International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395 -0056
Volume: 04 Issue: 06 | June -2017 www.irjet.net p-ISSN: 2395-0072

Improvement in Repeater Spacing For Fiber Optic Communication

[1]Deepak Tomar

[1]*DCRUST University, Sonepat-131001, Haryana, India*

---***---

Abstract - *This paper surveys late advance on repeater spacing for fiber optic communication for Long-haul distance in fiber optical communication. The pragmatic thought of the extensive range strands, for example, joining and cabling for terrestrial transport frameworks, is additionally quickly tended to. We have studied the various factors affecting repeater spacing fiber attenuation, Stimulated Brillouin Scattering (SBS), Stimulated Raman Scattering (SRS) ,Dense wavelength division multiplexing (DWDM), .In our work we have increased the distance between two repeaters from 304 km to 400 km and 450 km. In our work, we have used Erbium doped Fiber Amplifier (EDFA) and reduced the non-linearity. Likewise, we have attained results for different repeater spacing.*

Key-Words: Erbium doped Fiber Amplifier (EDFA), Stimulated Brillouin Scattering (SBS), Stimulated Raman Scattering (SRS), Dense wavelength division multiplexing (DWDM)

1. INTRODUCTION

As of late, examination on optical transmission frameworks has been centered on the expansion of their distance and capacity. Tight optical filtering (TOF) can enhance the transmission Capacity by expanding the spectral efficiency, prompting ultra-dense wavelength-division-multiplexing (UDWDM) frameworks [1], [2]. For long-haul transmission frameworks, high powers are required at the fiber input to expand the optical signal-to-noise ratio (OSNR) lessened by collected amplified spontaneous emission (ASE) noise of optical Amplifiers. To keep up the OSNR in a point of confinement of loyal transmission, an option is boosting the signal control, yet high input optical power uncovered systems to the serious nonlinear impacts of the transmission fiber [3]. Soliton pulse is another solution to transmit data over a long distance. Soliton is a kind of pulse for which dispersion is cancelled out by its self-phase modulation, so it can maintain its shape for long distance transmission.

Most of the research as of now is under approach to create high bite rate correspondences frameworks which utilize dispersion compensation to permit long-haul single traverse transmission. A number of ways have been proposed to actualize dispersion compensation, for example, midpoint spectral inversion [4] or the utilization of negative dispersion fiber. Another strategy which is right now creating a parcel of enthusiasm, by virtue of its smaller uninvolved nature, is the chirped fiber Bragg grating [5]. For WDM systems, the Kerr effect also causes cross phase modulation (XPM) and four wave mixing (FWM) between neighboring channels [6].

In long-haul optical communication frameworks, chromatic scattering (CD) and polarization mode scattering (PMD) constrain transmission execution. Different digital signal processing (DSP) procedures, for example, orthogonal frequency division multiplexing (OFDM) [7]–[10] and coherent single carrier transmission (COSC) with time domain equalization (TDE) [11]–[13] were proposed to repay the impacts of CD and, PMD.

Phase noise is the fundamental variable affecting the execution of DPSK system [14], Amplitude changes caused by amplified spontaneous emission (ASE) noise are changed over into phase noise by Gordon-Mollenauer effect phase noise causes serious constraint to the communication framework capacity. The most effective method to decrease the phase noise productively, particularly the nonlinear phase noise, turn into the keying variable to move forward the execution of the phase modulation frameworks. Researchers utilized phase sensitive to stifle phase noise [15]-[16]

2. DWDM (DENSE WAVELENGTH DIVISION MULTIPLEXING)

Dense Wavelength Division Multiplexing (DWDM) [17] is an optical transmission innovation that empowers noteworthy increments in the information rates that can be persisted a solitary optical fiber by the utilization of various wavelengths, each conveying a different channel. The customary way to deal with DWDM framework configuration has been to utilize a non-return to zero (NRZ) transmission format for every wavelength.

It enhances the capacity of embedded fiber by first allocating approaching optical signals to particular frequencies within designated frequency band and afterward multiplexing the subsequent signals out onto one fiber. Because incoming signals are never ended in the optical layer, interface can be bit-rate and configuration autonomous, enabling the service providers to coordinate the DWDM innovation effectively with existing gear in the system while accessing the undiscovered capacity in the embedded fiber. DWDM consolidates different optical signals so they can be amplified as a group and transported over a solitary fiber to expand capacity

3. EDFA (ERBIUM DOPED FIBER AMPLIFIERS)

The new light wave innovation based on the Erbium-doped fiber-Amplifier (EDFA) will permit the up-coming era of fiber optic cable networks to have eight times the capacity of existing cables. Erbium-doped fiber-amplifiers (EDFAs) have a few attributes that make them a perfect decision for some light wave applications, including long-haul transmission:

(1)EDFAs can be made with an assortment of gains in the low-loss 1550 run wavelength window of telecommunications fibers, with nearly ideal noise performance.[18] (2) EDFAs amplify high-speed without distortion or crosstalk between wavelengths, notwithstanding when the intensifier is worked somewhere down in gain compression.. (3) EDFAs are a fiber gadget, splicing naturally with telecommunications fiber, what's more, are insensitive to polarization impacts [19]. (4)The EDFA's pump laser diodes are fabricated from the same InGaAsP semiconductor family that has demonstrated dependability with millions of devices hours on 1.3 pm and 1.55 pm flag lasers; all other EDFA parts are uninvolved devices, making enhancer plans straightforward and guaranteeing that EDFAs can be made with high reliability.

4. SOLITON

It has been observed that in an optical communication framework when Gaussian pulse is utilized for flag transmission through a non-linear channel, scattering happens with the transmitted signal. With a specific end goal to maintain a strategic distance from Inter-Signal Interference, Soliton pulses utilized. Soliton is a sort of pulse for which scattering is offset by its self-phase modulation, so it can keep up its shape for long distance transmission .For a long-haul communication framework; after a specific distance, the Soliton pulse additionally gets lessened regardless of the possibility that it is not scattered. Along these lines, usage of the amplifiers is required in the transmission channel to help up the power level of the Soliton pulse. In this manner, the number of amplifiers utilized for a long-haul communication is a decent sign of which pulse creates better execution for the framework. Here the use of Soliton beat is more compelling in correlation with utilization of Gaussian pulse as it guarantees diminished number of amplifiers.

5. FIBER NON-LINEARITIES

Fiber shows less attenuation at 850 nm, 1310 nm and 1550 nm in view of the hint as in ref [20] and furthermore considering the non-linearity of the fiber at different wavelengths. So here, we take up the work to advance the repeater spacing in fiber optic communication. One conceivable strategy in this approach is to diminish the ASE and coming about increment in the optical signal to noise ratio (OSNR) as in ref [21].Excess ASE is an undesirable parameter in any laser source as in ref [22] since it restricts the most extreme pick up that can be accomplished. Hence by considering all the above parameters we would take a stab at decreasing the spacing between the repeaters.

6. INFLUENCE OF ASE

When light travels a long distances it picks up interruption called noise. In an optical amplifier if G is the gain of the amplifier the signal amplitude is multiplied with gain G times. But in case of optical fiber communication with the noise $N_{in,}$ the signal picks up during its long travel. Which is amplified gain times with the required signal amplification the amplifier in turn insert its own additional noise. This is storyline in the real time optical fiber communication network.

Therefore the output noise $N_{out,}$ becomes greater than G times the input noise, Nout will be

$$N_{out} = G * N_{in} + \text{Amplifier's own Noise} \quad (1)$$

Optical signal propagating through an optical fiber will be subjected to weakening as it travels very long distances before it reaches to the other end. Repeaters also along its path introduces its own noise. So the signal is degraded to a large value when it reaches the other end. This issue can also be expanded to WDM system as in ref [23] [24] [25].So we deploy repeaters at equal intervals to boost the signal level.

7. SBS THRESHOLD

One practical way to decrease the number of repeaters is to deliver more power into the fiber however it may lead to Fiber non-linearity. Stimulated Brillouin Scattering decimate the dumping of power. So, phase control is being made to augment the threshold power to be launched into the fiber. By increasing the SBS threshold and thereby feed in more power and in due course the spacing between the repeater can be large enough. Repeater spacing is most complex in the case of optical fiber networks. So by taking these into considerations the cost factor and the tediousness in installation and maintenance of the repeaters. It allows to release a reasonably high amount of power in the fiber, this helps us to attain the optical signal to noise ratio requirements and receiver sensitivity requirements based on square law detection. For the particular application, since the dispersion effects are minimum at 1550nm wavelength we use the same. We could set the max tolerable spectral width σ_λ in the optical source so as to maximize the power threshold.

Pth = 21Aeff/gB Leff (1+σλ/ΔVB) (2)

8. SECURITY MEASURES PROTECTION AGAINST TAPPING

Optical fiber communication is not as secure as it looks. There are various known strategies for separating or infusing data into a fiber connect, while keeping away from location. Eavesdropper can compromise security of a fiber link with existing technologies. Some measures to prevent fiber tapping or to nullify the significance of information tapped from fiber are also discussed: Pilot Tone Methods ,OTDRs (Optical time domain reflect meters), Optical Mean Power Measuring, Modes' Power Monitoring, Electrical Conductors and Monitoring Signals around the Fiber. If these measures taken carefully then protection can be done against tapping.

9. METHODOLOGIES

The methodology that will be used it accomplished the objectives listed above can be divided into two distinct steps.

The steps are:
1) Analysis
2) Simulation

The first step will be to study existing literature available and also analysis the collected data. Select the suitable data and use in a concrete for improving their properties.

The second step is to simulate the results in Matlab to attain above results in an efficient manner.

10. SIMULATION RESULTS

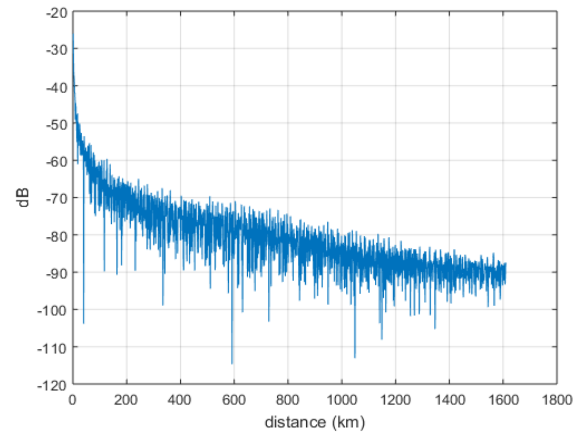

Fig -1: Received Power when no repeater is used

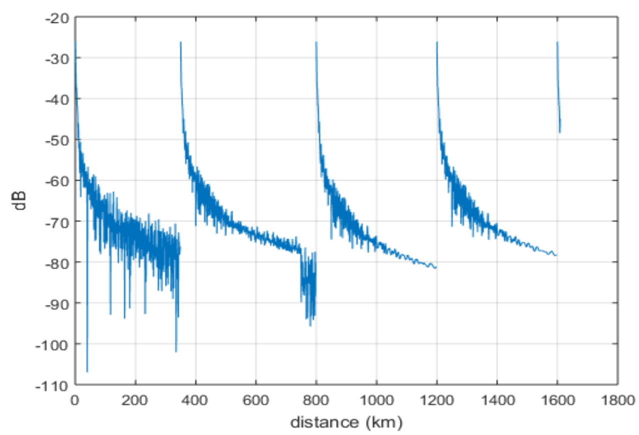

Fig -2: Received Power when three Repeaters are used

11. RESULTS

Table -1: Distance between the Repeaters

No of Repeaters used	Distance between Repeaters(Km)
1	350
2	450
3	400

12. CONCLUSION

Approaches have been explored to amplify the capacity of fiber optic cable network by upgrading the spacing between the repeaters, we have attempted to expand the power threshold of SBS considering all the affecting variables and along these lines backscattering is maintained a strategic distance from. As every one of the parameters are interrelated we have taken one fiber nonlinearity i.e., SBS and its tradeoff with the input power, correspondingly expanding the input power to build the Brillouin threshold. In this manner comes about utilizing recreation have demonstrated that we prevail to improvement in the repeater spacing in fiber optic cable more than 304 km. Fiber nonlinearities turns out to be a noteworthy requirement in the enhancement of spacing between the repeaters. Likewise DWDM innovation gives fiber optic systems with two central improvements: expanded limit and more prominent system adaptability. Dangers influencing fiber optic network can be maintained a strategic distance from if arrangements said above took after legitimately. Upgrading the spacing between the repeaters leads to less maintenance and decrease in cost.

REFERENCES

[1] G. Bosco, A. Carena, V. Curri, R. Gaudino, and P. Poggiolini, “Modulation formats suitable for ultrahigh spectral efficient WDM systems,” IEEE J. Sel. Topics Quantum Electron., vol. 10, no. 2, pp. 321–328, Mar./Apr. 2004.

[2] S. Bigo, “Multiterabit/s DWDM terrestrial transmission with bandwidth-limiting optical filtering,” IEEE J. Sel. Topics Quantum Electron., vol. 10, no. 2, pp. 329–340, Mar./Apr. 2004.

[3] G. Agrawal, Fiber-optic communication systems, vol. 222. Wiley, 2012.

[4] WATANABE. s., TAKAO, N., and CHIKAMA, T.: ‘Compensation of Chromatic dispersion in a single-mode fiber by optical phase Conjugation’, IEEE Photonics Technol. Lett., 5, (l), pp. 92-95, 1993.

[5] OUELLET~E. F.: ‘Dispersion cancellation using linearly chirped Brag grating filter; in optical waveguides’, &t. Letter.’’12, (Lo), pp. 847-849, 1987.

[6] G. Agrawal, Nonlinear Fiber Optics. Academic Press, 2012.

[7] A. Sano et al., “13.4-Tb/s (134111-Gb/s/ch) no-guard-interval coherent OFDM transmission over 3 600 km of SMF with 19-ps average PMD,” in Proc. ECOC2008, Belgium, Paper Th.3.E.1, 2008

[8] S. L. Jansen et al., “10121.9-Gb/s PDM-OFDM transmission with 2-b/s/Hz spectral efficiency over 1 000 km of SSMF,” in Proc. OFC/ NFOEC2008, San Diego, CA, Paper PDP2, 2008.

[9] Q. Yang et al., “107 Gb/s coherent optical OFDM reception using orthogonal band multiplexing,” in Proc. OFC/NFOEC, San Diego, CA, 2008, Paper PDP7, 2008.

[10] W. Shieh et al., “Coherent optical OFDM: Has its time come?” J. Opt. Netw. vol. 7, pp. 234–255, Feb. 2008.

[11] C. R. S. Fludger et al., “10111 Gbit/s, 50 GHz spaced, POLMUX-RZ-DQPSK transmission over 2375 km employing Coherent equalization,” in Proc.OFC/NFOEC2007, San Diego, CA, Paper PDP22, 2007.

[12] H. Sun, “Real-time measurements of a 40 Gb/s coherent system,” Opt. Exp., vol. 16, no. 2, pp. 873–879, Jan. 2008.

[13] S. J. Savory et al., “Transmission of 42.8 Gbit/s polarization multiplexed NRZ-QPSK over 6400 km of standard fiber with no optical dispersion Compensation,” in Proc. OFC/NFOEC2007, San Diego, CA, 2007

[14] Gordon, Mollenauer.Phase noise in photonics communication system using linear amplifier. Opt.Letter, Vol.15, pp1351-1355, 1999.

[15] K. Croussore, C. Kim and G. Li, All-optical regeneration of differential phase-shift keying signals based on phase-sensitive amplification[J].Opt.Lett,28(20):2357-2359, ,2004.

[16] Lixia Xi, Xianfeng Tang. Optimization of Phase Regenerator in Differential Phase-shift Keying Format Communication System[C], IEEE/CSO, 805-807, 2009.

[17] C. A. Brackett, "Dense wavelength division multiplexing networks: Principles and applications," IEEE J Selected Areas Communications, vol. 8, pp. 948-964, August 1990.

[18]J. L. Zyskind, et al., AT&T Technical Journal, Pg. 53. Vol. 71, No. 1 Jan/Feb 1992.

[19] E. Desurvire, C. R. Giles, and J. R. Simpson, LT 1990.

[20] John C. Mauro, Srikanth Raghavan, and A. Bohuffin” Enhanced stimulated Scattering threshold through phase control of multitone phase modulation”, 2010 Society of Photo-Optical Instrumentation Engineers. Oct. 26, 2010.

[21] Antonio Mecozzi, Member, IEEE” On the Optimization of the Gain Distribution of Transmission Lines with

Unequal Amplifier Spacing” IEEE photonics technology letters, vol. 10, No. 7, July 1998.

[22] P. Poggiolini, Member, IEEE, A. Carena, V. Curri, R. Gaudino and S. Benedetto ,Fellow, IEEE” New Analytical Results On Fiber Parametric Gain and Its Effects on ASE Noise” IEEE photonics technology letters, Vol. 9, No. 4, April 1997.

[23] T.Sabapathi, S, Sundaravadivelu, and P.Saravanakumar, “Capacity optimization in DWDM Optical Communication System”, International Journal on Information and Communication Technologies, Vol. 2, No. 1-2, pp. 123- 126,January – June 2009.

[24] T.Sabapathi and S.Sundaravadivelu, “Analysis of Bottlenecks in DWDM Fiber Optic Communication System”, In OPTIK, International Journal for Light and Electron Optics, ISSN 0030-4026, Vol. 122. Issue No. 16, pp. 14531457, 2011.

[25] A.Vairamuthu ,T. Sabapathi and S. Sundaravadivelu “Analysis of Optical Modulation Formats for DWDM system”, international Journal of Information and Communication Technologies(IJICT), Vol. 4, No. 1-2, pp. 5-10, January – June 2011.

[26] F. H. Tithi and M. S. Islam, “Suppression of Stimulated Brillouin Scattering Effect using Nonlinear Phase Modulation”, 6th International Conference on Electrical and Computer Engineering ICECE,(Dhaka,)Bangladesh,18-20 December 2010.

[27] Muxihito Tonzizuwu, Kenji Suto, , Kuzuo Hagimoto, Koichi Wukitu and Kuzutoshi Kuto, Akihide Sano, Tomoyoshi Klituoku” Automatic dispersion equalization by monitoring extracted clock power level in a 40-Gbit/s, 200-km transmission line” 22nd European Conference on Optical Communication- ECOC' 96.

[28]John Park, Student Member, IEEE, Aly F. Elrefaie, Senior Member, IEEE, and Kam Y. Lau, Fellow,IEEE” 1550-nm Transmission of Digitally Modulated 28-GHz Subcarriers Over 77 km of Non-dispersion Shifted Fiber” IEEE photonics technology letters, vol9, no. 2, February 1997.