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Performance Comparison of AODV, DSDV, DSR and TORA Routing Protocols in MANETs

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Abstract

Routing protocols have central role in any mobile ad hoc network (MANET). There are many routing protocol that exhibit different performance levels in different scenarios. In this paper we compare AODV, DSDV, DSR and TORA routing protocol in mobile ad hoc networks to determine the best operational conditions for each protocol. We analyses these routing protocols by extensive simulations in ns-2 simulator and show that how pause time and number of nodes affect their performance. In this study performance is measured in terms of Packet Delivery Ratio, Network Life Time, System Life Time, End-to-End Delay and Routing Overhead.

Keywords: AODV; DSDV; DSR; MANET; Routing; TORA.

Introduction

Recently mobile ad hoc networks have become very popular. A MANET is a collection of mobile nodes sharing a wireless channel without any centralized control or established communication backbone. MANET has dynamic topology and each mobile node has limited resources such as battery, processing power and on-board memory (Ramanathan and Redi, 2002; Kiess and Mauve, 2007). In MANETs mobile nodes communicate with each other in a multi-hop fashion. That means a mobile node sends a packet to a destination through intermediate nodes and each node can act as an end system and also can act as a router. Because of above mentioned characteristics, routing is a very important challenge in MANET (Boukerche et al, 2011; Abolhasan et al, 2004).

Routing protocols for MANETs broadly classified in two classes: proactive and reactive (Tarique, 2009). In proactive routing protocols such as DSDV (Perkins and Bhagwat, 1994), mobile nodes update their routing tables by periodically exchanging routing information among them. Due to periodic information exchanges, a proactive routing protocol generates large number of control messages in the network. Hence, proactive routing protocols are not considered suitable for MANETs. To overcome the limitations of proactive routing protocols, reactive routing protocols such as AODV (Perkins and Royer, 1999; Perkins, 1997), DSR (Johnson and Maltz, 1996) and TORA (Park and Corson, 1997) have been proposed for MANET. In a reactive routing protocol, a route is discovered when it is required. Reactive routing protocol consists of two main mechanisms: (a) route discovery and (b) route maintenance. A source node discovers a route to a destination by using the route discovery mechanism. On the other hand, a source node detects any topology change in the network by using the route maintenance mechanism. A global search procedure is used by the route discovery mechanism in which a source node uses flooding mechanism to discover all the available paths to a destination. Once all paths have been discovered, a source node chooses a path.

There are many routing protocols for MANETs; hence study performance of existing routing protocols for use of this protocols and also optimize this protocols is very important (Singh et al, 2011; Boukerche, 2004). The

main method for evaluating the performance of MANETs is simulation. In this paper, we have evaluated performance of AODV, DSDV, DSR and TORA routing protocols based on CBR connection with varying pause time and varying number of nodes and analyzed by means of Packet Delivery Ratio, Network Life Time, System Life Time, End-to-End Delay and Routing Overhead. By using of simulation results we compare performance of this four routing protocols. The reminder of the paper is organized as follows: section 2 describes four routing protocols AODV, DSDV, DSR and TORA of MANETs. Section 3 describes performance metrics. The simulations and results of simulations present in section 4. Finally section 5 concludes the paper.

Routing Protocols

In this section we briefly review the studied routing protocols.

AODV: Ad Hoc on Demand Distance Vector

AODV routing protocol is a reactive routing protocol which establish a route when a node requires sending data packets. AODV is capable of both unicast and multicast routing. The operation of the protocol is divided in two functions: route discovery and route maintenance. When a route is needed to some destination, the protocol starts route discovery. Then the source node sends route request message to its neighbors. And if those nodes do not have any information about the destination node, they will send the message to all its neighbors and so on. And if any neighbor node has the information about the destination node, the node sends route reply message to the route request message initiator. On the basis of this process a path is recorded in the intermediate nodes. This path identifies the route and is called the reverse path. Since each node forwards route request message to all of its neighbors, more than one copy of the original route request message can arrive at a node. A unique id is assigned, when a route request message is created. When a node received, it will check this id and the address of the initiator and discarded the message if it had already processed that request. Node that has information about the path to the destination sends route reply message to the neighbor from which it has received route request message. This neighbor does the same. Due to the reverse path it can be possible. Then the route reply message travels back using reverse path. When a route reply message reaches the initiator the route is ready and the initiator can start sending data packets.

DSDV: Destination-Sequenced Distance-Vector

DSDV is a table-driven routing scheme for mobile ad hoc networks which maintains a table to store the routing information. Each node will maintain a routing table in which all of the possible destinations within the network and the number of hops to each destination are recorded.

Each entry in the routing table is marked with a sequence number which will avoid the formation of loops. In a very large population of mobile nodes, adjustments will likely be needed for the time between broadcasts of the routing information packets. To reduce the amount of information carried in these packets, two types of route packets are used. The first is the full dump packet carries all available routing information and these packets are transmitted in frequently manner. The second packet is the incremental packets which are used to carry the information that has changed since the last full dump.

DSR: Dynamic Source Routing

DSR is one of the purest examples of an on-demand routing protocol that is based on the concept of source routing. It is designed especially for use in multi hop ad hoc networks of mobile nodes. It allows the network to be completely self organizing and self-configuring and does not need any existing network infrastructure or administration. DSR uses no periodic routing messages like AODV, thereby reduces network bandwidth overhead, conserves battery power and avoids large routing updates. Instead DSR needs support from the MAC layer to identify link failure. DSR is composed of the two mechanisms of Route Discovery and Route Maintenance, which work together to allow nodes to discover and maintain source routes to arbitrary destinations in the network. DSR has a unique advantage by virtue of source routing. As the route is part of the packet itself, routing loops, either short – lived or long – lived, cannot be formed as they can be immediately detected and eliminated. This property opens up the protocol to a variety of useful optimizations. Neither AODV nor DSR guarantees shortest path. If the destination alone can respond to route requests and the source node is always the initiator of the route request, the initial route may the shortest.

TORA: Temporally Ordered Routing Algorithm

TORA is a reactive, highly adaptive, efficient and scalable distributed routing algorithm based on the concept of link reversal. TORA is proposed for highly dynamic mobile, multi-hop wireless networks. It is a source-initiated

on-demand routing protocol. It finds multiple routes from a source node to a destination node. The main feature of TORA is that the control messages are localized to a very small set of nodes near the occurrence of a topological change. To achieve this, the nodes maintain routing information about adjacent nodes. The protocol has three basic functions: Route creation, Route maintenance and Route erasing. TORA can suffer from unbounded worst-case convergence time for very stressful scenarios. TORA has a unique feature of maintaining multiple routes to the destination so that topological changes do not require any reaction at all. The protocol reacts only when all routes to the destination are lost. In the event of network partitions the protocol is able to detect the partition and erase all invalid routes.

Performance Metrics

For MANET simulation, there are many performance metrics which are used to analysis the various proposals (Maqbool et al, 2011). In this paper we have used five performance metrics that evaluate routing protocols in all important aspects.

Packet Delivery Ratio

Packet delivery ratio is the ratio of number of packets received at the destination nodes to the number of packets sent from the source nodes (Gupta et al, 2010). The performance is better when packet delivery ratio is high.

Network Life Time

Network life time is the time when a node finished its own battery for the first time. The performance is better when network life time is high (Jamali and Jahanbaksh, 2011; Jahanbakhsh et al, 2011).

System Life Time

System life time is the time when 20% of nodes finish their own battery. The performance is better when system life time is high (Jamali and Jahanbaksh, 2011; Jahanbakhsh et al, 2011).

End-to-End Delay

End-to-end delay is the average time delay for data packets from the source node to the destination node (Gupta et al, 2010). To find out the end-to-end delay the difference of packet sent and received time was stored and then dividing the total time difference over the total number of packet received gave the average end-to-end delay for the received packets. The performance is better when packet end-to-end delay is low.

Routing Overhead

Routing overhead is the total number of control or routing (RTR) packets generated by routing protocol during the simulation. All packets sent or forwarded at network layer is consider routing overhead. The performance is better when routing overhead is low.

Simulations and Results

The simulations were performed using Network Simulator 2 (Ns-2) (www.isi.edu/nsnam/ns), particularly popular in the ad hoc networking community. The mobility model used is Random Way point Model (www.isi.edu/nsnam/ns). The traffic sources are CBR (continuous bit –rate), number of data connections is 10, data packet size is 512 byte and data sending rate is 4 packet/second. The source-destination pairs are spread randomly over the network in a rectangular filed of 1000m x 1000m. During the simulation, each node starts its journey from a random spot to a random chosen destination. Once the destination is reached, the node takes a rest period of time in second and another random destination is chosen after that pause time. This process repeats throughout the simulation, causing continuous changes in the topology of the underlying network. The simulation time is 500 seconds and maximum speed of nodes is 20 m/s. The primary energy of all nodes is 40 J. The interface queue is 50- packet drop-tail priority queue. Two types of network scenario for different number of nodes and pause times are generated.

Simulation 1: Impact of number of nodes

In this simulation number of nodes is varying and considered 20, 40, 60, 80 and 100 and other network parameters are considered as in the table 1.

Table.1 Network parameters

Parameter	Values
Routing Protocols	AODV, DSDV, DSR and TORA
Simulation Time	500 Second
Traffic Type	CBR
Maximum Connections	10
Transmission Rate	4 Packets per Second
Packet Size	512 byte
Pause Time	50 Second
Number of Nodes	20, 40, 60, 80 and 100
Network Area	1000m × 1000m
Maximum Speed of Nodes	20 m/s
Mobility Model	Random Waypoint
Interface Queue	50 Packet Drop-tail Priority
Primary Energy of Node	40 J

We simulated this network under each of routing protocols and outputs shown in Figs. 1-5. Figs. 1-5 show a comparison between the routing protocols as a function of number of nodes. From these graphs it is clear that routing overhead increase with increase in number of nodes. DSR has better packet delivery ratio and in overall DSDV has better performance. TORA has low performance because in our simulation network has middle dynamic. AODV and DSR have middle performance.

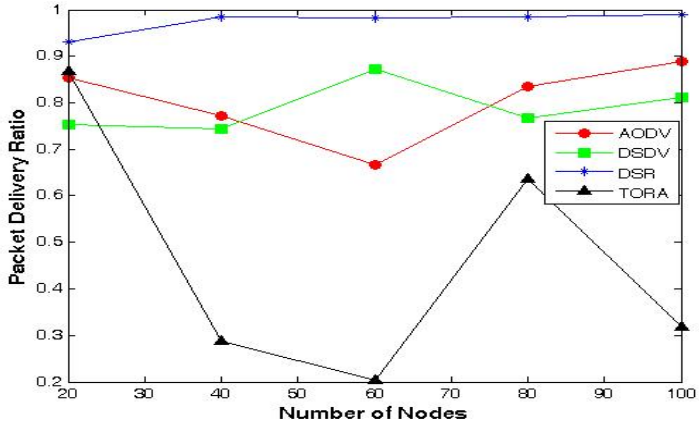

Figure 1. Packet Delivery Ratio versus Number of Nodes

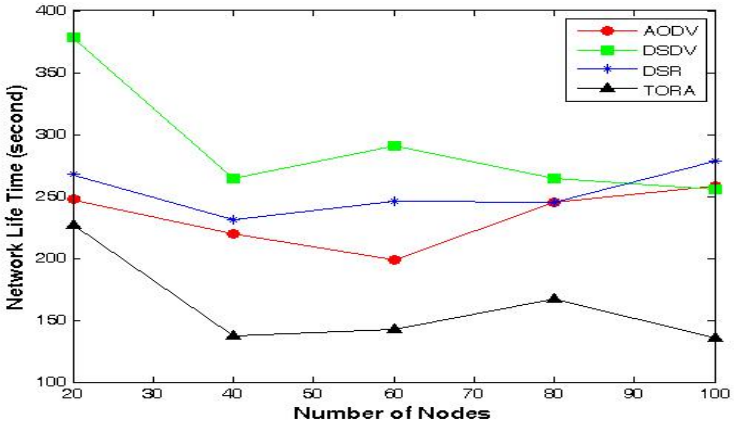

Figure 2. Network Life Time versus Number of Nodes

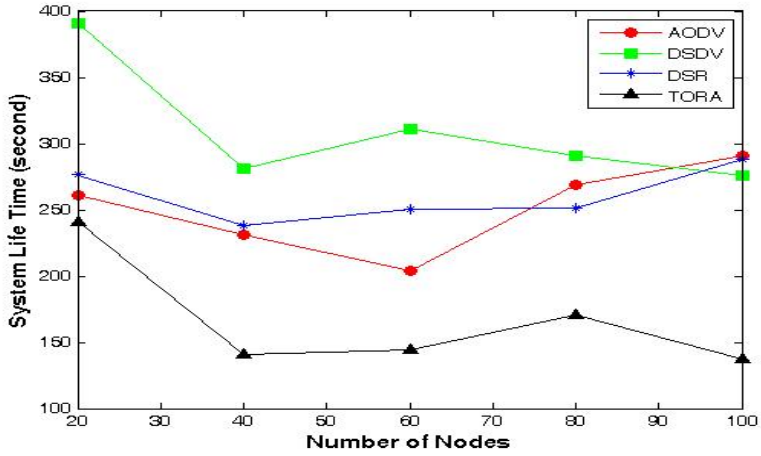

Figure 3. System Life Time versus Number of Nodes

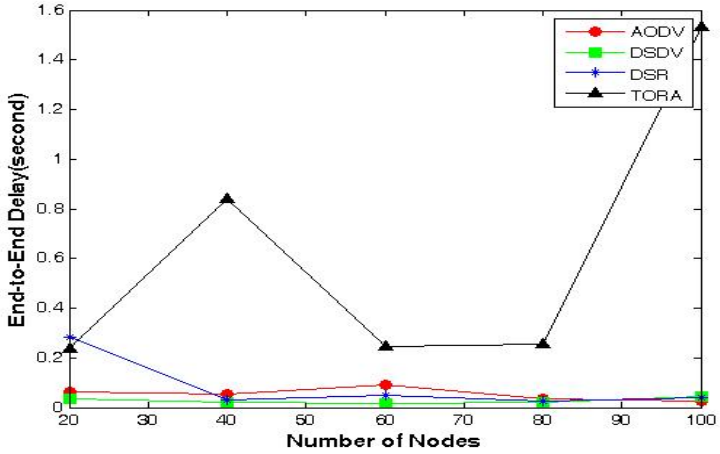

Figure 4. End-to-End Delay versus Number of Nodes

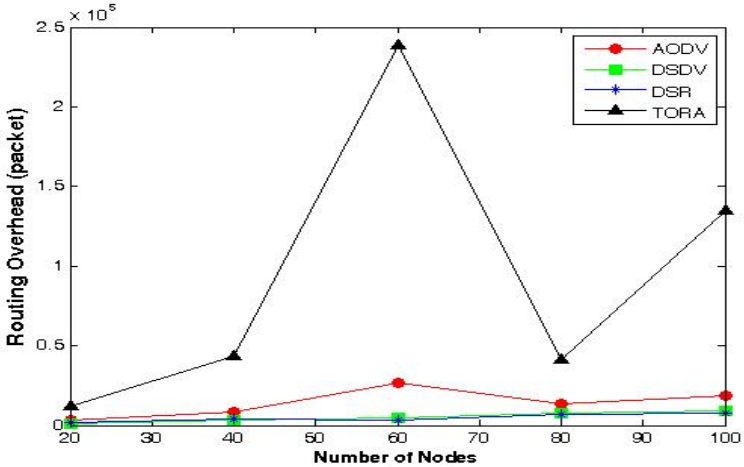

Figure 5. Routing Overhead versus Number of Nodes

Simulation 2

In this simulation pause time is varying and considered 0, 10, 20, 50, 100, 250 and 500 second. The network parameters we have used in this simulation shown in the table 2.

Table2. Network parameters

Parameter	Values
Routing Protocols	AODV, DSDV, DSR and TORA
Simulation Time	500 Second
Traffic Type	CBR
Maximum Connections	10
Transmission Rate	4 Packets per Second
Packet Size	512 byte
Pause Time	0, 10, 20, 50, 100, 250 and 500 Second
Number of Nodes	50
Network Area	1000m × 1000m
Maximum Speed of Nodes	20 m/s
Mobility Model	Random Waypoint
Interface Queue	50 Packet Drop-tail Priority
Primary Energy of Node	40 J

We simulated this network under various routing protocols and outputs are shown in Figs. 6-10.

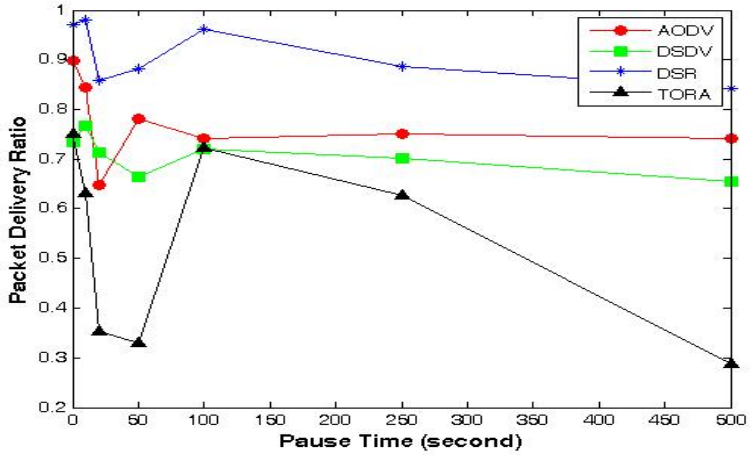

Figure 6. Packet Delivery Ratio versus Pause Time

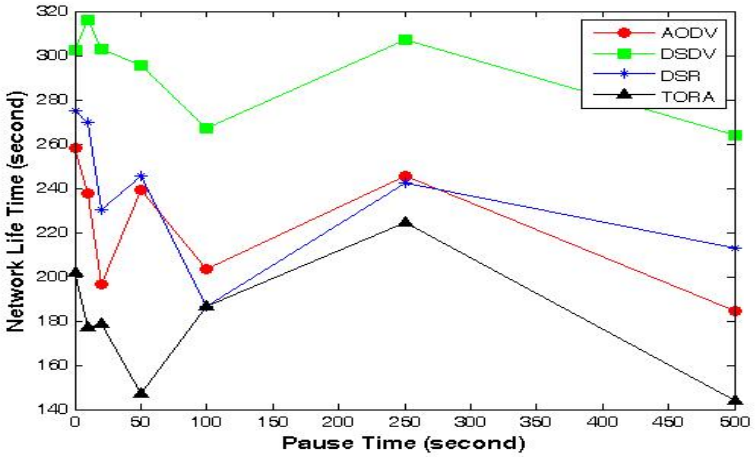

Figure 7. Network Life Time versus Pause Time

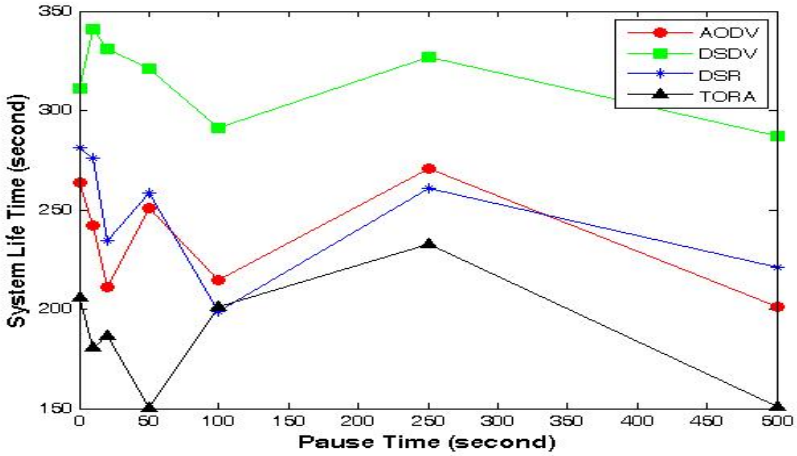

Figure 8. System Life Time versus Pause Time

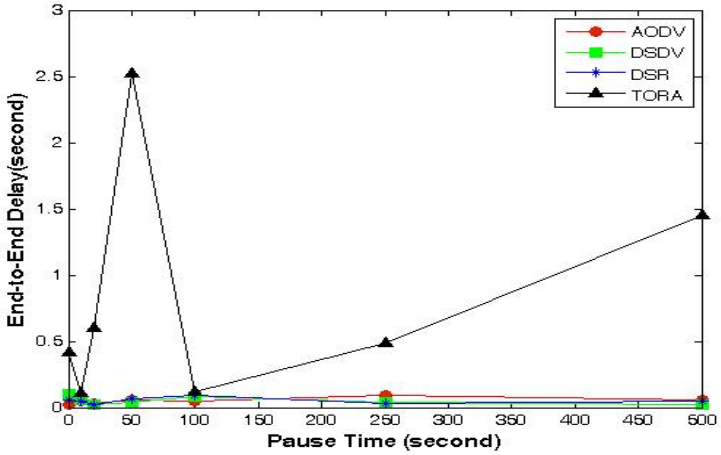

Figure 9. End-to-End Delay versus Pause Time

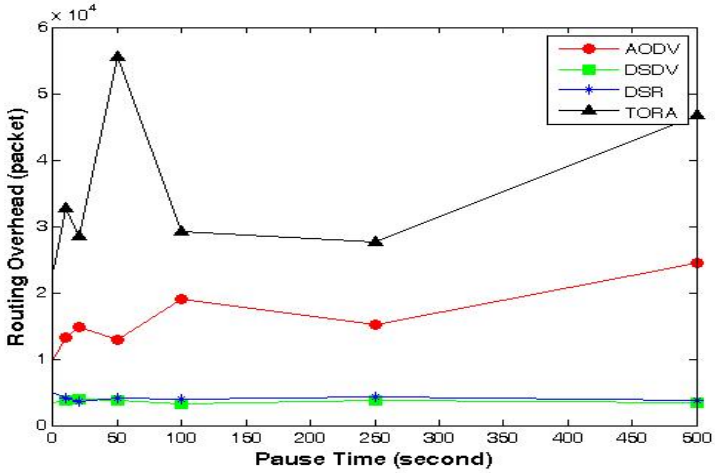

Figure 10. Routing Overhead versus Pause Time

Figs. 6-10 show a comparison between the routing protocols as a function of pause time. We can conclude from simulations results as follow. In case of Packet Delivery Ratio, DSR has better performance. In

cases of Network Life Time and System Life time DSDV has better performance. In case of End-to-End Delay AODV, DSDV and DSR have relative performance. In case of Routing Overhead, DSDV has better performance.

Conclusion

This paper is an attempt to evaluation performance of four commonly used mobile ad hoc routing protocols namely AODV, DSDV, DSR and TORA. Performance evaluation did in NS-2 simulator by doing many simulations. Comparison was based on Packet Delivery Ratio, Network Life Time, System Life Time, End-to-End Delay and Routing Overhead. Simulation results are shown by many figures. By using simulation results we can understand that DSDV gives better performance in wide range of simulation conditions.

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