QoS Enabled Hierarchical Robust Multicast Routing Protocol (QHRMR) in Wireless Networks

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***Abstract*— Establishing communication through portable devices without the dependence on or constraints of any central infrastructure is possible in Ad-hoc networks. Support for multicast solutions is crucial for mobile ad-hoc systems to become an affordable solution to facilities systems. Multicasting services of proven worth are provided through well established routing protocols in the wired networks. Progressive increase in the mobility of the nodes necessitates these protocols to evolve corresponding methodologies to provide efficient service in the new context. A novel protocol, QoS Enabled Hierarchical Robust Multicast Routing (QHRMR) is proposed in this paper for multicast routing in large IP networks. The priority objectives of QHRMR are to deliver packets to the receivers in an efficient and reliable way with QoS as a primary concern. The detailed protocol for constructing a shared multicast tree is presented in this paper. QoS is the main building block in this protocol to achieve effectiveness, reliable and robust environment.**

Keyword- Ad-Hoc, Multicast, QoS, QHRMR, Routing.

I. INTRODUCTION

Support for multicast solutions is crucial for mobile ad-hoc systems (MANETs) to become an affordable solution to facilities systems. Efficient multicasting in MANETs encounters difficulties that are not experienced in other types of systems such as the flexibility of nodes, the tenuous status of interaction hyperlinks, limited resources, and knowledge of the system topology. These difficulties by providing a structure and structure with practical and sensitive elements to back up multicasting in MANETs focusing stability and performance of end-to-end bundle delivery. The structure includes the Solid Multicast Redirecting method (QHRMR) to provide multicast solutions to multicast applications. QHRMR's practical component determines multiple multicast plants based on the forecast of future accessibility to the hyperlinks and the supposition that the trees will become turned off over time. The sensitive elements reply to changes in the system topology due to the flexibility of the nodes and to changes in the multicast group's account.

Sending repetitive data packets over multiple routes further increases the reliability at the cost of a rise in the use of system resources. QHRMR uses estimates to Steiner trees during tree development and forward error modification development methods during bundle transmitting in order to deal with this improve. To avoid additional system traffic, trees are distributed only when the existing trees cannot be easily repaired to provide changes in topology or group account. The unique of the suggested method arises from developing methods that have not previously been combined into a multicasting protocol and a unique method to determine the relative weights of the links.

Today the use of wireless gadgets is becoming well-known. Many users connect using a cell phone, often removing the land-based phone in their homes. Processing systems, both private and business, are including wireless system cards to computer systems and including access points into their topologies. Personal digital staff (PDAs) with wireless system availability has also become well-known with a variety of individuals which range from learners to professionals. As the gadgets become more frequent, the users will come to anticipate greater abilities from the gadgets and systems, and will also anticipate services that are much like those obtained in a wire-based system such as using point to point devices, receiving loading multi-media and enjoying conference meetings abilities.

The specialized issues associated with wireless devices are different from the issues experienced in a wire-based system. First, the transmitting of a radio indication through the air is much less efficient than transmitting of an electrical indication over cables. The wireless alerts can be impacted by ecological conditions such as rainfall and can possibly be obstructed by things in the signal's path. It is also impacted by disturbance from other stereo alerts in the place or disturbance from its own indication shown off of things. Second, the gadgets may have restricted resources such as battery power lifespan and memory. Third, the information available to wireless devices is a valuable product since it is restricted by federal rules. Rates of speed of 11Mbps have only lately been noticed in duplicate wireless local community systems although we may soon see speeds of 54 Megabyte per second become more common with the latest IEEE 802.11g standard.

Also, the fact that the amount of available bandwidth may not be static as the network changes is another resource of side-effect in wireless devices. Many of the problems have been resolved in infrastructured systems in which generally the last hop to the customer is the only wireless link the indication must navigate. An example of an infrastructured wireless system is a cell phone business's system which is separated into tissues. The devices transpiring over a wireless link is passed off to another mobile as the customer results in one mobile and goes into another.

Communications can be classified based on the number of senders and devices. A one-to-one device in which only one user conveys with another individual user is termed as unicast devices. One-to-all devices, in which only one user delivers a concept to everyone in the system, is termed as broadcast communication. The redirecting methods that have been designed to back up both unicast and transmitted devices in wired systems have progressed into consistent methods. A set of redirecting methods designed for unicasting and delivering in MANETs is in the process of becoming consistent. In both cases the methods used to find the routes used in the redirecting of information are effective. The staying groups of devices are one-to-many and many-to-many, both of which fall under the going of multicast devices. Let us analyze a series of gradually more effective techniques to execute multicasting in which a concept is allocated from only one user to a number of devices in a wireless system.

The difficulties of multicasting in a mobile ad-hoc network to a dynamically changing number of devices, complications arising from the use of wireless devices transferring through the air, cellular nodes, the lack of facilities and multicast devices. In addition we now face additional complexity caused by possible changes in team account. Can all of these issues be get over to offer an efficient multicasting assistance to users in a MANET? This paper details some of these vary issues and suggests a method to offer such assistance.

Several growing programs of the present and next generation Internet, e.g. IP radio, IP TV, and video and audio conference meetings, etc., include one to many and many to many data devices called multicasting. Many real-time programs over IP, such as IP Telephony and video conferencing, can not function with the best effort assistance provided by present IP systems. To support such programs, IP systems need to offer certain assistance quality (QoS) promises. Most of QoS-centered multicast redirecting methods are depending on a "flat" redirecting model that does not range well for large size systems.

This paper explains QHRMR; a novel QoS enabled robust and hierarchical multicast routing protocol. The scalability issue is resolved by planning the network as a hierarchy of domains using the full mesh aggrigation technique. The concept of domain controllers used for managing the creation and maintenance of multicast trees. The method uses a novel opposite surging approach to connect host routers with the shrub while fulfilling end-to-end QoS restrictions. This is a allocated criteria, which uses only local state details at each wireless router. The worst connection time and concept expense are approximated and research shows that QHRMR constructs cycle free multicast trees. Simulation results show that the message overhead of QHRMR is much smaller than that of the flat redirecting method using reverse flooding.

Routing is a key important operation for successful data transmitting in packet switching systems e.g. IP systems [1]. Routing methods can be arranged into two fundamental types: unicast redirecting and multicast redirecting. In unicast redirecting, packets are passed on from only one source to only one destination. Multicast redirecting sends packages from one or several sources to several destinations that have been designed as members of a multicast group in various spread sub systems. Examples of multicast include the transmitting of corporate messages to workers, interaction of stock quotations to agents, video and audio conference meetings, and copying directories and web site details, etc. IP multicast facilitates this type of transmitting by allowing resources to deliver only one duplicate of a concept to several individuals who clearly want to receive the details. This is far more efficient than demanding the resource to deliver an individual duplicate of a message to each requester (referred to as point-to-point unicast).

IP systems offer best attempt assistance that is subject to unforeseen wait and potential information loss. Many real time programs over IP, such as IP Telephone, tv and radio over IP, interactive video etc., can not function with the best attempt service provided by current IP systems. To service these programs, IP systems need to offer some service quality (QoS) assures. QoS is determined as the ability of system elements (e.g. a program, and router) to offer some stage of guarantee that the information traffic can meet certain assistance specifications (e.g. distribution time). Depending on program specifications, QoS can be separated into two basic types: resource reservation and prioritization. To provide the need for these different kinds of QoS, a variety of QoS protocols and methods have been designed or are under development such as source booking (RSVP) [2], classified services, and integrated services [3]. QoS aware protocols such as the one designed in this paper can be applied using new IP changing techniques such as multi protocol labeling switching (MPLS) [3].

The importance of QoS-centered multicast redirecting has persuaded several research projects in this area. Most of these protocols are centered on "flat" redirecting techniques [4, 5] which model the entire system as a single sector. These methods do not range well for large size systems. The scalability issue can be resolved by planning the system into a hierarchy of domains [6, 7]. In this approach, the system is organized as L levels of domains (called an L-stage hierarchy). Each stage in the structure includes several domains. A domain in stage -i is known as an i-domain and routers from 0-domain. A number of routers (i.e. 0-domains) are arranged together to form a 1-domain and, in general, a group of domains from level -i are arranged to form an (i+1) domain.

II. Related Work

The Internet routing being a major research place, a lot of literary works has been developed on redirecting methods [8] which has been analyzed quite effectively. Mobile IP multicasting routing algorithm was also proposed [15]. However, since QoS-centered multicasting is a new place, there are very few guides on this subject. In fact, there are no guides in the open literary works on QoS-centered ordered multicast redirecting. The purpose in this area is to temporarily touch upon the more important efforts that are directly appropriate. Therefore, this literary works review includes non QoS-centered multicasting and ordered redirecting as well as QoS-centered ordered unicasting.

Multicast routing methods build a routing tree linking all the senders and devices of the multicast group. There are two basic types of multicast trees: resource centered trees and distributed trees. In the resource based strategy, the method determines an implicit spanning tree for each source in the multicast group. In the distributed tree strategy, a single spanning tree is distributed by all the group members to send and/or receive information. Having only one distribution tree for several resources may result in non-optimal tracks and cause delays in message delivery.

The purpose of this research is to develop a multicast method to provide the multicast data with a high degree of stability from a single sender to each of the receiving devices of a powerful multicast group in a mobile ad-hoc system. The method should have practical as well as sensitive elements to increase the usefulness to a wide range of circumstances. The practical element should set up the multicasting in expectation of future activities and the sensitive element should deal with activities that have not been predicted. Another purpose is to perform the multicasting effectively, using system resources, especially information, smartly.

In order to better understand the issues of multicasting in mobile ad-hoc systems and the ideas behind the suggested solution to the multicasting issue, this section will evaluation the categories of redirecting methods, unicasting in mobile ad-hoc systems and multicasting in both wired and wireless systems. Unicast methods are included in the evaluation since some of the multicasting methods rely on a particular type of actual unicast method and they provide understanding into the redirecting issue in general. Some unicast methods are depending on computations of link accessibility which is temporarily mentioned. The segments working with multicasting include conversations of surging, multicast plants depending on Steiner plants, and a wide range of multicast methods.

Multicast Routing Algorithms

Multicast redirecting requires some distribution tree rather than a simple point-to-point path through the network. The purpose of multicast redirecting methods is to create and maintain the distribution tree, called the multicast tree. The routing algorithms can generally be classified as source routing and distributed routing. In the source routing, each router maintains the complete global state of the network. Based on the global state, the multicast tree is locally computed at the source router. In distributed routing, the tree is computed by an algorithm distributed over different routers in the network.

The easiest strategy for multicasting is flooding. In this strategy when a packet comes at a wireless router for the first time, the wireless router forwards the packet on all connections except the one on which it came. Otherwise, the wireless router simply discards the packet. A flooding algorithm is very easy to apply. However, flooding does not range for large systems and makes ineffective use of wireless router storage since each wireless router is needed to sustain a unique desk access for each lately seen bundle. The flooding approach has been applied for link state information advertisement in the Open Shortest Path First (OSPF) protocol [9]. An improved version of flooding has also been used to develop a distributed algorithm for QoS based routing [10].

The spanning tree algorithm is a improvement of easy flooding to offer a more effective routing. A spanning tree is a part of the Internet that covers all nodes in the internetwork. The spanning tree can also be produced by Dijkstra's criteria [11]. A spanning tree remedy is relatively easy to apply. However, it has two drawbacks: it centralizes all the visitors on a small set of links and it does not consider the multicast group account. The Reverse Path Forwarding (RPF) criteria create a group-specific spanning tree for each potential sub system [12].

Although Steiner trees reduce system sources for building a distribution tree, complications in calculations has made these trees of little realistic significance. Ordered Redirecting methods mentioned so far arrange the whole internet into a single domain and do not range well with improving system dimension. Several hierarchical methods have been suggested to deal with the scalability problem associated with smooth routing methods. Ordered methods that use link state details and routing platforms use topology gathering or amassing for improving scalability [16]. Topology aggregation is obtained by collection nearby system nodes into routing domains and comprising the routing details for each domain in an aggregated way. The aggregated details are used by system nodes outside the domain to make routing choices. Different techniques such as symmetric star, full-mesh, spanning tree, and complex node representation have been used for topology aggregation.

QoS-based Routing

As previously mentioned, the unity of different real-time applications over IP wants certain QoS assures. Different redirecting methods have been suggested to fulfill the QoS specifications of different programs [10]. Selective probing is a distributed QoS-based unicast routing protocol that selectively floods along links, which can meet the QoS requirements, to find a path between a source and a destination. The number of flooding information is managed by enabling only one flooding concept that belongs to a particular (source, destination) couple to complete through a wireless router. However, this strategy may fall short to discover a preliminary direction even when such a direction prevails [13]. This issue is taken care of by presenting a wait, which is same as the node wait, at each wireless router while sending the information.

The path followed by the first message that arrives at the destination is then selected as the routing path. The QoS-aware multicast routing protocol (QMRP)[14] constructs a distributed key unicasting request message from the variety wireless router towards the core. If a wireless router in the unicast direction does not fulfill the QoS need, the request message backtracks one router and is then sent along all other available routes as unicast information towards the core. When an on tree router (i.e. a wireless router that is part of the multicast tree) or the core gets a request message it delivers an Ack message back to the host router. After getting all Ack messages, the router chooses a direction to get connected to the tree.

The QMRP may not be able to discover a possible route for preservative (e.g. delay) QoS specifications, even if such a direction prevails. Consider a situation where there is only one possible direction that meets the wait need. While unicasting, the Demand concept varies from the possible direction and does not fulfill the QoS need when it is more than one hop away from the possible direction, then the concept may never come returning to the possible direction. Therefore, the request message may never achieve the primary or any other on-tree router.

Fig 1. Multi cast routing protocols

In the suggested approach, the routers in the system are structured into an N-level hierarchy. Each level in the structure includes a number of domains. Each domain has at least one boundary router that describes the edge of the domain and is also connected to other external domains. One of the boundary routers is selected as the operator for the domain. The controllers store details about the multicast trees within its domain and organize the becoming a member of process. Each router in the network system connected to only one domain in a stage and keeps topology details of the domain to which it connected.

III. Overview of Proposed Algorithm

The purpose of the research issue at hand is to create a multicasting plan with practical and sensitive features which focuses on stability and performance to use in redirecting information packets from the sender to the destination in a multicast group of a mobile ad-hoc system. The best possible remedy to the multicasting issue is NP-hard, due to the Steiner tree problem, the multicasting issue is difficult to fix in a fixed static wired atmosphere and even more so in a powerful mobile ad-hoc system. Instead of seeking optimal solutions we will develop heuristics to achieve the objective of reliably delivering packets while meeting the constraints to avoid network congestion due to redundant packets as closely as possible. In the rest of this section we explain the QHRMR as a set of heuristics for the issue.

The priority objectives of QHRMR are to deliver packets to the receivers in an efficient and reliable way with QoS as a primary concern. First let us address the reliability factor. Instead of creating a single dynamic multicast tree over which all of the packets from the source are routed as found in many of the multicast protocols.

This approach provides different routes for packets to transfer in the event that some of the routes become unavailable. Packets travel down each one of the trees in the set of trees increasing the chances that a recipient gets the packet sent from the sender node as the topology of the network changes. Another aspect of QHRMR which impacts stability in a good reputation is that it does not wait until all trees become disconnected before it finds a new set. Rather it tracks the variety of trees in the current set of trees that remain connected and when that number reaches a limit, new trees are computed and allocated before all distribution routes are lost.

The second major goal of QHRMR is to deliver the packets reliably without placing an undue burden on the network. Inefficiency stems from two sources: i) routing may result in many unnecessary redundant packets and ii) recomputing and distributing the multicast trees may occur too often. In order to accomplish the sub goal of efficient multicasting, QHRMR incorporates two ideas into its heuristics. First it makes use of an encoding scheme whereby k packets are encoded as n packets, where n is the number of multicast trees in the current set of multicast trees. When k = 1 and n is large, the number of extra packets injected into the network is high producing an n-fold increase in the number of packets travelling in the network due to multicasting. QHRMR attempts to find values of k and n such that the reliability due to redundancy is high, yet the amount of extra network traffic is not overly burdensome. Second, QHRMR makes the trees based on the reliability of the links in hopes that the trees will remain intact as long as possible. This second approach to efficiency must not make the paths from sender to receiver overly long.

QHRMR Framework

Given:

G(t) = (N (t); E (t);W (t)): A time varying network modelled as a directed graph with

N (t): a set of nodes that comprises the network at time t. It is assumed that all nodes in the network have the capabilities to receive and forward transmissions so a node is able to act as a router in a multicast tree as well as a receiver in a multicast group.

E(t): a set of directed edges representing the radio links at time t. If link (u; v) exists then we assume link (v; u) also exists.

Q: a dynamic set of join and leave requests. Each request is a triplet (node, action, t) to describe the action of a particular node joining or leaving the set of receivers of a group at a given time t.

P: a percentage of the links that can be reused from one tree in the formation of the next tree in a set of trees.

τ: a threshold that represents the lowest level of desired reliability of an entire set of trees.

μ: a minimum number of trees to create.

Computing:

-W (t): a set of weights we. Each link e ϵ E(t) is associated with a weight we (Ik+1) which corresponds to the probability that link e will continue to exist over the next time interval Ik+1 given link e existed during time interval Ik.

- A dynamic graph G(t) for group i called gi of m multicast trees, such that each tree has P percent of links common to its successor tree.

-The value of m is based on current topology of the network τ and μ as well.

- Set of trees are adjusted to reflect the group membership changes specified in Q.

When ever possible m≥μ.

- An encoding method that will encode a group of packets from the source as n packets (where n = m, the number of multicast trees) such that a receiver that receives a subset of a given size of the n packets will be able to decode the original source packets.

- A group management scheme that will maintain group membership information and up-date the multicast trees when a change in membership occurs.

QHRMR FRAMEWORK

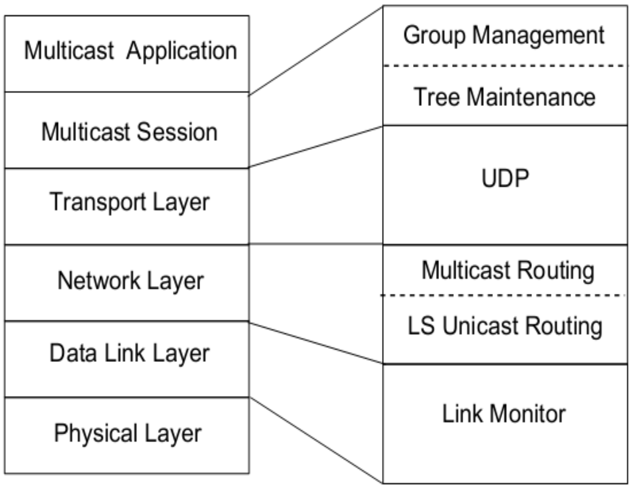

Fig 2. Layered Framework

QHRMR has four primary elements that work together to accomplish the goal under the set of constraints of the problem. The link element is accountable for tracking the signal strength of links, determining weights for the links, and exchanging the link information with neighbors using the underlying unicast method. The tree element is accountable for the making, circulating, and maintaining the multicast trees, the routing element is accountable for the redirecting of packets from other applications to the group members over the multicast plants, and the membership element or component is accountable for maintenance demands for nodes to join and leave the group and to maintain the account lists. The outing element uses the trees established in the trees element, the tree component uses the topology tables maintained by the unicast protocol as well as the list of member nodes kept by the membership component, and the unicast component includes the weights of the links determined by the link component during its exchange of topology tables.

IV. Simulation Results

The proposed protocol was implemented for hierarchical and flat network topologies for both bandwidth and delay QoS requirements. Two forwarding conditions, the hierarchical and QoS conditions were implemented in the simulation. Performance measures are presented for different values of link traffic loads, node-delay, and QoS requirements.

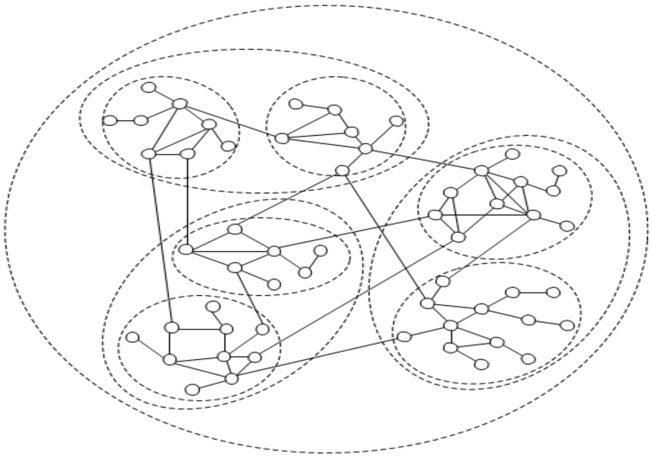

Fig 3. Topology used in the simulation process

Each point in the graphs presented below is the results of 150 simulation runs. In each simulation run, a random multicast tree with a specified number of nodes (5, 10, 15 or 28 i.e. half of the total number of routers) was generated. A host router was randomly selected from the off – tree nodes. The bandwidth and delay QoS requirements were randomly selected from the range [1,15] Mbps and [400, 600] ms, respectively. The performance metrics for each simulation run were calculated and the average values of performance metrics for all 150 runs were estimated.

Simulation results are presented separately for each performance metric. The performance results are primarily determined by the size of the flooding domain and the distance between the host routers and on-tree routers. The size of the multicast tree decides these parameters. For larger multicast trees, the size of the flooding domain, which contains the host router and an on-tree router, will be smaller and vice-versa. Similarly, as the size of the tree increases, the average distance between the host router and the nearest on-tree router decreases. The simulation results and discussion are presented below.

Success Ratio

The success rate for different node setbacks and tree sizes for simulations with delay QoS specifications are provided in Figure. As the same simulation factors are used for the flat as well as hierarchical routings, the success ratio has similar behavior in both situations. The path delay of Flooding messages increases with the node delay. Therefore, for a given tree size, the number of messages denied by the QoS sending condition improves and, hence, the achievements rate reduces with an increase in the node wait. Since the normal direction length of Flooding messages is higher for fewer on-tree routers, this effect is more Prominent for 5-node trees than in the other cases.

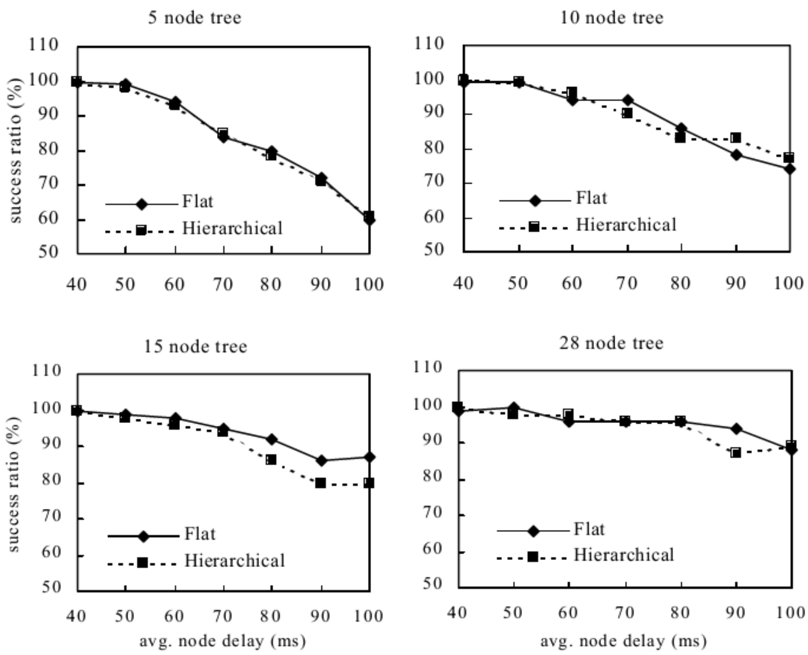

Fig 4. Success ratios of different node delays and sizes

The success ratio for different delay requirements is presented in Figure 4, the performance of hierarchical and flat routing protocols are similar. For a given tree size, the number of Flooding messages rejected by the QoS forwarding conditions decreases and, hence, success ratio increases with an increase in the delay requirement. The average path length of Flooding messages decrease with an increase in tree size. Therefore, for a given node delay, the path delay and the number of messages rejected by the QoS forwarding conditions decreases and, hence, the success ratio increases with an increase in tree size.

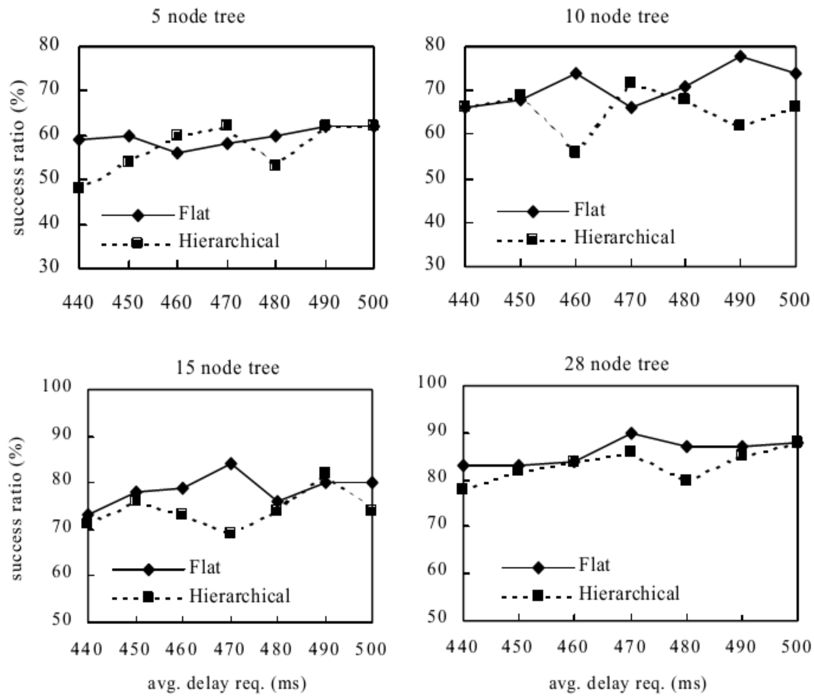

Fig 5. Success ratio of different delay requirements

The success ratio for the bandwidth QoS requirement is not affected by the tree size. In this case, the success ratio decreases with an increase in average traffic load or bandwidth requirement.

Message Overhead

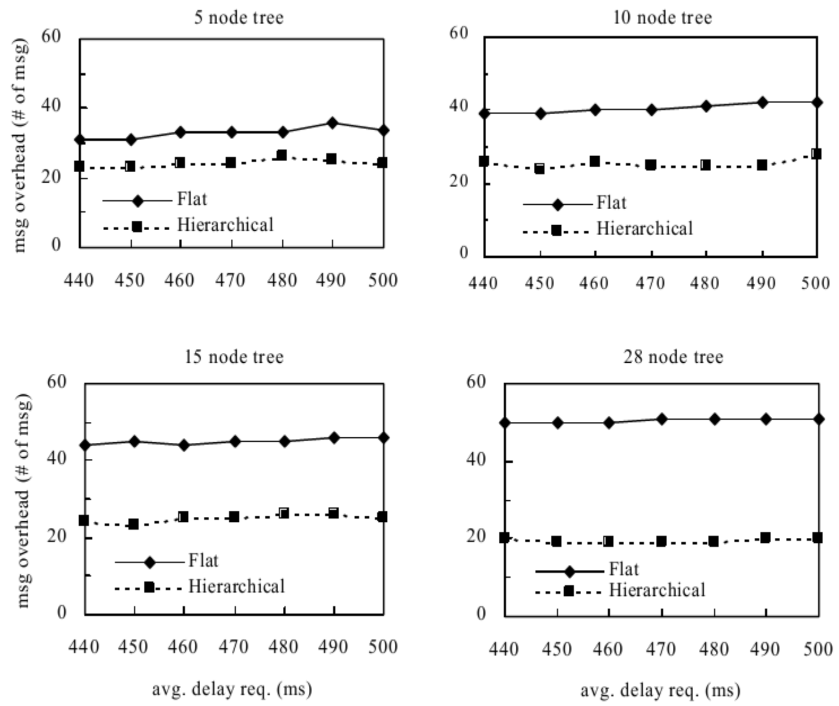

Fig 6. Message overhead for different delay QoS Requirements.

The message overheads (i.e. number of messages) for the delay and bandwidth QoS requirements are presented in Figure 5 and Figure 6. The estimated worst-case message overhead is 77 for flat routing and less than 77 for hierarchical routing.

V. Conclusion

A novel protocol, QHRMR is proposed for multicast routing in large IP networks. To achieve scalability, the network is divided into domains organized into an L-level hierarchy. One of the border routers of each domain is designated to be the domain controller. Every router in a domain is either aware of the domain controller or can identify it using a query/response Session Directory. The controllers have the addresses of their sub-domain controllers and on-tree routers in their domain, and they facilitate the construction of the multicast tree. The detailed protocol for constructing a shared multicast tree is presented in the Section. QoS is the main building block in this protocol to achieve effectiveness, reliable and robust environment.

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