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Technological Trends in Optical Fibre Communication

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Abstract — **This paper provides the overview in the recent development and the technological trends towards the next generation in fibre optic systems, which is an important telecommunication infrastructure for world-wide broadband networks. Signal transmission with less delay and wider bandwidth is a key requirement in present day applications. The wide ranged bandwidth provided by optical fibres are the transmission medium of choice, for the communication over long distances and provide high data rate transmission in telecommunication.**

Keywords — **Optical fibre communication, multimode step index fiber, single mode step index fiber.**

I. INTRODUCTION

Using fiber optic communication information can be transmitted from one point to another using light pulses via an optical fiber. The transmitted information is the digital information generated by telephone systems, cable service provider and computer systems. An optical fibre made from low-loss materials is a dielectric cylindrical waveguide, usually silicon dioxide [1]. The core of the waveguide has a refractive index, a little higher than the cladding which is the outer medium, so by total internal reflection the light pulses are guided along the axis of the fibre. This system consists of an optical transmitter to convert an electrical signal to an optical signal for transmission, a cable containing several bundles of optical fibres, optical amplifiers to boost the power of the optical signal, and an optical receiver to reconvert the received optical signal back to the original transmitted electrical signal [2-3]. Figure 1 below gives a description of a basic fibre optic communication system.

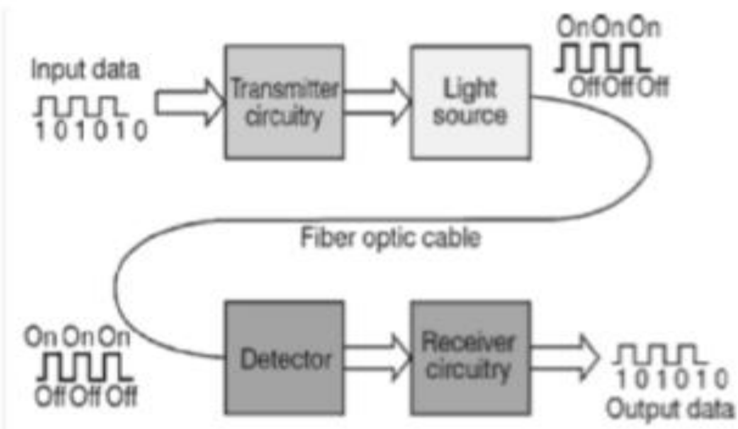

Fig. 1: Block Diagram of Optical Fiber

Optical fibres are divided into two major categories, namely: multimode step index optical fibre and graded index optical fibre [4].
Multimode step index optical fibre allows several light paths as it has a core diameter greater than or equal to 50 micrometres which leads to modal dispersion. This mode is mostly used for imaging and illumination.
The core refractive index of Graded index optical fibbers gradually decreases farther from the centre of the core allowing an increase in the refraction at the core centre and reducing the speed of some light rays, thereby allowing all the light rays to reach the receiver at almost the same time resulting in decreased dispersion [5]. This mode is used for data communication and network carrying signals for typically no more than a couple of kilometres. Figure 2 below shows the types of optical fibres modes.

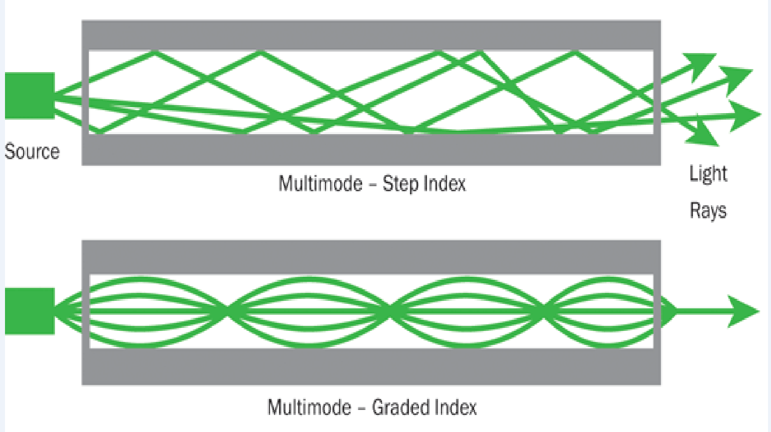

Fig. 2: Types of Optical Fiber

II. EVOLUTION OF FIBER OPTICS

There has been an increasing need to transmit more data even faster since the earliest days of telecommunications. Initially single line wires were used. These wires gave way to coaxial cables that enabled several channels to transmit over the same cable. However, these systems were limited in bandwidth and optical systems were investigated [6-7]. The possibility of Optical communications came after the first lasers were developed in the 1960s. The next piece of the jigsaw fell into place when the first optical fibres with a sufficiently low loss for communications purposes were developed in the 1970s. Then, during the late 1970s a considerable amount of research was undertaken. This resulted in the installation of the first optical fibre telecommunications system. It ran over a distance of 45 km and used a wavelength of 0.5 mm and had a data rate of just 45 Mbps - a fraction of what is possible today. The first generation fibre optic system was developed in 1975, it used GaAs semiconductor lasers, operated at a wavelength of 0.8 µm, and bit rate of 45Megabits/second with 10Km repeater spacing.
The second generation of fibre-optic communication which are mainly used in GaAsP semiconductor lasers, operated at 1.3 µm was developed for commercial use in the early 1980s. These early systems were initially limited by multi-mode fibre dispersion, and the single mode fibers was revealed to greatly improve system performance in 1981, however working with single mode fibre proved difficult to develop with practical connectors. In 1984, they had already developed a fibre optic cable that would help further their progress toward making fibre optic cables that would circle the globe.
The third-generation fibre-optic systems operated at 1.55 µm and had losses of about 0.2 dB/km. This development was spurred by the discovery of Indium gallium arsenide and the development of the Indium Gallium Arsenide photodiode by Pearsall. Also to operate commercially at 2.5 Gbit/s with repeater spacing in excess of 100 km was seen as a development in third-generation systems. Optical communication is used by fourth generation of fiber-optic communication to limit the need for repeaters and wavelength-division multiplexing hereby increasing data capacity. These two improvements resulted in the doubling of system capacity starting in 1992 in every six months until a bit rate of 10 Tb/s was reached by 2001. In 2006 a bit-rate of 14 bit/s was reached over a single 160 km line using optical amplifiers [8].
To extend the wavelength range over which a WDM (Wavelength division Multiplexing) system can operate, has been the main focus for the development in fifth generation of fiber optic communication [9-11]. The conventional wavelength window, known as the C band, covers the wavelength range 1.53–1.57 µm, and dry fibre has a low-loss window promising an extension of that range to 1.30–1.65 µm.

III. ADVANTAGES OF FIBER OPTICS

A. *Long distance transmission*: optical fibres have lower the transmission losses compare to copper wire. Consequently, data can be sent for long transmission, thereby reducing the number of intermediate repeaters needed to boost and restore signals in long span. This reduction in equipment and components decreases system cost and complexity.
B. *Large information capacity*: they have wider bandwidth than copper wire. So that more information can be sent over a single physical line. This property decreases the number of physical lines needed for sending a given amount of information.
C. *Small size and low weight*: these dimensions of fibres offer a distinct advantage over heavy, bulky wire cables in crowded underground city ducts or in sealing mounted cables trays. This feature is also used in aircrafts, ships, where small and light weight cables are useful.
D. *Immunity to electrical interface*: optical fibre cables are made of dielectric materials and they are immune to electromagnetic interference effects seen in the copper wires. Such as inductive pick up from the other

adjacent signal carrying wires or coupling of electrical noise into the line from many types of nearby equipment.

E. *Enhanced safety*: these fibres offers a high degree of operational safety since they do not have problems of sparks, underground loops and potentially high voltages inherent in the copper wires.

IV. DISADVANTAGES OF FIBER OPTICS

A. Usually optical fiber cables are made of glass, which lends to they are more fragile than electrical wires.

B. Attenuation & Dispersion: as transmission distance getting longer, light will be attenuated and dispersed, which requires extra optical components like EDFA to be added.

C. Cost Is Higher Than Copper Cable.

V. FUTURE TRENDS OF FIBER OPTICS

There are many considerable amendments that have been made in the technology. Data rates have amended and in integration to this the performance of the optical fibre has been ameliorated to enable many preponderant distances to be achieved between repeaters. As a designation of this the speeds that can now be achieved along through a fibre optic system exceed 10 Tbps.

Fibre optic communication has revolutionised the telecommunications industry. It has withal made its presence widely felt within the data networking community as well.

Some of the envisioned future trends in fibre optic communication are:

A. All optical communication networks

Fibre optic communication is envisioned to be completely in the optical domain where all the signals will be processed in the optical domain, without any form of electrical manipulation. Presently processing and switching of signals take place in the electrical domain, optical signals must be converted to electrical signals first before they can be processed and routed to their destination. After the processing and routing, the signals are then converted to optical signals, which are transmitted over a long distance. The optical to electrical conversion and vice versa adds a delay in the network and is a limitation to achieving very high data rates.

B. Multi – terabit optical networks

Dense wave division multiplexing relates to the way for multi-terabit transmission. The need for increased bandwidth availability has led to the interest in developing multi-terabit networks.

Researchers are looking at achieving higher bandwidth with 100Gb/s with the continuous reduction in the cost of fibre optic components, the availability of much greater bandwidth in the future is possible.

C. Intelligent optical transmission network

Traditional optical networks are unable to adapt to the rapid growth of data services due to the unpredictability of dynamic allocation of bandwidth, mainly of manual configuration of network connectivity, which is time consuming and unable to fully adapt to the demands of modern networks.

Intelligent optical network is expected to adopt to the unpredictability of bandwidth allocation making it a future trend in optical communication.

D. Polymer optic fibre

Polymer optical fibres offer many benefits when compared to other data communication solutions such as copper cables, wireless communication system, and glass fibre.

In comparison with glass optical fibres, polymer optical fibres provide easy and less expensive processing of optical signal and are more flexible.

E. Improvement in optical amplification technology

Erbium Doped Fibre Amplifier (EDFA) is one of the critical technologies used in optical fibre communication systems.

To increase the gain bandwidth of EDTA, better gain equalization technology for high accuracy optical amplification will be developed.

For attaining higher output power, high power pumping lasers having excellent optical amplification characteristics are expected to exist in the nearest future.

F. Ultra-Long Haul Optical Transmission

Due to the imperfections in the transmission medium, the limitations imposed are a subject for research in the area of ultra-long haul optical transmission.

Cancellation of dispersion effects has prompted researches to study the potential benefits of soliton propagation.

More understanding of the interaction of the interaction between the electromagnetic light wave and the transmission medium is necessary to proceed towards an infrastructure with the most favourable conditions for a light pulse to propagate.

G. High-Altitude Platform

Presently, optical inter satellite links and orbit to ground links exists the latter suffering from unfavourable weather conditions.
Current research explorer's optical communication to and from high altitude platforms. High altitude platforms are airships situated above the clouds at heights of 16 to 25 km, where the unfavourable atmospheric impact on a laser beam is less severe than directly above the ground.
Optical links between high altitude platform satellite and ground stations are expected to serve as broadband back-haul communication channels, if a high altitude platform functions as a data relay station.

VI. CONCLUSION

This paper gives the basic details and future aspects of optical fibre communication. The fibre optics communication industry is always advancing, the industrial growth has been enormous but there is still much work to be done to support the need for faster data rates, advanced switching techniques and more intelligent network architectures that can automatically change in response to traffic patterns and at the same time be cost efficient. A new generation in fibre optics communication is expected to continue in the future trends.

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REFERENCES

[1] M. Noshada, A. Rostami, "FWM minimization in WDM optical communication systems using the asymmetrical dispersion managed fibers", International Journal for Light and Electron Optics, vol. 123, no. 9, pp. 758– 760, 2012.
[2] U.H.P. Fischer, M. Haupt and M.Janoic, "Optical Transmission Systems Using Polymeric Fibers", In Tech, available from: http://www.intechopen.com/books, 2011.
[3] "Status of Optical Communication Technology and Future Trends", available at: www.qqread.net, 2013.
[4] Guide To Fiber Optics & Permises Cabling". The Fiber Optics Association. Retrieved December 22, 2015.
[5] Mary Kay Carson (2007). Alexander Graham Bell: Giving Voice To The World. Sterling Biographies. New York: Sterling Publishing. pp. 76–78. ISBN 978-1-4027-3230-0.
[6] Alexander Graham Bell (October 1880). "On the Production and Reproduction of Sound by Light". American Journal of Science, Third Series. **XX** (118): 305–324. also published as "Selenium and the Photophone" in *Nature*, September 1880.
[7] Nishizawa, Jun-ichi & Suto, Ken (2004). "Terahertz wave generation and light amplification using Raman effect". In Bhat, K. N. & Das Gupta, Amitava. Physics of semiconductor devices. New Delhi, India: Narosa Publishing House. p. 27. ISBN 81-7319-567-6.
[8] "Optical Fiber". Sendai New. Archived from the original on September 29, 2009. Retrieved April 5, 2009.
[9] "New Medal Honors Japanese Microelectrics Industry Leader". Institute of Electrical and Electronics Engineers.
[10] Buzzelli, S., et al. "Optical fibre field experiments in Italy: COS1, COS2 and COS3/FOSTER." International Conference on Communications. Seattle. 1980.
[11] Rigby, P. (2014). Three decades of innovation. Lightwave, 31(1), 6–10.

