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End to End Delay Improvement Using Multipath Routing in MANET

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***Abstract* - Congestion and the loss of energy is the most common problem in the Ad hoc network. A considerable amount of energy is consumed in wireless interfaces. On the other hand the actual available bandwidth varies due to change in contention affected by node mobility. Many of routing protocols use the shortest path route from source to destination with minimum hop count as optimal route selection. But minimum end to end delay may not always achieved through shortest path because of high collision rate and flows at the intermediate nodes. In this paper we propose an improvement of end to end delay using multipath routing which determines the best path selection out of the N-available shortest paths by considering congestion and energy constrains at each of the intermediate nodes. Contention window along with buffer size at MAC layer affects successfully transmission of packets. Performance results show that increase in the PDR, throughput and decrease of overhead and latency when compared to AODV. The proposed method improves the performance of network.**

Keywords- *MANET, IEEE 802.11, MAC layer, Contention window, Performance*

I. INTRODUCTION

A mobile ad hoc network [1] is a self-configuring network of mobile devices connected by wireless links. A MANET is an ever-changing dynamic wireless network established by a group of mobile users needs not necessarily taking any pre-existing infrastructure or using any centralized administration. A mobile device has a limited battery and a considerable amount of energy is consumed in wireless interfaces Therefore, many power management schemes have been proposed to reduce the power consumption in the wireless interfaces and thereby increase the network lifetime in the MAC layer using 802.11 standards.

Wireless communications are an emerging technology that became an essential feature of every day's life. Especially, the IEEE 802.11 WLAN standard [2] is being accepted for many different environments. IEEE 802.11 is now considered as a wireless version of Ethernet. The IEEE 802.11 MAC layer defines two medium access coordination mechanisms: Distributed Coordination Function (DCF), and Point Coordination Function (PCF). DCF is based on Carrier Sensing Multiple Access/Collision Avoidance (CSMA/CA) protocol [3]-[7]. It is non centralized contention based which strongly participate in the success of 802.11b for its simplicity [7]. The PCF is centralized [8] allows an 802.11 network to provide fair access to medium also provide contention free service. In DCF mode, if the medium is found idle for longer than a DIFS (Distributed InterFrame Space), then the station can transmit a packet. Otherwise, a back off process is started and the station computes a random value called back off time, in the range of 0 and Contention Window size. The back off timer is periodically decremented by one for every time slot where the medium was sensed idle. As soon as the back off timer expires, the station can access the medium. If no acknowledgment is received, the station assumes that collision has occurred, and schedules a retransmission by re-entering the back off process.

The reminder of this paper is organized as follows. Section II describes about the MAC contention window and the problem associated with DCF algorithm. Section III describes proposed CWM routing protocol in detail. The simulation environment and results shown in Section IV. Section V presents the conclusion.

II. MAC LAYER

The IEEE 802.11 standard defines both MAC and PHY layer. A key part of IEEE 802.11 standard are the Medium Access Control (MAC) protocol needed to support asynchronous and time bounded delivery of data frames. The basic access method in the IEEE 802.11 MAC protocol is DCF. The main inefficiency of the DCF mechanism is the frequent collisions and wasted idle slots caused by back off intervals associated to each contention stage. In fact, when the number of active stations increases, there are permanently too many stations backed off with small contention windows since each successful transmission results in CW re-initialization. Therefore, the network experience excessive collisions and retransmissions, which reduce overall throughput. Actually, there are two major factors affecting the throughput performances in the IEEE 802.11: transmission failure and the idle slots due to back off during each contention period.

Many works have analyzed the performance of the IEEE 802.11 DCF mechanism with a particular focus on the throughput metric. In [9] proposes an analytic model that derives the 802.11 throughput limit in saturation situations; the model assumes that each mobile station has always a packet to send and try to find the optimal network operation point in terms of the number of stations. By consider that the channel is under ideal conditions (no hidden terminals). Still, the only way to achieve optimal performance (maximize the throughput) is to employ adaptive techniques to tune network parameters rather than limiting the number of stations. Particularly, both the parameters m and CWmin have an important incidence on network performances; m is the maximum retry limit and CWmin is the minimum Contention Window size. The optimal CWmin value depends closely on the number of contending terminals in network. On the one hand, low values of CWmin (e.g. 31) give excellent throughput performance in case of small number of contending station, while it drastically penalize the throughput in case of large number of contending stations. On the other hand, large values of CWmin (e.g. 1023) give reverse effects.

$$CW = N\sqrt{2Tc} \qquad (1)$$

Tc is the time wasted by collision and N is the number of active stations in equation (1). To solve this problem we employ a contention window algorithm. To achieve this we consider the parameters like energy, queue size and contention window size.

III. PROPOSED METHOD

Currently the 802.11 DCF resolves collision through multiple levels of CWs and back off stages. In the initial back off stage (stage 0), the value of CW has the minimal value CWmin. After each collision, the CW will be doubled until reaching the maximum CWmax. After each successful transmission, the back off will resume with initial stage (0) and the CW will be reset to CWmin regardless the network condition or the number of competing nodes. By resetting the CW to CWmin, DCF increases the probability of collision and frequent retransmissions remain high until the CW attains appropriate values.

In this Paper we present a new technique of contention based multipath routing where each of the nodes participate in routing using contention mechanism. Contention window selects path with less contending nodes from source to sink. Earlier the use of single path routing increases much overhead in case of collision. So by considering this multiple path is adopted for better performance and selects the path based on the cost which is minimum cost path and minimum cost path is sorted in ascending order. After finding the paths from source to sink, traffic splitting mechanism is used based on least cost metric and selects the best multiple path. Every node measures its contention window size, queue size and remaining energy and all the values are averaged using exponential moving average function which helps to select the recent paths. A type of moving average that is similar to a simple moving average, except that more weight is given to the latest data. The exponential moving average is also known as exponentially weighted moving average function this type of EMA which reacts faster to the recent data.

From Fig.1 nodes has data packets to send then checks the routes to the destination in cache if route found then it sends the data packets. If routes are not present then it broadcasts the RREQ message to intermediate nodes and gets route reply if its destination. In this we add energy parameter to avoid energy drain so it checks for energy consumed for each of transmission if it reaches below threshold range then it stop. So this increases lifetime of network. The use of multipath routing provides better result compare to single path but we also need to consider the energy factor.

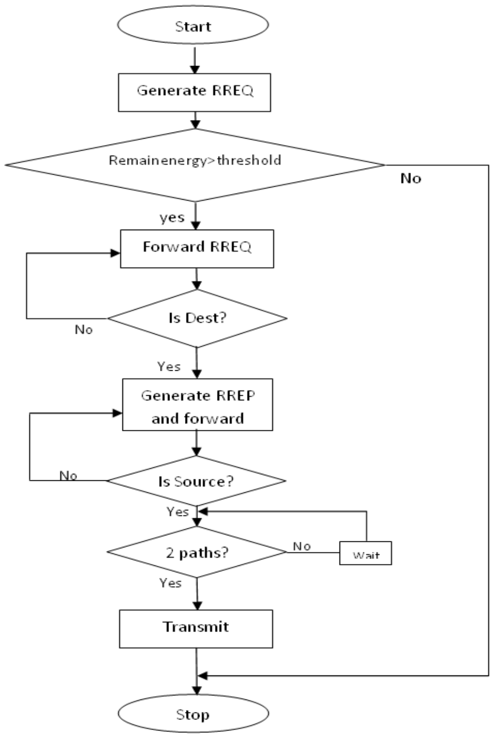

Figure.1: Flow chart

As more energy consumed this can reduce the performance of network. Below formulae shows the energy calculation of nodes.

Remaining Energy= Queue size * Energy per packet for transmission

The cost of the path is calculated using formulae

$$Cost = \frac{Remaining\ Energy + Queuesize}{Contention\ window} \qquad (2)$$

When source receives RREP from destination then source node wait for certain amount of time so that few other RREP may arrive. If no other path arrives then all traffic sent on one path. If other path arrives then traffic is splits which shown below

$$Traffic\ Split1 = \frac{Least\ cost1}{Total\ cost} \qquad (3)$$

$$Traffic\ Split\ 2 = \frac{Least\ Cost\ 2}{Total\ cost} \qquad (4)$$

After the route request and reply then there are N-number of paths found with different cost, The cost value is calculated using equation (2) and now selecting the best path which is consume less energy and cost of path is minimum with the help of traffic splitting using the equation (3) and (4) for the least cost path selection and from that data packets are sent from source to destination.

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Table 1: Parameters of 802.11b

PLCP Preamble	18 bytes
PLCP Header	6 bytes
ACK	14 bytes
Class bit rate	1,5.5,11 Mbit/s
DIFS	50 µs
SIFS	10 µs
Back off slot time	20 µs
CWmin	31
CWmax	1023

IV. PERFORMANCE EVALUTION

To evaluate the effectiveness of the proposed CWM protocol is implemented by using OMNeT++ simulator [11]. In simulation we consider parameters shown in Table 1.

Simulation environment

In our simulation, we simulated a scenario of 20 nodes in square area of 500m x 500m. The mobility model is random waypoint model. At the beginning, each node has random initial location, it will move to random destination with random speed. Simulation runs for 100 seconds. Metrics used for the performance of network are 1) Packet Delivery Ratio is defined by a factor of number of packets received by number of packetstransmitted.2) Network throughput is number of packets received. 3) Control overhead is defined as number of control packets transmitted for every data packet delivered. 4) Latency is the amount of time that is required for a packet to travel from source to destination.

Simulation result

The Proposed Contention window multipath (CWM) routing protocol is compared with AODV on demand routing. In Fig.2 shows that proposed approach is having high PDR compare with AODV because in proposed method we maintain stability of network by setting Time pause to high randomWP which is not possible in AODV protocol.

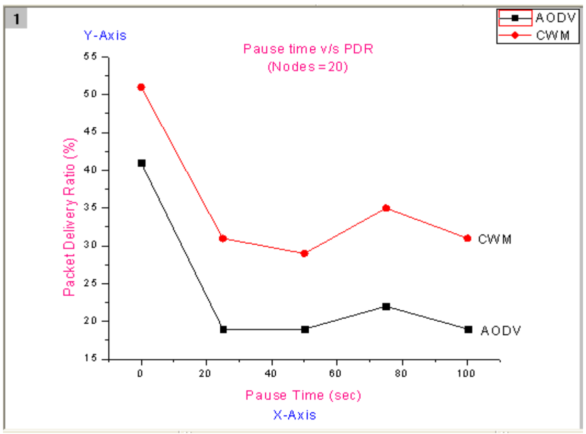

Figure.2: Pause Time v/s PDR (20 nodes)

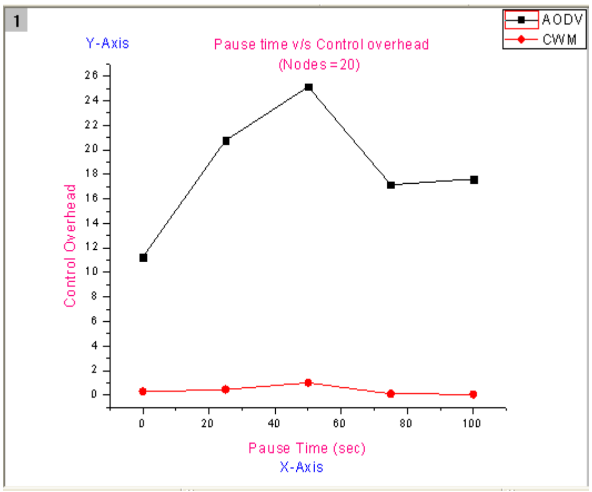

Figure.3: Pause Time v/s Overhead (20 nodes)

The Control overhead of CWM, AODV shown in fig.3 The overhead in network observed due to packets loss and more retransmission which leads much overhead. Proposed CWM protocol use queue buffer for storing data packet when channel is busy. When channel become idle first packet gets channel and this controls overhead in network. Because of this in Fig.3 CWM routing has less overhead compare to AODV protocol.

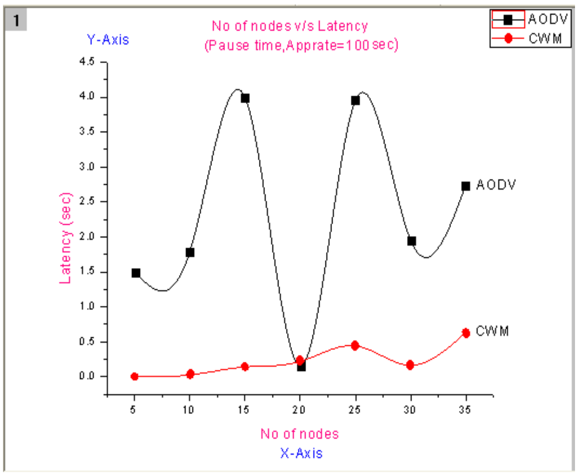

Figure.4: Number of Nodes v/s Latency

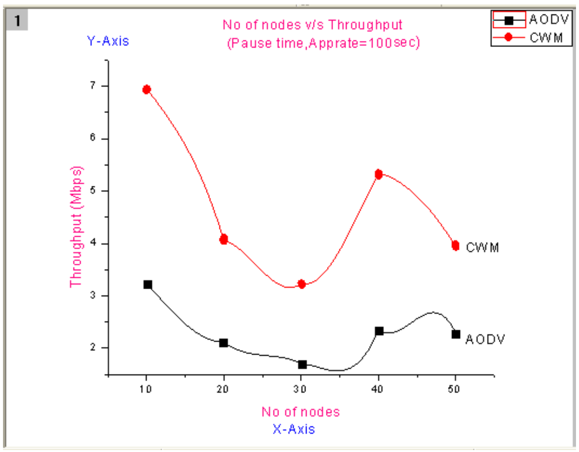

Figure.5: Number of Nodes v/s Throughput

In Fig.4, we can see the latency with varying number of nodes the result shows that CWM protocol reduce the latency when compare to AODV protocol.

The throughput [12] reduces due to factors like distance, unfairness, and packet loss, re routing instability. As the distance increases more time needs. So selecting path based on least cost which is best path and use of contention window mechanism adjust window size and loss of packets are retransmitted using exponential back off mechanism and Contention window doubles from previous value when transmission successful then Contention window which set to minimum and increases throughput. From Fig.5 illustrate throughput of CWM is much better than AODV protocol.

V. CONCLUSION

In this paper, we present new approach to improve the end to end delay using multipath routing in ad hoc network. In proposed approach all paths are cached at the beginning only so that source select best multi-path route from source to destination based on cost metric with maximum Contention Window. The selected path based on less contending nodes and nodes with high energy and residual queue helps overcoming the problem of control overhead with use of multipath and traffic split increase of network lifetime. The AODV protocol does not support Qos and link stability property. The proposed contention window multipath (CWM) routing method can make use of Qos and also improves the stability of links which results in better network performance. The system can be further improved by making use of the parameters using a Fuzzy based technique and obtaining the cost based on fuzzy inference score rather than a singular cost metric.

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