# OpEx savings by reduction of stock of spare parts with Sliceable Bandwidth Variable Transponders.

**Beatriz de la Cruz, Oscar Gonzalez de Dios, Victor Lopez, Juan Pedro Fernández-Palacios**
*Core Network Evolution Team, Telefónica I+D, c/ Don Ramón de la Cruz, 82-84, 28006 Spain*
**contact email: ogondio@tid.es**

**Abstract:** This work analyses the OpEx savings related to stock of spare parts for Sliceable Bandwidth Variable Transponders versus traditional fixed rate transponders. Target cost of sliceable transponders based on these OpEx savings is obtained.

## 1. Introduction

Operators of telecommunication networks have to deal with an ever-increasing demand for new services. Competitiveness has grown in the last years, bringing many troubles to operators to maintain a sustainable business, and hence, cost reduction, both in Capital Expenses and Operational Expenses is a key issue. Emerging technologies can help network operators to cope with the demand and keep both CAPEX and OpEx under control.

One of the emerging technologies which has received lot of attention from research community is the Elastic Optical Networks (EONs) which allow the use of optical spectrum in more flexible way, for instance, by changing the frequency slot granularity and central frequency granularity. In particular, one of the main novel blocks of EON is the Sliceable Bandwidth Variable Transponder (SBVT). This kind of transponder enables transmitting from one point to multiple destinations, changing the traffic rate to each destination and the number of destinations on demand. Different studies in the literature show that SBVTs can achieve CAPEX savings in network operators [1]. However, operational expenditures savings by SBVTs has received little attention. OpEx is the amount of money that network operators spend on an ongoing, day-to-day basis in order to run their business. In particular, the OpEx category where SVBTs can play a significant role is the network operation, which includes costs related to maintenance of the network.

Hence, the goal of this work is to quantify the reduction of network maintenance and reparation related OpEx by using SVBTs instead of a set of fixed rate transponders. Part of the cost of maintenance and reparation is related to keeping a stock of spare parts. Whenever there is a failure in a network element, there may be damaged parts that need to be replaced and a stock of spare parts for replacement needs to be maintained. Such stock can be maintained either by the network operator or a third party supplier and translates into a yearly cost.

In the case of optical transport networks, spare transponders need to be stocked. Following current model, transponders of different rates are needed, and thus a number of each rate needs to be stored. However, with the newly proposed Sliceable Bandwidth Variable Transponders, it is possible to reduce the number of transponders and reduce the variety of transponders. This study aims to analyze whether equipping a network with Sliceable Bandwidth Variable Transponders instead of fixed rate transponders of multiple rates reduces the needs in terms of stock maintenance.

The remaining of this paper is organized as follows. Section 2 introduces the procedure to calculate the number of required stock in a communication network. Section 3 shows the results in the different scenarios. Finally, section 4 concludes the paper.

## 2. Procedure to calculate the number of required stock of spare parts in a communication network.

This study is based on a centralized stock model. It is assumed that a central warehouse has stored all the spare elements (e.g. transponders) and in case of a damaged part event, such part is shipped from the central location. The procedure described in this section can be used to calculate the number of required stock of any component subject to fail, but it has been focused on transponders for a nation-wide optical core network.

The procedure uses as a starting point the number of transponders required in the network for normal operation for two cases, one with different kinds of fixed rate transponders (40, 100 and 400 Gbps are used in section 3), and a second case with sliceable BVT (400 Gbps for the results in section 3). The Mean Time Between Failures (MTBF) of transponder is fixed and equal for all transponders. Then, the second step is performing a set of simulations where the transponders are set to fail according to an exponential distribution with mean MTBF. Every time an element fails, it is replaced and a new element is requested to factory. The mean delivery time (MDT) is the time to receive a new transponder from the vendor. Then, it has been obtained the number of stock that needs to be maintained to guarantee certain availability.

The steps of the procedure are summarized below:

1. Number of transponders needed for normal operation is obtained.
2. Failures in every transponder are distributed randomly in time based on an exponential distribution with mean MTBF.
3. At the same moment that failure happens, a spare transponder is taken from the stock and a replacement request to factory is made.
4. Stock accounting:
    a. One is added to the stock counter of the given transponder if a failure happens.
    b. One is subtracted to the stock counter when the replacement happens (a new transponder arrives from factory to the stock).
5. From the previous steps, the peak value of the minimum stock number to be maintained at the warehouse is obtained.
6. Once the maximum stock is known, steps 2-4 are repeated, reducing the maximum stock in one each time, with one remark:
    a. When a failure happens, if the stock is zero, one is added to the number of failed cases. Otherwise, one is added to the successful case.
7. The percentage of the successful cases is obtained for each stock value, until the stock is one.

Given that the time between failures is a random variable, the previous steps are repeated several times in order to achieve a higher accuracy.

## 3. Results

This study has been performance for two different IP topologies of the Spanish IP/MPLS over Optical Core Network shown in Figure 1. The first scenario represents a full mesh topology of IP/MPLS nodes. The second scenario is based on current IP/MPLS topology and traffic is routed through the shortest path between IP/MPLS nodes

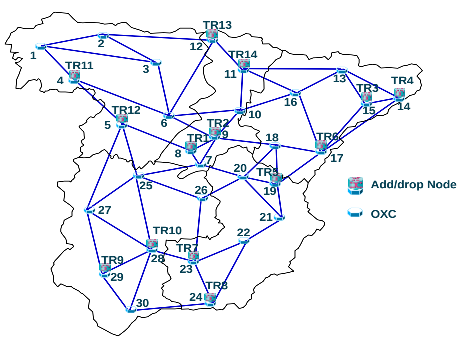


Figure 1: Reference Network base on Spanish National Backbone

| TxP parameters | Cost |
|---|---|
| 40Gb/s, 2500km, 50 GHz | 6 |
| 100Gb/s, 2000km, 50 GHz | 15 |
| 400Gb/s, 75GHz, 500km | 22 |
| 1000Gb/s, 175GHz, 500km | 25 |

Table 1: Non-Sliceable transponders cost [3]

At the end of the study the results obtained are the percentage of successful cases for each stock value, which are represented on the next Figure 2 and Figure 3. These figures show the percentages for year 2014 using the first scenario and comparing the case based on fixed transponders and the case based on SBVT transponders.

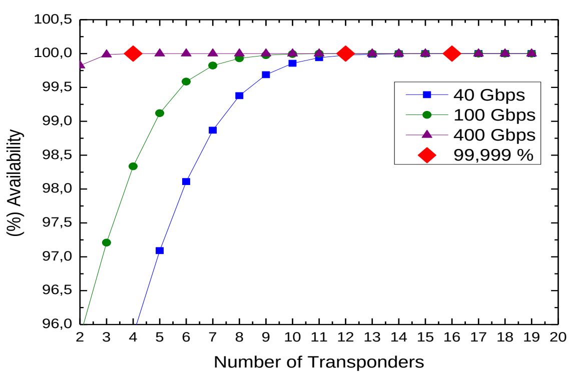


Figure 2: Stock number of fixed transponders

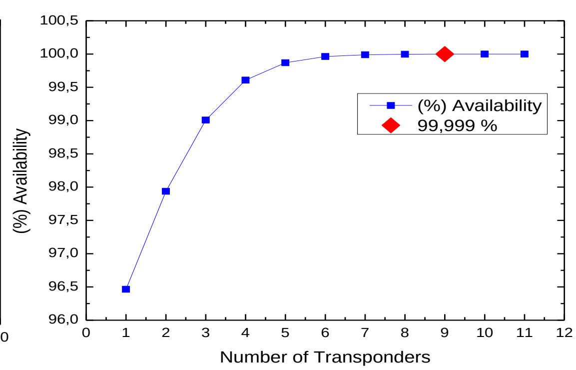


Figure 3: Stock number of SBVT transponders

In light of these results, we can say that a less number of transponders are necessary in the case of using SBVT in a communication network to keep the service with certain availability. The previous results have been obtained from year 2014 to 2020 for the two earlier commented scenarios. Figure 4 and Figure 5 show the number of stock needed to accomplish with 99,999% availability. The study of each year has been done based on the traffic of the Telefonica network in 2012. In order to compare the result in several years a 50% traffic increase has been assumed. It has to be taken into account the remaining stock of one year is not used the next year.

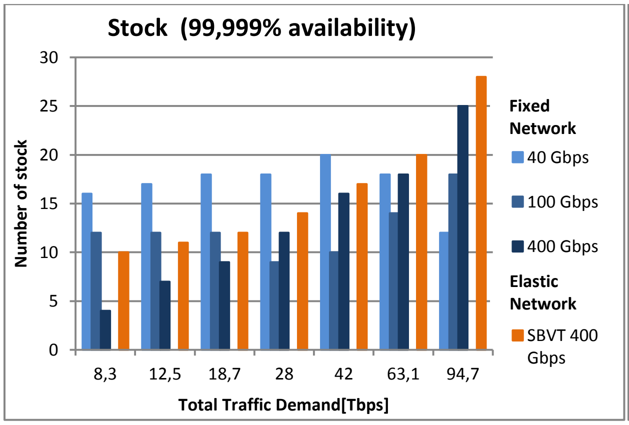


Figure 4: Stock for scenario 1 (full mesh)

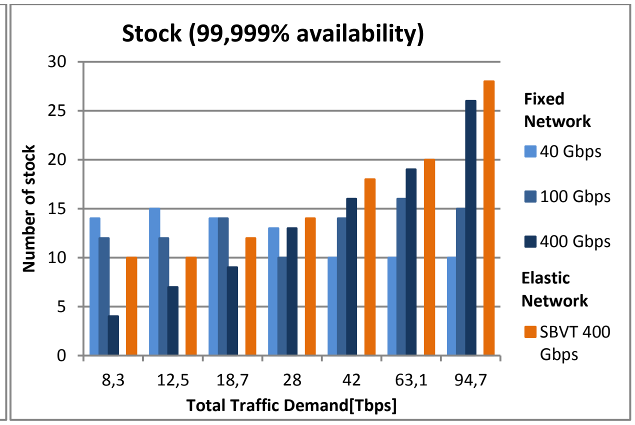


Figure 5: Stock for scenario 2 (IP topology shortest path)

It can be observed that a higher number of total fixed transponders are needed versus SBVT to keep 99,999% of service available. According with [3] the cost of the fixed transponder is 6, 15 and 22 for 40 Gbps, 100Gbps and 400Gbps transponders respectively. Based on the previous information we have calculated what would be the cost of SBVT to save 30% operational expenditures.

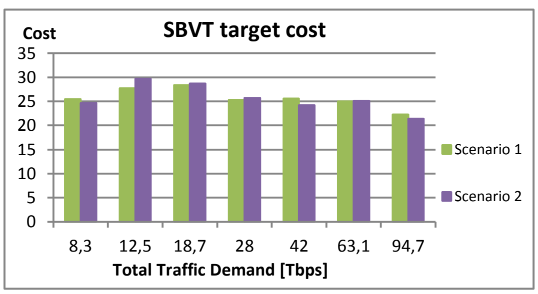


Figure 6: SBVT Target cost

Figure 6 shows that the possible cost of SBVT can vary between 22 which is the cost of fixed 400Gbps transponder and 30 which imply an increase to 36% in the cost of fixed 400Gbps transponder. The peak target cost value is reached in 2015 (a total traffic demands of 12,5 Tbps) then it steadily drops so that in 4-5 years the cost of the 400 Gbps SBVT should be similar to the cost of a fixed transponder to achieve overall 30% savings in the operational expenditures of the network.

## 4. Conclusions

This work shows how it is possible to save operational expenditures using SBVT versus fixed transponders despite the cost of the SBVT is greater than the fixed transponders. Another advantage of using SBVT is that it has to be stored just one kind of transponder. This paper also presents the target cost of SBVT transponder in order to save 30% of operational expenditures, obtaining that this cost can vary from fixed 400 transponder cost (22) to an increase of 36% of this cost (30).


## 5. Acknowledgements

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## 6. References


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