Optic Fibers as a Broadcasting Media

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ABSTRACT

Fast brodcasting of an information is always a challange from our daily activities. Through fast broadcasting of the information always created pre-eminence in military activities, business, researching, etc. From ancient times we know that information was orally and hand in hand broadcasted which in most of the times casused in loss of information and due to this also in loss of activities which are mentioned above.

Due to information technology notably computer networks and internet overtime information started broadcasting faster. Information started broadcasting through copper wires and through wireless. Big applications started to develop with the increased use of Internet, high quality broadcasting (HD), video on demand broadcasting (VoD), triple pay broadcasting (three services on a medium), etc., then these two mediums couldn't complete all these requests.

Therfore after these problems, optic fiber began to be used as a broadcasting medium which eleminated all the defects of other mediums. Importance of this paper work is telling developing stages of optic fiber, it's characteristics and it's losses. Then it is shown that which devises enforce the signal of fibers and in the end all three mediums that we mentioned are compared on the basis of attributes.

Findings form the paper will only enforce that knowledge we had before about optic fiber, the best broadcasting medium.

Key Words: Broadcast, Medium, Information, Optic Fiber, etc.

1. Entry

Optic fibers technology developing for communication networks, medicine applications and for other fields shows a unique union of physics, electro and mechanical engineering disciplines. Today, the amount of optic fibers installed all over the earth is equivalent with 70 journeys across moon, and this technology is ready to be used as an Internet post, as a global infrastructure of broadcasting, and like a base harassment for new resplendence developing, images, sensing and controlling. By increasing this area, a huge number of participants with a past in electrical engineering and physics started working in some optic fiber departments. Servicing technicians used to working with copper wires are retrained and learned to install optic wires. Apart of the others that started working on this field, the students also began to follow the first lectures of this field. Meaning of optic fibers bases is essential for application designers and researchers, therefore this copy has a lot of full references available.

2. Stages f Optic Fibers Development

Laser invention and it's presentation dates from 1960[1]. In 1966 it was clear that optic fiber is the best way of using lasers light for optic communication, in the same way as electrones are transfered through copper wires. Biggest problem at the beginning in optic fibers was loss of 1000 dB/km . A big invention happened in 1970 when losses were reduced in 20 dB/km.

Real stage of optic fiber communication research started in 1975, and this progress has its oun stages through years.

First Stage

First stage of light waves system has operated nearly 85 nm and has used laser semi-conductors GaA with multimode fibers. After some tests between 1977-1979, this type of system was released for commercial use in 1980. They have operated in 34-45 Mbps and space of repeater

[1] Malcolm Johnson, "Optical fibres, cables and systems", Geneva 2009, pg 5

was 10 km away. Unlike koaksial wire needed a repeater only 1km away, which reduced costs of instalatin and maintenance.

Second Stage

Second stage of optic fiber communication system, based in laser semi-conductors and InGaA detectors that has operated nearly 1300 nm, was made available in 1980 and they have operated in a borderline below 100 Mbps because of multimode fiber dispersion. This borderline was overcome through single-mode fibers. In 1988, second generation of light waves system has been operated in bits line up to 1.7 Gbps with repeater placed 50 km away. Signal weakening in this stage was 0.5 dB/km.

Third Stage

In third stage which has operated in 1550 nm, laser semi-conductors InGaAs became unfit because of dispersion and longitudinal oscillations modes of waves. Dispersion problem is overcome through dispersion-shifted fibers. In 1985, laboratory experiments have shown a chance of information broadcasting from 4Gbps in a distance near 100 km. third generation of optic fiber communication system has operated in 2.5 Gbps and was used commercially in 1992. This system was able to operate up to 10 Gbps.

Forth Stage

Forth stage enables optic amplifier usage that enables broadcasting in a distance even larger also WDM-wavelength division multiplexing for increasing broadcasting line. This type of amplifier operates in C line (1565 nm) and was developed for commercial use in 1990. In 1992 experiments have shown that there is a possible way for broadcasting above 21.000 km in 2.5 Gbps line and above 14.300 km in 5 Gbps line. This performance shows that all broadcasting based on amplified fibers available intercontinental communication.

Fifth Stage

In this stage optic fiber broadcasting was increased. Commercial terrestrial system has 1.6 Tbps capacity (160 optic channels in 10 Gbps line).

3. Optic Technology Applied in Telecommuniction Networks

Based on the fact that first generation of this system had a capacity of 34 to 45 MBps dor a fiber in 1980, capacity of optic system was increased for 10.000 times through a 20 year period. In the same time, optic technology was applied in a progressive way that short distances were increased for some kilometers in very long distances of backbone networks, completely replacing traditional copper wires[2]. Broadband of the application is based not only on the development of optical fibers and sytems but also it is very necessary to develop and specify many other aspects of practical implementation of optical fibers.

Optical fiber cable should be inserted into cables which are provided in different ways, buried, in ditches, air, sanitation, submarines, etc. For each of these ways of distributing, it is necessary to accurately design the cable to comply with the defined conditions as mechanical and environmental ones.

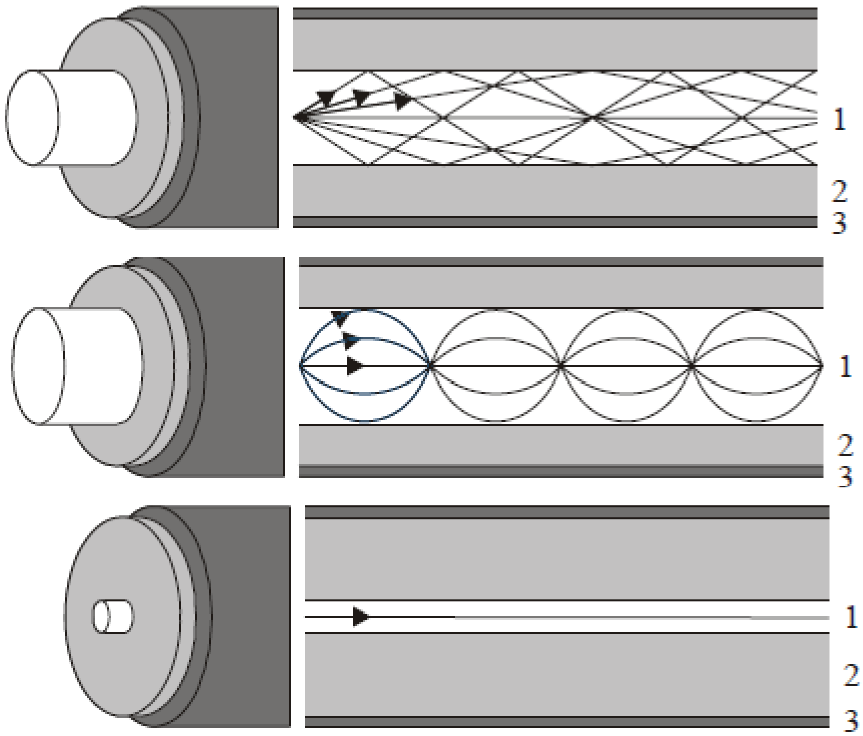
At the same time it is necessary to define installation techniques as well as to maintain its tensions to a maximum permissible value in order not to reduce the estimated life time of the fiber.

4. Optical Fiber Characteristics

Multimode optical fibers are non-conductor waves regulators who may have many ways to spread. Light spread like trails by seen in the following figure where the numbers 1, 2 and 3 are shown as core, inner layer and outer mantle. The inner layer of glass has the index of refraction of the light rays less than the index of refraction of the core. For fiber used in communications

[2] Malcolm Johnson, “Optical fibres, cables and systems”, Geneva 2009, pg 17

systems, the difference between the index of refraction of the core and the inner layer is 0.002-0.008[3].



Fiber in the first image is called "scale fiber" as fleeting changes refraction index from the middle layer in core. As a result, all rays (modes) within a certain angle will be reflected fully in the boundary core-middle layer. From this we see that the modes reach the end of fiber at different times causing signal limites to be broadcast.

Different modes speeds can be approximated by using the "fiber classified" (middle picture). Here, refractive index varies smoothly from the center out in a way that causes the travel times of different rays to be approximately equal, even when they have different paths.

By reducing the diameter of the fiber core and changeing the refraction index of the core and the middle layer in just a beam, then the fiber is a single mode (third figure).

[3] Ulf L. Osterberg, "Optical Fiber, Cable and Connectors", Academic Press 2002, pg 38

Diameter of the middle layer of all fiber types used for telecommunications is 125 μm. Core diameter for multimode fiber is 50 µm, while for single mode fibers from 8 to 10 µm.

5. Losses in Fiber

- Losses during installation

It is appropriate that link to be divided into two areas: the loss during installation and power available.**Losses during insallation** refers to optical losses associated with losses while placing the connectors in the optic cable and fiber loss during ascent(spice loss). Available optical power is the difference between the transmit outout power of the power received at the entrance, minus additional losses during the noise in sources.

-Losses during transmission

Loss during transmission is the most important feature in an optical fiber as it directly affects the length of the fiber that will be used. While maximum optical power which enters the optical fiber is defined by international safety standards for laser, the number of optical regenerator repeaters use is determined by the loss. The mechanism responsible for this loss includes absorbing material (absorption) as well as linear and nonlinear dissemination of light by impurities in the fiber.

- Attenuation and wavelength

While fiber loss varies with wavelength, changes in the source of the waves cause additional losses. A model of the exact loss in fiber as a function of wavelength is very complex, and it has to include effects such as linear dissemination, absorption of the material because the edges ultraviolet and infa red and absorbing material due to impurities common (phosphorus)[4]. The loss coefficient is found by Beer's law[5].

[4] Casimer M. DeCusatis, & Carolyn J. Sher DeCusatis, "Fiber optic essentials", Elsevier Inc. 2006, pg 109
[5] Govind P. Agrawal, "Fiber-Optic Communication Systems" Third edition, John Wiley & Sons Inc. 2002, pg 74

$$\frac{dP}{dz} = -\alpha P$$

$$P_{out} = P_{in} \exp(-\alpha L)$$

$$\alpha\left(\frac{dB}{km}\right) = -\frac{10}{L}\log_{10}\left(\frac{P_{out}}{P_{in}}\right)$$

Where,

α-The loss coefficient

L-length of fiber

Pin-power signal in entrance of the fiber

Pout- signal strength at the end of the fiber

For example, if we take the fiber with 100m (100 m = 0.1 km) length we have Pin = 10 μW and Pout = 9 μW, then signal attenuation will be as follows:

Always, the loss in optical fibers denoted by the term dB / km. Negative sign means loss[6].

Repeaters and optical reinforcements

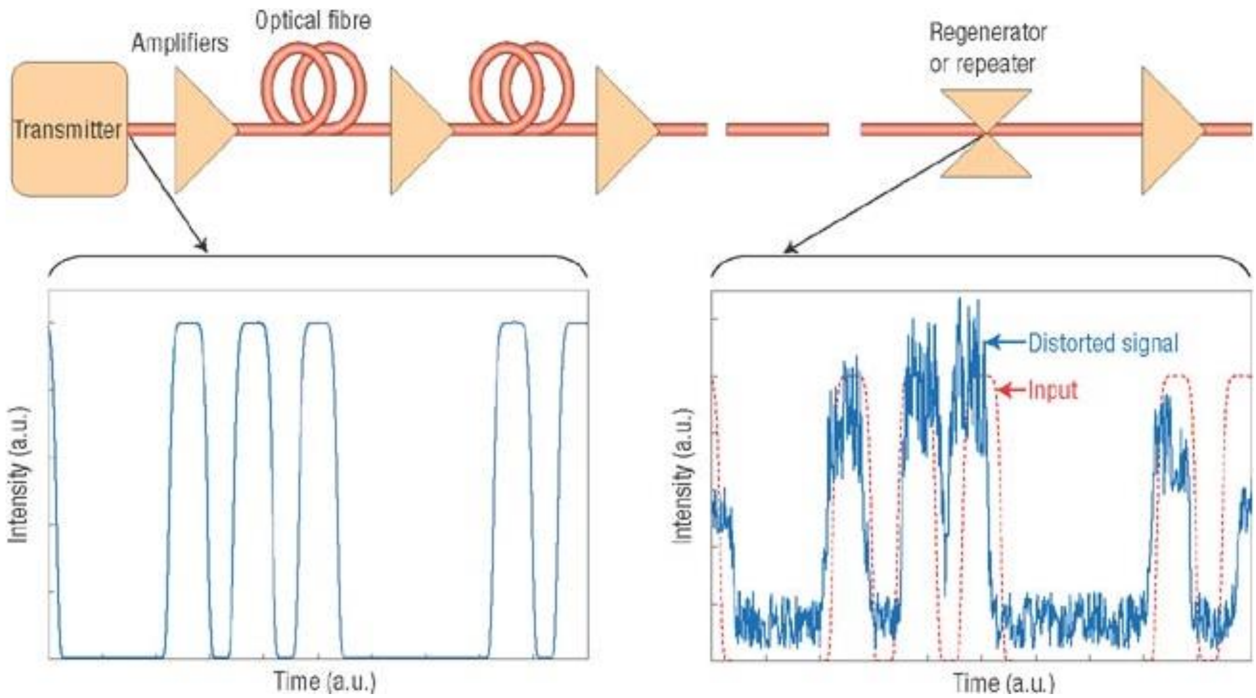
To expand communication net in very large distances, then we use optical reinforcements (amplifiers). However, the noise in the background while also strengthening, then there are limitations to this approach. Optical repeaters (repeater) can be used for remeasurement of the time , reformation and regeneration of the optical signal, providing even greater distance than optical reinforcements do it themselve. Sometimes these functions are built within the switch

[6] Nick Massa, "Fundamentals of Photonics-Fiber Optic Telecommunication", University of Connecticut 2000, pg 299

(key) which convert the optical signal into electronic form, and then rebroadcast the signal with a high level of optical power.

It is desirable that the optical telecommunication net distances between nodes to be much longer without the use of repeaters. Optical repeaters or key in general terms convert optical signals into electronic form, and then rebroadcast the signal different optical fiber. There are optical amplifier, which have the capacity to reinforce directly any optical signal that can be in fiber without converting it to electronic form. Some devices may also support transmission over great distances using optical amplifier as a pre-amplifier, post-amplifier or as a gap space. Amplifiers that have the capacity to increase the optical signal power are called optical power amplifiers and can be placed directly after the signal source to increase its power. Pre-reinforcement are placed directly in the front of the signal receiver (receiver), and are characterized with a very little noise and the opportunity to work with a very weak signal.

Repeaters and enforcers are needed to overcome the different effects of optical communication network. Special problem is the noise in optical enforcers produced during spontaneous empowerment, which is created by increasing the strength of the empowerment of the desired signal but also unwanted instant noise. Not all of these effects can be overcome simply by increasing signal strength.



Source: http://www.nature.com/nphoton/journal/v2/n1/fig_tab/nphoton.2007.261_F1.html

6. Optical Repeaters

To carry optical signals across large distances, repeaters or regenerator are always used. These devices receive the modulated optical signal (usually high signal), converting it into an electrical signal in the same signal, ratchet (amplify) signal, and rebroadcast the signal in optical form. So, we can say that the repeater has three main parts: an optical receiver, an electronic amplifier , and an optical transmitter. Repeaters amplify optical wave only, and can be placed in every 40-50 km or by the network communication standards[7].

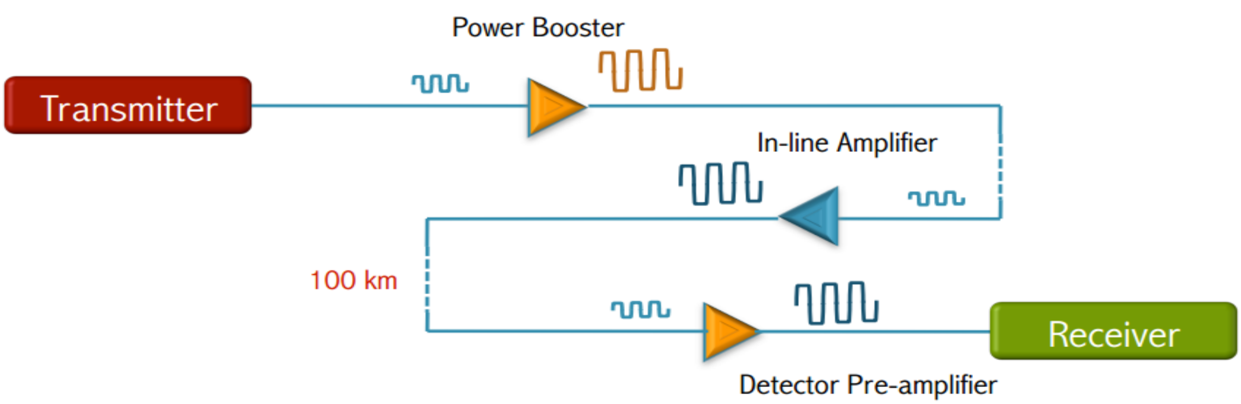
Devices that only support the amplification, which is an optical amplifier, it can be called device 1R. Devices that support the functions of regeneration (known as amplification and ensures that the output signal is powerful enough to reach the destination), reshaping (eliminating distortion of the shape of the signal caused by dispesion or dispersal) is called repeater "2R" while those devices that support the remeasurement of time (retiming)are called repeater "3R". Generally, longest distance and greatest reliability of financial statements was possible using repeaters "3R".

[7] Casimer M. DeCusatis, & Carolyn J. Sher DeCusatis, "Fiber optic essentials", Elsevier Inc. 2006, pg 124

It is worth mentioning that they can be configured as repeaters that convert multimode fiber in single mode fiber allowing multiple types of cables. This is possible because, unlike climbing or splicing, optical repeater has a receiver, demodulator and located districts , and broadcasters who send the signal to other nodes. In this way, repeaters contain elements similar to those of the receiver transmitter (transceivers). By selecting a suitable transmitters for new types of fibers, the signal will have the highest reliability. In fact, signal repeaters can convert from copper cable to fiber also that well.

7. Optical Amplifiers

Optical amplifiers (enforcers) are designed as a more simplified alternative of repeaters to overcome the weakening in optical fibers. Similarly on an electronic amplifier, these optical signals give a definite increase (the ratio between the input and the output power measured in



dB). Its function is as follows.

Source: http://www.ee.ryerson.ca/~courses/ee8114/optical-amplifiers-venkat.pdf

While such a device can be seen below

Source: http://www.ee.ryerson.ca/~courses/ee8114/optical-amplifiers-venkat.pdf

Optical amplifiers enable signal to remain in optic form throughout network connecting. Their priority is to allow repeaters to change without affecting the signal of statements in amplifiers,or transmits multiple signals in a single fiber at different wavelengths, and always achieve the desired strengthening. One of the two types of optical amplifier is a semi-conductive optical amplifier.

8. Bandwidth

Regarding the transmission of optical signals, the two most important parameters of fiber (not just the fiber) they are bandwidth (transmission band) and signal attenuation. The basic reason why we use fiber instead of copper cable is that bandwidth is far greater. Bandwidth is the difference of frequencies between the highest and the smallest information that can be transmitted from one system. The bigger the bandwidth means a larger capacity to carry information channel. Bandwidth is tested using very fast and sensitive (sensitive) reciever laser. The software analyzes the difference between input and output pulse, and calculates bandwidth in fiber[8].

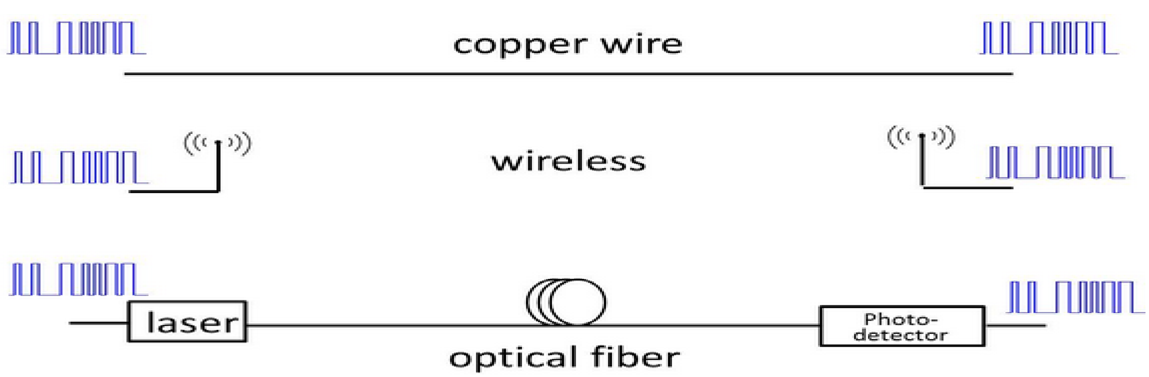
Bandwidth is also dependent on the design, for example bandwidth "interval of multimode fibers" (~ 125 MHz) is smaller than the bandwidth of "multimode fibers classified" (~ 500 MHz)[9].

[8] Hill K. “Fiber Bragg Gratings”, OSA Press 2000, pg 29
[9] Casimer M. DeCusatis, & Carolyn J. Sher DeCusatis, “Fiber optic essentials”, Elsevier Inc. 2006, pg 24

If we talk about links within objects, then small signal attenuation and wide bandwidth of optical fibers are not the only factors of use. For such cases, optical fibers are used primarily because of other priorities such as the immunity to interfering electromagnetic waves. The situation is different for intercontinental links thousands of kilometers in length. In transoceanic systems small signal attenuation and wide bandwidth of optical fibers are important factors for reducing total unit costs during transmission.

9. Fiber vs Copper vs Wireless

In the beginning of Internet, connections were made through copper cable but with technology development they have also developed other transmission media such as the wireless- and fiber.



Source: http://www.alanptlau.com/Research.html

Whereas in the table below we are going to record some other feature comparable between these three technologies.

	Fiber	Coper	Wireless
Quality	✓	little	x
Cable maintenance	not needed	periodic	x
Future	✓	x	x

Interference	x	✓	✓
Bandwidth	10240 Mbps	24 Mbps	24 Mbps
Security	✓	x	x

10. Conclusions

From the above description and table we noticed that optical fiber as a transmission medium is indispensable. This was a confirmation of our hypothesis submitted at the beginning of the paper. It all has to do with the most significant case during the transmission which is information security transmission (the last table). Taking into consideration those who we have described is not accidental connection with underwater optical cable between the UK and France. Tirana and Prishtina are also connected directly with optical cable all the way.

References:

Malcolm Johnson, "Optical fibres, cables and systems", Geneva 2009, pg 5

Ulf L. Osterberg, "Optical Fiber, Cable and Connectors", Academic Press 2002, pg 38

Casimer M. DeCusatis, & Carolyn J. Sher DeCusatis, "Fiber optic essentials", Elsevier Inc. 2006, pg 109

Govind P. Agrawal, "Fiber-Optic Communication Systems" Third edition, John Wiley & Sons Inc. 2002, pg 74

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