DESIGN AND PERFORMANCE STUDY OF TRIPLE-BAND DWDM (160 CHANNEL)

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ABSTRACT

This article explores performance study of the proposed high data rate triple band novel one hundred sixty channel dense wavelength division multiplexed (DWDM) optical communication link. The model has been designed to operate over multiband S/C/L and channel to channel spacing of 100 GHz bit rate of 20 Gb/s with employed semiconductor optical amplifier, transmission performance were investigated over three hundred kilometres of transmission length. The simulated results showed very good transmission performance for the randomly received channels with Q-factor greater than 10dB, good eye pattern over the entire S/C/L bands along with 6dBm booster power. From the results it is inferred that conventional band of DWDM may be upgraded with inclusion of short band, long band communication capacity thus a boost in the spectral efficiency. Hence it may be one of the prevailing schemes to further enhance the competence of the modern photonic systems.

KEYWORDS

Spectral efficiency(SE), Erbium-Doped fiber amplifiers(EDFA),Mach Zehnder modulator(MZM)

1. INTRODUCTION

Blazing need for huge capacity communication applications has spurred concentrated research on huge data rate, spectral efficiency fiber optic communication networks. From time to time scientists have tried to novel design and to upgrade the existing communication systems through which information signal may be sent from source to destination point. The present trend is that in every fourth year worldwide internet protocol communication traffic may go beyond half a Zettabyte. Huge speed broadband incursion and high definition video subscriber's internet protocol data traffic shall boost net internet protocol expansion rate. So it needed constant development rate through previous year (2012) and developing on a composite annual development rate of forty six percentages [1]. Number of novel schemes have been devised in the past to enhance the information carrying capacity of the existing systems, as time division multiplexing(TDM),orthogonal frequency division multiplexing(OFDM),code division multiplexing(CDM),space division multiplexing(SDM), Wave length division multiplexing (WDM).

WDM is one of the extensively investigated schemes since decades for the shorter and longer reach transmission. The transmission capacity in long haul transmission wavelength division multiplexing photonics systems has been stepped up into huge data transmission rate and narrow channel spacing to exploit the available bandwidth more efficiently and for augmentation in communication spectral efficiency. This is very significant work for structuring wavelength division multiplexed optical communication traffic systems. As it permits optical system to bifurcate it in several channels of WDM as it minimizes cost per transmitted information bit in completely burdened systems. A number of modulation formats have showed separate response and effects of nonlinearity [2, 3,4].Thus for optimized wavelength division multiplexed network capacity all the contributing factors must be taken into considerations in system design. For large dense wavelength division multiplexed fiber systems channel spacing is one of the significant parameter for better solution. Therefore to diminish systems transmission performance degradation and to exploit optical systems capacity performance investigation and optimization have been the key issues [5].

Accordingly study of the wavelength division multiplexing with Erbium-Doped fiber amplifiers (EDFA) performances of both WDM and EDFA in conventional band of frequency. Pumping for an efficient EDFA has been possible with application of semiconductor lasers operating near 980- and 1480-nm wavelengths, 980nm pump lasers have been used by many of the EDFA since this may supply additional pump power, and have been applied in small noises need. Gain through population inversion is achieved with suitable wavelength and spectrum is based on scheme of pumping and very similar occurs due to dopants like Germanium, Alumina within core of fiber. So to compensate fiber optic attenuation optical amplifiers were in application. The hybrid conventional band EDFA has been applied in this system with characteristics of broad bandwidth and gain flattened with low noise figure. This has got huge applications in transmission system like WDM and the investigated results were analyzed and indicated that 1532.68nm is the most excellent wavelength that is appropriate to be applied in WDM and EDFA. Therefore it is an excellent selection for long range optical fiber communications [6, 7].As well as in the performance study for sixteen channels WDM and operating on 10Gbps with feed forward linearization technique showed that using linearized SOA the system may be increased up to 120 km length with channel spacing as small as 50 GHz and achieved Q-Factor was eleven at 100km and 4.2 at 120 km **[8].** Further comparative transmission performance investigated for thirty two channel systems operating at different bit rates with NZDSF single mode fiber, with study at different bit rates, signal power along with employed dispersion compensation covered the transmission distance of over four thousands with ASE noise. It revealed that with increase of transmission distance and bit rate, quality factor decreases that is performance degrades [9, 10].
Afterward the WDM communication systems investigated for long haul optical communications, every optical signal may operate at up to 2.5Gbps or 10Gbps or more than that. At present the available optical communication systems supports smaller group of the multiplexed channels from 32 to 64 communication channels. But in the coming future communication dealers has assured for one hundred sixty channel systems for the next generation systems and it may have higher capability with single fiber to transmit greater than 1Terabit/s optical communication [11]. Further augmentation of the optical fibres information carrying capacity with wavelength division multiplexing , has made possible bidirectional traffic flow for the single strand of optical fiber[12] and along with introduction of dense wavelength division multiplexing have essentially transformed the economics of centre optical communication networks [13].

Investigators with optical communication networks have been simultaneously concentrated on the further augmentation of every specific optical fibres data rate. But most of the works are around study of novel modulation methods, to concrete wavelengths. Wavelength division multiplex systems were commercially competent of communication up to forty channels at forty gigabit/s or eighty channels on ten gigabit/s in the conventional band so make available complete optical capacity of up to terabit/s. Study for a wavelength division multiplexed system along with PIN and APD photo detectors depicted that WDM systems were affected with dispersion and non-linear effects. However investigation for 40Gbps NRZ-WDM systems bit error rate of less than 10^{-15} showed employing SMF also with dispersion compensation optimized optical and electrical filter characteristics on the receiver end. It has also illustrated that flattop-shaped optical filter at the receiver end show good result than Gaussian-shaped filter unless insertion losses of the optical filter were larger than 5dB[14,15].Together with normally used optical transmission systems capacity may be enhanced with the application of supplementary optical windows L/S/C and further higher bands of communication defined by ITU.

Earlier a lot of works have been presented however some uncovered work has to come in front of rapidly changing optical communication world. Thus in this vision, the paper proposes performance study of the multiband optical transmission with one hundred sixty channel system operating on higher data rate. Comprehensive analysis of the proposed optical system, discussion of the results and conclusion are illustrated in the following sections.

2. PROPOSED DESIGN PRESENTMENT

The proposed model is designed for the multi-band optical communication system along with EDFAs. The optical link wavelengths have been selected to appear in (multiband) three wavelength regions L/S/C. In the figure 1 shown there are total of one hundred sixty (8x20) transmitters, consisting total of 160 lasers each operating at 20Gb/s bit rate, with 100GHz spacing between adjacent channels and has been set up for the multi span fiber transmission analysis.

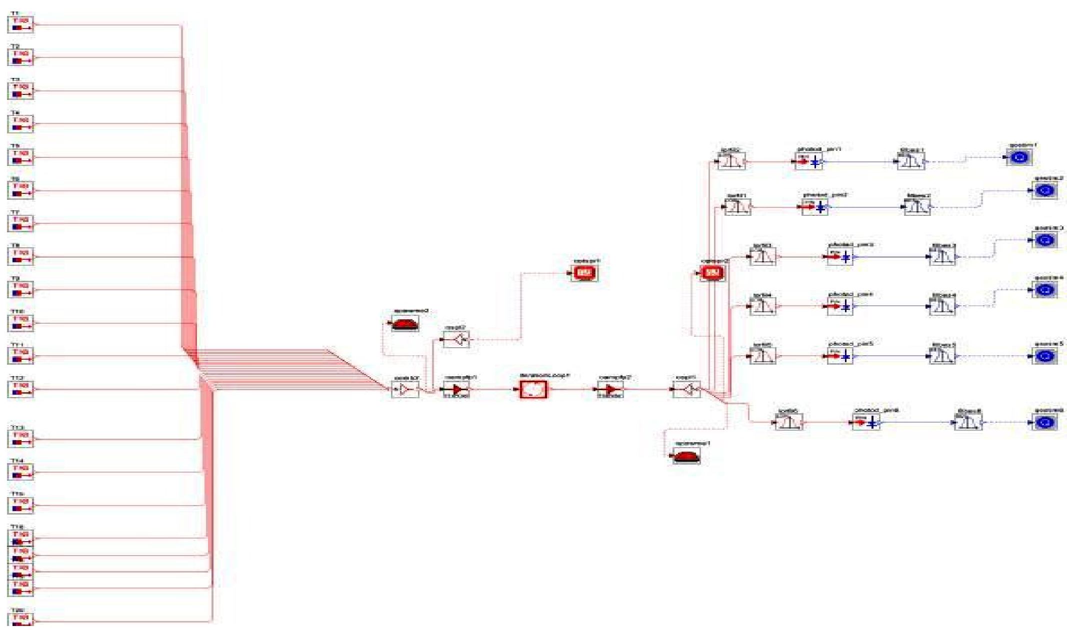

Figure1: Simulation model used for 160x20Gbps (3.2Tb/s)

Each of the single transmitters has been equipped with data source CW Lorentzian laser source and optical amplitude modulator Sin^2MZ with optical link section. Binary sequence of the data stream is produced by PRBS data source which can be modified with baud rate, length of period and level of logical signal. Resulting output of driver and Lorentzian laser source were passed into optical modulator, optical pulses were then modulated using MZ modulator at 20 Gb/s bit rate then passed to amplitude dual-arm Mach Zehnder modulator is used to modulate optical signal of desired form.

Now multiplexed optical signal is passed through booster amplifier, this boosted signal then passes through dispersion managed single mode fiber loop (lucent true wave) of 40 to 300 km, with EDFA gain it is amplified thereafter resulting signal is passed through optical demultiplexer which splits the signal in the parallel form. The resulting signal were passed through detector section, a single receiver consisting of optical raised cosine filter with band pass filter, PIN photodiode and low pass Bessel filter electrical filter. The optical splitter used here with attenuation of 0 dB at each output port, an ideal splitter without any insertion loss it completely splits the incoming optical signal. Finally to observe links output transmission performance electrical scopes were employed for eye patterns, bit error rates (BER), quality factor (Q) can be measured.

3. RESULTS AND DISCUSSION

Dense wave length division multiplexing is one of the prevailing techniques for the augmentation in optical communication systems capacity. To further enhance optical systems capacity numbers of solutions were devised and different key solutions must need least renovation to the present optical and electronic subsystems. This paper explores multiband transmission for the designed DWDM (160x20Gb/s) system along with nonzero dispersion shifted fiber, transmission performance have been successfully investigated over communication range of three hundreds of kilometres. For an optical communication systems satisfactory transmission performance quality factor (Q) must be more than 6dB and eye pattern must be broader.

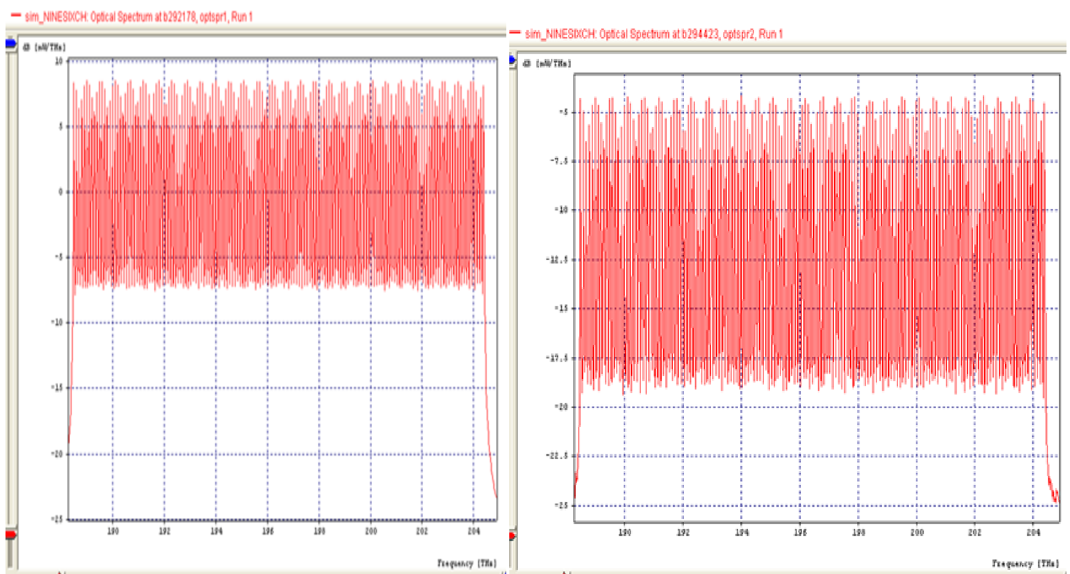

Figure 2.Input and output Optical spectrums (160chx20Gbps)

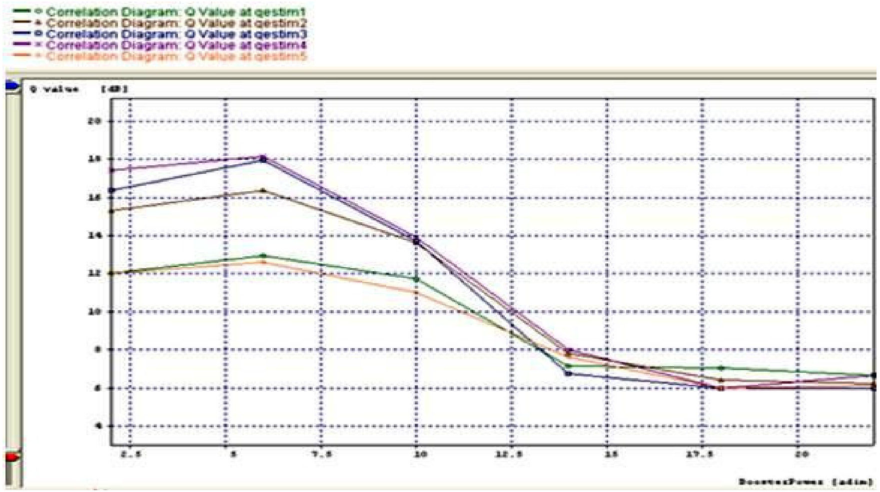

Figure4: 160chx20Gbps system Q vs. booster power over 300km transmission

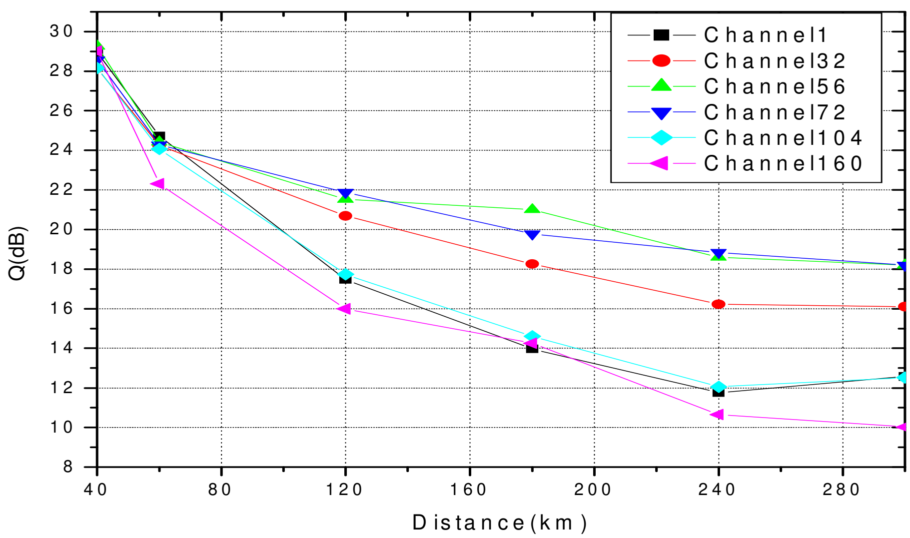

Figure5. Q vs. Transmission distance over 300km transmission for 160chx20Gbps

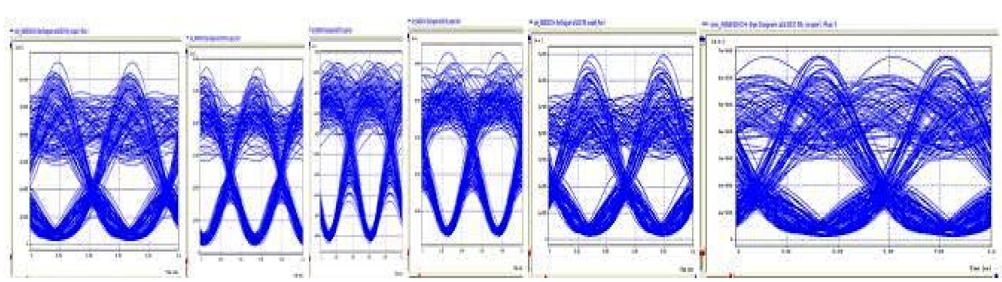

Figure6. Eye pattern for 300km transmission for multiband transmission system

Figure (4) shows plot of quality factor (Q) vs. booster power, it is observed that highest quality factor at 6dBm booster power for the randomly detected numbers of channels and thus optimized transmission performance have been achieved. The simulated results as illustrated in the figure5 for quality factor vs. transmission distance, it is observed that required optical transmission parameter the quality factor is very much satisfactory for all of the received channels at the selected transmission reach. It indicates quality factor (Q) greater than 10 dB for randomly selected channels 1, 32, 56, 72, 104 and 160th over the L/S/C transmission bands. Figure 6 shows eye patterns of the randomly selected received channels at the selected transmission reach. The received eye patterns were broader, thus illustrating better transmission performance. Consequently it can be revealed that the simulated results for 3.2Tb/s DWDM link have shown good optical transmission performance over the entire L/S/C bands. Thus the usual band (C) of DWDM can be upgraded with inclusion of short band, long band, consequently increased spectral range and transmission capacity.

4. CONCLUSION

The article has effectively presented the novel multiband 3.2Tb/s(160chx20Gbps) DWDM system with channel to channel spacing of 100GHz over the transmission distance of three hundred kilometers.

Simulated results showed better transmission performance with achieved quality factor of ≥10dB for the randomly detected channels operating over different transmission bands, while for the satisfactory performance Q>6dB. It also depicted good eye pattern performance over the selected transmission reach. Consequently, it is perceptible that the presented work will be supportive to enhance the spectral efficiency of the existing DWDM systems.

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REFERENCES

[1] Cisco Systems.Cisco(2008) Visual Networking Index – Forecast and Methodology. 2007–2012. White paper. vol.1, pp.1-15, 2008.

[2] G. Bosco, A. Carena, V. Curri, R. Gaudino, and P. Poggiolini.Sept.(2002) On the use of NRZ, RZ and CSRZ modulation at 40 Gbit/s with narrow DWDM channel spacing. Light wave Technol., vol.20, pp.1694–1704, 2002.

[3] Martin Pfennigbauer and Peter J. Winzer(2006), Choice of MUX/DEMUX Filter Characteristics for NRZ, RZ, and CSRZ DWDM Systems, Journal of light wave Technology, vol.24 (4), pp.1689, 2006.

[4] Meg Mahat, Antonio Llopis, Richard D. Schaller, Ian Watson, Sergio Periera and Arup Neogi (2012). “Carrier-induced nonlinearities in InGaN/GaN quantum wells with V-pits.” MRS Communications, 2, pp 55-60, 2012

[5] Bobrovs V, Ivanovs G,(2008)nvestigation of Mixed Data Rate and Format Transmission in WDM Networks,Lithuanian J. Electron.Electr. Eng.,vol. 4(84),pp. 63-66, 2008.

[6] M.M. Ismail, M.A. Othman, H.A. Sulaiman, M.H. Misran & M.A. Meor Said, M.M. Ismail, et.al,(2012), Performance analysis of WDM and EDFA in C-band for optical communication system IJRRAS,vol.13,pp.311-316, 2012.

[7] R.P.khare(2004)Fiber Optics and Optoelectronics, Republished in India by Oxford University.

[8] KeshavSood ,Jaswinder Singh Harjit Singh ,Amritsar,(2012), 160 Gbps WDM Transmission System using Linearized SOA with 50 GHz Channel Spacing.IJCA (0975 – 8887),432, pp.4-6, 2012.

[9] D.K.Tripathi et.al,(2011),Comparative Performance Study in 32 Multiplexed Channels Optical Transmission in Bit Rates 10, 20, 30,40Gbps with NZDSF,IJSCE,vol.1,Issue.5,pp.322-326.
[10] D.K.Tripathi et.al,(2012), SPM limited long haul optical transmission in RZ-DPSK for varying input launch power with SMF, Monte Carlo Simulation, J.I.E.A.Vol 2, No.2, pp.20-29.
[11] Brackett, C. A.(June2000), Is there an Emerging Consensus on WDM Networking, Light wave Techno, vol.14, pp.936–941, June2000.
[12] Numai T. and Kubota O.(May2000)Analysis of Repeated unequally Spaced Channels for FDM,Light wave Systems. IEEE J. Light wave Techno, vol.8 (5), May2000.
[13] Mizrahi, V. et al(ECOC 2000)The Future of WDM systems, in Proc. ECOC 2000, pp. 137–141,2000.
[14] KawalPreet Singh, Navpreet Singh, Gurinder Singh Dhaliwal(March 2012), Performance Analysis of different WDM systems,IJEST,vol.4(3),pp.1140-44, March 2012.
[15] Jong-Hyung Lee, Dae-Hyun Han, Jeom-Young Ahn.(2005, Simulation of 40Gbps WDM Systems using Single Mode Fiber.(IEEE)KORUS'2005Korea:777-80, 2005.

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