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An efficient bit error rate reduction using pulse shaping in Li-Fi technology

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ABSTRACT

One of the noticeable non-linear properties in Li-Fi technology is the four wave mixing occurrence. Mixing consequence is booming when the segment matching disorder is fulfilled. It only happens for particular groupings of fiber diffusion and signal occurrences. It is a very disagreeable transmission phenomenon happening in a translucent optical network based on Li-Fi, but it can be recycled favorably for implementing optical strategies such as wavelength converters, parametric amps, optical multiplexers or de-multiplexers, chromatic scattering compensators, as well as a gesture to noise regenerators. This paper discusses the consequence of channel spacing, dispersion, optical fiber length and the dissimilarity of input power in the Li-Fi technology to reimburse the consequence of mixing of frequencies when realized in a short haul situation. The approach used is match filtering with pulse shaping to increase the quality factor with less bit error rates and the whole simulation is taken place in MATLAB.

Keywords— *Li-Fi, Optical communication, Four wave mixing, Pulse shaping, Match filtering*

1. INTRODUCTION

According to the time, the necessity for communication using distances, to pass data from one place to a different place, became essential and the creation of telegraphy carried the whole world into the electrical communication. This event has radically transformed the growth of communication expertise. Today's extensive distance communication has the capability to transmit and obtain a large quantity of information in a little time period. [1][2] The optical fibre technology has established fast to attain larger broadcast capacity and lengthier transmission distance, to please the increased request of a computer network. Since the request on the collective system and system capacity is projected, more bandwidth is desirable because of the extraordinary data rates submission, like video conference and image transmission in real time scenarios, and to achieve reasonable communication for every person, at any phase and place [3] [4]. The broadcasting capabilities permit not human to human communication and interaction, but also human to machine interactions and machine to machine communication. It is a technology which is used to distribute RF indications over optical links which are Analog in nature. In such systems, microwave data are controlled onto an optical carrier at a significant location and then conveyed to remote sites by optical fibre [8] [9]. The base locations then communicate the RF signals over minor areas using microwave projections. Such expertise is projected to play a significant role in present and upcoming wireless networks since it delivers an end user with an actually broadband admittance to the network while assuring the increasing necessity for mobility. In accumulation, since it allows the generation of millimetre signal waves with excellent belongings, and makes operative use of the comprehensive bandwidth and low broadcast loss features of optical fibers, it is a very attractive and flexible configuration [10][11]. The rapid growth of wireless communication systems has increased the necessity of optical signal processing. The connection lengths have full-grown to thousands of kilometres without the necessity to convert optical indications back and forth to the electric procedure, and the transmission hustles of terabits are feasible nowadays [12][13]. This growing request for the high rapid communication is compulsory to use advanced bit rates as well as broadcasting powers.

2. RELATED WORKS

FWM well known by frequency mixing procedure is a fibre-optic representative that affects WDM systems, where numerous optical wavelengths are spread out at equal intermissions or channel spacing. The belongings of FWM are marked with decreased network spacing of wavelengths for instance in dense WDM schemes and at high signal control levels. High dispersion reduces FWM effects as signals lose coherence, or increases the phase incongruity. The interfering FWM produced in WDM schemes is known as crosstalk in inter-channel. FWM can be diminished by using rough channel spacing that raises dispersion. Brian Pamuk, Doan Perdana et al. [1] analyzed the influence of Kerr-effect happening at 10 Gbps transmission DWDM schemes which originate the cost of the refractive index of nonlinear influences on decreasing the amount of input channel. The consequences show that soliton can increase the excellence of presentation with Q factor above 6. Several investigations with similar bitrate using a distance of 100 km, this paper examined longer detachments have doubled. Sai Vineel Reddy Chittamuru, Ishan G Thakkar, Sudeep

Pasricha et al. [2] proposed a novel scrambling mechanism that perceptively adapts to on-chip procedure variations, and recovers worst-case SNR by dropping crosstalk noise in Mrs used inside DWDM.

Gurleen Kaur, Gurinder Singh et al. [3] proposed knowledge of transmitting data from dissimilar sources over a solitary link at the same time while each data frequency is carried on its own exclusive wavelength. The presentation is limited by numerous Non-Linear belongings which are produced by the requirement of the refractive index on the strength of the optical control. FWM is a non-linear procedure that generates new frequency mechanisms from existing components. Atul Mahajan, Harminder Singh et.al [4] focused on the connection between occurrence and quality factor with improved bit rate and enhanced power with adequate regularity levels, reimbursement is done by using three approaches pre, post and symmetric reparation but the post-compensation technique is used in their research work while assessing the results for better presentation and high efficiency. Habib Ullah Manzoor, Abaid Ullah Salfiy, Tayyab Mehmood and Tareq Manzoorx et.al [5] proposed a method which has been presented in which alternative round polarizers are used to alter the polarization of response pulses into right and left tendered polarized pulses earlier multiplexer which consequences in the reduction of FWM. Iftikhar Rasheed, Muhammad Abdullah, Shahid Mehmood, Mahwish Chaudhary et.al. [6] put light on various nonlinear effects in optical communication. They have found that the most significant non-linear consequence occurs in the fiber communication scheme are Self-phase modulation, stimulated Brillouin scattering (SBS), Four-wave mixing (FWM) and Raman scattering.

Saurabh Kothari, Kamal Jaiswal, SagarVijayvargiya and A. Jabeena et.al [7] proposed wavelength division multiplexing systems in which four-wave mixing can powerfully affect the broadcast presentation on an optical link. As a consequence, it is significant to investigate the influence of FWM on the strategy and presentation of WDM optical communication schemes. The aim of this proposed work is to reduce the four waves mixing in DWDM to calculate the deficiencies connected with long-distance high bit rate communication systems in optical fibers.

3. Li-Fi

Li-Fi is a technology for wireless or optical communication among devices having light to transmit statistics and location. In its existing state, the light emitting devices can be used for the broadcasting of visible light. In more technical words, Li-Fi deals with the visible light communications scheme that is accomplished in transmitting statistics at high speeds among the visible light coverage area, ultraviolet or infrared radiation. Its end use is the technology which is very alike to Wi-Fi. The key technical alteration is that Wi-Fi uses radio frequency to communicate information. Using light to communicate data permits Li-Fi to offer several compensations like working crossways higher bandwidth occupied in areas susceptible to electromagnetic intrusion and offering higher transmission hustles.

4. DENSE WAVELENGTH DIVISION MULTIPLEXING

Dense Wavelength division multiplexing (DWDM) is a method of combining multiple signals on laser beams at various infrared (IR) wavelengths for transmission along fiber media. Wavelength Division Multiplexing (DWDM) is expected to be a popular technique for constructing large optical networks interconnecting a large number of nodes. Each laser is modulated by an independent set of signals. Wavelength-sensitive filters, the IR analogy of visible-light colour filters, are used at the receiving end [14][15]. DWDM is similar to frequency-division multiplexing (FDM). But instead of taking place at radio frequencies (RF), DWDM is done in the IR portion of the electromagnetic. Each IR channel carries several RF signals combined by means of FDM or time-division multiplexing (TDM). Each multiplexed IR channel is separated, or demultiplexed, into the original signals at the destination. Using FDM or TDM in each IR channel in combination with DWDM or several IR channels, data in different formats and at different speeds can be transmitted simultaneously on a single fiber. In DWDM each wavelength can carry data modulated at several gigabits per second and it is feasible to have simultaneous transmission of hundreds of wavelengths in the low-attenuation 1550 nm window of standard single mode fiber [16][17].

FWM well known by frequency mixing procedure is a fiber optic representative that affects WDM systems, where numerous optical wavelengths are spread out at equal intermissions or channel spacing. The belongings of FWM are marked with decreased network spacing of wavelengths for instance in dense WDM schemes and at high signal control levels. High dispersion reduces FWM effects as signals lose coherence, or increases the phase incongruity. The interfering FWM produced in WDM schemes is known as crosstalk in inter-channel. FWM can be diminished by using rough channel spacing that raises dispersion [18][19].

The pulse shaping filter assists the purpose of producing signals such that every symbol epoch does not overlay, the matched filter is significant to filter out whatever signal reflections occur in the broadcasting process. Since a direct route signal reaches at the receiver before an imitated signal does, it is conceivable for the imitated signal to overlap with a succeeding symbol period which produces the mixing of the frequencies in the nonlinear medium. The matched filter decreases this effect by weakening the creation and end of each symbol epoch. Thus, it is able to reduce the wave mixing process. [2]

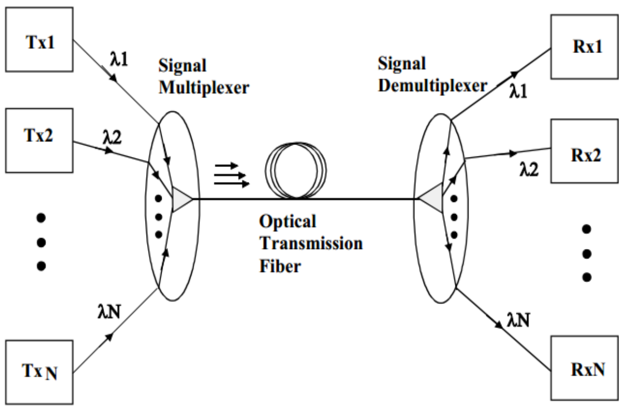

Fig. 1: DWDM Systems

5. PROPOSED FLOWDIAGRAM

Figure 2 gives the proposed flow diagram.

6. RESULTS AND DISCUSSIONS

Below mentioned results will reduce the effect of FWM i.e. the mixing of the frequencies in an efficient manner with less error probabilities i.e. the Bit error rates.

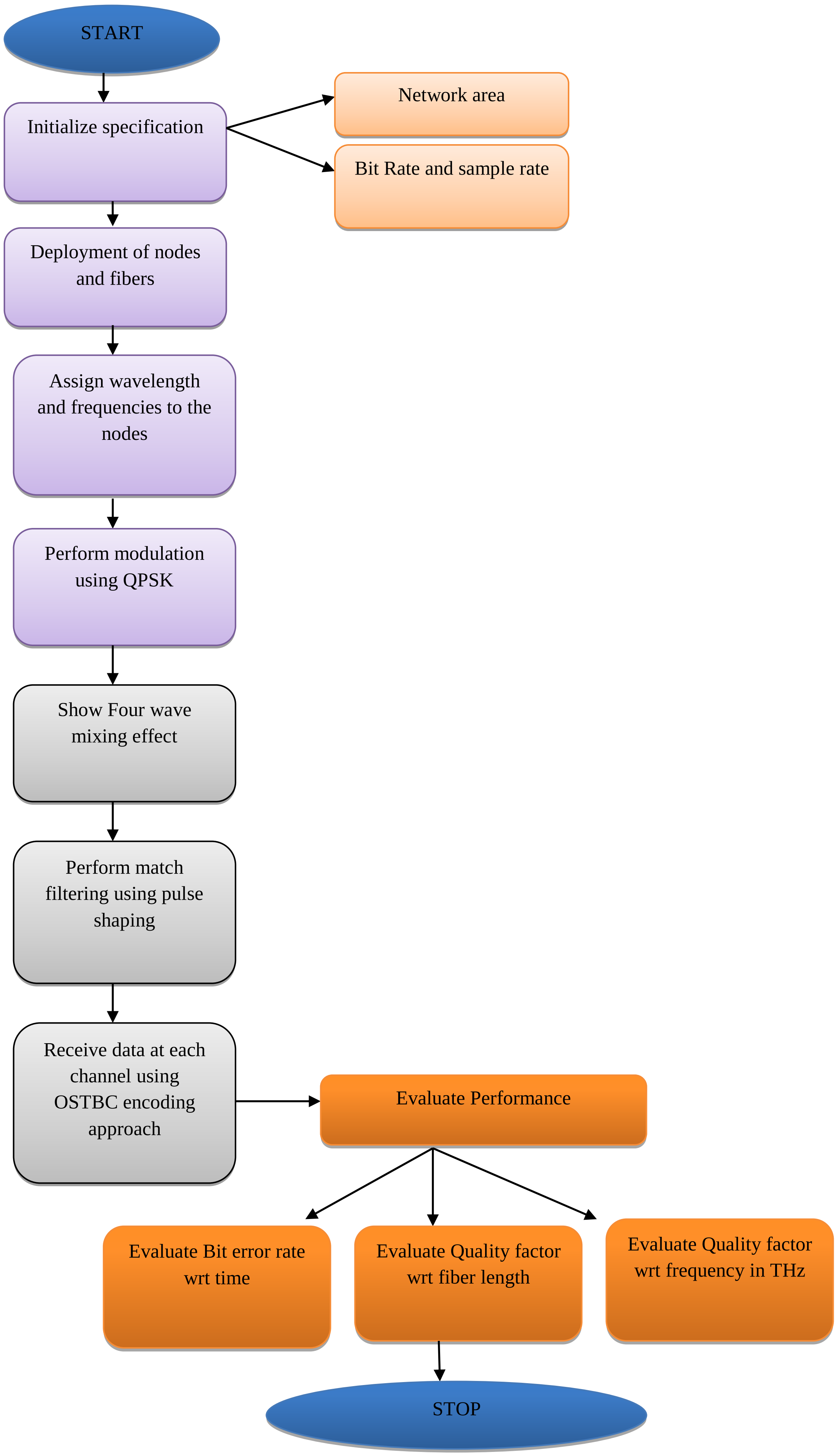

Fig. 2: Proposed flow diagram

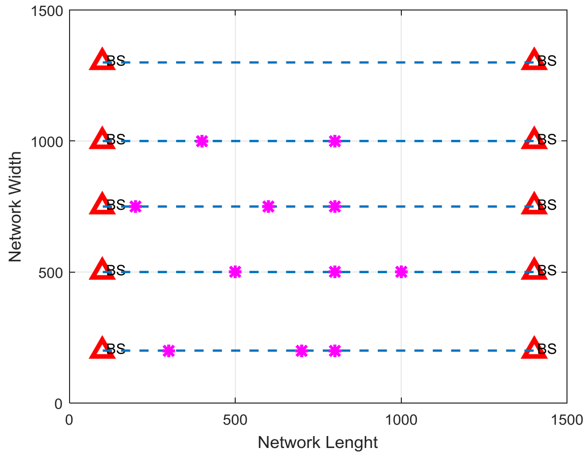

Fig. 3: Network creation

Figure 3 shows the network creation process in which base stations are deployed which are red in color and fibers on which nodes are deployed. Each node is connected with fiber and will start to communicate packets in an efficient and reliable manner

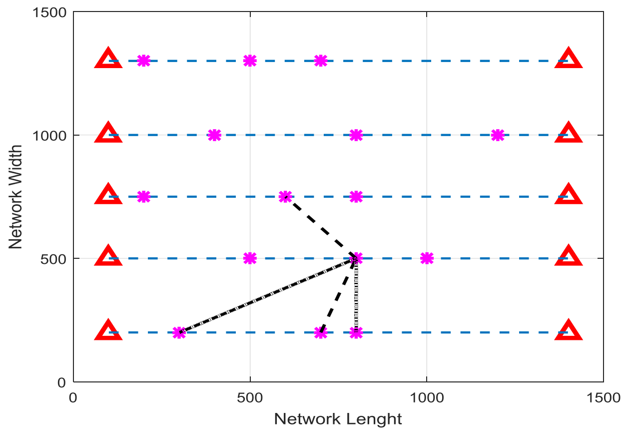

Fig. 4 : Frequency Mixing

Figure 4 shows the four wave mixing (FWM) process in two or more frequencies are mixing on fibers and are disturbing the spectrum. It shows that nodes are having mixing of one or two frequencies which will produce the inter symbol interference with high error probabilities.

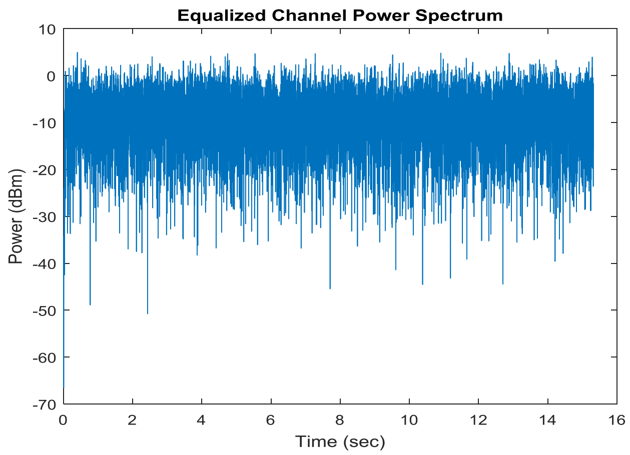

Fig. 5: Channel spectrum

Figure 5 shows the channel power spectrum in which the signal is having very high peaks due to four wave mixing process and is showing the un-stability of the signal in the power spectrum. It is showing the number of bits transmitted with respect to the time in seconds as the power is evaluated at every iteration to know the channel state information based on four wave mixing.

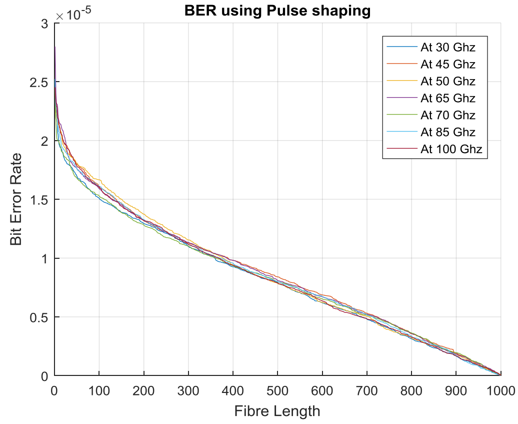

Fig. 6: Bit Error Rate w.r.t Fiber Length

Figure 6 shows the bit error rate with respect to fiber length. As the above figure is showing the number of loss bits as the time increases. It shows that the bit error rate is reducing which is one of the main advantages in Li-Fi technology. The bit error must be reduced for the appropriate functioning of the system. Through bit error rate we can evaluate the quality parameter for FWM products so this is one of the main performance parameters to check the reliability of the system.

Table 1: Quality Factor w.r.t Fiber Length

Frequency	Fiber length (m)		Q-factor	
24Ghz	500	1000	58.29	0.05227
30 GHz	500	1000	58.62	0.009396
45 GHz	500	1000	61.36	0.1647
50 GHz	500	1000	59.88	0.08377
65 GHz	500	1000	57.99	0.09215
70 GHz	500	1000	58.5	0.3593
85 GHz	500	1000	62.26	0.02255
100 GHz	500	1000	58.63	0.08574

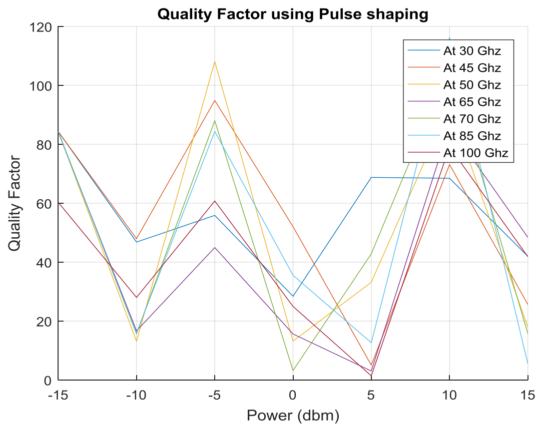

Fig. 7: Quality Factor w.r.t Power (dbm)

Figure 7 shows the quality factor with respect to the Frequency. As we can see that at frequency 195 THz the quality factor is coming 34.65 which shows the robustness of our system. The quality factor decreases as the frequency increases because, with the increase of frequency, it will generate the high-frequency components which will create the distortions and as a result Q factor decreases.

7. RESULTS COMPARISION

This section deals with the result and discussions of the proposed approach comparison with the traditional approach.

Table 2: Comparison Table Quality Factor

Frequency	Base Q Factor	Proposed Q factor
193.332	29.24	34.89
193.376	29.68	34.90
193.526	29.78	34.92

Table 3: Bit Error Rate

Parameter	Base	Proposed
Bite Error Rate	$2*10^{-10}$	$1.911*10^{-12}$

Table 4: FWM suppression level

Parameter	Base	Proposed
Suppressed Power Level	31 dBm	7.729 dBm

8. CONCLUSION AND FUTURE SCOPE

The presentation of WDM networks is powerfully influenced by nonlinearity representative inside the fiber. Consequently, the nonlinearity properties of fiber optics pose an extra limitation in WDM schemes. It is well recognized that FWM in WDM for high-frequency signals are mostly produced by non-degenerate FWM procedure regardless of the number of input indications. In this proposed work the FWM effect is analyzed and reduced. The simulated consequences clearly determine that the degradation due to frequency mixing can be diminished by ensuring that the matching of the phase does not occur. This has been attained by increasing separation of the channel and providing low signal power controls. The high operative area is also created to the reduction FWM effect.

The future scope can work on different hybridization approaches to decrease the effect of FWM in high dense wavelength division multiplexing. Also, the future work can deal with designing of low pass filters which will attenuate the high-frequency components to achieve less four waves mixing effect.

9. REFERENCES

[1] Pamukti, Brian, and D. Perdana, "Non-linear effects of high rate soliton transmission on DWDM optical fibre communication system", In Information Technology, Information Systems and Electrical Engineering (ICITISEE), International Conference on, pp. 26-30, 2016.

[2] Chittamuru, S. V. Reddy, I. G. Thakkar, S. Pasricha, "Process variation-aware crosstalk mitigation for DWDM based photonic NoC architectures, " In Quality Electronic Design (ISQED), 17th International Symposium on, pp. 57-62, 2016.

[3] G. Kaur and G. Singh. "Analysis to find the best Hybrid modulation technique for suppression of Four-Wave Mixing." In Recent Advances in Engineering & Computational Sciences (RTECS), 2nd International Conference on, pp. 1-6, 2015.

[4] A. Mahajan, and H. Singh, "Simulative analysis of fibre non-linearities using lightwave systems for enhanced bit rate with optimized power level", In MOOCs, Innovation and Technology in Education (MITE), 3rd International Conference on, pp. 452-456, 2015.

[5] Manzoor, H. Ullah, A. U. Salfi, T. Mehmood, and T. Manzoor. "Reduction of Four-Wave Mixing by employing circular polarizers in DWDM optical networks", in Applied Sciences and Technology (IBCAST), 12th International Bhurban Conference on, pp. 637-640, 2015.

[6] Rasheed, Iftikhar, M. Abdullah, S. Mehmood, and M. Chaudhary. "Analyzing the non-linear effects at various power levels and channel counts on the performance of DWDM based optical fibre communication system", In Emerging Technologies (ICET), International Conference on, pp. 1-5, 2012.

[7] Kaur, Gurmeet, and M. L. Singh. "Effect of four-wave mixing in WDM optical fibre systems." Optik-International Journal for Light and Electron Optics 120, pp. 268-273, 2006.

[8] Bhalla, Devan, and M. Bhutani, "Performance analysis of four-wave mixing: A non-linear effect in optical fibres", International Journal of computer applications 93, no. 7, 2014.

[9] Dot, Audrey, E.M. Scott, R. Ahmad, M. Rochette, and T. Jennewein. "Converting one photon into two via four-wave mixing in optical fibres." Physical Review, no. 4, pp. 043808, 2014.

[10] Panda, and D. P. Mishra, "Nonlinear Effect of Four-Wave Mixing for WDM in Radio-over-Fiber Systems", Journal of Electronics and Communication Engineering Research 2, no. 4 pp. 01-06, 2014

[11] Singh, Surinder, and S. Singh, "Investigation on four waves mixing effect in various optical Fibers for different spectral efficient orthogonal modulation Formats", Optics & Laser Technology, vol. 76, pp. 64-69, 2016.

[12] Wason, Amit, and R. S. Kaler. "Investigation of four waves mixing effect with a different number of input channels at various channel spacing." Optik-International Journal for Light and Electron Optics, no. 20, pp. 4227-4230, 2013.

[13] Shah, A. Mithilesh, V. Shanmugam, and R. Akkipeddi. "Design considerations for Electrostatically tunable InP based Fabry-Perot filters for WDM applications", In Proc. of SPIE, vol. 5641, pp. 27, 2004.

[14] An, Fu-Tai, Kyeong Soo Kim, David Gutierrez, Scott Yam, Kapil Shrikhande, and Leonid G. Kazovsky, "SUCCESS: A next-generation hybrid WDM/TDM optical access network architecture", Journal of lightwave technology, no. 11, pp. 2557, 2004.

[15] Wozniak, Michal, D. Krishnaswamy, C. Callegari, H. Takagi, N. R. Prasad, X. Que, N. Meghanathan, and R. Sandhu, "Advances in Computing, Communications and Informatics (ICACCI)." (2015).

[16] Barnsley, E. Peter, A. McGuire, and H. Tsushima, "WDM network with control wavelength ", U.S. Patent 5,864,414, 1999.

[17] Zhang, Fan, Pak L. Chu, R. Lai, and G. Ron Chen., "Dual-wavelength chaos generation and synchronization in erbium-doped fibre lasers", IEEE Photonics technology letters 17, no. 3, pp.549-551, 2005.

[18] Adgaonkar, and S. N. Sharma. "A review of a burst scheduling algorithm in WDM optical burst switching network", IJCSI International Journal of Computer Science, vol. 8, no. 3, 2011.

[19] Huang, Sophia, Jui-Che Tsai, Dooyoung Hah, H. Toshiyoshi, and M. C. Wu, "Open-loop operation of MEMS WDM routers with analogue micromirror array", In Optical MEMs, 2002. Conference Digest, IEEE/LEOS International Conference on, pp. 179-180, 2002.

[20] Jia, Feeling, and B. Mukherjee. "The receiver collision avoidance(RCA) protocol for a single-hop WDM lightwave network." Journal of Lightwave Technology 11, no. 5, pp. 1053-1065, 1993.

