Impact of Energy and Mobility on MANETs Routing Protocols: AODV and DSR

Rajesh Kumar Upadhyay, Subodh Kumar, Manoj Kumar Rana

Abstract*: Routing protocols can be tested in realistic conditions of Mobile Ad-hoc network (MANET)). The performance of MANET depends on different parameters such as used number of nodes, mobility speed, routing protocols, mobility model and energy models etc. In this paper, researchers made an effort to analyze the impact of energy and mobility on the performance of AODV and DSR routing protocols with varying mobility speed under random waypoint mobility model and radio energy models in the MANET. Detailed simulations have been carried out using QualNet simulator for 50 nodes. Performance of AODV and DSR routing protocols has been analyzed under the premise of performance metrics namely average throughput, average end to end delay and average jitter using CBR traffic patterns.

Keywords: AODV, DSR, Speed, Mobility Model, Energy Model

I. INTRODUCTION

MANET (Mobile Ad-hoc network) is a self configuring network which creates an arbitrary network of mobile nodes. In this network, all mobile nodes can be linked dynamically when required without any centralized control [1]. The lifetime of any mobile node is dependent on battery energy and hence the consumption of any mobile node is an important [2]. In various situations such as scientific field missions, military actions, disaster rescue; routing protocols and mobility pattern play important role as any node can survive in network for long time if the sufficient energy is available for the node. All nodes are worked as router and play a significant role in discovery and maintenance of routes. The availability of any mobile node in the network can be increased or decreased at any moment due to the limited battery energy and mobility of the node as a result the availability of paths between nodes can vary in an Ad-hoc network during communication.

There is lot of ways to categorize the MANET routing protocols according to packet delivery mechanism from source to destination such as unicast routing, multicast routing and broadcast routing. Generally routing protocols are broadly categorized into three types such as proactive, reactive and hybrid protocols [2] [3].

(i) Proactive Protocols

These types of protocols are also known Tab. driven protocols in which, the routes are consistent and up-to-date the routing information to all the nodes. The data packets are communicated over the available route specified by the routing Tab.. Proactive protocols have lower response time because all available routes are maintained at all times for all available nodes. Some of the proactive routing protocols are DSDV, OLSR, STAR, FSR, and BELLMAN FORD.

(ii) Reactive Protocols

These protocols are also known as on demand routing protocols where routes are not maintained before transferring the packets for routing. Whenever a source node desires to send the information to a destination, it appeals the route discovery mechanisms for discovering the path to the desired destination. This route discovery is done by flooding mechanism, in which a source node precisely broadcasts the data packets to all the surrounding and intermediate nodes and forward that data packet to their surrounding nodes until it reaches to the destination node. Reactive protocols have littler routing overheads because of no need of prior information, but higher response time. This type of protocols is much appropriate and does better for Ad-hoc network. Some of the reactive routing protocols are AODV, DSR LAR and TORA.

(iii) Hybrid Protocols

Hybrid protocols comprises the features of both reactive and proactive routing protocols and take the advantages of both protocols which results in quick routes discovery in the routing zone. Some of the hybrid routing protocols are ZRP and ZHLS. In MANETs, movement of one mobile node from one point to another point characterizes mobility. Mobility is also an important component for Mobile Ad-hoc network and acts a life sustaining role in evaluation of the performance of the routing protocols. A fundamental issue involve in MANETs is the selection of optimal path between any source to destination. The MANETs are very prone to link failure due to mobility of nodes in highly dynamic environment. So as a result, the link maintenance and route re-formation are required and the entire process have a significant effect on the energy consumption at any node. Under the mobility modeling, the behavior or activity of a mobile node can be represented using analytical and simulation models. Detailed and realistic mobility scenarios can be performed in simulation models. These models are useful to drive reliable solutions for complex problems [4].

Following mobility models are available in QualNet simulator:

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(i) File Mobility Model

In this model, positions of the mobile nodes can be read from the file at various simulation times. The mobile node moves from one location to the next location in a straight line with constant speed.

(ii) Random Waypoint Mobility Model

In this model, mobile node identifies the random position and moves nearing it in a straight line with the constant speed that is randomly selected from a range, and pauses at that destination. The mobile node iterates this process throughout the simulation.

(iii) Group Mobility Model

In this model, the mobile nodes move unitedly in the groups. The entire group of nodes follows the random waypoint model for the movement within the group area

(iv) Pedestrian Mobility Model

In this model, mobile nodes simulate the doings of pedestrians in the urban environment.

The radio energy models have an important role for the evaluation of any wireless network. The energy models are used to calculate the energy consumption in transmitting and receiving circuits in the numerous energy state functions of the radio (transmit, receive, idle, and sleep). Main radio energy models are Generic, MicaZ and Mica-Motes [5].

(i) Generic Radio Energy Model

This model calculates energy consumption in different energy states. It also works in variable transmission.

(ii) Mica-Motes Radio Energy Model

This model is pre-configured model that having the specification of energy consumption of Mica motes.

(iii) MicaZ Radio Energy Model

This model is pre-configured model that having the specification of energy consumption of MicaZ motes.

In this research effort, researchers presented the impact of energy and mobility on the performance of AODV and DSR routing protocols with varying mobility speed under random waypoint mobility model using three radio energy models. Detailed simulations have been carried using QualNet simulator for 50 nodes scenario of 500x500 m^2 terrain size. This work has analyzed the performance of AODV and DSR routing protocols using five CBR connections based on throughput, average jitter and average end to end delay.

II. PERFORMANCE METRICS

The numerous performance metrics are used to monitor the performance of routing protocols in the network. During the performance evaluation of routing protocol, these metrics provide statistics related to area, node density speed, data transfer mode, energy model, mobility model etc. Some important performance metrics are following [6]:

(i) Throughput

The average rate of data packet received by the node per unit time successfully is known as throughput.

(ii) Average Jitter

The time variation between arrival of data packets due to change in route and congestion etc. is known as average jitter.

(iii) Average End-to-End Delay

Total average time consumed by the network when packets are sent from any source node to destination node is called average end to end delay.

III. RELATED WORK

A simulation study was conducted on GloMoSim simulator by [2] and they have investigated the effect of mobility based on the performance of AODV, LAR, FSR ABR, DSR, and WRP protocols using random waypoint mobility model. Routing protocols experienced negative effect due to mobility in MANETs and resulted more energy consumption in along with latency and packet lost. Reactive routing protocols are found to be more adaptive to MANETs than the proactive routing protocols. It was also cleared from the study that proactive protocols were not performed well in case of change in topology was occurred.

Research work in [7] concluded that the working of routing protocols heavily rests on the mobility pattern. In their study, they have used AODV, DSR, DSDV and TORA protocols and CBR traffic pattern using random waypoint, RPGM, and Manhattan Grid and various scenarios in NS-2 simulator.

An investigation was carried out for DSR, AODV and OLSR for a MANET environment and observed that OLSR offers better performance for CBR traffic with lowest delay, jitter and more consumption of bandwidth. AODV and DSR are found more adaptive in case of data services. 80 % packet delivery ratio was guaranteed for 60 connections. There was no obvious winner between DSR and AODV as both have shown quite identical results for various performance metrics [8]. Researchers in [9] studied AODV, DSR, DYMO, OLSR and DSDV using RWP, RPGM and CMM mobility models to determine the effect of mobility models in the MANET with the help of network simulator NS-2. The simulation results indicated that the node mobility have significant effect on the working of routing protocols. It was also observed that an increment in network density in network has similar effect on the protocols along with said mobility models. Optimum performance was generally provided by the MANET protocols for small networks.

Evaluation of the performance DYMO, OLSR, DSR and RIP Protocols has been done in [10] using two transmission traffic mode namely CBR and VBR with the help of network simulator QualNet. It was cleared from the results that in case of CBR, OLSR protocol consumed utmost energy in transmit and receive mode and it was followed by DSR, DYMO and RIP. In case of VBR, OLSR protocol consumed utmost energy in transmit and receive mode and it was followed by RIP, DSR and DYMO. Energy consumption was utmost by RIP in the idle mode and that was followed by DYMO, DSR and OLSR using CBR. DYMO consumed utmost energy at the idle mode followed by DSR, RIP and OLSR using VBR. RIP protocol was provided the best average jitter and end to end delay for both traffic modes. DSR protocol was provided the best throughput in CBR traffic mode but OLSR provided best throughput in VBR traffic mode.

The performance of AODV and DSR in different scenarios was surveyed in [11] and found that DSR protocol achieved better performance in small network and low mobility scenario. Performance of AODV was good when node density and mobility was high.

A study for the evaluation of the performance of DYMO, DSR and AODV using QualNet identified in [12] that the energy consumption in DYMO was maximum compare than DSR and AODV. Average jitter for DYMO was high and lowest for AODV. Throughput for AODV was best in increased load and in high mobility.

The working of STAR and OLSR protocols for 50 mobile nodes is compared in [13]. This study was performed with three CBR connections and random waypoint mobility model using QualNet simulator. Simulation results indicated that OLSR performed better compare to STAR protocol

The simulations for analyzing the performance of AODV and DSDV protocols have been carried out in [14] in term of throughput, routing overhead and energy consumption using academic simulator GloMoSim. Simulation results indicated that AODV has shown higher throughput with lower routing overhead compare than DSDV in case of both simulated scenarios. DSDV consumed less energy than AODV.

The simulation study of the AODV, DYMO and ZRP routing has been done in [15] using energy models. Simulation results are indicated that ZRP routing protocol performed superior than AODV and DYMO and less energy was consumed in transmit and receive state by the mobile nodes using all energy models. But on the other hand DYMO consumed less energy compared than AODV and ZRP in case of idle state using all energy models. As per other investigations, the Mica-Motes energy model was found superior for AODV, DYMO and ZRP respectively as compared to other energy models on the basis of energy consumed in transmit and receive state by mobile nodes. In case of energy consumed in idle state by the mobile nodes, MicaZ energy model was found more appropriate than Generic and Mica-Motes energy models.

The comparative study of AODV, DSR and DSDV in mobility and non mobility scenarios concluded that AODV had the best all round performance [16]. Throughput for AODV was better than DSR routing protocol in mobility scenario (MANET) and almost same on stable node. DSDV had very low throughput than both AODV and DSR routing protocols. Packet delivery ratio of DSDV was very good performance than AODV and DSR in both scenarios for up to 300 nodes.

A critical analysis of routing protocols with reference to effect of mobility on energy consumption in MANETs routing protocols was carried out in [3]. It was cleared from the study that the energy is the main factor in MANETs as every node can function or alive till his battery life. However, it is also clearly indicated that the mobility has an adverse effect on the performance of MANET routing protocols.

IV. SIMULATION SCENARIO AND RELATED PARAMETERS

The following Tab.-1 represents the simulation parameters that have been used to evaluate the performance of AODV and DSR routing protocols during the simulation in presented work.

Fig. 1 shows the animation view of the simulation carried out using 5 CBR connections using 50 nodes for a MANET under the varying mobility speed.

Tab.-1: Simulation Scenario and Parameters

Parameters	Value
Routing Protocols	AODV and DSR
No. of Nodes	50
Node Placement Strategy	Random
Terrain Size	500 m x 500 m
Radio Type	802.11b
Mobility Model	Random Waypoint
Energy Model	Generic, Mica-Motes, MicaZ
Shadowing Model	Constant
Fading Model	Rayleigh
Speed	0-10, 10-20, 20-30, 30-40 and 40-50 meter/second
Application Layer Traffic Source	CBR Traffic (5 Connections)
Antenna Model	Omni-Directional Antenna
Simulation Time	120 seconds, seed 5
Packet Size	512 bytes

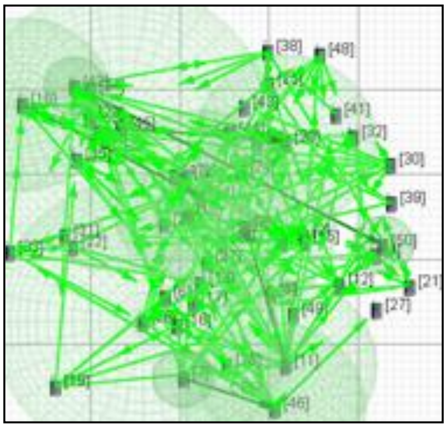

Fig.1: Animation view of simulation scenarion

V. SIMULATION RESULTS AND ANALYSIS

The performance of AODV and DSR routing protocols using three energy models namely Generic, Mica-Motes MicaZ under varying mobility speed has been carried out in this study. This study is conducted for 50 mobile nodes in the area of 500x500 m2. Performance of AODV and DSR routing protocols has been analyzed under the premise of performance metrics namely throughput, average end to end delay and average jitter using CBR traffic pattern with five connections.

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Tab.-2 Throughput (bits/s)

Protocol	Energy Model	Speed (m/s)				
		0-10	10-20	20-30	30-40	40-50
AODV	Generic	4274.6	4203.2	4239.0	4238.4	4203.2
	Mica-Motes	4275.8	3578.4	4239.8	4239.6	4239.4
	MicaZ	4133.0	4275.4	4240.0	4204.0	4239.6
DSR	Generic	4291.6	4311.6	4255.6	4228.6	4297.6
	Mica-Motes	4299.0	4318.2	4341.4	4300.2	4296.6
	MicaZ	4296.2	4291.2	3566.4	4285.0	4239.0

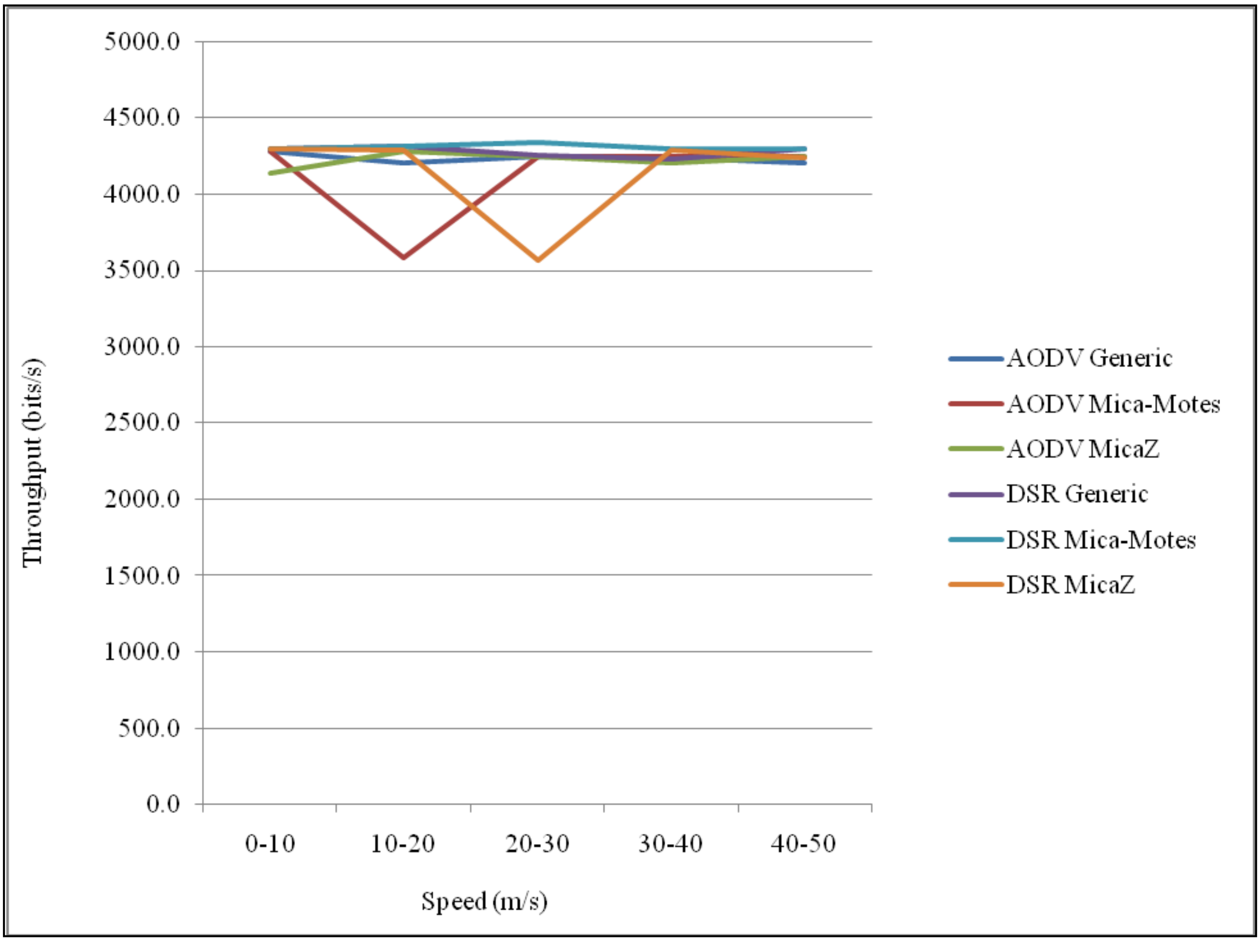

Fig.2: Throughput (bits/s)

Throughput

Performance of AODV and DSR routing protocols have been discussed in this section on the basis of throughput metrics. The results obtained from simulations are indicated that DSR routing protocol outperform AODV routing protocol incase of increasing mobility speed with the Mica-Motes energy model.

The detailed simulation results for throughput have been represented in Tab.-2 and Fig.2. In case of Mica-Motes energy model, DSR routing protocol also outperformed AODV routing protocol in all the cases of varying mobility speed. On the other hand, the performance of DSR routing protocol outperformed AODV routing protocol in all the cases of mobility speed except in mobility speed of 20-30 m/s using MicaZ energy model. Overall, the DSR routing protocol outperformed AODV routing protocol incase of throughput using various energy models under different mobility speeds.

Tab.-3 Average End to End Delay (s)

Protocol	Energy Model	Speed (m/s)				
		0-10	10-20	20-30	30-40	40-50
AODV	Generic	0.0107556	0.0124818	0.0136797	0.0139997	0.0151347
	Mica-Motes	0.0108513	0.0108852	0.0149529	0.0134649	0.0135076
	MicaZ	0.0118447	0.0110448	0.0123605	0.0124921	0.0131055
DSR	Generic	0.0247856	0.0237162	0.0250181	0.0238183	0.0256254
	Mica-Motes	0.0174455	0.0219993	0.0253041	0.0161396	0.0153381
	MicaZ	0.0222777	0.0284831	0.0328923	0.0295350	0.0330269

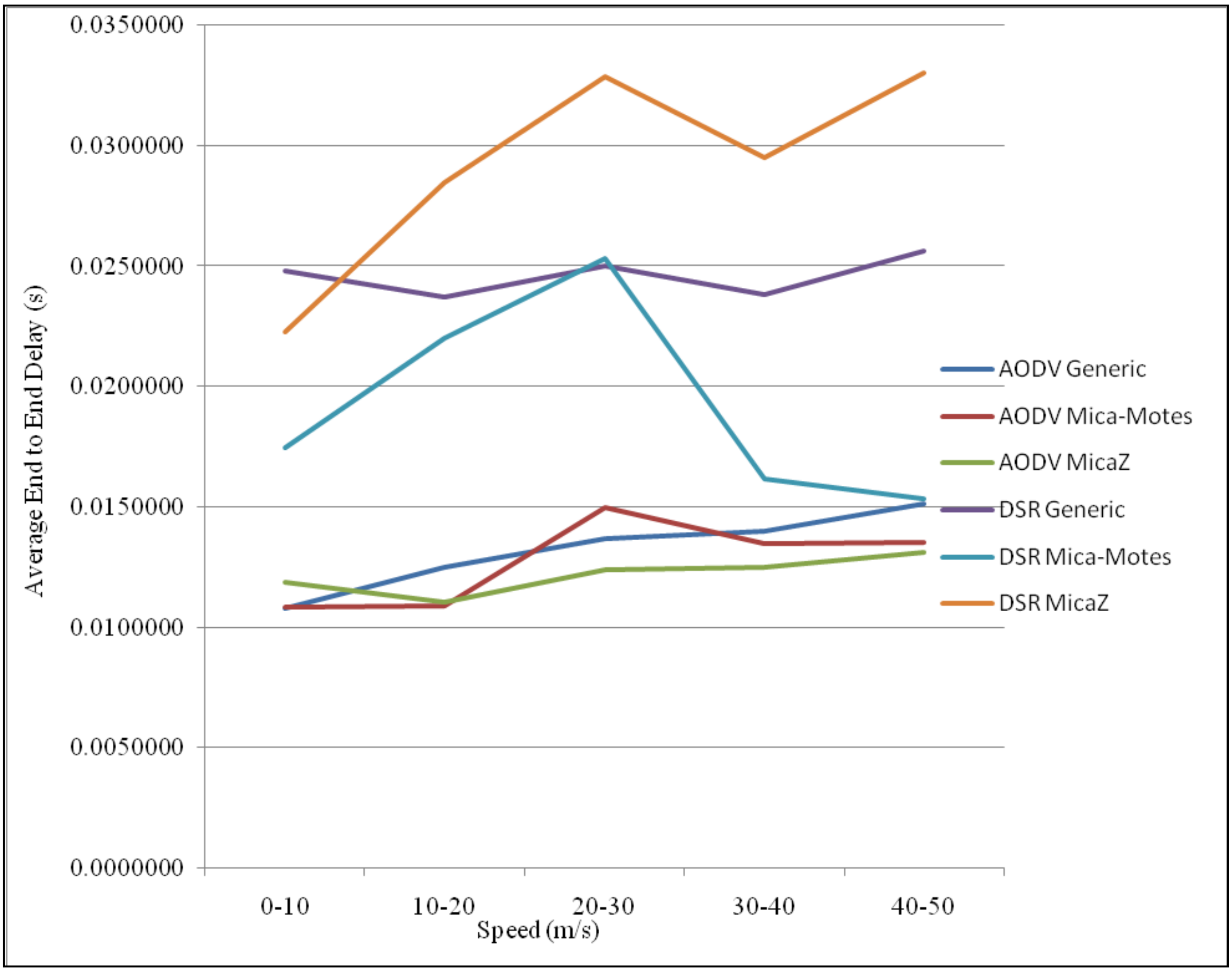

Fig.3 Average End to End Delay (s)

Average End to End Delay

The performance analysis of AODV and DSR routing protocol for average end to end delay metrics using different energy models under varying mobility speed has been presented. From the results, it has been clearly observed that performance of AODV routing protocols is better under MicaZ in high mobility scenario from 20-50 varying speed and in the cases of low mobility i.e. 0-20 speed in comparison of DSR routing protocol. The performance of AODV is also satisfactory incase of MicaZ energy model in most of the cases of increasing varying mobility speed. The similar results have also observed for Mica-Motes energy model. The performance of DSR routing protocol is very poor with increasing mobility speed in case of MicaZ energy model. The overall AODV routing protocol outperformed DSR routing protocol incase of various energy models under varying speed. The performance of both routing protocols is better in case of Mica-Motes energy model under varying mobility speed in case of average end to end delay.

Tab.-4 Average Jitter (s)

Protocol	Energy Model	Speed (m/s)				
		0-10	10-20	20-30	30-40	40-50
AODV	Generic	0.0030145	0.0035757	0.0044462	0.0051005	0.0050463
	Mica-Motes	0.0025676	0.0024044	0.0056990	0.0042573	0.0042933
	MicaZ	0.0029952	0.0029308	0.0035555	0.0038965	0.0043750
DSR	Generic	0.0116959	0.0128009	0.0128933	0.0128340	0.0150543
	Mica-Motes	0.0068668	0.0101228	0.0149086	0.0075100	0.0065763
	MicaZ	0.0090380	0.0131661	0.0163607	0.0177183	0.0172589

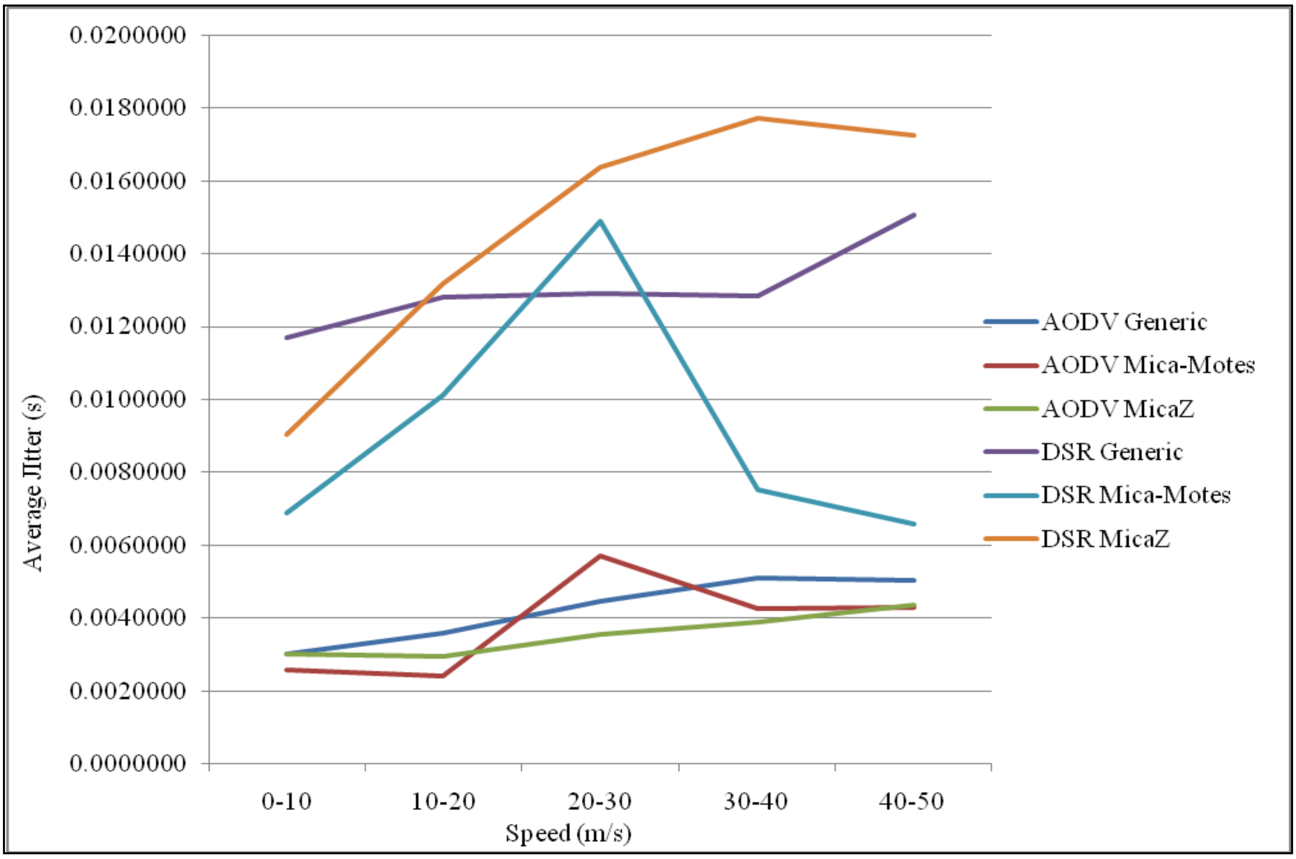

Fig.4 Average Jitter

The detailed simulation results for average end to end delay have been represented in Tab.-3 and Fig.-3. Overall, the AODV routing protocol outperformed DSR routing protocol incase of end to end delay using various energy models under different mobility speeds.

Average Jitter

The simulation results indicated that the AODV routing protocol is having the low average jitter using MicaZ model under increasing varying mobility speed. However, in case of MicaZ energy model, the DSR routing protocol performed burst in comparison of all other energy models. AODV routing protocol is also performed satisfactory for the average jitter in comparison of DSR routing protocols under Mica-Motes and Generic energy model. Overall, the AODV routing protocol outperformed DSR routing protocol for the average jitter performance metrics incase of different varying mobility speed and energy models.

From the above discussion, it has been concluded that the AODV routing protocol outperformed DSR routing protocol in all the cases of varying mobility speed under MicaZ energy model. The MicaZ energy model also supports to the available nodes in the present network scenarios to make them alive for long time in comparison of other energy models. Henceforth, the MicaZ energy model is more suitable in comparison of all other energy model. The detailed simulation results for average jitter have been represented in Tab.-4 and Fig.-4.

VI. CONCLUSION

The performance evaluation of AODV and DSR routing protocols has carried by using different energy models under varying speed from 0-10, 10-20, 20-30, 30-40 and 40-50 m/s for a MANET scenario of 50 nodes network in presence of the random waypoint mobility model. In the study, CBR data traffic model has been used. From the above detailed analysis part, it is concluded that DSR routing protocol outperformed AODV routing protocol in case of throughput. However, on other side AODV routing protocol provide satisfactory performance in case of average end to end delay and average jitter performance metrics in comparison of DRS routing protocol under the various energy models with different mobility speeds. This study can be enhanced using different mobility models and increasing the node density for better adaptability in the practical and real situations.

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