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A Study on Li-Fi (Light -Fidelity)

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ABSTRACT

Presently in world speed of the internet is a major issue and everyone needs internet for business, institutions, organizations, entrepreneurs are thrust for getting right information at the right time and right place. Hence it requires high speed internet technology and large spectrum of channels. Presently our paper speaks about future communication (Li-Fi)It is a technology that may provide theoretically a speed of up to 10Gbps, cost effective and more robust and useful than Wi-Fi. Li-Fi is not expected to completely replace Wi-Fi, but the two technologies could be used complementarily to create more efficient, green and future-proof access networks.The inventor of Li-Fi, Harald Haas a German physicist and professor has come up with this technology which he calls "data through illumination". It is a method in which wireless technology make use of visible light instead of radio waves where Wi-Fi transmits data terabytes per second. This technology would be immense possibilities for the future like it can be provided in public street lights to auto-piloted cars that communicate through their headlights and also data for laptops, smart phones, and tablets will be transmitted through the light in a room.

I. INTRODUCTION

Transfer of data from one place to another is one of the most important day-to-day activities. The current wireless networks that connect us to the internet are very slow when multiple devices are connected. As the number of devices that access the internet increases, the fixed bandwidth available makes it more and more difficult to enjoy high data transfer rates and connect to a secure network. But, radio waves are just a small part of the spectrum available for data transfer. A solution to this problem is by the use of Li-Fi. Li-Fi stands for Light-Fidelity. Li-Fi is transmission of data through illumination by taking the fiber out of fiber optics by sending data through an LED light bulb (shown in Fig. 1) that varies in intensity faster than the human eye can follow. 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. Li-Fi uses visible light instead of Gigahertz radio waves for data transfer.

The idea of Li-Fi was introduced by a German physicist, Harald Hass, where he also referred to as ―data through illumination. The term Li-Fi was first used by Haas in his TED Global talk on Visible Light Communication. According to Hass, the light, which he referred to as D-Light, can be used to produce data rates higher than 10 megabits per second which is much faster than our average broadband connection [9]. Li-Fi can play a major role in relieving the heavy loads which the current wireless systems face since it adds a new and unutilized bandwidth of visible light to the currently available radio waves for data transfer. Thus it offers much larger frequency band (300 THz) compared to that available in RF communications (300GHz). Also, more data coming through the visible spectrum could help alleviate concerns that the electromagnetic waves that come

with Wi-Fi could adversely affect our health. Li-Fi can be the technology for the future where data for laptops, smart phones, and tablets will be transmitted through the light in a room. Security would not be an issue because if you can't see the light, you can't access the data. As a result, it can be used in high security military areas where RF communication is prone to eavesdropping.

II. ARCHITECTURE OF LI-FI SYSTEM

Li-Fi which can be the future of data communication appears to be a fast and cheap optical version of Wi-Fi. Being a Visible Light Communication (VLC) It uses fast pulses of light to transmit information in wireless medium. The main components of a basic Li-Fi system may contain the following:

a) A high brightness white LED which acts as transmission source.

b) A silicon photodiode with good response to visible light as the receiving element.

Switching the LEDs on and off can make them generate digital strings with different combination of 1s and 0s. To generate a new data stream, data can be encoded in the light by varying the flickering rate of the LED. In this way, the LEDs work as a sender by modulating the light with the data signal. The LED output appears constant to the human because they are made to flicker at a phenomenal speed (millions of times per second) and it's impossible for human eye to detect this frequency. Communication rate more than 100 Mbps can be achieved by using high speed LEDs with the help of various multiplexing techniques. And this VLC data rate can be further increased to as high as 10 Gbps via parallel data transmission using an array of LED lights with each LED transmitting a different data stream.

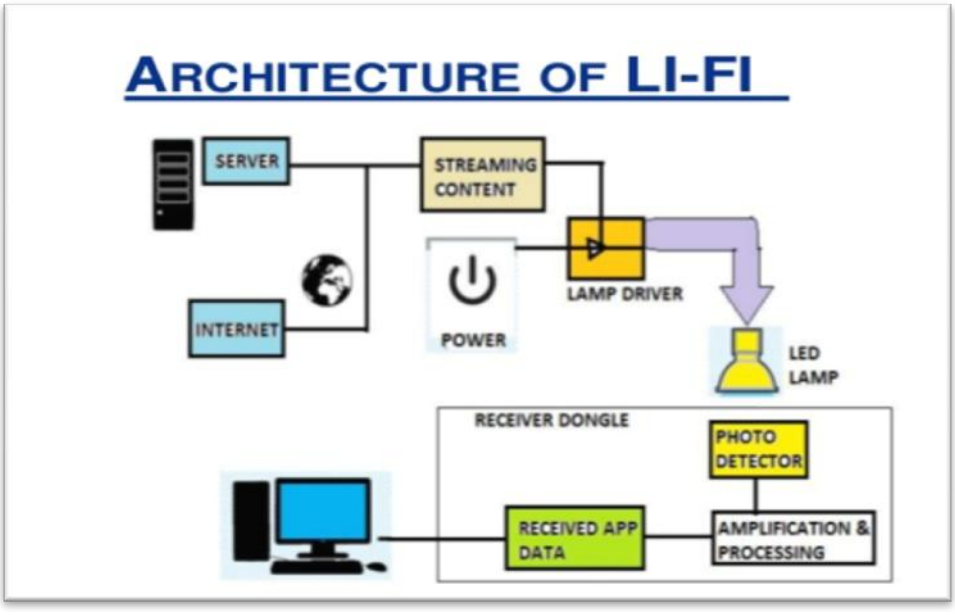

Fig.1. Architecture of LiFi

The Li-Fi transmitter system comprises of four primary subassemblies:

- Bulb
- RF Power Amplifier Circuit (PA)
- Printed Circuit Board (PCB)

- Enclosure

III. LI-FI BULB SUB-ASSEMBLY:

The bulb sub-assembly is the main part of the Li-Fi emitter. It consists of a sealed bulb embedded in a dielectric material which serves two purposes: one, it acts as a waveguide for the RF energy transmitted by the PA (Power Amplifier) and two, it acts as an electric field concentrator that focuses the energy into the bulb. The collected energy from the electric field rapidly heats the material in the bulb to a plasma state that emits light of high intensity of Visible light spectrum. Figure () shows the sub-assembly of the bulb.

There are various inherent advantages of this approach which includes high brightness, excellent color quality and high luminous efficacy of the emitter – in the range of 150 lumens per watt or greater. The structure is mechanically robust without typical degradation and failure mechanisms associated with tungsten electrodes and glass to metal seals, resulting in useful

lamp life of 30,000+ hours. In addition, the unique combination of high temperature plasma and digitally controlled solid state electronics results in an economically produced family of lamps scalable in packages from 3,000 to over 100,000 lumens.

Important factors that should be considered while designing Li-Fi are as follows:

- Presence of Light
- Line of Sight (Los)
- for better performance use fluorescent light & LED

IV. WORKING PRINCIPLE OF LI-FI

The working principle of li-fi was first proposed by Harald Haas from University of Edinburgh, UK, in his TED global talk on VLC. The working principle of li-fi is very simple, it is based on the transmission of digital data 0's and 1's. The logic is, if the LED is OFF, digital 0 is transmitted and if theLED is ON, digital1 is transmitted, which can't be detected by human eye. The LED's can be switched ON and OFF very quickly by which we can transmit data with the help of light. Generally white LED bulbs are used for implementing the concept of li-fi which is used for illumination by applying a constant current. However, the light output can be made to vary at extremely high speeds by fast variations of the current. To build up a message we are flashing the LEDs numerous times.

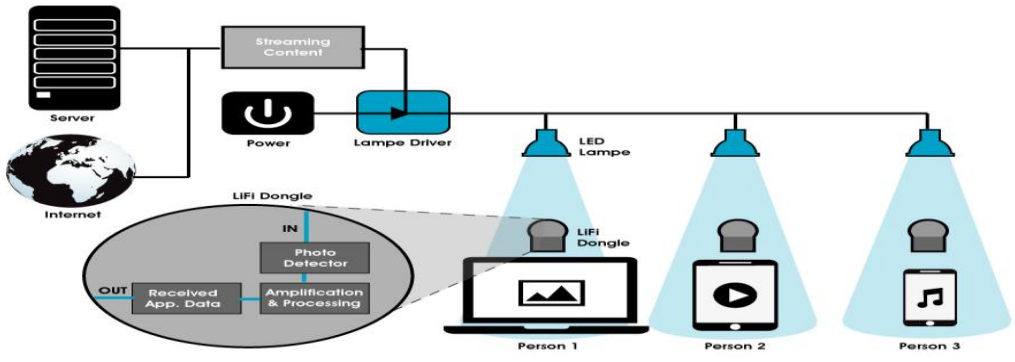

Fig.2. Working of LIFI

In order to obtain data rates in the range of hundreds of megabytes per seconds we can use array of LEDs which also helps us for parallel data transmission or we can also use combination of three basic colors LEDs red, green, blue to alter the frequency of light. The VLC (Visible Light Communication) uses visible light between 300 THz (780 nm) and 800 THz (375 nm) as the optical carrier for data transmission and for illumination.

V. 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 (780 nm) 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:

- Radio waves are expensive (due to spectrum charges) and less secure (due to interference and possible interception etc.)
- 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. X-rays have health issues, similar to the Gamma Rays.
- 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.
- 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.

VI. COMPARISON BETWEEN LI-FI AND, WI-FI AND OTHER RADIO COMMUNICATION TECHNOLOGIES

Li-Fi is the name given to describe visible light communication technology applied to obtain high speed wireless communication. It derived this name by virtue of the similarity to Wi-Fi. Wi-Fi works well for general wireless coverage within buildings, and Li-Fi is ideal for high density wireless data coverage inside a confined area or room and for relieving radio interference issues. Table I shows a comparison of transfer speed of various wireless technologies. Table II shows a comparison of various technologies that are used for connecting to the end user. Wi-Fi currently offers high data rates. The IEEE 802.11.n in most implementations provides up to 150Mbit/s although practically, very less speed is received.

Advantages of Li-Fi

❖**Efficiency:** Energy consumption can be minimized with the use of LED illumination 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.

❖**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.

❖**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.

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

❖**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.

Limitations of Li-Fi:

✓Internet cannot be accessed without a light source. This could limit the locations and situations in which Li-Fi could be used.

✓It requires a near or perfect line-of-sight to transmit data

✓Opaque obstacles on pathways can affect data transmission

✓Natural light, sunlight, and normal electric light can affect the data transmission speed

✓Light waves don't penetrate through walls and so Li-Fi has a much shorter range than Wi-Fi.

✓High initial installation cost, if used to set up a full-fledged data network.

Applications of Li-Fi

- **Education systems**: Li-Fi is the latest technology that can provide fastest speed internet access. So, it can replace Wi-Fi at educational institutions and at companies so that all the people can make use of Li-Fi with the same speed intended in a particular area.
- **Medical Applications**: Operation theatres (OTs) do not allow Wi-Fi due to radiation concerns. Usage of Wi-Fi at hospitals interferes with the mobile and pc which blocks the signals for monitoring equipment's. So, it may be hazardous to the patient's health. To overcome this and to make OT tech savvy Li-Fi can be used to accessing internet and to control medical Cheaper Internet in Aircrafts: The passengers travelling in aircrafts get access to low speed internet at a very high rate. 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.
- **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.
- **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 [1]. Also, for normal periods, Li-Fi bulbs could provide cheap high-speed Web access to every street corner.

V. CONCLUSION

Li-fi is an emerging technology and has vast application. If this technology can be put into practical use, every bulb can be used like a Wi-Fi hotspot to transmit wireless data. This concept can be used to solve issues such as shortage of radio frequency bandwidth. Thus, this technologyprovides numerous benefits. By using this technology we can proceed towards a greener, safer and cleaner future. It is an advanced approach that will make our lives more technology driven in the near future.

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