Li-Fi-A New Generation Wireless Communication

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***Abstract*-Li-Fi (light fidelity) is the next step in communication technology after Wi-Fi. It is a 5Gvisible light communication system that uses light from light-emitting diodes (LEDs) as a medium to deliver networked, mobile, high-speed communication in a similar manner as Wi-Fi. 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. In this paper i am discussing this next generation wireless communication with its technology used.**

Keywords- 5G, GigaShower, GigaSpot and Giga-MIMO, Li-Fi, Wi-Fi.

I. INTRODUCTION

Li-Fi, or "light fidelity", is a technology, that can be a complement of RF communication (Wi-Fi or Cellular network), or a replacement in contexts of data broadcasting. Li-Fi, like Wi-Fi, is the high speed, bidirectional and fully networked subset of visible light communications (VLC). It is wireless and uses visible light communication (instead of radio frequency waves), which carries much more information, and has been proposed as a solution to the RF-bandwidth limitations. [1]

II. WHY WI-FI IS INSUFFICIENT

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 bandwidth 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 largedata 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.

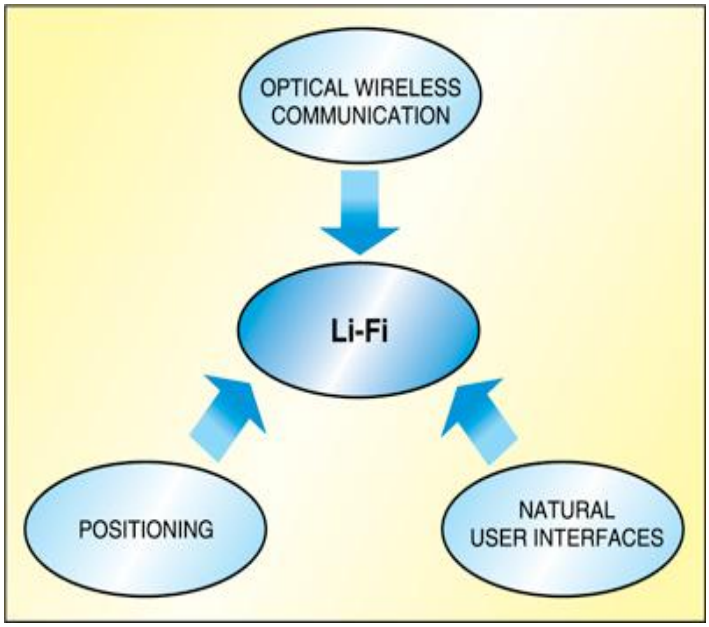

Figure 1. Li-Fi as a superset of different optical wireless technologies involving communication, positioning, natural user interfaces and many more.[3]

III. VISIBLE LIGHT COMMUNICATIONS IS USED AS TECHNOLOGY IN LI- FI

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. 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 (Fig. 2) 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. On the other side are portable or fixed devices on a desk in an office, in an operating room, in a production hall or at an airport. GigaShower provides unidirectional data services via several channels to multiple users with gigabit-class communication speed over several metres. This is like watching TV channels or listening to different radio stations where no uplink channel is needed. 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 in a room, hall or shopping mall for example.

IV. HOW LI-FI WORKS

The basic principle of Li-Fi is this: visible light has 10,000 times as broad a spectrum as the radio frequencies which Wi-Fi uses, allowing for much more bandwidth, once tapped. This is accomplished by the flickering of LED lightbulbs to create binary code (on = 1, off = 0), and is done at higher rates than the human eye can detect. The more LEDs in your lamp, the more data it can process.

V. SIDE EFFECTS OF LI-FI

A side effect of Li-Fi is that your power cord immediately becomes your data stream, so if you have power, you have Internet. The only infrastructure is an equipped lightbulb. Your internet provider doesn't even need to bring you a box, they just connect you to their power-grid-mounted signal relays, and you're online. [4]

VI. HOW IS IT 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.

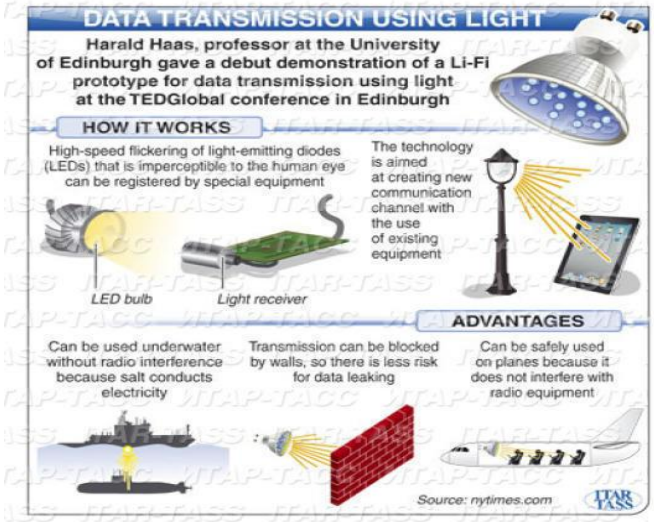

Figure 2. Data Transmission using light

VII. THE MIND BEHIND THIS MAGIC

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 pure Li-Fi. [2]

Figure3. Inventor of Li-Fi Professor Harald Haas

VIII. APPLICATION OF LI-FI

Li-Fi is particularly suitable for many popular internet "content consumption" applications such as video and audio downloads, live streaming, etc. These applications place heavy demands on the downlink bandwidth, but require minimal uplink capacity. In this way, the majority of the internet traffic is off-loaded from existing RF channels, thus also extending cellular and Wi-Fi capacities.

There are many applications for Li-Fi. These include:

- **RF Spectrum Relief**: Excess capacity demands of cellular networks can be off-loaded to Li-Fi networks where available. This is especially effective on the downlink where bottlenecks tend to occur.
- **Smart Lighting**: Any private or public lighting including street lamps can be used to provide Li-Fi hotspots and the same communications and sensor infrastructure can be used to monitor and control lighting and data.
- **Mobile Connectivity**: Laptops, smart phones, tablets and other mobile devices can interconnect directly using Li-Fi. Short range links give very high data rates and also provides security.
- **Hazardous Environments**: Li-Fi provides a safe alternative to electromagnetic interference from radio frequency communications in environments such as mines and petrochemical plants.
- **Hospital & Healthcare**: Li-Fi emits no electromagnetic interference and so does not interfere with medical instruments, nor is it interfered with by MRI scanners.
- **Aviation**: Li-Fi can be used to reduce weight and cabling and add flexibility to seating layouts in aircraft passenger cabins where LED lights are already deployed. In-flight entertainment (IFE) systems can also be supported and integrated with passengers' own mobile devices.
- **Underwater Communications**: Due to strong signal absorption in water, RF use is impractical. Acoustic waves have extremely low bandwidth and disturb marine life. Li-Fi provides a solution for short-range communications.
- **Vehicles & Transportation**: LED headlights and tail-lights are being introduced. Street lamps, signage and traffic signals are also moving to LED. This can be used for vehicle-to-vehicle and vehicle-to-roadside communications. This can be applied for road safety and traffic management.
- **RF Avoidance**: Some people claim they are hypersensitive to radio frequencies and are looking for an alternative. Li-Fi is a good solution to this problem.
- **Location Based Services (LBS)**: Highly accurate location-specific information services such as advertising and navigation that enables the recipient to receive appropriate, pertinent information in a timely manner and location.
- **Toys**: Many toys incorporate LED lights and these can be used to enable extremely low-cost communication between interactive toys.[5]

CONCLUSION

This is all about the Li-Fi- A new paradigm in wireless communication and it is sure to be a huge hit as soon as it is put to use for the general public.LiFi is designed to use LED light bulbs similar to those currently in use in many energy-conscious homes and offices. 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.The world of Lighting companies experiences a true revolution with the development of Led lighting devices. With reduced energy consumption and a longer liftime, Leds appear as a solution that cannot be overlooked to face up to the challenge of the CO2 emission reduction at the worldwide scale. The sale of Leds Lighting units knows an impressive increase these last years.Leds are different from the other kinds of lamps because they are semiconductors. This characteristic gives them the capability to switch-on and off within few nanoseconds or billionth of a second. Converted in terms of data rates, this corresponds to 1 Gbits/s. In order to compare, at best WiFi can reach 100 Mbits/s data rates and so 10 times lower. Thanks to the LiFi technology, the 14 billion lamps in the world will become gradually green mobile internet masts that will permit to respond to the impressive increasing demand of mobile conectivity. Also, this will allow reducing the electromagnetic pollution generated by the numerous radio wave solutions developed until now.

REFERENCE

[1] "Light Fidelity (Li-Fi): Towards All-Optical Networking", D. Tsonev, S. Videv and H. Haas; Institute for Digital Communications, Li-Fi R&D Centre, The University of Edinburgh, EH9 3JL, Edinburgh, UK.

[2] THE FUTURE'S BRIGHT – THE FUTURE'S LI-FI, Calendonian Mercury, 29 November 2013

[3] http://electronicsforu.com/electronicsforu/circuitarchives/view_article.asp?sno=778&title%20=%20Li%2DFi%3A+A+New+Paradigm+in+Wireless+Communication&id=12042&article_type=8&b_type=new

[4] http://www.dvice.com/archives/2012/08/lifi_ten_ways_i.php

[5] http://purelifi.com/what_is_li-fi/applicationsof_lifi/