



## A REVIEW ON LI-FI: A NEW AND FASTER WAY OF COMMUNICATION

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### ABSTRACT

*In the world of wireless communication a new technology is introduced which is known as “LI-FI” .LI-FI is known as light fidelity. The working of LI-FI is same as WI-FI but with a difference that WI-FI uses radio frequency spectrum to transmit data, where as LI-FI uses visible light communication (VLC),LED’s bulb and is a subset of optical wireless communication (OWC).OWC uses light from LED’s as a medium to deliver networked, mobile, speed communication. To overcome the problem of slow speed of data transmission “LI-FI” is the best solution. LI-FI is a bidirectional, high speed and fully networked wireless communication. This paper speaks about the various features, working and future challenges of LI-FI, and citing the reason why and how it is more useful and safe as compared to WI-FI.*

**Keyword:** VLC, OWC, WI-FI, LI-FI, Image sensor, Photodiode.

**Introduction:** Communication is the most important part of anyone’s life for exchanging information and knowledge on devices, in wired or wireless network. As the number of devices that access the network is also increasing, so the high data transmission rate is also needed. Presently, we have “WI-FI” as the wireless standard, which uses radio signal to transmit and receive data. When we are accessing the radio waves in school, college, office or any public places the speed gets slower and slower, it happens due to large number of users are connected over the network, as the capacity of radio spectrum is limited this lead to the breakdown in the speed of data transmission.

To solve the above defined problem “LI-FI” is developed. It’s an advance version of WI-FI and a replacement of radio frequency spectrum in context of data broadcasting.

The term LI-FI was first coined by Prof. Harald Hass. He started his research in this field in 2004. The first LI-FI prototype was given in TED Global Conference in Edinburgh on 12<sup>th</sup> July 2011. He used a table lamp with an LED light bulb to transmit a video of blooming flowers that was then projected on the screen behind him.

The working principal of LI-FI is very simple. It uses VLC and LED light bulb to transmit data. LI-FI is a VLC system, which means that it accommodates a photo-detector to receive light signals and a signal processing element to convert the data into the 'Streamable' content and an LED light bulb is a semi conductor light source, which means that the constant current of electricity supplied to an LED light bulb can be dipped and dimmed, up and down at extremely high speed, without being visible to the human eye.

If the LED is on it transmit a digital signal '1' and if the LED is off it transmit the digital signal '0'. Any LED bulb can be used along with a microchip inside it.

D-light (LED) is used to produce data rates higher than 10 Gbps which is much higher than an average broadband.

### **Problem of Wi-Fi:**

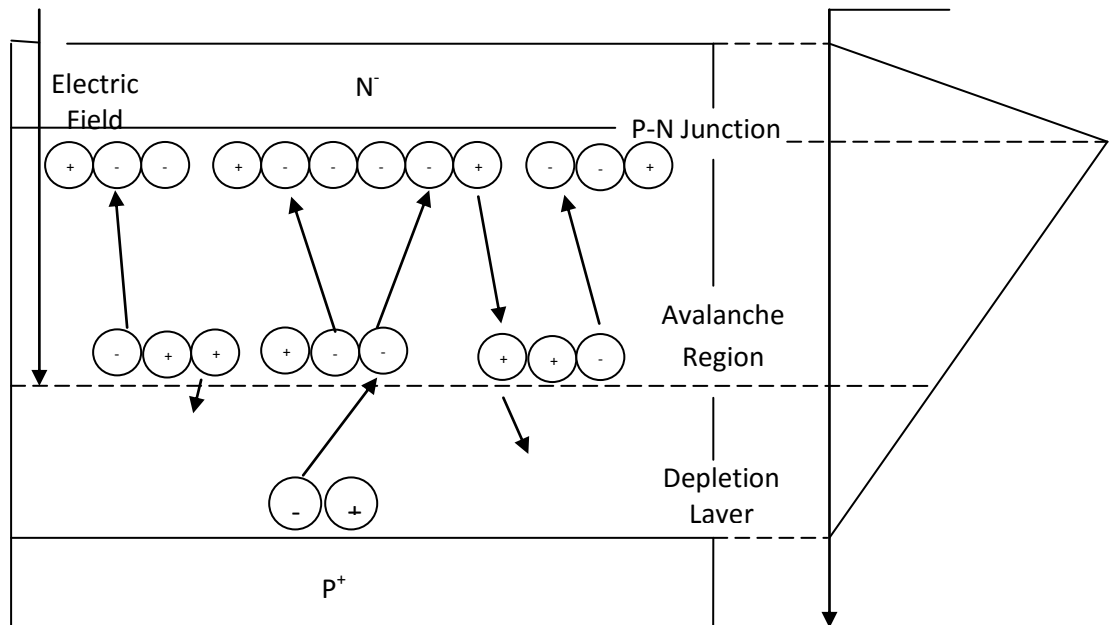
Presently we are using Wi-Fi services everywhere, around 10-100 meters distance to connect our wireless or wired devices. The challenges faced by Wi-Fi in today's time are:-

1. **Capacity:** The bandwidth of radio spectrum is limited; when the number of users increases the availability of spectrum get congested which leads to decrease in speed.
2. **Efficiency:** Radio waves consumes huge amount of energy for transmitting data because of which its efficacy is reduced.
3. **Availability:** Since radio waves are available in denser medium only, as a result we cannot access it in the rare medium i.e., under water, airplanes etc.
4. **Security:** Radio spectrum can sink into any solid object so they are not secure.
5. **Free band:** For radio spectrum we need to purchase a license.

### **Primary Sub-assemblies of Li-Fi:**

There are four sub-assemblies of Li-Fi. They are as follows:

1. **Photodiode:** - Photodiode is a kind of light detector, semiconductor device that converts light into current or voltage. It's a device with a P-N junction and an intrinsic layer between P and n layers. Photodiode outturns photocurrent by generating electron-hole pairs, due to the absorption of light in the intrinsic or depletion region.



**Fig. 1 Working of Photodiode**

Li-Fi uses either pin diode or Avalanche photodiode (ADP). APD are high sensitivity, high speed semiconductor “Light” sensors. They are operated in a high reverse bias condition which allows multiplication of an avalanche breakdown to each photo-generated electron-hole pairs. This results in internal gain within the photodiode, which constantly increases the responsibility of the device.

2. **Image Sensor:** - Image sensor is a sensor that detects and conveys the information that constitutes an image. By converting the variable attenuation of light waves into signals, small bursts of current that convey information.

In Li-Fi image sensors are used as receivers. It makes it possible to find incoming data and to provide correct direction of incoming vector from transmitter to receiver.

3. **LED (Light Emitted Diode):**- A light emitting diode (LED) is a semi conductor device that emits visible light when an electric current passes through it. The light is not particularly bright; in most LEDs it is monochromatic, occurring at a single wavelength. The output from a LED can range from red (at wavelength of approx. 700nm) to blue-violet (about 400 nm).

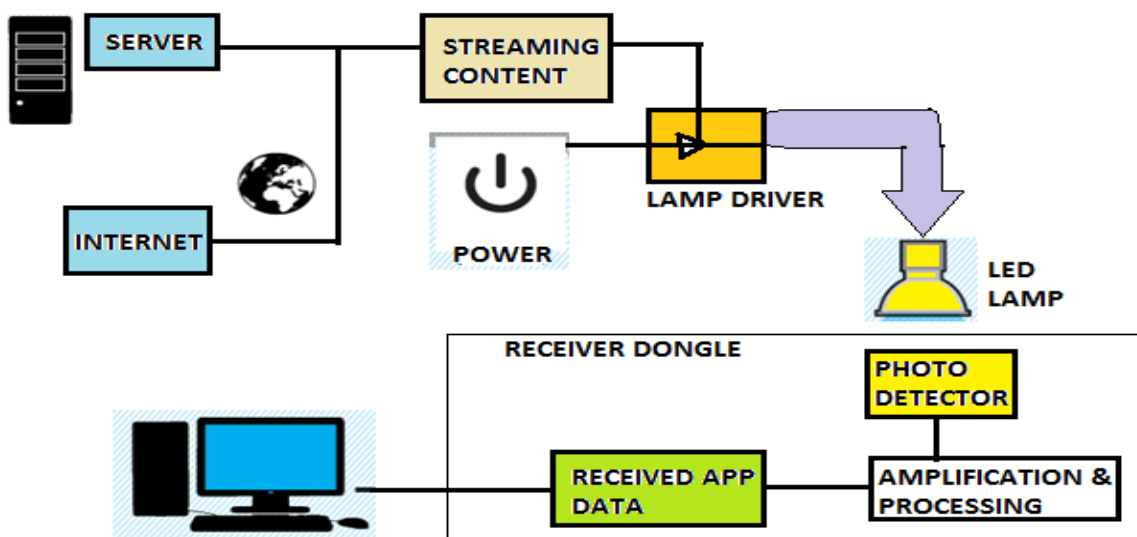
4. **PCB:** - PCB is an acronym for printed circuit board. It is a board that has lines and pads that connects various points together. It allows signals and power to be routed between physical devices.

### Working of Li-Fi:

Visible Light communication (VLC) is used in Li-Fi for data transmission. Li-Fi is implemented using white LEDs light bulbs at the downlink transmitter. The functioning of Li-Fi is very easy when the LED light is on a digital '1' is transmitted and when Led is off the digital '0' is transmitted. Led turned on and off quickly because the response time of led is less than microsecond, which is not identified by the human eye. This will appear to be continuous beam of light. The change in the on and off state in high frequencies enable the data transmission.

At one end all the data are stored on the server, when the LED is turned on; the microchip converts this digital data in the form of light, which is transferred to the led bulb.

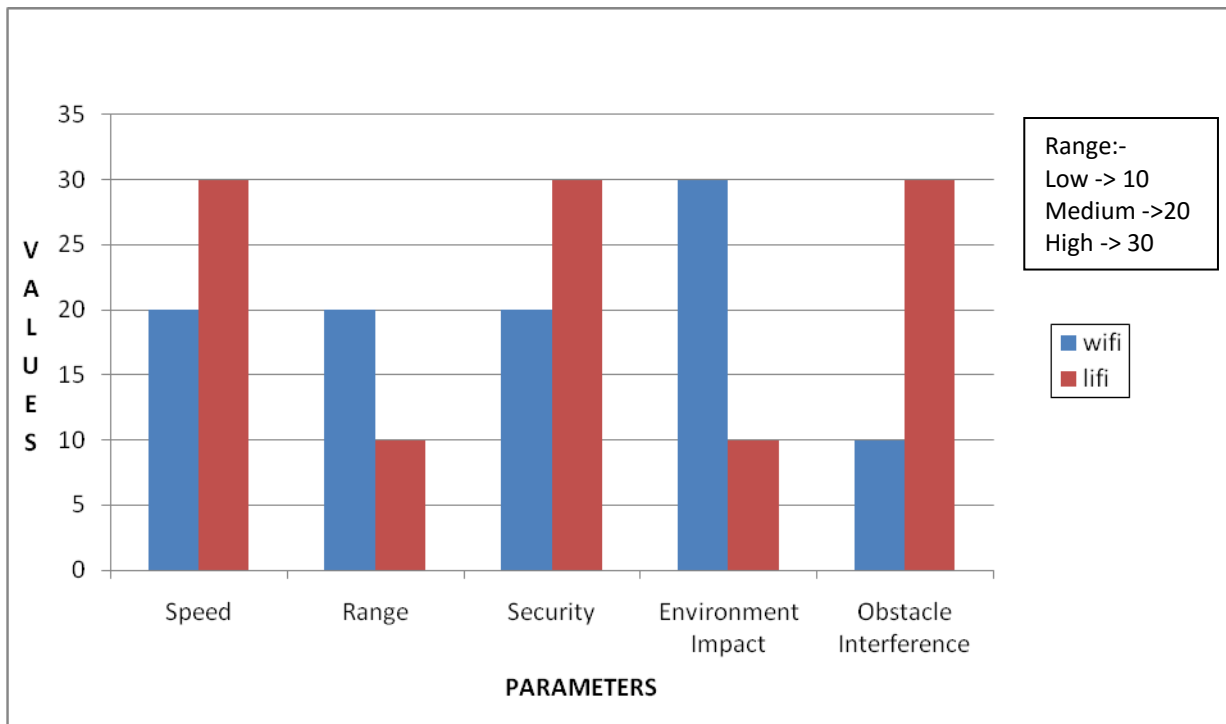
At the other end i.e. receiver end a photo detector converts the light data into digital data. After this amplification is done to control the flow of data from both the ends. After this, user receives the requested data.



**Fig.2 Working of Li-Fi**

### Comparative study of Li-Fi Vs Wi-Fi:

S.No.	Parameter	Wi-Fi	Li-Fi
1	Average Sped	150-600 Mbps	>10 Gbps
2	Transmitter	Antenna	LED
3	Receiver	Antenna	Photodiode
4	Signal Radiation Distance	150m	10m
5	Radiation Strength	Can penetrate the walls indoor and outdoor access is possible	Can't penetrate the wall. Not possible for outdoor.
6	Spectrum range	Radio spectrum	100 times faster than radio spectrum
7	IEEE standard	IEEE 802.11	802.15.xx
8	Network Topology	Point to point	Point to Point
9	License	license required	No license required
10	Development year	1994	2011
11	Secure	Less secure	More secure
12	Interference with Electronic	Radio waves to interference	No interference
13	Power consumption	Less	More
14	Environmental Impact	Low	High
15	Cost	Cheap	Costly



**Fig. 3 Comparison between Li-Fi Vs Wi-Fi**

#### **Application of Li-Fi:**

1. **Aircrafts:** Whenever we travel through the aircrafts we cannot access the internet so Li-Fi can be used there, because it provide high speed internet using the light source such as overhead reading bulbs.

2. **Underwater Applications:** : Li-Fi can even work underwater were Wi-Fi fails completely. For eg:-The LED light (Li-Fi) can also be used by the under water divers which will be useful for underwater recording and for live telecast.

3. **Medical applications:** As Wi-Fi uses radio waves which can cause hazardous to the patients in OT (Operation Theatres).Li-Fi technology can be used in OT where internet is required for telecasting. Since Li-Fi does not produce any harmful rays, it can be easily used without causing any damage to patient. Also a very close and clear picture of surgery can be view.

4. **Traffic light:** We can use Li-Fi in the LED of car also with the help of which cars can communicate with each other and prevent accidents by exchanging information.

**5. Applications in Sensitive Areas:** Wi-Fi are bad for sensitive areas such as power plants. Li-Fi can provide much safer connectivity in such sensitive areas. Also Li-Fi can be used in petroleum or chemical plants where other transmission medium can be hazardous.

**6. Disaster Management:** In times of natural calamities such as earthquakes, Flood, volcano Wi-Fi fails. LI-FI can be used as a powerful means of communication because it uses light.

**7. Radio Broadcast:** Large amount of power is required for radio waves to broadcast a signal this makes them inefficient. LED requires low power to operate it means that LI-FI needs very little power to broadcast a signal.

### **Benefits of LI-FI:**

1. Li-Fi is secure as compared to Wi-Fi because it uses light which cannot enter the wall.
2. The speed of data transmission is very fast it is in Gpbs, because it uses light signal for transmission of data.
3. Li-Fi solve the problem of insufficiency of radio frequency bandwidth because it use light and capacity of its spectrum is 10,000 time faster than radio waves.
4. Li-Fi can be used under water, where Wi-Fi fails.
5. Because of the radioactive waves Wi-Fi is more risky and dangerous for environment as well as human being. But as Li-Fi uses light technology it is more secured.

### **Shortcoming of Li-Fi:**

1. Light can't pass through objects.
2. Li-Fi require line of sight communication
3. High installation cost
4. Interferences from external light sources like sun, light, normal bulbs, opaque materials.
5. Li-Fi doesn't work in the dark or outdoors.

### **Future Scope of Li-Fi:**

Li-Fi is an emerging technology, still research is on and by the end of this year it will be implemented in Dubai. The future improvement will be focused on:

1. For analyzing the effect of interference from external light source like sunlight and normal bulbs and how to reduce the effect.
2. Data transmission rate and large area can be covered.
3. Integrated transmitter and receiver will be manufactured.
4. The next wave of energy efficient lighting will be based on laser diode.
5. Cars headlight, backlight and traffic signals will be changed with Li-Fi technology.
6. Li-Fi bulb will be used as Wi-Fi hotspot to transmit data.
7. The future of Li-Fi is Gi-Fi or gigabit wireless refers to wireless communication at a data rate of more than one billion bits (gigabits) per second.

### **Challenge of Li-Fi:**

Above all such advantages Li-Fi is still having some issues which need to be resolved.

1. **Line of Sight:** since Li-Fi uses light to transfer the data and light cannot penetrate the object. This becomes problem to access internet.
2. **Multipath Distortion:** when the transceiver is equipped with wide beam, the copies of the same signal from different paths arrive the destination with different amount of delay, because each path has different length from source to destination. This creates a problem called multipath distortion which can cause inter symbol Interference that severely degrades the performance.
3. Changing weather can be a problem, if apparatus is set outdoor.
4. A major challenge is how the receiving device will transmit the data back to transmitter.

### **Conclusion**

Li-Fi is an effective, secured, efficient and cheaper solution to replace radio waves spectrum used for internet data communication. As Li-Fi uses LED lights, it gives the best solution over security, speed and limited bandwidth of Wi-Fi. Li-Fi will make internet available all over including air, water and land. Since Li-Fi is quite protected, it is very helpful for the confidential data of different service like Defense, Military and Navy. Li-Fi technology will lead to us environment friendly, nontoxic and virtuous.



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