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A Study on Li-Fi-Internet at the Speed of Light

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ABSTRACT: Li–Fi [Light Fidelity] technology is the milestone in the history of wireless communication. Li-Fi is the latest technology that makes use of LED lights which helps in the transmission of data much faster, cheaper and flexible than data that can be transmitted through Wi-Fi. The basic idea behind this communication scheme is transmission of 'DATA THROUGH ILLUMINATION', introduced by Professor HARALD HASS of University of EDINBURGH. High data transmission rates of up to 10Gbps can be achieved through Li-Fi. Li-Fi technology can be implemented in hospitals where it is difficult to use optic fibre, traffic management and under water communications. 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 Wi-Fi hotspot to transmit wireless data and we will proceed towards the Greener, Cleaner, Safer and Brighter future.

KEYWORDS: Li-Fi, Wi-Fi, LED, VLC.

I. INTRODUCTION

Light Fidelity is the abbreviated form of Li-Fi. The advancement of Wi-Fi is Li-Fi. It is an upcoming latest technology which paves the new way to establish wireless communication links through LED lights and uses visible light communication as a substitute for radio frequency waves. It is a 5th generation wireless system which allows high-speed communication for a networked mobile using light emitting diodes [LEDs]. It uses optical wireless communication technology, to overcome the disadvantages of RF-bandwidth limitations by carrying much more information. It is a major breakthrough in this new generation high brightness light bulbs. Major potential use of this technology includes wireless home networks and in vehicles transmitting data for managing traffic signals .this is still in research, currently number of groups exploring for various wireless technologies. It is almost 10,000 times larger than radio frequency spectrum. This technology is capable of transferring 10Gbps which is almost super faster than the superfast broadband connections. It provides much secure connection from hacking compared to Wi-Fi. Because light waves can't penetrate through walls. It is user-friendly and as well as environmental friendly technology.

II.GENESIS

The Father of Li-Fi created his own company called OLEDCOMM, the first European company which commercially spread Li-Fi worldwide. The evolution of Li-Fi is first introduced by Professor Harald Hass, of Edinburgh University in UK, who is widely recognized as an original founder of Li-Fi technology. The technology has its potential to change how we access net, video, receive emails and more. The D-Light project has been conducted in the Institute of Edinburgh from January 2010 to January 2012.Hass endeavoured himself to setup and to commercialize the Li-Fi products with LEDs. In October 2011, Li-Fi Consortium was planned by many organization and industry groups to support high-speed optical wireless systems to overcome the available limited amount of radio-based wireless spectrum. Li-Fi introduced VLC technology in 2012 Li-Fi or VLC systems do not require a line-of-sight conditions, this news was released in a press release in September 2013. Russian company StinsComan announced Beam Caster a development of Li-Fi wireless local network which transfers 1.25Gbits of data for a second. But in near

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future it can be raised upto 5GB per second. Transformation of data using light is easier and faster than transferring data in U-V rays and I-R rays.

III.RELATED WORKS

In [1] paper author demonstrated for the first time that it is possible to use off-the-shelf LEDs to transmit data wirelessly at very high speeds using a technology referred to as Orthogonal Frequency Division Multiplexing (OFDM). It provides a comprehensive overview of spatial modulation. Spatial modulation is a novel technique to enhance data transmission speeds of wireless systems by encoding data in the index of a transmitter that consists of multiple transmitting elements. Motivated by the looming radio frequency (RF) spectrum crisis, [2] paper aims at demonstrating that optical wireless communication (OWC) has now reached a state where it can demonstrate that it is a viable and matured solution to this fundamental problem. In particular, for indoor communications where most mobile data traffic is consumed, light fidelity (Li-Fi) which is related to visible light communication (VLC) offers many key advantages, and effective solutions to the issues that have been posed in the last decade. In [3] paper represents the overview of the 5G telecommunication features till date. It incorporates all the technological advancements from 0g to 5G. 1G to 5G telecommunication world has seen many improvements and advancements. In [4] paper author demonstrated that Li-Fi is also way faster; the latest Wi-Fi standard, 801.11ac, has a maximum possible speed of about 867 Megabits per second for a typical handheld. Li-Fi, meanwhile, can reach speeds up to 3.5Gbit/s per colour – meaning a typical Red-Green-Blue (RGB) LED can emit speeds up to 10.5Gbit/s – more than 10 times faster than the latest Wi-Fi technology. These speeds offer a lot of potential for wireless connectivity. In [5] paper represents Li-Fi as a bidirectional, high-speed and fully networked wireless communication technology similar to Wi-Fi. The term was coined by Harald Haas and is a form of visible light communication and a subset of optical wireless communications (OWC) and could be a complement to RF communication (Wi-Fi or cellular networks), or even a replacement in contexts of data broadcasting. It is wire and UV visible-light communication or infrared and near-ultraviolet instead of radio-frequency spectrum, part of optical wireless communications technology, which carries much more information and has been proposed as a solution to the RF-bandwidth limitations.

IV.STANDARDS

Like Wi-Fi, Li-Fi is wireless and uses similar 802.11 protocols. But uses visible light communication which has much wider bandwidth. The standard is able to deliver enough data rates to transmit audio, video and multimedia services. IEEE 802 workgroup established communication protocols for one part of VLC. However this IEEE 802.15.7 standard is out-of –date. The introduction of O-OFDM means that the new drive for standardization of optical wireless communication is required. Nonetheless the IEEE 802.15.7 standard defines the physical layer (PHY) and media access control layer (MAC). The standard defines three physical layers (PHY) with different rates:

- The PHY l was established for outdoor application and works from 11.67Kbits/s to 267.6Kbits/s.
- The PHY layer ll premise reaching data rates from 1.25Mbit/s to 96 Mbit/s.
- The PHY layer lll many emissions with a particular modulation method called Colour Shift Keying (CSK). PHY lll can deliver rates from 12Mbit/s to 96Mbit/s.

V.WORKING OF LIFI

Working principle of Li-Fi is very simple. The modules have a light source from LED light bulbs at downlink transmitter, at one end and a photo detector light sensor at other end. When the LED light starts to glow, the photo detector or light sensor will detect light. The beam passes into the photo detector in ultra-high speeds. A receiver then converts the tiny changes in amplitude into an electrical signal, which is then converted back into a data stream and transmitted to a computer or mobile device. Because of the fast variations of current, by switching ON and OFF the switches in a high-speed, optical output can be made to vary at extremely high speeds. When LED light is ON, then digital signal will be transmitted as 1 and if LED is OFF, then digital signal will transmit as 0. Here we all need is some LEDs and a controller that code data into those LEDs.

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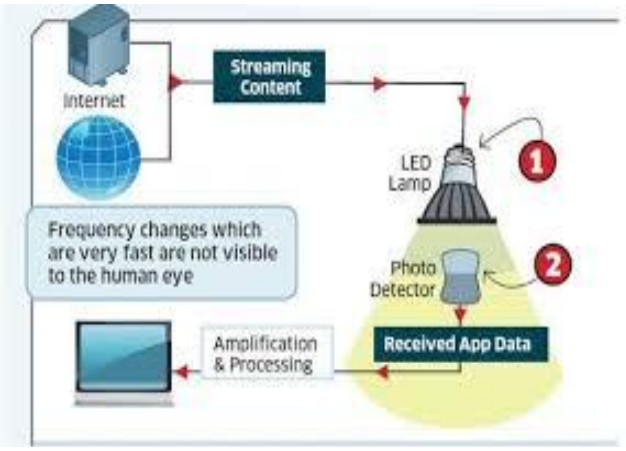

Fig.1.WORKING MODEL OF LI-FI

VI.VISIBLE LIGHT COMMMUNICATION

Visible Light Communication is a data communication medium using visible light between 400 and 800 THz(780-375nm). The history of visible light communication VLC dates back to the 1880's in Washington D.C. when Scottish scientist Alexander Graham Bell invented the photo phone, which transmitted speech on modulated sunlight over several hundred meters. Using visible light it is less dangerous for high-power applications because humans can perceive it and act to protect their eyes from damage. The VLC standardization process is conducted within IEEE Wireless Personal Area Networks working group 802.15. The technology uses fluorescent lamps ordinary lamps, not special communication devices to transmit signals at 10Kbits/s or LEDs for upto 500Mbits/s. RONJA (Reasonable Optical near Joint Access) achieves full Ethernet speed over the same distance thanks to larger optics and more powerful LEDs. Recently Organic LEDs (OLED) have been used as optical transreceivers to build up VLC communication links upto 10Mbits/s.

VII.COMPARISON BETWEEN WIFI AND LIFI

Li-Fi uses Light as a medium to transfer data widely called as Visible Light Communication (VLC), whereas Wi-Fi uses Radio Frequency [RF] spectrum whose range is comparatively less than visible light spectrum. The data transfer speed in Li-Fi is much faster compared to all wireless connection links of about 10Gbits/s. But in Wi-Fi data transfer speed is only upto 150Mbits/s. The spectrum range of visible light is 10,000 times broader in comparison to radio frequency. In turn spectrum range of Radio Frequency spectrum is less than visible light. Li-Fi is comparatively cheaper than Wi-Fi because free band doesn't need license and it uses light. Wi-Fi is costlier in comparison to Li-Fi because it use Radio Spectrum. Both Wi-Fi and Li-Fi uses PTP [Point-To-Point] network topology. Li-Fi uses hundreds of Tera Hz operating frequency and Wi-Fi uses only 2.4GHz as its operating frequency.

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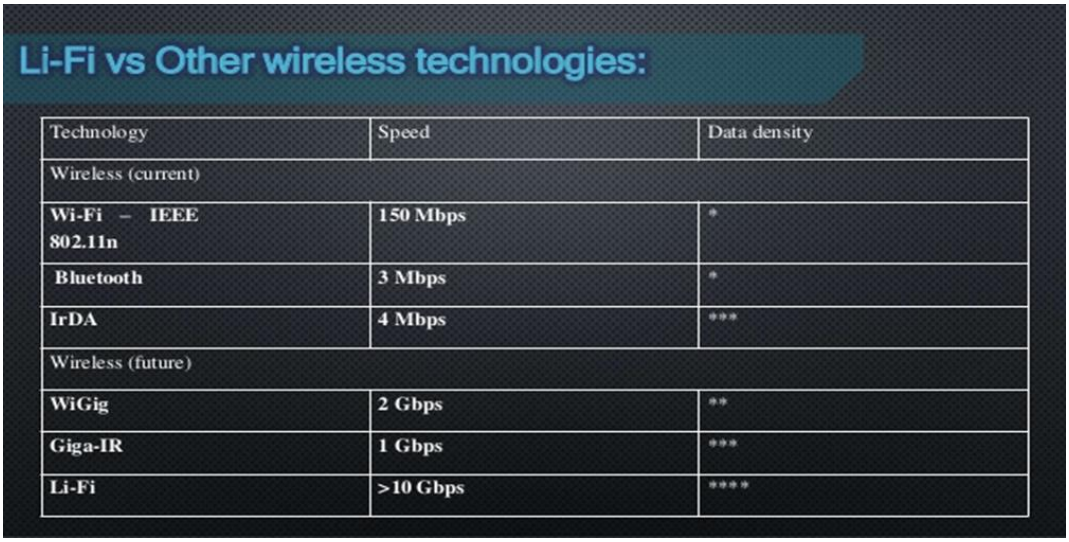

Fig.2.COMPARISON OF LIFI TO OTHERS

VIII.ADVANTAGES OF LIFI

Li-Fi has the advantage of being useful in electromagnetic sensitive areas such as hospitals, nuclear power plants and aircraft cabins without electromagnetic interference. Li-Fi technology uses visible light spectrum instead of radio frequency bandwidth, these visible light spectrum can solve problems related to insufficiency of radio frequency bandwidth. Data transmission is high upto 10gbps.It provides more security and privacy because it does not penetrate through walls and provides secured access. It will come under low budget project. It is safer and human friendly since it does not penetrate human body. Li-Fi is expected to be 10 times cheaper than Wi-Fi. Long duration or long life of LED bulbs saves money. Light is present everywhere and provides a free band which does not requires any license.

Provides high installation costs but very low maintenance cost. Free from monthly broadband bills only low electricity bills. It speeds upto 1 GB per second and provides less energy and time consumption. Li-Fi technology is expected to be implemented within 20 years. It provides a green environment without the use of radio wave spectrum. Because of the use of light spectrum it can be implemented in areas where radio waves cannot do its part in some fields such as hospitals, under water research, aircraft cabins, etc.

- *HEALTH TECHNOLOGIES*:

As Wi-Fi technology is not admitted inside the operating rooms of hospitals due to radiation concerns and also there is a whole lack of dedicated spectrum. If Wi-Fi is implemented in hospitals the cell phones and computer signals can interfere and block the monitoring equipment. But Li-Fi technology can solve both these drawbacks because of light intensity. Li-Fi spectrum is 10,000 times to that of Wi-Fi, so we can neglect red light to priority medical data. As it is difficult to use optic fibres in places like hospitals, it can be replaced by Li-Fi. Using this technology modern medical instrument can be used in operation theatres.

- *AIRLINES*:

Airlines need Wi-Fi technology to provide captive audience for the service of “dial-up” on the plane for every passenger and it is too expensive. In future, Li-Fi technology will introduce the sort of speech to each passenger providing high-speed connections on airlines. It would also be interruption free from other wireless signals available on the board.

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- *POWER PLANTS*:

Radiation waves like Wi-Fi and many other are bad for sensitive areas and areas that are surrounding power plants. It needs fast and inter-connected data systems to monitor the things in detail like demand, grid integrity and core temperature. The proper monitoring at a single power plant can add savings upto hundreds of, thousands of dollars. This technology can also be used in petroleum or chemical plants since other transmissions or frequencies could be hazardous.

- *UNDERWATER AWESOMENESS*:

Radio waves cannot penetrate into water, so to make underwater researches Li-Fi technology can be used. We can use large cables to operate and supply their power and allow receiving signals pilots above the water surface. Head lamps are used by the researchers to communicate with each other.

- *TRAFFIC MANAGEMENT*:

Apart from other implementations Li-Fi technology can also be used in traffic management by transmitting signals, Such that LED lights of cars can be connected to communicate between them so that accident numbers can be decreased eventually. To transfer data thousands and millions of street lamps can be transfers to Li-Fi lamps.

IX.CONCLUSION

The possibilities and implementations for this technology are numerous and can be further explored in future. As population explosion and their numerous devices to access wireless internet the airway becomes clogged increasingly thus making the access of internet more and more difficult to get reliable and high-speed signal. This technology solves issues of radio frequency bandwidth shortage and allows net access where traditional radio based wireless services cannot be implemented, places such as hospitals, aircraft cabins, under water and power plants. Every light bulb can be used as a source or hotspot for this technology to transmit wireless data to make the environment safer, greener and brighter future.

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