Simulation based Comparative Study of MANET Routing Protocols

Bhagyashri R Hanji
Asst Professor Department of CSE
Global Academy of Technology
Bangalore, India

Rajashree Shettar, Ph. D
Professor, Department of CSE
RV College of Engineering
Bangalore, India

ABSTRACT
Mobile Adhoc Networks (MANET) is an infrastructure less mobile network where the nodes communicate with each other inspite of frequent changes in network topology due to mobility, interference and highly error prone environment. Each node operates not only as an end system but also as a router to forward packets. The nodes are liberated to travel and systematize themselves into a network. The vision of mobile adhoc networking is to support robust and efficient operation in mobile wireless networks by incorporating routing functionality into mobile nodes. This paper analyzes the performance of three routing protocols AODV, DSR, DSDV based on Packet Delivery ratio, Packet drop, Energy Consumed, Control overhead and routing overhead using the Discrete Event Simulator [NS2.35-Network Simulator version 2.35]. The results show that the performance of AODV and DSR is better than DSDV.

Keywords
MANET,AODV,DSR,DSDV,CBR

1. INTRODUCTION
Mobile adhoc Network is a dynamic and autonomous network and works without the aid of any centralized authority. MANET nodes are equipped with wireless transmitters and receivers using antennas which may be omnidirectional, highly directional, and possibly steerable or some combination. Due to the mobility of nodes, routing is quite a challenging task. At a given point in time, depending on the nodes location and their transmitter and receiver coverage patterns, transmission power levels, a wireless connectivity in the form of a random, multi-hop graph or "ad hoc" network exists between the nodes. The dynamic topology of the adhoc network leads to the frequent breakup of routes. Route failure affects the connectivity of the network. Moreover the nodes are dependent on the limited battery power [1].

Following are the list of desirable properties of MANET routing protocols: (i) Distributed operation (ii) Loop Freedom (iii) Demand-based operation (iv) Proactive operation (v) Security (vi) "Sleep" period operation (vii) Unidirectional link support [2].

A MANET protocol should function efficiently over large variety of networking context – from small, collaborative, ad- hoc groups to larger mobile, multi-hop networks. There are two types of routing protocols – table driven (proactive) and on demand routing (reactive) protocol. In table driven protocol each node maintains the routing information of all the nodes in the network in advance. Routing information is periodically updated and exchanged among the neighbors. Periodic exchange of routing table information generates large number of overhead bits. Proactive routing refers to the condition that whenever a node has some data for a particular destination it can transmit immediately. Destination Sequenced Distance Vector (DSDV) is an example for proactive routing protocol.

Reactive routing protocol determines the routes as and when it is required by a node in the network. On demand route creation significantly reduces the control overhead. Adhoc on Demand Distance Vector (AODV) and Dynamic Source Routing (DSR) fall under this category.

The remaining paper is organized as follows: In Section 2 AODV, DSR and DSDV protocols have been discussed in brief. Section 3 describes the simulation environment, node properties, various metrics used for performance evaluation of routing protocols. Section 4 gives the graphical simulation results followed by conclusion in Section5.

2. ROUTING PROTOCOLS
2.1 AODV
AODV is an event driven protocol rather than time driven protocol. AODV is a reactive protocol, which plans the path for packets "*as and when*" it desires to. It is a loop free protocol as it maintains a sequence number which is increased every time a change is detected in the environment. There is a minimal routing traffic in the network since routes are built on demand. AODV is mainly an improvement over DSDV. When the network is silent and no route is required, the AODV protocol becomes still. Each node is associated with a routing table having a number of fields which are updated when a communication route needs to be set up between two nodes [1].

2.2 DSR
DSR makes use of source routing in which the source node identifies the complete sequence of nodes through which the data packets will be sent and route caching to store the information of routes. The nodes first check its cache to determine the route availability. If a route exists it is used else the node starts with the route discovery process. DSR maintains multiple route cache for each destination [3].

2.3 DSDV
DSDV is based on the Bellman Ford routing algorithm. Every node maintains a routing table in which the routing information of all possible routes is stored. DSDV protocol provides a unique shortest path to the desired destination among all the possible routes. Route updates are transmitted either periodically or immediately after a significant topology change is being detected. Hence DSDV is both a time driven and an event driven protocol. DSDV protocol generates a large number of overhead bits making it less appropriate for larger network [3].

3. SIMULATION ENVIRONMENT
This section evaluates the performance of the three routing protocols of mobile ad-hoc network using NS2. NS2 as an open source software has attracted much attention in recent years. Although NS2 can be built on various platforms, the experiment

is conducted on LINUX platform. The performance metrics are graphically visualized as shown in graphs below (Fig 1, 2, 3, 4).

Simulation Scenario: The experiment was carried out on the 1000m × 1000m region with 5,15,25,35,45,55 nodes to represent Adhoc network and was simulated for 50,100,200,500,1000ms. Nodes were generated randomly at random position. Totally 30 scenarios were generated (6 for each simulation). The mobility model used is Random Waypoint mobility model because it models the random movement of mobile nodes. Each node moves independently with same average speed and also each node have same transmission range of 250m. To overcome the effect of randomness in the result analysis the average values are considered to get the realistic values.

The simulation results expose some important characteristic differences between the routing protocols.

3.1 Node Properties

The following are the properties set to all the nodes in the experimental region.

Table 1: Node Properties

Method	Value(s)
Channel Type	Channel/Wireless
MAC Type	MAC/802.11
Radio Propagation Model	Propagation/TwoRayGround
Mobility Model	Random Waypoint
Network Interface Type	Phy/WirelessPhy
Interface Queue Type	Queue/DropTail/PriQueue
Antenna	Antenna/OmniAntenna
Source Type	UDP/CBR
Routing Protocol	AODV,DSR,DSDV
Number of Node	5,15,25,35,45,55
Number of Connection (Src-Dest)	2,4,6,8,10
Simulation Time (ms)	50,100,200,500,1000
Initial Energy of a Node	100.0 J

3.2 Performance Metric

The following important performance metrics are considered for evaluation of these three routing protocols:

- ***Packet Delivery Ratio (PDR)***:
  It is the ratio of total number of packets received by the destination to the packets sent by Source node.
- ***Packet Drop (PD):***
  It is the number of data packets that are not successfully sent to the destination.
- ***Control Overhead (CO)***:
  It is the number of Control packets generated by each routing protocol.
- ***Routing Overhead (RO)***:
  It is the number of routing packets transmitted per data packet delivered to the destination.
- ***Energy Consumption (E):***
  It is the average energy consumption by different routing protocols. The number of nodes in the network versus the total consumed energy**.**

4. SIMULATION RESULTS

Following graphs shows the result of comparing the three routing protocols with above mentioned metrics simulated for 5, 15,25,35,45,55 nodes for 50ms, 100ms, 200ms, 500ms and 1000ms with varying number of source destination pairs. The X-axis in all the graphs represent the number of nodes and Y-axis represent packet delivery ratio, routing overhead, control overhead, packet drop and energy consumption respectively.

Figure1 details that, the Packet delivery ratio of AODV and DSR is greater than DSDV. DSDV holds only one path for each destination therefore when the route is destroyed packets is not delivered and is dropped. AODV and DSR packet delivery ratio does not depend on the traffic load. For 1000ms the PDR of AODV reduces to 95.33% where as for DSR it is 98.12% and DSDV at 90.88%.

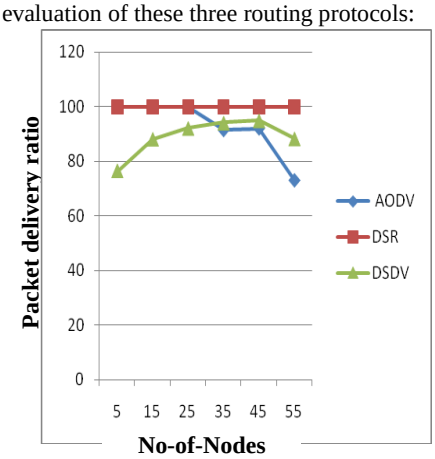

Fig 1.1 : PDR for simulation time=50

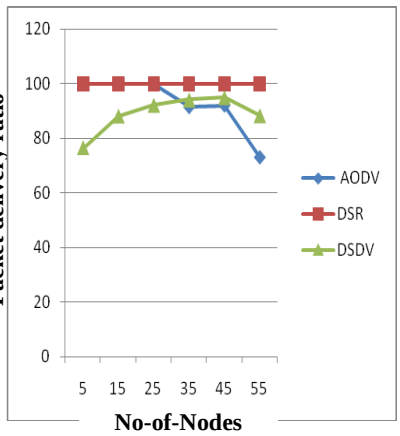

Fig 1.2 : PDR for simulation time=100

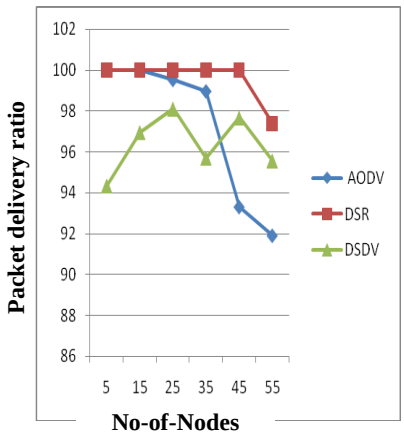

Fig 1.3 : PDR for simulation time=200

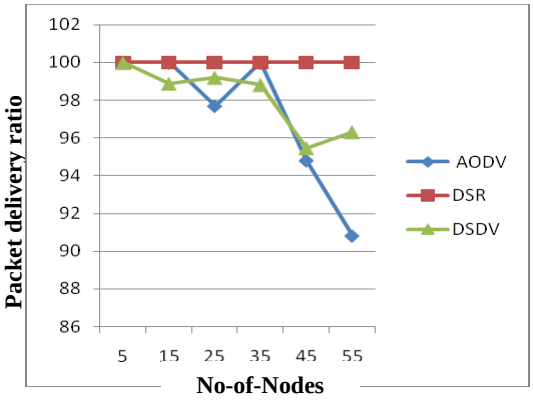

Fig 1.4 : PDR for simulation time=500

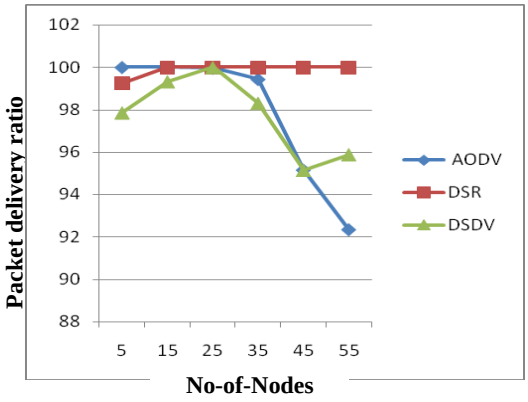

Fig 1.5 : PDR for simulation time=1000

Figure 1 : Packet delivery ratio

Figure 2 below shows the results of routing overhead and control overhead. Overhead in AODV is greater then DSR because of broadcasting of packets to all nodes for each path discovery. DSDV has more overhead (0.034 - 0.11) when compared to AODV and DSR because of the broadcasting of update packets at constant time interval and whenever there is a topology change. DSR has less overhead as it uses caching. Routing load for DSR is more at the initial (0.0061) but reaches the stable state as the time increases (0.0012). The dominance of DSR comes from the nature of its routing operation i.e. source routing which makes the source aware of the entire path the packet will flow. All intermediate nodes use the cache information to transmit the traffic and do not send replies during route discovery. Only the destination node responds with route reply to the route request. The existence of multiple paths in DSR reduces the number of route discoveries in case of link malfunction. DSR also does not broadcast periodic updates which also reduces the overhead. Whereas in AODV the routing load is initially less (0.0044) and later increases (0.033). Control overhead of AODV and DSDV is more compared to DSR and also increases as the number of nodes and Simulation Time increases. In AODV every intermediate node sends route request replies to the source. Control overhead increases due to the multiple route replies to single route request packet. In AODV even if the single node in the path fails a route error message is sent to all its neighbors due to the absence of multiple paths to use. This initiates the full route rediscovery process thus increasing overhead.

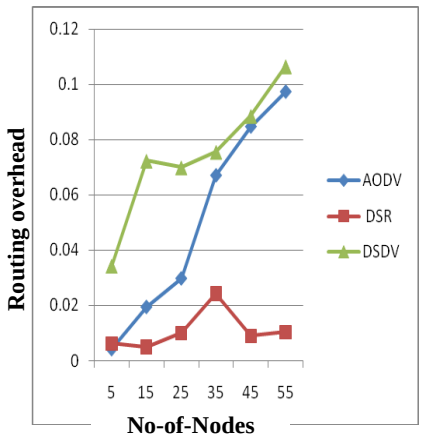

Fig 2.1 : RO for simulation time=50

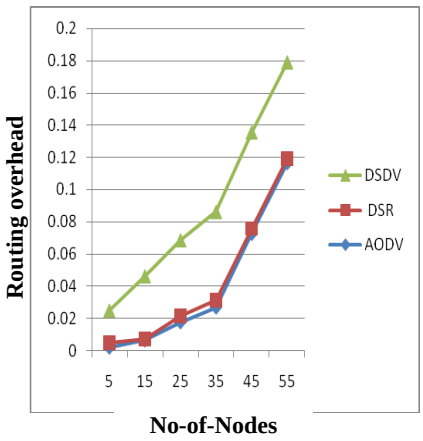

Fig 2.2 : RO for simulation time=100

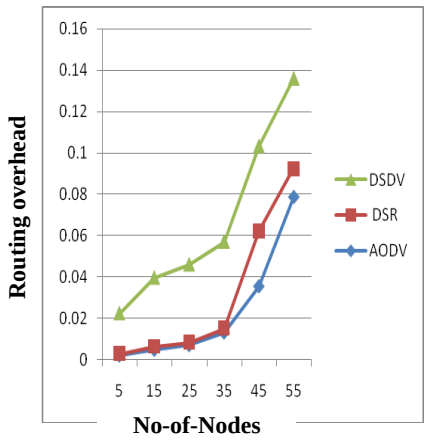

Fig 2.3 : RO for simulation time=200

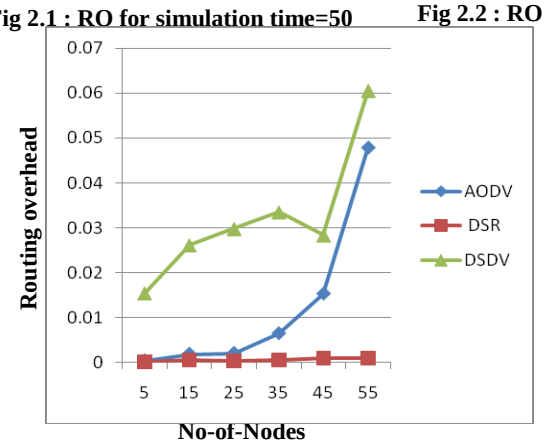

Fig 2.4 : RO for simulation time=500

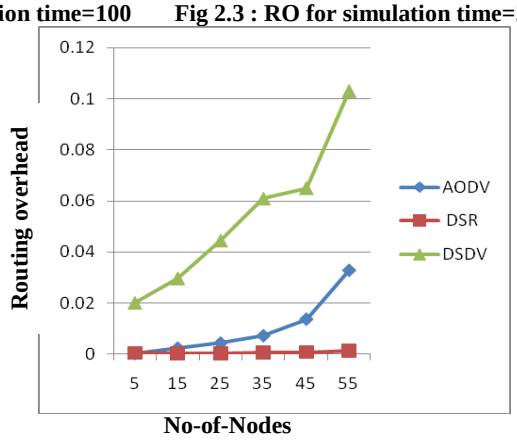

Fig 2.5 : RO for simulation time=1000

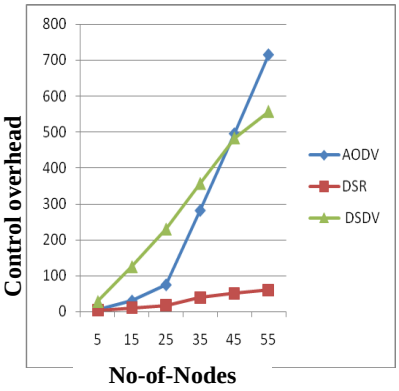

Fig 2.6 : CO for simulation time=50

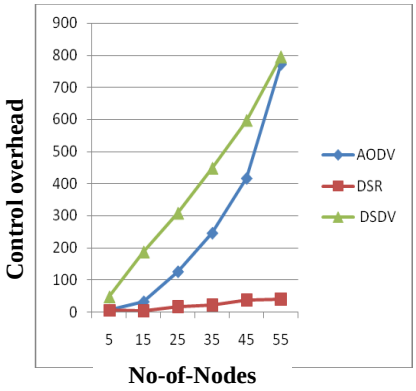

Fig 2.7 : CO for simulation time=100

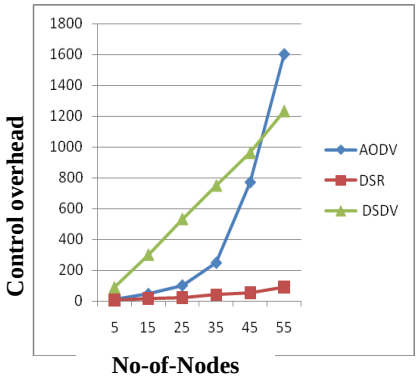

Fig 2.8 : CO for simulation time=200

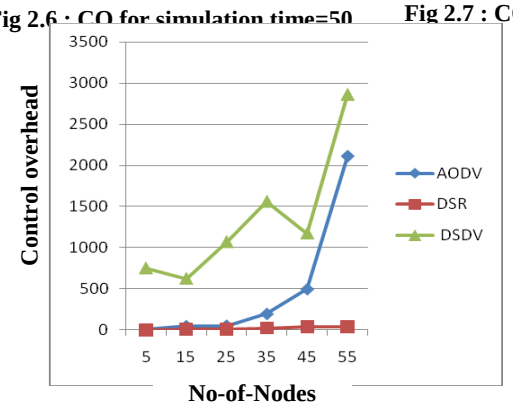

Fig 2.9 : CO for simulation time=500

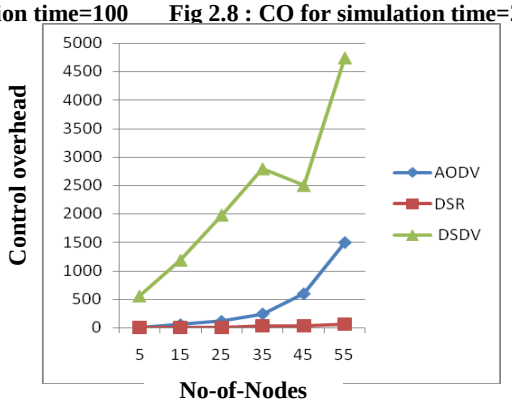

Fig 2.10: CO for simulation time=1000

Figure 2 : Routing Overhead & Control Overhead

Figure 3 shows the packet drop analysis. Packet loss is very less (68) in case of AODV, initially but it increases substantially as the simulation time increases (2450). In case of DSR the packet loss is high initially (183) but it decreases (12) as the simulation time increases. AODV protocol has to be considered if MANET has to be set up for a small amount of time and DSR protocol is to be considered if MANET has to be set up for a long time.

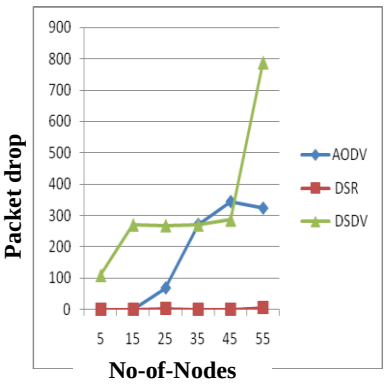

Fig 3.1 : PD for simulation time=50

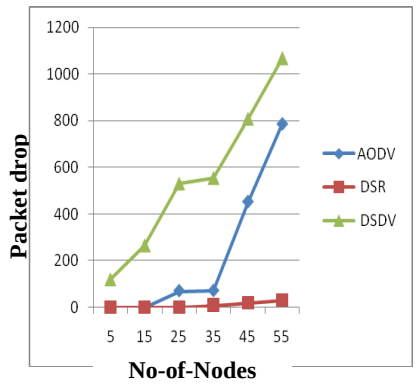

Fig 3.2 : PD for simulation time=100

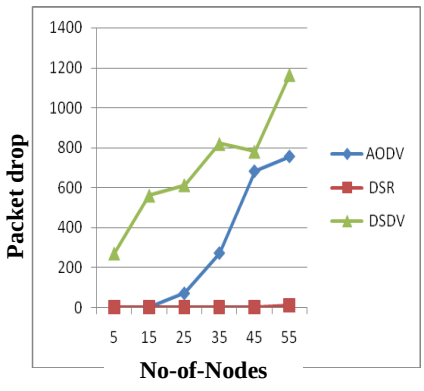

Fig 3.3 : PD for simulation time=200

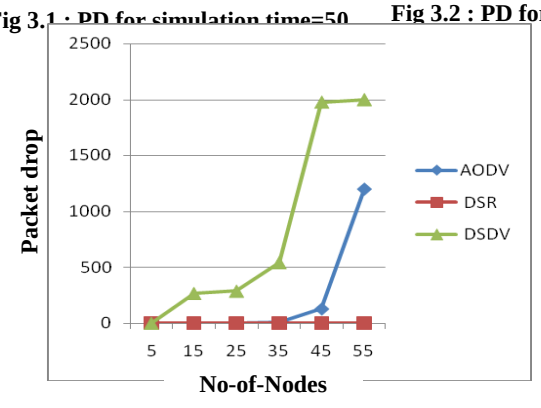

Fig 3.4 : PD for simulation time=500

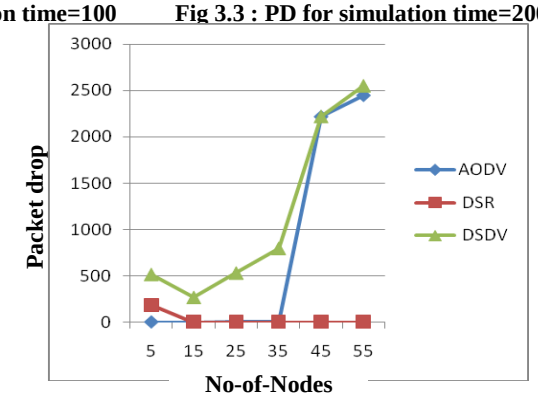

Fig 3.5 : PD for simulation time=1000

Figure 3 : Packet Drop

Figure 4 shows the energy consumption by nodes for the simulation run for 50,100,200,500 and 1000ms. Energy consumption of DSR and AODV are almost same and less than DSDV. DSDV consumes more energy because of its periodic exchange of routing information. At higher level of mobility AODV and DSR have same behavior whereas at low level of mobility DSR is better than AODV.

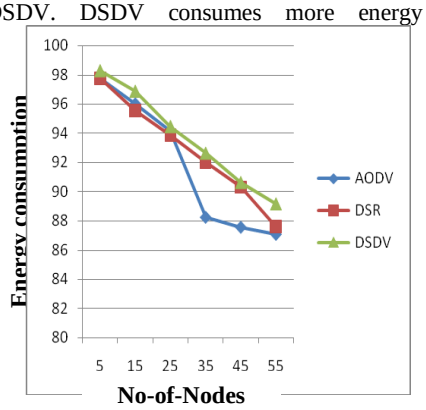

Fig 4.1 : E for simulation time=50

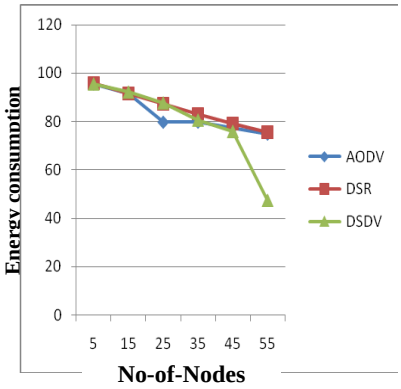

Fig 4.2 : E for simulation time=100

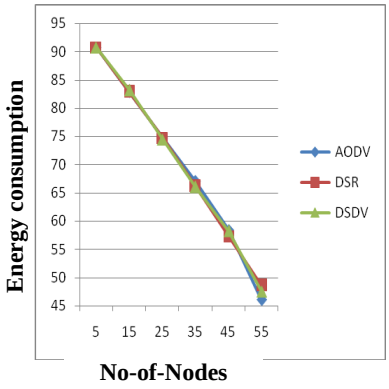

Fig 4.3 : E for simulation time=200

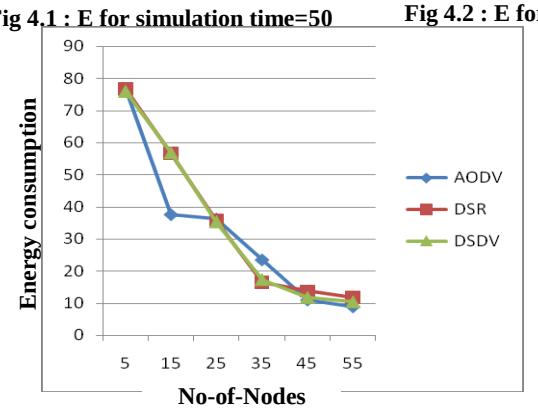

Fig 4.4 : E for simulation time=500

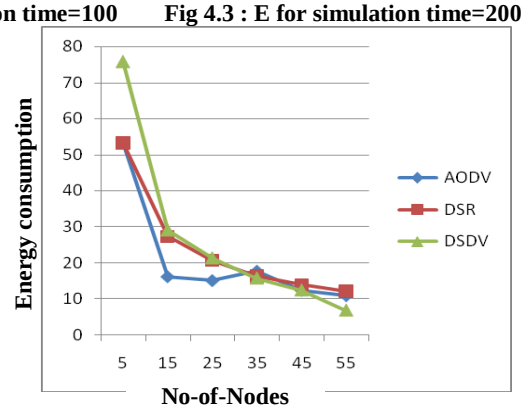

Fig 4.5 : E for simulation time=1000

Figure 4 : Energy Consumption

Following table 2 shows the average result analysis of the three routing protocols.

Table 2: Average result Analysis

Result Analysis							
		Number of Nodes					
		5	15	25	35	45	55
AODV	PDR	100	99.994	99.228	97.308	91.242	84.984
	RO	0.00179	0.00571	0.01191	0.02415	0.04284	0.07605
	CO	5.8	41.8	212.4	242.8	554.8	1339.8
	PD	1	1	240	211	1025	2297.4
	E	82.80568	64.84602	64.04112	55.23074	49.38114	45.54657
DSR	PDR	98.3131	99.9948	99.9879	99.9299	96.1897	99.4684
	RO	0.00317	0.00153	0.00201	0.00315	0.00305	0.00310
	CO	5.4	10	16.8	32.6	41.6	53.2
	PD	0.2	0.4	0.6	0.8	1.8	3.4
	E	82.90268	70.83322	62.26228	54.9312	50.88888	51.0449
DSDV	PDR	91.431	95.4162	97.1545	96.2567	93.4422	93.6286
	RO	0.09422	0.04143	0.04541	0.05466	0.0454	0.07198
	CO	368.2	482.2	815.2	1179.8	755.6	2021.6
	PD	265.2	276.8	324.4	597.4	1115.4	1098.2
	E	82.46234	71.52322	62.68904	55.37062	50.73448	46.21925

5. CONCLUSION

This paper discusses the performance of the three routing protocols by varying selected parameters and it shows that the performance degrades as the number of nodes and simulation time increases. As the network size increases the communication between the source and destination depends on intermediate nodes or neighbors and causes more traffic in the network due to increase in broadcast. The results show that AODV and DSR show a better performance than DSDV.

The Energy Consumption graph shows that DSR consumes less energy when compared to other two routing protocols.

The Routing and Control overhead graphs show that AODV protocol generates more control and routing overhead as the route is established on-demand. DSDV also generates huge routing and control overhead as it exchanges update packets periodically and when there is change in topology.

The routing overhead in DSR is minimum because of the presence of multiple routes and the absence of periodic updates.

The Packet Delivery Ratio graph shows that the PDR for DSR is maximum. As the number of nodes and simulation time increases the PDR ratio goes down for AODV and DSDV.

The Packet Drop graph shows that number of packet drops initially is less in AODV and DSDV but increases gradually as the time increases.

6. REFERENCES

[1] Sachin Dahiya , Manoj Duhan,Vikram Singh, "A Comprehensive Performance Analysis of Routing Protocol for Adhoc Network",IJAET,Vol. 2, Issue 1, pp.587-593, Jan 2012.

[2] S. Corson,J. Macker, Network Working Group, RFC : 2501, Category : Informational, January 1999.

[3] Neha Purushothaman, Neeta Abiraami T N,Sherin Varghese,Varada Sanathanan Menon "Performance Comparison of AODV and DSDV Routing Protocols in MANET Networks," International Journal of Emerging Technology and Advanved Engineering, Vol. 3, Issue 11, November2013.

[4] Pratik Gitel,Manish Sharma,"Performance Evaluation of Ad-hoc Network Routing Protocols using ns2 Simulation",ACEEE Int J. on Network Security, Vol 03, No. 01, Jan 2012.

[5] Anand Nayyar, " Simulation Based Evaluation of Reactive Routing Protocol for MANET",Second International Conference on Advanced Computing & Communication Technologies,2012.

[6] Biswaraj Sen,Sanku Sinha, "A Simulation Based Performance Analysis of AODV and DSDV Routing Protocols in MANETs",IJMER,Vol. 2,Issue 4, July-Aug 2012,pp. 2404-2408.

[7] Mahabaleshwar S kakkasageri, Dr SunilKukmar S Manvi, "Wireless and Mobile Networks : Concepts and Protocols", Wiley India Pvt Ltd, New Delhi .

[8] C. Siva Ram Murthy, B S Manoj,"Ad Hoc Wireless Networks Architectures and Protocols" , Pearson,2nd Edition,2008.

[9] C Perkins,E-Belding-Royer, S Das, Network Working Group Request For Comments : 3561, Category : Experimental,July 2003.