A Study on the Behavior of MANET Routing Protocols with Varying Densities and Dynamic Mobility Patterns

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ABSTRACT

Mobility and node density are the two major factors which has much influence on the performance of any routing protocol of mobile ad hoc network. Several previous works [1,2,3,4] highlighted this fact. In this paper, we will evaluate some of the widely used MANET routing protocols with different mobility and network density.

The proposed evaluation will be made on MANET routing protocols DSDV, DSR and AODV which are readily available in network simulator- ns2. The performance of these protocols will be measured with suitable metrics.

Keywords

Mobile Ad hoc Network, Routing Overhead, Route Discovery , Mobility Aware Routing, Routing Protocols, DSDV, DSR, AODV.

1. INTRODUCTION

A Mobile Ad-Hoc Network (MANET) is a self-configuring network and the nodes are connected through wireless link. It is an infrastructure less network. The wireless network topology may change rapidly. Each node in the network act as router and it communicate other nodes. There is no centralized administration. Nodes in ad hoc networks are differentiated by their limited resources like power ,memory and mobility. Due to the limited transmission range of the nodes, multiple hops may be needed for a node to send data to any other node in the network. Thus each node acts as a host and router. If a node needs to communicate with another that is outside its transmission range, an intermediate node acts as a router to relay or forward packets from the source to the destination. For this purpose, a routing protocol is needed. Routing protocol design is an important and essential issue for Ad Hoc networks due to dynamism of the network. One interesting research area in MANET is routing. Routing in the MANETs is a challenging task and has received a tremendous amount of attention from researches.

Guaranteeing delivery and the capability to handle dynamic connectivity are the most important issues for routing protocols in wireless mobile ad hoc networks. Once there is a path from the source to the destination for a certain period of time, the routing protocol should be able to deliver data via that path. If the connectivity of any two nodes changes and routes are affected by this change, the routing protocol should be able to recover if an alternate path exists. Different types of communications used in mobile ad hoc networks are

- Unicasting
- Broadcasting
- Multicasting
- Anycasting

Unicasting

Unicast transmission is between one-to-one nodes. only two nodes are exchanging the informations.

Broadcasting

Broadcast is a type of transmission in which information is sent from just one node but is received by all the nodes connected to the network. One to all communication is called as broadcast.

Anycasting

Anycast is communication between a single sender and several receivers topologically nearest in a group. The term exists in contradistinction to multicast, communication between a single sender and a group of selected receivers.

Multicasting

Multicast is a very much different from Unicast. It is a type of transmission or communication in which there may be more than one nodes and the information sent to a set of nodes. It is a limited case of broadcasting. Multicasting is used with in the network has many advantages. Multicasting reduces communication cost for applications that send the same data to more recipients.

Types of MANET Routing Protocols

Routing protocols are classified into two types based on their Properties.

- Proactive Routing Protocols.
- Reactive Routing protocols.

Table Driven Routing Protocols (Proactive)

In proactive or table-driven routing protocols, each node continuously maintains up-to-date routes to every other node in the network. Routing information is periodically transmitted throughout the network in order to maintain routing table consistency. The areas in which they differ are the number of necessary routing-related tables and the methods by which changes in network structure are broadcast..The proactive protocols are not suitable for larger networks, as they need to maintain node entries for each and every node in the routing table of every node.

On-Demand routing Protocols (Reactive)

With on-demand protocols, if a source node requires a route to the destination for which it does not have route information, it initiates a route discovery process which goes from one node to the other until it reaches to the destination or an intermediate node has a route to the destination. If a node wants to send a packet to another node then this protocol searches for the route in an on-demand manner and establishes the connection in order to transmit and receive the packet. The route discovery usually occurs by flooding the route request packets throughout the network.
This Paper examines routing protocols designed for these ad hoc networks by first describing the classification of ad hoc routing protocols The section II describing the properties of each of the protocols and then comparing their different characteristics. The section III, IV&V describes the simulations and results and followed by conclusion.

About this Works

Mobility and node density are the two major factors which has much influence on the performance of any routing protocol of mobile ad hoc network. All the overheads such as MAC layer overheads and Network Layer will get worse very much while increasing the mobility of the nodes and the node density of the network. In this work, we will measure the performance of three MANET routing protocols with different mobility and node density.

2. ABOUT THE OTHE COMPARED ROUTING PROTOCOLS

Dynamic Source Routing (DSR)

Dynamic source Routing[5] is a on demand routing protocol for Mobile Ad hoc Network and is based on the concept of source routing. The protocols maintains route cache in each node which is updated when new routes are learned. The protocol consist of two phases. Route Discovery and Route maintenance. The source node broadcasts a route request(RREQ) packet consist of the destination node address, source node address and unique request ID. Each node receives the packet checks whether if route is available or not. If does not, it adds its own address to the route record and forwards the packet. Route Maintenance is achieved through the use of route error packet (RERR) and acknowledgements. Route error packets are generated at a node due to the problem of fatal transmission at the data link layer. When a route error packet is received, the hop in error is removed from the node's route cache and all routes containing the truncated at the point

Destination-Sequenced Distance-Vector (DSDV)

The destination sequenced distance vector routing protocol[8,9] is a proactive routing protocol based on the Bellman-Ford algorithm. Routing table is maintained at each node and with this table, node transmits the packet to other nodes in the network. To guarantee loop-freedom DSDV uses a concept of sequence numbers to indicate the freshness of a route. The Broadcasting mechanism in the dsdv is of two types-Full dump and incremental dump. Full dump will carry all the routing information and the incremental dump will carry only last updation of full dump to improve the efficiency of the system. DSDV is not fit for large networks.

Ad hoc On-demand Distance Vector (AODV) Routing

AODV is a reactive routing protocol [6,7] implemented for mobile ad hoc networks. AODV is used for unicast, multicast and broadcast communication. AODV is combination of both DSR and DSDV. It adopts the basic on demand mechanism of Route Discovery and Route maintenance from DSR and the use of hop by hop routing sequence number and periodic beacons from DSDV. When a source node desires to sent information to destination node and does not have a route to destination, it starts the route discovery process. It broadcasts RREQ to neighbors and then forward the request to their neighbors on so on up to route for the destination is located .And also send a route reply packet to the neighbors which is the first receives RREQ.RREP is routed along the reverse path. Each node maintains own sequence number and broadcast id. To maintain routes the nodes survey the link status of their next hop neighbor in active routes. If the destination or some intermediate node move, the node upstream of the break remove the routing entry and send route error(RERR) messages to affect the active route upstream neighbors. This continues until source node is reached.

Table 1 Comparison of three routing protocols[6]

PROTOCOL PROPERTY	DSDV	AODV	DSR
Routing Type	Flat	Flat	Flat
Routing Metric	Shortest path	Fresh and Shortest path	Shortest path
Routing maintenance	Routing Table	Routing Table	Routing Cache
Multiple route	No	No	Yes
Loop free	Yes	Yes	Yes
Multicast	No	Yes	No
Periodic Broadcast	Yes	Yes	No

3. SIMULATIONS AND METRICS

3.1 Simulation Environment

The simulations were performed using Network Simulator (Ns-2) [10,11,12], particularly popular in the ad hoc networks. The source-destination pairs are spread randomly over the network. The mobility model uses 'random waypoint model' in a rectangular filed of 800m x 800m with 50 nodes. The model parameters that have been used in the following experiments are summarized in Table 2.

Table 2 Parameters for Simulation

Parameters	Values
Channel type	Wireless Channel
Radio-propagation model	TwoRayGround
Antenna type	Omni Antenna
Interface queue type	Drop Tail/PriQueue
MAC type	802_11
Max packet in Queue	50
Topographical Area	800 x 800 sq.m
txPower	0.1819 W
rxPower	0.0501W
idlePower	0.0350 W
Routing protocols	DSDV/DSR/AODV
Node Density	10,20,30,40,50 / 800x800sq.m

Mobility

With mobility scenario	**0 m/s to 40 m/s**
Mobility Model	**Random Waypoint**
Traffic Parameters	
Traffic	**CBR over UDP**
% of communicating Nodes	**50 %**
CBR Packet Size	**512 Bytes**
CBR Interval	**0.1 s**
Maximum Packets	**200**

We have tested the performance of the four routing protocols with different network size and with nodes of different speeds in all scenarios.

3.2 Metrics considered for Evaluation

Throughput:

The throughput metric measures how well the network can constantly provide data to the sink. Throughput is the number of packet arriving at the sink per ms/second.

Mac Load:

The ratio of the number of MAC layer messages propagated by every node in the network and the number of data packets successfully delivered to all destination nodes. In other words, the MC load means the average number of MAC messages generated to each data packet successfully delivered to the destination.

Dropped Packets:

The Number of Nodes in the Network vs Agent level Total Dropped Packet is considered as the metric to analyze the performance.

***Routing load*:**

It is the number of routing packets required to be sent per data packet delivered.

Total Transmitted and Received Routing Control Messages :

This metric is nothing but the count of all the control packets send and received at network layer. It will indirectly signify the total effort made during resolving a route.

4. RESULT AND ANALYSIS

The Simulation Results

The following graph shows throughput provided by the three different protocols with mobility in different node densities. As shown in the graph, DSR performed well in terms of throughput. Next to DSR, ADOV performed good. DSDV is the poor performer in terms of throughput with mobility

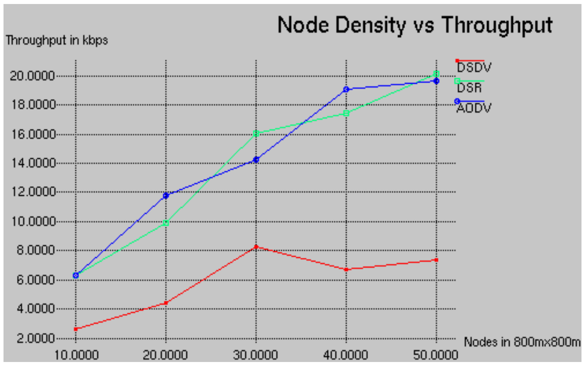

Figure 1 Node density Vs Throughput

The following graph shows total dropped packet by the three different protocols with mobility in different node densities. As shown in the graph, AODV with mobility performed very poor and dropped much packets than all other cases

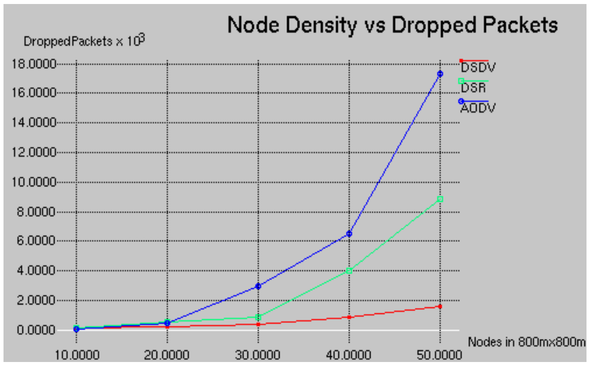

Figure 2 Node density Vs Dropped packets

The following graph shows total transmitted routing control messages by the three different protocols with mobility in different node densities. As shown in the graph, AODV with mobility performed very poor and produced too many routing control message packet than all other cases

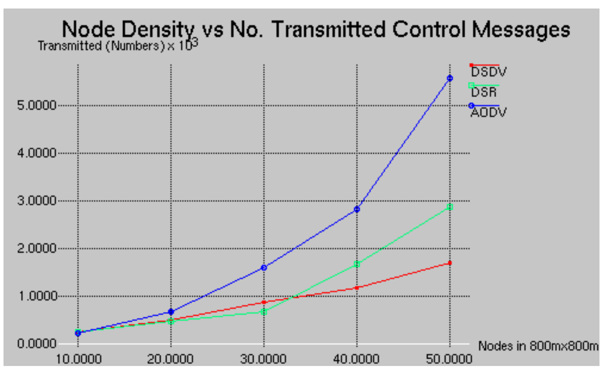

Figure 3 Node density Vs Transmitted control Messages

The following graph shows total received routing control messages by the three different protocols with mobility in different node densities. As shown in the graph, AODV with mobility performed very poor and received too many routing control message packet than all other cases.

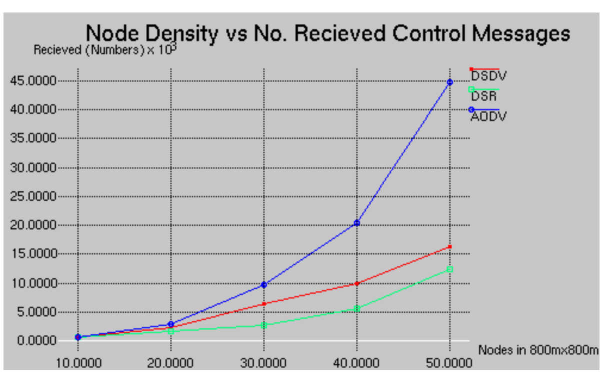

Figure 4 Node density Vs Received control Messages

The following graph shows MAC load of the three different protocols with mobility in different node densities. As shown in the graph, DSR with mobility performed very poor and caused much MAC load. AODV also performed very poor and caused much MAC load during Mobility

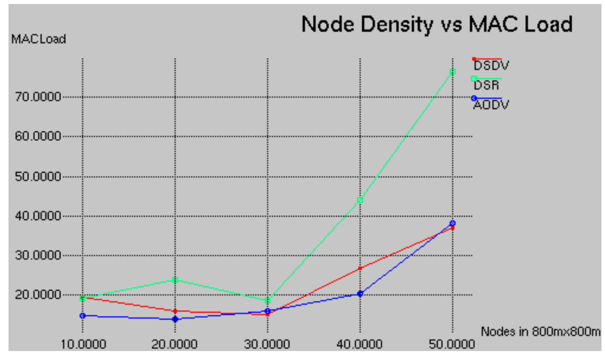

Figure 5 Node density Vs MAC Load

The following graph shows routing load of the three different protocols with mobility in different node densities. As shown in the graph, AODV with mobility performed very poor and caused much routing load. DSDV is the next protocol which caused much routing load next to AODV

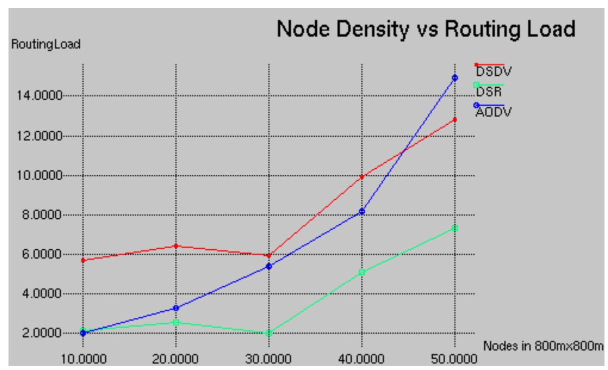

Figure:6 Node Density Vs Routing Load

If we carefully examine all the above graphs it is obvious that AODV is the protocol which is getting affected too much by mobility and node density.

5. CONCLUSIONS AND FUTURE WORK

We have evaluated three commonly used ad hoc routing protocols DSDV, DSR and AODV in different mobility and node density. If we carefully examine the graphs presented in previous section it is obvious that AODV was the protocol which was getting affected too much by mobility and network density. The reason for such poor behaviors is caused by the way in which its rooting mechanism is working.

So future works may investigate the routing mechanism of AODV to improve its performance little further. For that, we will explore the routing message processing mechanism of AODV and try to reduce the different kinds of overheads involved in routing message processing and improve them little further to provide better performance. There is much possibility for developing a mobility and node density aware extension to AODV routing protocol. Future works may address these issues.

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