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Review of Optical CDMA with Fiber Bragg Grating & without Fiber Bragg Grating

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Abstract— Increase in the number of users increases the interference between the signals and decreases the bit error rate (BER). This sets a limit for number of users in the given bandwidth in optical fiber. To improve the bit error rate of the system uniform fiber bragg grating is used at transmitter and receiver end with same reflectivity. With distance, performance of OCDMA decreases. To check the effectiveness of FBG on OCDMA in optisystem simulink software, various lengths of optical fibre are taken and bit error rate is checked. Comparison of BER and various parameters of eye diagram is done with FBG and without FBG.

Key words: FBG, OCDMA, BER, TDMA, FDMA.

I. INTRODUCTION

The Multiple access techniques provides very important functions of access network. The three basic multiple access techniques are : Time division multiple access (TDMA), Frequency division multiple access(FDMA), Code division multiple access(CDMA). As compared to TDMA & FDMA, CDMA is more attractive. Optical CDMA is considered as the “next generation CDMA” which uses fiber-optic technology. Optical fibers use light pulse stream to transmit messages. Optical signal travel at much higher speed than electrical ones and give a higher bandwidth as well. The excess bandwidth offered by fiber-optic CDMA facilitates the conversion of low information rates of electrical data into high rate optical signals. OCDMA can been seen as a combination of OWDM and OTDM, however, OCDMA encodes each user's data bit with sets of different time slots and different wavelengths rather than assigns each user with unique OWDM and OTDM channels. A communication system based on optical technology cannot transmit binary data streams consisting of +1 and -1 signals. It can only send binary data of the form 0 and 1. The reason is that an optical system is unable to distinguish between the various phases of light or optical signals. OCDMA facilitates the simultaneous access of multiple users to the network asynchronously. OCDMA uses asynchronous data transmission which can make network control and management quite simple. Thus, OCDMA is well-suited for network applications like LANs (Local Area Networks). OOC (Optical Orthogonal Code). Since the number of network nodes is equal to the number of codes, the requirement of a central node for arbitration between channels is not there. Addition of new users is also quite easy provided that extra codes are available. In case, extra codes are not available, system upgradation to increase time slots and wavelengths can be carried out. OCDMA offers dynamic coding which makes the network connection very secure. The requirements of an OCDMA system are: (1) cost-effective and robustness of generating coded bits; (2) suitable design of address signature code; (3) suppression of Multi-Access Interference (MAI), which is the interference between users with different code sequences, and (4) successful detection of data bits in a code-specific manner.

II. CDMA V/S OPTICAL CDMA:

Comparisons between OCDMA and radio CDMA reveals that the Signal-to-Noise-Ratio or SNR is very poor for radio CDMA whereas it is quite good for OCDMA [7]. The bit rate is very high for OCDMA whereas it is relatively low for radio CDMA. Radio CDMA is non-dispersive whereas OCDMA is dispersive in nature. Voice activity is easy to implement in radio CDMA whereas it is relatively difficult to implement in a “high bit-rate aggregated traffic”. With the help of Optical Orthogonal Codes (OOC), OCDMA can offer a large division of bandwidth. This helps the designers to manipulate spreading as per the needs of a particular system which is being designed.

III. FIBER BRAGG GRATING

Fiber bragg grating (FBG) is a type of distributed bragg reflector constructed in a short segment of optical fiber that reflects particular wavelength of light and transmits all other. Bragg gratings are made by illuminating the core of a suitable optical fibre with a spatially-varying pattern of intense UV laser light. Short-wavelength (<300 nm) UV photons have sufficient energy to break the highly stable silicon-oxygen bonds, damaging the structure of the fibre and increasing its refractive index slightly. A periodic spatial variation in the intensity of UV light, caused by the interference of two coherent beams or a mask placed over the fibre, gives rise to a corresponding periodic variation in the refractive index of the fibre. This modified fibre serves as a wavelength selective mirror: light travelling down the fibre is partially reflected at each of the tiny index variations, but these reflections interfere destructively at most wavelengths and the light continues to propagate down the fibre uninterrupted. However, at one particular narrow range of wavelengths, constructive interference occurs and light is returned down the fibre.

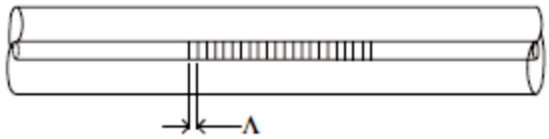

Fig. 1: FBG, indicating core refractive index variations

Maximum reflectivity occurs at the so-called Bragg wavelength λ_B, given by:

$$\lambda_{B} = 2 n_{eff} \Lambda$$

where neff is the effective refractive index of the mode propagating in the fibre and Λ is the FBG period.

The FBG has certain useful characteristics.

(1) The sensor is a modified fibre. It has the same size as the original fibre and can have virtually the same

high strength. This is in marked contrast to many other types of optical fibre sensor which are either bigger, weaker or both.

(2) Because information about the measurands is encoded in the wavelength of the reflected light, FBG sensors are immune to drifts and have no down-lead sensitivity. The responses to strain and temperature are linear and additive and the FBG itself requires no on-site calibration.

(3) Multiple gratings can be combined in a single fibre by taking advantage of multiplexing techniques inspired by the telecommunications industry. This gives FBG sensor systems the important property of being able to simultaneously read large numbers of sensors on a very few fibres, leading to reduced cabling requirements and easier installation.

(4) Temperature and strain can be measured with the same sensor. In practise, this property can be a two-edged sword. Accurate measurements of strain in the presence of significant temperature excursions require gratings to be deployed in pairs, one sensitive to temperature and strain, bonded securely to the structure of interest and one close to it but isolated from strain, responding to temperature only. In practise, this doubling-up of sensors is not too problematical because there are almost invariably 'spare' FBG which a given unit can address, specifically for the purpose of temperature compensation.

A. Working Principle:

The working principle of FBG is based on fresenel reflection.

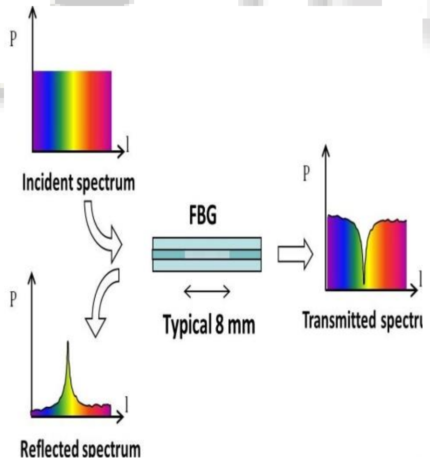

Fig. 3: Working Principle

Therefore, light propagates through the grating with negligible attenuation or signal variation. Only those wavelengths that satisfy the Bragg condition are affected and strongly back-reflected. The ability to accurately preset and maintain the grating wavelength is a fundamental feature and advantage of fiber Bragg gratings.

The central wavelength of the reflected component satisfies the Bragg relation: $\lambda refl=2n\Lambda$, with n the index of refraction and Λ the period of the index of refraction variation of the FBG. Due to the temperature and strain dependence of the parameters n and Λ, the wavelength of the reflected component will also change as function of temperature or strain. This dependency is well known what allows determining the temperature or strain from the reflected FBG wavelength.

A Fibre Bragg Grating (FBG) is a periodic, or almost periodic, structure consisting of a variation of the refractive index along the length of a fibre. It acts as a band-rejection filter, reflecting any wavelength that satisfies the Bragg condition and passing all wavelengths that are not resonant with the grating. The advantages of FBGs in systems applications include low insertion loss, all fibre compatibility, relative ease of manufacture and low cost; but a major feature is that by changing the grating parameters such as induced index change, length, period chirp, fringe tilt, we can achieve the desired grating spectral characteristics. The FBG has a range of applications in the optical communications area, such as wavelength selection, laser stabilization, dispersion compensation, pulse shaping, etc.

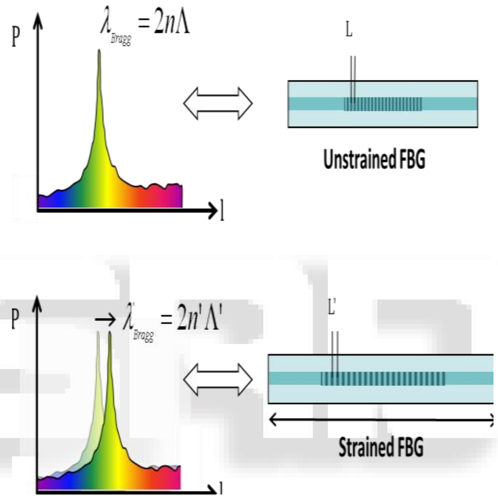

Fig. 2: Fibre Bragg Grating

IV. COMPARISON B/W OCDMA WITHOUT FBG & WITH FBG

The simple OCDMA has a lot of interference between the signals and the bit error rate is very high. As the number of users increases bit error rate is increased very rapidly. When we will use the OCDMA with fiber bragg grating then we will see that the bit error rate is very less as compared to OCDMA without fiber bragg grating with the same number of users as used in simple optical CDMA. And the interference is also very less. For this implementation we will use opti-system tool. OptiSystem is an innovative optical communication system simulation package which was explored by optiwave company in order to meet the academic requirement of the system designers, optical communications engineers, researchers. It integrates design, test and optimize all types of broadband optical network physical layer functions such as virtual optical connection. From the long-distance communication systems to LANS and MANS, it can be well used. It has a huge database of active and passive components, including power, wavelength, loss and other related parameters. Parameters allow the user to scan and optimization of device-specific technical parameters on the system performance. OptiSystem has powerful simulation environment and real components and systems of classification definitions. A fiber optic communication system model is based on the actual system-level simulator. Its performance can be attached to the device user interface library and can be completely expanded to become a widely used tool.

V. Conclusion

There is always of bandwidth regulation so that maximum user can transfer data through a single optical fiber cable. But the interference between the signal increases with the increase of users. In our work this problem has been discussed and tackled. For this purpose a comparison is shown between proposed work and simple OCDMA. Three users have been considered who transfers data simultaneously, as CDMA is the principle which assigns unique code to each user so that interference is minimised, yet bandwidth is a constraint. 10 Gbps system is designed for testing in Optisim tool of Optiwave. Initially 10 km length of optical fibre is considered and there users transmit data through that simultaneously. Without proposed work the signal at receiving end get distorted. But when fibre bragg grating is used at both transmitting and receiving end for each user then this distortion in minimized. Eye diagram is used to check the distortion. Results have been checked for different length of fibre cable and it has been noticed that with FBG structure, distortion is minimised to a good extent and so three users can easily transmit data through optical fibre simultaneously with distortion minimised. As the length of fiber is increased, BER is increased and for 10 km it is less as shown in table 4.4 in previous chapter. This table also shows the comparison between BER for different lengths of optical fibre in case of FBG and without FBG. It clearly shows that with FBG performance is improved.

References

[1] Hilal A. Fadhil, Thanaa Hussein Abd, Hamza M. R. Al-Khafaji, S. A. Aljunid," WDM and OCDMA Systems under MAI Effects: A Comparison Analysis" World Academy of Science, Engineering and Technology 64 2012

[2] Shweta Patel , Prof. Mukesh Tiwari & Prof. Jaikaran Singh," Performance Analysis of Dynamic OCDMA using Matlab" Global Journal of Researches in Engineering Electrical and Electronics Engineering Vol. 12 Issue 8 Version 1.0 Year 2012

[3] Karl J. Dexter, Student Member, IEEE, Douglas Alexander Reid, and Liam P. Barry, Member, IEEE," Reduction of MAI and Beat Noise in OCDMA Systems Using an SA-SOA-TPA-Based Receiver" IEEE PHOTONICS TECHNOLOGY LETTERS, Vol. 21, NO. 22, NOVEMBER 15, 2009

[4] NEETIKA ARORA, RAKHI AGRAWAL," Design and Performance Analysis of an Optical CDMA System for 2-D Perfect Difference Codes Using Shifted Sine" (IJITR) INTERNATIONAL JOURNAL OF INNOVATIVE TECHNOLOGY AND RESEARCH Vol. 1, Issue No. 3, April - May 2013, 261 – 264.

[5] Shweta Patel, Mukesh Tiwari, Jaikaran Singh,"Multiuser Interface Optical Code Division Multiple Access System" International Journal of Engineering and Innovative Technology (IJEIT) Vol. 2, Issue 2, August 2012

[6] Xiaohui Fang, Dong-Ning Wang," Fiber Bragg grating for spectral phase optical code-division multiple-access encoding and decoding" Vol. 20, No. 8/August 2003/J. Opt. Soc. Am. B 1603.

[7] Neetu Sharma, Kiranpreet Kaur ," Performance Evaluation of Optical Combinatorial Code For Potentially Increasing Number of Users" IJCSET |September 2011 | Vol. 1, Issue 8, 476-479

[8] K.Suresh," Reduction of Four Wave Mixing Effect in Hybrid Optical CDMA/WDMA System-A Simulation Study" International Journal of Engineering Research and Development e-ISSN: 2278-067X, p-ISSN: 2278-800X, www.ijerd.com Vol. 2, Issue 11 (August 2012), PP. 42-50.

[9] Zou Wei, Student Member, IEEE, H. M. H. Shalaby, Senior Member, IEEE, and H. Ghafouri-Shiraz, Senior Member, IEEE," Modified Quadratic Congruence Codes for Fiber Bragg-Grating-Based Spectral-Amplitude-Coding Optical CDMA Systems" Journal Of Lightwave Technology, Vol. 19, No. 9, September 2001

[10] Abdallah IKHLEF, Rachida HEDARA, Mohamed CHIKH-BLED," Uniform Fiber Bragg Grating modeling and simulation used matrix transfer method" IJCSI International Journal of Computer Science Issues, Vol. 9, Issue 1, No 2, January 2012.

