

## LED and laser ,the backbone and essence of Visible Light Communication (VLC)

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**Abstract**—“Wi-Fi has made revolution all around in today’s world. It’s everywhere is available with ease ; your neighbours have it, it’s free in coffee shops, and essential for smartphones. Our world of information is incomplete till we do not Wi-Fi . It has shown a magic . We all know and well aware with Wi-Fi, but what is Li-Fi, the future green , clean and the energy efficient communication system.”

{ Li-Fi, like Wi-Fi, enables electronic devices like computers, laptops and smartphones to wirelessly connect to the Internet. Even though Wi-Fi was also originally intended for such devices, it is widely used today to connect all sorts of things: printers, televisions, speakers, headphones, and even running shoes! In simple terms, Li-Fi is equivalent to Wi-Fi, but using light waves instead of radio signals. In this direction, Dr Harold Haas, a German physicist proposed an idea called “Data through Illumination” in which he used fiber optics to send data through LED light bulb. The idea is similar as of infrared remote controls but far more powerful. So imagine a modern LED light bulb – fitted with Li-Fi technology – in your living room, or office, or in a lamp on your desk, or by your bedside. Anywhere that is illuminated by the Li-Fi enabled LED, can also communicate via Li-Fi.}

**Keywords :**[Wi-Fi, Li- Fi, VLC, Visible light communication, LED, OWC ,RF, OPA381].

### I. INTRODUCTION

#### 1.1 Light Fidelity (Li-Fi)

**L**IGHT Fidelity (Li-Fi) is a bidirectional high-speed and fully networked wireless communication technology similar to Wi-Fi. The term was coined by Harald Hass and is a form of visible light communication and a subset of optical wireless communication (OWC) and could be a complement to RF communication, or even a replacement in contexts of data broadcasting. It is so far measured to be about 100 times faster than some Wi-Fi implementations, reaching speeds of 224 gigabits per second.

Li-Fi deals with transfer of data through illumination by taking fiber out of optics by sending data through a LED light bulb that varies in the intensity faster than a human eye can predict. Dr Haas amazed people by streaming HD video from a standard LED lamp, at TED Global in July 2011 and thereby coined the term Li-Fi. Li-Fi is now part of visible

light communication (VLC) PAN IEEE 802.15.7 standard. It can be very easily explained as, if the LED is ON, you are transmitting the data means you transmit a digital 1 ; and if the LED is OFF you transmit a digital 0, or null, or simply no data transfer happens. As one can switch them on and off very frequently one can transmit data easily because the LEDs intensity is modulated so rapidly that human eye cannot notice, so the output in form of light appears constant and hence offering permanent connectivity. More sophistication in the transmission techniques can further increase the data rates through VLC. Till now it was implemented through white LED bulbs only but teams at the University of Oxford and the University of Edinburgh are focusing on parallel data transmission by using multiple LEDs or array of LEDs, where each LED transmits a different stream of data. Mixtures of red, blue, green LEDs are also used by some groups to encode different data channels by altering the light frequencies.

In simple terms we can consider it to be a light based Wi-Fi which has achieved blistering high speed in the labs at Heinrich Hertz institute in Berlin, Germany of around 500 megabytes per second using a standard white-light LED. So quiet obviously, modems would be replaced by transceiver fitted LED lamps which can serve both in purposes of lightening the room as well as transmitting the data. The technology uses a part of an electromagnetic spectrum and was demonstrated at 2012 consumer electronics show in Las Vegas whereby a pair of Cisco smart phone was used to exchange data using light of varying intensity from their screens.

#### 1.2 Common Myths of Li-Fi:

Uni-Directional Only. No. Li-Fi can be implemented as a transceiver, providing both transmission and reception.

Visible Light Essential. No. Li-Fi enabled LEDs can be dimmed until no light is humanly visible, but data communications is still maintained reliably.

Line-Of-Sight Required. No – but desired. Li-Fi is perfectly capable of data communications from reflected light, but the signal will be stronger on direct light.

Requires Special LEDs. No.

## II. WORKING OF LI-FI:

It is very simple, You have a light on one end (an LED in this case), and a photodetector (light sensor) on the other. If the LED is on, the photodetector registers a binary one; otherwise it's a binary zero. Flash the LED enough times and you build up a message. To increase the speed an array of LEDs, with different colors can be used. Which increases the rates in the range of hundreds or megabits per second.

### 2.1 Block Diagram of the data transmission and reception using LED

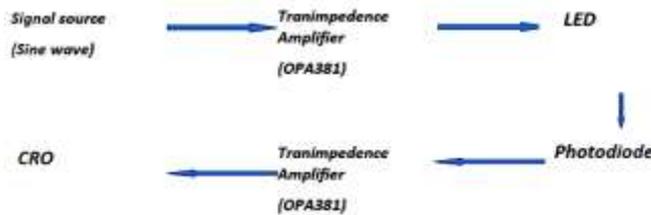


Fig1: Method of data transmission and reception using LED

**Signal source:** It can be sine wave, square wave etc.

**Transimpedance Amplifier (OPA381):** Current to voltage converter

**LED:** Light emitting diode. The voltage applied to LED controls its flickering rate.

**Photodiode:** It is the sensor which receives the light from LED and convert the light to corresponding electrical signal.

**CRO:** Cathode ray oscilloscope to view the final signal

## III. LED AS HEART OF DATA TRANSMISSION

At the moment, commercial LEDs don't get much smaller than 1mm<sup>2</sup>. The Scottish researchers, however, are developing LEDs that are just 1µm<sup>2</sup> — one micron; one thousand times smaller. Not only can you cram more of these micron-sized LEDs into the same space as a larger LED, but apparently they can also flicker on and off 1,000 times faster. A grid of 1,000 micro-LEDs, flashing 1,000 times faster, would be able to transmit data a million times faster than a normal LED.

Furthermore, these micro-LEDs are ultimately just pixels — and at one micron, these LEDs would be a lot smaller than those in your smartphone's Retina display. You could have a huge array of these LEDs that double up as a room's light source and a display — and provides networking capability on the side. Perhaps a next-next-gen console would communicate with your gamepad, smartphone, and other peripherals via a LiFi-equipped TV. How about a highway lighting that illuminates the road, provides up-to-date traffic info/warnings, and provides internet access to your car, plus all of the devices on-board?

### 3.1 LED colours

There is a wide variety of different LEDs available on the market. The different LED characteristics include colours light / radiation wavelength, light intensity, and a variety of other LED characteristics.

The diagram below shows some typical approximate curves for the voltages that may be expected for different LED colours.

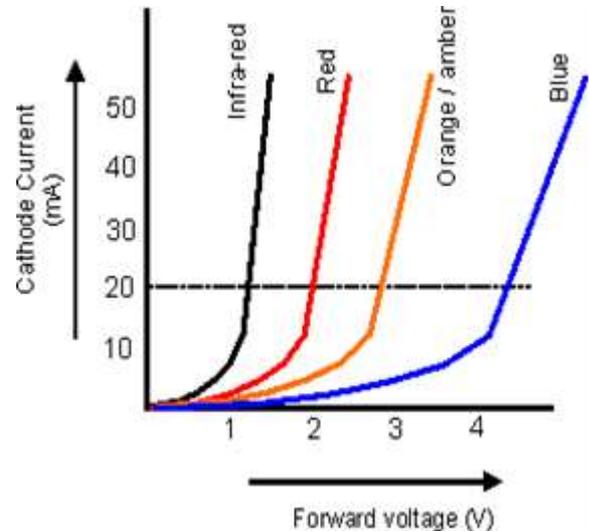


Fig:2

The researchers used a micro-LED light bulb to transmit 3.5Gbit/s via each of the three primary colours - red, green, blue - that make up white light.

This means over 10Gbit/s is possible.

Li-fi is an emerging technology that could see specialised LED lights bulbs providing low-cost wireless internet connectivity almost everywhere.

### 3.2 High Speed

The tiny micro-LED bulbs, developed by the University of Strathclyde, Glasgow, allow streams of light to be beamed in parallel, each multiplying the amount of data that can be transmitted at any one time.

"If you think of a shower head separating water out into parallel streams, that's how we can make light behave," said Prof Harald Haas, an expert in optical wireless communications at the University of Edinburgh and one of the project leaders.

Using a digital modulation technique called Orthogonal Frequency Divisional Multiplexing (OFDM), researchers enabled micro-LED light bulbs to handle millions of changes in light intensity per second, effectively behaving like an extremely fast on/off switch.

This allows large chunks of binary data - a series of ones and zeros - to be transmitted at high speed.

Earlier this year, Germany's Fraunhofer Heinrich Hertz Institute claimed that data rates of up to 1Gbit/s per LED light frequency were possible in laboratory conditions.

And this month, Chinese scientists reportedly developed a microchipped LED bulb that can produce data speeds of up to 150 megabits per second (Mbps), with one bulb providing internet connectivity for four computers.

#### IV. ADVANTAGES

**Efficiency:** LED's produce more light per watt than incandescent bulbs.

**ON-off Time:** LED's light up very quickly. A typical red indicator LED will achieve full brightness in micro second.

**Life time:** LED's can have a relatively long useful life.

**Toxicity:** LED's don't contain mercury, unlike fluorescent lamps.

**Speed:** LIFI wireless communication is high speed, as high as 500mbps or 30GB per minute.

#### V. CONCLUSION

It has been observed that LED illumination is better than any general illumination systems (including CFLs) in terms of energy saving and cost effectiveness. The technology is being improved and full conversion will 'save' many generating stations in the world. White LED acts as a better communication source and a silicon photodiode which shows good response to visible wavelength region serving as the receiving element. LED can be switched on and off to generate digital strings of 1s and 0s. Data can be encoded in the light to generate a new data stream by varying the flickering rate of the LED.

#### VI. FUTURE SCOPE:

In future, data for laptops, smart phones & tablets can be transmitted through light in room by using Li-Fi. Researchers are developing micron sized LED which are able to flicker on & off around 1000 times quicker than larger LED. They offers faster data transfers and take up less space so we could save space or add more LED's to further boost the channel of communication. Also 1000 micron sized LED can fit into area required by 1sq. mm large single LED. A 1 sq.mm sized array of micron sized LED's could therefore communicate 1000×1000 (i.e. a million) times as much information as a single 1mm LED. We can be sure that the future for Li-Fi is bright. Li-Fi consortium believes it is possible to achieve more than 10Gbps, theoretically allowing a high definition film to be downloaded in 30 seconds. Hence we can just imagine people clustering underneath street lights, strip lights, and billboards, clamoring for their fix of high-speed interwebs.

#### VII. CONCLUSION

A conclusion section is not required. Although a conclusion may review the main points of the paper, do not

replicate the abstract as the conclusion. A conclusion might elaborate on the importance of the work or suggest applications and extensions.

#### REFERENCES

- [1] D. Tsonev, S. Sinanović, and H. Haas, "Enhanced Subcarrier Index Modulation (SIM) OFDM" in Proc. Of IEEE Global Communications Conference (IEEE GLOBECOM 2011), Houston, Texas, USA, 5-9 Dec. 2011.
- [2] Li-Fi (Light Fidelity)-The future technology In Wireless Communication Neha Singh, International Journal of advances in computing & communications, vol.1, 2013 www.ijacc.org
- [3] M. Afgani, H. Haas, H. Elgala, and D. Knipp, "Visible Light Communication using OFDM" in Proc. of the 2nd International Conference on Testbeds and Research Infrastructures for the Development of Networks and Communities (TRIDENTCOM), Barcelona, Spain, March 1-3 2006, pp. 129-134.
- [4] M. Di Renzo, H. Haas, and P.M. Grant, "Spatial Modulation for Multiple-Antenna Wireless Systems: A Survey", IEEE Communications Magazine, vol. 49, no. 11, Nov. 2011.
- [5] H. Haas, "Wireless Data from Every Light Bulb", TED Website, Aug. 2011. [Online]. Available: [http://bit.ly/ted\\_vlc](http://bit.ly/ted_vlc).
- [6] H. Elgala, R. Mesleh, and H. Haas, "Indoor Optical Wireless Communication: Potential and State-of-the-Art", IEEE Communications Magazine, vol. 49, no. 9, pp. 56-62, Sep. 2011, ISSN: 0163-6804.
- [7] Visible Light Communication blog site. <http://visiblelightcomm.com>.
- [8] technopits.blogspot.com/technology.cgap.org/2012/01/11/a-lifi-world
- [9] <http://www.extremetech.com/extreme/147339-micro-led-lifi-where-every-light-source-in-the-world-is-also-tv-and-provides-gigabit-internet-access>
- [10] "Visible-light communication: Tripping the light fantastic: A fast and cheap optical version of Wi-Fi is coming", Economist, dated 28Jan 2012
- [11] International Journal of Applied Engineering Research, ISSN 0973-4562 Vol.7 No.11 (2012) <http://www.ripublication.com/ijaer.htm>

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