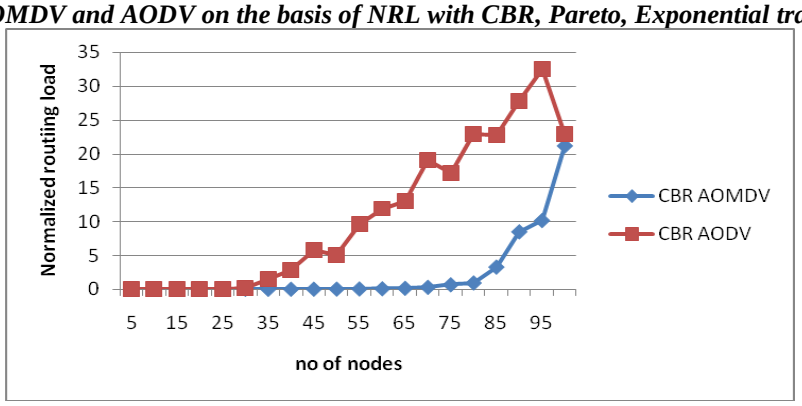

Fig 12. NRL versus no of nodes (CBR)

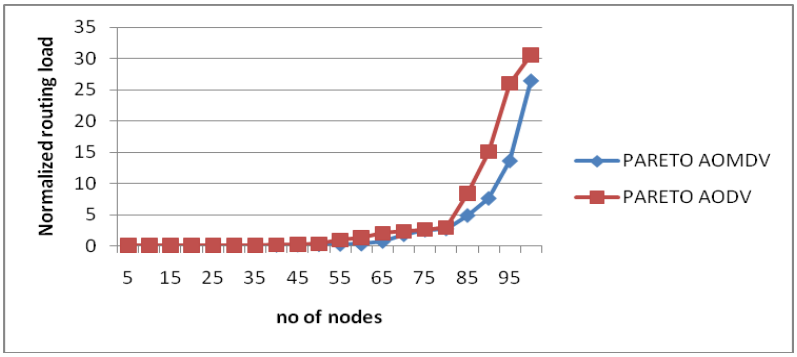

Fig 13. NRL versus no of nodes (Pareto)

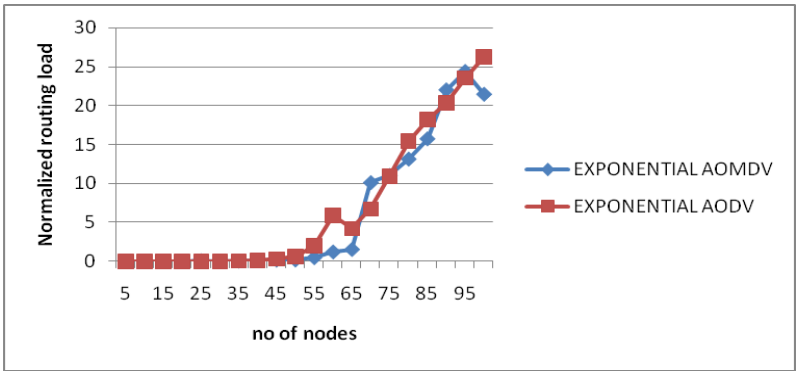

Fig 14. NRL versus no of nodes (Exponential)

In Fig 12, upto 30 nodes AOMDV and AODV have a constant normalized routing load but after the increase in the node value AODV has better NRL than AOMDV with cbr traffic. When using pareto on/off traffic (Fig 13) AOMDV and AODV has same performance upto 80 nodes and with nodes more than 80, there is a increase in the value of the AOMDV and AODV but AODV has a higher NRL value than the AOMDV protocol. Fig 14 describes the performance of AOMDV and AODV versus the no of nodes with exponential traffic. It is observed that the two routing protocols have a constant behaviour from node 5 to 50. After that, both the protocols have almost similar behaviour with a very small difference.

VI. CONCLUSION

While comparing the performance of two reactive protocols AOMDV and AODV with the increasing number of nodes using NS-2, version 2.35 (Ubuntu 12.04) using different performance parameters and traffics i.e. cbr, pareto and exponential, AOMDV performed better than AODV in some cases while in some conditions, AOMDV showed better performance. It can be concluded that

A. For Packet Delivery Fraction

With cbr traffic AOMDV performs better than AODV with the increase in the number of nodes because AOMDV is a multipath protocol if current link is broken then it finds the alternate route to send the packets but AODV cannot be utilized in this situation. With pareto and exponential traffic both the routing protocols have constant performance with the increasing number of nodes.

B. For Generation throughput

With cbr traffic AOMDV and AODV have same performance but in the last case AOMDV's performance is improved because AOMDV has a load balancing feature. With pareto traffic both the routing protocols have same performance. With exponential traffic AODV performs better than AOMDV protocol

C. For Instant jitter

With cbr traffic it was observed that performance of AOMDV and AODV is almost same. With pareto traffic we have observed that there is abrupt rise and fall in delay of AOMDV. Thus AODV performs better because in multipath protocol there is a possibility of congestion when selecting the multiple routes due to this delay is more. With exponential traffic AOMDV has more delay than AODV so more is the delay poor is the performance of the protocol.

D. For Normalized Routing Load(NRL)

With cbr and pareto traffic AODV has high NRL than AOMDV. With exponential traffic both the protocols have almost similar behavior with a small difference.

Overall we have concluded that multipath protocol i.e. AOMDV has a better performance than single path routing protocol (AODV) in most of the conditions.

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