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Performance Evaluation of Optical Networks in Multifarious Environments

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Abstract: The increase in the demand for broadband services and generated traffic, communication networks has motivated the need to implement next generation networks. This paper aims to evaluate the performance of optical networks in multifarious environments. The main idea of this work is to build fictitious multifarious environments that will allow studying and evaluating the performance and decide which the most optimal option for these environments. To make this possible, theoretical part is followed and then finally, in practical part, simulation software is chosen that meets the design requirements. The designs of optical networks are made and simulation results obtained justify that the networks are viable and can be implemented in a real case.

Keywords: Broadband, communication networks, multifarious, simulation

I. INTRODUCTION

An optical network is a network which by its nature provides a variety of broadband services to users through optical fiber access. Passive optical network allows removing all active components between the server and client introducing in place optical passive components to guide the traffic throughout the network. Its principal element is the optical splitter. The usage of passive architecture can reduce costs and are mainly used in FTTH networks. The bandwidth is not dedicated, but multiplexed in a single fiber in the network access points. In short, this is a point-to-multipoint configuration network. Moving from the network to the user, it can say that network architecture consists of the following equipment: an Optical Line Terminal (OLT) at the service provider's central office and a number of Optical Network Units (ONUs) or Optical Network Terminals (ONTs) close to end users.

This paper proposes models of passive optical infrastructure for a neutral operator that puts its fiber optic network available to different cable operators in the market. This model consists of deploying a WDM network, a Broadband Optical network and a Gigabit Optical network from a central telecommunication to different areas where end users will enjoy the services that only optical fiber network can provide. The area under deployment is a fictitious environment as an expansion of a city but it could easily belong to a real environment. Here we can clearly see 5 distinct areas that will need a new generation network for meet their needs:

· Hospital area: in that it can find a huge hospital that covers the whole region and have all the latest technological advances.

· Business offices area: it will find 2 buildings with a total of 30 offices that will give service to several companies.

· Residential area: it is a distribution of 20 single-family homes that they will require a full suite of triple play service.

· Mall and school area: next to the residential area it will be located a school and a shopping center that at least will enjoy access to broadband internet and HDTV.

· Buildings area: Finally it will find another residential area similar to above but in the form of apartment buildings. In that it will be located 2 buildings employing a total of 22 apartments and they will also need triple play service.

II.WDM OPTICAL NETWORK

WDM-PON (Wave Division Multiplexing Passive Optical Network) provides the dedicated bandwidth of a point-to-point network with the fiber sharing inherent in PON networks. WDM-PON usually has an Arrayed Waveguide (AWG) filter that separates the wavelengths for individual delivery to subscriber ONTs. WDM optical network is not still fully defined but carriers and vendors expect up to 32 subscribers to be served by a single WDM optical network access fiber.

Advantages of the WDM approach are inherent in the completely separate downstream wavelengths for each subscriber. This provides more bandwidth to each subscriber, more security, and better operational control since there is no interference in the downstream direction among the various wavelengths. The biggest disadvantage of WDM optical network is its cost (and its maturity as an FTTx technology). Each subscriber requires its own dedicated transceiver at the OLT, and this is one of the cost advantages of the other optical network technologies lost with WDM optical network. Additionally, the AWG filter is expected to be more expensive than the splitters used with rest of the optical networks.

The diagram below shows simulation model of WDM optical network. The final goal pursued with this paper is to evaluate the performance of the whole system. The parameters used to evaluate this behaviour will be the BER and the Eye Diagram.

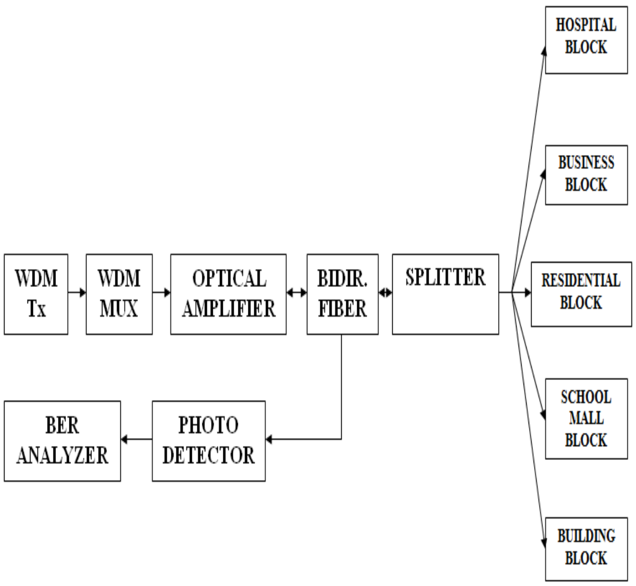

Fig 1 WDM Optical Network Simulation Model

In Fig 1 the left side of the design shows the OLT which will transmit information to different users and it will receive information from the ONT's. All this information will be transmitted multiplexed at different wavelengths through a single optical fiber, and then demultiplexed to spread to different areas in downstream, and multiplexed from different areas in upstream. The simulation also has been divided in 5 areas.

The global bit rate used for the design will be 2.5 Gbps. This bit rate will be used throughout the design because if the network is working for this bit rate it will work for all other bit rates because they will be lower than this. Other important parameters are the sequence length (128 bits) and the samples per bit (64). These will make a total of 8192 samples and are important because it needs a large enough sequences for simulate the network at these high bit rates.

In the case of the ONU located in the hospital block, obtained results are as follows:

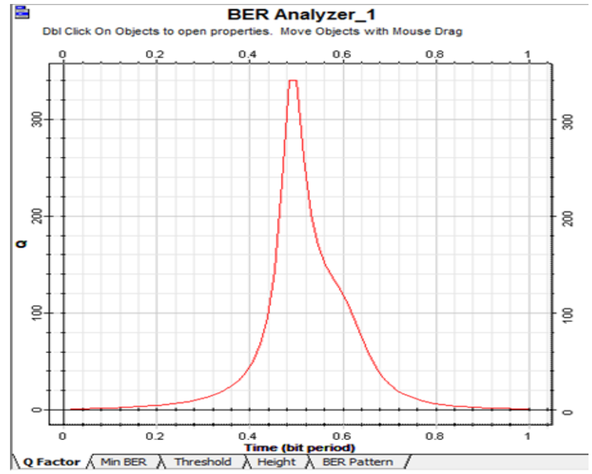

Fig 2 (a)

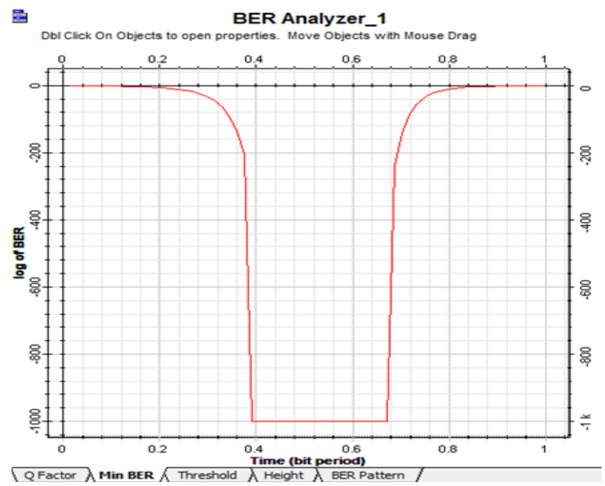

Fig 2 (b)

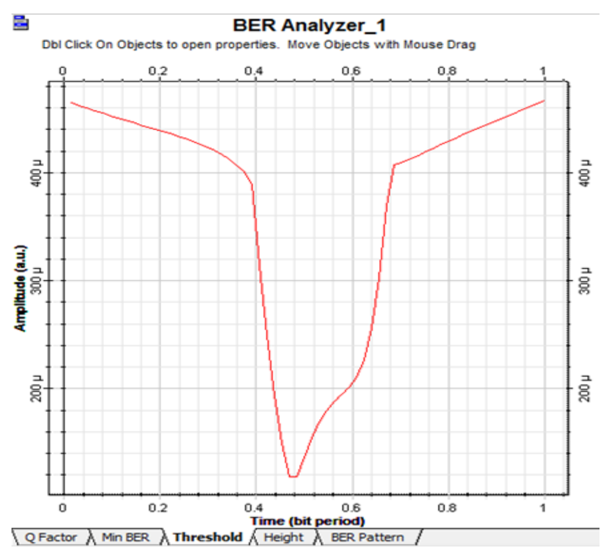

Fig 2(c)

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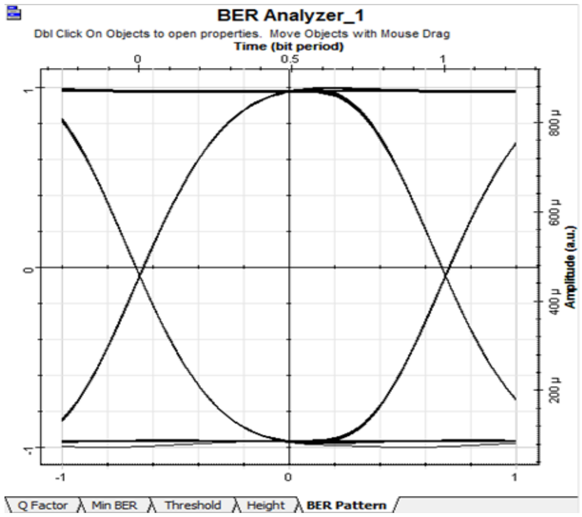


Fig 2 (d)

Fig 2 HOSPITAL ONU Results

Table 1 Obtained Results of Hospital ONU

Max. Q Factor	339.92
Min. BER	0
Eye height	0.00077705
Threshold	0.000154279
Decision Inst.	0.515625

In the BUSINESS block, the path that the signal covers to two ONU's is exactly the same since the last fiber has the same dimensions. So the results are identical:

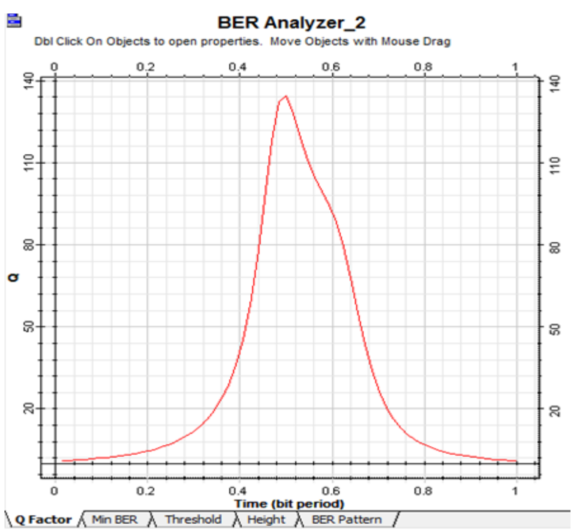
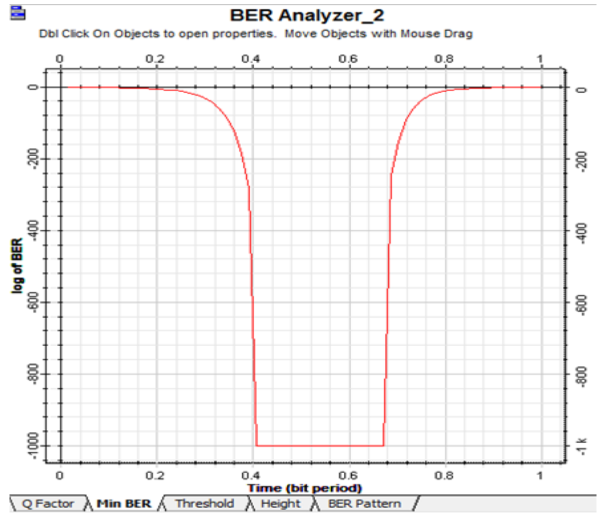


Fig 3 (a)



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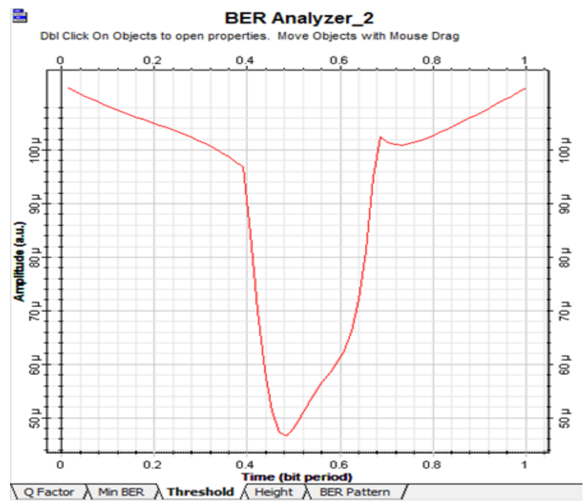

Fig 3 (c)

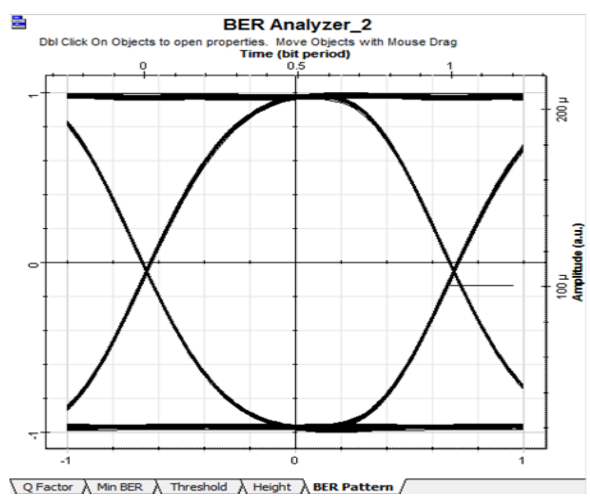

Fig 3 (d)

Fig 3 BUSINESS ONU Results

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Table 2 Obtained Results of Business ONU

Max. Q Factor	134.46
Min. BER	0
Eye height	0.000182791
Threshold	5.02412e-005
Decision Inst.	0.515625

The RESIDENTIAL Block will have 20 ONU's. As expose the results of the 20 ONU's will require a lot of space, we are going to put the results of the closest ONU (located at 50 meters from the splitter).

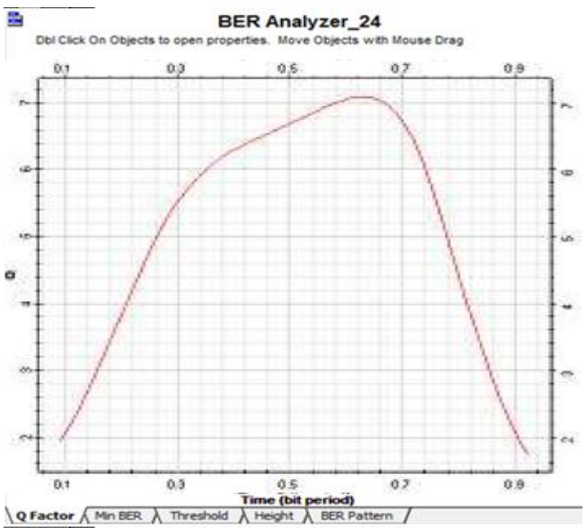


Fig 4 (a)

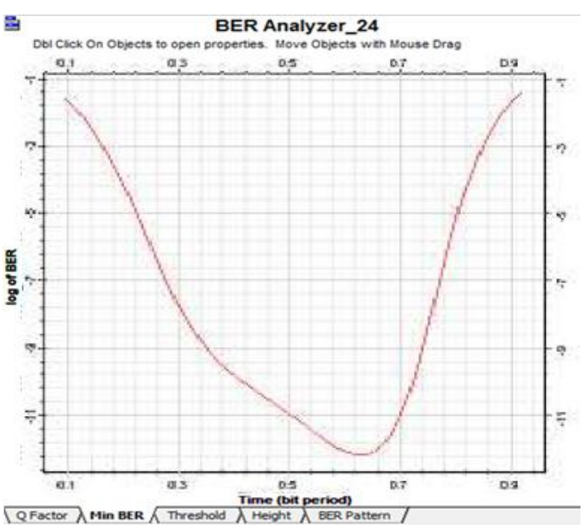
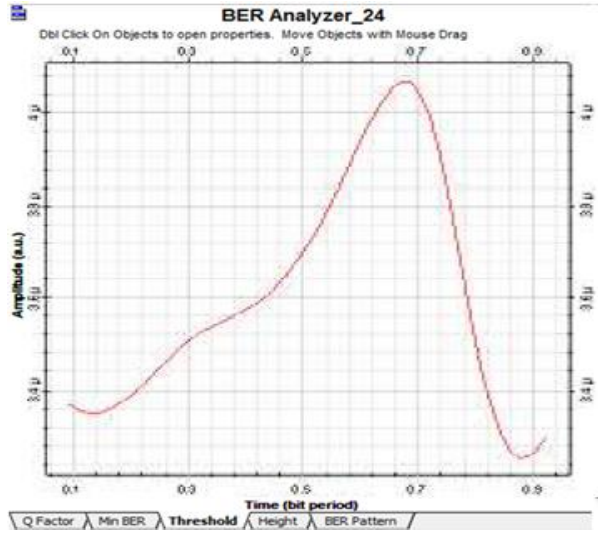


Fig 4 (b)



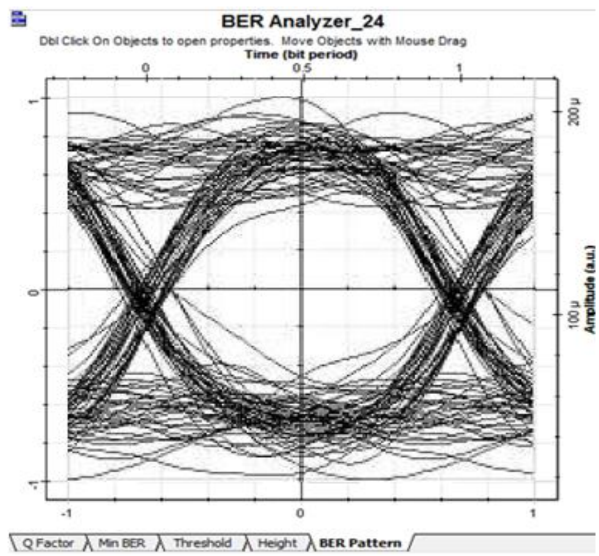


Fig 4 (d)

Fig 4 RESIDENTIAL ONU Results

Table 3 Obtained Results of Residential ONU

Max. Q Factor	7.09078
Min. BER	6.65572e-013
Eye height	4.28723e-006
Threshold	3.99967e-006
Decision Inst.	0.625

Turning now to the SCHOOL-MALL Block, the results for the two ONU's are:

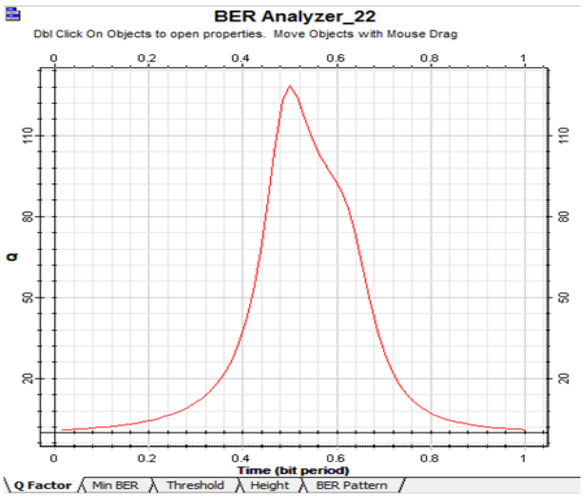


Fig 5 (a)

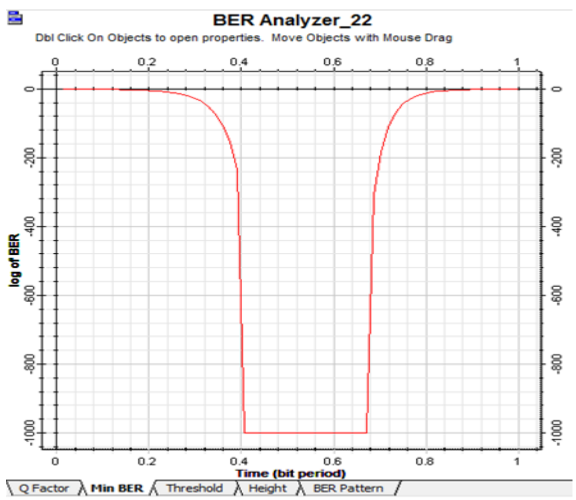


Fig 5 (b)

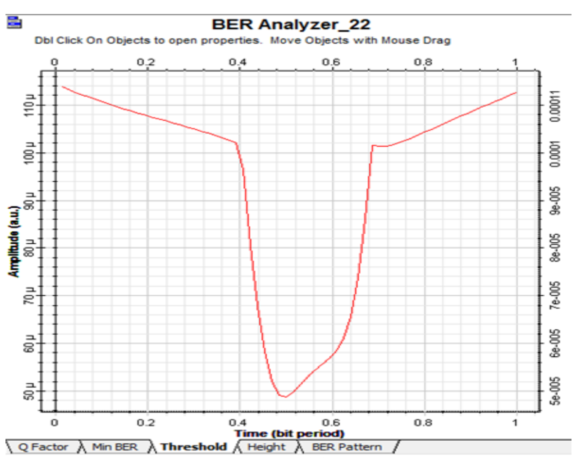


Fig 5 (c)

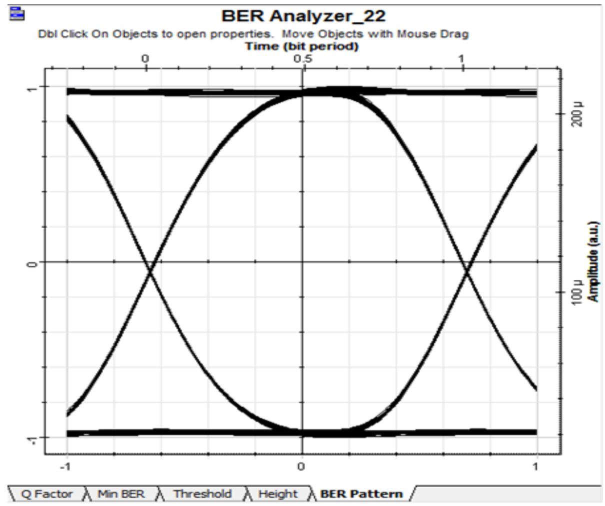


Fig 5 (d)

Fig 5 SCHOOL-MALL ONU1 Results

Table 4 Obtained Results of School Mall ONU1

Max. Q Factor	128.569
Min. BER	0
Eye height	0.00018662
Threshold	4.9797e-005
Decision Inst.	0.515625

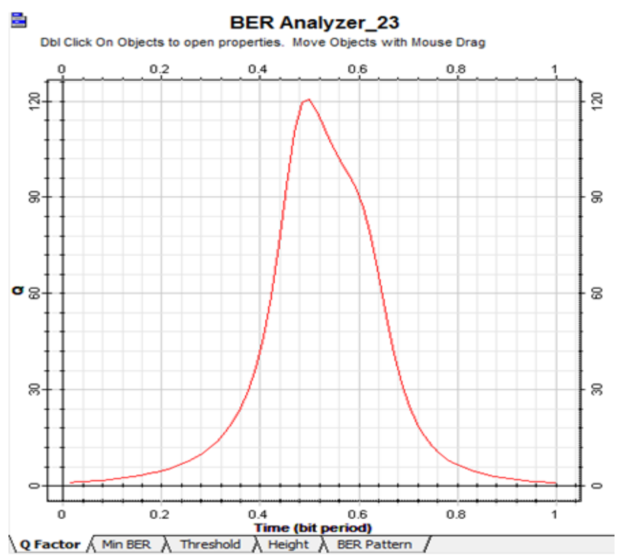


Fig 6 (a)

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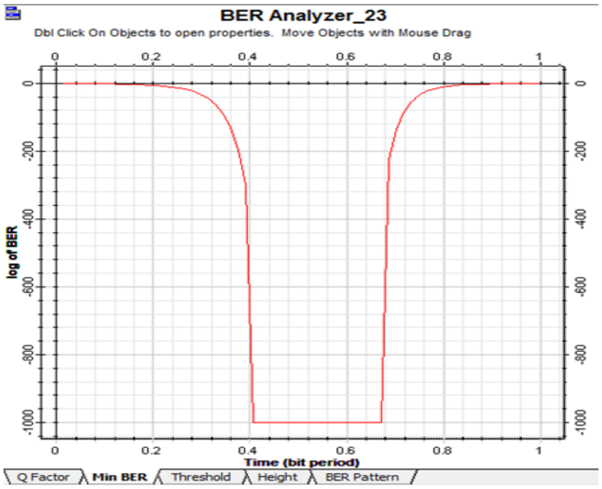

Fig 6 (b)

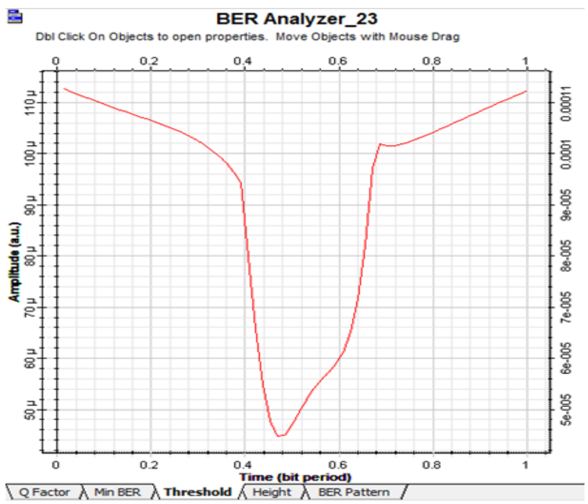

Fig 6 (c)

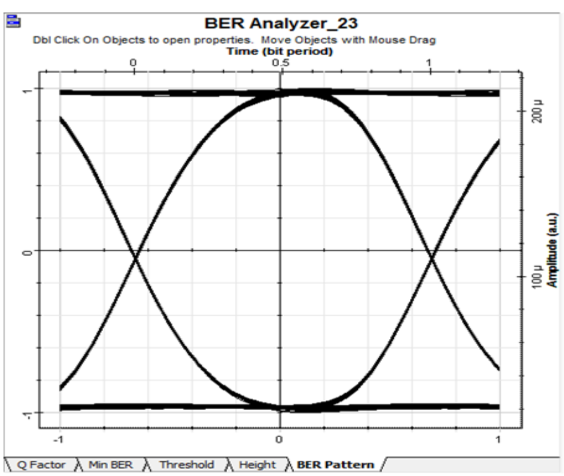

Fig 6 (d)

Fig 6 SCHOOL-MALL ONU2 Results

Table 5 Obtained Results of School Mall ONU2

Max. Q Factor	120.497
Min. BER	0
Eye height	0.000185369
Threshold	4.96148e-005
Decision Inst.	0.515625

The last block in downstream is BUILDINGS Block. As in the case of the business block, the paths that the signal covers are identical, so both ONU's will offer the same results:

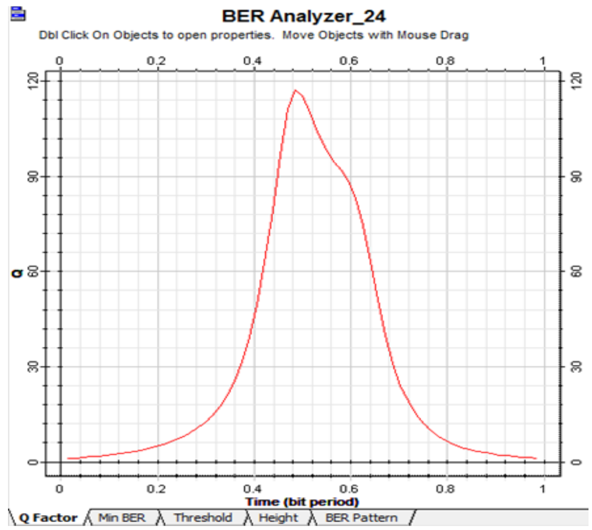

Fig 7 (a)

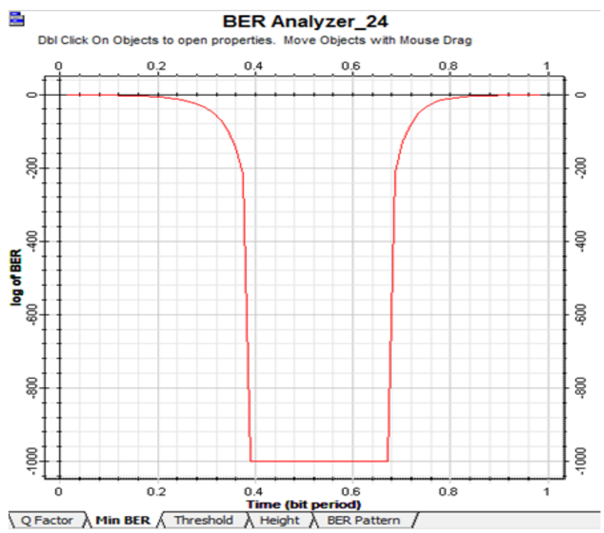

Fig 7 (b)

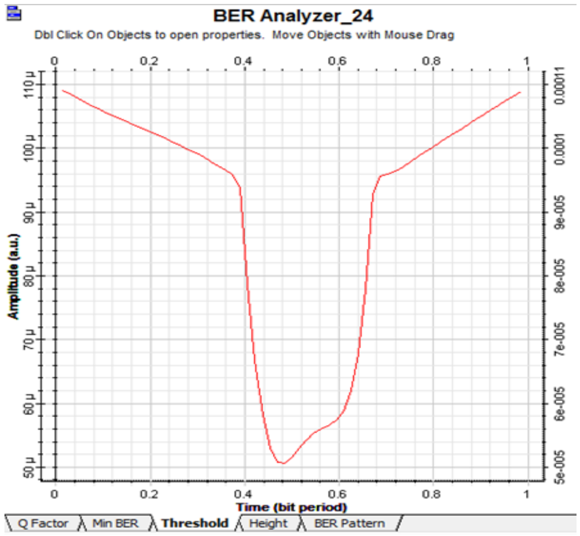

Fig 7 (c)

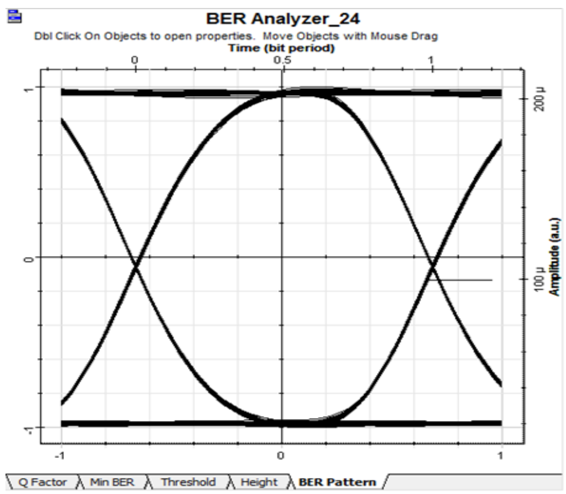

Fig 7 (d)

Fig 7 BUILDING ONU Results

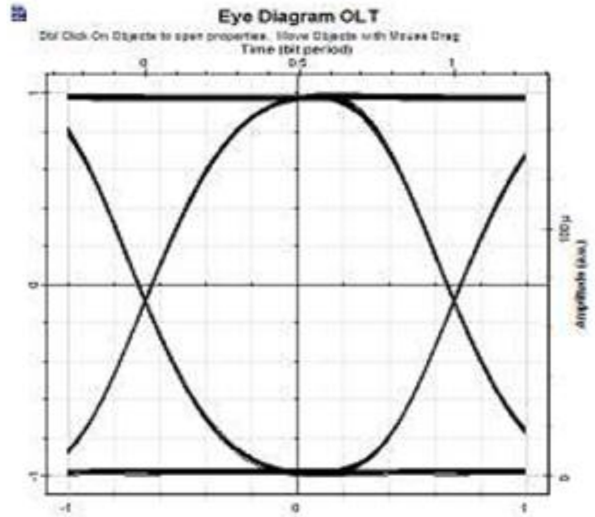

Fig 8 (a)

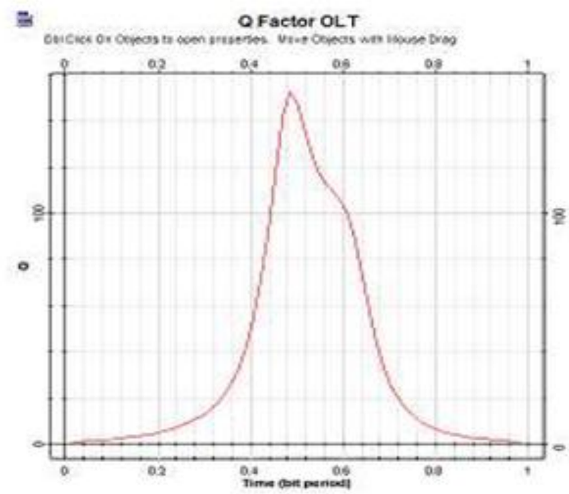

Fig 8 (b)

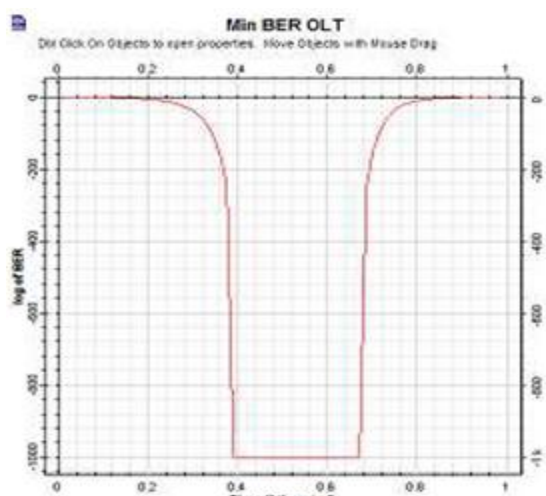

Fig 8 (c)

Table 6 Obtained Results of Building ONU

Max. Q Factor	117.217
Min. BER	0
Eye height	0.000178463
Threshold	5.15936e-005
Decision Inst.	0.5

As for the uplink, the results obtained in the OLT are:

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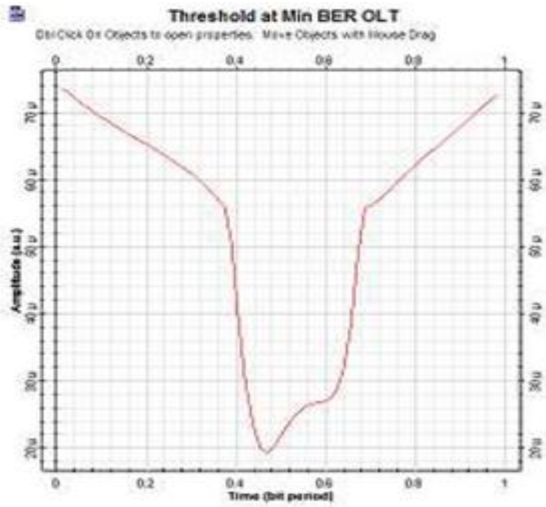

Fig 8 (d)

Fig 8 OLT ONU Results

Table 7 Obtained Results of OLT ONU

Max. Q Factor	152.686
Min. BER	0
Eye height	0.000148733
Threshold	2.18475e-005
Decision Inst.	0.5

II. CONCLUSION

Throughout the paper it has undertaken a number of general guidelines whose development has resulted in a thorough understanding of a passive optical network. These basically are:

· Theoretical detail and physical basis of the operation of optical networks.

· Planning and design of different types of networks.

· Simulation and obtained results by the designed network.

Finally, it has attached the obtained results in each of the ONT's, being these the eye diagram, the quality factor, the BER and the decision threshold for the minimum BER.

Other features that have the design is the high degree of availability and network capacity, the ability to integrate multiple systems and services and the possibility of interconnecting these networks with other wide area networks and adding local networks by creating LAN.

At present, there would have no sense to design a municipal network that is not expandable in the future to offer FTTH connections to each user. This paper has taken this into account and have raised a fiber network that bring the fiber to the maximum number of users so in medium to long term the current infrastructure is reusable for future use.

The deployment of next generation networks over FTTH networks is becoming more common and the emergence of companies such as neutral carrier model are an important solution for the evolution of them. Companies that are launched in this field are increasingly common, with important views of the future at technological and economic level.

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REFERENCES

[1] Claudio Porzi, Yasuyuki Kado, Satoshi Shimizu, Akihiro Maruta, Naoya Wada, Antonella Bogoni, and Ken-Ichi Kitayama, "Simple Uplink SOA – Pattern Effects Compensation for Reach Extended 10G-EPONs," *IEEE Photonics Technology Letters*, vol. 26, no. 2, Jan 15, 2014.

[2] Dieu Linh Truong, Phan Thuan Do, and Anh T. Pham, "Optimization of Survivable Mesh Long- Reach Hybrid WDM-TDM PONs," *Journal of Optical Communication Network*, vol. 6, no. 1, Jan 2014.

[3] Rivael S. Penze, Joao B. Rosolem, Ulysses R. Duarte, Getulio E. R. Paiva, and Renato Baldini Filho, "Fiber Powered Extender for XG-PON/G-PON Applications," *Journal of Optical Communication Network*, vol. 6, no. 3, Mar 2014.

[4] Xiaomin Liu, George N. Rouskas, Feng He, and Huagang Xiong, "Multipoint Control Protocol with Look- Ahead for Wavelength Division Multiplexed Ethernet Passive Optical Network," *Journal of Optical Communication Network*, vol. 6, no. 2, Feb 2014.

[5] Yuanqiu Luo, Xiaoping Zhou, Frank Effenberger, Xuejin Yan, Guikai Peng, Yinbo Qian, and Yiran Ma, "Time- and Wavelength-Division Multiplexed Passive Optical Network (TWDM-PON) for Next-Generation PON Stage 2 (NG-PON2)," *Journal of Lightwave Technology*, vol. 31, no. 4, Feb 15, 2013.

[6] Zaineb Al-Qazwini, Madhan Thollabandi, and Hoon Kim, "Colorless Optical Transmitter for Upstream WDM PON Based on Wavelength Conversion," *Journal of Lightwave Technology*, vol. 31, no. 6, Mar 15, 2013.

[7] Sang-Rok Moon, Hoon-Keun Lee, and Chang-Hee Lee, "Automatic Wavelength Allocation Method Using Rayleigh Backscattering for a WDM-PON With Tunable Lasers," *Journal of Optical Communication Network*, vol. 5, no. 3, Mar 2014.

[8] Abhishek Dixit, Bart Lannoo, Goutam Das, Didier Colle, Mario Pickavet, and Piet Demeester, "Dynamic Bandwidth Allocation With SLA Awareness for QoS in Ethernet Passive Optical Networks," *Journal of Optical Communication Network*, vol. 5, no. 3, Mar 2013.

[9] Jonathan M. Buset, Ziad A. El-Sahn, and David V. Plant, "Experimental Demonstration of a 10 Gb/s Subcarrier Multiplexed WDM PON," *IEEE Photonics Technology Letters*, vol. 25, no. 15, Aug 1, 2013.

[10] Jingjing Zhang, Mina Taheri Hosseinabadi, and Nirwan Ansari, "Standards-Compliant EPON Sleep Control for Energy Efficiency:

Design and Analysis," *Journal of Optical Communication Network*, vol. 5, no. 7, July 2013.

[11] Mirjana R. Radivojevic´ and Petar S. Matavulj, "Highly Flexible and Efficient Model for QoS Provisioning in WDM EPON," *Journal of Optical Communication Network*, vol. 5, no. 3, Mar 2013.

[12] M. Presi, A. Chiuchiarelli, R. Corsini, E. Ciaramella, "Self-Seeding of Semiconductor Lasers for Next-Generation WDM Passive Optical Networks," *ICTON* 2013.

[13] Tiago M. F. Alves, Maria Morant, Adolfo V. T. Cartaxo, and Roberto Llorente, "Design of Directly Modulated Long-Reach PONs Reaching 125 km for Provisioning of Hybrid Wired–Wireless Quintuple-Play Service," *Journal of Optical Communication Network*, vol. 5, no. 8, Aug 2013.

[14] Hehong Fan, Jianqing Li, and Xiaohan Sun, "Cost-Effective Scalable and Robust Star-Cross-Bus PON Architecture Using a Centrally Controlled Hybrid Restoration Mechanism," *Journal of Optical Communication Network*, vol. 5, no. 7, July 2013.

[15] Hui-Tang Lin and Ying-You Lin, "Intra-ONU Bandwidth Allocation Games in Integrated EPON/WiMAX Networks," *Journal of Optical Communication Network*, vol. 5, no. 6, June 2013.

[16] T. Orphanoudakis, E. Kosmatos, J. Angelopoulos, and A. Stavdas, "Exploiting PONs for Mobile Backhaul," *IEEE Communications Magazine*, Feb 2013