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Performance Analysis of Routing Protocols in Mobile Ad Hoc Networks

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ABSTRACT: Mobile Ad hoc Network (MANET) is a self-organizing and self-configuring network without the need of any centralized organization or any switching centre. In MANETs, the nodes are mobiles and battery operated. It is seen that MANETs will be an integral part of the next generation networks because of its flexibility, infrastructure less nature, ease of maintenance, auto configuration, self-administrations capabilities and the cost effectiveness. In MANET each node must be able to communicate with each other in order to connect and forward the data packets to the destination. The routing in MANET is done by using the routing protocols. The MANET routing protocols are proactive, reactive, and hybrid. In this project we have shown the comparison of the proactive and reactive protocols like DSDV, AODV, DSR based on the important performance metrics like node throughput, packet delivery ratio and the average end-to-end delay by using network simulator-2.

Keywords: MANET, DSDV, AODV, DSR, Throughput, Packet delivery ratio, Average End-to-End delay.

I. INTRODUCTION

A Mobile Ad hoc Network is a self-configuring network and without the need of any centralized organization or any switching canter [1]. In fact all the nodes in MANET themselves can act as routers. Even the topology also changes frequently. Each node of the MANET has the freedom of moving while the communication is going on moreover, in MANET the nodes are mobiles and they are operated on batteries. The MANET concept gives the capability of accessing the internet while on the move using the wired or wireless network. Up to now we have the traditional wired network was the only solution to get network or internet access. The use of wireless technology has become a more popular technology currently to access the internet. It is very easy and less expensive to organize a wireless network, compared to traditional wired network, as the required work and cost of wired cables are negligible. If we want to add additional devices in wireless network is very easy, when compared to it with the wired system. Here, wireless equipped devices are called as the nodes, and every node is having some certain transmission range, to communicate with the other node. MANETs are providing an emerging technology in civilian and military applications. Here the medium of communication is wireless, so we have only a limited bandwidth is available.

For the communication among all the nodes in MANET several routing protocols have been proposed. We have three types of routing protocols are there in MANET [2][13]. They are the table driven or proactive routing protocols, the on demand or reactive routing protocol and the hybrid routing protocols.

1. Proactive routing protocols: These are also called as table driven routing protocols. In proactive routing protocols, each node maintains one or more tables containing routing information to every other node in the network. All the nodes update these tables so that an up to date network is maintained. When the topology changes, the nodes sends update messages to the entire network. The main disadvantage of the proactive routing protocols is that all the nodes in the network should always maintain an updated table.
E.g. DSDV, OLSR, etc.

2. Reactive routing protocols: These are also called as on demand routing protocols. These are fully opposite to the table driven routing protocols. In this all the up to date routing information is not maintained at every node, instead the routes are created when required. When the source want to communicate with the destination then it starts route

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discovery process to find the path to the destination. The route remains valid till the destination is reachable or until the route is no longer needed. Unlike the proactive, the reactive or on demand routing protocols do not maintain an update table.
E.g. DSR, AODV, etc.

3. Hybrid Routing Protocols: These are the mixture of both table driven and on demand routing protocols.
E.g. TORA, ZRP, etc.

The rest of the paper is organized as follows. The descriptions of the routing protocols are given in section-II. The section III describes the performance metrics that are used for the comparison and section IV describes the simulation environment. The simulation results are discussed and analysed in section V and finally the conclusion is given in section VI.

II. ROUTING PROTOCOLS

1. Destination sequenced distance vector routing protocol (DSDV): The destination sequenced distance vector routing protocol is a proactive routing protocol and it is the modified version of the Distributed Bellman-Ford (DBF) method that was used successfully in most of the dynamic packet switched networks [6]. The Bellman-Ford (DBF) method is used to calculate the shortest path from source to the destination. In this method some routing loops are formed in the network. The DSDV protocol overcomes this problem by introducing a parameter called destination sequence number. In this protocol every node in the network should transmit a sequence number, which is periodically increased and transmitted along with any other routing update messages to all neighbouring nodes. In this protocol all the nodes maintains routing tables. It provides a single path to a destination, which is selected using the distance vector shortest path routing algorithm. In order to reduce the amount of overhead transmitted through the network, two types of update packets are used. The "full dump" and "incremental dump" packets. The full dump includes the all the available routing information and the incremental packet includes only the information changed since the last full dump. Even though DSDV is still having a large amount of overhead due to the requirement of the periodic update messages. Due to this it is used only for small sized networks.

2. Ad hoc on demand distance vector protocol (AODV): The ad hoc on demand distance vector routing protocol is an on demand or reactive routing protocol [4]. And it is the modified version of the DSDV protocol. In this, to find the route to a destination, the source will broadcast a route request packet. This broadcast message will propagate through the network until it gets an intermediate node that has the recent route information about the destination or until it reaches the destination. When the intermediate nodes forwards the route request packet (RREQ) it records in its routing table from which node the route request came from. This data is used to create the route reply path. The AODV supports only the symmetric links. In this the nodes maintain the route cache and uses destination sequence number for each route entry. In this the route discovery mechanism is limited when a route to a new destination is needed by sending a route request packet (RREQ). When the route reaches the destination then a route reply packet (RREP) will be sent back to the source. When there is any breakage in between two nodes the route error packet (RERR) will be sent to all the nodes in the network. Then the routing tables will be updated and the broken link will be eliminated.

3. Dynamic source routing protocol (DSR): The dynamic source routing protocol is an on demand routing protocol, which uses source routing [5]. The source routing enables us to specify the total route information in the packet header. The major difference between DSR and AODV protocol is that, in DSR routing information is contained in packet header. Since the routing information is maintained in packet header, that's why the intermediate nodes are not needed to maintain the routing information. Another feature of DSR is that it supports the asymmetric links, hence a route reply can be sent back on to a new route request packet. Another important feature of the DSR protocol is that it maintains a route cache. The route cache maintains all the used routing data. If a node sends a route request then the intermediate node checks the route cache, whether there is a route available for the destination or not. If there is route then it takes the route without going for the route discovery. When there is a link failure occurs between nodes then the RERR message will be sent back to the source in order to maintain the route information. Then the source node initiates a route discovery and then all the nodes will remove the broken link. The advantage of this protocol is that it reduces the route discovery control overheads with the use of the route cache. The disadvantage is when it is used for large size networks then the packet header size will be increased then the routing overhead becomes more due to source routing.

III. METRICS USED FOR COMPARISON

1. Throughput: It is the measure of performance of a network and it measures the speed *(bps)* with which a node is transmitting the data. And it is the ratio of the total amount of data received by the receiver from a sender to the time it takes for the receiver to get the last packet.

Throughput = total received data / simulation time

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2. Packet delivery ratio (PDR): It is the ratio of total received packets to the total sent packets. And it is the average rate of successful transmission of a packet from source to the destination.

PDR = received packets / sent packets

3. Average End-to-End-Delay: It is the average time from the beginning of a packet transmission at a source node until the packet reached to a destination. It is measured in seconds.

IV. SIMULATION ENVIRONMENT

The Network simulator is an event driven network simulator and developed at US Berkeley that simulates variety of IP networks [10][11]. It implements network protocols such as FTP, UDP, Telnet, Web, Router queue management such as drop tail, RED, CBQ, routing algorithms. NS also implements multicasting and some of the MAC layer protocols for LAN simulations. NS is written in C++ and OTCL (Object oriented tool commanding language) as a front end programming language.

A simulation study has been carried out to analyse the performance of MANET routing protocols DSDV, AODV, and DSR based on the important performance metrics such as throughput, packet delivery ratio, and average end-to-end delay are calculated by using the following simulation setup shown in Table I. Here we have taken the maximum packet size as 512 bytes and the maximum node transmission range as 250 meters. Here pause time is the time in which all the nodes are in motionless condition but the transmission is going on. The dimensions used for the simulations are 500m x 500m with varying the network size as 50, 75 and 100 nodes with varying pause time as 20, 40, 60, 80, 100 seconds. We have used two ray ground propagation model for its effectiveness in large sized networks.

TABLE I: SIMULATION ENVIRONMENT

Parameter	Value
Radio Propagation model	Two ray ground
Protocols used	DSDV, AODV, DSR
Traffic source	Constant Bit Rate (CBR)
Packet size	512 bytes
Maximum speed	10 m/s
Area	500 m x 500 m
Node Transmission range	250 m
Number of nodes	50,75,100
Application	File Transfer Protocol
MAC	MAC-802.11
Total Simulation time	100 sec
Pause time (sec)	20,40,60,80,100
NS Version	2.30
Platform	Red Hat Linux

V. SIMULATION RESULTS AND DISCUSSIONS

1. Throughput: The throughput is defined as the ratio of total received data in bytes to the total simulation time. Here simulation time is the difference between stop time –start time. It gives the speed of a network in Bytes per second (BPS) with which a node is transmitting the data. When comparing the routing throughput of each protocol, AODV has shown the high throughput. The throughput values of DSDV, AODV, DSR protocols for 50,75,100 nodes with varying pause time as 20,40,60,80,100 seconds are plotted and shown in the Figures-(1,2 and 3). Based on the simulation results the DSDV protocol increased initially and then decreases when the time increases. DSR performed well than DSDV. The throughput values of DSR increases at lower pause time and then decreases when the time increased. AODV has shown high throughput among the three protocols. After the simulation study of throughput we can say that the DSR and AODV performed better than the DSDV protocol.

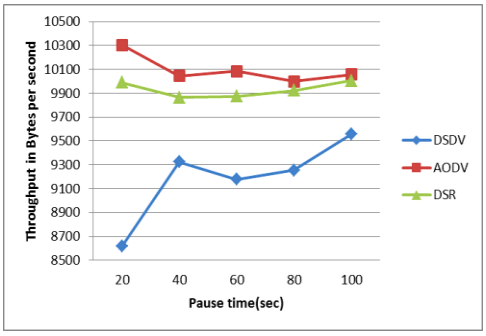

Figure-1.Comparison of Node Throughput for 50 Nodes

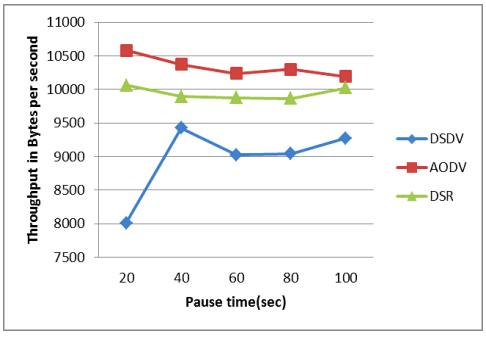

Figure-2.Comparison of Node Throughput for 75 Nodes

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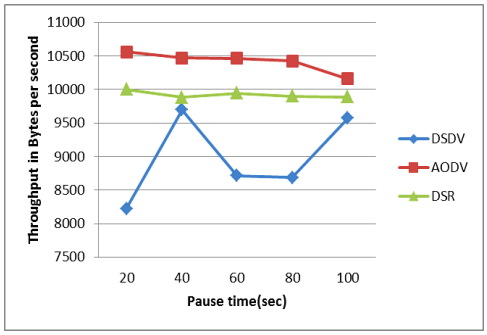

Figure-3.Comparison of Node Throughput for 100 Nodes

2. Packet delivery ratio (PDR): It is the ratio of total received packets to the sent packets. It characterizes both correctness and efficiency of ad hoc routing protocol. A high packet delivery ratio is desirable in any network. The packet delivery ratio values for DSDV, AODV, and DSR for 50, 75,100 nodes with varying pause time are plotted and shown in the Figures-(4, 5, and 6). The PDR values of DSR are higher than all the other protocols. The PDR values of AODV are almost same as DSR because both are on demand protocols but when the number of nodes increasing DSR has shown higher throughput than AODV.

The PDR value of DSDV is worse in lower pause time and gradually grows in higher pause time. From the above study, in the view of packet delivery ratio DSR protocol shown good performance than others. And overall we can say the reliability of AODV and DSR protocols is greater than DSDV protocol.

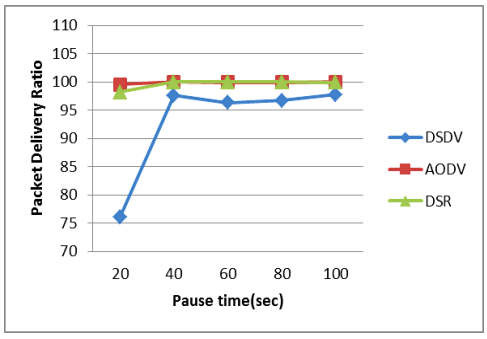

Figure-4.Comparison of PDR for 50 Nodes

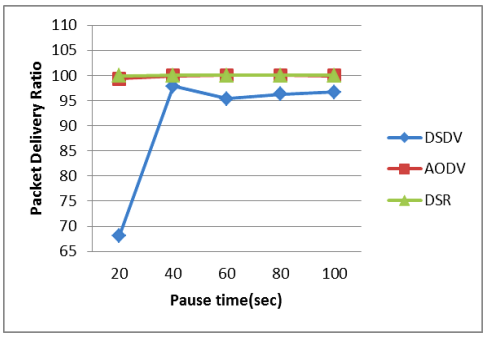

Figure-5.Comparison of PDR for 75 Nodes

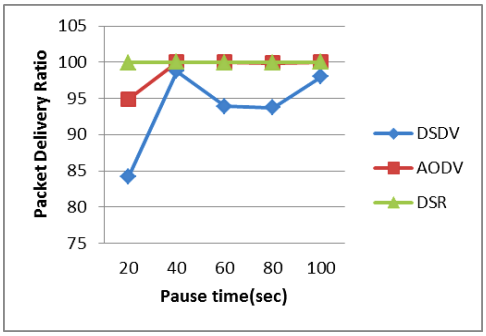

Figure-6.Comparison of PDR for 100 Nodes

3. Average End-to-End-Delay: It is the average time that a packet takes to traverse the network. It is the time from the starting of a packet transmission at a source node until it reaches to a destination. It is measured in seconds. It includes all possible delays such as buffer queues, transmission time and delays induced by routing activities and MAC control exchanges. A good routing protocol should show a very less delay. The average end-to-end delay values of DSDV, AODV, DSR for 50, 75, 100 nodes with varying pause time are plotted and shown in Figures-(7, 8, 9). From the simulation results it is clear that DSDV has the less end-to-end delay than AODV and DSR, because DSDV is a table driven protocol i.e. all the routing information is stored in routing tables. Hence it consumes lesser time delay than others. On an average case the DSR has shown better performance than AODV but worse when compared to DSDV. AODV has shown worse performance than DSR and DSDV because AODV takes more time in finding the route. From the study on End-to-End delay we can say that DSDV has shown higher reliability than AODV and DSR.

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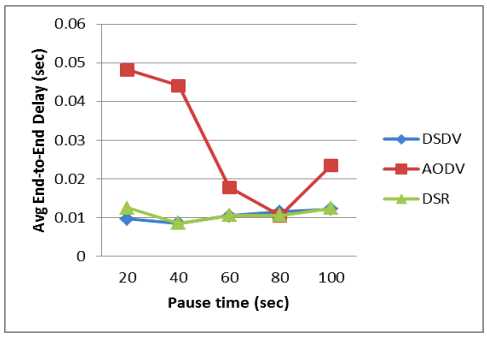

Figure-7.Comparison of Avg.End-to-End Delay for 50 Nodes

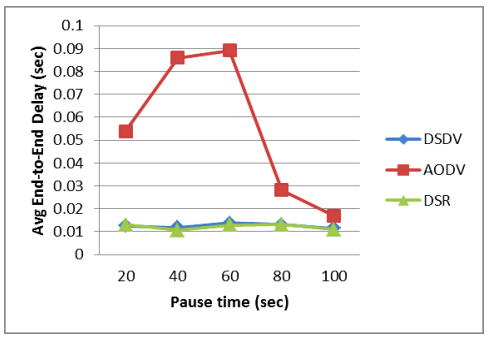

Figure-8.Comparison of Avg.End-to-End Delay for 75 Nodes

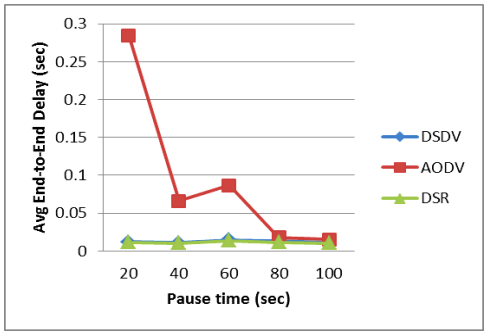

Figure-9.Comparison of Avg.End-to-End Delay for 100 Nodes

VI. CONCLUSION

In this paper the performance of three MANET routing protocols such as DSDV, AODV, DSR is analyzed by using NS-2 simulator. We have generated the simulation results of Average End-to-End delay, Throughput, Packet delivery ratio of all the three routing protocols with varying network size and varying pause time. DSDV is a proactive or table driven protocol and it is suitable for small networks with limited number of nodes and for a network which has lower mobility. That's why it produces a low End-to-End delay. It is not suitable for a network with high mobility because the routing information is stored at each node. Comparing DSR protocol with DSDV and AODV the data overhead will be increased whenever the network topology changes since DSR uses source routing and route cache. Hence DSR is suitable for medium sized networks with moderate traffic and moderate mobility. DSR has shown better performance in the case of packet delivery ratio and End-to-End delay than AODV. Coming to AODV routing protocol it needs to find routes by on demand that's why the End-to-End delay of AODV is worse than any other protocol. The AODV performed well in the case of throughput and in the case of higher mobility networks it performs much better than DSR protocol. In all the cases DSR and AODV are good but DSDV is best in case of End-to-End delay. Over all in all the cases DSR has shown a steady performance among the three protocols.

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BIOGRAPHIES

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