

# Li-Fi: A 5G Visible Data Communication

Shubham Rastogi

Moradabad Institute of Technology, Moradabad

**Abstract:** Internet services are very highly demanding and essential accessories in ICT. As per the Cisco Survey of the usability of the existing spectrum, we are presently using about 80% of the existing capabilities of the data utilization. Presently we are utilizing the Wi-Fi services within the campus and around the 10-100 meters of distances to connect our P.C., Laptops, palmtops and P.C. notes etc. Present paper deals with the new technology, Visible Light Communication (VLC) which may provide a wide and fast data rate like something 500MBPS. Study made comparison between Wi-Fi and Li-Fi and other important parameters of the communication processes.

**Keywords:** VLC, spectrum, VIBGYOR, photo-diode

## 1. Introduction

Transfer of data from one place to another is one of the most important day to day activities. The current wireless networks that connect us to the internet are quite responsive. As the number of external devices that access the internet increases, the signals are being clogged up due to the heavy traffic which results in less free transmission of data. The fixed bandwidth available makes it more and more difficult to enjoy higher data transfer available for data transfer rates and connect to secure network and radio waves are just a small part of spectrum. Now a days Wi-Fi is widely used in all public areas like homes, cafes, hotels, airports etc. Due to rapid frequency is blocked day by day at the same time usage of wireless is increasing exponentially.

A solution of this problem is Li-Fi. Li-Fi stands for Light Fidelity. It is the transmission of data through illumination by taking out fibre out of fibre optics by sending data through LED bulb that varies in intensity faster than human eye can follow. Li-Fi is a wireless communication in which light is used as a carrier signal instead of traditional radio frequency as in Wi-Fi. (VLC) Visible light communication uses rapid pulses of light to transmit information wirelessly that cannot be detected by human eye.

## 2. Literature Survey

In July, 2011, Dr. Herald Harass, Professor, mobile communication, University of Edinburgh, publicly demonstrated Light Fidelity for the first time, a method of visible light communication (VLC) technology. Germany have reached data rates of over 500 Mbps using a standard white light LED.[1]

Teams from University of Oxford and University of Edinburgh are focussing on parallel data transmission using arrays of LED's where each LED transmits a different data stream while other groups a mixtures of red, blue and green. This paper would be introducing some characteristics of LI-FI encompassing its distribution and reduction in power losses comparatively to WI-FI. This paper would introduce and present a brief summarized view on LI-FI technology along by means of theoretical analysis.

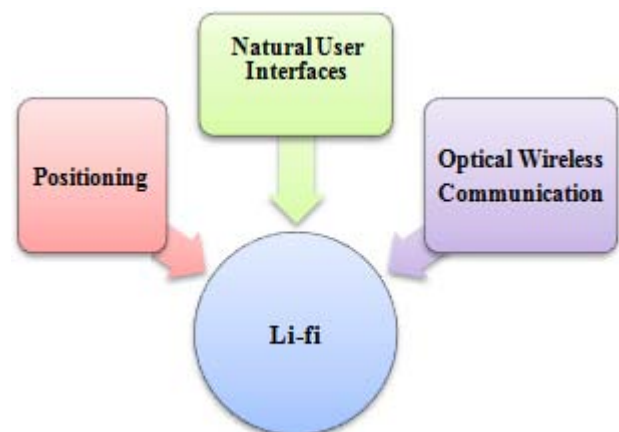


Figure 1: Block Diagram of Li-Fi interface

The above block diagram shows how li-fi is easy user interface. Li-fi uses optical wireless communication as optical means light and Li-Fi uses visible light communication technique. Other thing is that it provides natural user interface as it is light based technology and hence does not cause any pollution and the other thing is its positioning facility because it can be used anywhere

## 3. Principle & Technology of Li-Fi

Heart of Li-Fi technology is high brightness LED's. These can be switched on and off faster since operating speed of led is less than 1 micro second than human eye can detect causing the light source to appear continuously. Switching on and off led is a logical „1“ and switching it off is a logical „0“. It is possible to encode data in light by varying rate at which led's flicker I and off to give different string of 1's and 0's.

A light sensitive device (photodiode) receives signal operates and converts it back to original data. This method of using rapid [pulses of light to transmit information wirelessly is VLC (Visible Light Communication).

Further enhancements can be made like using array of led for parallel data transmission or using mixtures of Red, Green and Blue led to alter lights frequency encoding a different data channel.

It is band on use of visible light between blue (670 THz) and red(480 THz). Wi-Fi uses radio part of electromagnetic wave spectrum, Li-Fi uses optical spectrum. The principle of Li-Fi is based on sending data by amplitude modulation of light source in a well-defined and standardised way.

This is a whole new spectrum of possibilities as compared to the radio waves spectrum and 10000 times more in size.

#### 4. VIBGYOR Region!! Why?

The frequency spectrum that is available to us in the atmosphere consists of many regions like X-rays, gamma rays, u-v region, infrared region, radio waves, etc. Out of these regions, any ray of light can be taken under operation for this upcoming technology, then why the VIBGYOR part is chosen? The reason behind this is the harmful effects that occurs due to this rays of light.[4]

- Gamma rays are harmful because it could be dangerous dealing with it.
- Infrared has eyes issues, as it can cause harm to the eyes on exposure of it.
- X-rays has health issues
- U-V rays can be considered for this operation only in the absence of people, otherwise it also cause harm to the people.

Hence we are left only with the VIBGYOR region from red to blue part as it does not causes any harm to the people.

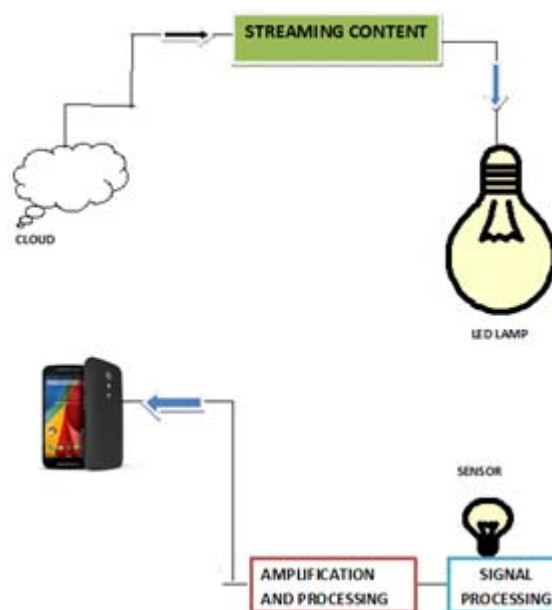
#### 5. Working of Li-Fi Technology

The heart of the li-fi technology is the high brightness LED's these led's can be switched on and off very quickly which gives you opportunities for transmitting data since operating speed of led is less than 1  $\mu$ s.

We just have to vary the rate at which the led flicker depending upon the data we have to transmit. This invisible on off activity enables a kind a data transmission using binary codes. A light sensitive device(photo detector) receives the signal and converts back into the original data. This method of using rapid pulses of light of data transmission wirelessly is technically referred as visible light communication (VLC).There is an emitter on one end. Led and a photo detector (light sensor) on other. The photo detector registers a binary 1 when led is on and binary 0 when led is off. To build a message flash the led numerous times or use an array of led of red, blue and green colour to obtain data rates in range of hundreds of megabits per seconds.[2]

An overhead lamp fitted with a led with signal processing technology streams data embedded in its beam at ultra-high speeds to the photo detector.

A receive dongle then converts the tiny changes in amplitude into electrical signal which is then converted back to a data stream and transmitted to a computer or mobile device. The data can be encoded in light by varying the flickering rate which led flicker on and off to generate different strings of 1's and 0's.the led intensity is modulated so rapidly that human eye cannot notice so the light of led appears constant to humans.



**Figure 2:** Working of Li-Fi Technology

#### 6. Analogy of Wi-Fi and Li-Fi

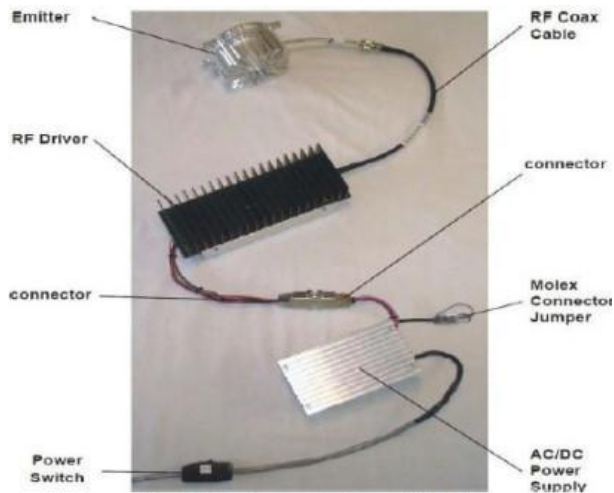
Li-Fi is term used to describe VLC technology applied to high speed wireless communication while Wi-Fi uses only radio waves or radio frequency. Wi-Fi is a great for general wireless coverage within buildings and Li-Fi is a ideal for high density wireless data coverage in confined area and for the receiving radio issues.

**Table 1:** Comparison of Li-Fi and Wi-Fi

Technology	Speed
<b>Wireless(Current)</b>	
WIFI-IEEE 802.11 n	150 Mbps
Bluetooth	3 Mbps
IrDA	4 Mbps
<b>Wireless(Future)</b>	
WiGig	2 Gbps
Giga-IR	1 Gbps
Li-Fi	>1 Gbps

#### 7. Set-Up for the Li-Fi Technology

Basically the Li-Fi technology is implemented by using the high speed LED's which are of white colour initially. These devise are normally used for the illumination of light on the application of the current. However flickering the light of the Led can be done by changing the current flowing through it at a faster rate. In this way, the data can be transmitted at a very fast rate. The overall control of this phenomenon is under the control of the microcontroller connected by a coaxial cable via connector, power supply and a power switch. However changes can be made to enhance the performance like parallel connections, using different colour LED's. [3]



**Figure 3:** Setup for the Li-Fi Technology

## 8. Advantages

- Speed is higher than Wi-Fi
- It does not require license
- Low maintenance cost
- Extremely energy efficient
- Contain no hazardous mercury materials
- Cheaper than Wi-Fi
- Versatility and longevity
- Secured light does not penetrate through walls.

## 9. Limitations

- Can't be used in those areas where there are large number of obstacles or hurdles are present
- If receiver is blocked the signals cut off
- Interference from external light sources
- It only works in direct line of sight

## 10. Applications

- Major application in medical science and technology areas. As in hospitals usage of Wi-Fi interferes with mobile and pc which blocks signal, so it may be hazardous for patients. Hence Li-Fi can be taken under consideration.
- VLC can be used safely in aircrafts
- Underwater in sea Wi-Fi does not work whereas Li-Fi can work better than Wi-Fi.
- Wi-Fi and many radiation types are bad for area slake power plants, thermal plants and nuclear plants. Li-Fi could offer safe connectivity for these sensitive locations.

## 11. Conclusion

With the development of technology, it can be put into practical use. Every bulb can be used as a hotspot bulb to transmit wireless data and will proceed to cleaner, greener, cheaper and safer future to the coming new generation. It is a very attracting and efficient technology as with the increase in the number of device connected, higher data rate

transmits required. The problem of short bandwidth of radio waves can be solved.

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## Author Profile



**Shubham Rastogi**, currently pursuing B. Tech in Electronics and Communication from Moradabad Institute of Technology, Moradabad. He is a student of B. Tech 4<sup>th</sup> year and has keen interest in electronics field like digital logic design, integrated circuit technology etc. and aspire to go in research in this field only. He is a member of IEEE and authored and co-authored 4 technical papers.