Network Applications and Traffic Modelling for ASONs

S. Spadaro (1), J. Solé-Pareta (1), A. Lason (2), J. Rzasa (2), R. Stankiewicz (2), A. Manzalini (3), A. D'Alessandro (3), D. Colle (4), S. De Maesschalck (4), I. Lievens (4), I. Shake (5), K. Shimano (5)

1: Universitat Politècnica de Catalunya (UPC), C/ Jordi Girona, 1-3 08034 Barcelona, Spain, spadaro@tsc.upc.es, pareta@ac.upc.es; 2: University of Mining and Metallurgy (AGH), Poland, {lason, rzasa, stankiewicz}@kt.agh.edu.pl; 3: Telecom Italia Lab, Italy, {antonio.manzalini, alessandro.dalessandro}@tilab.com; 4: Ghent University – IMEC, Belgium, {didier.colle, sophie.demaesschalck, ilse.lievens}@intec.rug.ac.be; 5: Nippon Telegraph and Telephone Corporation, Japan, {shake, shimano)@exa.onlab.ntt.co.jp

Abstract *This paper describes some applications of ASONs, currently under wide investigation by Network Operators and Service Providers, and highlights its potential savings. A connection demand triggering mechanism for the IP-over-ASON scenario is modelled. All results were obtained within the IST LION project.*

Introduction

An Automatic Switched Optical Network (ASON) is basically a DWDM-based network designed to provide Client Networks and Customers with very flexible transport services, called permanent, soft-permanent and switched optical connections.

Apart from permanent connections, also known as leased lines, the other two innovative optical transport services are based on distributed network intelligence (i.e., Control Plane) and signalling. A switched connection is set up and released directly either by Client Network or by Customer equipment by means of a User Network Interface (UNI); in case of a soft-permanent optical connection, it is the Management System that triggers the Control Plane (CP) of the head-end node. Both kinds of connections are then established via Network Node Interface (NNI) signalling and Control Plane processing.

ASON applications and cost-effectiveness

As recommended by ITU-T Rec. G.8080, the purpose of the Control Plane is to facilitate fast and efficient (re)configuration of connections and to perform a restoration function. The principles of automatic switching are applicable to both SDH transport networks (ITU-T Rec. G.803), and Optical Transport Networks (OTN) (ITU-T Rec. G.872).

In principle, an ASON seems to fulfil many of the new emerging requirements for transport networks, such as: fast, flexible and automatic end-to-end provisioning of high capacity links, client independent support of multiple clients, wavelength-based re-routing and optical restoration, and support of Optical Virtual Private Networks (OVPNs).

a. Network applications

This sub-section considers some of the envisaged network applications of an ASON and the potential Customers of such transport services.

Optical Virtual Private Networks (OVPNs) for Corporate connectivity are being recognised as a service that can be provided through ASON. Basically the OVPN service unit [1] is an optical connection between a pair of customer/client devices.

Some recent studies [2] showed an increased usage of streaming media in corporate applications. The extent to which streaming media will reach a mass-market is highly dependent on the network infrastructures carrying it: from this perspective, ASONs are likely to fulfil such network requirements.

Another need that is being faced [2] today by companies is to access and retrieve data and information assets from huge data repositories or servers. This, together with corporate disaster recovery needs, may be satisfied with ASON infrastructures.

To be more specific, some preliminary results from an investigation of the banking sector will be reported. Huge banks usually consist of a headquarter (BH), that is protected by one or more backup centres (BC), dozens of branch offices (BO) and a few hundreds of local offices. Based on statistics found in [4,5,6], assumptions were made for an arbitrary European country on the number of banks, its structure and the number and average size of users' accounts, leading to an estimation of the data volume to be transferred between BH and BC and between BH and BO. This translates into the connection mean Holding Time (HT) and the mean Inter-Arrival Time (IAT), shown in Table 1. For the BH-BC case, data are sent once a month (this can increase if switched services become reality). For the BH-BO, data are sent once a day (within 3 hours after closing). The table illustrates that the banking sector is likely to be one of the potential customer areas that might benefit from the provisioning of dynamic transport services.

Table 1: Connection mean HT and IAT

	Holding Time			Inter-Arrival Time	
	2 Mbit/s	155 Mbit/s	2,5 Gbit/s	Metro Netw.	Core Netw.
BH-BC	~166h	~90 min	~5,6 min	~2,4 h	~4,8 h
BH-BO	~3,44 h	~2,6 min	~10 s	~4,5 s	~5,1 s

Tele-medicine is another potential application. A lot of different information might be dynamically sent between remote centres (including high-resolution video streaming and on-line data from medical equipment) during surgery. Hence, the need for high-capacity automatic switched connections emerges. The Quality of Service must be very high, since cutting off the channel during surgery may have fatal consequences [6].

Other potential applications that might use ASON transport services are: interactive collaboration environments, common access to remote resources, network-wide computation and data services (e.g., Grid) and display of information through virtual reality environments [3]. The project LION is also investigating the dynamic optical connections needed to track a daily ISP traffic pattern (client of an ASON).

b. Cost and resource savings

From a Network Operator perspective, ASONs might be beneficial, as they might result in:

- More revenues: due to the deployment of the above described customer applications.
- Lower CAPEX (capital expenditure): because switched connections allow a more efficient usage of the network resources (switched connections can be realised for only the duration that they are really needed, allowing to share resources dynamically). Also fast, distributed restoration (instead of 1+1 OCh protection) may become a reality due to the distributed intelligence of the control plane.
- Lower OPEX (operational expenditure): due to the automatic network discovery and inventory features of the distributed intelligence of the Control Plane.

Assuming an IP-over-ASON multilayer network, we have shown [7] that reconfiguring the logical IP network (in case of an IP layer equipment failure) saves between 8% and 20% of the total network cost, compared to multilayer survivability strategies that are not able to reconfigure the logical IP network (the underlying transport network does not support switched connection services).

ASON connection demand model

In this section we deal with an IP-over-ASON scenario, addressing the problem of designing a mechanism to allow IP clients to trigger demands for setting up/releasing connections, and to identify typical values for HT and IAT in such a scenario. It is worth noting that in an IP-over-ASON scenario the IP layer is connectionless, while ASON provides a connection-oriented service.

a. Connection triggering mechanisms

In order to adapt the available network capacity to the traffic fluctuations by the automatic set-up/release of ASON connections, the IP customer or client network equipment has to monitor the traffic that it offers to the ASON, and trigger demands accordingly.

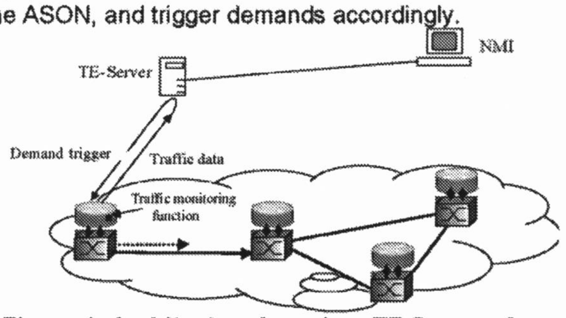

Figure 1: Architecture based on TE Servers for IP/ASON.

Figure 1 shows a possible architecture based on Traffic Engineering (TE) Servers for an IP-over-ASON scenario. Traffic monitoring is installed at the ASON client (e.g. the egress router of an ISP network), and is designed to monitor a parameter of the IP traffic injected in the ASON (e.g., amount of data, link utilisation or output buffer occupancy). The monitoring function can be done by monitoring either the instantaneous value or the average value (computed periodically) of that parameter. The reaction (triggering of a demand) is produced once that value goes above/below a predefined threshold. Either a single threshold can be used, or two, one for setting up connections and the other for releasing them. Also, different rules (e.g. static, hysteresis etc. [8]) can be applied to trigger a demand.

b. ASON demand characterisation

Table 2 includes some indicative results obtained by simulation under the following conditions: point-to-point link providing 70 channels of 2 Mbps, IP traffic modelled by a self-similar source with a peak rate of 140 Mbps and an average rate of 60 Mbps. The monitored parameter was the occupancy of a buffer placed between the self-similar source and the link, and demands were triggered when occupancy went above/below a static threshold set at 50 KB.

Triggering mechanisms based on monitoring the instantaneous variations of the IP traffic parameters (no Observation Window (OW) in Table 2) may cause Control Plane instabilities, because it requires to set up/release connections too often (IAT and HT have very low values) [9]. Thus, a scheme based on monitoring the traffic periodically is needed (use an OW, compute the average on this period and trigger a connection demand accordingly). By adequately dimensioning the OW size, it is possible to fix the minimum values of IAT and HT, and make them feasible for the ASON Control Plane.

Table 2: HT and IAT vs. different values of OW

OW	HT	IAT
No OW	7 s	15 s
OW = 30 s	30 min	1h 15 min
OW = 60 s	60 min (1h)	2h 30 min

Finding the optimum size for the OW (that allows capturing both short and long term traffic variations) is still being investigated within the LION project.

Conclusions

This paper describes some of the envisaged network applications for ASON, while highlighting potential cost and resource savings. Indicative values for HT and IAT, showing the need of dynamic connections, were presented. Also a preliminary ASON connection demand characterisation was discussed for the IP-over-ASON scenario.

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