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Analysis and Enhancement of Multipath Routing in MANET

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Abstract - Mobile ad hoc networks are vulnerable concerning link breaks, since the nodes are mobile and moving consistently. Many routing protocols for MANET are already tested in different simulators. Single path routing is used to find out single path from source to destination. In case of link breakage it drops that packet since no alternate path is available from source to destination until new path is discovered. Multipath protocols which allow more than only one path for routings; the incentive of multipath routings is evidently to reduce the overhead and to guarantee a better network load balancing. When there are multiple routes between the source and the destination, the sending source might just skip to the second route when the first one is broken without restarting a new route discovery process which is time intensive. In this paper we compared and analyzed proposed contention based multipath algorithm with modified version of AODV (AODV Multipath) that allows multiple node disjoint path from source to destination.

Keywords **- Ad-hoc Networks, Routing, Contention Window, AODVM.**

1. Introduction

A mobile ad hoc network" MANET is an autonomous system of mobile routers and associated hosts 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. These networks are very useful in disaster recovery situations or where there is not enough time or resources to configure a wired network. In wireless ad hoc networks, a mobile device has a limited battery and a considerable amount of energy is consumed in wireless interfaces. These characteristics limit the network lifetime of the wireless ad hoc networks. 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. There are several ways to set up such a network which we refer to as routing protocols. One of the main problems in ad-hoc networking is the efficient delivery of data packets to the mobile nodes where topology is not pre-determined nor does the network have centralized control. Hence, due to the frequently changing topology, the number of network nodes can be large or traffic can be high, routing in ad-hoc networks can be viewed as a challenge [2]. The main challenge of MANET is to route with low overheads even when conditions are dynamic. In MANETs, the main purpose of the standard protocols is to control the way in which the mobile nodes decide how to transfer the route packets to each other [3]. Routing Protocol is used to find valid routes between communicating nodes. They do not use any access points to connect to other nodes .It must be able to handle high mobility of the nodes.

In wireless network there are different protocols used in estimation of end to end delay like load aware routing protocol which concern about fast transmission and accuracy, Queue aware routing for measurement of traffic have been used for minimizing delay and also try to avoid the congestion occurs in the network to improve the performance. In this work we focus on finding the best path selection rather than shortest path to minimize end to end delay from source to destination using multipath routing which determines the best path selection out 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 the successful transmission of packets. Path selection is mainly based on least cost matrix using contention window, queue size and remaining energy of the nodes. This work helps to understand the concept of controlling overhead in network by using the parameters as contention window, queue size and remaining energy. The path from source to destination with less contending nodes, high queue size and higher energy are selected.

2. Literature Review

Mobile Ad hoc Network (MANET) is a collection of independent mobile nodes that can communicate to each other via radio waves. The mobile nodes that are in radio

range of each other can directly communicate, whereas others need the aid of intermediate nodes to route their packets. These networks are fully distributed, and can work at any place without the help of any infrastructure. This property makes these networks highly flexible and robust [4]. Ad-Hoc networking has become a primary concern in order to provide an effective communication between each other without any form of centralized administration. This kind of networking would go-ahead with dynamic asymmetric topologies caused by natural disaster and bears from inherent limitations such as limited bandwidth and power. To overcome this concern a routing protocol is needed. Reactive Routing Protocols is a bandwidth efficient on-demand routing protocol, which means that the originator node initiates the process of route search for a destination node only when it needs to communicate with the destination node.

There are two architectures that allow two wireless stations to communicate with each other. The first one relies on a third fixed party (a base station) that will hand over the offered traffic from a station to another. This same entity will regulate the allocation of radio resources. When a source Node wishes to communicate with a destination node, the former notifies the base station, which eventually establishes the communication with the destination node. At this point, the communicating nodes do not need to know about the route from one to the other. All that matters is that both source and destination nodes are within the transmission range of the base station; if one of them loses this condition, the communication will abort. The second approach, called ad-hoc, does not rely on any stationary infrastructure. All nodes in ad hoc networks are mobile and can be connected dynamically in an arbitrary manner. Each node in such networks behaves as a router and takes part in discovery and maintenance of routes to other nodes destination. The router chooses the next node to which a packet should be forwarded according to its current understanding of the state of the network.

IEEE 802.11 MAC protocol defines two different access methods; a distributed coordination function (DCF) and polling based point coordination function (PCF). In MANET, the DCF feature is used. The DCF access is basically a carrier sense multiple access with collision avoidance (CSMA/CA) mechanism. In Contention window performance analysis which focuses limitation and bottleneck problem of current technology and improve it by using the queuing approach and IEEE 802.11 standard is used. Although 802.11b is adequate for basic connectivity issues and packet switching, it is evident that there is ample scope for its improvement in areas like quality of service, fairness, performance, security etc.
Traffic Patterns describe how the data is transmitted from source to destination. The two types of traffic patterns employed in MANET are CBR and TCP Traffic patterns. Mobility models describe the movement pattern of the mobile users, their location; velocity and acceleration. They play a vital role in determining the performance of a protocol and also differentiated in terms of their spatial and temporal dependencies. The commonly used mobility models are RWM, RPGM, MGM and GMM [2].

3. Proposed Scheme

3.1 IEEE 802.11

IEEE 802.11 standard provides physical (PHY) and MAC layer solutions for wireless local area networks. With the popularity of IEEE 802.11 standard family used in laptops, and Personal Digital Assistants (PDAs), this standard is considered to be one of the solutions used in ad hoc networks. Especially in the simulations, IEEE 802.11 standard is used in ad hoc networks by most of the people. The IEEE 802.11 is the standard to specify the Wireless LAN and it has two access mechanisms namely DCF and PCF [8]. In 802.11 DCF is mainly based on Carrier Sense Multiple Access with Collision Avoidance (CSMA/CA). In MANET CSMA/CD is not used because a station is unable to listen to the channel while transmitting. The Distributed Coordination Function (DCF) is used for synchronous, contention-based, distributed access to the channel. DCF is more widely accepted by the researchers as well as by the telecommunication industry and best suitable for delay intensive data and support both infrastructure and ad hoc network which is not possible by point coordination function.

3.2 Contention Window

The contention window (CW) size is a value chosen from the range between the minimum contention window (CWmin) and the maximum contention window (CWmax). CWmin and CWmax are PHY dependent value, e.g. in 802.11b, the Cwmin and CWmax are 15 and 1023 respectively. The initial value of CW is CWmin.
The size of contention window should be chosen very carefully because of the following reasons

- If the CW is too small: The back off time chosen between the range of zero and contention window will be close together and there will be higher probability that the random value chosen has the same value. With the same CW, nodes will transmit at the same time after waiting for the same CW period of time. Collision will happen in this situation.

- If the size of CW is too big: There might be some unnecessary high delay. For each of the

retransmission, Contention Window size will be increased to the value twice of the previous used CW.

3.2 Retransmission of Packet

Packets are retransmitted using binary exponential back off mechanism. BEB used to schedule retransmission after collision. The retransmission is delayed by an amount of time derived from the slot time and the number of attempts to retransmit. .The size of the contention window determines how long a node would back off before attempting to gain access to the channel.

After *c* collisions, a random number of slot times between 0 and 2^c - 1 are chosen. As the number of retransmission attempts increases, the number of possibilities for delay increases exponentially. But after a certain number of increases, the exponentiation stops.

In this work we proposed a new technique of contention based multipath routing where each of the nodes participate in routing. Contention window selects path with less contending nodes from source to sink. The source node selects the best path based on cost. in multipath routing , node sends data along several paths and selects the best path which is based on minimum cost arranged in ascending order. 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.

The use of multipath routing provides efficiency compare to single path but we also need to consider the energy factor. The consideration of the energy consumption factor important because in wireless ad hoc networks, a mobile device has a limited battery and a considerable amount of energy is consumed in wireless interfaces. These characteristics limit the network lifetime of the wireless ad hoc networks. As more energy consume performance is decreases. Below formulae shows the energy calculation of nodes.

Remaining Energy=Queue size * Energy per packet for transmission (1)

In this we are using cost based path matrix for splitting the traffic from source over different multiple path to destination. As the nodes receives the RREQ from previous neighboring nodes it decides whether to forward the RREQ packets or not which is mainly based on parameters used in this project which is Remaining energy, queue size and contention window. As the Remaining energy which is less than the threshold value then it stops forwarding RREQ. The cost is calculated for each of the nodes and forward till reach to destination after getting RREQ packets the destination generates the RREP.

The cost of the path from source to destination is calculated using formulae

Cost=Remaining Energy + Queue size / Contention window (2)

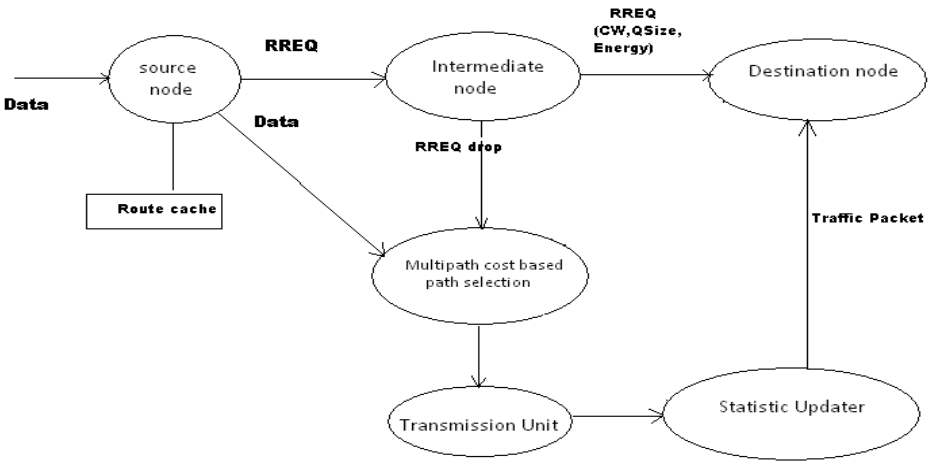

Fig 1 Data Flow Diagram

In Figure 1 the source has no route entry in its route cache, so it starts a route discovery by broad- casting a RREQ-packet to its neighboring node. Route cache contains all the routes from source to the destination which is based on least cost. Intermediate nodes used to forward the RREQ with parameters like energy, CW and queue size to the desired destination. It checks for the condition that remaining energy which must not less than given threshold which is less than 30% energy. If energy goes beyond 30% then it drops the packet if not it continue till it reaches to destination if its destination then it replies with route reply and route cache is updated. Transmission unit used to transmit given data. Statistic updater is used to update recent paths and send to destination. The source node preemptively selects the best path based on cost. As we are using multipath routing source node tries to send data along with multi paths and checks for best path based on minimum cost if not it waits for 2 best paths and after finding 2 best paths then transmits the data to destination. The use of energy factor which is for decreasing the overhead in the network.

4. Simulation Model

In our study to compare contention window mechanism with AODVM[5] protocol we have used Ns-2 (version NS- 2.34) simulator.

4.1 Simulation Scenarios

We compare our proposed system Contention window multipath routing (CWM) with Ad-hoc on distance vector multipath routing protocol for different scenarios
The simulation is carried out by varying Pause time 100 seconds for nodes and keeping the simulation time, speed and nodes constant. We measure the throughput (Mbps), packet delivery ratio (%), control overhead and latency (sec). We measure the throughput (Mbps), packet delivery ratio (%), control overhead and latency (sec).

4.2 Simulation Parameters

The table below presents the parameters used in NS-2 simulations.

Table 1. Simulation Parameters

Parameters	**Values**
Simulation time	100 seconds
Number of nodes	50,60,70,80,90
MAC protocol	IEEE 802.11
Pause time	0-100 sec
Simulation area	1000m*1000m
Mobility model	Random way point
CW min	31
CW max	1023

5. Performance Matrices

We measure different performance metrics. In particular, for each source we evaluate:

Packet Delivery Ratio: It is defined by a factor of number of packets received by number of packets transmitted. As the stability of nodes increases in the network then the packet delivery ratio increases.

Throughput: Network throughput 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.

Control overhead: It is defined as number of control packets transmitted for every data packet delivered.

Delay: The delay is the amount of time that is required for a packet to travel from source to destination. The latency includes propagation delay, transmission delay and processing delay.

6. Simulation Results

We ran the simulation environment for 100 seconds. We measure the throughput (Mbps), packet delivery ratio (%), control overhead and latency (sec) and compare it with AODVM. The results are summarized below with their corresponding graphs.

6.1 Number of Nodes v/s PDR

PDR is best parameter to evaluate the performance of network. When the number of nodes increases the ratio of packet delivery decreases because of congestion and collision rate increases compared to less nodes. In collision either contents of the data packets are modified or the contents are completely lost and the data packet is of no

use for the destination. So the source has to transmit those data packets again to the destination.PDR matrix is used to measure that how many collision occur during transmission.

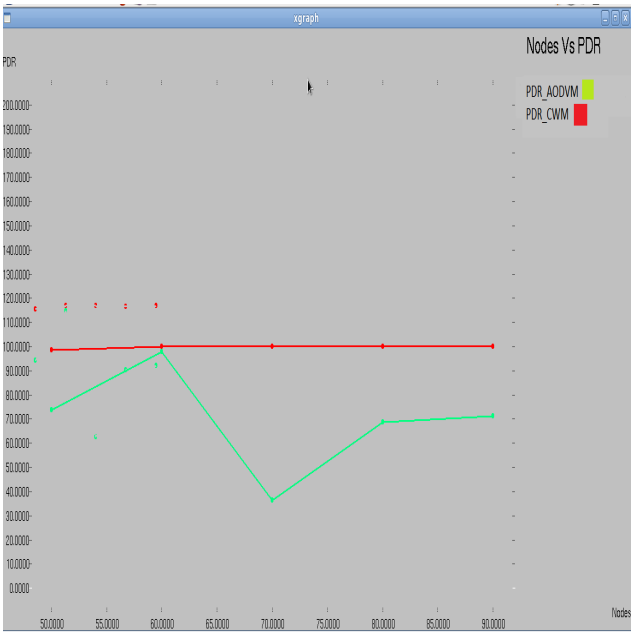

Fig 2 Number of nodes vs packet delivery ratio

From above fig 2 by keeping the pause time and packet rate as constant to 100 and as the number of nodes increases the delivery ratio is slightly dropping but in proposed CWM routing has better PDR than the AODVM.

6.2 Number of Nodes v/s Control Overhead

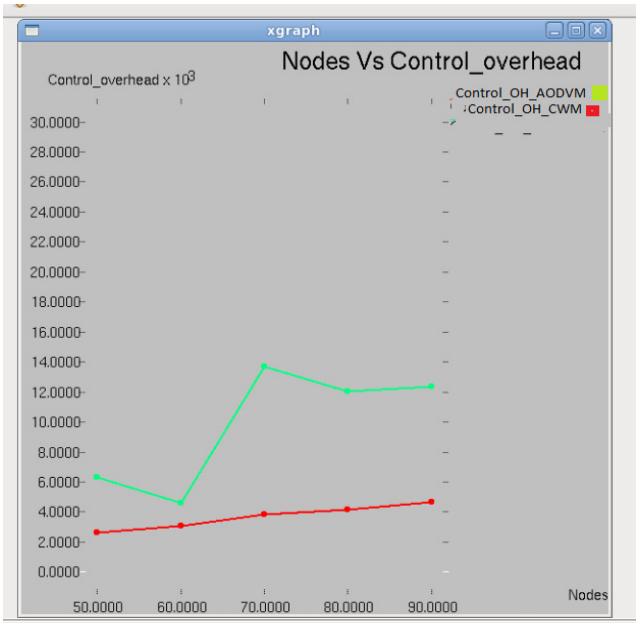

Fig 3: Number of nodes v/s control overhead

The above fig 3 shows the overhead of CWM routing is less than the AODVM because of best path selection based on least cost matrix.

6.3 Number of Nodes v/s Delay

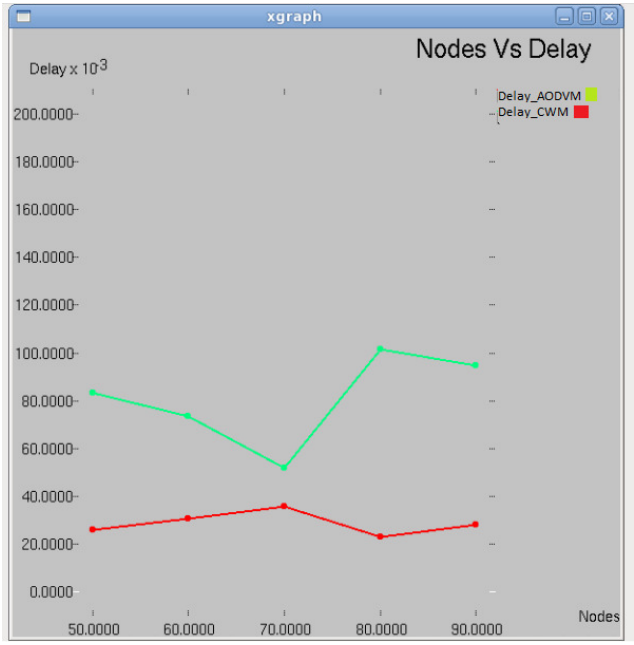

Fig 4: Number of nodes v/s delay

6.4 Number of nodes v/s Throughput

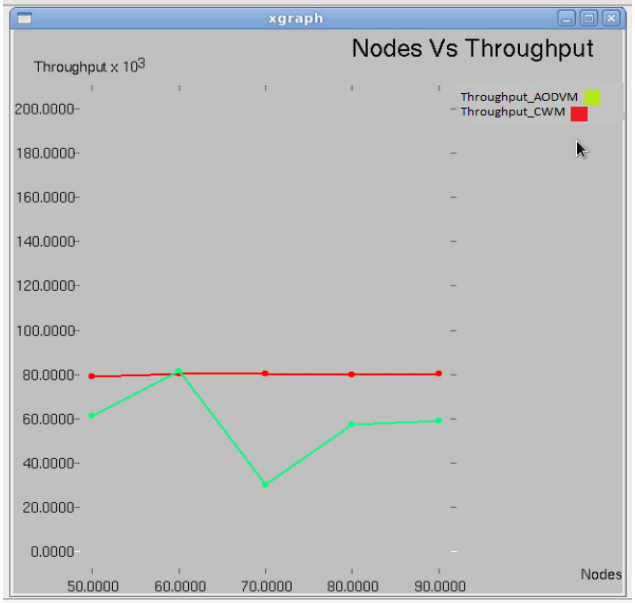

Fig 5: Number of nodes v/s throughput

In fig 4 by keeping the pause time and packet rate constant to 100 and varying the number of nodes the delay for proposed solution

is better than AODVM. From fig 5 by keeping pause time and packet rate as constant to 100. Here at node 60 even AODVM giving same throughput as CWM but with increasing the number of nodes the throughput of AODVM again dropped compared to CWM.

7. Conclusion

This paper evaluated the performance of proposed multipath routing algorithm with AODV Multipath protocol. Proposed mechanism limit the power consumption of mobile nodes to some extent and it provides better performance compared to AODVM protocol. Contention window selects path with less contending nodes from source to sink so reduces overhead in network. Along with this use of multipath routing improves the efficiency of network. Contention window based multipath routing algorithm is analyzed with different parameters. Results will be obtained as Contention window based multipath routing algorithm providing better performance compared to AODVM.

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