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Performance Evaluation of AODV Using NS-2 Simulator

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***Abstract*- Wireless communication technologies have brought in fundamental changes in telecommunication and computer networking. A mobile ad hoc network (MANET) is a collection of wireless mobile nodes dynamically forming a network topology without the use of any existing network infrastructure or centralized administration. Routing is the task of directing data packets from a source node to a given destination. Routing in a MANET is done with the goal of finding a short and optimized route from the source to the destination node. For this many efficient routing protocols such as AODV are used. The main method for evaluating the performance of MANETs is simulation. This paper is subjected to Ad-hoc On Demand Distance Vector (AODV) routing protocol and its performance has been evaluated using the NS-2 simulator. The AODV (Ad-Hoc On-Demand Distance Vector) routing protocol is a reactive routing protocol wherein routes are established on-demand that is the path between the source and the destination is found only when the path is needed. Hence AODV is best suited protocol for wireless networks as compared to other routing protocols. This paper presents result of performance evaluation of AODV done for the following performance parameters i.e. throughput, total energy spent, packet delivery ratio and end to end delay by varying network size for 50 and 200 nodes respectively.**

***Index Terms*- AODV, MANET, NS-2, Routing Protocol.**

I. INTRODUCTION

Communication networks can be wired or wireless. Wireless communication between mobile users is becoming more popular due to the recent technological advances in laptop computers and wireless data communication devices, such as wireless modems and wireless LANs. There are two distinct approaches for enabling wireless communication between two hosts. The first approach is to let the existing cellular network infrastructure carry data as well as voice. In an infrastructure network, a mobile station must find the nearest base station within its communication range before it communicates with another. The problem is that networks based on the cellular infrastructure are limited to places where there exists such a cellular network infrastructure. The second approach is to form an ad-hoc network among all users wanting to communicate with each other. In an ad hoc network where there is no base station, each mobile node acts as a router. The mobile nodes in an ad hoc network, moves randomly, resulting in a dynamic topology [1]. MANET is a wireless mobile ad hoc network having no fixed routers wherein wireless nodes randomly move to form a network without any decided infrastructure or topology. Routing is task of forwarding packets from one node to another in a network. Routing in MANET is done for finding an optimized path between source and destination. MANET can be simulated using NS2 simulator. Many efficient routing protocols have been defined for MANETS for providing better performance. Routing protocols are classified into proactive and reactive protocols. In proactive protocols, the route is pre-decided in a routing table while sending packets from source to destination. Examples are DSDV (Destination Sequence Distance Vector) and OLSR (Optimized Link State Routing) protocol. In reactive protocols, routing is done on demand that is only when packets are to be sent and there is no pre-decided path in routing table. Examples are DSR (Distance Source Routing) and AODV (Ad hoc On Demand Distance Vector) protocol [6].

II. AODV

Ad hoc On Demand Distance Vector (AODV) is a reactive routing protocol which initiates a route discovery process only when it has data packets to send and it does not know any route to the destination node, that is, route discovery in AODV is "on-demand". AODV uses sequence numbers maintained at each destination to determine freshness of routing information and to avoid the routing loops that may occur during the routing calculation process. All routing packets carry these sequence numbers [2].

The AODV protocol consists of following two main processes:-

1. Route discovery

A node broadcasts a RREQ when it needs a route to a destination and does not have one available. This can happen if the route to the destination is unknown, or if a previously valid route expires. After broadcasting a RREQ, the node waits for a RREP. If the reply is not received within a certain time, the node may rebroadcast the RREQ or assume that there is no route to the destination. Forwarding of RREQs is done when the node receiving a RREQ does not have a route to the destination. It then rebroadcast the RREQ. The node also creates a temporary reverse route to the Source IP Address in its routing table with next hop equal to the IP address field of the neighbouring node that sent the broadcast RREQ. This is done to keep track of a route back to the original node making the request, and might be used for an eventual RREP to find its way back to the requesting node. The route is temporary in the sense that it is valid for a much shorter time, than an actual route entry. When the RREQ reaches a node that either is the destination node or a node with a valid route to the destination, a RREP is generated and unicasted back to the requesting node. While this RREP is forwarded, a route is created to the destination and when the RREP reaches the source node, there exists a route from the source to the destination [3][9].

2. Route maintenance

When a node detects that a route to a neighbour no longer is valid, it will remove the routing entry and send a link failure message, a triggered route reply message to the neighbours that are actively using the route, informing them that this route no longer is valid. For this purpose AODV uses a active neighbour list to keep track of the neighbours that are using a particular route. The nodes that receive this message will repeat this procedure. The message will eventually be received by the affected sources that can chose to either stop sending data or requesting a new route by sending out a new RREQ [3][9].

A. Route table management in AODV

AODV needs to keep track of the following information for each route table entry:

1) Destination IP Address: IP address for the destination node.
2) Destination Sequence Number: Sequence number for this destination.
3) Hop Count: Number of hops to the destination.
4) Next Hop: The neighbour, which has been designated to forward packets to the destination for this route entry.
5) Lifetime: The time for which the route is considered valid.
6) Active neighbour list: Neighbour nodes that are actively using this route entry.
7) Request buffer: Makes sure that a request is only processed once.

B. Advantages

In AODV routing protocol there is no central administration system to control the routing process. Reactive protocols like AODV tend to reduce the control traffic messages. AODV dynamically updates according to the changes in network topology. The AODV protocol reduces storage and energy consumption [7] [8].

C. Disadvantages

AODV gathers limited amount of routing information and route learning is limited only to the source of any routing packets being forwarded. These causes AODV to rely on a route discovery flood .Uncontrolled flooding may cause the broadcast storm problem. The performance of the AODV protocol is poor in larger networks and also AODV is vulnerable to various kinds of attacks in network [7] [8].

III. SIMULATION ENVIRONMENT

The network simulator NS-2 is discrete event simulation software for network simulations which means it simulates events such as sending, receiving, forwarding and dropping packets. The latest version, NS-allinone-2.34, supports simulation for routing protocols for ad hoc wireless networks such as AODV, TORA, DSDV, and DSR. NS-2 is written in C++ programming language and Object Tool Common Language (OTCL). Although NS-2.34 can be built on various platforms, we chose a Linux platform [UBUNTU], as Linux offers a number of programming development tools that can be used along with the simulation process. To run a simulation with NS-2.34, the user must write the simulation script in OTCL, get the simulation results in an output trace file and here, we analyzed the experimental results by using the awk command. The performance metrics are graphically visualized in XGRAPH. NS-2 also offers a visual representation of the simulated network by tracing nodes movements and events and writing them in a network animator (NAM) file [1].

A. Performance Metrics

The following performance metrics are used to evaluate the AODV protocol:

Throughput**:** Throughput is the amount of work that a computer can do in a given time period. High value of throughput means better performance.

Delay: The average time taken by a data packet to arrive in the destination. It also includes the delay caused by route discovery process and the queue in data packet transmission. Only the data packets that successfully delivered to destinations that counted. The lower value of end to end delay means the better performance of the protocol.

Energy spent**:** The metric is measured as the percent of energy consumed by a node with respect to its initial energy. The initial energy and the final energy left in the node, at the end of the simulation run are measured. The percent energy spent by a node is calculated as the energy spent to the initial energy. Finally the percent energy consumed by all the nodes in a scenario is calculated as the average of their individual energy consumption of the nodes.

Packet Delivery Ratio: The ratio of the number of delivered data packet to the destination. This illustrates the level of delivered data to the destination.

B. Simulation Setup Parameters

Here the following Simulation setup is used:

TABLE I: Parameters of Simulation

IV. SIMULATION RESULT AND OBSERVATION

The simulation results are shown in the form of following graphs. The performance of AODV based on the varying the number of nodes for 50 and 200 nodes is done on parameters i.e. Throughput, End To End Delay, Energy spent and Packet delivery ratio.

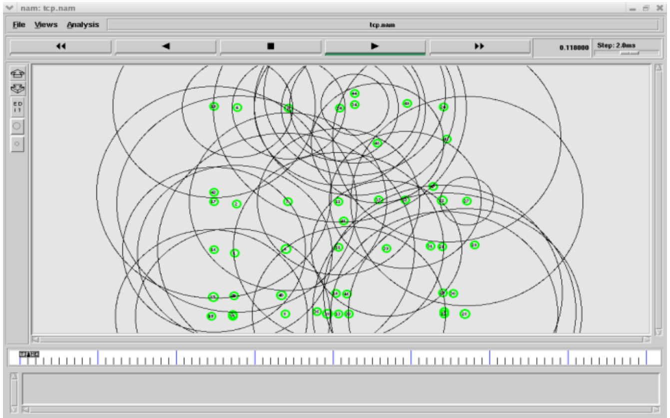

Fig. 1.Simulation window for 50 nodes

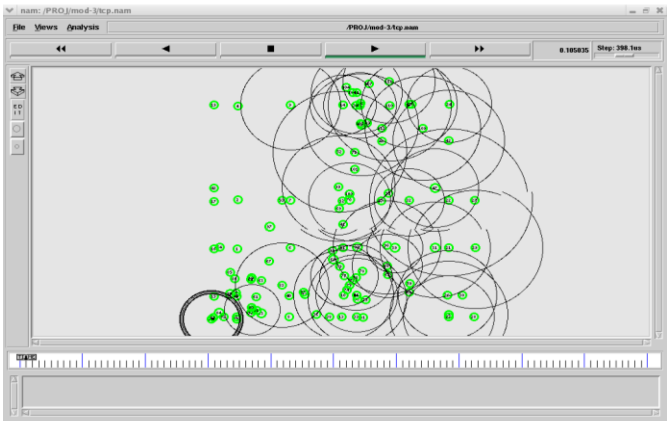

Fig. 2.Simulation window for 200 nodes

Fig. 1. and Fig. 2. shows the creation of clusters with 50 and 200 mobile nodes as it is shown in the NAM console which is a built-in program in NS-2-allinone package after the end of the simulation process.

A. Comparison Graphs for 50 and 200 Nodes

PARAMETER	**VALUE**
Area of simulation	500X500
Channel Type	Wireless
Propagation model	Radio-propagation model
Number of Nodes	50, 200 Nodes
Receiving Power	0.3
Transmitting Power	0.3
Initial Energy	90 Joules
Packet s.ize	100 bytes
Window Size	150bytes
Simulation Time	2,4,6,8,10.12 s

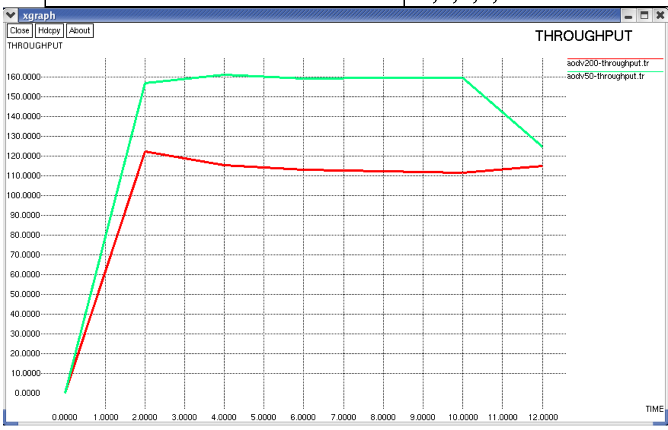

Fig . 3. Throughput in AODV at 50 vs. 200 nodes

According to the above graph throughput is better for 50 nodes as compared to 200 nodes.

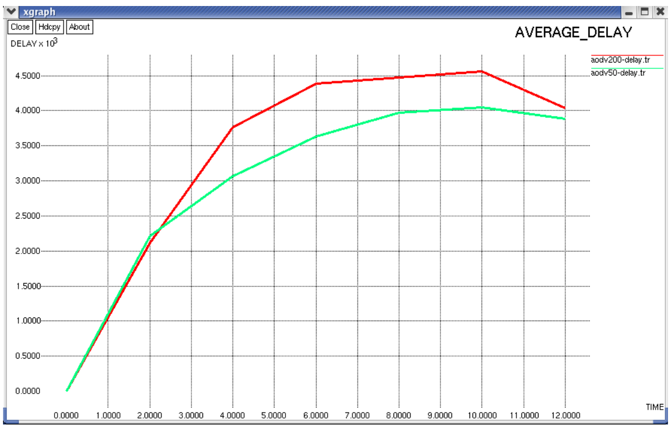

Fig . 4. Delay in AODV at 50 vs. 200 nodes

As seen in the above graph delay is better for 50 nodes as compared to 200 nodes.

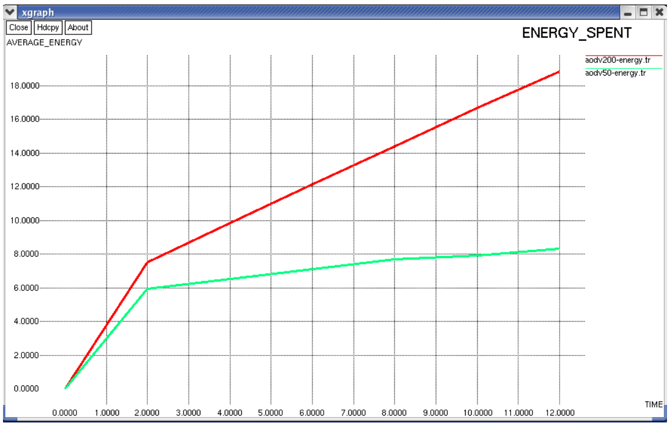

Fig . 5. Energy Spent in AODV at 50 vs. 200 nodes

From the above graph energy spent is better for 50 nodes as compared to 200 nodes.

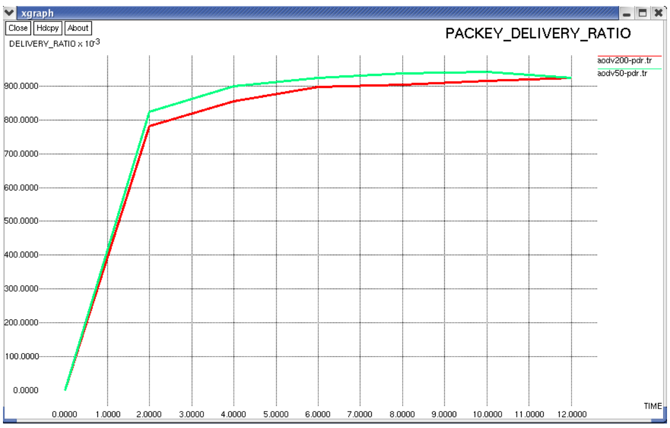

Fig . 6. PDR in AODV at 50 vs. 200 nodes

From the above graph Packet Delivery Ratio is better for 50nodes as compared to 200 nodes.

TABLE II: Comparison of Performance Parameters at 50 and 200 Nodes

Parameter	**Output**	
	50 Nodes	**200 Nodes**
Throughput	High	Less
Delay	Less	High
Energy Spent	Less	High
Packet Delivery Ratio	High	Less

Table II shows the overall comparative performance of AODV at 50 and 200 nodes.

V. CONCLUSION

In this project we have simulated the performance of AODV for 50 and 200 nodes using NS-2 Simulator. The Ad Hoc On-Demand Distance Vector (AODV) routing protocol only requests a route when needed and does not require nodes to maintain routes to destinations that are not actively used in communications. The performance of the AODV was measured with respect to metrics like Throughput, Packet Delivery Ratio, End to End Delay and Energy Spent for 50 and 200 nodes. From simulation of AODV at 50 and 200 nodes, the conclusions drawn are given in Table II. From those conclusions, it could be summarized that: throughput, packet delivery and energy spent is better at less number of nodes. Also it is seen that delay is low with less number of nodes. Hence from simulation it is concluded that AODV performs better for less number of nodes.

VI. FUTURE SCOPE

We can change the simulation parameters to enhance the performance of the routing protocol and also increase the number of nodes for simulation. May be for the future we would be able to focus more on security issue. Comparison can be in better way if we change the parameters values.

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