Review on the use of Optical Amplifiers to enhance Optical Communication

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Abstract
The recent advancements in the technology of this era has defined the new trends in the field of network communication. The optical communication is the one of the most prominent field that has become popular among research domain. A large number of research works have been conducted in this field in order to enhance the quality of the communication and services provided by the optical communication. In optical communication the data travels in the form o light signals from optical transmission mediums such as fiber optic cables etc. The data transmission performed through the fiber optics cable suffers from the various issues such as increased BER, inter symbol interference etc. In order to overcome these issues, the concept of WDM and optical amplifiers is collaborated with the optical communication. This study presents the role of WDM and Optical amplifiers in the fiber optics communications. Along with this an analysis to the recent research work of this domain by various authors is also represented in a section of the study.

Keywords
Optical Communication, Optical Amplifier, Hybrid Amplifiers, Wavelength Division Multiplexing.

I. Introduction

It is seen that in the present period the utilization of system and communication application is expanded. This makes this field as the all the more intriguing field for the analysts to work upon it. With the improvement in the field of systems the count of clients are additionally expanded [1]. The execution of the applications which are identified with the system or web relies on the bandwidth of the system. To make the framework more viable and proficient the accessibility and utilization of transmission capacity is essential factor. To expand the bandwidth of the system [2-3], different arrangements are given by the analysts. WDM (Wavelength Division Multiplexed) is one of these arrangements [4]. The WDM network supports immense bandwidth range and furthermore gives the better information transmission array. In WDM system, the information is multiplexed to the transmission lines. It gives the facility to exchange the various wavelengths at a given timeframe or all the while. The WDM utilizes the idea of Fiber optic system that supports the enormous bandwidth and information transmission range [5]. Thus there is necessitation to satisfy the necessity in regards to the better information transmission rate and huge bandwidth. To satisfy this need the idea of WDM alongside fiber optic system is composed. The key element of optical fiber arranges is that it gives extensive scope of information transmission and huge bandwidth for information transferring [6].

Because of its highlights the utilization of WDM alongside optic fiber is expanded step by step. Subsequently there is a great deal of work to do so as to build the execution of the optic fiber system [7-9]. Along these lines there is a necessity to discover the parameters or factor that influences the nature of the fiber optic system. Loss and dispersion are the variables that leave an effect on the execution of optic fiber organize by corrupting its execution.

Wavelength Division Multiplexing (WDM) adds versatility to confused communication frameworks separated from enhancing the capacity of transmission. In particular, a few information channels can be included at different areas in a framework and rest of the channels can be dropped. Add– drop multiplexers can be utilized for these kinds of tasks that empower one to embed or remove information channels based on their wavelengths [10].

II. Fiber Optics

Fiber optics or optical fibers imply to the media and advancements related to the data transmission in the form of light signals along with the glass strands or fibers. The fiber optics cable is used in this communication and this cable is comprised of various numbers of glass strands, it can be 2 to 3 hundred in count. The glass fiber is covered with another layer of glass and it is known as cladding. The layer that protects the cladding is known as buffer tube. The individual strand is protected by the jacket layer [11].

The optical fiber is defined as a flexible fiber that is made up of glass or plastic whose breadth is thicker than of human hair. The optical strands are exploited so frequently in order to transfer the light signals within both ends of the fiber and found to be highly applicable to the fiber optic communication where the data transmission is done over a larger distance with a higher bandwidth [12].

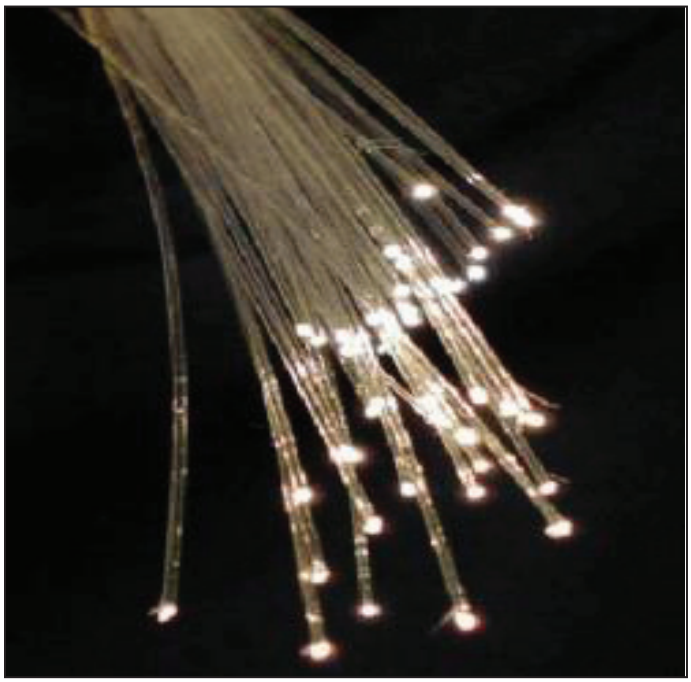

Fig. 1: Bundle of Fiber Optical Cables

Fiber cables are utilized at a higher level for communication in comparison to the metal wires since the fiber cables allows the light

signals to travel without any loss. The fiber strands are additionally impenetrable to electromagnetic obstruction. Electromagnetic obstruction is a problem in which the metal wires suffer too much.

III. Fiber Optics Communication

The fiber optic communication is the mechanism where kind is boosted up by a radio signal and broadcasted on the optical fiber connection to aid the Wi-Fi attains correct entry to, comprehensive of 3G and Wi-Fi concurrent from the similar antenna. In further phrase, the radio indications are conceded on the fiber-optic cable as a result a single antenna can acquire hold of any and whole radio indications that are the 3G, Wi-Fi, mobile etc. conceded on a single-fiber-cable to a main position in that afterward [13] the system alters the pointers. It is divergent to the conventional way as each protocol type needs alienated component on the position of the antenna. On the fiber the radio transmission is utilized for two functions, among cable television (CATV) networks and in satellite base stations. The Wi-Fi indicators are transmitted in the optical form along with an important station and a rigid of base station previous than radiated by the air in the RoF structures. Each base station is modified to converse on the radio connection among minimally single customer's mobile station situated in the radio variety of stated base station. The component for Wi-Fi, 3G and another protocol can be focused in single area that is the huge merit among far off antennas connected by fiber optic serving entire protocols. Considerably, it decreases the gadget and preservation significance of the community. The RoF transmission methods are generally classified into a couple of major classes that are the RF-over-fiber and the IF-over-fiber relying at the frequency array of the radio signal to be broadcasted [14].

A. RF-over-fiber Structure

Among maximum frequency a facts-wearing Radio Frequency (RF) signal is forced on a light wave signal previously than broadcasting it on the optical hyperlink. Subsequently, wireless signals are optically distributed to base stations on single time at extreme frequencies and altered from the optical to electric area at the base stations previously than enhanced and radiated by utilizing an antenna. As concluded result, the frequency up-down alteration is not required at the several base stations, thus assuring in simple and then again value-powerful implementation is facilitated at the base stations.

B. IF-over-fiber Structure

Among a lesser frequency an Intermediate Frequency (IF) radio signal is utilized for boosted up gentle previously than broadcasted on the optical connection. Subsequently, previous to radiation by the air, the signal must be up-converted to RF at the base station.

IV. Optical Amplifiers

Optical Amplifiers has a major role to play in the optical communications. It has vital role in various communications such as telecommunication networks like community antenna televisions (CATV), WDM transmission systems and radio over fiber applications. Other than this, optical amplifiers are also considered or utilized different space applications such as light detection and ranging i.e. LIDARs, earth observations, deep space missions and optical inter satellite communication links (OISL) etc. Thus, by applying optical amplifiers along with the various optical technologies, is expected to introduce the remarkable enhancements corresponding to the overall performance of the networks. Thus the defined applications of optical amplifiers need an efficient optical amplifier because of the optical losses throughout the longer optical link. The optical links face the issue of attenuation and dispersion. The effect of attenuation leads to the signal power loss and in this way limits the data transmission distance. The effect of dispersion leads to another problem i.e. Inter Symbol Interference (ISI), limits the bandwidth, increase in bit error rate (BER) [15]. Thus, the optical amplifiers are needed to implement in order to compensate the various defined optical losses. There are various types of optical amplifiers such as RAMAN amplifier, Erbium Doped Fiber Amplifier (EDFA), Semiconductor Optical Amplifier (SOA) and Hybrid Amplifiers.

V. Related Work

Anjali Kaushik et al. [1] (2016), In this paper the author had offered a three stage Hybrid Optical Amplifier by applying Raman and Erbium Doped Fiber Amplifier in order to attain wideband and nearly all flat gain profile. Several methods of a pump optimization and pump recycling residues the mind of the arrangement. The gain flatness is increased by the pump recycling and the span length of the system was enhanced among no addition to the expense of novel pumps. The simulation results had demonstrated that the gain bandwidth of ~80 nm and gain ripple under 3 dB had been monitored.

Avneet Kaur et al. [2] (2016), In this paper the author had illustrated that for the long haul wavelength division multiplexed optical fiber communication mechanisms there was an enhancing demand of transmission bandwidth. Through utilizing wideband and gain flattened amplifiers the bandwidth can be used efficiently. Through merging many amplifiers having diverse gain bandwidths the Wideband amplification can be accomplished. Several gain flattening mechanisms were accessible for gain flattening purposes to decrease gain fluctuation like gain flattening filters as fiber bragg gratings, optimization of material composition of fiber amplifiers, by applying rare earth doped ions, hybrid amplifiers, wavelength splitters. In this work various gain flattening mechanisms had been illustrated therefore the bandwidth of optical communication method was used to the maximum.

S. Olonkins et al. [3] (2015), in this paper the author had demonstrated the merits of a hybrid Raman EDFA optical signal amplification resolution on the utilization of traditional EDFA amplifiers. Among a distributed Raman amplifier the traditional discrete amplifier was supplemented by the utmost emerging resolution of hybrid amplification where it can widen and level the gain spectrum and also can enhance the optical signal-to-noise ratio of the signal at the output of the amplifier and can offer higher level of amplification. The simulation result had demonstrated that the execution of the hybrid arrangement has enabled expanding the optical single-to-noise proportion by no less than 1.7 dB in the majority of the channels.

Chanakya Chandel et al. [4](2015), We propose and delineate a bidirectional Wavelength Division Multiplexing (WDM)- Passive Optical Network (PON) with 110 channels with 0.8 nm channel dividing .Gain of around 7 dB is accomplished in both upper and lower arm for 10 Gb/s information rate and - 15dBm input power. An exceptionally intelligent pump reflector utilizing Fiber Bragg Grating (FBG) is use to pump bring down arm C+L band 1556 – 1599.2 nm . Utilizing Hybrid (RFA+EDFA) amplifier

arrangement BER of 2.007× 10-9 and 6.177 ×10-9, after 35 km bidirectional amplification.

Akchita Khemariya et al. [5] (2015), To sum up the points of interest and offset the downsides of different optical amplifier composes, a hybrid amplifier can be made. Here a blend of two most mainstream and oftentimes utilized amplifiers i.e. EDFA-RFA i.e. Erbium Doped Fiber Amplifier through and through with Raman Fiber Amplifier; has been utilized to ascertain the most minimal gain variety in C band i.e. from 1530nm to 1552.18nm with - 24dBm information control utilizing NRZ balance arrange. In this paper, enhancement of the length of EDFA is finished. Additionally the gain variety and noise figure for different estimations of pump wavelengths and pump control is dissected. The attained results indicated better gain leveling with four pumps RFA with estimation of gain proportion lessening to 0.692 with decent NF.

Simranjit Singh et al. [6] (2015), Hybrid optical amplifiers (HOAs) are significantly essential for broadband band intensification, and are generally sent in high-limit thick wavelength division multiplexed frameworks. We abridge the current situation with the-craftsmanship in this quickly developing field. Likewise, hypothetical foundation and different inline designs of optical enhancers have been introduced. Different issues, for example, gain flatness; gain bandwidth, transient effect, and crosstalk were exhibited in HOAs. Results demonstrate that the HOAs give better gain levelness without utilizing any costly gain flattening strategies, and an adequate scope of gain, noise figure, bit error rate, and transience.

Francis Edaba [7](2014), Fiber optic frameworks are vital media transmission foundation for overall broadband systems. Wide bandwidth signal transmission with low delay is a key necessity in display day applications. Optical fibers furnish colossal and amazing transmission bandwidth with negligible latency, and are currently the transmission medium of decision for long separation and high information rate transmission in media transmission systems. This paper gives a diagram of fiber optic correspondence frameworks including their key mechanisms.

Prachi Sharma [8](2013), this paper manages communication utilizing optical fibers. The transmission utilizing high bandwidth can deal with tremendous measures of data, which can be additionally enhanced by decrease in fiber misfortunes, increment in information rates and separations, advancement of optical sources and indicators good with fibers. The ongoing improvement in the territory of fiber optic correspondence and in addition the advances in various fiber composes and their properties, optical sources, identifiers, framework impediments and applications are likewise examined in the paper.

VI. Conclusion

The optical fiber communication has gain wide range of popularity due its various features such as high speed data transmission at the higher bandwidth without any extra costing. After having a review to this domain, it has been seen that it is quite advantageous to use the optical fibers as a medium of communication in order to make a fast and reliable data transmission but still it has some drawbacks such as dispersion compensation, higher BER, ISI etc. On the basis of the analysis done in this study, it has been concluded that the optical amplifiers are used widely in this communication in order to overcome the issue of high BER and ISI but due to the availability of variety of optical amplifiers it becomes tedious task to choose the most suitable and efficient optical amplifier for the implementation. Thus in future, more work could be done in the field of optical amplifiers to enhance the performance of the communication system.

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