Current Journal of Applied Science and Technology

38(6): 1-7, 2019; Article no.CJAST.49878
ISSN: 2457-1024
(Past name: British Journal of Applied Science & Technology, Past ISSN: 2231-0843, NLM ID: 101664541)

A Comparative Study of LiFi and Other Data Transfer Mediums

R. I. Nwosu[1*]

[1]Department of Computer Engineering, Ahmadu Bello University, Zaria, Kaduna State, Nigeria.

Author's contribution

The sole author designed, analysed, interpreted and prepared the manuscript.

Article Information

DOI: 10.9734/CJAST/2019/v38i630430
Editor(s):
(1) Dr. Chien-Jen Wang, Professor, Department of Electrical Engineering, National University of Tainan, Taiwan.
(2) Dr. Orlando Manuel da Costa Gomes, Professor of Economics, Lisbon Accounting and Business School (ISCAL), Lisbon Polytechnic Institute, Portugal.
(3) Dr. Rodolfo Dufo Lopez, Professor, Department of Electrical Engineering, University of Zaragoza, Spain.
Reviewers:
(1) Muhib Ur Rahman, Dongguk University, South Korea.
(2) Mudasir M. Kirmani, Sher-e-Kashmri Unviersity of Agricultural Sciences and Technology, India.
(3) Pasupuleti Venkata Siva Kumar, VNR VJIET, India.
Complete Peer review History: http://www.sdiarticle4.com/review-history/49878

Original Research Article

Received 05 May 2019
Accepted 11 July 2019
Published 26 December 2019

ABSTRACT

The growing rate of data transfer is a concern for end users in transmitting large files. There is need for a faster mechanisms for data transfer and Light Fidelity (LiFi) is an alternative medium for transferring data. This study compares LiFi and other data transfer mediums using selected parameters to improve data transfer. It is a better alternative because it's safer, greener, cheaper and it does not have any radio waves or any other medium. It shows that LiFi have a better transfer rate of 1-3.5Gbps as compared to other mechanisms and its future application is in different fields such as industries, medicine, education and other regions requiring further exploration.

Keywords: LiFi; media; VLC; WiMax.

1. INTRODUCTION

As technology growth increases, there is a need for a higher rate of data transfer between two or more digital devices via some form of transmission medium. However, current research in the data communication system has lead to the development of light Fidelity (LiFi) by Harald Hass a German Physicist. LiFi is a visible light communication (VLC) system that enables data

**Corresponding author: E-mail: nwosurichard82@gmail.com;*

transfer. In his TED Global talk on Visible Light Communication He stated that “Data can be transferred through illumination” and D-light can produce data rates higher than 10 Megabits per Second which is much faster than our average broadband connection [1]. In LiFi, electronic devices can connect to the internet without wire. Communication line between node is established with a transceiver to transmit and receive the data. In the transceiver, there is presence of a modulation technique to make the LED enable to carry the data using the light. LiFi came into existence to overcome the shortage of the current technology which is mostly used by WiFi technology to connect many devices to the internet. The use of internet based devices is increased rapidly as time comes by which made the capacity of WiFi to reduce due to the limitation of radio frequency resources [2]. Li-Fi is very effective in our present world because it represents an alternative to data delivery at a faster rate. With current technology and devices, users get to connect to wireless internet, but unfortunately, there is less and less accessibility to free bandwidth which makes Li-Fi very helpful in this situation [3].

Li-Fi can be regarded as light-based Wi-Fi, i.e. instead of radio waves because it uses light to transmit data. Li-Fi uses transceivers fitted with LED lamps to transmit and receive information as well as that light a room. Technically there can be any number of access points since simple light bulbs are used [4]. It makes use of the underutilized visible portion of the electromagnetic spectrum. Li-Fi can be considered better than Wi-Fi because there are some limitations in Wi-Fi. Wi-Fi uses 2.4 – 5 GHz radio frequencies to deliver wireless internet access and its bandwidth is limited to 50-100 Mbps. With the increase in the number of Wi-Fi hotspots and the volume of Wi-Fi traffic, the reliability of signals, Security and speed is a major concerns as Wi-Fi communication is vulnerable to hackers [5].

2. LIFI WORKING PRINCIPLES

There is 10, 000 times more space available in the visible light spectrum which makes it possible to encode data by varying the rate at which the LEDs flicker on and off to give different strings of 1s and 0s. As the LED intensity is rapidly modulated without the human eye noticing it, the output appears constant [4]. The primary ideology behind LiFi innovation is that visible light illuminated by a light emitting diode (LED) is methodically amplitude modulated at the transmitter end by rapid switching of LED lights, whereas at the receiving end, photodiodes detect the modulated light and demodulates it to binary form by synchronized receiver circuits as shown in Fig. 1 [6]. A Lifi system includes a transmitter device (light source equipped with a signal processing element), a communication medium (Visual light) and a receiver device (photodetector which can get light signals).

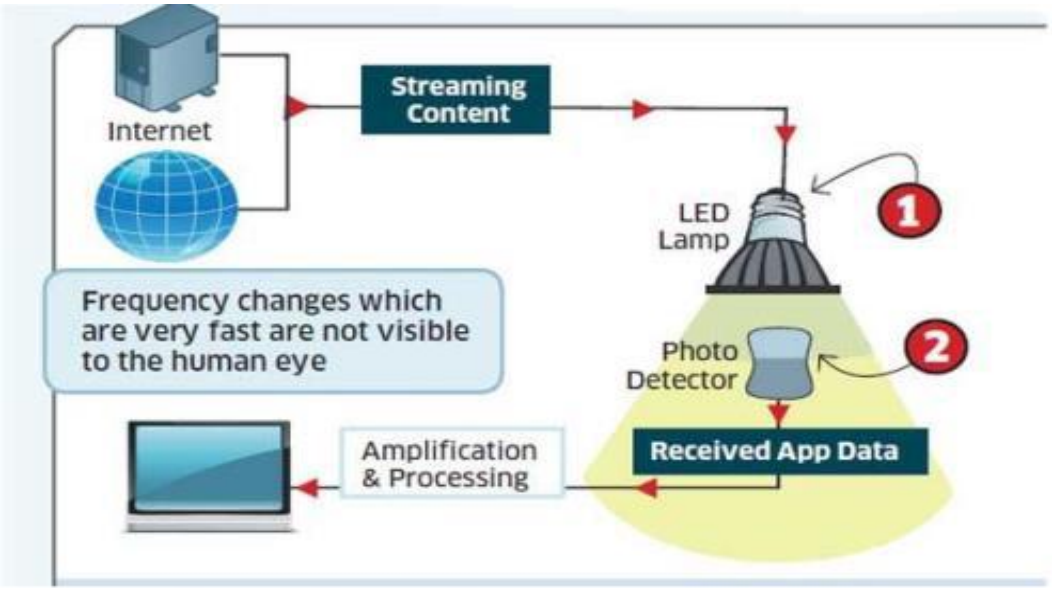

Fig. 1. Li-Fi block diagram [3]

Fig. 2. Li-Fi bulb [7]

Large amount of data transmission can be actualized by connecting the LEDs in an array so as to improve the intensity of light [8].

3. LIFI COMPONENTS

According to [3] the following components are required in a Li-Fi system:

3.1 Photodiode

It is a semiconductor element which changes light into current which is generated when photons are received in the photodiode. When no light is present, small amount of current is generated. These photodiodes might include optical filters, lenses which are built-in with small or large surface areas.

3.2 Led Lamps

It is a light-emitting diode (LED) system which takes the form of a lamp (light bulb) and it is used for lighting fixtures. LEDs are capable to come to perfect brightness without requiring any warm-up period. However, the lifespan of this fluorescent lighting reduces due to the constant switching on and off. It is known that lighting for common purposes needs white light. LEDs release light in a narrow band of wavelengths, and this light which is emitted has the colour of the semiconductor material used to produce the respective LED. Thus, the white light will only be released by mixing light coming from red, green and blue LEDs or by using phosphor to change some of this light to other colours.

3.3 RF Power Amplifier Circuit

It is a radio frequency amplifier that is used to enhance the high-frequency signals which are used for radio communication. The frequency of an RF amplifier can vary depending on the inductance or capacitance of this tuned circuit. It is possible for an RF amplifier to tune over the required range of incoming frequencies. The derivation of capacitance enables high gain for radio frequencies as it modifies the gain of a resistance-capacitance coupled amplifier. Nevertheless, the power gain of RF amplifiers will be reduced at high radio frequencies.

3.4 Printed Circuit Board

A printed circuit is also called "printing wiring cards". It refers to a type of electronic circuit which includes fine strips of a material like copper. The strips are engraved on a layer which is assembled on a kind of insulating sheet.

4. FORMS OF DATA TRANSFER MEDIUMS

4.1 WiFi

It is a data transfer media that allows computers and other devices to communicate over a wireless signal. Wi-Fi (Wireless Fidelity), which uses 2.4-5GHz RF to deliver wireless Internet access around our homes, schools, offices and in public places. We have become quite dependent upon this nearly ubiquitous service. But like most technologies, it has its limitations. While Wi-Fi can cover an entire house, its bandwidth is typically limited to 50-100 megabits per second (Mbps) today using the IEEE802.11n standard. This is a good match to the speed of most current Internet services, but insufficient for moving large data files like HDTV movies, music libraries and video games [1].

4.2 Bluetooth

Fixed and mobile electronic device data over short distances can be transmitted using this medium. It is a wireless substitute for RS-232 cables. This is the first wireless technology for information interchange over short distances. It operates over a range of 2400MHz and 2483.5 MHz, including the guard bands. This technology operates over a range of 10 m radius with a data rate of 5Gbps [7].

4.3 2G

Second generation wireless telephony technology (2G) is characterized by the data rate of 64kbps. It operates with a frequency of 1.8Ghz.

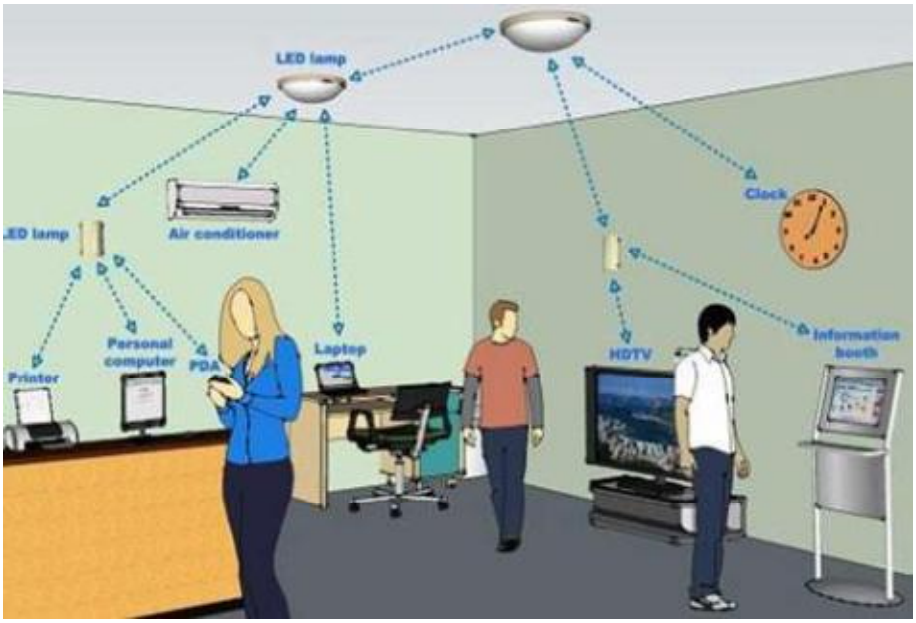

Fig. 3. Study model [1]

The most notable upgrade of 2G over its predecessor is the digital encryption of telephone conversations, and considerably higher efficiency on the spectrum, mobile data service (SMS text messaging).

4.4 3G

3rd Generation is characterized by digital broadband and high speed. It has a data rate of 144kbps-2Mbps with a frequency 1.5-2Ghz.

4.5 4G

Fourth generation wireless (4G) securely provide mobile service users with bandwidth higher than 100 Mbps, enough to support high quality streaming multimedia content.

4.6 5G

Fifth generation wireless (5G) is a wireless networking architecture built on the 802.11ac IEEE wireless networking standard, which aims to increase data communication speeds by up to three times compared to 4G (IEEE 802.11n).it has a speed up to 1.5 Gbps and cover a distance of 90 meters. 5G incorporates the architecture amendments recommended by IEEE 802.11ac and operates in the 5 GHz frequency mode.

4.7 Satellite

Satellite technology is developing fast, and the applications for satellite technology are increasing all the time. Not only can satellites be used for radio communications, but they are also used for astronomy, weather forecasting, broadcasting, mapping and many more applications. With the variety of satellite frequency bands that can be used, designations have been developed so that they can be referred to easily. The higher frequency bands typically give access to wider bandwidths but are also more susceptible to signal degradation due to 'rain fade' (the absorption of radio signals by atmospheric rain, snow or ice).

Because of satellites' increased use, number and size, congestion has become a serious issue in the lower frequency bands. New technologies are being investigated so that higher bands can be used.

S-band (2–4 GHz): Weather radar, surface ship radar, and some communications satellites, especially those of NASA for communication with ISS and Space Shuttle. In May 2009, Inmarsat and Solaris mobile (a joint venture between Eutelsat and Astra) was awarded each a 2×15 MHz portion of the S-band by the European Commission.

Table 1. Comparison table for data transfer media

Media	IEEE standard	Range	Data rate	Bandwidth	Technology
LiFi	802.15.7	10M	1-3.5 Gbps	100T Hz	Light
WiFi	802.11	40km	11-54 Mbp	2.4-5Ghz	RF
Bluetooth	802.15.1	10m	789kbps	2.4Ghz	Ism Band
2G	-	Varies	64kpbs	900MHz	GSM
3G	802.16e	Varies	144-2Mbps	100MHz	CDMA, EDGE
4G	802.16m	Varies	100Mbps-1Gbps	100MHz	LTE, WIFI
5G	-	Varies	1Gbps<	1000xBW /area	WWW
Satellite		Varies			Microwave
Zigbee	802.15.4	10-300m	250kbps	<2.4GHz	RF
WiMax	802.16	30-100m	54 -250Mbps	2-11 GHz	Microwave

C-band (4–8 GHz): Primarily used for satellite communications, for full-time satellite TV networks or raw satellite feeds. Commonly used in areas that are subject to tropical rainfall, since it is less susceptible to rain fade than Ku band (the original Telstar satellite had a transponder operating in this band, used to relay the first live transatlantic TV signal in 1962).

X-band (8–12 GHz): Primarily used by the military. Used in radar applications including continuous-wave, pulsed, single-polarization, dual- polarization, synthetic aperture radar and phased arrays. X-band radar frequency sub-bands are used in civil, military and government institutions for weather monitoring, air traffic control, maritime vessel traffic control, defence tracking and vehicle speed detection for law enforcement.

Ku-band (12–18 GHz): Used for satellite communications. In Europe, Ku-band downlink is used from 10.7 GHz to 12.75 GHz for direct broadcast satellite services, such as Astra.

Ka-band (26–40 GHz): Communications satellites, uplink in either the 27.5 GHz and 31 GHz bands, and high-resolution, close-range targeting radars on military aircraft.

4.8 ZigBee

ZigBee networking technology is working for long periods without the need for providing electrical energy between short periods. Consume low power. As well as specially designed for users that need to provide a high degree of service, so there is a direct replacement in the event of a hardware failure. Has a low data transfer. This is enough to transfer the value of the sensors. It does not need a long time to start working. Using different frequencies as ranked in countries such as 902 MHz and 868 MHz and can proceed in mesh (peer-to-peer) sites larger than is possible with Bluetooth. Compliant cellular devices are required to transmit 10-75 m, with regards to the RF environment and electric power output consumption necessary for a given application, and turn on in the unlicensed RF worldwide [9].

4.9 WiMax

Worldwide Interoperability for Microwave access (WiMax) was developed to overcome the short comings of WiFi in covering small area [10]. This technology is capable of transmitting data at a rate of 1Gbps [7]. Telecommunications service over long distances and connectivity between multiple locations without the use of cables can be provided with WiMax [11]. The evolution of Digital phone technology (IP Telephony) was led by the expansion of WiMax which depends mainly on the domestic and international networks and connection lines T1 connections, but is more costly than Wi-Fi [12].

5. EVALUATION

Table 1 shows the comparison between LiFi and other dater transfer media using selected parameters.

6. APPLICATIONS OF LIFI

According to [5], Li-Fi technology can find application in a wide variety of fields. Its various applications are discussed below.

6.1 Medical and Healthcare

Li-Fi can be used to solve issues relating to signal interference from computers and cell phones which block signals from medical and

monitoring equipment. However, no electromagnetic interference is emitted by Li-Fi and hence it does not interfere with any medical instruments such as MRI scanners.

6.2 Airlines and Aviation

Li-Fi can be used for data transmission in aviation sector since Wi-Fi is often prohibited in aircraft.

6.3 Power Plants and Hazardous Environments

Li-Fi can provide safe connectivity in power plant since it offers alternative to electromagnetic interference due to radio waves in environments e.g petrochemical plants and mines.

6.4 Underwater Explorations and Communications

In underwater explorations, headlamps (light) can be used with Remotely operated underwater vehicles (ROVs) instead of wires to explore underwater area to ensure communication, data processing and reporting findings back to the surface at regular intervals as well as receiving the next batch of instructions. Li-Fi offers solution for conducting short-range underwater communications.

6.5 Traffic

Li-Fi can be used for communications between the LED lights of cars to reduce and prevent traffic accidents. Li-Fi can be used for effective vehicle-to-vehicle as well as vehicle-to-signal communication which will lead to increased traffic management and safety.

6.6 Giga-Speed Technology

The Li-Fi offer effective transmission rates of up to 10 Gbps which allows a 2 hour HDTV film to be transferred in less than 30 seconds.

6.7 Smart Lighting

Street lamps can be used to provide Li-Fi hotspots and can also be used to control and monitor lighting and data.

6.8 Mobile Connectivity

Digital devices such as Laptops, Tablets, smartphones can be used to interconnect with each other using Li-Fi just like Wi-Fi. Short-range links communication provides very high data rates as well as increased security.

6.9 Toys

Toys packaged with LED lights can be utilized to implement low-cost communication in order to build interactive toys.

6.10 RF Spectrum Relief

Excessive capacity demands of cellular networks can be relieved using Li-Fi networks.

6.11 RF Avoidance

Where radio waves cannot be used for communication, Li-Fi can be used as a solution in case of hypersensitivity to radio frequencies.

6.12 Indoor Wireless Communication

Li-Fi is very well suited for indoor wireless communication and data transmission because it makes use of a free, unlicensed spectrum which is not affected by RF noise.

6.13 Retail Analytics

Li-Fi can be used to track the behaviour of individual shoppers in retail analytics. Li-Fi could be used to connect to customers smartphones to link up the people, product and purchasing, and thereby greatly simplify the overall shopping process.

6.14 Casinos

Lightning effects in casinos could be great for Li-Fi to be harnessed for video monitoring equipments.

6.15 Hidden Communications

Li-Fi can be useful for hidden communication in military, defence-based, and hospitals.

6.16 Line of Sight Applications

Li-Fi would be useful where line of sight makes a difference, such as in vehicle to vehicle communication (indoor GPS systems).

6.17 Spatial Reuse

Li-Fi can act as an alternative in regions with high-density wireless communication inorder to

reduce the excess load and low speed experienced in WiFi.

6.18 Smart Class

Implementing smart classes using Li-Fi solves these problems face by wired LAN such high cost of equipments, expensive to install, time-consuming to set up, not flexible and requires maintenance by skilled technicians.

7. CONCLUSION

This paper present a comparative study of LiFi and other transfer medium. Table 1 shows that LiFi is better than other data transfer Medium based on selected parameters and can be applied in many areas.

COMPETING INTERESTS

Author has declared that no competing interests exist.

REFERENCES

1. Dipalee MK, Khizer MRH. A real-time data transmission with LED bulb. International Journal of Science Technology & Engineering. 2017;3(09):553-556.
2. Ramadhani E, Mahardika P. The technology of LiFi: A brief introduction. IOP Conf. Series: Materials Science and Engineering. 2018;3(25):1-10.
3. Rachita, Rohini V. Comparison of LI-FI with wireless media. International Research Journal of Engineering and Technology. 2017;4(03):1935-1938.
4. Sapna M, Rasmiranjan S. A survey on Li-Fi technology and its applications. International Journal of Science and Research (IJSR). 2018;7(7):1388-1392.
5. Anurag S, Shalabh A. Li-Fi technology: Data transmission through visible light. International Journal of Advance Research in Computer Science and Management Studies. 2015;3(06):1-12.
6. Mihir C, Aditya K. Li-Fi – Let there be light. International Journal of Engineering Trends and Technology. 2015;28(04):163-165.
7. Thaiyalnayaki S, Chockalingam J. Li-Fi technology (Optical Communication) compare with other technologies. International Journal of Computer Science and Information Technologies. 2017;8(5): 578-581.
8. Vinnarasi A, Aarthy ST. Transmission of data, audio signal and text using LiFi. International Journal of Pure and Applied Mathematics. 2017;117(17):179-186.
9. Hadia AEA, Mohamed AH. Wireless telecommunication technologies: Li-Fi Vs. Wi-Max Vs. Wi-Fi Vs. ZigBee Vs. Bluetooth. International Journal of Recent Trends in Engineering & Research. 1996;2(8):395-397.
10. Biplob H, Selim H, Mahasin A, Toufikur R, Rupam C, Farhana M, Dulal H. Evaluation and critical technical study of Li-Fi compared with Wi-Fi and WiMax technology. American Journal of Engineering Research (AJER). 2015;4(09): 63-71.
11. ATIS Telecom Glossary 2007. Available:https://glossary.atis.org (Retrieved 22-16-2018)
12. Brute Forcing Wi-Fi Protected Setup. (Retrieved 01-15-2018)

Peer-review history:
The peer review history for this paper can be accessed here:
http://www.sdiarticle4.com/review-history/49878