Li-Fi: The Revolutionary Wi-Fi

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As amount of users are increases in using wireless network, this has unfortunately led to an increase in network complexity, speed decreases, shortage of wireless radio bandwidth and an increased risk of interference of radio frequencies. Moreover efficiency and safety of the internet are dominating issues now. Though Wi-Fi gives us speed up to 150mbps, which is not sufficient to accommodate number of anticipated users. To Resolving this limitation of Wi-Fi, a new technology always is desirable and, there are enormous new technologies participating to make sophisticated environment for an end user. Thus ,this introduces a need of new technology which steps up with our modern needs; i.e. LIFI. Li-Fi is the technology that transmits data through a method of 'illumination'.LiFi is a wireless optical networking technology that uses light-emitting diodes (LEDs) for data transmission. LEDs have become a more common source for room lighting, they're opening a new pathway for linking mobile devices to the Internet, with the potential for wider bandwidth and quicker response time than Wi-Fi.Li-Fi, is a bidirectional, high speed and fully networked wireless communications similar to Wi-Fi[1].Li-Fi is a subset of optical wireless communications (OWC) and can be a complement to RF communication (Wi-Fi or Cellular network).LiFi would also be more secure than WiFi, because light can't go through walls, people would not be able to log on to LiFi networks in the same way that they're able to log on to and eavesdrop in on ongoing WiFi communications. LIFI differs from fiber optical cables because lifi protocol layers are suitable for wireless communication over short distances. It is wireless and uses visible light communication or infra-red and near ultraviolet (instead of radio frequency waves) spectrum, part of Optical wireless communications technology, which carries much more information, and has been proposed as a solution to the RF-bandwidth limitations.[2]

I. TECHNOLOGY DETAILS

This OWC technology uses light from light-emitting diodes (LEDs) as a medium to deliver networked, mobile, high-speed communication in a similar manner to Wi-Fi.[3] Li-Fi could lead to the Internet of Things, which is everything electronic being connected to the internet, with the LED lights on the electronics being used as Li-Fi internet access points.[4] The Li-Fi market is projected to have a compound annual growth rate of 82% from 2013 to 2018 and to be worth over $6 billion per year by 2018.[5] Li-Fi technology can be applied to many different field navigation, undersea communication and etc. Important factors we should consider while designing Li-Fi as following:

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

Visible light communications (VLC) works by switching bulbs on and off within nanoseconds,[6] which is too quickly to be noticed by the human eye. Although Li-Fi bulbs need to be kept on to transmit data, the bulbs could be dimmed to the point that they were not visible to humans and yet still functional.[7] LiFi's early developmental models were capable of 150 megabits-per-second (Mbps).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 semiconductor devices, the current. Therefore 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 [radio frequency technology].Some commercial kits enabling that speed have been released. In the lab, with stronger LEDs and different technology, researchers have enabled 10 gigabits-per-second (Gbps), which is faster than 802.11ad. The light waves cannot penetrate walls which makes a much shorter range, though more secure from hacking, relative to Wi-Fi.[8][9] A complete solution includes an industry led standardization process. LiFi provides ubiquitous high-speed wireless access that offers substantially greater security, safety and data densities than Wi-Fi along with inherent properties that eliminate unwanted external network intrusion. In addition, the integration of illumination and data services generates a measurable reduction in both infrastructure complexity and energy consumption. Li-Fi refers to visible light communications (VLC) technology, which delivers high-speed, bidirectional, networked mobile communications in a manner similar to Wi-Fi. It promises huge speed advantages, as well as more-secure communications and reduced device interference. Direct line of sight isn't necessary for Li-Fi to transmit a signal; light reflected off the walls can achieve 70 Mbit/s.[10][11]Li-Fi has the advantage of being useful in electromagnetic sensitive areas such as in aircraft cabins, hospitals and nuclear power plants without causing electromagnetic interference. Both Wi-Fi and Li-Fi transmit data over the electromagnetic spectrum, but whereas Wi-Fi utilizes radio waves, Li-Fi uses visible light. While the US Federal Communications

Commission has warned of a potential spectrum crisis because Wi-Fi is close to full capacity, Li-Fi has almost no limitations on capacity.[12] There are many advantages to using LEDs to transmit information. For one thing, LEDs can communicate much faster than WiFi. At 15 gigabits per second, LEDs are more than twice as fast as the fastest WiFi. The visible light spectrum is about ten thousand times larger than the radio spectrum. This would allow communication systems to not only use a huge amount of free spectrum. All we need to do is fit a small microchip to every potential illumination device and this would then combine two basic functionalities: illumination and wireless data transmission," Haas said. "In the future, we will not only have 14 billion lightbulbs, we may have 14 billion Li-Fis deployed worldwide for a cleaner, greener and even brighter future.

The visible light spectrum is 10,000 times larger than the entire radio frequency spectrum.[13] Researchers have reached data rates of over 10 Gbit/s, which is more than 250 times faster than superfast broadband.[14][15] Li-Fi is expected to be ten times cheaper than Wi-Fi.[7] Short range, low reliability and high installation costs are the potential downsides.[5][6]

PureLiFi demonstrated the first commercially available Li-Fi system, the Li-1st, at the 2014 Mobile World Congress in Barcelona.[16]

Bg-Fi is a Li-Fi system consisting of an application for a mobile device, and a simple consumer product, like an IoT (Internet of Things) device, with color sensor, microcontroller, and embedded software. Light from the mobile device display communicates to the color sensor on the consumer product, which converts the light into digital information. However, LiFi bulbs are outfitted with a chip that modulates the light imperceptibly for optical data transmission. LiFi data is transmitted by the LED bulbs and received by photoreceptors. Light emitting diodes enable the consumer product to communicate synchronously with the mobile device.[17][18][19]

II. HISTORY

Modern society have gradually become hooked to the internet some way or the other in this 21st century. When there is no internet connection, it is difficult to think of a single day in human life. The internet that is using for a variety of purposes, topmost among them being sharing of data. In circumstances where people want to exchange data quickly and efficiently, low internet speeds can be quite maddening when numerous devices are connected. Professor Harald Haas, from the University of Edinburgh in the UK, is widely recognised as the original founder of Li-Fi. He coined the term Li-Fi and is Chair of Mobile Communications at the University of Edinburgh and co-founder of pureLiFi.[12]

The general term visible light communication (VLC), includes any use of the visible light portion of the electromagnetic spectrum to transmit information. The D-Light project at Edinburgh's Institute for Digital Communications was funded from January 2010 to January 2012.[20] Haas promoted this technology in his 2011 TED Global talk and helped start a company to market it.[21] PureLiFi, formerly pureVLC, is an original equipment manufacturer (OEM) firm set up to commercialize Li-Fi products for integration with existing LED-lighting systems.[22][23]In October 2011, companies and industry groups formed the Li-Fi Consortium, 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.[24] A number of companies offer uni-directional VLC products which is not the same as Li-Fi.LiFi would also be available in places where communication is typically difficult. One can use LiFi in areas where we traditionally can't use radio, such as on the water, or intrinsically unsafe environments like petrochemical plants or oil rigs, everywhere where an antenna could spark an explosion.

VLC technology was exhibited in 2012 using Li-Fi.[25] By August 2013, data rates of over 1.6 Gbit/s were demonstrated over a single color LED.[26] In September 2013, a press release said that Li-Fi, or VLC systems in general, do not require line-of-sight conditions.[27] In October 2013, it was reported Chinese manufacturers were working on Li-Fi development kits.[28]In April 2014, the Russian company StinsComan announced the development of a Li-Fi wireless local network called Beam Caster. Getting better control of the light emitted from organic LEDs (OLEDs) could lead to faster links between the Internet and mobile devices, according to a Scottish researcher. Anyone who has tried to use the Wi-Fi on a crowded airplane or a packed hotel conference room knows it can be maddeningly slow; there usually isn’t enough band width . Some researchers, notably Harold Haas, head of the mobile communications group at the University of Edinburgh, have proposed an alternate system—Li-Fi—which rapidly flickers room lighting to send signals. To get even more bandwidth out of such a system, it would help if there were an easy way to break the light up into different colors, using individual wavelengths to send different signals. Their current module transfers data at 1.25 gigabytes per second but foresee boosting speeds up to 5 GB/second in the near future.[29]

III. SCOPE OF IMPROVEMENT

Since Li-Fi technology uses visible light as its means of communication, it won't work through walls. This means that to have a Li-Fi network throughout your house, you will need these light bulbs in every room (and maybe even the fridge) to have seamless connectivity. LI-FI uses light as a carrier as opposed to traditional use of radio waves as in WI-FI and this means that it cannot penetrate walls, which the radio waves are able to. It is typically implemented using white LED bulbs at the downlink transmitter [1]. By varying the current through the LED at a very high speed, we can vary the output at very high speeds. This is the principle of the LI-FI. The working of the LI-FI is itself very simple—if the LED is ON, the signal transmitted is a digital 1 whereas if it is OFF, the signal transmitted is a digital 0. By varying the rate at which the LEDs flicker, we can encode various data and

transmit it. Li-Fi is no longer a concept or an idea but a proven technology, although still at its infancy. Already, several experts in the field of communication have attested that Li-Fi technology would soon become a standard adjunct to Wi-Fi. That is, until its inherent limitations could be overcome. Since it is light-based, its major drawback is that it won't be able to penetrate solid objects such as walls. Though it could also mean privacy for the personal user, it also questions its use for largescale delivery of data transmissions. Another major issue is that Li-Fi does not work outdoors, meaning that public Li-Fi will not be able to replace public Wi-Fi networks any time soon. While Li-Fi's employment in direct sunlight won't be possible, pure LiFi said that through the use of filters the technology can be used indoors even when sunlight is present. Hence, there is a wider aspect of improvement in such type of technology which can easily satisfy our inernet needs.

IV. CHALLENGES OF LI-FI TECHNOLOGY

Although there are a lot of advantages of LI-FI, there are still certain challenges which need to be overcome.

LI-FI requires Line of Sight

.• If the apparatus is set up outdoors, it would need to deal with changing weather conditions

.• If the apparatus is set up indoors, one would not be able to shift the receiver.

- The problem of how the receiver will transmit back to the transmitter still persists.
- Light waves can easily be blocked and cannot penetrate thick walls like the radio waves can.
- We become dependent on the light source for internet access. If the light source malfunctions, we lose

•access to the internet.

V. CONCLUSION

Li-Fi is still in its developing stages and thus offers remarkable scope for future research and revolution. It has massive potential. A large number of research projects have focused on this new technology to support the higher data transmission. This technology, pioneered by Harald Haas, can become one of the major technologies in the near future. If this technology can be used efficiently, we might soon have something of the kind of WI-FI hotspots wherever a light bulb is available. It will be cleaner and greener and the future of mankind will be safe. As the amount of available bandwidth is limited, the airwaves are becoming increasingly clogged, making it more and more difficult to get a reliable, high-speed signal. The LI-FI technology can solve this crisis. This paper presents a summarized overview of the recent research works being conducted in this technology. Visible light communication (VLC)-"A potential solution to the global wireless spectrum shortage" 'Li-Fi provides promising features to improve the data communication. As the amount of available bandwidth is limited, the airwaves are becoming gradually blocked, difficult to used wire-less technology with accurate. The LI-FI technology can give solution to this problem. Also it will shape the better future for next generation and can offer candid and very effective alterations to radio waves communications. This technology will be going to change the scenario of wireless communication in many harmless ways near in future.

Standards

Like *Wi-Fi*, LiFi is wireless and uses similar 802.11 protocols; but it uses visible light communication (instead of radio frequency waves), which has much wider bandwidth. One part of VLC is modeled after communication protocols established by the IEEE 802 workgroup. However, the IEEE 802.15.7 standard is out-of-date, it fails to consider the latest technological developments in the field of optical wireless communications, specifically with the introduction of optical orthogonal frequency-division multiplexing (O-OFDM) modulation methods which have been optimized for data rates, multiple-access and energy efficiency.[30] The introduction of O-OFDM means that a new drive for standardization of optical wireless communications is required. Nonetheless, the IEEE 802.15.7 standard defines the physical layer (PHY) and media access control (MAC) layer. The standard is able to deliver enough data rates to transmit audio, video and multimedia services. It takes into account optical transmission mobility, its compatibility with artificial lighting present in infrastructures, and the interference which may be generated by ambient lighting. The MAC layer permits using the link with the other layers as with the TCP/IPprotocol.[*citation needed*]

The standard defines three PHY layers with different rates:

- The PHY I was established for outdoor application and works from 11.67 kbit/s to 267.6 kbit/s.
- The PHY II layer permits reaching data rates from 1.25 Mbit/s to 96 Mbit/s.
- The PHY III is used for many emissions sources with a particular modulation method called color shift keying (CSK). PHY III can deliver rates from 12 Mbit/s to 96 Mbit/s.[31]

The modulation formats recognized for PHY I and PHY II are on-off keying (OOK) and variable pulse position modulation (VPPM). The Manchester coding used for the PHY I and PHY II layers includes the clock inside the transmitted data by representing a logic 0 with an OOK symbol "01" and a logic 1 with an OOK symbol "10", all with a DC component. The DC component avoids light extinction in case of an extended run of logic 0's.[*citation needed*]

The first VLC smartphone prototype was presented at the Consumer Electronics Show in Las Vegas from January 7–10 in 2014. The phone uses Sun Partner's Wysips CONNECT, a technique that converts light waves into usable energy, making the phone capable of receiving and decoding signals without drawing on its battery.[32][33] A clear thin layer of crystal glass can be added to small screens like watches and smartphones that make them solar powered. Smartphones could gain 15% more battery life during a typical day. This first smartphones using this

technology should arrive in 2015. This screen can also receive VLC signals as well as the smartphone camera.[34] The cost of these screens per smartphone is between $2 and $3, much cheaper than most new technology.[35]

Philips lighting company has developed a VLC system for shoppers at stores. They have to download an app on their smartphone and then their smartphone works with the LEDs in the store. The LEDs can pinpoint where they are located in the store and give them corresponding coupons and information based on which aisle they are on and what they are looking at.[36]

VI. FUTURE WORK

Li-Fi is the term some have used to label the fast and cheap wireless communication system, which is the optical version of Wi-Fi. There are a plethora of possibilities to be gouged upon in this field of technology. If this technology becomes justifiably marketed then every bulb can be used analogous to a Wi-Fi hotspot to transmit data wireless.

The concept of Li-Fi is attracting a lot of eye-balls because it offers a genuine and very efficient alternative to radio based wireless.y At the rate, currently adopt wireless data, It will ultimately run out of radio spectrum as cope with the long-term demand of wireless data communications and transmission the tons of bytes of data communicated each and every month. Therefore, Li-Fi will be the better choice. In future this technology will lead to produce every bulb to become a Li-Fi access point to transmit data. For the future researchers are developing very small size LED such as micro size LED. These LEDs collected and fix into large LED. Therefore, communicate and transfer data in a single LED. Hence the future applications of the Li-Fi can be predicted and extended to different platforms and various walks of human life. Li-Fi will surely revolutionize the way we connect with the man and the machines.

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