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Comparatively analysis of FBG optical fiber in 25 & 35 Gbps DCDM based Communication System

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Abstract:- In this paper, we design five user optical based DCDM system where FBG used as optical filter. The performance comparison of without and with FBG filter has been done. The system performance is evaluated on the basis of the SNR, Q-factor and BER, for all five users. It has been observed that as FBG filer increases the performance of system also improved.

Keywords:- Duty Cycle, Fiber Bragg Grating, Optical Filter

I. INTRODUCTION

The never-ending bandwidth requirement results in advancement of communication technology for bulk data transfer through the networks. The exponential increase in network capacity has made the use of various multiplexing techniques mandatory for every communication system [1]. For efficient use of available bandwidth an alternative multiplexing scheme called as duty cycle division multiplexing (DCDM) and subsequently AP-DCDM (absolute polar duty cycle division multiplexing) were reported. In these techniques, users can transmit data with different duty cycle simultaneously over the communication media. The information can be easily distinguished from the received signal at the receiver side, based on the signal amplitude and the duty cycle [2-5].Multiplexing is the key issue to increase the capacity of communication systems. It allows different users to share the available carrier bandwidth and communicate simultaneously. The goals of all multiplexing techniques are to support as many users at as high speed and at the lowest cost possible. In existing systems, the medium is normally shared based on time slot (TDM, carrier frequency (FDM/WDM) or spectrum coding (CDM) [2]. TDM is the most widely used multiplexing technique in communication systems today. However, for multiplexing high number of users with high data rates, high speed multiplexer and de-multiplexer are required, resulting in very high cost for TDM systems. At higher speeds clock recovery is another essential issue that may render the system highly complicated and costly for TDM systems. Therefore, many investigations have been done to design and develop reliable and cost-effective clock recovery modules for TDM in both the electrical and optical (thus, OTDM) versions [4]. A requirement for higher transmission capacity has drawn the attention of researchers worldwide to develop new modulation formats, multiplexing techniques and detection systems. Several high bandwidth applications requiring huge amount of bandwidth of the optical fibers exploits sharing by multiple users using multiplexing techniques. [2]. This paper proposes a near futuristic approach for better utilization of the transmission capacity of optical fibers. A new multiplexing technique based on duty cycle division is proposed, thus the name Duty Cycle Division Multiplexing (DCDM). DCDM can be applied in both electrical and optical domains, for wired and wireless systems. This technique allows for more efficient use of time slots as well as the spectrum, taking advantage of both the conventional TDM and FDM. Here we have designed a 25 & 35 Gbps DCDM system, the system features multiplexing of the basebands in electrical domain (DCDM).

II. DUTY CYCLE DIVISION MULTIPLEXING (DCDM)

Duty cycle division multiplexing (DCDM) was proposed as an alternative multiplexing technique to obtain large spectral efficiency. In DCDM, different users can share the same channel for transmitting data simultaneously by using the same frequency band but each user uses different duty cycle for RZ encoding. The electrical adder adds up signals from different channels, each is assigned with a different duty cycle. A single optical source is then modulated by the multiplexed signal. For multiplexing ‘n’ users, the value of the duty cycle for each user can be assigned in various ways. The duration for i user T_i is defined as:-

$$T_i = \frac{i \times T_s}{(n+1)} \qquad (1)$$

Where, ‘n’ represents number of multiplexing users and T_S is symbol duration. For example, assigning the duty cycle value for 5 users, using DCDM technique will results:

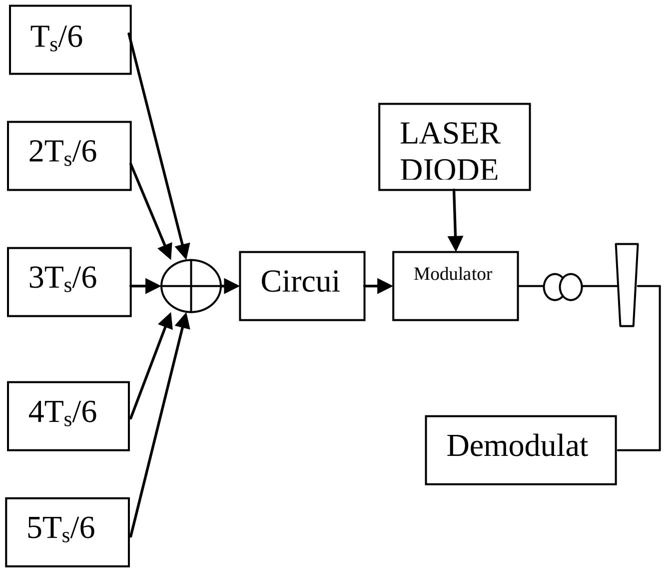

Figure 1: Simulation setup of 5-user DCDM based optical communication System

$$for\,the\,I^{st}\ user = {T_s}/{6}$$

$$for\,the\,II^{st}\ user = {2T_s}/{6}$$

$$for\,the\,III^{st}\ user = {3T_s}/{6}$$

$$for\,the\,IV^{st}\ user = {4T_s}/{6}$$

$$for\,the\,V^{st}\ user = {5T_s}/{6}$$

The DCDM technique is based on the unipolar RZ line code. In this technique, each user transmits a bit of 0 volts within T_S second where T_S is symbol duration and bit 1 is transmitted with A volts with a duration less than T_S seconds time slot but within their respective duty cycle allotted. . For multiplexing 5 users, the 1^{st}, 2^{nd}, 3^{rd}, 4^{th} & 5^{th} user uses duration of T_S /6, (2×T_S)/6, (3× T_S)/6, (4× T_S)/6 and (5× T_S)/6 respectively to transmit bit 1s. The net multiplexed signal possesses multiple amplitude levels. At the receiver side, the input signal can be extracted from the demodulated signal based on the signal voltage amplitude and the duty cycle’s time duration [1].

Figure 1 shows the simulation setup of 5×10 Gbps DCDM based Optical Communication System. The data of each user is transmitted with a bit rate of 10 Gbps, that generated by RZ pulse generator with different duty cycle. The RZ-PG1 modulates 15%, RZ-PG2 modulates 30%, RZ-PG3 modulates 45%, RZ-PG4 modulates 60%, and RZ-PG5 modulates 75%. The last 25% is used for guard band purpose, to avoid symbol overlapping in communication system. The output of RZ pulse generators are electrically multiplexed using Electrical adder. The Output of electrical adder-4 is the electrical multiplexed signal of all users, the multiplexed data is converted in optical signal by modulating the continuous wave (CW) laser**.** The output of Amplitude Modulator is sent down through an optical fiber cable of 100 km. The received optical signal is amplified by an optical amplifier and feed to FBG. The fiber bragg grating work as wave length filter, that reflect a single wave length signal and transmit others. Then these signals detected by a PIN detector which converts the optical signal in electrical form.

III. FIBER BRAGG GRATING

A FBG is a type of distributed Bragg reflector constructed in a short segment of optical fiber that reflects specific wavelengths of light and transmits all the other components**.** This is achieved by creating a periodic variation in the refractive index of the fiber core, which generates a wavelength specific dielectric mirror. A fiber Bragg grating can therefore be used as an inline optical filter to block certain
Wavelengths, or as a wavelength-specific reflector Optical fiber gratings are important components in fiber communication and fiber sensing fields. The FBGs are used extensively in telecommunication industry for dense wavelength division multiplexing, dispersion compensation, laser stabilization, and Erbium amplifier gain flattening, simultaneous compensation of fiber dispersion, dispersion slope and optical CDMA [3].

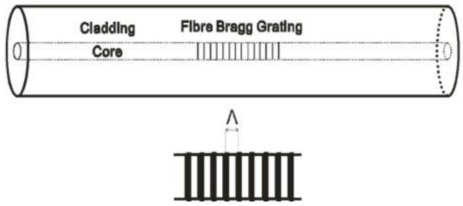

Figure 2: Illustration of a uniform fiber Bragg Grating.

A grating is a device that periodically modifies the phase or the intensity of a wave reflected on, or transmitted through, it. The propagating wave is reflected, if its wavelength equals Bragg resonance wavelength, λ*Bragg*, in the other case is transmitted. The uniform means that the grating period, Λ, and the refractive index change, δ*n*, are constant over whole length of the grating. The equation relating the grating spatial periodicity and the Bragg resonance wavelength is mentioned as below.

$$\lambda_{Bragg} = 2\eta_{eff} \qquad (2)$$

Where *neff* is effective mode index

Figure 3, gives a reflection power spectrum as a function of the wavelength, in which the side lobes of the resonance are due to multiple reflections to and from opposite ends of the grating region.

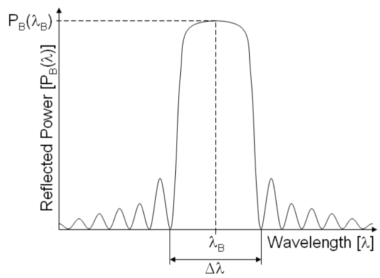

Figure 3: FBG reflected power as a function of wavelength

The wavelength spacing between the first minima or the bandwidth of grating is given by

$$\Delta\lambda = \left[\frac{2\delta\eta_o\eta}{\pi}\right]\lambda_B \qquad (3)$$

Where $\delta\eta_o$ is the variation in the refractive index and η is the fraction of power in the core

IV. SIMULATION RESULT

Figure 4, shows the graph of received electrical BER Vesus SNR length for the 25 Gbps DCDM systems.

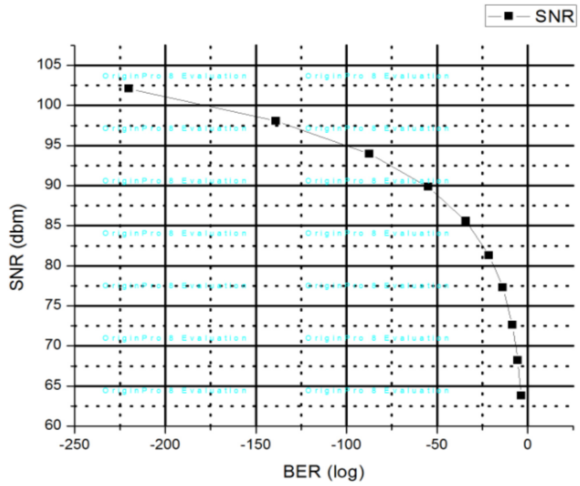

Figure 4: Show the graph between BER Vs SNR at 25 Gbps

Figure 5, shows the graph of received electrical BER Vesus SNR length for the 35 Gbps DCDM systems.

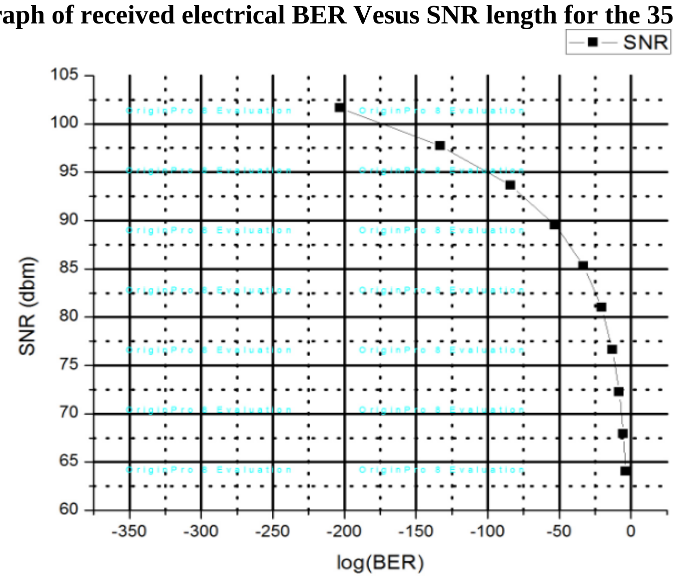

Figure 5: Show the graph between BER Vs SNR at 35 Gbps

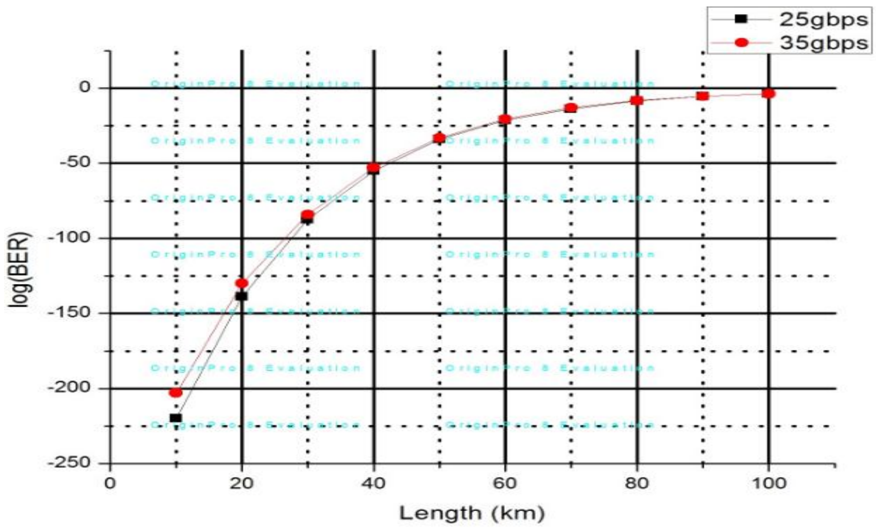

Figure 6: Comparison between BER and SNR

V. CONCLUSION

The comparatively analysis of single and double FBG optical filter in 75 Gbps Optical DCDM based communication system has been simulated. The system performance has been is evaluated on the basis of the SNR, Q-factor and BER, for all five users. It has been observed that as FBG filer increases the performance of system also improved.

REFRENCES

[1].]M. K. Abdullah, G. A. Mahdiraji, A. M. Mohammadi, M. Mokhtar and A. F. Abas "*Duty Cycle Division Multiplexing (DCDM), A New Electrical Multiplexing Technique for High Speed Optical Communication Systems*", Proceedings of IEEE 2008 6th National Conference on Telecommunication Technologies and IEEE 2008 2nd Malaysia Conference on Photonics, 26-27 August 2008, Putrajaya, Malaysia.

[2]. Jyotsna Rani Mahapatra, Manisha Chattopadhyay "*Spectral characteristic of UNIFORM FIBER BRAGG GRATING using couple mode theory*" International Journal of Electrical, Electronics and Data Communication, ISSN (p): 2320-2084, Volume-1, Issue-, July-2013.

[3]. J. H. Lee, S. Ohara, T. Nagashima, T. Hasegawa, N. Sugimoto, K.Igarashi, K. Katoh, and K. Kikuchi, "*Clock recovery and demultiplexing of high-speed OTDM signal through combined use of bismuth oxide nonlinear fiber and erbium-doped bismuth oxide fiber*," IEEE Photonics Technology Letters, vol. 17, no. 12, pp. 2658-2660, Dec. 2005.

[4]. O. Ozoliņ, Ģ. Ivanovs "*Realization of optimal FBG Band–Pass Filters for High Speed DWDM" Journal of Electronics and Electrical Engineering*, 2009. No. 4(92) ISSN 1392 – 1215.

[5]. Vineet Tiwari, Akash Mohan Soni, Abhishek Tripathi and Gireesh G. Soni, "Analysis of 6×10 Gbps Spectrally Efficient Optical AP-DCDM based Communication System", 2014 International Conference on Computer Communication and Informatics (*ICCCI* -2014), Jan. 03 – 05, 2014, Coimbatore, INDIA.

[6]. A. Malekmohammadi, M.K. Abdullah, G.A. Mahdiraji, "Analysis Of Return-To-Zero-On-Off-Keying Over Absolute Polar Duty Cycle Division Multiplexing In Dispersive Transmission Medium" IET Optoelectronics, Vol. 3, No. 4, pp. 197–206., 2009.

[7]. Amin Malekmohammadi, M.K.Abdullah, A.F.Abas, G.A.Mahdiraji,M.Mokhtar, "Absolute Polar Duty Cycle Division Multiplexing(APDCDM); Technique for Wireless Communications", InternationalConference on Computer and Communication Engineering, KualaLumpur, Malaysia, May 13-15, 2008.

[8]. A. Singh, G.G. Soni, A. Tripathi, "Design of 3×60 Gbps DCDM basedWDM system", International Conference on Optical Engineering, 2012.

[9]. M. K. Abdullah, G. A. Mahdiraji, M. F. Elhag, A. F. Abas, E. Zahedi,and M. Mokhtar, "A New Duty Cycle Based Digital Multiplexing Technique", proceedings of IEEE International Conference on Telecommunications, 14-17 May, 2007.