

# Li-Fi: The Power of Visible Light in Data Communication

S.Kavipriya<sup>1</sup>, S. Porselvi<sup>2</sup>, L. Bhagyarakshmi<sup>3</sup>, Sanjay Kumar Suman<sup>4</sup>

<sup>1,2,3,4</sup> Dept. of ECE

<sup>1,2,4</sup> MNM Jain Engineering College

<sup>3</sup> Rajalakshmi Engineering College

**Abstract-** *The impact of internet on our day to day life has become so extensive that it is impossible to think of a day without it. It has become a fundamental requirement in our daily lives. Survey reports show that nearly 46 % of homes throughout the world have access to the internet and the percentage is growing each day. With such a high demand, there has been a looming Radio Frequency spectrum crisis, which paved the way to the invention of a new technology:- LI-FI. LI-FI, acronym of light fidelity, is a new wireless technology which has the ability to provide high speed internet connection within localized environment. Till today we are familiar with WI-FI which uses radio spectrum for communication. Even though it gives a speed of nearly 150 Mbps (as perIEEE802.11n), it isn't sufficient to satisfy all users. On the other hand LI-FI uses spectrum comprises a wide range of frequencies, from infrared through visible, down to the ultraviolet spectrum for communication which has the ability to produce a theoretical speed of 10 Gbps. It is not only confined to light-emitting diode (LED) or laser technology or to any specific receiving technique, LI-FI is a framework for all those technologies which provides new ways to all present as well as future services or applications.*

**Keywords-** Li-Fi, Visible Light Communication, WLAN, LED.

## I. INTRODUCTION

A simple definition of Li-Fi is wireless communication through visible light. In contrast to Wi-Fi, Li-Fi uses visible light spectrum to communicate. Light has been around for millions of years. It has created us, has created life and has created all stuffs of life. We can't imagine life without light, light is everywhere, be it at home, at work place, meeting hall, hospitals, aircrafts, street lights, vehicles, traffic lights and so on. In recent years, the rapid development in solid state Light emitting diodes (LED's) material has given rise to next generation 5G data communication called Li-Fi alias Visible Light Communication or we can say a new Wi-Fi [5]. Li-Fi is a label for wireless-communication systems using light as a carrier instead of traditional radio Frequencies as in Wi-Fi. Li-Fi has the advantage of being able to be used in sensitive areas such as in Aircraft without causing interference [3]. Nowadays with the advent of technology, communication became the backbone of Information and Communication

Technology. ICT is made our globe like a town. Today everyone like Business, institutions, organizations wants right information at the right time which, needs fast internet connectivity. Present paper reflects the Future of Communication (LI-FI) which may affect all lives [2]. As human's birth has taken place on earth, he is developing, inventing and creating. He has made considerable and consistent progress in the fields of science and technology. He has made technology for his convenience and ease that are ultimately resulting in saving his time. Even for data transferring and sharing among multiple devices, he has invented technologies and techniques that give maximum flow capacity by consuming minimum time or having very low time complexity. His developments vary from wired communication to wireless communication to communication using transparent fibre made of glass or optical fibre. In this plethora of developments in wireless communication he has gone one step ahead and invented a technology of Li-Fi and set a mile stone in this field [7]. Li-Fi is the future technology that guarantees to replace the 2G, 2.5G, 3G and the latest 4G systems of communication. The current technologies which employ WIFI defines it as any "wireless local area network (WLAN) products that are based on the Institute of Electrical and Electronics Engineers' (IEEE) 802.11 standards"[2]. LIFI is thought of as an alternative or an exchange to the currently used WIFI. With an exhausted and congested network, it was necessary to articulate our minds into a technology which not only is ubiquitous but also a resourceful quantity. Professor Harald Haas during his TED global talk rightfully coined LIFI as the future upcoming technology [6]. Thus, just by sitting under the light we can transfer data and access internet. Signals are transmitted from one system to another by using LED as a LiFi transmitter and photodiode as a LiFi receiver.. Lifi is based on Visible Light spectrum is which is,10,000 times faster in transmission of data, more secure and immune to EMI relative to radio waves [5].The operational procedure is very simple-, if the LED is on, you transmit a digital 1, if it's off you transmit a 0. The LEDs can be switched on and off very quickly, which gives nice opportunities for transmitting data. Hence all that is required is some LEDs and a controller that code data into those LEDs. All one has to do is to vary the rate at which the LED's flicker depending upon the data we want to encode [3].data in the form of illumination taking the fibber out of fibre optic by sending data through an LED light

bulb that varies in intensity faster than the human eye can follow. It's the same idea behind infrared remote controls but far more powerful. Haas says his invention, which he calls D-LIGHT, can produce data rates faster than 10 megabits per second, which is faster than your average broadband connection [4]. Quiet significant amounts of advantages make LIFI a potent technology. Visible light is defined as having a wavelength in range of 400 nanometres to 700 nanometres, which pros to have 10,000 times broader spectrum than the radio wave spectrum employed in WIFI[4]. This technology further has the quintessential advantage of not needing any base stations and primarily requiring unlicensed services. Very high data rates can be achieved due to low interference, high device bandwidths and high intensity optical output[5]. Moreover, it is non-hazardous and a safe technology which can even be employed in riverbeds and is cost effective [6].

## II. DESIGNING A LI-FI BASED SYSTEM

A LIFI product is mainly an assembly of four primary sub-components:

- Bulb
- Radio Frequency Power Amplifier (RFPA) circuit
- Printed Circuit Board (PCB), and
- An enclosure

The function of the Printed Circuit Board is to control all the electrical signals of the lamp and also contains the microcontroller which manages the different functions of the lamp. The solid-state Power Amplifier generates a radio frequency signal which is converted into an electric field. Due to high concentration of energy in the electric field the contents of the bulb gets transformed to a plasma state at the centre of the bulb. This controlled plasma is responsible for the generation of an intense source of light. All these subcomponents are contained in an enclosure made up of aluminium.

## III. FUNCTION OF THE BULB SUB-ASSEMBLY

The centre of a LIFI system consists of a bulb sub-assembly, in which a sealed bulb which is inserted in a dielectric material. This particular design is much more reliable than other well-known light sources which usually use degradable electrodes inside the bulb. The dielectric material has two functions; primarily it acts as a waveguide for the radio frequency energy radiated by the Power Amplifier and secondly it also helps in concentrating the electric field thus focusing energy in the bulb.

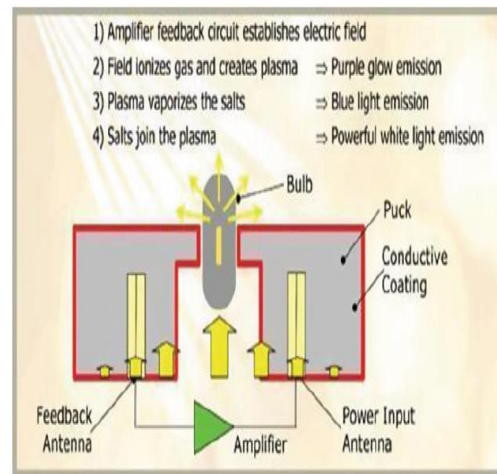


Figure 1. Bulb sub-assembly

This energy from the electric field is responsible for heating the material in the bulb readily and transforms it to a plasma state that has the power to emit light of high intensity.

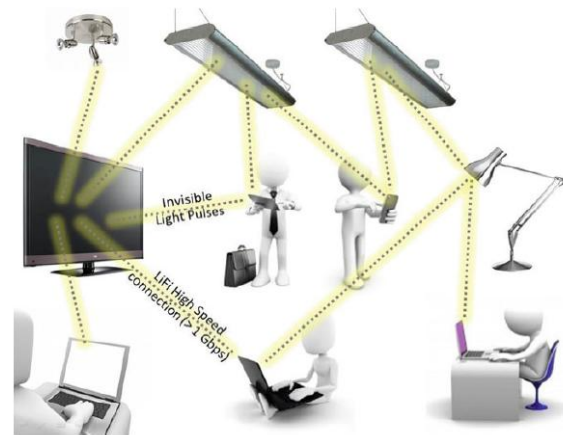


Fig. 59.1 A future Li-Fi environment

Figure 2. A future Li-Fi environment

## IV. DATA TRANSMISSION THROUGH LI -FI

In case of transmitting a simple audio file in a smart phone; a proto board table is connected to the smart phone via a simple audio jack. In the proto board table the received audio signal is converted into an optical signal which is transmitted by a special emitter across the light spectrum generated by a LED. At the receiving end, a receptor which is located in a speaker captures the signal and converts it back to an audio signal which can be played by the speaker.

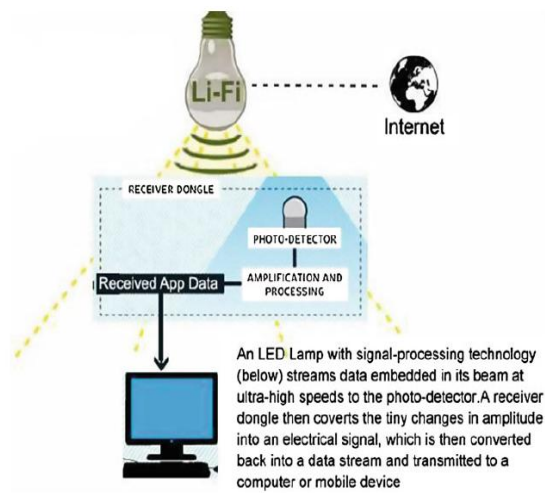


Fig. 59.3 This is how data is transmitted through a LED lamp

Figure 3. This is how data is transmitted through a LED lamp.

For wireless internet transmission, the principle remains the same but it makes use of a receptor device which is designed to be placed over a router. The router incorporates an LED lamp to transmit the data so that anyone falling within the range of light emitted by the LED lamp will be able to access the internet.

### V. SPECTRUM

Wi-Fi works on radio frequency, which only formulate up a small part of the electromagnetic spectrum. With growing user demand for wireless internet, the available radio spectrum is getting exploited. Radio waves are harmful for human beings as they penetrate the body and may cause mutation. They can't be used in all environments, mostly in aircrafts, chemical factories and power plants as well as in hospitals. In Li-Fi visible light spectrum is used to pass on information as there is much extra space existing in this spectrum and it has the potential to pass on higher bandwidths [2]. The communication of the information can be with the help of all kinds of light close to visible region [10]. This part of spectrum is not harmful to our body and is safe to use in different environments.

### VI. SUPERIORITY OF LI-FI OVER OTHER TECHNOLOGY

1. Data transmission can be done at a very high speed, as high as 30 GB per minute [5].
2. Visible Spectrum is used in Li-Fi making it safer than radio frequency signals.
3. VLC can be used in aircrafts.

4. Li-Fi can be used for medical fields, and also in such areas where infrared, WI-FI, and Bluetooth technologies are banned [7].
5. Li-Fi has the potential to work under water.
6. There are about nineteen billion bulbs spread worldwide, they just need to get replaced with LED bulbs that transmit data [8].
7. Security is an added benefit, since light does not penetrate through walls can also be used in streets for traffic control. Cars having LED based headlights and backlights can communicate with each other and prevent road accidents. Even the traffic lights can also communicate to the car with the help of this technology [9].
8. By implementing this technology worldwide every street lamp has the potential to be a free access point.
9. Li-Fi is the solution for the problem concerning the shortage of radio frequency bandwidth [10].

### VII. LIMITATIONS OF LI-FI

1. One of the most basic problems is that light cannot pass through opaque objects, so if the receiver somehow gets blocked then the signal will immediately get cut out and transmission is disabled [11].
2. Two major issues that have to be kept to be kept in mind by the companies (while providing VLC services) are reliability and network coverage. External sources of light like sun rays, bulbs; and other opaque materials may interfere in the transmission path and this may lead to interruption or disturbance in the communication process [12].
3. The cost of installation of VLC is quite high.

LI-FI v/s WI-FI

Table 1. Li-Fi/Wi-Fi comparison

Parameter	Li-Fi	Wi-Fi
Speed	H	H
Range	L	M
Data density	H	L
Security	H	M
Reliability	M	M
Power available	H	L
Transmit/receive power	H	M
Ecological impact	L	M
Device-to-device connectivity	H	H
Obstacle interference	H	L
Bill of materials	H	M
Market maturity	L	H

## VIII. LED

This technology can offer us with a wireless Internet connectivity, as long as we have a LED light bulb. LED can be used to transfer binary coded information quickly by using visible part of spectrum. Total number of the world's light bulbs is projected at about 14 billion which can be used to obtain data transmission if we replace with LED's \*11+.



Figure 4. LED bulbs used for Li-Fi

Hence, Li-Fi is a rising way to create wireless connectivity links by means of the LED illumination networks. We can exchange light bulbs with LED's so that all street can be transformed into an Internet access points for all Electronics.

Security Radio waves can penetrate all the way through walls. This leads to numerous security concerns as they can be intercepted without difficulty. While information transfer for Li-Fi is very protected and safe (no one can hack it).



Figure 5. Data transfer by radio waves and visible light

As we use visible light no signal disperses through walls [12]. Such visible light communication could be used securely in airplanes without disturbing airlines signals.

## IX. TRAFFIC CONTROL

Li-Fi can be used in traffic control wherein data can be exchanged among vehicles and traffic lights to improve road safety. It can also be used to revise traffic information at roughly every instant and it will be trouble-free for traffic police to pact with traffic and catch the one who disobeys the rules. In traffic signals, Li-Fi can be used which will communicate with the LED lights of the vehicles which can help in organization of the traffic in an improved way and the accidents can be avoided [12].

## X. INTER VEHICLE COMMUNICATION

Vehicles headlights and their headlights are gradually being substituted with LED's. This offers the hope of vehicle-to-vehicle communication through Li-Fi, and thus allowing development of the anti-collision systems and swap over of the information at time of driving between vehicles. Traffic lights now already use LED lights, so that there is also the vision presented of city wide traffic organization systems [7].

## XI. GPS PRACTICE

Satellite map-reading has been one of the most significant hi-tech advances of the last 5 decades. No matter how fine the method gets, it doesn't work preciously where we spend the most of our time i.e. indoors. Gears have been invented that smartly use Wi-Fi triangulation & "hybrid" GPS (say, GPS synchronizes combined with censored data from a accelerometer, pedometer, and compass), but these are erroneous and usually untrustworthy. A company called Byte Light is attempting to change this with a mechanism that uses LED to offer devices with exact location data \*13+. Byte Light's indoor position system works by scheming the pulses of LEDs to make them work in definite pattern. This pattern is not noticeable to the naked eye but can be picked by the specialized camera [13]. By means of the information collected from LED modulation, the machine works with an application to execute client-side computation to outline where it is within the arrangement.

## XII. CONCLUSION

Light Fidelity or Li-Fi is one of the upcoming and growing technologies which have the ability to compete with various other existing technologies or being developed. Since in this technology light is the main source of transmission it will be very advantageous and can be implemented in various fields that is not possible with Wi-Fi and other related technologies. The present research in VLC is focussed on finding a modulation scheme for IM/DD for point to point

VLC links taking into account the fact that VLC would serve two purposes at the same time namely, illumination and gigabit wireless communication. OFDM has proved to be the most suitable choice as a digital modulation scheme for use in Li-Fi Technology. The Li-Fi technology based on VLC principles is advantageous over the Wi-Fi technology in terms of spectrum availability, high efficiency, secure data transfer, and, high data rate transmission. Owing to the high frequency range of visible light spectrum Li-Fi is a powerful wireless network solution to the looming RF-spectrum crisis. Bidirectional point to point communication using Li-Fi system has been practically realizable. At present work on an entire Li-Fi at to cell networking solution is going on. Li-Fi Technology will find huge applications in various industries, offices, hospitals and even in homes for high speed data transfer because of its safety features and its intelligent use of the visible light spectrum which otherwise is used in most cases to serve the purpose of illumination.

### REFERENCES

- [1] Sinku U. Gupta, "Research on Li-Fi Technology & Comparison of Li-Fi/Wi-Fi," International Journal of Advanced Research in Computer Science and Software Engineering, Vol. 5, Issue 6, pp 429-433, 2015.
- [2] Neha S.Jaiswal, Payal S.Chopade, "Review of Li-Fi Technology: New Future Internet," International Journal of Scientific & Engineering Research, Vol. 4, Issue 12, pp 36-40, 2013.
- [3] Ravi Prakash, Prachi Agarwal, "International Journal of Advanced Research in Computer Engineering & Technology (IJARCET)," Vol. 3, Issue 2, pp285-290, 2014.
- [4] Polshetwar Poonam V, Mr. Saad Siddiqui, "Li-Fi Technology," (IJCSIT) International Journal of Computer Science and Information Technologies, Vol. 5, Issue 6, pp 8031-8032, 2014.
- [5] Shaista Tarannum, ILLUMINATION VIA "VISIBLE LIGHT COMMUNICATION TECHNOLOGY," International Journal of Technical Research and Applications, Vol. 4, Issue 2, pp 136-141, 2014.
- [6] Dr. Naveen Rathee Abhinav Malik, Shreyaa Napal "Transmission of Numeric Data and Voice Using Light Fidelity (LIFI) Technology," International Journal for Research in Applied Science & Engineering, Vol. 2, Issue X, pp149-153, 2014.
- [7] Anurag Tiwari, Aakanksha Kapoor, Ajmer "LIGHT FIDELITY (LIFI) STUDY", NATIONAL CONFERENCE ON RECENT TRENDS IN CSE VOL-1, ISSUE 1, 2016.
- [8] Ruchi Garg, "Li-Fi: Data Onlight Instead of Online", International Journal Of Engineering And Computer Science & Applications, Vol. 1, Issue 1, pp33-37, 2013.
- [9] LI-Fi the latest technology in wireless IJCE. 2(3), July 2012
- [10] <http://dvice.com/archives/2012/08/lifi-ten-ways-i.php>
- [11] <http://beyondweblogs.com/what-is-li-fi-is-this-replacing-Wi-Fi>
- [12] Smith T (2012) WTF is... Li-Fi? Optical data transfer's new leading light? The Register.