

## **Performance Investigation of DYMO, DSR, AODV and LAR Routing Protocols using Different Mobility and Energy Models in MANETs**

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### **Abstract**

*An ad hoc network is a collection of mobile nodes which communicate with each other using multi-hop wireless links. MANET nodes are equipped with wireless transmitters and receivers. In these networks, nodes act as router as well as host enabling the cooperation between them. In this paper we focus on the impact of mobility models (Random Waypoint and Group Mobility Model) and Energy Models (Mica Motes, Micaz, Generic) on the performance of reactive routing protocols AODV, DSR, DYMO, and LAR. With the help of Qualnet 5.2 simulator, we investigated various scenarios by varying number of nodes, maximum velocity of the mobile nodes, Pause time and Packet size. Performance analysis is carried out on the basis of Throughput, Packet delivery ratio, Jitter, End to End Delay, Total Energy Consumption under mobility and Energy model. This work shows that mobility models and energy models have great effect on the performance of routing protocols.*

**Keywords:** MANET, AODV, DSR, DYMO, LAR, Mobility Models.

### **1. Introduction**

Mobile Ad-Hoc Network is a self-configuring network of mobile nodes connected by wireless. It forms an topology without any use of existing infrastructure [1]. Nodes of Mobile Ad-Hoc network are free to move randomly, therefore topology of the network may change rapidly and may be unpredictable. Because of this unpredictable nature of mobile nodes, traditional protocols are not suitable for mobile ad-hoc network.

#### **1.1. Mobility models**

Mobility of mobile nodes is one of the key parameter that researchers have to consider when they want to analyze the performance of routing protocol in their simulation environment. The mobility models describe the movements of mobile nodes, and how their location, velocity and acceleration changes with time [2].

In this we consider two mobility models i.e. Random Waypoint and Group Mobility Model.

The Random Waypoint Mobility Model includes pause times between changes in direction and/or speed. An Nodes

begins by staying in one location for a certain period of time which ( a pause time). Once this time expires, the Node chooses a random destination in the simulation area and a speed that is uniformly distributed between [*minspeed*, *maxspeed*] [3].

Group Mobility Model represents the scenarios in which multiple mobile nodes move in a group generally in the same direction with a short distance of separation [3].

#### **1.2. Routing Protocols**

Due to changing topology of MANET, Routing in such networks is a challenge for transferring information between nodes. Routing protocols for Mobile ad hoc networks has been classified into three categories Proactive, Reactive and Hybrid protocols [2]. Proactive routing protocols attempt to maintain consistent, up-to-date routing information from each node to every other node in the network. Each node maintains tables to store routing information [2]. DSDV, OLSR are example of proactive protocols. Reactive or on demand protocols are based on source initiated on-demand reactive routing. This type of routing discover routes only when a node requires a route to a destination [2]. DSR,

AODV, DYMO and LAR are examples of Reactive Routing Protocols.

**1.2.1. Dynamic Source Routing (DSR).** Dynamic Source Routing (DSR) [9] is a reactive protocol. During route construction phase, RREQ is flooded in network. The destination nodes respond by RREP, which carries the route traversed by the RREQ packet. Each RREQ carries a sequence number generated by source which is used to prevent loop formation and to avoid multiple transmission of the same RREQ by intermediate node that receives it through multiple paths.

**1.2.2. Adhoc on Demand Distance Vector (AODV).** AODV adopts a very different mechanism to maintain routing information. It uses traditional routing tables, one entry per destination. This is in contrast to DSR, which can maintain multiple route cache entries for each destination. AODV uses sequence numbers maintained at each destination to determine freshness of routing information and to prevent routing loops. All routing packets carry these sequence numbers [12].

**1.2.3. Dynamic MANET On-Demand (DYMO).** The basic operations of the DYMO protocol are route discovery and route management. During route discovery, the source node initiates a RouteRequest (RREQ) throughout the network to find a route to the destination node. During this hop-by-hop dissemination process, each intermediate node records a route to the source node. When the destination node receives the RREQ, it responds with a Route Reply (RREP) sent hop-by-hop toward the source node. Each node that receives the RREP records a route to the destination node, and then the RREP is unicast hop-by-hop toward the source node. When the source node receives the RREP, routes have then been established between the source node and the destination node in both directions [9].

**1.2.4. Location Aided Routing (LAR).** LAR exploits position information. It was proposed to improve the efficiency of the route discovery procedure by limiting the scope of route request flooding. In LAR, a source node estimates the current location range of the destination based on information of the last reported location and mobility pattern of the destination. In LAR, an expected Zone is defined as a region that is expected to hold the current location of the destination node. During route discovery procedure, the route request flooding is limited to a request zone, which contains the expected zone and location of the sender node [11].

We have taken four routing protocols DSR, AODV, DYMO, LAR against two Mobility Models (Random Waypoint, Group Mobility Model) and three Energy Models. We tried to analyse the performance of these protocols on the basis of performance metrics like throughput, packet delivery ratio (PDR), end to end delay, jitter and total energy consumption through simulations. The rest of the paper is organized as follows: Section 2 describes related work. Section 3 describes the simulation scenario, Section 4 describes results and Section 5 concludes the paper.

### 1.3. Radio Energy Model

A Radio Energy Model computes the energy consumed in transmitter and receiver circuitry and power amplifier of the transmitter in the various power state functions of the Radio (primarily transmit, receive, idle and sleep modes). Reactive routing protocols consume no energy in sleep mode. There are various energy modes which are following: MICA<sub>Z</sub>, MICA-MOTES, GENERIC are the three energy models.

## 2. Related Work

Liu Tie-yuan, et. al's [6] presented the effect of different entity mobility models on the performance of MANET routing protocols are analyzed. This study is significant in practice for the simulation study of MANET as well as for the design and improvement of mobility models.

Nadir Shah, et. al's [7] evaluate the performance of multiple routing protocols (DSDV, DSR, OLSR, AODV) using most common mobility models (RW, RD, RWP) for mobile ad hoc networks.

Asma Tuteja, et. al's [8] have compared the performance of three protocols (AODV, DSDV, DSR). In this paper, The performance matrix PDR, Throughput, End to End Delay, Routing Overhead compared when Packet size changes, when time interval between packet sending changes, when mobility of node changes.

Lakhan Dev Sharma, et. al's [9] analysed analyzes the effect of mobility on performance of three MANET on-demand routing protocols i.e. DYMO, DSR, AODV. The performance metrics for analysis consists of different parameters such as throughput, Packet delivery ratio, average end-to-end delay and average jitter.

S. Mohapatra, et. al's [10] analysed the performance of AODV, DSR, OLSR and DSDV protocols using NS2 simulator. The delay, throughput, control overhead and packet delivery ratio are the four common measures used for the comparison of the performance of above protocols.

Pooja jolly, et.al's [13] analysed four routing protocols AODV, ZRP, DSR, and DYMO are analyzed and compared by using QualNet simulator on the basis of performance metrics such as Throughput, Average End-to-End Delay, Average Jitter, Total Packets Received, Packet Delivery Ratio, Energy Consumption in transmit mode, receive mode, sleep mode and idle mode. The results are taken, examined and analyzed in order to test the efficiency of these four protocols using different energy models.

S. R. Biradar, et. al's [15] has compared the performance of two on demand routing protocols for mobile ad hoc networks DSR and AODV. They demonstrate that even though DSR and AODV both are on-demand protocol, the differences in the protocol mechanics can lead to significant performance differentials. The performance differentials are analyzed using varying mobility.

## 3. Simulation Scenario

In this paper, an attempt has been made to study and investigate the impact of mobility models and Energy Models on four reactive routing protocols named AODV, DSR, DYMO and LAR1. The simulations are carried out using Qual-Net 5.2 simulator. For the entire simulations traffic source used is CBR, queue length is 50 simulation time is 300 seconds transmission range is 250m within an area of 1500m\*1500m.

**Table 1: Simulation parameters**

Simulation parameters	Value
Dimension of space	1500*1500
Network Type	Mobile
Node Placement Strategy	Random
Traffic source	C B R
Network size (Number of nodes)	20,40,60,80,100
Pause time	2s,4s,6s,8s,10s
Velocity	10mps, 20mps, 30mps, 40mps, 50mps
Protocols	AODV, DSR, DYMO, LAR1
Mobility Model	Random Waypoint, Group Mobility Model
Item size	500,1000,1500 bytes
Energy Models	Mica Motes, Micaz, Generic
Source data pattern	4 packets/sec
Maximum size of buffered packets	50
MAC protocol	802.11
Transmission range	250m
Simulation time	300 seconds

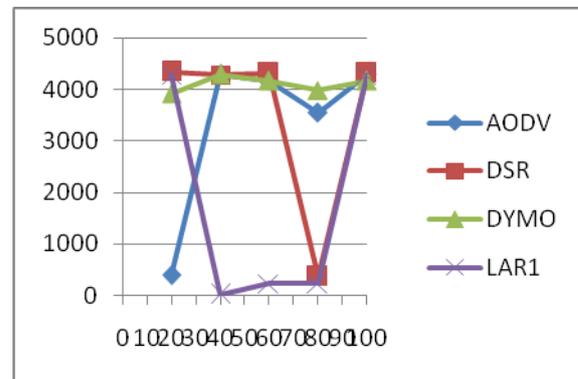
#### 4. Results Investigation

An attempt has made to evaluate the performance of (DSR, AODV, DYMO and LAR1 ) reactive routing by varying the Mobility pattern ( Pause time and Velocity), Energy Model and Number of nodes, Packet size.

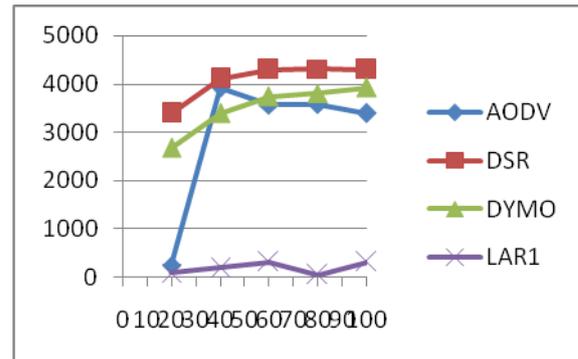
##### 4.1. Throughput

It is defined as the amount of data a receiver receives from the sender divided by the time it takes from the receiver to get the last packet.

From Figure 4.1.1 and 4.1.2, it is clear that with increasing nodes, on average, DYMO shows best performance for throughput in case of Random Mobility Model and DSR is best in Group Mobility Model. LAR1 shows worst performance for throughput in both Mobility models.

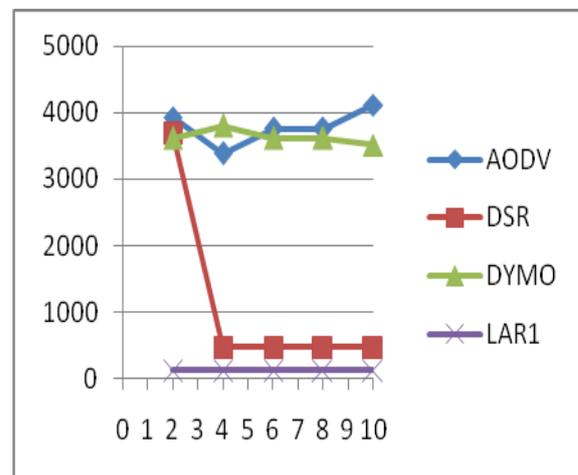


**Fig. 4.1.1 No. of Nodes v/s Throughput for RWP**

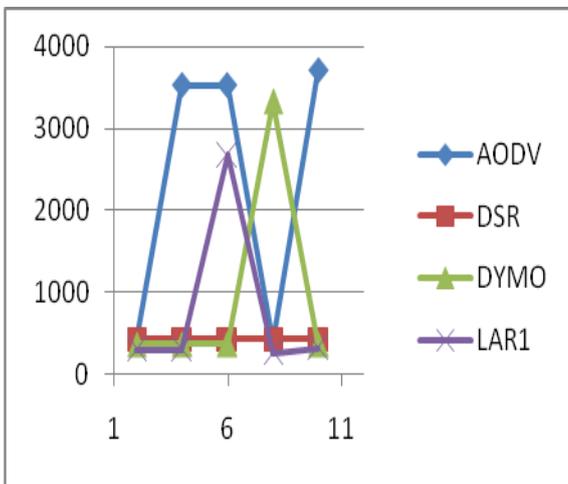


**Fig. 4.1.2 No. of nodes v/s Throughput for Group Mobility Model**

Figure 4.1.3 and 4.1.4 shows the throughput with respect to increasing pause time. It shows that AODV shows the best performance in terms of throughput of for variable pause time under both Mobility Models. LAR1 shows poor performance in both cases.

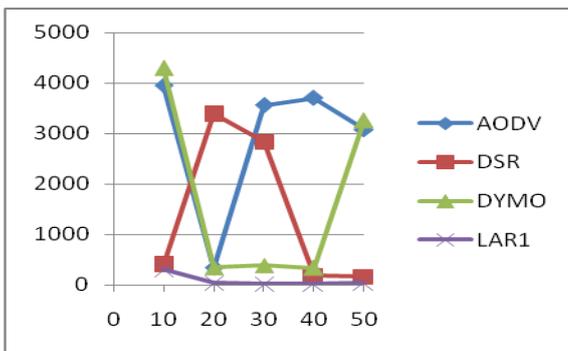


**Fig. 4.1.3 Pause Time v/s Throughput for Random Waypoint**

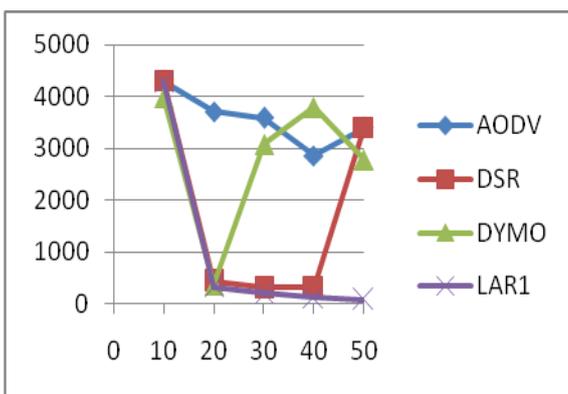


**Fig. 4.1.4 Pause Time v/s Throughput for Group Mobility Model**

Figure 4.1.5 and 4.1.6 shows Throughput with respect to increasing maximum velocity. With increase in velocity, performance of AODV increases in random Mobility Model and decreases in Group Mobility model. Overall AODV shows best performance in both mobility Models. LAR1 shows worst performance in both cases.

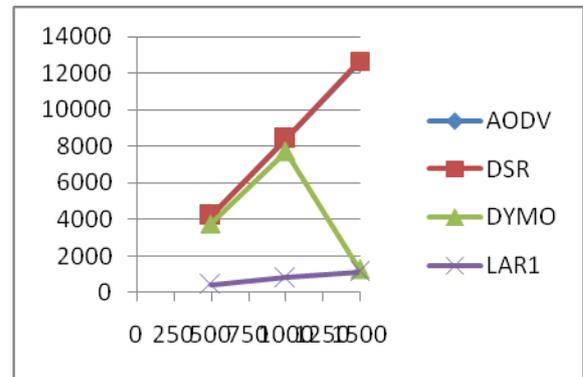


**Fig. 4.1.5 Maximum Velocity v/s Throughput for Random Waypoint**

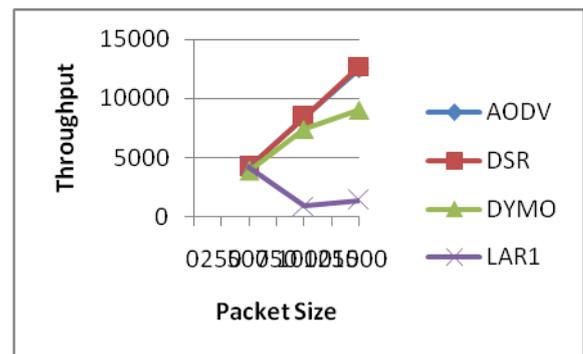


**Fig. 4.1.6 Maximum Velocity v/s Throughput for Group Mobility Model**

Figure 4.1.7 and 4.1.8 shows throughput with respect to increasing Pause Time. DSR and AODV are best in both cases and perform almost equally and its throughput increases with increase in packet size. LAR1 gives worst performance in both Mobility Models.



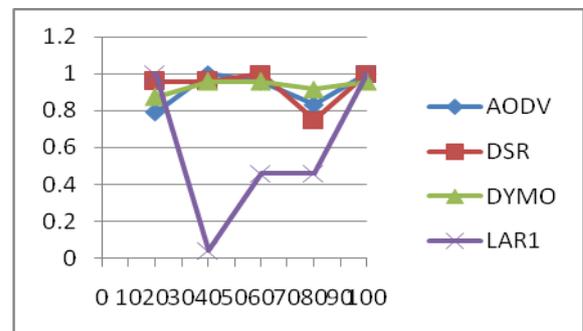
**Fig. 4.1.7 Packet Size v/s Throughput for Random Waypoint**



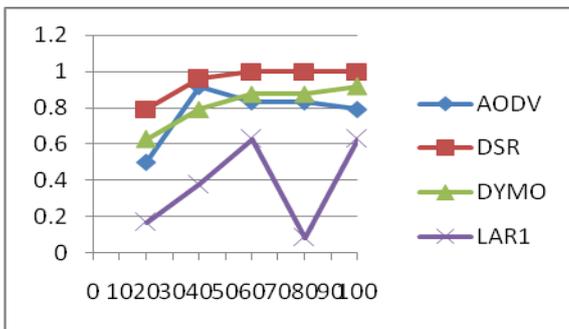
**Fig. 4.1.8 Packet Size v/s Throughput for Group Mobility Model**

## 4.2. Packet delivery ratio

It is obtained by dividing the number of packets received by the destination through the number of packets originated by the application layer of the source i.e. (CBR source). From Figure 4.2.1 and 4.2.2, it is clear on average; DSR shows best performance for PDR in case of both Random and Group Mobility Model. LAR1 shows worst performance for throughput in both Mobility models and its performance first decreases and then increases in Random mobility model.

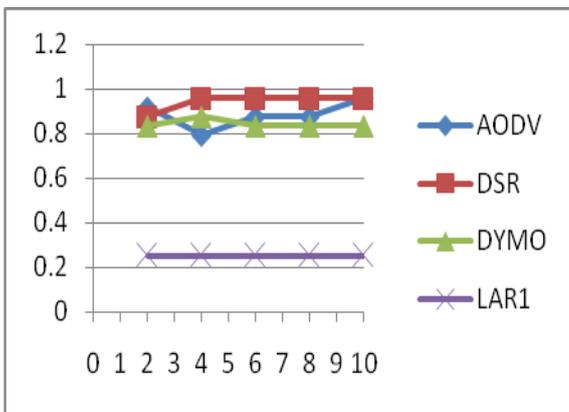


**Fig. 4.2.1 No. of Nodes v/s PDR for Random Waypoint**

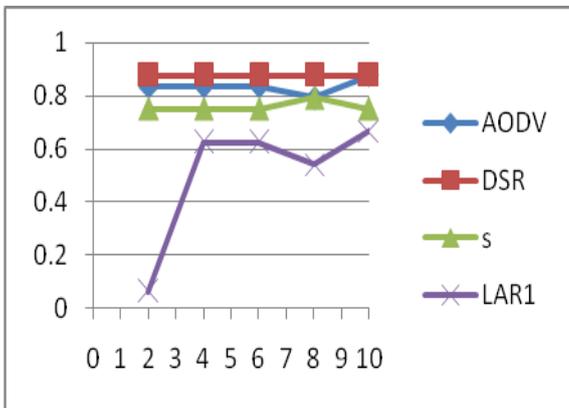


**Fig. 4.2.2 No. of Nodes v/s PDR for Group Mobility Model**

Figure 4.2.3 and 4.2.4 shows the PDR with respect to increasing pause time. It shows that DSR shows the best performance in terms of PDR for variable pause time under both Mobility Models. LAR1 shows poor performance in both cases and its performance increases with increase in pause time in Group Mobility model.

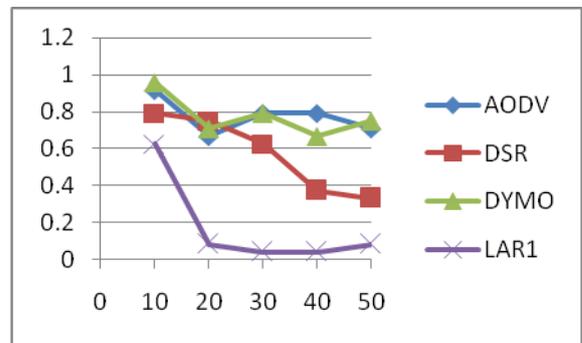


**Fig. 4.2.3 Pause Time v/s PDR for Random Waypoint**

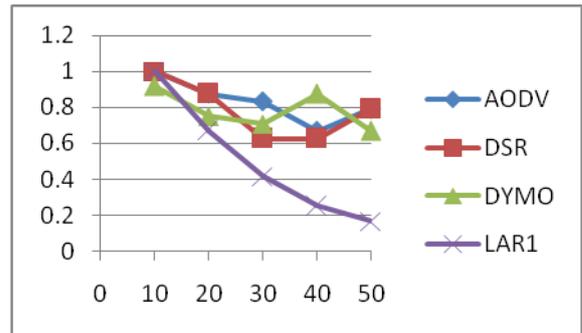


**Fig. 4.2.4 Pause Time v/s PDR for Group Mobility Model**

Figure 4.2.5 and 4.2.6 shows PDR with respect to increasing maximum velocity. AODV and DYMO perform almost equally and show highest performance for PDR and Lar1 shows poor performance in both Mobility Models. Overall AODV shows best performance in both mobility Models. On average performance of all protocols decrease with increase in velocity of nodes.

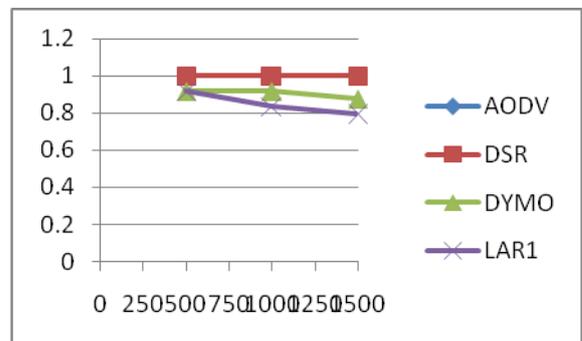


**Fig. 4.2.5 Maximum Velocity v/s PDR for Random Waypoint**



**Fig. 4.2.6 Maximum Velocity v/s PDR for Group Mobility Model**

Figure 4.2.7 and 4.2.8 shows PDR with respect to increasing Pause Time. DSR is best in both cases and its PDR remains constant with increase in packet size. LAR1 and DYMO gives worst performance in both Mobility Models and their performance decrease with increase in packet size.



**Fig. 4.2.7 Packet Size v/s PDR for Random Waypoint**

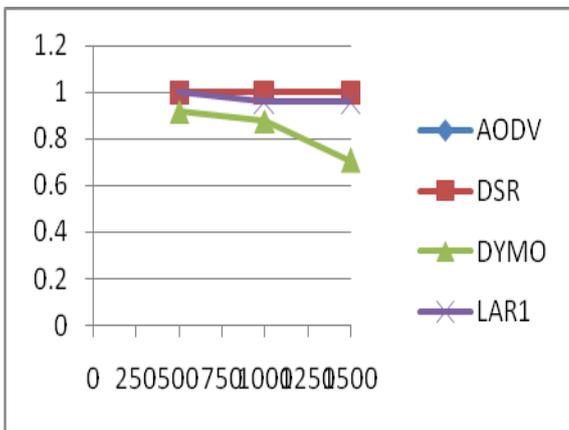


Fig. 4.2.8 Packet Size v/s PDR for Group Mobility Model

### 4.3. The average End-to-End Delay

It is the time interval when a data packet generated from the CBR source is completely received to the application layer of the destination.

From Figure 4.3.1 and 4.3.2, it is clear that with increasing nodes, on average, LAR1 shows best performance for average End to End Delay in case of both Mobility Models and DYMO shows worst performance for average End to End Delay in both Mobility models.

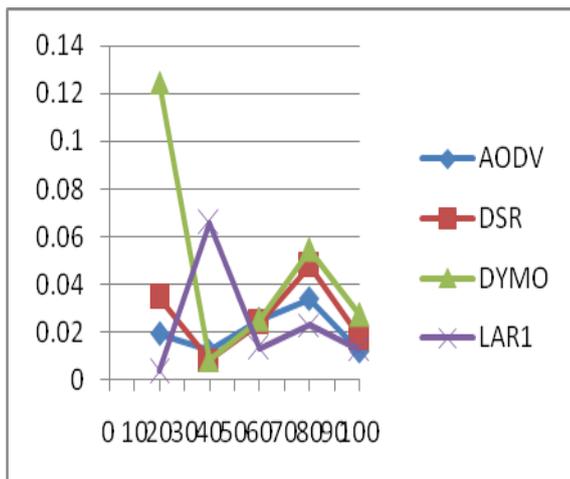


Fig. 4.3.1 No. of Nodes v/s Average End-to-End Delay for Random Waypoint

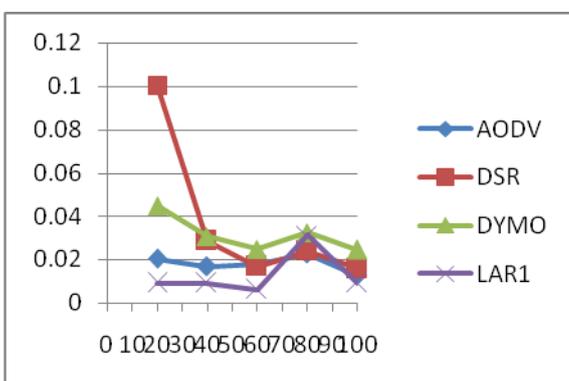


Fig. 4.3.2 No. of Nodes v/s Average End-to-End Delay for Group Mobility Model

Figure 4.3.3 and 4.3.4 shows average End to End Delay with respect to increasing pause time. On average AODV shows the best and DYMO shows worst performance in terms of average End to End Delay for variable pause time under both Mobility Models.

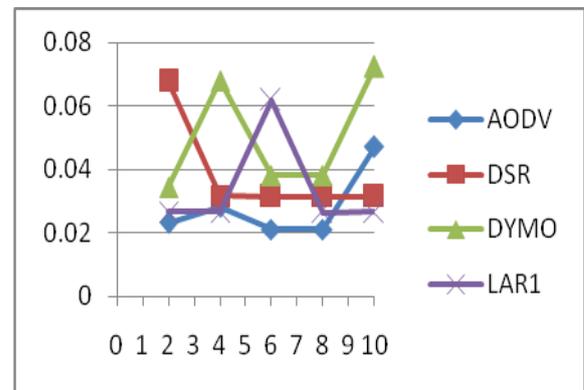


Fig. 4.3.3 Pause Time v/s Average End-to-End Delay for Random Waypoint

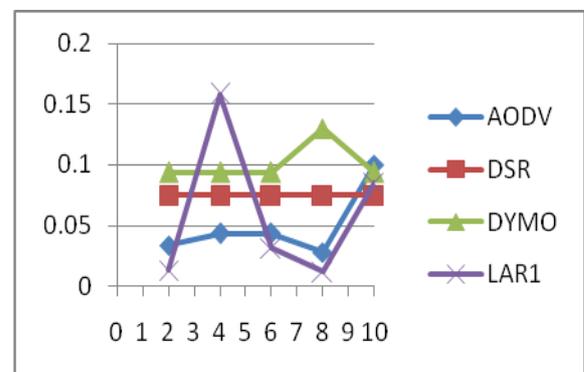


Fig. 4.3.4 Pause Time v/s Average End-to-End Delay for Group Mobility Model

Figure 4.3.5 and 4.3.6 shows average End to End Delay with respect to increasing maximum velocity. With increase in velocity, AODV and LAR1 are better than DSR and DYMO in both Mobility models. Overall AODV shows best performance in both mobility Models. DSR has poor performance for average End to End Delay and increases with increase in velocity in Random Mobility model.

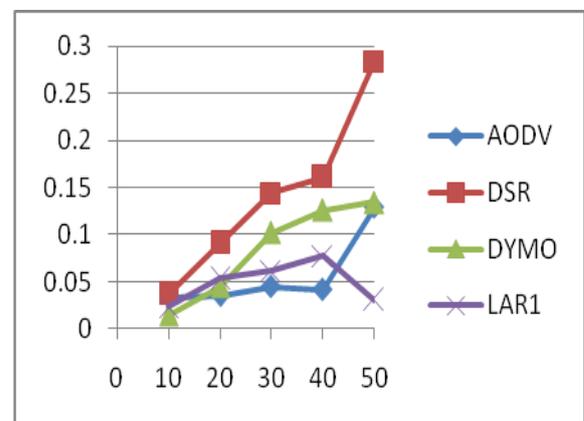
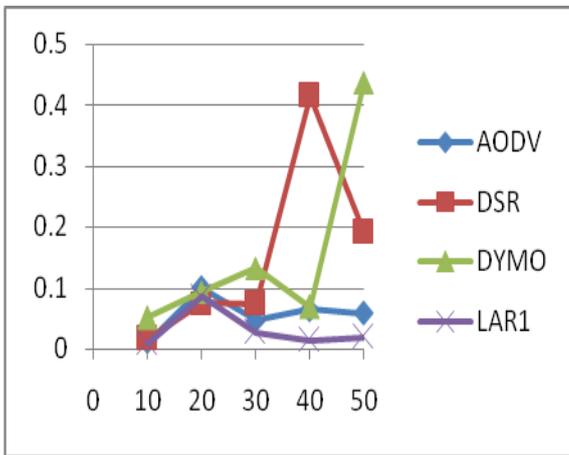
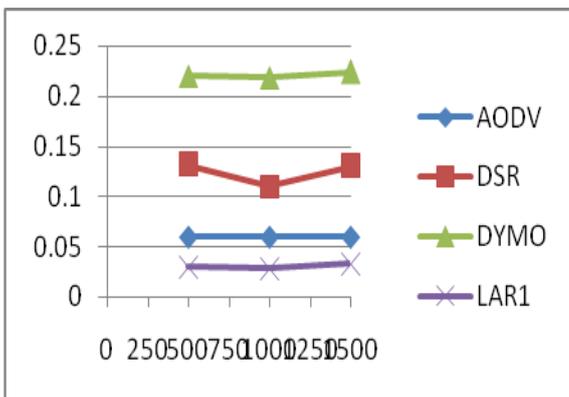


Fig. 4.3.5 Maximum Velocity v/s Average End-to-End Delay for Random Waypoint

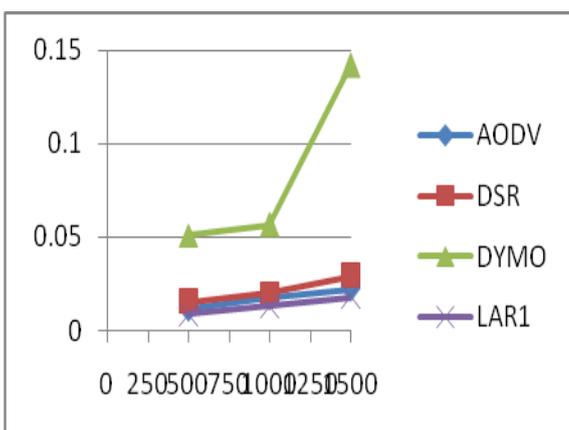


**Fig. 4.3.6 Maximum Velocity v/s Average End -to -End Delay for Group Mobility Model**

Figure 4.3.7 and 4.3.8 shows average End to End Delay with respect to increasing Pause Time. LAR1 is best in both cases. DYMO gives worst performance in both Mobility Models. Packet size has minor effect on the performance of all four protocols.



**Fig. 4.3.7 Packet Size v/s Average End -to -End Delay for Random Waypoint**

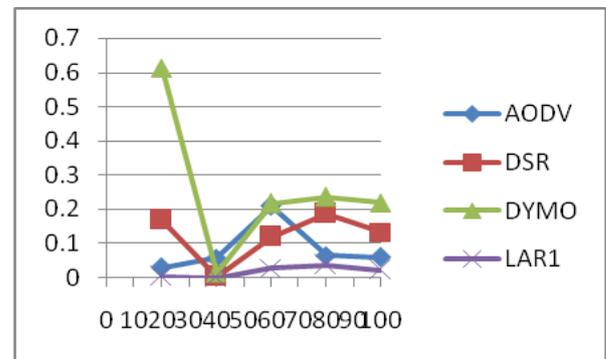


**Fig. 4.3.8 Packet Size v/s Average End -to -End Delay for Group Mobility Model**

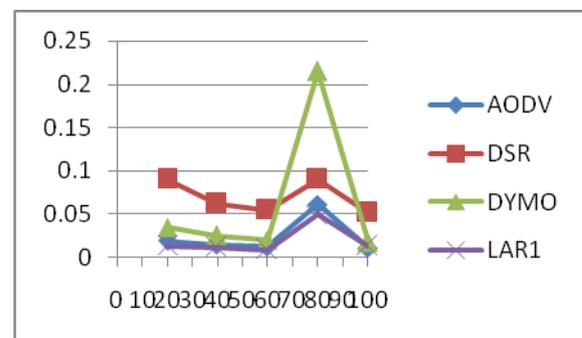
#### 4.4. Average Jitter

It is the time interval between subsequent packet arrivals.

From Figure 4.4.1 and 4.4.2, it is clear that with increasing nodes, on average, LAR1 shows best performance for Average Jitter in both Mobility Models and DSR is best in Group Mobility Model. LAR1 shows worst performance for throughput in both Mobility models. On average DYMO is worst for Average Jitter in Random Mobility Model and DSR is worst in Group mobility Model.

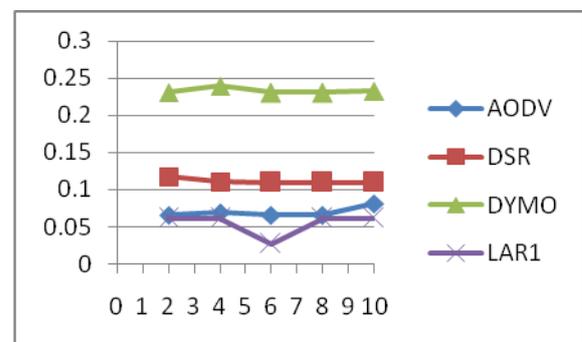


**Fig. 4.4.1 No. of Nodes v/s Average Jitter for Random Waypoint**

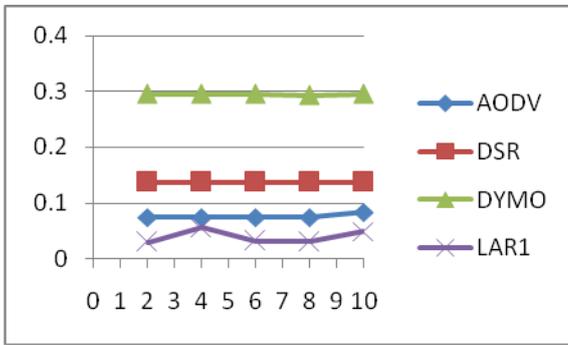


**Fig. 4.4.2 No. of Nodes v/s Average Jitter for Group Mobility Model**

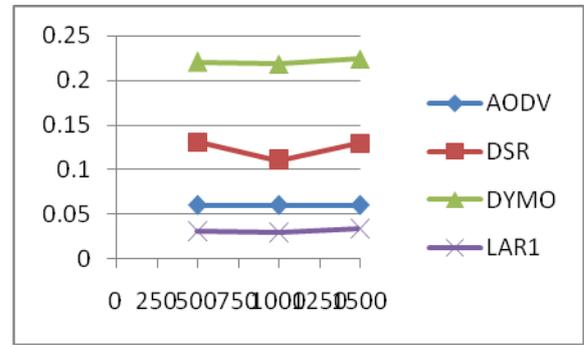
Figure 4.4.3 and 4.4.4 shows the Average Jitter with respect to increasing pause time. It shows that LAR1 shows the best performance in terms of Average Jitter for variable pause time under both Mobility Models. DYMO shows poor performance in both cases.



**Fig. 4.4.3 Pause Time v/s Average Jitter for Random Waypoint**

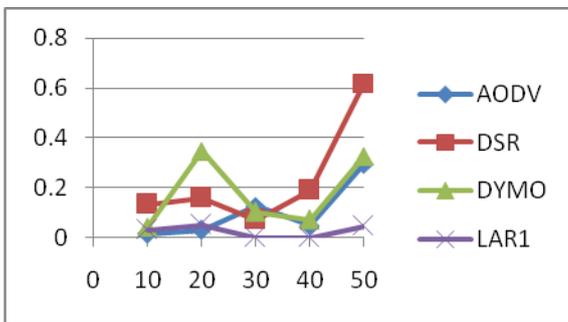


**Fig. 4.4.4 Pause Time v/s Average Jitter for Group Mobility Model**

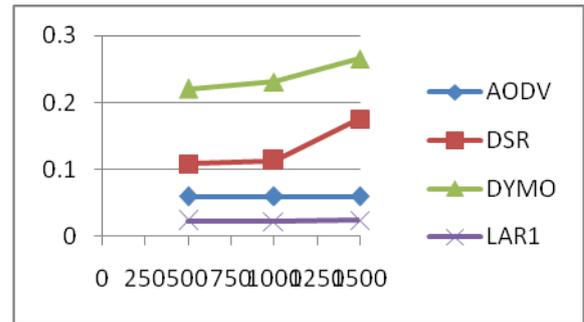


**Fig. 4.4.7 Packet Size v/s Average Jitter for Random Waypoint**

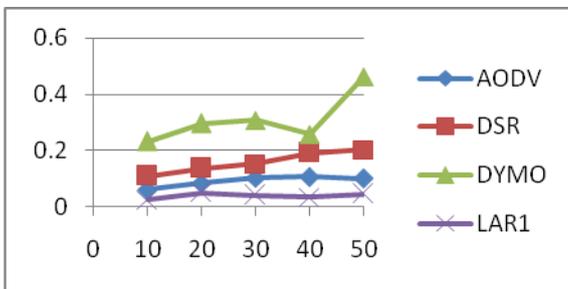
Figure 4.4.5 and 4.4.6 shows Average Jitter with respect to increasing maximum velocity. With increase in velocity, performance of AODV, DSR, DYMO decrease in both Mobility Models. Overall LAR1 shows best performance for Average Jitter in both mobility Models.



**Fig. 4.4.5 Maximum Velocity v/s Average Jitter for Random Waypoint**



**Fig. 4.4.8 Packet Size v/s Average Jitter for Group Mobility Model**



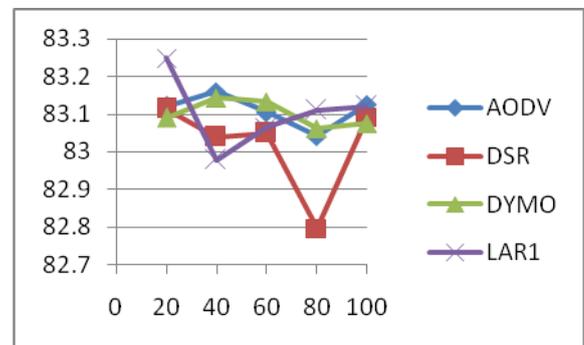
**Fig. 4.4.6 Maximum Velocity v/s Average Jitter for Group Mobility Model**

Figure 4.4.7 and 4.4.8 shows Average Jitter with respect to increasing Pause Time. LAR1 gives best performance in case of jitter and DYMO gives poor performance in both Mobility Models.

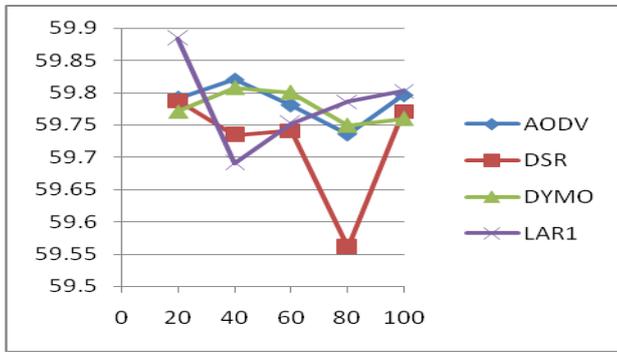
#### 4.5. Total Energy Consumption

The lifetime, scalability, response time and effective sampling frequency, all these parameters of the Mobile Ad-Hoc Networks depend upon the power. Power failure occurs often because of breakage in network. So energy is required for maintaining the nodes, during receiving the packets and transmitting the data as well.

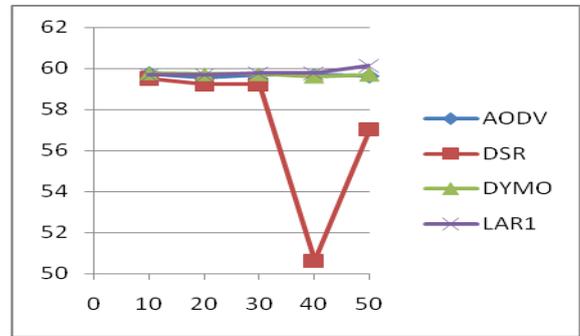
Figure 4.5.1, 4.5.2 and 4.5.3, it is clear that with increasing nodes, on average, DSR consumes less energy in case of all three energy models and DYMO shows highest energy consumption. In all three energy models, Generic energy model gives highest value of energy consumption for all four protocols and Micaz energy model gives lowest value.



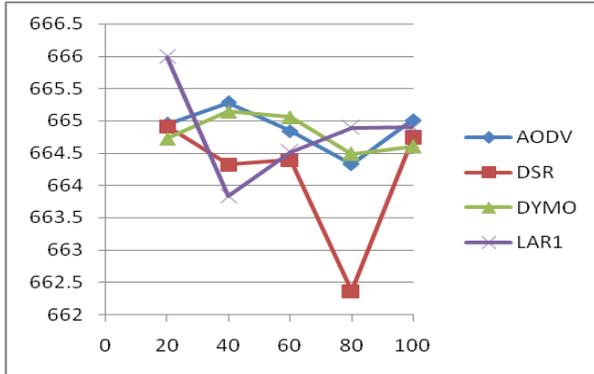
**Fig. 4.5.1: No. of Nodes v/s Total energy consumption in Mica Motes**



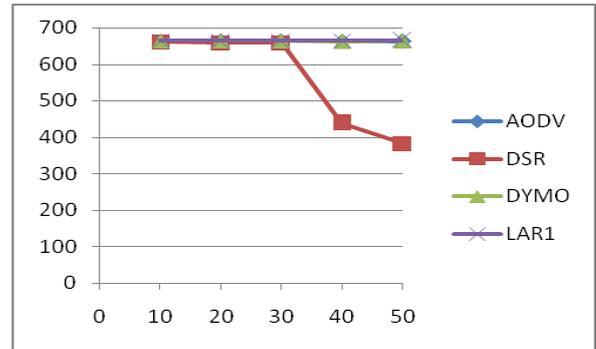
**Fig. 4.5.2: No. of Nodes v/s Total energy consumption in Micaz**



**Fig. 4.5.5: Maximum Velocity v/s Total energy consumption in Micaz**



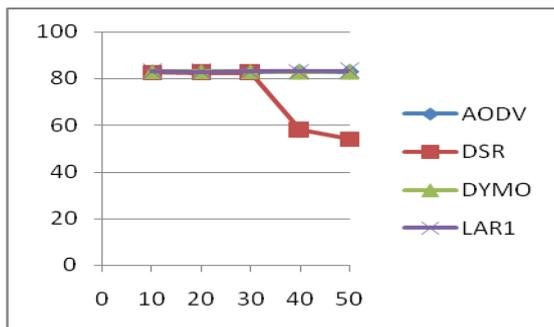
**Fig. 4.5.3: No. of Nodes v/s Total energy consumption in Generic**



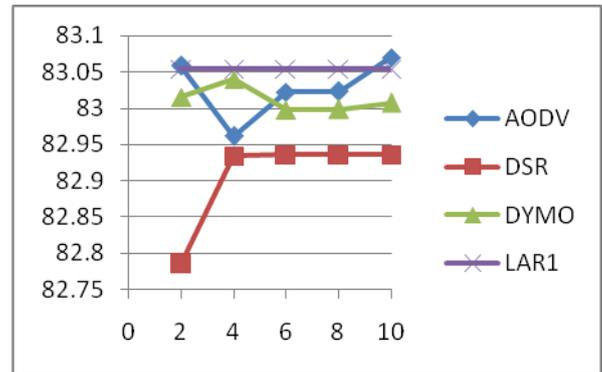
**Fig. 4.5.6: Maximum Velocity v/s Total energy consumption in Generic**

Figure 4.5. 4, 4.5.5 and 4.5.6 shows Total energy consumption with respect to increasing maximum velocity. With increase in velocity, performance of AODV increases in terms of total energy consumption in all three energy models. DSR, DYMO, LAR1 have similar energy consumption. Generic energy model gives highest values for total energy consumption for all four protocols.

Figure 4.5.7, 4.5.8 and 4.5.9 shows the total energy consumption with respect to increasing pause time. It shows that total energy consumption increases with increase in pause time. DSR shows lowest energy consumption among other three protocols and LAR shows highest energy consumption in all three energy models. Generic energy model shows highest value for energy consumption for all four protocols.



**Fig. 4.5.4: Maximum Velocity v/s Total energy consumption in Mica Motes**



**Fig. 4.5.7: Pause Time v/s Total energy consumption in Mica Motes**

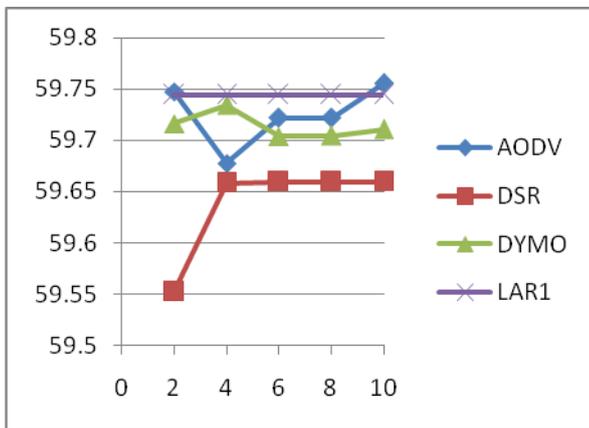


Fig. 4.5.8: Pause Time v/s Total energy consumption in Micaz

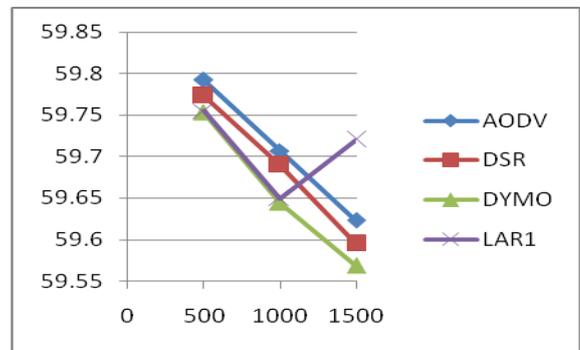


Fig. 4.5.11: Packet Size v/s Total energy consumption in Micaz

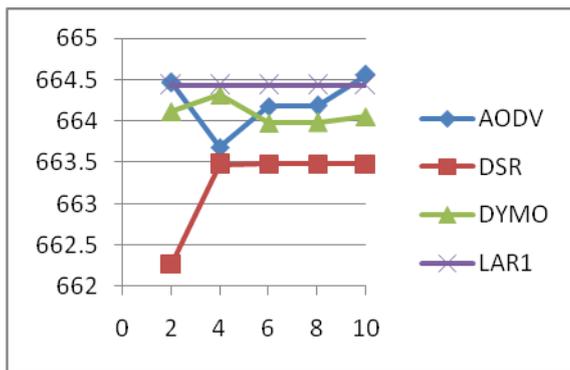


Fig. 4.5.9: Pause Time v/s Total energy consumption in Generic

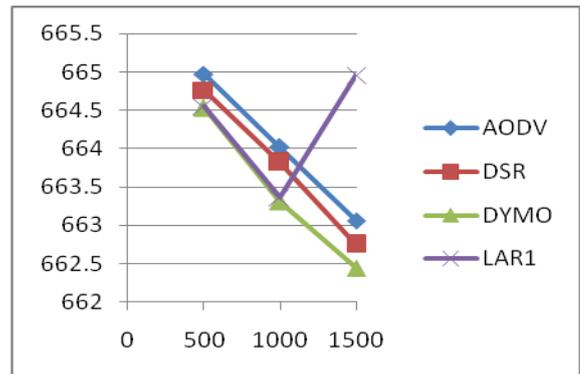


Fig. 4.5.12: Packet Size v/s Total energy consumption in Generic

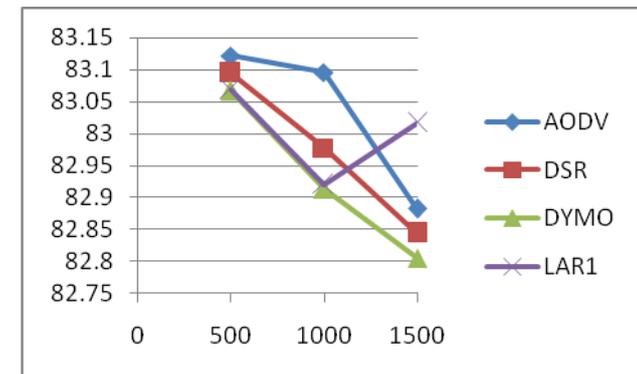


Fig. 4.5.10: Packet Size v/s Total energy consumption in Mica Notes

### 3. Conclusion

Figure 4.5.10, 4.5.11 and 4.5.12 shows the total energy consumption with respect to increasing packet Size. It shows that DYMO shows the best performance in terms of total energy consumption for increasing packet size. AODV shows poor performance in all cases. Micaz gives lowest values of total energy consumption for all four protocols.

We have compared the performance of four reactive routing protocols (AODV, DSR, DYMO, LAR) using four metrics (Throughput, Average Jitter, Average End to End Delay, PDR) under two Mobility Models and three Energy Models. From above investigation it is clear that mobility models and Energy Models have great effect on the performance of all protocols. There are large variations in the value of performance metrics in different Mobility Models. It is clear none of the protocol gives best performance for all the performance metrics. The protocol which gives best performance for one performance metric may poor worst for other metric. LAR1 is better choice for Average Jitter and End to End Delay sensitive application with respect to all performance metrics and in both Mobility Models. AODV is better for PDR with increasing nodes, increasing maximum velocity in Random Mobility Model and DSR is better for PDR in Group Mobility Model. DSR is better for Throughput with increasing nodes, velocity in both Mobility Models. From above analysis it is clear that on average, DSR is better choice in case of total energy consumption. In all three energy models, Generic energy model shows highest value and Micaz energy model shows lowest value of total energy consumption for all four protocols.

### 6. References

[1] Liu Tie-yuan, CHANG Lian, Gu Tianlong "Analyzing the Impact of Entity Mobility Models on the Performance of Routing Protocols in the MANET" Third International Conference on Genetic and Evolutionary Computing , pp.56-59© 2009 IEEE

- [2] Rashmi Rohankar, et. al's, "Performance Analysis of Various Routing Protocols (Proactive and Reactive) for Random Mobility Models of Adhoc Networks", IEEE conf., 2012.
- [3] Tracy Camp, Jeff Boleng, Vanessa Davies, "A Survey of Mobility Models for Ad Hoc Network Research", Wireless Communication & Mobile Computing, vol. 2, no. 5, 2002, pp. 483-502.
- [4] Mehran Abolhasan, Tadeusz Wysocki, Eryk Dutkiewicz, "A review of routing protocols for mobile ad hoc networks", Ad Hoc Networks Elsevier, Vol. 2, 2004, pp. 1-22.
- [5] Anil Bhasin, Dinesh Kumar, "Comparative Study of Chain Mobility Models using Reactive Routing protocols", International Journal of Computer Applications, Vol. 42, No.9, 2012.
- [6] Liu Tie-yuan, CHANGE Liang, Gu Tian-long, "Analyzing the impact of Entity Mobility Models on the Performance of Routing Protocols in the MANET", IEEE conf., 2009.
- [7] Nadir Shah, Depei Qian, Khalid Iqbal, "Performance evaluation of multiple routing protocols using multiple mobility models for mobile ad hoc networks", IEEE conf., 2008.
- [8] Asma Tuteja, Rajneesh Gujral, Sunil Thalia, "Comparative Performance Analysis of DSDV, AODV and DSR Routing Protocols in MANET using NS2", IEEE conf., 2010.
- [9] Lakhman Dev Sharma, Nirmal Roberts, "Effects of Velocity on Performance of DYMO, AODV and DSR Routing Protocols in Mobile Ad-hoc Networks", Procedia Technology, vol. 4, 2012, pp. 727-731.
- [10] S. Mohapatra, P.Kanungo, "Performance analysis of AODV, DSR, OLSR and DSDV Routing Protocols using NS2 Simulator", Procedia Engineering, Vol. 30, 2012, pp. 69-76.
- [11] Dharm Vir, S. K. Agarwal, S.A. Imam, "Quantitative Analyses and Evaluation of MANET Routing Protocols in Effect of Varying Mobility Model using Qual-Net Simulator", IEEE conf., 2012.
- [12] Parul Sharma, Arvind Kalia, Jawahar Thakur, "Performance Analysis of AODV, DSR, DSDV Routing Protocols in Mobile Ad-Hoc Network(MANET)", Journal of Information Systems and Communication, Vol. 3, Issue 1, 2012, pp. 322-326.
- [13] Pooja Jolly, Anjali Goyal, Sandip vijay, "Energy Model based Performance Analysis of Wireless Sensor Networks", International Journal of Computer Applications, Vol. 52, No.18, August 2012.
- [14] Er. Hanisha Goyal, Er. Parveen Kakkar, "Performance Investigation of DYMO, DSR, AODV and LAR Routing Protocols using Different Mobility in MANETs", International Journal of Engineering Research and Technology, Vol. 2, Issue 12, December 2013.
- [15] S. R. Biradar, et. al's, "Performance Comparison of Reactive Routing Protocols of MANETs using Group Mobility Model", IEEE conf., 2009.