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Li-Fi: Light Fidelity Technology-A Review

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Abstract: 21st century has witnessed many technological innovations which have redefined the way we communicate with each other and this pace of technological innovation is increasing with each passing day Li-Fi stands for light fidelity this technology was first proposed by a German physicist Prof. Herald Haas it is a data transmission technique which utilizes light or illumination as a medium of communication Herald Haas proposed this technology which he calls "data through illumination" taking the fibre out of fibre optic by sending data through an LED bulb that varies in intensity faster than the human eye can follow it transmits data using the spectrum of visible light Haas coined term D-light for his invention which he claims can produce data rates faster than 10 Mbps this paper will explore this new technology its genesis, advantages, limitations and future scope.

Keywords: Li-Fi, D-light, data transmission, LED.

I. INTRODUCTION

In present day computer communication and Internet access wireless(Wi-Fi) technology has acquired a pivotal role due to its various benefits most prominent one being portability everyone wants to avail the benefits of wireless technology but due to its excessive usage it is facing many challenges like capacity, availability, efficiency and security to counter this situation light fidelity(Li-Fi) technology was introduced by German physicist Herald Haas from University of Edinburgh, UK, in his TED Global talk on Visual Light Communication. Prof Haas has founded a company called Pure LIFI to carry on work in the field of this new technology the company's mission statement is:

"Pure LiFi seeks to resolve the global struggle for diminishing wireless capacity by developing and delivering technology for secure, reliable, high speed communication networks that seamlessly integrate data and lighting utility infrastructures and significantly reduce energy consumption."

Li-Fi is transmission of data through illumination by taking the fibre out of fibre optics by sending data through an LED light bulb that varies in intensity faster than the human eye can follow. Li-Fi is transmission of data through illumination using LED light bulbs, this term is used to label fast and cheap communication system which is an advanced version of Wi-Fi or say it the optical version of Wi-Fi. When the LED switched on digital 1 is transmitted and when it's off digital 0, thus can be switched on and off very quickly Li Fi would use transceiver fitted LED lamps that can glow a room as well as transmit and receive information

II .WORKING PRINCIPLE

In Li-Fi technology there is a light source at one end like an LED and a photo detector on the other end as soon as LED starts glowing, photo detector on the other end will detect light and get a binary1 otherwise binary 0 VLC(visible light communication) is a data communication medium, which uses visible light between 400 THz (780 nm) and 800 THz (375 nm) as optical carrier for data transmission and illumination. It uses fast pulses of light to transmit information wirelessly. The main components of this communication system are 1) a high brightness white LED, which acts as a communication source and 2) a silicon photodiode which shows good response to visible wavelength region serving as the receiving element Li-Fi is typically implemented using white LED light bulbs at the downlink transmitter [1]. 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 so what you require at all are some LEDs and a controller that code data into those LEDs we have to just 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 10 Gbps- meaning you can download a full high-definition film in just 30 seconds [1].

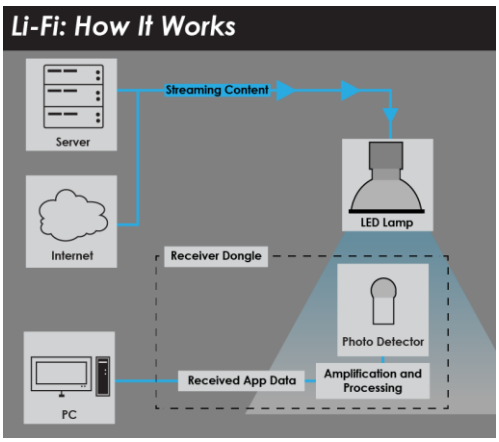

Fig 1 working principle of Li-Fi

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The main component of this communication system is a high brightness white LED which acts as a communication source and a silicon photodiode LED can be switched on and off to generate digital strings of 1's and 0's data can be encoded in the light to generate a new stream by varying the flickering rate of LED by modulating LED light with data signal the LED illumination can be used as a communication source a data rate greater than 100 Mbps is possible by using high speed LED's with approximate multiplexing techniques. Standard LED light bulbs are controlled by a driver that turns the LED on and off or dims and brighten it with Li-Fi enabled LED light bulbs, the driver is used to transmit encoded data by controlling the LED light an optical sensor is used to receive the data, which is then decoded the receiver has optics, and is fast enough to 'see' the light dimming and brightening, smart enough to decode the Li-Fi data, and then deliver it to the attached device such as a laptop computer, a receiver dongle converts tiny charges in amplitude into an electrical signal which is then converted back into a data stream and transmitted to a device.

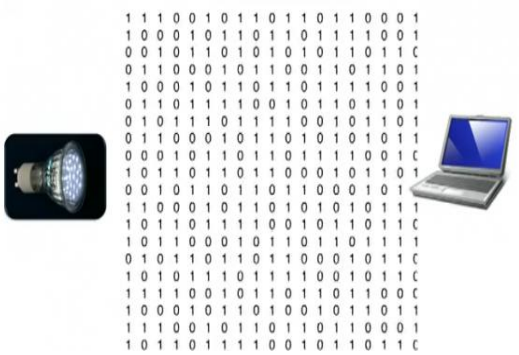

Fig2. Li Fi data transmission

Li-Fi communication is structured according to communication Protocols set forth by the IEEE 802 workgroup. The proposed plan is to establish a wireless network using visible light the visible light is termed as electromagnetic radiation in the range of wavelengths from about 390 to 700 nm corresponds to a frequency band of 430-790 THz

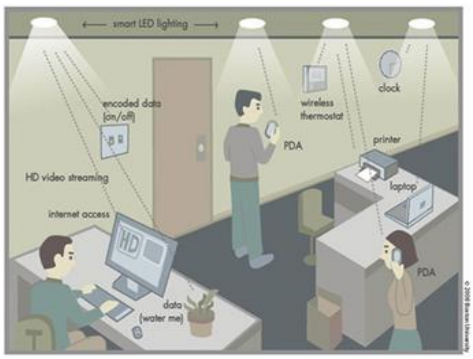

Fig 3 Li-Fi environment

III. LI-FI & WI-FI

- Wi-Fi stands for wireless fidelity and Li-Fi stands for light fidelity
- Wi-Fi transmits data using radio waves Li-Fi transmits data using light with the help of LED bulb
- Wi-Fi suffers from interference and its signals cannot pass through denser regions Li-Fi suffers less interference as compared to Wi-Fi
- Wi-Fi signals are not blocked by walls on the contrary Li-Fi signals get blocked hence more privacy and security is ensured than Wi-Fi.
- Wi-Fi has demonstrated maximum data rate of 1Gbps in case of Li-Fi its pioneer Prof. Haas demonstrated data of 3Gbps
- Wi-Fi creates electromagnetic interference which interferes with airplane signals and equipment's in hospitals which can prove to be hazardous Li-Fi uses light which does not create any EMI hence its safer in those circumstances
- Li-Fi utilizes spectrum of visible light which is more than the spectrum of radio waves hence capacity provided by Li-Fi is much higher
- In Li-Fi data transmission takes place using bits Wi-Fi utilized radio waves for transmission.
- Li-Fi has an effective range of 10 meters in case of Wi-Fi its 20-100 meters
- Li-Fi is a point- to -point network technology Wi-Fi is point- to- multi point network technology
- Li-Fi is cheaper as utilization of light spectrum does not need a license on the other hand radio spectrum needs a license hence Wi-Fi is expensive.
- Wi-Fi uses radio frequencies, and these are very limited. Devices like computers, laptops, printers, smart TVs, smartphones and tablets must compete for bandwidth hence there is problem of congestion Li-Fi uses the frequencies of light waves, which are up to 10,000 times more plentiful than radio frequencies and do not compete with Wi-Fi.

IV. APPLICATIONS OF LI-FI

- **Healthcare Industry:** In operating rooms all over the world there are many health monitoring equipment's which play a crucial role in patients treatment Wi-Fi is in place in most hospitals but interference from phones and computers can block and distort signals from the health monitoring equipment so operating rooms do not allow Wi-Fi signals inside them in such a scenario Li-Fi can solve the problem lights are not only allowed in operating rooms, but tend to be the most glaring fixtures in the room moreover the spectrum of light is much larger than radio waves.

- **Internet Access in Airplanes:** Wi-Fi is not used abroad airplanes as the radio waves can cause interference with the pilots radio signal which can compromise the safety of the plane so to overcome this shortcoming we can use Li-Fi inside the plane to access high speed Internet moreover as this technology is based on light waves so it won't interfere with the planes radio signals also the surfing speed would be much higher than Wi-Fi Internet.

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- **Power Plants:** Power plants are a vital entity of energy sector infrastructure of a nation in such plants safety is a prime concern especially in nuclear capability ones Wi-Fi radio waves can interfere with the signals of sensitive machines on the factory floor and produce erroneous results so in such sensitive environment Li-Fi technology can come to our rescue as the light waves on which it depends for its operation does not produce any EMI and interfere with radio signals
- **Education and Entertainment:** According to Prof. Haas the speed of Internet on Li-Fi would be much higher than that of the Wi-Fi this was also demonstrated by him moreover the capacity of light spectrum is much larger than that of radio waves so this advantage of speed and capacity can redefine and revolutionize the Internet usage in education and entertainment domain.
- **Intelligent Transport System**: LED equipped headlight and backlights, where the cars can talk to each other and react faster when they are Li-Fi enabled. Traffic lights and street lights can talk to each other and also to the cars which can indeed reduce the number of accidents [2].
- **Smart Museums:** Another area where communications and radiation levels are intensely monitored, museums have strict rules about the environments where they store their treasures Li-Fi could enable a museum to deliver much more information on prices in their collection than those tiny cards they paste to the walls could ever dream of you could learn about the artist's history, listen to an audio tour, peruse recent auctions of their work, and may be even stream [1]
- **Underwater:** Radio wave cannot propagate underwater due to its property but light can we could envisage communication system such as divers can talk to each other with their lights. Remote under sea operated vehicles works with large cable that supply their power and send the signal information from their pilots above the sea. When the cable is not long enough to explore an area there is nothing that we can do but with Li-Fi we could be cable to replace the cable and only communicate with light [3].
- **Ease of accessibility:** The numerous light bulbs and lamps that dot the streets and lanes all over the world have the potential of becoming access point for high speed Internet access if Li-Fi technology is implemented in its true sense not only street lamps but light sources in homes, offices and other public places

V. CHALLENGES

- Li-Fi requires Line of Sight just like in the case of Infrared (IR) so its effectiveness is nulled if line of sight is not maintained.
- The problem of how the receiver will transmit back to the transmitter still persists.
- Light waves get easily be blocked by dense bodies and cannot penetrate thick walls like the radio waves can.
- Due to dependence on the light source for internet access if the light source malfunctions, we lose access to the internet.

VI. CONCLUSION

The concept of Li-Fi proposed by Prof. Haas has opened a new chapter in the domain of data transmission and is receiving due attention from researchers all over the world this technology is poised to become an alternative to Wi-Fi technology this concept is still in its nascent stages but has tremendous potential for growth. Li-Fi has shown promising solution in scenarios where interference by Wi-Fi signals is unwelcomed like airplanes, operating rooms and power plants it also has its own set of limitations regarding necessary condition of line of sight and blocking of light by dense bodies but in due course of time this technology will undergo many facelifts and is all set to redefine the field of data transmission

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