

# Li-Fi – A CHANGE TOWARDS FUTURE

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**ABSTRACT:** As the number of electronic gadget is constantly increasing day-by-day, the demand for wireless data transmission i.e. internet is also increasing rapidly. The slow speed in transmission of data, stealing data from neighbour or competing for bandwidth wherever free internet is available are some of the common traits that are observed these days. Whenever many device access wireless internet, the transmission speed of data reduces considerably. To overcome these problems the solution available is “Data through illumination” or “Visible Light Communication” and the technology is known as “Li-Fi”

Li-Fi can be used as a complementary technology to Wi-Fi as it uses LED light for the transmission of data. Light being the fastest travelling ‘thing’ in the universe ensures the faster transmission of data than Wi-Fi and also light is almost present everywhere ensures uninterrupted communication. The bit-rate achieved by Li-Fi can never be matched by Wi-Fi.

Li-Fi is the transfer of data through light by taking fiber out of fiber optics and sending data through LED light. In this paper we are going to emphasize on various aspects of Li-Fi technology such as its working, its advantages over Wi-Fi, features and applications.

**KEYWORD:** Li-Fi, Wi-Fi, LED, VLC, Radio Frequency waves, light, speed, transmission of data.

## I. INTRODUCTION

Li-Fi stands for “Light Fidelity”. Li-Fi is a Visible Light Communication (VLC) technology developed by a team of scientists including Dr Gordon Povey, Prof. Harald Haas and Dr Mostafa Afgani at the University of Edinburgh. Li-Fi is similar to Wi-Fi as it is bi-directional, high speed and fully networked wireless communication technology. In simple terms Li-Fi can be considered as a light based Wi-Fi as it uses light instead of radio waves for transmission of data. Li-Fi would use transceiver-fitted LED lamps that can light a room as well as transmit and receive information in the form of data. Since simple light bulbs are used, there can technically be any number of access points.

This technology makes use of a segment of electromagnetic spectrum that is not utilised efficiently even today- The Visible Spectrum. Over the years light has played a major role in our life and light doesn't have any significant ill-effects. Moreover a huge amount of space is unoccupied in this spectrum.

The basic ideology behind this technology is that LED light whose intensity varies quicker than the human eye can be used for transmission of data way quicker than the technology available that is Wi-Fi. Encoding of data in the light can be done by varying the rate at which LED flickers ON and OFF, giving strings of 0's and 1's.

The testing of Lifi technology in the labs have achieved a blistering high speeds. Researchers at the Heinrich Hertz Institute in Berlin, Germany, have reached data rates of over 500 Megabytes/seconds by just using a standard white-light LED. The maximum speed that can be obtained in transmission of data for Li-Fi technology is 10 Gbit/s whereas for Wi-Fi it is only about 54Mbit/s.

## II. WORKING OF LIFI TECHNOLOGY

Dull performance of Wi-Fi technology can be overcome with the use of Li-Fi technology. Li-Fi technology typically makes use of white LED bulbs at the downlink transmitter.

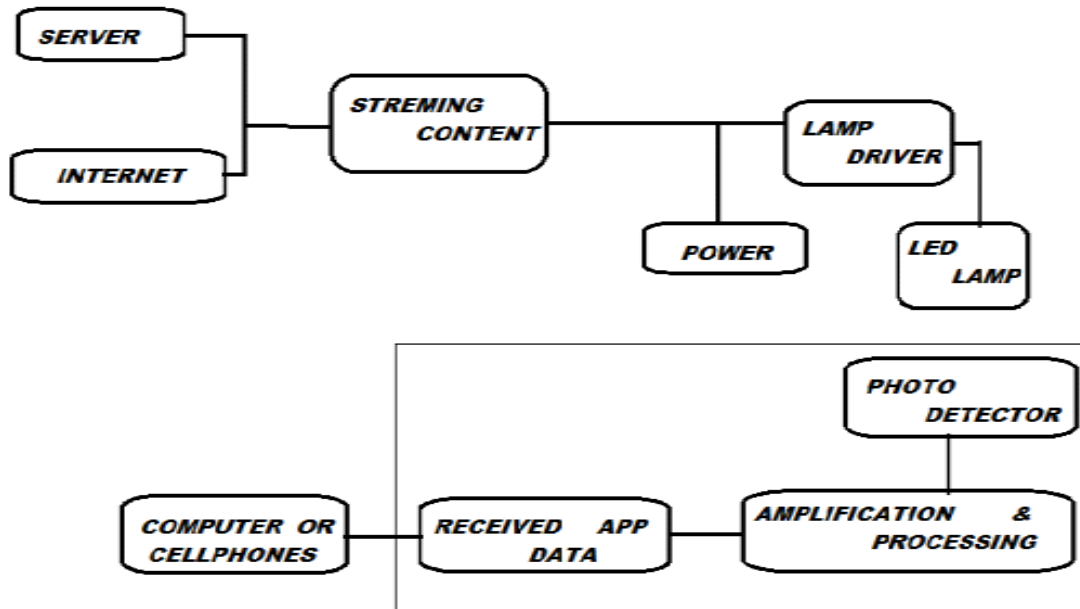


Fig. 1 WORKING OF Li-Fi

A constant current is applied to the LED bulb resulting in emission of photons which is observed as visible light. However, by varying the current, the optical output of very high speed can be achieved. LED being a semi-conductor device, the current and output can be modulated at very high speeds and can be detected using photo-detector device.

The Li-Fi setup is based on this property of optical current. The operational methodology is very simple- in order to transmit a 1, LED bulb has to be switched ON and in order to transmit a 0, LED bulb has to be switched OFF. The LED can be switched ON and OFF at a very speed resulting in formation of array of information that is to be transmitted at a very high speed. Hence, only variation in the rate of LED's flicker has to be done according to the data that we want to encode.

Further enhancements can be made by using lights of different colors to change the frequency of light with each frequency encoding a different data channel.

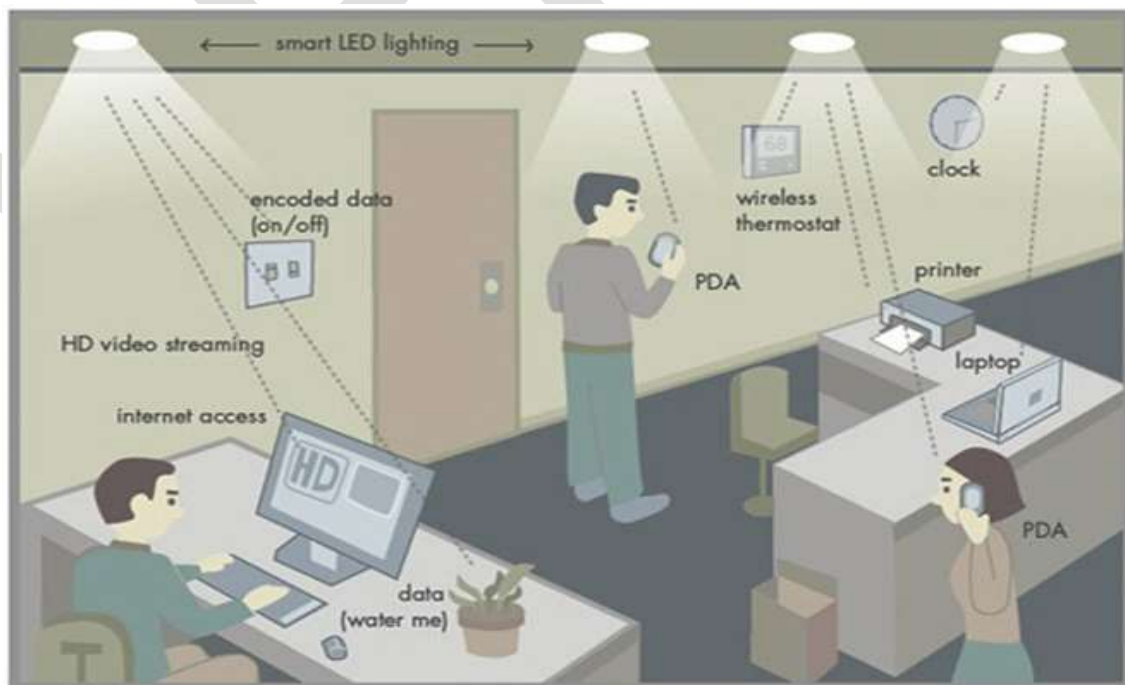


Fig. 2 Li-Fi system connecting devices in a room.

Li-Fi technology makes use of direct modulation techniques similar to those used in low-cost infra-red communications devices such as remote control units whereas Wi-Fi makes use of radio frequency communication which requires radio circuits, antennas and complex receivers.

### III. STANDARDS

Like Wi-Fi, Li-Fi technology also makes use of 802.11 protocols but instead of using radio frequency waves for transmission of data it makes use of Visible Light Communication (VLC) which has a much wider bandwidth. IEEE 802.11 is a set of specifications of Media Access Control (MAC) and Physical Layer (PHY) for setting a Wireless Local Area Network in different frequency bands which includes 2.4, 3.6, 5, and 60 GHz. The MAC layer allows using the link with different layers as with TCP protocol. This standard is capable to transmit data in the form of audio, video and multimedia services at very high speed. It considers various parameters such as optical transmission mobility, its compatibility with artificial lighting present in infrastructures, and the interference which may be generated by ambient lighting.

### IV. COMPARISON BETWEEN Li-Fi AND Wi-Fi

Li-Fi and Wi-Fi can be compared on various parameters which are as follows:

Parameter	Li-Fi	Wi-Fi
Speed	***	***
Range	*	**
Security	***	**
Data Density	***	*
Reliability	**	**
Power Available	***	*
Ecological Impact	*	**
Transmit/Receive power	***	**
Device-to-device connectivity	***	***
Obstacle interference	***	*
Bill of Materials	***	**
Market maturity	*	***

**Table 1: Wifi v/s Lifi based on parameters**

Comparison based on features:

SR. NO	Li -Fi	Wi-Fi
1	Data transmission takes place using bits.	Data transmission takes place using radio waves.
2	Fast speed internet (1- 3.5Gbp0073)	Comparatively slow speed (54-250 Mbps)
3	Range is limited (10 Meters)	Extended range (20-100 meters)
4	The Spectrum range is 10000times than Wi-Fi	It has radio spectrum range
5	It uses Point-To-Point network topology	It uses Point-To-Multi network topology.
6	It uses light as its data transfer medium	It uses radio spectrum as data transfer medium.
7	It is cheaper because free band doesn't need license and it uses light	Expensive because it uses radio spectrum.
8	The frequency band is 100 times of Tera Hz	The frequency band is 2.4GHz.
9	Data density is high	Data Density is comparatively low
10	Lifi is more secured	Comparatively less secured

**Table 2: Wifi v/s Lifi based on features**

### V. APPLICATIONS

With the growing number in the use of LED light, the number of applications increases. Some of the applications are as follows:

- **Medical applications:** Unlike the Wi-Fi technology, Li-Fi technology makes use of LED light, which is not hazardous to the patient in the hospital.
- **Education System:** As the speed for internet access of Li-Fi is greater than Wi-Fi, it can replace it in the educational institutes and companies.
- **Aviation:** Wi-Fi can't be used in aircraft industry as the radio waves could interfere with the navigation system of the aircraft but Li-Fi makes use of light. Therefore, Li-Fi can be used for internet access by the passengers from every light source available such as overhead lights.
- **Underwater communication:** The signal absorption rate is stronger in water making RF use impossible. Also RF waves disturb marine life making use of Wi-Fi difficult but these problems can be overcome by using Li-Fi technology.
- **Toys:** Many toys have LED and these can be used as a mode of communication without any hazardous effect.
- **Applications in Hazardous environments:** Safer alternative is provided by VLC technology in the form of Li-Fi in sensitive areas such as mines, power plants, etc.
- **Smart Lighting:** Any public or private lighting such as street lights can be used for both lighting purpose and as a Li-Fi hotspot for transmission of data.

## VI. ADVANTAGES

Li-Fi technology makes use of light for transmission of data unlike Wi-Fi which uses Radio Frequency waves. So, due to this there are many advantages of Li-Fi over Wi-Fi:

- **Capacity:** The transmission of data is effectively possible as the bandwidth of light is 10000 times greater than the bandwidth of radio waves. Therefore, the capacity of Li-Fi is greater than that of Wi-Fi.
- **Availability:** Light is omni-present, hence, Li-Fi is also present everywhere but for better transmission LED light is necessary.
- **Bandwidth:** The bandwidth of light is 10000 times greater than that of radio waves and unlicensed.
- **Low Cost:** Light is unlicensed and free to use, also a very few components are required making it cheap.
- **Data Density:** One of the drawback of RF waves is that it tends to spread out and cause interference. About 1000 times the data density can be obtained by Li-Fi as light can be contained in a tight illumination area.
- **Security:** Stealing data from neighbour is a common trait observed these days but this problem can be solved using Li-Fi technology as light cannot penetrate through walls.
- **Eco-friendly:** RF waves are hazardous to both human life as well as marine life but light is non-hazardous making the technology eco-friendly.
- **Efficiency:** LED light consumes less energy making it more efficient.

## VII. LIMITATIONS

- If anything comes in the way of propagating light towards receiver, the transmission of data is cut then and there itself.
- The light waves cannot penetrate through walls making the range for transmission smaller.

## VIII. CONCLUSION

With the number of electronic devices increasing every minute, there is a possibility that Li-Fi technology soon becomes reality. On implementation of this technology, every bulb could be then used as a Li-Fi hotspot with better transmission rate of data.

Implementing this technology will have a direct impact on environment making it cleaner and greener as this technology uses light for transmission of data and light does not have any ill-effects on environments unlike Wi-Fi which makes use of RF waves which are hazardous in nature.

Medical applications is one of the brighter side to this technology as Wi-Fi could not be used for such applications. Also with the increase in number of Wi-Fi users the speed for transmission of data has reduced and price for the service has increased. Thus, Li-Fi can overcome all these problems and can be used cheaply and readily.

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