# Finding an Efficient Network Medium: Wi-Fi or Li-Fi

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*Abstract*— In today's world where wireless technology is dominating the world, new methods are being invented each day to make wireless communication fast and efficient. One of the most popular one is Wi-Fi. It is available in almost every office, college, airport, railway station, restaurants, etc. It provides easy and quick access to internet whenever we are in need.  But along with its easy availability and advantages, there are some disadvantages also. Wi-Fi requires a proper infrastructural setup and consumes more power. Moreover, it makes use of radio waves for data transmission that is harmful to our health. So, to make wireless communication more efficient and overcome disadvantages of Wi-Fi, researchers have introduced new technology called Li-Fi. It uses Light Emitting Diodes as a light source to transmit data, which makes it cheaper and more operative compared to Wi-Fi. Though Li-Fi is not being used commercial yet but in near future it is surely going to hit the wireless communication industry.  In this paper, we are going to study about both Wi-Fi and Li-Fi along with which a detailed comparison between both of these technologies has been done.

*Keywords*— Wi-Fi, Li-Fi, Wireless communication, Visible Light Communication, radio waves, light source.

## I.    INTRODUCTION

Wireless networking is the most trending technology, as our lives are not static these days. We keep on moving from place to place therefore these networks provide us with internet facility on our gadgets (laptops, smart phones, tablets) so that we can use them whenever is the need and communicate when we are not at our places. To do so, we need some source and it is here where wireless communication comes to rescue. Wireless communication means communication without wires i.e. there is no physical infrastructure between two devices that want to communicate. Instead mediums like microwaves, infrared waves and radio waves are used [1]. It is more efficient than wired communication systems as it is fast, productive, has less chances of data loss and is reliable. Due to the flexibility of these networks, they had become a preferred form of communication. The influence of wireless networks is so much that it lead to the increase in number of users which resulted in decrease in data transfer speed.  To overcome this problem, many different technologies were invented depending upon the area or we can say distance between the devices that want to communicate.

Wireless communication gave birth to various technologies like Bluetooth, Satellite communication, Wi-Fi, ZigBee, WiMax, Li-Fi, IR (infrared communication)  and NFC (Near Field Communication) which uses radio frequency, infrared rays or light source for point to point communication [2].  All of these technologies fall under wireless network standard

IEEE (Institute of Electrical and Electronics Engineers) 802.x. Out of these Wi-Fi and Li-Fi are the latest ones. Wi-Fi uses radio frequency and is limited to small area like homes, office, school, colleges, etc Whereas, Li-Fi is an advanced version of Wi-Fi which uses light source as the medium to transfer data. It is limited to area where light can reach.

The paper is organized into following different sections, Section I contains the introduction of the paper, Section II describes Wi-Fi (features, working, advantages and disadvantages), Section III is on Li-Fi (evolution, importance, how it is better than Wi-Fi, working, advantages and disadvantages), Section IV is an important section, here the comparison between Wi-Fi and Li-Fi technology is made on the basis of different features and Section V concludes which technology is better than the other one and why.



*Figure 1: Different devices connected by internet.*

## II. WI-FI: WIRELESS FIDELITY

Wi-Fi stands for "Wireless Fidelity". It is a trade name of Wi-Fi Alliance, which limits the utilization of the term "Wi-Fi certified" only to the items that completes its ability test. Wi-Fi is basically a wireless networking technology that allows devices to use network/internet or communicate in local area. It is based on IEEE standard 802.11. It is a most popular wireless networking technology these days as Wi-Fi is available everywhere we go (school, college, shop, office, hotels). The main equipment required by Wi-Fi is the device which can transmit signals. Wi-Fi enabled devices (computers, smart phones, cameras, printers, etc) can send or receive any data from anywhere by connecting with the base station which should be within the range [3]. The connection between the device and the base station is established with the help of radio waves emitted by the antenna of the base station. The range of these radio waves is usually limited to small area. Wi-Fi uses 2.5 GHz UHF (Ultra High Frequency) and 5 GHz SHF (Super High Frequency) band and works up to 54 Mbps in 20 MHz channel [3].

A router acts as a base station that transmits the internet connection received from the ISP (Internet Service Provider), and provides the internet services to all the devices that are able to receive the wireless signal. Once the connection is made, data can be easily exchanged until the device is within the range. Almost all the devices available today in the market support Wi-Fi. Wi-Fi can also be accessed through Wi-Fi hotspot, which is a feature in phones or computers to share its wireless/wired internet connection with other devices. Wi-Fi facility is not free of cost and it requires internet connection for which we have to pay to the service provider and sometimes there is a cap on the amount of data to be accessed unlike the ones we use in our homes which is unlimited.

Wi-Fi can be easily attacked by anyone who is within its range. So, to protect the information being transferred, a technology known as "Wi-Fi Protected Access" is used.

Advantages of Wi-Fi:
- We can connect to the network wirelessly.
- No costly equipments are required; its deployment is cheaper compared to wired systems.
- More people can be connected to a network at a time, if required, which was difficult in wired as more people means more wired connections.
- Wi-Fi helps to increase the productivity of the employees in the office as they can do their work sitting at any place of their choice.
- Wi-Fi enabled devices like printers, scanners, etc, reduces the menace of wires.

Disadvantages of Wi-Fi:

- As more and more people are connected, the data rate reduces.
- Wi-Fi network is more prone to attack than the normal wired network.
- The range of Wi-Fi network is limited to few hundred meters only.
- The power consumption of Wi-Fi is more as compared to others.
- As Wi-Fi uses radio frequency, it is subjected to interference and propagation effect from outside source.
- Wi-Fi uses radio waves which are said to be dangerous for human health.

## III. LI-FI: LIGHT FIDELITY

Li-Fi stands for "Light Fidelity". It is a latest invention in wireless communication. Li-Fi basically overcomes the flaws of Wi-Fi [4]. It uses visible light in the form of LEDs (Light Emitting Diodes) to transmit data. And unlike Wi-Fi which uses radio waves. Li-Fi uses VLC technology, short form of Visible Light Communication, invented by Prof. Harald Haas at the University of Edinburgh [5] and was introduced in March 2011. VLC requires visible light to transmit data that should be within the range of 400THz-800THz [6]. Li-Fi is based on the concept that the intensity of LED light can be varied. Due to which encoding of the data can be done by varying the rate of LEDs flickering, resulting in binary codes 0s and 1s (OFF and ON). Li-Fi is faster in speed, carries more data and is bidirectional (travels in both directions). Among different wireless communication systems available, Li-Fi is considered as the optical version of Wi-Fi and one of the cheapest and fastest among all [7].

### A. Working of Li-Fi:

The most important components required for Li-Fi are [8]:
- A light source i.e. white LED.
- A light sensor or photo detector.

The data that is to be transmitted is sent to the LED lamp. A visible light is created when a constant current is passed to an LED bulb which emits a constant beam of photons. The intensity of light can be varied by altering the current i.e. the light from LED bulb can be dimed up and down. These photons are then received by the photo detector. In the event that the LED is on, the photo detector stores a binary one (1); else it's a binary zero (0). Flashing a LED multiple times produces a message that has to be transmitted. All the connections (internet, server, LED) to the lamp driver are made using an optical fibre cable [6]. When the photo detector receives the signal from LED, it performs its further operations and processing. It basically converts it into its original digital form [9]. And at the other end data is received by the connected device (PCs, laptops).
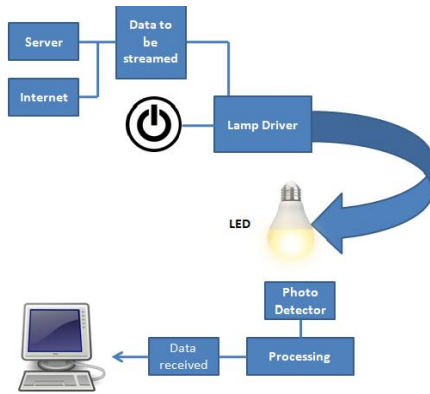
*Figure 2: Working of Li-Fi*

There are also some limitations of using Li-Fi as the transmission of data may halt if something comes in the way of light source. Moreover, the light waves cannot penetrate through opaque medium/wall which limits its range [5].

Advantages of Li-Fi:

- The speed of Li-Fi is higher than that of Wi-Fi.
- Li-Fi is more secure as the data transmitted cannot be intercepted without line of sight vision and it also cannot penetrate through the walls.
- It does not create interference due to electronic items which makes it better to use in hospitals, aircraft, offices or any other place.
- Li-Fi is efficient in terms of cost and energy than any other wireless technology.
- As it uses light source (LED) as a mean of data transmission, which is easily available everywhere. So, Li-Fi can be available anytime and anywhere.
- The Li-Fi setup is easy to install and is not very costly.

- Li-Fi has no harmful affect on the health as it uses optical spectrum instead of radio waves.

Disadvantages of Li-Fi:

- Li-Fi is fully dependent on the availability of light source, so internet cannot be used if light source is not available.
- The range of Li-Fi is limited as light cannot penetrate walls or any barrier.
- It requires a separate infrastructure to be established.
- Li-Fi signals can be interrupted by the sunlight.
- Energy wastage is there as the light source needs to remain ON all the time, if we want to use internet.

## IV.   COMPARISON BETWEEN LI-FI AND WI-FI

Below is the pictorial comparison between Wi-Fi and Li-Fi, followed by the tabular comparison for better understanding of two technologies:
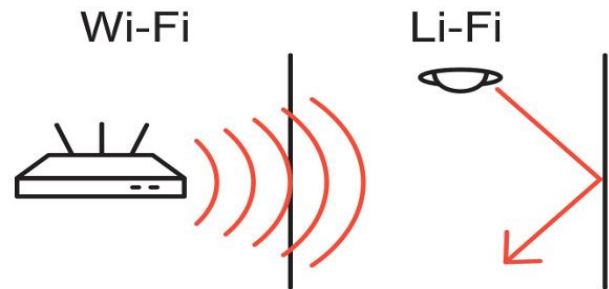


*Figure 3: Range transmission in Wi-Fi and Li-Fi*

*Table 1. Comparison between Wi-Fi and Li-Fi*

| S.no | Features | Wi-Fi | Li-Fi |
|---|---|---|---|
| 1. | Full form | Wireless Fidelity | Light Fidelity |
| 2. | IEEE standard | 802.11b | 802.15.7 |
| 3. | Speed | Slow and uncontrolled | Fast and controlled |
| 4. | Security | It is less secure compared to Li-Fi as radio waves have penetration power so they can be easily intercepted. | It is secured as light cannot penetrate through walls. |
| 5. | Medium for data transfer | Radio waves are used for data transfer. | Visible light is used for data transfer. |
| 6. | Range | The range of Wi-Fi is more than that of Li-Fi, usually 10-100 meters. | Li-Fi's range is shorter, upto 10 meters. |
| 7. | Type of network topology used | Wi-Fi uses point to multipoint topology. | Li-Fi uses point to point topology. |
| 8. | Data transfer rate | Less | More |
| 9. | Cost | Wi-Fi is expensive as radio spectrum is used. | Li-Fi is cheaper because it uses LED and does not require any license. |
| 10. | Range of the spectrum | The range of radio frequency spectrum used by Wi-Fi is less than that of visible light used by Li-Fi. | The spectrum range of Li-Fi is 10000 broader than that of Wi-Fi. |
| 11. | Efficiency | It is less as it consumes large amount of energy, most of which is wasted. | Efficiency is more as LEDs consume less amount of energy. |
| 12. | External interference | Radio waves are affected by any external interference. | No effect of external interference. |
| 13, | Frequency band | The frequency band is about 2.4 GHz (Gigahertz). | About 100 times of THz (Terahertz). |
| 14. | Hardware required | Router and device (laptop, PC, phone) which act as station | LED, photo detector and lamp driver |
| 15. | Capability to travel in sea | Cannot travel through sea water. | Can pass through sea water. |

## V.  CONCLUSION AND FUTURE SCOPE

After studying about both Wi-Fi and Li-Fi technology and their comparison, we observed that though Wi-Fi is widely spread and used almost everywhere. But in comparison to Li-Fi, it is less efficient and requires radio waves for transmission which is not allowed at some places. Whereas, Li-Fi uses light source which is easily available and its infrastructure is also less costly. Its frequency and spectrum is also broader than that of Wi-Fi. According to the researchers from University of Oxford, recently they have succeeded in achieving a bi-directional speed of 224 Gbps, which will allow downloading approximately 18 movies in a second. These speeds are much more than that offered by modern Wi-Fi [10].

Therefore, we concluded that Li-Fi promises a bright future in the upcoming generation of wireless communication as compared to Wi-Fi [11]. And it is also an appropriate solution to manage heavy traffic which is going to be a problem in near future due to increasing demand of wireless communication [12].

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