Performance Evaluation of DSR with Reference to Varying Number of Nodes

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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 work an attempt has been made to compare the performance of DSR routing protocols for mobile ad hoc networks on the basis of varying number of nodes. The simulations are carried out using the ns-2 network simulator, which is used to run wired and wireless ad hoc simulations. Analyses of the results are done in Tracegraph with Matlab.

Index Terms: DSR, MANET, Performance Evaluation, Protocol.

I. 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.

II. 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 mobile ad hoc network is presented here in Fig. 1

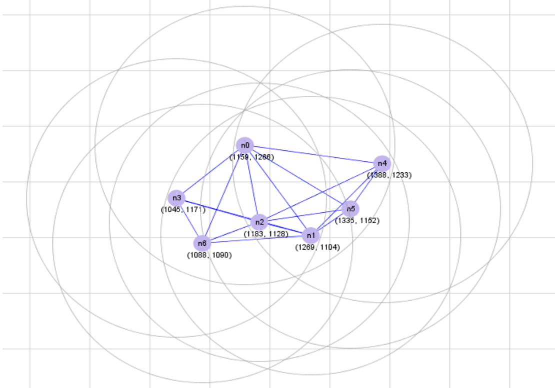

Fig. 1 An Example of Mobile Ad hoc Network (MANET)

Applications for MANETs are wide ranging and have use 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.

III. 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].

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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]

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

IV. 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 already there 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.

V. SIMULATION OF ROUTING PROTOCOL

Simulation of 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 simulation are listed in table 1.

Table 1: Network Parameter Definition

Parameter Name	Value
Channel Type	Channel/Wireless Channel
Netif	Phy/Wireless Phy
Mac Protocol	Mac/802_11
Queue Length	50
Number of Nodes	3/6/9/12/15
Routing Protocol	DSR
Grid Size	500 x 400
Packet Size	512
Simulation Time	50
Topology	Random

VI. 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 3 nodes.
2. DSR with 6 nodes.
3. DSR with 9 nodes.
4. DSR with 12 nodes.
5. DSR with 15 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.

VII. COMPARISON OF PERFORMANCE OF DSR BASED UPON NUMBER OF NODES

As we increase the number of nodes for performing the simulation of 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, average end-to-end delay when number of nodes is increased.

Packet Size---------------------- 512

Simulation Time---------------- 150 sec

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

No of Nodes→ / **Parameters**	**3**	**6**	**9**	**12**	**15**
Packets Generated	22867	22691	23347	24456	25399
Packets Delivered	22631	22199	22335	22113	21985
Packets Forwa-rded	108	376	305	623	755
Packets Dropped	242	509	1042	2483	3550
Packets Lost	10	93	356	517	447
Throug-hput	0.98967	0.95082	0.9566 5	0.9041 95	0.86558 5
Average end-to-end delay	0.53412 0	1.5535	2.4040 9	3.4138 4	4.40102 36

The data in table 2 is plotted in MS Excel

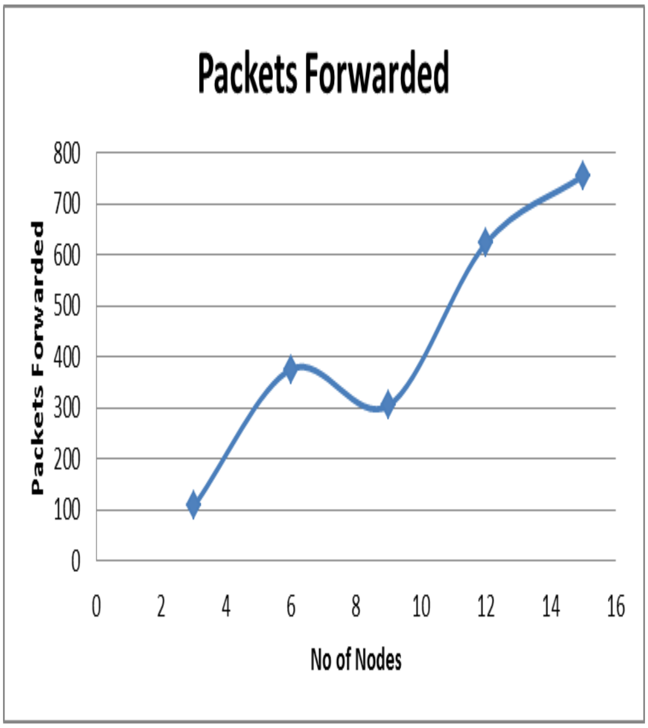

Fig. 2 Plot of Packets Forwarded against No. of Nodes

Fig. 2 shows total number of packets forwarded vary with increasing number of nodes. As the number of nodes goes on increasing, the packets forwarded first increases then decreases and as no. of nodes becomes 9 it only increases.

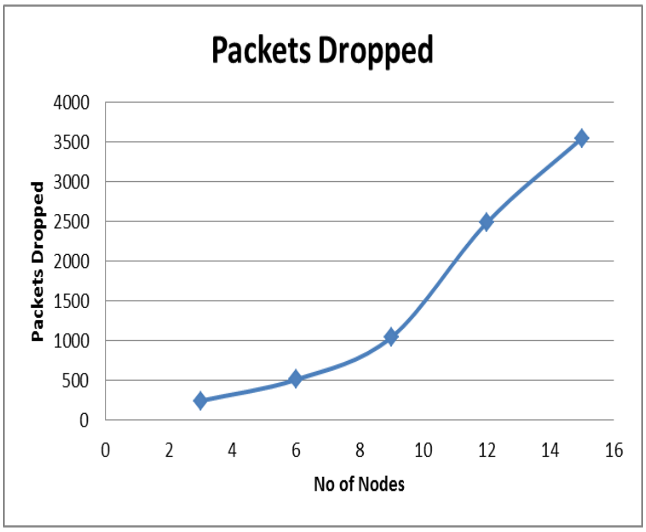

Fig. 3 Plot of Packets Dropped against No. of Nodes

Fig. 3 shows the graphical representation of Packet Dropped versus number of nodes of DSR protocol. As the number of nodes goes on increasing, the packets forwarded increases.

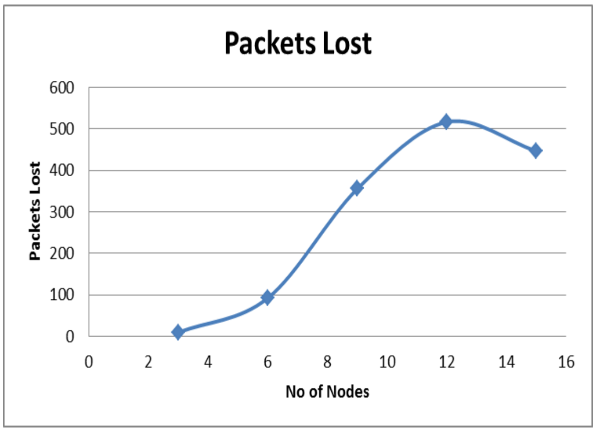

Fig. 4 Plot of Packets Lost against No. of Nodes

Fig. 4 shows the Packets Lost graph plotted against number of nodes. Packets Lost, at the starting increases when numbers of nodes are increased to 12 from 3, but after that decreases as we further increase the number of nodes to 15.

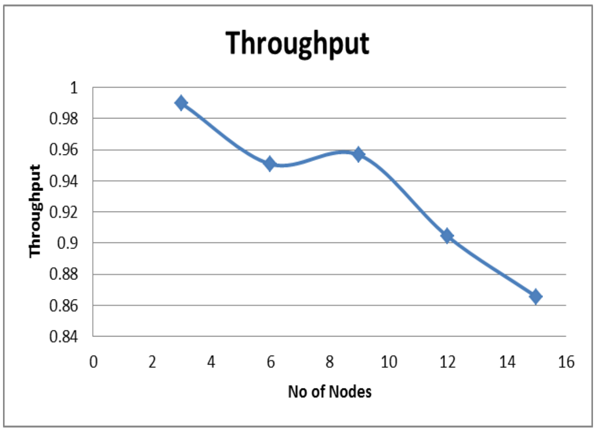

Fig. 5 Plot of Throughput against No. of Nodes

Fig. 4 shows the Throughput graph plotted against number of nodes. Packets Lost, at the starting decreases when numbers of nodes are increased

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to 3 from 6, but after that increases as we increase no of nodes from 6 to 9. Further, from 9 till 15 no. of nodes it decreases. This means that the packet delivery ratio goes on decreasing when numbers of nodes are increased in DSR protocol.

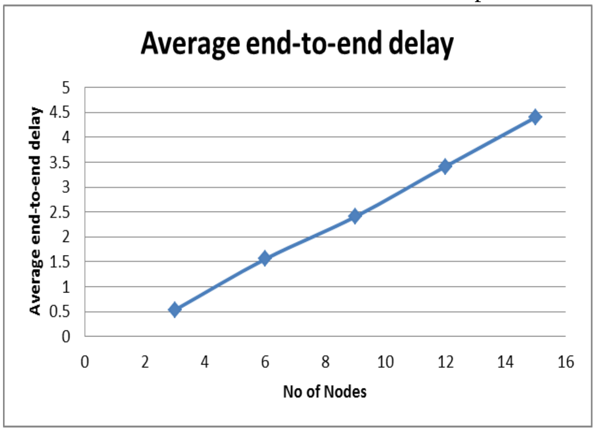

Fig. 6 Plot of Average end-to-end Delay against No. of Nodes

Fig. 6 shows the average end-to-end delay graph plotted against number of nodes. Average end-to-end delay, increases when numbers of nodes are increased to 15 from 3. This means that the average time to reach its destination taken by a packet is decreased as the number of nodes increases. That is, more the number of nodes, less time will be taken by a packet to reach its final destination from the source.

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