Lifetime Enhancement of AODV Routing Protocol for Homogeneous and Heterogeneous MANETs

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Abstract

In Mobile wireless ad-hoc Networks, power, mobility, topology and node density are important network environments that significantly influence the performance of routing protocols in Mobile Ad-hoc Networks (MANET). Mobile ad-hoc network is a dynamic network and it does not depend on any fixed infrastructure due to their wireless nature and nodes interact through multi-hop routing. Most of the surviving MANET routing protocols are considered for homogeneous networks, where all nodes have the identical communication and processing capability. Although homogeneous networks are easy to model and investigation, so they shows poor performance when compared to heterogeneous networks in terms of scalability of the MANET. The suggested routing protocol advised that requiring a schedule to use diverse transmission powers in different periods, so thereby reducing power consumption of a node and increases network lifetime. To enhance the network lifetime
it is desirable to incorporate an powerful routing protocol in MANET. In this paper, proposed routing protocol gives better results in terms of transmitting power, data rate, battery life, radio range, etc. when compared with homogeneous networks. The simulations performance of AODV routing protocol is observed and are carried out using network Simulation 3.25 (NS-3.25).

**Key Words:** MANET, AODV, H-MANET, Mobility speed, Scalability and Throughput.

1 INTRODUCTION

Mobile wireless ad-hoc network is an important concept in wireless communications, which means that users want to communicate with each other form a temporary network, without the aid of any centralized administrator [1]. Each node participating in mobile wireless ad hoc network acts as both a router and a host and must be willing to forward data packets for other nodes. Ad hoc networks have no stable routers; all nodes are capable of movement and can be connected dynamically in an arbitrary manner. The goal of mobile wireless ad hoc networking is to support efficient and robust operation in mobile wireless networks by incorporating routing functionality into mobile nodes. Ad hoc networking can be useful anywhere at any time without any infrastructure and its flexible networks. The traditional applications of MANETs are diverse, ranging from small-scale, mobile, highly dynamic networks to large and static networks that are controlled by limited battery power.

In MANET, power, mobility, topology and node density are important network environments that significantly influence the routing protocol performance. Most of the up-to-date MANET routing protocols have motivated on achieving reliability and stability to reduce the communication overhead, power consumption, delay, packet loss and to increase packet delivery ratio different techniques have been planned to achieve those goals [2]. In a network scenario, each MANET device interconnects with other devices using single-hop or multi-hop wireless transmission. Single-hop communication is possible only when they are within the direct radio transmission range of each other. However, in multi-hop communication a data
packet reaches to the destination node through the intermediate nodes, in this particular situation they act as relay devices. These relay devices in a network can transmit their individual traffic as well as traffic from other nodes.

Ad hoc wireless routing protocol is a standard routing protocol that controls how the nodes decide and in which way to route the data packets between the source node and destination node in an MANET [3]. The current MANET routing protocols are divided into three broad categories they are Proactive, Reactive and Hybrid routing protocols. Most proactive routing protocols are DSDV (Destination Sequence Distance Vector) and OLSR (Optimum Link State Routing) while reactive routing protocols are AODV (Ad hoc On-Demand Distance Vector) and DSR (Dynamic Source Routing) protocols. Zone routing protocol (ZRP) is an example for Hybrid MANET routing protocols.

AODV routing protocol encounters the requirements for self-organizing, dynamic and multi-hop routing between source node and destination node requiring to establish and maintain efficient route in an ad hoc network. AODV routing protocol is mainly used for reducing the routing overhead since nodes do not sustain unnecessary route information [4]. In this paper, the performance of AODV routing protocol is estimated in terms of scalability, throughput, end-to-end delay, network lifetime and packet delivery ratio related metrics with diverse network sizes and mobility speed. The objective of this paper is to compare the performance of homogeneous network and heterogeneous network in terms of scalability of MANET using the AODV routing protocol. The results exposed that the performance of heterogeneous MANET is better than homogeneous MANET routing protocols.

Rest of the paper is organized in several sections. Section II will discuss on overview of AODV routing Protocol and challenges posed by heterogeneous MANET in Section III. The performance metrics of AODV routing protocol is simulated in section IV. Section V describes the simulation results. Finally there will be a conclusion and future scope in section VI.
2 AODV ROUTING PROTOCOL

Ad hoc On-demand distance vector routing (AODV) protocol is a reactive type MANET routing protocol. It is also known as On Demand routing protocol. This protocol does not keep the routing information, when there is no communication on a route between source node and destination node. If a node in a network wants to communicate with another node then AODV routing protocol examine for the route and establish the connection for efficient communication between the source node and destination node in an on-demand manner. AODV routing protocol is generally a hop by hop routing protocol, which introduces more dynamic approach to discover and restoration the route when compared to other MANET routing protocols [5] and [6]. It supports multicast, broadcast and unicast communications. It can decide multiple routes between source node and destination node but implements only a single route because hard to manage all the nodes in between source and destination pairs and therefore decreases the control overhead. AODV uses three different types of messages during routing process viz. RREQ, RREP and RERR.

The route detection and route maintenance in AODV routing protocol is described in the following steps:

1. The source node needs a route to destination node.
2. Creates a route request (RREQ) packet with source IP address, destination IP address, Sequence number and hop count.
3. Source node broadcasts RREQ packet to all the neighbouring nodes.
4. Neighbouring node receives RREQ packet and rebroadcast RREQ packet until it reaches to destination node.
5. The destination node sends route replay (RREP) packet to source node through the intermediate nodes in a more recent route.
6. After receiving RREP message, the source node can send the data packet to destination node.
When a valid route does not exist between source and destination nodes, then it generates a route error (RERR) packet to all other nodes in route.

In this paper, the route detection and route maintenance process in AODV routing protocol is required in order to avoid routing loops and can be calculated by using the following formulas.

Route Request + Route Reply = Route Discovery Overhead.
Route Discovery + Route Maintenance = Routing Overhead.

3 HETEROGENEOUS MANET

In this paper, MANETs are separated into two broad categories one is homogeneous MANET and another is heterogeneous MANET. Most of the surviving routing protocols have homogeneous network functionality because all the nodes need to require the identical communication capabilities and other resources. Therefore, homogeneous networks are easy to model and investigation so they exhibit poor performance when compared with heterogeneous networks.

Heterogeneous MANET comprises of mobile nodes having different communication capabilities such as data transmission rate, battery life and radio transmission range. Therefore, heterogeneous MANETs are used to reduce the amount of power consumption of a node and thereby enhancing the network lifetime. The architecture of heterogeneous MANET is shown in below figure 1.
In homogeneous MANET, more number of nodes are out of wireless access point (AWP) range and each device can communicate with another device through the intermediate nodes in an ad hoc manner that is called MANET. While in heterogeneous MANETs mobile nodes in ad hoc network will communicate with LAN through the fixed gateways. LAN (Local Area Network) is an IP network. In heterogeneous MANET all nodes cannot maintain the same IP address due to their random node mobility nature. This paper, the performance of AODV routing protocol in terms of scalability and various mobility speed for heterogeneous MANET and homogeneous MANET routing protocols are presented and calculated the various performance metrics.

4 NETWORK SIMULATION MODEL

In this section we present network simulation model that have been carried out to compare the performance of heterogeneous and homogeneous AODV routing protocol. The performance evaluation has been done by considering mobility speed and varying number of nodes in a network scenario. In homogeneous network each node is assigned with identical communication and processing capabilities, but in heterogeneous network different processing and communication capabilities are assigned to different nodes in a network.

The simulation based analysis has been carried out using Network Simulator 3 (ns-3.25) [10, 11]. NS-3 is an open-source and discrete-event network simulator and provides models of how data packet networks perform and provides simulation output. The simulation was performed and determines the following parameters are summarized in table 1.

TABLE 1: SIMULATION PARAMETERS
It is worth noticeable that several simulations have been executed and results are drawn in graphical form in the next section.

5 SIMULATION RESULTS

The AODV routing protocol performance evaluation has been done using different parameters like delay, Packet Delivery Ratio, Packet loss and Control Overhead. The simulation results are shown in below figure 1-4.

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Simulation Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Routing Protocol</td>
<td>AODV</td>
</tr>
<tr>
<td>2</td>
<td>Size</td>
<td>600m$^2$</td>
</tr>
<tr>
<td>3</td>
<td>Nodes</td>
<td>50, 100, 150, 200</td>
</tr>
<tr>
<td>4</td>
<td>Simulation Time</td>
<td>300 sec</td>
</tr>
<tr>
<td>5</td>
<td>Radio Transmission range</td>
<td>300 meters</td>
</tr>
<tr>
<td>6</td>
<td>Data rate</td>
<td>64 Mbps</td>
</tr>
<tr>
<td>7</td>
<td>Mobility Model</td>
<td>Random Waypoint</td>
</tr>
<tr>
<td>8</td>
<td>Pause Time</td>
<td>100 sec</td>
</tr>
<tr>
<td>9</td>
<td>Protocol</td>
<td>UDP</td>
</tr>
</tbody>
</table>

Figure 1: Delay Vs Number of Nodes

In AODV routing protocol, as the number of nodes increases in the network, the delay remains same in case of heterogeneous...
MANET, but in homogeneous MANET delay increases abruptly as the number of nodes increases.

Figure 2: Packet Delivery Ratio Vs Number of nodes.

The packet delivery ratio is the ratio between the number of packets delivered successfully to the destination node to the total number of packets transmitted by the source node. The value of packet delivery ratio for AODV in homogeneous MANET is better than heterogeneous MANET.

Figure 3: Packet loss Vs Number of Nodes.
The packet loss for AODV in homogeneous is lower at less number of nodes when compared to heterogeneous network. But at higher number of nodes the packet loss rate is high in heterogeneous network than the homogeneous.

![Figure 4: Control Overhead Vs Number of Nodes.](image)

The Control overhead for AODV in heterogeneous is high compared to homogeneous as the number of nodes increases in the network.

6 CONCLUSION

In this paper, the performance of AODV for both heterogeneous MANET and homogeneous MANET with respect to varying number of nodes was analyzed and observed its simulation performance outputs. The results clearly gives the difference between the homogeneous and heterogeneous networks. The packet loss rate and control overhead parameters have not considered in the literature [8 &9]. In real time applications point of view, the simulation studies of networks having heterogeneous nodes are very important. The performance of AODV routing protocol in heterogeneous network is better than homogeneous networks. The possible feature works include further improvement and develop the enhanced AODV routing protocol and compare it with other routing protocols like DSR, DSDV, OLSR and ZRP routing protocols in heterogeneous networks.
References


[11]