Content Based Concurrent Multipath Routing in Mobile ad hoc Network

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Abstract- **In order to achieve better throughput, load balancing and congestion avoidance multipath routing has been widely studied and used in wired networks. In this paper, a Content Based Concurrent Multipath Routing protocol is proposed. This paper mainly deals with the distribution of the data packets along the paths in the ratio of the stability of paths. The stability of the paths is proportional to the vector cost provided to the path vector by using the fuzzy concept []. The results of our simulation showed that when compared to the existing fuzzy logic based multipath routing protocol, CCMR exhibited higher performance, notably in terms of throughput and delay.**

Keywords—Multi-path; Fuzzy Cost; Packet Distributiom

I. INTRODUCTION

A mobile ad hoc network (MANET) is a collection of mobile nodes with no pre-established infrastructure forming a temporary network. Each device in a MANET is free to move independently in any direction, and will therefore change its links to other devices frequently. Because of the limited transmitter range of the nodes, multiple hops may be needed to reach other nodes. Due to the mobility of the nodes, the structure of the network changes dynamically [1]. In MANET, each node participates in routing by forwarding data for other nodes, and so the determination of which nodes forward data is made dynamically based on the network connectivity. Mobile Ad Hoc networks find its application in many areas and are useful for many cases. In MANET, the challenging problem is routing.

In MANET, there may be numerous routing paths between sources to destination. In order to utilize these alternate paths, there have been many multipath routing protocols proposed for mobile ad hoc networks throughout years. In these protocols, one important thing is to select the most feasible path for routing of packets. In multipath routing, the packets can be transferred in parallel manner between the source and destination.

This paper mainly deals with the distribution of the data packets along the paths in the ratio of the stability of paths. The ranking of the paths is done by using the fuzzy concept [2]. Using the fuzzy logic also declines the possibility of having same raked paths.

The rest of the paper is organized as follows: Next section will define the related work regarding the MANET and multipath routing. This section also defines the work done in fuzzy logic based multipath routing. In Section 3, the framework that we are going to use to distribute the packets along with the paths will be described. The proposed algorithm can also be found in Section 3. Section 4 will define the implementation details. Section 5 and 6 will conclude our work.

II. LITERATURE SURVEY

The routing protocols in MANET are based on two approaches-

1. Table driven routing approach
2. Without table

The table driven approach is mainly inherited by DSDV[] protocol. **Destination-Sequenced Distance-Vector Routing (DSDV)** is a table-driven routing scheme for ad hoc mobile network based on the Bellman–Ford algorithm. It was developed by C. Perkins and P.Bhagwat in 1994. The main contribution of the algorithm was to solve the routing loop problem. Each entry in the routing table contains a sequence number, the sequence numbers are generally even if a link is present; else, an odd number is used. The number is generated by the destination, and the emitter needs to send out the next update with this number. Routing information is distributed between nodes by sending *full dumps* infrequently and smaller incremental updates more frequently[].

The above table driven approaches are simple, but cost too much memory to maintain information tables and also consume too much bandwidth in order to refresh the information periodically, since every mobile need to maintain its own information table.

In another approach, the paths are formed only when there is a need. The main on demand protocols are DSR[] and AODV[]. **DSR** is a routing protocol for wireless mesh networks. It is similar to AODV in that it forms a route on-demand when a transmitting node requests one. However, it uses source routing instead of relying on the routing table at each intermediate device. The Ad-hoc On-Demand Distance

Vector (AODV) [4], proposed by Perkins et,al ,finds a more stable routing path with a lower block probability. This method typically selects the shortest route among several possible ones.

In these protocols, the same node is repeatedly utilized and hence subjected to higher resource exhaustion. This increased overload may results into link breakage between the source and the destination node. This results into decrement in the lifetime of the network. Furthermore, in the unipath approaches like DSDV, AODV and DSR, there is no utilization of alternate paths until the path does not break.

To overcome this problem, multi path routing protocols have been proposed. Instead of using shortest *K* paths multipath routing algorithms are using low delayed, less congested paths which do not have to be shortest between source and destination. The usage of such multiple paths will employ nodes from different regions of the communication area, and hence enable load balancing and better utilization of the network.

In [], the various paths between the source and the destination are ranked by using fuzzy logic. This approach gives an idea of survival factor of the paths. One more advantage of using fuzzy logic is the uniqueness of the ranks of different paths. In [], protocol the traffic is distributed amongst the best selected paths from the existing multipath routing the selection is based on consideration of five resource constraints bandwidth, computing efficiency, power consumption, traffic load, and the number of hops.

TABLE I. THE RESOURCES ALLOCATED TO FIVE PATHS AND THEIR VECTOR COSTS

Vector	**Vector Resources**					
	Bandwidth	***Computation Efficiency***	***Power Consumption***	***Traffic Load***	***No. of Inter nodes***	***Total Vector Cost***
1	*60*	*400*	*50*	*1*	*4*	*3.018*
2	*40*	*350*	*40*	*0.25*	*3*	*2.518*
3	*30*	*200*	*55*	*0.5*	*1*	*2.547*
4	*20*	*450*	*70*	*0.75*	*2*	*2.8*
5	*70*	*100*	*60*	*0*	*5*	*1.528*

In [], the cost of each path is evaluated by using the fuzzy logic. Later, the paths are ranked by using the cost as their survival factor. The data packets are forwarded along the paths in the ratio of their cost.

III. PROPOSED ALGORITHM

In this protocol, the data packets to be transferred from source node to destination node are distributed among the various paths in the ratio of the survival factor of respected paths. The survival factor is helpful in deciding the lifetime of the paths.

A. Survival Factor:

Survival factor gives an idea of lifetime of the network. The cost of the vector evaluated in [] can be understand as the survival factor of the path. Higher the survival factor, higher will be the lifetime and the transmission rate of the path. On the basis of this survival factor, the ranking of the path is done.

B. Packet Distribution:

- Let, there be a set of path vector Π from the source Vs to Vd defined as-

  $$\Pi = \{V1, V2, V3, V4\ldots\}$$

  This set Π is ranked by using the fuzzy logic []. The ordered pair of Π and the cost C is defined as-

  $$\Lambda\ (Vi,Ci) = \{(V1, C1), (V2, C2), (V3, C3),\ldots.\}$$

- The evaluation of the distribution factor, λ can be done by using the following formula-

  $$£i = Ci/f(Ci)$$

  Where, $f\ (C1, C2, C3\ldots) = \sum Ci$

- The number of packets to be transferred from the path vector Vi can be calculated by following formula-

  $$Ni = Z^* £i$$

  Where, Z is number of total packets to be transmitted.

- The bandwidth and computer efficiency are computed using the definitions from previous studies [13, 14]. The bandwidth calculation function is defined as:

  $$BD_{F(I)} = BD_{T(I)} - (BD_{(I)U} + BD_{(x)M})$$

According to our band width calculation function, a mobile device can keep at least BDF amount of bandwidth. Only the remaining free bandwidth can be used to serve another routing path with a required band width BM, making the node join the other path as an intermediate node. In other words, the bandwidth, BF, is reserved for the mobile device and the bandwidth embedded in a device will not be all occupied during the discovery of routing path. The computing efficiency function is computed as follows-

$$EI = 1/n\ \Sigma\ x=1n\ Tl\ (x) = 1/n\ \Sigma\ x=1n\ SM\ (x)/\ Cl$$

Assuming that the distance between the transmitter node and the receiver node is d, the strength of the signal received can be determined using the following equation.

$$Pr(d) = (PtGtGr\lambda 2\ )/(4\Pi)2\ d2\ L$$

Where Pr(d) is the received power ,Pt is the transmitting power, and Gt transmitter antenna gain ,Gr is receiver antenna gain.

C. Algorithm: The below method is encorporated to evaluate the number of the packets to be transferred from each path-

Input: A set of path vectors Π = {V1, V2, V3, V4…} and their cost values Λ (Vi,Ci) = {(V1, C1), (V2, C2), (V3, C3),….}

Output: Number of packets Ni to be transferred from each path in the set

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for each i from 1 to n
{
    total_cost = total_cost + cost_value[i];
    distribution_factor[i] = cost_value/total_cost;
    No_of_packets[i] = size * distribution_factor[i];
}
```

D. *Packet routing and path maintenance:*

In this approach, the ranking is done before sending the packets. Since the numbers of packets to be transferred from each path vector are proportional to the survival factor of the path vector, there is no possibility of higher resource exhaustion. If however there is any path break, the remaining number of packets can be transferred from the other paths, thus reducing the RREQ packets. After each successful transmission of the content, the ranking is done and new paths are established.

IV. IMPLIMENTATION DETAILS

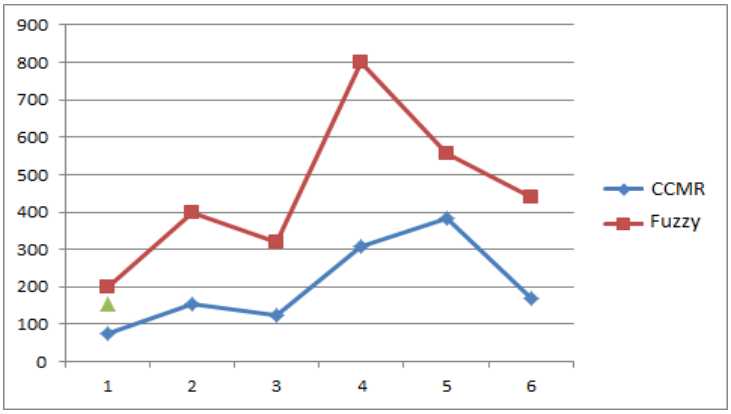
In the proposed protocol, a content based concurrent multipath routing protocol is proposed. To simulate the protocol, a java based environment is used on windows platform. Java is a cross platform programming language. The logic of the protocol is implemented completely in java language. The input is taken from the file and output is stored in the file too. Our simulation environment consist 5 vector paths and their respected resource values.

V. RESULTS AND DISCUSSION

In the proposed algorithm, a content based routing protocol is proposed. We implemented the protocol in JAVA programming language. We compared our protocol with the existing fuzzy cost based multipath routing protocol [].

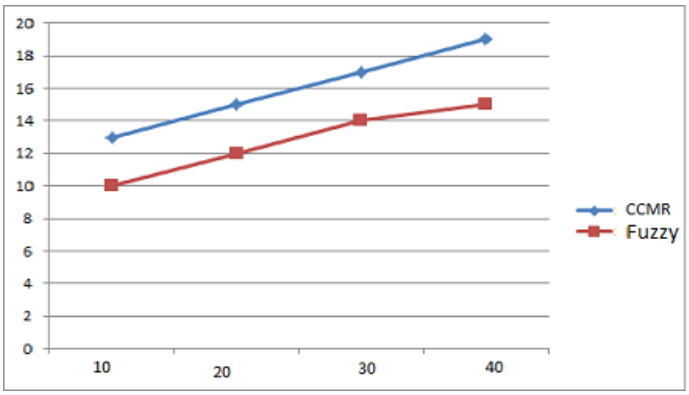
In proposed protocol, the delay of the network is significantly lower than the existing fuzzy cost based multipath routing protocol. This is due to the concurrent multipath routing of the packets. In CCMR, the total delay depends on the delay in the path with the maximum hop counts or the path with the higher number of the packets to be transferred, whichever is higher. When comparing the output of the proposed protocol with the existing fuzzy cost based protocol, there is significant decrease in the delay of the content to be transmitted.

FIG 1: Delay VS Size



When comparing the CCMR with the existing fuzzy logic based multipath routing protocol, the proposed algorithm out spade the existing one. Hypothetically, a routing path with more resources should naturally support a higher throughput. Hence, more number of packets is transmitted using the path with higher ranking. Since the packets to be transmitted are distributed along the paths in the ratio of their survival factor, there is no possibility of higher resource exhaustion.

FIG 2: Throughput VS Size



VI. CONCLUSION

In this study, a content based concurrent multi-path routing protocol was proposed. Compare to prior approaches, the algorithm uses the distribution of the packets along the path vectors in the ratio of their stability. The optimal concurrent routing of the packets is more helpful and meaningful when there is a problem of redundancy of traffic load. It is our hope that the proposed algorithm help shed lights on how a more effectively and efficiently multi-path routing algorithm can be utilized to meet the challenging needs in a mobile ad hoc network

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