Energy aware Routing in MANET

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Abstract : The rapid deployment of independent mobile users are needed for the next generation of wireless network systems. These network scenarios can be formed as applications of Mobile Ad hoc Networks(MANETs). MANETs need efficient distributed algorithms to determine network organization , link scheduling and routing. AODV is a prominent routing protocol for MANET that uses hop count as a path selection metric. However, AODV has no means to convey the traffic load on the current route. In the second approach we proposed modifications to AODV for a load balanced routing protocol for MANETs. The routing strategy projected in this work mainly focuses on distributing the traffic on the routes consisting of nodes with comparatively longer life and have less traffic to pass through. We also introduced a new metric named as Aggregate Interface Queue Length (AIQL), to deal with traffic issues. Before route selection, the weight of each route will be calculated .The weight of a route is decided by three factors such as the aggregate interface queue length, the route energy and the hop count. The route with highest weight value is selected for further data transmission. Performance evaluation through simulation shows that the proposed protocol performs better than AODV protocol.

***IndexTerms* - AODV, Aggregate Interface Queue Length, Modified AODV.**

I. INTRODUCTION

Wireless Ad hoc Networks are a collection of two or more devices equipped with wireless communications and networking capability. These devices can communicate with other nodes that immediately within their radio range or one that is outside their radio range. For the later, the nodes should deploy an intermediate node to be the router to route the packet from the source toward the destination. The Wireless Ad-hoc Networks [1] do not have gateway, every node can act as the gateway. In the next generation of wireless communication systems, there will be a need for the rapid deployment of independent mobile users. Significant examples include establishing survivable, efficient, dynamic communication for emergency/rescue operations, disaster relief efforts, and military networks. Such network scenarios cannot rely on centralized and organized connectivity, and can be conceived as applications of Wireless ad hoc networks.

A MANET is an autonomous collection of mobile users that communicate over relatively bandwidth constrained wireless links. Since the nodes are mobile, the network topology may change rapidly and unpredictably over time. 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. The set of applications for MANETs[1] is diverse, ranging from small, static networks that are constrained by power sources, to large-scale, mobile, highly dynamic networks. The design of network protocols for these networks is a complex issue. Regardless of the application, MANETs need efficient distributed algorithms to determine network organization, link scheduling, and routing. However, determining viable routing paths and delivering messages in a decentralized environment where network topology fluctuates is not a well-defined problem. While the shortest path from a source to a destination in a static network is usually the optimal route, this idea is not easily extended to MANETs[3]. Factors such as variable wireless link quality, propagation path loss, fading, multiuser interference, power expended, and topological changes, become relevant issues. The network should be able to adaptively alter the routing paths to alleviate any of these effects. Hence, 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.

II. ENERGY EFFICIENT ROUTING IN MANETS

This work proposes an energy efficient protocol where 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:

Route Energy (RE) [4],[5]: 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.

Aggregate Interface Queue Length (AIQL): The sum of interface queue lengths of all the intermediate nodes from the source node to the current node.

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.

III. ROUTE DISCOVERY

Source node Ns[16] wants to find a path to destination node Nd. 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 Ni is an intermediate node that receives the RREQ packet. **If** (node N_i 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 Nd 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 Ns.

}

else Node Ni forwards the RREQ packet to the neighboring node.

IV. ROUTE SELECTION

After receiving all the route RREP packets the source node then computes the weight value for each route. Weight [16],[17]for a route i is calculated based on the following:

$$W_i = C1 * (RE_i / MaxRE) + C2 * (AIQL_i / MaxAIQl) + C3 * (HC_i / MaxHC)$$

$$\text{Where} \, |C1| + |C2| + |C3| = 1$$

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.

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.

V. ROUTE MAINTNANCE

Route Maintenance[18] 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.

VI. RESULTS

The Figure shown below exhibits the performance of the Modified-AODV and AODV for different pause time and mobility speed. From the Fig.5 and Fig.6 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.

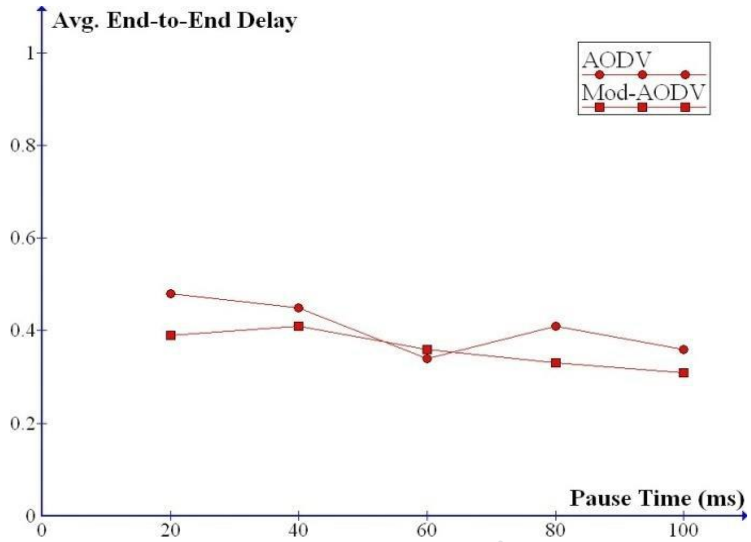

Fig. 5 Average end to end delay vs Pause time

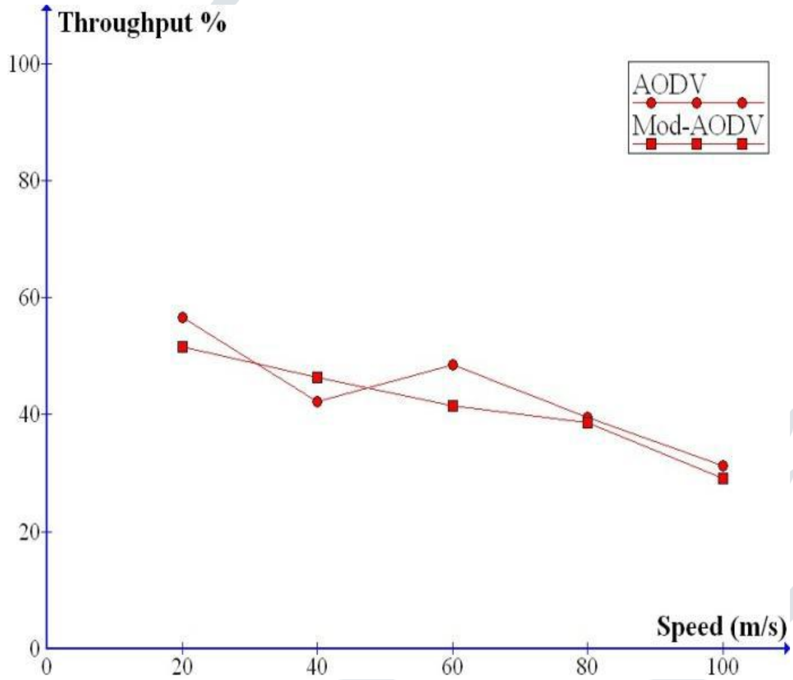

Fig.6 Throughput vs Speed

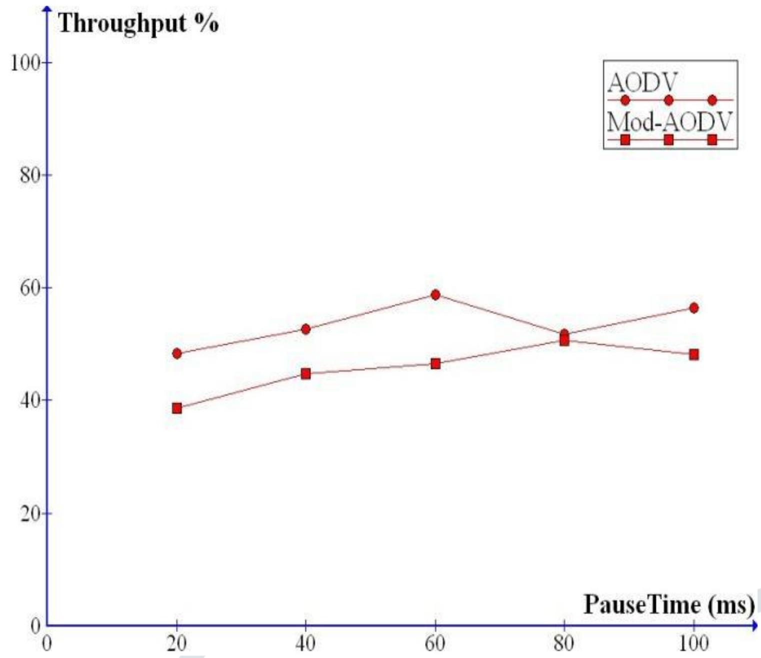

Fig.7 Throughput vs Pause Time

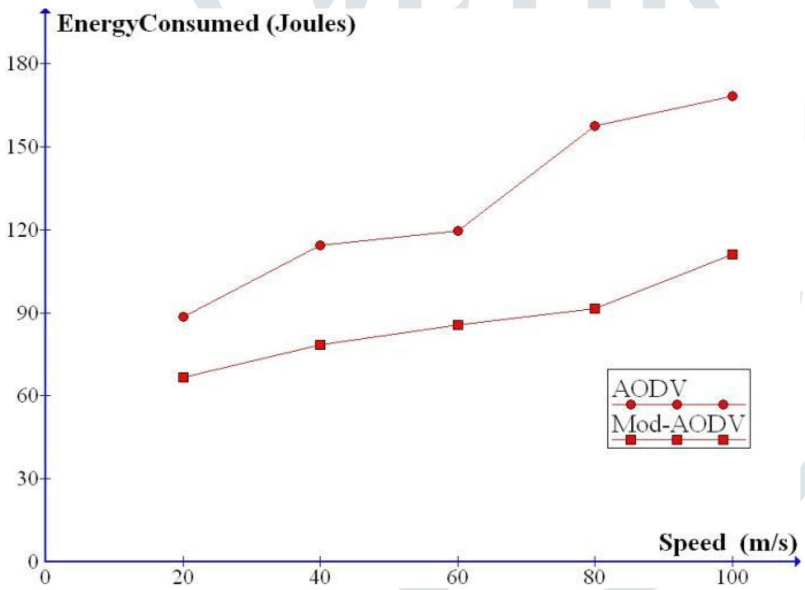

Fig.8 Energy consumed vs Speed

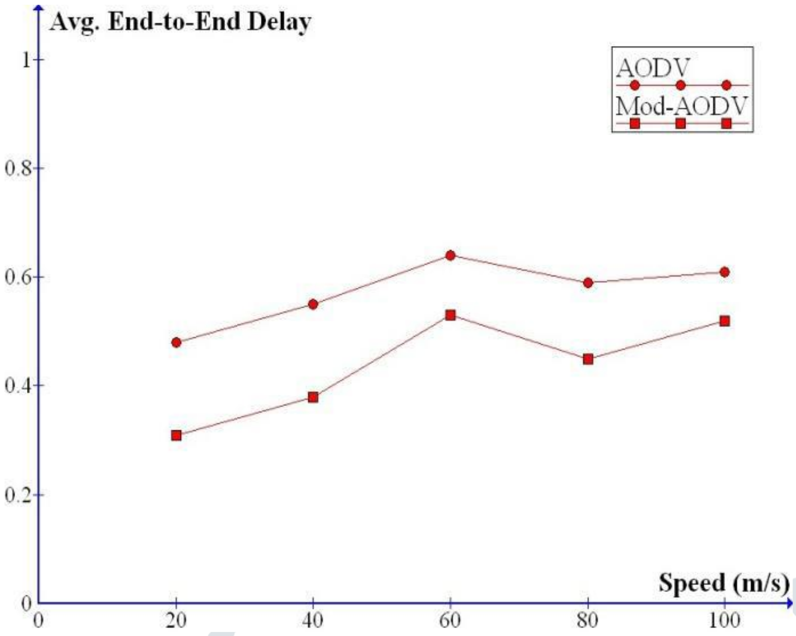

Fig.9 Average end-to-end delay vs Speed

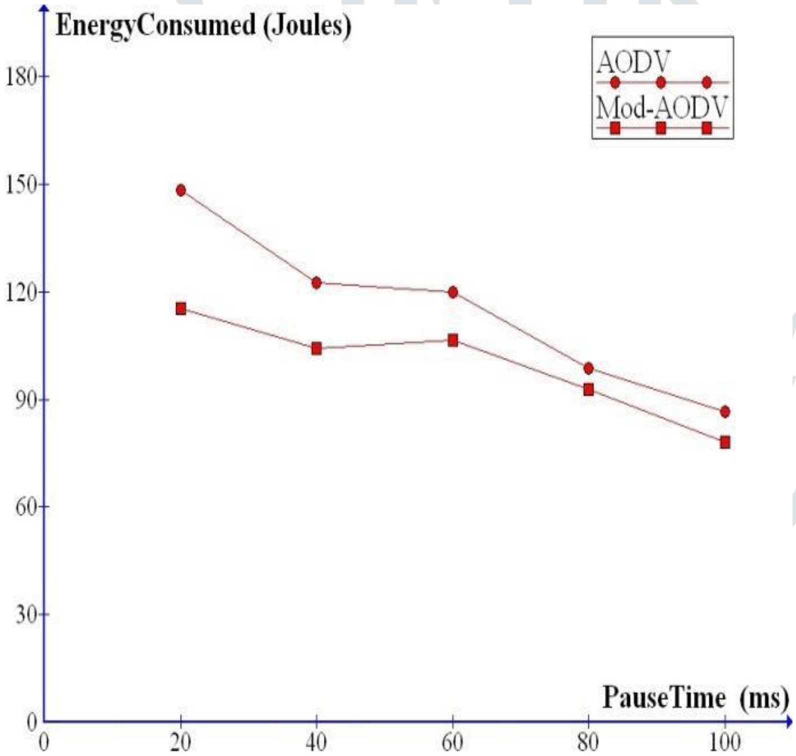

Fig.10 Energy consumed vs Pause Time

Fig.7 & Fig.9 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.

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