Cost versus flexibility in next generation optical core networks

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I. Introduction

Ever-increasing bandwidth demands and higher flexibility are the main challenges for the core network during the next years. Core networks of the future will evolve to a more transparent optical structure.

The planning horizon of this evolution is a long-term (of up to about 5 years) decision process. This leads to a high uncertainty of the planning environment. The new technologies that are considered in the planning decisions can have a big influence on the benefits during the next years. In the first place a change in the total cost of the infrastructure, or capital expenditures (CAPEX), can occur. Secondly it can have an important impact on the operational processes, or operational expenditures (OPEX), of the network provider.

In this paper, we first present the technical evolution in next generation core networks. We then describe the two main parts in a techno-economic study: the total cost of the infrastructure and the operational cost.

II. Technical architectures

The considered architectures are a traditional opaque network and a transparent network with different kind of add/drop possibilities, each with a different degree of flexibility.

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A. Opaque network

In opaque architectures the optical signal carrying traffic undergoes an optical-electronic-optical (OEO) conversion at every switching or routing node in the network. In a nation wide network this is a costly operation because you need a lot of transponders.

B. Transparent network

In transparent networks the signals are transported end-to-end optically, without any OEO conversions along their path. Transparent networks add the flexibility of easy reconfiguration of optical circuits and upgradeability to new transmission standards (for example a higher bitrate). The transponders (TSP) are connected to different kind of add/drop terminals, in degree of flexibility:

- Colored ports

Have a permanently assigned wavelength channel, a transponder can not be tuned to another wavelength.

- Colorless ports

Every wavelength can be dropped/added to this add/drop port. A tunable transponder gives a higher flexibility.

- Colorless and directionless ports

A transponder can be assigned to another fiber direction [1].

III. Infrastructure (CAPEX)

We performed a dimensioning study to make a comparison of the total CAPEX of different proposed technologies (figure 1). In this dimensioning we used the German network topology and the traffic matrix of 2009 [3]. In

the opaque case the biggest cost is this of the line cards (LC) and represents 57% of the total cost. That makes the difference with the transparent scenarios, a transparent scenario can be 67% cheaper. In the transparent cases we observe an increase of the optical cross-connect (OXC) cost when the optical add/drop terminal is more flexible. If you switch from colored ports to colorless ports the cost of the system will increase with 19%. There is still a big differcence with the opaque case.

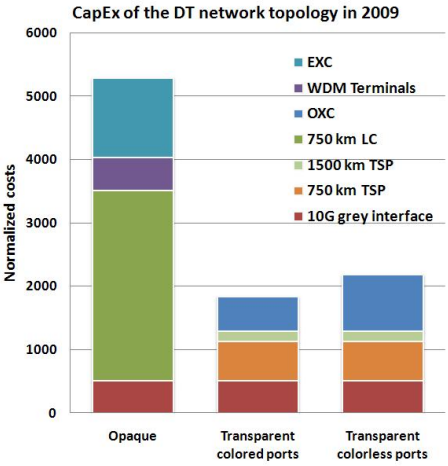

Figure 1. Total CAPEX of different node architectures

IV. Operational processes

The other important area of comparing different technologies are the changes in the operational processes. One possible approach is to model the processes and calculate the cost of all the building blocks [2]. In this project we will consider the processes to setup, tear down and reroute a lightpath.

An important cost driver is the amount of manual interventions. For this reason, it is useful to build a tool which keeps record of the number of manual interventions, remote configurations and necessary upgrades when adding new demands over a certain time period. Here we can also add the influence of the number of pre-provisioned transponders on the total cost (or amount of interventions).

The activities of setting up a lightpath are planning, connecting the client, calculating the routing, configuring of the intermediate nodes and finally testing. If it is a transparent path which means you can configure the intermediate nodes remotely. With colored add/drop it is difficult to pre-provision transponders so you need a manual intervention at the source and destination to install them.

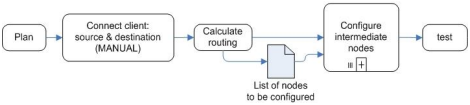

Figure 2. Setup process of a lightpath

V. Further research

Our work aims at a total cost of ownership (TCO) comparison of different future optical core networks, there are still some possible extensions. Especially the interplay of sparsely pre-provisioned transponders and reconfigurable OXC with different kinds of add/drop flexibility could be studied in more detail. An extension of the already proposed processes and the addition of extra processes is an interesting topic too. Simulation of these processes can give an excess value to the current studies.

Acknowledgments

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