Journal of The Gujarat Research Society
ISSN: 0374-8588
Volume 21 Issue 10, October 2019

# Communication with the Help of Optical Fiber

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***Abstract***

*A fiber optics is a transparent and flexible fabric with a diameter slightly thicker than that of human hair made of plastic or glass. It is essentially used for the light transmitted from one end of the fiber to the other. In fiber optic communication, where optic fiber communication transmits over a longer distance with a higher bandwidth than an electrical cable, this transmission is commonly used. The radical transition from conventional architecture to a dynamic, scalable, energy-efficient and versatile concept is currently being implemented by the Optical Fiber communication system and network. In this paper, we briefly analyses the evolution of technologies and methods for optical networks of the fifth century.*

***Keywords:*** *Time Division Multiplexing, Wavelength Division Multiplexing (WDM), Non-Return to Zero (NRZ), Fifth-Generation (5G), Elastic Optical Network (EON), Hybrid Optical Switching (HOS).*

## I. INTRODUCTION

Optical Fiber is the study of light propagation through a transparent dielectric waveguide. It is used for the transfer of data signals from one location to another location. The optical fiber is a transparent substance where light is sent as a signal within it. High frequency signal is typically used in optical fiber communication networks where the higher the carrier frequency, the higher the bandwidth and data carrying capacity available. Gallium arsenide semiconductor was used as a laser and operating area in the first generation of light wave device near 0.8 Micrometers [1]. The bit rate of the first-generation device was initially around 45mbps using the process of time division multiplexing (TDM) and the repeater spacing was 10km. The bit rate of the second generation device was 100mbps, the spacing of the repeater was 50 km and the wavelength used in optical fibers was 1.3 micrometers over a single fiber from one to many using multiplexing technologies for wavelength division (WDM). Then the machine progressed to a third generation where the bit rate was 10 GBps compared to the first and second generations, the face of the repeater was 100 km and 155 micrometers of wavelength were used.

Now the Optical Fiber is working with a fourth generation system where the bit rate is thousand times greater than third generations i.e. 10tbps, repeater spacing is 10,000 km and wavelength is 1.62 micrometer using the same wavelength division multiplexing technology used in third generation. Wavelength division multiplexing is a technology in which a number of optical carrier signals is multiplexed into a single Optical Fiber using different wavelengths of laser light. The most widely installed system are working on wavelength division modulation at a bit rate of 10tbps, the simplest modulation format i.e. non return to zero (NRZ) which is a data Encoding scheme in which negative voltage is used to represent the binary "0"and a positive voltage is used to represent the binary "1".

Right now the evaluation of fifth generation System is in process wherein the Specification of 5th generation system with Optical Fiber communication will be the bit rate of 40 tbps-60tbps, repeater spacing will be up to 35000 km which is extremely larger than the previous generation and wavelength will be 1.5 micrometer. This generation uses Raman amplification techniques and optical solicitors. During the last two decades the optical fiber communication and networks have continuously made progress with respect to capacity, efficiency and topology. Figure 1 represents the growth rate of the optical fiber network in these two decades.

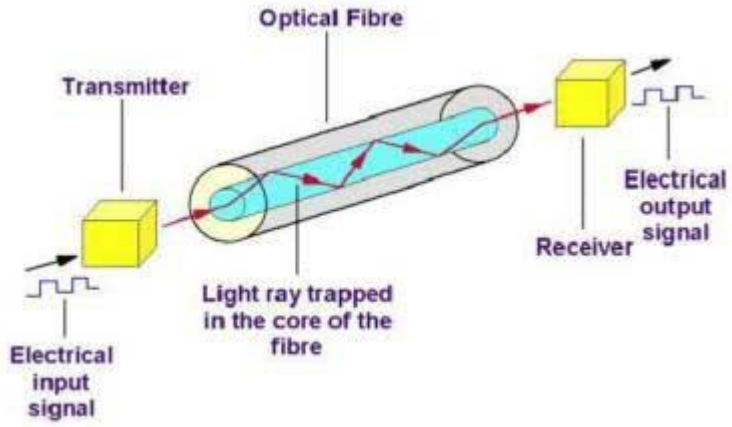


Fig. 1: The diagram above reflects the evolution of the optical networks of the fifth century.

Software-defined networking architecture that makes the network scalable and agile.it increases network control efficiency by including companies and services that contribute to fast response and security of the network. Network function networking operates on the visualization of the network function, which passes data packets from one network system to another. Visualization to view the entire network node class when software is specified. An evolution towards fifth generation (5G) Optical Fiber communication transport network evolve fast and efficient arrangement of high data rate in optical parts, which can be possible by developing and utilizing flexible bandwidth variables and software control optical components.

Using an Elastic optical networking (EON) Which is capable of fulfilling the requirement of capacity and dynamicity by combining two Technologies i.e. transponder and flex grid transmission and switching technology [2] wherein hybrid optical switching (HOS)Is used to

transport Both optical circuit switching and optical burst switching, this both HOS and EON are used in the fifth generation optical network for the advancement of Optical network system. An Additional introduction of network function virtualization and software defined networking in optical fiber communication network and development of advanced optical network interconnections for data center will give rise to high performance optical clouding. This recent evolution and achievements of research in different areas smoothed the fifth generation optical network, this 5G system has improved by increasing the capacity, performance, flexibility and Energy Efficiency. This system is also improving the security by introducing physical layer security with the combination of cryptography. In this paper with the above information and recent efforts will lead to completeness of 5G optical network without any claim.

## II. ENABLING TECHNOLOGIES FOR 5G OPTICAL NETWORK TRANSPORT

A lot of search has been done in developing new methods and components for the transmission of optical networks, and making it more efficient and flexible.

1. **High capacity optical links:-**

   The capacity of optical transmission network has already approached Shannon with an optimal combination of multiplexing format such as wavelength-division multiplexing (WDM), time-division multiplexing (TDM), space-division multiplexing (SDM) and polarization-division multiplexing (PDM) together with advanced multilevel modulation to increase the intensity and phase modulation of optical carriers. Wherein, WDM is a technique which multiplexes the multiple optical carrier signal into a single optical fiber by varying the wavelength of laser light. It is used in optical fiber communication because it allows communication in both directions of fiber optics [3]. TDM is a technique in which multiple signals are combined, transmitted and separated based on different time limits. In optical fiber communication when different data channels with different time arrival are travelled then this time division technique multiplex the multiple signal in one single fiber. Space division multiplexing (SDM) is used for substantial increase of transmission capacity and avoiding the shortage of capacity. Polarization division of multiplexing is used to multiplex signals carried in an electromagnetic wave in a single signal by combining the wavelength of both the signals [3]. By performing all this division multiplexing technique all the signals get modulated with the carrier signal and get transmitted in a single signal.

2. **Bandwidth-variable and software-controllable optical transceivers:-**

Both bandwidth variable and software controllable optical transceiver are considered to the major part of 5G optical transport network wherein bandwidth variable used to operate on flexibility of wavelength grid with the spectral separation range of 12.5 GHz and with 6.25 GHz granularity for center frequency which enable to accommodate traffic need by varying the bit rate and spectral efficiency. But with this new generation 5G optical coherent transceiver along with the digital signal processing a high adaptability is provided to support balance achieved between bit rate, spectral efficiency and reach. They can also provide various modulation techniques together with forward error correction in the signal, the various modulation techniques used for flexible optical networks are BPSK, QPSK and QAM. The binary phase shift keying (BPSK) is a two phase modulation technique in which message signal is represented in the form of binary code "0" and "1" [4]. This 0 and 1 format reduces the complexity of continuous signals which carry noise along with the original signal. Quadrature phase shift keying (QPSK) is a type of phase shift keying in which two bits are modulated together at once [2]. QPSK in comparison to other PSK allows the signal to carry signal twice using the same bandwidth and quadrature amplitude modulation (QAM) allows to combine two amplitude signals in a single channel [5]. Forward error correction (FEC) is a technique which removes the error at the transmitting end itself so that when the receiver receives the signal it does not contain any error. The flexibility, elastic optical network and error correction increase the costing capacity of the architecture.

### 3. Energy efficient communication system and networks:-

When the cost input which we used for energy consumption is travel through the cellular network and we receive data through that is the benefit we get. In order to measure the benefit and cost balancing towards each other there is a process to calculate the benefit to cost ratio or the efficiency. The energy efficiency can be improved by keeping an eye on active and sleep mode, in most various applications we want our device to be able to receive some real time information but during most time we donate our device to work at full load therefore 5G they have the function of active and sleep mode wherein the device only need to transmit the data during sleep mode but if we need to transmit last data during mode, by this we can save a lots of energy because if a device works under sleep mode we generally use less energy than an active mode [6].

## III. CONCLUSION

We also analyzed the recent high-performance and development of fiber optic transmission and network technologies in this paper. For potential networks and applications, the Optical Fiber transmission network has to be advanced. Capacity and reliability should be high in order to make it advantageous, increasing versatility, adaptability, energy efficiency and security. We

can conclude with this paper the new fifth-generation trend that evolves the above-mentioned improvements in the optical fiber transport network. The fifth generation of optical fiber communication is the foundation of this article. As we know fiber optics is one of the major building blocks of the telecommunication infrastructure, so with the coming 5G technology high bandwidth capability can be determined with very low energy consumption. This characteristic will make it ideal for gigabit transmission and more. Many different types of division multiplexing technology, application, detectors, coupler, splitter and wavelength division are used to perform different processes to enhance the problem which was found on 4th generation of the optical fiber communication. In the production of biosensors, the fiber optics biosensor plays a very important role because it will help to quickly miniaturize and incorporate those targets. Compared to the fourth generation, the growth of fiber optics is extremely high, i.e. the bit rate has increased up to 40-60tbps, repeater spacing up to 35000 km and wavelength up to 1.5 micrometers.

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