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Performance Evaluation of AODV for Mobile Ad Hoc Network with Varying Network Size

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***Abstract* — An ad hoc network 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. The main method for evaluating the performance of MANETs is simulation. The Ad Hoc On Demand Distance Vector (AODV) routing protocol performs better than the table-driven protocol. This paper is subjected to the on demand routing protocol AODV and evaluated its performance. We investigated the performance metrics namely Packet Delivery Fraction (PDF) and Average end-to-end delay by varying network size through simulation using NS-2 network simulator. Also the performance is an interesting issue. Almost always the network protocols were simulated as a function of pause time (i.e. as a function of mobility), but not as a function of network size. The main interest of the paper is to test the ability of AODV routing protocol to react on network topology changes (for instance link breaks, node movement, and so on).**

Index Terms — Ad Hoc Network, AODV, MANETs, Performance Evaluation, NS-2.34, Simulation.

I. INTRODUCTION

A Mobile Ad hoc Networks (MANETs) represents a system of wireless mobile nodes that can freely and dynamically self-organize in to arbitrary and temporary network topologies, allowing people and devices to seamlessly communicate without any pre-existing communication architecture. Each node in the network also acts as a router, forwarding data packets for other nodes. A central challenge in the design of ad hoc networks is the development of dynamic routing protocols that can efficiently find routes between two communicating nodes. Our goal is to carry out a systematic performance study of routing protocol Ad hoc On Demand Distance Vector (AODV) [2][14] for ad hoc networks. Moreover our analysis is based on varying number of nodes in the Ad Hoc Network. Almost always the network protocols were simulated as a function of pause time (i.e. as a function of mobility), but not as a function of network size. The rest of the paper is organized as follows: The related work is provided in section II. The AODV routing protocol Description is summarized in section III. The simulation environment and performance metrics are described in Section IV. We present the experimental results in section V and the conclusion is presented in section VI.

II. RELATED WORK

Several researchers have done the qualitative and quantitative analysis of Ad Hoc Routing Protocols by means of different performance metrics. They have used different simulators for this purpose.

J Broch et al. [1] performed experiments for performance comparison of both proactive and reactive routing protocols. In their simulation, a network size of 50 nodes with varying pause times and various movement patterns were chosen. The simulation was done with ns-2 simulator.

Jorg D.O. [3] studied the behavior of different routing protocols on network topology changes resulting from link breaks, node movement, etc. In his paper performance of routing protocols was evaluated by varying network sizes, number of nodes etc. But he did not investigate the performance of protocols under heavy loads (high mobility +large number of traffic sources + larger number of nodes in the network), which may lead to congestion situations. In his simulation, packets of small sizes and one source node were only considered.

Khan et al. [4] studied and compared the performance of routing protocols by using NCTUns 4.0 network simulator. In this paper, performance of routing protocols was evaluated by varying number of nodes in multiples of 5 in the ad hoc network. The simulations were carried out for 70 seconds of the simulation time. The packet size was fixed to 1400 bytes.

Arunkumar B R et al. [8] in this paper they present their observations regarding the performance comparison of the routing protocols for variable bit rate (VBR) in mobile ad hoc networks (MANETs). They

perform extensive simulations, using NS-2 simulator [13]. Their studies have shown that reactive protocols perform better than proactive protocols.

S. Gowrishanker et al [9] performed the Analysis of AODV and OLSR by using NS-2 simulator in it, the simulation period for each scenario is 900 seconds and the simulated mobility network area is 800 m x 500 m rectangle. In each simulation scenario, the nodes are initially located at the center of the simulation region. The nodes start moving after the first 10 seconds of simulated time. The MAC layer protocol IEEE 802.11 is used in all simulations with the data rate 11 Mbps. The transmission range is 250m. The application used to generate is CBR traffic and IP is used as Network layer protocol.

N Vetrivelan & Dr. A V Reddy [10] analyzed the performance differentials using varying network size and simulation times. The performed two simulation experiment for 10 & 25 nodes for simulation time up to 100 sec.

III. AODV ROUTING PROTOCOL DESCRIPTION

Ad hoc On Demand Distance Vector (AODV) [12] 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 prevent routing loops. All routing packets carry these sequence numbers.

A. Route Discovery

During a route discovery process, the source node broadcasts a route query packet to its neighbors. If any of the neighbors has a route to the destination, it replies to the query with a route reply packet; otherwise, the neighbors rebroadcast the route query packet. Finally, some query packets reach the destination as shown in the "Fig. 1".

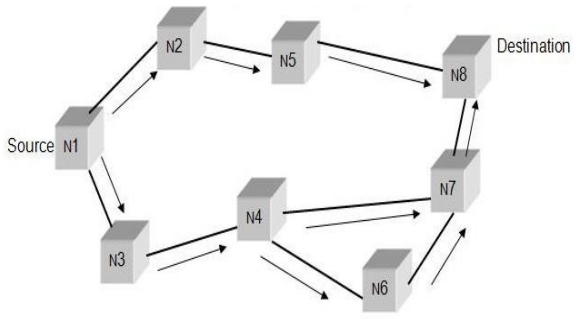

Figure 1. Route Request Packet Propagation in AODV

At that time, a reply packet is produced and transmitted tracing back the route traversed by the query packet "Fig. 2".

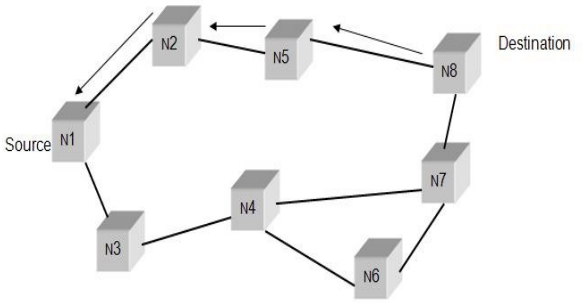

Figure 2. Route Reply Packet Propagation in AODV

B. Route Maintenance

To handle the case in which a route does not exist or the query or reply packets are lost, the source node rebroadcasts the query packet if no reply is received by the source after a time-out. A path maintenance process is used by AODV to monitor the operation of a route being used. If a source node receives the notification of a broken link, it can re-initiate the route discovery processes to find a new route to the destination. If a destination or an intermediate node detects a broken link, it sends special messages to the affected source nodes.

IV. SIMULATION ENVIRONMENT

Here we give the emphasis for the evaluation of performance of Ad Hoc routing protocol AODV with varying the number of mobile nodes. The simulations have been performed using network simulator NS-2 version 2.34[13] running on Fedora 7 is an open source discrete event simulation tool, which means it simulates events such as sending, receiving, forwarding and dropping packets.

A. Simulation Model

We consider a network of nodes placing within a 1000m X 1000m area. The performance of AODV is evaluated by keeping the network speed and pause time constant and varying the network size (number of mobile nodes).Table 1 shows the simulation parameters used in this evaluation.

Table 1: Parameters values for AODV Simulation

Simulator	ns-2.34
Protocol	AODV
Simulation duration	200 seconds
Simulation area	1000 m x 1000 m
Number of nodes	2, 4, 6, 8, 10
Transmission range	250 m
Movement model	Random Waypoint

MAC Layer Protocol	IEEE 802.11
Pause Time	100 sec
Maximum speed	20 m/s
Packet rate	4 packets/sec
Traffic type	CBR (UDP)
Data payload	512 bytes/ packet

B. Performance Metrics

While analyzed the AODV protocol, we focused on two performance metrics which are Packet Delivery Fraction (PDF) and Average End-to-End Delay.

Packet delivery fraction: The ratio of the number of data packets successfully delivered to the destinations to those generated by CBR sources is known as Packet delivery fraction.

Packet delivery fraction = (Received packets/Sent packets)*100

Average End to end delay of data packets: The average time from the beginning of a packet transmission at a source node until packet delivery to a destination. This includes all possible delays caused by buffering during route discovery latency, queuing at the interface queue, re-transmission delays at the MAC, and propagation and transfer times of data packets. Calculate the send(S) time (t) and receive (R) time (T) and average it.

V. EXPERIMENTAL RESULTS

The performance of AODV based on the varying the number of nodes is done on parameters like packet delivery fraction and average end-to-end delay.

"Fig. 3", helps us to see the flow of packets i.e. route discovery between 10 nodes by NAM which is a built-in program in NS-2-allinone package.

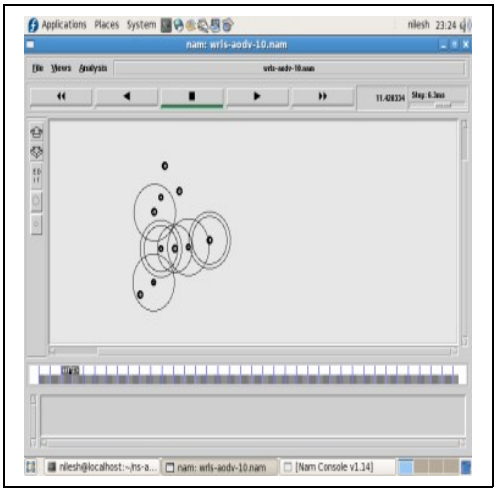

Figure 3. AODV with 10 nodes: Route Discovery

"Fig. 4", shows the calculation of PDF and average end-to-end delay for AODV simulation with 10 nodes by running AWK script.

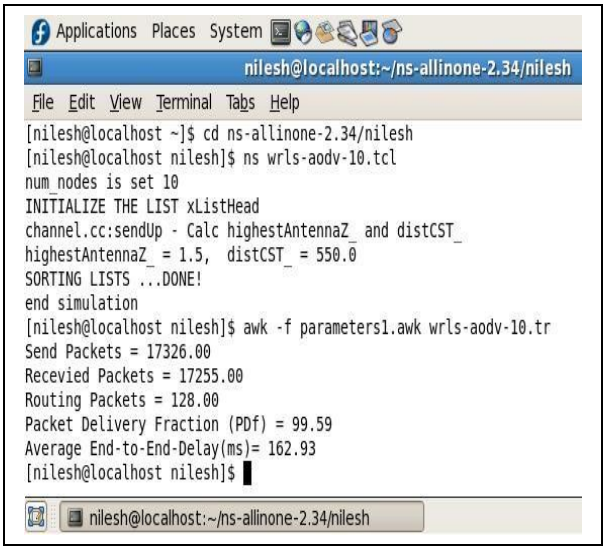

Figure 4. Snapshot of the results of performance Metrics

"Fig. 5", highlights the relative performance of AODV i.e. it delivers a greater percentage of the originated data (above 99%).

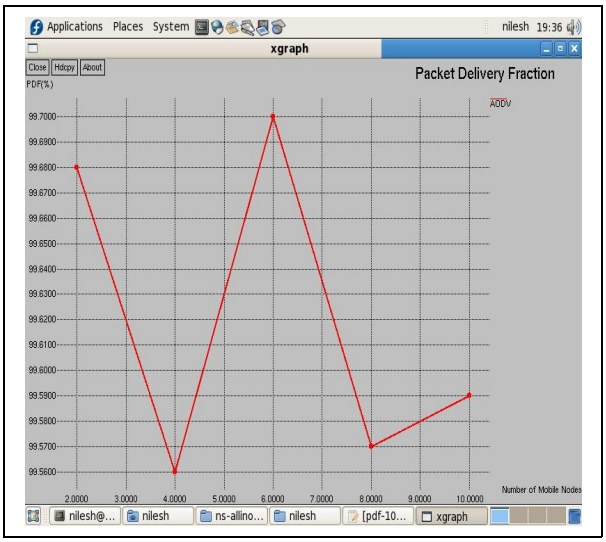

Figure 5. Packet Delivery Fraction Vs Number of Mobile Node

In "Fig. 6", AODV has the highest delay for less no of mobile nodes.

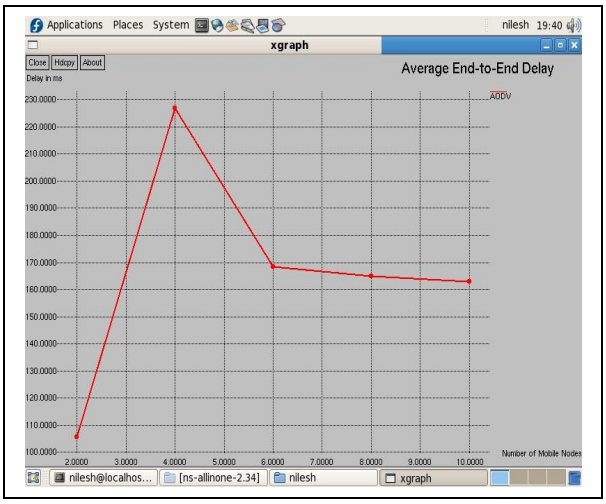

Figure 6. Average End-to-End Delay (ms) Vs Number of Mobile Nodes

VI. CONCLUSION

In the presented work, the AODV routing protocol is evaluated for the application oriented performance metrics such as Packet Delivery Fraction, Average end-to-end delay with increasing the number of mobile nodes. As we increase the number of nodes for performing the simulation of AODV routing protocol, number of sent and delivered packets changes, hence the performance parameters changes. As a result of our studies, we conclude that AODV exhibits a better performance in terms of packet delivery fraction and average end-to-end delay with increasing number of mobile nodes due to its On Demand mechanism to determine the freshness of the routes.

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