A Survey on Birth of Li-Fi & Its Features

Himanshu Trivedi[1], Vaibhav Trivedi[2]

[1]M.Tech Scholar, GITS Udaipur, [2]B.Tech U.C.E, Kota

Abstract: **Li-Fi is designed to use LED light bulbs similar to those currently in use in many energy-conscious homes and offices. However, LiFi bulbs are outfitted with a chip that modulates the light imperceptibly for optical data transmission. LiFi data is transmitted by the LED bulbs and received by photoreceptors. It is wireless and uses visible light communication (instead of radio frequency waves), part of Optical wireless communications technology, which carries much more information, and has been proposed as a solution to the RF-bandwidth limitations. A complete solution includes an industry led standardization process.**

Keywords: Li-Fi, LED, Data transmission, Optical, Wireless communication Technology.

I. INTRODUCTION

Back in 2012Professor Harald Haas is pioneering his own light-centric wireless communications technology. LiFi is designed to use LED light bulbs similar to those currently in use in many energy-conscious homes and offices. However, LiFi bulbs are outfitted with a chip that modulates the light imperceptibly for optical data transmission. LiFi data is transmitted by the LED bulbs and received by photoreceptors. LiFi's early developmental models were capable of 150 megabits-per-second (Mbps). Some commercial kits enabling that speed have been released. In the lab, with stronger LEDs and different technology, researchers have enabled 10 gigabits-per-second (Gbps), which is faster than 802.11ad.

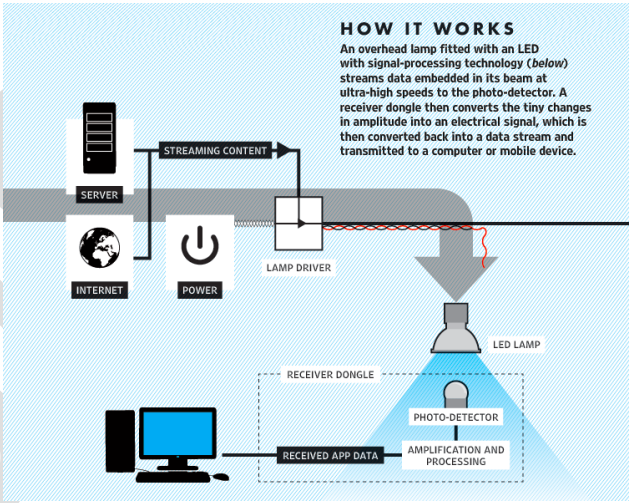
Li-Fi signals are confined to narrowly-focused 'beams' that don't travel through walls. Moreover, LED lights are natural beam-formers, which makes it easier to create separate uplink and downlink channels, which essentially means more secure internet browsing, given that both channels have to be 'intercepted' if someone did manage to coerce their way into the same room as you.

"This [Li-Fi] is a technology that can aid cybersecurity in a very new way," says Haas.

The Li-1st delivers a capacity of 5Mbps in the uplink and downlink channels, covering a range of "up to" three meters. And yes, you benefit from a nicely lit working space too. It's worth noting here that it has been shown that speeds of up to 10Gbps have been proven with Li-Fi too.

II. HOW IT WORK

When a constant current is applied to an LED light bulb a constant stream of photons are emitted from the bulb which is observed as visible light. If the current is varied slowly the output intensity of the light dims up and down. Because LED bulbs are semi-conductor devices, the current, and hence the optical output, can be modulated at extremely high speeds which can be detected by a photo-detector device and converted back to electrical current. The intensity modulation is imperceptible to the human eye, and thus communication is just as seamless ad RF. Using this technique, high speed information can be transmitted from an LED light bulb.



Radio frequency communication requires radio circuits, antennas and complex receivers, whereas Li-Fi is much simpler and uses direct modulation methods similar to those used in low-cost infra-red communications devices such as remote control units. Infra-red communication is limited in power due to eye safety requirements, whereas LED light bulbs have high intensities and can achieve very large data rates.

III. STANDARDS

Like Wi-Fi, LiFi is wireless and uses similar 802.11 protocols; but it uses visible light communication (instead of radio frequency waves), which has much-wider bandwidth. One part of VLC is modeled after communication protocols established by the IEEE 802 workgroup. the IEEE 802.15.7 standard defines the physical layer (PHY) and media access control (MAC) layer. The standard is able to deliver enough data rates to transmit audio, video and multimedia services.

The standard defines three PHY layers with different rates:

- The PHY I was established for outdoor application and works from 11.67 kbit/s to 267.6 kbit/s.

- The PHY II layer permits reaching data rates from 1.25 Mbit/s to 96 Mbit/s.
- The PHY III is used for many emissions sources with a particular modulation method called color shift keying (CSK). PHY III can deliver rates from 12 Mbit/s to 96 Mbit/s.

IV. FEATURES OF Li-Fi

Li-Fi features include benefits to the capacity, energy efficiency, safety and security of a wireless system with a number of key benefits over Wi-Fi but is inherently a complementary technology.

A. Capacity

Bandwidth: The visible light spectrum is plentiful (10,000 more than RF spectrum), unlicensed and free to use.

Data density: Li-Fi can acheive 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.

B. Efficiency

Low cost: Requires fewer components than radio technology.

Energy: LED illumination is already efficient and the data transmission requires negligible additional power.

Environment: RF transmission and propagation in water is extremely difficult but Li-Fi works well in this environment.

C. Safety

Safe: Life on earth has evolved through exposure to visible light. There are no known safety or health concerns 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.

D. Security

Containment: It is difficult to eavesdrop on Li-Fi signals since the signal is confined to a closely defined illumination area and will not travel through walls.

Control: Data may be directed from one device to another and 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.

Li-Fi / Wi-Fi comparison

Parameter	Li-Fi	Wi-Fi
Speed	***	***
Range	*	**
Data density	***	*
Security	***	**
Reliability	**	**
Power available	***	*
Transmit/receive power	***	**
Ecological impact	*	**
Device-to-device connectivity	***	***
Obstacle interference	***	*
Bill of materials	***	**
Market maturity	*	***

* low ** medium *** high

Summaries features are as follows:

- Higher speeds than Wi-Fi.
- 10000 times the frequency spectrum of radio.
- More secure because data cannot be intercepted without a clear line of sight.
- Prevents piggybacking.
- Eliminates neighboring network interference.
- Unimpeded by radio interference.
- Does not create interference in sensitive electronics, making it better for use in environments like hospitals and aircraft.

V. APPLICATION OF Li-Fi

Li-Fi is particularly suitable for many popular internet "content consumption" applications such as video and audio downloads, live streaming, etc.

There are many applications for Li-Fi. These include:

- RF Spectrum Relief
- Smart Lighting
- Mobile Connectivity
- Hazardous Environments
- Hospital & Healthcare
- Aviation
- Underwater Communications
- Vehicles & Transportation
- RF Avoidance
- Location Based Services (LBS)

REFERENCES

[1] http://en.wikipedia.org/wiki/Li-Fi
[2] http://purelifi.com/what_is_li-fi/applications-of-li-fi/
[3] http://thenextweb.com/insider/2014/08/21/purelifi-li-fi-vlc-led/
[4] http://whatis.techtarget.com/definition/LiFi
[5] An IEEE Standard for Visible Light Communications visiblelightcomm.com, dated April 2011. It is superfast modern intelnet technology.
[6] Tsonev, D.; Sinanovic, S.; Haas, Harald (15 September 2013). "Complete Modeling of Nonlinear Distortion in OFDM-Based Optical Wireless Communication". IEEE Journal of Lightwave Technology 31 (18): 3064–3076. doi:10.1109/JLT.2013.2278675.