

# Li-Fi : Future of Wireless Optical Communication

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**Abstract:**With the vast growing gadgets, their usage and their developments led to the advancement in the Wi-Fi which provides a technology so called Li-Fi. Li-Fi is a technology that makes use of LED light which helps in the transmission of data much more faster and flexible than data that can be transmitted through Wi-Fi. Light reaches nearly everywhere so communication can also go along with light freely. Though Wi-Fi gives us speed up to 150mbps as per IEEE 802.11. Haas says his invention, which he calls D-LIGHT, can produce data rates faster than 10 megabits per second, which is speedier than your average broadband connection. Light Fidelity is a branch of optical wireless communication which is an emerging technology. By using visible light as transmission medium, Li-Fi provides wireless indoor communication. The bit rate achieved by Li-Fi cannot be achieved by Wi-Fi. DrHarald Haas ,the professor of mobile communications at the university of Edinburgh school of engineering ,first time publically displayed the proof of Light Fidelity(Li-Fi) ,a method of Visible Light communication(VLC). Li-Fi is the transfer of data through light by taking fiber out of fiber optics and sending data through LED light.

**Keywords :**Wireless-Fidelity(Wi-Fi), Light-Fidelity (Li-Fi), Light Emitting Diode (LED), Line of Sight(Los) Visible Light Communication (VLC).

## I. INTRODUCTION

Li-Fi basically known as "light fidelity" is an outcome of twenty first century. The basic ideology behind this technology is that the data can be transmitted through LED light whose intensity varies even faster than the human eye. As the transmission of the data takes place through the light

'emitting diodes (LED's) the amount is comparatively small .In modern times, it is called as the optimized version of WI-FI .The advantageous thing is the wireless communication which decreases the cost enormously. HARALD HASS, who is considered to be the father of Li-fi from university of Edinburgh, UK says that the heart of this technology lies in the intensity and the potential of the light emitting diodes. The major reason which lead the modern man through this invention is that the confinement of Wi-Fi to comparatively small distance. As there are more and more devices coming up day-by-day the signals are being clogged up due to heavy traffic, there arised a need for an error free transmission technology.And the solution to this problem was the Li-fi technology.. It has been designed in such a way that it overcomes the disadvantages that occurs during the usage of wi-fi. In general terms, Li-fi works even under water thereby causing a great benefit to the military operations..

## II. HISTORY

The notion of using visible light for data transmission is not totally new. Research based on this technology started in 1880. The first VLC transmission, which is also considered as first wireless transmission in the world was done by Dr. Alexander Graham Bell on 3 June 1880 in Washington D.C. Voice message was sent by modulating light. That system was patented and named as Photo phone. That time he used sunlight as source, but the unpredictable nature of sunlight was the drawback. Today almost similar projects are in process using more reliable LED technology.

Haas has a small lab stuffed with equipment, including the now-famous table lamp and its box of electronics. It was here in 2007 that his re-search assistant, MostafaAfgani, first sent data using light signals. Haas's invention centres on how these signals are modulated: the infor-mation, embedded within

visible light emitted from the LEDs, is transmitted by means of many subtle changes made to the intensity of the light at the ultra-high rate of 100 million cycles per second (100MHz). The photo-detector in Haas's box monitors these tiny variations and converts them back into a digital signal, from which the transmitted information is extracted.

### III. TECHNOLOGY DEMONSTRATION

It was demonstrated that table lamp that successfully transmit data at speed exceeding 10 Mbps using light waves from LED light to a computer located below the lamp.

To prove that the light bulb was the source of the data stream, he periodically blocked the light beam, causing the connection to drop.

### IV. WORKING

Li-Fi is typically implemented using white LED light bulbs at the downlink transmitter. These devices are normally used for illumination only by applying a constant current. However, by fast and subtle variations of the current, the optical output can be made to vary at extremely high speeds. This very property of optical current is used in Li-Fi setup. The operational procedure is very simple-, if the LED is on, you transmit a digital 1, if it's off you transmit a 0. The LEDs can be switched on and off very quickly, which gives nice opportunities for transmitting data. Hence all that is required is some LEDs and a controller that code data into those LEDs. All one has to do is to vary the rate at which the LED's flicker depending upon the data we want to encode. Further enhancements can be made in this method, like using an array of LEDs for parallel data transmission, or using mixtures of red, green and blue LEDs to alter the light's frequency with each frequency encoding a different data channel. Such advancements promise a theoretical speed of 10Gbps – meaning one can download a full high-definition film in just 30 seconds.

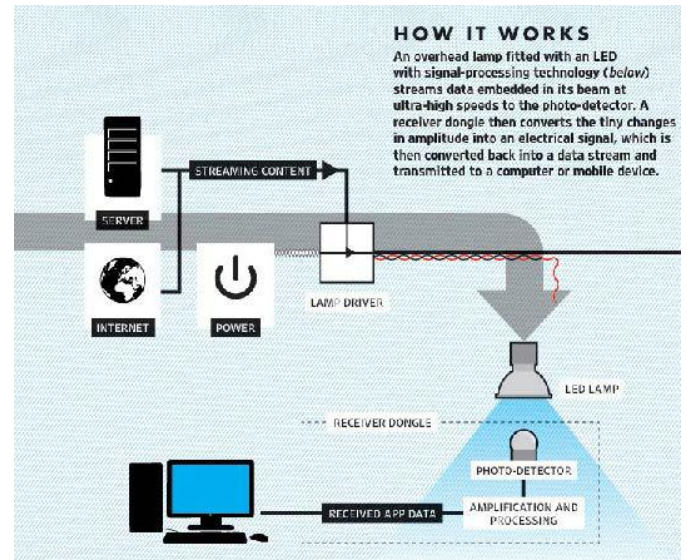


Figure 1: Data transmission with (Light Emitting Diode)

Orthogonal Frequency Division Multiplexing (OFDM), modulation scheme is the basis of visible light communication or wireless optical communication. The signal sent by transmitter is to be converted into the data. For this purpose receivers are to be used. For serving the purpose of receivers to convert the light into electric pulses photodiodes are used. These photodiodes demodulates the optical signals into actual data. Present Data Rate is 100kbps to 100mbps by using different modulation schemes for different applications.

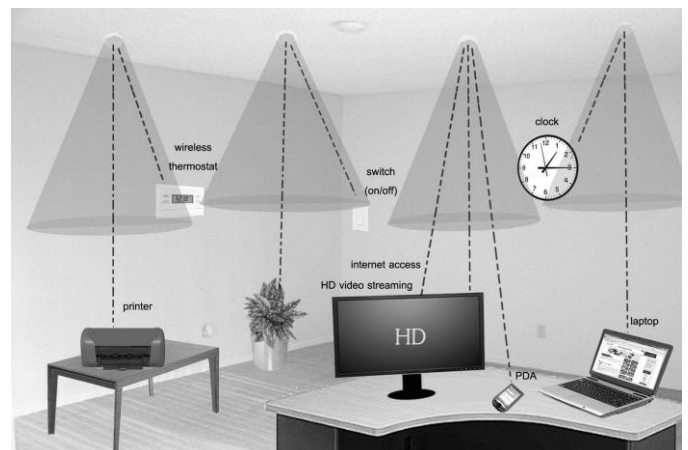


Figure 2 : communication via Li -Fi.

### V. LIMITATIONS

□ The main problem is that light can't pass through objects, so if the receiver is inadvertently blocked in any way, then the signal will immediately cut out. If the light signal is blocked, or when you need to use your device to send information — you can seamlessly switch back over to radio waves, Harald says.

□ Reliability and network coverage are the major issues to be considered by the companies while providing VLC services. Interference from external light sources like sun light, normal bulbs; and opaque materials in the path of transmission will cause interruption in the communication. □ High installation cost of the VLC systems can be complemented by large-scale implementation of VLC though

Adopting VLC technology will reduce further operating costs like electricity charges, maintenance charges etc.

□ This research report categorizes the global VLC technology market; based on component, applications, and geography. Li-Fi uses light-emitting diodes (LEDs) which are rapidly gaining in popularity for standard light bulbs and other domestic and commercial purposes. They are expected to be ubiquitous in 20 years. VLC is not in competition with Wi-Fi, Prof. Haas says, it is a complimentary technology that should eventually help free up much needed space within the radio wave spectrum. "We still need Wi-Fi we still need radio frequency cellular systems. You can't have a light bulb that provides data to a high-speed moving object or to provide data in a remote area where there are trees and walls and obstacles behind," Haas says.

#### VI. APPLICATIONS OF LI-FI

##### 1. *You Might Just Live Longer :*

For a long time, medical technology has lagged behind the rest of the wireless world. Operating rooms are not allowed Wi-Fi over radiation concerns, and there is also that whole dedicated spectrum. Wi-Fi is in place in many hospitals, interference from smart phones and personal computers can block signals from monitoring equipment. Li-Fi solves two problems: lights are not only allowed in operating rooms, but tend to be the most glaring fixtures in the room. And, as Haas mentions in his Lecture, Li-Fi has 10,000 times the spectrum of Wi-Fi, so maybe we can, I dun no, delegate red light to priority medical data.

##### 2. *Airlines used in plane :*

Airline Wi-Fi Nothing says captive audience like having to pay for the "service" of dial-up speed Wi-Fi on the plane.. The best I've heard so far is

that passengers will "soon" be offered a "high-speed like" connection on some airlines. United is planning on speeds as high as 9.8 Mbps per plane. Li-Fi could easily introduce that sort of speed to each seat's reading light. I'll be the guy wowing next to you. It's better than listening to you tell me about your wildly successful son.

##### 3. *Smarter Power Plants (Small Industries) :*

Wi-Fi and so many other radiation types are bad for sensitive locations. Like those surrounding power plants. But power plants required fast, interconnected data systems to monitor things like demand, grid integrity and (in nuclear plants) core temperature. Li-Fi could provide safe, abundant connectivity for all areas of these sensitive Area. Not only would this save money related to currently implemented solutions, but also the draw on a power plant's reserves could be lessened if they haven't yet converted to LED lighting.

##### 4. *Under water sea Awesomeness :*

Underwater ROVs work great, except when the tether isn't long enough to explore location, or when it gets stuck on something. If their wires were cut and replaced with light — say from a submerged, high-powered lamp — then they would be so much free to explore. They could also use their headlamps to communicate with each other, processing data autonomously and referring findings periodically back to the surface, all the while obtaining their next batch of orders.

##### 5. *It Could Keep You Informed and Save Lives :*

What the protocols are for those kinds of disasters. Until they pass under a street light, that is. Remember, with Li-Fi, if there's light, you're online. Stations and tunnels, common dead zones for most emergency communications. Plus, in times less stressing cities could opt to provide cheap high-speed Web access to every street corner.

#### VII. ADVANTAGES

1. High Speed.
2. Li-Fi can use light rather than radio frequency signals.
3. Integrated into medical devices and in hospitals as this technology does not deal with radio waves, so it can easily be used in such places where Bluetooth, infrared, Wi-Fi and internet are banned.

- In this way, it will be most helpful transferring medium for us.
- There are around 19 billion bulbs worldwide, they just required to be replace with LED ones that transmit data.VLC is at a factor of ten, cheaper than WI-FI.
  - Security is another benefit, he points out, since light does not penetrate through walls.
  - In streets for traffic control. Cars having LED based headlights, LED based backlights, and Car can communicate each other and prevent accidents in the way that they exchange Information. Traffic light can communicate to the car and so on.
  - By implementing the Technology worldwide every street lamp would be a free access point.
  - Li-Fi may solve issues such as the shortage of radio frequency bandwidth.

#### VIII. LIMITATIONS

- Still there are some backdrops like it can only transmit when in the line of sight well it can be sorted out someday or incoming days I hope. "There has been a lot of early , and there are some very good applications".
- Although this technology sounds like a replacement to Wi-Fi but this high speed data transferring technology also has some limitations that is the inability of light to pass through obstacles .

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

LI-FI is a term of one used to describe visible light communication technology applied to high speed wireless communication. It acquired this name due to the similarity to WI-FI, only using light instead of radio. WI-FI is great for general wireless coverage within buildings and LI-FI is ideal for high density wireless data coverage in confined area and for relieving radio interference issues, so the two technologies can be considered complimentary.

TABLE I  
 COMPARISON BETWEEN CURRENT & FUTURE WIRELESS TECHNOLOGIES

Technology	Speed	Data Density
<b>Wireless(Current)</b>		
WI-FI IEEE802.11n	150Mbps	*

Bluetooth	3 Mbps	*
IrDA	4 Mbps	***
<b>Wireless(Future)</b>		
WiGig	2 Gbps	**
Giga-IR	1 Gbps	***
LI-FI	>1 Gbps	****

The table also contains the current wireless technologies that can be used for transferring data between devices today i.e. Wi-Fi, Bluetooth and IrDA. Only Wi-Fi currently offers very high data rates. The IEEE 802.11n in most implementations provides up to 150Mbit/s (in theory the standard can go to 600Mbit/s) although in practice you receive considerably less than this. Note that one out of three of these is an optical technology.

#### X. CONCLUSION

Li-Fi is the upcoming and on growing technology acting as competent for various other developing and already invented technologies. Since light is d major source for transmission in this technology it is very advantageous and implementable in various fields that can't be done with the Wi-Fi and other technologies. Hence the future appli-cations of the Li-Fi can be predicted and extended to different plat-forms like education fields, medical field, industrial areas and many other fields.

Li-Fi is certainly not useless, but it has certain inherent limits for the technology. Li-Fi may not be able to replace conventional radios altogether, but it could turbo charge the development of wireless television and make it easier to throw a wireless signal across an entire house.

The possibilities are numerous and can be explored further. If this technology can be put into practical use, every bulb can be used something like a Wi-Fi hotspot to transmit wireless data and we will proceed toward the cleaner, greener, safer and brighter future.

To provide high speed communication, light is modulated without interfering the main purpose of lamp that is of illumination. Constant Research is going on for increasing the transmission range and data rate of VLC. It appears to be a potential technology for creating endless applications but many areas are still to be improved to reach a state of maturity. According to Dr. Suresh Borkar, communication expert and faculty member at Illinios Institute of Technology is regarding the hardware which is required when optics is interfaced with electronics. Also this technology needs to be miniaturized by developing application specific integrated

circuits, optical devices inclusive of photodiodes as receivers. Many other challenges will also incur in the path of its research and implementation but soon Li-Fi products will complement the consumer market with its applications.

#### XI. REFERENCES

- 1) <http://en.wikipedia.org/wiki/Li-Fi>
- 2) *Wireless data from every light bulb* Harald Haas, TED Global, Edinburgh, July 2011
- 3) [www.lificonsortium.org](http://www.lificonsortium.org)
- 4) Apurba Pradhan, *Li-Fi Design Considerations for Projection Display, application notes for LUXIM, U.S.A, June 2008*
- 5) Christian Pohlmann, *Visible Light Communication*
- 6) <http://beyondweblogs.com/what-is-li-fi-is-this-replacing-Wi-Fi/>
- 7) [Seminarprojects.com/s/seminar-report-on-lifi](http://Seminarprojects.com/s/seminar-report-on-lifi)
- 8) *Li-Fi – Internet at the Speed of Light*, by Ian Lim, the gadgeteer, dated 29 August 2011
- 9) [www.digplanet.com/wiki/Li-Fi](http://www.digplanet.com/wiki/Li-Fi)