

## A Review: Wireless Communication Using Li-Fi

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**Abstract:** - In 21 century, modern civilization is enormously dependent upon electronic and communication system. In this electronic world, speed of internet is a major issue. Internet is used for downloading, social networking, e-banking, online shopping official works like online freelancer, tickets booking, data sharing software and also studies material, etc. These tasks accomplishes through wired or wireless network. But wireless is preferable technique. As the user increases proportionally speed decreases. To overcome this problem German physicist Herald Hass, proposed Li-Fi technology. Present paper reflects the Future of Communication (Li-Fi) which may affect all lives. Li-Fi is a Visible Light Communication (VLC) as is implemented using white LED's. It is a technology that may provide theoretically a speed of upto 10Gbps, cost effective and more robust and useful than Wi-Fi and other wireless communication technology. Li-Fi is not expected to completely replace Wi-Fi, but the two technologies could be used complementarily to create more efficient, green and future-proof access networks.

**Keywords-** Li-Fi, Wi-Fi, Visible Light Communication (VLC)

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### I. INTRODUCTION

Wireless communication is among technology's biggest contribution to the mankind. It has many advantages over wired communication. The term wireless refers to the communication or transfer of information between two or more points over a distance without requiring wires, cables and any electrical conductor. Wireless communication is one of the important medium for transmission of data or information to other devices. The communication is a information transmitted through air without requiring any cable by using electromagnetic waves like radio frequencies, infrared satellite etc. in a wireless communication technology network.

As a growing number of people and their need increases, therefore it is difficult to get a reliable, high-speed signal. The number of multimedia-capable and Internet-connected devices is rapidly increasing. This data consumption occurs indoor, and increasingly in spaces such as aircraft and other vehicles. To satisfy this insatiable demand, Number of techniques exists on earth. This technology has lot of disadvantages like increase in networks complexity, shortage of wireless radio bandwidth and an increased risk of interference of radio frequencies which put limitation on radio frequency which is used in Wi-Fi, Bluetooth and other wireless communication technology. Here a new technology mentioned which gives fast data transfer, low consumption of energy and cost-effective which is beneficial for present and future.

This new technology is Li-Fi. Li-Fi stands for Light-Fidelity. Light-Fidelity is a branch of optical wireless communication which is an emerging technology. Simply, Li-Fi is nothing but Wi-Fi using light. By using light data can transmit. Li-Fi technology came into existence in 2011. German scientist professor Herald Hass was coined the term Li-Fi and promoted Li-Fi. Li-Fi is used for enjoying high data transfer rate. Li-Fi is a fast and cheap optical version of Wi-Fi. It is based on Visible Light communication (VLC) which is used to transmit data using the spectrum of visible light. Light reaches nearly everywhere so communication can also go along with light easily. Wi-Fi use radio spectrum to transmit data, but due to shortage of radio frequencies it having some limitation.

Li-Fi uses visible light instead of gigahertz radio waves for data transfer. The working of Li-Fi is very simple as if the LED is on, you transmit 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.

This paper gives a new idea to the very popular LED's as high speed data transmitters. LED can be used as a replacement to RF communication for short ranges to some extent. VLC has no health hazards associated with it. If this technology can be put into practical use, every bulb can be used something like a Wi-Fi hotspot to transmit wireless data and we will proceed toward the cleaner, greener, safer and brighter future. The excess radio frequency spectrum demands of cellular networks and Wi-Fi can be met by using Li-Fi. Besides this the visible light spectrum is unregulated and vast. So Li-Fi not only solves the problem of radio frequency congestion but it also is very cheap as compared to radio frequency communication. Li-Fi has incredible data rates that can be put into use as a solution in many real time applications.

### II. LITERATURE REVIEW

#### 1. Research on Zigbee wireless communication technology

This paper presented a overview of Zigbee wireless communication technology [1] and the process of establishing Zigbee network. This paper introduced the networking technology, application of Zigbee wireless sensor, the basic concepts of Zigbee wireless communication technology, its origin. Zigbee protocol stack and the application of Zigbee technology were also introduced.

Zigbee wireless communication technology is a kind of newly arisen wireless network technology. Its characteristic is short distance communication, low speed, low power dissipation and low cost. Zigbee wireless communication technology has advantages of high-capacity networks, safe and reliable data transmission. It could be applied in remote control and data acquisition. Zigbee will be used in a couple of years in the area of industry control, industrial wireless location, home network, building automation, medical equipment control, mine safety, etc, especially home automation and industry

control will be the main application fields. This technique is disadvantageous because coverage area is very small.

## 2. The Bluetooth Technology: Merits and Limitations

This paper clarified the broad concept of bluetooth, discussed the merits and limitations of the Bluetooth technology [2] and addresses the challenging and interesting open research problems in this area that may arise in the future. In this paper, author compared Bluetooth wireless communication with existing Wireless LAN standards such as RF and the IrDA protocol. They highlighted the limitations of Bluetooth version 1.0: interference from other sources, co-channel interference, capacity limitations, device discovery capabilities and discuss open problems that may be of great interest to the research community.

Bluetooth operates in the 2.4 GHz ISM (Industrial, Scientific and Medical) band and is based on a low-cost, short-range radio link, and that facilitates ad-hoc connections for stationary and mobile communication environments. The disadvantage of this technique is slow data rate transmission and coverage area is very small.

## 3. Device-to-Device Communications with Wi-Fi Direct: Overview and Experimentation

This paper presented an overview of the technical features specified in Wi-Fi Direct [3]. Wi-Fi Direct is a new technology defined by the Wi-Fi Alliance aimed at enhancing direct device to device communications in Wi-Fi. Wi-Fi Direct technology takes a different approach to enhance device to device connectivity. Wi-Fi Direct builds upon the successful IEEE 802.11 infrastructure mode. Thus, legacy Wi-Fi devices may seamlessly connect to Wi-Fi Direct devices. By taking this decision, Wi-Fi Direct immediately inherits all the enhanced QoS, power saving, and security mechanisms developed for the Wi-Fi infrastructure mode in the past years. After a tremendous success, Wi-Fi has become a easy and superior way to access the Internet wirelessly. It is now embracing challenge of becoming pervasive also in direct device to device communications. This technology is disadvantageous because of its cost and it does not work in water efficiently.

## 4. Analysis of Wi-Fi and WiMAX and Wireless Network coexistence

This paper introduced two technologies and make comparisons between WiMAX and Wi-Fi[4]. In this paper the Wi-Fi and WiMAX technologies and then their own characteristics are compared and the coexistence of Wi-Fi and WiMAX is analyzed. They used OPNET Modeler software and the wireless coexistence deployment is evaluated with output graphs. Finally, conclusion is made by discussing the future of WiMAX in relation to Wi-Fi.



Figure 1. Wireless coexistence (WiFi, WiMAX and 2G/3G)[4]

## 5. What is Li-Fi?

This paper explain the Li-Fi technology[5] and attempts to clarify the difference between visible light communication (VLC) and Light-Fidelity (Li-Fi). In particular, it will show how Li-Fi takes VLC further by using light emitting diodes (LEDs) to realise fully networked wireless systems. This paper discussed the key differences between VLC and Li-Fi. A summary of state-of-the-art modulation techniques used in Li-Fi systems. This paper explained the first Li-Fi transmitter and receiver application-specific integrated circuits (ASICs) components, full Li-Fi network and Li-Fi autocell networks including the consideration of co-channel interference (CCI). It covers all of the key research areas from Li-Fi components to hybrid Li-Fi/wireless fidelity (Wi-Fi) networks to illustrate that Li-Fi autocells are not a theoretical concept any more, but at the point of real-world deployment.

## 6. Wireless Communication using Li-Fi Technology

This paper designed a prototype Li-Fi system[6] to transfer data as well as Files. Data and files were transmitted as serial data using UART serial communication from one PC to another PC using VLC. Visible light communication is used at the transmitting end and photodiodes at the receiving PC. Photo-diode transistor is used to recover the data from visible light and inverting amplifier is used to get the data processed by PIC controller. PIC microcontroller is used for toggling of the LED at the transmitting end and again for binary conversion of received stream of data into a suitable file to be recognized by the PC software. Photo diode transistor is used to recover the data from visible light and inverting amplifier is used to get the data and processed by PIC controller connected to PC serial communication port as well as Android Phone using OTG cable. It can be used wherever LED light source is available. By using Li-Fi technology, data transfer rate is achieved of 10 Gbps, medium power consumption with highly secured data.

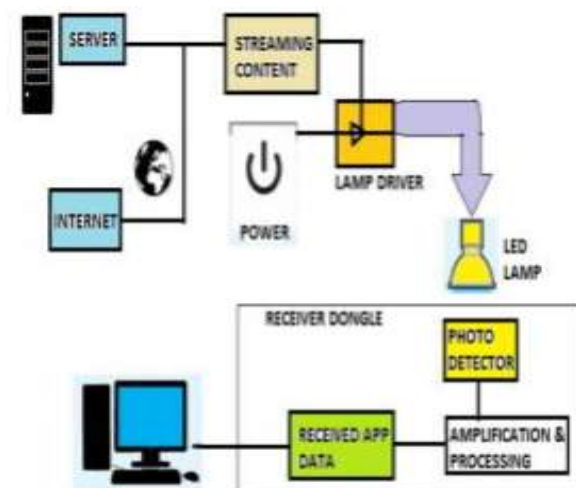


Figure 2. Data transmission using LED.[6]

## 7. Coexistence of Wi-Fi and Li-Fi Toward 5G: Concepts, Opportunities, and Challenges

This paper described the coexistence between Wi-Fi and Li-Fi [7] which is a new promising research area. The proposed Li+WiFi HetNet is tested using bidirectional high-speed LiFi transceiver devices. This paper discussed the

primary characteristics of both technologies and the possibility for them to coexist. That both technologies(Wi-Fi + Li-Fi) together can more than triple the throughput for individual users and offer significant synergies, yielding highest data rates needed in the 5th generation of mobile networks (5G).This technology require more hardware and consumes more power, So expensive.



Figure 3. The proposed Li+WiFi HetNet.[7]

#### 8. Ship to Ship Communication using Li -Fi Technology

This paper presented the system which uses the light is the communication medium between the two ships which is underwater communication [8]. The existing technology uses electromagnetic wave, due to which communication can be established at higher frequency and bandwidth. This causes high absorption/attenuation that has adverse effect on the transmitted signals. Big antenna also needed for this type of communication which increases design complexity and cost. Due to absorption characteristics of sea water ultrasound is not used for underwater communication. Unwanted noise signal may be present. To overcome this problem Li-Fi system is used. Li-Fi system can be used for minimizing the disadvantages of ultrasound underwater communication. Due to high speed of light, Light signals can travel long distance without any obstruction in water. For Long Distance communication, they use the LASER in place of LED. So the communication distance can be increased. At the receiver section they used Photo detector which accepts the signals or string light signals from the LED and it process it. After the Photo detector the signals is applied to the amplification and signal processing to get the actual transmitted signal. At the receiver side they also connected the LCD display to verify the actual transmitted signal. This is system easy to implement, helpful for less power application and for transmit secured data.



Figure 4. Block Diagram of The Proposed System.[8]

#### 9. Audio Multicast by Visible Light Communication for Location Information for the Visually Impaired

This paper implemented audio multicasting using visible light communication[9] that is used to send location information to aid the visually impaired. The study was executed using light emitting diodes, which has the capability to transmit fast light pulses and then a receiver will be able to collect the light pulses as a code and translate it to a corresponding audio data. The system has three devices that communicate through multicasting. It consists of a central device which acts as a transmitter and two end devices acting as receivers. The end devices have LEDs that send a request and receive an acknowledgement to and from the central device. The central device upon receiving a request continuously sends data while the end devices checks if the bits sent correspond to a set of code in its look up table.

In this study, the visible light communication system uses modulation schemes, such as on-off keying, so that the digital HIGHs and LOWs are representations of the binary code to be transmitted. Acknowledgement lights incorporated in the receiver are also utilized to make multicasting possible, and to signal that transmission is successful. The system is also able to function in both dark and bright lighting environments.

Innovations can be done in the future. In this study, digital codes are sent through the LEDs. For future experiments, audio signals can be sent through the LEDs, instead of the digital codes.

#### 10. LI-FI: A New Era Of Wireless Communication Data Sharing

This paper discussed the various application of Li-Fi technology[10]. By using Li-Fi we access internet anywhere in streets, footpaths, house, etc. with the help of available light source such as tube-light, lamps, street-lights etc. LED's are fast switching easily available cheap low power consumption and hence can be used in large amount to transfer data. Communicating and obtaining data from satellite will be more easy than ever before. It will be beneficial for defence services as their data is very confidential and Li-Fi cannot be hacked so data is protected. For marine commandos, who operates under water can send important commands to other areas (either under water or in land etc.) since Li-Fi signals works under water. With the hands provided by Li-Fi we will be future ready.



III. TABULAR COMPARISON

Parameter	Zigbee	Bluetooth	Wi-Fi	Wi-Max	Li-Fi
Development Year	1998	1994	1990	2001	2011
Standard	IEEE.802.15.4	IEEE 802.15.1	IEEE 802.11	IEEE 802.16d/e	IEEE.802.15.7
Range	10 to 20m(approx)	Typically less than 10m to up to 100m	About 300m	30-100m	Based on LED Light Intensity
Operating Band	Radio Frequency Band	Radio Frequency Band	Radio Frequency Band	Radio Frequency Band	Visible Light band
Frequency	2.4Ghz(GSM)	2.4Ghz(GSM)	2.4-5Ghz	2-11 GHz	400-800 THz (Visible light)
Network Topology	Mesh Topology	Piconet: Star topology	Point-to-Multipoint	Point-to-Multipoint	Point-to-Point
Data Transfer Rate	Slow	Slow	Downlink speed:10.9Mbps Uplink Speed: 2.8 Mbps	70Mbps	>1Gbps
Power Consumption	Low	Low	Medium	Medium	Medium
License required	Not required	Not required	required	Required	Not required
Environmental impact	Low	Low	Medium	Medium	Low
Cost	Low	Low	High	High	Low
Security	Less Secured	Less Secured	Medium Secured	Medium Secured	Highly secured

III. CONCLUSION

Li-Fi is an emerging technology currently attracting us a great deal of the interest because of its latest and very efficient alternative to wireless technology. It uses the visible spectrum of light which is much better than the RF. Li-Fi has large bandwidth and high speed than Wi-Fi. With the use of LEDs the information can be transmitted with just the simple turning on and off of the LEDs. This technology is a effective not only for wireless but also underwater communication. This technology minimizes the effect of high absorption/attenuation that has significant effect on the transmitted signal. This technology is not only free to use but also provides a safe and secure access. By using this technology we can proceed towards a greener, safer and cleaner future. It is an advanced approach that will make our lives more technology driven in the near future.

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