Future of Wireless Technology-Lifi

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***Abstract*: Wireless communication is something which has to be safe, fast, free from error and reliable.LI-FI or light fidelity is the modern technology which is designed to overcome these problems. The paper focuses on description of development of light fidelity (Li-Fi) an optical wireless technology, its current use in communication field and future scope of Li-Fi which promises to revolutionize the wireless communication.**

Keywords*:- *Li-Fi (light fidelity), Los (line of sight), LED (light emitting diode), VLC (visible light communication), ASE (area spectral efficiency), long-term evolution (LTE)

I. INTRODUCTION

A new era in wireless communication is soon going to hit the world. A German physicist, Harald Hass who has evolved a method facilitating data transfer through illumination which he called it as D-light (or LI-FI). LI-FI is a very sophisticated and an advanced version of WI-FI which is basically, light fidelity, it uses visible light for communication instead of the radio wave as in WI-FI as shown in figure2. As the speed of light is very fast compared to radio waves, therefore it can be used with a speed of around 250 times more than any high speed broadband present anywhere in the world. Day by day use of internet is increasing and hence traffic is increasing.

It is possible to encode the data in the light by varying the rate at which the LEDs flicker on and off to give different strings of 1s and 0s[1]. It transmits data via LEDs (light emitting diodes) which changes its intensity faster than which the human eye can detect and that change in intensity is captured by a photo detector. Estimated transmission of data is around 10GBps. A recent project in foreign universities proved that speeds such as 3.5GBps can be achieved of the three primary colors from a small LED. Combined, this makes a total of 10GBps or more which can be achieved by the "Li-Fi" technology.

Fig.1 overview of Li-Fi

I. LITERATURE SURVEY

Author name	Title paper	Highlights of paper
Renu M Patil Dattatray S Shitole	Boon to optical wireless technology-Li-Fi.	Design and use of attocell.
Birender Singh Rawat Brijesh Rawat Dishant Passi	LIFI:A New era of wireless communication data survey.	Comparison of wifi and lifi,introduction of lifi.

II. PROBLEM DEFINITION

Researchers have mainly concentrated on the disadvantages of the Wi-Fi and have worked extensively on overcoming these disadvantages [2].

The disadvantages of WI-FI are:

1. Range of coverage is small.
2. More traffic slower speed.
3. Costly.

These limitations are overcome by LI-FI which can be used for:

1. Large coverage of area.
2. Exceptional traffic handling capacity.
3. Cheaper.

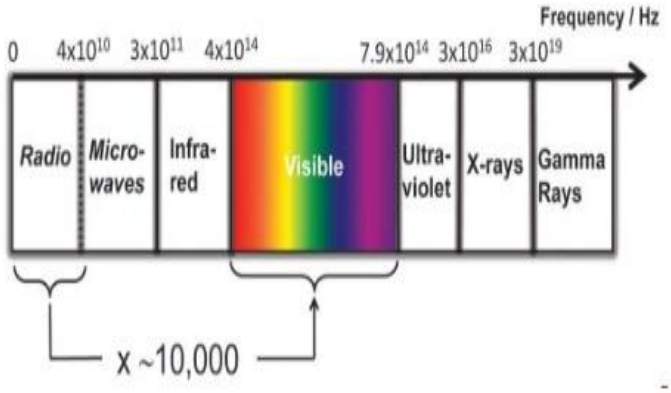

Fig.2 Spectrum of visible light

III. SYSTEM DESIGN

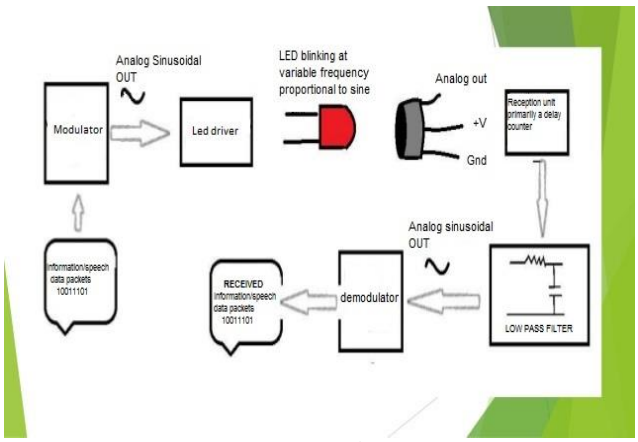

Fig.3 Design of Li-Fi

The Li-Fi architecture consist number of LED bulbs, an LED driver which is used to encode the 1's and 0's to the LED bulb which regulates the fluctuation the light from the LED, Photo detector, low pass filter, demodulator and its many wireless devices such as PDA, Mobile Phones, and laptops which are at the receiving end[3]. Important factors that should be considered while designing Li-Fi is as follow

1. Presence of Light
2. Line of Sight (Los)
3. For better performance use fluorescent light & LED

As shown in figure 3 streaming content must have proper integration with server & internet network, so that it is easily possible to work efficiently

IV. IMPLEMENTATION

Li-Fi is basically implemented using the white LED light bulbs at the downlink transmitter as shown in figure 4. These devices are used normally for illumination purposes by applying a constant current. However, by fast and subtle variations of the current, the optical output is made to vary at extremely high speeds. These variations are at abnormally high speeds due to which it appears as a constant light to the naked human eye[4].

This property of the optical current is used in Li-Fi setup. The procedure of operation is very simple, if the LED is on, a digital 1 is transmitted, and if it's off a digital 0 is transmitted. The LEDs can be set to switch on and off very quickly, which gives the opportunity for transmitting the data. Therefore all that is required is a set of LEDs and a drive controller that codes the data into those LEDs. Depending upon the data we want to encode, all one has to do is to vary the rate at which the LED's flicker.

There is a scope for further enhancement in this technology, by using an array of LEDs for parallel data transmission, or by using mixtures of red, green and blue color LEDs to alter the light's frequency enabling individual frequency encoding at different data channel. Such advancements can lead to theoretical speeds of up to 10 Gbps – meaning a full high-definition film can be downloaded in about 30 seconds.

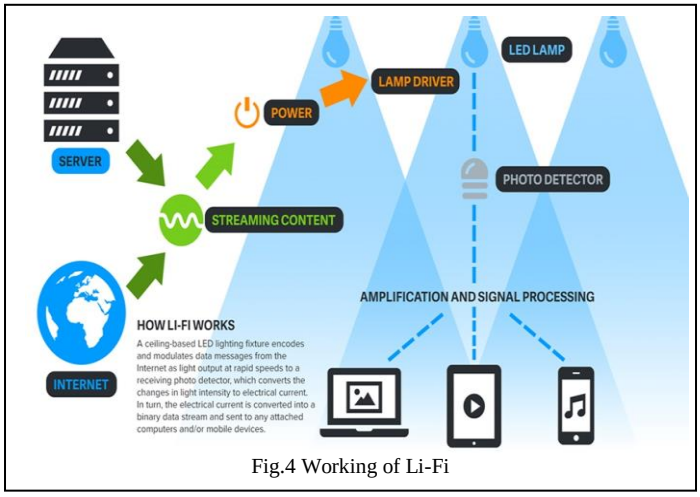

Fig.4 Working of Li-Fi

Further get a clear understanding of Li-Fi, consider an IR remote. It has the capability to send single data stream of bits at the rate of 10,000-20,000 bps. Now when we replace the IR LED with a Light Box containing a large LED array. The system as shown in figure 5 is capable of sending thousands of such individual streams at a very fast rate.

Light is inherently safe and can be used in places where radio frequency communication is often a problematic issue, such as in hospitals, aircraft cabins or radiation free zones. So the visible light communication not only has the potential to solve the problem of lack of spectrum space, but can also enable novel application. The visible light spectrum is unused; hence it's not regulated, and can be used for data communication at very high speeds.

If we equip a room with multiple light fixtures such that each function as a very small radio base station, the result network is a network consisting of very small cells called as 'optical attocells.' These cells are analogous to that of the femtocells in the RF communications, which covers a small area and are, therefore, classed as 'small cells.' For the past 50 years, these small cells have been the major contributors for the three times improvement of the magnitude reported in spectral efficiency gains in wireless communications. Therefore, it is a logical step to consider that the smaller cells like the optical attocells have the added advantage of not interfering with RF-based wireless networks.

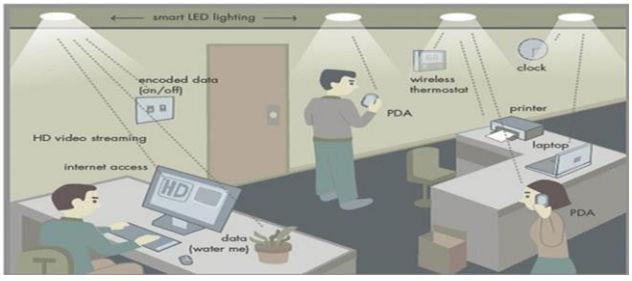

Fig.5 LI-FI at home and office

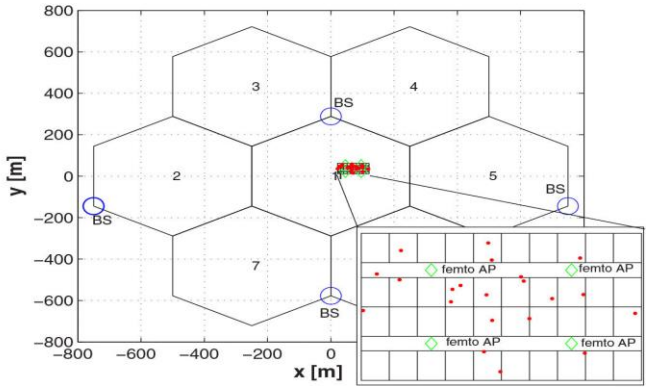

Fig.6 Simulation of a three-floor office building surrounded by seven macrocell base stations using the long-term evolution (LTE) standard. Floor loss (FL) is 17dB, internal wall loss is 12dB and external wall loss is 20dB. Users are randomly distributed in the building. Femto AP: Femtocell access point. BS: Base station.

A single room can be housed by multiple optical attocells, with each covering an area of 1–10m^2 and distances of about 3m. Interference is the main limiting factor. Therefore, the area spectral efficiency (ASE) is bits/s/Hz/m^2 of an indoor office environment, assuming that networks of RF femtocells are present within the office block. We can compare the attained ASE with that of an optical attocells network where the LED light fixtures basically serve two purposes: optical access points and illumination units ensuring a minimum of 400lx[5].

The indoor cells were surrounded by a macrocellular network that is assumed to use the long-term evolution (LTE) standard also common in mobile phones. The femtocell uses the same RF frequency spectrum as that of the macrocell base station, and so the femtocell network suffers from the macrocell interference as shown in Figure 6. The ratios of the ASEs, attained for the attocell and femtocell networks for a varying number of femtocells per floor are plotted as a graph as shown in figure 7. The ASE gain is higher in the attocell networks for smaller rooms. This is due to the fact that the femtocell network suffers from the wall losses additionally, whereas the attocell network is immune from this problem as the interference is prevented by the walls, which refuses the light to propagate through them. As the number of femtocells per floor increases, gain diminishes, but the gain is still about 12 (i.e., the area spectral efficiency of the optical attocell network is 12 times more than that of the RF femtocell network) for the largest room and 20femtocells per floor. The maximum gain in ASE is about 920 for 4 femtocells per floor, which solidifies the fact that using the optical attocells could achieve another three times more magnitude improvement in spectral efficiency. This could be realized within the next 2-5 years, with the additional benefit that optical attocells use a different part of the electromagnetic spectrum, which provide it the freedom to offload the traffic from the RF systems. This multiplicative effect can contribute significantly for solving the looming spectrum crisis.

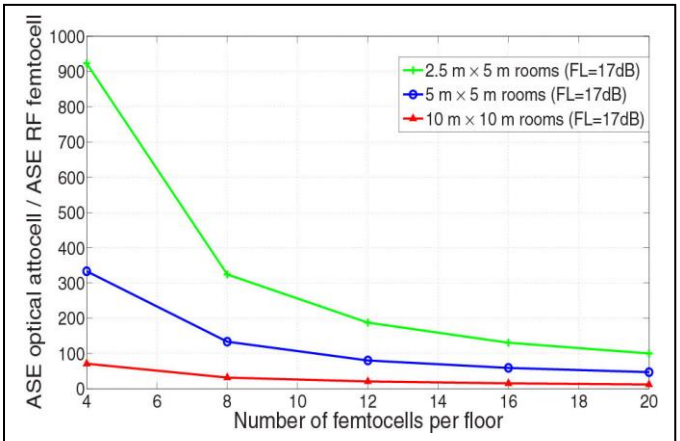

Fig.7 The area spectral efficiency (ASE) of the attocell network is divided by the ASE of the femtocell network. Results from different room sizes are shown.

An optical attocell network with an ASE of 1.2 bit/s/Hz/m^2 and a 10MHz bandwidth in a 12.5m^2 room would enable the users to share on average a total of 150Mbps from the attocell network. If we assume 20 femtocells per floor, the maximum capacity that can be attained for the same room (2.5M x 5m) is about 1.5Mbps. When the same bandwidth is used for both the systems, the optical attocell network needs more power, and is a variable function of the minimum illumination requirement. Piggy-backing the communication functionality on energy-efficient room lighting makes this a very energy-efficient method of wireless communication.

VI.ADVANTAGES OF LI-FI OVER WI-FI

TABLE I. LI-FI IN ALL ASPECTS WAY BETTER THAN WI-FI

S.NO	BASIS OF COMPARISON	WIFI	LIFI
1.	Security	Not secure and can be prone to hack.	Secured, cannot be easily hacked.
2.	Data transmission rate	Slower as it uses the radio waves.	Much faster since it uses visible light.
3.	Range	Small	Large
4.	Traffic control	Less as the signal becomes weaker with increase in traffic.	More due to high speed & easy availability.
5.	Where can it be used	Can be used within the range of the WLAN infrastructure, usually inside a building.	Anywhere, where light source is present.
6.	Cost	Costly	Cheap
7.	Working concept	Makes use of various topologies.	Serves direct binary data.

A Disadvantages Of Li-Fi

LIFI like other technologies has its share of disadvantages

1. These signals cannot penetrate walls. So the person needs a wired bulb or any other source of light in that room also.

2. direct line of sight is required between source and receiver.

B. Advantages Of Li-Fi

1. Radio waves on frequent exposure are harmful for the human beings as they penetrate the body causing mutation. So it is safe.
2. It is very secure, since the signal cannot penetrate through a wall.
3. High speed data transfer rates.
4. It can be used under water where the radio waves fail to, so it is beneficial in many fields.
5. Longevity of led bulbs
6. Electricity costs are minimal
7. Free band which does not need license unlike the RF communications.

Because of these advantages the LI-FI technology is going to hit an upper level.

V. APPLICATIONS OF LIFI

1. Underwater communications: The radio waves when used under water will be absorbed by the water within a short distance of transmission which makes it ineffective, whereas light can be used as a replacement [6].
2. Health sector: Since WIFI uses radio waves it is not safe for usage in hospitals and other health care sectors because it penetrates human body. LIFI can be implemented and is a perfect replacement in this sector.
3. Internet anywhere: street lamps and light of vehicles can be used to access internet anywhere in footpaths, roads, malls, anywhere where light source is available.
4. Safety and management: it can be used to update traffic information at almost instantly which makes it easy for the traffic police to deal with traffic and to apprehend the offenders.
5. Airlines: The passengers of the airline usually pay a considerable amount of money for the pay for the dialup speed Wi-Fi on the plane. Now at the same price as checking a bag, Li-Fi could easily provide speeds of up to 9.8Mbps when installed at each seat's reading light.

VII.EXPERIMENTAL RESULTS

Since the LIFI is a very modern and new technology it is not possible to implement and the results are tentative. Experimental results with off-line processing have revealed the capability of the link supporting a Gb/s transmission at the same distance. Furthermore, for more realistic indoor transmission distances of up to 3-4 meters, the large lens at the receiver frontend can be removed whilst still retaining the link capabilities of achieving a Gb/s transmission. These exciting new experimental results have demonstrated the enormous potential of MicroLEDs for realizing high-speed visible light communication (VLC) links at practical transmission distances. In future applications, such VLC-capable micro LEDs can be integrated into smart device displays and indicator lights, turning them into powerful data transmission ports. Truly, we seem to be at a verge of VLC where every single pixel counts.

VII.CONCLUSIONS

Although LIFI has some disadvantages but it shows huge advancements in the field of wireless technology. It has hit almost all the sectors and is definitely going to be boon for our society. LIFI technology has shown lots of scope since its inception. So these signals will provide many facilities in future. 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. Since LEDs 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. In field of data electronics, it provides ample ways to transfer signals and its relative data to the greatest accuracy and in the most precise way. Communicating and obtaining data from satellite will be easier than ever before. It will be beneficial for defense services as their data is very confidential and private and LIFI cannot be hacked so data is protected. For marine commandos, who operate under water, it enables them to send important commands to other areas such as under water or in land etc.Since LIFI signals works under water. With the hands provided by LIFI the future is bright and ever so exciting [7].

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