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Li-Fi: Lighting the Smart Classes using Wireless Networks

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***Abstract*—** Li-Fi stands for Light-Fidelity. Proposed 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. This technology is based upon the concept of visible light communication (instead of radio frequency waves). At the same time, the concept of smart class education is indeed a blessing to the students of the 21st Century. Technology is changing the way life functions and there are numerous advantages of Smart class but if used with Li-Fi technology, more advantages will be added. The author through the medium of this paper attempts to review basic concept of visible light transmission, how it is different from Wi-Fi, its applications in various fields, future usage, challenges and latest advancements over Wi-Fi.

I. INTRODUCTION

With ever growing needs of telecommunication world, there is an increased thrust for higher bandwidth that facilitates faster and secure data transmission. Existing telecommunication industry relies on radio waves of electromagnetic spectrum for data transmission. Both Li-fi and Wi-Fi uses electromagnetic spectrum for data transmission, but whereas Wi-Fi utilizes radio waves, Li-Fi uses visible light communication in the range of 100Mbps. Unfortunately, the radio wave spectrum has certain key limitations: Capacity, Efficiency, Availability and Security [1].

A solution to this problem is Li-Fi (Light Fidelity) which is a concept based on data transmission via optical fiber and LED. This technology uses LED light bulbs for data transmission. A German physicist Harald Hass introduced the concept of Li-Fi. The data is transferred through a Light emitting diode (LED) by varying the intensity of light faster than a human eye can trace. Haas claimed that his invention, which he calls DLIGHT, could produce data rates faster than 10 megabits per second, which is speedier than average broadband connection [1]. In place of Wi-Fi modems, Li-Fi would use transceivers fitted with LED lamps that could light a room as well as transmit and receive information. It makes use of the visible portion of the electromagnetic spectrum which is underutilized. Visible Light Communication (VLC) is a substantial solution to the spectrum crunch problem. The fundamental property of light can be exploited to circumvent the problems associated with the RF waves which dominate the current communication domain [2].

Comparison between Wireless Networks

Li-Fi is basically a visible light technology to achieve high speed wireless communication by using visible light to transfer data. It acquired this name due to its similarity to WI-FI which utilizes radio waves for transfer of data. Li-Fi is seen as a major breakthrough technology for the mobile internet community and for the connected objects domain. Li-Fi is seen as a light-based Wi-Fi [3].

TABLE I. Li-Fi versus Wi-Fi [3]

SrNo.	Comparison Basis	LIFI	WIFI
1.	Full Form	Light fidelity	Wireless fidelity
2.	Operation	Transmits data using bits with help of light from LED bulbs.	Transmits data with help of radio waves with help of WIFI router
3.	Security	Secured (cannot be hacked) as light is blocked by walls.	Not secured (can be hacked) as for RF signal dry walls are transparent
4.	Interference	Do not have any interference issue similar to radio waves.	Has interference issue from nearby access points (routers)
5.	Spectrum	The Spectrum range is 10000times than Wi-Fi	It has radio spectrum range.
6.	Frequency	The frequency band is 100 times of Tera HZ	The frequency band is 2.4GHz,4.9GHzand 5GHz
7.	Speed	Fast speed internet (greater than 1- 3.5Gbps)	Comparatively slow speed (54-250 Mbps)
8.	Where To Use	Anywhere, where light source is present.	Inside a building. typically Within a array of WLAN communications , habitually inside a structure.
9.	Cost	Cheap as LED lamps are used.	Quiet expensive.
10.	Data transmission rate	Very high rate of data transmission due to visible light spectrum.	Transmission rate is slow as compared to Li-Fi as RF is used to communicate.
11.	System components	Lamp drivers, LED bulbs and light detectors will form complete Li-Fi system.	Routers have to be to be installed, devices like laptops, PDAs, desktops are called as stations.

General Working Principle

As we now know, Li-Fi is a Visible Light Communications (VLC) system. This means that it accommodates a photo-detector to receive light signals and a signal processing element to convert the data into 'stream-able' content.

Li-Fi or Light Fidelity is a technology that uses light emitting diodes to transmit data wirelessly. The functioning of new Li-Fi technology is just simple. A light source at one end like a LED and a photo detector (Light Sensor) on the other end is used and the LED is connected to the internet through the modem and the receiver decodes the information, which is then displayed on the device. 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 as RF. Even

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incandescent lamps turn off and on 60 times in 1 second (60 Hertz), and we already have the perception that it is continuously on. Using this technique, high speed information can be transmitted from an LED light bulb. As soon as, LED starts glowing, photo detector or light sensor on other end will detect light and get a binary 1(on) otherwise binary 0(off).

Flashing a LED certain times will build up a message to transmit. Flashing of light is detected by the photo detector or light sensor and it will receive a message. Li-Fi bulbs are outfitted with a chip that modulates the light imperceptibly for optical data transmission. Li-Fi data is transmitted by the LED bulbs and received by photoreceptors. Communicates with a very high speed with a theoretical limit of 1Gbps.

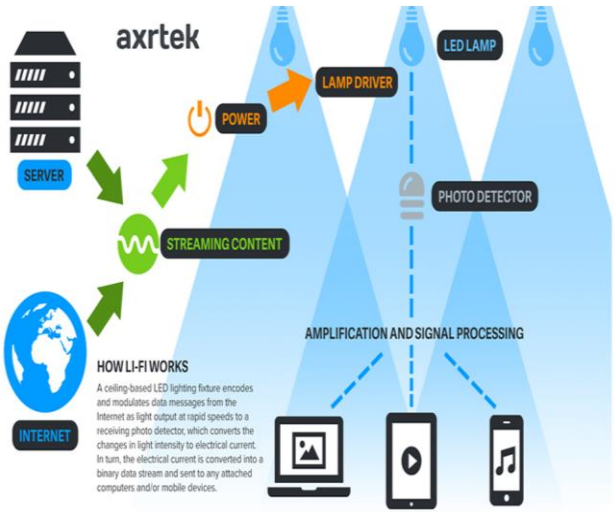

Fig. 1: Li-Fi Working[4]

Smartclass Using Li-Fi Technology

Li-Fi finds application in the innovative smart class technology which is rapidly turning vital for progressive educational institutes. With the help of this technology, teachers can give details on diverse topics, zoom in to demonstrate the major particulars and freeze and explain for right importance. Using attractive animations, sounds and colors, the teachers can get the complete attention of each child in the lecture hall.

Every child acquires image input on what, how, when and where everything occurs and the notions are nicely understood. Currently the smart classes use Wi-Fi in which every single computer is linked to the server with the help of wired LAN technology. The physical transmission means for wired LAN includes cables, which can be either fiber optics or twisted pair [3]. But wired LANs have a lot of drawbacks because it requires drilling of holes in walls, running cables in roof space, fitting hole, etc. Therefore, the gear is costly to install, time consuming and need safeguarding by expert technicians and flexible materials. Executing smart classes with the help of Li-Fi can work out these troubles.

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. As the transmission of the data takes place through the light emitting diodes (LED's) the amount is comparatively small. In modern times, it is called as the optimized version of WI-FI. The advantageous thing is the wireless communication which decreases the cost enormously. The main components that can be used for the Li-Fi network in the Smart classes are [5]:

a. Transmission Source: A high brightness white LED which acts as transmission source.

b. Receiving Element: A silicon photodiode which shows good response to visible wavelength region serving as the receiving element fitted over the computer.

c. Server: It is a database of the Smart means it stores all the data of the smart class.

d. Interactive Board: It acts as a input device and monitor, allows us to control the application by simply touching the board. It connects with the computer and the projector. It usually hangs on the wall or the stand.

e. Computer: It loads an application of Smart class and connected to the server, projector and interactive board.

f. Projector: It is used to project the image on the interactive board, and placed in front of the interactive board.

Challenges of using Li-Fi:-

1. It can only transmit when in the line of vision.
2. Although this technology sounds like a substitute to Wi-Fi but this high speed information transferring technology also has some restrictions that is the lack of ability of light to go by obstacles. It cannot go by the walls and can be blocked. If the light signal is blocked, we can seamlessly change back over to radio waves (Wi-Fi) [6].
3. As Li-Fi technology uses light as communication means, so if the receiver is somehow blocked in a way then the signal will directly be cut out.
4. Information transfer obstruction from exterior light sources for instance sunlight, normal bulbs, and dense materials can cause loss of consistency and network.
5. We still need Wi-Fi and we still require RF cellular systems. You can't have a light bulb that provides info to a speedy moving object or to make accessible data in a remote area where there are trees, walls and obstacles.
6. This tech requires constant supply of illumination which means that the LED have to be kept on throughout the day and albeit the cost of using LED is lower, the requirement by Li-Fi will raise the expenditure [7]

II. CONCLUSION

Although, the possibilities are numerous and can be explored further. Smart classrooms provide an interesting technical solution that does not necessarily guarantee improved student learning based on grades measured. Overall, students want more engaging ways to learn and are open to technology in their classrooms as it seems like a natural progression. It is necessary to support the technology with appropriate learning styles and pedagogies and then assess the appropriateness of the technical solution. Students seem to be more passive learners and require more effort from educators to get them to engage in traditional learning approaches If this technology can be put into practical use, every bulb in the

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school or college can be used something like a Wi-Fi hotspot to transmit wireless data and we will proceed toward the cleaner, greener, safer and brighter future. The concept of Li-Fi is currently attracting a great deal of interest, not least because it may offer a genuine and very efficient alternative to radio-based wireless. As a growing number of people and their many devices access wireless internet, on one way, it can transmit the data at higher rate and on the other it is very cheap as compared with WI-FI and LANs. Smart class using Li-Fi can also be used in the companies for the providing training. Hence the future applications of the Smart class using Li-Fi can be predicted and extended to different platforms and various walks of human life.

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