

LiFi –Wireless Communication using Light

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ABSTRACT

LiFi (Light Fidelity) is a high-speed wireless communication technology that uses visible light (presently using LEDs) to transmit information. LiFi is a wireless technology. LiFi uses visible light communication (VLC) or infrared and near-UV spectrum waves rather than radio waves. In other words, LiFi works by using visible light, like the light that is emitted by any regular lamp or bulb. This paper draws its attention on working of LiFi based system and applications of LiFi in different area.

1. Introduction to LiFi

Access to the internet is beginning to be seen as a basic human right. Internet is as important as oxygen for human body. It is the main source of power for professionalism. As in a technology-dependent lifestyle we have, the internet is no longer an option; it's an essential part of our life. Imagine a scenario where standing under a light bulb for one minute, we would have downloaded around five movies in HD. It feels like a dream. But with LiFi technology, this dream will soon turn into

reality. We can redefine the role of light in the universe. The idea of LiFi was introduced for the first time by a German physicist Harald Hass in the TED (Technology, Entertainment, and Design) Global talk on Visible Light Communication (VLC) in July 2011, by referring to it as "data through illumination". He used a table lamp with an LED bulb to transmit a video of a blooming flower that was then projected onto a screen.

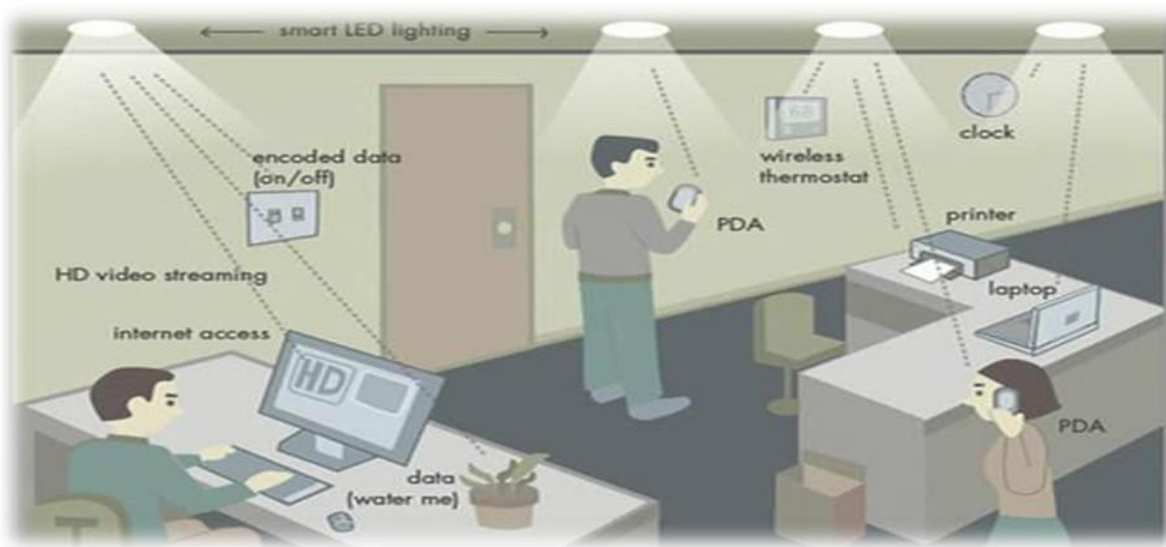


Fig -1 LiFi Environment

LiFi is high speed bi-directional networked and mobile communication of data using light. LiFi comprises of multiple light bulbs that form a wireless network, offering a substantially similar user experience to Wi-Fi except using the light spectrum. [1]. LiFi is a visual light communication system concept that will change the way we connect and use the internet. Imagine a world where every light can be a receiver and transmitter of information. With the advent of LiFi, light bulbs in our homes can connect us to high speed wireless internet with a simple switch movement. It is a developing technology that may change the future of wireless networking. LiFi is a wireless optical networking technology that uses light-

emitting diodes (LEDs) for data transmission. 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.

2. Working of LiFi

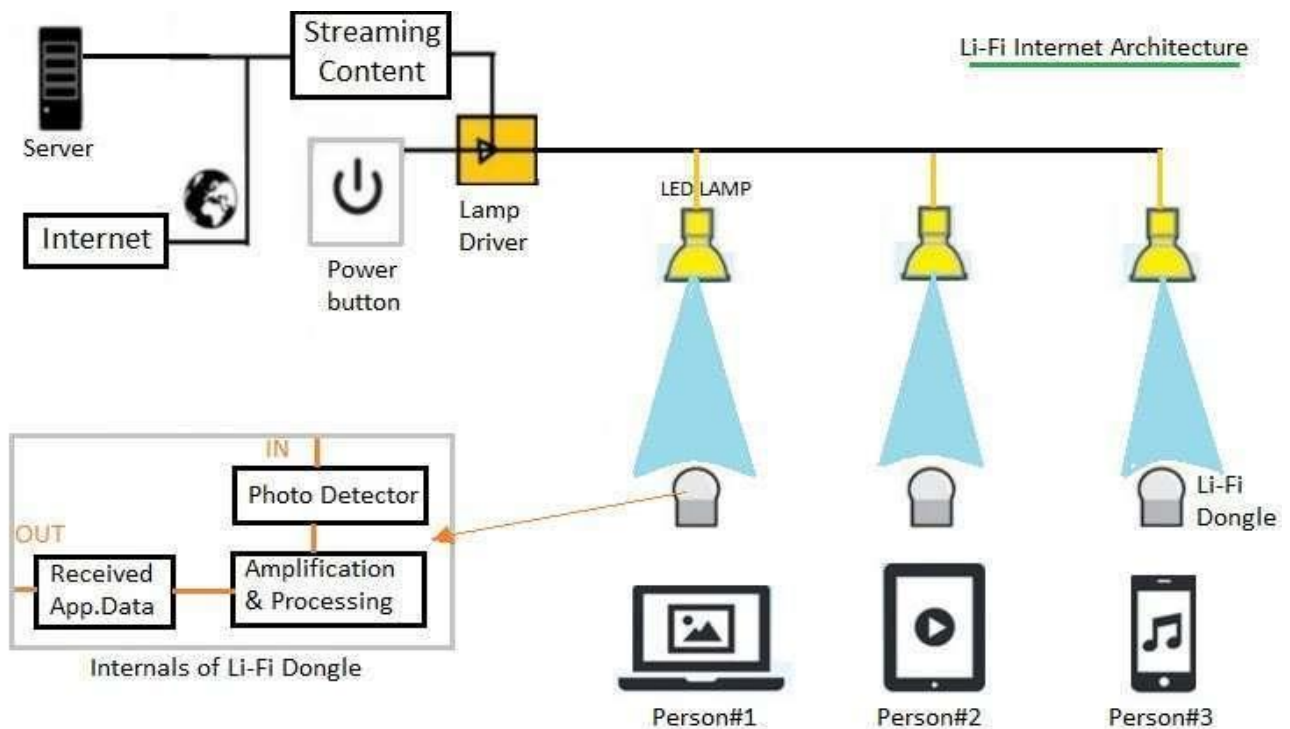


Fig-2 Internet Network Architecture

The fig-2 depicts LiFi internet network architecture. As shown in the figure there are two major components in LiFi internet

1. LED Lamp
2. LiFi Dongle.

As shown lamp driver is connected with internet on one end and with LED lamps on the other end. Streaming content from the internet are pushed to the LED lamps through Lamp driver software. LED lamps are placed at different locations as per requirement in the office or home premises for multiple users. LiFi dongle is used in order to use LiFi internet services by various users. As shown Person1 is browsing the internet in Laptop, Person2 in tablet and Person3 in smart phone. As shown LiFi dongle is composed of photo detector, amplification & processing and applications for different types of data. All the LED lamps can be switched on and off using a power button switch provided. LiFi internet provides very fast data rate at 1 Gbps speed.

3. Applications of LiFi

- **LiFi in Healthcare:** LiFi is more suitable in hospital application for monitoring the patient's conditions without frequency interference with the human body. LiFi networks in the hospital is used to monitor the patient's conditions such as temperature, pressure, heartbeat, glucose level, and respiratory conditions using respective sensors. The collected data from the sensors is transmitted to the sink, and further these data are processed using microcontroller and sent to display unit in the form of graphs or charts. [2].
- **LiFi in Road Safety and Traffic management:** LiFi technology has an imperative use in road safety and traffic management. LiFi enabled LED head-light, tail-light and traffic signal can be used for traffic management and road safety using vehicle to vehicle

data transmission. [Nilufa, Rianon, Israt] assigns each vehicle a unique number against which information is stored in database. Whenever any car breaks the traffic signal or crosses the maximum speed limit the information against the unique number of cars goes to the central server through LiFi.[3]

- **LiFi in Education:** With the increasing number of internet-connected devices in classrooms, installing LiFi alongside Wi-Fi provides additional bandwidth to reduce network congestion – enabling students to stream educational videos and download resources with seamless connectivity. Scottish secondary school pupils have become the first in the world to benefit from next-generation high-speed wireless internet connectivity – using light.[4] Students and teachers can be part of a more active educational community in a classroom that is LiFi enabled. Students with devices such as Smartphone or laptops can communicate with the teacher, or with each other, to create a more efficient learning environment. Teachers can be able to collaborate with students to help better understand class material.
- **LiFi in Underwater:** Most remotely underwater operated vehicles (ROVs) use cables to transmit command, but the length of cables then limits the area ROVs can detect. However, as light waves could travel through water, LiFi could be implemented on vehicles to receive and send back signals. While it is theoretically possible for LiFi to be used in underwater applications, its utility is limited by the distance light can penetrate water. Significant amounts of light do not penetrate further than 200 meters. Past 1000 meters, no light penetrates.[6]
- **LiFi in Security:** LiFi provides security in all forms. There is no need to worry about data leaving the room

or that intercepted by a third party. This is one reason why banks and government agencies want to implement Li-Fi as their primary source of communication and data transmission. Also Li-Fi speed rates are much faster, up to 10Gbps. concerning health, Li-Fi is safer because it relies on visible and infrared light, avoiding the use of potentially harmful radio waves. Furthermore, it is more efficient since it requires fewer components than radio technology. Another perk is that **LED** allows you to save energy. With regards to safety, light beams don't interfere with any other electronic devices, a big advantage when it comes to using Li-Fi technology in hospitals and airplanes. In fact, Li-Fi has already been tested on aircrafts in mid-air and has proven to be 100% safe.

- **Li-Fi and Live Streaming:** According to a Go-Globe report, 82% of consumers prefer to watch live videos from a brand than posts, 80% of brand audience prefer to watch live video from a brand than read a blog and live videos are watched three times longer than videos that are not live anymore. Because of the high-speed rates Li-Fi can reach, it can be made available in big shopping malls, sport stadium, street lights, air planes, trains including underground, train stations, airports and hence. This allows any user to consume rich content media like videos as well as live streaming from their Smartphone or other mobile devices nearly anywhere they are like in stadiums, trains and planes provided they are exposed to Li-Fi enabled LEDs.
- **Li-Fi in the Workplace:** Li-Fi will not offer illumination but secure wireless connectivity in workspaces. As well as the networking capability, people will be able to take a Skype video conference call and move from one room to another without that conference call being interrupted. Workers and visitors will have a constant internet speed connection from the Li-Fi networks in the workspace. Using light, network access can also be controlled more effectively. Philips Lighting's Li-Fi-enabled LEDs are currently being trialing Li-Fi technology in real-estate company Icade's office in La Defense, Paris.
- **Li-Fi in Retail:** Li-Fi can help directing shoppers from the time they enter the shop. It can also help them to locate specific products in the store, collect digital coupons, check store promotions, check stock availability of some products on the shelves, engage in store online services through their smart devices and improve their store experience. For retailers, Li-Fi can enable them to send promotions to shoppers' smart devices, displaying promotions and offers. Li-Fi can also help retailers understanding behavior anonymously for most customers, understanding the demographics of their shoppers, enabling target marketing campaigns, conducting display advertising campaigns and checking real-time stock availability. Li-Fi will bring an opportunity for shopping malls and centers to be a frontrunner in gaining an understanding of their customers and ultimately influencing them.

- **Augmented Reality:** Augmented reality is being used in institutions such as museums to enhance the customer experience. However, like many other services that are dependent upon Wi-Fi, the experience can be slow and sluggish as the number of people connected on the network increases. Li-Fi can easily solve this problem by providing each exhibit with its own data stream using a LED light bulb. Moreover, Li-Fi enabled lighting can also provide localized information within that light.

Li-Fi will enable the customers to not only enjoy an uninterrupted experience at the museum, but it will also empower them to download information about that exhibit using the light that illuminates the exhibit.

4. Advantages of Li-Fi

- 1) Data transmission over Li-Fi is a hundred times faster. It enables data transfer, boasting speeds of up to 224 gigabits per second. At this speed, a high-definition video can be downloaded in mere seconds. Li-Fi can deliver speeds as high as 1Gbps
- 2) Wi-Fi is being used in almost all residential and commercial areas. Due to this, radio frequency spectrum occupancy is increasing day by day limiting the capacity of data that can be transmitted over radio waves. At the same time, usage of wireless data is increasing exponentially year by year.
- 3) Li-Fi can be used to cater to the growing demand for wireless data. The size of the visible light spectrum is 10,000 times greater than the radio waves spectrum used in conventional Wi-Fi data transmission. Light bulbs exist everywhere and so the infrastructure is already there for adopting Li-Fi on a large scale.
- 4) Radio waves can penetrate through walls, and they can be intercepted by agents outside your network compromising the security of your data. In contrast, light cannot penetrate through walls. It is confined to the room that it has been created in. Therefore, no one outside the room can intercept the data being transmitted over Li-Fi.
- 5) Because most homes and offices already use light, data transmitted over Li-Fi is far more energy efficient as compared to data transmission over radio waves.
- 6) Li-Fi is also free from problems such as neighboring network interference, radio interference or interference generated due to sensitive electronics making it much more energy efficient.

5. Disadvantages of Li-Fi

- 1) With Li-Fi, light must be available 24/7. You cannot switch off the light; you can only dim it if you want uninterrupted transmission of data. This seriously limits the locations and situations in which Li-Fi may be used.
- 2) This range for Li-Fi is limited as the light signal cannot penetrate across walls. While this makes Li-Fi secure, the limited range can be a nuisance for some people.
- 3) It will take years for Li-Fi to become more practical than Wi-Fi. Current devices such as laptops, Smartphone, and tablet computers still use hardware

for Wi-Fi networking. These devices would not readily work with a LiFi network because they do not have the necessary hardware specifications.

- 4) LiFi are susceptibility to light interference and the promotion of light pollution. LiFi-enabled LED lamp

must remain on, they can contribute further to light pollution, especially if set at higher brightness to compensate for possible interference with other light sources.

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