DIFFERENT DISPERSION COMPENSATION METHODS IN WDM OPTICAL NETWORKS -A REVIEW

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Abstract: In Fiber-Optics communication network pulse broadening due to chromatic dispersion becomes an important factor for signal quality degradation. This paper review of the chromatic dispersion compensation in optical fiber communication system. In optical communication system to compensate dispersion Fiber Bragg grating (FBG) is one amongst the applicable and necessary components. During this the appliance of chirped FBG was studied as a dispersion compensator in optical communication systems. This paper studied the various types of simulation in optical fiber communication system. The reviews of the analysis based on the chromatic dispersion are studied in the paper. There are three widely used dispersion compensation techniques i.e. Fiber Bragg Grating (FBG), EDFA and Dispersion Compensation Fiber (DCF). A fiber brag grating (FBG) is one of the most important and applicable component in an optical communication system. The use of chirped FBG has been studied as a dispersion compensator in an optical communication system. Besides this we also analyze how dispersion is compensated in WDM system using different techniques like FBG, DCF, and Digital Filters. The rapid growth in demand for high-capacity telecommunication links, and the speed limitation of single-wavelength links, has resulted in an extraordinary increase in the use of WDM in advanced light wave networks.

Keywords: (DCF) Dispersion Compensating Fiber, (OPC),EDFA,(FBG)Fiber Bragg Grating.

I. LITERATURE SURVEY

In order to improve the overall system performance and reduced as much as possible the transmission performance affected by dispersion, several dispersion compensation techniques were proposed. Among the various techniques proposed in literature, the techniques that appear to hold immediate promise for dispersion compensation can be broadly classified as: Dispersion compensating fibers (DCF), Fiber Bragg grating (FBG) and High order mode (HOM) fiber. The idea of using dispersion compensating fibers (DCF) was proposed in 1980. As the components of DCF are more stable, not easily affected by temperature, wide bandwidth, DCF has become a most suitable method for dispersion compensation. There is a positive second order and third order dispersion in single mode fiber, while the DCF dispersion value is negative. So by inserting a DCF the average dispersion is close to zero. Different Compensation Techniques to compensate Chromatic Dispersion in Fiber Optics" that dispersion compensation is most challenging as well as important aspect to maintain signal to noise ratio in an optical communication. He discussed that Dispersion Compensation Fiber (DCF) is a reliable technology but it also gives high insertion loss as well as introduce some nonlinear distortion when there is high input power. Other dispersion techniques such as electronics dispersion Compensation (EDC), Fiber Bragg Grating (FBG) and Digital Filters are discussed by him. Dispersion Compensation is necessary to reduce losses and coast of the system and can be done through two different methods i.e. DCF and FBG [08-12].

II. TYPES OF DISPERSION

Dispersion is defined as spreading of pulse in an optical fiber. As a pulse of light travel through a fiber, elements such as numerical aperture (NA), core diameter, refractive index profile, wavelength (λ), and laser line width cause the pulse to broaden and one more thing about dispersion is that it increases along the fiber length [5]

2.1 Polarization Mode Dispersion

Polarization Mode Dispersion (PMD) occurs due to birefringence along the length of the fiber that causes different polarization modes to travel at different speeds which will lead to rotation of polarization orientation along the fiber [2].

2.2 Modal Dispersion

Modal dispersion is defined as pulse spreading caused by the time delay between lower-order modes and higher-order modes. Modal dispersion is problematic in multimode fiber, causing bandwidth limitation.

2.3 Chromatic Dispersion

Chromatic Dispersion (CD) is pulse spreading due to the fact that different wavelengths of light propagate at slightly different velocities through the fiber because the index of refraction of glass fiber is a wavelength-dependent quantity; different wavelengths propagate at different velocities. Chromatic dispersion consists of two parts: material dispersion and waveguide dispersion [5].

2.3.1 Material Dispersion

It is due to the wavelength dependency on the index of refraction of glass i.e. refractive index of the core varies as a function of wavelength.

III. DISPERSION COMPENSATION TECHNIQUES

Dispersion compensation is the most important feature required in optical fiber communication system. The most commonly used techniques for dispersion compensation are as follows:

3.1 Electronic dispersion compensation(EDC)

Electronic equalization technique is used, here chromatic dispersion gets translated into nonlinear distortions after optical to electrical conversion. It is due to concept of nonlinear cancellation and nonlinear channel modeling. For this mainly feed forward equalizer(FFE) and decision feedback equalizer(DFE) structures are used. EDC slows down the speed of communication as it slows down the digital to analog conversion.

3.2 Fiber brag grating(FBG)

FBG has recently found a practical application in compensation of dispersion broadening in long haul communication using chirped fiber grating(CFG). CFG is a small fiber passive device with low insertion loss that is compatible with the transmission system and CFG's dispersion is easily adjustable. For optimum results, CFG should be located in-line through the architecture for using FBG is complex.

3.3 Dispersion compensating fiber

The process of inserting a loop of fiber into the link having a dispersion characteristic that negates the accumulated dispersion of the transmission fiber is called dispersion compensation and the fiber loop used is known as dispersion compensating fiber(DCF). Hence DCF is a loop of fiber having negative dispersion equal to the dispersion of the transmitting fiber.

IV. CONCLUSIONS

In this paper it is concluded that during data transmission through optical fiber there are various types of dispersion occurred for example model, chromatic and polarization dispersion. As we know these dispersion are not beneficial for our transmission so we have to remove these so that communication between transmitter and receiver side would be successful so that there are some technique which we have to use to compensate the dispersion and some of technique are as DCF,FBG and EDC. There are various parameters which we have to analyze during our research work.

REFRENCES

[1] Gopi, N.; Muthumani, I.; Sivanantha Raja, A.; Selvendran, S., "Dispersion compensation for WDM signals with polarization insensitivity," Information Communication and Embedded Systems (ICICES), 2013 International Conference on , vol., no., pp.840,844, 21-22 Feb. 2013

[2] Bo-ning Hu; Wang Jing; Wang Wei; Rui-Mei Zhao, "Analysis on dispersion compensation with DCF based on Optisystem," Industrial and Information Systems (IIS), 2010 2nd International Conference on , vol.2, no., pp.40,43, 10-11 July 2010

[3] Saurabh Kumar;Prof. A. K. Jaiswal; Er.Mukesh Kumar; Er.Rohini Saxena,"Performance Analysis of Dispersion Compensation in Long Haul Optical Fiber with DCF"IOSR Journal of Electronics and Communication Engineering (IOSR-JECE)e-ISSN: 2278-2834,p-ISSN: 2278-8735.Volume 6,Issue 6(Jul-Aug. 2013), PP19-23

[4] Optimization for the Best Performance for Wavelength Division Multiplexed Passive Optical Network, NikShahidah Afifi bt. Md. Taujuddin, Maisara Othman and Zarina Tukiran, Proceedings of EnCon2008 2nd Engineering Conference on Sustainable Engineering Infrastructures Development & Management December 18 -19, 2008, Kuching, Sarawak, Malaysia . ECO2008-F-28

[5] Symmetrical Dispersion Compensation For High Speed Optical Links, Ojuswini Arora1, Dr.Amit kumar Garg2, Savita Punia3, IJCSI International Journal of Computer Science Issues, Vol. 8, Issue 6, No 1, November 2011 ,ISSN (Online): 1694-0814 ,www.IJCSI.org

[6] Keiser, G. Optical Fiber Communications, Third Edition. McGraw-Hill, 2000. Roeland J. Nuyts, Yong Kwan Park , and Philippe Gallion,

[7] Dispersion equalization of a 10 Gb/s Repeatered Transmission System Using Dispersion compensating Fibers‖, Journal of Lightwave Technology, Vol.15, Issue 1,1997. pp.31-42

[8] J. Yu and P. Jeppesen, ―Investigation of cross-phase modulation in WDM systems with NRZ and RZ modulation formats‖, Opt. Comm. 184, pp. 367, 2000

[9] M. I. Hayee and A. E. Willner, ―NRZ versus RZ on 10-40 Gb/s dispersion managed WDM transmission systems‖, IEEE Photon. Tech. Lett. 11, pp. 991, 199

