Performance Analysis of Different QoS Routing Protocols to Minimize Power in Heterogeneous Network

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Abstract - **Power consumption of nodes in ad hoc networks and fixed network is major issue in current world. The lifetime of network will be improved by suitably reducing the requirement of power for connections. There is a challenge to provide QoS solutions that operate seamlessly over wired-wireless domains and maintain end-to-end QoS with user mobility. In this paper we have proposed different QoS Multipath routing protocols for heterogeneous network. Multipath routing separates the traffic among different paths to minimize congestion in terms of multiple alternative paths through a network which can provide a variety of benefits such as minimize delay and congestion , maximize bandwidth, or improved security. Different types of adhoc routing protocols are discussed in this paper such as Ad-Hoc On-Demand Distance Vector (AODV) , Ad-Hoc On Demand Multipath Distance Vector (AOMDV). AOMDV is the extension of AODV routing protocol. These routing protocol are used in wireless network which is designed to form multiple routes from source to the destination and also avoid the loop formation so that it reduces congestion in the channel. The NS2 simulation result shows that the performance analysis of AODV and AOMDV protocols in hybrid environment and comparison done based on power consumption, average end to end delay, bandwidth , routing overhead and packet delivery ratio by varying the traffic load in the network.**

Keywords : AODV,AOMDV, QoS, Average end to end delay, Bandwidth, Mobile Ad Hoc network, Normalized Routing load Packet Delivery Ratio.

I. INTRODUCTION

A Heterogeneous network consists of collection of wired and wireless mobile nodes. There are two different routing algorithms are used in this paper for heterogeneous network, one for wired network i.e hierarchical routing and another side is wireless network routing algorithms such as AODV,AOMDV. The challenging task of routing in heterogeneous is to provide expected Quality of Service (QoS). . The main goal of a QoS multipath routing protocol is to identify loop free paths from the source to the destination with the available resources to meet the QoS requirements of the desired service. The advantages are better network utilization, network resilience to failures and efficient usage of bandwidth. Ad hoc Routing protocols is classified into two types such as proactive and reactive. The table-driven routing protocol is proactive , it worked on distance vector based or link state based routing strategies. The drawback of this algorithms is the frequent table updation is required which consumes large amount of memory, bandwidth and power [1]. But, in the reactive routing protocol, each node does not need to maintain the routing table. When a source node is ready to send data, it initiates the route discovery procedure and maintains its routes only. The reactive routing protocol minimizes the routing overhead and also called on-demand approach.

The AODV [2] protocol based on the reactive routing discovery uses three different kinds of messages: Route request (RREQ), Route Reply (RREP) and Route Error (RERR). In addition, destination sequence numbers are used to ensure loop freedom at all times. In AODV, each source node finds a new route by the limited flooding of RREQ and obtains a route to its destination through RREP. The AOMDV [3] protocol is the extension of AODV routing protocol, in which the source node keeps several different alternative routes from multiple RREPs. The static route selection is used in AOMDV, it cannot handle the dynamic change of the network due to severe congestion caused by biased traffic. Multipath Routing with Load Balancing QoS in Ad hoc Network [4] gives new proposed protocol for Ad Hoc routing. Analysis is QOS parameters for DSDV and DSR [5] deals with the performance of different routing protocols in hybrid routing environment. Minimization of Maximum Delay in [6] deals with only delay that does not satisfy the bandwidth requirement. A Review of Multipath Routing Protocols [7] From Wireless Ad Hoc to Mesh Networks illustrate the performance comparison between different routing protocols. Analysis of AOMDV and OLSR Routing Protocols Under various Mobility Model for Ad Hoc Networks [8] deals with mobility model for Mobile Adhoc network and their performance is compared. Performance Evaluation of AOMDV-PAMAC protocols [9] is shown that the power consumption in Ad Hoc Networks. Routing issues in connection oriented network [10] with QOS multipath routing minimizes the congestion.

In this paper the performance of different routing protocols are evaluated and the average power consumption , bandwidth utilization, throughput, Average end-to-end delay , packet loss ratio, routing overhead of the network are calculated.

This paper is organized as follows: Section II briefly details the proposed QOS Multipath Routing Protocol for Heterogeneous Network Section III introduces the fundamental topics involved in heterogeneous network. Section IV discusses the Simulation model , Mobility Model and Traffic Model for wired cum wireless network. Section V gives the performance metrics for various QoS parameters. Section VI deals with Result Analysis, in Section VII, Conclusions are outlined.

II. QoS Multipath Routing for Heterogeneous Network

The main aspect of this protocol is to minimize the amount of bandwidth needed and end-to-end delay and overhead through multipath routing scheme (i.e. load balancing scheme). The QoS routing protocols used in wired and wireless networks are discussed. QoS based routing becomes challenging in MANETs, as nodes should keep an up-to-date information about link status. Also, due to the dynamic nature of MANETs, maintaining the precise link state information is very difficult. Finally, the reserved resource may not be guaranteed because of the mobility caused path breakage or power depletion of the mobile hosts. QoS routing should rapidly find a feasible new route to recover the service. QoS is an agreement to provide guaranteed services, such as bandwidth, delay, delay jitter and packet delivery rate, to

Consider a heterogeneous network that is represented by a directed graph G = (V,E). Where V is the set of wired and wireless nodes and E is the set of links between different networks. Each link(i,j) € E is associated with a primary cost parameter c(i,j) j) and p is additive QoS parameters P =

users. End-to-end delay estimation is one of major element of any QoS enabled routing protocol. We determine the time taken to send RREQ and receive RREP packets along the specified path in order to estimate end-to-end delay. By using a proactive fault tolerant routing with QoS aware multipath route discovery, We can achieve smaller end-to-end delay and large throughput to a host. Multipath routing is also more promising for QoS provisioning in ad hoc networks. The reason is multipath routing can provide load-balancing, fault-tolerance and higher throughput. Load balancing can be achieved by spreading the traffic along multiple routes. To alleviate congestion as well as bottlenecks and maximize the resources for MANET, the ideal number of multipath routing should be taken into consideration. It is also beneficial to avoid traffic congestion and frequent link breaks in communication because of the mobility of nodes. It has to be able to satisfy the QoS requirements.

In this paper, we employ the facility to determine multiple routes to a host and switch between them to expand the definition of AOMDV [5]. Enabling a QoS constrained route from source to destination is one of the objectives of the routing protocol. The route chosen by the protocol must send packets with minimum bandwidth and end-to-end latency, without facing congestion. The protocol should satisfy the above constraints and also select the most robust among all possible candidate routes. The quality of the service can be estimated and specified in terms of some parameters (called metrics) that are of prime importance to the application under consideration. These parameters are used to express the applications requirements that must be guaranteed by the underlying network.

III. Heterogeneous Network

A Heterogeneous network is a collection of wired ,wireless and mobile networks. The convergence of this network is the success of the next generation networking. It has some challenge like

(1) Maximize network resources utilization, and Minimize operational costs, delay and bandwidth on all the types of wired-wireless-mobile networks (2) Mix the QoS associated with Fixed, Mobile and Core networks

1,2,…..p. The problem is to find a shortest path from source to destination.

(i)A Heterogeneous network is a collection of wired, wireless and mobile networks. It is denoted as

N = (N1,N2,N3 ……Nn).

N is the heterogenous network. N1,N2 …. Nn may be wired, wireless and mobile node.

(ii)Multiple path is denoted as P.

$$P = P1,P2\ldots\ldots Pn$$

n is a number of paths. Message passed over mulitiple paths. Load is shared between various links between source to destination

(iii)The set Ri=R1,R2,R3…..Rn represents the distribution of the load across the set of the resources. Total traffic sent from the source is $R = \sum Ri$

A. Hierarchical routing for Wired Network

The main drawback of flat routing is every node knows about every other node in the network topology. So the table size is increased into n^2. It is reduced through hierarchical routing. In this routing a topology is to be broken into several layers. Each node knows only those nodes in its level and for other nodes outside its level it forwards the packets through base station of its level. Thus the routing table size is reduced into log n.

The network is divided into three levels of address, they are domain, cluster and nodes. If the routing protocol uses hierarchy techniques then group of nodes use unique addressable entity from the top of the hierarchy. The three main important advantages originated from this mechanism are the decline in the number of routing messages needed to converge, the reduction of the size on the route table (reducing the memory needed) and also the reduction of the convergence time .

The hierarchy scheme used to settle the direction of the information flow in all area. OSPF has contact to all areas with the backbone area thro hierarchical addressing.

B. Routing protocols for Wireless Network

1) AODV Protocol

The properties of Dynamic Source Routing (DSR) and Destination Sequenced Distance Vectoring (DSDV) are combined into Adhoc On Demand Distance Vector routing algorithm. The route-discovery and route maintenance of DSR and hop- by-hop routing, sequence numbers and beacons of DSDV are taken in this protocol.

The Ad hoc On-Demand Distance Vector (AODV) algorithm enables dynamic, self-starting, multihop routing between participating mobile nodes and also establish as well as maintain an ad hoc network. It helps mobile nodes to obtain routes quickly for new destinations, and it is not require nodes to maintain routes to destinations that are not in active communication. AODV allows mobile nodes to notify the link breakages and changes in network topology in periodical manner. The operation of AODV is loop-free, The main advantage is to avoid the Bellman-Ford "counting to infinity" problem offers quick convergence when the ad hoc network topology changes . When links break, AODV causes the affected set of nodes to be notified so that they are able to invalidate the routes using the lost link. One special feature of AODV is its use of a destination sequence number for each route entry. The destination sequence number is included in all RREQ packet. Using destination sequence numbers loop freedom is verified. Given the choice between two routes to a destination, a requesting node is required to select the one with the greatest sequence number this is called as hop count value. Three messages are used in AODV, Route Requests (RREQs), Route Replies (RREPs), and Route Errors (RERRs). These message types are received via UDP

2) AOMDV Routing Protocol

Adhoc On Demand Multipath Distance Vector Routing Algorithm (AOMDV) has been proposed in mobile network. The major advantage of this algorithm is "Multiple Loop-Free and Link-Disjoint path" technique .In AOMDV all paths have only disjoint nodes, So path disjointness will be achieved. The first step of the algorithm is route discovery, Route Request packets are forwarded throughout the network. Hence multiple paths are established at destination node and at the intermediate nodes. the advertised hop count method at each node are helpful to get Multiple Loop free path. Route advertisements of the destination passed through hop count. An alternate path to the destination is selected by a node if the hop count is less than the advertised hop count for the destination.

In AOMDV algorithm is used to compute multiple paths during route discovery. The AOMDV protocol has Two main components:

1. Establish and maintain *multiple loop-free* paths at each node of the network.
2. Compute *link-disjoint* paths

IV. WIRED CUM WIRELESS SIMULATION

A.Simulation Environment

Wired-cum-wireless allows simulation using both wired and wireless nodes and mobileIP integrated into the wireless model. Base station Node is created which plays the role of a gateway for the wired and wireless domains, it is responsible for delivering packets into and out of the wireless domain

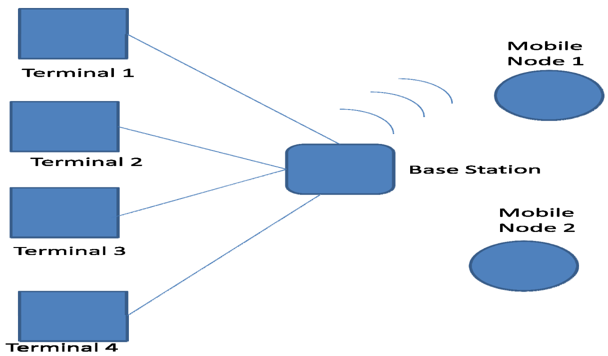

Fig 1. Topology of Wired Cum Wireless Network

Figure 1 shows the topology for heterogeneous network

Table I . SIMULATION PARAMETERS

Simulator	NS2
Routing Protocols	AODV,AOMDV
Simulation Time(Sec)	500
Simulation Area	1000 * 1000
Number of Wired Nodes	10
Number of Mobile Nodes	10,20,30,40,50,60,70
Transmission Range(m)	250 m
Mobility Model	Random way point
Maximum Speed	20 m/sec
Pause Time	10,20,30,40,50
Connection Rate	4 packets /sec
Data Payload	512
Traffic Type	CBR

B.Traffic Model

Random traffic connection of Transmission Control Protocol (TCP) and Continuous Bit Rate (CBR) can be setup between mobilenodes using a traffic scenario generator script. The source to destination pairs are spread randomly over the mobile and fixed network. The number of clusters and the packet sending rate in each cluster is varied by change the traffic load and pause time.

C.Mobility Model

The mobility model for the simulation is random waypoint model in a rectangular field. The field configurations used is 1000m * 1000m field with 10 to 100 nodes. Each packet starts its transmission from random location to random destination with randomly chosen speed. After the destination is reached it select another random destination after a pause.
The pause time affects the relative speed of the mobile.

V. Comparison Metrics

Five metrics are used to compare the performance of AODV, AOMDV and QAOMDV protocol such as normalized routing overhead, packet delivery ratio, throughput and end-to-end delay. The definitions of the five metrics are given in the following sections.

A. Packet Delivery Ratio

It is calculated as the ratio between the total numbers of data packets received by the destination nodes to the number of data packets sent by the source nodes during the time period of the simulation.

$$\text{Packet Delivery Ratio} = \frac{\sum \text{Number of Received Data packets}}{\sum \text{Number of sent Data packets}}$$

B. Routing overhead

It is defined as the ratio of the number of routing packets send to the destination node and to the number of data packets actually received at source node.

$$\text{Routing Load} = \frac{\text{Number of Routing Packets sent}}{\text{Number of Data Packets Received}}$$

C. Average Throughput

$$\text{Throughput} = \frac{\text{Number of bytes received} * 8}{\text{Simulation Time} * 1000} \text{ kbps}$$

D. Energy

The power consumption is calculated by using this formula.

Energy = Power * Time

The energy consumption is measured by the transmitting power or receiving power multiply the transmitted time.

Time = 8 * Packet size /Bandwidth

Transmitting Energy = Transmitting Power * 8 * Packet Size/Bandwidth

Receiving Energy = Receiving Power * 8 * Packet Size/Bandwidth

E. Average End-End Delay

The average end-to-end delay is a measure of average time taken to transmit each packet of data from the source to the destination. Network congestion is indicated by higher end-to-end delays

$$\text{Average Delay} = \frac{\sum \text{Time to packet arrive at Destination} - \text{Time to packet sent at Source}}{\text{Total Number of Connection pairs}}$$

VI. SIMULATION RESULTS

The Network Simulator 2 (NS-2.34) tool is used to calculate End to End delay, Bandwidth Utilization, Packet delivery ratio, Power consumption, Throughput and routing overhead against Number of nodes for AODV,AOMDV protocol.
Figure 2 shows the average end-to-end delay. It includes the queue delay in every node and the propagation delay from the source to the destination.

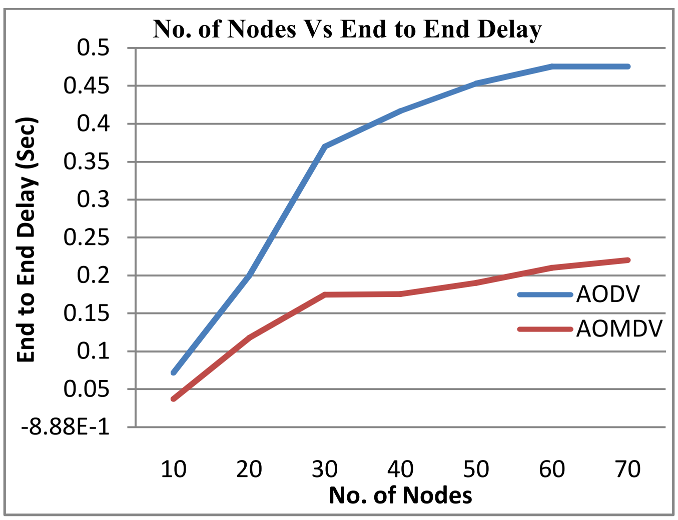

Fig 2. Number of Nodes vs End to End delay

The multipath routing could effectively reduce the queue delay because the traffic is distributed in different routes and gives the minimum delay queue delay because the traffic is distributed in different routes and gives the minimum Delay.
Figure 3 shows the Number of Nodes versus Routing Overheads. The Overhead of AOMDV is higher than AODV protocol

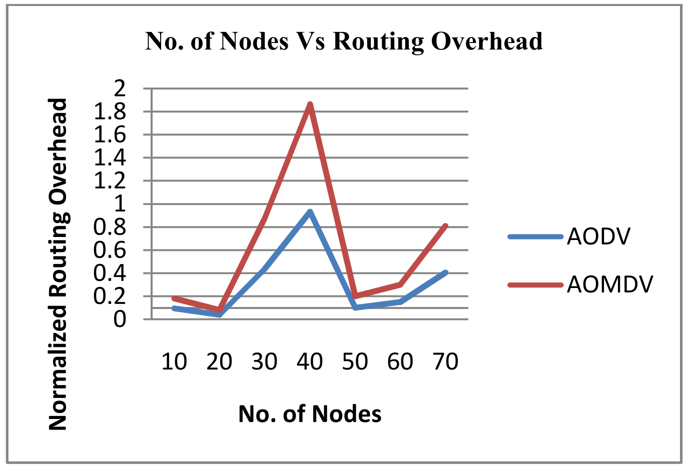

Fig 3. Number of Nodes vs Routing Overhead

Figure 4 shows the packet delivery ratio according to the connection number. Simulation process done for 100 nodes. The PDR of AODV is better than AOMDV protocol.

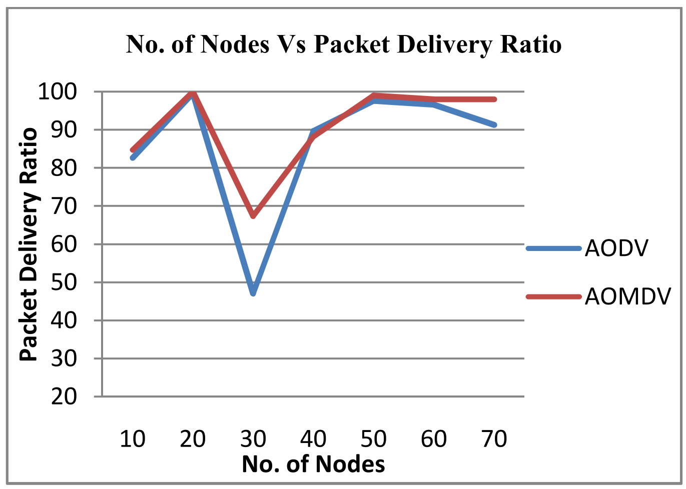

Fig 4. Number of Nodes vs Packet Delivery Ratio

The Bandwidth utilization of AOMDV is reduced compared to AODV. By splitting the single path into multiple path the bandwidth is effectively utilized between source to destination. Limited bandwidth is utilized that leads to reduce the packet loss during transmission.

The Figure 5 illustrate the bandwidth utilization of different routing protocols. Here we proved AOMDV protocol utilize bandwidth in effective manner.

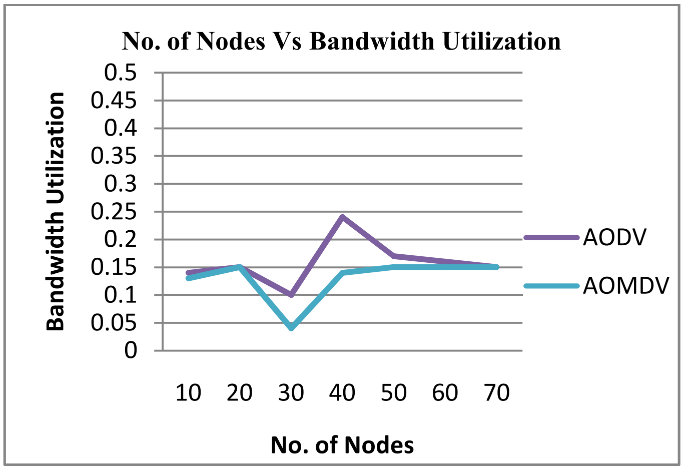

Fig 5. Number of Nodes vs Bandwidth Utilization

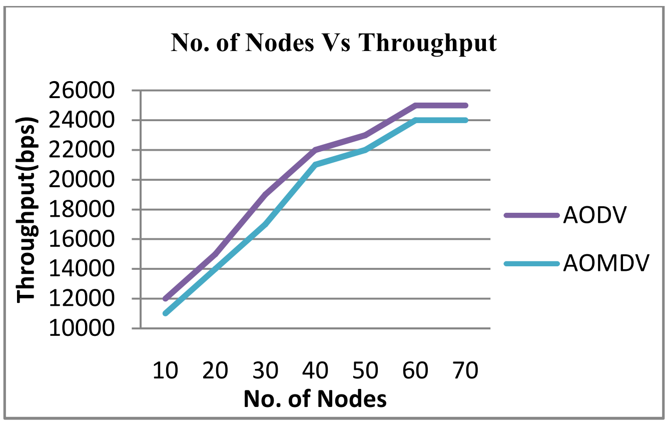

Fig 6. Number of Nodes vs Bandwidth Utilization

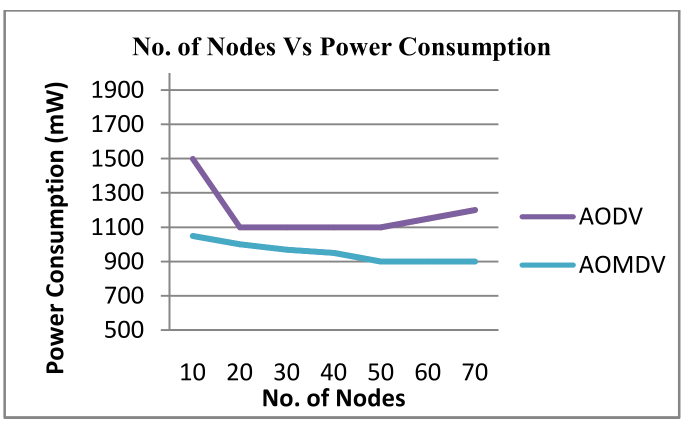

Fig 7. Number of Nodes vs Power Consumption

Throughput is calculated as the number of data bytes delivered to all destinations during the simulation. The Figure 6 shows the throughput of AOMDV is higher than AODV. In Figure 7 indicates AOMDV consumes less power than AODV protocol.

VII. Conclusion

This paper analyzes the performance of different routing protocols such as AODV, AOMDV in wireless segment has been compared.

Multipath routing protocols that computes multiple paths during route discovery avoids high overhead , latency and bandwidth. Simulation results show that the performance of AOMDV is better than other routing protocol in wireless side and hierarchical routing is used in wired network. In this paper we proved that Multipath routing algorithm provides low delay and high throughput, better bandwidth utilization and low packet loss and low power consumption during data transmission.

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