Policy-based Admission Control in GMPLS Optical Networks

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Abstract

In this paper we present a policy-based admission control architecture responsible for managing the installation and aggregation of packet-based LSPs within lightpaths (optical LSPs). We have defined some policies in order to reduce the optical network overhead to remove and reroute lower priority LSPs. The architecture is composed of an Admission Control and a Policy Manager and the performed simulations indicated that the number of LSP removals is smaller when policies are applied.

1 Introduction

Future transmission networks are supposed to have ten to thousands of Gb of available bandwidth to attend all kinds of applications requiring faster transmission rates. These networks will likely consist of elements such as routers, switches, Dense Wavelength Division Multiplexing (DWDM) systems, Add-Drop Multiplexors (ADMs), photonic cross-connects (PXCs) and optical cross-connects (OXCs) [5]. Due to the advent of Generalized Multiprotocol Label Switching (GMPLS), there is a common sense to use it to dynamically provide resources and perform the routing and signaling functions of the control plane.

This paper presents a policy-based admission control architecture responsible for managing the installation and aggregation of packet-based Label Switched Paths (LSPs) within optical LSPs assuming that there are several lightpaths between two end nodes. We are also considering single hop traffic grooming since the aggregation is only done in the ingress node. In this work, the packet-based LSPs are divided into two classes: Low Priority (LP) LSPs and High Priority (HP) LSPs. HP LSPs have higher priority than LP LSPs and, therefore, if an HP LSP needs to be installed in an optical LSP, some LP LSPs from that optical LSP may be removed to attend the higher requirement in the case of not having enough bandwidth in that lightpath. The policies we have defined are mainly intended to reduce the number of LP LSP removals in the optical domain. Some representative situations in order to highlight the actual advantages of using policy-based admission control will be depicted. All the simulations have been made using the GLASS Simulator from NIST [3].

Other groups have also been working on optical networks. In [4] a traffic engineering system is presented considering the peer model (multilayer approach) and taking into account both methods of routing, off-line and on-line. In [1] the traffic grooming problem is well treated and a formulation on how to use an integer linear programming is presented. In [2] an example of an Service Level Agreement (SLA) applied to the optical domain is presented together with its parameters as well as their values for four classes of services.

2 The Proposed Framework for Policy-based Admission Control

Our framework is responsible for receiving the request from the client, verifying the SLA between the client and the provider and applying the policies we have defined in order to find an optical LSP to be used. All the information about the client (client ID, SLA, etc.) and the LSP (traffic parameters) being installed is carried by the PATH message of the Resource Reservation Protocol (RSVP). In this work we have only used RSVP as the signaling protocol and some few modifications were made on it to deviate the PATH message to reach our framework and to allow the interaction between the framework and the GLASS simulator.

The policies we have created try to separate HP LSPs from LP LSPs. The main point is to dynamically find a tunnel to allocate each packet-based LSP in order to minimize the number of LP LSP removals in case of increasing the bandwidth of HP LSPs. This decision is taken each time a new packet-based LSP (L_i) is being installed. The PATH message carries the information about the LSP and each LSP has the following data:

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- Requisition bandwidth: This is the quantity of bandwidth required by the LSP at the moment of its installation. After installing it, this value can be increased up to the maximum bandwidth and decreased down to the minimum bandwidth;
- Maximum bandwidth: This is the maximum bandwidth an LSP can ask for and must respect what was agreed in the SLA;
- Minimum bandwidth also based on what was agreed in the SLA.

The architecture we propose for verifying the SLA and applying the policies is shown in Fig.1. The Admission Control and the Policy Manager belong to the Bandwidth Broker responsible for managing the domain as a whole and coordinating the tasks of each inner module.

- **Admission Control-AC**: It receives the PATH message (step 1 in Fig. 1) and gets the information carried by it in order to verify the SLA between the client and the transport network provider. After verifying the SLA and in the case of agreement, the AC calls the PM (Policy Manager, see below) to apply the policies (step 2).
- **Policy Manager-PM**: Responsible for applying the defined policies and finding a tunnel to allocate a given LSP. If a tunnel is found and the LSP is an HP LSP, the PM verifies whether one or more LP LSPs need to be removed to accommodate such LSP. Considering that LP LSP removals are necessary, the AC is in charge of interacting with RSVP to send a tear down message for each LP LSP that needs to be removed (step 3). After removing the LP LSPs, the new HP LSP will be installed and thus the PATH message will be returned to the ingress node to follow its path (step 4).

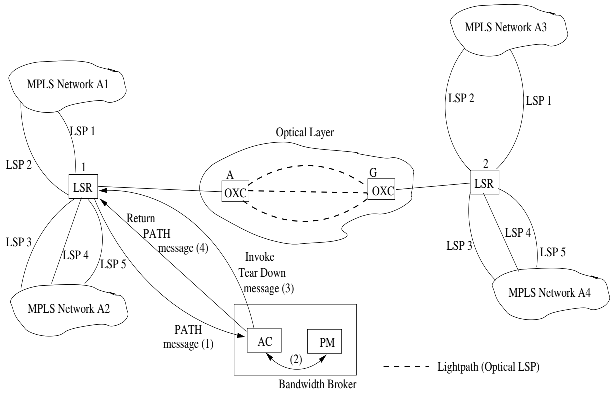

Figura 1. The proposed architecture.

3 Implementation and Results

The policies we have created try to separate HP LSPs from LP LSPs. The main point is to dynamically find a tunnel to allocate each packet-based LSP in order to minimize the number of LP LSP removals in case of increasing the bandwidth of HP LSPs. This decision is taken each time a new packet-based LSP is being installed.

In order to test our policies we have created many different scenarios. We assumed that the bandwidth of each tunnel is 1 Gb/s, the number of LSPs to be installed is 200 and about 50% of LSPs will ask for increasing their bandwidth. The LSPs are randomically created and their minimum bandwidth is 50 Mb/s and their maximum bandwidth is 400 Mb/s. The number of available tunnels, and consequently the quantity of available bandwidth between two end nodes varies from 10 to 40. We randomically generated 200 LSPs to be installed and this was done 300 times. The average is obtained after repeating those 300 loops.

In the first simulations we created more HP LSPs (≈66%) than LP LSPs (≈33%). This case represents a situation in which there are more high priority LSPs than low priority LSPs. The requisition bandwidth average for HP LSPs is 16 Gb. The maximum bandwidth average for HP LSPs is 35 Gb and the requisition bandwidth average for LP LSPs is 8 Gb. When the HP LSPs ask for increasing their bandwidth, the number of removals is quite smaller when applying the defined policies as we can see in Fig. 2 (increasing the bandwidth in 50%).

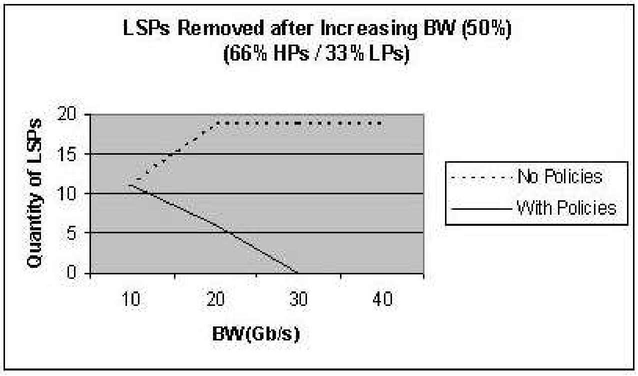

Figura 2. LP LSPs removed after increasing the bandwidth in 50%.

While the number of removals without using policies increases up to 19 and keeps that behavior until the end, the number of removals when applying the policies decreases and with 30 Gb there are no more removals. Having 20 Gb of bandwidth available in the optical layer, the number of removals with policies is 6 and without the policies it is 19, a difference of 68%. The point is that in the case of not using policies, the more LSPs are accepted since the network bandwidth increases, the more the number of removals. However, this is not the case when applying the policies because we are separating HPs from LPs. Fig. 3 shows the same situation except that we are now increasing the bandwidth to the maximum allowed. Because we are requiring more bandwidth, the number of removals increases in both situations. With 20 Gb there are 35 removals using the policies and 42 without them, a difference of 16%. With 30 Gb there are 10 removals with policies and 52 without using them, a difference of 80%. Finally, with 40 Gb the number of removals is only 1 when applying the policies and 52 without using them.

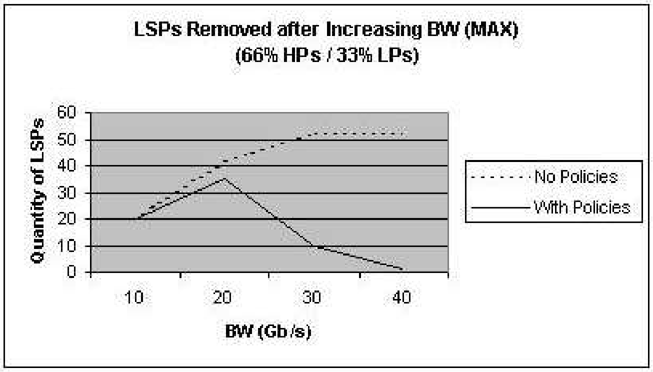

Figura 3. LP LSPs removed after increasing the bandwidth to the maximum.

The next figures show the simulations with ≈50% of HP LSPs and ≈50% of LP LSPs. Fig. 4 and Fig. 5 show respectively the results after increasing the bandwidth in 50% and to the maximum. We can observe that in Fig. 4 the number of LP LSP removals is greater when compared to Fig. 2. With 30 Gb the quantity of removals is 25 without using policies and 3 with policies, a difference of 88%. The result is better with 40 Gb: no removals with policies and 25 without them.

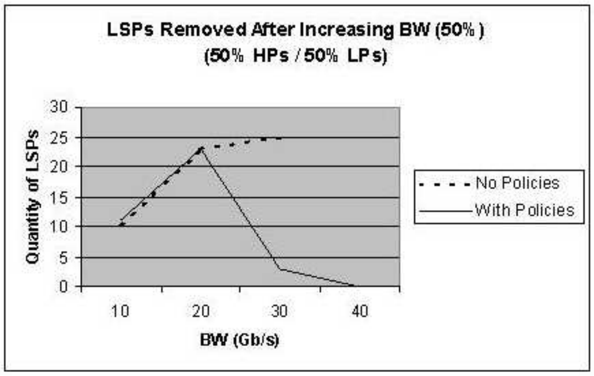

Figura 4. LP LSPs removed after increasing the bandwidth in 50%.

In Fig. 5 we can see that because there is more demand for bandwidth (increasing to the maximum) more removals are necessary when compared to Fig. 4. This is the same case when we compare Fig. 5 to Fig. 3. Since there are more LP LSPs in the network, more LP LSP removals will take place.

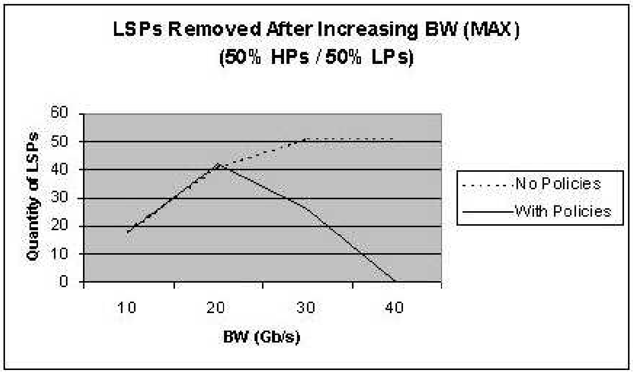

Figura 5. LP LSPs removed after increasing the bandwidth to the maximum.

4 Conclusions and Future Works

In this paper we present a policy-based framework to manage the integration between the IP/MPLS layer and the optical network layer taking into account two different classes of services: High Priority (HP) LSPs and Low Priority (LP) LSPs. The architecture we are developing is intended to have more modules. One of them is a Fault Manager responsible for controlling the faults in the optical layer and applying corrective solutions. At the same time, more policies are currently being defined and tested taking into account a lower bound for the number of removals. Finally, although we have tested several scenarios there are others to be created and analyzed considering new policies and situations.

Acknowledgments

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