

# Li-Fi: Light Fidelity

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**Abstract**—Technology is a deep ocean and the more we get deeper into it the more treasured it gets. With better technology in the world of software, the need for better connectivity and internet has rose over the years and so has the demand for a more and better spectrum. The invention or rather discovery of Li-Fi, has somehow quenched the thirst for more spectrum. Light Fidelity or better known as Li-Fi has sworn in as a savior and has provided the world an alternative to the more conventional and monotonous applications like Wi-Fi, Bluetooth etc. Discovered by Prof. Harald Haas, at the University of Edinburgh in UK, Li-Fi provides a mindboggling internet connectivity with a download speed up to 10GB/s and that too with the use of the basic LED lights. It works in the visible light spectrum from BLUE to RED and overcomes the drawbacks faced by the likes of UV Rays, X-Rays, and GAMMA Rays. It works by the principle of data through illumination. Its applications in the field of Medicine and in Sea and oceans make it a wonderful thing in itself. It is considered to be a big thing and have a big global market in the upcoming decade and leave humanity and technology spellbound.

**Key words:** Wireless Fidelity (Wi-Fi), Light Fidelity (Li-Fi), Light Emitting Diodes (LED)

## I. INTRODUCTION

Li-fi basically known as —light fidelity is an outcome of twenty first century. The basic ideology behind this technology is that the data can be transmitted through LED light whose intensity varies even faster than the human eye. As the transmission of the data takes place through the light emitting diodes (LED's) the amount is comparatively small. In modern times, it is called as the optimized version of Wi-Fi. In simple terms, Li-Fi can be thought of as a light-based Wi-Fi. That is, it uses light instead of radio waves to transmit information. This technology uses a part of the electromagnetic spectrum that is still not greatly utilized- The Visible Spectrum. Light is in fact very much part of our lives for millions and millions of years and does not have any major ill effect. As there are more and more devices coming up day-by-day the signals are being clogged up due to heavy traffic, there arise a need for an error free transmission technology and the solution to this problem was the Li-fi technology. It has been designed in such a way that it overcomes the disadvantages that occurs during the usage of Wi-Fi. As there is a limited amount of Radio based wireless spectrum available a number of companies formed a consortium called Li-fi consortium in order to promote high speed optical wireless systems. The member of this consortium believes that a speed of 10Gbps can be achieved in no time. If this would be possible then a high clarity image would take about 30 seconds to download!



Fig. 1: An illustration of its working

## II. HISTORY

Professor Harald Haas, from the University of Edinburgh in the UK, is widely recognized as the original founder of Li-Fi. Harald Haas continues to hit the world that there is a possibility for communication through light. LI-FI technology has the possibility to change how we access the internet, stream videos, receive emails and much more. Experiments have shown that LEDs can be electronically adapted to transmit data wirelessly as well as to provide light. VLC is faster, safer and cheaper than other forms of wireless internet, advocates say – and so could eliminate the need for costly mobile-phone radio masts Haas has a small lab stuffed with equipment, including the now-famous table lamp and its box of electronics. Haas's invention centuries on how these signals are modulated: the information, embedded within visible light emitted from the LEDs, is transmitted by means of many subtle changes made to the intensity of the light at the ultra-high rate of 100 million cycles per second (100MHz). In October 2011 a number of companies and industries formed the Li-Fi Consortium, to promote high speed optical wireless

system sand to enhance the limited bandwidth provided by radio based light communication is this method of using rapid pulses of light to transmit information wirelessly.

### III. PRESENT SCENARIO

At present we have as many as 1.5 million radio wave base stations across the globe. We also have close to 5 billion mobile connections which transmit a data over 600TB. This penetration of mobile devices into our lives has led to a wide recognition of WI-FI technology. Radio Spectrum is congested but the demand for wireless data double each year .Everything, it seems want to use wireless data but the capacity is drying up. So what can carry this excess demand in the future?

### IV. WORKING

#### A. Basic Concept:

Li-Fi technology is a wireless communication system based on the use of visible light between the blue (670 THz) and red (480 THz). Unlike Wi-Fi which uses the radio part of the electromagnetic spectrum, Li-Fi uses the optical spectrum. The principle is simple: the LED turns on and off at high speed and is not visible to humans. This ribbon of on and off signals is interpreted to create binary streams of 0 and 1. Because there are no battling light frequencies like that of the radio frequencies in Wi-Fi, Li-Fi is thought to be 80% more efficient. Which means it can reach speeds of up to 1Gbps. Li-Fi differs from fiber optic because the Li-Fi protocol layers are suitable for wireless communication over short distances (up to ten meters). This puts Li-Fi in a unique position of extremely fast wireless communication over short distances. The technology has already attained IEEE standard certification and is currently being tested at the Oledcomm headquarters in France.

#### B. Way of Working:

The working procedure is very simple, if the light is on then transmits a digital 1, if it's off transmit a 0. The LEDs can be switched on and off very quickly which gives nice opportunities for transmitting data. Hence all that required is some LEDs and a controller that a code data into those LEDs. All one has to do is to vary the rate at which the LEDs flicker depending upon the data want to encode. Further enhancements can be made in this method, like using array of the 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.

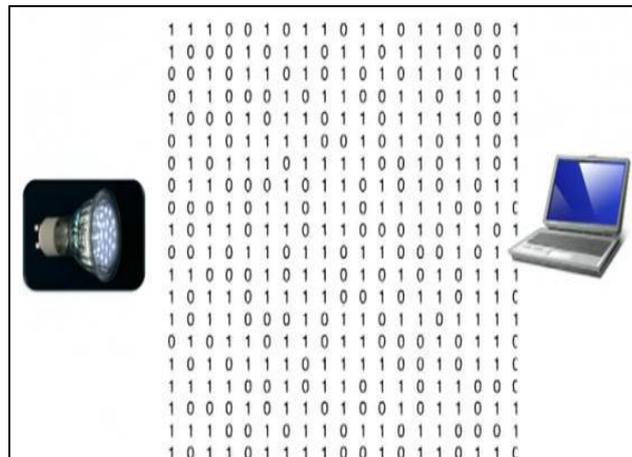


Fig. 2: Data transfer in binary

#### C. Need For Visible Light Communication:

At first, Radio waves are expensive and less secure. Infrared, due to eye safety regulation can only base with low power. Gama rays cannot be used as they could be dangerous. Ultraviolet light is good for place without people, but otherwise dangerous for the human body. But, visible rays is safe to use larger bandwidth. VLC 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. Fast pulses are used for wireless transmission.

#### D. Components:

- A high brightness white LED which acts as a communication source.
- Silicon photo diode which shows good response to visible wavelength region.

#### E. Use of Fiber Optics cables:

This is mainly done because transmission of light through it is possible without having much losses. Data is sent in 1's and 0's.

#### F. Implementation:

Li-Fi is typically implemented using white LED light bulbs at the downlink transmitter. 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. Implementation of Li-Fi given in the figure. In figure a internet connection is connected to the lamp driver. A switch connected with lamp driver and LED lamp also connected this lamp driver through fiber optics cable. Now a receiving device named photo detector is using for receive signal and processing, this device is connected with PC or Laptop's LAN port. On one end all the data on the internet will be streamed to a lamp driver when the LED is switched on the microchip converts the digital data in form of light. The light sensitive device photo detector receives the signal and converts it back into original data. This method of using rapid pulses of light to transmit information wirelessly is technically referred as Visible Light Communication.

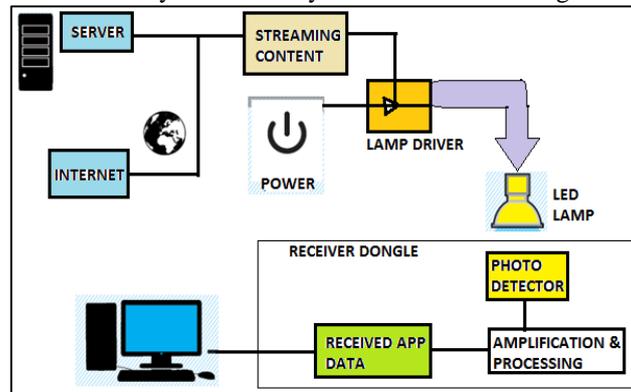


Fig. 3: Block Diagram of working

## V. APPLICATIONS

There is a wide necessity for data transfer and by the end of the day every field involves the use of technologies. one such technology is Li-Fi which can have its applications extended in areas where the Wi-Fi technology lack. Some of them are:

- Spectrum Relief: This refers to the excess capacity demands of cellular networks can be off-loaded to Li-Fi networks where available. This is especially effective on the downlink where bottlenecks tend to occur.
- Mobile Connectivity: Laptops, smart phones, tablets and other mobile devices can interconnect directly using Li-Fi. Short range links give very high data rates and also provides security.
- Hazardous Environments: Li-Fi provides a safe alternative to electromagnetic interference from radio frequency communications in environments such as mines and petrochemical plants.
- Aviation: Li-Fi can be used to reduce weight and cabling and add flexibility to seating layouts in aircraft passenger cabins where LED lights are already deployed. In-flight entertainment (IFE) systems can also be supported and integrated with passengers' own mobile devices.
- Underwater Communications: Due to strong signal absorption in water, RF use is impractical. Acoustic waves have extremely low bandwidth and disturb marine life. Li-Fi provides a solution for short range communications.
- Reduction in accident numbers: LED headlights and tail-lights are being introduced. At traffic signals, we can use LIFI in order to communicate with LED lights of the cars by the number of accidents can be reduced. Data can be easily transferred by making use of LIFI lamps with the street lamps. This can be used for vehicle-to-vehicle and vehicle-to-roadside communications. This can be applied for road safety and traffic management.
- RF Avoidance: Some people claim they are hypersensitive to radio frequencies and are looking for an alternative. Li-Fi is a good solution to this problem.
- Location Based Services (LBS): Highly accurate location-specific information services such as advertising and navigation that enables the recipient to receive appropriate, pertinent information in a timely manner and location.
- Airlines: Airline Wi-Fi, nothing says captive audience like having to pay for the "service" of dialup speed Wi-Fi on the plane. The best so far is that passengers will "soon" be offered a "high-speed like" connection on some airlines. United is planning on speeds as high as 9.8 Mbps per plane.
- Smarter Power Plants: Wi-Fi and many other radiation types are bad for sensitive areas. Like those surrounding power plants. But power plants need fast, inter-connected data systems to monitor things like demand, grid integrity and (in nuclear plants) core temperature. The savings from proper monitoring at a single power plant can add up to hundreds of thousands of dollars. Li-Fi could offer safe, abundant connectivity for all areas of these sensitive locations. Not only would this save money related to currently implemented solutions, but the draw on a power plant's own reserves could be lessened if they haven't yet converted to LED lighting.
- Education systems: As with the advancement of science the latest technology is the LIFI which is the fastest speed internet access service. so this will leads to the replacement of WIFI at institutions and at companies so that all the people can make use of LIFI with same speed intended in a particular area. E.g. Schools, Colleges, Universities etc.
- Extends our life span: For a long time, medical technology has lagged behind the rest of the wireless world. Operating rooms do not allow Wi-Fi over radiation concerns, and there is also that whole lack of room, dedicated spectrum. While Wi-Fi is in places like in many hospitals, interference from cell phones and computers can block signals from monitoring

equipment. Li-Fi solves both problems: lights are not only allowed in operating rooms, but tend to be the most glaring (pun intended) fixtures in the room.

- Replacement for other technologies: This technology doesn't deal with radio waves, so it can easily be used in the places where Bluetooth, infrared, WIFI and Internet are banned. In this way, it will be most helpful transferring medium for us.
- It also provides better safety unlike Wi-Fi.

## **VI. FEATURES**

- Bandwidth: It provides a bandwidth which is 10,000 times more than that of RF and which is unlicensed and is also free to use.
- Data density: Li-Fi can achieve about 1000 times the data density of Wi-Fi because visible light can be well contained in a tight illumination area whereas RF tends to spread out and cause interference.
- High speed: Very high data rates can be achieved due to low interference, high device bandwidths and high intensity optical output.
- Planning: Capacity planning is simple since there tends to be illumination infrastructure where people wish to communicate, and good signal strength can literally be seen.
- Another point is the user can see where the data is going; there is no need for additional security such as pairing for RF interconnections such as Bluetooth.
- Environment: RF transmission and propagation in water is extensively difficult but Li-Fi works well in this environment.
- Low cost: It requires much fewer components than radio technology.
- Energy: LED illumination already has good efficiency and the data transmission requires negligible additional power.
- Safety: Life on earth has evolved through exposure to visible light. There are no safety or health concerns which are known for this technology.
- Non-hazardous: The transmission of light avoids the use of radio frequencies which can dangerously interfere with electronic circuitry in certain environments
- Containment: It is difficult to eavesdrop on Li-Fi signals since these signals are confined to a closely defined illumination area and will not travel through walls.

## **VII. CONCLUSION**

The Idea of Li-Fi technology currently attracting us a great deal of interest because it's latest and very efficient alternative to radio-based wireless technology. The possibilities are very large, numerous and can be explored further. If this technology is put into practical use, every bulb can be used for something like a Wi-Fi hotspot which transmits wireless data and we can proceed toward a cleaner, greener, safer and brighter future. As a growing number of people and their many devices access wireless internet, the airwaves are becoming increasingly clogged, making it more and more difficult to get a reliable, high speed signal. "Li-Fi seeks to resolve the global struggle for diminishing wireless capacity by developing and delivering technology for a secure, reliable and a high speed communication networks that seamlessly integrates data and lighting utility infrastructures and significantly reduced energy consumption." said by Harald Haas. It is considered to be a big thing and have a big global market in the upcoming decade and leave humanity and technology spellbound.

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