

Research Paper on Li-Fi

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1. ABSTRACT

Li-Fi stands for Light-Fidelity. Li-Fi is a Visible Light Communications (VLC) system that runs wireless communications that travel at terribly high speeds. With Li-Fi, our light-weight bulb is basically our router. It uses common household light-emitting diode(LED) light-weight bulbs to change knowledge transfer, jactitation speeds far better than Wi-Fi. In this paper, we'll discuss the technology in more detail and also how Li-Fi is much higher than Wi-Fi. Wi-Fi is helpful for general wireless coverage inside buildings whereas Li-Fi is ideal for high density wireless data coverage in restricted areas where there are no obstacles (barrier). Li-Fi provides higher information measure, efficiency, handiness and security than Wi-Fi and has already achieved high speeds within the science laboratory. By investment the affordable nature of LEDs and lighting units, there are legion opportunities to take advantage of this medium. Li-Fi is that the transfer {of knowledge|of knowledge|of information} through light-weight by taking fiber out of fiber optics and causation data through light-emitting diode light-weight bulb.

2. INTRODUCTION

Technology never stops to amaze US. Sometimes, it even appears capable of acting magic actions. Since the beginnings of the web, connections haven't stopped up,

driven by ever- increasing demand. The globe is hungry for additional knowledge, additional affiliation, additional intelligence, more speed.



Fig 1: Li-Fi System

What happens is that current technologies have their limits, and thus new solutions are sound powerfully at the door from time to time. these days we have a tendency to board a Wi-Fi world. Some highly regarded terminals, like mobile phones, furthermore as several different devices, use today's wireless networks to supply all types of services over the web. What happens is that even such a good technology has its limitations. Li-Fi (or light-weight Fidelity) technology is one in every of the choices planned as a replacement sort of knowledge transmission. The term Li-Fi was coined by University of capital prof Harald Haas throughout a plug-ugly speak in 2011. Haas pictured light-weight bulbs that would act as wireless routers. later, in 2012 once four years of analysis, Haas came upon company pureLiFi with

the aim 'to be the globe leader in actinicray Communications technology'.



Fig 2: Using Li-Fi system

3. A BRIEF INTRODUCTION

3.1 How Li-Fi works?

Li-Fi uses light from LEDs, instead of radio waves as in the case of Wi-Fi, to send information in the form of binary data. This binary data is received by the receiver equipped with decoder that decrypts the data and triggers actions in your smart device.

Li-Fi uses light from light-emitting diodes as a medium to deliver networked, mobile, high-speed communication. Data is transmitted by modulating the intensity of the light at nanosecond intervals which is too quick to be detected by the human eye. This data is then received by a photosensitive detector. Thereafter, the light signal is demodulated into electronic form.

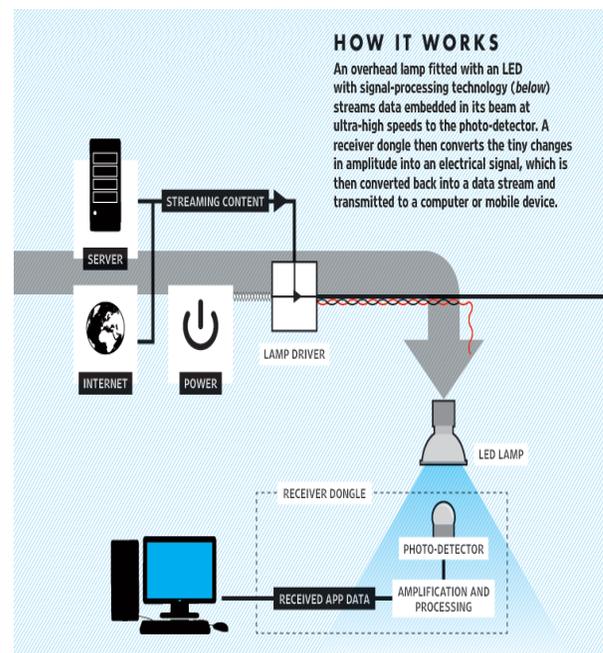


Fig 3: Working of Li-Fi

3.2 What hardware does Li-Fi require to function?

Li-Fi requires three basic hardware devices to function. These include:

- i] an LED lighting system
- ii] a router (which can be installed along with the lighting system)
- iii] a receiver equipped with decoder (in order to decrypt the light signal)

3.3 Why Visible Light Communication?

The frequency spectrum that is available to us in the atmosphere consists of many wave regions like X-rays, gamma rays, u-v region, infrared region, visible light rays, radio waves, etc. Any one of the above waves can be used in the upcoming communication technologies but why the Visible Light part is chosen? The reason behind this is the easy availability and lesser harmful effects that occur due to these rays of light. VLC uses the visible light between 400 THz (780nm) and 800 THz (375 nm) as medium which are less dangerous for high-power applications and also humans can easily perceive it and protect themselves from the harmful effects whereas the other wave regions have following disadvantages:-

3.3.1 Radio waves are expensive (due to spectrum charges) and less secure (due to interference and possible interception etc.)

3.3.2 Gamma rays are harmful because it could be dangerous dealing with it, by the human beings due to their proven adverse effects on human health.

3.3.3 X-rays have health issues, similar to the Gamma Rays.

3.3.4 Ultraviolet light can be considered for communication technology purposes at place without people, otherwise they can also be dangerous for the human body when exposed continuously.

3.3.5 Infrared, due to high safety regulation, can only be used with low power.

Hence the Visible light portion (from red to blue) of the electromagnetic spectrum does not cause any harm to the people as visible rays are safe to use, provide larger bandwidth and also have a promising future in the communication field.

4. COMPARISON BETWEEN Li-Fi, AND Wi-Fi AND OTHER RADIO

COMMUNICATION TECHNOLOGIES

Both Wi-Fi and Li-Fi can provide wireless Internet access to users, and both the technologies transmit data over electromagnetic spectrum. Li-Fi is a visible light communication technology useful to obtain high speed wireless communication. The difference is: Wi-Fi technology uses radio waves for transmission, whereas Li-Fi uses light waves. Wi-Fi works well for general wireless coverage within building/campus/compound, and Li-Fi is ideal for high density wireless data coverage inside a restricted area or room and is free from interference issues unlike the Wi-Fi.

Technology	Speed
Li-Fi	~1 GBPS
Wi-Fi – IEEE 802.11n	~150 Mbps
IrDA	~4 Mbps
Bluetooth	~3 Mbps
NFC	~424 Kbps

Table 1: Comparison between speeds of different technologies

Parameters	Li-Fi	Wi-Fi
Spectrum Used	Visible Light	RF
Standard	IEEE 802.15.7	IEEE 802.11
Range	Based on Light Intensity (< 10m)	Based on Radio propagation & interference (< 300 m)
Data Transfer Rate	>1 GBPS	800 Kbps-11 Mbps

Power Consumption	Low	Medium
Cost	Medium	High
Security	Medium	High
Transmitter	LED	Antenna
Receiver	LED	Antenna
Efficiency	More, LEDs consume less energy and highly efficient	Less, Radio Base Stations consume high amount of energy
Availability	Anywhere, available in airplanes and underwater	Limited
Secure	More secure because light waves cannot penetrate through walls and cannot be intercept by anyone outside the illumination of LED	Less secure because of high penetrating power of radio waves, anyone can intercept
Network topology	Point-to-point	Point-to-multipoint

Table 2: Comparison between Li-Fi and Wi-Fi

4.1 Shortcomings of Radio Waves

The following square measure the essential problems with radio waves:

4.1.1 Capacity

Wireless data is transmitted through radio waves which are limited and expensive. It has a limited bandwidth, in relation to Li-Fi. With the rapidly growing world and development of technologies like 3G, 4G and so on we are running out of radio spectrum.

4.1.2 Energy Efficiency

There are a large number of cellular radio base stations that consume huge amount of energy. Most of the energy is used for cooling down the base station instead of transmission. Therefore, efficiency of such Radio base stations is very low.

4.1.3 Availability

Availability of radio waves is a big concern. Further, Radio waves are not advisable to be used in aeroplanes and at places where radio interference may cause undesirable/catastrophic result.

4.1.4 Security

Radio waves will penetrate through walls. they'll be intercepted. If somebody has data and dangerous intentions, they will misuse it. This causes a serious security concern for Wi-Fi.

4.2 Benefits of Li-Fi

Li-Fi, which uses visible light to transmit signals wirelessly, is an emerging technology assured to compete with Wi-Fi. Also, Li-Fi removes the limitations that have been put on the user by the Radio wave transmission such as Wi-Fi as explained above 4.1. Benefits of Li-Fi technology include:

4.2.1 Efficiency

Energy consumption can be minimized with the use of LED brightness which are already available in the home, offices and Mall etc. for lighting purpose. Hence, the transmission of data requiring negligible additional power, which makes it very efficient in terms of costs as well as energy.

4.2.2 High speed

Combination of low interference, high bandwidths and high-intensity output, help Li-Fi provide high data rates i.e. 1 GBPS or even beyond.

4.2.3 Availability

Availability is not an issue as light sources are present everywhere.

Wherever there is a light source, there can be Internet. Light bulbs are present everywhere – in homes, offices, shops, malls and even planes, which can be used as a medium for the data transmission.

4.2.4 Cheaper

Li-Fi not only requires fewer components for its working, but also uses only a negligible additional power for the data transmission.

4.2.5 Security

One main advantage of Li-Fi is security. Since light cannot pass through opaque structures, Li-Fi internet is available only to the users within a confined area and cannot be intercepted and misused, outside the area under operation.

Li-Fi technology has a great scope in future. The extensive growth in the use of LEDs for illumination indeed provides the opportunity to integrate the technology into a excess of environments and applications.

5. CHALLENGES

The challenge in Li-Fi is predicated on purpose that has been mentioned in literature and therefore the infrastructure that already out there. as well as the important users of Li-Fi technology is a way to response.

5.1. Modulation

The key of Li-Fi communication is the using of modulation. A modulation in Li-Fi is to carry a binary data by turning the LED on and off quickly. There are many aspects in Li-Fi related to modulation, illumination and dimming scheme is the first concern. Illumination is the spread of the light that making the LEDs can be as a media in data communication. The challenge is how the modulation is enabling the illumination of LEDs in order can send the data while the illumination

is low. While the dimming process is to proportional of LEDs brightness. The challenge in dimming technology is how the Li-Fi can fulfill the user satisfaction in order the dimming of LED can stay safe for the user

5.2. Interference

In optical illumination based on data communication, the hard part is to provide the optical uplink service. It is because the uplink service can interfere the downlink signal. These problem is one of the challenge in the interference signal issue. In Li-Fi, the transmitter should be able to maintain a directional link during the transmission.

5.3. Infrastructure

The basic infrastructure in Li-Fi is indoor and outdoor. Same as in the optical characteristic, a Li-Fi also has an effect shadowing while transmission. This shadowing effect off course will give an effect in the process of sending and receiving the data.

5.4. Security

According to a threat like eavesdropping will happen in Li-Fi. It happens once there's gap between the ground and therefore the door, the sunshine might unfolded between them. The crack from within floor and secure windows can also be a discharge.

5.5. Coverage

Li-Fi is a technology that has a good perform in an indoor infrastructure while it's not happen in the outdoor area. The coverage in outdoor area for Li-Fi needs to be set up in order the quality of connection

can give a good performance. According to, Li-Fi is integrated with the Wi-Fi to get a good performance in an outdoor or in a mobile infrastructure.

Ideally, at night when we don't require lights, then it might seems impossible to use the Li-Fi technology.

6. APPLICATIONS OF LI-FI

There are numerous applications of Li-Fi technology, from public Internet access through

existing lighting (LED) to auto-piloted cars that communicate through their headlights (LED based). Applications of Li-Fi can extend in areas where the Wi-Fi technology lacks its presence like aircrafts and hospitals (operation theatres), power plants and various other areas, where electromagnetic (Radio) interference is of great concern for safety and security of equipments and people. Since Li-Fi uses just the light, it can be used safely in such locations or areas. In future with the Li-Fi enhancement all the street lamps can be transformed to Li-Fi connecting points to transfer data. As a result of it, it will be possible to access internet at any public place and street.

Some of the future applications of Li-Fi could be as follows:

6.1 Education systems

Li-Fi is the latest technology that can provide fastest speed for Internet access. So, it can augment/replace Wi-Fi at educational institutions and at companies so that the people there can make use of Li-Fi with the high speed.

6.2 Medical Applications

Operation theatres (OTs) do not allow Wi-Fi due to radiation concerns. Usage of Wi-Fi at hospitals interferes/blocks the signals for monitoring equipments. So, it may have hazardous effect to the patient's health, due to improper working of medical apparatus. To overcome this and to make OT tech savvy Li-Fi can be used to access internet and also to control medical equipments. This will be beneficial for conducting robotic surgeries and other automated procedures.

6.3 Aircrafts applications

The passengers travelling in aircrafts get access to low speed Internet that too at a very high price. Also, Wi-Fi is not used because it may interfere with the navigational systems of the pilots. In aircrafts Li-Fi can be used for data transmission. Li-Fi can easily provide high speed Internet via every light source such as overhead reading bulb, etc. present inside the airplane.

6.4 Underwater applications

Underwater ROVs (Remotely Operated Vehicles) operate from large cables that supply their power

and allow them to receive signals from their pilots above. But the tether used in ROVs is not long enough to allow them to explore larger areas. If their wires were replaced with light --- say from a submerged, high powered Lamp --- then they would be much freer to explore. They could also use their headlamps to communicate with each other, processing data autonomously and sending their findings periodically back to the surface. Li-Fi can even work underwater where Wi-Fi fails completely, thereby throwing open endless opportunities for military underwater operations.

6.5 Disaster management

Li-Fi can be used as a powerful means of communication in times of disaster such as earthquake or hurricanes. The average people may not know the protocols during such disasters. Subway stations and tunnels, common dead zones for most emergency communications, pose no obstruction for Li-Fi.

6.6 Applications in sensitive areas

Power plants need fast, inter-connected data systems so that demand, grid integrity and core temperature (in case of nuclear power plants) can be monitored. The Radio communication interference is considered to be bad for such sensitive areas surrounding these power plants. Li-Fi can offer safe, abundant connectivity for all areas of these sensitive locations. Also, the pressure on a power plant's own reserves (power consumption for Radio communications deployments) will be lessened.

6.7 Traffic management

In traffic signals Li-Fi can be used to communicate with passing vehicles (through the LED lights of the cars etc) which can help in managing the traffic in a better manner resulting into smooth flow of traffic and reduction in accident

numbers. Also, LED car lights can alert drivers when other vehicles are too close.

6.8 Mobile Connectivity

Mobiles, laptops, tablets, and other smart phones can easily connect with each other. The short-

range network of Li-Fi can yield exceptionally high data rates and higher security.

6.9 Replacement for other technologies

Li-Fi does not work using radio waves. So, it can be easily used in the places where Bluetooth, infrared, Wi-Fi, etc. are banned.

7. INVESTMENT IN Li-Fi

In November 2014, Li-Fi introducer pureLiFi joined forces with French lighting company Lucibel to launch Li-Fi-enabled products.

PureLiFi has a few products on the market: a Li-Fi ceiling unit to connect to an LED light fixture and Li-Fi-XC which is for connecting to a device via USB or as part of the hardware, providing about 43Mbps from each LiFi-enabled LED light. Plus, with faster connectivity and data transmission it's an interesting space for businesses. The integration of internet of things devices and Li-Fi will provide a wealth of opportunities for retailers and other businesses alike. For example, shop owners could transmit data to multiple customers' phones quickly, securely and remotely.

Popular Netherland's brand company Philips has also entered to invest in Li-Fi, now offering full and integrated Li-Fi services including LED products and Li-Fi. In 2016, it was reported that Li-Fi was being tested in Dubai, by UAE-based telecommunications provider Du and Zro1. Du claimed to have successfully provided internet, audio and video streaming over a Li-Fi connection.

In addition, reports suggested that Apple may build future iPhones with Li-Fi capabilities.

Department of Energy and the National Science Foundation has released three Li-Fi products- a desk light, USB stick and LED panel.

8. PUBLIC SURVEY

8.1 Questionnaire

- Are you aware of Li-Fi technology?
- As we know, Wi-Fi uses radio waves for communication; would you like to replace Wi-Fi with Li-Fi?

- Which technology will you adopt when it comes to fast processing and data security?
- As an organization, which technology would you like to adopt?
- Do you think Li-Fi can be a good replacement of Wi-Fi at home, colleges, workplaces in future?

8.2 Results

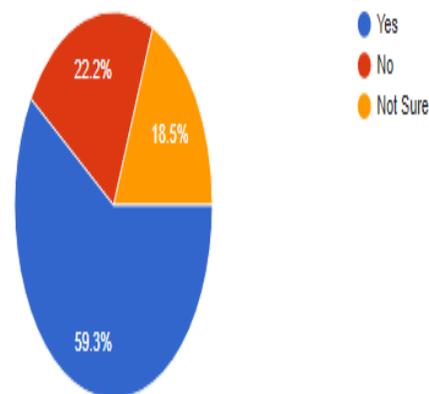
When people were asked about Li-Fi, whether they are aware or not about Li-Fi?

Majority people were aware about Li-Fi technology. Some were unaware about this technology and also some of them were unsure about this.

Below pie chart shows the awareness of Li-Fi.

Are you aware of Li-Fi Technology?

54 responses

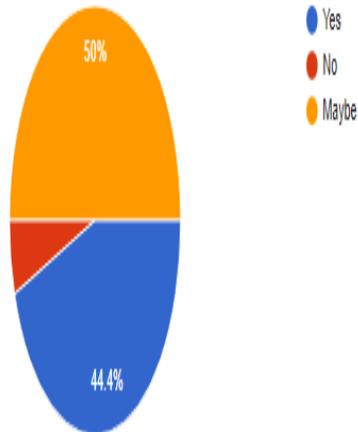


Secondly, people were asked about replacement of Wi-Fi with this new Technology. Then, responses was half of the surveyed people were not sure about this. Some people told it can be replaced and also some people given a response as can't replace.

Given pie chart shows the responses.

As we know, Wi-Fi uses radio waves for communication; would you like to replace Wi-Fi with Li-Fi?

54 responses



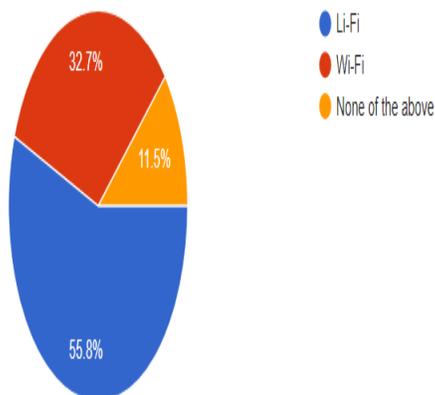
As, Li-Fi can process more data than Wi-Fi and also is better in security purpose; So, third question for survey was which technology will you adopt when it comes to fast processing and data security?

Majority people shown their interest towards Li-Fi technology. Some were interested in Wi-Fi technology and some individuals were neither interested in Wi-Fi nor Li-Fi.

Given pie chart shows the responses.

Which technology will you adopt when it comes to fast processing and data security?

52 responses



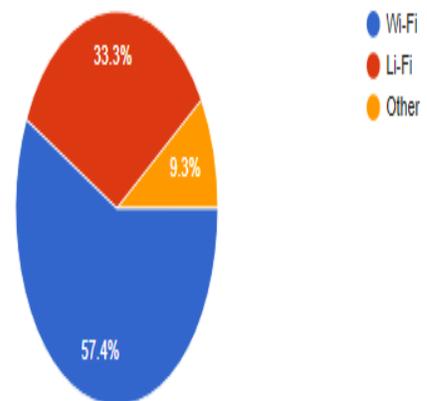
Next, people were asked about whether they want to adopt Li-Fi or Wi-Fi from organizational point of view?

So, the response was more than 50% people was not willing to use Li-Fi. People feels Wi-Fi as a good option from organizational point of view. Also, few people were willing to use some other type of technology instead of Li-Fi and Wi-Fi.

Below pie graph depicts the responses;

As a organization, which technology would you like to adopt?

54 responses



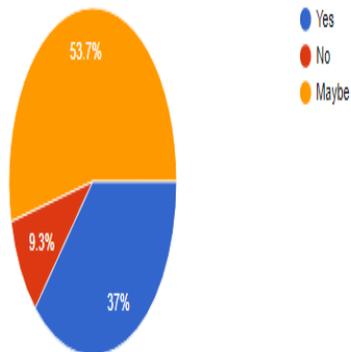
Lastly, a question which was asked in a survey was do they think Li-Fi can be a good replacement of Wi-Fi at home, colleges, workplaces in future?

So, coming to the responses, more than half of majority was not sure about this. Some people told that it can be a better replacement and also few people shown that it can't be a good replacement.

It is represented with the help of survey pie chart;

Do you think Li-Fi can be a good replacement of Wi-Fi at home, colleges, workplaces in future?

54 responses



9. CONCLUSION

In this paper, we outlined the basic working of Li-Fi technology, when it was introduced, benefits of Li-Fi, and Challenges of Li-Fi.

We have also summarized the comparison of Li-Fi, Wi-Fi and other technology. We have listed questionnaire which was asked during survey and also results of the survey. The purpose of Li-Fi technology is to provide a high speed data communication using visible light spectrum. Now Li-Fi is on-going of research, it has a potential advantage that can make a supplement RF communication and can be used to improve wireless network performance. We had also seen who all are investing in Li-Fi technology.

10. REFERENCES

- [1] Joseph F Hair Multi variate data analysis 7th revised
- [2] A Review Paper on Li-Fi Technology by Sandeep Kumar Jain
- [3] Youtube Technical Guruji Channel Concept of Li-Fi
- [4] Youtube TED Channel Wireless data from every light bulb Harald Haas
- [5] <https://pandorafms.com/blog/what-is-lifi/>
- [6] <https://www.elprocus.com/> An Overview of Li-Fi Technology and its Benefits
- [7] Image Source- <https://phys.org>

[8] Image Source-<https://visiblelightcomm.com>

[9]<https://purelifi.com/lifi-technology/>

[10] <https://whatis.techtarget.com/>

[11]

<https://www.techopedia.com/7/31772/technology-trends/what-are-the-advantages-and-disadvantages-of-li-fi-technology>