

Twilight in the Wireless Web: Light Fidelity

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Abstract:

Using Wi-Fi at homes, offices, colleges will now become a thing of the past. Now we have Li-fi, Light Fidelity, refers to wireless communication systems using light from [light](#) emitting diodes as a medium instead of traditional radio frequencies, as in Wi-Fi. Li-fi is expected to be ten times cheaper than wi-fi. Li-Fi has the advantage of being able to be used in electromagnetic sensitive areas such as in aircraft or nuclear power plants, without causing interference. However, the light waves cannot penetrate walls which makes Li-Fi more secure relative to Wi-Fi. The visible light spectrum is 10,000 times larger than the entire radiofrequency spectrum. This paper will focus on Li-Fi technology over Wi-Fi technology and challenges for the new VLC technology.

Keywords: LED (Light emitted diode), Wi-Fi, VLC

INTRODUCTION



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 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. The term was first used in this context by Harald Haas in his TED Global talk on Visible Light Communication. "At the heart of this technology is a new generation of high brightness

light-emitting diodes", says Harald Haas from the University of Edinburgh, UK, "Very simply, if the LED is on, you transmit a digital 1, if it's off you transmit a 0," Haas says, "They can be switched on and off very quickly, which gives nice opportunities for transmitted data." It is possible to encode data in the light by varying the rate at which the LEDs flicker on and off to give different strings of 1s and 0s. The LED intensity is modulated so rapidly that human eye cannot notice, so the output appears constant. More sophisticated techniques could dramatically increase VLC data rate. Teams at the University of Oxford and the University of Edinburgh are focusing on parallel data transmission using array of LEDs, where each LED transmits a different data stream. Other group are using mixtures of red, green and blue LEDs to alter the light frequency encoding a different data channel. Li-Fi, as it has been

dubbed, has already achieved blisteringly high speed in the lab. Researchers at the Heinrich Hertz Institute in Berlin, Germany, have reached data rates of over 500 megabytes per second using a standard white-light LED. The technology was demonstrated at the 2012 Consumer Electronics Show in Las Vegas using a pair of Casio smart phones to exchange data using light of varying intensity given off from their screens, detectable at a distance of up to ten metres.



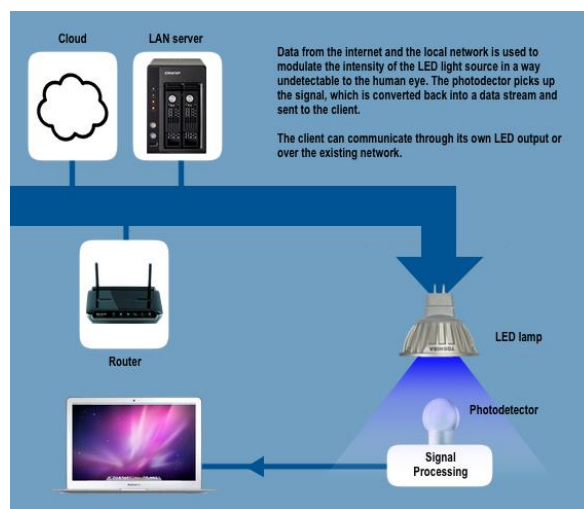
Fig.1 Li-Fi environment

In October 2011 a number of companies and industry groups formed the Li-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.

WORKING TECHNOLOGY

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 its potential to compete with conventional Wi-Fi has inspired the popular characterization Li-Fi.

2.1 Visible light communication (VLC)-“A potential solution to the global wireless spectrum shortage”

Li-Fi (Light Fidelity) is a fast and cheap optical version of Wi-Fi, the technology of which is based on Visible Light Communication (VLC). VLC is a data communication medium, which uses visible light between 400 THz (780 nm) and 800 THz (375 nm) as optical carrier for data transmission and illumination. It uses fast pulses of light to transmit information wirelessly. The main components of this communication system are 1) a high brightness white LED, which acts as a communication source and 2) a silicon photodiode which shows good response to visible wavelength region serving as the receiving element? LED can be switched on and off to generate digital strings of 1s and 0s. Data can be encoded in the light to generate a new data stream by varying the flickering rate of the LED. To be clearer, by modulating the LED light with the data signal, the LED illumination can be used as a communication source. As the flickering rate is so fast, the LED output appears constant to the human eye. A data rate of greater than 100 Mbps is possible by using high speed LEDs with appropriate multiplexing techniques. VLC data rate can be increased by parallel data transmission using LED arrays where each LED transmits a different data stream. There are reasons to prefer LED as the light source in VLC while a lot of other illumination devices like fluorescent lamp, incandescent bulb etc. are available.

HOW IT WORKS

An overhead lamp fitted with an LED with signal-processing technology (*below*) streams data embedded in its beam at ultra-high speeds to the photo-detector. A receiver dongle then converts the tiny changes in amplitude into an electrical signal, which is then converted back into a data stream and transmitted to a computer or mobile device.

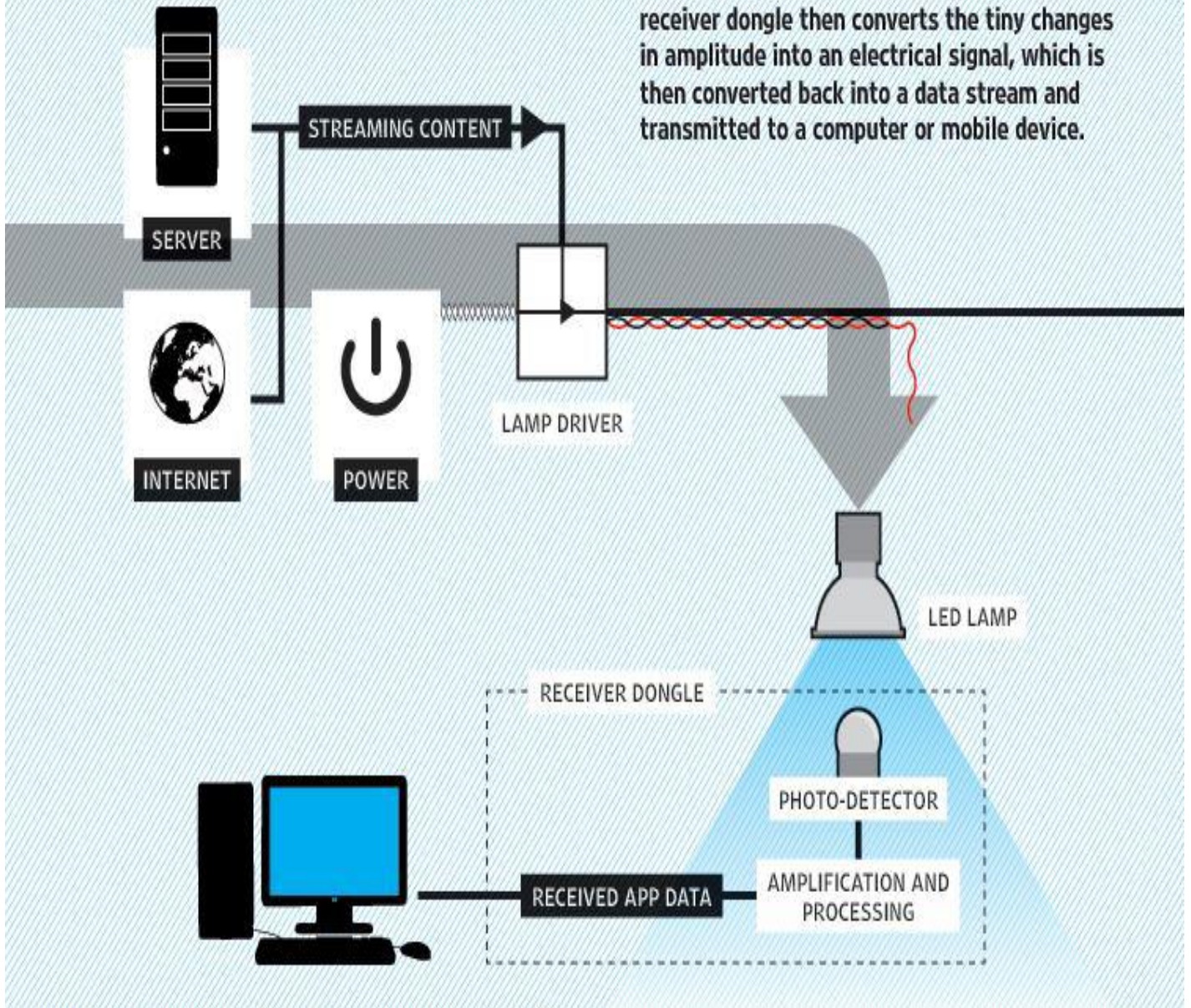


Fig 2.Data transmission using LED

COMPARISON BETWEEN Li-Fi & Wi-Fi

LI-FI is a term 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. WI-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.

S.No.	Parameters	Li-Fi	Wi-Fi
1.	Speed for data transfer	Faster transfer speed (>1 Gbps)	Data Transfer speed (150 Mbps)
2.	Medium through which data transfers occurs	Used Light as a carrier	Used Radio spectrum
3.	Spectrum Range	Visible light spectrum has 10,000 time broad spectrum in comparison to radio frequency	Radio frequency spectrum range is less than visible light spectrum
4.	Cost	Cheaper than Wi-Fi because free band doesn't need license and it uses light.	Expensive in comparison to Li-Fi because its uses radio spectrum.
5.	Operating frequency	Hundreds of Tera Hz	2.4 GHz

Table 1.Comparison between Li-Fi and Wi-fi

CONCLUSION

In future, data for laptops, smart phones & tablets can be transmitted through light in room by using Li-Fi. Researchers are developing micron sized LED which are able to flicker on & off around 1000 times quicker than larger LED. They offers faster data transfers and take up less space so we could save space or add more LED's to further boost the channel of communication. Also 1000 micron sized LED can fit into area required by 1sq. mm large single LED. A 1 sq.mm sized array of micron sized LED's could therefore communicate 1000×1000 (i.e. a million) times as much information as a single 1mm LED. We can be sure that the future for Li-Fi is bright. Li-Fi consortium believes it is possible to achieve more than 10Gbps, theoretically allowing a high definition film to be downloaded in 30 seconds.

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