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Implementation of Fuzzy Logic Based Node Traversal Time Performance Enhanced AODV in Mobile Ad Hoc Networks

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ABSTRACT

In this paper, the performance of Ad-Hoc on Demand Distance Vector Routing Protocol (AODV) and Fuzzy logic Based Node Traversal Time Performance Enhanced AODV (FLBNTTPEAODV) Routing Protocols for Mobile Ad hoc Networks are analyzed in various Node Placement Models. The result shows that the FLBNTTPEAODV performs better than the existing AODV.
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Key words: AODV, FLBNTTPEAODV, MANETs, Node Placement Models, Performance Metrics, Routing Protocols.

1. INTRODUCTION

Mobile nodes in a Mobile Ad hoc network [1][2][3][4] enter into the network and exit from the network arbitrarily. The Node placement models [5] describe the placement position order of the mobile nodes. Routing is a major issue [6] in Mobile Ad hoc Networks. The rest of the paper is organized as follows: Reactive routing protocol "AODV" is illustrated in section 2, FLBNTTPEAODV is summarized in section 3, simulation environment is presented in section 4, and results are presented in section 5 and finally concluded with section 6.

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

The On demand routing protocol, Ad Hoc On-Demand Distance Vector (AODV) Protocol [7][8] finds the routes as and when required. The *route discovery* and *route maintenance are th*e key elements during AODV routing.

In Route Discovery process whenever a mobile node needs to send data to a particular node, a *ROUTE REQUEST* (RREQ) message was flooded.

Once the RREP message was received by the sending node, the route has been established and data packets may be forwarded on that route.

The failure of the links or routers was handled in the route maintenance process through a *ROUTE ERROR* (RERR) message.

3. FUZZY LOGIC BASED NODE TRAVERSAL TIME PERFORMANCE ENHANCED AODV (FLBNTTPEAODV)

Fuzzy Based Node Traversal Time AODV [9][10] is further extended to a new method for very larger networks. This new method "Fuzzy Logic Based Node Traversal Time Performance Enhanced AODV (FLBNTTPEAODV)" is strengthened by its large number of fuzzy logic [11][12] rules and behavior of membership functions. This model calculates node traversal time associated with the network size up to 120 nodes. The linguistic variables associated with input variable 'number of nodes (nn)' are Low (L), Medium (M) , High (H), and Very High(V). The linguistic variable associated with input variable 'speed' are Low(L), Medium(M) High(H), and Very High(V). The linguistic variable associated with output variable 'node traversal time (ntt)' are Low(L), Medium(M) High(H), and Very High(V). The membership functions for the input variables number of nodes, speed are shown in the Figure1 and Figure 2 respectively. The membership function for the output variable nodetraversaltime is shown in the Figure 3. The surface view of the Model is shown in the Figure 4. Table 1 presents the rule base used in the model.

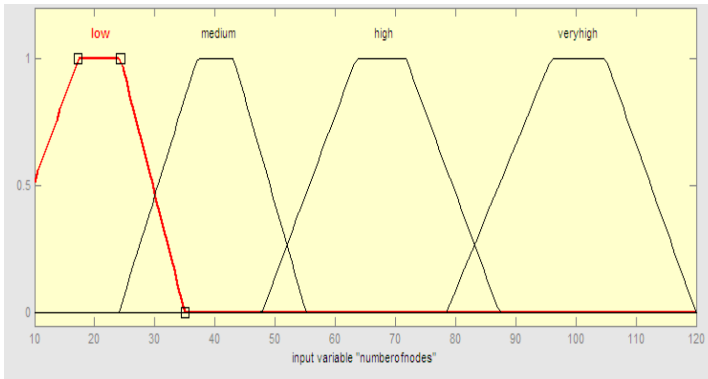

Figure 1: Membership function for the input variable 'number of nodes'

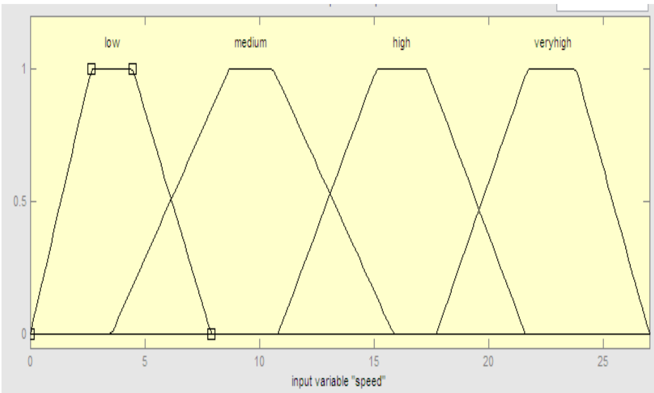

Figure 2: Membership function for the input variable 'speed'

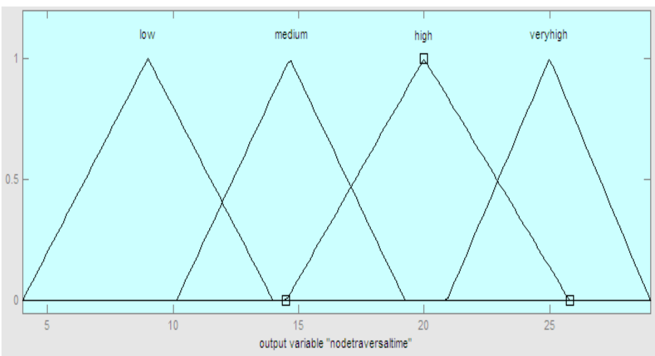

Figure 3: Membership function for the output variable 'nodetraversaltime'

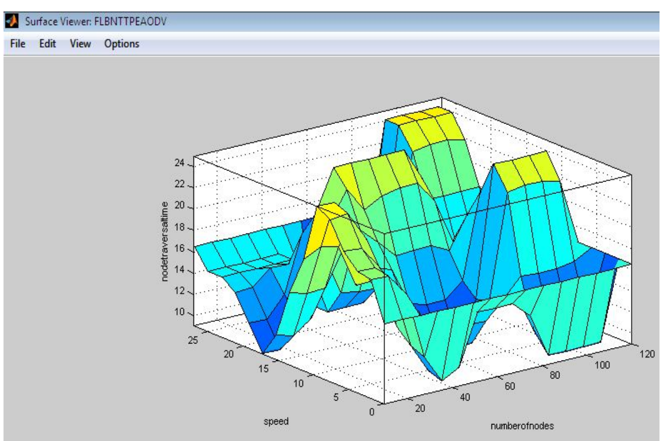

Figure 4: Surface viewer of the FLBNTTPEAODV

Table 1: Fuzzy Rule Base

NumberofNodes	Speed	nodetraversaltime
Low	Low	High
Low	Medium	VeryHigh
Low	High	Low
Low	VeryHigh	Medium
Medium	Low	Low
Medium	Medium	Medium
Medium	High	VeryHigh
Medium	VeryHigh	Medium
High	Low	Medium
High	Medium	Low
High	High	VeryHigh
High	VeryHigh	Low
VeryHigh	Low	Low
VeryHigh	Medium	VeryHigh
VeryHigh	High	Medium
VeryHigh	VeryHigh	VeryHigh

4. SIMULATION ENVIRONMENT

Network Simulation software namely NS2 [13], GloMoSim[14] and Qualnet[15] etc., plays a vital role to evaluate the network performance. Qualnet Library is used in this simulation process. To evaluate the performance [16][17][18] of FLBNTTPEAODV , various simulations was conducted in low network size (27nodes), Medium Network size (54), High network size (81nodes) and very large network size (108) nodes. The simulation parameters used in the experiment are elaborated in the Table 2.

Table 2: Simulation Environment parameters

Routing Protocols	AODV,FLBNTTPEAODV
Simulation Time	360s
Area (sq.m)	1000x1000
Propagation Model	Two Ray
Traffic	CBR
Packet Size	512 bytes
Nodes	27,54,81,108
Antenna Type	Omni directional
Transmission range	250m
Receiver range	250m
Pause time	0 sec
Minimum speed	1 m/s
Node Placement Model	Grid, Random, Uniform
Mobility Model	RandomWaypoint

5. RESULTS AND ANALYSIS

The performance of AODV and FLBNTTPEAODV were analyzed in the metrics namely Average Jitter, Average end-end delay, Average Throughput and Packet delivery ratio.

Average Jitter is calculated as the delay variation between each received data packet. Figure 5, Figure 6 and Figure 7 shows the variation of Average Jitter in seconds with various Network size for Uniform, Grid and Random Placement models respectively
.
Average End-to-End delay describes the data packets travelling time from the sender to a particular receiver. Figure 8, Figure 9 and Figure 10 shows the variation of Average End-to-End Delay in seconds with various Network size for Uniform, Grid and Random Placement models respectively.

Average Throughput elaborates the total amount of data received by the particular receiver during the simulation time. Figure 11, Figure 12 and Figure 13 shows the variation of Average throughput in bps with various Network size for Uniform, Grid and Random Placement models respectively.

Packet Delivery Ratio represents the ratio of the number of data packets delivered to a particular receiver to the number of data packets sent from the sender. Figure 14, Figure 15 and Figure 16 shows the variation of Percentage of packet delivery ratio with various Network size for Uniform, Grid and Random Placement models respectively.

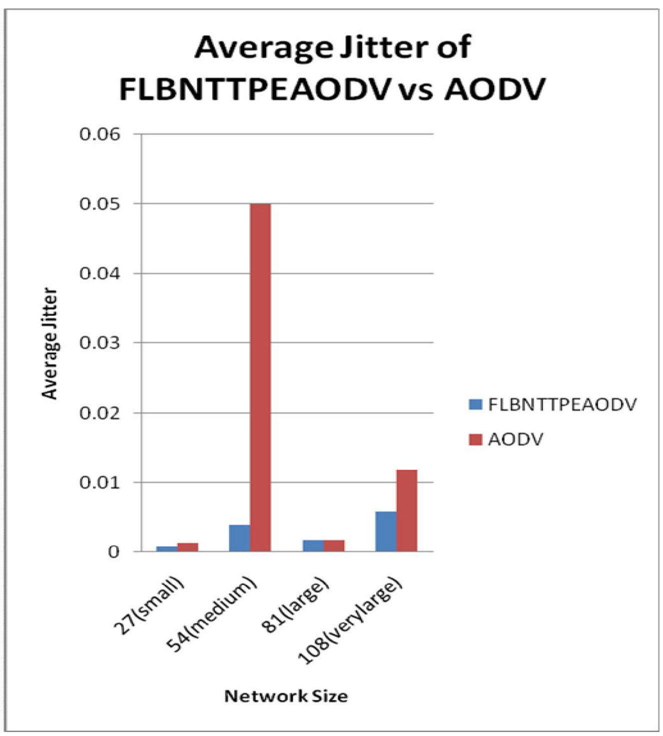

Figure 5: Variation of Average Jitter (seconds) with Network size in Uniform Placement Model

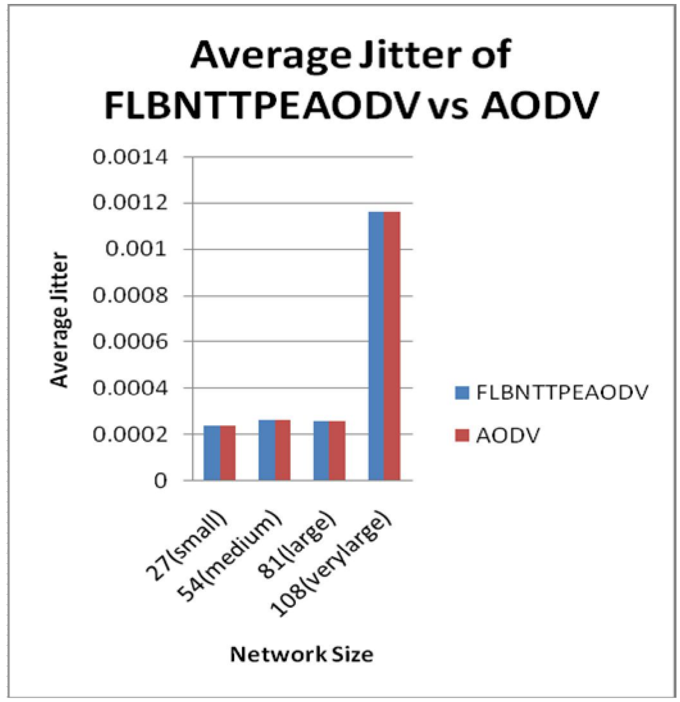

Figure 6: Variation of Average Jitter (seconds) with Network size in Grid Placement Model

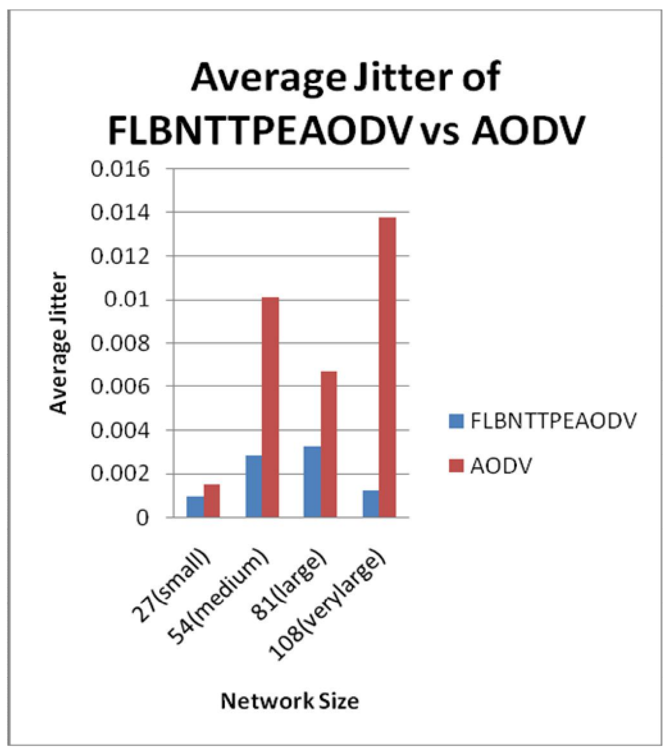

Figure 7: Variation of Average Jitter (seconds) with Network size in Random Placement Model

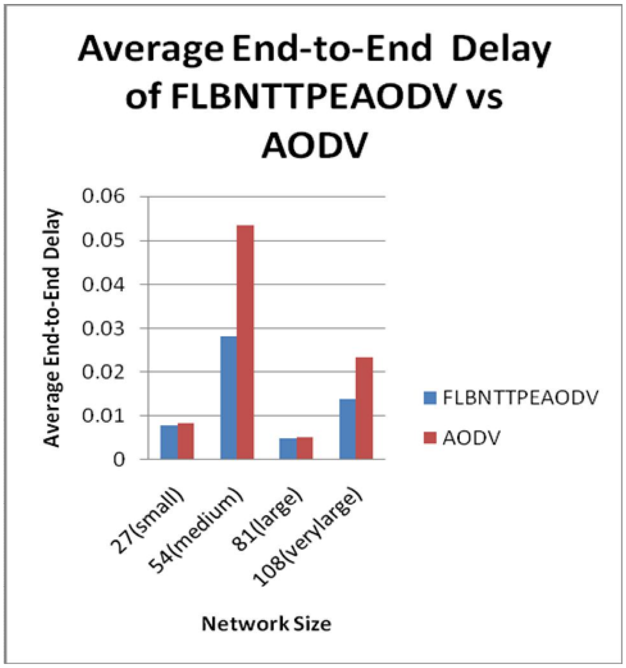

Figure 8: Variation of Average end-to-end Delay (seconds) with Network size in Uniform Placement Model

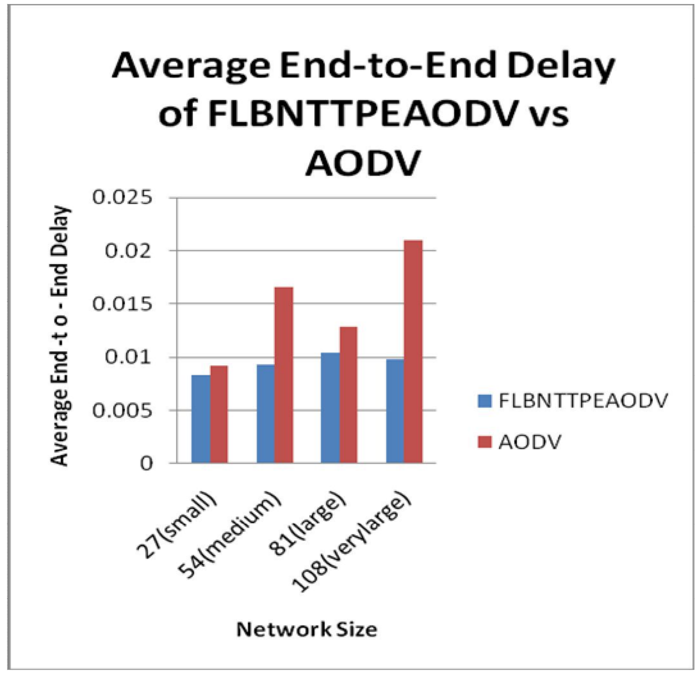

Figure 10: Variation of Average end-to-end Delay(seconds) with Network size in Random Placement Model

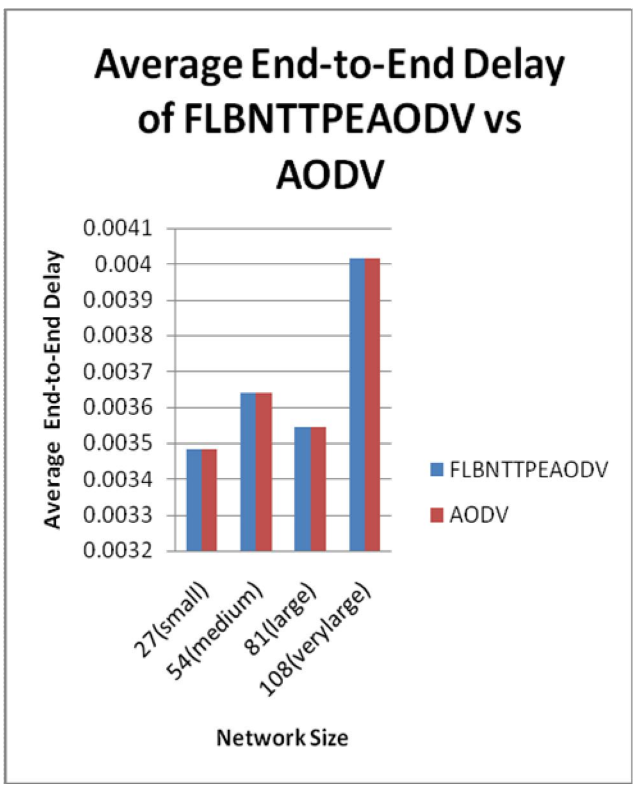

Figure 9: Variation of Average end-to-end Delay (seconds) with Network size in Grid Placement Model

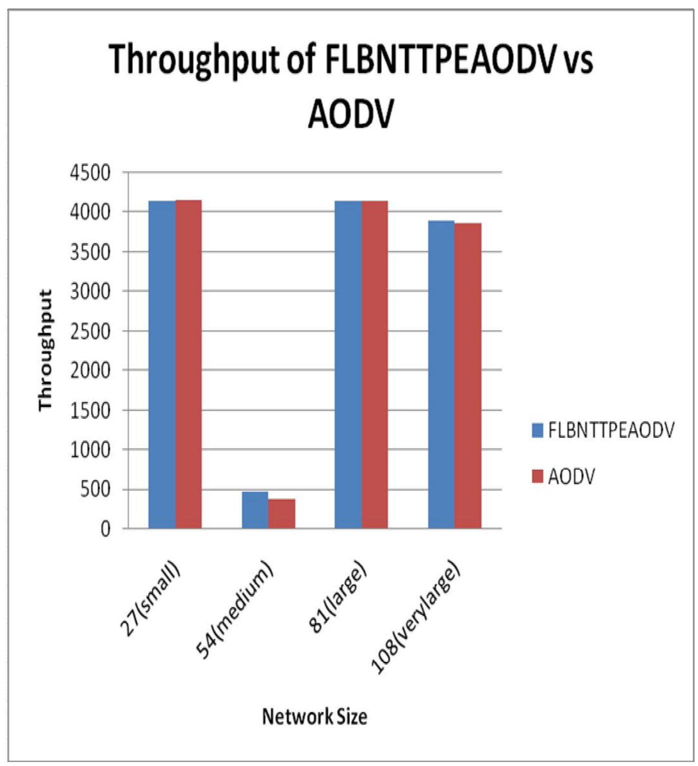

Figure 11: Variation of Average Throughput (bps) with Network size in Uniform Placement Model

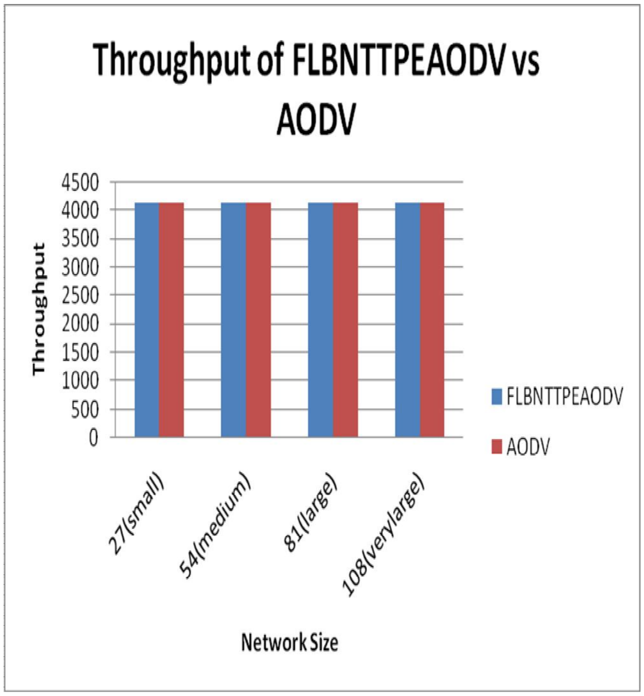

Figure 12: Variation of Average Throughput (bps) with Network size in Grid Placement Model

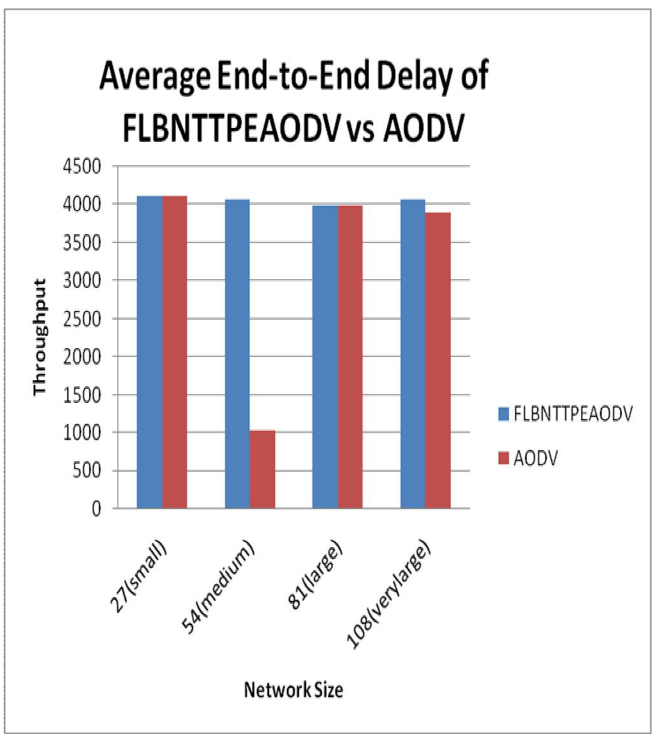

Figure 13: Variation of Average Throughput (bps) with Network size in Random Placement Model

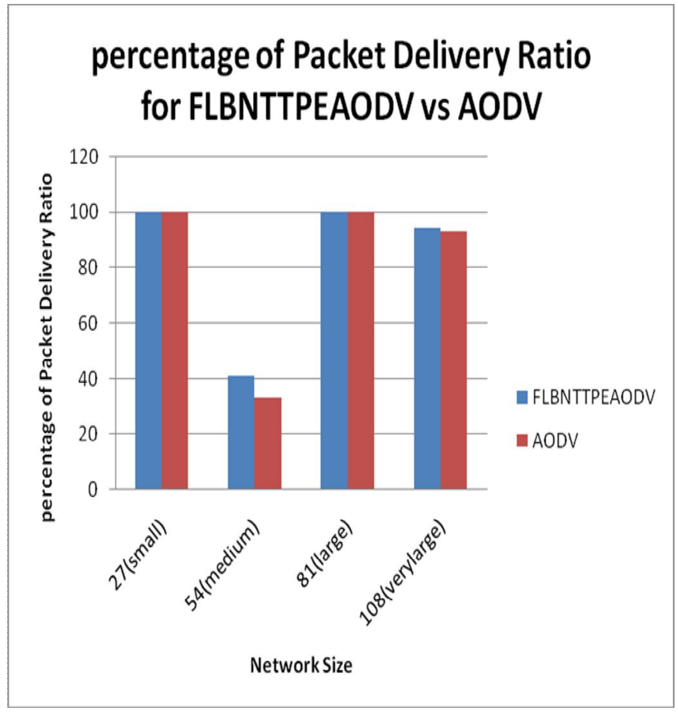

Figure 14: Variation of Percentage of packet delivery ratio with Network size in Uniform Placement Model

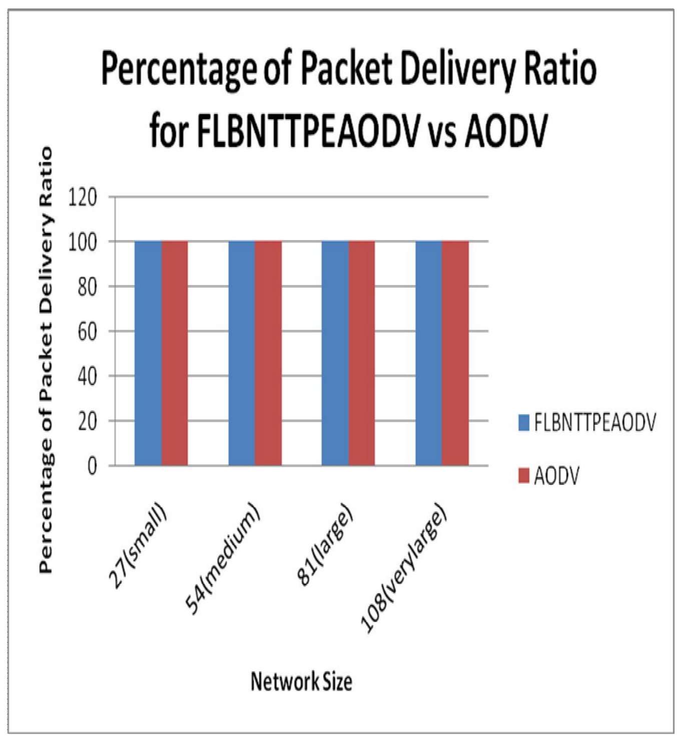

Figure 15: Variation of Percentage of packet delivery ratio with Network size in Grid Placement Model

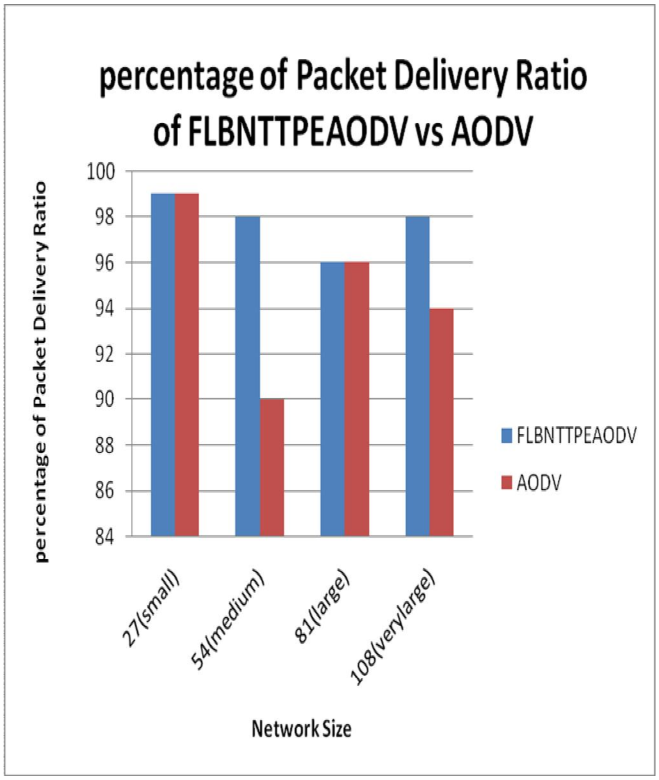

Figure 16: Variation of Percentage of packet delivery ration with Network size in Random Placement Model

6. CONCLUSION AND FUTURE SCOPE

From the Simulation results it was concluded that FLBNTTPEAODV performs better than the AODV in case of Uniform and Random Placement Models. Its behavior is similar to the AODV in the Grid Placement Model. One of the future scope is the study of the model with network offered load.

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