

# LI-FI Technology – A Visible Light Communication

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**Abstract**— At the time of using wireless internet at any place whether it is own or stealing from others, one has probably gotten frustrated because of the slow speed of internet when more devices are connected to a single router. Due to increasing of internet users exponentially, Radio Spectrum is congested but the demand for wireless data double each year. Dr. Harald Haas has come up with a solution for those he calls “Data through illumination”. LI-FI is a new epoch of high intensity light source of solid state design which bring clean lighting solutions to general and specialty lighting. LI-FI is now part of the VLC as is implemented using white LED light bulbs. Data transmission takes place from this LED bulb by varying the current at extremely high speeds which undetectable by the human eye.

**Keywords**— *LI-FI, WI-FI, Visible Light Communication, Radio Spectrum*

## I. INTRODUCTION

Harald Haas was coined the term LI-FI and promoted LI-FI in his 2011 TED Global talk by giving demonstration of an LED light bulb to transmit a video with the speed more than 10 Mbps.

German scientists succeeded in 2011 to creating an 800Mbps (Megabits per second) capable wireless network by using nothing more than normal red, blue, green and white LED light bulbs, thus the idea has been around for a while and various other global teams are also exploring the possibilities.

In simple terms, LI-FI can be thought of as a WI-FI based on light as it uses light instead of radio waves to transmit information. Instead of WI-FI modems or routers, LI-FI uses transceiver-fitted LED lamps that can be used as a light or for transmission of the data communication through internet [4].

This technology uses a visible light communication spectrum and has not major ill effect as we know that the light is very much part of our life. Moreover in this spectrum 10,000 times more space is available and it also multiplies to 10,000 times more availability as a light bulb and street bulbs are available already [3][5].

The figure-1 shows the environment with the LI-FI technology where light bulbs are used as a data communication medium to PC, Laptop, Tablet and PDA as it all have photo detector connected to it as receiver.

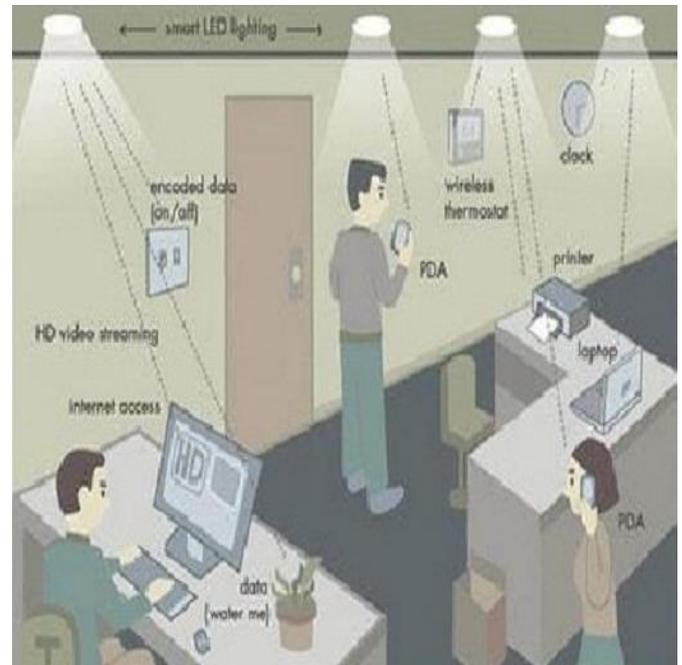


Figure 1: Environment with LI-FI Technology

## II. WORKING TECHNOLOGY

LI-FI is implemented using white LED light bulbs which used for illumination by applying a constant current. However, by fast variations of the current, the light output can be made to vary at extremely high speeds. If the LED is on, it transmits a digital 1 otherwise it transmits a digital 0. The LEDs can be switched on and off quickly to transmit the data that can't be detected by a human eye [7].

There are also some enhancement could be made, like using an array of LEDs for parallel transmission, or using amalgamation of basic three colour's i.e., red, green and blue LEDs as different frequency with each having a different data channel. To further get a grasp of LI-FI consider an IR remote. It sends a single data stream with 10-20 kbps speed. Now if we replace the IR LED with a large LED array then that can be capable of sending thousands of such streams at a very fast rate [2].

The figure-2 shows the working principle of a LI-FI.

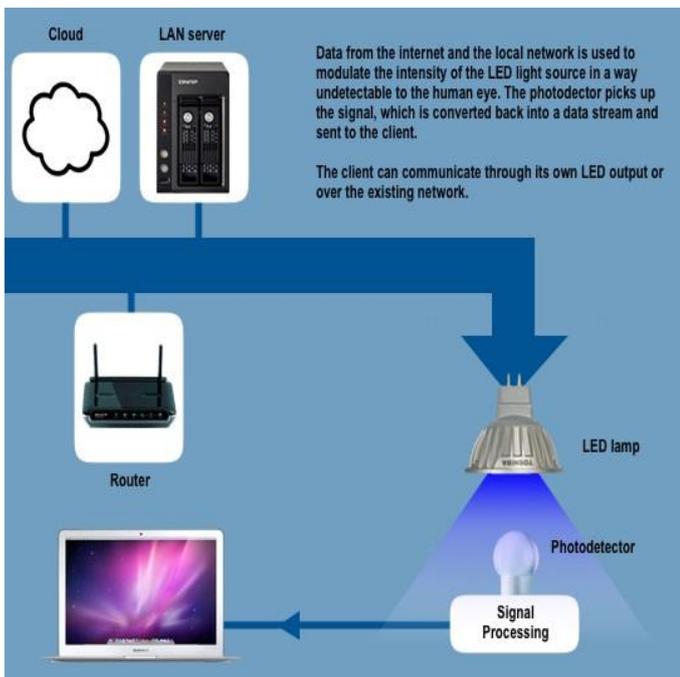


Figure 2: Working Principle of LI-FI Technology

Transmission of data is done by single LED or multi LED through a visible light as shown in below figure-3. On the receiver side there is a photo detector, which convert this light into electric signals and it will give to the device which connected to it. Voltage regulator and level shifter circuits are used on both the side to convert or maintain a voltage level between transmitter and receiver.

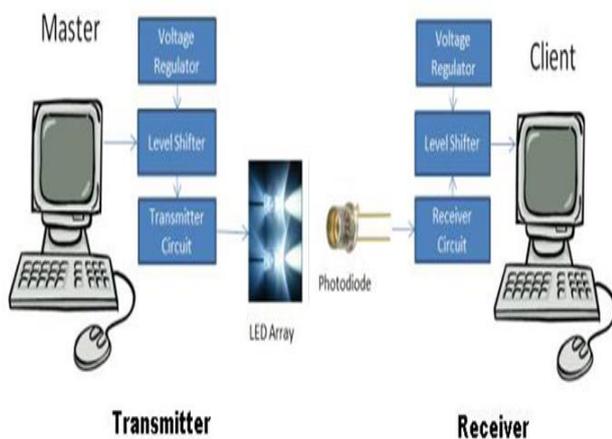


Figure 3: Transmission and Reception in LI-FI

### III. BRIGHTNESS OF LI-FI SOURCE

The LI-FI source has a very high amount of light emitted per second in a unit solid angle from a uniform source (light intensity). A single source with only a few millimetres in size can produce 2300 lumens of brilliant white light. In most cases, it will only need to use one light source per street light. It makes the mechanical and optical implementation of light much simpler and less expensive.

### IV. APPLICATION & ADVANTAGES

**Airways:** We were facing the problem in communication media at the time of travelling in the airways, because the whole airways communications are performed on the basis of

radio waves. We can overcome this drawback by using LI-FI technology as shown in below figure-4.



Figure 4: LI FI in Airways

**Fill Green information technology:** LI-FI never gives any side effects on any living thing like radio waves and other communication waves which effects on the birds, human bodies, etc.

**Free From Frequency Bandwidth Problem:** LI-FI is a visible light communication medium, so it does not require any kind of spectrum license i.e. we don't need to pay any amount for communication and license.

**Smarter Power Plants:** Power plants need fast and data systems with interconnected to monitor things like grid integrity, demand and (in nuclear plants) core temperature and Wi-Fi could not work properly in these areas as these are more sensitive to radio frequency like as in petrochemical plants.

LI-FI could work properly in these sensitive areas and it also saves money.

**Increase Communication Security:** Light can't penetrate to the wall so in visible light communication, security is higher than any other communication technology as shown in below figure-5.



Figure 5: Communication Security

**Multi User Communication:** LI-FI helps to share multiple things at a single instance which supports the broadcasting of network as shown in figure-6.

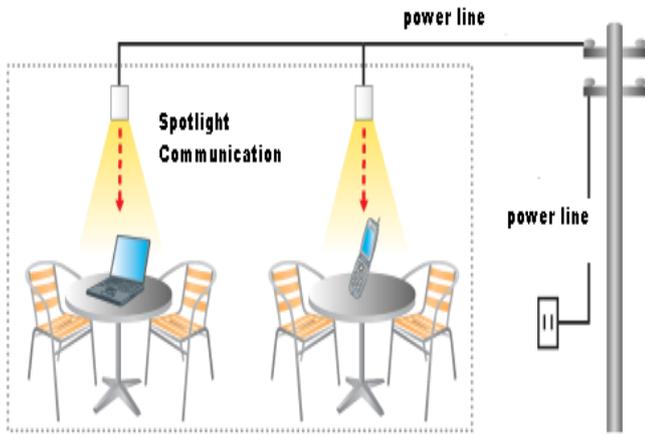


Figure 6: Multiuser Communication

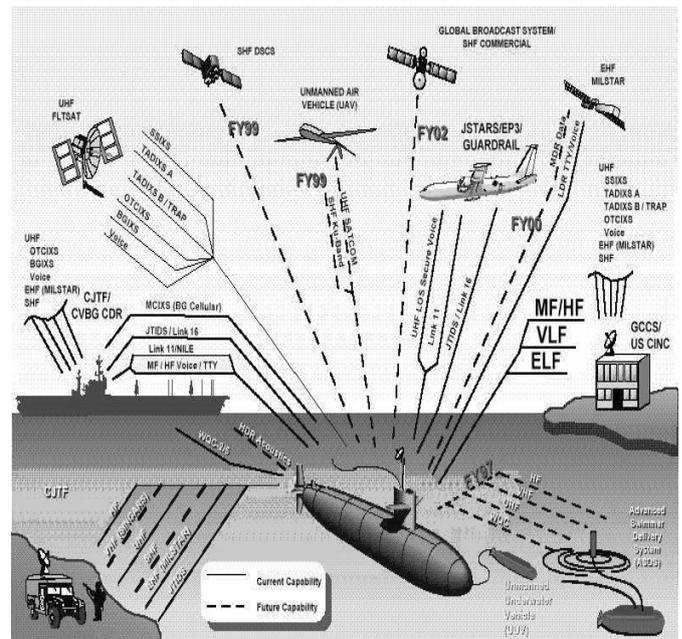


Figure 8: Underwater Communications

**Lightings Points Used as Hotspot:** Any lighting devices like car lights, ceiling lights, street lamps, etc. are performed as a hotspot. It means that the any light able to spread internet using visual light communication which helps us to low cost architecture for a hotspot. The hotspot is a limited region in which some amount of device can access the internet connectivity [5].

Traffic lights also can communicate to the car and with each other as cars have LED-based headlights, LED-based back lights, and cars can communicate with each other and prevent accidents in by exchanging information as shown in below figure-7.

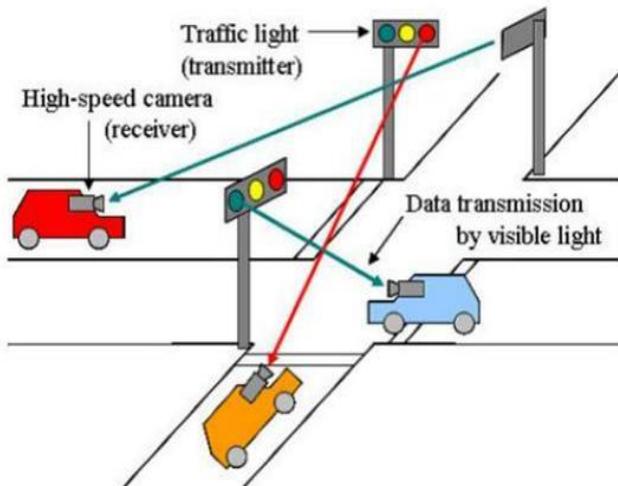


Figure 7: Road to Vehicle Visible Light Communications

**Undersea Awesomeness:** Underwater there are large cables that supply power and allow receiving signals from others but if their wires were cut and replaced with light — say from a descend below the surface of water, high-luminance lamp — then they would be much freer to explore. They could use their lamps to communicate with each other [1] as shown in figure-8.

V. COMPARISON WITH OTHER TECHNOLOGY

**Capacity:** With the advent of new technologies like 3G, 4G we are running out of radio spectrum as its capacity are drying up. Compare to this VLC spectrum has more spectrum space than radio spectrum as light boxes are already present and already installed.

**Efficiency:** There are 14 lacks cellular radio base stations with efficiency of each station is just 5%. In base station most of the energy has been used for cooling system. Li-Fi is highly efficient because LED consumes less energy.

**Security:** Radio waves can penetrate through walls and hence can be intercepted and misused it. Light waves do not infiltrate through walls. Hence they can't be intercepted.

**Availability:** We have to switch off mobiles in aircrafts and petrol pump is also area where mobile phones are restricted. Light is present everywhere. Data is present where light is present. The comparison of LI-FI speed with other technology is as given in below Table-1.

TABLE I. COMPARISON

TECHNOLOGY	SPEED	DATA DENSITY
<b>WIRED</b>		
Fire Wire	800 Mbps	*****
USB 3.0	5 Gbps	*****
THUNDERBOLT	2 X 10 Gbps	*****
<b>WIRELESS (CURRENT)</b>		
WI-FI-IEEE (802.11N)	150 Mbps	*
Bluetooth	3 Mbps	*
IrDA	4 Mbps	***
<b>WIRELESS (FUTURE)</b>		
Wi-Gig	2 Gbps	**
Giga-IR	1 Gbps	***
LI-FI	>10 Gbps	****

## VI. CHALLENGES FOR LI-FI

Apart from many advantages over Wi-Fi, Li-Fi technology is facing some problems such as Li-Fi requires line of sight. Receiving device would not be shift in indoors. A major challenge is how the receiving device will transmit data back to transmitter. Other disadvantage is visible light can't penetrate through brick walls as radio waves and is easily blocked by somebody simply walking in front of LED source [6].

## VII. CONCLUSIONS

If LI-FI technology can be put into practical use, every bulb used to transmit a data and will lead toward the cleaner, greener, safer and brighter future. LI-FI may solve issues such as the shortage of radio-frequency bandwidth and is aimed at creating new communication channels with the use of existing equipment. Currently, the LI-FI concept is attracting a great deal of interest, because it provides an authentic and very efficient alternative to wireless device which used radio spectrum.

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