International Journal of Recent Development in Engineering and Technology
Website: www.ijrdet.com (ISSN 2347-6435(Online) Volume 2, Issue 6, June 2014)

A New Era in Wireless Technology using Light-Fidelity

Jitender Singh[1], Vikash[2]
[1,2]Scholar, Computer Science & Engineering, RPSGOI Mohindergarh, India

Abstract **– Li-Fi is using visible light instead of radio waves for communication. This new wireless technology can save a large amount of electricity by transmitting data through the light bulbs. In an age where we face a challenge of data congestion in the free air medium, where we strive hard to squeeze in all the data in the allocated spectrum. Something we generally use every day, there is not any area where we do not use light. With this emerging technology we can use all the light around us that we produce to transmit data. .Let us consider the amount of dependency that we have in the present world on the use of cell phones or laptops or the internet it is a need of the present world that we check alternate ways to transmit all this huge amount of data we generally use. By flickering the light from a single LED, any change a human eye can detect, they can transmit far more data than a cellular tower using SIM OFDM technique-- and do it in a way that's more efficient, secure and widespread. In this paper we are going to compare the existing Wi-Fi technology and newly adopted Li-fi wireless technology.**

Keywords- **Wi-Fi, Electromagnetic Spectrum, Modulation, SIM OFDM, Visible Light, SCP, PPM, FSK**

I. Introduction Of Li-Fi

As in now days we are just using radio spectrum to make communication and using radio waves as a packet carrier. Li-Fi refers to wireless communication systems that have light as a carrier rather than of radio frequencies, Radio frequency technology using the Wi-Fi. Li-Fi always uses the electromagnetic sensitive areas such as in aircraft or nuclear power plants, without causing the environment. However, the light waves used cannot effect by the walls, which make Li-Fi significantly more secure relative to Wi-Fi.

The current wireless communication uses radio waves. But the radio spectrum is very short and the no of users are increasing every day. There are around 1.4 million masts in world-wide and about 8 billion users and increasing day-by-day. By the increasing of more and more users radio spectrum is unable to give proper bandwidth to each user. To overcome the spectrum one technology was introduced by Dr. Harald Haas in July, 2011, i.e. wireless communication using visible light. This new communication technology was named as Li-Fi (light fidelity). In Li-Fi the radio waves were replaced by the visible light to communicate [2]. This was named as Visible Light Communication (VLC).

In October 2011, companies and industry groups formed the Li-Fi technology, 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 [1].

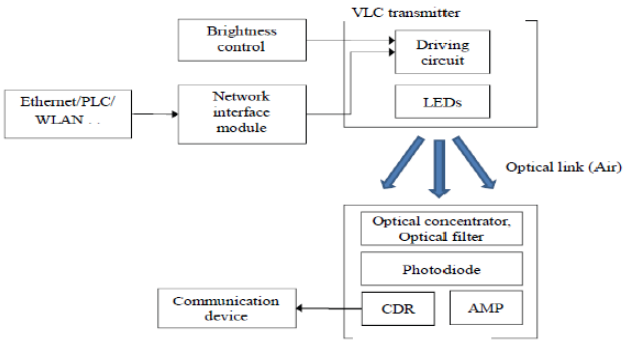

Fig1: Process of Li-Fi

The Li-Fi technology is an international platform which is focusing on optical wireless technologies. It was founded by four technology-based organizations in October 2011.

II. Electromagnetic Spectrum

The electromagnetic spectrum is the range of all possible frequencies of electromagnetic radiation. The "electromagnetic spectrum" of an object has a several meaning, instead of the characteristic distribution of electromagnetic radiation emitted or absorbed by that particular object.

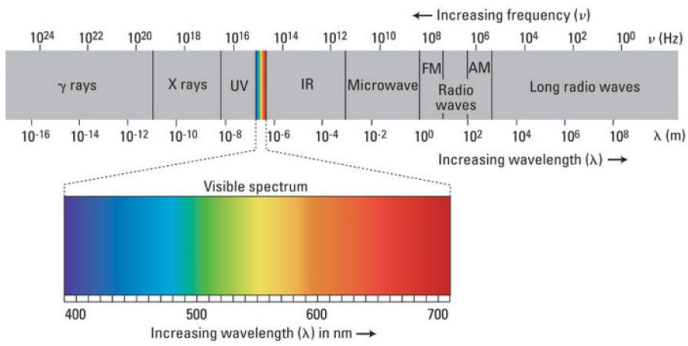

Fig2: Electromagnetic Spectrum

International Journal of Recent Development in Engineering and Technology
Website: www.ijrdet.com (ISSN 2347-6435(Online) Volume 2, Issue 6, June 2014)

II -A. Range of the spectrum

Electromagnetic waves are defined by any of the following three physical properties: frequency *f*, wavelength λ, or Photon energy *E*.

Frequencies observed in a astronomy range from 2.4×10^{23} Hz (1 GeV gamma rays) down to the local plasma frequency of the ionized interstellar medium (~1 K Hz). Wave frequency is directly proportional to the Wavelength, so gamma ray contains size like an atom due to very short wave length; however, spectrum wavelength is so much longer like a universe. Due to the proportionality of photon with respect to wave frequency, gamma ray photons have the highest energy (around a billion electron volts). However radio wave photons have very low energy (around a femto electron volt). These relations are illustrated by the following equations:

$$f = \frac{c}{\lambda}, \quad \text{or} \quad f = \frac{E}{h}, \quad \text{or} \quad E = \frac{hc}{\lambda},$$

Where:

c = 299,792,458 m/s is the speed of light in vacuum and

h $=6.62606896(33)\times10^{-34}$ J s $= 4.13566733(10)\times10^{-15}$ eV is Planck's constant.

VLC (Visible Light Communication): The general term visible light communication (VLC) includes any use of the visible light portion of the electromagnetic spectrum to transmit information. Many people's first exposure to optical wireless technology was VLC [4]. This emerging technology offers optical wireless communications by using visible light. The visible spectrum is 10000 times larger than that of radio spectrum. The premise behind VLC is that because light is present everywhere now a days, communications can ride along for nearly free. One of the biggest attractions of VLC is the energy saving of LED technology. 19% of the worldwide electricity is using by light.

A VLC interest group is certified by the IEEE 802.15. The final standard was approved in 2011. The standard of VLC specifies VLC comprising between mobile-to-mobile (M2M), fixed-to-mobile (F2M) and infrastructure-to-mobile (I2M) communications. The main motive of the VLC is to focus on the medium-range communications for intelligent traffic systems at low-speed and on high-speed, short-range mobile to mobile and fixed to mobile communications to exchange, for example, video, audio data. Data rates are supported from some 100 kbps up to 100 Mbps using different modulation schemes [6].

III. Drawbacks Of Current Wireless System

The current wireless communication uses radio waves. But the radio spectrum is very short and the no of users are increasing every day. There are around 1.4 million masts in world-wide and about 8 billion users and increasing day-by-day. By the increasing of more and more users radio spectrum is unable to give proper bandwidth to each user. So there are some drawbacks of current wireless system are as given below:

Availability: Even though current wireless system promises the large coverage area, but they are not available in remote areas. In remote area planting a base station is not affordable for communication companies. Hence availability of RF communication is having limitations [7].

Efficiency: There are 1.4 million cellular radio masts deployed worldwide? And these cellular radio masts are base stations. And here more than five billion of cellular devices are present. These RF cellular masts consume lot of energy. Most of the energy is not used to transmit data but to cool the base stations. These cellular must have efficiency up to 5%.HenceRF communication is inefficient.

Capacity: With these mobile phones, we can transmit more than 600 terabytes of data in a month. And wireless communications has become a utility like electricity and water. Because of this importance I decided to look into the issues of this technology. Water is so fundamental to our lives. RF communication has a problem of a limited bandwidth, hence it running out of capacity.

Security: Radio waves Radiofrequency can penetrate through wall and hence it can be hacked. Wi-Fi networks that are open (unencrypted) can be monitored and used to read and copy data which is transmitted over the network. While another security method is used to secure the data, like a VPN (virtual private network) or a secure web page.

IV. Li-Fi Working

Li-Fi is typically implemented using white LED light bulbs at the downlink transmitter. These devices are basically used to discover only by applying a constant current. While by using the fast and suitable variations of the current, the optical output can be made to reach at a high speeds. This type of property of optical current is used in Li-Fi setup. The type of operational procedure is so simple-, if the LED is on, you can transmit a digital 1and if the LED is off then you can transmit a 0. By switching the LED on and off, very quickly, gives nice opportunities for transmitting data.

International Journal of Recent Development in Engineering and Technology
Website: www.ijrdet.com (ISSN 2347-6435(Online) Volume 2, Issue 6, June 2014)

Hence all this is possible by LEDs and a controller that coded data into those LEDs. The data rate can be varied at which the LED's flicker depending upon the data we want to encode. Further experiments can be made in this method, by using an array of LEDs for parallel data transmission, or by applying the mixtures of red, green and blue LED to alter the light's frequency with each frequency encoding a different data channel. Such experiments promise a theoretical speed of 10 Gb/s – meaning one can download a full high-definition film in just 30 seconds. 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. The light dims up and down when the current is varied slowly. LED bulbs are semi-conductor devices by which a output can be modulated at extremely high speeds which can be detected by a photo-detector device and converted back to electrical current.

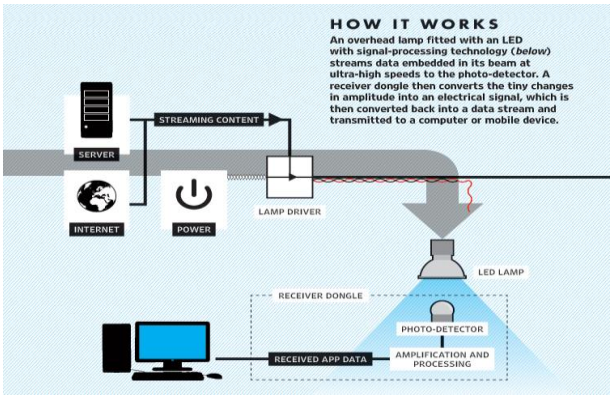

Fig3: Working process of Li-Fi

Due to the intensity modulation imperceptible in to the human eye, a communication is just becomes seamless as RF. High speed information can be transmitted from an LED light bulb by using this technique. A novel modulation technique coined SIM-OFDM was recently proposed [5]. SIM-OFDM uses different frequency carrier states to convey information and leads to increased performance in comparison to conventional OFDM. Due to its innovative structure, it can lead to a decrease of the peak system power. A peak system power is highly beneficial in the context of optical wireless communication [9] [10].

V. Modulation Techniques Used In Li-Fi

In order to actually send out data via LED, like any multimedia data, it is necessary to modulate these into a carrier signal. This carrier signal consists of light pulses sent out in short intervals. How these are basically depends on the chosen modulation scheme.

Two of which are: 1) Sub-carrier pulse (SCP): is presented which is already established as VLC-standard by the VLCC. 2) The second modulation scheme to be addressed is called frequency shift keying (FSK).

V -A. Pulse-position modulation (PPM):

Sub-Carrier Inverse PPM (SCIPPM), method whose structure is divided into two parts (1) sub-carrier part and (2) DC part. The DC part is only for lighting or indicating. When there is no need of lighting or indicating SCPPM (Sub-Carrier PPM) is used for VLC to save energy.

V -B. Frequency Shift Keying (FSK):

In frequency shift keying (FSK) data is represented by varying frequencies of the carrier wave. Before transmiting two distinct values (0 and 1), there need to be two distinct frequencies. This is also the normal form of frequency {shift keying, called binary frequency shift keying (BFSK)}.

V-C. SIM-OFDM Technique (Sub-Carrier Index Modulation OFDM):

Unlike traditional OFDM depicted in the SIM-OFDM technique splits the serial bit-stream *B* into two bit-sub streams of the same length [3]. Unlike traditional OFDM depicted in the SIM-OFDM technique splits the serial bit-stream *B* into two bit-sub streams of the same length. . The next step is to select two different modulation alphabets *M*H and *M*L (*i.e.* 4-QAM and BPSK) to be assigned to the first and the second subsets of the first bit-sub stream.

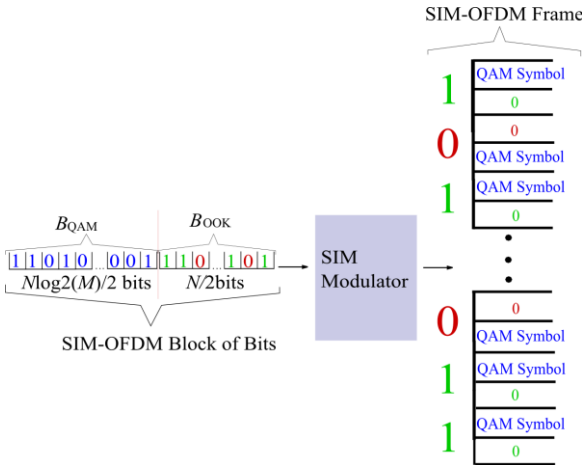

Fig. 4: Modified SIM-OFDM modulation approach.

For spectrally-efficient implementation, the majority subset of the first bit-sub stream is allocated the high-order modulation while the minority subset is allocated the low-order modulation (e.g. BPSK).

International Journal of Recent Development in Engineering and Technology
Website: www.ijrdet.com (ISSN 2347-6435(Online) Volume 2, Issue 6, June 2014)

Finally, the second bit-sub stream is mapped by modulating the subcarriers belonging to the majority subset according to the constellation size of *M*H, and the third bit-sub stream is mapped by modulating the subcarriers belonging to the minority subset according to the constellation size of *M*L. Fig. illustrates an example on SIM using two different modulation instead of OOK modulation.

VI. Difference Between Li-Fi And Wi-Fi

Li-Fi is a new way to establish wireless communication links using the Led lighting networks. The Li-Fi protocols are defined by the international standard IEEE 802.15. Some of the differences between Li-Fi and Wi-Fi are given below:

Characteristics	Li-Fi	Wi-Fi
Spectrum	10,000 times broad spectrum than Wi-Fi.	Narrow Spectrum
Speed	Controlled Speed due to intensity of light	Uncontrolled speed
Data Density	Due to visible light transfer rate is more	Transfer rate is less
Security	More secure due to non penetration of light through walls	Less secure due to transparency
Bandwidth	Due to broad spectrum bandwidth is more	Due to less spectrum bandwidth is less
Cost	Set up cost is less	Set up cost is more than Li-Fi
Transmitter/Receiver power	More	Less

VII. Future Scope Of Li-Fi

Existing spectrum becomes narrow and causes interference, so broad spectrum is required to accommodate wireless signals without any effect.

In hospitals where radio waves can't be used due to harmful effect on body visible light can be used for wireless communication. In airplanes where radio waves can affect the equipments li-fi can be used without any distortion. In the depth of water where radio waves can't travel more visible light communication can be more beneficial. So li-fi has higher advantages than other wireless technologies and can be seen as a future technology.

VIII. Conclusion Of Li-Fi

This may solve issues such as the shortage of radio-frequency bandwidth and also allow internet where traditional radio based wireless isn't allowed such as aircraft or hospitals. If his technology can be put into practical use then every bulb can be used something like a Wi-Fi hotspot to transmit wireless data and we will proceed toward the safe, attractive, and beautiful future. The new technology Li-Fi is currently attracting a great deal of interest of researchers because it may offer a great and very efficient alternative to radio-based wireless. One of the shortcomings is that it can only work in direct line of sight.

REFERENCES

[1] http://newtechnology22.blogspot.in/2012/11/li-fi-tomorrows technology.html

[2] http://www.reportlinker.com/p01083658/Visible-Light-Communication-VLC-Li-Fi-Technology-Free-Space-Optics-FSO-Market--By-Component-LED-Image-Sensor-Opto-couplers-Application-Indoor-Networking-Underwater-Communication-Location-Based-Service-ITS-Geography.html

[3] Dobroslav Tsonev, Sinan Sinanovic and Harald Haas focusing their paper on" Enhanced Subcarrier Index Modulation (SIM) OFDM Email: {dtsonev,s.sinanovic, h.haas}@ed.ac.uk

[4] http://www.wikipedia.com;

[5] Tsonev, D., Sinanovi´c, "Novel Unipolar Orthogonal Frequency Division Multiplexing (U-OFDM).

[6] Research paper of Afgani, M., Haas, H., Elgala, H., and Knipp, D.is focusing on the, "Visible Light Communication Using OFDM,"

[7] http://edition.cnn.com/2012/09/28/tech/lifi-haas- innovation.

[8] Visilink, ―Visible Light Communication Technology for Near-Ubiquitous Networking‖ White Paper, January 2012.

[9] http://beyondweblogs.com/what-is-li-fi-is-this-replacing- Wi-Fi/

[10] Technopits.blogspot.comtechnology.cgap.org /2012/01/11/a-li-fi-world/