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FACM: Fuzzy Based Resource Admission Control For Multipath Routing in MANET

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Abstract

Mobile ad-hoc network is a self organizing and adaptive wireless framework where there is no central co-ordination among the nodes. Due to the mobility and resource constraints of mobile nodes, Quality of Service (QoS) provisioning faces severe challenges, especially in multicast scenarios. Resource admission control is very efficient method for resource utilization and QoS guaranteed. This aim of paper is, to increase the throughput with less energy consumption. By combines resource admission control mechanism and fuzzy decision making methods, propose Fuzzy Based Resource Admission control for Multipath routing in MANET (FACM) which can fast respond to dynamic topology changes and tolerate unstable link status. Multipath Routing supports, for increase throughput of network and less energy consumption by Resources shares along multiple paths.

Keywords

Mobile Ad-hoc Network, MANET, Resource Admission control, Fuzzy based Decision making, Multipath Routing

I. Introcuction

A Mobile Ad Hoc network consists of wide range of mobile nodes that actively participate in data transmissions Mobile ad hoc networks (MANETs) have attracted a lot of attention due to the popularity of mobile devices and the advances in wireless communication technologies. A MANET is a multihop mobile wireless network that has neither a fixed framework nor central servers. Every single node in a MANET act as a router, and convey messages with each other. Two nodes can communicate if they are within each other's conveyance range; otherwise, intermediate nodes can play as routers if they are out of range limit .In this type of networks, some pairs of terminals may not be able to convey directly with each other and have to rely on some terminals so that the message are delivered to their destinations. A large variety of application has been developed. For example, a MANET can be used in special situations, where installing infrastructures may be difficulty, or even infeasible, such as a battle field or a disaster areas.

MANET's routing algorithms construct the network by automatically discovering the topology of the connectivity among constituent nodes.

In order to facilitate communication within the networks, a routing protocol is used to discover routes between nodes. The vital goal of an ad-hoc network routing protocol is find the exact route establishment between a pair of nodes so that messages may be delivered.

A. Routing In MANET

Routing in a MANET depends on many factors including topology, selection of routers, and initiation of request, and specific underlying characteristics that could serve as a heuristic in finding the path quickly and efficiently. One major challenge in designing a routing protocol for Ad-hoc network from the fact that, on one hand ,a node needs to know at least the reach ability information to its neighbors for determining a packet route and on the other hand, a network topology can change quite often in an Ad-hoc network. Ad-hoc routing protocols can be generally categorize as Proactive(or table-driven) or Reactive(on demand).Proactive protocols mandate that nodes in a MANET should keep track of routes to all possible destinations so that when a packet needs to be forwarded, a route is already known and can be immediately used. Proactive routing schemes continuously update the routing tables of mobile nodes. This consumes large portion of the scarce network capacity for exchanging huge part of routing table data. This reduces the available capacity of the network for communication.

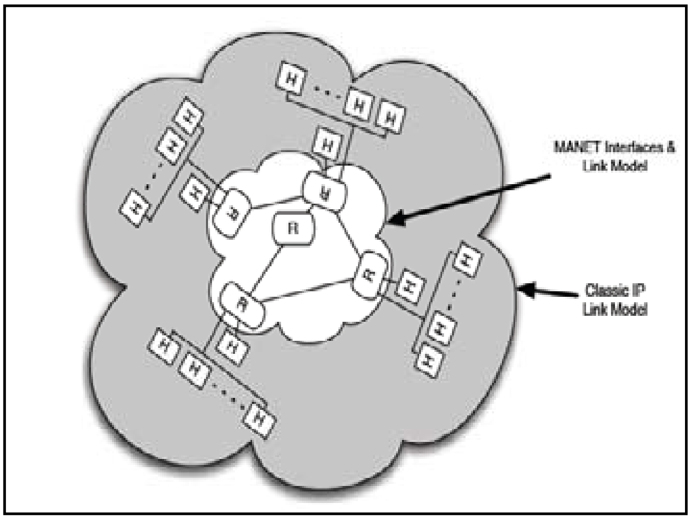

Fig. 1: Configured MANET with routers and hosts

Reactive On-demand routing creates routes only when desired by the source node. When a node requires a route to destination, it initiates the route discovery process within network. This process is completed once a route is found or all possible route transmission have been checked. Once a route has been established, it is maintained by some form of route maintenance procedure until either the destination becomes inaccessible along every path from the source or until the route is no longer desired.

B. Quality of Service In MANET

When real time applications, Such as conversational audio, video conferencing or on-demand multimedia retrieval, require quality of service (QoS) guarantees for active communication, best effort applications, such as file transfer, are more tolerant to changes in bandwidth and delay and generally always have backlogged packets for transmission.

Quality of Service (QoS) is usually defined as a set of Service requirements that need to be met by the network while transporting a packet stream from source to Destination. Providing quality of service (QoS) to users in a MANET is a key challenge for service providers. Many advance applications consist of real-time voice and video traffic that require QoS support for efficient communication. The purpose of any QoS support model is to offer services with guarantees in terms of delay, bandwidth, jitter, or packet loss.. To provide QoS guarantees assurance in dynamic ad hoc networks admission control (AC) mechanism uses here. AC aims, to measure the state of network's resources and thereby to decide which services can admit without promising more resources than are available. AC controls the usage and allocation of resources for various applications. AC is a fundamental component in mixed media systems, which needs to allow the bandwidth to be used by flows only when it is available. In addition, if several services meet the acceptance rules at the same time, the mechanism should choose one service which adapts the best with network current status or user requirements to accept first. So we introduce intelligent methods to calculate alternative services and choose the most reasonable one to accept first. Fuzzy decision mechanism uses to evaluate alternative services,

Fuzzy Decision making is the intelligent function trying to optimize the admission control decision.

In this paper, basing on research about Routing mechanism, resource admission control and Fuzzy intelligent methods, we propose Fuzzy Based Resource Admission Control for Multipath Routing in MANET.

II. Related Works

The issue of QoS guaranteed in mobile Ad Hoc networks has received a lot of attention due to its significance in terms of enabling the delivery of real-time services over these networks.

QoS calculation is different for intermediate nodes and destination nodes, intermediate nodes only need to calculate bandwidth, while destination nodes need to calculate end-to-end QoS information and compare it with user requirements. According to [8] paper Estimating accurate available bandwidth allows a node, to make optimal decision before sending a packet in networks. It is therefore obvious that the available bandwidth estimation improves the Quality of Service (QoS) in wired and wireless Networks.Mr. Yadav M, Mr. Chavan G. propose QoS Aware Routing and Admission Control in MANETs which estimate nodes exact location in the network first and then apply admission control part on route to check whether all QoS parameters are available or not. According to FAST [1] Multicast Ad-hoc On-demand Distance Vector Routing protocol (MAODV) applied for routing for respond quickly in dynamic network changes.

Authors in [7] proposed Multi-path routing mechanisms that maintain alternate paths to the destination and propose a new admission control protocol. The protocol discovers multiple paths that can provide the required quality of service between the source and the destination. This allows a source to quickly find an alternate if the current path becomes unusable. Yang and Kravets [6] proposed a multi-priority admission rate control (MPARC), the model performs accurate control on every newly arriving real-time flow appropriate rate policing on all best effort traffic.

Even though the existing models have many advantages, it has a significant drawbacks to lead a network performance degrades. [8] Paper estimates the accurate bandwidth, but the mechanisms are more complex and difficult to achieve, extra cost are brought. According to [2] Admission control the available bandwidth considered for each intermediate nodes. But it doesn't consider about the reserved bandwidth and bottleneck bandwidth. So it network leads less efficient. Available bandwidth calculated steps is very difficult during the performance evaluated based on bandwidth. According to FAST [1] it's a best method for reduce packet drop and jitter in less mobility network. But it not suitable properly for high mobility multicast scenarios. Alone multipath Admission control doesn't provide the high throughput if hob count is more [4]. From the above models results, separate usage of admission control mechanism, fuzzy control, bandwidth, and multipath routing will not give better improvement in network outcomes. So here concludes by use of combine all the features of above four strategies we can expect more throughputs and less end-to-end delay for both less and more mobility nodes reside networks.

III. Proposed Work

For solve the network high density problem in multicast scenarios like video conferencing and multimedia applications; here uses Multicast Adhoc on- demand multipath Distance Vector Routing. The network load is balanced by distributing the services in multiple paths. Services are move to various destinations along multiple parallel paths at a time. By those method, can receive high throughput with less time. Admission control mechanism by considering the reserved bandwidth and bottleneck bandwidth the network energy saves by avoiding those tree paths . By the fuzzy decision controller the best services only can will enter in the network .Combines model of admission control fuzzy decision maker, multipath routing can give high reliable throughput even though Network load high. By reducing the packet drop and end-to-end delay, can expect high packet delivery ratio.

A. Block Diagram

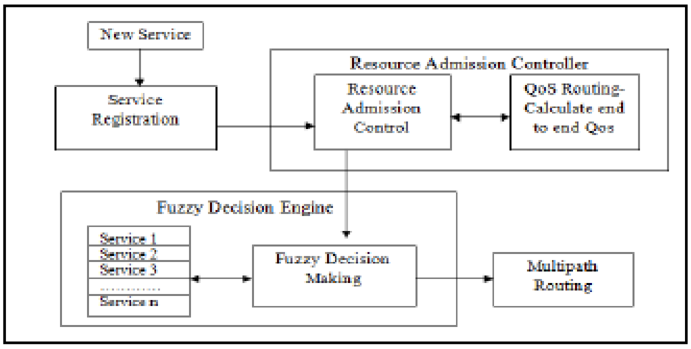

Fig. 3.1 System Design-Block Diagram

It consists of four parts. Service Registration, Resource admission Control,Fuzzy Decision making and Multipath Routing.

Service Registration

When a new service arrives, it would register to the service registration engine of source node with its basic information, including arrival time, needed bandwidth and other QoS requirements.

Resource Admission Controller

It consists of Resource admission control decision engine and QoS Routing .Admission control decision engine makes initial decision whether to admit the new service. QoS Routing Contains two steps of processes

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1. Node Joining or Node leaving in multicast tree.
2. Calculate bandwidth for intermediate nodes and end to end QoS in destination node.

Then compare this with user requirements and used to take admission decision.

Fuzzy Decision Function
Alternative services waiting to be accepted are stored in fuzzy queue, while fuzzy decision engine evaluates the services according to different QoS parameters and makes final admission decision. If the fuzzy decision queue is full or it has reached a certain length of time, for example, 2 seconds, the fuzzy decision mechanism would be trigged; all services in the fuzzy queue would be evaluated as alternative services.

Multipath Routing
The protocol discovers and maintains multiple paths that can provide the required quality of service between the source and the destination. This allows a source to quickly find an alternate if the current path becomes unusable.

B. Working Steps
Detail steps of Fuzzy based Resource Admission Control for multipath routing are described in this section;

1. A new service would register into service registration engine with its basic information. After register the new services it forwards to Resource admission controller. It consists of Qos Routing and admission control.

3.2.1 Multicast Tree Establishment
2. The multicast tree is established for Qos routing. If any node wants to join a multicast group, it originates a route request (RREQ) packet and unicasts. if it has the address of the group leader. If the address of the group leader is un known, then broadcasts the RREQ packet. When the receiving node receives more than one RREP packet, it selects the most recent one and the shortest path from all the RREP packets.

3. If a non leaf node wishes to leave a multicast group, it sends a multicast activation message to their next hop with its prune flag set and prunes itself; otherwise, it cannot leave and must remain on the tree.

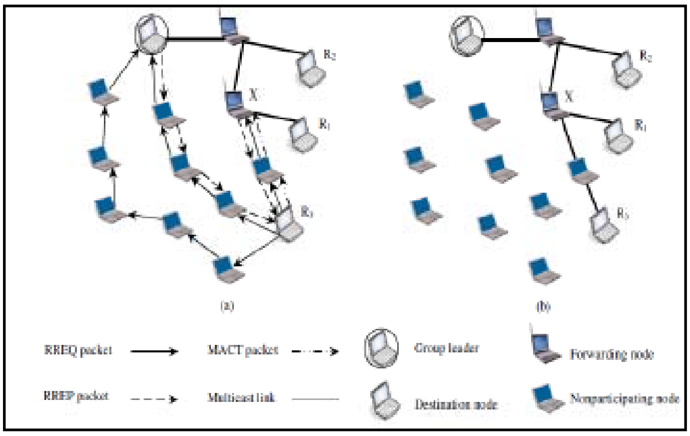

Fig 3.2.1 Node R3Joining in Multicast tree

3.2.2 Calculate Bandwidth and End-to-End QOS for Admission Control
4. Source node sends a resource reservation request message along the multicast tree which contains service ID, arrival time, and needed bandwidth of the service;

5. Intermediate node receives the reservation request message and calculates local available bandwidth.

$$Ba = Bt - \sum_{i=1}^{n} Bi \qquad (1)$$

- If B_a > Maxband(4 M for service 1), it would forward the message along the multicast tree without any change, then authorize 4 M bandwidth to the appropriate service.

- If B_a < Minband(2 M for service 1), which means the node cannot meet the minimum requirements of the service, so the node would prune and send a refuse message to the source node.

- If Minband< Ba < Maxband, such as 3.5 M, the node would check the "Min/Max" segment of REQ message. If the segment is "Max" which means this node is the first bottleneck node.

6. The REQ message information is continuously updated along the multicast tree. The whole link can meet the minimum requirement of the service if the destination node could receive the packet. Then the destination node calculates the end-to-end QoS (delay,jitter, packet loss ratio etc), and compares it with user's requirements, decides whether to accept or refuse the service. If accept, the destination node would send a resource reservation response (RES)message to the source node and put the service into fuzzy queue.

3.2.3 Fuzzy Decision Making
7. If the fuzzy queue is full or it has reached a certain length of time, for example, 3 seconds, the fuzzy decision mechanism would be trigged; all services in the fuzzy queue would be evaluated as alternative services.

- construct m*n parameter matrix

$$X_{mn}=\begin{pmatrix} x11 & x12\cdots & x1n \\ \vdots & \cdots & \vdots \\ xm1 & xm2\cdots & xmn \end{pmatrix} \qquad (2)$$

m = QoS evaluation parameters and
n = services waiting to be accepted

- Using fuzzy membership functions find maximum and minimum values.

$$r_{ij}=\begin{cases} \dfrac{xij}{ximax} & ki = 1 \\ \dfrac{ximin}{xij} & ki = 0 \end{cases} \quad i=1,2,\dots, j=1,2,\dots.n. \qquad (3)$$

Construct membership matrix

$$R_{mn}=\begin{pmatrix} r11 & r12\cdots & r1n \\ \vdots & \cdots & \vdots \\ rm1 & rm2\cdots & rmn \end{pmatrix}=(r_{ij})_{m*n} \qquad (4)$$

- Using membership matrix We choose the maximum and minimum value of each row in R_{mn}, then construct the optimal vector $\vec{G}$ and the worst vector $\vec{B}$

$\vec{G}$ = (g1, g2, ...gm)^T gi = max{r_{i1}, r_{i2}, ..., r_{in}} (5)
i=1, 2,…,m;
$\vec{B}$= (b1, b2, ...bm)^T bi = min{r_{i1}, r_{i2}, ..., r_{in}} (6)
i = 1, 2,…,m;

- Each parameter has a evaluation weight and the sum of all parameters' weight is 1. The weight vector of evaluation parameters is $\vec{W}$ According to the evaluation weight, we can calculate the distance

$d(\vec{Rj},\vec{G})$ and $d(\vec{Rj},\vec{B})$

$\vec{W}=(w1,w2,\ldots wm)^T \quad ; \quad \sum_{i=1}^{m} wi = 1$ (7)

$d(\vec{Rj},\vec{G})=\sum_{i=1}^{m}(wi|r_{ij}-g_i|^p)$ (8)

$i=1,2,\ldots,m \quad j=1,2,\ldots,n$

$d(\vec{Rj},\vec{B})=\sum_{i=1}^{m}(wi|r_{ij}-b_i|)^p$ (9)

$i=1,2,\ldots,m \quad j=1,2,\ldots,n$

- Users expect that $d(\vec{Rj},\vec{G})$ is great as possible and $d(\vec{Rj},\vec{B})$ is small as much as possible. Calculate u_j as an acceptance factor of j-th alternative objects.

$$u_i=\frac{1}{1+\frac{d(\vec{Rj},\vec{G})}{d(\vec{Rj},\vec{B})}} \quad (10)$$

8. The fuzzy decision engine will choose the service which has the biggest acceptance factor uj choose to accept first;

$u_{choose} = \max(\overline{uj})=\max(u_1,u_2,\ldots,u_n)$ (11)

9. If a service has been in the fuzzy queue for a certain time such as 2 minute, which means the evaluation result is not ideal, the service would be rejected and the appropriate reserved bandwidth of all nodes would be released.

3.2.4 Multipath Routing

Multicast Adhoc On demand Multipath Distance Vector Routing (Multicast-AOMDV) algorithm used for service routing. The network load will balance by shares the services along multiple paths. This allows a source to quickly find an alternate if the current path becomes unusable.

Properties of AOMDV:

- Maximum hop count to each destination is used to avoid loops.
- Multiple routes are established in single route discovery process.
- Nodes maintain next-hop info for destinations (multiple next-hops possible).
- No complete route(s) information known at a source.
- RREQs from different neighbours of the source are accepted at intermediate nodes.
- Multiple link-disjoint routes are created.

IV. Simulation Analysis

In order to verify the correctness and effectiveness of our mechanism, we simulated the FACM on network simulator 2 and collected the results. We implemented Multicast adhoc on demand multipath distance vector routing on ns2 for build and maintain the multicast multipath tree.

NAM editor used to show the animated schema of the Admission control, Multicast-AOMDV performances and their routing paths. Furthermore we have used X-graph to graphically represent the energy consumption and number of packets drops . From the result Fuzzy based Resource Admission control for multipath routing handling the Qos routing process smoothly.

The following two quantitative performance metrics have taken in this study

Delivery rate: This metric measures the number of Packets successfully delivered during the simulation.

End-to-end delay: The primary motivation for admission control is to support real-time traffic. Such traffic is sensitive to delay, so it is important to ensure that a new scheme does not impose large additional delays. We study the average delay for each packet to reach its destination.

Additionally Bandwidth/Energy Consumption: The term bandwidth refers to the information carrying capacity of a node in networks. It is measured by bits per second which refers to the speed of bit transmission in a channel or link.

Resource Admission Control process

Source node broadcast RREQ packet and establish multicast tree along the nodes which sent RREP packets.

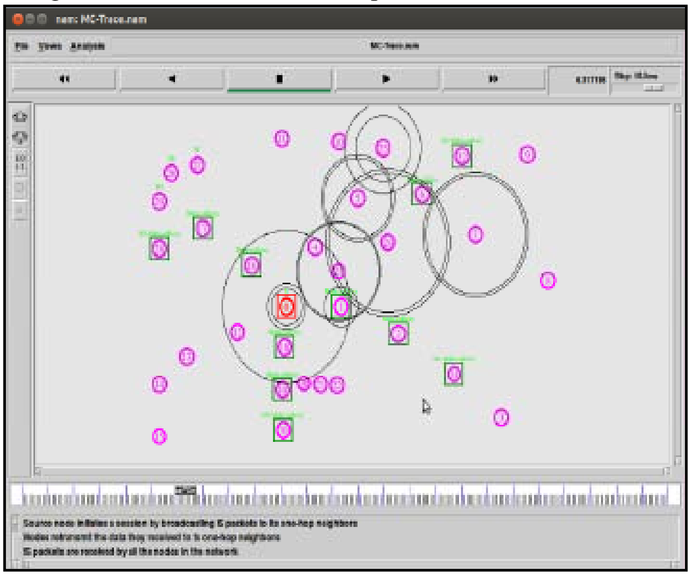

Fig. 4.1: Multicast Tree Establishment (Based on bandwidth)

Tree pruned from where they not receive any ack or RREP packet with in TTL time.

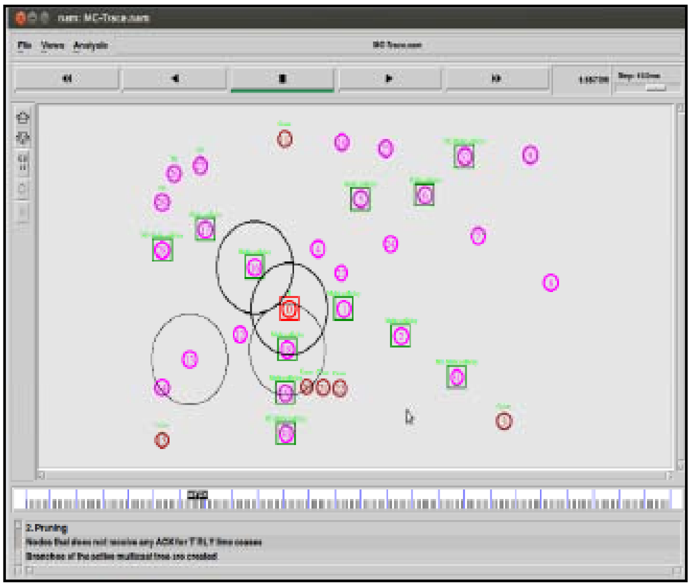

Fig. 4.2: Tree Pruning

Simulation results obtained in our simulator are less packet drop and high packet delivery with less energy consumption.

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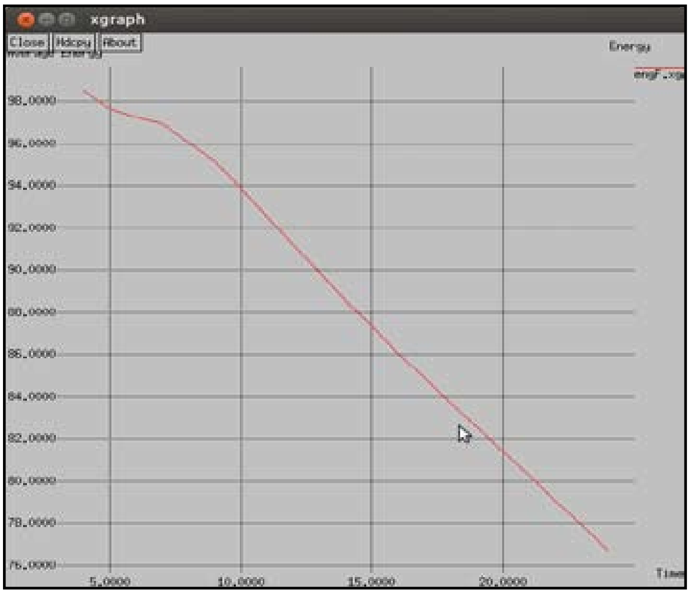

Fig. 4.3: Energy versus Time graph

Energy Consumption during packet transmission decreases based on time.

Packet Delivery Ratio

The ability to deliver a high percentage of packets to a destination increases the overall utility of the system. Because the amount of traffic transmitted by the traffic sources varies based on the admission decisions during the simulation, it is not possible to express this metric as a percentage in a meaningful way. Therefore, we simply count the number of data packets received.

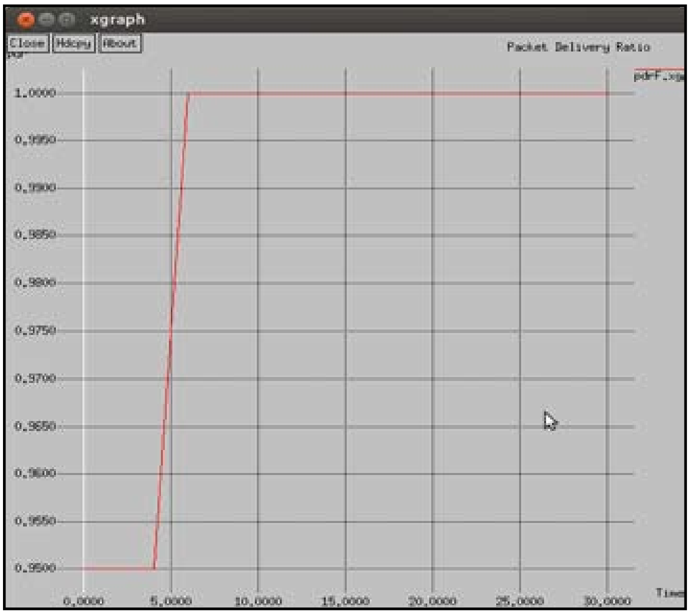

Fig. 4.4: Packet Delivery versus Time

Delivery of packets increases while the flow of time increases.

Packet Dropping

The average rate of packets doesn't reach their destination by end-to-end delay. FACM model reduces the packet drops by load shares among the node.

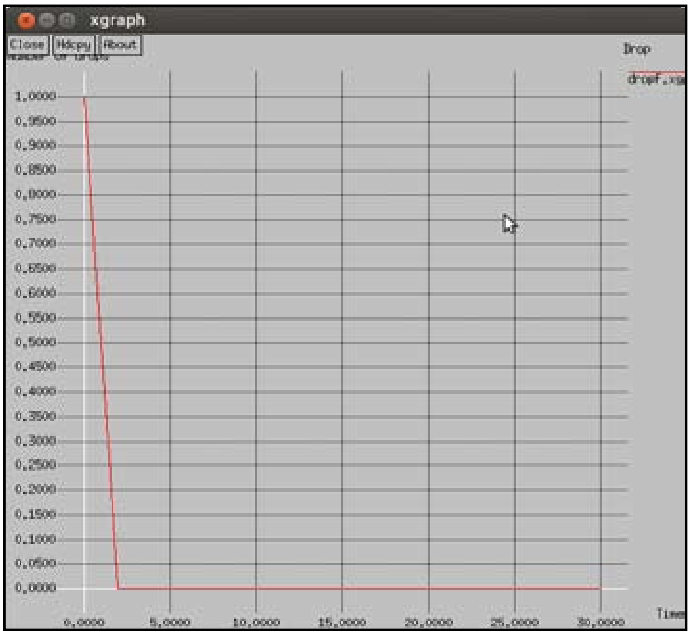

Fig. 4.5: Packet dropping versus Time

Finally, we examine the number of flows, the results in delivery rate; energy consumption proved that FACM is able to use the resources in the network more efficiently than FAST.

V. Conclusion

This paper proposes FACM an improvement to existing protocols for admission control in multicast mobile ad hoc networks. By uses of admission control mechanism distributes QoS calculation and resource control across multiple destination nodes; intermediate nodes only need simple operation and adjustments, so it can improve the efficiency of resource admission without introducing too much cost in Ad Hoc networks; Service Registration controls the excess load of network; and by register the services, an unauthorized services can't enter into the network. So it may gives security assurance. Fuzzy logic controller selects only the optimal services among the multiple services using membership functions. Users can choose different evaluation parameters of service as well as input needed weights of the parameters, so the mechanism has good scalability and flexibility. Multipath routing enables multiple paths at a time for single service in multicast environment.

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