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Performance Assessment of Dynamic Source Routing Protocol Using Random Waypoint Mobility Model

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ABSTRACT

Mobile ad hoc network is a dynamic network. In this network the mobile nodes dynamically form a temporary network without any centralized administration or the use of any existing network infrastructure. A number of routing protocols like Ad Hoc On-Demand Distance Vector Routing (AODV), Dynamic Source Routing (DSR) and Destination-Sequenced Distance-Vector (DSDV) have been proposed. The Dynamic Source Routing protocol (DSR) is an efficient routing protocol designed specifically for use in wireless ad hoc networks of mobile nodes. The DSR protocol is composed of the two mechanisms of "Route Discovery" and "Route Maintenance", which allow nodes to discover and maintain routes to arbitrary destinations. In this paper DSR was studied and its characteristics with respect to the Random Waypoint Mobility Model are analyzed based on packet delivery fraction, routing load, end-to-end delay, PDF, number of packets dropped, throughput and jitter using Network Simulator (NS2) that is employed to run wired and wireless ad hoc simulations. Analyses of the trace files are done in Tracegraph with Matlab.

Keywords: DSR, MANET, Performance Evaluation, Random Waypoint Mobility Model.

INTRODUCTION

Mobile ad hoc network is the emerging area of research in academics with the rapid growth of wireless handheld devices. A mobile ad hoc network (MANET) is a network where a number of mobile nodes work in cooperation & coordination without the involvement of any centralized authority or any fixed infrastructure. MANETs are elf-configuring, self-organizing network where the topology is dynamic. With the increase of portable devices as well as progress in wireless communication, ad hoc networking is gaining importance with the increasing number of widespread applications [1]. Ad hoc networks are normally used where there is little or no communication infrastructure or the existing infrastructure for communication is expensive.

MANET APPLICATIONS

Qualities like Quick deployment, Minimal configuration and absence of centralized infrastructure make them suitable for medical, combat and other emergency situations. All nodes in a MANET have the capability of moving in a given space and establishing connection between themselves. Mobile Ad-Hoc Networks allow users to access and exchange information regardless of their geographic position or proximity to infrastructure. In contrast to the infrastructure networks, all nodes in MANETs are mobile and their connections are dynamic.

In the absence of any centralized authority in such a network, we consider each node as a host and a potential router at the same time. A sample scenario of wireless nodes of a mobile ad hoc network is presented here in Fig. 1

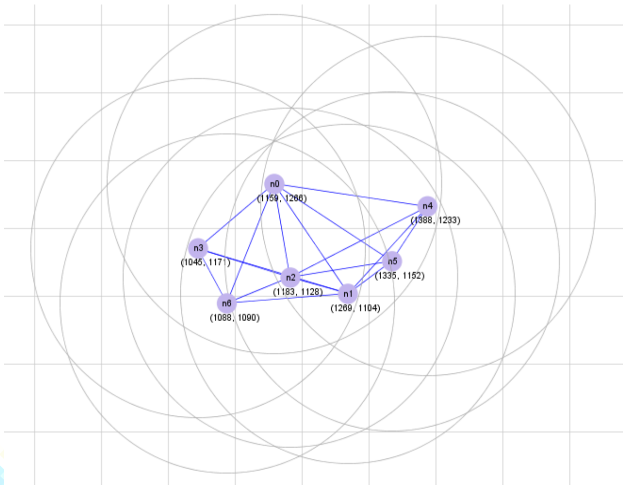

Fig. 1 An Example of Mobile Ad hoc Network (MANET)

Applications for MANETs are wide ranging and they can be employed in many critical situations: An ideal application is for search and rescue operations. Such scenarios are characterized by the lack of installed communications infrastructure. Another application of MANETs is sensor networks. This technology is a network composed of a very large number of small sensors. These can be used to detect any number of properties of an area. Examples include temperature, pressure, toxins, pollutions, etc.

ROUTING IN MOBILE AD HOC NETWORK

An ad-hoc network is a collection of wireless mobile hosts forming a temporary network without the aid of any stand-alone infrastructure or centralized administration [2]. Mobile Ad-hoc networks are self-organizing and self-configuring multi-hop wireless networks, where the structure of the network changes dynamically. This is mainly due to the mobility of the nodes [3]. Nodes in these networks utilize the same random access wireless channel, cooperating in a friendly manner to engaging themselves in multi-hop forwarding. The nodes in the network not only act as hosts but also as routers that route data to/from other nodes in network [4].

Classification of routing protocols in MANET's can be done in many ways, but most of these are done depending on routing strategy and network structure [3, 5]. According to the routing strategy the routing protocols can be categorized as Table-driven and source initiated, while depending on the network structure these are classified as flat routing, hierarchical routing and geographic position assisted routing [3].

Flat routing protocols are of two types; proactive routing (table driven) protocols, and reactive (on-demand) routing protocols. They further can be classified according to their design principles; proactive routing follows LS strategy (link state) while on-demand routing follows DV (distance-vector).

Proactive protocols continuously learn the topology of the network by exchanging topological information among the network nodes. Thus, when there is a need for a route to a destination, such route information is available immediately [6]. Hence there is minimum delay in determining the route to be chosen. This is important for time-critical traffic. Proactive protocols suits well in networks that have low node mobility or where the nodes transmit data frequently. Examples of Proactive MANET Protocols include:

- Optimized Link State Routing, or OLSR [7]
- Topology Broadcast based on Reverse Path Forwarding, or TBRPF [8]
- Fish-eye State Routing, or FSR [9]
- Destination-Sequenced Distance Vector, or DSDV [10]
- Landmark Routing Protocol, or LANMAR [11]
- Clusterhead Gateway Switch Routing Protocol, or CGSR [12]

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Reactive / On Demand routing is a relatively new routing style that provides solution to relatively large network topologies. These protocols are based on some sort of query-reply dialog. In this routing there is no need periodic transmission of topological information. Common for most on-demand routing protocols are the route discovery phase where packets are flooded into the network in search of an optimal path to the destination node in the network. Examples of Reactive MANET Protocols include:

- Ad hoc On-Demand Distance Vector, or AODV
- Dynamic Source Routing, or DSV
- Temporally Ordered Routing Algorithm, or TORA

DYNAMIC SOURCE ROUTING (DSR)

Dynamic Source Routing (DSR) [14] allows nodes in the MANET to dynamically discover a source route across multiple network hops to any destination. In this protocol, the mobile nodes are required to maintain route caches or the known routes. The route cache is updated when any new route is known for a particular entry in the route cache.

Routing in DSR is done using two phases: route discovery and route maintenance. When a source node wants to send a packet to a destination, it first consults its route cache to determine whether it already knows about any route to the destination or not. If there already is an entry for that destination, the source uses that to send the packet. If not, it initiates a route request broadcast. This request includes the destination address, source address, and a unique identification number. Each intermediate node checks whether it knows about the destination or not. If the intermediate node does not know about the destination, it again forwards the packet, and eventually this reaches the destination. A node processes the route request packet only if it has not previously processed the packet and its address is not present in the route record of the packet. A route reply is generated by the destination or by any of the intermediate nodes when it knows about how to reach the destination. Figure 4.10 shows the operational method of the dynamic source routing protocol.

RANDOM WAYPOINT MOBILITY MODEL

Random Waypoint Mobility (RWP) model is a commonly used model for providing mobility in ns2. It is the most basic model which describes the movement pattern of independent nodes in simple terms. Briefly, in the Random Waypoint Mobility model:

- Each node moves along a zigzag line from one waypoint Pi to the next Pi+1 where Pi is the position of a particular node.
- The waypoints are uniformly distributed over the given deployment area, e.g. unit disk.
- At the start of each round a random speed is drawn from the speed distribution. (in the basic case the velocity is constant 1)
- Optionally, the nodes may have so-called "thinking times" when they reach each waypoint before continuing on the next round, where durations are independent and identically distributed random variables.

SIMULATION OF ROUTING PROTOCOL

Simulation of the DSR routing protocol has been carried over to evaluate the performance of the network with varying number of nodes. Various parameters that are considered for the simulation are listed in table 1.

Parameter Name	Values
Channel Type	Channel/Wireless Channel
Netif	Phy/Wireless Phy
Mac Protocol	Mac/802_11
Queue Length	50
Number of Nodes	4/ 8/ 12/ 16/ 20
Routing Protocol	DSR
Grid Size	500 x 500
Packet Size	512
Simulation Time	200
Mobility Model	Random Waypoint

Table 1: Network Parameter Definition

Results, Performance Evaluation & Analysis

Experiments are carried out in Network Simulator 2 (ns2 [16]) with programming done in tcl language. Two resultant files with *.nam and *.tr extension were further analyzed. Nam is a Tcl/TK based animation tool for viewing network simulation traces and real world packet traces. It supports topology layout, packet level animation, and various data inspection tools. Trace files (with *.tr extension) can be analyzed by tracegraph [15] tool that runs within Matlab. We also evaluate the performance of DSR by taking number of nodes as a parameter. We are able to analyze the simulation of DSR with different number of nodes, with the help of 2D and 3D graphs generated with tracegraph. The simulation is divided in five parts based on the number of nodes that vary:

1. DSR with 4 nodes.
2. DSR with 8 nodes.
3. DSR with 12 nodes.
4. DSR with 16 nodes.
5. DSR with 20 nodes.

The comparison of performance of DSR, based on the number of nodes is done on following parameters like packet sent, packet received, packet dropped, packets lost, throughput and average end-to-end delay.

COMPARISON OF PERFORMANCE OF DSR BASED UPON NUMBER OF NODES

As we increase the number of nodes for performing the simulation of the DSR protocol, number of sent and delivered packets changes, which in turn changes the throughput and average end-to-end delay. Throughput is defined as the ratio of data delivered to the destination to the data sent by the sources. Average end-to-end delay is the average time a packet takes to reach its destination. The table 2 shows the difference between sent packets, received packets, lost and dropped packets, the average end-to-end delay when the number of nodes is increased.

Packet Size---------------------- 512
Simulation Time---------------- 150 Sec

No of Nodes□ Parameters	4	8	12	16	20
Packets Sent	17517	10502	511	2534	16884
Packets Received	17453	10470	482	2502	16797
Packets Forwarded	0	0	0	0	0
PDF	0.9963	0.9970	0.9432	0.9874	0.9948
Throughput	489.14	485.99	245.37	485.59	485.74
Average end-to-end delay (ms)	255.73	147.13	144.83	399.59	288.10

Table 2: Comparison of Various Parameters v/s No. of Nodes

The data in table 2 are plotted in MS Excel

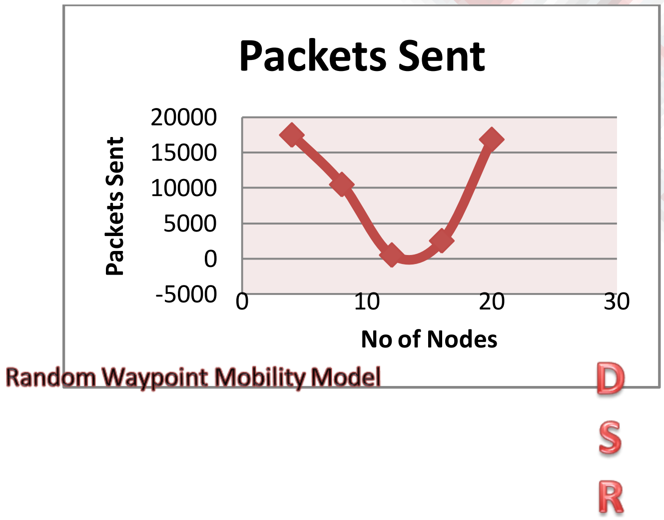

Fig. 2 Plot of Packets Sent against No. of Nodes

Fig. 2 shows the total number of packets sent vary with increasing number of nodes. As the number of nodes goes on increasing, the packets sent first decreases, then increases and as no. of nodes becomes 16 it only increases.

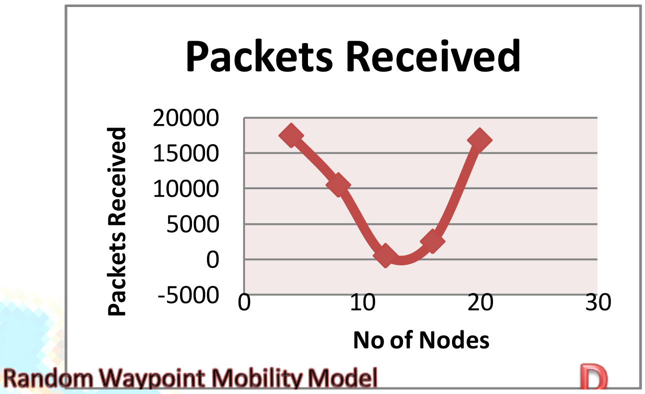

Fig. 3 Plot of Packets Received against No. of Nodes

Fig. 3 shows the graphical representation of Packet Received versus number of nodes of DSR protocol. As the number of nodes goes on increasing, the packets received first decreases, then increases and as no. of nodes becomes 16 it only increases.

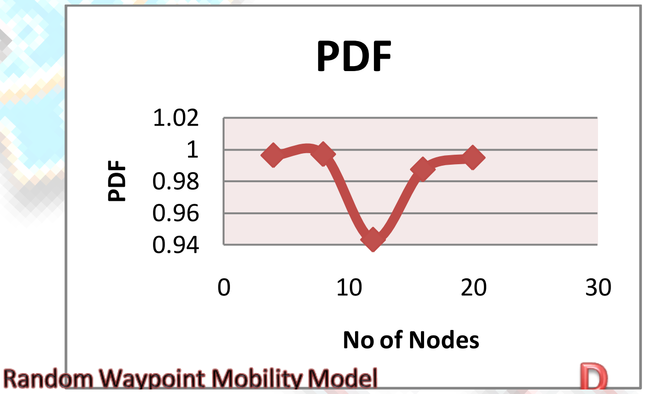

Fig. 4 Plot of PDF against No. of Nodes

$$\text{PDF} = \frac{\text{Number of Received Packets}}{\text{Number of Sent Packets}}$$

Figure 4 shows the graphical representation of PDF versus the number of nodes of DSR protocol. As the number of nodes goes on increasing, the PDF value first decreases and then increases.

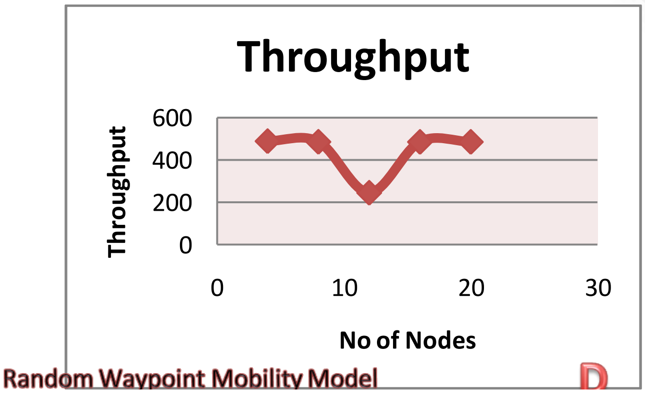

Fig. 5 Plot of Throughput against No. of Nodes

Fig. 5 shows the Throughput graph plotted against number of nodes which gives nearly the same value except for node no. 12.

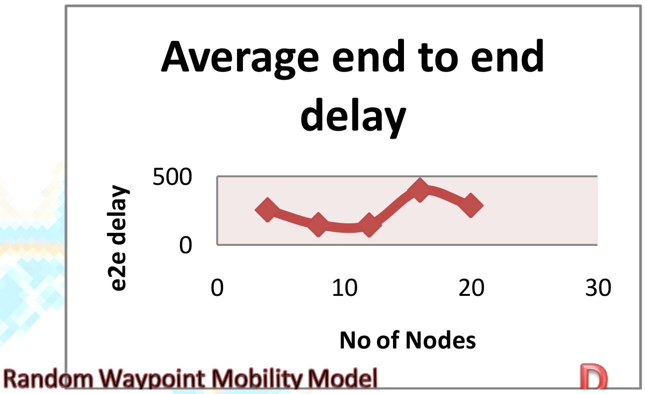

Fig. 6 Plot of Average end-to-end Delay against No. of Nodes

Fig. 6 shows the average end-to-end delay graph plotted against number of nodes. Average end-to-end delay, decreases when numbers of nodes are increased to 12 from 4.

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