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Design of a Elastic ROADM optical Network for Spectral Efficiency using WDM

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***Abstract*—In this modern era, Optical Communication Networks are contemplated the leading catalyst for the revolution of communication technology, and serve as the pillar of present day Internet. However, to sustain the cost usefulness for the rising bandwidth demand and enable faster provision, optical networks must continue to evolve. Optical networks are experiencing noteworthy changes, powered by the exponential evolution of traffic due to multimedia services. The next tailback is the 10-year-old division of the optical spectrum which will no longer work for 400 Gb/s and above, indicating the need for a more flexible grid. If the switches become flexible, a whole new elastic optical networking prototype is born. This paper presents the design of a Hybrid Optical Network by using different exciting technologies, such as, wavelength division multiplexing (WDM), optical amplifiers and optical add/drop multiplexers (OADM). A systematic analysis has been implemented using OptiSystem to improve the performance of the proposed network. Finally, this paper concentrates on spectral efficiency and improving the bit error rate.**

Keywords- Bandwidth variable transponder, Bandwidth variable cross-connect, Optical add/drop multiplexer, Hybrid optical network, OptiSystem,WDM

I. INTRODUCTION

The expeditious evolution of global communication and rapid promotion of internet to increase the demand for bandwidth has drastically modified our way of life. It was believed that optical fiber will offer commendably infinite capacity to support the increasing traffic progress.

Even if adequately broad spectrum is accessible, it is tough to transmit high data rate signals over long distances at high spectral efficiency. To meet the future demands of the internet, optical networks are moving toward to the goals of achieving greater efficiency, scalability and flexibility. Therefore, elastic optical network (EON) has been proposed as a promising prototype to address the challenges in future optical networks. Since optical network carry traffic and data rates, even a small network failure can cause severe penalties. The durability features are very important when designing network topology.

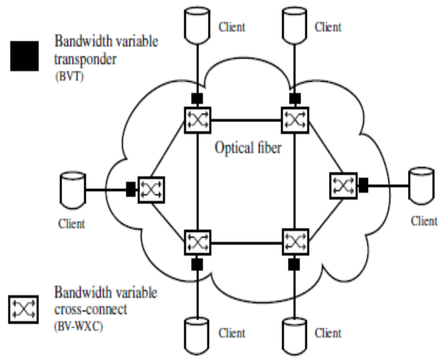

Fig. 1: Elastic Optical Network.

An Elastic Optical Network architecture is described in Fig 1 which consists of Bandwidth variable transponder (BVT) and Bandwidth variable cross-connect (BV-WXC). BVTs are used to adjust the bandwidth by adjusting the transmission rate and support high speed transmission. The BV-WXC is used to assign a suitable sized cross-connection with the matching bandwidth. Thus, a BV-WXC needs to align its switching frame according to the incoming optical signal which will offer better flexibility.

Enabling technologies for elastic optical networks have recently gained significant attention in the research and standardization communities. In [2], authors proposed a spectrum sliced elastic optical path network architecture (SLICE) that can efficiently utilize the spectrum. The paper also presented the key technologies of elastic networks, such as bandwidth variable transponders, bandwidth variable WXCs and OFDM modulators. Akin to the Routing and Wavelength Assignment (RWA) algorithms in WDM networks, a spectrum path in elastic optical networks is decided by the so-called RSA (Routing and Spectrum Assignment) algorithms, which define the path from source and destination along with its allocated spectrum. RSA is used to find the suitable path for source and destination pair and assign the fitting spectrum slots to the requested path. All current RSA algorithm consider single path routing, where a unified modulation format is assumed in the entire network. In [3], the authors suggest an Integer Linear Programming (ILP) model to lessen the allocated

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spectrum with a static traffic matrix. The paper has also presented a comprehensive study on RSA problem in SLICE networks. The paper has also proposed an ILP model and heuristics to find spectrum paths using minimal number of sub-carriers. The notion of distance adaptive spectrum resource allocation for long distance paths was discussed in [3]. The authors also studied the spectrum resource allocation considering OSNR degradation and filter narrowing effects in the paths of various lengths. [3] shows that distance adaptive spectrum allocation is a promising approach in elastic optical networks, especially when the channel conditions are known or easy to estimate. In this paper, we have presented a hybrid optical network to operate in optical communication. The simulation results were attained using OptiSystem ver. 7.

II. PROPOSED SYSTEM DESIGN AND METHODOLOGY

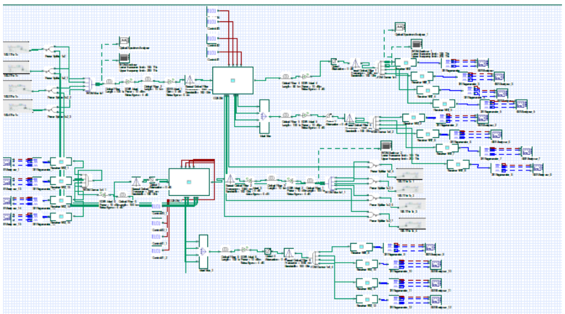

Fig. 2: Proposed Hybrid Optical Network.

The proposed HON (hybrid optical network) architecture employs a different set of four transmitter, receiver, wavelength splitter and an oadm switch in both directions to increase the network capacity as shown in Fig. 2. DWDM technology technique is used in proposed system because of following advantages:

1) Less fiber cores to transmit and receive high data.
2) A single core fiber cable could be divided into multiple channels instead of using fiber core.
3) DWDM systems are capable of longer span lengths.

The optical transmitter is used to convert the electrical signal into optical form, and launch the ensuing optical signal into the optical fiber. The transmitter consists of the following components: an optical source, electrical pulse generator and an optical modulator. The key element of an optical receiver which converts light into electricity using the photoelectric effect is a photodetector,

An OADM consists of three stages: an optical de-multiplexer, an optical multiplexer and between them a way of reconfiguring the paths between the multiplexer, de-multiplexer and a pair of ports for adding and dropping signals. The de-multiplexer splits wavelengths in an input fiber onto ports. The reconfiguration can be accomplished by optical switches which govern the wavelengths to the multiplexer/drop ports. Then, the wavelength channels are multiplexed by the multiplexer that are to continue on from de-multiplexer ports with those from the add ports, onto a single output fiber.

III. RESULTS AND DISCUSSION

OptiSystem version 7 software is used for simulating the proposed system design.

a) Q-Factor

The simulated Q-factor of the proposed system design can be seen in Fig. 3. Higher Q-factor means less loss and from the above figure, Q-factor is obtained approximately to 7.8 which is pretty high.

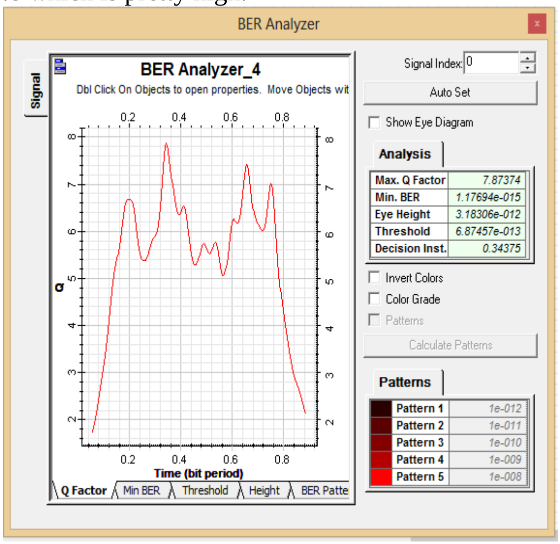

Fig. 3: Q-factor.

b) *Bit Error Rate*

Fig. 4 shows the BER (bit error rate) of the proposed network. It shows an error of approximately $1.2x10^{-15}$ which is satisfactory for optical communication compared to other networks.

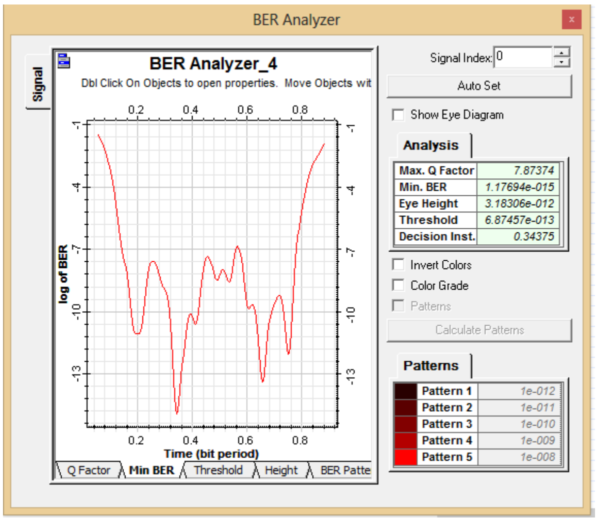

Fig. 4: BER Simulation Result.

c) *Ber Pattern and Eye Height*

Fig. 5 displays the simulated BER pattern also known as "eye diagram" of the proposed design and Fig. 6 shows the eye height of the proposed network respectively. The eye height is the extra or additive noise in the signal and it is realized to be $3.18x10^{-12}$ which is sufficient for optical communication.

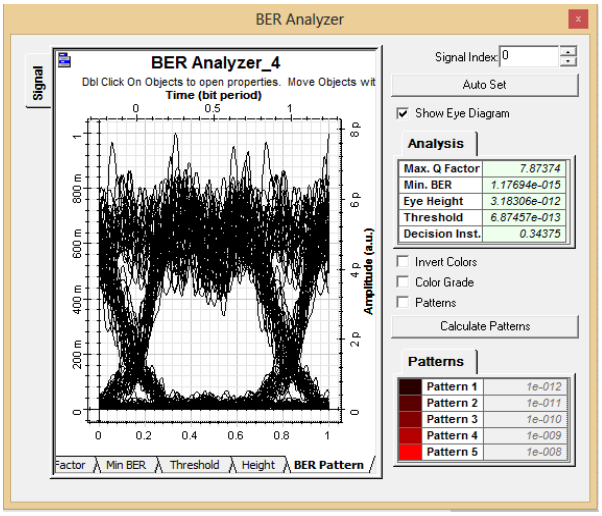

Fig. 5: BER Pattern.

d) *Spectral Efficiency*

The simulated power against the frequency is shown in Fig. 7. It shows that the power obtained at 193.2THz is -22.5dBm which is sufficient for optical communication.

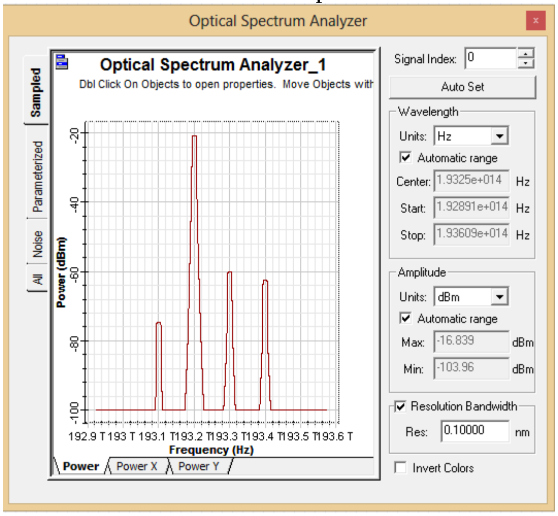

Fig. 7: Spectral Analyser.

IV. CONCLUSION

This paper represents the design of a Hybrid Optical Network using OptiSystem software. The Q-factor, BER (Bit error rate), Eye height, BER pattern and spectral efficiency have been calculated and from the simulation we have achieved the BER of this network is approx. 1.2×10^{-15}, Q-factor is approx. 7.8, eye height is 3.8×10^{-12}, the power obtained is -22.5dBm and from the following results it can be seen that the proposed design has a suitable affinity.

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