International Journal of Computing and Business Research (IJCBR)
ISSN (Online) : 2229-6166
Volume 4 Issue 2 May 2013

Comparative Study of PDR and NRL for MANET Protocols using Self Created Network Scenario

Sunil Taneja
Department of Computer Science
Government College, Chhachhrauli, India

Abstract—**Mobile Adhoc Network is characterized by multi-hop wireless connectivity and dynamic topology. The mobile nodes in this network communicate with each other without established infrastructure. Since the wireless links are highly error prone and can go down frequently due to mobility of nodes, therefore, routing in MANET is a critical task due to highly dynamic environment. In this research paper, analysis of two prominent MANET routing protocols has been done by presenting their functionality. An effort has been carried out to do the performance evaluation of MANET protocols using self created network scenario with random way point mobility model. A simulation model with TCP and UDP connections has been developed to study inter-layer interactions and their performance implications. The performance metrics used for analysis are Packet Delivery Ratio (PDR) and Normalized Routing Load (NRL) with UDP and TCP traffic agents. Based on the observations, recommendations can be made about the significance of either protocol in various situations.**

Key Words— **Analysis, AODV, DSR, Protocols, Routing**

I. INTRODUCTION

Mobile Adhoc Network is a collection of wireless mobile nodes forming a temporary network without any fixed infrastructure where all nodes are free to move about arbitrarily and where all the nodes configure themselves. In this network, each node acts both as a router and as a host & even the topology of network may also change rapidly. Some of the key challenges in the area of MANET include stable unicast/multicast routing, dynamic network topology, network overhead, scalability, security and power aware routing. In this research paper, intend is to study the mobility patterns of prominent MANET routing protocols by evaluating the packet delivery ratio and normalized routing load.

II. MANET ROUTING PROTOCOLS

A routing protocol is needed whenever a packet needs to be transmitted to a destination via number of nodes and numerous routing protocols have been proposed for such kind of adhoc networks. These protocols find a route for packet delivery and deliver the packet to the correct destination. The studies on various aspects of routing protocols [1, 2] have been an active area of research for many years. Many protocols have been suggested keeping applications and type of network in view. Basically, routing protocols can be broadly classified into two types as: Table Driven Protocols or Proactive Protocols and On-Demand Protocols or Reactive Protocols. In Table Driven routing protocols each node maintains one or more tables containing routing information to every other node in the network. All nodes keep on updating these tables to maintain latest view of the network. Some of the existing table driven protocols are DSDV [4], GSR [8], WRP [7] and ZRP [10]. In on-demand routing protocols, routes are created as and when required. When a transmission occurs from source to destination, it invokes the route discovery procedure. The route remains valid till destination is achieved or until the route is no longer needed. Some of the existing on demand routing protocols are: DSR [5], AODV [3] and TORA [9]. The emphasis in this research paper is concentrated on the study of mobility pattern and performance analysis of two prominent on-demand routing Protocols i.e. DSR and AODV. Surveys of routing protocols for adhoc networks have been discussed in [11, 12, 13]. A brief review of DSR and AODV is presented here as these have been compared for their performance.

A. Dynamic State Routing (DSR)

DSR [5] is an Adhoc routing protocol which is source-initiated rather than hop-by-hop and is based on the theory of source-based routing rather than table-based. This is particularly designed for use in multi hop wireless adhoc networks of mobile nodes. This Protocol is composed of two essential parts of route discovery and route maintenance. Every node maintains a cache to store recently discovered paths. When a node desires to send a packet to some node, it first checks its entry in the cache. If it is there, then it uses that path to transmit the packet and also attach its source address on the packet. If it is not there in the cache or the entry in cache is expired (because of long time idle), the sender broadcasts a route request packet to all of its neighbors asking for a path to the destination. The sender will be waiting till the route is discovered. During waiting time, the sender can perform other tasks such as sending/forwarding other packets. As the route request packet arrives to any of the nodes, they check from their neighbor or from their caches whether the destination asked is known or unknown. If route information is known, they send back a route reply packet to the destination otherwise they broadcast the same route request packet. When the route is discovered, the required packets will be transmitted by the sender on the discovered route. Also an entry in the cache will be inserted for the future use. The node will also maintain the age information of the entry so as to know whether the cache is fresh or not. When a data packet is received by any intermediate node, it first checks whether the packet is meant for itself or not. If it is meant for itself (i.e. the intermediate node is the destination), the packet is received otherwise the same will be forwarded using the path attached on the data packet. Since in adhoc network, any link might fail anytime. Therefore, route maintenance process will constantly monitors and will also notify the nodes if there is any failure in the path. Consequently, the nodes will change the entries of their route cache.

B. Adhoc On-Demand Distance Vector Routing (ADOV)

AODV [3] is a variation of Destination-Sequenced Distance-Vector (DSDV) routing protocol which is collectively based on DSDV and DSR. It aims to minimize the requirement of system-wide broadcasts to its extreme. It does not maintain routes from every node to every other node in the network rather they are discovered as and when needed & are maintained only as long as they are required. The key steps of algorithm used by AODV for establishment of unicast routes are explained below.

Route Discovery: When a node wants to send a data packet to a destination node, the entries in route table are checked to ensure whether there is a current route to that destination node or not. If it is there, the data packet is forwarded to the appropriate next hop toward the destination. If it is not there, the route discovery process is initiated. AODV initiates a route discovery process using Route Request (RREQ) and Route Reply (RREP). The source node will create a RREQ packet containing its IP address, its current sequence number, the destination's IP address, the destination's last sequence number and broadcast ID. The broadcast ID is incremented each time the source node initiates RREQ. The requests are sent using RREQ message and the information in connection with creation of a route is sent back in RREP message. The source node broadcasts the RREQ packet to its neighbours and then sets a timer to wait for a reply. To process the RREQ, the node sets up a reverse route entry for the source node in its route table. This helps to know how to forward a RREP to the source.

Setting up of Forward Path: When the destination node or an intermediate node with a route to the destination receives the RREQ, it creates the RREP and unicast the same towards the source node using the node from which it received the RREQ as the next hop. When RREP is routed back along the reverse path and received by an intermediate node, it sets up a forward path entry to the destination in its routing table. When the RREP reaches the source node, it means a route from source to the destination has been established and the source node can begin the data transmission.

Route Maintenance: A route discovered between a source node and destination node is maintained as long as needed by the source node. Since there is movement of nodes in mobile adhoc network and if the source node moves during an active session, it can reinitiate route discovery mechanism to establish a new route to destination. Conversely, if the destination node or some intermediate node moves, the node upstream of the break initiates Route Error (RERR) message to the affected active upstream neighbors/nodes. Consequently, these nodes propagate the RERR to their predecessor nodes. This process continues until the source node is reached. When RERR is received by the source node, it can either stop sending the data or reinitiate the route discovery mechanism by sending a new RREQ message if the route is still required.

III. PERFORMANCE METRICS

RFC 2501 describes a number of quantitative metrics [14] that can be used for evaluating the performance of a routing protocol for mobile adhoc networks. The performance metrics used in this research work are defined as follow:

Packet Delivery Ratio: This is the ratio of number of packets received at the destination to the number of packets sent from the source. In other words, fraction of successfully received packets, which survive while finding their destination, is called as packet delivery ratio.

Normalized Routing Load: The normalized routing load is defined as the fraction of all routing control packets sent by all nodes over the number of received data packets at the destination nodes. In other words, it is the ratio between the total numbers of routing packets sent over the network to the total number of data packets received.

IV. SIMULATION RESULTS & DISCUSSION

International Journal of Computing and Business Research (IJCBR)
ISSN (Online) : 2229-6166
Volume 4 Issue 2 May 2013

IEEE 802.11 is used as the MAC layer protocol. The simulation experiments are carried over network simulator. Both UDP and TCP traffic agents have been used to analyse the traffic. The mobility model used is random waypoint model in a square area. Packet size is 512 bytes and transferring rate is 5Mb. The packets start their journey from a random location to a random destination with a randomly chosen speed. Same scenarios have been used for performance evaluation of both DSR and AODV protocols.

A. Simulation Environment during Analysis using PDR

An extensive simulation model having scenario of 15 and 25 mobile nodes with varying number of UDP and TCP traffic agents is used to study inter-layer interactions and their performance implications. Area considered is 670 × 670 for 15 nodes and 750 × 750 for 25 nodes. Simulation run time is 500 seconds and speed has been varied from 1m/s to 10 m/s. Pause time varies 0 to 500s. Figure 1 shows the packet delivery ratio using speed as a parameter. This performance metric has been evaluated for DSR and AODV using 15 nodes and 6 UDP connections. Speed has been varied from 1m/s to 10 m/s. The PDR values, computed using received and dropped packets, range from 99.31% to 99.74%. The results show that only at one point of time, DSR and AODV gives same PDR value (approx.), otherwise, DSR protocol outperforms AODV in "low mobility" situation. In figure 2, the packet delivery ratio has been evaluated for DSR and AODV protocols using pause time as parameter with same number of nodes and UDP connections. Pause time has been varied from 100 to 500. The PDR values, computed using received and dropped packets, range from 99.34% to 99.97%. In this scenario, the observation is that the DSR and AODV protocol gives approximately same PDR values when pause time ranges from 100 to 300, DSR outperforms AODV when pause time is between 300 and 500 & AODV outperforms DSR when pause time is more than 500. Figure 3 depicts the packet delivery ratio using speed as a parameter for DSR and AODV protocols. The results are on the basis of 15 mobile nodes and 6 TCP connections. Speed variation is from 1m/s to 10 m/s. The PDR values, computed using received and dropped packets, range from 97.65% to 98.22%. The results show that in "low mobility" situation, AODV protocol gives approximately same PDR value as that of DSR protocol but in "high mobility" situation, AODV outperforms DSR protocol. In figure 4, the packet delivery ratio has been evaluated using pause time as a parameter on 15 mobile nodes having 6 TCP connections. Pause time varies 0 to 500. The PDR values, computed using received and dropped packets, range from 97.76% to 98.03%. The observation is that the AODV protocol outperforms DSR when pause time is less but DSR outperforms AODV when pause time is high. Figure 5 shows the packet delivery ratio using speed as a parameter. This performance metric has been evaluated for DSR and AODV using 25 nodes and 6 UDP connections. Speed has been varied from 1m/s to 10 m/s. The PDR values, computed using received and dropped packets, range from 96.97% to 98.78%. The results show that only at one point of time, DSR and AODV gives same PDR value (approx.), otherwise, DSR protocol outperforms AODV in "low mobility" situation. In figure 6, the packet delivery ratio has been evaluated for DSR and AODV protocols using pause time as parameter with same number of nodes and UDP connections. Pause time has been varied from 0 to 500. Pause time of 0 means very fast moving nodes and 500 shows minimum movement. The PDR values, computed using received and dropped packets, range from 95.19% to 98.98%. In this scenario, the observation is that the DSR protocol outperforms AODV in all the situations. Figure 7 depicts the packet delivery ratio using speed as a parameter for DSR and AODV protocols. The results are on the basis of 25 mobile nodes and 6 TCP connections. Speed variation is from 1m/s to 10 m/s. The PDR values, computed using received and dropped packets, range from 97.87% to 98.50%. The results show that in "low mobility" situation, AODV protocol gives same PDR value (approx.) as that of DSR protocol in the beginning, intermediate and end stage only otherwise, DSR protocol outperforms AODV. On the other hand, AODV outperforms DSR protocol in "high mobility" situation. In figure 8, the packet delivery ratio has been evaluated using pause time as a parameter on 25 mobile nodes having 6 TCP connections. Pause time varies 0 to 500. The PDR values, computed using received and dropped packets, range from 97.33% to 98.40%. The observation is that the DSR protocol outperforms AODV when pause time is less but AODV outperforms DSR when pause time is high.

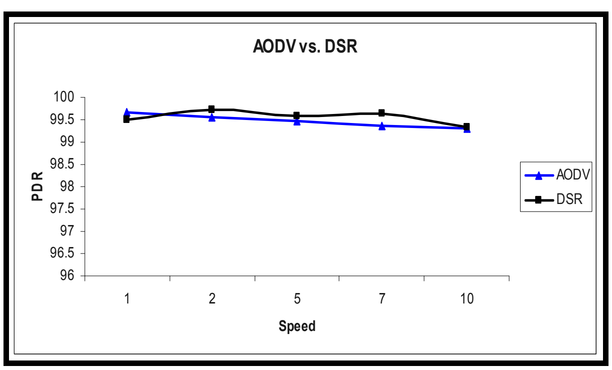

Figure 1: PDR vs. Speed for 15 nodes (UDP connections)

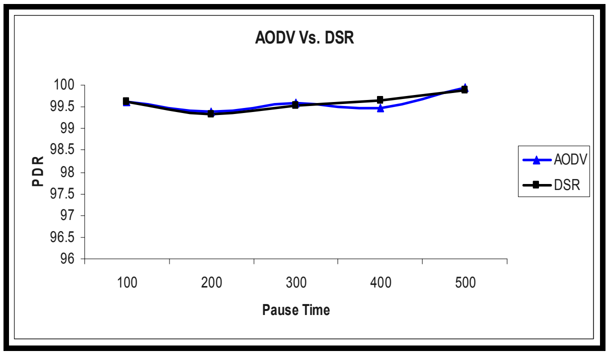

Figure 2: PDR vs. Pause Time for 15 nodes (UDP connections)

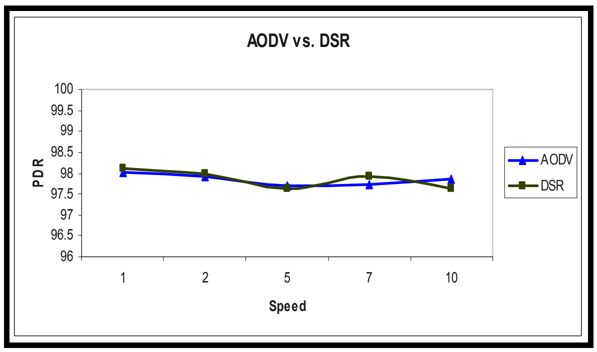

Figure 3: PDR vs. Speed for 15 nodes (TCP connections)

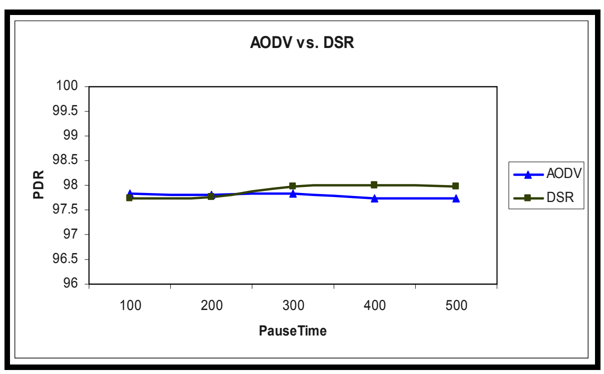

Figure 4: PDR vs. Pause Time for 15 nodes (TCP connections)

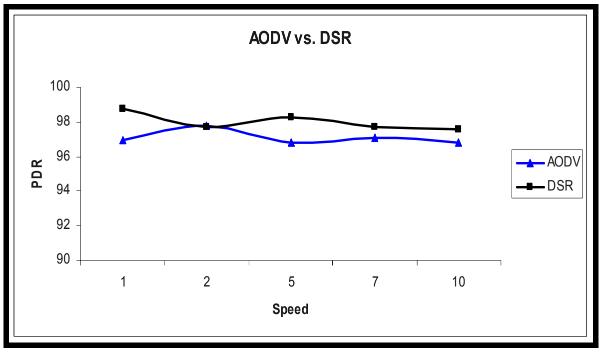

Figure 5: PDR vs. Speed for 25 nodes (UDP connections)

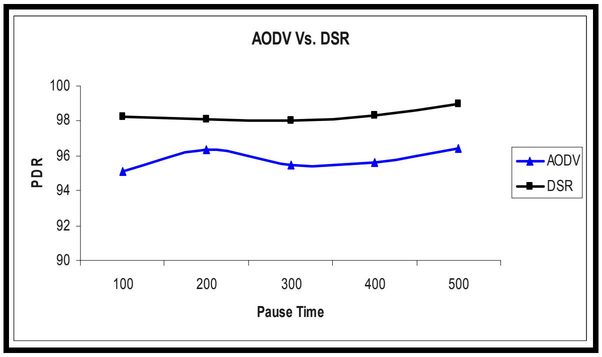

Figure 6: PDR vs. Pause Time for 25 nodes (UDP connections)

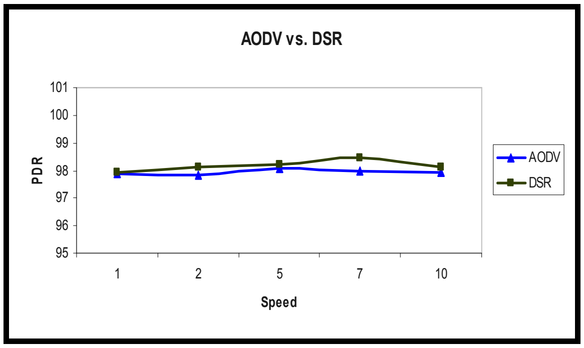

Figure 7: PDR vs. Speed for 25 nodes (TCP connections)

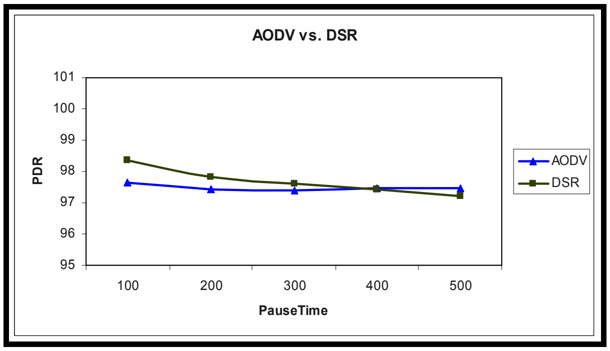

Figure 8: PDR vs. Pause Time for 25 nodes (TCP connections)

B. Simulation Environment during Analysis using NRL

An extensive simulation model having scenario of 25 and 60 mobile nodes with varying number of UDP and TCP traffic agents has been used. The area configurations used are 750 meter x 750 meter for 25 nodes and 1000 meter x 1000 meter for 60 nodes. The simulation run time is 500 seconds during analysis of 25 nodes and 650 seconds for 60 nodes. In figure 9, normalized routing load has been evaluated for DSR and AODV protocols using pause time as varying parameter with six UDP agents. Pause time has been varied from 100s to 500s. The normalized routing load values range from 0.13 to 0.50. In this scenario, the observation is that the DSR protocol presents low normalized routing load than AODV. Hence DSR protocol outperforms than AODV in terms of efficient routing. In figure 10, normalized routing load has been evaluated using pause time as a varying parameter on 25 mobile nodes having six TCP agents. Pause time varies 100s to 500s. The normalized routing load values range from 0.01 to 0.04. The observation is that on an average, the DSR protocol presents low normalized routing load than AODV in all situations and therefore DSR protocol outperforms than AODV in terms of efficient routing. In figure 11, normalized routing load has been evaluated for DSR and AODV protocols using pause time as varying parameter and ten UDP agents. Pause time has been varied from 100s to 650s. The normalized routing load values range from 0.7 to 0.25. In this scenario, again, the observation is than on an average, the DSR protocol presents low normalized routing load than AODV and therefore DSR protocol outperforms than AODV in terms of efficient routing. In figure 12, normalized routing load has been evaluated for DSR and AODV protocols using pause time as a varying parameter with ten TCP agents. Pause time varies 100s to 650s. The normalized routing load values range from 0.15 to 0.75. The observation is that the results have changed now in comparison to the previous results. It has been found

International Journal of Computing and Business Research (IJCBR)
ISSN (Online) : 2229-6166
Volume 4 Issue 2 May 2013

that the AODV protocol presents low normalized routing load than DSR in all situations and therefore AODV protocol has started outperforming than DSR in terms of efficient routing.

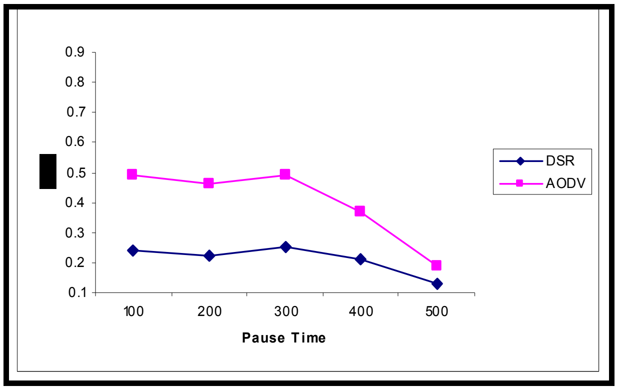

Figure 9: NRL for 25 Nodes (UDP Connections)

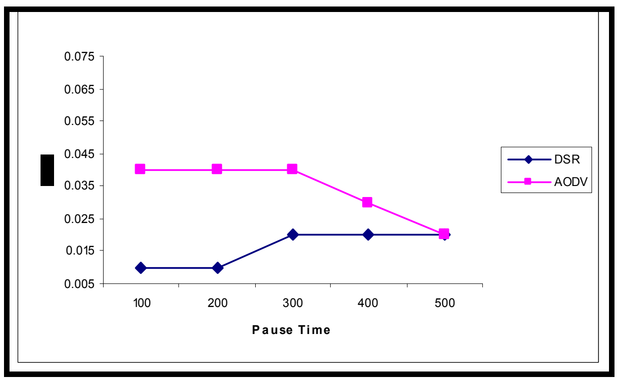

Figure 10: NRL for 25 Nodes (TCP Connections)

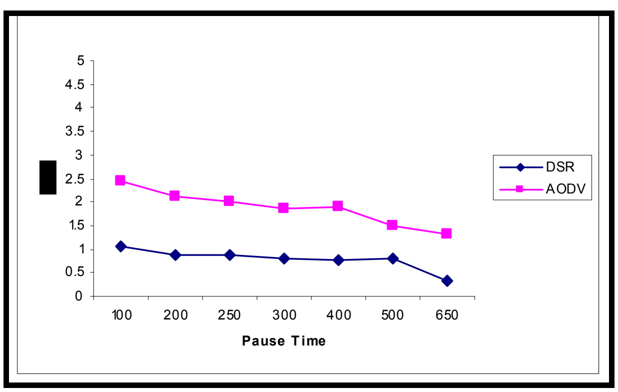

Figure 11: NRL for 60 Nodes (UDP Connections)

International Journal of Computing and Business Research (IJCBR)
ISSN (Online) : 2229-6166
Volume 4 Issue 2 May 2013

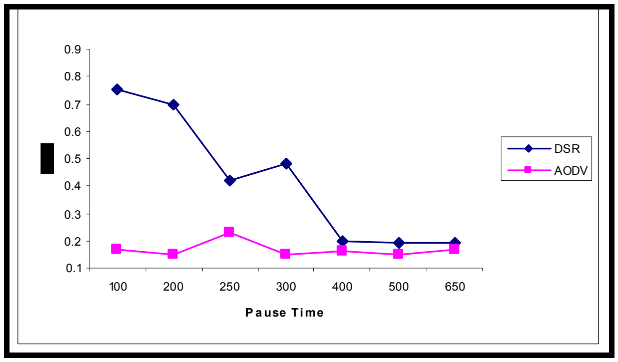

Figure 12: NRL for 60 Nodes (TCP Connections)

It can be seen from the figures 9, 10 and 11that DSR presents the lower normalized routing load than AODV proving that source routing proves to be an efficient routing mechanism in networks because it utilizes the wireless medium for data traffic in a better way than the other tested protocols. The key point to note from these figures is that these results are for sparse medium i.e. small number of nodes. The low normalized routing load for DSR protocol can be attributed to the caching strategy used by DSR. By virtue of aggressive caching, DSR is more likely to find a route in the cache, and hence resorts to route discovery less frequently than AODV. It can be further analysed from figure 12 that AODV presents low normalized routing load than DSR when TCP agents are used and number of nodes are high. If numbers of nodes are further increased to a large extent, AODV demonstrates low normalized routing load than DSR in all cases and hence it means that in denser medium, routing using AODV is more efficient than DSR. The DSR performance decreases in denser networks with higher mobility disclosing that source routing cannot efficiently adapt the network topology changes that are caused by the frequent movement of the nodes. Concluding, DSR demonstrates significantly lower routing load than AODV with the fact that it increases for DSR with growing number of nodes. When the number of nodes is less, the performance of DSR and AODV is similar regardless of mobility. With large numbers of nodes, AODV starts outperforming DSR. The major contribution to AODV's routing over-head is from route requests, while route replies constitute a large fraction of DSR's routing overhead. Furthermore, AODV has more route requests than DSR, and the converse is true for route replies.

V. CONCLUSION AND FUTURE SCOPE

In this paper, an effort has been made to carry out analysis of two prominent MANET routing protocols. On the basis of PDR, the study reveals that DSR protocol outperforms AODV under low as well as high mobility situation in case of both UDP and TCP traffic agents and AODV protocol also starts performing well under high mobility situation. Further, DSR protocol outperforms AODV protocol when the connections are through UDP and the analysis is independent of pause time. Also AODV protocol outperforms the DSR protocol when the connections are through TCP and the pause time is increased up to a large extent. On the basis of NRL, the study reveals that in networks with a small number of nodes and low mobility, AODV does not suggest a good solution as a routing protocol. However, AODV has better performance in networks with higher mobility and a greater number of nodes. It is concluded that AODV is the proper protocol for any kind of application (voice, video, file transfer, etc.) in networks with high mobility that consist of large number of nodes. In most cases, DSR presented the lower normalized routing load, proving that source routing proves to be an efficient routing mechanism in networks with a small number of nodes because it utilizes the wireless medium for data traffic in a better way than the other tested protocols. However, DSR performance decreases in denser networks with higher mobility, disclosing that source routing cannot efficiently adapt the network topology changes that are caused by the frequent movement of the nodes. The general observation from the simulation is that the AODV protocol performs better in denser mediums and the DSR protocol performs better in sparse medium. The performance of AODV under highly denser medium is still to be compared with TORA, STAR and ZRP. A sincere effort will also be made to evaluate the performance using throughput. Work also need to be done in the field of energy efficient and secure routing.

REFERENCES

[1] A.Kush, S. Taneja, "A Survey of Routing Protocols in Mobile Adhoc Networks", *International Journal of Innovation, Management and Technology*, Vol. 1, No. 3, pp 279-285, 2010.

[2] A.Kush, R.Chauhan,C.Hwang and P.Gupta, "Stable and Energy Efficient Routing for Mobile Adhoc Networks", Proceedings of the Fifth International Conference on Information Technology: New Generations, ISBN:978-0-7695-3099-4 available at *ACM Digital Portal*, pp. 1028-1033, 2008.

[3] C. Perkins, E. B. Royer, S. Das, "Adhoc On-Demand Distance Vector (AODV) Routing - *Internet Draft*", RFC 3561, IETF Network Working Group, July 2003.

[4] C. E. Perkins and P. Bhagwat, "Highly dynamic destination-sequenced distance vector routing (DSDV) for mobile computers", *Proceedings of ACM SIGCOMM 94*, pp. 34–244, 1994.

[5] D. B. Johnson, D. A. Maltz, Y.C. Hu, "The Dynamic Source Routing Protocol for Mobile Adhoc Networks (DSR)", *IETF Draft*, http://www.ietf.org/internet-drafts/draft-ietf-manet-dsr-09.txt, April 2003.

[6] P. Chenna Reddy, Dr. P. Chandrasekhar Reddy, "Performance Analysis of Adhoc Network Routing Protocols", *Academic Open Internet Journal*, Volume 17, 2006.

[7] S. Murthy and J. J. Garcia-Luna-Aceves, "An Efficient Routing Protocol for Wireless Networks", *ACM Mobile Networks and App. Journal*, Special Issue on Routing in Mobile Communication Networks, pp. 183-97, 1996.

[8] Tsu-Wei Chen and M. Gerla, "Global State Routing: A New Routing Scheme for Ad-hoc Wireless Networks", *Proceedings of International Computing Conference IEEE ICC 1998*.

[9] V. Park and S. Corson, Temporally Ordered Routing Algorithm (TORA) Version 1, Functional specification *IETF Internet draft*, http://www.ietf.org/internet-drafts/draft-ietf-manet-tora-spec-01.txt, 1998.

[10] Z. J. Hass and M. R. Pearlman, "Zone Routing Protocol (ZRP)", *Internet draft* available at www.ietf.org.

[11] J. Broch, D. A. Maltz and J. Jetcheva, "A performance Comparison of Multi hop Wireless Adhoc Network Routing Protocols", *Proceedings of Mobicomm'98*, Texas, 1998.

[12] S. Ramanathan and M. Steenstrup, "A survey of routing techniques for mobile communications networks*", Mobile Networks and Applications*, pp. 89–104, 1996.

[13] E. M. Royer and C. K. Toh, "A review of current routing protocols for adhoc mobile wireless networks", *IEEE Communications*, pp. 46–55, 1999.

[14] Georgios Kioumourtzis, "Simulation and Evaluation of Routing Protocols for Mobile Adhoc Networks", Thesis, Master of Science in Systems Engineering and Master of Science in Computer Science**,** Naval Postgraduate School, Monterey, California, 2005.

International Journal of Computing and Business Research (IJCBR)
ISSN (Online) : 2229-6166
Volume 4 Issue 2 May 2013