Jurnal Mantik, 5 (3) (2021) 1982-1987

Published by:Institute of Computer Science (IOCS)

Jurnal Mantik

Journal homepage: www.iocscience.org/ejournal/index.php/mantik/index

Analysis of Light Fidelity (LiFi) Network Implementation

Idwan Harry[1], Syarifuddin[2]
[1,2] Informatics Management Study Program, Faculty of Computer Science
[1,2] AMIK Indonesia. Jl. T. N. Arief Simpang Tugu Pena No. 400, Banda Aceh, Provinsi Aceh, Telp. 0651-7552708, Indonesia

E-mail: [1]harry.smis.nad@gmail.com, [2]syarifuddin@amikindonesia.ac.id

ARTICLEINFO

Article history:

Received: September 17, 2021
Revised: October 22, 2021
Accepted: November 20, 2021

Keywords:

Light Fidelity (LiFi),
Internet of Things (IoT),
Light Emitting Diodes-LED
Internet
Network Perform

ABSTRACT

The existence of Wifi which is the main facility in life demands an increase in internet network performance in the future. Technology continues to develop, innovating the creation of internet network access methods such as Light Fidelity (LiFi). The current internet network access speed has reached 10 Gbps (called 5G) using WiFi, while the LiFi generation access speed reaches 100 Gbps, where LiFi is classified as Internet of Things (IoT) technology. LiFi data is transmitted by an LED bulb and received by a sensor that converts light into electrical waves (photoreceptors) [1]. The working principle of LiFi technology is (1) the LED can be turned on and off very quickly which provides a good opportunity for data transfer in the form of a Binary code (a series of numbers 0 and 1 or also called off and on); (2) Turning on the LED is logic '1' is called on, switching LED is logic '0' is called off. (3) It is possible to encode the data into the LED using a controller so that the LED blink can be varied when the data to be encoded on the 0 and 1 strings is different. (4) using a micro-LED light bulb the data transmission speed reaches 10 Gbps using LiFi [2]. The specific purpose of this research is to inform the public about the advantages and disadvantages of LiFi technology. The research stages consist of (1) Analysis of the LiFi access speed of transferring data that reaches 100 Gbps compared to WiFi which only reaches 7 Gbps (which has been carried out by Oxford University and University College). (2) Analyze and evaluate the performance of LiFi so that the network implementation will be able to control the obstacles that always occur in bandwidth (especially throughput) such as WiFi networks. Research methods include research subjects focused on previous research [1] so that recommendations for the development of LiFi network infrastructure are achieved, namely optimization of throughput as an indicator and evaluation of the real condition of bandwidth (quality of successfully transferred data). Based on this, the object or target that becomes the determinant is to control and overcome obstacles in the LiFi network transferring data packets. The results showed that the waves or light beams used as communication lines in LiFi technology were able to carry more data and information than radio waves in WiFi technology. This is evidenced by the bandwidth using LiFi is doubled compared to WiFi. LiFi is capable of transmitting data at speeds up to 224 Gbps (GB/second-gigabyte/second), while WiFi is between 300-720 Mbps (MB/second-megabyte/second). Then LiFi uses ordinary LED lights, not using special LED lights. The contribution of the research results is expected to increase throughput through control strategies and reduce weaknesses that arise during the data transfer process.

1. Introduction.

The existence of WiFi which is the main facility in today's life demands an increase in internet network performance in the future. Technology continues to develop, innovating the creation of internet network access methods such as Light Fidelity (LiFi). The current internet network access speed has reached

Accredited "Rank 4"(Sinta 4), DIKTI, No. 36/E/KPT/2019, December 13th 2019.

10 Gbps (called 5G) using WiFi, while the LiFi generation has access speeds of up to 100 Gbps, where LiFi is classified as Internet of Things (IoT) technology.

Harald Haas of the University of Edinburgh in the UK was the first to coin the term LiFi and co-founder of Purelifi . But his creation is claimed by many other scientists including Chinese scientists at Shanghai Fudan University who are seen as the inventors of the technology [1]. LiFi technology and infrastructure implementation can make fast data transfers and reduce the use of fiber optic cables. LiFi is included in Internet of Things (IoT) technology, defined as (1) LiFi is a wireless optical network technology that uses light as a light emitting diode (LED) for data transmission; (2) A similar LiFi design is to use LED light bulbs as an energy-saving light source that is widely used in homes and offices; (3) The difference between LEDs and LiFi bulbs is that LiFi is equipped with a chip that modulates invisible light to transmit data optically; (4) LiFi data is transmitted by an LED bulb and received by a sensor that converts light into electrical waves (photoreceptors) [2].

The working principle of LiFi technology is (1) the LED can be turned on and off very quickly which provides a good opportunity for data transfer in the form of Binary code (a series of numbers 0 and 1 or also called off and on); (2) Turning on the LED is logic '1' is called on, switching LED is logic '0' is called off . (3) It is possible to encode the data into the LED using a controller so that the LED blink can be varied when the data to be encoded on the strings 0 and 1 is different. (4) British researchers stated that using micro-LED light bulbs the data transmission speed reached 10 Gbps using LiFi [2].

The need for people to use the internet via cellular or mobile phones, is the main interest in carrying out research, with the hope that the results of the research can contribute to the effectiveness or prevention in the use of the internet network so that an analysis of the LiFi network infrastructure model that has been produced, the results of the evaluation are expected to be considered in infrastructure development LiFi models into the future.

2. Method

The research subject focuses on previous research [1-2] so that recommendations for developing LiFi network infrastructure are achieved so that recommendations for developing LiFi network infrastructure are achieved, namely optimization of throughput as an indicator and evaluation of the real condition of bandwidth (quality of successfully transferred data). Figure 1 shows the mechanism for the LiFi network infrastructure that has been developed.

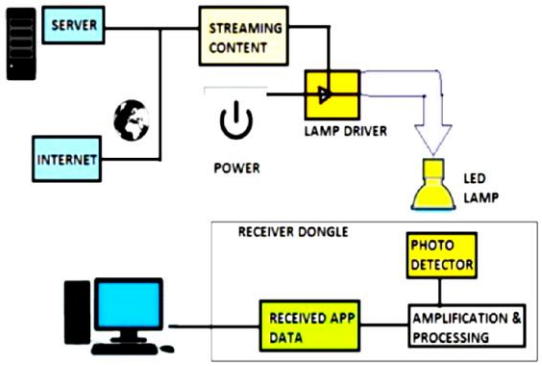

Fig 1. Basic LiFi Infrastructure Mechanism

Figure 2 describes the steps taken in the research, both the network model, basic data, testing mechanisms and comparisons based on the analysis of the results achieved in the study

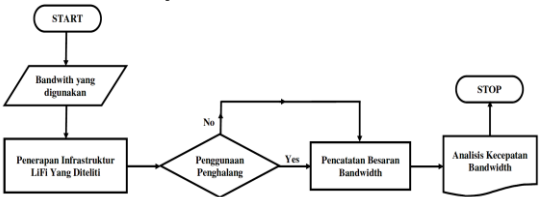

Fig 2. Research Mechanism.

The research was carried out in the AMIK Indonesia Computer Network Laboratory, which can be used as the development of the planned network model. In addition, the research involved other parties as supporters and students outside the laboratory in the process of testing the model that was made. The flow of activities can be seen in Figure 3.

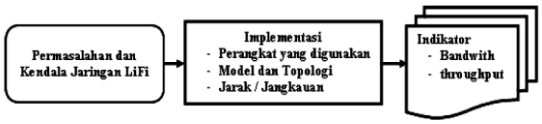

Fig 3. Research Problems and Objectives

a. Identify the results of previous research based on journals and articles that have been published both nationally and internationally, regarding the advantages and disadvantages of the LiFi network model.
b. Analyze and evaluate the performance of the LiFi network performance by simulating the model of the LiFi network infrastructure in order to obtain how the real constraints affect throughput.

The collection technique is the collection of qualitative research data through and Focus Discussion Groups (FGD)/groups and literature. Initial data is needed to obtain the LiFi infrastructure needs that have been developed previously, namely a literature study on network models. The literature was identified in order to analyze between LiFi networks that became the current standard. Next is the study of the LiFi network model documentation and recommended according to the development of LiFi networks in the future.

After the implementation process will be carried out, the final data is collected through recordings that meet certain requirements and their comparison, and the implementation of the LiFi network model or infrastructure is obtained based on the data from the performance test results. Then the model is tested in the presence of obstacles and without obstacles (in this case the walls as barriers) to get feedback in terms of control over LiFi communication network problems (data transfer). The results of the interviews are the evaluation data of improvements and inputs to the LiFi network model in the research conducted or the next.

3. Results and Analysis.

The results of previous research trials, LiFi technology that acts as a wireless router is a light bulb. The recommended bulb is an LED because of its characteristics as a semi conductor light source. When the electric current is constant, the LED can be adjusted up and down signal reception and the speed is very high when the signal processing element. The data stored on the LED lamp through signal processing technology, can be sent through the LED beam at high speed to the photo detector (photodiode). The signal is converted into binary data and then converted into video, audio and website applications, so that it can be operated by devices that can communicate via the internet.

LiFi network modeling needs in this study include:

Fig 4. Light Emitting Diode (LED) Device

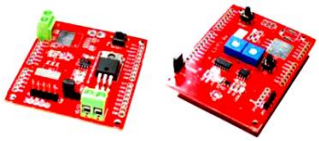

Fig 5. LiFi Signal Transmitter/Receiver Device

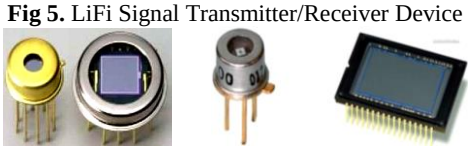

Fig 6. Diode and Photo Sensor Devices (Photodiode and Image Sensor)

Light emitted by a diode (Light Emitting Diode-LED) is a semiconductor light emitted when an electric current passes. The light produced when the particles (electrons) that carry current are joined together, can be

Accredited "Rank 4"(Sinta 4), DIKTI, No. 36/E/KPT/2019, December 13th 2019.

seen in Figure 4. The intensity of the light emitted is not large. LEDs generally occur at a single wavelength (monochromatic). The LED light generated on a solid semiconductor material is called a solid-state device .

The photodiode component is made of a semiconductor material that contains a pn junction, and functions when it is reverse biased. So the photodiode can convert light into electric current. Photodiode functions to propagate current in large quantities when photons are absorbed and when there is no light, photodiode spreads current. The use of photodiode technology is due to its easy structure and low cost. The photodiode is known as the photovoltaic mode and the photo conductive mode, these are two separate modes of operation. Photovoltaic mode, light non-linearity, high speed and very small dynamic range. In the photoconductive mode, the light is very linear, the speed is low when the current is dark or the gain is when the light is not present, and the light has no great effect when the current is opposite.

Image sensor functions as a tool to convert images into electronic signals, photodiodes are used as image/image receivers. The reaction of the photons will enable the image sensor and convert it into an electric current. The next process to the analog-digital converter (see figure 6). Commonly used digital image detectors are Charge-Coupled Device (CCD) and Complementary Metal Oxide Semiconductor (CMOS) because they use less electrical power.

Data traffic on wires or signals over the air is a WiFi technology. LiFi is a data transmission process that occurs using LED lighting. If the LED is active the user (user) can send 1 as a digital string (ON in electric current), if it is off then the user (user) can send 0 as a digital string (OFF in electric current) and the process occurs very quickly. This means that data traffic via light LED varies when the LED in a state of ON and OFF and data security systems take effect when the light goes on different grooves (1s and 0s). In LiFi technology, the use of light as a means of sending and receiving data is called D-light. In D-Light, Tx serves as a data sender and Rx as a data receiver which is connected through an array of LEDs. This is the function of the LiFi Dongle, the LED is displayed to the hyper-terminal on the personal user (laptop, desktop or mobile) that is connected using the serial port.

This study uses a structure or modeling that has been done using a device or tool that has become a standard LiFi model, Figure 7 explains clearly. The results of the trial implementation of the implementation of the LiFi device structure as shown in Figure 7, obtained the following results:

a. Waves or light beams that are used as communication lines in LiFi technology, are able to carry more data and information than radio waves in WiFi technology. This is evidenced by the bandwidth using LiFi is doubled compared to WiFi. LiFi is capable of transmitting data at speeds up to 224 Gbps (GB/s-gigabytes/secound), while WiFi is between 300-720 Mbps (MB/s-megabytes/ secound)
b. LiFi, which is a 2 (two) way technology and utilizes LED lights, does not require specific LED lights, meaning that they are standard/ commonly used. Utilization of LiFi uses direct light bands and electromagnetic waves between 400-800 THz when sending data.
c. LiFi data transmission speed is high compared to WiFi, can reach 100 times. Implementation at the Banda Aceh AMIK laboratory showed that the real speed reached 1 Gbps from the maximum power of LiFi 224 Gbps .
d. Laptops, desktops and mobiles require completeness of light signal reading sensors that can convert in the form of data. Until now, the tool is still the size of a mobile or smartphone, so for mobile or smartphone users it is not yet feasible to use.

Previous research [3], showed that there are several types of parameters used, the drawbacks of which are complemented in this study are by adding barrier parameters to network connections and topological models that have been applied. So this research can complement the weakness of Li-Fi in terms of bandwidth that affects throughput. So that for the future, the infrastructure used by Li-Fi technology can consider the size of the throughput.

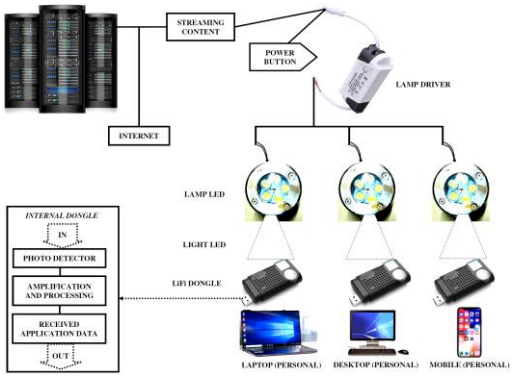

Fig 7. Implementation of Standard LiFi Device Model

The results of research trials using 3 (three) samples of internet website usage, by comparing the results of measuring bandwidth without barriers, glass barriers and wall barriers, the standard measurement results are achieved as shown in table 1, measurements using Wireshark and PING applications. It is clear that the LiFi network will be weaker when there is no light reflection such as a wall barrier, just like using WiFi. This is what in the future or future research strategies need to be developed to overcome the barrier, at least the bandwidth is not too weak. If the bandwidth is getting smaller, it will affect the throughput .

Table 1
Results of Previous Research Measurements

No.	Parameter	Wireless Technology (Light Fidelity)	Wireless Technology (Wide Fidelity)
1	Data Transfer Speed	>1Gbps	150 Mbps
2	Introduction to Data transfer	Light	Radio Wave
3	Wave Limit/Distance	>Light exceeds 10,000 times faster than radio waves	Radio waves ability under light
4	Network Topology	Point to point	Point to point
5	Operating Frequency	100 THz	2.4 GHz
6	Technology and Speed	Li-Fi >1Gbps	Wi-Fi – IEEE 802.11.n 150 Mbps

Table 2.
Measurement Results of Bandwidth (1 Gbps) LiFi Modeling using a Laptop.

No	Internet usage (web browser)	No Barriers	Obstacle Glass	Obstacle Wall (10 cm)
1	Google	1 Gbps	800 Mbps - 1 Gbps	64 - 100 Mbps
2	Yahoo	1 Gbps	800 Mbps - 1 Gbps	64 - 100 Mbps
3	Facebook	1 Gbps	750 Mbps - 1 Gbps	64 - 100 Mbps

4. Conclusion

As for all the trials and analysis in this study, it is still felt to be very minimal and there are shortcomings, input and development are highly expected for the improvement of subsequent research. Some conclusions in this study, among others:

a. The results of trials and research related to LiFi technology, show the results that LiFi is faster than WiFi in sending and receiving data.
b. Modeling (network infrastructure design) of existing LiFi standards or previously researched, still requires development, both in terms of device development and handling of obstacles that exist in LiFi technology.
c. The hope of this research can provide input on the stability of LiFi network throughput through strategies to control and reduce weaknesses that arise during the data transfer process.

Accredited "Rank 4"(Sinta 4), DIKTI, No. 36/E/KPT/2019, December 13th 2019.

d. For the future, there should be development of sensor equipment for LiFi technology that can be used or adapted to mobile users, so that it will be more practical and optimal to use LiFi technology, meaning that it can be used with mobile wherever we are, especially in areas that have lighting and lamplight.

5. References.

[1] Harald Haas and C. Chen, "What is LiFi", In Proc, 41st European conference on Opt Communication, Valencia, Spain, pp:1-3, Sept, 27, 2015.
[2] Sarkar, Anurag & Agarwal, Shalabh & Nath, Asoke, "Li-Fi Technology: Data Transmission through Visible Light", IJARCSMS, Vol. 3, pp: 1-10, 2015.
[3] Ashmita Shetty, M.E, "A Comparative Study and Analysis on Li-Fi and Wi-Fi", International Journal of Computer Applications (0975 – 8887), Mumbai, India, Volume 150. No. 6, September 2016.
[4] Evandyano, G. and Ashari, A, "Studi Perbandingan Metode Pengalamatan Pada Jaringan Sensor Nirkabel Berbasis XBEE", Doctoral Dissertation, Universitas Gadjah Mada, 2017.
[5] Kokkonis, G., Psannis, K.E., Roumeliotis, M. and Schonfeld, D, "Real-Time Wireless Multisensory Smart Surveillance with 3D-HEVC Streams for Internet-of-Things (IoT)", The Journal of Supercomputing, 73(3), pp.1044-1062, 2017.
[6] Idwan, Harry, H., Arif, T.Y. and Munadi, R. "Analisis Round Trip Time (RTT) Terhadap Kinerja Jaringan Wireless TCP New Reno", Karya Ilmiah Teknik Elektro, 3(3), 2018.
[7] Idwan, Harry, Ihsanuddin, "Optimization of Round-Trip Time (RTT) on New Reno TCP Wireless Network Performance (Case Study: Banda Aceh City Coffee Shop)", Department of Informatics, Faculty Informatics of Management, AMIK Indonesia, Indonesia, Artikel Volume 83, PP: 4465-4476, Publication Issue: July-August 2020.
[8] Irina Stefan, Hany Elgala, Raed Mesleh, Dominic O'Brien and Harald Haas. "Optical Wireless OFDM System on FPGA: Study of LED Nonlinearity Effects", IEEE. 978-1-4244-8331-0/11, 2011.
[9] Dobroslav Tsonev, Stefan Videv and Harald Haas. "Light Fidelity (Li-Fi): Towards All-Optical Networking", Institute for Digital Communications, Li-Fi R&D Centre, The University of Edinburgh, EH9 3JL, Edinburgh, UK. 2014.
[10] Cisco & amp; Network Hardware News and Technology, "Introduction to LiFi Internet", http://ciscorouterswitch.overblog.com/2017/02/ introduction-to-lifi-internet. 2017, 23 Juli 2021.
[11] Aman Sodhi, y Jeslin Johnson, "Light Fiedelity (LI-FI)-The Future of Visible Light Communication", IJERGS, Vol. 3, P. 117, 2015.
[12] Md. Imran Hossain Bulbul, Md. Abdul Latif, Golam Dastagir, "Implement A Transcever System Using Li-Fi Technology", Bachelor of Science Electronical and electronic Engineering, Dhaka University of Engineering &Technology, Gazipur, 2019.
[13] Wafa S. M. Elbasher, Amin B. A. Mustafa, Ashraf A. Osman, "A Comparison between Li-Fi, Wi-Fi, and Ethernet Standards", International Journal of Science and Research (IJSR), Volume 4, 12 December 2015.
[14] Chen, C., Serafimovski, N., and Haas, H, "Fractional Frequency Reuse in Optical Wireless Cellular Net-works", IEEE in Proc. of the IEEE International Symposium on Personal, Indoor and Mobile Radio Communications (PIMRC), 2013.
[15] Harald Burchardt, Nikola Serafimovski, Dobroslav Tsonev, Stefan Videv, and Harald Haas, "VLC: Beyond Point-to-Point Communication", The University of Edinburgh EH9 3JL, Edinburgh, UK, 2013.