

# The Design of Optical Routes Applications

Martin Kyselak<sup>1</sup> and Miloslav Filka<sup>1</sup>

<sup>1</sup> Department of Telecommunications, Purkynova 118, Brno  
Faculty of Electrical Engineering and Communication  
Brno University of Technology;  
[martinkyselak@phd.feec.vutbr.cz](mailto:martinkyselak@phd.feec.vutbr.cz); [filka@feec.vutbr.cz](mailto:filka@feec.vutbr.cz)

**Abstract.** Contemporary optical fibers can deal with almost all of the unfavorable effects which are known these days. They have sufficiently low specific slump, they can handle a slump caused by OH<sup>-</sup> ions, they can restrain the multimode effect and finally they can compensate a chromatic dispersion. But there is one problem, which the present science can't solve and this problem is the Polarization Mode Dispersion (PMD). This effect is a restricting factor of high-speed long-distance optical routes. The capacity increase of the existing optical routes is more often realized by multiplexing methods. Using more wavelengths makes multiplication of the optical fiber transfer rate possible. It evokes not only the advancement of fiber letting (known as "Dark Fiber" service), but more often also a single wavelength letting.

**Keywords:** optical fibre, design, application, pmd, polarization mode dispersion.

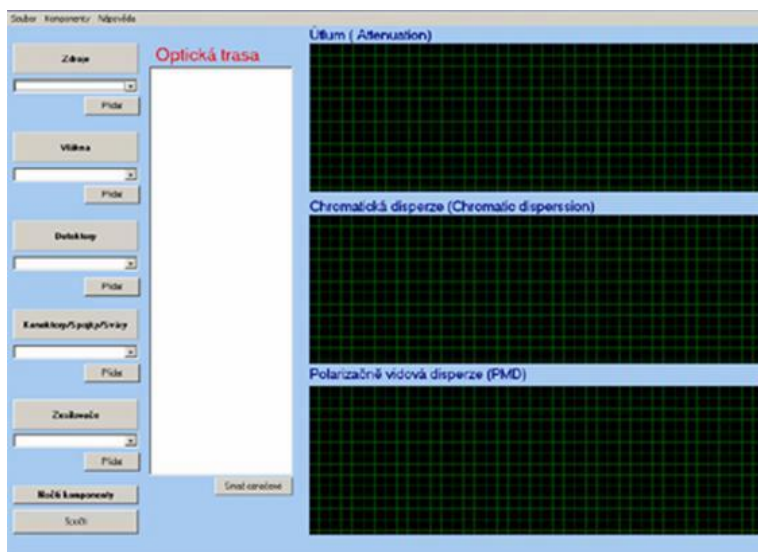
## 1 Introduction

Contemporary demand for data services is not a realistic demand anymore because of capabilities of currently existing optical routes. Services like Video on Demand, videoconference, real-time audio and video streams, large-file transmissions and other multimedia services lead to an increasing demand for transmission capacity. The quick transport layer is not established only on high-quality end-point equipment with sufficiency throughput, but it is necessary to ensure an equivalent physical layer by optical fiber routes.

## 2 Interface Description

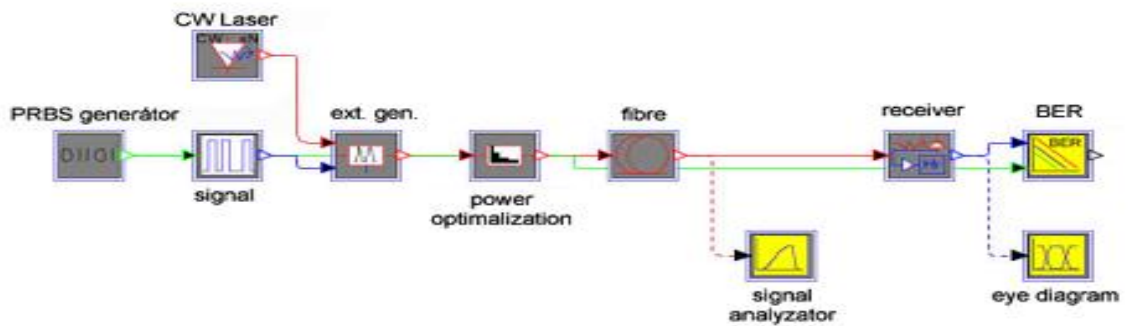
The project documentation, including DGD values analysis along the optical fiber, is very important in order to build up a new optical route. The paper deals with efforts to develop the new complex application set to demonstrate the attenuation values and chromatic dispersion values. Further the applications, which can be able to simulate and calculate the probable PMD value by various ways in MATLAB environment.

OptView Application – is considered as an overall route overview. OptView will be a complex application which can depict the behavior of the basic values along the route. Fundamental features include the selection of: optical components, route parameters, modification possibilities, libraries reading, component selections and also fully automatic route protocol creating and of course creating and printing of attenuation and dispersion values graphs. OptView application is using a simple linear mathematics to determine the particular attenuations and to determine a total value of chromatic dispersion. The PMD calculation will be made by unsophisticated sum of partition squares bellow the square root. The preview is shown in the fig. 1.



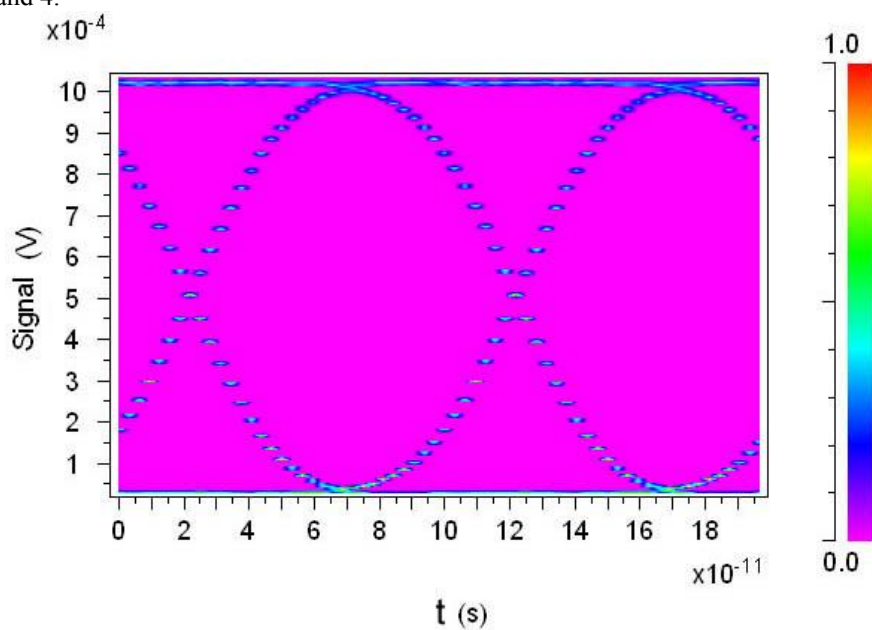
**Fig. 1.** The OptSim preview

MATLAB simulation process is being prepared for both of the polarized waves. It is a complicated three-dimensional simulator with the “mode delay regulation” option and “watch the vector sum” option. The result of the simulation will serve for the transparent depiction of complicated physical principles of light polarization results, which are not really easy to grasp mathematically and present them in an easy way. Thanks to the option of “mode delay regulation”, the simulator will be fabulous to estimate the PMD effect on the multi-channel optical transmissions, especially on the dense wavelength multiplexing optical systems - DWDM. As an aid in simulation program development in Matlab environment, a 30-day trial version of OptSim application was provided by Safibra Company. The connection diagram is shown in the fig. 2.

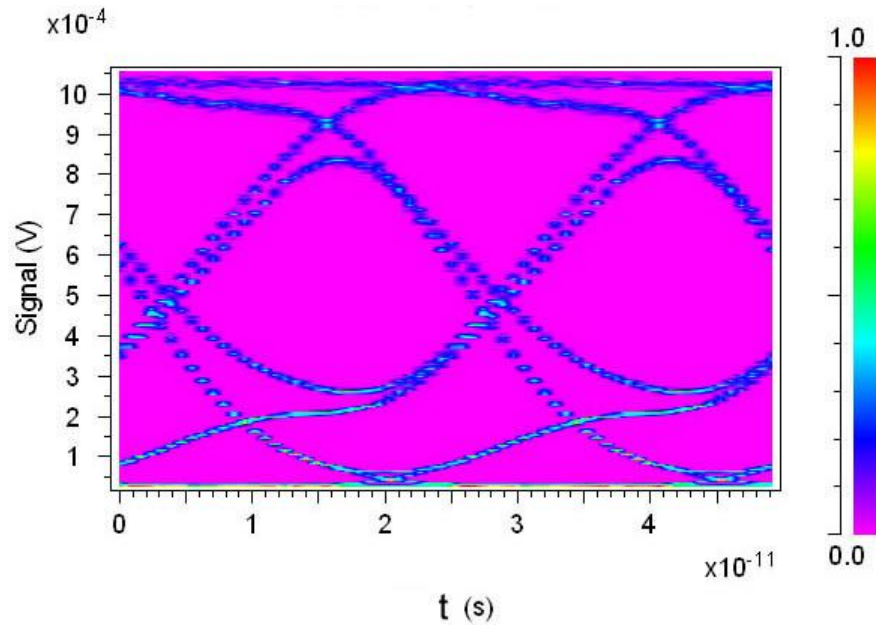


**Fig. 2** The OptView connection diagram

Thanks to a sophisticated function, which can draw an “eye diagram”, application outputs were used in order to compare it to the results from simulation that is currently being developed. For individual optical route input parameters, three “eye diagrams” have been generated. Two most important of them are shown in the figure 3 and 4.



**Fig. 3** Eye Diagram, 10 Gbps

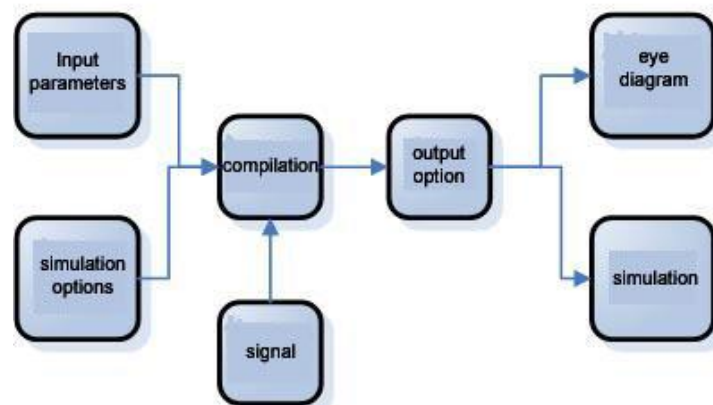


**Fig. 4** Eye Diagram, 40 Gbps

Obviously clear depiction is caused by intentional omission of all influences on the optical transmission, except PMD. Following optical paths were used for the simulation: length 50 km, fiber G.652.d, attenuation and chromatic dispersion - zero, PMD = 0,1 ps/sqrt km. Bit rate 10 Gb/s for the fig. 3 and 40 Gb/s for the fig. 4.

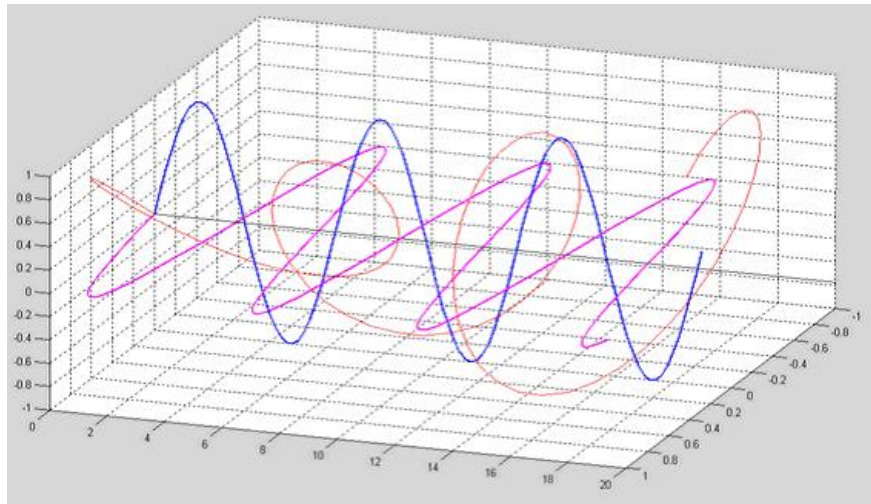
There is only a block diagram prepared for the simulation of compensation technique in MATLAB environment. The block diagram is shown in the figure 5. The first output from MATLAB application is shown in the figure 6.

**Simulation Application Block Diagram**



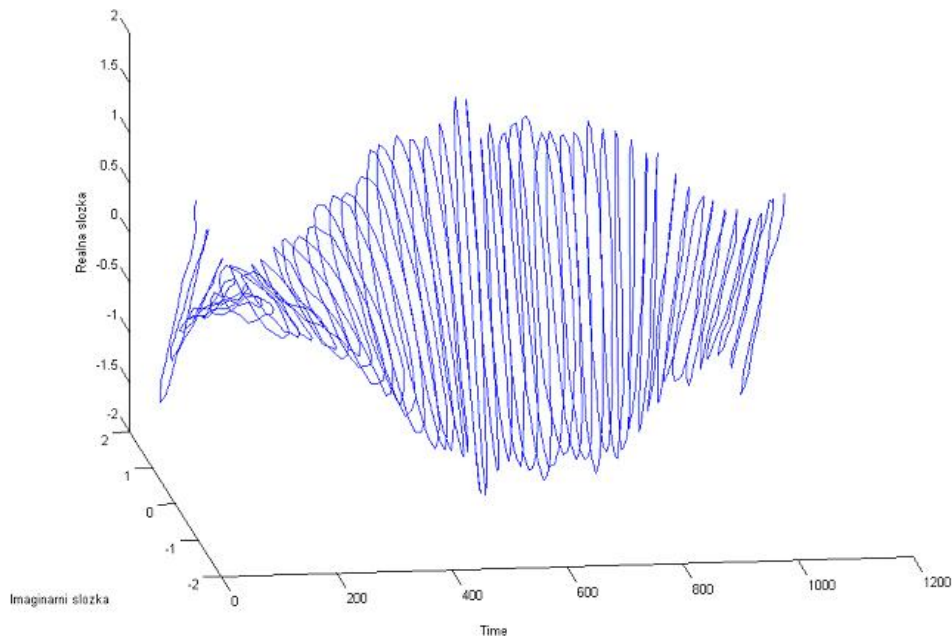
**Fig. 5** The Simulation Application Block Diagram

The application capable of simulating both of the polarization planes of optical ray going through the optical fiber is being completed. Similar principle has been used as for compensation techniques simulator. One of the simulation moments is shown in the figure 6. Instantaneous sum of vectors with different input parameters option can be seen here.



**Fig. 6** The Simulation Application Output

The output will be curves of all polarization planes in both channels. This application deals with the transmission of power among particular channels. In the figure 7 there is a vector showing a sum of both of the polarization (reciprocally delayed) planes in time “t”. The application calculates using the Maxwell distribution way and the probability of single DGD values occurrence [1]. Amplitudes are (for this example) non-dimensional values, since the values from the measuring are not used for the simulation, but the random values.



**Fig. 7** The Vector Sum in the Time  $t$

### 3 Conclusion

All the applications mentioned above can be used to obtain any accessible data about existing or planned optical paths. These application results will lead to an effective judgment of polarization mode dispersion resultant value. The partial results will lead to the frailest place of the paths locating in light of dispersion and will help with planning really high-capacity long-distance optical paths. Simulation results will also be used to determine the final values and polarization factors, and with advantages it can be used to assess the causes of each influence and precede them effectively. Appreciable advantage is transforming a mathematical machinery of optical physics (optic polarization) to the transparent graphical illustrations with “input parameters choice” option.

Final results and application outputs will be compared to each other and investigated in the future. It will be possible to presume the causes of aggravated parameters and to localize the place with the largest portion of total PMD value. Finally there will be a comparison of theoretically and practically obtained values - gained by measuring on existing paths. The equipment FTB-5500B and POTDR (Polarization Optical Time Domain Reflectometer) will be used for measuring. By a mutual comparison of calculated and measured values, it will be possible to evaluate the successfulness of

the whole work. In case of equivalence of partial results and total results, the developed applications might be used as a professional part of design for high-speed multi-channel optical paths designers and developers.

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