QoS Routing for MPLS Networks Employing Mobile Agents

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Introduction

The paper "QoS Routing for MPLS Networks Employing Mobile Agents", by Sergio Gonzalez-Valenzuela and Victor Leung discusses providing an extension to an MPLS network. New protocols such as MPLS and DiffServ are promising technologies which are used to support quality of service requirements in a network. Although these are impressive technologies, there is deficient support for routing in a QoS network. The authors propose the use mobile agents, using the Wave paradigm to create QoS compliant routes.

Framework Components

The authors envision an Internet architecture that uses DiffServ to provide quality of service, MPLS to perform forwarding and mobile agents using Wave to create QoS compliant routes.

The main benefit of using MPLS is it allows packets in a data stream to be forwarded quickly. MPLS works by creating a header that is placed between the IP header and data link header. The MPLS header contains a label, so packets in the data stream can be forwarded based on the label instead of looking up an IP address of the destination in a routing table. Each label will have a Forward Equivalence Class (FEC). The FEC can be used to aggregate data streams. Each time a packet enters an MPLS Domain a label is attached to it based on the FEC.

DiffServ provides a means of categorizing and prioritizing flows. DiffServ is used to provide scheduling and classes of service. The reason that DiffServ is used in the framework is because it scales well as compared to other QoS protocols such as IntServ. DiffServ can not work isolation. DiffServ must work in conjunction with another protocol to perform forwarding, which is where MPLS comes into play. MPLS is used with DiffServ because it provides a forwarding aggregate scheme.

The main problem that the authors are addressing with the use of DiffServ over MPLS is the lack of routing support. MPLS needs to work in conjunction with a routing protocol for label distribution and determining routes. Another problem that the authors are addressing is the lack of support of multiple point-to-point (mp2p) connections in current routing protocols such as OSPF. Multiple point-to-point connections originate from multiple nodes that converge to a common node or follow a common path and then later diverge. A problem is the OSPF does not support mp2p routes. Another problem with using existing routing protocols with DiffServ over MPLS is that they may generate a lot of network traffic due to sending routing updates. The authors propose using mobile agents to create mp2p trees. The mobile agents in the architecture will use the Wave paradigm to implement the agents.

Wave Paradigm

Mobile agents are software entities that can execute on a node in a network and when they complete there execution they can be then transferred to another node. Mobile agents have typically been used for tasks at the application layer, such as data mining. In contrast, the authors suggest using mobile agents at the network layer. As it current stands, there is no support for mobile agents in the Internet infrastructure. The Wave platform is used in the framework to implement the mobile agents. The benefit of Wave is that mobile agent known as waves can start executing their algorithm on a given node and the transfer themselves in a parallel manner to other nodes. Waves within the system will spread themselves in a virus like manner and use the information they gather at each node to create a Knowledge Network (NK). Wave provides a

number of benefits, such as parallel processing, agent collaboration and fault tolerance, to name just a few.

Each wave contains a string that represents its execution. The waves are also able use local and global variables to allow the communication with other waves. One of the benefits of Wave is that agents are able interface with programs written in other language such as Java or C++. In order to use the Wave protocol each node must have a Wave interpreter. This is probably the main drawback to the architecture since each router will need to have a Wave interpreter.

Discovering QoS Routes

The framework uses two types of agents to discover routes. The first set agents are static agents, which gather information concerning the availability of network resources. A second set of agents are used to determine the QoS compliant routes and to build a shortest path tree.

Static agents monitor the links from them self to their neighbors. The static agent keeps information regarding the resources between their neighbor, such as bandwidth and jitter. Agents then record the value of a link to their neighbor. The main benefit of this is that if one of the values that an agent is monitoring changes, for instance if the amount of delay on link increases, the agent simply records the value and updates the cost of the link. There is no need to send routing updates to all nodes in the network based on the change. The new value will be found in the route discovery phase of the routing algorithm.

A second set of agents are used to discover the QoS compliant routes. During this phase a minimal span tree is created. The goal to minimize the amount of network resources used and to find overlapping routes to the destination. The search for QoS compliant routes consists of two parts. The first part of the algorithm is used finding all shortest paths to the root. The second part of the algorithm is used to find all overlapping routes. When the route discovery algorithm completes an egress node will contain all shortest path from each origin to itself.

These two phases are used to create the Knowledge Network. When the routing algorithm terminates the interface feature of Wave can be used to update each MPLS switch. The MPLS switches can then assign labels and use a label distribution protocol.

Results

The authors of paper implemented the routing algorithm to test the framework. Each node was monitored every second. The authors found that the ability of nodes to be processed in parallel increased performance. One consequence of parallel processing is the routing traffic can increase drastically, since a large number of agents may be sent throughout the network. The authors found that large bursts in traffic can result from the use of mobile agents. These burst in traffic can lead to increased queuing delays and congestion in a network.

Sample Case

The architecture that the authors are proposing could be use in any case where there is a need for a certain level of quality of service. Many multimedia applications could benefit from this framework such as video conferencing or streaming video. Applications such as these need certain guarantees in the level of service that the network provides. For instance, if a user is receiving a video stream over link that does not provide enough bandwidth the quality of the

video may degrade to the point that the user is unable to watch it. A framework such as the one suggested can be used to ensure the bandwidth requirements of this application is met.

The main benefit of using the framework is it supports the routing of QoS streams. A video conferencing application could benefit from the use of mp2p routing. In this case video streams would be coming from multiple locations and would converge at a common point and would need certain to meet certain QoS requirements. Using mp2p routing would allow for QoS guarantees to be met for a video conferencing application. The use of mobile agents in turn provides an efficient way of creating QoS routes.

What I Learned

Before reading this paper I was unfamiliar with the use of mobile agents. In the future it is likely that more algorithms will be implementing using mobile agents. One of the great benefits of mobile agents is that no centralized control is needed. Using mobile agents would make it easier to implement many distributed algorithms. In the future, I feel that mobile agents will become more common place in the Internet. Although there are some disadvantages of using them such as lack of infrastructure support and some security concerns, further research into the use of mobile agents help to solve some of these problems. The use of mobile agents would in turn greatly simplify many tasks.

Conclusion

The proposed framework would probably have little chance being used in practice at the present time. There are a few obstacles that would need to be overcome to use mobile agent routing. Some problems with the using Wave are that each router would need to have a Wave interpreter running on it. It seems unlikely that router vendors will rush to install an interpreter in their routers.

Another problem is the security concerns that would arise from using mobile agents. The Internet is filled with security threats as it is and providing router with the ability to execute mobile code would even further increase security risks. As the authors of the paper state burst in traffic can take place from the mobile agents. I could see one possible threat to a network using mobile agents, which would be denial of service attacks. If an attacker could manipulate the waves to continuously launch themselves, they could consume a large amount of the network bandwidth and overwhelm the routers. The authors don't talk about any of the security concerns of using mobile agents for routing. The security of mobile agents was out of the scope of their paper.

The paper is an initial step in using mobile agents for routing with further research it may become common to use mobile agents for routing protocols. The goal of the paper was to introduce some possible longer term routing solutions.