



Experimental implementation of dynamic in-service performance monitoring for lambda services

C. Pinart, R. Martínez, G. Junyent

Publication:	31st European Conference on Optical Communications (ECOC 2005)
Vol.:	-
No.:	-
pp.:	-
Date:	Glasgow (UK), September 25-29, 2005

This publication has been included here just to facilitate downloads to those people asking for personal use copies. This material may be published at copyrighted journals or conference proceedings, so personal use of the download is required. In particular, publications from IEEE have to be downloaded according to the following IEEE note:

©2007 IEEE. Personal use of this material is permitted. However, permission to reprint/republish this material for advertising or promotional purposes or for creating new collective works for resale or redistribution to servers or lists, or to reuse any copyrighted component of this work in other works must be obtained from the IEEE.

Experimental implementation of dynamic in-service performance monitoring for lambda services

Carolina Pinart (1), Ricardo Martínez (1), Gabriel Junyent (1, 2)

1 : Centre Tecnològic de Telecomunicacions de Catalunya (CTTC), {carolina.pinart, ricardo.martinez}@cttc.es

2 : Universitat Politècnica de Catalunya (UPC), junyent@tsc.upc.es

Abstract A novel approach to in-service OPM combining optical and IP information is presented. Experimentation results with an ASON/GMPLS testbed¹ confirm suitability, in terms of delays, for SLA guarantee and physical aware routing for lambda services.

I. Introduction

The accelerating growth of data traffic is motivating the research for more efficient, flexible, intelligent optical network architectures. In this direction, IP over Wavelength Division Multiplexing (WDM) is becoming accepted as one of the most promising candidates. Generalized Multi-Protocol Label Switching (GMPLS) is also thought to be an integral part of next-generation networks, especially as control plane of the Automatic Switched Optical Network (ASON), because it renders optical networks intelligent. Introducing transparency in optical networks results in a lack of electrical regeneration of signals, that is, in the accumulation of the impairments due to fiber transmission (attenuation, dispersion, ASE noise, non-linearities), as well as attenuation and cross-talk introduced by optical elements (cross-connects, add-drop multiplexers, d/mux, etc.). On the other hand, future lambda service provisioning is expected to be very rapid and quality enabled. This leads to the need for accurate in-service performance monitoring to guarantee Service Level Agreements (SLA), trigger resilience mechanisms and provide information for physical-aware routing.

II. Approach: combining optical and IP

In [1], Kilper et al. provide a list Optical Performance Monitoring (OPM) parameters, some of which are included in ITU-T's draft new recommendation G.697 [2]. Among the many definitions of OPM, we adopt "physical layer monitoring of the signal quality", and add IP monitoring as a means of obtaining QoS parameters about data in low delays (packet-level).

Table 1: Implemented performance parameters

OCM/WDM layer	Signal quality	Packet-level
Aggregate power	In-band OSNR	Loss*
Channel power	BER	Delay*
Channel wavelength		
Channel OSNR		

Table 1 lists the performance parameters used in this work, and marks with * those not included in the OPM literature [2][3]. Dispersion is not considered because the experimental testbed is a network with short (35 km), low-dispersion links and 1 Gbit/s-channels. The advantage of combining signal (BER, in-band OSNR) and OCM/WDM layer (wavelength, power and OSNR, provided by commercial monitors) parameters [1], as well as packet-level (IP), is to increase the

number of elements for judging the verification of SLAs, as well as for achieving fast monitoring (msec) of the state of health of lambda services while in service. For example, obtaining bit rates or BER may take minutes, which is not acceptable in a dynamic environment such as ASON/GMPLS. Instead, packet measurements can be obtained rapidly with proven tools (ping, ICMP). On the other hand, since the performance of the physical layer (OPM) is not necessarily correlated with digital performance [1], combining optical and IP parameters seems a good way for assessing the QoS of digital applications carried as lambda services.

II.1 Use of performance information for routing

Routing of lightpaths in all-optical networks usually assumes that all the routes have adequate signal quality. Under this assumption, current GMPLS extensions to routing protocols (e.g. OSPF-TE) are mainly focused on opaque networks, whereby optical signals are regenerated at every hop. Then, each data link is optically isolated by electro-optic (O/E/O) conversions. Introducing transparency overcomes the constraints of O/E/O conversions (basically bandwidth transmission), but eliminates electrical regeneration, which results in accumulation of optical impairments, and hence, in the degradation of signal quality of the lightpaths along the routes [3]. Hence, in transparent networks or domains, routing mechanisms (protocols and algorithms) should be enhanced not only to consider traffic engineering aspects but also physical performance parameters to fulfil stringent SLAs.

In the control plane, optical and IP layer parameters are locally handled by the Link Resource Manager (LRM). The LRM is responsible for two sequential tasks: 1) local collection and storage of performance parameters, and 2) information and update of routing for disseminating the collected parameters within the transparent domain. To this end, the routing protocol may be extended with monitored parameters following GMPLS principles.

As a result, once the routing is synchronized within the transparent domain, every node may be aware of both local and remote performance parameters, thus an optimal constraint-based routing algorithm can be used to compute end-to-end lightpaths with adequate/required signal quality. Obviously, this approach increases routing information to be flooded, which may result in scalability problems. This can be alleviated by adopting threshold policies for routing dissemination, because thresholds allow routing to

¹ This work is part of the NOBEL (IST-2002-506760) and NetCat projects. The authors acknowledge the development support of R. Jiménez.

disseminate information only when changes are significant, hence reducing the control overhead. Establishing a trade-off between scalability and up-to-date information is necessary to consider the degree of significance of performance parameters.

II.2 Use of performance information for SLAs

Performance monitoring in optical networks has traditionally referred to the SONET/SDH layer, that is, bit/block error rates and other SDH QoS measures. The primary application of performance monitoring is to certify SLAs between network operators and their clients. We consider three main issues for this; threshold management, number of performance parameters, and verification period. In a dynamic environment, it seems wise to use pre-defined thresholds obtained before the establishment of a service in order to minimize the exchange of information in the network (management overhead). However, dynamic threshold management is an interesting option when the lambda services to be carried on the channels are not known in advance. As with routing, the question of what information should be passed around the network in order to keep the network management scalable is still to be answered. As for the number of parameters, SLAs are usually "electrical" in the sense that the preferred parameter is BER, used in electronic networks and at network end-terminal for QoS. However, BER computation (or Q-factor estimation) may not be as fast as desired in a dynamic environment (msec-sec order); other parameters could be used for guaranteeing SLAs with a lower operational cost, and lower delays, such as packet loss rate (important for the client), or OSNR (important for transmission, thus, for the operator). Finally, average values and tide levels are periodically recorded by the monitoring points in the network, and read out by management software through an optical supervisory channel, which in this work is the out-of-band IP control channel of the Data Communication Network. Since the monitoring points are distributed, and measurements are obtained asynchronously, each QoS needs a verification period in order to guarantee that a given quality is being met.

III. Experimental results

Experiments were performed in the ADRENALINE testbed, a 9-node ASON/GMPLS [4]. OPM is implemented through non-disruptive monitors (Digital Lightwave OWM and Proximion Wistom). BER is computed at the edges by Agilent's Router Tester. Packet measurements are done by agents embedded in GMPLS nodes. Gatherers filter and aggregate performance information, which is processed by an event manager (EM). Fig. 1 illustrates this.

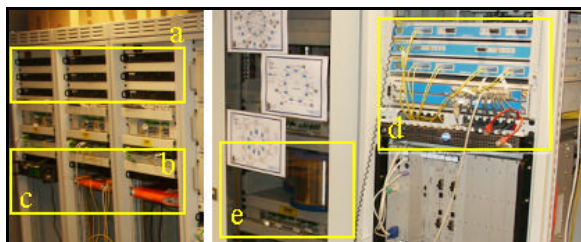


Fig. 1. ADRENALINE: a) GMPLS OCCs, b) monitors, c) gatherers and EM, d) Router Tester, e) fiber links.

Results in this paper focus on the delays of the performance monitoring system in terms of verifying SLAs and to update routing parameters on a link-state basis. We consider the delays in Fig. 2.

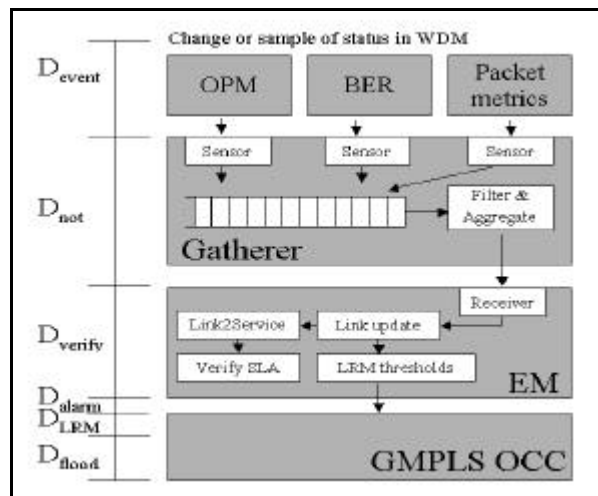
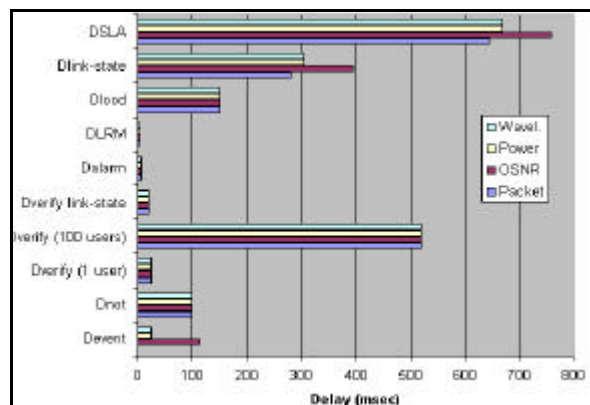


Fig. 2. Delays for SLA and link state verification.

Note that D_{verify} can be either for SLA (depending on number of users) or link/channel values ($D_{verify\ link\ state}$). In the latter, an alarm may be raised to the LRM of the/an affected node (D_{alarm}). To update information globally, a suitable routing algorithm is computed (D_{LRM}) and flooding is performed (D_{flood}). Sample values of involved delays are given in Fig. 3.



IV. Conclusions

This paper presents a novel approach for in-service performance monitoring combining optical and IP parameters. In an ASON/GMPLS setting, the system achieves delays below 400 msec for link-state information update and 800 msec for SLA verification (100 users) using WDM and packet metrics. By using BER, D_{even} is augmented by at least 4 sec.

References

- 1 D. C. Kilper *et al.*, "Optical Performance Monitoring", *Journal of Lightwave Technology*, Vol. 22 (1), Jan. 2004.
- 2 ITU-T Draft new Recommendation G.697, *Optical Monitoring for DWDM systems*, June 2004.
- 3 J. Strand, Angela L. Chiu, "Issues for routing in the optical layer", *IEEE Communications Magazine*, Vol. 39, Issue 2, February 2001.
- 4 R. Muñoz, *et al.*, "ADRENALINE testbed: user management of lighpahts over intelligent optical WDM networks through GMPLS & XML", *TRIDENTCOM 2005*.

