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Li-Fi: The New Way of Communication

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ABSTRACT

Nowadays, we use mobiles for communications on the go, whether that is through calling over the network, messaging, or using the internet services available to us. In recent years, there have been greater developments in the adscititious things a mobile phone can do such as take pictures, play video games and read books to name a few. While there have been extensive improvements in the industry, a new issue has risen - The network bandwidth that we use to pass information has become increasingly crowded. Thus, every time we try to connect to the internet via our home wireless router in every router and fail to do so, one tends to blame it on the company. Due to the rise of the wireless routers in every home, there arises a situation which no company can currently address – shortage of bandwidth. Such issues faced by traditional wireless routers can now be solved through the use of a new technology called Li-Fi. Li-Fi works on the same ideas as Wi-Fi except, it uses light to transmit data instead of radio waves. The data can be transmitted in the range of Gbps which is greater than the transmission rate of the W-Fi.

Keywords: Li-Fi, Wi-Fi and Gbps.

1. INTRODUCTION

Li-Fi is a bidirectional, light based form of communication offering high data transfer speeds. It utilizes light the way radio waves are in Wi-Fi to transfer data wirelessly. Li-Fi employs lighting which is required by human beings. Consequently, the introduction of Li-Fi does not put us at any extra risk. Scientists have been able to achieve speeds as high as 224Gbps by keeping the device adjacent to a source of light.

This idea was first introduced by German physicist Professor Herald Hass who then went on to address TED Global on Visible Light Communication. According to Hass, the light used to transmit data (which he referred to as D-Light) can be used to produce data rates higher than 10Mbps. This was drastically faster than our average broadband connection [1-7].

Li-Fi technology can contribute to relieving cumbrous connection loads which overburdened wireless systems are dealing through concatenation of the bandwidth of visible light to the bandwidth of radio waves used for sending data in wireless routers.

It offers an exponentially larger frequency band (up to 300THz) which can then be juxtaposed to that available in RF communications (up to 300GHz). Also, the colossal amount of data arriving via visible spectrum could help alleviate concerns that the electromagnetic waves that come with Wi-Fi could conflict our health.

Li-Fi is now a part of the visible light communication (VLC) PAN IEEE 802.15.7 standard. It can be elucidated as, the transfer of binary 1 when the light is switched ON, and the transfer of binary number 0 when there is absence of light [8-12].

To transfer data, one needs to use a device which is able to switch on and off rapidly. Therefore, we use LED's to transmit the data. Also, the LEDs severity is modulated so expeditiously that human eye cannot decipher the absence of light, so the output in the form of light supervenes fixed and hence offers permanent connectivity.

In order to maintain more users and data traffic, multifarious solutions has been proposed. They can be grouped in three sections. They are:-

I. Reforms the spectrum handling.
II. Installing distinct networks (Het Net) on a single device.
III. Concatenate new spectrums with larger bands. Li-Fi technology does not seek to replace Wi-Fi, but rather to complement it.

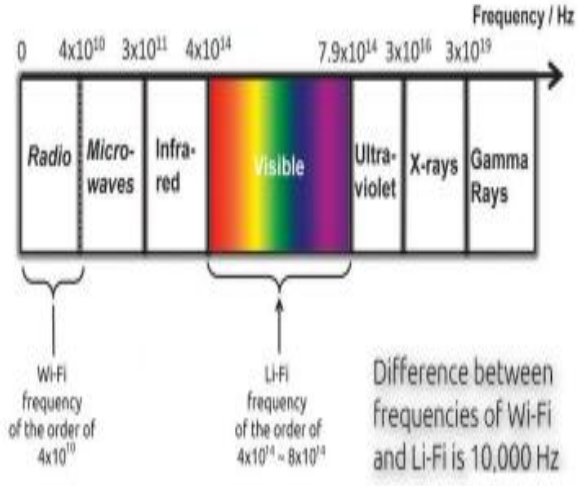

Fig.1: Electromagnetic Spectrum

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2. WORKING PRINCIPLE

Li-Fi technology uses light in the way a wireless router uses radio waves. An LED bulb fitted with Li-Fi enabling chip is connected to the source of the LED bulb. By changing the intensity of the light emitted from the LED bulb, data can be transferred from the light bulb to a photo-receptor on a mobile device such as phone or laptop. If the device also has an LED transmitter, it can send data from the device to the receptor of the Li-Fi equipment as well. The frequency of change in intensity of light is at such a pace that the human eye is unable to detect it.

VLC data communication or Li-FI communication utilises light between 300THz (780nm) to 800THz (375nm) range as the optical carrier for data transmission and illumination [13].

The construction of Li-Fi largely consists of elementary sub-assemblies:

I. Bulb
II. RF Power Amplifier Circuit (PA)
III. Printed Circuit Board (PCB)
IV. Enclosure

The working of Li-Fi is facile. This technology is implemented using simple and normal white LED light bulbs used for emitting light by applying stagnant current. However, by brisk transformation of current, a varying light output can be achieved at extremely high speed.

A light emitter at one point and photo detector at the other point constitutes a basic transmission network. The photo detector sensors sense and register binary 1 when the LED is ON; and binary 0 when the LED is OFF.

The LED bulbs are connected interfaced with a micro-controller chip that helps to vary the rate at which the LED flickers to encode the data on the light transmitted through it. The speed of switching of LEDs are so fast, that a normal eye cannot detect it causing LED light bulbs to be on continuously even though its flickering.

The data can be encoded by varying the intensity of light which is emitted by normal visible light bulbs.

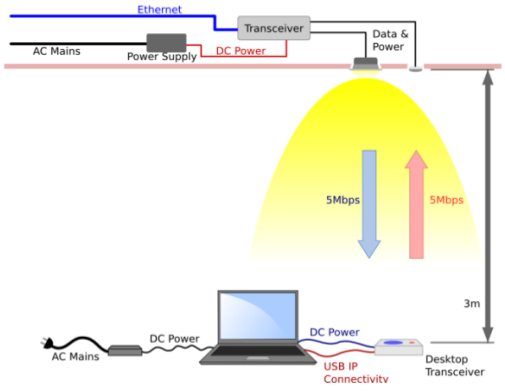

Fig.2: Working of Light-Fidelity (Li-Fi)

3. HISTORY

Hass rediscovered and coined this technology in 2011. He has also given a TED global talk after starting a company to market it. In October 2012, a companies working on this technology formed the Li-Fi consortium to standardise the use of high speed optical wireless system and overcome the radio-based wireless spectrum challenge. In 2012, VLC technology was demonstrated by the Li-FI consortium. October 2013, Chinese manufacturers began work on Li-Fi development kits. In April 2014, Stins Coman, a Russian company successfully created a wireless Li-Fi hub at a local network called Beam Caster. Their current module can transfer information at rate of 1.25 Gbps [14].

4. D-LIGHT PROJECT

D-Light, which means “data through illumination” is the mintage of Prof. Hass. He stated that his invention can generate data rates faster than 10Mbps, faster than the average broadband connection. He envisages the forthcoming technology where data for laptops, smart phones and tablets is transmitted through the illumination of a room.

He made a developed an apparatus which grants a much better data rate closer to the promised 4 Gbps by operating on a mere 5 milli watt of optical output power through the use of high bandwidth photo-diodes at the receiving end.

D-Light system uses Orthogonal Frequency Division Multiplexing (OFDM) techniques, which allows us to vary the intensity of the LEDs output at a very fast rate, invisible to the human eye; for the eye, the bulb would simply be on and providing light.

5. ADVANTAGES

Li-Fi technology seeks to address key issues which have been difficult to do so until now:

1. Speed of communication
2. Larger bandwidth to communicate
3. Enhanced security

Each of these is a great solution but together, Li-Fi can bring about a revolution in the way we have transferred data until now. Connections using Li-Fi will allow a greater number of devices to be connected at the same time.

This gives room for IOT devices to be a part of the house and not swamp up the wireless bandwidth.

Enhanced rates of communication can allow for faster speeds than the house can provide – limited to 100 Gbps in fiber optic enabled homes leaving room for new innovation.

Wi-Fi is exalted for wide wireless coverage such as through walls while Li-Fi provides advanced or the high density coverage in a bounded region.

It is presumed that the technology can provide a speed up to 10Gbps which can theoretically allow HD films can be downloaded within 30 seconds. This would pave the way for new technologies such as streaming a 4k video on a mobile device which has a 4k display.

The key benefits are:

1. Advanced wireless infrastructure by arranging an extra stratum miniature cells which is known as the ato-cells.
2. The abstention of the radio frequency spectrum crunch while having 10,000 times more BW.
3. Having high peak transfer rates of up to 10 Gbps.

Fig.3: Application of Light-Fidelity (Li-Fi)

6. HOW LI-FI CAN AFFECT OUR LIVES

1. No risk of ionising radiation.
2. Much faster current Wi-Fi communication.
3. Cost effective as it is powered by LEDs.
4. Eliminates network interference from neighboring devices.
5. Green technology as it is based on LEDs and the infrastructure is in place. Also promotes the use of LED's in lighting future homes.

7. FACTORS AFFECTING LI-FI

Li-Fi uses light as a source for transmitting the data, but infiltration of light is not possible through the walls. Although it is a major defence against hackers, the fact remains that the Wi-Fi network can address a larger audience that Li-Fi cannot do such as operating the Wi-Fi through walls to reach multiple rooms.

The lights also need to remain ON all the time. Without light, it is simply not possible to transmit data. It has been proposed that lessening the intensity of light can be sufficient to transfer data but this change can be detected by the human eye.

8. ARCHITECTURE

The world has come a long way from being a paper based society to a digital one. With the introduction of gadgets enabling mobility, it has become ever more important to successfully communicate larger amounts of data securely.

The Wi-Fi provided some relief however; it is not feasible in the long run.

A solution to the radio spectrum problem came in the form of cognitive radio networks (CRN) in which the unaccustomed spectrum is used effectively by assigning one frequency band to the another frequency band for transmission.

Although CRN does not produce radio waves, the channels can transmigrate (move from a used channel to a vacant channel). The next idea is to use Visible Light (VLC) for communicating and transmitting the data.

This allows a large number of radio channels to be saved from interfering with each other while the number of wireless devices in homes and offices increases.

9. COMPARISON BETWEEN LI-FI AND WI-FI

Parameters	Li-Fi	Wi-Fi
Speed	In the order of Gbps (Commercially 1.25Gbps available)	Only up to 150Mbps
Transfer Medium	LED Light Bulbs	Radio Waves
Operating Frequency	300 THz	2.4GHz, 4.9GHz and 5GHz
Cost	Cheaper	Expensive
Privacy	More Secure	Less Secure
Natural Impact	No harmful radiations	Risk of Harmful Radiations at transmission frequencies
Applications	Home use as well as in airplanes & exploring undersea.	Used for regular internet usage with the help of Wireless router.

Table 1:- Showing difference between Light-Fidelity and Wireless-Fidelity

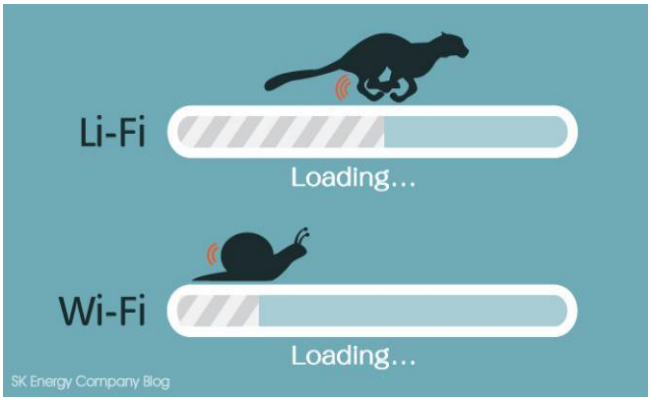

Fig.4: Comparison between Li-Fi and Wi-Fi

10. SCOPES AND CHALLENGES

Li-Fi has the potential to be revolutionary however, it faces many challenges ahead. If this technology can put into actual use, each LED bulb can be used like a Wi-Fi hotspot to receive data wirelessly.

This contributes to the cleaner, greener and safer path of wireless networks for the flamboyant future. The idea of Li-Fi is currently drawn a great deal of zest.

On the other hand light has a few other drawbacks – As visible light cannot penetrate through opaque objects, it is easily blocked by something as simple as somebody simply walking in front of the LED source. Light is still bounced of walls albeit, the signal quality decreases.

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11. SCOPE FOR FUTURE

Instead of using white light, by using blue light, more data can be transferred in the same light in the way white light used to encode CD's has now shifted to blue for reading Blu-ray disks. It can also be possible to provide the switching of frequencies into infra-red or ultraviolet at night.

12. DISADVANTAGES

Li-Fi is no doubt a great technology but it requires a great deal of rethinking on the consumers behalf. Users will need to consciously try and not cover the special photoreceptor meant for Li-Fi communication.

Bringing in yet another component into already restricted phones will increase their weight. For companies looking to adopt this technology in their phones and tablets, this may make or break the deal.

Li-Fi is suited for indoor uses such as offices, in homes during the day, however, people often open windows and let sunlight enter their surroundings. This can interfere with the transmission of data as the intensity of light given out by LEDs today is yet to match that of the sun. This would promote relying on Wi-Fi for that duration. Thus, Li-Fi may be cheap solution, but the consumers who will use it face large limitations in where they can use it.

Li-Fi in its current form may bring about a revolution which will be limited in scope. A possible solution to use the new technology could be to buy curtains that absorb the very sunlight that is good for your skin to use a trending piece of technology. This is counterintuitive to the idea bringing in ease of access.

This defeats the very purpose of bringing Li-Fi into our environment as a technology that improves our life.

Fig.5: Li-fi is being used inside the room

13. APPLICATIONS

Li-Fi has several uses in homes and offices but it is not limited to that. Li-Fi can also be used in places where wireless transmission was not originally thought to be possible.

Underwater Communications: Radio signals can be easily absorbed by sea water. It is therefore difficult to use Wi-Fi to communicate between waterborne equipments. Vehicles such as submarines, ships as well as boats can utilize Li-Fi to boost connectivity when at sea. Head lamps can be used as their light source to transmit and receive data.

Traffic Management: With the rise of driverless cars, it has become increasingly important to set up good communication between traffic instruments and cars. One way to do so is through the use of Li-Fi. By encoding the street lights with information about the current situation, cars will be able to make more "informed" decisions.

Air-ways: Generally, mobile phones are not to be used while travelling in an airplane. This is due to the overlapping of mobile signals with navigation and control signals used by aircraft. Li-Fi can overcome this problem by utilising light for communication.

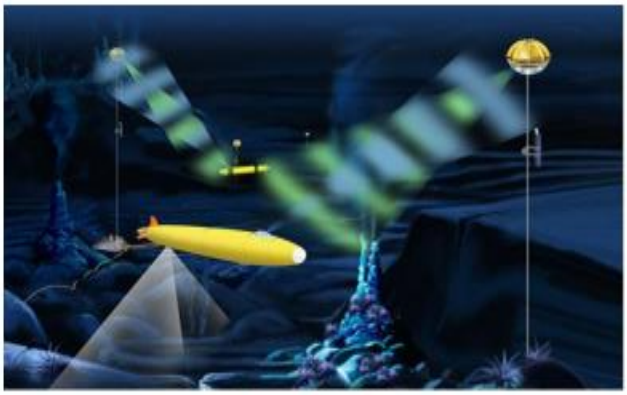

Fig.6: Submarines using their headlights as the source of Li-Fi

14. CONCLUSION

Li-Fi is the upcoming and on growing technology acting as competent for various other developing and already invented technologies.

Li-Fi sounds great from the start, but don't throw your Wi-Fi routers just yet. Li-Fi technology isn't meant to replace Wi-Fi: it's meant to work alongside it. Li-Fi doesn't work outside, so public Wi-Fi hotspots would still need to be used.

This concept promises to solve issues such as the shortage of radio-frequency bandwidth and boot the disadvantages of Wi-Fi. Hence, future applications of the Li-Fi are predicted and they extended to different platforms and various walks of human life.

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