



The Commercialization of LiFi

A CABA WHITE PAPER

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CABA
Intelligent Buildings Council



CABA
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ABOUT CABA

The Continental Automated Buildings Association (CABA) is an international not-for-profit industry association, founded in 1988, and dedicated to the advancement of intelligent home and intelligent building technologies. The organization is supported by an international membership of over 385 organizations involved in the design, manufacture, installation and retailing of products relating to “Internet of Things, M2M, home automation and intelligent buildings”. Public organizations, including utilities and government are also members. CABA's mandate includes providing its members with networking and market research opportunities. CABA also encourages the development of industry standards and protocols, and leads cross-industry initiatives. CABA's collaborative research scope evolved and expanded into the CABA Research Program, which is directed by the CABA Board of Directors. The CABA Research Program's scope includes white papers and multi-client market research in both the Intelligent Buildings and Connected Home sectors. www.caba.org

ABOUT CABA'S CONNECTED HOME COUNCIL (CHC)

Established in 2004, the CABA Connected Home Council initiates and reviews projects that relate to connected home and multiple dwelling unit technologies and applications. Connected homes intelligently access wide area network services such as television and radio programming, data and voice communications, life safety and energy management/control information and distribute them throughout the home for convenient use by consumers. The Council also examines industry opportunities that can accelerate the adoption of new technologies, consumer electronics and broadband services within the burgeoning connected home market. www.caba.org/chc

ABOUT CABA'S INTELLIGENT BUILDINGS COUNCIL (IBC)

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1. INTRODUCTION

Building architects and engineers are continually evaluating lighting control technologies when planning new or renovated buildings. Adoption of LiFi communications technology can enhance the return on investment for such buildings by making them more efficient, usable, and livable for the occupants.

The efficiency of LED lighting technologies combined with Visible Light Communication (VLC) systems carried over Light Emitting Diodes (LEDs), otherwise known as LiFi, has emerged as an eco-friendly IT green building technology. This technology utilizes visible or infrared light communication to provide wireless access to the Internet while offering increased security, higher data density and improved reliability. LiFi provides Wi-Fi-type services that are private because they are bounded by line-of-sight to the LED lamp carrying the LiFi communications signal, with data invisibly embedded in the light.

2. WHAT DOES IT TAKE TO DEPLOY LIFI VISIBLE LIGHT COMMUNICATION TECHNOLOGY

Two considerations:

1. Deployment and commissioning of LiFi technology in a new smart building:

LiFi technology may be engineered into the plans for the new building by the architects and building engineers. This involves a level of understanding of the technology and buy-in from the stakeholders of the building project including the IT department. Besides provisioning the light fixtures with LiFi, we must equip every node (device) accessing network connectivity with special hardware (via a dongle or network interface card (NIC)), a device driver, and configuration to utilize LiFi. Education and training about new building systems such as LiFi are keys to the success of any new technology implementation, use, and support.

The return on investment in LiFi fixtures and adoption by the stakeholders are based on the cost of LiFi equipment versus the revenue from LiFi as-a-service if LiFi network access is metered and charged back to the end users. There are multiple business models that require a partnership between building services management and IT management for the deployment and configuration of a light communications network. When LiFi technology is engineered into the smart building, it gleans rapid deployment, and usage (Figure 1).

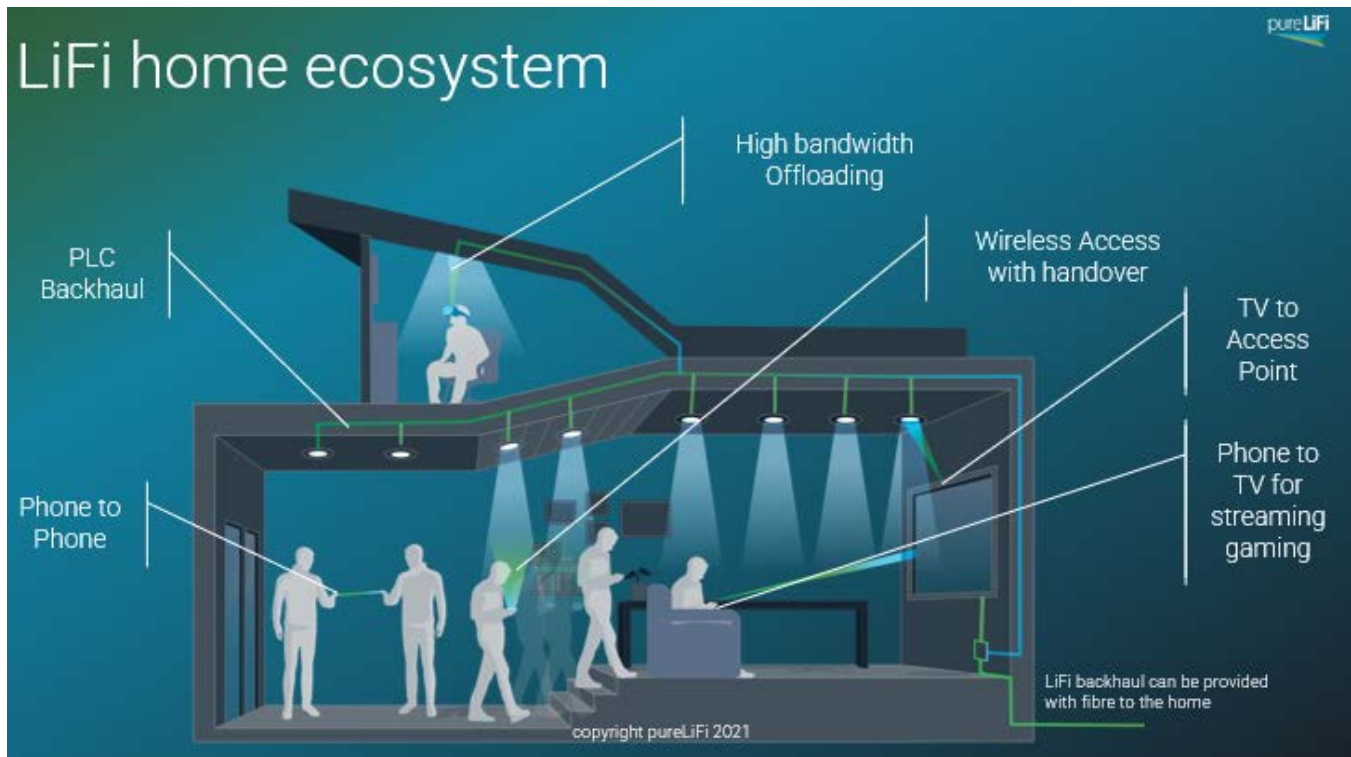


FIGURE 1: EXAMPLE OF LIFI DEPLOYMENT IN THE HOME

2. Deployment of LiFi technology in an existing building:

Many buildings are still utilizing fluorescent tube lighting technology. As more and more building managers decide to phase out this technology and replace it with more efficient LED technology, consideration should include the capability of the LED lighting to provide not only light, but also access to the Internet. LiFi technology is scalable and flexible to co-exist with Wi-Fi technologies. Indeed, several technologies such as Power over Ethernet (PoE) or Power over Optical Fiber, offer options to deliver power and data to a single luminaire simultaneously. Multiple commercially available LiFi systems can be powered using PoE such as the PureLiFi Kitefin systems.

LiFi network deployment will require special hardware (dongle or NIC), device drivers, and configuration to connect devices to the Internet initially. However, device integration has already started with GETAC, which created the world's first LiFi-enabled rugged device (*becomes world's first manufacturer to bring integrated LiFi technology to rugged mobile computing market*). (2021, February 3). Getac. <https://www.getac.com/en/news/getac-becomes-worlds-first-manufacturer-to-bring-integrated-lifi-technology-to-rugged-mobile-computing-market/>).

LiFi technology has proven to be a high availability and low latency network technology. The following use case studies are deployments of LiFi and/or complementary LiFi/Wi-Fi technology.

3. OPTICAL WIRELESS COMMUNICATIONS/LIGHT FIDELITY (OWC/LIFI) MARKET SEGMENTS:

Enterprise - LiFi and Wi-Fi are the two technologies that when combined can achieve a more efficient and more secure network for the enterprise. LiFi should facilitate Internet access by enabling more devices to connect to one another, a trend that is expected to continue growing.

Data access - Where network connections are based on optical wireless communications (OWC) using LiFi for work, conference streaming, remote desktops possibly with video, etc. Enhanced data security can be achieved for organizations that require a high level of confidentiality. The directionality of light propagation can effectively reduce interferences in heavily populated offices. Complementary wireless off-loading to light-based communications releases spectrum for connecting other devices in the crowded unlicensed bands used by Wi-Fi. LiFi avoids interference with all current and future RF systems including, Wi-Fi, 4G/5G, mmWave, and more.

RF sensitive facilities - Such as defense, hospitals, healthcare, and mining, OWC/LiFi can provide safe data access where RF may not be allowed or insecure.

Home - Smart homes apply device-to-device communications (often called the Internet of Things) to enhance the quality of human life by improving comfort, savings, convenience, and peace of mind at home. LiFi technology as a smart green technology communications medium provides low power secure wireless access to the Internet while lighting the smart home, as shown in Figure 1.

- Data access: where mobile devices use OWC/LiFi for high data rate network access especially for heavily populated apartments so that reduced interference and enhanced privacy can be achieved.
- Home theater: where high-definition video and audio equipment connect to an OWC/LiFi access point.
- Virtual reality (VR): where VR goggles/glasses are connected to an OWC/LiFi access point.

Schools and Education – With the rise of cloud computing school networks have become strained because of the number of devices trying to connect at once. LiFi can transform the classroom into a fully connected environment allowing students to have educational tools accessible through light.

Retail-Geo Location (GeoLiFi) optimizes indoor and outdoor floor plan information so customers can search and access points of interest using LiFi-enabled smartphones. Retailers can apply lighting strategically by using LiFi luminaires for consumer services provided via in-store devices that include location tracking, while offering privacy. The same use-case can also be delivered currently via Optical Camera Communications (OCC), which uses a smart OCC-enabled light and existing mobile phones.

- Currently, delivery of high-bandwidth data at points in a store requires cabled connections, making these locations immobile. Alteration of retail space to enable new customer experiences is a key part of retailer strategy. High-bandwidth flexible retail space through OWC/LiFi enables cost reductions for retailers.
- When modifying or refitting the space.
- OWC/LiFi can offer high data density that can enable very-high bandwidth content streaming without interference from other wireless resources.

Smart Cities – Smart cities will require extensive bandwidth for connecting people and IoT. LiFi provides a highly secure and private bidirectional communications channel. Today, high energy consumption and connectivity leaks are major obstacles to unleashing the power of the Internet. LiFi has the potential to solve these problems.

- Entire cities may use optical wireless communications to provide a better quality of life for its citizens in daily activities such as:
 - Libraries, civic centers, and religious facilities
 - Factories
 - The commissioning of LiFi technology in smart buildings
 - Smart car communication with streetlights/attocells, intelligent LiFi enabled signage, and traffic lights

Conference centres and hotels - The content of events and communications by the participants at a conference can be highly sensitive. LiFi is a proven method for keeping sensitive information secure.

Aviation – Airline passengers place greater demands on the inflight Internet bandwidth. As a result, the connected experience in aircraft may be limited by the available bandwidth. LiFi has the potential to transform Flight Entertainment (IFE) systems as well as cabin and fuselage design.

Government, defense, secure operations – Use of LiFi technology in active theatres provides secure communications.

4. PENETRATION OF LEDS IN THE MARKET

LED-based lighting provides the opportunity for LiFi-based networks. Therefore, the proliferation of LED installations in buildings is an enabler for LiFi deployment (Graph 1). Graph 2 illustrates the growth of LED adoption in buildings. Graph 3 depicts LiFi deployment growth by industry. Graph 4 indicates LiFi growth in USD of 4.98 billion 2021-2025.

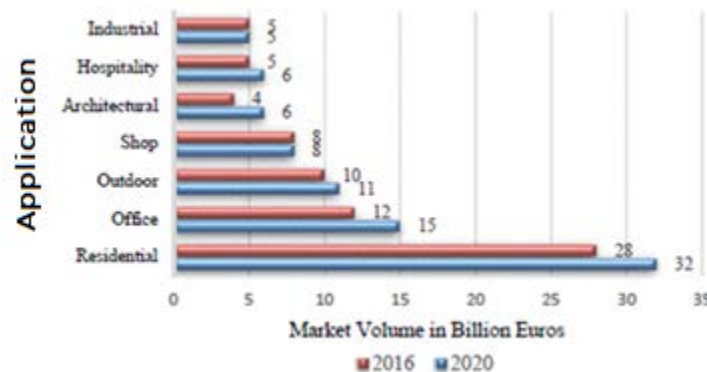
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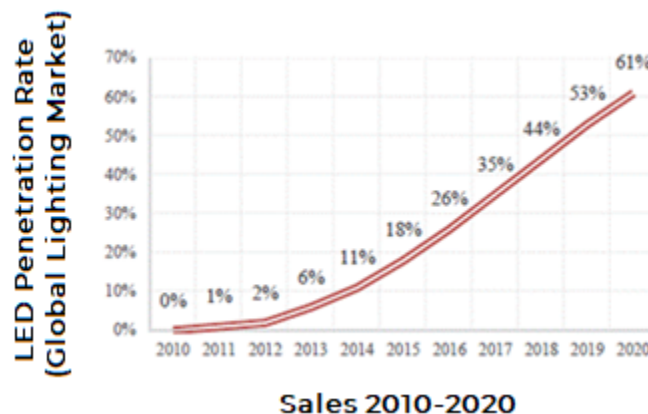
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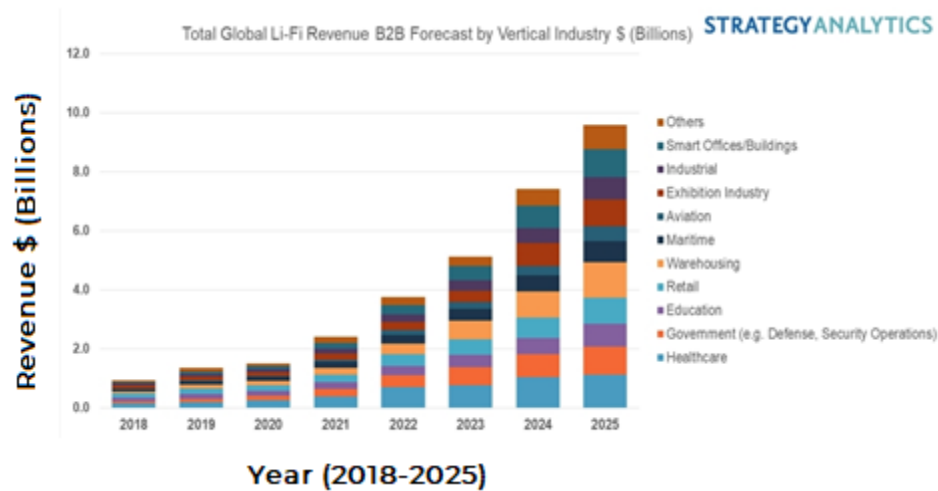
Graph 1



Graph 2



Graph 3



Graph 4



5. LIFI TECHNOLOGY TIMELINE REWIND

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6. SUMMARY

- LiFi is a “change agent” in lighting-controls, data/tele-communications, and energy saving technology.
- LiFi may be thought of as a fundamental shift in wireless network communications technology utilizing light instead of radio waves in the high MHz/GHz/THz range.
- LiFi complements RF technologies through capacity optimization.
- LiFi technology can be utilized as a managed service for smart buildings.
- LiFi provides a means for Building Management and IT departments to champion innovation through modification of the network landscape.
- LiFi deployment relies on architects, building technology specifiers, resellers, and system integrators.
- LiFi deployment relies on the technology to be implemented by architects and building engineers.
- LiFi deployment will require the IT department’s management and staff buy-in.
- LiFi may be considered a managed smart green building service.
- LiFi government and military use of LiFi will provide highly secure communication.
- Finally, end users and building occupants will need education and training to utilize the technology.

GLOSSARY

Access Point (AP) is a device, such as a wireless router (either Wi-Fi or LiFi), that allows wireless devices to connect to a network. Most access points have built-in routers, while others must be connected to a router in order to provide network access.

Attocell a cellular LiFi network is an attocell network as the cell sizes are smaller than a typical radio frequency (RF) femtocell network, potentially unlocking very high area spectral efficiencies.

Binary (or base-2) is a numeric system that only uses two digits — 0 and 1. Computers operate in binary, meaning they store data and perform calculations using only zeros and ones.

LiFi (short for light fidelity) is wireless light-based communication technology that uses light instead of longer-wavelength radio waves to deliver data. Data are converted to light signals and transmitted by an LED lamp that sends the data at rapid speeds to the photodetector.

LiFi dongle is a small piece of hardware that allows a user device to communicate with LiFi lamps. A modulator transforms the data into a form that can be sent within the spectrum of the lamp. The dongle receives this signal and translates it into data for the devices.

LiFi multicell is the first-ever smart interference orchestrator. It can enhance existing solutions by supporting user’s mobility within a network of light sources to ensure optimal data rates among users. It automatically detects interference and optimizes data transmission rates for each peripheral.

Light Emitting Diode (LED) a light-emitting diode (a semiconductor diode that emits visible light when a voltage is applied).

Luminare a complete lighting unit consisting of a lamp or lamps mounted in a housing designed to distribute the light, to position and protect the lamps, and to connect the lamps to the power.

Microcontroller Unit (MCU) is a small computer on a single metal-oxide-semiconductor (MOS) integrated circuit chip. In modern terminology, it is similar to, but less sophisticated than, a system on a chip (SoC); a SoC may include a microcontroller as one of its components.

Network Interface Card (NIC pronounced “nick”) is a component that provides networking capabilities for a computer or device that communicates via a network.

Optical Wireless Communications (OWC) is a form of optical communication in which unguided visible, infrared (IR), or ultraviolet (UV) light is used to carry a signal.

Photodetector a device that detects or responds to incident light by using the electrical effect of individual photons.

Photon is a type of elementary particle. It is the quantum of the electromagnetic field including electromagnetic radiation such as light and radio waves, and the force carrier for the electromagnetic force (even when static via virtual particles).

Visible light is a form of electromagnetic (EM) radiation, as are radio waves, infrared radiation, ultraviolet radiation, X-rays and microwaves. Generally, visible light is defined as a portion of the electromagnetic spectrum with wavelengths that are visible to most human eyes.

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