International Journal of Engineering and Advanced Technology (IJEAT)
ISSN: 2249-8958 (Online), Volume-6 Issue-6, August 2017

Digital Transmission over Optical Fiber

Diouba Sacko, Hassana Ganamé

Abstract: Surrounded by the cladding of lower refractive index, the optical fiber is a guide of wave which exploits the refractive properties of the light. It is a physical transmission channel used for the propagation of luminous signals modulated in wavelengths. Compared with the other existing transmission channels, it presents an almost constant attenuation on an enormous interval of frequencies and thus offers the advantage of large band-widths. By allowing the communication on a long distance, the optical fibers constitute one of the key channels of the telecommunications. Information to be transmitted is either analogical or discrete; however the digital transmission by optical fiber constitutes the main use of optical fiber connections. Indeed, because of their limited performance, optoelectronic components such as LED, laser, photodiode or phototransistor are not the best ones in the analogical multiplexed transmissions. The development of the diode-pumped, erbium-doped fiber amplifier (EDFA) played a crucial role in enhancing the feasibility and performance of long-distance and WDM applications. The emission module of an optical link is made up of various components (laser, modulator, driver…). It provides to transmission channel a visible signal on which the data are been registered. The external technique of modulation to 40 Gbits/s was retained because beyond 5 Gbits/s, the external modulation is essential to maintain a quality of correct transmission. The principal element of the transmission channel is the optical fiber. It offers a very great transport capacity, larger than the opto-electronics converters and the electronic components. The reception module converts the information carried by the modulation of the luminous signal into pulses. It is composed of a photodiode, an electrical amplifier, a filter and a regenerator. In this study, simulation system was been used in order to optimize an optical link with 40 Gbits/s in temporal electronic multiplexing (ETDM) and to evaluate the drifts impact of the parameters of the components on the performances of the optical systems. In this paper, the simulator system COMSIS was retained, it allows the researchers and the engineers to model, simulate, analyze and design any module of treatment of the signal, from the most elementary device to the more complex communication system . It is an interactive environment which combines numerical tools with graphic functionalities and a user interface.

***Index Terms**: Digital transmission, Optical fiber, Modulation, Simulation.*

I. INTRODUCTION

Telecommunications allow the communication remotely. Their goal is to transmit a signal, carrying information from source to destination.

Manuscript published on 30 August 2017.
***** Correspondence Author (s)
Diouba Sacko, Département Génie Industriel, Ecole Nationale d'Ingénieurs – Abderhamane Baba Touré (ENI-ABT), Bamako, République du Mali, E-mail: sacko_dioba@hotmail.com / sacko_dioba@yahoo.com
Hassana Ganamé, Département Génie Industriel, Ecole Nationale d'Ingénieurs – Abderhamane Baba Touré (ENI-ABT), Bamako, E-mail: ganamé_hasana@yahoo.fr

© The Authors. Published by Blue Eyes Intelligence Engineering and Sciences Publication (BEIESP). This is an open access article under the CC-BY-NC-ND license http://creativecommons.org/licenses/by-nc-nd/4.0/

To do that, we must elaborate techniques effective of transmissions called transmission networks. The capacity of the traditional transmission channels such as the copper wire or the coaxial cable was been congested because of increase of needs in the field for the communication. Thus, we passed from the copper cable to radio system then to the optical cable.

The fastest means to transmit information is certainly the light. The transmission with a negligible disturbance of information from one point to another is carried out by using a guide of light (optical fiber).

The optical fiber is a guide of wave which exploits the refractive properties of the light. It is a physical transmission channel used for the propagation of luminous signals modulated in wavelengths. Compared to other transmission channels, it presents an almost constant attenuation on a large interval of frequencies and thus offers the advantage of large band-widths. Nowadays, it is possible to transmit very significant numerical sequences required because of the multiplication of the services and the needs increased for data transmission. It is more reliable, more powerful and has a low cost compared to the coppered cables. The optical fibers are also used in spectroscopy and photometry. In those cases, they must transmit the large spectral band possible and present a great homogeneity on the entire diameter.

There are two main types of fibers: the multimode (step index and graded index fibers) and the monomode or single mode. The multimode fibers are used for applications on short distances, while the monomodes are especially used for telecommunications applications and thus on long distances.

The installation of optical fiber is made in a protected medium, the protection of the fiber itself being ensured by a shielded cable. These measurements of installation allow a good mechanical protection and guarantee an excellent reliability.

To ensure the continuity of the services of the data transmission, the great difficulty does not reside at the level of the transmission channel which has a broad frequency band and a very weak attenuation but at the level of emission and reception modules. Indeed, to carry out a qualitative transmission system between the transmitter and the receiver, it is necessary to overcome the insufficiencies resulting from the optoelectronic components within these modules.

II. STRUCTURE OF PAPER

The work is subdivided in two chapters. The first gives the general information about various components and different modes of transmission.

The second simulates the digital transmission line, using the simulator COMSIS (Communication System Interactive Software).

Published By:
Blue Eyes Intelligence Engineering and Sciences Publication (BEIESP)
© Copyright: All rights reserved.

III. DIAGRAM BLOCK OF THE BASIC LINKAGE

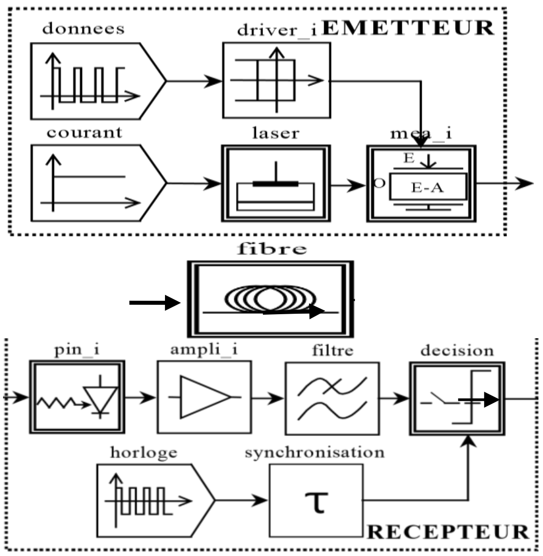


Figure 1: Diagram block of the basic connection

The diagram above shows the block diagram of the basic connection**.** The following paragraphs present the parameters characteristic of the operators present in library COMSIS and used for the construction of the transmitter, the transmission channel and the receiver.

A. Presentation of the Connection Blocks

Emission module

The modulation of the data must be made in an external way by using the laser. This article uses the modulator electro-absorbent (MEA). For simulation, five blocks were been used to compose the emission module.

Table 1 : Parameters characteristic of the MEA (Modulator Electro-Absorbent

Losses	-13 dB	Référence voltage	- 4 V
Coefficient of the exhibitor of the absorption function	2	Coupling coefficient phase - amplitude	-0,5

Curve of absorption of the MEA, using parameters summarized in the Table 1, is presented on the figure 3.

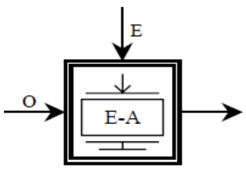


Figure 2: Model of simulation MEA

In an external modulation, the output power of the laser is continuous. This luminous signal is modulated by the modulator electro-absorbent. Output power of the transmitter is equal to the power delivered by the laser, decreased by the insertion losses and the absorption losses of the modulator.

$$P(fiber)_{dBm} = P(laser)_{dBm} - Pertes(insertion)_{dB} - Pertes(absorption)_{dB} \quad (1)$$

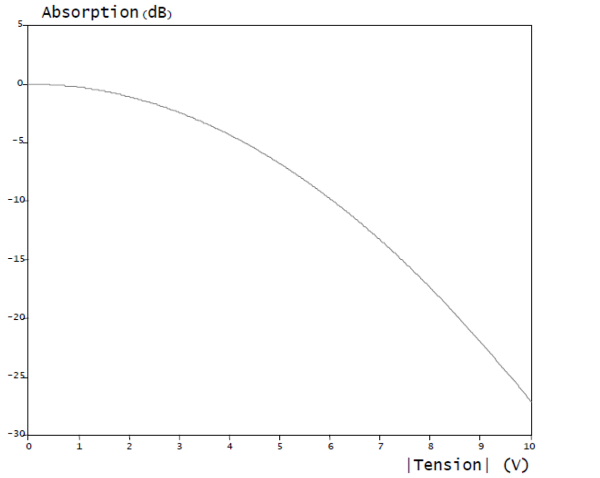


Figure 3: Curve of absorption of the model of MEA according to the received electric tension.

For a null tension, the modulator is traversed by the received current at its optical entry. For a negative tension, the modulator absorbs a proportion of the optical signal. The reference voltage (- 4 V) indicates that the modulator will be used when the electrical tension will be in the interval (- 4V, 0V). Out this interval, the performance of the component will decrease. Within this interval, we will feed the modulator by an optical signal from laser, representing the information to be transmitted.

The Laser

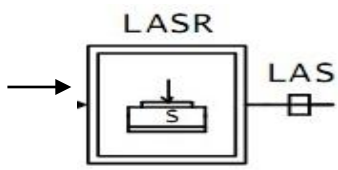


Figure 4: Laser simulation model

This model simulates a diode "DFB". For its description, we use its internal physical parameters or its parameters "systems". For our simulation, we use the parameters "systems".

Tableau 2: Characteristic parameters of the laser

System parameters of the laser¶		Laser data	
Wavelength	1550 nm	Reflexion factor	0,25
Threshold current	25 mA	Differential output	0,6
Output	0,25 W/A	Spontaneous emissivity	2
Sampling width	5 MHz à 60 mA	Height of the cavity	0,1 µm
Attenuation rate	2 GHz à 100 mA	Width of the cavity	5 µm
Band to -3 dB	10 GHz à 100 mA	length of the cavity	200 µm
Spacing between mode	1 nm	Density carrier-transparency	5.1017cm^{-3}
Chirp	100	Factor of	0,1

Published By:
Blue Eyes Intelligence Engineering and Sciences Publication (BEIESP)
© Copyright: All rights reserved.

	MHz/mA	contaminent	
Noise RIN	-145dB/Hzà1 00 mA		

The RIN mean value that we used is the typical value of the bit rates (40 Gbits/s). Let us note that parameters such as the depreciation rate or the laser chirp don't affect the external modulation because the laser emits continuously.

The current of the Laser feeds the laser. The value of the command current is determined by the characteristics of the diode whose characteristics however depend on selected fiber.

The output power of signal at the exit of the laser changes according to its command current.

Since the optical signal is modulated at the entry of the fiber, we chose the maximum power to 2MW. The insertion losses on the level of the modulator are equal to 13 (dBm), the emitted power by the laser is equal 16 (dBm).

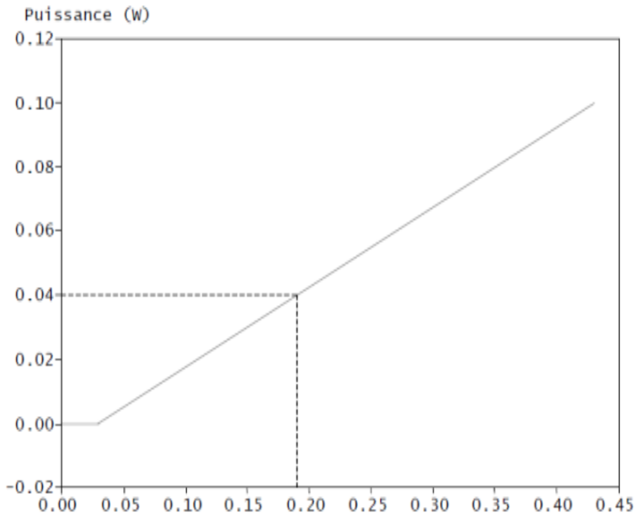


Figure 5: **Variation of the optical power in function of the command current of the laser.**

The above characteristic (figure 5) from static analysis gives us 190 mA as injected current into the laser. For simulation of the laser command current (constant current) we used shown block in Figure 6.

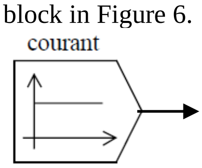


Figure 6: **Simulation model of the laser command current**

The electrical data circuit

The Sequence-Binary-Pseudo-random operator (within the software COMSIS) is used for the simulation of electrical data. Its symbol is shown on the figure below. The entry parameters representing information to be transmitted are 40 Gbits/s as binary rate and 23 as register length.

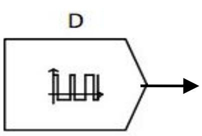


Figure 7: **The simulation model of pseudo-random data NRZ**

The choice of the register length (*N) determines* the sequence period, which is equal to *2N-1* for the sequences with the maximum length (in COMSIS, 2 ≤ N ≥ *34*).

The Driver

Transmitted message is already modeled. However, the electrical levels at the exit of this block are not appropriate for the used modulator. Indeed, the MEA does not function when tension is equal to + 1 Volt and it absorbs very low when it is equal to - 1 Volt (0, 27 dB, that is to say an absorption slightly higher than 1%; Figure 8). So, it is necessary to modify high and low values of the binary sequence (40 Gbits/s). That is the role of the driver. The modulator electro-absorbent is configured so that the amplitude modulation becomes maximum; in order to separate the optical levels during the transmission. Usually, we assume that the driver is ideal; it converts the low level of -1 V to - 4 V, and the high level from + 1 V to 0 V, without disturbing the step of the signal. In COMSIS, there is an operator who modifies the various levels without deformation of the signal and which plays the role of the ideal driver (threshold detector).

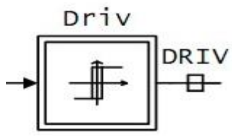


Figure 8: **driver simulation model**

Table 3: **Characteristic Parameters of driver**

Characteristic *Parameters of the driver*			
Low level of detection	- 1V	Exit low level	- 4V
High level of detection	+ 1V	Exit high level	0V

B. Optical Fiber

The transmission chain uses the SMF fiber (Single Mode Fiber) whose characteristics are detailed in Table 4.

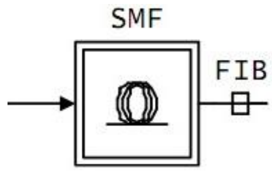


Figure 9: **Simulation model of the SMF fiber.**

Table 4: Characteristic parameters of the SMF fiber

system parameters of transmission fiber(SMF)	
Length (km)	53
Attenuation (dB/km)	0,25
Chromatic dispersion (ps/nm/km)	17
Kerr Effect	Yes
Raman Effect	No
Coefficient of non linearity (m^2/W)	$2{,}7.10^{-20}$
Effective surface of the section (μm^2)	80
Step value (km)	1
Modal dispersion of polarization	No
Delay (ns)	4

Published By:
Blue Eyes Intelligence Engineering and Sciences Publication (BEIESP)
© Copyright: All rights reserved.

Beyond 2.5 Gbits/s, we will be confronted to the problem of chromatic dispersion. Moreover with the components chirp (in particular the coefficient of coupling phase/amplitude of the external modulator); chromatic dispersion in a channel is due to a deformation of the luminous impulses transporting information. Indeed; various optical frequencies give us different speeds of propagation. The problem will be even acuter when a WDM multiplexer is installed. Thus, WDM channels are shifted ones compared with the others.

Reception

The objective of the reception module is to convert the luminous signal into pulses. It is composed of photodiode , electrical amplifier, filter and regenerator.

The Photodiode: P.I.N

The model available in COMSIS is an operator representing a photodiode "P.I.N". Its characteristic parameters are its sensitivity (0.8 A/W) and its darkness current (5 nA).

The darkness current, I_{obs} is the current which circulates in junction P.I.N in the absence of illumination.

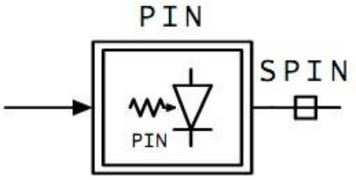
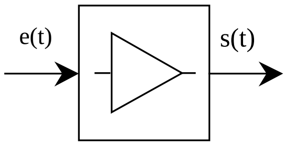


Figure 10: Simulation model PINE

The electrical amplifier

The luminous signal has been attenuated during its propagation, and the photodiode P.I.N does not emit a sufficient current. Thus, an amplification of the signal is necessary before making decision. The model of electrical amplifier, available in COMSIS, is an operator named PROFIT (Figure 11). This model multiplies the input signal by a constant.



s(t) = G.e(t) avec G_{dB} = 20.Log(G) (2)

Figure 11: Simulation model of the electrical amplifier

The value of the attenuation is a formal parameter. For our simulation, it has been fixed to 20 dB to have a diagram of the eye standardized around the threshold before the decicion operator.

The filter

During its propagation, the signal has been affected of noise when passing by various components. In order to attenuate this noise at the exit of the receiver, it is necessary to filter the numerical signal in the bandwidth [0 - ΔF] without creating the intersymbol interferences (IES), i.e. so that the response of the filter to a symbol to each moment of decision cancels the close symbols. Indeed, a low-pass filter has been inserted at the end of the chain. The model available in COMSIS is called low-pass FILTER of CONTINUOUS (diagram 12). Diagram 13 presents the simulation model of the reception filter.

Filter of Bessel

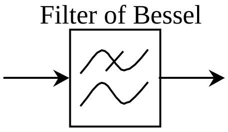


Figure 12: Simulation model of the reception filter.

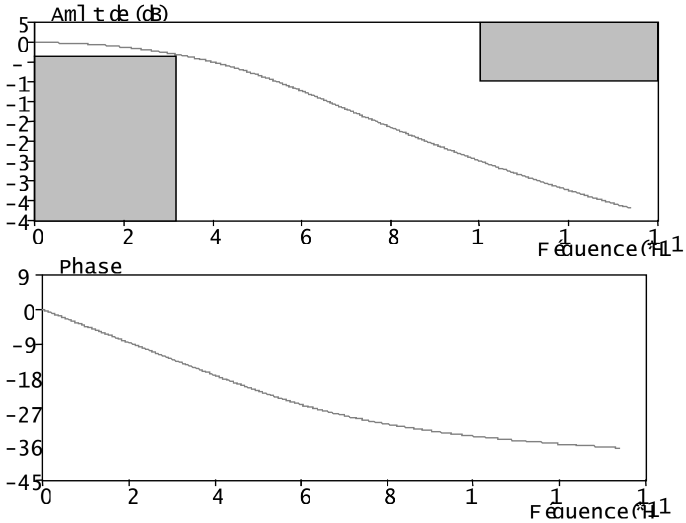


Figure 13: Simulation model of the reception filter.

The parameters of the filter used in this simulation are as follows:

A sampling rate (in the case of a numerical filter) of 2AF = 80 GHz, where ΔF indicates the width of spectrum of the signal (ΔF = 40 GHz).

A Low-pass filter of Bessel type of order 5, cut-off frequency equal to 32 GHz.

A maximum attenuation tolerated in the bandwidth: A1 = 3 dB. Minimal attenuation tolerated in the cut band: A2= 5.91553 dB, A2 = kA1 with A2 > A1 and k entire multiple.

The model decision operator available in COMSIS is shown in the Figure 14 below.

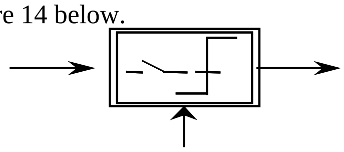


Figure 14: Simulation model of the decision-making body.

This diagram has an exit and two inputs. The exit represents a regenerated binary signal. First input comes from the filter and the second is from a signal clock synchronized at the frequency rhythm of the signal. Amplification of the electrical amplifier has been selected so that the signal at the input of the decision block is standardized around the threshold. The decision is put at the rising level of the clock and done at the center of bit of the signal to be regenerated, where the intersymbols interferences are minimal.

For the simulation, the decision threshold is fixed at 0, 5.

Thus, we decrease the possibilities of errors of decision. We use a clock (CLOCK) followed by a delay operator (Delay-continuous) and synchronization is carried out visually, on the diagram of the eye. The circuit of regeneration is represented on the following figure.

Published By:
Blue Eyes Intelligence Engineering
and Sciences Publication (BEIESP)
© Copyright: All rights reserved.

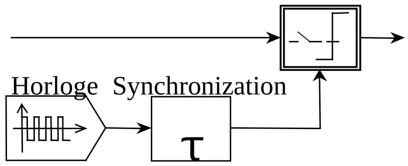


Figure 15: Simulation model of the regeneration circuit.

Visualization and treatment of the results COMSIS offers results based on the analysis of signals: power evaluation, Factor Q, signal to noise ratio, measure error rate…. Results called chart window are shown in a display screen (Figure 16).

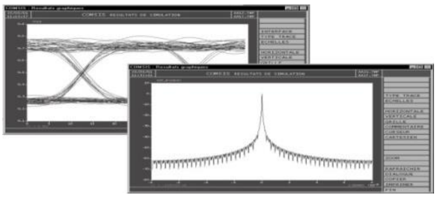


Figure 16: The display screen of the results.

IV. SIMULATION

A. Presentation of the Software

COMSIS (COMmunication System Interactive Software) is software used for the simulation. It has been developed by a French company, IPSIS. Researchers and Engineers use it in order to model, simulate, analyze and design any module of communication system. It is an interactive environment which combines numerical tools with graphic functionalities and an user interface. It's used to analyze analogical and numerical systems.

Software allows an easy construction of the block diagrams. Using its library, available models can be selected, interconnected and named. Before launching the analysis, the parameters must be defined, in discrete form or using a formal parameter. In addition, it will be necessary to insert intermediate variables (corresponding to the sizes of entry and exit operators) and to name them. Thus, the simulator will have access to the signals in each point of the diagram. After complete description of the system, we can carry out various temporal and spectral analyses (showed in the below diagrams).

B. Simulation Parameters ¶

Simulation results can be analyzed by considering various parameters in order to evaluate the performances of the transmission chain.

Visualization of the results

The command "Visualization" posts the variables calculated in the temporal field, either directly or after they underwent a pretreatment. When this command is activated, the window "Variables" and "Pretreatments" appears and gives access to the choices of the treatments to carry out and the variables on which these treatments must be carried out.

The temporal answer

This command allows to observe simulated variables without pretreatment.

Functions of correlation

These pretreatments allow us to calculate autocorrelation function of a signal and an inter-correlation function of two signals. COMSIS proposes the choice between a direct method of calculation and a method based on the Fourier transformation.

The diagram of the eye

The performance evaluation of an optical connection can also be done through the observation of the diagram of the eye. This manner rather simple to assess the quality of the received numerical signals before they reach the device of demodulation is regarded as one of basic measurements of digital transmission.

According to their rounded form we call them diagram of the eye.

In experiments, one obtains the diagram of the eye by observing, on an oscilloscope, the received signal, according to a base of time synchronized on the clock of the data. In simulation, one uses an identical technique which rests on the knowledge of a variable of clock of synchronization, used to generate the suitable base of time.

COMSIS allows quantitative measurements based on the diagrams of the eye: horizontal opening, vertical opening, rate of extinction, eye level, factor Q, position of the intersections, width of the eye, gigue…

The vectorial diagram or trajectory

In the communication systems, propagated signals come from the combination of their amplitude and their phase and contain the message to be transmitted. The vectorial representation of these combinations gives us the vectorial diagram called trajectory.

Three-dimensional sight

This pretreatment allows visualization of evolution of the components in phase and to square a signal in narrow band represented by the complex envelope in function of time.

The three-dimensional sight is interesting from a qualitative point of view because it adds temporal dimension to the vectorial diagram of the signal and complex dimension with the diagram of the eye.

The diagram of constellation

Sampling, by the clock of the data of the vectorial diagram of a signal, leads to the diagram of constellation. This diagram represents consequently the states of amplitude and of phase of the signal modulated at the moments of decision. The geometry of these states and their dispersion are qualitative indications for the diagnosis of the defects and the margins of error of the systems. COMSIS permits measurements which are identical to those carried out by the analyzer of constellation developed by the Hewlett-Packard Company.

The Fourier transform

The Fourier transform being complex, COMSIS publishes within two different frameworks, the real and the imaginary parties.

Spectral density of power

The spectral density of power of a signal gives an idea of the bandwidth necessary for the transmission. Also, it appreciates the effectiveness of certain functions and evaluates various types of blocking.

Published By:
Blue Eyes Intelligence Engineering
and Sciences Publication (BEIESP)
© Copyright: All rights reserved.

The spectral density of power of a stationary process in the second order is defined like the Fourier transform of the function of autocorrelation. Easily, we treat the case of the periodic real signals, but the treatment of the signals random or represented by complex envelope calls upon the modified periodograms method.

Instantaneous power

This pretreatment makes it possible to visualize the variation of the instantaneous power of a signal according to time.

The histogram

This pretreatment makes it possible to visualize the distribution of the samples of a variable. It is possible to visualize the histogram of all the samples which were calculated or only those located on the rising faces of a given clock. This possibility is particularly adapted to the analysis of distributions of the values taken by the variable on which the decision is carried out.

The function of cumulative distribution

The function of cumulative distribution (FDC) is a technique used to measure the signals with spread out spectrum. The scale of the ordinates is a logarithmic scale representing a probability expressed as a percentage. The scale of the X-coordinates is a scale in decibel (dB) considering the offset compared to the average power of the signal.

As for the histogram, it is possible to visualize the FDC on all the samples or only those located on the rising faces of the clock.

Safeguard results of simulation

Each variable simulated in COMSIS can be stored independently in a binary file containing the characteristics of the safeguarded signal. For that, it is necessary to activate the order Sortie File. The results of simulation thus safeguarded can be in COMSIS or reinjected in another application.

Assessment of power

The power is an essential size to characterize the level of the emitted signals and receipts.

With the order Power, for each variable, COMSIS recovers the file relating to the simulation of the components in phase and squaring and calculates the average power in each point of simulation. This power is given in dBm (decibels relating to 1 MW).

Report/ratio signal noise

In the systems of telecommunications where the received signal can be of a very low level, it is significant to be interested in the noise present in each point of the chain of reception. Since the noise varies constantly in a imprédictible way, one prefers to analyze it by the means of his average power. Thus one introduces the concept of relationship between the average power of the signal and the average power of the noise.

The method of calculation is based on the second simulation of the system which aims to insulate, either the contribution of the noise, or that of the useful signal. By cutting off with the signals resulting from the first simulation the signals resulting from the second simulation, one obtains the contribution either of the useful signal, or of the noise. The validity of this method imposes that there is no correlation between the useful signals and the signals jammers.

Determination of the factor Q

Simulation made it possible to calculate the disturbed signal which one wants to evaluate the factor Q COMSIS then calculates the mean levels of the disturbed signal and the standard deviations on the transmission of the high levels and the bottom grades. The factor Q results from this.

C. Results and Discussion

Simulations were carried out by seeking the optimal length of fiber. This evaluation is simulated by the diagram of the eye at the exit of the filter, because the function EYE is applicable only to the real electric signals. The visible signals being treated by the complex envelope to visualize their diagram of the eye would have to be used a made up function EYE (Power). Unfortunately, COMSIS does not make a composition of functions.

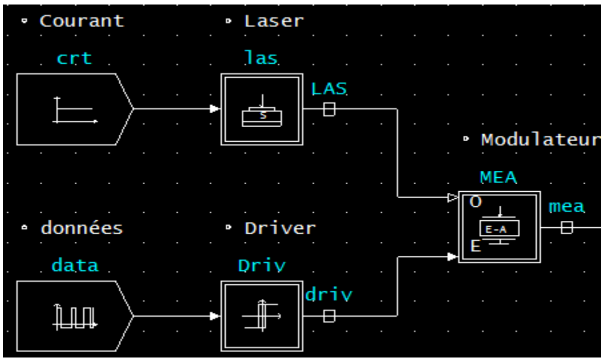
Simulation is carried out for a frequency of reference associated with fiber with

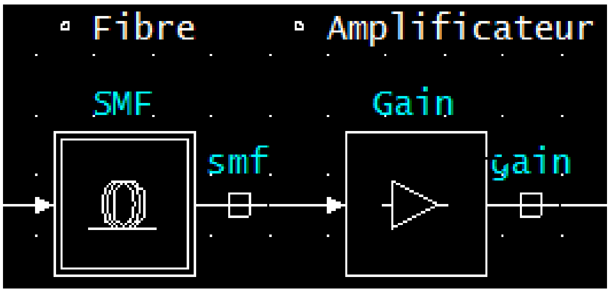
F=1/λ=1/1550 Nm (that is to say, 1.935483871x1008 MHz), the step of calculation is of 0.5.10 $^{-06}$ µs for a flow of 40 Gb/s. The delay of synchronization is the sum of time bits/2 + delays fibers + delay filters.

The delays obtained on the outlet side of the filter are 2,245.10 $^{-04}$ µs for the not compensated connection and 2.45.10 $^{-04}$ µs for the compensated connection.

Results of simulations for not compensated fiber SMF

The first simulation is carried out without compensating for chromatic dispersion. The simulated connexion and the corresponding characteristics are represented on the figures below





Published By:
Blue Eyes Intelligence Engineering
and Sciences Publication (BEIESP)
© Copyright: All rights reserved.

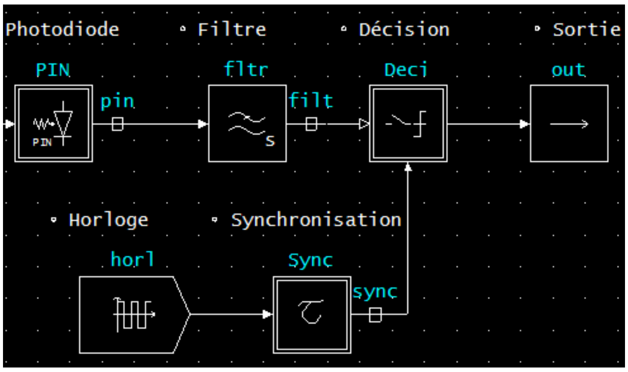
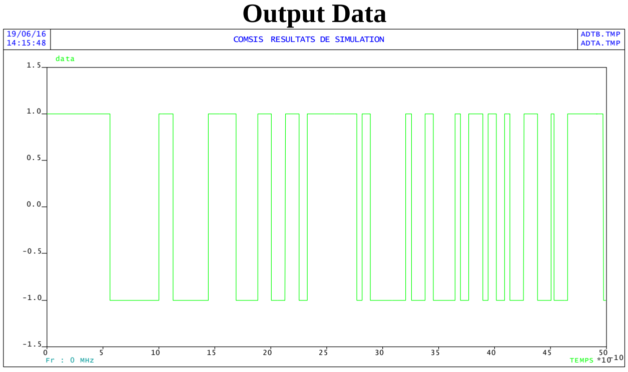


FIGURE 17: Transmission chain without compensating for DCF.

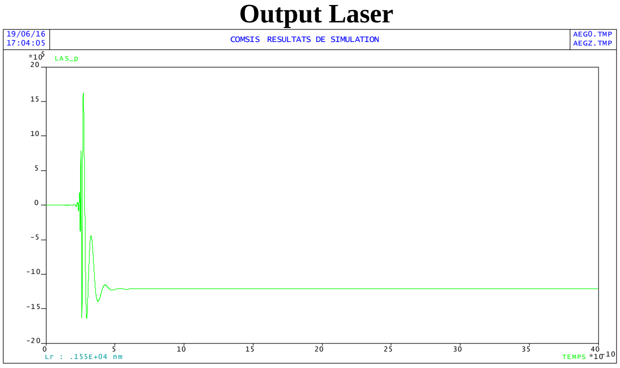
The electrical signals to 4 km length are visualized in the form of temporal answer in the window "Variables and Preprocessing". Then, we can visualize the different transformations undergone by the signal, the behavior and the influence of every operator.

Simulation is carried out by taking 50 points per bit (either a step of calculation of 0, 5 picoseconds) and 200 bits simulated (10 000 points).

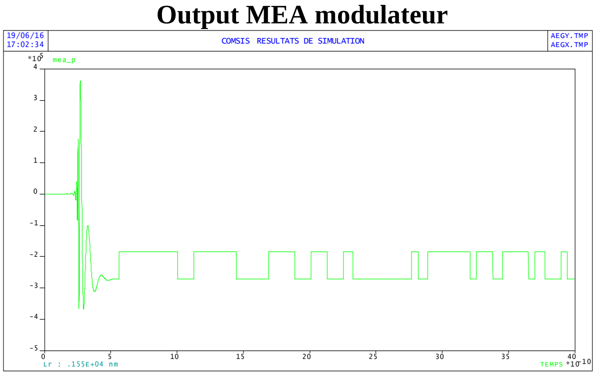
Output Data



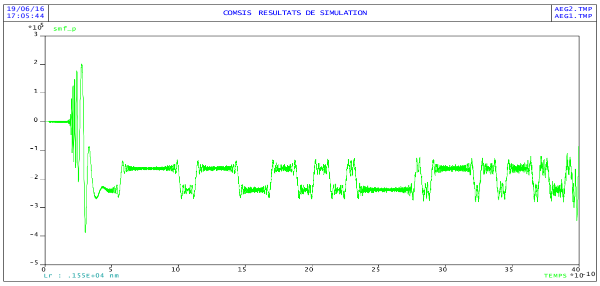
Output Laser



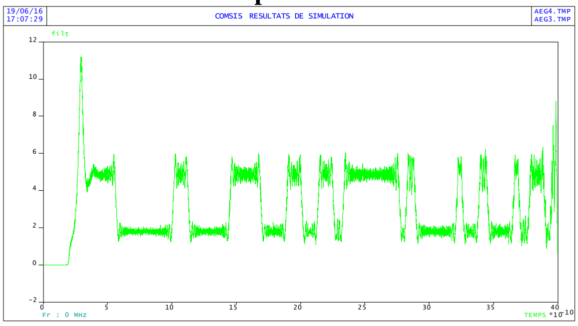
Output MEA modulateur



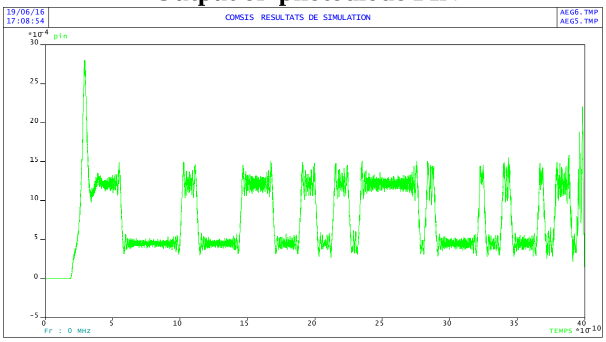
Output of fiber



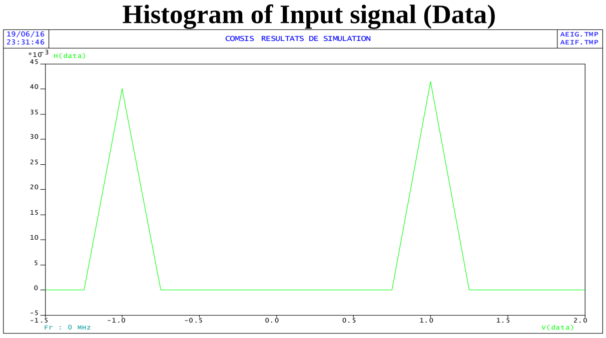
Output of filter



Output of photodiode PIN



Histogram of Input signal (Data)



Histogram of Output signal

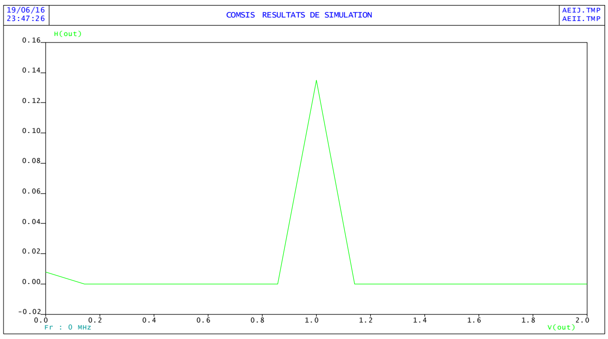


Figure 18: Signals in different points of the connection of reference system.

Published By:
Blue Eyes Intelligence Engineering
and Sciences Publication (BEIESP)
© Copyright: All rights reserved.

V. DISCUSION

The exit power of laser is 40 MW. The absorption of the MEA is taken into account and the information overwrites the visible signal. The reception filter attenuates efficiently the noise. As proof, we observe that the signals at the entry and the exit of the filter are identical. For a 4 km length a factor of quality Q = 7 was been obtained.

Moreover, the histograms show that the signal emitted at the entry of the chain is accurately reproduced at its exit. Several simulations were carried out using the same emission and reception modules but using different lengths of fiber. We observed that beyond 4 km, the received signal is strong distorted because of chromatic dispersion undergoes.

To overcome this problem, we need a fiber having a chromatic dispersion with opposite sign.

To do that, several DCF fibers (Dispersion Compensation Fiber) exist with varied characteristics. A study was thus undertaken on COMSIS, to determine the best optical fiber couple. To form these couples, two conditions must be satisfied: a null cumulated chromatic dispersion and a cumulated attenuation of the signal equal to 20 (dB). Respecting those conditions, we determined the length of fiber for every couple.

Then, we repeated the previous simulations using the same emission and reception modules, but with pairs of different fibers. By making a compromise between the quality and the cost, we obtained the characteristic parameters of DCF fiber summarized in the table below.

Tableau 5: Characteristic parameters of simulated fiber DCF.

Length (Km)	L2
Attenuation (dB/Km)	0.6
Chromatic dispersion(ps/nm/Km)	-80
Kerr effect	Yes
Raman effect	No
Coefficient of non linearity(m^2/w)	7.10^{-20}
Effective surface of the section(μm^2)	30
Polarization modal dispersion	No
Delay(ns)	4.10^{-3}

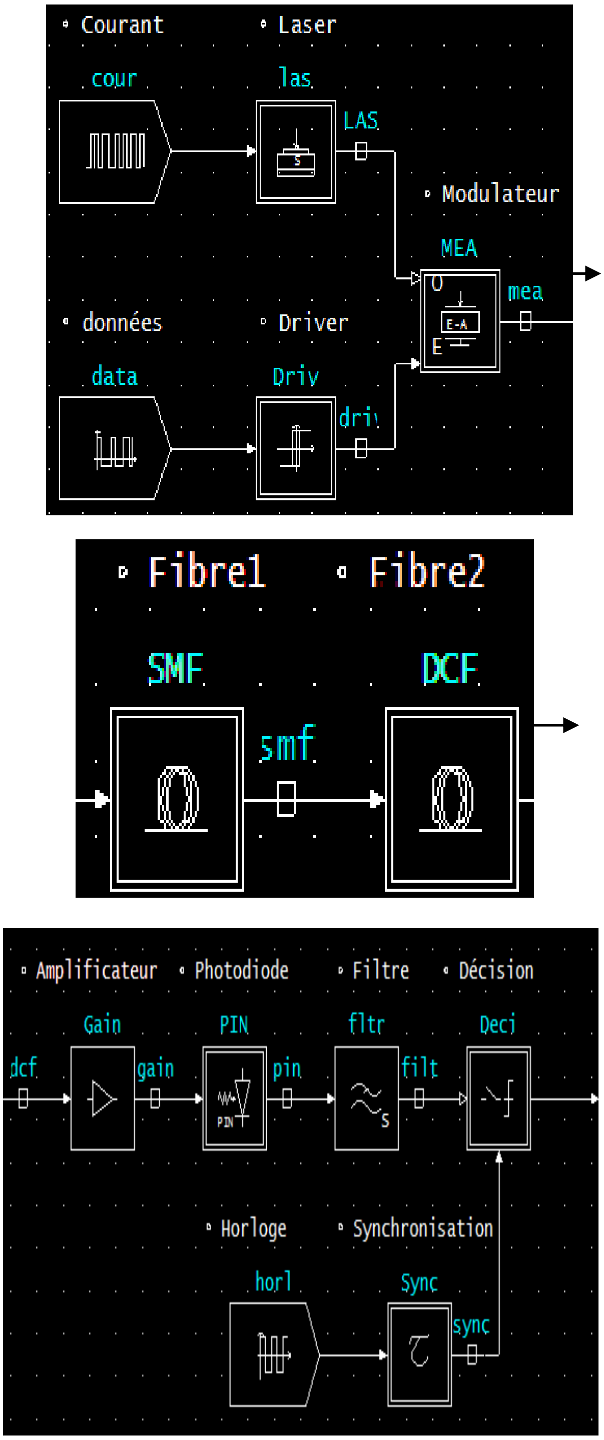


Figure 19: Transmission chain with compensation of DCF.

Now, the line is composed of a SMF fiber and a DCF fiber.
We vary the lengths to observe the impact of chromatic dispersion.

The results of the progression of the signal are shown on the figures below.

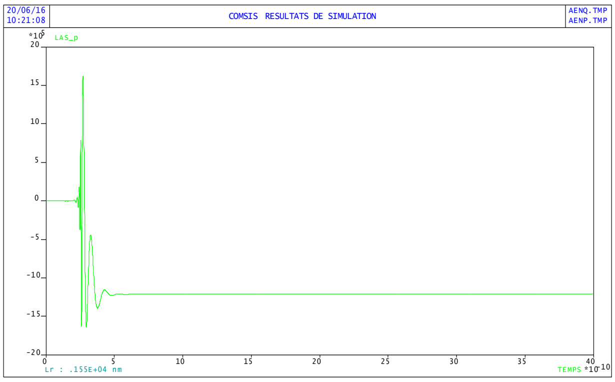
When we compare signals at the entry and at the exit of SMF fiber, we observe an important attenuation of the signal due to the SMF fiber.

Published By:
Blue Eyes Intelligence Engineering
and Sciences Publication (BEIESP)
© Copyright: All rights reserved.

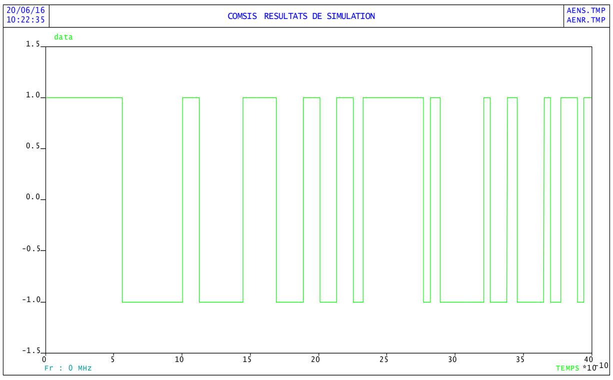
Comparing signals at the entry (exit signal of the SMF fiber) and at the exit of the DCF fiber, one notes that the signal at the exit of DCF fiber is identical to that one at the exit of M.E.A.

Thus the DCF fiber has efficiently reduced attenuation due to the SMF fiber.

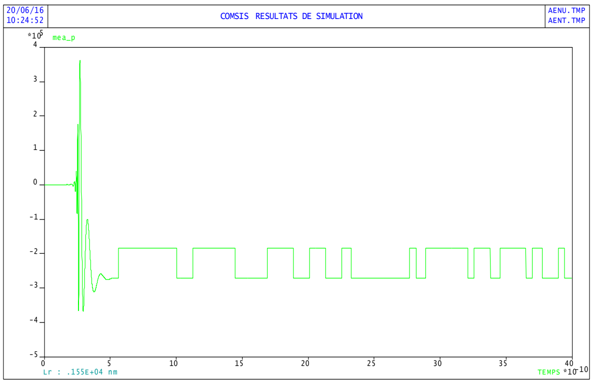
Exit of the Laser



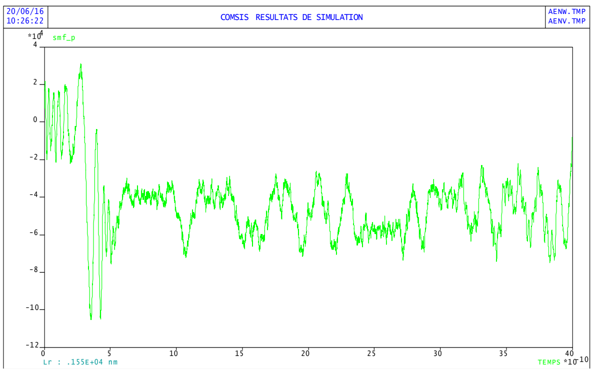
Transmitted data



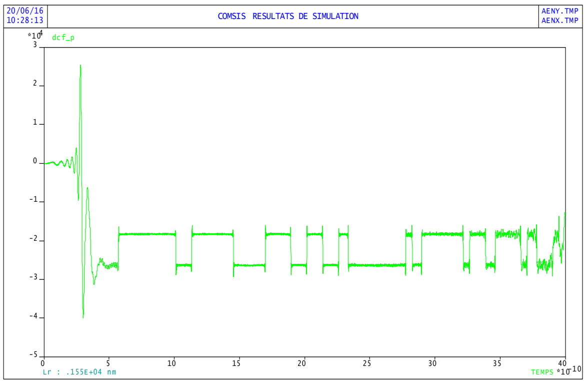
Exit of the Modulator



Exit of fiber SMF



Exit of fiber DCF



Exit of filter

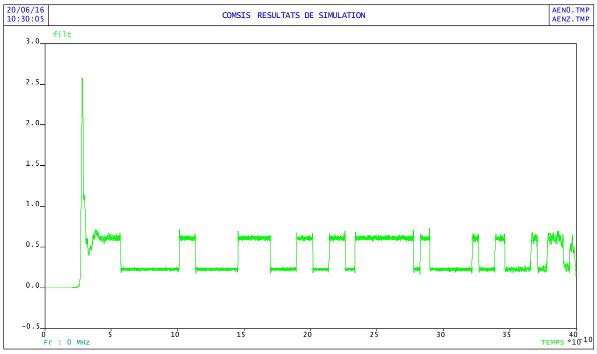


FIGURE 20: Curves of the signals at every point of the connection for 53 km of SMF fiber and 11.25 km of DCF fiber

Effects of chromatic dispersion increase with the transmission distance tha a reduction of the Q factor.

The disadvantage of this technique is that the attenuation is three times more significant with the DCF than with the SMF. That implies the need to increase the amplification. An observation on 200 bits is not sufficient to detect error rates less than 10^{-9}.

However with COMSIS, we are able to measure the quality of a system of data transmission using the diagram of the eye. So, let us plot the diagram of the eye to evaluate the performances and let us compute the Q factor. The diagram of the eye is visualized at exit of the filter of reception, just before the decision-making (Figure 21). Simulation is carried out for 50 points/ bit and 200 emitted bits. To plot this diagram, we truncated the first 40 bits, representative of the delay of propagation and the time of setting in motion of the laser.

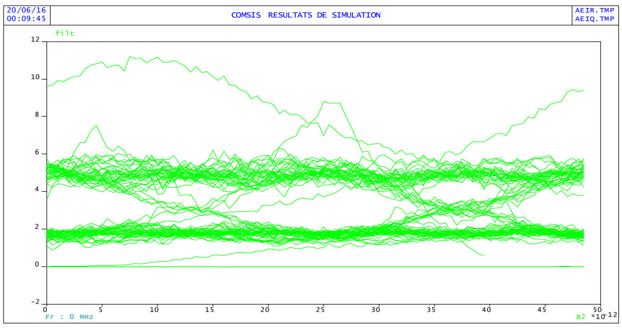


Figure 21: Diagram of the eye of the exit of the filter

Published By:
Blue Eyes Intelligence Engineering and Sciences Publication (BEIESP)
© Copyright: All rights reserved.

Results of simulation of the reference connection, give a factor of quality equal to 9. It corresponds to a binary error rate TEB = 10^{-20}

VI. CONCLUSION

In this paper, we saw the importance of the external modulation during a digital transmission over an optical fiber. We analyzed the effects of DCF in a simple optical transmission chain to 40 Gbits/s using COMSIS simulator.

Chromatic dispersion will become a significant problem when the bit rate increases. Thus, multiple techniques, such as optics and electronic, were been developed these fifteen last years to avoid this situation.

Electronic solutions are generally more reliable, but also complex to implement and expensive compared to the optical solutions, therefore the choice of compensation optical fiber was justified.

We showed that the compensation DCF fiber chromatic dispersion is limited compared to the SMF fiber.

This study can be extended to simulations between VPI and MATLAB-Simulink or between VPI and ADS what will lead to more realistic results but to increasingly complex structures. .

At the end of this experiment, we deduce that the optical fiber is the most reliable transmission channel and most stable.

The great bandwidth, the high binary rate and the weak linear attenuation make that the optical fiber is the best transmission support adapted in the fields such as mobile telephony, multimedia, Internet, medicine, aeronautics. It optimizes the imperfections of the copper cable. Nevertheless it presents some gaps due to its installation which is very complex and to the maintenance actions.

REFERENCES

1. S. C. COULIBALY ’’Raccordement de la fibre optique’’ Société des Télécommunications du Mali(SOTELMA), Centre de Formation Professionnelle des Télécommunications(CFPT), manuel du stagiaire, 2007-2008.
2. I. K. Maiga ’’Synchronous Digital Hierarchy(SDH)’’ Société des Télécommunications du Mali(SOTELMA), Centre de Formation Professionnelle des Télécommunications(CFPT), manuel du stagiaire.
3. I. Maiga ‘’ Base de la transmission par la fibre optique’’ Société des Télécommunications du Mali(SOTELMA), Centre de Formation Professionnelle des Télécommunications(CFPT), manuel du stagiaire.
4. I. P. Kaminow, T. L. Koch “Optical Fiber Telecommunications III A “, Lucent Technologies, Bell laboratories, Holmdel, New Jersey.
5. J- L. Verneuil ’’ Simulation de systèmes de télécommunications par fibre optique à 40 Gbit/s’’ Université de LIMOGES 2003.
6. Y. Zouine ’’Contribution par la simulation système à l’étude des contraintes des composants optoélectroniques sur la transmission optique utilisant technique CDMA’’ Thèse de doctorat Université de.LIMOGES 2005.
7. M. Fadila ‘’ Optimisation par la simulation système d’une chaine de transmission numérique par fibre optique haut débit’’ Mémoire de Magister Université ABOU BEKR BELKAID – TLEMCEN 2010.
8. Available:http://www.spc.ac-aix-marseille.fr
9. Available:www.formation-fibre-optique.com
10. Available:www.irisa.fr
11. Available:www.ifremer.fr
12. Available:www.itu.int
13. Available:http://www.sedi-fibres.com/index.php?art=1&th=87
14. Available:http://mptranss.free.fr/cc/fibre.html
15. Available:http://documents.exfo.com/appnotes/anote122-ang.pdf
16. Available:http://www.telcite.fr/nwdm.htm
17. Avalable :http://christian. caleca.free.fr/fibroptique

Diouba Sacko PhD in Communication and Information Systems / MANETs, publications : 1. “ Overview of Reference Region Group Mobility Model for Ad Hoc Networks”, 2. “A Survey of Group Merge and Split Mobility Models”, 3. “Dynamic Group Mobility Model for Hybrid Networks”, 4. “Group Partitioning and Merging Mobility model for MANETs”, 5. “Autonomic Group Mobility for Mobile Ad Hoc Networks”, 6. “Study on Indoor and Outdoor environment for Mobile Ad Hoc Network: Random Waypoint Mobility Model and Manhattan Mobility Models “, 7. “A Survey of Geographic Restriction Mobility Models”, 8. “A Survey of Geographic Restriction Mobility Models”,9. “Link analysis on Indoor and Outdoor environment for Mobile AdHoc NETwork using Random Waypoint Mobility Model and Manhattan Mobility Model”, 10. “Opportunistic Virtual Antenna Arrays with Optimal Relay Mobile Terminals Selection”, research work: “Group Partitioning and Merging Mobility model for MANETs”.

Hassana Ganamé Master of Science, performance analysis for soft handover in UMTS cellular System.

© Copyright: All rights reserved.