ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

Light Fidelity

K.Nikitha Reddy
B.Tech Student,
Department of CSE,
Sphoorthy Engineering College,
Nadergul (Vill.), Sagar Road,
Saroornagar (Mdl.), R.R.Dist., T.S.

Msr.Sri Lakshmi
Assistant Professor,
Department of CSE,
Sphoorthy Engineering College,
Nadergul (Vill.), Sagar Road,
Saroornagar (Mdl.), R.R.Dist., T.S.

J.Deepthi
Associate Professor & HOD,
Department of CSE,
Sphoorthy Engineering College,
Nadergul (Vill.), Sagar Road,
Saroornagar (Mdl.), R.R.Dist., T.S.

Introduction:

- Light Fidelity (Li-Fi) is a bidirectional, high-speed and fully networked wireless communication technology similar to wifi.
- The term was coined by Harald Haas and is a form of visible light communication and a subset of optical wireless communication (OWC) and could be a complement to RF communication (Wi-Fi or cellular networks), or even a replacement in contexts of data broadcasting.
- It is wire and uv visible-light communication or infrared and near-ultraviolet instead of radio-frequency spectrum, part of optical wireless communications technology, which carries much more information and has been proposed as a solution to the RF-bandwidth limitations.

About:

The Li-Fi R&D Centre conducts internationally leading research in collaboration with, and on behalf of industry. It aims to accelerate society's adoption of Li-Fi and emerging wireless technology through engagement with major industrial partners, to fully harness the commercial and innovative potential of Li-Fi, and to help establish a major new £5 billion ($8.5 billion) Li-Fi industry by 2018. The UK based research and development centre was formed in 2013, and stems from research into fundamental communications science begun in 2002 that has now received in excess of £8 million ($13.5 million) of competitively won funding.

By facilitating collaboration between industry, internationally renowned experts from the University of Edinburgh, and other key research institutes around the world, the Centre is taking emerging Li-Fi technologies through into mainstream applications that will soon begin to impact on many aspects of the modern world. The Centre, with its partners and collaborators, will foster the wide spread market adoption of Li-Fi technologies. The Centre continues to drive all aspects of Li-Fi communication from novel devices, through to the integration of Li-Fi access points in agile heterogeneous 5G and 6G networks enabled by emerging software defined networking (SDN) infrastructures.

Our Vision:

Li-Fi is a technology with enormous potential to create societal benefits through enhancing the communications infrastructure of the future. The Li-Fi R&D Centre's activities are dedicated to accelerating the development of Li-Fi as a major global industry, through creating a pipeline for innovative ideas, technologies, products and partnerships. The scope is across the full chain of technologies required for the realisation of Li-Fi deployment.

The Centre brings together:

- University research capability
- Major international electronics companies (routes to market)
- SME engagement and company formation (new products)

ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

By employing our advanced research and complex architectures, the Centre will assist in the creation of marketable Li-Fi products, spin-out Li-Fi related companies, promote knowledge exchange within the global Li-Fi community, including providing recommendations for industry standards, and provide expertise and services that accelerate the adoption of Li-Fi technology within specific applications.

Research Background:

The following Li-Fi research projects, involving members and collaborators of the Li-Fi Research and Development Centre, provide research background on activity currently underway.

Research Projects:

Processor Automated Synthesis by iTerative Analysis (PASTA2):

Processor Automated Synthesis by iTerative Analysis (PASTA-2) brings together research in microprocessor design, software, signal processing, and the important emerging application area of Li-Fi. The overall objective of the PASTA-2 project is to investigate new and novel methods of automating the design of embedded systems to enable the timely creation of future generations of high-performance low-power digital appliances.

Ultra-Parallel Visible Light Communications (UP-VLC):

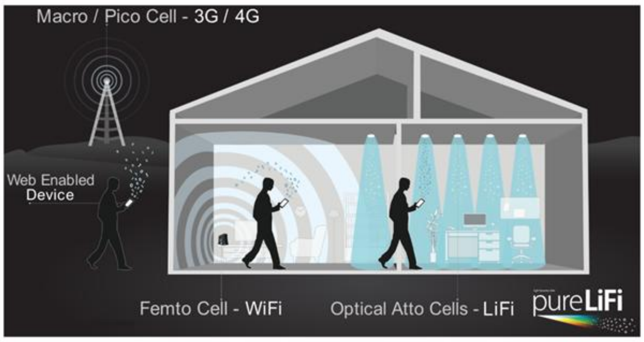
Ultra-Parallel Visible Light Communications (UP-VLC) is an ambitious project, funded through an EPSRC Programme Grant, which will explore the transformative technology of communications in an imaginative and foresighted way. The vision is built on the unique capabilities of gallium nitride (GaN) optoelectronics to combine optical communications with lighting functions, and especially on the capability to implement new forms of spatial multiplexing, where individual elements in high-density arrays of GaN based light emitting diodes (LEDs) provide independent communications channels, but can combine as displays.

Tackling the Looming Crisis in Wireless Communication:

Proposes radical new solutions to the looming "spectrum crisis", whereby the demand for data sent through wireless networks increases far faster than the necessary bandwidth can be made available. Recent advancements in light emitting diode (LED) device technology now seems to let the vision of using light for high speed wireless communications become a reality. By using the visible and infrared spectrum to supplement the r.f. spectrum, there are potential large overall performance improvements when wireless systems can select their transmission medium autonomously and in a dynamic as well as self-organising fashion.

Towards Ultimate Communication Network Convergence (TOUCAN):

Towards Ultimate Communication Network Convergence (TOUCAN) will develop a unified information-driven ICT architecture, where seamless and flexible use of heterogeneous network resources and end devices will optimally interconnect any users, machines and data sets. A service driven approach will provide solutions that consider global resiliency and security issues, and aims to alleviate bottlenecks in capacity, connectivity, spectrum utilization, resource and energy efficiency, and will address Quality of Service and Quality of Experience metrics across the end-to-end communications paths.

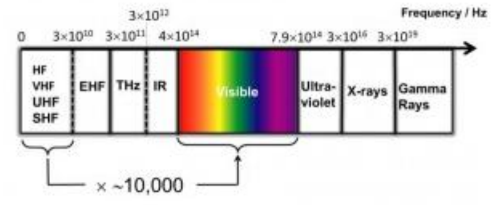


ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

What Is Li-Fi Technology?

Li-Fi technology is a ground-breaking light-based communication technology, which makes use of light waves instead of radio technology to deliver data.

Li-Fi Can Compensate As The Radio Spectrum Becomes Overloaded:



Using the visible light spectrum, Li-Fi technology can transmit data and unlock capacity which is 10,000 times greater than that available within the radio spectrum. The visible light spectrum is plentiful, free and unlicensed, mitigating the radio frequency spectrum crunch effect.

The Future Internet:

Li-Fi technology will in future enable faster, more reliable internet connections, even when the demand for data usage has outgrown the available supply from existing technologies such as 4G, LTE and Wi-Fi. It will not replace these technologies, but will work seamlessly alongside them. Using light to deliver wireless internet will also allow connectivity in environments that do not currently readily support Wi-Fi, such as aircraft cabins, hospitals and hazardous environments. Light is already used for data transmission in fibre-optic cables and for point to point links, but Li-Fi is a special and novel combination of technologies that allow it to be universally adopted for mobile ultra high speed internet communications.

A dual use for LED lighting:

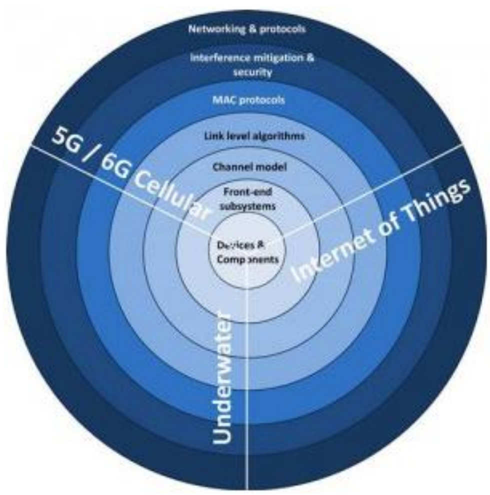
The wide use of solid state lighting offers an opportunity for efficient dual use lighting and communication systems. Innovation in LED and photon receiver technology has ensured the availability of suitable light transmitters and detectors, while advances in the modulation of communication signals for these types of components has been advanced through signal processing techniques, such as multiple-input-multiple-output (MIMO), to become as sophisticated as those used in mobile telecommunications.

An Integrated Communication Solution:

Li-Fi technology is being developed into a ubiquitous systems technology, consisting of application specific combinations of light transmitters, light receivers including solar cells, efficient computational algorithms and networking capabilities that can be deployed in a wide range of communication scenarios and in a variety of device platforms.

The Li-Fi Net:

The Li-Fi R&D Centre works to enable these advantages by addressing all aspects of wireless systems, from devices to networking protocols.



Commercial Opportunities:

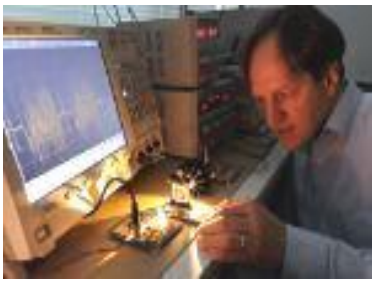
These commercial opportunities in Li-Fi highlight the various licensing opportunities and technology platforms that are currently available.

Licensing Opportunities:

These licensing opportunities are currently available from the University of Edinburgh for potential industry partners seeking to license Li-Fi technologies:

ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

Improved signal performance in visible light Communications



This Li-Fi technology offers a new transmission medium for high speed communications, significantly increasing the data rate capacity of optical wireless communication, while re-using LED lighting infrastructure as the transmission channel. This Edinburgh technology has the ability to convert a signal transmitted over an LED based communication link from a bipolar signal into a unipolar signal. By applying a pulse shaping filter to the bipolar signal, and then transforming the negative values of the pulse shaped bipolar signal into a unipolar signal, the net effect is a significant enhancement in data rate transmission. The method can be readily integrated into LED lighting infrastructure, using low cost front end devices to implement a range of Li-Fi applications.

Enhanced data transmission protocol for visible light communications:

This Li-Fi technology combines spectral efficiency with power efficiency and allows very high speed data communications to be reliably achieved using LED lighting infrastructure as the transmission channel. A special configuration and encoding algorithm is applied to data frames occupying a single frequency band, before simultaneously transmitting the frames over a visible light communication link, and successfully separating them again at the transmitter by use of symmetry properties in the decoder.

The novel method applies to any intensity modulated transmission medium where direct detection is employed, and acts to reduce the effects of inter-symbol interference and to increase spectral efficiency.

Technology Platforms:

Li-Fi Research and Development Centre platform designs

UP-VLC Transmitter Driver Chip

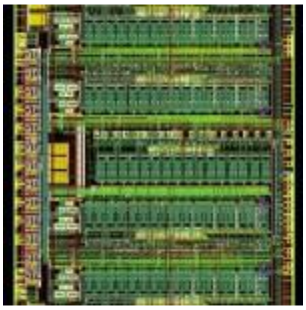


Figure 1: The driver chip layout

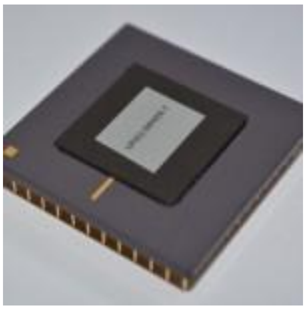


Figure 2: The fabricated transmitter driver chip

A custom-designed transmitter driver chip, implemented in an Austria Micro Systems 0.18 μm CMOS process. The chip consists of 4 independent digital-to-analogue converters (DACs), each capable of directly driving an individual light emitting diode (LED) and having its own 8-bit LVDS digital data interface. The chip also comes with an internal buffer/de-serializer to support ganging/MIMO operation. A serial LVDS interface is provided for chip configuration. An n-channel metal-oxide semiconductor (NMOS) transistor based circuitry is used to realize the driver functionality due to the better carrier mobility and lower area requirement compared with p-channel MOS (pMOS) transistors.

ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

Each driver can sink an LED drive current of up to 255 mA, and is designed to operate at a bandwidth of up to 250 MHz.

UP-VLC Receiver Chip

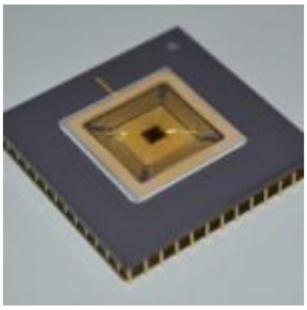


Figure 3: The fabricated receiver chip

A custom-designed receiver chip, implemented in a 0.18 μm CMOS process and featuring nine individually-addressable avalanche photo diode (APD) receivers. Each photo diode (PD) can be operated as a regular PIN diode or in avalanche mode. The maximum reverse bias necessary for the avalanche mode is 12 V, which is significantly lower than other APD technologies. The measured receiver sensitivity is around 2.5 A/W – so comparable to standard off-the-shelf APDs. Each PD is paired with an on-chip shunt-feedback transimpedance amplifier (TIA). As a result, the overall configuration is able to support up to nine individual receiver channels operating at up to 250 MHz of analogue bandwidth.

Li-Fi Front-End Platform:

Figure 4: A first generation prototype board

A custom designed platform on a single PCB, able to support a range of Li-Fi analogue front-end components and to form the basis of Li-Fi demonstration systems and tranceivers. The board features an FPGA chip, Ethernet connectivity, an analogue-to-digital converter (ADC), a digital-to-analogue converter (DAC), and expansion connectors. It includes a custom designed digital signal processing (DSP) chip developed in the course of the University of Edinburgh 'PASTA2' project, as well as a transmitter driver chip developed in the 'UP-VLC' programme. The platform supports communication speeds in the range from several hundred Megabit per second, up to a Gigabit per second.

Other Technology Platforms from Partners:

The following Li-Fi technology platforms are currently available from Li-Fi R&D Centre partners.

Purelifi Li-1st:

The Li-1st provides the first major opportunity for customers to rapidly develop and test VLC applications for cost-effective, high-speed data communication solutions that utilize commercial light emitting diode (LED) infrastructures. The product offers full duplex communication with a capacity of 5Mbps in both the downlink and uplink over a range of up to three metres, while simultaneously providing ample desk space illumination.

Pure LiFi Li-Fire platform:

The Li-Fire platform will enable the world's first ubiquitous high-speed wireless network solution using VLC.

Li-Fire technology will deliver data densities substantially greater than state-of-the-art Wi-Fi solutions and its inherent security properties will eliminate unwanted external network intrusion. In addition, the merger of illumination with wireless communications will provide a measurable reduction in both infrastructure complexity and energy consumption.

Centre team:

Professor Harald Haas:

Director, Li-Fi Research and Development Centre, Chair of Mobile Communications, School of Engineering Harald's main research interests are in interference management in heterogeneous wireless networks, energy and spectrum efficient wireless transmission techniques and optical wireless communications. He is co-founder and chief scientific officer of pureLiFi Ltd, a University of Edinburgh spin-out company.

Professor Nigel Topham:

Chair of Computer Systems, School of Informatics and Member, Institute for Computing Systems Architecture (ICSA), School of Informatics Nigel's main research area is computer architecture, particularly the development of next-generation micro architectures for high-performance embedded systems. His current research projects focus on the automated synthesis of processors, and the interactions between the synthesis of architecture, micro architecture and physical design.

Dr Oscar Almer:

Research Associate:

Oscar researches the digital algorithm and design for Li-Fi communications chips, and works on the PASTA2 project, focusing on digital high-speed SoC and PCB design, development, and verification. His PhD research was on the automatic application-specific optimization of the interconnect in embedded many-core systems.

Freddie Qu:

Research Associate

Freddie is an experienced embedded architect and system engineer focusing on HW-SW co-design, and has experience in making accelerator-enhanced MPSoC for DSP. He was behind the creation of EnCore processors, and was pivotal in implementing LiFi modem's computational platform, a 32-core MPSoC chip.

Adean Lutton:

Research Support Officer:

Adean provides a complete range of research and project support for the Centre members and partners, and is the first point of contact for enquiries. With a MPhil in Publishing and extensive experience of collaborative projects and networks, her specialist areas are knowledge transfer and dissemination and technical copy editing.

Tom Higgison:

IP Projects Manager, Edinburgh Research and Innovation Ltd Tom provides business support for technology transfer projects at the University of Edinburgh, including securing several high value outcomes through spin-out companies. He is involved in technology and IP areas, including: Li-Fi; MEMS; communications technologies; reconfigurable circuits and sensors; in a wide range of markets, including: oil and gas; electronics; and manufacturing.

Mark Chapman

International Business Development

Mark provides business support for International Partner development. He is a business strategist, with 25 years experience in strategic planning, product development and marketing of advanced products, semiconductors and systems in the wireless market. Mark is based in California where he has held executive positions in both public and private companies, including several start-ups.

ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

Latest News

Lifi In The News Again – The Connected Solar Panel

Light is used to transmit high speed data and the solar panel is LiFi-enabled to be a receiver – as well as energy harvesting, the solar panel provides energy for LiFi Technology and is a broadband receiver.

Solar LiFi – New TEDTalk

Harald Haas' TEDGlobal London TED Talk is now online – watch this short film to see a demonstration of the Solar LiFi.

The connected solar panel

At TED Global 2015 in London, Harald Haas has shown for the first time in public how Li-Fi Technology can be used with solar cells to transmit data. This means that now solar panels on houses or other objects can be adapted to also be used.

Light Brings Users Super-Fast Wireless Internet:

See Harald Haas explain to NBC News how lights in shop windows, cars and classrooms can be used to access the wireless internet. Harald says" Li-Fi is seven times faster than wi-fi, and you can download an entire DVD in a couple of seconds – the end of download frustration!" See http://on.msnbc.com/1gDRWlb

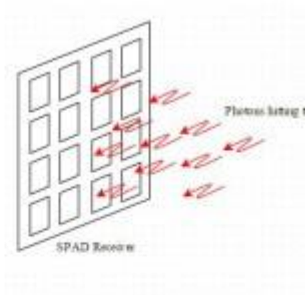
Best Systems Paper Award:

Professor Harald Haas, Chair of Mobile Communications and Director of the Li-Fi Research and Development Centre at the University of Edinburgh and co-author Dr Marco Di Renzo, researcher with Laboratory of Signals and Systems (L2S) have been awarded the Jack Neubauer Memorial Award for the best systems paper by the IEEE Vehicular Technology Society (VTS).

Bell Meets Tesla: Optical Wireless Communications And Power Transfer:

The 'birth' of optical wireless communications by Bell "I have heard articulate speech produced by sunlight. I have heard a ray of the sun laugh and cough and sing!" Alexander Graham Bell, February 1879. These were the words of Alexander Graham Bell that expressed his idea of the use of light for communications.

Highly Sensitive Photon Counting Receivers for Li-Fi Systems:



A New Solution to Long Distance Communication The concept of Li-Fi, first introduced to the general public by Professor Harald Haas, Chair of Mobile Communications at the University of Edinburgh, in a TED Talk in 2011, is currently attracting a great deal of interest and many researchers have stepped into the field by proposing new device.

SDMA: Creates parallel optical pipes:

How spatial separation can be used to increase the data rate of Li-Fi Imagine a cocktail party, there are multiple friends and couples who want to talk to each other in a small single room. If they all talk at the same time, the room will be too noisy and no one can hear each. Li-Fi Access Nodes Networking Technology – its Inherent Programmable Features Li-Fi communication and networking researchers at the University of Edinburgh are inspired by quantum mechanics to develop systems to control the number of photons in light emitted from a simple off-the-shelf

ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

LED light bulb by changing the frequency of the light, making it the most perfect wireless carrier for wirelessly transmitting Internet data .

Li-Fi For Smart Cities

Li-Fi has been featured in El Pais, the national daily newspaper of Spain, and in the interview, the pioneer of Li-Fi, Harald Haas, explains the simplicity of the li-fi technology using LED light bulbs to transmit data, including for example, high speed data connections that might be served from street lights.

History:

- Harald Haas, coined the term "Li-Fi" at his TED Global Talk where he introduced the idea of "Wireless data from every light". He is Chairman of Mobile Communications at the University of Edinburgh and co-founder of pureLiFi
- The general term visible light communication (VLC), whose history dates back to the 1880s, includes any use of the visible light portion of the electromagnetic spectrum to transmit information.
- Haas promoted this technology in his 2011 TED Global talk and helped start a company to market
- In April 2014, the Russian company Stins Coman announced the development of a Li-Fi wireless local network called BeamCaster. Their current module transfers data at 1.25 gigabytes per second but they foresee boosting speeds up to 5 GB/second in the near future.

Standards:

- Wi-Fi, Li-Fi 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.
- The multiplexing (O-OFDM) modulation methods which have been optimized for data rates, multiple-access and energy efficiency.[The introduction of O-OFDM means that a new drive for standardization of optical wireless communications is required.

Application:

Li-Fi applications are varied as a result of its key features, such as directional lighting, energy efficiency, intrinsic security, high data rate capability, signal blocking by walls and integrated networking capability. Each light fixture in the application environment becomes a separate data channel. These channels can supply different data into each separate pool of light, delivered at the full rated download speed for that channel.

- **Security:**

In a meeting room environment, the access area of each channel is the width of the light pool, and can be accessed by multiple users. Each user can receive higher data rates than would be the case for an equivalent Wi-Fi channel. In the Wi-Fi case, each user or group of users directly competes for access to bandwidth. The net result is that the more connections there are, the slower the download speeds are for all. By contrast, in the case of Li-Fi, with its greater number of available access points, each pool of light provides full channel data rates with fewer simultaneous users. The overall net benefit to each user is up to 1000 time's greater speeds. In addition, and in contrast to radio waves, the light does not pass through the walls. Therefore, with minimal precautions to avoid leakage from windows, etc., security is fundamentally enhanced as compared with Wi-Fi

- **Dense Urban Environments:**

Dense urban environments by their nature tend to have complete artificial lighting coverage.

ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

This lighting infrastructure can provide always available high data rate access for users as they move through that environment. For example, along a hotel corridor or reception hall a number of users can receive high data rate downloads at any point. Moreover, high speed wireless communication would be available in every room since the light waves do not propagate through walls. This results in interference-free wireless communication, and spectrum does not have to be shared among a large number of users in the rooms.

- **Connectivity:**

Our homes already have lighting widely installed.
The use of Li-Fi enabled lighting will transform the applications that can be envisaged, not only the interconnection of devices, such as televisions, computers and Hi-Fi, but also connecting ordinary domestic appliances, such as fridges, washing machines, microwaves and vacuums. The "internet of everything".

- **Sensitive Data:**

Hospitals are a specific case of an environment where both EMI sensitivity and security of data are issues. Li-Fi can enable the better deployment of secure networked medical instruments, patient records, etc

- **Underwater Application:**

Most remotely underwater operated vehicles(ROVs) use cables to transmit command, but the length of cables then limits the area ROVs can detect. However, as light wave could travel through water, Li-Fi could be implemented on vehicles to receive and send back signals.

- **Hospital:**

Many treatments now involve multiple individuals, Li-Fi system could be a better system to transmit communication about the information of patients. Besides providing a higher speed, light waves also have little effect on medical instruments and human bodies.

- **Vehicles:**

Vehicles could communicate with one another via front and back lights to increase road safety. Also street lamps and traffic signals could also provide information about current road situations.

- **Safety environments:**

In explosion hazard environments, the use of electrical equipment, including mobile phones, is generally greatly restricted. The use of Li-Fi to pass data will simplify the configuration of data networks in such environments, and can enable new systems to enhance security in these environments.

EMI Sensitive Environments:

On aircraft, Li-Fi enabled lighting will allow high data rate connectivity for each passenger. It will allow connectivity at all times, without creating electromagnetic interference (EMI) with sensitive radio equipment on the flight deck. The reduction in cabling requirement also means a lighter aircraft.

Augmented Reality:

Exhibits in museums and galleries are illuminated with specific lighting. Li-Fi enabled lighting can provide localised information within that light. This means that a visitor's camera or mobile phone can be used to download further information regarding the object being viewed from the light that illuminates the exhibit.

Localised Advertising:

By using shop display lighting as a Li-Fi broadcast channel, it is possible to transmit advertising information on the goods being viewed, as well as say special offers and coupons. This will allow the merging of the high street and online shopping experience, and provide novel retail business models to emerge. Catalogue information, discount coupons, and advertising videos could all be provided to shoppers.

ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

Indoor Navigation:

By identifying each light (for example, through the use of the widely used MAC codes used by data routers and computers) it is possible to provide a smart means of navigating through urban environments. The identification of each code would be linked to a specific location. For example, light received from the closest fixture can indicate to a mobile user their exact position as they travel along a corridor.

Advantages:

- Wifi is great for general wireless coverage while Lifi is ideal for high density coverage in a confined region.
  It is believed that the technology can yield a speed more than 10 Gbps, allowing a HD film to be downloaded within 30 seconds.

Disadvantage:

- Is that the light waves cannot penetrate walls.
  In 2012, this technology was demonstrated and it was detectable upto a distance of 10 meter. Amazing Fact about Li-If is
- Every light source in homes and offices could potentially be a "Li-Fi" within 20 years.
- When this technology becomes feasible like the Wifi, then our life will be awesome on earth.

Author's Details:

K.Nikitha Reddy
B.Tech Student,
Department of CSE,
Sphoorthy Engineering College,
Nadergul (Vill.), Sagar Road,
Saroornagar (Mdl.), R.R.Dist., T.S.

Msr.Sri Lakshmi
Assistant Professor,
Department of CSE,
Sphoorthy Engineering College,
Nadergul (Vill.), Sagar Road,
Saroornagar (Mdl.), R.R.Dist., T.S.

J.Deepthi
Associate Professor & HOD,
Department of CSE,
Sphoorthy Engineering College,
Nadergul (Vill.), Sagar Road,
Saroornagar (Mdl.), R.R.Dist., T.S.