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Study of the Migration At 40 Gbit/S Over Existing 10 Gbit/S DWDM System

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Abstract

The increasing demand for higher transmission capacity originated by upcoming internet services forces the network operators to increase the transmission capacity. An attractive alternative to upgrade existing 10 Gbit/s metropolitan network is the deployment of the mixed solution on the same link by adding 40 Gbit/s channels on the existing model [1]. The main advantage of the mixed DWDM system [2] is its flexibility in utilizing fiber bandwidth to increase the transmission capacity of a fiber link. Therefore the line rates of installed networks, operating at 10 Gbit/s must be upgraded in the metro and long haul systems. This paper proposes the view of possible future upgrade of an existing 10Gbit/s DWDM network to 40Gbit/s in the metropolitan area of Algeria National Backbone. The hybrid model is used to increase the existing DWDM system capacity from 80 Gbit/s to 160 Gbit/s. In this simulation the performances in terms of Frequency Domain, Eye Diagram, Q2 (quality factor) is presented to illustrate the transmission distance limitation.

Index terms*-Multiplex, hybrid model, NRZ, SMF DWDM, chromatique dispersion, Q factor*.

1. Introduction

Most operators prefer to migrate to 40Gbit/s technology gradually. Since a new build-out of a complete 40 Gbit/s network is costly, the most common alternative is to add 40 Gbit/s channels over an existing 10 Gbit/s network. In this paper, we present the performance analysis of NRZ format for a mixed 10/40Gbit/s, 100GHz spacing wavelength-division-multiplexing (WDM) [3] grid through 20x60 km spans of standard single mode fiber (SMF) [4]. An existing configuration is used in our work. Substantial performance ameliorations are obtained with this format in long haul transmission. Using 40Gbit/s and 10Gbit/s NRZ format, 100GHz spaced channels have been transmitted over 20×60km on the same link. In this study The hybrid transmissions system implemented consists of 2×40Gbit/s channels operated on a 100 GHz grid and ranged from 1550.0nm to I550.8 nm added in the middle of 8×10 Gbit/s NRZ channels operated on a 100 GHz grid and ranged from 1547.2nm to 1552.0nm.

2. Communication system

A set of system simulation was carried out in order to study the overall system performance in realistic Metropolitan Algerian Network.
Figure1 shows the experimental setup of our proposed hybrid DWDM system for transmission over a distance of 1200 km.

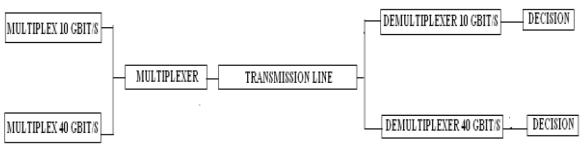


Fig .1: Block Diagram of the Simulated System

In the first multiplex 8×10Gbit/s optical channels are generated from 1547.2nm to 1552.0nm. The second multiplex is used to generate 2×40Gbit/s optical channels from 1550.0nm to I550.8.The channel spacing of all these signals is 100GHz and they are externally modulated using NRZ format. These modulated signals are combined using a multiplexer with Gaussian characteristics and sent to the transmission fiber, amplified by a 15 dB Erbium Doped Fiber Amplifier (EDFA)[5] and compensated by a DCF[6] (dispersion Compensated fiber).The gain of amplifiers is equal to the fiber losses in each span. The noise figure for EDFA is 4dB.The launched power into the fiber for each channel is 7.78 dBm. The SMF fiber is assumed to have D=16ps/nm/km and an optical loss coefficient α =0.2dB/km. High local dispersion in the DCF has D = −80ps/nm/km and α

= 0.5dB/km. The non linear coefficients γ[6] of the SMF and DCF fibers are respectively 1.32 ($w.km^{-1}$) and 4.6 ($w.km^{-1}$).At the receiver signals are demultiplexed using respectively 10Gbit/s and 40Gbit/s demultiplexers with a Gaussian characteristic before electrical conversion and processing. PMD [7] and the non-linear phenomena SPM [8], XPM [9] and Raman effects are taken into account.

3. Results

The performances in terms of Frequency Domain, Eye Diagram, Q^2(quality factor) are shown to illustrate the good results obtained in our work.

A. Spectrum:

Fig 2a and Fig 2b Show respectively the input and the output optical spectrum of the hybrid multiplex at the input and output end of the fiber.

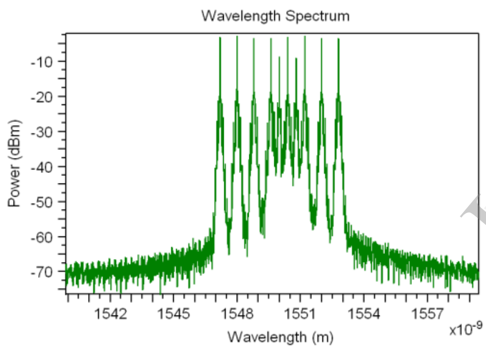


Fig .2a. Input Spectrum

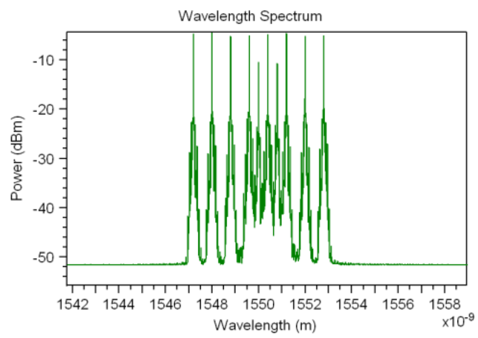


Fig .2b. Output Spectrum

We note that all the channels of the hybrid system are well transmitted.

A. Q factor

We analyzed the results of the system shown in fig1. The input power is maintained constant. The Q factor relative to the distance is noted respectively in the tables Ia, Ib, Ic reported below. Only the central three adjacent wavelengths are

taken in consideration. It concerns the following channels
- λ=1550nm and λ=1550.8nm at 40 Gbit/s
- λ=1550.4nm at 10 Gbit/s

Table Ia.: Q factor value obtained for λ=1550nm.

D(km)	60	240	480	600	960	1200
Q	29.85	25.37	22.75	21.30	17.40	15.95

Table Ib.: Q factor value obtained for λ=1550.8nm.

D(km)	60	240	480	600	960	1200
Q	24.12	21.98	19.65	18.65	18.05	15.90

Table Ic: Q factor value obtained for λ=1550.4nm.

D(km)	60	240	480	600	960	1200
Q	15.97	16.28	16.80	16.10	15.8O	16.25

We note that:
- The Q factor of the 10 Gbit/s NRZ channel λ=1550.4nm. is not affected by the two 40 Gbit/s adjacent channels inserted.

- The 40 Gbit/s channels for λ=1550nm and λ=1550.8nm still have a good quality factor over a distance of 1200km.These best performances over distances are shown in the fig3.

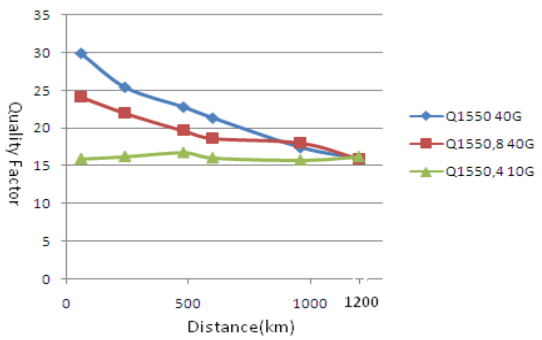


Fig.3.Q factor value for the 40Gbit/s and 10 Gbit/s NRZ adjacents channels for respectively λ=1550nm. λ=1550.8nm and λ=1550.4nm.

These results can be explained by the chromatic dispersion and nonlinearity effects robustness with NRZ format using the channel spacing of 100 GHz between the 10 Gbit/s and 40 Gbit/s multiplex channels.

C Eye Diagram

The results obtained are well supported by the receiver eye diagram as shown in Fig.4. and it is wide open and provides error free communication.

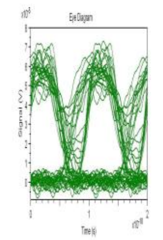
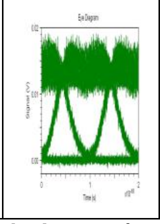
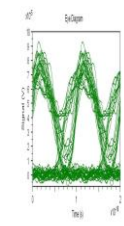
Wavelength (nm)	1550	1504	1508
Q(quality factor)	15.95	16.25	15.90
Eye Diagram			

Fig. 4. The eye diagram at the distance of 1200km.

4. Conclusion

This study shows that NRZ modulation formats can be used to offer significant advantage and improvement in the hybrid DWDM system performance with a100 GHz channel spacing and could accept a 40GBit/s channels with a good results. Consequently it is possible that 40Gbit/s new services can be added efficiently to an existing 10 Gbit/s metropolitan area of Algeria National Backbone network that was not necessary designed to support 40 Gbit/s channel. However to intensively increase the capacity we pointed out that a hybrid DWDM system with a channel spacing of 50GHz using Standard Mode Fibers (SMF) associated to advanced modulation formats[10] has greater potential for enhancing the bit-rate and the transmission distance than conventional WDM NRZ Systems.

V. REFERENCES

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