Simulation of MANET Routing Protocols
DSDV, DSR and AODV for different Mobility Models

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Abstract
MANET Mobile Ad-hoc Network is a special kind of wireless network that consists of group of mobile nodes that communicate each other. A routing node is a collection point in the network and it uses a protocol to forward data from source to destination. The nodes are free to move randomly and organized themselves arbitrarily. A routing node is a collection point in the network and it uses a protocol to forward data from source to destination. This paper is a simulation based comparison of three Mobile Ad Hoc Networks (MANETs) routing protocols – Destination Sequenced Distance Vector (DSDV), Ad hoc on demand Distance Vector (AODV) and Dynamic Source Routing (DSR). The mobility models used for the comparison in this work are Random Waypoint, Manhattan Grid, Reference Point Group using network simulation tool NS2. With detailed simulation we compare these routing protocols for different mobility models and investigate that which routing protocol gives better performance in which mobility model.

Keywords:- Ad-hoc network, DSDV, DSR, AODV, MANET

[1] INTRODUCTION
A mobile ad hoc network is collection of mobile devices like laptops, smart phones, sensors, etc. that communicate with each other over wireless links and cooperate in a distributed manner in order to provide the necessary network functionality in the absence of a fixed infrastructure. The routers are free to move randomly and organize themselves at random; thus, the network's wireless topology may change rapidly and unpredictably. Such a network may operate in a standalone fashion, or may be connected to the larger Internet. Minimal configuration and quick deployment make ad hoc networks suitable for emergency situations like natural or human induced disasters, military conflicts, emergency medical situations etc. The fundamental characteristic which differentiates MANETs from other wireless or wired networks is mobility. Choosing mobility model that describes the movements of the nodes is one of the most important choices of simulation parameters. Therefore, MANET routing protocols are designed to adaptively cater for dynamic changes in topology while maximizing throughput and packet delivery ratio, and minimizing delay, routing load and energy consumption. The mobility of the nodes affects the number of average connected paths, which in turn affect the performance of the routing algorithm. Our goal is to carry out systematic performance study of DSDV, DSR and AODV using different mobility models. Organization of the paper is as below. In section II, routing protocols of MANETs is briefly reviewed. Section III, describes the Mobility Models of MANET. Section IV gives simulation detail used and section V describe Performance parameter. Section VI and VII presents simulation setup and simulation result respectively. Finally conclusion is in section VIII.

[2] MANET ROUTING PROTOCOLS
A number of routing protocols for Ad Hoc networks exist and generally they can be classified as proactive and reactive protocols. Proactive protocols mandates that nodes in the MANET should keep track of routes to all possible destinations so that when packet needs to be forwarded, the route is already known and can be immediately used while in reactive protocols nodes only discover routes to destination on demand. This work focuses on DSDV (proactive), AODV and DSR (reactive) protocols.

2.1 Destination-sequenced Distance-Vector (DSDV)
Destination-sequenced Distance Vector (DSDV) routing protocol is a pro-active, table-driven routing protocol for MANETs developed by Charles E. Perkins and Pravin Bhagwat in 1994. It uses the hop count as metric in route selection. Here, every mobile node in the network maintains a routing table for all possible destinations within the network. Every node has a single entry in the routing table. The entry will have information about the node’s IP address, last known sequence number and the hop count to reach that node. Along with these details the table also keeps track of the next hop neighbor to reach
the destination node, the timestamp of the last update received for that node. The DSDV update message consists of three fields, Destination Address, Sequence Number and Hop Count.

2.2 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 hoc networks of mobile nodes. The protocol 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 ad hoc network. Route Discovery is the mechanism by which a node S wishing to send a packet to a destination node D obtains a source route to D. Route Discovery is used only when S attempts to send a packet to D and does not already know a route to D. Route Maintenance is the mechanism by which node S is able to detect, while using a source route to D, if the network topology has changed such that it can no longer use its route to D because a link along the route no longer works. When Route Maintenance indicates a source route is broken, S can attempt to use any other route it happens to know to D, or can invoke Route Discovery again to find a new route. Route Maintenance is used only when S is actually sending packets to D.

2.3 Ad hoc On-demand Distance Vector Routing (AODV)

Ad-Hoc On-demand Distance Vector Routing (AODV) is an improvement on the DSDV algorithm. To find a path to the destination, the source broadcasts a route request packet. The neighbors in turn broadcast the packet to their neighbors till it reaches an intermediate node that has recent route information about the destination or till it reaches the destination. When a node forwards a route request packet to its neighbors, it also records in its tables the node from which the first copy of the request came. This information is used to construct the reverse path for the route reply packet. As the route reply packet traverses back to the source, the nodes along the path enter the forward route into their tables. If the source moves then it can reinitiate route discovery to the destination. If one of the intermediate nodes move then they moved nodes neighbor realizes the link failure and sends a link failure notification to its upstream neighbors and so on till it reaches the source upon which the source can reinitiate route discovery if needed.

3.1 Random Waypoint Mobility Model

A model includes pause times between changes in destination and speed. The current speed and direction of an MN is independent of its past speed and direction. A Mobile node begins by staying in one location for a certain period of time (i.e. pause). Once this time expires, the mobile node chooses a random destination in the simulation area and a speed that is uniformly distributed between \([\text{min-speed, max-speed}]\). The mobile node then travels toward the newly chosen destination at the selected speed. Upon arrival, the mobile node pauses for a specified period of time starting the process again.

3.2 Manhattan Mobility Model

The Manhattan mobility model uses a grid road topology. In the Manhattan model the movement pattern of mobile nodes on streets defined by maps, where the streets are arranged in an organized manner. The Manhattan model employs a probabilistic approach in the selection of nodes movements, since, at each intersection, a vehicle chooses to keep moving in the same direction. The velocity of the mobile nodes at a time slot is dependent on the velocity at the previous time slot.

3.3 Reference Point Group Mobility Model (RPGM)

It represents the random motion of a group of MNs as well as the random motion of each individual MN within the group. The group movements are based upon the path traveled by a logical center of the group. Individual MNs randomly move about their own pre-defined reference points. The motion of the group center completely characterizes the movement of this corresponding group of mobile nodes including their direction and speed.
RPGM can be used in military battlefield communication where commander and soldiers form a logical group.

[4] SIMULATION

We chose a Linux platform i.e. UBUNTU 12.04, as Linux offers a number of programming development tools that can be used with the simulation process. The simulation software used in this paper is the network simulator, NS2. NS2 is discrete-event driven simulation software targeted for network simulation. This software is currently maintained by the Information Science Institute of University of Southern California. NS2 is an object oriented simulator, written in C++ and OTcl (Object oriented Tool command language) as the frontend.

![NS2 Simulation Process](image)

**Figure 3 NS2 Simulation Process**

Figure depicts the overall process of how a network simulation is conducted under NS2. Two files can be generated at the end of a simulation run: an event trace file and a network animation NAM file. The trace events can be logged at the application level (CBR, TCP traffic agent), routing layer, MAC layer as well as the node’s movements at specific intervals. The NAM file provides a visual appreciation of the entire node’s movement and interaction with other nodes and thus enables the user to obtain a visual validation of the simulation model. Output files such as trace files have to be parsed to extract useful information. The parsing can be done using the awk command or perl scripts. The results can be analyzed using Excel or Matlab to plot graphs. Here, we use awk command and use Excel to plot the ghaph.

4.1 Traffic Generation

Two types of traffic can be generated for the purpose of simulation: constant bit rate (CBR) traffic or transmission control protocol (TCP) traffic. All simulations used CBR traffic type as the source of data traffic. CBR presents a more stringent demand on the mobile ad hoc network. CBR and TCP (in fact, it is a FTP application) traffic can be generated using pre-built in OTCL scripts (cbrgen.tcl) in the NS2 directory.

4.2 Scenario Generation

The scenario of the network is generated using BonnMotion software. BonnMotion is a Java software tool for the investigation of mobile ad hoc network characteristics. To use this software, you need to have a JDK or JRE installed.

[5] PERFORMANCE METRICS

5.1 Packet Delivery Ratio

It is the ratio of data packet delivered to the destination to those generated by the sources.

5.2 Average End to end Delay

It is the average amount of time taken by a packet to go from source to destination.

5.3 Average Throughput

It is ratio of total received size to Elapsed time between sent and receives.

5.4 Routing load

It is the number of routing packets which would be sent for route discovery and maintenance. All the above mentioned performance metrics are quantitatively measured. For a good routing protocol, throughput and PDR should be high where as other two parameters value should be less.

[6] SIMULATION SET UP

We simulate the AODV, DSR and AODV routing protocols for Random Waypoint, Manhattan, RPGM mobility models individually. The individual scenarios were generated with the following configurations:

<table>
<thead>
<tr>
<th>Table 1: General Simulation Parameters</th>
</tr>
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<tbody>
<tr>
<td>Protocols</td>
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<tr>
<td>Simulation Time</td>
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<tr>
<td>No of Nodes</td>
</tr>
<tr>
<td>Map Size</td>
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<tr>
<td>Mobility model</td>
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<tr>
<td>Traffic Type</td>
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<tr>
<td>Packet Size</td>
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<tr>
<td>Connection rate</td>
</tr>
<tr>
<td>No of connection</td>
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</tbody>
</table>

[7] SIMULATION RESULTS AND ANALYSIS FOR SCENARIO

7.1 Random Waypoint model

7.1.1 Node Density - Result

In the first set of simulations, the node density of the simulation network was varied to ascertain the performance impact of the four routing protocols. The node density is increased from 10 to 50 nodes within the same map area as each simulation run is executed. The goal is to understand the impact of having more nodes within a fixed area of operation on the network’s packet delivery ratio and its delay as well as the overall routing overheads. Figure 4 shows the results of the simulation, which demonstrates the overall packet delivery ratio of the network using the routing protocols. DSR and AODV, in general, have better packet delivery performance than DSDV. Figure 5, 6 and 7 shows the network delay.
routing load and throughput against node density. It shows DSR and AODV are better.

7.1.2 Network Loading

In second simulation, the connection load of each pair of communicating nodes was varied. The offered load is increased from 5 pkts/sec to 20 pkts/sec. The total number of nodes in this system remains at 20. The entire simulation run lasts for 200s. Figure 8, 9, 10, 11 shows PDR, Network delay, Routing load and throughput against Network loading which is obtained from change of connection rate. The performance of DSR is better in variation connection rate as compared to AODV and DSDV.
7.1.3 Network Connection

In this third simulation of network load variation, the number of connections the simulated system will take was varied instead. The number of connections increases from five to 20 connections in each different set of simulation. The Figure 12 shows the PDR of AODV and DSR is better than DSDV. Figure 13, 14, 15 shows Delay, Routing Load and Throughput respectively for the varied network connection. From the figures AODV and DSR are better than DSDV.

7.2 Manhattan Mobility Model

7.2.1 Node Density

In this experiment on Manhattan Grid model, we investigate the performance aspect when the node density is varied within a fixed map area. The node density increases from 10 to 50 nodes within the same map area of 500m x 500m. The results shown in Figure 16 illustrate the packet delivery ratio against the node density and in Figure 18 demonstrate the routing overhead incurred in this variation. Also, Figure 17 is the overall network delay of the system as the node density varies. The DSR and AODV outperformed DSDV.
7.2.2 Network Loading
In this simulation on Manhattan Grid model, we investigate the routing performance aspect when the offered load increases. We do so by increasing the average connection load offered by each connection, starting at 5 pkts/sec to 20 pkts/sec. AODV and DSR is better than DSDV.

7.2.3 Network Connection
In this third simulation of network load variation, the number of connections the simulated system will take was varied instead. The number of connections increases from five to 20 connections in each different set of simulation. AODV and DSR are better than DSDV.
7.3 Node Density

The results are shown in the series of graphs below. Figure 76 shows the packet delivery ratio of the network using the three different protocols in a RPGM model.

- **Figure 23** PDR with varied No of Connection

- **Figure 24** Delay with varied No of Connection

- **Figure 25** Routing Load with No of Connection

- **Figure 26** Throughputs with No of Connection

### RPGM

In the Reference Point Group Mobility model (RPGM), nodes cluster together and move as a group. All things being equal as in the Random Waypoint model, similar parameters for simulation are used.
7.3.2 Network Loading
In this simulation on RPGM model, we investigate the routing performance aspect when the offered load increases. We do so by increasing the average connection load offered by each connection, starting at 5 pkts/sec to 20 pkts/sec. All the three protocols AODV, DSR and DSDV are performed equal.

7.3.3 Network Connection
In this third simulation of network load variation, the number of connections the simulated system will take was varied instead. The number of connections increases from five to 20 connections in each different set of simulation.
[8] CONCLUSION
This work uses ns2 simulator and evaluates the performance of three widely used Ad hoc on demand routing protocols under different mobility models and parameters such as Packet Delivery Ratio, Normalized Routing Overhead and End-to-end delay. A few conclusions can be drawn from the performance of the three protocols.

- The Result of simulation indicate that performance of AODV and DSR protocols are superior to DSDV.
- For Random Waypoint mobility model DSR is best because it has high PDR ratio and less routing load.
- For RPMG mobility model, PDR for AODV and DSR are nearly near to one another. There is no difference in the choice of routing protocols.
- For Manhattan mobility model DSR perform better as it has high PDR and less routing load.
- It is worthy of note to state that in terms of the chosen metrics, DSR performs best making it efficient in the utilization.

FUTURE WORK
In this work other network parameters such as simulation time, traffic type-CBR, etc. are kept constant. It would be interesting to observe the behavior of these three protocols by varying other network parameters and by using other performance metrics.

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REFERENCES

BIOGRAPHIES

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