



Li-Fi (Light-Fidelity)-The upcoming technology in wireless communication

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Abstract- Li-Fi is a new paradigm for optical wireless technology to provide connectivity within a localized data-centric environment. The increasing demand for higher bandwidths, faster and more secure data transmission as well as environmental and undoubtedly human friendly technology heralds the start of a major shift in wireless technology, a shift from RF to optical technologies. Li-Fi is a wireless optical networking technology that uses light-emitting diodes (LEDs) for data transmission. Li-Fi is designed to use LED light bulbs similar to those currently in use in many energy-conscious homes and offices. However, Li-Fi bulbs are outfitted with a chip that modulates the light imperceptibly for optical data transmission. Li-Fi data is transmitted by the LED bulbs and received by photoreceptors. With the vast growing gadgets, their usage and their developments led to the advancement in the Wi-Fi which provides a technology so called Li-Fi. Li-Fi is a technology that makes use of LED light which helps in the transmission of data much more faster and flexible than data that can be transmitted through Wi-Fi. Light reaches nearly everywhere so communication can also go along with light freely. Light Fidelity is a branch of optical wireless communication which is an emerging technology. By using visible light as transmission medium, Li-Fi provides wireless indoor communication. The bit rate achieved by Li-Fi cannot be achieved by Wi-Fi. Dr herald Haas, the professor of mobile communications at the university of Edinburgh school of engineering, first time publically displayed the proof of Light Fidelity(Li-Fi), a method of Visible Light communication(VLC). Li-Fi is the transfer of data through light by taking fiber out of fiber optics and sending data through LED light.

Keyword-Li-Fi, Wi-Fi, VLC, LED

1. INTRODUCTION

Li-Fi is transmission of data through illumination by sending data through a LED light bulb that varies in intensity faster than the human eye can follow. Li-Fi is the term some have used to label the fast and cheap wireless-communication system, which is the optical version of Wi-Fi. The term was first used in this context by Harald Haas in his TED Global talk on Visible Light Communication.

At the heart of this technology is a new generation of high brightness light-emitting diodes, says Harald Haas from the University of Edinburgh, UK. Very simply, if the LED is on, you transmit a digital 1, if it's off you transmit a 0, Haas Says, they can be switched on and off very quickly, which gives nice opportunities for transmitted data. 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 eye cannot notice, so the output appears constant. More sophisticated techniques could dramatically increase VLC data rate. Terms at the University of Oxford and the University of Edinburgh are focusing on parallel data transmission using array of LEDs, where each LED transmits a different data stream. Other groups are using mixtures of red, green and blue LEDs to alter the light frequency encoding a different data channel.

Li-Fi, as it has been dubbed, has already achieved blisteringly high speed in the lab. Researchers at the Heinrich Hertz Institute in Berlin, Germany have reached data rates of over 500 megabytes per second using a standard white-light LEDs. The technology was demonstrated at the 2012 Consumer Electronics Show in Las Vegas using a pair of Casio smart phones to exchange data using light of varying intensity given off from their screens, detectable at a distance of up to ten meters.

In October 2011 a number of companies and industry groups formed the Li-Fi Consortium, to promote high-speed optical wireless systems and to overcome the limited amount of radio based wireless spectrum available by exploiting a completely different part of the electromagnetic spectrum. The consortium believes it is possible to achieve more than 10 Gbps, theoretically allowing a high-definition film to be downloaded in 30 seconds.

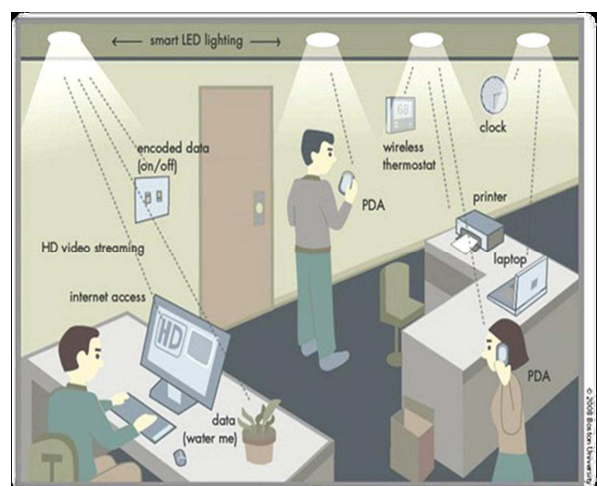


Fig1.1- Li-Fi Environment



International Journal of Ethics in Engineering & Management Education

Website: www.ijeee.in (ISSN: 2348-4748, Volume 1, Issue 4, April 2014)

2. HISTORY

This brilliant idea was first showcased by Harald Haas from University of Edinburgh, UK, in his TED Global talk on VLC. He explained, 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. So what you require at all are some LEDs and a controller that code data into those LEDs. We have to just 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 each frequency encoding a different data channel. Such advancements promise a theoretical speed of 10Gbps—meaning you can download a full high-definition film in just 30 seconds. Simply awesome! But blazingly fast data rates and depleting bandwidths worldwide are not the only reasons that give this technology an upper hand. Since Li-Fi uses just the light, it can be used safely in aircrafts and hospitals that are prone to interference from radio waves. This can even work underwater where Wi-Fi fails completely, thereby throwing open endless opportunities for military operations. Li-fi promises to be cheaper and more energy-efficient than existing wireless radio systems given the ubiquity of LED bulbs and the fact that lighting infrastructure is already in place. Visible light is part of the electromagnetic spectrum and its bandwidth is 10,000 times bigger than the radio frequency spectrum used by existing communication systems, affording vastly greater capacity. 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 micro chipped LED bulb that can produce data speeds of up to 150 megabits per second (Mbps), with one bulb providing internet connectivity for four computers.

3. WHY Li-Fi.....?

Li-Fi is the latest technology introduced for communication and it is more preferable compare to present technology mainly regard following following some issues.

- 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.

By using Li-Fi in all the lights in and around a building, the technology could enable greater area of coverage than a

single Wi-Fi router. Drawbacks to the technology include the need for a clear line of sight, difficulties with mobility and the requirement that lights stay on for operation. Li-Fi, an alternative to Wi-Fi that transmits data using the spectrum of visible light, has achieved a new breakthrough, with UK scientists reporting transmission speeds of 10Gbit/s – more than 250 times faster than 's Many experts claim that Li-Fi represents the future of mobile internet thanks to its reduced costs and greater efficiency compared to traditional Wi-Fi.

The premise behind VLC is that because lighting is nearly everywhere, communications can ride along for nearly free. Think of a TV remote in every LED light bulb and you'll soon realise the possibilities of this technology. One of the biggest attractions of VLC is the energy saving of LED technology. Nineteen per cent of the worldwide electricity is used for lighting. Thirty billion light bulbs are in use worldwide. Assuming that all the light bulbs are exchanged with LEDs, one billion barrels of oil could be saved every year, which again translates into energy production of 250nuclear power plants. There are some issues with radio wave communication. As we are using visible light communication(VLC) in Li-Fi we can overcome these issues as follows.

Capacity -10000 times more than radio waves spectrum band. Light boxes are already present, so we have the infrastructure available and light boxes are already installed in it.

Efficiency -Data through illumination and thus data transmission comes for free. LED light bulbs consume less energy and highly efficient.

Availability -Light is present everywhere.

Security -Light-waves don't penetrate through walls. They can't be intercepted or misused. Data is present only where there is light.

WORKING-This brilliant idea was first showcased by Harald Haas from University of Edinburgh, UK, in his TED Global talk on VLC.He explained," Very simple, if the LED is on, you transmit adigital 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." So what you require at all are some LEDs and a controller that code data into those LEDs. We have to just vary the rate at which the LED's flicker depending upon the data we want to encode. An overhead lamp fitted with an LED with signal-processing technology streams data embedded in its beam at ultra-high speeds to the photo-detector. A receiver dongle then converts the tiny changes in amplitude into an electrical signal, which is then converted back into a data stream and transmitted to a computer or mobile device.

Li-Fi is typically implemented using white LED light bulbs at the downlink transmitter. 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 can be made to vary at extremely high speeds. This very property of optical current is used in Li-Fi setup. The

operational procedure is very simple-,data from the internet and local network is used to modulate the intensity of the LED light source if any undetectable to the human eye. The photo detector picks up signal, which is converted back into a data stream and sent to the client.

The client can communicate through its own LED output or over the existing network. An overhead lamp fitted with an LED with signal-processing technology streams data embedded in its beam at ultra-high speeds to the photo-detector. A receiver dongle then converts the tiny changes in amplitude into an electrical signal, which is then converted back into a data stream and transmitted to a computer or mobile device.

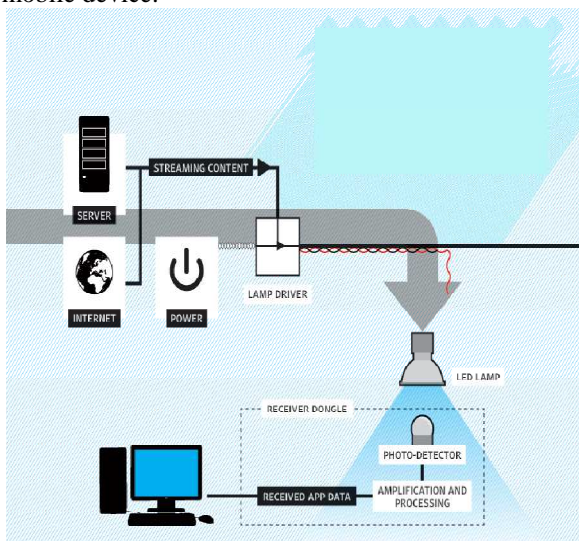


Fig1.2-working of Li-Fi

4. ADVANTAGES

Both Wi-Fi and Li-Fi transmit data over the electromagnetic spectrum, but whereas Wi-Fi utilises radio waves, Li-Fi uses visible light. This is a distinct advantage in that the visible light is far more plentiful than the radio spectrum (10,000 times more in fact) and can achieve far greater data density. One draw-back is that the data receiver would have to be in sight of the transmitter-bulb as visible light does not penetrate solid materials. The makers of Li-Fi note that this quality might actually be an advantage in some scenarios, making Li-Fi more secure than Wi-Fi with hackers unable to access unsecured internet connections from out of sight of the transmitter.

- The twin benefit is that the LEDs also provide light as any incandescent bulb.
- If there are other lights present, the technology is such the receiver can ignore the constant light source and is interested in the subtle amplitude changes of the LEDs.
- High speed, as high as 500mbps or 30GB per minute.
- Li- Fi uses light rather than radio frequency signals.
- VLC could be used safely in aircraft.
- Integrated into medical devices and in hospitals as this technology does not deal with radio waves, so it can

easily be used in such places where Bluetooth, infrared, Wi-Fi and internet are banned. In this way, it will be most helpful transferring medium for us.

There are around 19 billion bulbs worldwide, they just need to be replaced with LED ones that transmit data. We reckon VLC is at a factor of ten, cheaper than Wi-Fi.

Security is another benefit, he points out, since light does not penetrate through walls.

Cars have LED based headlights, LED based backlights, and Car can communicate each other and prevent accidents in the way that they exchange Information. Traffic light can communicate to the car and so on.

- By implementing the Technology worldwide every street lamp would be a free access point.
- Li-Fi may solve issues such as the shortage of radio frequency bandwidth.
- Easy to use.
- Fast data transfer.
- Reliable.
- Harmlessness.
- Low cost.

5. APPLICATION OF LI-FI

You Might Just Live Longer- For a long time; medical technology has lagged behind the rest of the wireless world. Operating rooms do not allow Wi-Fi over radiation concerns, and there is also that whole lack of dedicated spectrum. While Wi-Fi is in place in many hospitals, interference from cell phones and computers can block signals from monitoring equipment. Li-Fi solves both problems: lights are not only allowed in operating rooms, but tend to be the most glaring (pun intended) fixtures in the room. And, as Haas mentions in his TED Talk, Li-Fi has 10,000 times the spectrum of Wi-Fi, so maybe we can, I don't know, delegate red light to priority medical data. Code Red!

Airlines- Airline Wi-Fi, Nothing says captive audience like having to pay for the "service" of dial-up speed Wi-Fi on the plane. And don't get me started on the pricing. The best I've heard so far is that passengers will "soon" be offered a "high-speed like" connection on some airlines. United is planning on speeds as high as 9.8 Mbps per plane. Uh, I have twice that capacity in my living room. And at the same price as checking a bag, I expect it. Li-Fi could easily introduce that sort of speed to each seat's reading light

Smarter Power Plants- Wi-Fi and many other radiation types are bad for sensitive areas. Like those surrounding power plants. But power plants need fast, inter-connected data systems to monitor things like demand, grid integrity and (in nuclear plants) core temperature. The savings from proper monitoring at a single power plant can add up to hundreds of thousands of dollars. Li-Fi could offer safe, abundant connectivity for all areas of these sensitive locations. Not only would this save money related to currently implemented solutions, but the draw on a power plant's own reserves could be lessened if they haven't yet converted to LED lighting.

Under sea Awesomeness- Underwater ROVs, those favorite toys of treasure seekers and James Cameron, operate from large cables that supply their power and allow them to receive signals from their pilots above. ROVs work great, except when the tether isn't long enough to explore an area, or when it gets stuck on something. If their wires were cut and replaced with light say from a submerged, high-powered lamp then they would be much freer to explore. They could also use their headlamps to communicate with each other, processing data autonomously and referring findings periodically back to the surface, all the while obtaining their next batch of orders.

It Could Keep You Informed and Save Lives- Say there's an earthquake in New York or a hurricane. Take your pick it's a wacky city. The average New Yorker may not know what the protocols are for those kinds of disasters. Until they pass under a street light, that is. Remember, with Li-Fi, if there's light, you're online. Subway stations and tunnels, common dead zones for most emergency communications, pose no obstruction. Plus, in times less stressing cities could opt to provide cheap high-speed Web access to every street corner.

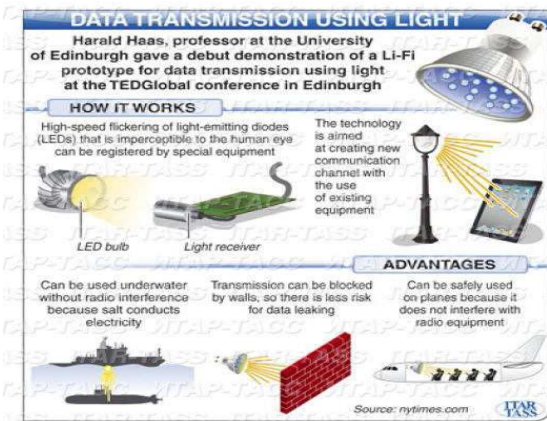


Fig1.3-Working and advantages

6. CONCLUSION

Thanks to the Li-Fi technology, the 14 billion lamps in the world will become gradually green mobile internet masts that will permit to respond to the impressive increasing demand of mobile connectivity. Also, this will allow reducing the electromagnetic pollution generated by the numerous radio wave solutions developed until now. Lighting reaches nearly everywhere, so communications can ride along for nearly free. Think of a TV remote in every LED light bulb and you'll soon realise the possibilities of communications using visible light—also dubbed as li-Fi. The possibilities are numerous and can be explored further. If this technology can be put into practical use, every bulb can be used as something like Wi-Fi hotspot to transmit wireless data and we will proceed toward the **Cleaner, Greener, Safer** and **Brighter** future. The concept of Li-Fi is currently attracting a great deal of interest, not least because it may offer a genuine and very efficient alternative to radio-based wireless. As a growing number of

people and their many devices access wireless internet, the airwaves are becoming increasingly clogged, making it more and more difficult to get a reliable, high-speed signal. This may solve issues such as the shortage of radio-frequency bandwidth and also allow internet where traditional radio based wireless isn't allowed such as aircraft or hospitals. One of the shortcomings however is that it only work in direct line of sight.

REFERENCES

- [1]. Jamie Condliffe, will Li-Fi be new Wi-Fi? Dated on 28 July 2011.
- [2]. Jyoti Rani, Prerna Chauhan, Ritika Tripathi
- [3]. "Li-Fi-The future technology In wireless communication" International Journal of Applied Engineering Research, ISSN 0973-4562 Vol .7 No.11,(2012).Richard P.Gilliard, Marc DeVincentis, Member, IEEE, Abdeslam Hafidi, Daniel O'Hare, and Gregg Hollingsworth "Operation of the Li-Fi", Vol. 39, No.4, April 2011.
- [4]. H. Elgala, R. Mesleh, and H. Haas, "Indoor optical wireless communication: potential and state-of-the-art", IEEE Communication Magazine, Optical Communications series, vol.49, pp. 56-62, September 2011.
- [5]. seminarprojects.com/s/seminar-report-on-lifi
- [6]. <http://en.wikipedia.org/wiki/Li-Fi>
- [7]. www.lificonsortium.org
- [8]. Wireless data from every light bulb Harald Haas, TED Global, Edinburgh, July 2011