A Performance Analysis of TORA, AODV and DSR Routing Protocols in MANET using NS2

G.Pragadeeswaran, D.Ezhilarasi, P.Selvakumar

Abstract— A Mobile Ad-hoc Network (MANET) is a multi hop wireless network formed by a group of mobile nodes that have wireless capabilities. MANET is a collection of wireless nodes that dynamically create a wireless network among them without any infrastructure. Nodes of these networks functions as a routers which discovers and maintains the routes to other nodes in the network. In such networks, nodes are able to move and synchronize with their neighbors. Due to mobility, connections in the network can change dynamically and nodes can be added and removed at any time. In this paper, we are going to compare Mobile Ad-Hoc network routing protocols TORA, AODV and DSR using network simulator NS2.34. We have compared the performance of three protocols together and individually too. The performance matrix includes PDR (Packet Delivery Ratio), Throughput, End to End Delay, Routing overhead. We are comparing the performance of routing protocols when packet size changes, when time interval between packet sending changes, when mobility of nodes changesIndex Terms— Minimum 7 keywords are mandatory, Keywords should closely reflect the topic and should optimally characterize the paper. Use about four key words or phrases in alphabetical order, separated by commas.

Index Terms — TORA, AODV, DSR, PDR, throughput, end to end delay, routing overhead, packet size, time interval, mobility.

1 INTRODUCTION

Mobile ad hoc networks (MANETs) are rapidly evolving as an important area of mobile mobility. MANETs are infrastructure less and wireless in which there are several routers which are free to move arbitrarily and can manage themselves in same manners. MANETs have characteristics that network topology changes very rapidly and unpredictably in which many mobile nodes moves to and from a wireless network without any fixed access point where routers and hosts move, so topology is dynamic. It has to support multi hop paths for mobile nodes to communicate with each other and can have multiple hops over wireless links; also connection point to the internet may also change. If mobile nodes are within the communication range of each other than source node can send message to the destination node otherwise it can send through intermediate node. Major challenges in mobile ad hoc networks are routing of packets with frequently mobile nodes movement, there are resource issues like power and storage and there are also wireless communication issues. Movement of hosts results in a change in routes. In this paper we have used routing protocols from reactive, proactive and hybrid categories to make comparison

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2. ROUTING PROTOCOL

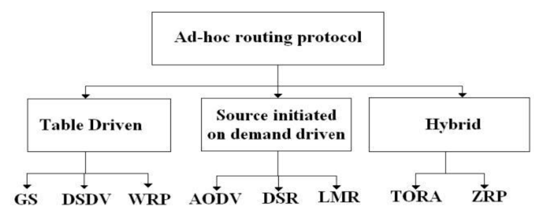

Fig – 1 Classification of routing protocols

Ad-hoc On Demand Distance Vector (AODV): AODV is an reactive (On-demand routing protocol) with small delay. Since it is an "On demand" routing protocol, the rotes are established only when needed to reduce traffic load. AODV supports the Unicast, Broadcast and Multicast scheme. The Count-To-Infinity and loop problem is solved with sequence numbers and the registration of the costs. In AODV every hop has the constant cost of one. The routes age very quickly in order to accommodate the movement of the mobile nodes. Link breakages can locally be repaired very efficiently. AODV is a modification of the DSDV algorithm. When a source node desires to establish communication session, it initiates a path discovery process to locate the other node. The main advantage of AODV protocol is that routes are established on demand and destination sequence numbers are used to find the latest route to the destination. The connection setup delay is less. The HELLO messages supporting the routes maintenance are range-limited, so they do not cause unnecessary overhead in the network.

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Dynamic Source Routing (DSR): The Dynamic Source Routing protocol (DSR) is a simple and efficient routing protocol designed specifically for use in multi-hop wireless Ad-networks of mobile nodes. DSR allows the network to be completely self-organizing and self-configuring, without the need for any existing network infrastructure or administration. The protocol is composed of the two main mechanisms of "Route Discovery" and "Route Maintenance", which work together to allow nodes to discover and maintain routes to arbitrary destinations in the ad hoc network. However, this protocol has a number of advantages over routing protocols such as AODV, LMR and TORA and in small to moderately size networks (perhaps up to a few hundred nodes), this protocol may perform better. An advantage of DSR is that nodes can store multiple routes in their route cache, which means that the source node can check its route cache for a valid route before initiating route discovery and if a valid route is found there is no need for route discovery. This is very beneficial in network with low mobility. Since they routes stored in the route cache will be valid longer. Another advantage of DSR is that it does not require any periodic beaconing, therefore nodes can enter sleep node to conserve their power. This also saves a considerable amount of bandwidth in the network.

Temporally Ordered Routing Algorithm (TORA): Temporally-Ordered Routing Algorithm (TORA) is a distributed protocol designed to be highly adaptive so it can operate in a dynamic network. For a given destination, TORA uses a somewhat arbitrary "height" parameter to determine the direction of a link between any two nodes. As a consequence of this multiple routes are often present for a given destination, but none of them are necessarily shortest route The TORA routing protocol is based on the LMR protocol. It uses similar link reversal and route repair procedure as in LMR and also the creation of a DAGs, which is similar to the query/reply process used in LMR. Therefore, it also has the same benefits as LMR. The advantage of TORA is that it has reduced the far-reaching control messages to a set of neighboring nodes, where the topology change has occurred. Another advantage of TORA is that it also supports multicasting; however this is not incorporated into its basic operation. TORA can be used in conjunction with Lightweight Adaptive Multicast Algorithm (LAM) to provide multicasting. The disadvantage of TORA is that the algorithm may also produce temporary invalid routes as in LMR.

Table.1. Comparison of three protocols

Parameters	AODV	DSR	TORA
Source rooting	No	Yes	No
Topology	Full	Full	Reduced
Broadcast	Full	Full	Local
Update information	Route error	Route error	Node's height
Update destination	Source	Source	Neighbors
Method	Unicast	Unicast	Broadcast

3. SIMULATION

The simulations were performed using Network Simulator 2 (NS-2.34), particularly popular in the ad hoc networking community. The traffic sources are CBR (continuous bit –rate). The source-destination pairs are spread randomly over the network. The mobility model uses 'random waypoint model' in a rectangular filed of 500m x 500m with 50 nodes. 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. Different network scenario for different number of nodes and pause times are generated. The model parameters that have been used in the following experiments are summarized in Table 2.

Packet Delivery Fraction (PDF): The ratio of the data packets delivered to the destinations to those generated by the sources.

Average end-to-end delay: This includes all possible delays caused by buffering during route discovery latency, queuing at the interface queue, retransmission delays at the MAC.

Table.2. Simulation parameters

Statistic	**Value**
Simulator	NS2.34
Protocol studied	AODV,DSR,TORA
Simulation time	500sec
Simulation area	500 × 400
Transmission range	250m
Node movement model	Random way point
Bandwidth	2MBit
Traffic type	CDR(UDP)
Data payload	Bytes/sec

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4. RESULT AND COMPARISON

The simulation results are shown in the following section in the form of line graphs. Graphs show comparison between the three protocols by varying different numbers of sources on the basis of the above-mentioned metrics as a function of pause time.

A. Packet Delivery Fraction (PDF) or Throughput

Figure 2 a-c, shows a comparison between the routing protocols on the basis of packet delivery fraction as a function of pause time and using different number of traffic sources. Throughput describes the loss rate as seen by the transport layer. It reflects the completeness and accuracy of the routing protocol. From these graphs it is clear that throughput decrease with increase in mobility. As the packet drop at such a high load traffic is much high.

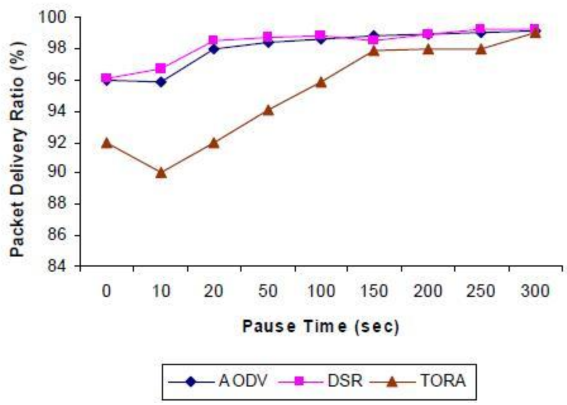

Fig – 2.a Packet delivery fraction vs. Pause time for 50 node model with 10 sources

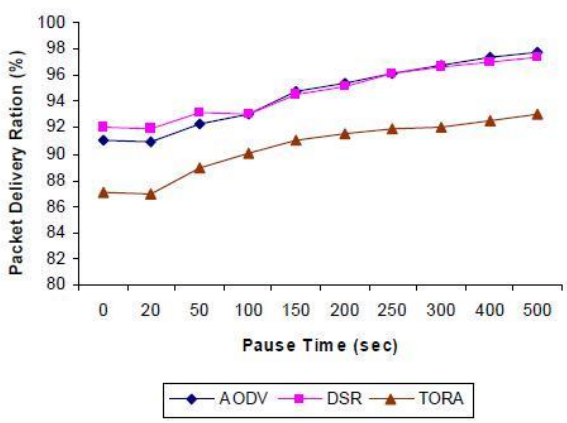

Fig – 2.b Packet delivery fraction vs. Pause time for 50 node model with 20 sources

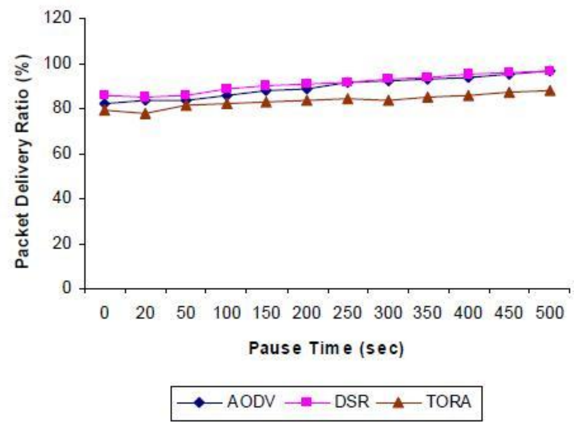

Fig – 2.b Packet delivery fraction vs. Pause time for 50 node model with 50 sources

TORA performs better at high mobility but in other cases it shows to have a lower throughput. AODV in our simulation experiment shows to have the best overall performance. On-demand protocols (DSR and AODV) drop a considerable number of packets during the route discovery phase, as route acquisition takes time proportional to the distance between the source and destination. The situation is similar with TORA. Packet drops are fewer with proactive protocols as alternate routing table entries can always be assigned in response to link failures. TORA can be quite sensitive to the loss of routing packets compared to the other protocols. Buffering of data packets while route discovery in progress, has a great potential of improving DSR, AODV and TORA performances. AODV has a slightly lower packet delivery performance than DSR because of higher drop rates.

Figure 2 a-c, shows the graphs for end-to-end delay Vs pause time. From these graphs we see that the average packet delay increase for increase in number of nodes waiting in the interface queue while routing protocols try to find valid route to the destination. Besides the actual delivery of data packets, the delay time is also affected by route discovery, which is the first step to begin a communication session. The source routing protocols have a longer delay because their route discovery takes more time as every intermediate node tries to extract information before forwarding the reply. The same thing happens when a data packet is forwarded hop by hop. Hence, while source routing makes route discovery more profitable, it slows down the transmission of packets.

AODV and DSR show poor delay characteristics as their routes are typically not the shortest. Even if the initial route discovery phase finds the shortest route (it typically will), the route may not remain the shortest over a period of time due to node mobility. However, AODV performs a little better delay-wise and can possibly do even better with some fine-tuning of this timeout period by making it a function of node mobility. TORA too has the worst delay characteristics because of the loss of distance information with progress. Also in TORA route construction may not occur quickly. This leads to potential lengthy delays while waiting for new routes to be determined. In DSR Route Discovery is fast, therefore shows a better delay performance than the other reactive protocols at low pause time (high mobility). But in case of congestion (high traffic) DSR control messages get loss thus eliminating its advantage of fast establishing new route. Under such situations DSR has a relatively high delay that AODV, but however the delay decreases with increase in pause time

Table.3. Numerical Comparison

Metrics	**AODV**	**DSR**	**TORA**
Scalability	2	3	1
Delay	3	2	4
Routing overhead	2	1	3
Drop packet	1	2	3
Dynamic adaptability	2	3	1
Error conservation	2	1	3

5. CONCLUSION

Mobile Ad hoc Networks (MANETs) have received increasing research attention in recent years. There are many active research projects concerned with MANETs. Mobile ad hoc networks are wireless networks that use multi-hop routing instead of static networks infrastructure to provide network connectivity. MANETs have applications in rapidly deployed and dynamic military and civilian systems. The network topology in MANETs usually changes with time. Therefore, there are new challenges for routing protocols in MANETs since traditional routing protocols may not be suitable for MANETs. Researchers are designing new MANETs routing protocols, comparing and improving existing MANETs routing protocols before any routing protocols are standardized using simulations. This work is an attempt towards a comprehensive performance evaluation of three commonly used mobile ad hoc routing protocols (DSR, TORA and AODV). Over the past few years, new standards have been introduced to enhance the capabilities of ad hoc routing protocols. As a result, ad hoc networking has been receiving much attention from the wireless research community. In this paper, using the latest simulation environment NS 2, we evaluated the performance of three widely used ad hoc network routing protocols using packet-level simulation. The simulation characteristics used in this research, that is, packet delivery fraction and end-to-end delay are unique in nature, and are very important for detailed performance evaluation of any networking protocol. We can summarize our final conclusion from our experimental results as follows:

• Increase in the density of nodes yields to an increase in the mean End-to-End delay.

• Increase in the pause time leads to a decrease in the mean End-to-End delay.

• Increase in the number of nodes will cause increase in the mean time for loop detection.

In short, AODV has the best all round performance. DSR is suitable for networks with moderate mobility rate. It has low overhead that makes it suitable for low bandwidth and low power network. Whereas TORA is suitable for operation in large mobile networks having dense population of nodes. The major benefit is its excellent support for multiple routes and multicasting.

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