Analysis of AODV Routing Protocol on the variation of network diameter in MANET

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Abstract: The proper parameter selection of any protocol for optimization is difficult task in a network. Due to dynamic nature of mobile ad-hoc networks (MANETs), selection of routing protocol should be very precise. Keeping this in mind we have selected an Ad-hoc On-demand Distance Vector (AODV) as a routing protocol and analyzed its performance in MANET. There are many parameters in AODV protocol to control its working operation. One of them is network diameter (NET_DIAMETER) that effects the working operation of AODV. Therefore, the selection of network diameter is very important role in AODV. By default, it is set at 35 in AODV rfc3561. But we have observed that on changing the network diameter, the network performance also gets affected accordingly and found that when the network diameter is set at 30 for low node density, Throughput, Packet Delivery Ratio and Average End to End Delay are found better. The simulation software used for this paper is NS-3.29.

***Index Terms* - AODV, MANET, NS-3.29**

I. INTRODUCTION

MANET is an infrastructure less ad-hoc network that can be establish easily anywhere. MANETs are mostly employed in battels fields, disaster management etc. [1, 2]. Due to its dynamic nature routing are important for data transferring. Routing protocol in ad-hoc network performs a crucial role. Routing is responsible for forwarding the data packets along the efficient metrics in the network [3]. Routing can be classified into three categories viz. reactive, proactive and hybrid. Reactive routing protocols are those in which routes are found whenever there is a need to transfer packets, some of the reactive routing protocols are AODV, DSR etc. However, in case of proactive routing protocols routes are found in advance, some of the famous proactive routing protocols are DSDV, OLSR etc. Hybrid routing protocols are the combination of both reactive and proactive routing protocols viz. ZRP [4]. The choice of routing protocols depends upon various situation like when energy is not a constraint in that situation selection of proactive routing protocols are best. In this paper, we are analyzing the performance of reactive routing protocol viz. Ad-hoc On-demand Distance Vector (AODV). AODV routing protocol is commonly used in mobile ad-hoc networks. It works in two phases viz. Route Discovery, Route Maintenance [5].

1.1 Route Discovery

In this phase, AODV find the best route for data transfer from source to destination. For this it uses two types of packets viz. route request (RREQ) and route reply (RREP). RREQ is initiated by the source node, in this process source node broadcast the RREQ to its neighbors which on receiving this route request will broadcast the same to their immediate neighbors, while doing this process the precursor node discard the duplicate RREQ and this process is repeated until the RREQ reaches the destination. When the destination receives the RREQ packet then it generates RREP packet and respond back to the source node. At the end, active route is created for data transfer [6]. All the process as shown in Figure 1.

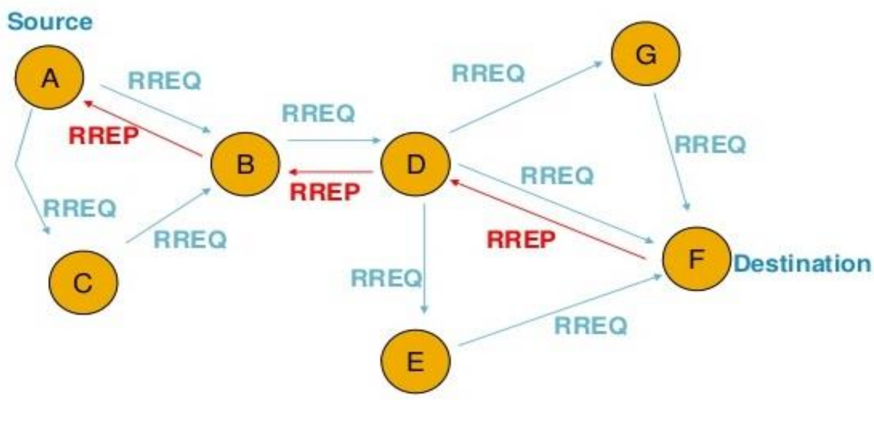

Figure 1: RREQ and RREP packets along with route discovery process in AODV

1.2 Route Maintenance

In this phase, when any links between active route are broken or damaged due to mobility or any other factor, then RERR packet is generated and again route discovery phase will be started by the source node [6].

In this paper, we are analyzing the performance of AODV routing protocol in MANET by using one of the AODV parameters viz. NET_DIAMETER with varying the node density [6]. The simulation work has been carried out on NS-3.29 which is the latest version of NS3 [7]. NS-3 is a discrete event network simulator for wireless network. It is an open source software which is being mostly used by the research community [8]. The rest of works are divided as following. In section II the parameters of AODV routing protocols have been discussed. Simulation environment has been focused in section III. Result and discussion have been discussed in section IV and finally conclusion in section V.

II. AODV PARAMETERS

There are many parameters given in AODV rfc3561. The values of these parameters are implemented as default values in AODV implementation of NS-3 [6]. Changing the value of any parameters of AODV will affect some other parameters as shown in below table-1 [9]. Therefore, we have to carefully changed the network diameter of AODV protocol [10].

Parameters	Value
ACTIVE_ROUTE_TIMEOUT	3,000 Milliseconds
ALLOWED_HELLO_LOSS	2
BLACKLIST_TIMEOUT	RREQ_RETRIES * NET_TRAVERSAL_TIME
DELETE_PERIOD	5 * max (ACTIVE_ROUTE_TIMEOUT, HELLO_INTERVAL)
HELLO_INTERVAL	1,000 Milliseconds
LOCAL_ADD_TTL	2
MAX_REPAIR_TTL	0.3 * NET_DIAMETER
MY_ROUTE_TIMEOUT	2 * max (ACTIVE_ROUTE_TIMEOUT, PATH_DISCOVERY_TIME)
NET_DIAMETER	35
NET_TRAVERSAL_TIME	2 * NODE_TRAVERSAL_TIME * NET_DIAMETER
NEXT_HOP_WAIT	NODE_TRAVERSAL_TIME + 10
NODE_TRAVERSAL_TIME	40 milliseconds
PATH_DISCOVERY_TIME	2 * NET_TRAVERSAL_TIME
RERR_RATELIMIT	10
RING_TRAVERSAL_TIME	2 * NODE_TRAVERSAL_TIME * (TTL_VALUE + TIMEOUT_BUFFER)
RREQ_RETRIES	2
RREQ_RATELIMIT	10
TIMEOUT_BUFFER	2

III. SIMULATION ENVIRONMENT

The analysis of AODV routing protocol are done on NS-3.29 over the platform of UBUNTU 18.04 operating system while the hardware configurations are used with processor-i7 8th generation having clock frequency of 2.2 GHz and RAM 8 GB. All the simulations have been averaged over 10 runs. Some important simulation parameters are listed in the below table 2.

Parameter	Value
Simulator	NS-3.29
Seed	1
Number of Iterations	10
Routing Protocol	AODV
Mobility Model	Random Way Point Mobility Model
Warm-Up Time	100 sec
Simulation Time	500sec

Application Duration	350 sec
Node Speed	Min = 0.01 m/sec, Max = 10 m/sec (Uniformly Distributed)
Node Pause Time	2 sec
No. of Nodes	50, 60, 70,80,90,100
Application	On-Off Application
Traffic	CBR
Transport Protocol	UDP
Packet Size (Payload)	1024 Bytes
Data Rate	2048 bps
MAC/PHY	802.11b
No. of Source-Destination Pairs	5

3.1 Network Metrics:

THROUGHPUT: Throughput is the rate at which successful packet transferred in a wireless network.

Throughput = (received Bytes x 8 / (time Last Rx packet – time First Tx packet)) / 1024 Kbps

PACKET DELIVERY RATIO: It is defined as the ratio of received packets by the destination with respect to send packets from the source.

$$PDR = \frac{\sum Packets\ received\ by\ destination\ nodes}{\sum Packets\ sent\ by\ source\ nodes}$$

AVERAGE END to END DELAY: Average End to End Delay is the average time between transmission of packet and its reception.

$$\text{Average End to End delay} = \frac{\sum delay}{\sum packets\ received}$$

IV. RESULTS AND DISCUSSION

In this section, we present the results of the experiments, which have organized in three parts. In the first part, we show the node density versus average throughput performance for network diameter 30, 35 and 40. In the second part, we show the node density versus packet delivery ratio performance for network diameter 30, 35 and 40. In the third part, we show the node density versus average end to end delay performance for network diameter 30, 35 and 40.

As we can see in Figures 4.1, 4.2, throughput & packet delivery ratio improves as the node density increases. In Figure 4.3, we can see average end to end delay decreases as node density increases. This may be attributed due to increase number of nodes between source and destination. Which will further increase the connectivity.

Fig. 4.1 shows that the throughput improves as the node density increases. As depicted in figure the performance of AODV routing protocol degrade for the network diameter 35 as compare to network diameter 30 and 40 for the case when the node density is less than 80. This may be due to the fact that for network diameter 30 and 40, the intermediate nodes between source and destination are closed to each other, which therefore maintains the connectivity. At node density 80, the network performance is better for the network diameter 35. This may be due to the attribute of random waypoint mobility model, in which node converges at the centre after some time.

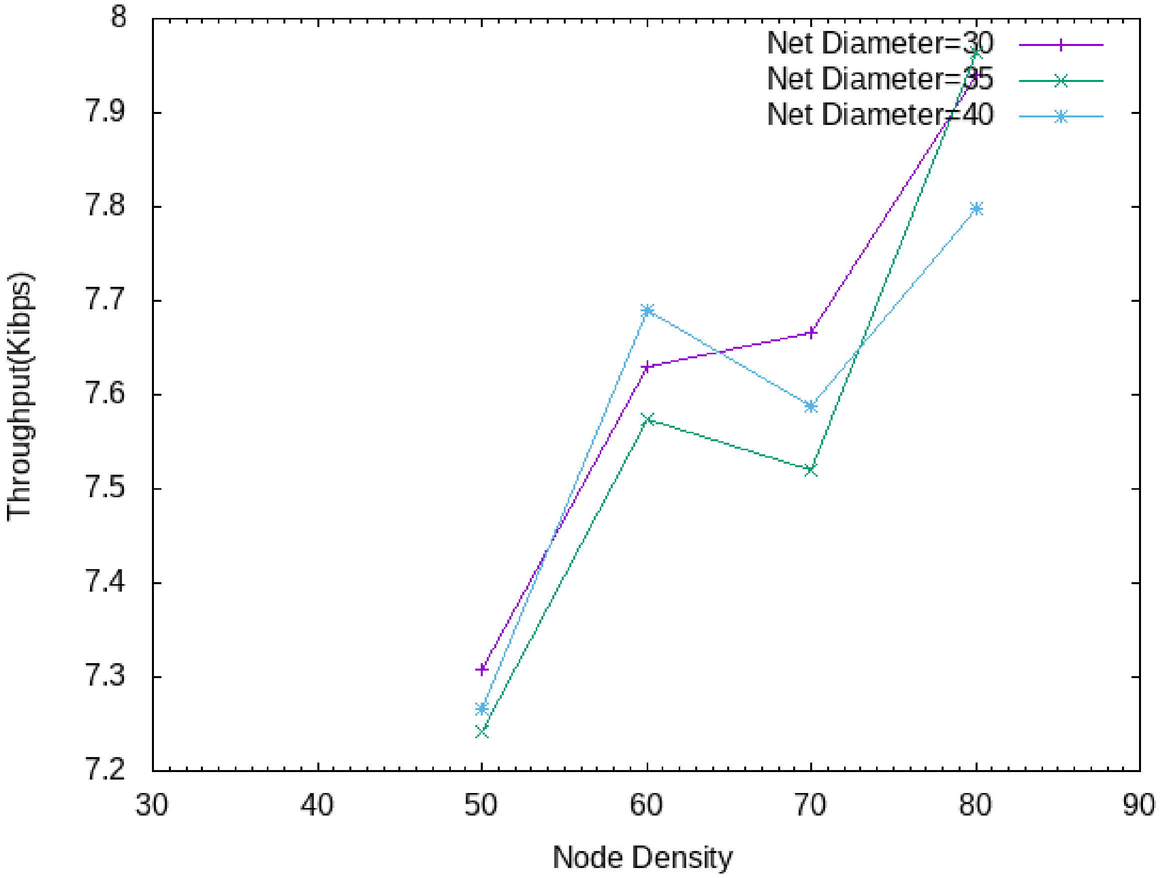

Fig. 4.1 Node Density vs Throughput for Network Diameters 30, 35 and 40.

Fig. 4.2 shows that the packet delivery ratio improves as the node density increases. As depicted in figure the performance of AODV routing protocol degrade for the network diameter 35 as compare to network diameter 30 and 40 for the case when the node density is less than 80. This may be due to the fact that for network diameter 30 and 40, the received packets are maximum. At node density 80, the network performance is better for the network diameter 35. This may be due to the attribute of random waypoint mobility model, in which node converges at the centre after some time.

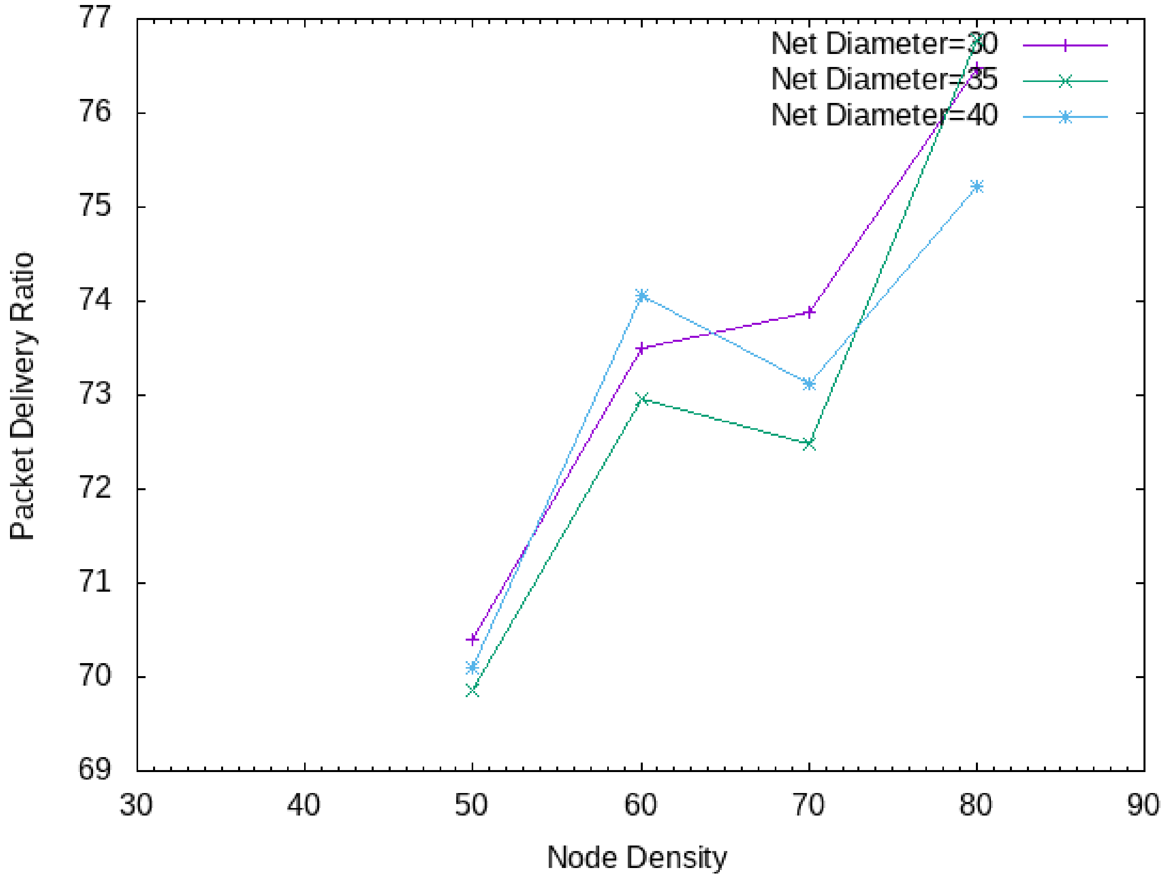

Fig. 4.2 Node Density vs Packet Delivery Ratio for Network Diameters 30, 35 and 40.

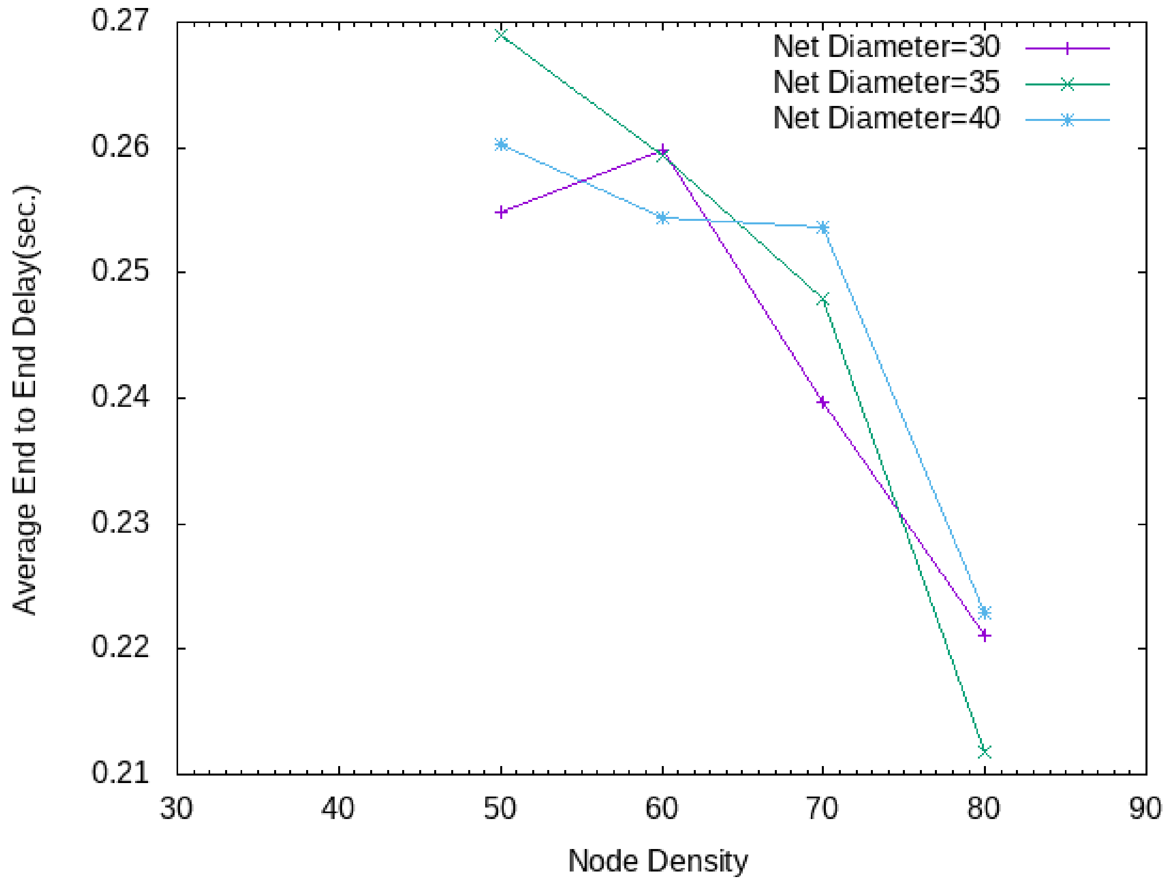

Fig. 4.3 Node Density vs Average End to End Delay for Network Diameters 30, 35 and 40.

Fig. 4.3 shows that the average end to end delay decreases as the node density increases. As shown in figure, the performance of AODV routing protocol increase for the network diameter 30 as compare to network diameter 35 and 40. This may be due to the fact as the number of nodes on active route increases which in turn will increase the number of hops, due to which the time for traversing from source to destination will increase.

V. CONCLUSION

In this paper, we have explained AODV routing protocol along with their parameters viz. active route time out, network diameter, path discovery time etc. It has been shown here that network diameter plays a significant role on the performance of AODV. Overall observation was that at the network diameter of 30, the performance is found much better compare to when it was 35 and 40 keeping in mind when the node density was less than 80. Future work can be done to make an adaptive AODV that will change the network diameter with respect to node density.

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