

## A Review Paper on on Light Fidelity Technology and its Applications

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### Abstract

In this advanced and forward-thinking era of science, data transmission is an extremely common practice. Up to this point, the majority of our data transfer has been accomplished through the use of Wi-Fi technology. But light itself is another option for us to employ as a source for the data transfer. The technique of exchanging data by the use of light is referred to as Li-Fi, which is short for "light Fidelity." The Visible Light serves as the channel of communication in the Li-Fi protocol. This is the newest technology that has been created in the field of data exchange in recent years. Additionally, this technology is in the process of being developed as a result of the increasing number of studies that are being conducted on this particular subject for the purpose of facilitating its improvement. From a scientific standpoint, this optical communication technology is now the most cutting-edge issue of discussion. Because Li-Fi uses VLC, which stands for visible light communication, the rate of data transfer is quite fast with this technology (VLC). In terms of the data transmission, it adheres to the standards established by the IEEE (Institute of Electrical and Electronics Engineers). In this study article, we will be pointing out some particular elements such as the characteristics, techniques, applications, pros and downsides, and comparison with ongoing related technologies such as Wi-Fi.

**Keywords:** Li-Fi, Light Fidelity, Wireless Communication Medium, Latest Technology, Visible Light, and LED are some of the keywords associated with this topic.

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### 1. Introduction

One of the newest and most popular forms of wireless communication is known as Li-Fi. Its widespread popularity can be attributed to the lightning-fast transmission it offers. If we are discussing the most recent communication or transmission medium, then we must acknowledge that it has a sluggish data transfer rate. Additionally, the speed will be split among the connected devices if there are more than two of them at the same time. In addition to this, we need to investigate the background of the Li-Fi standard. Harald Haas, a professor of mobile communications at the University of Edinburgh, and Dr. Mostafa Afgani, a co-founder of pureLiFi, presented Li-Fi for the first time in 2011 at the TED Global Talk in Edinburgh. In addition, there is a relationship between Li-Fi and Visible Light Communication (VLC), which was established around the year 1880 and similarly involves the utilisation of a visible light component of the electromagnetic spectrum in the process of data transmission. Li-Fi was inspired by this technology. The end-to-end data transfer in this wireless optical networking system is accomplished with the help of LEDs, also known as light-emitting diodes. Li-Fi, like other communication systems, emits electromagnetic waves; however, for the purposes of communication, Li-Fi does not have any of these other types of waves due to the advantages it offers. The hospital, the laboratory, and the aircraft may all benefit greatly from installing LI-Fi. Because of these advantages, there are a number of potential applications for this technology in the future.



Figure 1: Harald Haas

Wi-Fi and Li-Fi are very similar technologies, but there are some significant technological differences between the two. For example, Li-Fi does not utilise radiofrequency to transport data; instead, it uses the intensity of the light to modulate the signal and send it on. It has been demonstrated in theory that the data transmission speed of Li-Fi can reach up to 100 gigabits per second. In addition to this, the enormous stress that is now placed on the wireless medium that we use today can be alleviated by Li-Fi. In contrast to RF communication medium, which only has the potential to operate at 300 THz, it offers a frequency range operating at 400 THz. Specifics Regarding the LI-FI Technology The technology that underpins Li-Fi is known as optical wireless communication (OWC), and this technology makes use of LEDs as the medium for the exchange of data across a specialised network. As a result, Li-implementation Fi's of the method resembles that of Wi-Fi in certain respects. Visible Light Communications begins precisely at the same moment when we switch the current to the LEDs, and it operates at a very rapid speed. Because it happens so quickly and there is no flickering involved, human eyes are unable to pick it up.

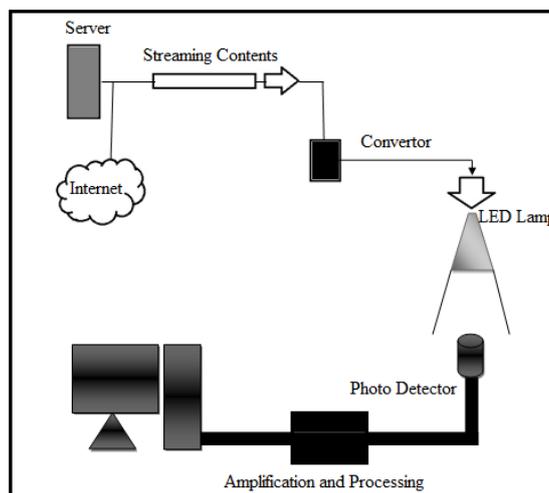


Figure 2: Block Diagram of Li-Fi

For the purpose of data transfer, we need to install the Li-Fi LEDs. The light is responsible for the transfer of all of the data by itself. because the data packet is carried by light and transmitted to the receiver end of the connection. Therefore, the light that will be generated from the LEDs will

serve as the primary medium via which the data will be sent from the source to the destination. But the light that is emitted comes from LEDs, which can be dimmed to a level where it is not visible to the human eye. Because of this, human eyes are unable to perceive the light that is emitted by LEDs.

Li-Fi, which is an alternative to Wi-Fi, is likewise capable of transmitting data throughout the electromagnetic spectrum. The most significant distinction between the two is that although the process of Wi-Fi involves the production of radio waves, the procedure of Li-Fi involves the presence of infrared light and an ultraviolet form of visible light. This is the primary distinction between the two.

There is a significant problem with Wi-Fi in that it makes full use of the possible spectrum. On the other hand, Li-Fi does not have any constraints on its capacity and hence does not have this problem.

In addition, the most significant advantage of the Li-Fi technology is that, in comparison to the spectrum of radio frequencies, its spectrum of visible light is 10,000 times greater. When compared to Wi-Fi, the cost of using Li-Fi is around one tenth of what it would be using Wi-Fi. Because the Li-Fi installation process requires a limited range, it has a lower initial cost, and it has a higher degree of dependability. It is conceivable for Li-Fi to be reliable under these circumstances since the participation of a hacker or intruder in the overall mechanism of Li-Fi is extremely little, or we might even argue that the chance of their presence is zero. Therefore, in response to the security problem, the use of Li-Fi rather than Wi-Fi is recommended.

## 2. The Operation of the LI-FI Mechanism

In the case of Wi-Fi, the medium of transmission is the radio frequency; however, in the case of Li-Fi, the transmission mechanism is carried out by the light spectrum. Seeing as how the Light itself will serve as the data carrier. The light emitted from the solid-state LED that makes up the modulated light is what carries the data. The current photosensitive detector that is a part of the Li-Fi system is the one that demodulates the data once it has been modulated. After that, the data stream produced by the demodulated light frequency signal will be converted into an electronic format. After then, the existing signal will be managed, which means that depending on the circumstances, it will either be quicker or slower, unidirectional or bidirectional.



Figure 3: Li-Fi System with the connecting devices in a room

In this manner, Li-Fi becomes a great opportunity for the Internet due to its capability to send the signal from source to destination in a very high speed mode. The maximum speed on which the Li-Fi can transmit the data is 100 Gbps, and this speed is approximately 14 times faster than the Wi-Fi. Between the setup of the transmitter and receiver when the LED will be switched on then there

will be generated a virtual pipe (imagine). The visual light is too much low that it can directly be detected by the normal human eyes. This light photon carries the data packet and is received to the destination side that is receiver in this case.

#### 4. LI-Architectural FI's Makeup

The following is a list of all of the most important parts of a basic Li-Fi system:

1. The primary light source for the transmission will be a white LED that is capable of producing a high amount of brightness.
2. a photosensitive detector that has the capability of providing a satisfactory response to the receiver for the visible light response.

On the other hand, the transmitter of Li-Fi is made up of four components that are linked to one another:

a Light Bulb, a Radio Frequency Amplifier Circuit, a Printed Circuit Board (PCB), and an Enclosure are the components of this System.

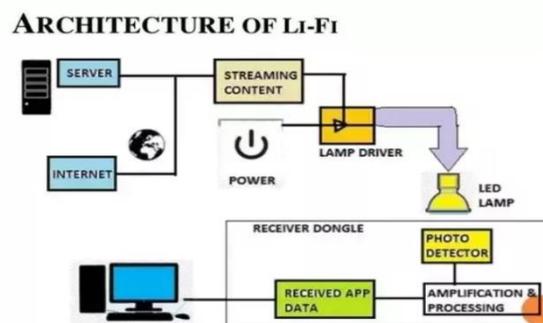


Figure 4: Architecture of Li-Fi

Table 1 showing the comparison between different wireless technology and their transfer speed.  
 Table 2 showing the comparison between Li-Fi and Wi-Fi.

Basis	Wi-Fi	Li-Fi
Spectrum Used	Visible Light	Radio Frequency
Range	Based on Light Intensity (< 10m)	Based on Radio Propagation & interference (<300m)
Data Transfer Rate	Very High (~ 1 Gbps)	Low (~100Mbps- 1 Gbps)
Power Consumption	Low	High
Cost	Low	High
Bandwidth	Unlimited	Limited
Standard	IEEE 802.15.7	IEEE 802.11

Table 1 showing the comparison between different wireless technology and their transfer speed

Technology	Speed
Li-Fi	~1 Gbps

Wi-Fi	~150 Mbps
IrDA	~4 Mbps
Bluetooth	~3 Mbps
NFC	~424 Kbps

Table 2 showing the comparison between Li-Fi and Wi-Fi

**4. Applications of LI- FI**

- Health Technologies: As we know that see, Wi-Fi emits radio waves which are very harmful for the patients and also the radio waves interpreting the actual medical instruments. In that case you can use internet in running rooms by Li-Fi technology.
- Faster Bank Transactions: Li-Fi connections speeds are remarkable, it is nearly 100 times faster than those of Wi-Fi. That kind of remarkable performance could result in quicker bank transactions onboard planes.
- Airlines: In Airlines also Li-Fi offering new applications for passengers, it also brings benefits for pilots. It is much safer than Wi-Fi and does not pose any risk of electromagnetic interference.
- Safety Environments: The use of Li-Fi to pass data will simplify the configuration of data networks in such environments, and can enable new systems to enhance security in these environments.
- Li-Fi uses light instead of radio frequency which cause problems for the human beings.
- Wi-Fi does not work under the water in sea but Li-Fi will work easily.
- Security: Li-Fi provides security benefits to the users, since light does not penetrate through walls.
- Li-Fi may resolve the issues such as the shortage of radio frequencies which comes under the Wi-Fi technology.
- Sensitive Data: There are several areas available where EMI Sensitivity and security of data are the key concern. Li-Fi can enable the better development of secure networked medical instruments, patient records etc.

**5. Advantages of LI-FI**

- Speed: Li-Fi uses Light wave which can carry more information than radio waves used in Wi-Fi technologies. Since the visible light spectrum contains almost 10,000 times longer spectrum occupied by radio waves. This is the reason by which Li-Fi is 100 times faster than Wi-Fi technology.
- Availability: If we use Li-Fi then every source of light can connect you to the internet. In future when the technology is available all over the world, public, street lights, building lights and transportation lighting can all communicate wirelessly and you can access the internet wherever you may be.
- Efficiency: Li-Fi technology is much more efficient than the Wi-Fi because of its high data transmission rate and it also transmit the data parallelly which brings about the expanding efficiency.

- Security: Li-Fi technology provide high amount of security as data communication is line of sight (LOS). It covers very low area by which it avoids unwanted access of Li-Fi signal by unauthorized person.
- Cost: The cost of Li-Fi is well organized due to the use of LEDs. It is much cheaper than the Wi-Fi technology.
- Bandwidth: Li-Fi technology can transfer the data faster than the Wi-Fi technology.
- Li-Fi technology is very much simple and easy to install.
- The Li-Fi devices consume low power for operations and hence used in various IoT applications.

## 6. Limitations of LI-FI

- Range Limitation: Light waves are not able to pass through opaque obstacle such as walls, so they would have range limitations. However, these could be defeated by sensors. These sensors will help to increase the distances.
- It depends upon the light source, if we do not have the light source then we cannot use this technology. This could also limit the locations and situations in which Li-Fi could be used.
- One of the biggest potential drawbacks of using this technology is the interception of signals outdoors. Some other source of light may interfere with the signal like sunlight.
- If you want to use this Li-Fi technology then you have to construct a new infrastructure which increases the cost.
- Li-Fi technology only works on those devices that have a Li-Fi receptor.
- Li-Fi technology uses very high frequency(400-800THZ) which limits it's to very short distance and point to point communication only.

## 7. Future Scope

As we know that light is the infinite source and it can be easily available everywhere. Due to its high speed in the comparison of Wi-Fi it can be accepted as a better source for the high-speed data transmission. In the security concern Li-Fi is highly reliable because there is negligible availability of the loop holes so it is very hard for the hackers and crackers to access the Li-Fi. The future of Li-Fi is as bright as the visible light of its.

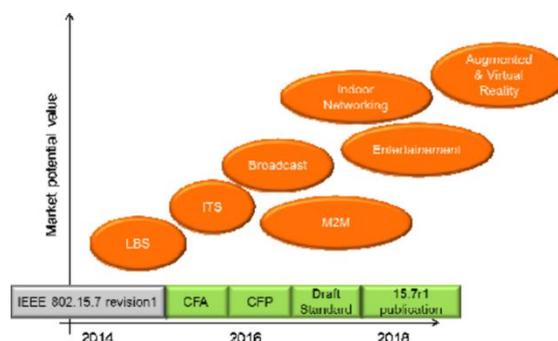


Figure 5: Roadmap of Li-Fi in different years

(Source:[https://www.researchgate.net/publication/284173584\\_Light\\_Fidelity\\_LiFi\\_The\\_new\\_wireless\\_communication\\_system](https://www.researchgate.net/publication/284173584_Light_Fidelity_LiFi_The_new_wireless_communication_system))

## **Conclusion**

Li-Fi technology is still in the developing mode. As this technology is very new in the field of modern science and technology. Li-Fi has little bit similarity with the Wi-Fi. But the key difference between Wi-Fi and Li-fi is the used spectrum. In Wi-Fi Radio Frequency is used and on the other hand, Visible Light spectrum is using in the Li-Fi. According to the better health concern Li-Fi is more suitable for the human being in comparison to the Wi-Fi. As the security concern this technology has the better future scope as well. The implementation of the Li-Fi is not very costly so, according to this statement it is economically the best suitable. But there is also the requirements of more and more development in this technology so that we can transmit the data to the receiver end by switching on the Light.

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