International Journal of Power Control and Computation(IJPCSC)
Vol 8. No.1 – 2016 Pp.13-19

available at : www.ijcns.com
ISSN: 0976-268X

PATH WAY TO 5G

(Visible light communication)

R.Subhashini Ramakrishnan
Dept. of Electronics and Communication
Arasu Engineering College,
Kumbakonam.

R.Lavanya
Dept. of Electrical and Electronics
Arasu Engineering College
Kumbakonam.

ABSTRACT

Li-Fi stands for Light-Fidelity. The technology is very new and was proposed by the German physicist Harald Haas in 2011. Li-Fi provides transmission of data through illumination by sending data through an LED light bulb that varies in intensity faster than human eye can follow. In this paper, the authors will discuss the technology in detail and also how Wi-Fi can be replaced by Li-Fi. Wi-Fi is useful for general wireless coverage within buildings while Li-Fi is ideal for high density wireless data coverage in confined areas where there are no obstacles. Li-Fi is a wireless optical networking technology that uses light emitting diodes (LEDs) for transmission of data. The term Li-Fi refers to visible light communication (VLC) technology that uses as medium to deliver high-speed communication in a manner similar to Wi-Fi Li-Fi provides better bandwidth, efficiency, availability and security than Wi-Fi and has already achieved high speeds in the lab. In the present paper the authors will give a detailed study on Li-Fi technology, its advantages and its future scope.

Keywords: *Light Fidelity; LED; VLC; Wi-Fi; Bandwidth*

1. INTRODUCTION

Li-fi basically known as "light fidelity". The basic ideology behind this technology is that the data can be transmitted through LED light whose intensity varies even faster than the human eye. Now a day's wireless technology is popularized as WI-FI which can be further developed as LI-FI. Wireless communication decreases the cost enormously. Heart of this technology lies in the intensity and the potential of the light emitting diodes. Major reason that leads to the development of the LI-FI is confinement of WI-FI to comparatively small distance. As many devices are coming up in day to day life's the signals are being clogged up due to heavy traffic, so there is a need for error free transmission technology. And the remedy for this problem is li-fi technology. It has been designed in such a way so that it can overcome the disadvantages of WI-FI. Li-fi can work even under water which turns out to a great benefit for the military operations. 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. 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. It is made possible
to achieve more than 10 Gbps, theoretically allowing a high-definition film to be downloaded in 30 seconds .

1. WORKING OF LI-FI:

There are many situations in which people get frustrated with the dull performance signals of Wi-Fi at a place with many network connections in seminars conferences etc… This can be solved using LI-FI. When a constant current is applied to an LED light bulb a constant stream of photons are emitted from the bulb which is observed as visible light. If the current is varied slowly the output intensity of the light dims up and down. Because LED bulbs are semi-conductor devices, the current, and hence the optical output, can be modulated at extremely high speeds which can be detected by a photo-detector device and converted back to electrical current.

The intensity modulation is imperceptible to the human eye, and thus communication is just as seamless ad RF. Using this technique, high speed information can be transmitted from an LED light bulb. Radio frequency communication requires radio circuits, antennas and complex receivers, whereas Li-Fi is much simpler and uses direct modulation methods similar to those used in low-cost infra-red communications devices such as remote control units. Infra-red communication is limited in power due to eye safety requirements, whereas LED light bulbs have high intensities and can achieve very large data rates.

3.IMPLEMENTATION OF LI-FI

The main components of a simple system based on Li-Fi are:

i) High brightness LED which acts as the communication source

ii)Silicon photodiode which serves as the receiving element

Data from the sender is converted into an intermediate data representation i.e. byte format and then converted into light signals which are emitted by the transmitter. The light signal is received by the photodiode at the receiver side. The reverse process takes place at the destination computer to retrieve the data back from the received light.LEDs are employed as the light sources. The model transmits digital signal by means of direct modulation of the light. The emitted light is detected by an optical receiver.

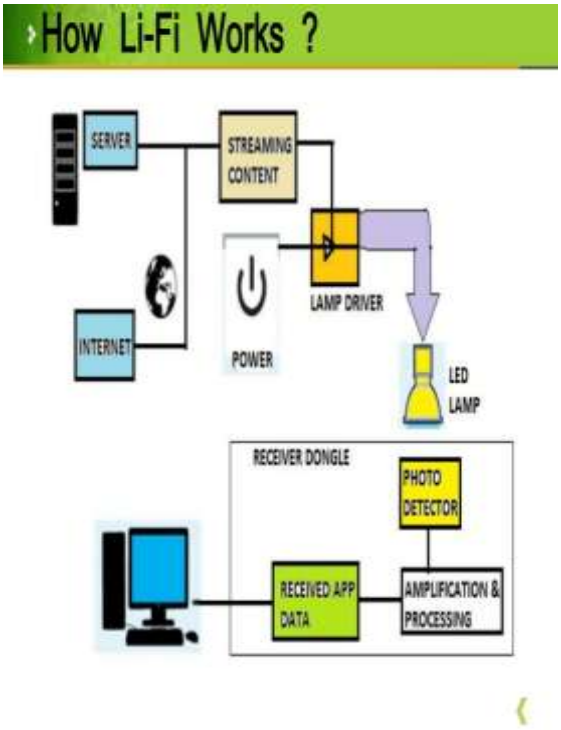
- Source Computer: Data Reading Module(Data Conversion Module(Transmitter Module

Destination Computer: Receiver Module (Data Interpretation Module (Data Display (GUI) The different components serve the following functions:

Data Conversion Module – converts data into bytes so that it can be represented as a digital signal. It can also encrypt the data before conversion.

Transmitter Module – generates the corresponding on-off pattern for the LEDs.

Receiver Module – has a photo diode to detect the on and off states of the LEDs. It captures this sequence and generates the binary sequence of the received signal.



4.TECHNICAL ASPECTS AND MODULATION

VLC refers to any use of the visible light portion of the electromagnetic spectrum to transmit information. A VLC interest group is certified by the IEEE 802.15 with the final standard being approved in 2011. The standard of VLC specifies VLC consisting of mobile-to-mobile (M2M), fixed-to-mobile (F2M) and infrastructure-to-mobile (I2M) communications. The main purpose of VLC is to focus on medium-range communications for intelligent traffic systems at low-speed and on short-range mobile to mobile and fixed to mobile communications at high speeds to exchange data. Data rates are supported from some 100 kbps up to 100 Mbps using various modulation schemes.

Li-Fi communication is modeled after protocols established by the IEEE 802 workgroup. It defines physical layer (PHY) & media access control (MAC) layer for VLC/Li-Fi.

The MAC layer supports 3 multi-access technologies: peer-to-peer, star configuration and broadcast mode. It also handles physical layer management issues such as addressing, collision avoidance and data acknowledgement protocols. The physical layer is divided into 3 types: PHY I, II, III and employ a combination of different modulation schemes.

In order to actually send out data by means of LEDs, it is required to modulate these into a carrier signal. The carrier signal consists of light pulses sent out at short intervals. The manner in which this is done depends on the modulation scheme employed.

Li-Fi systems use the following different modulation schemes:

1.On-Off Keying (OOK): The 802.15.7 standard uses Manchester coding so that the period of positive pulses is same as the period of negative ones, however this doubles the bandwidth required for transmission. For higher bit rates, run length limited (RLL) coding is used which is spectrally more efficient. Dimming is supported by adding an OOK extension which adjusts the aggregate output to the correct level.

2.Variable Pulse Position Modulation (VPPM): PPM encodes the data using the position of the pulse within a set time period. The duration of the period containing the pulse must be long enough to allow different positions to be identified. VPPM is similar to PPM but it allows the pulse width to be controlled to support light dimming.

3.Colour Shift Keying (CSK): This is used if the illumination system uses RGB-type LEDs. By combining different colours of light, the output data can be carried by the colour itself and hence the intensity of the output can be near constant. Mixing of RGB primary sources produces different colours which are coded as information bits. The disadvantage is that it increases the complexity of the transceivers.

4.Sub-Carrier Inverse PPM (SCIPPM): This method is divided into two parts (1) sub-carrier part and (2) DC part. The DC part is used only for lighting or indicating. When there is no requirement for lighting or indicating, SCPPM (Sub-Carrier PPM) is used in order to save energy.

.5.Frequency Shift Keying (FSK): In this method, data is represented by varying the frequencies of the carrier signal. Before transmitting two distinct values (0 and 1), there needs to be two distinct frequencies.

6.SIM-OFDM (Sub-Carrier Index Modulation OFDM): This is a new approach to transmission in which an additional dimension is added to conventional 2D amplitude/phase modulation (APM) techniques such as quadratature amplitude modulation (QAM) and amplitude shift keying (ASK). The key idea is to use the sub-carrier index to convey information to the receiver.

5. FEATURES

Li-Fi offers a number of key benefits over Wi-Fi but is inherently a complementary technology.
5.1. CAPACITY Bandwidth: The visible light spectrum is plentiful (10,000 more than RF spectrum), unlicensed and free to use.

Data density: Li-Fi can achieve about 1000 times the data density of Wi-Fi because visible light can be well contained in a tight illumination area whereas RF tends to spread out and cause interference.

High speed: Very high data rates can be achieved due to low interference, high device bandwidths and high intensity optical output.

Planning: Capacity planning is simple since there tends to be illumination infrastructure where people wish to communicate, and good signal strength can literally be seen

.

5.2. Efficiency Low cost: Requires fewer components than radio technology.

Energy: LED illumination is already efficient and the data transmission requires negligible additional power. **Environment**: RF transmission and propagation in water is extremely difficult but Li-Fi works well in this environment

. **5.3. Safety Safe**: Life on earth has evolved through exposure to visible light. There are no known safety or health concerns for this technology. **Non-hazardous**: The transmission of light avoids the use of radio frequencies which can dangerously interfere with electronic circuitry in certain environments.

5.4. Security Containment: It is difficult to eavesdrop on Li-Fi signals since the signal is confined to a closely defined illumination area and will not travel through walls. **Control**: Data may be directed from one device to another and the user can see where the data is going; there is no need for additional security such as pairing for RF interconnections such as Bluetooth.

6.APPLICATION

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

Hazardous Environments: VLC provides a safe alternative to electromagnetic interference from radio frequency communications in environments such as mines and petrochemical plants.

Hospital & Healthcare: VLC emits no electromagnetic interference and so does not interfere with medical instruments, nor is it interfered with by MRI scanners.

Aviation: Li-Fi can be used to reduce weight and cabling and add flexibility to seating layouts in aircraft passenger cabins where LED lights are already deployed. In-flight entertainment (IFE) systems can also be supported and integrated with passengers' own mobile devices.

Underwater Communications: Due to strong signal absorption in water, RF use is impractical. Acoustic waves have extremely low bandwidth and disturb marine life. Li-Fi provides a solution for short-range communications.

Vehicles & Transportation: LED headlights and tail-lights are being introduced. Street lamps, signage and traffic signals are also moving to LED. This can be used for vehicle-to-vehicle and vehicle-to-roadside communications. This can be applied for road safety and traffic management. **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.

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

Toys: Many toys incorporate LED lights and these can be used to enable extremely low-cost communication between interactive toys.

Pathway to 5G: Visible Light Communications

We know from the CISCO report that the compound annual growth rate (CAGR) of mobile data usage per month is around 80%. At the same time the network spectrum efficiency of state-of-the-art cellular systems exhibits a saturating trend. Given that the available radio frequency spectrum is limited and that it is unlikely that significant new spectrum is made available for mobile communications, the only option is to

increase the spectrum efficiency of wireless systems.

This requires radical new research in wireless networks, and keys to solving the issues, in my opinion, are (a) the elimination of interference, (b) a massively improved reuse of the available frequency resources, and (c) utilisation of the free, vast and unlicensed infrared and visible light spectrum leading to hybrid radio frequency (RF) and optical wireless systems. All three points are inter-linked. For example, an indoor wireless link can hugely benefit from high signal-to-noise ratio stemming from an illuminated room instead of forcing an outdoor radio base station to send the radio frequency signal through multiple walls. This would either mean low signal-to-noise-ratio for the indoor user, or high transmit powers for the outdoor radio base station, or both. Wouldn't it be better for the radio base station to serve an outdoor user or a user in a fast moving vehicle?

This has four effects:

(a) interference between the indoor user and the outdoor user is entirely avoided,

(b) since interference is avoided, the radio base station can transmit with reduced power resulting in 'greener' mobile networks,

(c) scarce wireless transmission resources are used in the best possible and most efficient way and (d) the radio frequency system enjoys a healthy spectrum relief resulting in improved user satisfaction.

In summary, I believe that Li-Fi should be an integral element of a 5G cellular standard!

7. CONCLUSION

1. Although LIFI has some disadvantages but it shows epic advancement in the world of wireless technology. It hits almost all sectors and definitely going to be boon for our society. LIFI technology has shown lots of improvements since it has discovered. So these signal will provide many facilities in future like:

2. We can access internet anywhere in streets, footpaths, house, etc. with the help of available light source such as tube-light, lamps, street-lights etc.

3. Since LED‟s are fast switching easily available cheap low power consumption and hence can be used in large amount to transfer data in a mere blink of an eye.

4. In field of data electronics, it provides ample ways to transfer signals and it‟s relative data to the greatest accuracy and in the most precise way.

5. Communicating and obtaining data from satellite will be more easy than ever before.

6. It will be beneficial for defence services as their data is very confidential and LIFI 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 LIFI signals works under water. With the hands provided by LIFI we will be future ready

REFERENCES

[1] Frank Deicke, Josef Shwartz, *Li-Fi: A New Paradigm in Wireless Communication*, article in EFY, April 2012

[2]SchnichiroHaruyama, „Visible light communication, Recent activities in Japan‟, Smart spaces: A smart lighting ERC industry- Academia day at BUPhotonics center, Boston University, Feb 8, 2011.

[3]„Li-Fi: Data through Light‟, The Institute of Engineers, Technorama Magazine, Volume 62, pp. 41,December 2012.

[4] Will Li-Fi be the new Wi-Fi?, New Scientist, by Jamie Condliffe, dated 28 July 2011

[5] Dominic O‟Brien, Hoa Le Minha, LubinZeng, GrahameFaulkner and HsiHsir Chou, Kyungwoo Lee, Daekwang Jung,YunJe Oh, Eun Tae Won,"Visible Light Communication:Recent Progress and Challenges", Wireless World ResearchForum.

[6] Jyoti Rani, Prerna Chauhan, RitikaTripathi, "Li-Fi (LightFidelity)-The future technology In Wireless communication",International Journal of Applied Engineering Research, vol. 7No.11,

2012,ISSN 0973-4562. [7] Dr. Isaac Jamieson, http://www.bemri.org/ visible light communication vlc systems.html, 2010