

Li-Fi(Light Fidelity)Technology: Is it a compliment for Wi-Fi(Wireless Fidelity)

Supriya Dinesh

Research Scholar, Electronics and Communication

SRK University,Bhopal, India

ABSTRACT:

The most common form of wireless technology in use today for telecommunications is Wi-F(Wireless Fidelity), which is based on radio signals operating in the range of 2.4 GHz or 5GHz. We all know Wi-Fi uses radio to transmit data wirelessly at very high speed. Every year world needs 60% more wireless data. The space for radio frequency becomes over saturated resulting what is called spectrum crunch. Now imagine the same functionality data transmission but not using radio but using lights. That is LED light around us transmitting Gigabits of data via LED light which is known as Li-Fi(Light Fidelity). Li-Fi or Light Fidelity is a high speed and fully networked, wireless communication technology similar to Wi-Fi which uses light spectrum which can open up 100 times more bandwidth. Li-Fi was first coined by University of Edinburgh Professor Harald Haas during TED talk in 2011.

Keywords:*Li-Fi, Wi-Fi, LED, VLC(Visual Light Communication), Photodetector.*

1. INTRODUCTION

Recent emerging technology and size of smart phones, laptop and other smart devices are leading to increase the interest of common people in wired and wireless communication. Most of the people are connecting through network for data sharing, interaction, communication, knowledge updates, education and social activities. Hence, people are interested to transmit the data swiftly, and efficiently using low cost and bandwidth [1]. Since Wi-Fi is accident to invention in 1992 by Dr. Jhon O'Sullivan but Wi-Fi has made a big revolution in Digital Communication. Wi-Fi can make 60% of internet traffic but there are some challenges faced by Wi-Fi in today's time are[2]:

- Capacity
- Availability
- Efficiency
- Security

So we have to improve technology to solve this problem. So we must use some chip, secure and plentiful amount of data must be transmitted as fast as possible for data transfer. The answer is "LIGHT". Light is perfect because it is a part of the electromagnetic spectrum just like radio waves and has very high frequency that is the light which carries energy much faster than radio waves. The concept of light being used is a medium to transfer data has been coined as "Li-Fi"(Light Fidelity). Now just imagine each and every light around is used for

communication. Only one thing we have to do is we have to replace all incandescent light bulb and fluorescent light bulb by this new technology of LED bulb.



Fig.1 Principle of Li-Fi

LED is a semiconductor and electronic device and it has a very nice and cute property, its intensity can be modulated at very high speed. Light “ON and OFF” is binary code. It is a fundamental principle which is used in this technology. When LED is ON ,we can transmit a digital signal 1 and if the LED is off ,we transmit a digital signal 0. Fig.1 illustrates the idea of data transmission using light. The LED intensity is modulated so rapidly that the human eye cannot notice, so the output appears constant ,also more sophisticated techniques could dramatically increase Li-Fi data rates such as using array of LEDs, where each LED transmits a different data stream, to provide parallel data transmission. Other ideas are using mixtures of red, green and blue LED’s to alter the light frequency encoding a different data channel[4].

1.1 HOW LI-FI WORKS

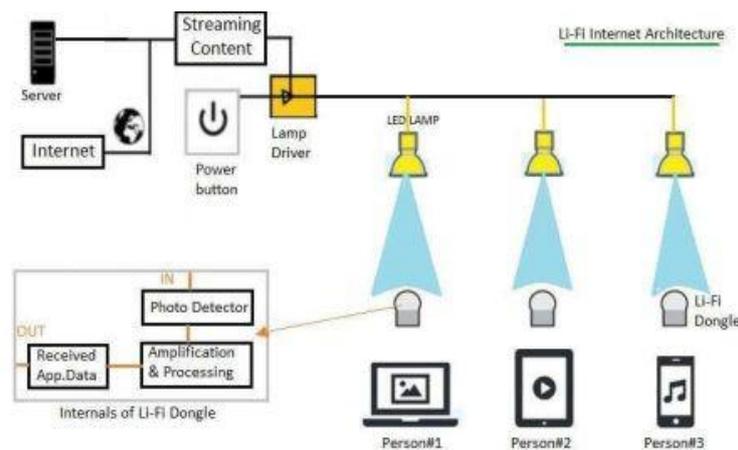


Fig.2 How Li-Fi works. Image source:lifi.ae.

The sources of the light waves used by Li-Fi are LED lamps. As illustrated in Fig.2 ,the digitized content that is to be streamed feeds a lamp driver circuit, which imposes the content on each LED lamp. At the receiving end

of the link, the receptor circuitry consists of a photo detector and circuitry to amplify the signal and convert it into a usable digital stream at each receiving device.

1.2 HOW WI-FI WORKS

Wi-Fi stands for Wireless-Fidelity. It starts with a signal received from the internet, usually by way of a cable modem. As shown in fig.3, internet access is granted to clients via cable, the cable modem connects to a wireless router, and local devices not connected via cable but equipped for Wi-Fi gain internet access via this now ubiquitous gateway. The hotspot device that is connected to the computer or any other device translates the data to be sent into the radio signals. The radio signals are then transmitted into the air through an antenna. On the receiving side, the decoder translates the radio signals back to the data, and thus the information is received. Wi-Fi uses the band of 2.4 GHz to 5.0 GHz for transmission of radio waves.

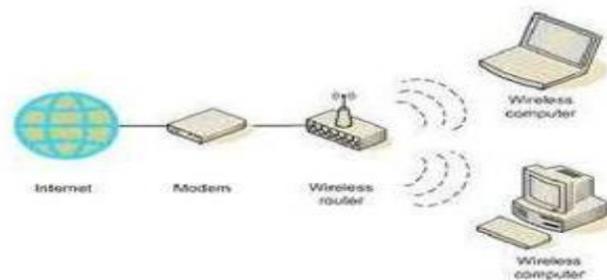


Fig.3 How Wi-Fi works

2. COMPARISON BETWEEN LI-FI AND WI-FI

Thus the table which shows the technology parameters between Li-Fi and Wi-Fi [5].

Table.1 comparison between Li-Fi and Wi-Fi

Features	Light Fidelity	Wireless Fidelity
IEEE Standard	802.15.7	802.11b
System components	Lamp driver, LED bulb and photo detector	Routers and subscriber device stations (laptops, PDAs, desktops)
Technology	IrDA based devices	WLAN 802.11a/b/g/n/ac/ad standard devices
Topology	Point to Point	Point to Multi-point

Data transmission	bits	Radio waves
Frequency	10000 times of Wi-Fi	Radio spectrum range
Frequency band	100 times of Tera Hz	2.4GHz, 4.9GHz and 5GHz
Data transfer speed	1-3.5 Gbps	WLAN-11n offers 150Mbps, WiGig/Giga-IR offers about 1- 2 Gbps
Operation	Data transmission by light of LED bulbs	Data transmission using radio waves with the help of Wi-Fi router
Coverage area	10 meters	20 - 100 meters (WLAN 802.11b/11g), varies based on type of transmission power and antenna
Interference	No interference issues with RF waves	Interfere with neighbour AP Routers
EcologicalImpact	Low	High
Privacy	More secure data transfer	RF cannot be prevented by brick walls and hence less security data transmission.
Data density	High density working environment	Less density environment due to interference issues
Latency	Microseconds	Milliseconds
Market Maturity	Low	High

3. ADVANTGES OF LI-FI

➤ Li-Fi technology is based on the light sources like LED for the transmission of data. With the help of all kind of light we can transfer the data, no matter what the part of the spectrum they belong. That is, the light can belong to the invisible, ultraviolet or the visible part of the spectrum. Also, the speed of the communication is more than sufficient for downloading movies, games, music and all in very less time[8].

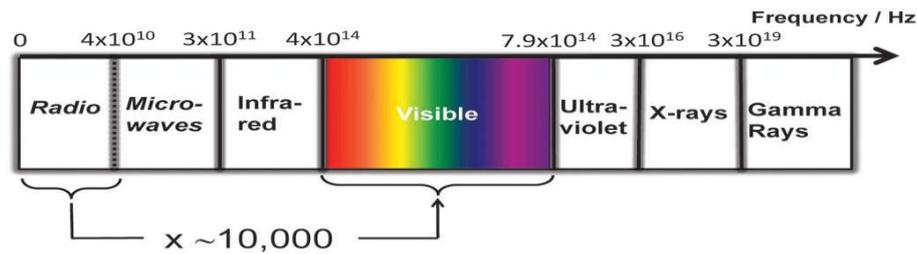


Fig.3 Difference between frequencies of Wi-Fi and Li-Fi is 10,000Hz.

➤ CAPACITY:

Bandwidth: The visible light spectrum is plentiful (10,000 more than RF spectrum), unlicensed and free to use.

Data Density: Li-Fi can achieve about 1000 times the data density of Wi-Fi because visible light can be well contained in a tight illumination area whereas RF tends to spread out and cause interference.

High Speed: Very high data rates can be achieved due to low interference, high device bandwidths and high intensity optical output.

Planning: Capacity planning is simple since there tends to be illumination infrastructure where people wish to communicate, and good signal strength can literally be seen.

➤ EFFICIENCY:

Low Cost: Requires fewer components than radio technology.

Energy: LED illumination is already efficient and the data transmission requires negligible additional power.

Environment: RF transmission and propagation in water is extremely difficult but Li-Fi works well in this environment.

➤ SAFETY:

Safe: Life on earth has evolved through exposure to visible light. There are no known safety or health concerns for this technology.

Non-Hazardous: The transmission of light avoids the use of radio frequencies which can dangerously interfere with electronic circuitry in certain environments.

➤ SECURITY:

Containment: It is difficult to eavesdrop on Li-Fi signals since the signal is confined to a closely illumination area and will not travel through walls.

Control: Data can be directed from one device to another and the user can see where the data is going; there is no need for additional security such as pairing for RF interconnection such as Bluetooth.

4.APPLICATION

➤ **RF Spectrum Relief:** Excess capacity demands of cellular networks can be offloaded to Li-Fi networks where available.

➤ **Smart Lighting:** Any private or public lighting including street lamps can be used to provide Li-Fi hotspots and the same communications and sensor infrastructure can be used to monitor and control lighting and data.

- **Mobile connectivity:** Laptops, Smart phones, Tablets and other devices can interconnect directly using VLC. Short range links give very high data rates and also provides security.
- **Hazardous Environments:** VLC provides a safe alternative to electromagnetic interference from radio frequency communications in environments such as mines and petrochemical plants.
- **Hospitals & Healthcare:** VLC emits no electromagnetic interference and so does not interfere with medical instruments, nor is it interfered with any MRI scanners.
- **Aviation:** Li-Fi can be used to reduce weight and cabling and add flexibility to seating layouts in aircraft passenger cabins where LED lights are already deployed.
- **Underwater Communication:** Due to strong signal absorption in water, RF use is impractical. Acoustic waves have extremely low bandwidth and disturb marine life. Li-Fi provides a solution for short-range communication.
- **Vehicles & Transportation:** LED headlights and tail-lights are being introduced .Street lamps, signage and traffic signals are also moving to LED .This can be used for vehicle-to-vehicle and vehicle-to-roadside communication.
- **Toys:** Many toys incorporate LED lights and these can be used to enable extremely low-cost communication between interactive toys.

5. CHALLENGES OF LI-FI

Apart from many advantages over Wi-Fi technology , it is facing few challenges which is need to overcome.

- For the transmission of data it requires line of sight
- We lose access to the internet , if the light source malfunction . For internet access we become dependent of light source.
- We have to deal with changing weather conditions, if the apparatus is set up outdoors.
- As visible light can't penetrate through brick walls so, it can be easily blocked by somebody simply walking in front of LED source.
- A major challenge is how the receiving device will transmit the data back to transmitter.

6. CONCLUSION

Li-Fi can be thought of as a light based Wi-Fi. That is, it uses light instead of radio waves to transmit information. On implementing this technology its possible to use every bulb as a hotspot, which produces a safer environment. Instead of Wi-Fi modems, Li-fi would use transceiver fitted LED lamps that can light a room as well as transmit and receive information. So the two technologies can be considered complimentary and there is no dark side to using LED lights to supplement Wi-Fi.

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