Simulation for the improvement of the performance of the digital transmission chain between Oum El Bouaghi and Ain Mlila

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Abstract
The aim of this work is to study and precisely adjust the values of the parameters of the components used at the level of the transmitter, receiver and physical support modules of the digital transmission (optical fiber) using the OPTISYSTEM 7 simulator, in order to improve the quality and the binary error rate of the transmitted signal and subsequently the development of the performance of the transmission chain at a distance of 70 Km.
Keywords: *parameters, components, digital transmission, quality, performance*

I. Introduction

In view of the rapid changes in telecommunications services accessible to users, in particular enriched multimedia services such as very high-speed Internet, high definition TV, future access networks and home networks will soon have to be able to carry data streams of up to gigabit per second[1, 2, 3].

This demand for very high speeds goes far beyond the possibilities offered by current solutions based on coaxial cable (ADSL .....) [2].

The advantages of optical fiber as a transmission medium (high bandwidth, low propagation losses, immunity to electromagnetic waves) justify the important development of optical transmission systems over the last decade[3, 4].

Unfortunately the sensitivity to propagation defects increases with the flow rate, whether for linear effects due to chromatic dispersion (Chromatic Dispersion) or nonlinear effects essentially induced by the Kerr effect (dependence of the refractive index of the fiber of light intensity). Next-generation Optical Access Networks are intended to provide several services simultaneously on the common network. Access networks that can interconnect a larger number of users with symmetrical bandwidth of up to 10 Gbps per client will be required. The objective is to achieve the growing demand for QoS capacity, performance and quality of service, by exploiting the large bandwidth available on optical fiber. The challenge will be in exploiting the bandwidth of the fiber to the maximum to create a more structured network[5, 6].

Currently, copper access networks can transmit up to 30Mbit/s, provided you are close enough to the central, which is enough to simply surf the internet. With the arrival of new services, such as high-definition television, video on demand, remote data backup, remote monitoring, . . ., copper access networks do not have sufficient physical properties to meet the growing demand for throughput[6]. Optical access technologies have been developed to meet demands and offer users speeds ranging from 50Mbit/s to 1Gbit/s or even more in the future. The different access architectures proposed are the point-to-point (P2P), and the multipoint point or passive optical network (PON: Passive Optical Network) [7].

II. Theoretical study

II.1. Description of the transmission system Theoretical study

Our communication system is composed of three essential blocks : issuer, communication channel and receiver (see Figure 1)

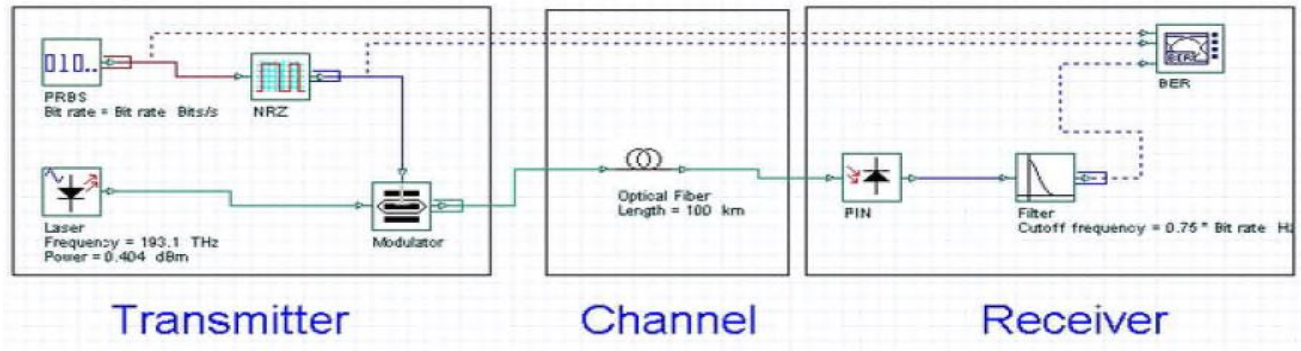

Figure 1 Optical Communication System Modules

II.2. Block 1

This block (see Figure 2) behaves to a transmission module, which consists of a laser diode produces a 193 THz carrier, a pseudo-random bit generator excites an RZ encoder which itself drives a Mach-Zehnder modulator.

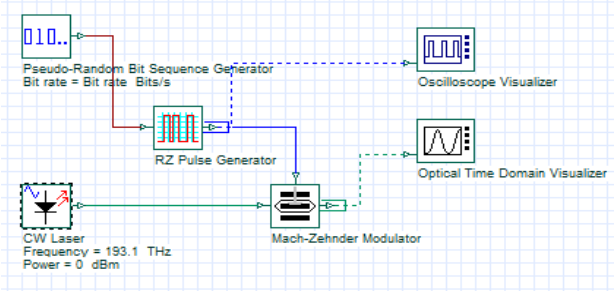

Figure 2 The transmission module

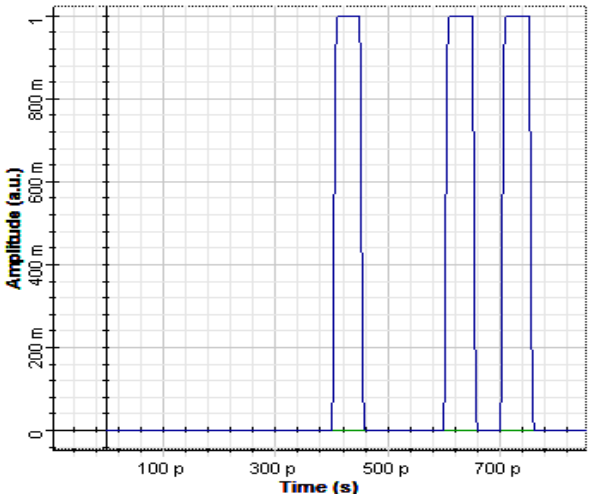

Figure 3 The signal at the output of the digital source (to be transmitted)

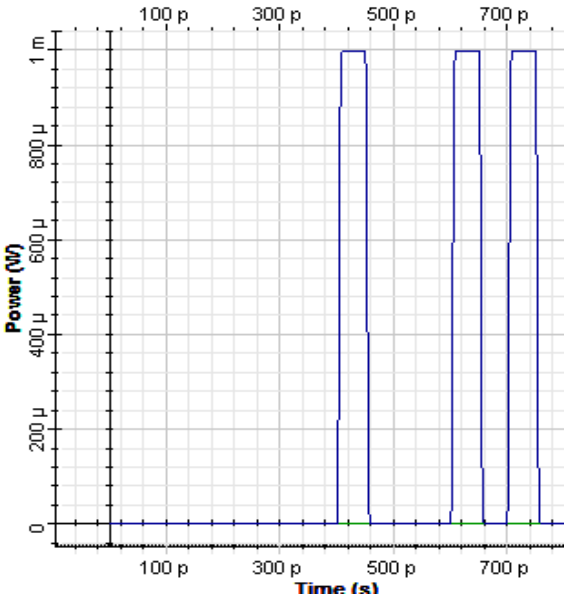

Figure 4. The signal at the output of the Mach-Zehnder Modulator

II.3 Block 2

This block has the physical digital transmission medium, which is an optical fiber type single mode (see Figure 5), the signal at the output of block 1, is amplified to recover the lost power within the Mach-Zehnder modulator, the signal at the output of the amplifier is injected into the optical fiber (block 2), the signal propagating through this type of support undergoes effects of the optical fiber (losses, chromatic dispersion, non-linear effects (Ker effect)) [8, 9, 10], The amplifier at the input of the optical fiber to recover losses at the Mach-Zehnder modulator, while qua the optical amplifier at the output of the fiber to recover losses in the optical fiber.

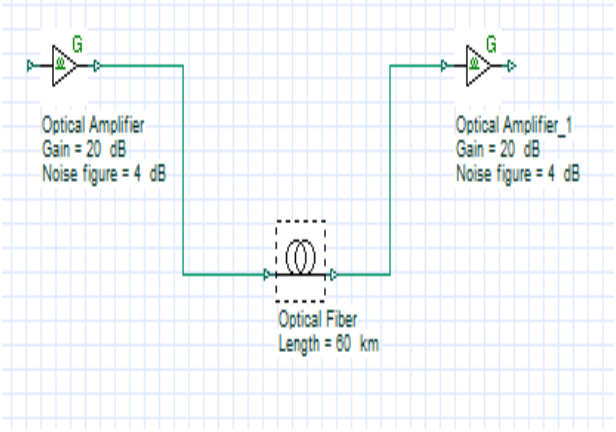

Figure 5. Block 2

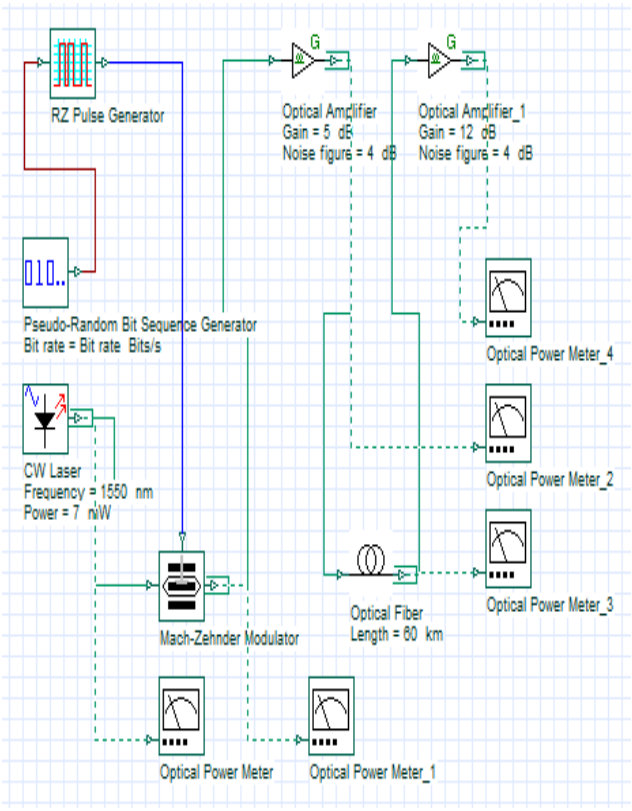

Figure 6. Power balancing.

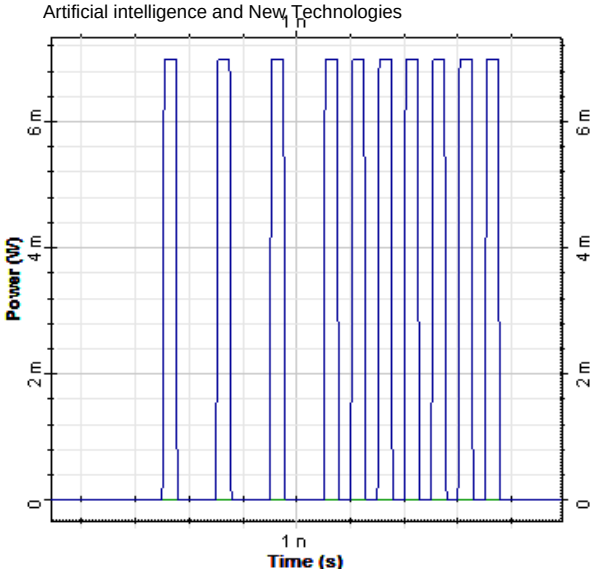

Figure 7. Time signal at the input of the fiber before amplification.

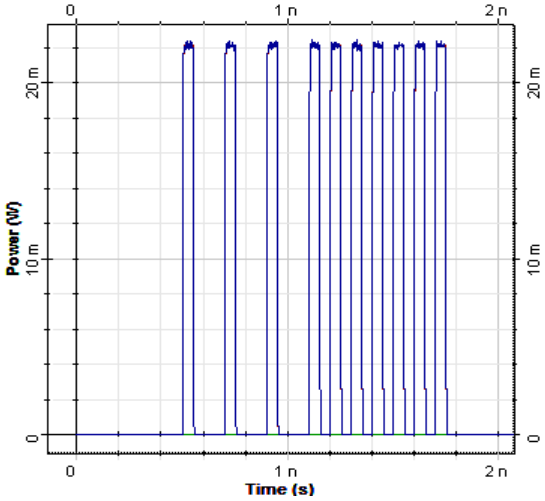

Figure 8. Time signal at the input of the fiber after amplification.

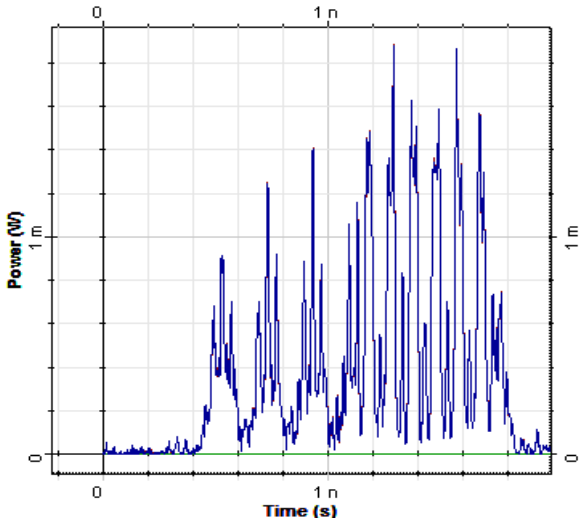

Figure 9. Time signal at the output of the fiber before amplification.

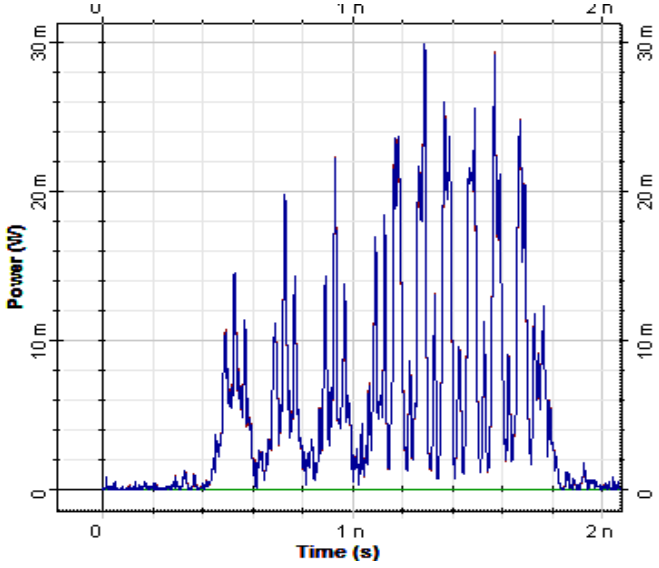

Figure 10. Time signal at the output of the fiber after amplification.

II. 4 Block 3

This block behaves to a PIN photodetector diode, is a component that transforms the light energy into an electrical energy of the same shape, this component is placed in series with a low-pass Bessel filter (see Figure 11).

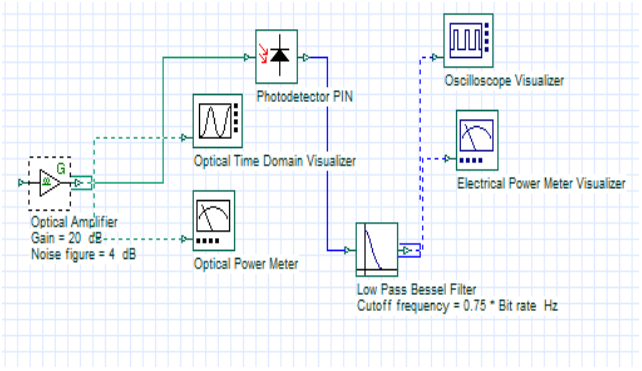

Figure 11. Block 3

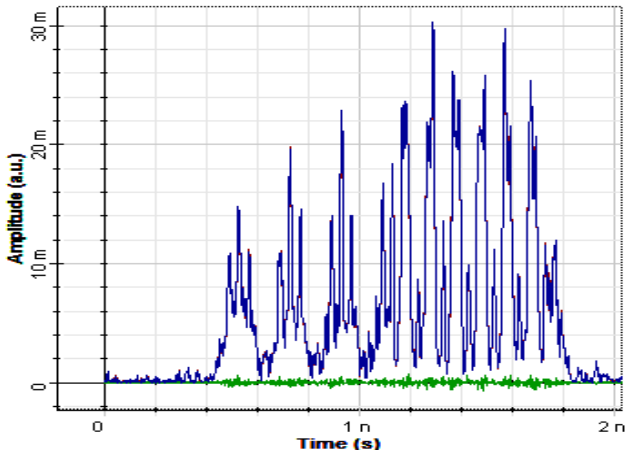

Figure 12. The time signal at the output of the PIN

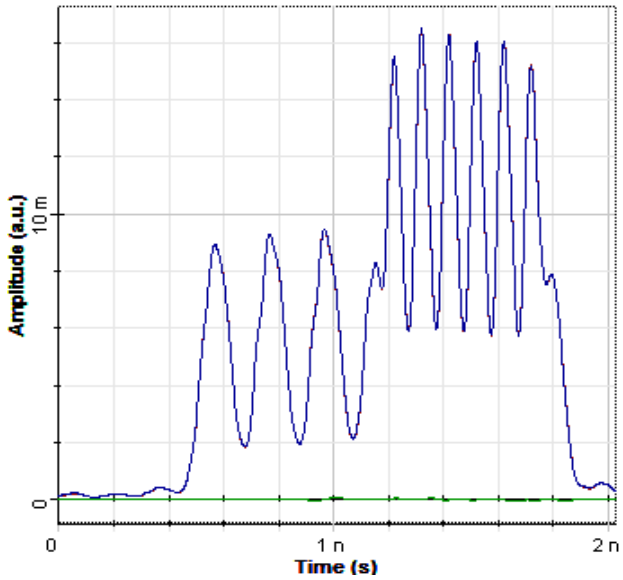

Figure 13. The time signal at the filter output

III. Digital simulation

Faced with the increasing complexity of the architectures and systems developed, simulation tools have acquired an important role. They are increasingly used to optimize the parameters involved in the realization of a system. They make it possible to predict results expected experimentally. They now also make it possible to use during a simulation, experimental elements such as signals recorded with measuring devices or curves characteristic of real components. In all that follows the simulation tool used is optisystem version 7[11, 12].

IV. Results and discussions

Despite the use of an optical amplifier at the output of one block to another or from one component to another in order to recover the power consumed (losses), we manage to balance the power but with amplitude jitters (see Figures 7 and 8).

At the level of block 2, it was possible to balance the optical power, but the length of the optical fiber influences the chromatic dispersion of order two which degrades the pulse (asymmetric distortion), (see Figures 9 and 10).

Also at block 2, the length of the fiber influences the modal dispersion of polarization (PMD), which causes the temporal jitter on the signal to be transmitted, (see Figures 12 and 13).

In addition at the level of the block 3 from Figures 12 and 13, one can notice the influence of the noise coming from the photo-detector diode PIN (Figure 12) before the filtering of the low-pass Bessel filter.

Because of these disadvantages mentioned above the use of optical fiber sections is necessary along the transmission line (see Figure 14).

The bit error rate analyzer gives us good signal quality recovered and an acceptable bit error rate (BER) (see Figures 15 and 16).

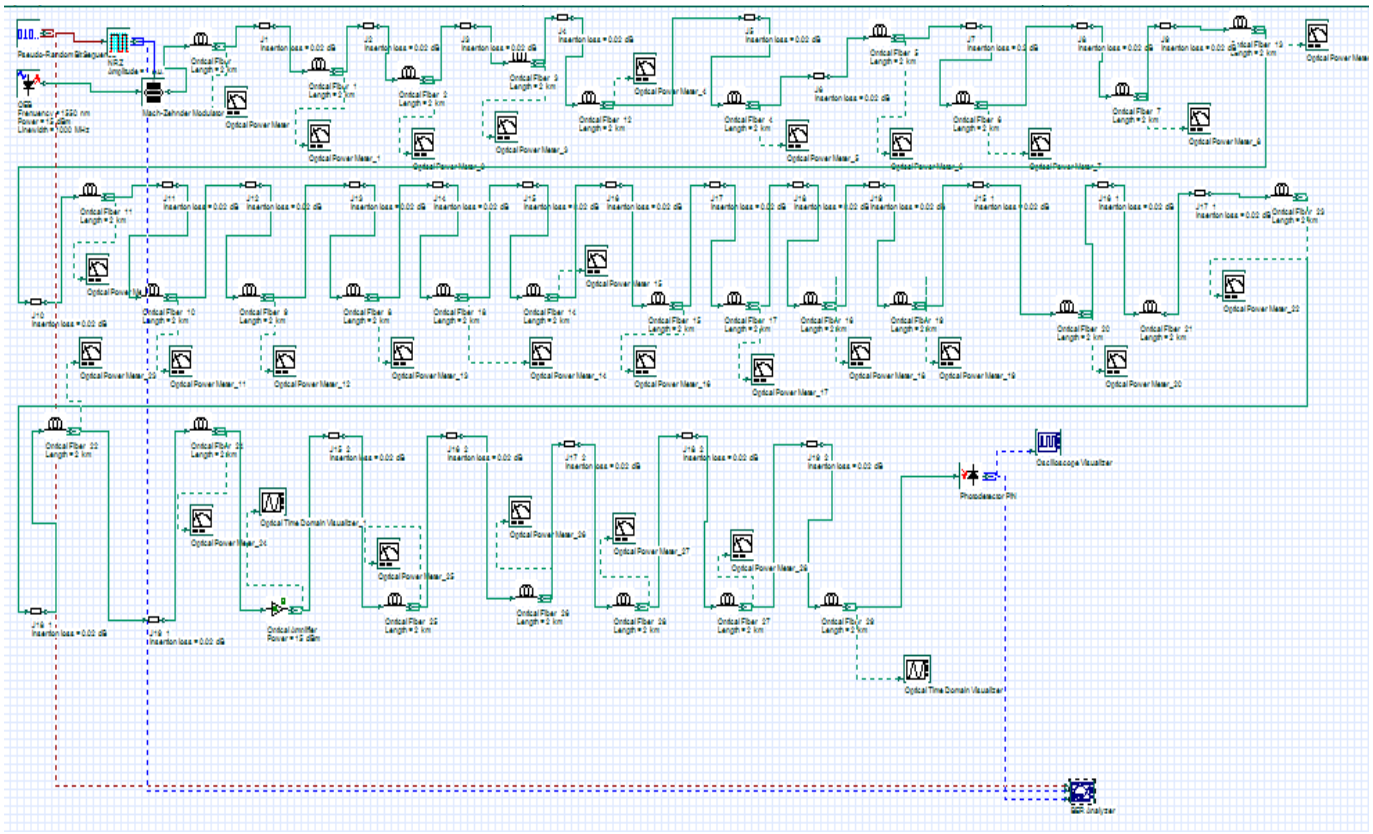

Figure 14. The actual chain of transmission

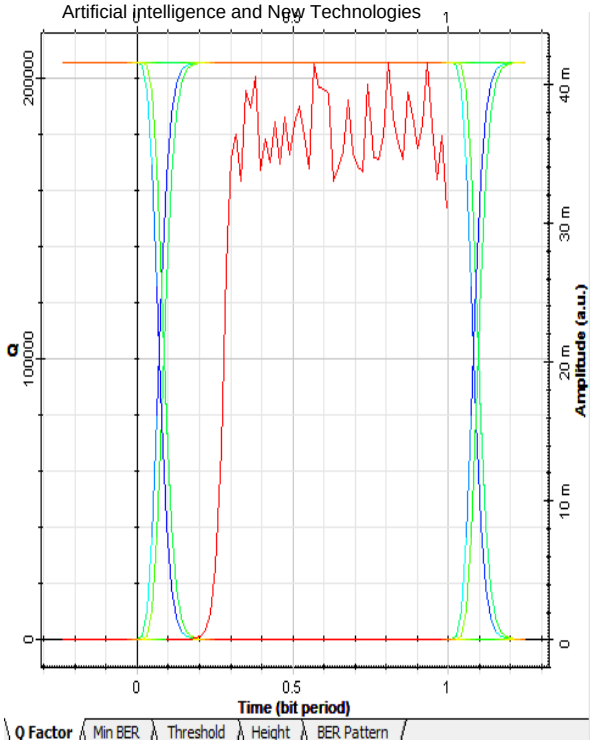

Figure 15. Quality of the recovered signal

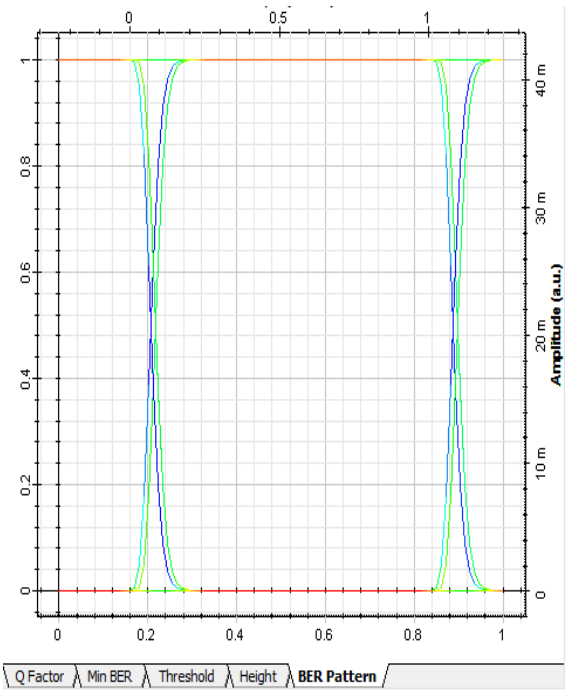

Figure 16. Transmission bit error rate

Conclusion

In order to transmit the growing mass of digital or analog information on the various networks and transmission chains with reliability and preserving a good quality of service. Indeed, this has necessitated the development of a communication system that is powerful and reliable enough to interconnect a constantly growing number of users across the globe.

To reduce the distortion of a signal across a transmission line, a compensating fiber must be inserted at the end of this optical link, but simulation results have shown that this cable causes a lot of losses that affect the distortion of the signal.

The final solution to improve signal quality is the addition of an amplifier and compensation cable, which is demonstrated by simulation.

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