An Energy Efficient Routing in Mobile Adhoc Networks using Aggregate Interface Queue Length and Node Remaining Energy

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ABSTRACT
in this paper we present an adaptive routing in adhoc networks using modified aodv and compared with aodv using the parameters aggregate interface queue length and node remaining energy. differently from exciting approaches , we made changes to the aodv routing protocol in such a way that only destination node can respond to a route request. this greatly reduces the control data packets sent in the network. we also evaluated the performance of modified aodv based on metrics like average end-to-end delay, throughput and energy consumption.

Key Words
AODV; Modified AODV; Interface Queue Length; Node Remaining Energy; Throughput; Average End- to-end delay; Energy Consumed.

1. INTRODUCTION
The rapid deployment of independent mobile users is needed for next generations of Wireless network systems. These network scenarios can be conceived as applications of **Mobile Ad Hoc Networks**. A MANET is an autonomous collection of mobile users that communicate over wireless links [1]. With the mobile nodes the network topology changes rapidly. The network is decentralized, where all network activity including discovering the topology and delivering messages must be executed by the nodes themselves, i.e., routing functionality will be incorporated into mobile nodes. . MANETs need efficient distributed algorithms to determine network organization, link scheduling, and routing. The nodes prefer to radiate as little power as necessary and transmit as infrequently as possible, thus decreasing the probability of detection or interception. A lapse in any of these requirements may degrade the performance and dependability of the network [2]. The aim of our work is to provide a characteristic comparison for the modified AODV protocol that balances the load on various routes and AODV routing protocol. We perform this work using the Ad hoc on demand Distance Vector (AODV) routing protocol, modified AODV and ns-2.34 as the simulation tool. The rest of the paper is organized as follows. Section 2 presents the overview of Load balanced algorithms. Section 3 describes about AODV routing Protocol. Section 4 represents the modified AODV routing protocol. Section 5 describes the Methodology of our work. Section 6 presents the Result and discussions. Section 7 describes the Conclusion.

2. OVERVIEW OF THE LOAD BALANCING ALGORITHMS
Existing Load balancing algorithms improve the efficiency of the system by transferring packets from overloaded to other unloaded nodes or idle nodes. This will cause routing delay. Existing adhoc routing protocols are not have provisions for conveying the load and/or quality of a path during route setup. Hence they cannot balance the load on different routes [3]. The proactive and reactive protocols chose a route based on the smallest number of hops to the destination. But it may not be the most significant route when there is congestion or bottleneck in the network. It may cause the packet drop rate, packet end-to-end delay, or increased routing overhead. The most of the proposed algorithms for load balancing that consider traffic load as a route selector, but these algorithms produces more traffic or congestion. For achieving good communication and to make routing protocols more efficient in presence of node movement, there may be need of Route maintenance and Bandwidth reservation. A very good solution to these issues is multi path routing. With this multi path routing, even if one path fails, data can still be routed to the destination using the other routes. Thus, the cost of rediscovering new path can be avoided. The major issues with these load balncing algorithms are like node pick up, high remaining energy and etc.

3.AODV ROUTING PROTOCOL
The Ad hoc On-Demand Distance Vector (AODV) algorithm enables dynamic, self-starting, multihop routing between participating mobile nodes wishing to establish and maintain an ad hoc network. AODV allows mobile nodes to obtain routes quickly for new destinations, and does not require nodes to maintain routes to destinations that are not in active communication. AODV allows mobile nodes to respond to link breakages and changes in network topology in a timely manner. The operation of AODV is loop-free, and by avoiding the Bellman-Ford "counting to infinity" problem offers quick convergence when the ad hoc network topology changes (typically, when a node moves in the network). 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 distinguishing feature of AODV is its use of a destination sequence number for each route entry. The destination sequence number is created by the destination to be included along with any route information it sends to requesting nodes. Using destination sequence numbers ensures loop freedom and is simple to program. Given the choice between two routes to a

destination, a requesting node is required to select the one with the greatest sequence number. Route Requests (RREQs), Route Replies (RREPs), and Route Errors (RERRs) are the message types defined by AODV. These message types are received via UDP, and normal IP header processing applies.

4. MODIFIED AODV FOR LOAD BALANCING

In the modified AODV routing protocol the network traffic is evenly distributed by using the information available in the network. The basic idea is to select a routing path that consists of nodes with higher energy and hence longer life in order to reduce the routing overhead and end-to-end delay by distributing the packets over the path which is less utilized.

The route determining parameters used in our modifications are defined as follows

1. Route Energy (RE): The route energy is the sum of energy possessed by nodes falling on a route. Higher the route energy, lesser is the probability of route failure due to exhausted nodes.
2. Aggregate Interface Queue Length (AIQL): The sum of interface queue lengths of all the intermediate nodes from the source node to the current node.
3. Hop count (HC): The HC is the number of hops for a feasible path.

The routing process involved in any routing protocol can be classified in to three main divisions 1.Route Discovery 2.Route Selection 3.Route Maintenance. For implementing our load balancing features effectively in AODV we modified the Route Discovery and Route Selection process.

4.1 ROUTE DISCOVERY:

The route discovery procedure is similar to that of Ad hoc On-demand Distance Vector (AODV) routing protocol. Whenever a node wants to send data packets to other node and if there is no route available for that destination node in the routing table, the source node initiates route discovery by broadcasting RREQ (Route Request) packet to all of its neighboring nodes [4]. After receiving the RREQ packet all nodes ensures whether there is a reverse route for that source node if there is no reverse route available in the routing table they update the reverse route to the corresponding source node in their route table. Then if it is the destination node it can send the RREP packet to the source node in the same reverse route. If it is not the destination node it simply forwards the RREQ packet towards the destination node even though they may have route information in their routing table for that destination node. The destination will receive multiple copies of the RREQ packets and each of these RREQ packets will arrive at destination after travelling in different route paths. The destination node responds to all the RREQ packets by sending the RREP packets to each of them in the same path in which the corresponding RREQ packets reached the destination node.

Normally in AODV the RREP packet will contain information like HOP Count, Sequence number but in our modified AODV to better distribute the traffic load evenly we added two more information and they are Route Remaining Energy and Aggregate Interface Queue length in the route path. Initially the destination node adds its Remaining Energy and Queue length and then forwards the RREP to the next intermediate node in the reverse path. When the RREP packets reach the intermediate nodes it sums up their Remaining Energy and queue length. Finally when the RREP packet reaches the source node it contains the sum of the Remaining energy and the total data packets waiting in the queue of the intermediate nodes along the route path in which the RREP packets arrived the source node.

Algorithm 1 [Route discovery process]. Source node Ns wants to find a path to destination node N_d. Suppose that z is the number of mobile nodes and N is the set of mobile nodes, i.e., $N = \{N_1, N_2, \ldots, N_z\}$, where $N_s, N_i, N_d \varepsilon N$, $1 \leq s, d, i \leq z$ and $s \neq d$. We assume that node N_i is an intermediate node that receives the RREQ packet.

If (node Ni is the destination node N_d)

{

4. Destination node Nd adds its remaining energy (RE), aggregate interface queue length (AIQL), and hop count (HC) to the RREP packet.
5. Destination node N_d forwards the RREP packet towards the source node along the path in which the RREQ packet arrived the destination node.
6. Destination node sends reply for each RREQ packet arriving at the destination node after travelling different route path.
7. The intermediate node forwards the route reply towards the source node N_s.

}

else

Node Ni forwards the RREQ packet to the neighboring node.

4.2 ROUTE SELECTION

After receiving all the route RREP packets the source node then computes the weight value for each route.

Weight for a route i is calculated based on the following:

Wi = C1 * (REi/MaxRE) + C2 * (AIQLi/MaxAIQl) + C3* (HCi/MaxHC)

Where |C1|+|C2|+|C3|=1

Route energy is taken as a factor keeping in view that MANETs have scarce energy resources. Using a route frequently while other routes are idle or under loaded may result in network instability. The aggregate interface queue length gives us the idea about how busy our route is. Its higher value depicts higher load on the route. Thus this parameter helps in determining the heavily loaded route. If each intermediate host has a large roaming area and the MANET has many nodes (and hops), then a feasible path with a low hop count is preferred and hence the metric hop count has been considered for route selection. Our protocol effectively combines all the three parameters with weighing factors C1, C2 and C3. The values of these factors can be chosen as per the requirements, e.g. Energy being very critical for MANETs can have more weight than other factors. The adverse contribution to traffic distribution is built into negative coefficients. The path with the maximum weight value is selected as the primary routing path among all feasible paths.

4.3 ROUTE MAINTENANCE

Route Maintenance process is carried whenever the route is active and data packets are transmitted .In MANET a link failure occurs when a mobile node moves out of its transmission range. Since the mobility of the node is high in MANET links breaks easily. Whenever an intermediate finds a link failure it broadcasts a RERR (Route Error) packet to other mobile nodes. After receiving a RERR packet the source node initiates a new route discovery or finds an alternative path.

METHODOLOGY

In this section we describe our simulation environment and performance metrics.

5.1. SIMULATION ENVIRONMENT

The simulations of the AODV and modified AODV routing protocols are carried out using ns-2.34 network simulator. In all our simulations 100 mobile nodes are taken in a rectangular grid of dimension 1000m x 1000m and the simulation time is 200 seconds. We have used a constant bit rate (CBR) source as the data source for each node. We considered 10 source nodes for simulation each node transmitting packets at the rate of four packets per second with a packet size of 512 bytes. We used a mobility pattern which is based on the random waypoint mobility model. The performance of the both the routing protocols are analyzed by varying the Pause time and the Speed of the mobile node for each simulation.

5.2. PERFORMANCE METRICS

We use the following performance metric to evaluate the effect of each scheduling algorithm:

- Throughput - It is the average rate of successful message delivery over a communication channel. This data may be delivered over a physical or logical link, or pass through a certain network node. The throughput is usually measured in bits per second (bit/s or bps), and sometimes in data packets per second or data packets per time slot.
- Average end-to-end delay refers to the length of time required to move a packet from source to destination through the network. Delay depends on many factors, including the port queues (receive and transmit queues that are there in the routers) at each node along the way, network congestion on all intermediate network links, and the physical distance to be traveled. Because delay is a conglomeration of several important variables, it is a common and useful metric.
- Energy consumed refers to the average amount of energy spent while transmitting data packets from source to sink.

1. RESULTS AND DISCUSSION

2. The Figure shown below exhibits the performance of the Modified-AODV and AODV for different pause time and mobility speed. From the Fig.1 and Fig.2 it is clear that the throughput of Mod-AODV reaches the throughput of AODV when the values of Pause Time and Speed of the mobile node are higher**.**

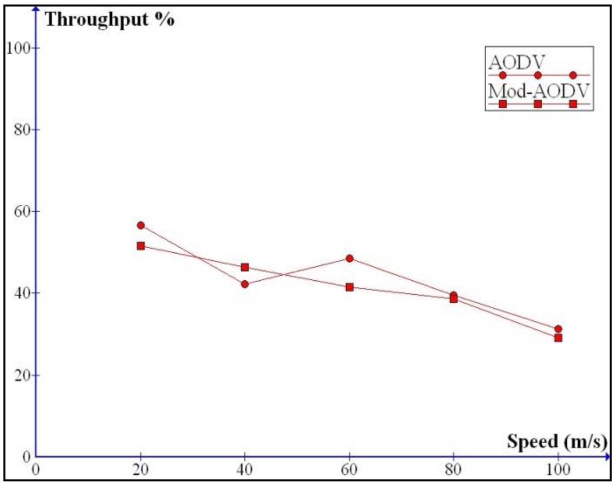

Fig .1 Throughput vs. Speed of mobile

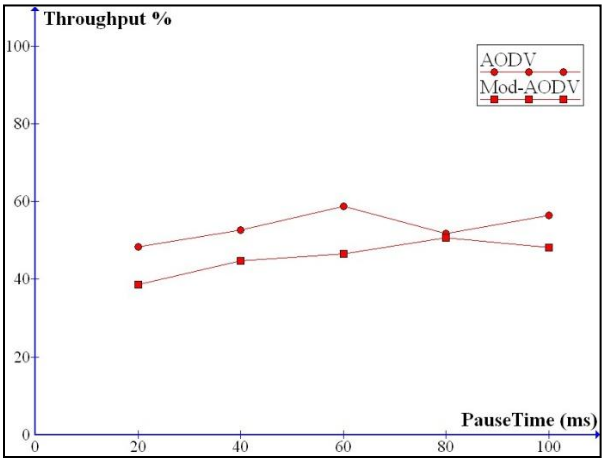

Fig .3 Avg. End-to-End Delay vs. Pause

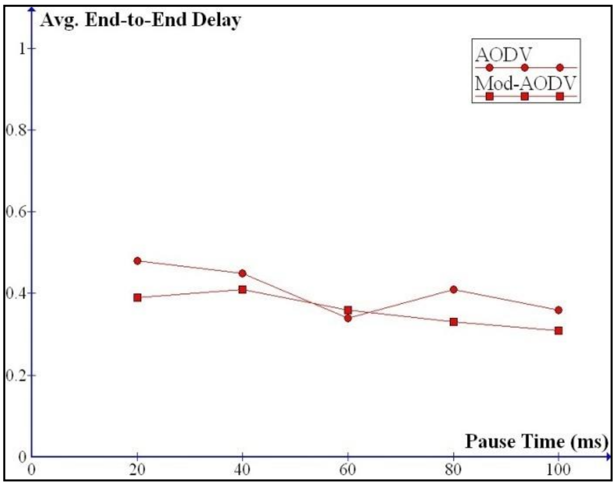

Fig .2 Throughput vs. Pause Time

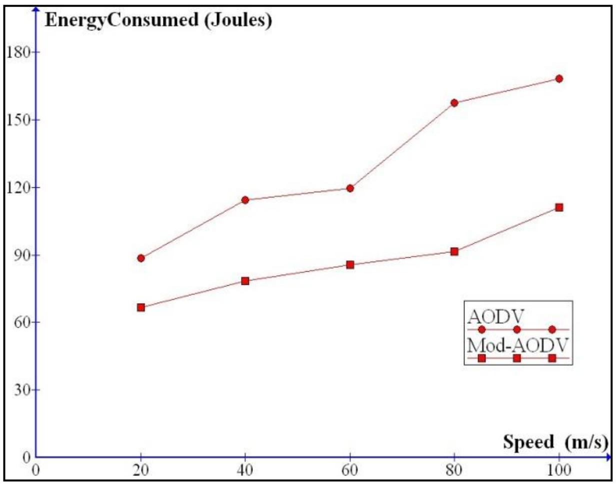

Fig .4 Avg. End-to-End Delay vs. Speed

Fig.3 & Fig.4 shows the average end-to-end routing delay of original and modified AODV at various mobile speed and pause time. The original AODV results in higher end-to-end delays ranging from **440 to 600** milliseconds when varying the speed of the mobile node and **310** to **480** milliseconds when varying the pause time. In original AODV, due to transmitting data packets over network by using only some of the node without distributing the data packets to other less utilized nodes resulted in increase in delay values. The use of

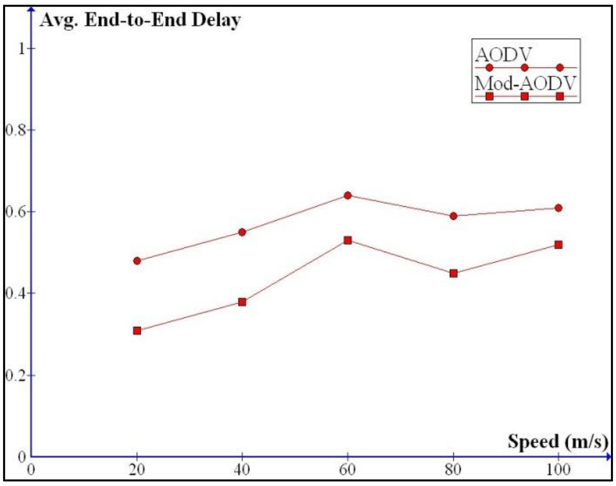

Fig .5 Energy Consumed vs. Pause Time

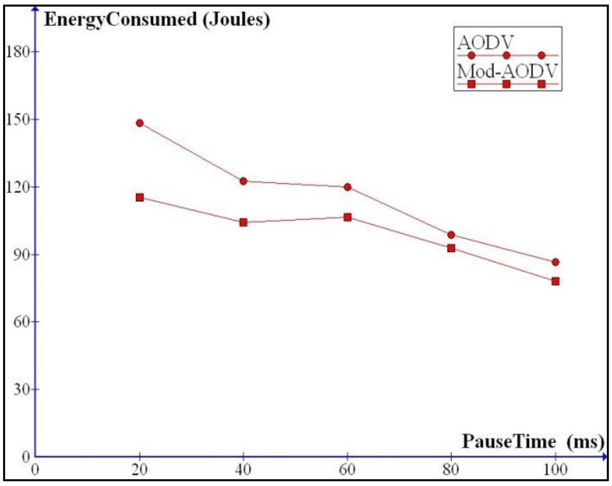

Fig .6 Energy Consumed vs. Speed

3. CONCLUSION

From the above results it is very clear that modified AODV is out performing AODV in all the simulation scenarios. The modified ADOV selects a routing path by maximizing the weight among the feasible paths. The three route selection parameters used in our modified AODV are aggregate interface queue length, the route energy and the hop count. The main disadvantages of the AODV routing protocol have been overcome in the modified AODV. The routing delay and the energy consumption are low in modified AODV when compared to the original AODV.

load balancing concepts in distributing the traffic overcomes the problem which exhibit reduced delay values. In different traffic scenarios, the delay varies between **380 to 490** milliseconds when varying the speed of the mobile node and **360** to **410** milliseconds when varying the pause time. The Fig.5 and Fig.6 exhibits that the energy consumption in joules, while transmitting data packets is also lower in Mod-AODV when compared to AODV

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