

Exploration and Supremacy of Li-Fi over Wi-Fi

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Abstract: To accomplish the work, the need of internet either through wired or wireless network is increasing nowadays. While using wireless network i.e. Wi-Fi, many issues are arising related to speed due to which the speed of transmitting data goes relatively slow as many devices gets connected. To remedy this, Harald Hass invented technology named Li-Fi which he terms as- Data through Illumination, where the data is transferred through an LED bulb which is 1000 times faster than Wi-Fi. This technology has now become the part of VLC as this technology is performed by using white LED light bulbs.

Keywords: Li-Fi (Light Fidelity), LED (Light Emitting Diode), Wi-Fi (Wireless Fidelity), VLC (Visible Light Communication).

1. INTRODUCTION

One of the most important activities in the current time of this fast moving world is transfer of data and information. As we need faster transfer of data, we can't avoid Wi-Fi in today's world. Though Wi-Fi is providing benefit by giving access to many devices and transferring the data at a high speed, it also turns up as a drawback of it. As the various types of devices such as Ipads, computers and many more are frequently increasing day by day, the limited bandwidth leads to the reduction in the speed of the data transfer. So to overcome this problem Li-Fi technology was introduced by **Harold Hass** to transfer the data at a high speed using VLC(Visible Light Communication). Well to simplify it more clearly, this technology can be thought of as a light based Wi-Fi. No one would have ever imagined that this invention will be used not only to illuminate the houses but also to transmit the data at a high speed.



Figure 1. Li-Fi Bulb [1]

2. Li-Fi DESIGN

The architecture of Li-Fi consists of many LED lights, bulbs and lamps with many wireless devices such as cell phones, idea-pad and other devices supporting internet on it. Important constituents that need to be considered while the designing of Li-Fi are as follows: [2]

- a) Presence of light
- b) Line of Sight (LoS)
- c) Fluorescent light and LED can be used for better performance
- d) Photo detector

As shown in the below figure, the flow of content must be properly incorporated with server and internet network, so that it is easily possible to work effectively.

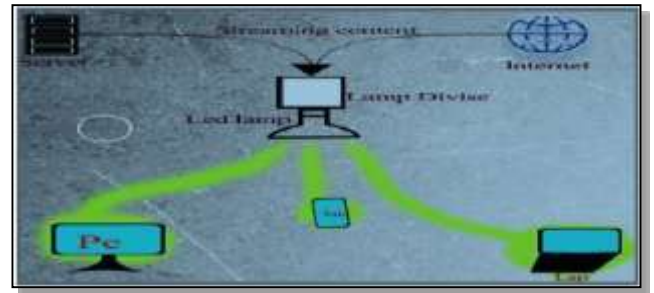


Figure 2. Architecture of Li-Fi[2]

3. WORKING OF Li-Fi

Before describing about the working of Li-Fi, we need to know the requirement of Li-Fi. Dynamically as the lifestyle is developing in respect to the time, the need of using the internet is also increasing. As the usage is incrementing day-by-day, the performance of Wi-Fi is degrading as many types of devices gets connected at a time which reduces the speed and power of it. To surmount this problem, Li-Fi technology was introduced which is basically implemented using LED lights. It renders logic that if LED is on then it transmits a digital signal 1 and if LED is off then it transmits a digital signal 0. The large bright LED lights can be switched off and on very rapidly or say quickly which gives nice opportunities for transmission of data through light [3].

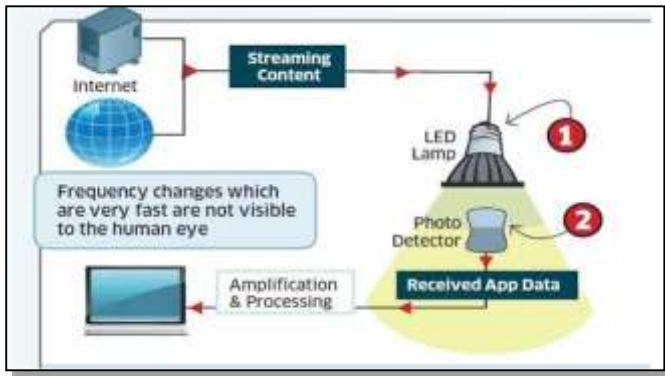


Figure 3. Working of Li-Fi [4]

Therefore all that is required is some LED lights and a controller that code the data into those LEDs [2]. The information encoding is possible in lights by monitoring and identifying the rate variance which all depends on the flickering of LEDs i.e. on and off to code the data accordingly which will pass binary strings i.e. 0s and 1s [5]. On one corner there will be a light emitter i.e. the LED and a photo detector i.e. a light sensor that converts light into current on the other end. The photo detector senses the light and converts the light into current by registering 1 when the LED is on and 0 when the LED is off. The intensity of LED is so high which when regulated gets impossible for a human eye to detect. As it is undetectable by a human eye it seems to be constant. These light waves gets undetectable as the light emitting diodes can be switched off and on very quickly which causes the light source to appear in a continuous state even though being in the flickering state. VLC (Visible Light Communication) is the method used for transmitting the information by using rapid pulses of light [6].

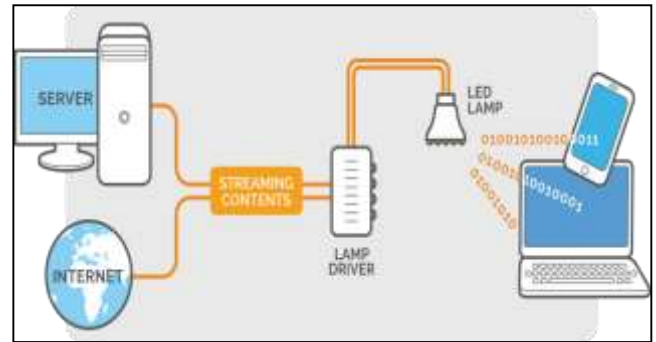


Figure 4. Working of Li-Fi [7]

o VLC (Visible Light Communication)

VLC is the wireless technology for next generation that uses light emitting diodes (LEDs) that offers multiple roles of illumination as well as data transmission. Usage of fast pulses of light is there which helps in transmitting information wirelessly. Data like audio, video and other types of data can be transmitted at a high speed using LED lights. It can be said as a data communication medium that uses visible light between 400 THz (780 nm) and 800 THz (375 nm) that act as an optical carrier for data transmission and illumination. The use of fast pulses of light helps in transmitting information wirelessly. [8], [9]

The major constituents of VLC are firstly the LEDs that is an essential element to be used and secondly the photodiode i.e. the photo detector that senses light and converts the light into current which helps in transferring the information with more accuracy. To define it more clearly, by regulating the data signals in the form of lights, the LED bulbs can be referred to as a communication source. The bandwidth is comparatively 1000 times more in size which makes it easy in transmission of data with different data channels at high speed. Adding up an advantage that these visible lights are not harmful to vision which is therefore a necessary part of the infrastructure and is easily available and accessible[9].

Therefore LED lights are preferred in working with Visible Light Communication (VLC).



Figure 5. Photo Detector (sensor) [10]

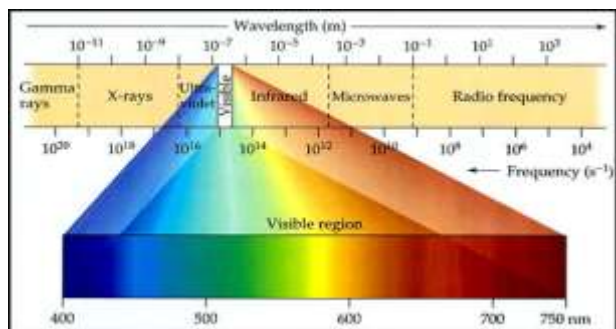


Figure 5. Visible Light Spectrum [14]

4. ADVANTAGES OF Li-Fi

Li-Fi technology is basically based upon LED lights for the transmission of data through illumination effectively and efficiently. Any kind of information like movies, games, images and many more can be downloaded in a very less time. By providing benefits for this technology, the justification of the superiority of Li-Fi over Wi-Fi is defined below:[11]

a. CAPACITY

The bandwidth of light is 1000 times wider than the radio waves bandwidth which enables the transfer of data effectively.

b. EFFICIENCY

Efficiency in terms of light refers to the minimum utilization of energy consumed by LED lights which is also cheaper and efficient.

c. AVAILABILITY

Presence of light means Li-Fi is available but for more efficiency in this technology if LED bulbs will be set then there will be proper transmission of data.

d. SECURITY

Unlike Wi-Fi, light waves cannot get across through walls so no worries of getting misused.

e. BANDWIDTH

The vast bandwidth provides easy transmission of data and as the visible light is license free it is free to use.

f. LOW COST

As this technology consists of very few components so it is cheaper comparatively.

g. FREQUENCY

Radio waves have lower frequency i.e. longer wavelengths due to which it consumes a lot more time when multiple devices get connected

to it whereas light waves with higher frequency and shorter.

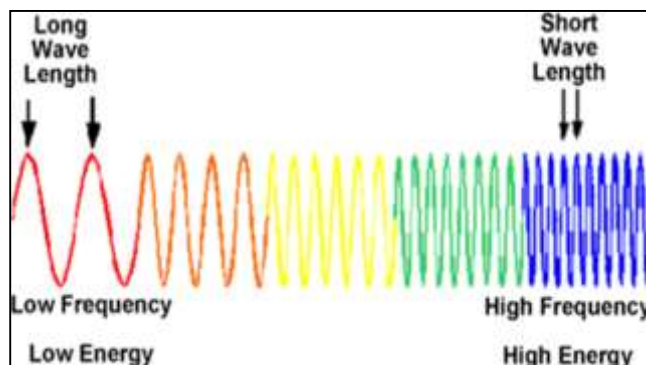


Figure 6: Relation between Wavelength and Frequency [15]

5. LIMITATION OF Li-Fi

- The major drawback of this technology is that the waves can't pass through objects or penetrate through walls which results in data loss while transmission of data. If the receiver is unknowingly blocked anywhere then the signal gets immediately cut off.
- Another major cause regarding reliability and network in the path of transmission is the interruption of external sources that maybe sunlight, normal bulbs or any interruption. This interference causes disturbance in the communication as Li-Fi works on direct line of sight.
- Harald Hass says that the need of Wi-Fi is still required as light bulbs can't be available everywhere. We can't have a light bulb that renders high speed data to the moving object or provide data in any remote area that have many obstacles like walls, huts and so on.[3]

6. COMPARISON BETWEEN Li-Fi and Wi-Fi

As the problem defined above that due to the heavy traffic and connection of many devices only to a single router the speed of Wi-Fi degrades. To justify the need of Li-Fi, a comparison is below with some base points to distinguish: [12, 13]

a) Capacity

The data is transmitted through radio waves having a limited bandwidth which is also highly expensive. With this fast moving world the new technologies are developing like 3G,4G due to which we are running out of spectrum.

Whereas in comparison with radio waves bandwidth, the light waves bandwidth are 1000 times wider than it which provides a broader spectrum for data transmission.

b) Congestion

As more and more devices gets involve for data transmission through Wi-Fi, the complication increases and therefore it results in the degradation of speed which shows dull performance of this technology. But talking about Li-Fi , as there is direct line of sight the availability of LED light is everywhere so there is no problem in the number of devices getting connected.

c) Security

Wi-Fi uses radio waves which can pass through any object. These waves can be intercepted and can be used which is a security issue whereas Li-Fi doesn't offer this opportunity to the intruder as the light waves cannot penetrate through objects.

d) Availability

Due to the radio waves that are used in Wi-Fi, the cell phones are restricted in some areas like aircraft and petrol pumps whereas there are no such restrictions with the light waves. It is available in any area.

e) Speed

According to the standard 802.11a, Wi-Fi provides communication rate of 54mbps which can be extended with the available techniques up to 1gbps.

While Prof.Harald Hass has already exhibited 3gbps on a single colour. The speed can be extended upto 9gbps if there will be full colour i.e. RGB on a single LED. These LED lights offer a lot more potential for wireless connectivity.

7. AREAS WHERE Li-Fi IS A NEED

Li-Fi technology can be implemented in those areas where it is a need. The areas where the radio waves are restricted as it is harmful to humans and those areas where radio waves doesn't work because it creates hazardous impact, light waves can be a superman in those areas. Pointing out some areas where this technology is a necessity: [3]

1. Petrol pumps and petrochemical plants : Radio waves are strictly restricted
2. Education system: For high speed so that multiple devices can access it at a time.
3. Aircraft : Radio waves doesn't work here

4. Underwater applications for military operations: For secret operations to be carried out with no fear of getting snapped.
5. Street lamps : For free access
6. Hospitals: For medical purpose as radiation can be dangerous to the patients.
7. Traffic System: To control traffic.

8. FUTURE AND FURTHER ADVANCEMENT

Though the speed offered is 3gbps on a single LED with a single colour, but future enhancement can be made in the speed by using full colour i.e. the mixture of red, blue and green in a single LED or different LEDs with different colour which will provide a variance in light's frequency. Along with it, the mixture of RGB will give the opportunity to alter the frequency of light with each frequency encoding a different data channel. Moreover, an array of LED lights can be used for parallel transmission of information which will result in rapid transmission with less or no traffic because of its extreme high speed [9]. Adding up more yes we are ready for Li-Fi as all the constituents are available and all the procedure just it has to be put together and needs to be implemented. Li-Fi is the future technology for next generation.



Figure 7. Multicolour LED bulbs [16]

9. CONCLUSION

With the rapid increase in technologies and development of new devices that require connectivity is in the need of high speed with efficiency and effectiveness which Wi-Fi technology's sluggish performance is making it down. Li-Fi technology appears as an alternate solution to the problems faced with radio waves by providing higher frequency, high speed and proper transmission of data with security. It can't be said as a replacement of Wi-Fi technology as need of Wi-Fi is still there but the areas where Wi-Fi is not supported, this new technology will overcome those limitations and will act as a dissolvent to it.

10. REFERENCES

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