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Building MPLS VPNs with QoS Routing Capability *

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Abstract

Recently MPLS has been proposed for building up VPNs in IP backbones. In this paper, we discuss issues of finding routes with QoS requirements (i.e., QoS routing) in MPLS VPNs. We first present the background on MPLS VPNs as well as QoS routing. Then we discuss both the benefits and problems resulting from introducing QoS routing into MPLS VPNs. We present an architecture of MPLS VPNs with QoS routing capability and then we discuss the methods of running QoS routing in MPLS VPNs in the architecture.

Keywords: Quality of Service (QoS), Multi-Protocol Label Switching (MPLS), Virtual Private Network (VPN), Constraint based routing, Differentiated Service (DiffServ), Inter-Domain Routing.

1 Introduction

With the rapid development of the Internet, there is great interest in the deployment of Virtual Private Networks (VPNs) across IP networks. Many preliminary works have been done in this area[1-3]. In these documents, MPLS is believed to be a key technology for building up VPNs (i.e., MPLS VPNs).

Meanwhile, QoS is regarded as a key element of any VPN service. Among various mechanisms of traffic engineering (e.g., traffic scheduling, resource management), QoS routing is one of the enhancing mechanisms for deploying quality classes into the IP networks [4]. The general objective of QoS routing is to improve the efficient utilization of network resources and to provide flexibility in support for various services. Therefore, QoS routing is expected to be used in MPLS VPNs.

In this paper, we investigate the issues of QoS routing in MPLS VPNs. The remainder of this paper is organized as follows. In section 2, we describe the background

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on MPLS VPNs and QoS routing. In section 3, we discuss the benefits and problems resulting from introducing QoS routing into MPLS VPNs. We present and describe an architecture of MPLS VPNs with QoS routing capability in section 4. In section 5, we present and discuss some methods for operating QoS routing in MPLS VPNs. Some conclusions are given in the final section.

2 Background on MPLS VPNs and QoS Routing

In this section, we give the general information on MPLS VPNs and QoS routing. We give the definitions and current status of some key components.

3 Benefits and Problems of QoS Routing in MPLS VPNs

QoS routing determines routes under the knowledge of network resource availability, as well as the requirements of flows. As a result, the performance of applications is guaranteed or improved in comparison with that without QoS routing. Meanwhile, QoS routing optimizes the resource usage in the network by improving the total network throughput. QoS routing could be used for constructing an efficient and high performance MPLS VPN. These benefits might be achieved in a number of ways.

However, in addition to the benefits of QoS routing, it also incurs the cost of developing new routing protocols or extending the existing ones. Moreover, it potentially increases communication, processing and storage overheads. It raises a number of problems [7, 10].

4 An Architecture for QoS Routing in MPLS VPNs

In this section, we present an architecture of MPLS VPNs where QoS routing can be used.

The architecture is depicted in Figure 1. A MPLS VPN is built up by connecting MPLS sites through tunnels across an IP backbone. Each MPLS site has a Bandwidth Broker (BB), which exchanges route and signaling information and manages and maintains the VPNs.

A Central Bandwidth Broker (CBB) in the IP backbone may be beneficial, although not compulsory. If the IP backbone can provide QoS support, CBB performs similar functions as BBs in each MPLS site. BBs of each MPLS site can negotiate with the CBB in order to setup QoS guaranteed tunnels or sessions. CBB performs centralized VPN management, for example, CBB determines the acceptance of a MPLS site into the MPLS VPN. CBB can be implemented in any router in the IP backbone, or virtually in BB of a MPLS site.

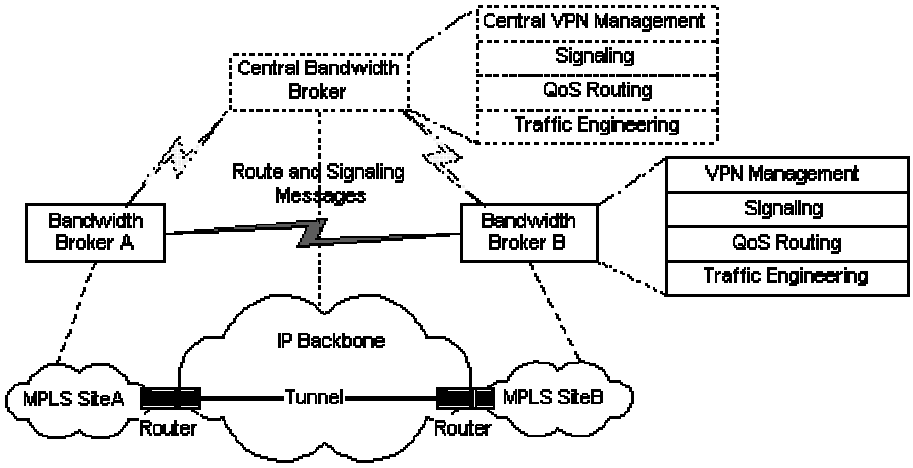

Figure 1 An Architecture of MPLS VPNs with QoS Routing

Each bandwidth broker consists of a number of components, i.e., VPN Management, Signaling Protocol, QoS Routing and Traffic Engineering. VPN management performs functions of management and administrative policies, e.g., addressing, access authentication, tunneling management, etc. The signaling protocol is needed to setup tunnels between MPLS sites or sessions between applications of different MPLS sites. QoS routing is used for finding feasible routes for tunnels or sessions and for maintaining topology of MPLS VPNs. Traffic Engineering includes a number of mechanisms (e.g., classifying, marking, shaping and queuing) for forwarding packets.

In practice, there are several candidates for implementing these components. For VPN management, SNMP might be used; For the signaling protocol, CR-LDP or Extended RSVP can be used; For QoS routing, QOSPF or inter-domain QoS routing might be used; For traffic engineering, Integrated Service or Differentiated Service might be used.

5 Methods for running QoS Routing in MPLS VPNs

In this section, we present and discuss some methods for running QoS routing in MPLS VPNs in the following subtopics:

Subtopic 1: Distributing label and VPN attributes

In MPLS VPNs, labels and VPNs attributes (e.g., label ID, VPN ID, VPN membership, etc) can be distributed and maintained by using QoS routing protocols. Extensions to BGP for carrying label and VPN attributes in MPLS VPN are proposed in [2, 11]. One can construct different kinds of VPNs by setting up the Target and Origin VPN attributes.

Subtopic 2: Distributing VPN route and topology information

QoS routing can be used for maintaining the interior VPN topology. Also resource state information may be bound to the interior topology information resulting in QoS routing within the VPN. The resource states can be clarified with a number of parameters, e.g., bandwidth, delay, etc.

Subtopic 3: Finding feasible routes

There are a number of algorithms for finding QoS routes [4]. Moreover, some mechanisms for operating inter-domain QoS routing proposed in [9] can be used.

Subtopic 4: Achieving scalability

To achieve scalability in establishing a large VPN, QoS routing may make use of methods like aggregation of routes or resource information in routers.

6 Conclusions

MPLS is proposed as a way of building VPNs due to its distinguished merits, e.g., fast forwarding, tunneling, etc. QoS routing is naturally used in MPLS VPNs for providing feasible routes with considerations on QoS constraints. QoS routing is beneficial for developing QoS guaranteed MPLS VPNs across IP networks. However, there are still a great number of open research problems concerning QoS routing in MPLS VPNs, e.g., methods of advertising and updating resource information, algorithms of computing routes, etc.

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