(Light Fidelity)-The future technology In Wireless communication

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ABSTRACT - In simple terms, Li-Fi can be thought of as a light-based Wi-Fi. That is, it uses light instead of radio waves to transmit information. And instead of Wi-Fi modems, Li-Fi would use transceiver-fitted LED lamps that can light a room as well as transmit and receive information. Since simple light bulbs are used, there can technically be any number of access points. Whether you're using wireless internet in a coffee shop, stealing it from the guy next door, or competing for bandwidth at a conference, you've probably gotten frustrated at the slow speeds you face when more than one device is tapped into the network. As more and more people and their many devices access wireless internet, clogged airwaves are going to make it increasingly difficult to latch onto a reliable signal. But radio waves are just one part of the spectrum that can carry our data. What if we could use other waves to surf the internet? One German physicist,DR. Harald Haas, has come up with a solution he calls "Data Through Illumination"—taking the fiber out of fiber optics by sending data through an LED light bulb that varies in intensity faster than the human eye can follow. It's the same idea behind infrared remote controls, but far more powerful. Haas says his invention, which he calls D-Light, can produce data rates faster than 10 *megabits* per second, which is speedier than your average broadband connection. He envisions a future where data for laptops, Smartphone's, and tablets is transmitted through the light in a room. And security would be a snap—if you can't see the light, you can't access the data. Li-Fi is a VLC, visible light communication, "Li-Fi is typically implemented using white LED light bulbs. These devices are normally used for illumination by applying a constant current through the LED. However, by fast and subtle variations of the current, the optical output can be made to vary at extremely high speeds. This technology uses a part of the electromagnetic spectrum that is still not greatly utilized- The Visible Spectrum. Light is in fact very much part of our lives for millions and millions of years and does not have any major ill effect. Moreover there is 10,000 times more space available in this spectrum and just counting on the bulbs in use, it also multiplies to 10,000 times more availability as an infrastructure, globally.

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1 INTRODUCTION

Most of us are familiar with Wi-Fi (Wireless Fidelity), which uses 2.4-5GHz RF to deliver wireless Internet access around our homes, schools, offices and in public places. We have become quite dependent upon this nearly ubiquitous service. But like most technologies, it has its limitations. While Wi-Fi can cover an entire house, its and width is typically limited to 50-100 megabits per second (Mbps) today using the IEEE802.11n standard. This is a good match to the speed of most current Internet services, but insufficient for moving large data files like HDTV movies, music libraries and video games.

The more we become dependent upon 'the cloud' or our own 'media servers' to store all of our files, including movies, music, pictures and games, the more we will want bandwidth and speed. Therefore RF-based technologies such as today's Wi-Fi are not the optimal way. In addition, Wi-Fi may not be the most efficient way to provide new desired capabilities such as precision indoor positioning and gesture recognition.

Optical wireless technologies, sometimes called visible light communication (VLC), and more recently referred to as Li-Fi (Light Fidelity), on the other hand, offer an entirely new paradigm in wireless technologies in terms of communication speed, flexibility and usability. LiFi is transmission of data through illumination by taking the fiber out of fiber optics by sending data through a LED light bulb that varies in intensity faster than the human eye

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can follow.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.

Consortium, to promote high-speed optical wireless systems and to overcome the limited amount of radiobased wireless spectrum available by exploiting a completely different part of the electromagnetic spectrum. The consortium believes it is possible to achieve more than 10 Gbps, theoretically allowing a high-definition film to be downloaded in 30 seconds.

.What Is VLC (Visible Light Communication)?

Many people's first exposure to optical wireless technology was VLC. This emerging technology offers optical wireless communications by using visible light. Today, it is seen as an alternative to different RF-based communication services in wireless personal-area networks. An additional opportunity is arising by using current state-of-the-art LED lighting solutions for illumination and communication at the same time and with the same module. This can be done due to the ability to modulate LEDs at speeds far faster than the human eye can detect while still providing artificial lighting. Thus while LEDs will be used for illumination, their secondary duty could be to 'piggyback' data communication onto lighting systems. This will be particularly relevant in indoor 'smart' lighting systems, where the light is always 'on.' Other examples for outdoor use include intelligent traffic systems to exchange data between vehicles, and between vehicles and road infrastructure like traffic lights and control units. Alternatively, the LEDs' primary purpose could be to transmit information while the secondary purpose of illumination would be to alert the user to where the data is being transmitted from.

In contrast to infrared, the so-called "what you see is what you send" feature can be used to improve the usability of transmitting data at shorter point-to-point distances between different portable or fixed devices. There, illumination can be used for beam guiding, discovery or generating an alarm for misalignment. The premise behind VLC is that because lighting is nearly everywhere, communications can ride along for nearly free. Think of a TV remote in every LED light bulb and you'll soon realize the possibilities of this technology.

(a) GigaDock (b) GigaBeam

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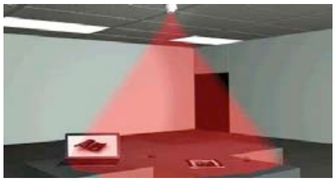
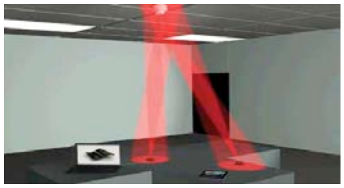


(c) GigaShower



(d) GigaMIMO

Fig. 2: GigaSpeed usage models

(Images courtesy: TriLumina Corp.)

One of the biggest attractions of VLC is the energy saving of LED technology. Nineteen per cent of the worldwide electricity is used for lighting. Thirty billion light bulbs are in use worldwide. Assuming that all the light bulbs are exchanged with LEDs, one billion barrels of oil could be saved every year, which again translates into energy production of 250 nuclear power plants. Driven by the progress of LED technology, visible light communication is gaining attention in research and development. The VLC Consortium (VLCC) in Japan was one of the first to introduce this technology.

After establishing a VLC interest group within the IEEE 802.15 wireless personal-area networks working group, the IEEE 802.15.7 task group was established by the industry, research institutes and universities in 2008. The final standard was approved in 2011. It specifies VLC comprising mobile-to-mobile (M2M), fixed-to-mobile (F2M) and infrastructure-to-mobile (I2M) communications. There, the focus is on low-speed, medium-range communications for intelligent traffic systems and on high-speed, short-range M2M and F2M communications to exchange, for example, multimedia data. Data rates are supported from some 100 kbps up to 100 Mbps using different modulation schemes. Light is inherently safe and can be used in places where radio frequency communication is often deemed problematic, such as in aircraft cabins or hospitals. So 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, it's not regulated, and can be used for communication at very high speeds.

What is LI-FI (Light-Fidelity)?

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Li-Fi comprises a wide range of frequencies and wavelengths, from the infrared through visible and down to the ultraviolet spectrum. It includes sub-gigabit and gigabit-class communication speeds for short, medium and long ranges, and unidirectional and bidirectional data transfer using line-of-sight or diffuse links, reflections and much more. It is not limited to LED or laser technologies or to a particular receiving technique. Li-Fi is a framework for all of these providing new capabilities to current and future services, applications and end users.

VLC represents only a fraction of what appears to be a much larger movement towards optical wireless technologies in general. This larger world has been dubbed 'Li-Fi' (Light Fidelity) by people such as Dr

Harald Haas of Edinburgh University and organizations such as the Li-Fi Consortium. In that connection, Li-Fi comprises several optical wireless technologies such as optical wireless communication, navigation and gesture recognition applied for natural user interfaces (Fig. 1). Thus it provides a completely new set of optical technologies and techniques to offer users add-on as well as complementary functionalities compared to well-known and established RF services. This could reach from a new user experience regarding communication speeds in the gigabit-class to bridge the well-known spectrum crunch, over to precise indoor positioning or controlling video games, machines or robots with entirely new natural user interfaces. Finally, these and many more could be merged to a full-featured Li-Fi cloud providing wireless services for other future applications as well.

Usage models :- Within a local Li-Fi cloud several databased services are supported through a heterogeneous communication sys-tem. In an initial approach, the Li-Fi Consortium defined different types of technologies to provide secure, reliable and ultra-high-speed wireless communication interfaces. These technologies included giga-speed technologies, optical mobility technologies, and navigation, precision location and gesture recognition technologies.

For giga-speed technologies, the Li-Fi Consortium defined GigaDock, GigaBeam, GigaShower, GigaSpot and GigaMIMO models to address different user scenarios for wireless indoor and indoor-like data transfers. While GigaDock is a wireless docking solution including wireless charging for smartphones tablets or notebooks, with speeds up to 10 Gbps, the GigaBeam model is a point-to-point data link for kiosk applications or portable-to-portable data exchanges. Thus a two-hour full HDTV movie (5 GB) can be transferred from one device to another within four seconds. GigaShower, GigaSpot and Giga-MIMO are the other models for in-house communication. There a transmitter or receiver is mounted into the ceiling connected to, for example, a media server. GigaShower provides unidirectional data services via several channels to multiple users with gigabit-class communication speed over several meters. In case GigaShower is used to sell books, music or movies, the connected media server can be accessed via Wi-Fi to process payment via a mobile device. GigaSpot and GigaMIMO are optical wireless single- and multi-channel HotSpot solutions offering bidirectional gigabit-class communication.

Block Diagram

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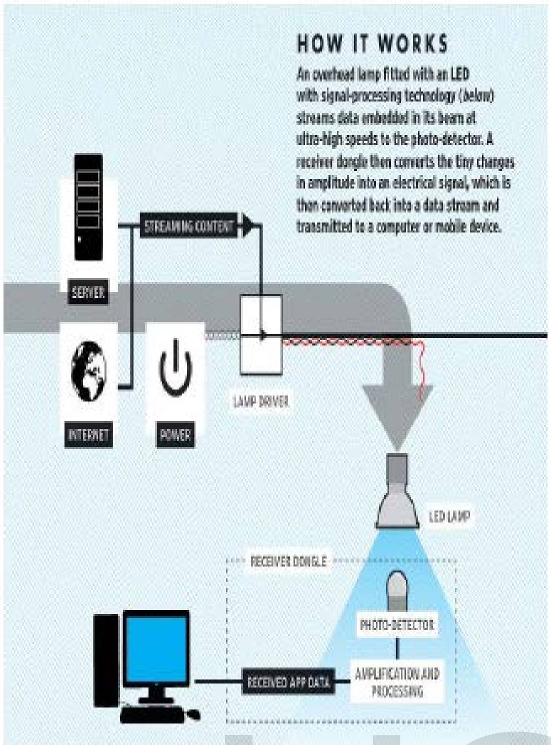
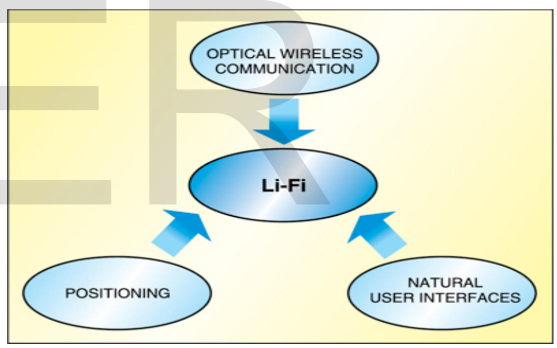
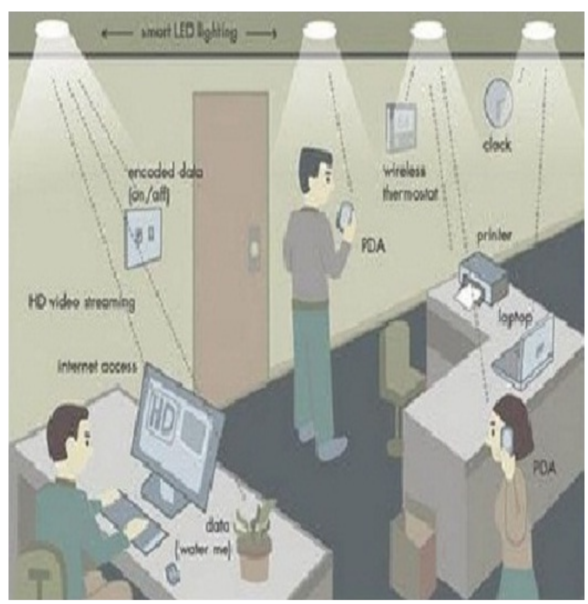


HOW IT WORKS ?

Li-Fi is typically implemented using white LED light bulbs at the downlink transmitter. These devices are normally used for illumination only by applying a constant current. However, by fast and subtle variations of the current, the optical output can be made to vary at extremely high speeds. This very property of optical current is used in Li-Fi setup. The operational procedure is very simple-, if the LED is on, you transmit a digital 1, if it's off you transmit a 0. The LEDs can be switched on and off very quickly, which gives nice opportunities for transmitting data. Hence all that is required is some LEDs and a controller that code data into those LEDs. All one has to do is to vary the rate at which the LED's flicker depending upon the data we want to encode. Further enhancements can be made in this method, like using an array of LEDs for parallel data transmission, or using mixtures of red, green and blue LEDs to alter the light's frequency with each frequency encoding a different data channel. Such advancements promise a theoretical speed of 10 Gbps – meaning one can download a full high-definition film in just 30 seconds. To further get a grasp of Li-Fi consider an IR remote. It sends a single data stream of bits at the rate of 10,000-20,000 bps. Now replace the IR LED with a Light Box containing a large LED array. This system, fig 3.4, is capable of sending thousands of such streams at very fast rate.



This brilliant idea was first showcased by Harald Haas from University of Edinburgh, UK, in his TED Global talk on VLC. He explained," Very simple, if the LED is on, you transmit a digital 1, if it's off you transmit a 0. The LEDs can be switched on and off very quickly, which gives nice opportunities for transmitting data." So what you require at all are some LEDs and a controller that code data into those LEDs. We have to just vary the rate at which the LED's flicker depending upon the data we want to encode. Further enhancements can be made in this method, like using an array of LEDs for parallel data transmission, or using mixtures of red, green and blue LEDs to alter the light's frequency with each frequency encoding a different data channel. Such advancements promise a theoretical speed of 10 Gbps – meaning you can download a full high-definition film in just 30 seconds. Simply awesome! But blazingly fast data rates and depleting bandwidths worldwide are not the only reasons that give this technology an upper hand. Since Li-Fi uses just the light, it can be used safely in aircrafts and hospitals that are prone to interference from radio waves. This can even work underwater where Wi-Fi fails completely, thereby throwing open endless opportunities for military operations. Imagine only needing to hover under a street lamp to get public internet access, or downloading a movie from the lamp on your desk. There's a new technology on the block which could, quite literally as well as metaphorically, 'throw light on'how to meet the ever-increasing demand for high-speed wireless connectivity. Radio waves are replaced by light waves in a new method of data transmission which is being called Li-Fi. Light-emitting diodes can be switched on and off faster than the human eye can detect, causing the light source to appear to be on continuously. A flickering light can be incredibly annoying, but has turned out to have its upside, being precisely what makes it possible to use light for wireless data transmission. Light-emitting diodes (commonly referred to as LEDs and found in traffic and street lights, car brake lights, remote control units and countless other applications) can be switched on and off faster than the human eye can detect, causing the light source to appear to be on continuously, even though it is in fact 'flickering'. This invisible on-off activity enables a kind of data transmission using binary codes: switching on an LED is a logical '1', switching it off is a logical '0'. Information can therefore be encoded in the light by varying the rate at which the LEDs flicker on and off to give different strings of 1s and 0s. This method of using rapid pulses of light to transmit information wirelessly is technically referred to as Visible Light Communication (VLC), though it's potential to compete with conventional Wi-Fi has inspired the popular characterization Li-Fi.



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HOW IT IS DIFFERENT?

Li-Fi technology is based on LEDs for the transfer of data. The transfer of the data can be with the help of all kinds of light, no matter the part of the spectrum that they belong. That is, the light can belong to the invisible, ultraviolet or the visible part of the spectrum. Also, the speed of the internet is incredibly high and you can download movies, games, music etc in just a few minutes with the help of this technology.

Also, the technology removes limitations that have been put on the user by the Wi-Fi. You no more need to be in a region that is Wi-Fi enabled to have access to the internet. You can simply stand under any form of light and surf the internet as the connection is made in case of any light presence. There cannot be anything better than this technology.

COMPARISION BETWEEN Li-Fi & Wi-Fi

LI-FI is a term of one used to describe visible light communication technology applied to high speed wireless communication. It acquired this name due to the similarity to

WI-FI, only using light instead of radio. Ii-FI is great for general wireless coverage within buildings, and li-fi is ideal for high density wireless data coverage in confined area and for relieving radio interference issues, so the two technologies can be considered complimentary.

Technology	Speed	Data density
Wireless (current)		
Wi-Fi – IEEE 802.11n	150 Mbps	*
Bluetooth	3 Mbps	*
IrDA	4 Mbps	***
Wireless (future)		
WiGig	2 Gbps	**
Giga-IR	1 Gbps	***
Li-Fi	>1Gbps	****

APPLICATIONS OF LI-FI

1.You Might Just Live Longer

For a long time, medical technology has lagged behind the rest of the wireless world. Operating rooms do not allow Wi-Fi over radiation concerns, and there is also that whole lack of dedicated spectrum. While Wi-Fi is in place in many hospitals, interference from cell phones and computers can block signals from monitoring equipment. Li-Fi solves both problems: lights are not only allowed in operating rooms, but tend to be the most glaring (pun intended) fixtures in the room. And, as Haas mentions in his TED Talk, Li-Fi has 10,000 times the spectrum of Wi-Fi, so maybe we can, I dunno, delegate red light to priority medical data. Code Red!

2. Airlines

Airline Wi-Fi. Ugh. Nothing says captive audience like having to pay for the "service" of dial-up speed Wi-Fi on the plane. And don't get me started on the pricing. The best I've heard so far is that passengers will "soon" be offered a "high-speed like" connection on some airlines. United is planning on speeds as high as 9.8 Mbps per plane. Uh, I have twice that capacity in my living room. And at the same price as checking a bag, I expect it. Li-Fi could easily introduce that sort of speed to each seat's reading light. I'll be the guy WoWing next to you. Its better than listening to you tell me about your wildly successful son, ma'am.

3. Smarter Power Plants

Wi-Fi and many other radiation types are bad for sensitive areas. Like those surrounding power plants. But power plants need fast, inter-connected data systems to monitor things like demand, grid integrity and (in nuclear plants) core temperature. The savings from proper monitoring at a single power plant can add up to hundreds of thousands of dollars. Li-Fi could offer safe, abundant connectivity for all areas of these sensitive locations. Not only would this save money related to currently implemented solutions, but the draw on a power plant's own reserves could be lessened if they haven't yet converted to LED lighting.

4. Undersea Awesomeness

Underwater ROVs, those favourite toys of treasure seekers and James Cameron, operate from large cables that supply their power and allow them to receive signals from their pilots above. ROVs work great, except when the tether isn't long enough to explore an area, or when it gets stuck on something. If their wires were cut and replaced with light — say from a submerged, high-powered lamp — then they would be much freer to explore. They could also use their headlamps to communicate with each other, processing data autonomously and referring findings periodically back to the surface, all thewhile obtaining their next batch of orders.

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5. It Could Keep You Informed and Save Lives

Say there's an earthquake in New York. Or a hurricane. Take your pick — it's a wacky city. The average New Yorker may not know what the protocols are for those kinds of disasters.Until they pass under a street light, that is. Remember, withLi-Fi, if there's light, you're online. Subway stations and tunnels, common dead zones for most emergency communications, pose no obstruction. Plus, in times less stressing cities could opt to provide cheap high-speed Web access to every street corner.

6.USES IN VARIOUS AREAS

Can be used in the places where it is difficult to lay the optical fiber like hospitals. In operation theatre LiFi can be used for modern medical instruments. In traffic signals LiFi can be used which will communicate with the LED lights of the cars and accident numbers can be decreased. Thousand and millions of street lamps can be transferred to LiFi lamps to transfer data. In aircraft LiFi can be used for data transmission.

It can be used in petroleum or chemical plants where other transmission or frequencies could be hazardous.

ADVANTAGES AND LIMITATIONS OF LI-FI

Advantages :

Larger bandwidth (10,000 times the radio bandwidth)

High efficiency

More availability

Highly secure

Limitations:

Presence of Light is essential

CONCLUSION

The possibilities are numerous and can be explored further. If his technology can be put into practical use, every bulb 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, the airwaves are becoming increasingly clogged, making it more and more difficult to get a reliable, high-speed signal. 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. One of the shortcomings however is that it only work in direct line of sight.

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