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ANALYSING PERFORMANCE OF AODV ROUTING PROTOCOL IN MOBILE ADHOC NETWORKS

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Abstract: Mobile Ad-hoc network is a collection of mobile nodes that communicate via wireless links and communication is carried out without any centralized control or fixed infrastructure. Each node participating in the network can act as host and router. The nodes in mobile ad-hoc network are free to move independently therefore topology changes frequently. Thus to route packets from source to destination, routing protocol is needed. Routing is the important issue in ad-hoc networks. A number of routing protocols have been implemented. Ad-hoc network routing protocols can be broadly divided into two categories proactive and reactive protocols. The main goal of this paper is to evaluate performance of Ad-hoc on demand distance vector routing protocol (reactive protocol) in Mobile ad-hoc networks with different network parameters using matlab. Our basic goal is to present vast information related to AODV protocol and to analyze its performance using different performance metrics such as packet delivery ratio, throughput, packet loss ratio and packet drop rate.

Keywords: Manet, AODV, Performance metrics, Matlab.

I INTRODUCTION

Ad-hoc network is a collection of mobile nodes that are capable of communicating with each other without the aid of any established infrastructure or centralized administration. They are self-organized, dynamically changing multi-hop networks. Each node in an ad-hoc network performs the dual task of being a possible source/ destination of some packets while at the same time acting as a router for other packets to their final destination. [17] There are two forms of ad-hoc networks namely static ad-hoc networks and mobile ad-hoc networks (MANET). Mobile ad- hoc network is a network which do not requires any fixed infrastructure; consist of mobile nodes which communicate via wireless links. Each node in manet acts as router as well as host. The nodes in manet are free to move independently. These nodes can be laptops, personal computers, music players etc. [20] Ad-hoc networks are often characterized by dynamic topology since nodes are free to move independently. Another characteristic is that nodes have limited power and bandwidth thus ad-hoc networks are energy constrained and bandwidth constrained. Also ad-hoc network have no predefined boundary and no physical security. The nodes in the network can freely join and leave the network. There is no centralized monitor server hence there is lack of physical security. [12]

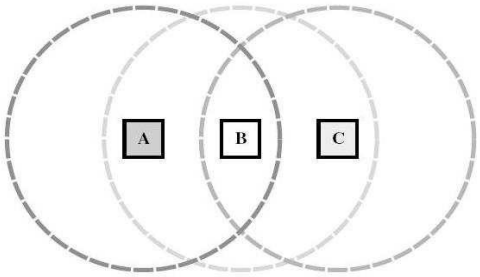

Fig. 1: Example of a simple ad-hoc network with three participating nodes [11]

As a new technology for information acquirement, the mobile ad-hoc network is of high research value and has wide applications. Mobile ad-hoc networks have very diverse applications. Some applications include military battlefield, it allow military to maintain information network between soldiers, vehicles, headquarters. Ad-hoc networks can also be used for emergency operations for disaster relief example in earthquake or floods. Another promising application field is personal area network (PAN).Short range mobile ad-hoc networks can simplify the communication between various mobile devices such as laptops and phones. Besides ad-hoc network vast applications, it has certain issues. Nodes in mobile ad-hoc network move randomly thereby changing the topology

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dynamically, thus routing packets between nodes is a major issue. In addition to routing, ad-hoc network has some security problems, thus security and reliability is another issue of mobile ad-hoc networks. Nodes in ad-hoc network have limited power thus power aware routing is another issue and providing different quality of services in constantly changing topology is a challenging task.[12] Routing in ad-hoc network has been a challenging task ever since the wireless networks came into existence. The major reason for this is the constant change in network topology because of high degree of node mobility. A number of protocols have been developed for accomplish this task. [9] In this paper , performance analysis of AODV routing protocol is done taking performance metrics parameters packet delivery ratio, throughput, packet loss ratio and packet drop rate. The simulation is done in Matlab.

The rest of the paper is organized as follows: In Section II, routing protocols classification is discussed. In Section III, overview of AODV routing protocol is given. Section IV describes the simulation of AODV routing protocol and brief overview of performance measuring metrics. Section V includes performance evaluation results. Section VI concludes the paper with future work.

II. ROUTING PROTOCOL CLASSIFICATION

Wireless ad-hoc networks have gained a lot of importance in wireless communications. Wireless communication is established by nodes acting as
routers and transferring packets from one to another in ad-hoc networks. Routing in these networks is highly complex due to moving nodes and hence many protocols have been developed. An ad-hoc routing protocol is a conventional or standard that controls how nodes decide which way to route packets between computing devices in mobile ad-hoc network.[9] All routing protocols are classified under three categories Table Driven, Source Initiated On Demand and Hybrid.[1]

1. Table Driven routing protocols:
In these protocols, every node maintains one or more tables containing routing information to every node in the network. All nodes update these tables so as to maintain a consistent and up-to-date view of the network. These protocols are also called as proactive because routing information is maintained by them even before it is required. Since, these protocols maintain node entries for each and every node in the form of table; it causes more overhead in the routing table which leads to more bandwidth consumption. So these protocols are not suitable for larger networks. DSDV protocol falls in this category. [19]

2. On Demand routing protocols:
On demand protocols obtain routes only on demand basis rather than maintaining a complete list of routing information all the time. The routes are created when desired by the source node. Whenever a node requires a route to destination a route discovery is initiated within the network. This process is completed once a route is found. Once a route is established, it is maintained by a route maintenance procedure. DSR, AODV protocols fall in this category. [19]

3. Hybrid routing protocols:
In this, various approaches of routing protocols are combined to form a single protocol. ZRP (Zone Routing Protocol) is one of the hybrid protocols which are the combination of table-driven and on-demand routing protocol.[19]

III. OVERVIEW OF AODV

Ad-hoc on demand distance vector routing protocol is a reactive routing protocol that maintain routes only when required. It uses broadcast route discovery mechanism as is used in dynamic source routing. Instead of source routing, AODV relies on dynamically establishing route table entries at intermediate nodes. To maintain the most recent routing information between nodes, it borrows the concept of destination sequence number from DSDV. The combination of these techniques yields an algorithm that uses bandwidth efficiently (by minimizing network load for control and data traffic) , is responsive to changes in topology and ensures loop free routing.[2] AODV protocol works in two steps:

*Path Discovery process

*Path Maintenance process

Path discovery process is the first step, whenever a source node wants to send packet to another node, path discovery process is initiated. The source node initiates path discovery by broadcasting route request RREQ packet to its neighbor. The RREQ contains the following fields: < source_addr , source_sequence_# , broadcast_id , dest_addr , dest_sequence_# , hop_cnt>. Each neighbor either satisfies the RREQ by ending a route reply (RREP) back to the source or rebroadcasts the RREQ to its own neighbors after increasing the hop_cnt. If a node cannot satisfy RREQ, it implements reverse path as well as forward path set up. [2]

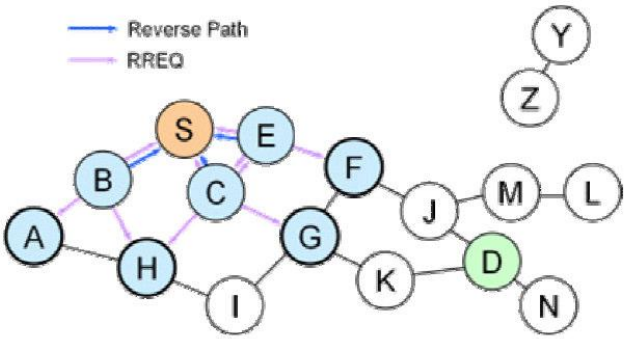

Fig 2: Path Finding in AODV [3]

As the RREQ travels from source to various destinations, it automatically sets up the reverse path from all nodes

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back to the source. Eventually, a RREQ will arrive at a node that possesses a current route to the destination. If an intermediate node has a route entry for the desired destination, it determines whether the route is current by comparing destination sequence number in its own route entry to the destination sequence number in the RREQ. If the RREQ's sequence number for the destination is greater than that recorded by the intermediate node, the intermediate node must not use its recorded route to respond to the RREQ. Instead, the intermediate node rebroadcasts the RREQ. The intermediate node can reply only when it has a route with sequence number that is greater than or equal to that contained in the RREQ. If it does have a current route to the destination, and if the RREQ has not been processed previously, the node then unicast a route reply packet (RREP) back to its neighbor from which it received the RREQ. A RREP contains the following information: < source_addr, dest_addr, dest_sequence_#, hop_cnt, lifetime >. By the time a broadcast packet arrives at a node that can supply a route to the destination, a reverse path has been established to the source of the RREQ.[2]

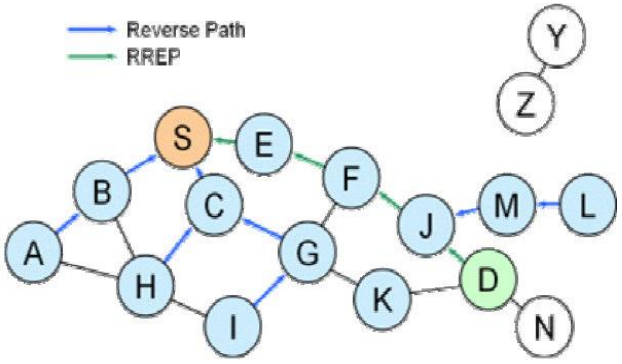

Fig 3: Path Finding in AODV [3]

As the RREP travels back to the source , each node along the path sets up a forward pointer to the node from which the RREP came. The source node can begin data transmission as soon as the first RREP is received. [2]

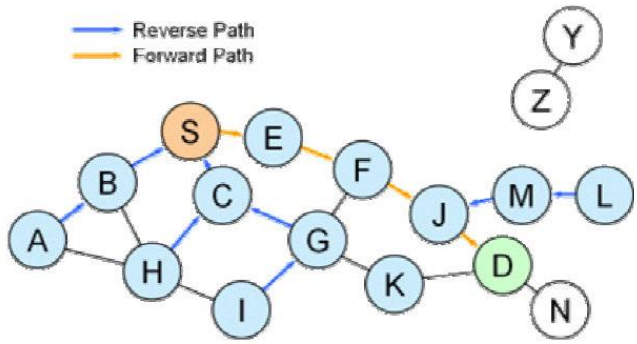

Fig 4: Path Finding in AODV [3]

Second step is the Path maintenance process in which hello messages are used to ensure symmetric links as well as to detect link failures. [2]

IV. SIMULATION OF AODV ROUTING PROTOCOL

Simulation is the main technique for evaluating the performance of mobile ad-hoc networks. simulation of ad-hoc on demand routing protocol is done in matlab. The network is taken as 100*100 sq kms. The source and destination pairs are spread randomly over the network. Performance is recorded by varying number of nodes and pause time. Performance is measured on the basis of four performance matrices parameters which are described as follows:

1. Packet Delivery Ratio: Packet delivery ratio is defined as number of packets actually delivered to the destination to the number of packets supposed to be received. [19] The greater value of packet delivery ratio means the better performance of the protocol.

2. Throughput: Throughput is the ratio of number of packets sent and total number of packets.[19] The greater value of throughput means the better performance of the protocol.

3. Packet loss ratio: Packet loss is the number of the packets that are not successfully sent to the destination during transmission.[20] The less value of the packet loss means the better performance of the protocol.

4. Packet drop rate: Packet drop rate is the ratio of packet loss and total number of data packets.

Simulation of AODV is done using matlab. First step in this simulation is to the deployment of network and finding path from source to destination. Figure 5 shows deployment of 100*100 sq kms network taking 30 nodes. Figure 6 shows of finding path from source to destination in the same area of network. The parameters taken for simulation are followed as

Table I: Simulation Parameters

PARAMETERS	**VALUE**
Simulator	Matlab
Area	100*100
No of nodes	20,40,60,80,100,120
Pause time	0.5,1,1.5,2,2.5,3,3.5,4,4.5,5,5.5
Traffic flow	Constant Bit Rate

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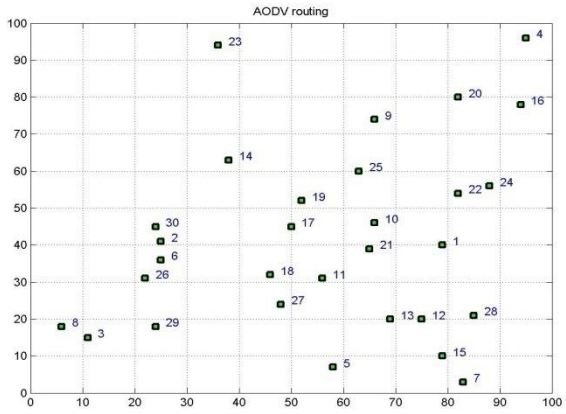

Fig. 5: Deployment of Network

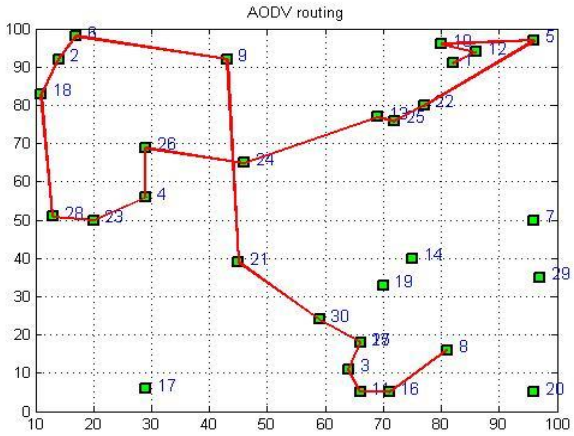

Fig. 6: Finding Path from Source to Destination

V. Simulation Results

The simulation results show the performance of AODV routing protocol. The analysis of the simulation of AODV routing protocol is done on the basis of performance metrics packet delivery ratio, throughput, packet loss and packet drop rate by varying number of nodes and pause time.

A. *By Varying Number of Nodes*

i) Packet delivery ratio:

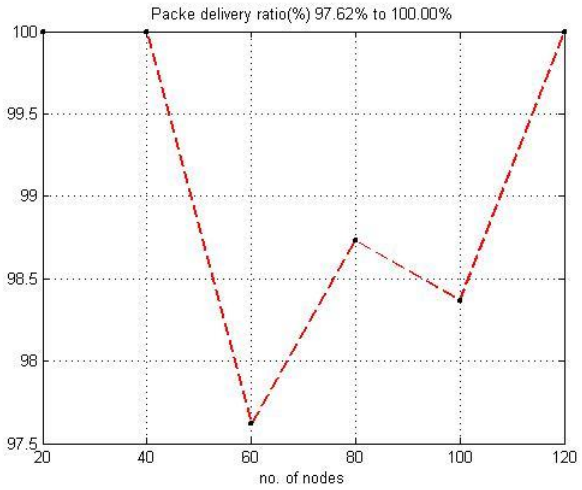

Fig. 7: Variation of Packet Delivery Ratio and Number of Nodes.

ii) Throughput:

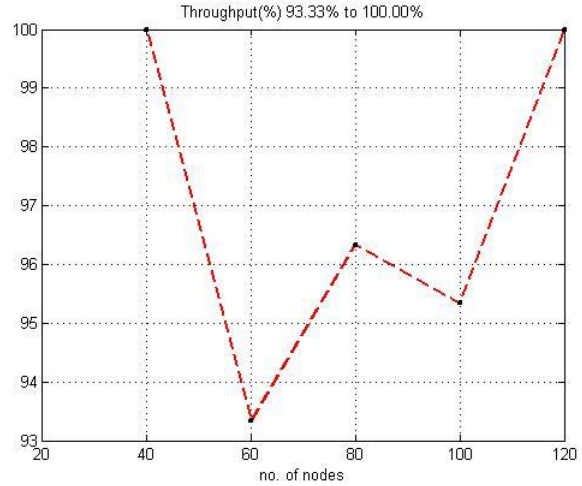

Fig. 8: Variation of Throughput and Number of Nodes

The packet delivery ratio is shown in Fig. 7. It is varying between 97.62 % to 100 %. It decreases as the number of nodes is increased. Fig. 8 shows variation of throughput and number of nodes. It is varying between 93.33 % to 100 %. As the number of nodes is increased, the collision between packets takes place causing loss of packets. Therefore packet delivery ratio and throughput decreases as number of nodes are increased. Due to mobility, some of the nodes move out ofunable to reach to destination. Thus route discovery process is again initiated to transfer the packets. Therefore increase in packet delivery ratio and throughput is seen after sometime.

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iii) Packet loss ratio:

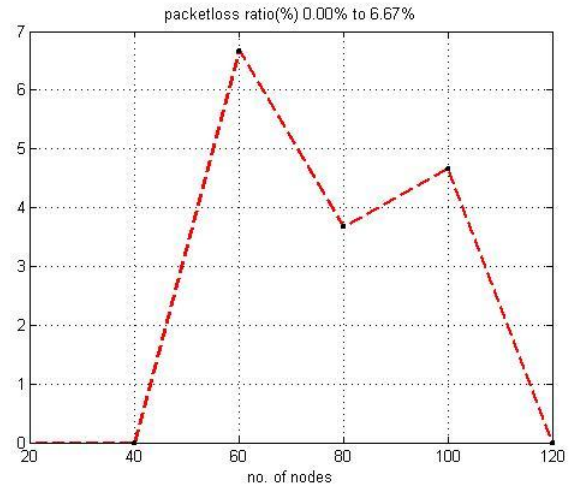

Fig.9 Variation of packet loss ratio and number of nodes

iv) Packet drop rate:

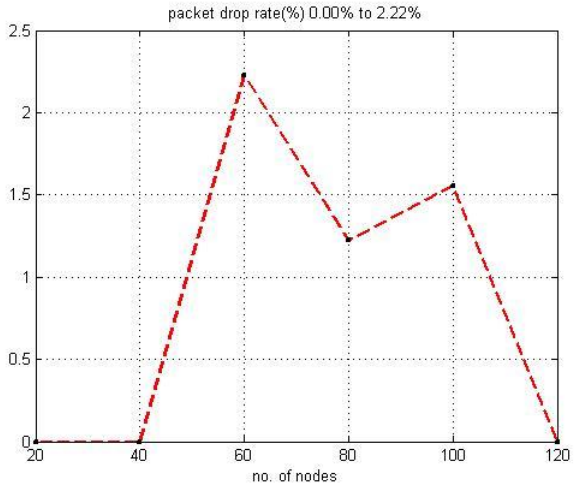

Fig.10 Variation of packet drop rate and number of nodes.

Fig.9 shows variation of packet loss ratio and number of nodes. It is varying between 0.0 % to 6.67 %. It increases with increase in number of nodes. Fig.10 shows variation of packet drop rate and number of nodes. It varies between 0.0 % to 2.22 % . It increases with increase in number of nodes. Each node is associated with some initial energy. When nodes energy becomes less than a threshold value assigned, then it starts dropping the packets. Collision increases due to increase in number of nodes resulting in increase in loss of packets. Thus packet loss ratio and packet drop rate increases with increase in number of nodes.

A. *By Varying Pause Time*

i) Packet delivery ratio:

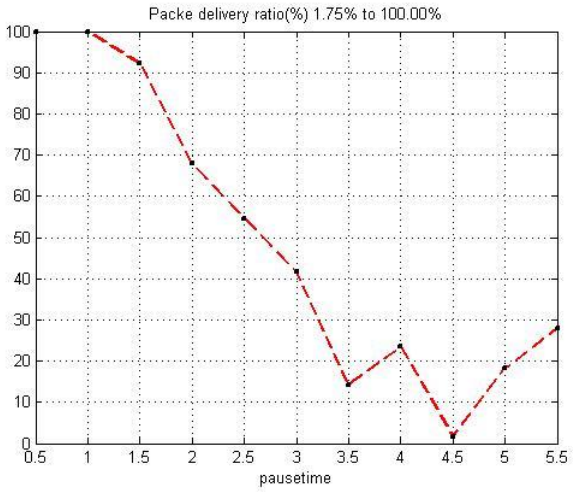

Fig.11: Variation of packet delivery ratio and pause time.

ii) Throughput:

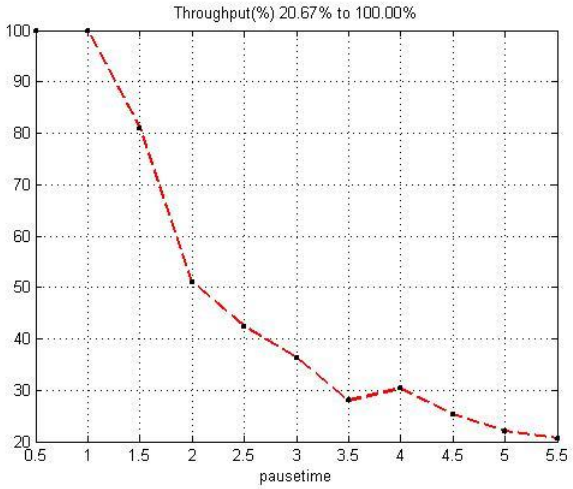

Fig.12: Variation of throughput and pause time

Fig.11 shows variation of packet delivery ratio and pause time. It varies between 1.75 % to 100 %. Fig.12 shows variation of throughput and pause time. It varies between 20.67 % to 100 % . It decreases with increase in pause time. When pause time increases, energy loss of nodes increases resulting in loss of packets. Thus packet delivery ratio and throughput decreases with increase in pause time.

iii) Packet loss ratio:

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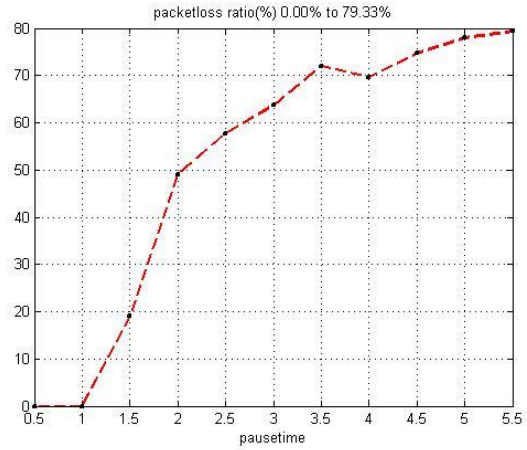

Fig. 13 Variation of packet loss rate and pause time.

Fig.13 shows variation of packet loss rate and pause time. It varies between 0.0% to 79.33 %. It increases with increase in pause time. Fig.14 shows variation of packet drop rate and pause time. It varies between 0.0% to 0.26% . It increases with increase in pause time.

iv) Packet drop rate:

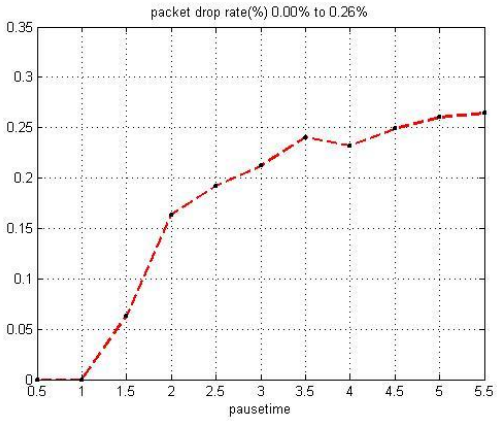

Fig.14 Variation of packet drop rate and pause time

VI. CONCLUSION

It is observed that AODV protocol performs with satisfactory results. When number of nodes is increased, packet delivery ratio and throughput decreases. As the number of nodes is increased, collision between packets takes place causing loss of packets .Therefore, packet delivery ratio and throughput decreases with increase in number of nodes. Packet loss ratio and packet drop rate increases with increase in number of nodes. Each node is associated with some initial energy, when nodes energy becomes less than threshold value assigned, then it starts dropping the packet. It is also observed that when pause time increases packet delivery ratio and throughput decreases whereas packet loss ratio and packet drop rate increases. When pause time increases, energy loss in nodes increases and when energy of nodes become less than threshold value , it drops the packet resulting in increase in packet loss ratio and packet drop rate. Further work can be done by taking different protocols, analyzing their performance by taking different parameters and comparing the results.

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