

Wavelength Selective Switches time requirements for shared path protection in ASON/GMPLS rings

Luis Velasco, Salvatore Spadaro, Jaume Comellas, Gabriel Junyent
 Optical Communications Group, Signal Theory and Communications Dept.
 Universitat Politècnica de Catalunya (UPC), C/ Jordi Girona, 31 08002 Barcelona, Spain
 {luis.velasco, spadaro, comellas, junyent}@tsc.upc.edu

Abstract. We analyze the protection time provided by the shared path protection scheme in GMPLS-based optical rings, as a function of the switching time of the Wavelength Selective Switches (WSS).

Introduction

The efficiency of protection schemes can be improved by supporting extra-traffic, transported by protecting resources under normal conditions. In case of failure the extra-traffic will be preempted.

The GMPLS recovery framework defines Label Switched Path (LSP) protection, providing RSVP-TE extensions [1-2]. One of the specified protection schemes is the pre-planned LSP rerouting. Two disjoint LSPs are established between the end nodes: the working and the protection LSPs. While the working LSP is established in the transport plane, the resources of the protection LSPs are only pre-reserved at the control plane level and it is necessary an additional signaling to instantiate them in the transport plane. This way extra-traffic can be accommodated over the protecting reserved resources.

In this paper we analyze the protection time that can be provided when the shared path protection (SPP) scheme is applied to optical GMPLS-based rings with extra-traffic. SPP has been implemented using the pre-planned LSP rerouting extensions to RSVP-TE.

Network scenario

In order to support SPP with extra-traffic, we have designed the Optical Add-Drop Multiplexer (OADM) shown in Fig. 1. The basic components are splitters/couplers (S) and WSSs. The incoming optical signal in the East and West ports can either pass-through or be dropped to any port. The local traffic can be added either to the East or to the West outgoing signals. Additional hardware to monitor the incoming optical power is required.

In case of link failure the adjacent OADMs detect the loss of light and notify the failure to the Optical Connection Controllers (OCCs) in the GMPLS control plane. Then, for each LSP to be protected, the OCC notifies the failure to the OCC of the closest end node (origin or destination) from the failure by sending a *Notify* message. The address of the node to be notified was received in the NOTIFY_REQ object in the RSVP-TE Path/Resv message.

When the source OCC receives the *Notify* message, the signaling of the protection LSP starts. It consists on sending an RSVP-TE Path message to eliminate the extra-traffic from the resources which the

protection LSP needs, and sending an RSVP-TE Resv message to effectively activate the protection LSP.

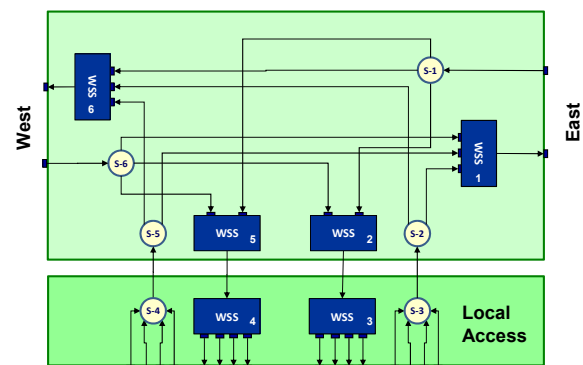


Fig. 1. OADM design to support SPP with extra-traffic.

One command to create/eliminate a connection in the OADM (see Fig. 1) implies a set of commands to the WSSs. When two connections are simultaneously requested, and they involve the reconfiguration of the same WSS, they are serially executed.

SPP protection time model

To analyze the protection time that can be provided by the SPP scheme let us denote t_{CCI} as the communication time between the OADM and the OCC, t_{OCC} as the time to process a single RSVP-TE message, t_{link} as the link propagation delay, and t_{switch} as the time required from the reception of a request in the OADM to the instant when the switching is physically performed.

Let us define the protection time (t_{SPP}) in an n nodes ring with pre-planned rerouting, as the interval from the failure detection to the completion of the switching operation (for each single connection and every LSP to be protected). We determine the expression of t_{SPP} considering two cases for the LSPs to be protected: a) The origin and destination nodes are adjacent to the failure (hereafter adjacent LSP); b) The origin LSP node is adjacent to the failure while the destination node is the farthest one (maximum number of hops). Note that OCCs adjacent to the failure are notified by its OADMs after the time t_{CCI} .

In the first case, the RSVP-TE signaling has to travel from one OCC to the adjacent using the opposite side of the ring. Each OCC has to process the Path and

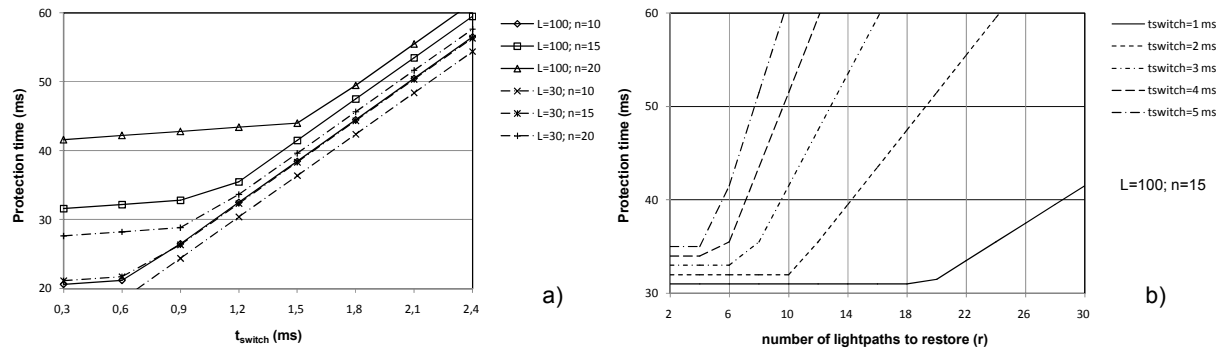


Fig. 2. Protection times a) as a function of the switching time, and b) as a function of the number of LSPs to protect.

Resv messages and send configuration messages to the OADM to perform the switch. Let us denote r_a as the set of adjacent LSPs to be protected. We assume that half of these LSPs have their origin in one of the adjacent nodes, while the rest have their origin node in the other failure adjacent node. Hence, $round(r_a/2)$ connections will be serially processed on each of the adjacent OADMs.

In the second case, the RSVP-TE signaling messages travel from the origin OCC to the destination OCC through the opposite side of the ring. Let us denote r as the total traffic to be protected.

All LSPs, independently from its destination nodes, have their protection route through the nodes which are at a distance of $round(n/2)-1$ hops from the failure adjacent nodes. Therefore, those OADMs have to perform r connections in a serial basis. Depending on the t_{switch} and r values, the effect of the serial processing of connections can be slower than the propagation delay around the ring.

We can express the time to protect as:

$$t_{SPP} = 2t_{CCI} + t_{OCC} + \max \left\{ \left(\left\lceil \frac{n}{2} \right\rceil + 1 \right) (t_{link} + t_{OCC}) + r t_{switch} \right. \\ \left. (2n-3)t_{link} + (2n-2)t_{OCC} + \left\lceil \frac{r_a}{2} \right\rceil t_{switch} \right\} \quad (1)$$

The first two terms are the time needed for the detection of the failure and to send the first switching command from the control to the transport plane ($2t_{CCI}$), and the time to process in the OCC adjacent to the failure. The max function captures the maximum of two terms the time to protect the adjacent LSPs around the ring, and the time to protect all affected traffic due to the coincidence of multiple connections in some nodes.

Experimental Evaluation

The performance of SPP using the pre-planned LSP rerouting RSVP-TE extensions has been experimentally evaluated over the ASON/GMPLS CARISMA network test-bed [3]. In our implementation, we have obtained the following times: $t_{CCI} = 1ms$, $t_{OCC} = 0.5ms$.

Fig. 2a shows the time needed to protect 20 LSPs, as a function of t_{switch} , for different types of rings (from long haul to metropolitan areas), and for different

number of nodes. As shown, when t_{switch} is low, propagation and control plane processing times are dominant on the protection time. However, when t_{switch} increases, the connections serial processing is the dominant effect. Thus, to protect 20 LSPs (we assume links with 40 wavelengths), we need t_{switch} to be lower than 1.8ms, even for metropolitan rings.

Fig. 2b shows the protection time as a function of the number of LSPs to protect, assuming a 15 nodes long-haul ring, and for several t_{switch} values. As shown, the higher is t_{switch} , the smaller is the number of LSPs that can be protected within 50ms after the failure detection. For example, with $t_{switch}=4ms$ it is possible to protect only 9 LSPs with in 50ms.

Note that t_{switch} represents the physical WSS switching time and also the time to process a request in the OADM. Currently available WSSs provide physical switching time close to 2ms, and the latest technology will provide commercial components with sub-millisecond physical WSS switching time [4].

However, telecom equipments are usually based on cards, where one card represents the interface with the control plane, and another card includes the WSS component. Cards are interconnected through a bus. In the card holding the WSS component, one specific command has to be generated. In our implementation we have measured the time from the reception of the command from the control plane to the WSS command is generated as about 1.5ms.

Conclusions

We have experimentally found 1.8ms as the maximum switching time to provide SPP protecting the maximum of LSPs (20) within 50ms in GMPLS-controlled optical rings, when extra-traffic is supported. We have found also the number of LSPs that SPP can protect with in 50ms, in the case of higher t_{switch} values.

References

1. J. P. Lang, et al., RFC 4872, (2007).
2. L. Berger, et al., RFC 4873, (2007).
3. S. Spadaro, et al., ICTON 3 (2007), 18-21.
4. Y. Goebuchi, et al. Optics Express 2 (2008), 535-548.