IJCSC 0973-7391 Volume 8 • Issue 2 March 2017 - Sept 2017 pp. 129-135 available online at www.csjournals.com

Uses of Li-Fi and Wi-Fi Technology in Wireless Communication

Anil Kumar
Assistant Professor, Dept. of Computer Science, University College, KUK
taparwal80@gmail.com

Abstract: Li-Fi is one of the future technologies in wireless communication sector. It is a bidirectional, with a very high speed and is a fully networked communication which is wireless technology similar to Wi-Fi. It was developed by the German Physicist Proff. Harald Hass who has come up with an idea of sending and receiving data through LED (Light Emitting Diode), light bulb that varies the intensity faster than the human eye. According to Dr. Harald Hass, we can use this technology in cellular phones, tablets, laptops and it would be highly secured that is if you can not see the light that the data can't be accessed. It uses light in place of RF waves to transmit information. In place of Wi-Fi Modems, LI-Fi uses transceiver which has fitted led lamps which can glow a room as well as send and receive the information. It is Hundred times faster than Wi-Fi reaching at a speed of 224 GB/s. It's the same idea band behind infrared remote controls but far more powerful. Li-Fi is the term some have used to label the fast and cheap wireless-Communication system, which is the optical version of Wi-Fi.

Keywords : Li-Fi,Wi-Fi,VLC.

INTRODUCTION

Light-Fidelty is an outcome of 21st century. The basic history behind this technology is that the data can be transmitted through the LED light whose intensity varies even faster than the Human-eyes. The term was coined by Dr. Harald Haas and is a form of visible light communication and a subset of optical wireless communications and could be a complement to RF communication (Wi-Fi Cellular network), or even a replacement in contexts of data broadcasting. It is measured that the Li-Fi is Hundred times faster than the Wi-Fi implementations, reaching speeds of 224 GB/s [1]

With Li-Fi is possible to encode the data into the light by varying the rate at which the LED's flicker ON and OFF which is too quickly to be noticed by the human eye. Light-Fidelty enables devices to use their in-built stand by LED lights to transmit data.

The disadvantage of traditional Wi-Fi routers is that multiple devices in a space can interfere with each other. Li-Fi however can use multiple lights in a room without interference. In modern days, it is known as the optimized version of Wide-Fidelty. The main thing is the wireless communication which decreases the cost. There are more and more devices coming up day-by-day the signals of Wi-Fi 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. [2] We will give a brief introduction and then we see some of the facts that appear why we are harry to using the Li-Fi in this days.

Li-Fi HISTORY

Dr. Harald Haas, from the University of Edinburgh in the UK, is widely recognized as the original founder of Li-Fi. He created the term Li- Fi and is Chairman of Mobile Communications at Edinburgh's university and co-founder of pure Light-Fidelty. The association believes it is possible to achieve more than 10GB/s speed using this optical wireless technology also known as Li-Fi. It gets affected if line of sight is not used, the speed of data transmission will reduce or data transmission will stop. The term Li-Fi, formerly pure VLC(Visible Light Communication), is an original equipment manufacturer firm set up to commercialize Li-Fi products for integration with existing LED-lighting systems. Philips lighting company has developed a Visible Light Communication (VLC) system for shopkeepers at stores. They have to download an app on their smart phone and then their smart phone works with the LEDs in the store. The Light Emitting Diodes can point where they are at in the store and give them corresponding coupons and information.[2]

ABOUT LIGHT-FIDELTY:-

Due to Wi-Fi, Light-Fidelty(Li-Fi) is a wireless internet connection standard. Li-Fi operates using visible light waves rather than operating on radio waves. The term Li-Fi was searched by pure Li-Fi's CSO, Professor Harald Haas, and refers to light based communications technology that delivers a high-speed, bidirectional networked, mobile communications in a similar manner as Wi-Fi. Light-Fidelty (Li-Fi) can used the data from existed Wi-Fi networks, this imply that it may be used to provide capacity for the greater downlink demand such that existing wireless or wired network infrastructure may be used in a complementary fashion. Li-Fi is the use of the visible light portion of the electromagnetic spectrum to transmit information at very high speeds. It is in relation to established forms of wireless communication such as Wi-Fi which use traditional radio frequency (RF) signals to transmit data. [1, 2, 3]

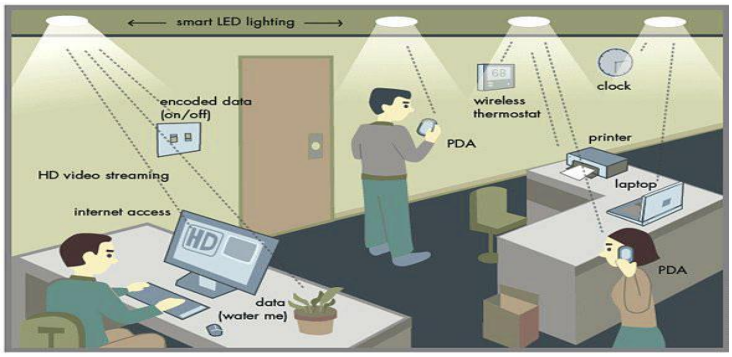

Fig.1 Li-Fi Environment

Li-Fi is a category of Optical Wireless Communications (OWC). Optical Wireless Communications includes ultra-violet and infra-red communications as well as visible light. However, Light-Fidelity (Li-Fi) is uniquely in that the same visible light energy used for illumination may also be applicable for communication.

The technology uses protocols similar to the RF-band 802.11 protocols, with additional standards to eliminate the impacts of interference and impacts of ambient lighting. Despite this, however, the technology cannot be deployed in outdoors in sunlight or in other odd conditions. [3]

Li-Fi has a good result with radio frequency (RF) signals, a lot of the benefits are powered by the simple fact that visible light cannot travel through walls, an essential factor which gives old-school Wi-Fi a large advantage. In line-of-sight(LOS) limitation can make the system more secure and gives better control over emissions, but it's unclear what the minimum distance for signal reception would be if clear line-of-sight is achieved. In our mind, it is easy to imagine the signal being intercepted by someone with a telephoto lens and an optical sensor tuned appropriately. On airplanes Li-Fi was tout as a possible channel for wireless communications.

In this context, the visible light spectrum is 10,000 times bigger than the radio-wave spectrum in which all of our wireless communications take place. With our Wi-Fi networks getting ever more crowded as more and more connected devices join the fray, internet performance is only going to suffer. A complete different spectrum is one obvious solution, and that's just what Li-Fi promises to provide access.

HOW DOES LI-FI WORK?

When a current is applied in constant form to an LED light bulb a constant stream of photons are emitted from the bulb which is observed as visible light. If the current is vary slowly the output intensity of the lightis also vary in between up and down. Because of Light Emitting Diode (LED) bulbs are semi-conductor devices, the current, and hence the optical output, can be modulated at extremely high speeds which can be detected by a photo-detector device and converted back to electrical current. The intensity modulation is imperceptible to the human eye, and thus communication is just as seamless as RF. Using this technique, high speed information can be transmitted from an LED light bulb.[5]

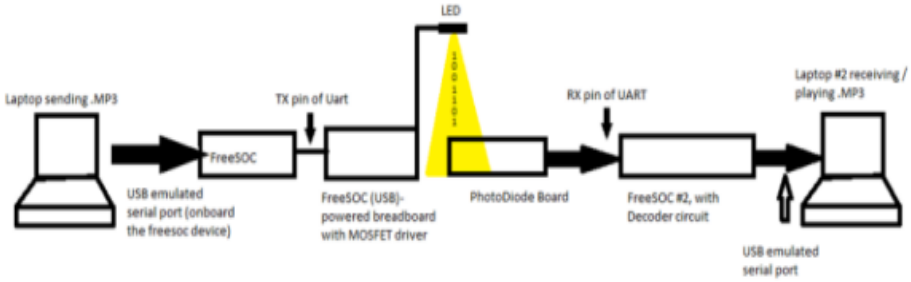

Fig.2 Bloackdiagram of Li-Fi

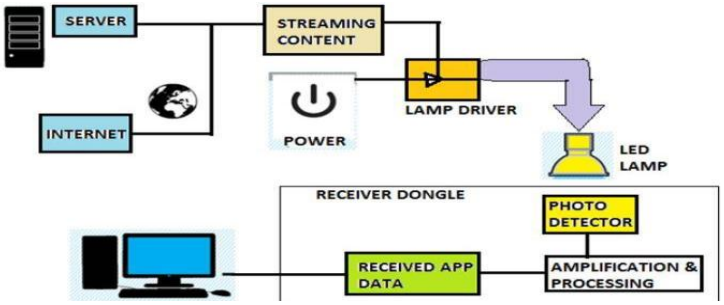

Fig.3 Working of Li-Fi

Radio frequency communication requires radio circuits, antennas and complex receivers, whereas Li-Fi is much simpler and uses direct modulation methods similar to those used in low-cost infra-red communications devices such as remote control units. A infra-red sensor based communication is limited in power due to eye safety requirements, whereas LED light bulbs have high intensities and can achieve very large data rates. Dr. Harass succeeded in 2011 creating an 800 mbps capable wireless network by using nothing more than normal white, blue, red, and green LED based bulbs, thus the idea has been around for a while and various other global teams are also exploring the advancement possibilities. Li-Fi is a wireless communication system in which light is used as a carrier signal in place of traditional radio frequency (RF) as in Wi-Fi. Light-Fidelity(Li-Fi) is a technology that uses LED to transmit data wisely. Visible light communication uses fast pulses of light to transmit information.

LI-FI CONSTRUCTION

The main components of Li-Fi system are [5]. The white LED with high brightness which acts as source of transmission and the silicon photodiode with good response to visible light as the receiving element. Light Emmiting Diodes (LEDs) can be switch on and off to generate digital strings of different combination of binary numbers that is 0s and 1s.To generate a new stream of data, it can be encoded in the light by varying the flickering rate of the LED. The Li-Fi System consists of four xprimary sub-assemblies are Bulb, RF Power Amplifier circuit (PA), Enclosure and Printed Circuit Board(PCB)

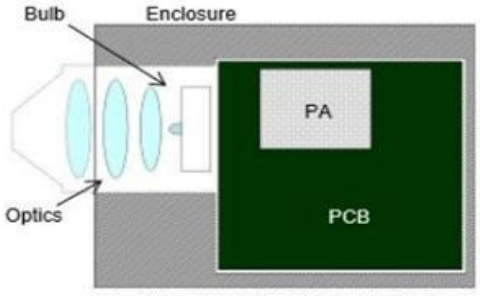

Fig.4 Li-Fi Bloack Diagram

The Printed Circuit Board : Controls the electric inputs and outputs of the lamp and houses the microcontroller used to manage different lamp functions. **An RF (Radio-Frequency)** signal is generated by the solid-state PA and is guided into an electronic field about the bulb. A high concentration of energy in electric field vaporizes the contents of the bulb to a plasma state at the center of **bulb's.** This controlled plasma generates an intense source of light. These all sub-assemblies are contained in an aluminum(Al) **enclosure.**

The Bulb's Functions: The heart of Light-Fidelity is the sub-assembly of bulb where a sealed bulb is embedded in a dielectric material. This type of design is more reliable as compare with conventional light sources that insert degradable electrodes into the bulb. The dielectric material serves two purposes; first as a waveguide for the RF energy transmitted by the PA and second as an electric field concentrator that focuses energy in the bulb. In electric field the energy rapidly heats the material in the bulb to plasma state that emits light of high intensity and the spectrum in full form.

WHY VLC USED:-

As we know that he radio waves are very less safe and costly. The use of Infrared can be done with power which is low for eye safety. Gamma rays cannot be used as they are dangerous. UV rays can be used at places where humans are not found otherwise they can be harmful. So the light in visible form is safe to use that is no harmful effects and it also have a larger bandwidth.

In (VLC) medium, that use light which is visible in (400–800) THz of range, as optical carrier for illumination and data transmission.

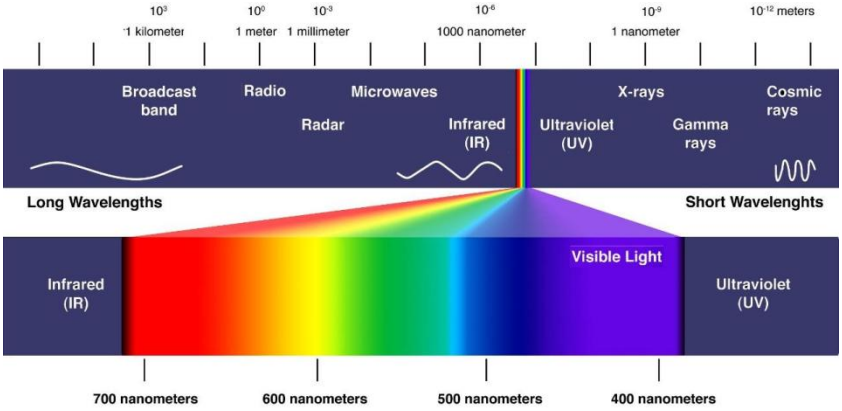

Fig.5: Electromagnetic Spectrum

COMPARISON BETWEEN LI-FI AND WI-FI

Light-Fidelty (Li-Fi) is a term which is used to describe VLC(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. Generaly Wireless-Fidelty(Wi-Fi) is best for wireless coverage 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. The features of Li-Fi include benefits to the energy, efficiency, capacity, security and safety of a wireless system with a number of key benefits over Wi-Fi . [7, 8]

Table 1 Comparison between Li-Fi and Wi-Fi

PARAMETER	Wi-Fi	Li-Fi
CAPACITY	Radio waves form only a small fraction of the entire EM spectrum	Visible light 10000 times than Radio waves
EFFICIENCY	Less. Radio Base Stations consume high amount of energy and most of the energy is just wasted in cooling down those stations, thus decreasing the efficiency.	More. LEDs consume less energy and are highly efficient

AVAILABILITY	Limited because of the harmful effects.	Anywhere. It can be available in airplanes, under water with the help of LED bulbs.
SECURE	Less secure because of high penetrating power of radio waves, anyone can intercept them on the way.	More secure because light waves cannot penetrate through walls and cannot be intercepted by anyone outside the illumination of LED i.e outside the room.
Development Year	1999	2011
Speed	11 Mbps	500Mbps, upto 10 Gbps, 100Gbps
Range	20-100 meters	10 meters
Parameter	**Wi-Fi**	**Li-Fi**
IEEE standard	802.11b	802.15.7
Spectrum range	Radio spectrum range (3 Hz to 3000 GHz)	10000 times than Wi-Fi (430–770 THz)

Network Topology	Point-to-Multi point	Point-to-point
Communication	Based on Radio Frequency Communication	Based on Visible Light Communication
Carrier	Information carried over electric field	Information carried over Optical intensities
Routing Device	Access Points	LEDs
Infrastructure Cost	More	Less
Interference with electronic systems	Radio Waves do interfere.	No interference.
Signal - to - Noise Ratio	May be more	Very high due to less distance between transmitter and receiver.
Beam Forming technique	20-100 meters	10 meters

ADVANTAGES OF LI-FI OVER RADIO WAVES [9]

1. High data transmission rates of up to 10Gbps can be archived. Potentially much faster speeds.
2. Li- Fi uses light rather than radio frequency signals so are intolerant to disturbances.
3. While travelling in planes, the VLC can be used without affecting the airline signals.
4. Security is a side benefit of using light because that Light cannot pass through walls, lot more secure.
5. This also means there's less interference between devices.
6. VLC could be used safely in aircraft without affecting airlines signals
7. Like Bluetooth, Wi-Fi, infrared and internet, the VLC can also be used all locations.

CHALLENGES FOR LI-FI

The advantage of Li-Fi over Wi-Fi, Li-Fi technology is having some challenges. One of these shortcomings is

that it works in direct line of sight. Another challenge is how the receiving device will transmit to the transmitting device. We couldnot shift device in case of inside arrangement of the apparatus as light cannot penetrate through walls and is easily blocked by somebody simply walking in front of LED source. Li-Fi requires line of sight. A major challenge facing Li-Fi is how the receiving device would transmit back to transmitter. [10] A major challenge is how the receiving device will transmit data back to transmitter. Another ambiguity is that visible light cannot penetrate through brick walls as radio waves and is easily blocked by somebody simply walking in front of LED source. [11] There are inherent limitations with the light medium that need to be considered and overcome. You will not be able to use Light-Fidelty outdoors with natural light strongin nature, or in areas with lots of interfering light sources.

FUTURE TOWARDS LI-FI

The Future of Li-Fi can be imagine having light as transmitting medium to our smart phones, laptops and tablets. And security would not be snapped if the device can't access the data.

In modern days Light-Fidelity has been in the news at everywhere with current tests yielding wild promises of vastly improved wireless connection speeds and an end to internet traffic congestion. New Startup Company from Talinn, called Velmenni, recently have been done a practical test with Li-Fi technology in a working office. Li-Fi get internet connection speeds of up to 1GB/s that's the hundred times faster than standard Wi-Fi. In laboratory conditions, it has been created that Light-Fidelity (Li-Fi) could theoretically reach speeds of up to 224GB/s. [4]

Further research in the field can look into the following issues:[13]

1) Driving illumination grade LEDs at high speed
2) Increasing data rate with parallelism/arrays
3) Achieving low complexity/low cost modulation
4) Overcoming the line of sight constraint
5) Achieving seamless interoperability with other networks

APPLICATIONS OF LI-FI

Li-Fi is suitable for many popular internet "content consumption" applications such as audio and video downloads, live streaming, etc. These types of applications are at high demands on the downlink bandwidth, but require only minimal uplink capacity.

There are many applications for Li-Fi. These include: [3,5,11]

1. Street Lamps (As Free Access Points), there are billions of bulbs worldwide which just need to be replaced with LED's to transmit data.
2. Traffic Lights Education Systems & traffic control applications
3. Hospitals (In Few Medical Equipment's) & Healthcare
4. Aircraft & Aviation
5. Underwater Communications Wi-Fi does not work at where Li-Fi will work.
6. Smart Lighting
7. Mobile Connectivity
8. Hazardous Environments
9. Vehicles & Transportation
10. RF Avoidance
11. Location Based Services (LBS)
12. Toys

CONCLUSION

Day by day with extended strength of people and their devices access wireless internet, the airwaves are becoming increasingly clogged, making it more and more difficult to get a reliable, high-speed signal. Some issues may be solve such as the shortage of Radio-Frequency(RF) bandwidth and also allowed the internet where traditional radio based wireless is not allowed. In coming years, we will not only have some billions light bulbs, we may have large number of billions Li-Fi is deploy worldwide for a greener, cleaner, and even brighter future. Now both light and radio waves can be used simultaneously to transfer data and signals.

REFERENCES

[1] Anthony Cuthbertson, "LiFi internet: First real-world usage boasts speed 100 times faster than WiFi". Retrieved 3, December 2015.
[2] http://en.wikipedia.org/wiki/Li-Fi
[3] N. Kulkarni, "Li-Fi Probably Won't Be The New Wi-Fi For Most People", Techcrunch Network, Nov. 2015, http://techcrunch.com/2015/11/29/li-fi-probably-wont-be-the-new-wi-fi-for-most-people/
[4] Jon Mundy, "What is Li-Fi and how could it make your internet 100 times faster". **Error! Hyperlink reference not valid.**3 December 2015. http://www.trustedreviews.com/opinions/what-is-lifi
[5] S. Panda, M.Soyaib, A. Jeyasekar "Li-Fi Technology –Next Gen Data Transmission through Visible Light Communication", National Conference on Emerging Trends in Computing, Communication & Control Engineering, September, 2015. http://www.ijirset.com/upload/2015/ncet2k15/22_Li_-Fi_Modify_CSE.pdf
[6] An IEEE Standard for Visible Light Communications visiblelightcomm.com, dated April 2011. It is superfast modern internet technology.
[7] J.Rani, P. Chauhan, R. Tripathi, "Li-Fi (Light Fidelity)-The future technology In Wireless communication", International Journal of Applied Engineering Research, ISSN 0973-4562 Vol.7 No.11 (2012).
[8] S. Saini, Y. Sharma, "Li-Fi the Most Recent Innovation in Wireless Communication ", International Journal of Advanced Research in Computer Science and Software Engineering 6(2), February - 2016, pp. 347-351.
[9] D. Khandal , S. Jain, "Li-Fi (Light Fidelity): The Future Technology in Wireless Communication", International Journal of Information & Computation Technology. ISSN 0974-2239 Volume 4, Number 16 (2014), http://www. irphouse.com
[10] M. Goyal1, D. Saproo2, A. Bhagashra, "New Epoch of Wireless Communication: Light Fidelity", International Journal of Innovative Research in Computer and Communication Engineering Vol. 1, Issue 2, April 2013
[11] http://www.ispreview.co.uk/index.php/2013/01/tiny-led-lights-set-to-deliver-wifi-style-internet-communications.html, January 2013.
[12] William Connell, http://www.servondesign.co.uk/thoughts/li-fi-internet-connection-using-light-source, Oct, 2011. [13] A. Nath , "Li-Fi Technology: Data Transmission through Visible Light ", Research gate, JULY 2015, https://www.researchgate.net/publication/279530585
[14] BEC CREW, "Li-Fi has just been tested in the real world, and it's 100 times faster than Wi-Fi", Nov. 2015, http://www.sciencealert.com/li-fi-tested-in-the-real-world-for-the-first-time-is-100-times-faster-than-wi-fi