A COMPREHENSIVE PERFORMANCE ANALYSIS OF ROUTING PROTOCOL FOR ADHOC NETWORK

Sachin Dahiya[1], Manoj Duhan[2], Vikram Singh[3]
[1]*Associate Professor, Haryana Institute of Technology, Asodha, Haryana, India*
[2]*Professor, Deptt. of ECE, DCRUST Murthal, Sonepat, Haryana, India*
[3]*Professor, Deptt. of Computer Science, CDLU Sirsa, Haryana, India*

ABSTRACT

Routing is always a challenging task in a mobile adhoc network. Several protocols have been proposed for adhoc network with different functionality. All the protocols have been designed to determine the routes between the communicating nodes based upon different criteria. Due to the movement of the nodes the topology of the adhoc network is not fixed and it poses a challenge for the routing protocol to provide a path from the source to destination in such a dynamic scenario. High mobility combined with the limited energy supply of the nodes affects the performance of the routing protocol. In this paper performance of three major routing protocols DSDV, DSR and AODV have been evaluated in different network condition. Protocols are also tested for energy consumed during packet transmission, network lifetime, average throughput, packet delivery fraction, end to end delay etc.

KEYWORDS: DSDV, DSR, AODV, Adhoc Network

I. INTRODUCTION

Mobile adhoc network [6] is a dynamic network formed by large number of nodes. Adhoc network is an autonomous network and it works without the aid of any centralizing authority. Due to the mobility of the nodes, routing is quite a challenging task. 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. Power shortage in any node may results in the network partitioning.

There are two types of routing protocols for adhoc network, table driven and on demand routing protocol. Table driven protocols are also known as proactive routing 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 neighbor. Periodic exchange of routing table information generates large number of overhead bits. DSDV[1] (Destination Sequenced Distance Vector) is an example of table driven protocol. Proactive routing refers to the condition that whenever a node has some data for a particular destination it can transmit immediately.

On the other hand reactive routing protocol determines the routes as and when it required by a node in the network. On demand route creation significantly reduces the control overhead. Routes are determined by sending route request packet to the immediate neighbors in response to the route request packet intermediate nodes or the destination replied by unicasting the route reply packet. AODV [2] & DSR [3] are the on demand routing protocols.

The remaining paper is organized as follows: In section 1 DSDV, DSR and AODV protocols have been discussed in brief. Section 2 describes the various metrics used for performance evaluation of routing protocols. Section 3 contains the simulation parameters for performance evaluation.

II. DESCRIPTION OF ROUTING PROTOCOLS

In this section basic features of DSDV, DSR and AODV protocols are summarized.

2.1. DSDV (Destination Sequenced Distance Vector Routing)

In this protocol every node in the network maintains the routing tables in which the routing information of all possible routes is stored. DSDV protocol is based on the Bellman- ford routing protocol. DSDV protocols provide a unique path to the desired destination. The selected path will be the shortest route among the entire possible routes. DSDV protocol routing table contains information about all the receivers. The entries present in the routing tables are marked with sequence number. Routes with the latest sequence number are preferred for making the forwarding direction. In order to reduce the amount of control over head the two types of packets are utilized. "Full dump packets" are utilized to convey all the available Information where as the second type of packet called Incremental packet are sent to convey information that has changed after the last full dump packet. In spite of utilizing the incremental packet the DSDV protocols still generates a large number of overhead bits making it less suitable for larger network.

2.2. AODV (Adhoc on Demand Distance Vector Routing)

AODV routing protocols was designed and developed for MANET. AODV basically is an improvement over DSDV. In DSDV the route information of all the possible routes have stored in routing table of a node. AODV minimizes the number of route broad last by creating the routes on demand basis. AODV provide loop free route and maintain a sequence number which if increased every time when ever a change is detected in the environment. Route discovery process requires the execution of the following steps:-

a) If a node has some data to send, it will broadcast a route request message to its neighbors.

b) Intermediate notes received the RREQ message and store the address of the source node in the routing table so that if duplicate RREQ is received in future may be discarded.

c) If any node has a current route to the destination lies send a response to the source in the form of RREP message. The node may be the destination node.

d) During the reverse movement of RREP, nodes in this path will store the forward route entries for setting up of forward route to the destination. The newly determined route is associated with a timer which amounts to the time of deletion of the route whenever the route is no larger in use. After the route establishment the route maintenance phase is required whenever a movement of nodes along the active path may be detracted. Route error message (RRER) is sent to the source node. This message is generated by the node which is near to break point. After getting RRER message the source node will reinitiate the route discovery procedure.

2.3. DSR (Dynamic Source Routing)

Dynamic source routing protocols (DSR) is a reactive on demand routing protocols. In this protocol mobile node utilizes the concept to route cache to store the information of routes. If a mobile node has some data to send, it first checks its cache to determine the route availability. If an alive route is found then the node will send its data along the already existing route. If not, the node will start its basic route discovery mechanism by broadcasting route request RREQ message. After recording this route request packet the intermediate node will search the route in the cache based upon the information in route request packet. If the route to the destination is available they replied back to the source node. If the node is not destination node then it add its own address and rebroadcast the message to its neighbors. This process will ends at the destination nodes.

III. PERFORMANCE METRICS

3.1. Packet Delivery Fraction

It is defined as the ratio of the packet received by the destination successfully to the total number of packets sent by the sender.

3.2. End to End Delay

It is defined as the time taken by a packet in reaching to destination from the time it is sent by the sender. It includes all kinds of delays like queuing delay propagation delay etc.

3.2. Normalized Routing Overhead
Normalized routing overhead is the number of routing packets transmitted per data packet received at the destination.

3.3. Throughput
It is defined as total number of packets received by the destination.

3.4. Energy Consumption per Packet [4]
It is defined as the total energy balance to the total number of packets delivered to the destination.

3.5. Network Life Time [4]
Network life time may be defined as the time when the first node die due to battery failure.

IV. SIMULATION SCENARIO

DSDV, DSR & AODV protocols have been tested using the network simulator [5] (NS2). It is discrete event simulator. This simulator software is widely acceptable among the research community. Implementations of DSDV, DSR & AODV protocol are inbuilt in ns2. Protocols are tested for energy consumed during packet transmission, network lifetime, average throughput, packet delivery fraction, end to end delay etc.

4.1. First Scenario
In the first case we have calculated average throughput, packet delivery fraction, normalized routing overhead and end to end delay. In this test following parameters have utilized as listed in table 1.Pause time indicates the mobility of the nodes. Pause time corresponds to the zero seconds indicates that mobile node is continuously moving without resting at a point. Whereas 100 seconds pause time corresponds to zero mobility.

Table 1. Parameters

Parameters	Value
Number of Nodes	50
Pause Time	0,10,30,50,70,100 sec
Number of source	10
Rate	4 packets/sec
Area	700*700
Speed	20 m/sec

Figure 1 shows that the Average throughput of the DSR and AODV protocols is much higher than DSDV. Effect of mobility on the throughput of DSR & AODV is negligible. Throughput of DSDV is increases with the value of pause time. DSDV performs better at low mobility levels

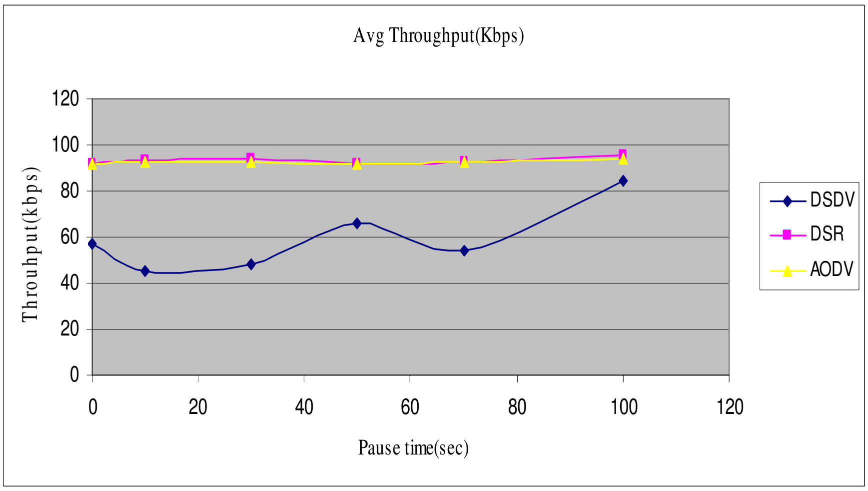

Fig 1 Throughput Vs Pause time

Figure 2 shows that the end to end delay of AODV is largest than DSR & DSDV. It is because at higher mobility, links are frequently broken. Since routes are available in the cache of DSR, hence Route discovery procedure is less required than the AODV in which routes are discovered whenever a change in the topology is detected. In DSDV routes are known well in advance, hence delay is less.

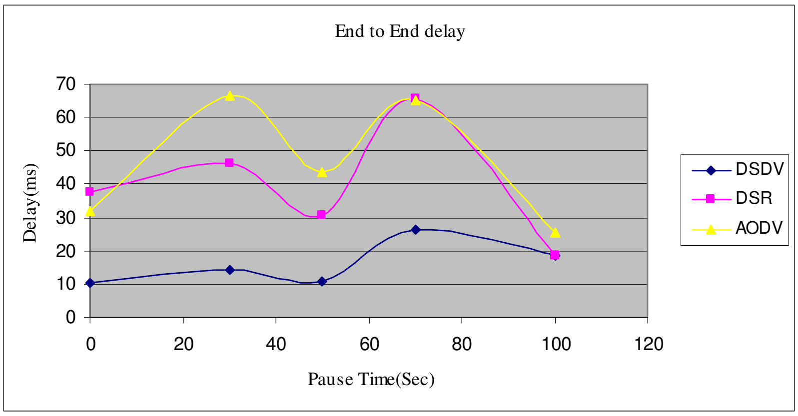

Fig 2 End to End Delay Vs Pause time

Routing overhead is also high for AODV than DSR & DSDV at high mobility level as shown in figure 3. Since frequent route discovery takes place in the AODV which leads to the generation of large number of control packets. DSDV protocol periodically exchange the routing table among the neighbor. Therefore it is also generating the significantly control overhead. Route availability in the cache makes the DSR most suitable candidate as far as this metric is concerned.

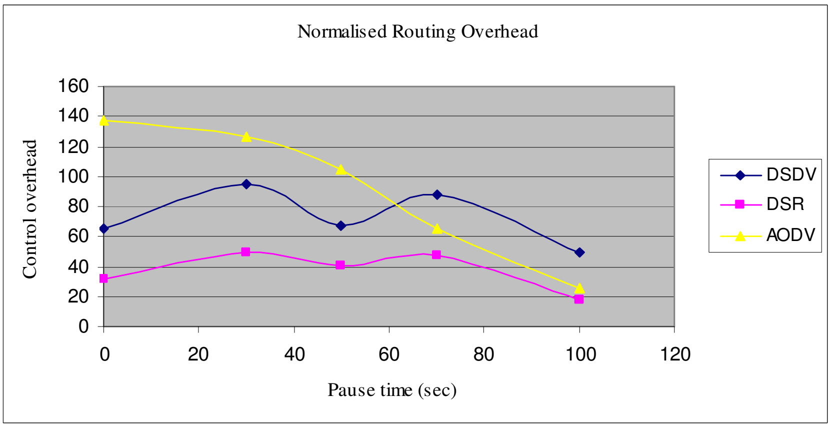

Fig 3 Normalized routing overhead Vs Pause time

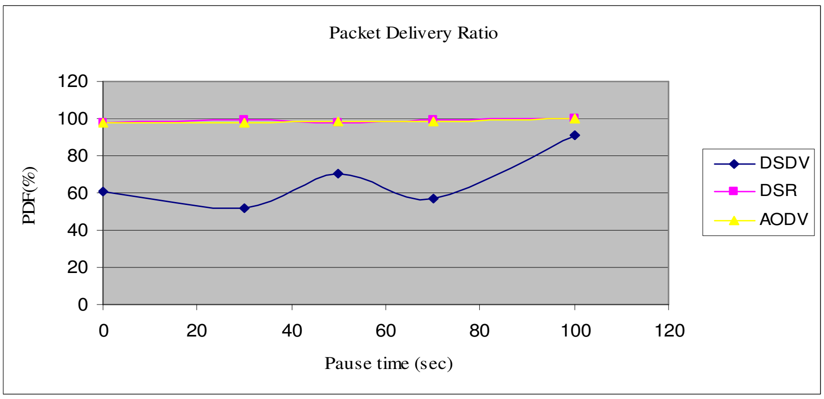

Fig 4 Packet Delivery Ratio Vs Pause Time

Packet delivery ratio of AODV and DSR are again greater than the DSDV as shown in figure 4. Above result indicates that throughput and packet delivery fraction of DSR & AODV is better than DSDV. AODV provides the high delay and generates huge control over head. Moderate delay and small overhead coupled with high throughput and packet delivery fraction shows that the DSR is the best choice among the three protocols for the adhoc network.

4.2. Analysis on the basis of Energy Metrics

Further the three protocols have been tested for energy metrics. The metrics considered are Energy consumed per packet and for network life time. The following parameters are utilized.

Table 2 Energy Parameters

Parameters	Value
Number of Nodes	50
Pause Time	0,30,50,70,100 sec
Number of source	10
Rate	4 packets/sec
Area	700*700
Speed	5 m/sec
Energy	3J

Fig 5 shows that the energy consumption of DSR is lower than AODV & DSDV. DSR consumes less energy than DSDV and AODV because of its route caching strategy. DSDV consumes more energy because of its periodic exchange of routing information. At higher level of mobility AODV and DSR have the same behavior where as at low level of mobility the performance of DSR is better than AODV. This is due to the fact that at higher level of mobility probability of choosing the stale route from the cache increases.

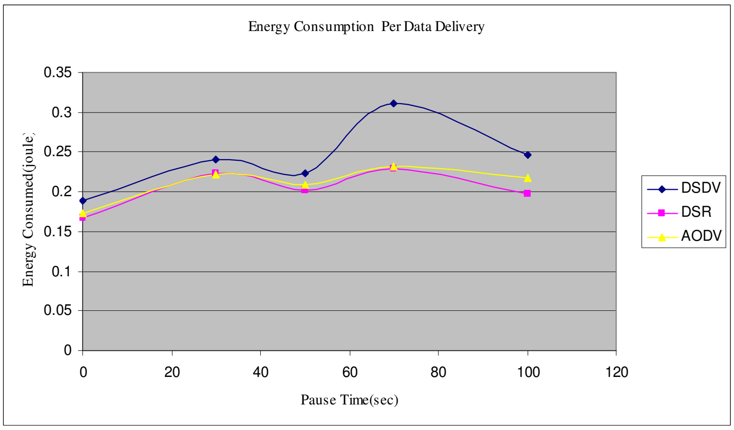

Fig 5 Energy Consumption Vs Pause Time

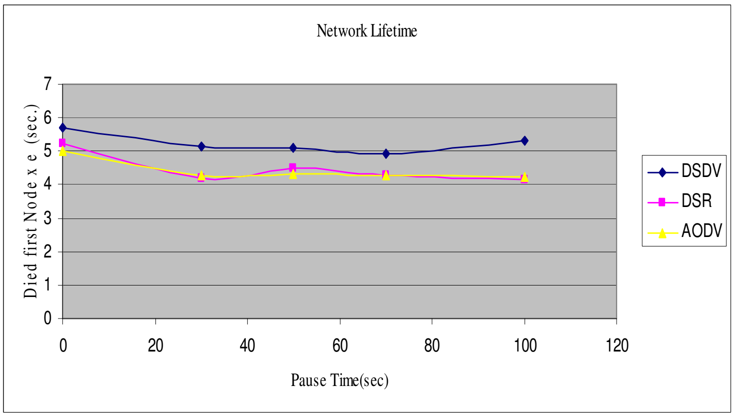

Fig 6 Network Life Time Vs Pause Time

Figure 6 shows the network lifetime of three protocols. As already stated that the network life time[4] defined in terms of the time when the first node died due to the battery failure. DSDV has the highest network life time. Since DSR depends upon the cache entries so it may be possible that some of the nodes will be over utilized than others. Moreover the mobility of the nodes has negligible impact on the lifetime. Performance of on demand routing protocols is poor as compared to the proactive protocols for this metric.

Figure 7 shows the pattern of energy consumption with node speed. There are smaller variations in the consumption pattern with speed. Energy consumption of DSDV is greater than DSR and AODV. At lower value of node speed i.e. at 1m/sec energy consumption of AODV and DSDV is almost equal. DSR performs better at low speed. It utilizes the route from the cache. At high speed the links are broken more frequently due to which caching of route will not provide a great help, rather it increases the retransmission of packets due to forwarding on the expired routes.

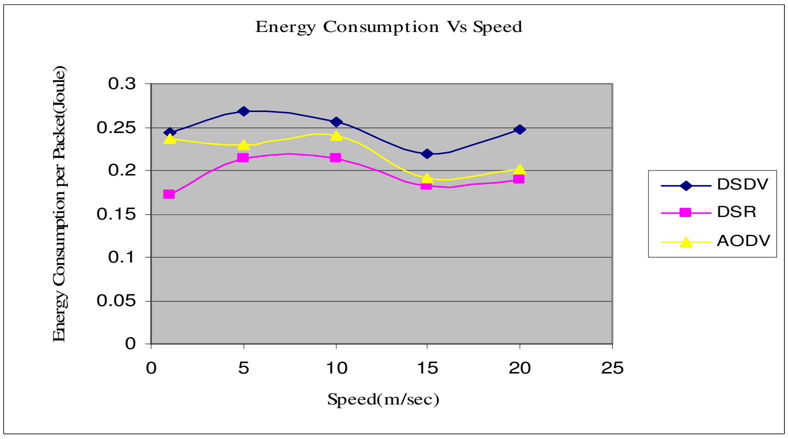

Fig 7 Energy consumption Vs node speed at Pause time 10 seconds

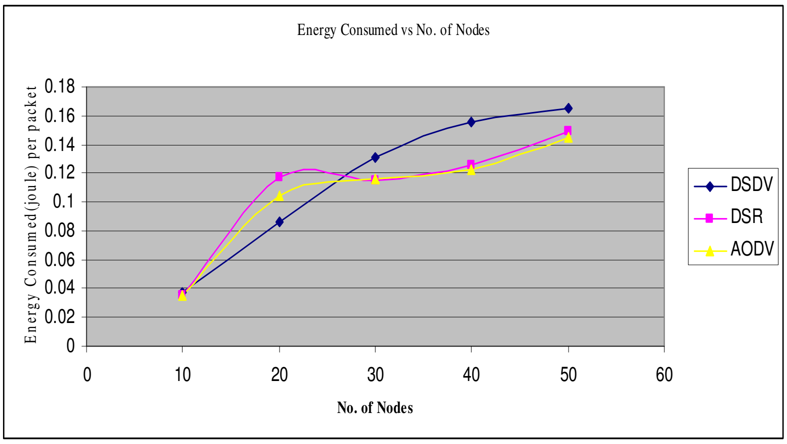

Fig 8 Energy consumption vs No. of node at Pause time 10 seconds

In sparse network all the three protocols consumes equal energy. As the network becomes denser than the energy consumption of DSDV increases because the routing information increases with the increasing number of nodes and hence circulation of routing table between nodes consumes more energy as shown in figure 8. On the other hand in AODV and DSR energy consumption also increases with increasing number of nodes. In large networks route maintenance phase consumes more energy than route creation phase. Figure 8 suggest that the DSDV is not suitable for large networks.

V. CONCLUSION

In this paper the DSDV, AODV, DSR protocols are tested in different scenario. On demand protocols AODV and DSR performs better in terms of average throughput, packet deliver fraction at high node speed. AODV has the longest end to end delay because it always establish route on demand basis. However cache mechanism of DSR reduces the end to end delay. DSDV because of its proactive nature provides the minimum delay. AODV protocol generates largest control overhead among the three protocols. DSR consumes less energy than AODV & DSDV. DSDV provides the maximum lifetime than other protocols because DSDV utilizes all the nodes efficiently than others. Energy consumption of DSR is less than AODV & DSDV with varying node speed. Similarly DSR performs well in high density networks. The above analysis suggests that DSR is most suitable Protocol in different network condition. DSR energy consumption is low, provides good throughput, High Pdf value Moderate delay. In future more research can be done in order to increase the life time of the nodes by energy efficient load balancing techniques.

REFERENCES

[1] Perkins C. E. and Bhagwat P., "Highly Dynamic Destination-Sequenced Distance-Vector Routing (DSDV) for Mobile Computers", SIGCOMM 94 -8/94 London England UK @ 1994 ACM 0-89791 -682-4/94/0008.

[2] Perkins C. E. and Royer E. M., "Ad-Hoc On-Demand Distance Vector Routing, Mobile Computing Systems and Applications," Proc. IEEE Workshop Mobile Computing Systems & Applications (WMCSA '99), pp. 90-100, 1999.

[3] D. B. Johnson and D. A. Maltz, The Dynamic Source Routing Protocol for Mobile Ad Hoc Networks (DSR), IETF Internet draft, July 2004, http://www.ietf.org/internet-drafts/draft-ietf-manetds10.txt.

[4] Alemneh Adane, "Active Communication Energy Efficient Routing Protocol of Mobile Ad Hoc Networks (MANETS)" school of Graduate Studies, Faculty of Technology, Electrical & Computer Engineering Deptt. , Addis Ababa University, Ethiopia, Apr 2008.

[5] NS-2 Network Simulator, http://isi.edu/nsnam/ns/

[6] Magnus Frodrigh and Per Johansson & Peter Larson, Wireless ad hoc networking- The art of networking without a network.

Authors

Sachin Dahiya is presently working as an Associate Professor in Department of Electronics & Communication Engineering at Haryana Institute of Technology, Asodha, Bahadugarh, Haryana. He has earned his Masters in Technology from NIT Kurukshetra. Presently he is doing PhD in Adhoc network from DCRUST Murthal, Haryana

Manoj Duhan is Professor & Chairman in ECE Dept at Deenbandhu chhotu ram University of Science & Technology Murthal, Sonepat, since 2008. He is also having the charge of Director Weekend Courses at DCRUS&T Murthal. He was Reader & Chairman, ECE Dept. GJUS&T Hisar from 2004 to 2008. Prior to this he was lecturer at Technological Institute of Textile & Sciences, Bhiwani. He obtained his B.E degree from COET Jalgaon, NMU in 1997. He was Gold Medalist in B.tech. He received his M.Tech degree from dept. Of Electronics, NIT Kurukshetra in 2001, followed by Ph.D degree in 2005 from Technological Institute of Textile & Sciences, Bhiwani, and M.D.U Rohtak. His areas of interest are Reliability, DSP, wireless Communication, Microprocessor. He is life member of IAENG, ISTE, ISITA, MCU and SSI. He was awarded "Best Lecturer Award" by Governor of Haryana in 1998 at SBMNEC Rohtak. In July 2007 he was awarded "Shiksha Ratan Award" by India International Friendship society, New Delhi. He has published more than seventy research papers in National & International Conferences & Journals.

Vikram Singh is presently working as a Professor of Computer Science and Dean, Faculty of Physical Sciences at Chaudhary Devi Lal University, Sirsa, Haryana (India). He has earned his Masters in Physics, Masters in Computer Science and Doctorate in Computer Science – all – from Kurukshetra University, Kurukshetra. Earlier, he has worked as a Lecturer with Department of Computer Science & Applications, Kurukshetra University, Kurukshetra. He has also worked as a System Programmer on a World Bank Project for four and a half years. Areas of his research interest include simulation and modeling, electronic governance, online social media technologies and data mining.