Constraint–Based Routing with Maximize Residual Bandwidth and Link Capacity – Minimize Total Flows Routing Algorithm for MPLS Networks

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Abstract—**This research proposes an on-line routing algorithm for bandwidth-based guaranteed tunnels in the Multi-Protocol Label Switching (MPLS) networks, called the Maximize Residual bandwidth and link Capacity – Minimize total Flows (MaxRC-MinF) routing algorithm. The proposed algorithm can be categorized into link-constrained and path-constrained routing problems. It is based on three objectives: minimizing the interference level among ingress-egress pairs, balancing the traffic load over under-utilized paths, and trying to reserve bandwidth for future request. Finally, we have compared the performance of the MaxRC-MinF algorithm with other previously proposed algorithms. We found that the MaxRC-MinF algorithm achieves lower rejection probability and higher total throughput, maximum and average link utilization. However, because of its computational complexity, the proposed algorithm has a few higher CPU calculation time.**

Keywords—**Routing algorithm, Constraint-Based Routing, QoS Routing, Bandwidth-based Guaranteed Tunnels, Traffic Management and MPLS network.**

I. INTRODUCTION

Firstly, the Multi-Protocol Label Switching (MPLS) network [1]-[3], proposed by the Internet Engineering Task Force (IETF), has been developed in order to overcome complexity and scalability problems of mapping the IP network over the Asynchronous Transfer Mode (ATM) backbone. The MPLS technology uses IP router software and label swapping paradigm as control and forwarding plane, respectively (see Fig. 1). The MPLS network uses Label Distribution Protocol (LDP) for the control plane which is able to establish explicit route, called Label Switched Path (LSP), from an ingress Label Switching Router (LSR) node to an egress LSR node (called source-destination node pair) and to assign label into different Forward Equivalent Classes (FECs). With label swapping, packets with the same label coming from the same ingress LSR are swapped and transmitted along the same LSP. The label switching technology allows administrators simply manages their own networks for new technologies such as Traffic Engineering (TE), Constraint-Based Routing (CBR), Quality-of-Service (QoS) routing, and Virtual Private Networks (VPNs).

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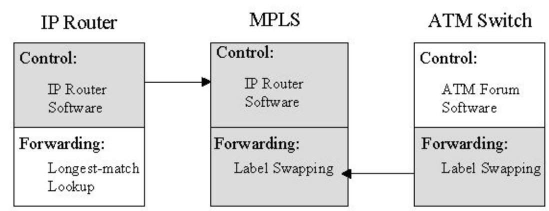

Figure 1. MPLS Architecture

The bandwidth-based guaranteed tunnels (or LSPs) routing problem over the MPLS network is the main topic of this research. This may call on-line routing problems since the LSP establishing requests arrive one-by-one and future demands are unknown. The only dynamic information available for the routing algorithm is residual capacities of links provided by Link-state protocols such as OSPF. Static information is ingress-egress node pairs, link capacity and network topology. Furthermore, the routing algorithm is aimed to achieve following performances:

- Low level of rejection probability
- High level of network total throughput
- High level of network utilization
- Low level algorithm complexity

To obtain above performances, we introduce a MPLS routing algorithm called Maximize Residual bandwidth and link Capacity – Minimize total Flows (MaxRC-MinF) routing algorithm. It tries to select an LSP with maximum residual bandwidth and link capacity in order to increase load balancing and network utilization over under-utilized path. Also, the selected LSP must have minimum traffic or flow in order to reduce interference level among source-destination node pairs and reserve bandwidth for future demand.

The remainder of the paper is organized as follows: Section II presents related works for bandwidth based guaranteed LSP routing. Section III describes the proposed