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Light-Fidelity – A Revolution in the Field of Wireless Data Communication

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Abstract: Internet data communication is a crucial activity for modern society. Since internet communication needs secure, efficient and high data rate communication, researchers propose different form of internet data communication. The current wireless data communication Wireless-Fidelity is based on radio frequency and uses router for signal transmitter and Wi-Fi card or chip as receiver which are built in modern computers and smart phones. This radio frequency based technology is limited in bandwidth, interfered with signals of different electronic equipment and easily accessed or hacked by unwanted hidden peoples. Light Fidelity (Li-Fi) is a new technology that, proposed in late 2011 by prof. Harald Haas, uses illumination for internet data communication and will be implemented in a near future. Li-Fi uses semiconductor diodes for both data source and data receiver. It uses different color light emitting diodes (LEDs) as a transmitter and photodiodes as a receiver which are connected with computers or smart phones. Li-Fi technology uses the very simple technique of transmitting data using LED bulbs ie, if the LED is ON, then the digital signal 1 is transmitted else, if the LED is OFF, the digital signal 0 is transmitted which are detected by the photodiode at the receiver side. Li-Fi has many advantages over wireless fidelity (Wi-Fi). The advantage of Li-Fi over Wi-Fi is due to data communication spectrum differences. The electromagnetic spectrum bandwidth used for visible light communication (VLC) of Li-Fi is 10,000 times greater than for electromagnetic spectrum bandwidth of radio frequencies for Wi-Fi. Li-Fi technology has many advantages over Wi-Fi as a result of its unlimited bandwidth, its poor object penetration capacity, its low electromagnetic interference property and its possibility to integrate with the existing light infrastructure. But Li-Fi technology has some draw backs than Wi-Fi due to its radiation range, radiation direction and penetration capacity through objects and opaque materials. Since Li-Fi is clean cheaper and efficient and secure, most computer related companies will join and the draw backs will be reduced.

Keywords: Wireless-Fidelity (Wi-Fi), Light Fidelity (Li-Fi), Light Emitting Diode (LED), LDR (Light Dependent Register).

I. INTRODUCTION

Communication is one of the integral parts of anybody's life for exchanging information on devices in wired or wireless networks. With the introduction of new mobile devices, wireless communications have become the basic necessity of our lives. Commercially, we have Wi-Fi as the wireless communication standard. Similarly, Li-Fi (Light-fidelity) is also wireless communication system based upon Visible Light Communication with higher data rate than Wireless Fidelity (Wi-Fi). Due to increasing demand for wireless communications, Wi-Fi is facing many challenges namely- capacity, availability, efficiency and security. So, the term "Li-Fi" was introduced by Harald Hass in 2011 in TED Global talk on visible light communication, to limit these challenges faced by Wi-Fi.

Fig 1: Shedding-Light-On-LiFi

Li-Fi uses visible light region of the electromagnetic spectrum, transmitting data through high brightness LED bulbs. It works on simple principle- if the LED is on, you transmit a digital '1', if it's off you transmit a digital '0'.

II. LITERATURE SURVEY

Haas in 2011 took the stage in TED explaining idea behind the data transfer through the light. He demonstrated a simple prototype to the system and announced the success of the first prototype of Light Fidelity (Li-Fi) technology. Li-Fi uses the light as a media of data transfer. The light is the gift to the human and it is available everywhere, therefore the success of the Li-Fi will be a new revolution to the science of the data transfer. A new dimension will be added to the wireless data technology.

Fig 2: Main concept of Li-FI technology

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The main concept of Li-Fi is to transfer the data through sending light through Light Emitting Diode (LED) Bulbs as shown in Fig 2. The transmission rate of the data can control the intensity of the bulb where the light intensity can vary more than the human eye can realize.
For simultaneous data transmission, data is encoded on the intensity of light to control the data variation and does not affect the brightness of the light [4].

The transmitter is not limited to LEDs but could be any kind of light emitters could be a transmitter to the data; however, selecting one source of light could be better than others based on that the data transfer rate ranges from 40 Mbit/s to 100 Mbit/s.

However, in 2010, Siemens announced that the Li-Fi data transmission rate could be 500Mbit/s. in fact, UK researchers [6] claimed that they can reach 10 Gbps using micro-LED light bulb to transmit 3.5Gbps via each of the three primary colors - red, green, blue - that make up white light.

At the receiver side, the light detectors are used to receive the sent data as shown in Fig [3]. A simplified receiver of Li-Fi could be photodiodes in which it turns the light into electrical pulses. However, some other ideas such as using cameras to detect the light flickers could be also possible.

Fig 3: Li-Fi main idea

The simplicity of the Li-Fi is that turning the LED on produces logic 1 and turning it off produces logic 0 as shown in Fig 3. In fact, the typical light bulb flickers 20,000 times a second while Fond an University researchers were able to flicker the light bulb billions of times per second[5].

A Simplified block diagram is depicted in Fig 4. As
Can be seen in the Figure, the LEDs are connected to a network interface module that is directly connected to the Internet or Wireless Local Area Network (WLAN). To control the LEDs intensity a brightness control as a driving circuit is designed for this purpose.

It is worth mentioning that the visible light wavelength ranges between 400 to 700 nm. At the receiving side, there are an optical concentrator/ detector, photodiode and amplifier. The receiver is directly connected to the communication device.

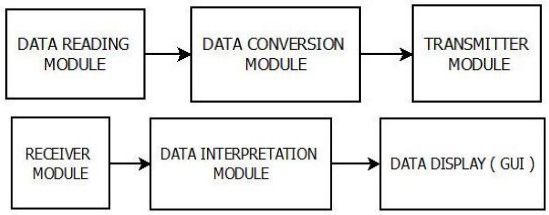

Fig 4: Simplified block diagram of Li-Fi

III. WORKING TECHNOLOGY OF LIFI

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. This can even work underwater where Wi-Fi fails completely, thereby throwing open endless opportunities for military operations. Very interesting results have recently been reported from the use of millimeter wave (mm Wave) communication in the 28 GHz region as well as from the use of infrared and visible light. The latter is particularly enticing as lighting is a commodity that has been integrated in virtually every inhabited environment and sophisticated infrastructures already exist. 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 10 Gbps – meaning you can download a full high-definition film in just 30 seconds. In that sense, the concept of combining the functions of illumination and communication offers the potential for tremendous cost savings and carbon footprint reductions. First, the deployment of VLC access points (APs) becomes straightforward as the existing lighting infrastructure can be reused, and there exist off-the-shelf technologies such as power-line communication (PLC) and power- over- Ethernet (PoE) as viable backhaul solutions for retrofit installations, and new installations respectively. Second, because lighting is on most of the time in indoor environments even during day time, the energy used for communication would practically be zero as a result of the piggy-backing of data on illumination [1].

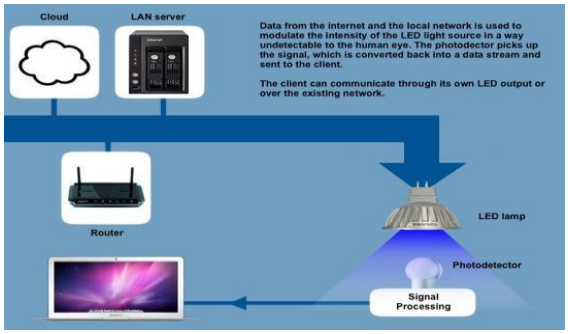

Fig 5: Working of Li-Fi technology

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IV. COMPARING Wi-Fi AND Li-FI

Li-Fi is basically a visible light technology to achieve high speed wireless communication by using visible light to transfer data. It acquired this name due to its similarity to WI-FI which utilizes radio waves for transfer of data [3].

Fig 6: Comparisons Wi-Fi and Li-FI

Table 1: comparison between parameters of Li-Fi and Wi-Fi

S:NO	Parameters	Li-Fi	Wi-Fi
1.	Frequency	2.4Ghz to 5Ghz	400 Thz to 800 Thz.
2.	Range	100 meters	Based on LED light
3.	Data transfer rate	11Mbps	>1Gbps
4.	Power consumption	Medium	Low
5.	Security	Minimum	secured
6.	Usage Location	Within range of W-LAN infrastructure, usually inside a building	Where ever light is available public places, home, office, road, etc.
7.	Network topology	Point to point	Point to point
8.	cost	low	High

V. CHARACTERISTICS OF VLC

Spectrum:
Wi-Fi works on radio frequency, which only formulate up a small part of the electromagnetic spectrum. With growing user demand for wireless internet, the available radio spectrum is getting exploited. Radio waves are harmful for human beings as they penetrate the body and may cause mutation. They can't be used in all environments, mostly in aircrafts, chemical factories and power plants as well as in hospitals. In Li-Fi visible light spectrum is used to pass on information as there is much extra space existing in this spectrum and it has the potential to pass on higher bandwidths [2]. The communication of the information can be with the help of all kinds of light close to visible region [10]. This part of spectrum is not harmful to our body and is safe to use in different environments.

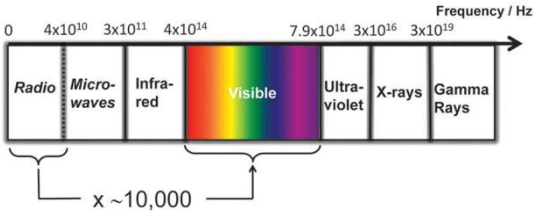

Fig 7: Electromagnetic Spectrum

LEDs:
This technology can offer us with a wireless Internet connectivity, as long as we have a LED light bulb. LED can be used to transfer binary coded information quickly by using visible part of spectrum. Total number of the world's light bulbs is projected at about 14 billion which can be used to obtain data transmission if we replace with LED's.

Fig 8: LED light bulbs

Hence, Li-Fi is a rising way to create wireless connectivity links by means of the LED illumination networks. We can exchange light bulbs with LED's so that all street can be transformed into an Internet access points for all Electronics. Just Simply Light the LED lamp!

Speed:
For Wi-Fi we have rate restrictions for information transfer. While, Li-Fi can offer enormously high speed of the internet and we can download massive files in just few seconds of time. Speed for Li-Fi is 10,000 folds more than Wi-Fi much larger than 1 Gbps can be achieved [9].

Security:
Radio waves can penetrate all the way through. This leads to numerous security concerns as they can be intercepted without difficulty. While information transfers for Li walls -Fi is much protected and safe (no one can hack it). As we use visible light no signal disperses through walls [12].Such visible light communication could be used securely in airplanes without disturbing airlines signals.

Safety:
VLC uses light as a carrier. Light is the source of life. Hence, there has no health hazard. While in case of RF, it is proved to be hazardous for all living things.

Efficiency:
VLC provides efficient way of communication due LED which require negligible power and less complexity. It is inexpensive because of the use of already available visible light sources. In case of RF communication, complexity and cost is very high[7].

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Unlicensed use:
As VLC uses visible spectrum which is free. Hence, there are no licensing issues.

High data rates:
VLC inherits high data rates from optical communication.

VI. APPLICATION OF Li-Fi

RF Avoidance:
Some people claim they are hypersensitive to radio frequencies and are looking for an alternative. Li-Fi is a good solution to this problem.

RF Spectrum Relief:
Excess capacity demands of cellular networks can be off-loaded to Li-Fi networks where available. This is especially effective on the downlink where bottlenecks tend to occur. Since we have ten thousand times greater than the RF spectrum the capacity has increased [6].

Mobile Connectivity:
Laptops, smart phones, tablets and other mobile devices can interconnect directly using Li-Fi [11]. Short range links give very high data rates and also provides security.

Significantly Lower Power Consumption:
Radio masts are very inefficient and require vast sums of power in order to broadcast and in some cases keep them cool enough to operate. LEDs on the other hand use very little power (much less than a fluorescent bulb), meaning Li-Fi also uses very little power. At the same time Li-Fi can also light a room, meaning it can do two jobs for the price of one [8][14].

Education systems:
As with the advancement of science the latest technology is the LIFI which is the fastest speed internet access service [13]. So this will leads to the replacement of WI-FI at institutions and at companies so that all the people can make use of LIFI with same speed intended in a particular area.

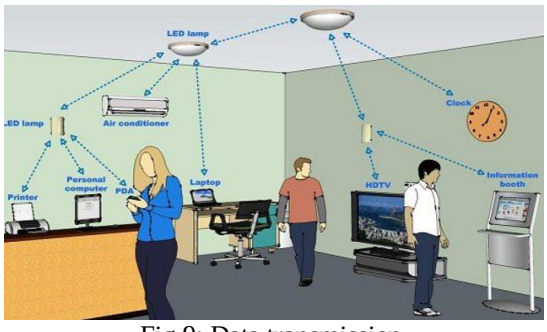

Fig 9: Data transmission

Smart Lighting:
Any private or public lighting including street lamps can be used to provide Li-Fi hotspots and the same communications and sensor infrastructure can be used to monitor and control lighting and data

Location Based Services (LBS):
Highly accurate location-specific information services such as advertising and navigation that enables the recipient to recumeive appropriate, pertinent information in a timely manner and location.

Airlines:
Airline Wi-Fi Nothing says captive audience like having to pay for the "service" of dial-up speed Wi-Fi on the plane. The best I have heard so far is that passengers will be offered a "high-speed like" connection on some airlines. United is planning on speeds as high as 9.8 Mbps per plane. Li-Fi could easily introduce that sort of speed to each seat's reading light.

Undersea Awesomeness:
One of the applications of the Li-Fi is in underwater ROVs, those beloved toys of treasure seekers, functions from huge cables that provide them power and permit them to collect signals from their pilots above ROVs work great, expect when hop isn't extended adequate to investigate an area or when it gets jammed on something. If their wires are cut and substituted with light – say from some submerged, high-powered lamp – then they would be much freer to explore. They could use their headlamps to keep in touch with each other, analyzing data autonomously and referring their findings from time to time back to the surface. Li-Fi even works underwater where Wi-Fi completely fails, thereby giving open everlasting opportunities for military operations [12].

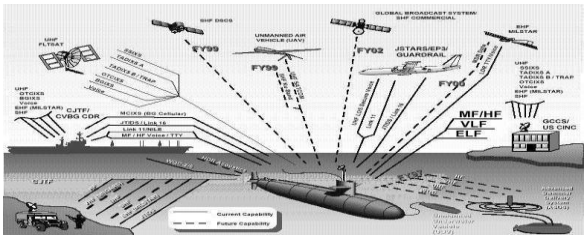

Fig 10: Underwater Communications

Vehicle transportation:
Vehicles with tail and head LED lamp can act as a transmitter and receiver for VLC communication. It will be easy to convey any message regarding traffic to vehicles. Efficient intra-vehicle communication is possible. Traffic control becomes easier.

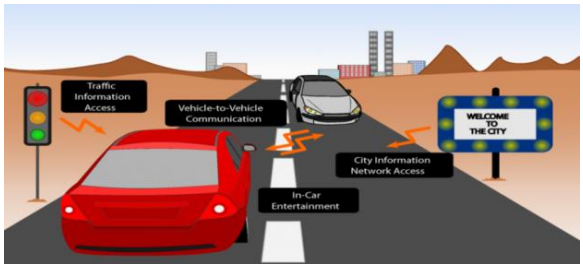

Fig. 11: Transport application

Giga Speed Technology:
The Li-Fi consortium provides the faster wireless data transfer technology presently available. Our current

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solution offer effective transmission rates of up 10 Gbps, allowing a 2 hour HDTV film to be transferred in less than 30 seconds. This can be extended several 100 Gbps in future versions.

Medical field: 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 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.

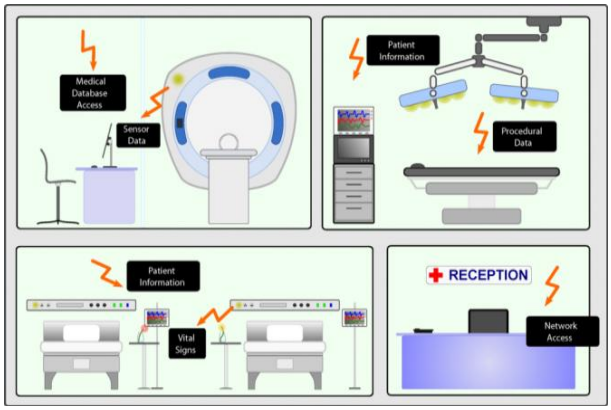

Fig 12: VLC used in Hospitals

Chemical Industry:
As we are familiar with radio frequencies being damaging in chemical or petrochemical sectors but Li-Fi is communication system based on the visible light which is used in all industries. So Li-Fi is secure alternate for data transmission.

VII. ADVANTAGES OF Li-Fi

1. Li-Fi can attain 1000 folds the info density of Wi-Fi, as visible light can be curbed in the light but in case of RF it is prevented due to interference.
2. A very widespread spectrum of operation over the visible range of EM is present.
3. A very high speed secure of information access can be possible from Li-Fi.
4. Li-Fi is a harmless alternative as compared to radio waves (RF), because in these waves the electromagnetic interference takes place in environments such as in mines and petrochemical sectors.
5. Integrated into medical appliances and in hospitals as this tech doesn't deal with RF, so it can easily be used in all such places where Bluetooth, IR, Wi-Fi and internet are broadly in use.
6. Using this technology globally every street lamp would be an open data access point.
7. It can be used to revise traffic information at almost every moment and it will be simple for traffic police to deal with traffic and arrest the one who breaks the rule.
8. Dynamic dark i.e. glow Modulation of lamp output to improve video contrast.
9. LED lights eat less energy and very competent. As it uses less energy it is economical and easy to use.

VIII. CHALLENGES OF USING LI-FI

1. It can only transmit when in the line of vision.
2. Although this technology sounds like a substitute to Wi-Fi but this high speed information transferring technology also has some restrictions that is the lack of ability of light to go by obstacles. It cannot go by the walls and can be blocked. If the light signal is blocked, we can seamlessly change back over to radio waves (Wi-Fi).
3. As Li-Fi technology uses light as communication means, so if the receiver is somehow blocked in a way then the signal will directly be cut out.
4. Information transfer obstruction from exterior light sources for instance sunlight, normal bulbs, and dense materials can cause loss of consistency and network.
5. We still need Wi-Fi and we still require RF cellular systems. You can't have a light bulb that provides info to a speedy moving object or to make accessible data in a remote area where there are trees, walls and obstacles.
6. This tech requires constant supply of illumination which means that the LED have to be kept on throughout the day and albeit the cost of using LED is lower, the requirement by Li-Fi will raise the expenditure [15].

IX. CONCLUSION

As of today, internet is becoming a basic need for everyone and with the shortage in radio spectrum and this new epoch of wireless communication being called as D-LIGHT opens an entire new world of possibilities. If this technology can be put into practical use, every bulb can be replaced by am LED which in turn will act something like a Wi-Fi hotspot to transmit wireless data and we will proceed towards a brighter, cleaner, safer and greener 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 the growing population and their many devices access wireless internet, the airwaves are getting choked, making it more and more difficult to get a reliable, high-speed signal. One of the shortcomings however is that it only work in direct line of sight.

REFERENCES

1. Dobroslav Tsonev, Sinan Sinanovic and Harald Haas, "Novel Unipolar Orthogonal Frequency Division Multiplexing (U-OFDM) for Optical Wireless", IEEE, 2012.
2. Harald Burchardt, Nikola Serafimovski, Dobroslav Tsonev, Stefan Videv, and Harald Haas, "VLC: Beyond Point-to-Point Communication," Communications Magazine, IEEE, 52(7), pp. 98-105, July 2014.

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ISSN (Print) 2394-1588

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ISO 3297:2007 Certified
Vol. 3, Issue 10, October 2016

3. Ian Lim, 'Li-Fi – Internet at the Speed of Light', the gadgeteer, 29 August 2011
4. Jay h. bhut, dharmrajsinh n. parmar, khushbu v. mehtaelectronics & communication engineering, marwadi education foundation, rajkot, india. Communication system engineering, charusat university, changa,india "li-fi technology – a visible light communication" issn: 2321-9939.
5. Jyoti Rani1, Prerna Chauhan2, Ritika Tripathi3 International Journal of Applied Engineering Research,ISSN 0973-4562 Vol.7 No.11 (2012).
6. Mr. Vinod Saroha, Ritu Mehta, "Network Security: Li-Fi: Data On light Instead of Online", International Journal of Engineering and Computer Science ISSN, Volume 3 Issue 1, Jan 2014 Page No. 3681-3688
7. "New Epoch of wireless communication: Light Fidelity"IJIRCCE, vol 1,issue 2,April 2013.
8. Nam-Tuan Le and Yeong Min Jang, "Virtual Cognitive MAC for Visible Light Communication System", International Journal of Smart Home, Vol. 6, No. 2, pp.: 95-100, 2012
9. N.Navyatha, T.M.Prathyusha, V.Roja, M.Mounika Li-Fi (Light fidelity)-LED Based Alternative International Journal of Scientific & Engineering Research, Volume 4, Issue 5, May-2013 1039 ISSN 2229-5518
10. Rani, Jyoti, Prerna Chauhan, and Ritika Tripathi. "Li-Fi (Light Fidelity)-The future technology In Wireless communication." Int. J. of Applied Engineering Research 7, no. 11 (2012).
11. Praveen Bandela, Punil Nimmagadda, Sravanthi Mutchu, "Li-Fi(Light Fidelity): The Next Generation of Wireless Network", International Journal of Advanced Trends in Computer Science and Engineering, Vol. 3 , No.1, Pages : 132– 137 (2014). Engineering, Vol. 4, No. 2, August 2014, pp. 86–89
12. Shubham Chatterjee, Shalabh Agarwal, Asoke Nath, "Scope and Challenges in Light Fidelity (LiFi) Technology in Wireless Data Communication",International Journal of Innovative Research in Advanced Engineering ,Issue 6, Volume 2 (June 2015)
13. Tsonev, D., Sinanovi´c, S., and Haas, H., ―Novel Unipolar Orthogonal Frequency Division Multiplexing (U-OFDM) for Optical Wireless,‖ in [Proc. of the Vehicular Technology Conference (VTC Spring)], IEEE, IEEE, Yokohama, Japan (May 6–9 2012).
14. Xu Bao, Guanding Yu, Jisheng Dai, Xiaorong Zhu, "Li-Fi: Light fidelity-a survey," Wireless Networks, Springer, pp 1-11, January 2015.
15. http://www.lifi.com/pdfs/techbriefhowlifiworks.pdf.
16. http://www.ispreview.co.uk/index.php/2013/01/tiny-led-lights set - to-deliver-wifi-style-internet-communications.html, January 2013.
17. http://electronicsforu.com/electronicsforu
18. http://en.wikipedia.org/wiki/Li-Fi

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