ISSN: 2319-8753

International Journal of Innovative Research in Science, Engineering and Technology

(ISO 3297: 2007 Certified Organization)

Vol. 2, Issue 8, August 2013

Performance analysis of AODV, TORA, OLSR and DSDV Routing Protocols using NS2 Simulation.

Ravi Kumar[1], Prabhat Singh[2]

Assistant Professor, Department of Computer Science and Engineering, ABES Engineering College Ghaziabad, India[1]

Assistant Professor, Department of Computer Science and Engineering, ABES Engineering College Ghaziabad, India[2]

Abstract: Selection of the protocols and path routing are the most common strategies that are to be focused while designing any kind of wireless networks such as MANETs, WSNs, WMNs and VANETs. MANETs are basically characterized as frequently changing network topology, multi-hop wireless connectivity and an efficient dynamic routing protocol. In MANETs, the protocol is selected on the basis of how the data is delivered and how its integrity is maintained. Hence, before making the selection of any routing protocol we should make the performance analysis of various routing protocol. In this paper, performance analysis of various routing protocols Ad-hoc On-Demand Distance Vector (AODV), Temporally Ordered Routing Algorithm (TORA), Optimized Link State Routing (OLSR) and Destination Sequenced Distance Vector (DSDV) are carried out using NS2 simulator. We compare the performance of these routing protocols on the basis of various parameters such as throughput, packet delivery ratio, delay and control overhead.

Keywords: Mobile Ad-hoc Network; Routing protocols; NS2 (Simulator); Throughput; Delay; Packet Delivery Ratio; Control Overhead.

I. INTRODUCTION

With the rapid growth in networking technology, peoples are attracted more towards the wireless networks as it is more convenient and scalable than other communication means. In the field of wireless network, 802.11, as a protocol of WLAN set by IEEE, is one of the most popular choose to establish wireless network.

Wireless networks are classified in to two basic types that is Infrastructure based wireless networks and Ad-hoc based wireless networks. In Infrastructure based wireless network nodes are kept mobile, base stations are fixed as a result of

Which nodes can go out of range of the base station and comes in range of other base station. In Ad-hoc based wireless networks, nodes are kept mobile but the base stations are not kept fixed and the entire nodes act as routers.

Ad hoc networks consist of hosts interconnected by routers without a fixed infrastructure and can be arranged dynamically. Considerable work has been done in the development of routing protocols in different types of ad hoc networks like MANETs, WMNs, WSNs, and VANETS etc [1]. While designing the ad-hoc network, we should consider the various capabilities and limitations that the physical layer imposes on the network performance. As in wireless network the radio links are unreliable, therefore a compact design is needed that consist of the physical layer, MAC layer and network layer. To provide the routing functionality at each of the mobile node is the main aim of the MANETs. For such designing aspects of ad hoc networks Routing-based approach, Information-theoretic approach, Dynamic control approach or Game-theoretic approach has been implemented [2].

ISSN: 2319-8753

International Journal of Innovative Research in Science, Engineering and Technology

(ISO 3297: 2007 Certified Organization)

Vol. 2, Issue 8, August 2013

In MANETs, a mobile host may communicate with other mobile hosts whether they lie within the same radio transmission range or not. Therefore, four important functions are to be performed by the routing protocols: maintaining network connectivity, network topology, packet routing, scheduling and channel assignment. Routing protocols are designed in MANETs with some basic goals that are minimum processing overhead, minimum control overhead, multi-hop routing, loop prevention and dynamic topology maintenance [3].

Routing protocols in MANETs are classified in to three basic types: proactive routing, reactive routing and hybrid routing. In proactive routing protocols, each node maintains one or more routing table containing the routing information to every other node in a network. All the nodes update these tables in order to maintain the consistent and up-to date view of the network. Proactive routing protocols are also called the table driven routing protocol. Proactive routing protocols discussed in this paper are DSDV and OLSR.

Reactive routing protocols are slow approach to routing than the proactive routing protocols. Reactive protocols are also called as the on-demand routing protocols. In reactive routing, all the up to date and consistent routes are not maintained at every other node, otherwise routes are created whenever they are required. Reactive routing protocols discussed in this paper are AODV and TORA.

Hybrid routing protocol is that protocol that combines the advantages of both reactive as well as proactive. The routing is initially established between the proactively prospected routes and then serves the demand from additionally activated nodes through reactive flooding.

The primary objective of this paper is to evaluate and quantify the effects of various factors that may influence network performance. While there has been performance analysis of ad hoc networks [4-6], still some of the influential factor evaluation is also missing. We focus on the performance metrics end to end delay, throughput, control overhead and packet delivery ratio. The above metrics are verified using the number of nodes, pause time and network area.
The remaining part of the paper is organized as follows: Section 2 gives the detailed idea about the routing protocols to be discussed such as AODV, TORA, DSDV and OLSR. In section 3, we provide the simulation environment. In section 4, simulation results and performance analysis of different routing protocols are discussed along with the conclusion and future scope of routing protocols in section 5.

II. MANETS ROUTING PROTOCOL

In this section, we will study the various key features of different routing protocols such as AODV, TORA, DSDV and OLSR. We also discuss those parameters that we used while implementing these protocols. We will also categorize the routing protocols on the basis of reactive as well as proactive routing protocol. Both of these approaches have some advantages as well as some disadvantages which can be analyzed by the performance metric which are discussed in next section. In this paper, we compare two reactive routing protocols with two proactive routing protocols i.e. AODV and TORA with DSDV and OLSR.

A. **Ad-hoc On-demand Distance Vector (AODV):** AODV is the enhancement of DSDV. But the basic difference between both is that AODV is the reactive routing protocol whereas DSDV is the proactive routing protocol. AODV is based on the hop to hop routing methodology. It is basically the combination of on-demand and distance vector routing protocol.

1. **Procedure:** Firstly, when the node wants to know the route from source to destination it first of all creates the ROUTE REQUEST mechanism. Next, when the route request is forwarded by intermediate nodes it also creates a reverse route for itself for Destination. When the request reaches a node with route to destination it creates a ROUTE REPLY mechanism which contains the number of hops that are required to reach the destination. All nodes that take part in forwarding this route reply packet to the source node creates a forward route to destination.

ISSN: 2319-8753

International Journal of Innovative Research in Science, Engineering and Technology

(ISO 3297: 2007 Certified Organization)

Vol. 2, Issue 8, August 2013

When the node forward packets, it type in ID in its table so that it constructs route from destination node to source node. If the source node moves, it will start route discovery again. If the intermediate node moves, the link will be invalid and the node will send this message to source nodes. Then, the source node will start route discovery again. The route created by each node from source to destination is by hop-to-hop methodology.

2. **Pros:**
   - Loop free routing in AODV.
   - Multicasting is optional in AODV.
   - Control and broadcasting overhead is reduced.

3. **Cons:**
   - In order to detect the unidirectional link. Bidirectional link is required.
   - Delay is caused by the route discovery process.

B. Temporally Ordered Routing Algorithm (TORA): TORA is the reactive and on-demand routing protocol. TORA is the adaptive and distributed algorithm which supports wireless network that changes dynamically. TORA is the on-demand routing protocol that provides multiple routes information.

1. **Procedure:** This protocol can be categorized into three basic forms: route generation, route maintain and route deletion. When initializing, the sequence number of destination node is set to 0. Then the source node broadcast a message contains ID of destination node and QRY packet. A node whose sequence number is not 0 will respond a UDP packet. Meanwhile, nodes, received UDP packets, will generate a larger sequence number. In this way, it can establish a DAG from source to destination. In addition, the route information should be re-established when nodes move.

2. **Pros:**
   - Control information can only be transmitted in area where the network topology changes dynamically.
   - Nodes maintain the route information about the adjacent nodes in TORA.

3. **Cons:**
   - Route shaking problem arises when several nodes delete routes at the same time.
   - In NS2, each node runs a different process for all the possible destination nodes.

C. Optimized Link State Routing (OLSR): Optimized link state routing protocol (OLSR) [7] is a proactive and link state routing protocol designed especially for the mobile ad-hoc networks.

1. **Procedure:** OLSR maintains multipoint Relays (MPRs) which minimizes the flooding by assigning the links of neighbors within its MPRs rather than of all links. Multicasting behavior of OLSR route discovery procedure can be combined with the mobile IP management by embedding the mobile-IP agent advertisement into OLSR flooding [8].Several extensions of OLSR are available that correspond to different network scenarios. Due to the proactive nature, OLSR works with the periodic exchange of messages like HELLO messages and Topology control messages only through its MPR.

2. **Pros:**
   - Only small subsets of links are declared.
   - Provide various parameters to control the overheads.

ISSN: 2319-8753

International Journal of Innovative Research in Science, Engineering and Technology

(ISO 3297: 2007 Certified Organization)

Vol. 2, Issue 8, August 2013

3. **Cons:**
   - It does not provide any form of security as other protocols provide.
   - This also limits the scalability as it is easy to locate destinations due to the flat addressing scheme.

D. **Destination Sequenced Distance Vector (DSDV) Protocol:** Destination Sequenced distance vector routing protocol is a proactive and distance routing protocol designed for mobile ad-hoc networks.

1. **Procedure:** The DSDV algorithm is basically the amendments made in distributed bellman ford algorithm, which provides loop free routes. It gives us the single path from source to destination using distance vector routing protocol. In order to reduce the amount of overhead in a network two types of updates packets are transferred i.e. full dump and incremental packet. Full dump broadcasting carry all the routing information while the incremental dump broadcasting will carry information that has changed since last full dump irrespective of the two types, broadcasting is done in the network protocol data unit(NPDU). Full dump requires multiple NPDU's whereas incremental dump requires one NPDU's to fit in all the information. Incremental update packets are sent more easily and frequently than the full dump packets. DSDV introduces the large amount of overhead to the network due to the requirement of periodic update messages. Hence, this protocol is not suitable for the large network because large portion of the network bandwidth is used for the updating of messages.
2. **Management of the routing table:** The routing table for each and every node consists of a list of all available nodes, their next hop to the destination, their metric and a sequence number generated by the destination node. With the help of the MANETs, routing table is used to send the data packets. Routing table can be kept consistent with the dynamically changing topology of ad-hoc network by periodically updating the routing table with some small changes in the network. Hence, mobile nodes provide their routing information by broadcasting the routing table update packet. The metric of the update packet starts with the initial value of one for one hop neighbors and goes on incremented with each forwarding node. The receiving node updates their routing tables if the sequence number of the update is greater than the current node or equal to the current node. Fluctuations in the routing table are minimized by delaying the advertisement of routes until we find the best route.
3. **Changes in the topology:** DSDV responds to the broken links by authorizing all the routes that contain this link. The routes are immediately assigned a metric as well as the incremented sequence number. Physical and data link layer components are used to detect the broken links or if the node does not receive broadcast packets from its neighbors node. Then, immediately the detecting node will broadcast an update packet and inform all the other nodes about the broadcasting mechanism. Route will again be reestablished when the routing table is broadcasted by the node.

4. **Pros:**
   - Count to infinity problem is reduced in DSDV.
   - With incremental updates, we can avoid extra traffic.

5. **Cons:**
   - It does not support the multipath routing.
   - Difficult to determine the delay for the advertisement of routes.

III. SIMULATION ENVIORNMENT

A. Simulation Modeling:

Simulation helps in analyzing the performance and behavior of complex networks before implementing it in today's real application. Several network simulators are available, whose output depicts as close as possible to real time implementation. In this work, we used the discrete-event simulator NS2 (version 2.34) [11] and the

ISSN: 2319-8753

International Journal of Innovative Research in Science, Engineering and Technology

(ISO 3297: 2007 Certified Organization)

Vol. 2, Issue 8, August 2013

performance analysis were conducted using AWK script [12]. There are several models available in NS2 simulator, from which, we considered the following models: (i) *Node Model* for energy source, memory capacity, processing capabilities etc, (ii) *Node deployment Model* for placement of nodes and its position as uniform model, (iii) Node *mobility model* for dynamic network topologies as Random Waypoint Mobility model, (iv) *Radio Model* for characteristics of radio used by node with a proper frequency, bandwidth, MAC layer functionality as IEEE 802.11 MAC model, (v) *Wireless Signal Propagation Model* for SNIR at receiver as Two Ray Ground propagation model, (vi) *Packet loss model* for packets collision or dropped in Markov error model, (vii) *Traffic Model* for nodes sending traffic to destinations mostly CBR, UDP Model.

B. Simulation Methods and parameters:

The goal of our experiments is to examine and quantify the effects of various factors and their interactions on the overall performance of ad hoc networks. Each run of the simulator accepts as input a *scenario file* that describes the exact motion of each node using Random Waypoint mobility model and the exact sequence of packets originated by each node together with exact time at which change in packet or motion origination occurs. Hence, to evaluate the performance at a particular factor, we consider 10 random simulation runs to generate 10 random scenario patterns and the performance of the considered factor is the average of these 10 outputs. In all our experiments we considered five sample points of a particular factor and verified for three different protocols i.e. AODV, OLSR and DSDV. Therefore 150 simulation runs were conducted to analyze each performance factor for these three protocols. Since our experiments is based on network layer characteristics so changes in routing strategy is only observed where as other characteristics like antenna gain, transmit power, ground propagation model and receiver sensitivity as physical layer characteristics, MAC 802.11 as wireless Ethernet for data link layer characteristics, UDP as transport layer characteristics and CBR as application layer characteristics remain fixed.

C. Performance Metrics:

The performance metrics helps to characterize the network that is substantially affected by the routing algorithm to achieve the required Quality of Service (QoS). In this work, the following metrics are considered.

1. **End-to-End Delay (EED):** It is the time taken for an entire message to completely arrive at the destination from the source. Evaluation of end-to-end delay mostly depends on the following components i.e. propagation time (PT), transmission time (TT), queuing time (QT) and processing delay (PD). Therefore, EED is evaluated as:

$$EED = PT + TT + QT + PD.$$

2. **Throughput:** It is the measure of how fast a node can actually sent the data through a network. So throughput is the average rate of successful message delivery over a communication channel.

3. **Control Overhead:** It is ratio of the control information sent to the actual data received at each node.

4. **Packet Delivery Ratio (PDR):** It is the ratio of the total data bits received to total data bits sent from source to destination.

IV. SIMULATIONS RESULTS

In this work the performance analysis is carried out in an adhoc network by varying parameters i.e. number of nodes. While keeping other parameters constant. Four protocols i.e. AODV, TORA, OLSR and DSDV are considered for the comparison purpose on the above performance. The tabular summary of all the four routing protocols AODV,TORA,OLSR and DSDV with control overhead, throughput, end to end delay and packet delivery ratio.

Simulation Parameters	Value
Network Type	Mobile
Connection Pattern	Random
Packet Size	500 Bytes
Duration	150bs
Connection Type	CBR/UBP
Simulation area(sq.m)	200,400,600,800,1000
Number of Nodes	10,20,30,40,50
Pause time	0s,30s, 90s,120s, 150s

Control Overhead: - On the basis of overhead, DSDV seems to be better than all the routing protocols which we have shown in the comparison.

1. **Tabular Summary of all four routing protocols vs. control overhead.**

No of → Nodes Protocols ↓	10	20	30	40	50
AODV	**.02**	**.08**	**.27**	**.35**	**.59**
TORA	**.01**	**.06**	**.21**	**.30**	**.42**
OLSR	**.06**	**.14**	**.23**	**.34**	**.36**
DSDV	**.001**	**.02**	**.04**	**.07**	**.10**

PDR: - On the basis of packet delivery ratio, AODV is best among all the four routing protocol.

2. **Tabular Summary of all four routing protocols vs. packet delivery ratio:**

No of → Nodes Protocols ↓	10	20	30	40	50
AODV	**.90**	**1.00**	**.98**	**.97**	**.99**
TORA	**.84**	**.935**	**.896**	**.925**	**.947**
OLSR	**.87**	**.96**	**.94**	**.945**	**.947**
DSDV	**.67**	**.68**	**.64**	**.66**	**.64**

End to End Delay:-Among all four, DSDV is best among all the four routing protocols as the number of the nodes increases.

IJIRSET

ISSN: 2319-8753

International Journal of Innovative Research in Science, Engineering and Technology

(ISO 3297: 2007 Certified Organization)

Vol. 2, Issue 8, August 2013

3. Tabular Summary of all four routing protocols vs. End to End delay:

No of → Nodes / Protocols ↓	10	20	30	40	50
AODV	**.039**	**.010**	**.013**	**.05**	**.01**
TORA	**.043**	**.015**	**.019**	**.067**	**.02**
OLSR	**.01**	**.009**	**.021**	**.019**	**.023**
DSDV	**.12**	**.009**	**.011**	**.006**	**.018**

.

Throughput:-IF we consider all the four routing protocols on the basis of throughput DSDV seems to be better.

4. Tabular Summary of all four routing protocols vs. Throughput.

No of → Nodes / Protocols ↓	10	20	30	40	50
AODV	2800	2500	2180	2170	2600
TORA	2700	2440	1990	2100	2480
OLSR	3190	3170	2700	2900	2600
DSDV	3600	3450	3100	3450	3220

V. CONCLUSION

In this paper we evaluated the four performance measures i.e. control overhead, PDR, end to-end delay and throughput with different number of nodes, different speed (pause time) of nodes and different size of network. From results reported in section 4 we concluded that DSR protocol is the best in terms of average PDR. For high mobility condition of nodes DSR gives better packet delivery ratio than other protocols making it suitable for highly mobile random networks. Similarly for network size analysis it is observed that the DSR protocol outperforms other protocols if the network size is less than 600x600sqm. From this analysis we consider 600X600 sqm size networks to evaluate the network load analysis and mobility analysis. If the network size is more than 600x600sqm. And if PDR and throughput are the prime criteria, the OLSR protocol is the better solution for high mobility condition. In future, utilizing these performances we can design such a protocol that can be suitably provide data integrity as well as data delivery in highly random mobility network. Our focus is to analyze the energy metrics as the cost function for routing in these protocols for better QoS applications.

REFERENCES

[1] Rahman A, Islam S, Talevski A. Performance measurement of various routing protocols in ad-hoc network. In: Proceedings of the international multiconference of engineers and computer scientists, vol. 1. Hong Kong: IMECS; 2009.
[2] Tyagi SS, Chauhan RK. Performance analysis of proactive and reactive routing protocols for ad hoc networks. Int J Comput Appl 2010;1(14).
[3] Basagni S, Conti M, Giordano S, Stojmenovic I. Mobile ad hoc networking. A John wiley and sons, Inc., Publication; 2004.

[4] Duyen Trung H, Benjapolakul W, Minh Duc P. Performance evaluation and comparison of different ad hoc routing protocols. Elsevier Comput Commun 2007;30:2478–96.
[5] Ahvar E, Fathy M. Performance evaluation of routing protocols for high density ad hoc networks based on energy consumption by GloMoSim simulator. World Acad Sci Eng Technol; 2007.
[6] Radwan AAA, Mahmoud TM, Houssein EH. Performance measurement of some mobile ad hoc network routing protocols. Int J Comput Sci Issues (IJCSI) 2011;8(1).
[7] Jayakumar G, Gopinath G. Performance comparison of two ondemand routing protocols for ad-hoc networks based on random way point mobility model. Am J Appl Sci 2008:659–64.
[8] Patil1 VC, Biradar RV, Mudholkar RR, Sawant SR. On-demand multipath routing protocols for mobile ad hoc networks issues and comparison. Int J Wireless Commun Simulation 2010;2(1):21–38.
[9] Nassef L. On the effect of fading and mobility in on-demand routing protocols. Elsevier Egyptian Informatics Journal 2010;11(2).
[10] Chlamtac I, Conti M, Liu JJ-N. Mobile ad hoc networking: imperatives and challenges. Elsevier Ad Hoc Networks 2003;1:13–64.
[11] Yahya A. Energy-aware architecture of multi-rate ad hoc networks. Elsevier Egyptian Informatics J 2010;11(1).
[12] Lang D. On the evaluation and classification of routing protocols.
[13] Sarkar S, Basavaraju T.G. and Puttamadappa C., " Ad Hoc Mobile Wireless Networks: Principles, protocols and applications", *Auerbach Publications*, 2008.
[14] Tonguz O and Ferrari G., "Adhoc Wireless Networks-A Communication -Theoritic Perspective, Wiley and Sons", 2009.
[15] Royer E.M.and Toh C., "A review of current routing protocols for adhoc mobile wireless networks", *IEEE personal communications*,1999, pp. 46–56.
[16] Tuteja A, Gujral A, Thalia A, "Comparative Performance Analysis of DSDV, AODV and DSR Routing Protocols in MANET using NS2", *IEEE Comp. Society*, 2010, pp. 330-333.
[17] Broach J, .Maltz D.A, Johnson D.B, Hu Y and Jetcheva J, "A Performance comparision of Multihop Wireless Ad-Hoc Network Routing Protocols", ACM MOBICOM, 1998.
[18] Boukhalkhal A, Yagoubi M.B., Djoudi D, Ouinten Y and Benmohammed M, "Simulation of Mobile Adhoc Routing Strategies" , *IEEE*, 2008, pp.128-132.
[19] Perkins C.E. and Royer E.M, Ad-hoc, "On-demand Distance Vector Routing", draft-ietf-manet-aodv-02.txt, 1998.
[20] Perkins C.E and Bhagwat P, "Highly dynamic Destination-Sequenced Distance-Vector Routing (DSDV)for Mobile Computers", *SIGCOMM ACM*, 1994, pp. 234-245.
[21] Clausen T, Jacquet P, RFC 3626-"Optimized Link State Routing Protocol (OLSR)", Oct 2003.
[22] Perkins C.E., *Adhoc Networking,* Chapter-5, Pearson, US 2000.
[23] Kelvin Fall, "The ns manual (formerly ns Notes & Documentation)", US Berkerley LBL USC/ISI and Xerox PARC, 2010
[24] Robins A.D.., "GAWK:an effective AWK programming", 3rd ed, April 2010.

BIOGRAPHY

Ravi Kumar graduated from Uttar Pradesh technical university, Lucknow. Now he is working as an assistant professor in department of computer science and engineering in ABES Engineering College, Ghaziabad.

Prabaht Singh graduated from Priyadarshini College of Computer Sciences, greater noida, Uttar Pradesh in Computer Science & Engineering in 2010. He is completed his M.Tech in the department of Computer Science & Engineering, Kamla Nehru Institute of Technology, Sultanpur (Uttar Pradesh). Now he is working as an assistant professor in department of computer science and engineering in ABES Engineering college, Ghaziabad.