Li-Fi the Futuristic Wireless Communication

Hanishraj B Rao
Student
Vivekananda College of Engineering and Technology
Puttur, Karnataka

Avaneeshakrishna Shastry C
Student
Vivekananda College of Engineering and Technology
Puttur, Karnataka

***Abstract*—Li-Fi stands for Light Fidelity. The term Li-Fi was coined by a German physicist Harald Hass in 2011 TED Global Talk on Visible Light Communication (VLC). Wi-Fi is useful for general wireless coverage within buildings while Li-Fi is ideal for high-density wireless data coverage in confined areas where there are no obstacles. Li-Fi is a wireless optical networking technology that uses light-emitting diodes (LEDs) for transmission of data. The term Li-Fi refers to visible light communication (VLC) technology that uses as a medium to deliver high-speed communication in a manner similar to Wi-Fi. Li-Fi provides better bandwidth, efficiency, availability and security than Wi-Fi and has already achieved high speeds in the lab. In the present paper, the authors will give a detailed study on Li-Fi technology, its advantages and its future advancement. Li-Fi, or Light Fidelity, could prove revolutionary, delivering data speeds far, far higher than any we're getting right now as well as being more efficient and more secure than typical wireless technologies.**

Keywords—Li-Fi:Light Fidelity; Wi-Fi:Wireless Fidelity;VLC:Visible Light Communication ; optical wireless communications ;LED:Light Emitting Diode;silicon photodiode;

I. Introduction

Li-Fi is a technology for wireless communication between devices using light to transmit data and position. In simple terms, Li-Fi can be thought of as a light-based Wi-Fi.[1] That is, it uses light instead of radio waves to transmit information. And instead of Wi-Fi modems, Li-Fi[2] would use transceiver-fitted LED[3] lamps that can light a room as well as transmit and receive information. Since simple light bulbs are used, there can technically be any number of access points. Li-Fi is a new method of wireless communication that uses led lights to transmit data wirelessly. Transmission of data is one in every of the most activities in the growing world. The current wireless networks that connect us to the internet are very slow when multiple devices are connected. additionally, with the rise in the number of devices that access the net, the provision of fixed bandwidth makes it far more difficult to relish high knowledge transfer rates and to attach a secure network. Radio waves are simply a small part of the electromagnetic spectrum available for data transfer. This technology uses a part of the electromagnetic spectrum[4] that is still not greatly utilized-The Visible Spectrum[5] .Light is in fact very much part of our lives for millions and millions of years and does not have any major ill effect. Moreover, there is 10,000 times more space available in this spectrum and just counting on the bulbs in use, it also multiplies to 10,000 times more availability as an infrastructure, globally. It is possible to encode data in the light by varying the rate at which the LEDs flicker on and off to give different strings of 1s and 0s. The LED intensity is modulated so rapidly that human eyes cannot notice, so the output appears constant.

II. Design and Architecture

Li-Fi the future of data communication appears to be a fast, cheap and affordable optical version of Wi-Fi. Being a Visible Light Communication (VLC) [6] Li-Fi uses visible light of electromagnetic spectrum between 400 THz and 800 THz as optical carrier for data transmission and illumination. Fast impulse of light is used to transmit information in wireless medium. The main components of a basic Li-Fi system may contain the following:

- A high intensity white LED (Transmission source).
- A silicon photodiode (Receiver end)

Flickering (ON/OFF) LEDs can generate digital strings with a different combination of 1s and 0s. generating a new data stream, data can be encoded in the light by varying the flickering rate of the LED. In this way, the LEDs work as a sender by modulating the light with the data signal. The LED output appears constant to the human because they are made to flicker at a phenomenal speed (millions of times per

second) and it's impossible for the human eye to detect this frequency.

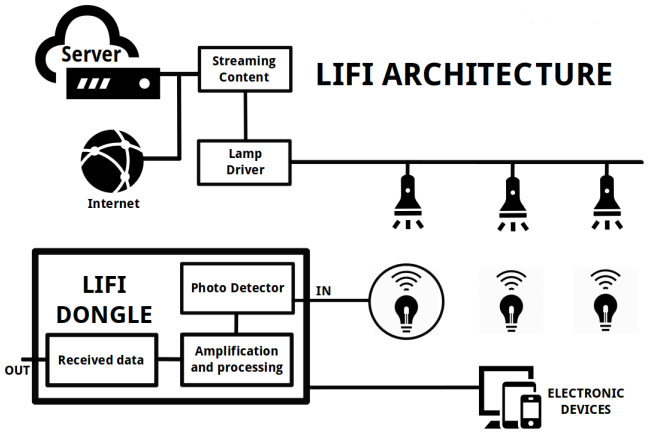

Fig 1:Li-Fi Architecture

Communication rate of more than 100 Mbps can be achieved by using high-speed LEDs with the help of various multiplexing techniques. And this VLC data rate can be further increased to as high as 10 Gbps via parallel data transmission using an array of LED lights with each LED transmitting a different data stream.

III. Working of Li-Fi

A typical Li-Fi system consists of a light source (transmitter) and a light detector (receiver). On the transmitter side, information data (streaming content) is introduced to the light source by changing its intensity (modulation) in a way that cannot be perceived by the human eye. On the receiver side, the light detector detects these tiny changes in the light amplitude and extracts them into an electrical signal (demodulation) to recover the transmitted data to a user's PC or mobile device. Due to their low cost and energy efficiency for most indoor applications, light emitting diodes (LEDs) are the favored light sources.They are replacing incandescent bulbs as the primary source of illumination in residential and public environments and the majority of new energy efficient lighting installations are expected to be LED-based. For higher speeds or longer distances, laser diodes appear to be a better choice. 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 varies at extremely high speeds. This very property of optical current is used in Li-Fi setup. the 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. Hence all that is required is some LEDs and a controller that code data into those LEDs. All one has to do is to 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 the different data channel. Such advancements promise a theoretical speed of 10 Gbps –meaning one can download a full high-definition film in just 30 seconds. When a constant current of electricity is applied to an led light bulb a constant stream of light is emitted from the bulb that is seen as visible light. One way of producing white light is to use a blue LED with a yellow phosphor coating. When a beam light passes through a yellow phosphor coating layer it becomes white light. Another way is to use a combination of red, green and blue (RGB) LEDs .when red, green and blue light properly mixed together it becomes white light. As the light emitted by LEDs is incoherent in nature so therefore there is a need of Intensity Modulation (IM). In IM signal is to the optical signal of instantaneous power. is received at a receiver by using Direct Detection (DD) method. In Direct Detection (DD) a photodiode is used to convert the optical signal power into a proportional current.

Technology	Speed
NFC	~424 Kbps
Bluetooth	~3 Mbps
IrDA	~4 Mbps
Wi-Fi –IEEE 802.11n	~150 Mbps
Li-Fi	~1 Gbps

IV. Advantages

- **Speed:** Li-Fi provides stunning speeds which is 100 times faster than currently available technology like Wi-Fi. This results in faster and better quality of communication.
- **Efficiency:** When it comes to cost and power consumption Li-Fi is more efficient. Since it makes use of LED bulbs for communication these bulbs can double up as regular lighting for a household decreasing power consumption of a Li-Fi network and making it far efficient than existing technologies alongside not requiring any additional hardware for implementation would cut the cost of setting up Li-Fi.
- **Availability:** Due to the use of LED bulbs, Li-Fi can be made available world wide by replacing traditional LED bulbs with Li-Fi compatible bulbs.
- **Security:** The traditional Wi-Fi which could be accessed from beyond walls and making it vulnerable to unauthorized access, unless Li-Fi makes use of visible light spectrum, it cannot

penetrate through objects like walls making it difficult for unauthorized access.

V. Limitations

- Light waves don't penetrate through walls and so Li-Fi has a much shorter range than Wi-Fi.
- Natural light, sunlight, and normal electric light can affect the data transmission speed.
- High initial installation cost, if used to set up a full-fledged data network.
- Internet cannot be accessed without a light source. This could limit the locations and situations in which Li-Fi could be used.

VI. Applications

- **Replacement for other technologies**: Li-Fi uses LED for the transmission of data where it will not be using radio waves. So, it can be easily used in the places where Bluetooth, NFC, Wi-Fi, etc. are banned.
- **Mobile Connectivity**: Mobiles, laptops, tablets, and other smartphones can seamlessly connect with each other. The short-range network of Li-Fi can provide exceptionally high data rates and higher security.
- **Traffic management**: In traffic signals Li-Fi can be used to communicate with passing vehicles (through the LED lights of the cars etc) which can help in managing the traffic in a better manner resulting into smooth flow of traffic and reduction in accident numbers. Also, LED car lights can alert drivers when other vehicles are too close
- **Medical Applications**: Operation theatres (OTs) do not allow Wi-Fi due to radiation concerns. Usage of Wi-Fi at hospitals interferes/blocks the signals for monitoring equipments. So, it may have hazardous effect to the patient's health, due to improper working of medical apparatus. To overcome this and to make OT tech savvy Li-Fi can be used to access internet and also to control medical equipments. This will be beneficial for conducting robotic surgeries and other automated procedures.

VII. References

[1] http://www.ieee802.org/11/
[2] pureVLC "pureVLC Demonstrates Li-Fi Using Reflected Light". Edinburgh.
[3] https://en.wikipedia.org/wiki/Light-emitting_diode
[4] https://en.wikipedia.org/wiki/Electromagnetic_spectrum
[5] https://en.wikipedia.org/wiki/Visible_spectrum
[6] http://visiblelightcomm.com/what-is-visible-light-communication-vlc/
[7] http://www.warse.org/pdfs/2014/icetetssp25.pdf
[8] http://www.onlinejournal.in/IJIRV2I6/006.pdf
[9] http://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=668 5753
[10] www.oledcomm.com
[11] http://tec.gov.in/pdf/Studypaper/lifi%20study%20paper% 20-%20approved.pdf
[12] Harald Haas. "Harald Haas: Wireless data from every light bulb". *ted.com.*
[13] Vincent, James. "Li-Fi revolution: internet connections using light bulbs are 250 times