National Conference on Recent Advances in Computer Science and IT (NCRACIT)
International Journal of Scientific Research in Computer Science, Engineering and Information Technology
© 2018 IJSRCSEIT | Volume 4 | Issue 1 | ISSN : 2456-3307

IoT Enabled by Li-Fi Technology

Sahil Nazir Pottoo[1], Tahir Mohammad Wani[2], Muneer Ahmad Dar[3], Sameer Ahmad Mir[4]

[1, 2, 3,4]Department of Electronics and Communication Engineering, BGSB University, Rajouri, Jammu and Kashmir, India
sahilpottoo294@gmail.com[1], tahir086991@gmail.com[2], darmuneer1@gmail.com[3], ersameerece@gmail.com[4]

ABSTRACT

Li-Fi is the high speed wireless communication technique through light emitting diodes (LEDs). Any light source anywhere can be turned into an operational Li-Fi (light) node that can communicate with the rest of the Li-Fi communication network and Internet infrastructure. Li-Fi node uses the light to enable internet users to communicate anytime anywhere in a greener, more secure, and safer manner. On the other hand, Internet of Things (IoT) emerges as a set of integrated technologies, new exciting solutions and services that are set to change the way people live. Evolution of IoT leads to the exponential growth of smart devices and sensors. These smart things require faster, secure, energy efficient data transmission. Li-Fi communication and networking technology can provide efficient and secure channel for ubiquitous communication in IoT networks. It can provide improved data rates with low energy consumption and therefore, can prove itself a true enabler of the Internet of Things.

Keywords: IoT (Internet of Things), Li-Fi (Light Fidelity), LEDs (Light Emitting Diodes)

I. INTRODUCTION

A key enabler for big data is big pipes, getting massive amounts of data to and from connected objects and machines. It is estimated that by 2020, we will be having 80 billion IoT devices generating about 44 zettabytes of data. Visible light communication (VLC) is a class of technologies for wirelessly transmitting and receiving information using light (from infrared, through visible, into ultra-violet visible light spectrum of about 400 THz to 800 THz) instead of radio waves. We investigate Li-Fi in the context of novel 5G technologies to solve the looming spectrum crisis in wireless communications [1]. It is, thus, possible to create small, low-complex transceiver units that enable any LED light to act as a high speed data transmitter. Li-Fi can compensate radio-frequency bandwidth shortage and is aimed at creating new communication channels with the help of existing technology. At the same time, Li-Fi signals are secure in that they cannot “leak out” of a space like radio signals do, and they can be blocked by simply putting the Li-Fi device (like a phone) in a pocket. In the present era, the number of devices that is connected to internet is increasing day by day. Due to high speed and security Li-Fi can be used to implement the connectivity in Internet of Things. Internet of Things (IoT) is a ubiquitous network where objects (things) are connected together to share data among them [2]. In IoT, devices have to connect instantly to carry out their tasks efficiently. To achieve this, a very wide bandwidth is required because any delay would make people’s lives at risk.

II. METHODS AND MATERIAL

A. Li-Fi

Li-Fi (Light Fidelity) is high speed wireless communication through light emitting diodes (LEDs). The term was first introduced by Prof. Harald Haas during a 2011 TEDGlobal talk. Li-Fi technology is

light based communication technology, which makes use of light waves instead of radio wave technology to deliver data [3]. This technology is specifically implemented to meet the needs in an easy way and to make nullify the issues from the existing technology of Wi-Fi. This technology mainly deals with the transmission of alphanumeric data using visible light communication (VLC) [4]. Li-Fi does not need line-of-sight (LoS). Li-Fi uses direct modulation without the need for intermediate frequencies (super-heterodyning) in RF systems. Moreover, it uses inexpensive optical components such as off-the-shelf LEDs and photodetectors. Li-fi uses LED light due to its many advantages such as long life, small volume, low power consumption and low heat radiation. Plus that LEDs can switch OFF or ON in very high speed that a human's eyes can't notice, so this gives a great opportunities for transmitting data. To explain how this unique technology works as shown in Fig. 1, firstly we use data from the internet and it is send to the server to LAM driver which have software code on it that confers the data to binary light flickers. LAM driver connects to LED. LEDs have a unique advantage that can flicker "OFF" or "ON" in very high speed. "ON" signifies a binary "1" and "OFF" signifies a binary "0". The frequency of these "ON" and "OFF" sequences is so high that the human eye can't see the light changing, so for us the light remains "ON" all the time. The photoreception receives these flickers and amplitudes them [5].

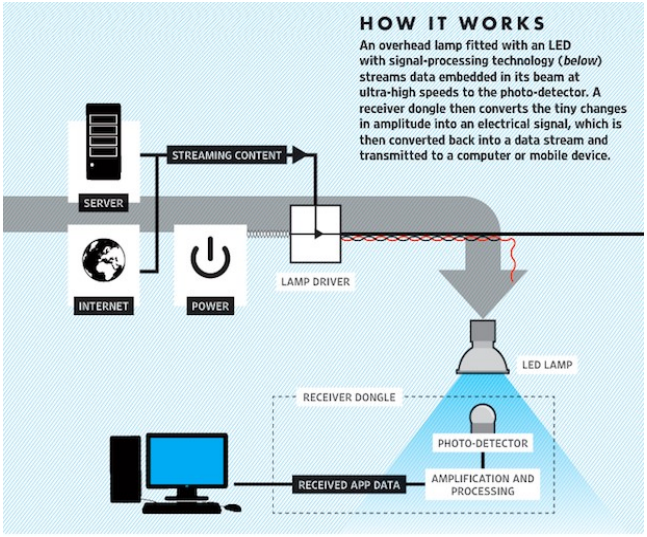

Figure 1. A Typical Li-Fi Working Scenario

The technology could even find a niche with consumers who fear the adverse effects of electromagnetic radiation, even if these are nonexistent, the perception of Li-Fi having a health advantage could turn into market momentum. Ultimately, however, the biggest impact of Li-Fi and its alternatives will not be from its present set of features. Within a few years, we expect to see it combining with other complementary technologies to create a new ubiquitous computing platform. Under this integration, every device large enough to mount an LED and a light sensor can be connected and even powered by Li-Fi. Any light bulb could include Li-Fi, a camera, microphone and speaker to function like an Amazon Echo, an unobtrusive, universal interface to the internet of everything.

B. IoT

One of the buzzwords in today's world is Internet of Things (IoT). The future is Internet of Things (Technological GOD), which will transform the real world objects into intelligent virtual objects. The IoT aims to unify everything in our world under a common infrastructure, giving us not only control of things around us, but also keeping us informed of the state of the things [6]. Even on business agenda when it comes to the internet of things, early adopters show a clear focus on customer services, followed by increasing single product revenue and efficiency optimization as shown in Fig. 2.

Figure 2. Impact of Internet Of Things On Business Agenda

In order to turn things to smart things in the internet of things, firstly, we need sensors which are small devices that detect or measure a signal or stimulus. Sensors collect information from the real life. Sensors usually use low power because they work for long

time. Usually sensors have analog input and convert it into digital data. On analysing cost of IoT sensors, one observes that their cost is falling considerably over time as shown in Fig. 3.

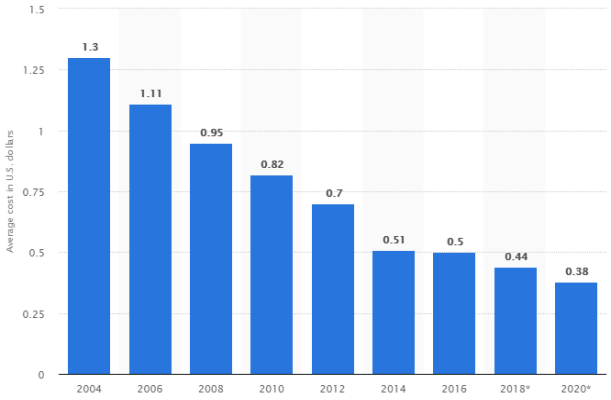

Figure 3. Average Sensor Cost Forecast Used In Internet of Things

Sensors do little processing so they need local processing device, sensors collect data and then send them to local processing device. Local processing is a device that collect data, process some data and make decision. Therefore, local processing device should have the necessary power to collect data, process data and make decision. We need to store data in local storage just in case of debugging or fail save. There will be incalculable number of data collected from sensors and need to store it locally. To provide connectivity for the internet of things we need internet and network. The main thing in internet of things is interconnected things. Internet connect local processing devices and send data over to the cloud processing. Cloud job is aggregate sensor and make inferences and store the data on long term, so this is the main part of internet of things.

III. RESULTS AND DISCUSSION

Li-Fi in IoT

With a rapid increase in the number of connected devices, some challenges appear which will be responded by increasing capacity and by improving energy efficiency, cost and spectrum utilization as well as providing better scalability for handling the increasing number of the connected devices. For the vision of all-communicating world relative to today's network, the overall technical aim is to provide a system idea that supports:

- 1000 times increased data volume per area
- 10 to 100 times increased number of connected devices
- 10 to 100 times increased typical user data rate
- 10 times extended battery life for low power Massive Machine Communication (MMC) devices
- 5 times reduced End-to-End (E2E) latency

IoT would fit well and well in Li-Fi and be enabled by it. IoT needs multiple access points and this is easily done in Li-Fi since simple light bulbs are used and these can technically be any number of access points. Li-Fi would improve IoT to becoming a ubiquitous network because it could be installed anywhere users might like light and data services: bus shelters, train stations, street lights, tourist information kiosks could all provide data transmission as well as light [8]. IoT can be enabled by Li-Fi in indoor communication for it has a small range of coverage compared to Wi-Fi. Undersea, things connected to above sea level, will continue connectivity because light reaches undersea. There would be innumerable benefits of IoT enabled by Li-Fi technology as follows:

1. Signaling

A reliable bidirectional signaling is very important with IoT connected devices to make the routing data easy. Data needs to be shared between two points in a fast, secure and reliable way. Li-Fi is bidirectional where visible light and infrared are used in downlink and uplink respectively. Even Hybrid Li-Fi, a network structure that combines Li-Fi with the conventional radio frequency (RF) system is considered.

2. Security

Security is a very important factor in IoT's connectivity. When sending or receiving a stream of data, it is essential to make sure that the IoT device or server has a correct authorization to send or receive the data. An IoT device is dangerously defenseless when it's about an open port out to the Internet. Therefore, an end to end encryption

between IoT devices is needed. In contrast to radio frequency waves used by Wi-Fi, lights cannot penetrate through walls and doors. This makes it more secure and makes it easier to control who can connect to a network.

3. Spectrum usage

The visible light spectrum is 1,000 times larger than the entire 300 GHz of radio, microwave and millimeter wave radio spectrum, so there is a big untapped reservoir of resources for wireless systems. The current and future growth of wireless data traffic will mean that the radio frequency spectrum will not provide sufficient resources by 2025. Phosphor coated white LEDs which are mostly used in all commercial lighting devices can deliver up to about 100 Mbps. Unipolar Orthogonal Frequency Division Multiplexing (U-OFDM) based Li-Fi scheme provides the opportunity of high speed data transmission along with room illumination. Thus, providing enough bandwidth to accommodate large number of IoT devices.

4. Omnipresent Detection

It is the ability to know immediately when an IoT device drops off or connects to the network. Omnipresent detection gives an exact state of all devices connected to a network. Li-Fi has the ability to monitor IoT devices and fixes any problems that may arise within the network. Hence, Li-Fi improves the reliability of Internet of Things.

5. Power consumption

Sending data among IoT devices takes a toll on power and CPU consumption. LEDs are low power devices and hence power consumption is considerably reduced in Li-Fi. It's more energy-friendly than Wi-Fi, which requires power-hungry masts. If photodetectors used are solar cells, then it might be possible to use wireless battery charging and wireless Internet simultaneously.

6. Massive machine communication (MMC)

Massive machine communication (MMC) will form the basis of the Internet of Things with a wide range of application fields including the automotive industry, public safety, emergency services and medical field. The Massive MIMO system operated under visible light spectrum offers large bandwidth for its operation.

7. Li-Fi everywhere

Vehicles could communicate with one another through front and back lights to increase road safety. Also street lights and traffic signals could also provide information about current road situations as shown in Fig. 4. Most Remotely Operated Underwater Vehicles (ROVs) use cables to transmit command, but the length of cables then limits the area ROVs can detect. However, as a light wave could travel through water, Li-Fi could be implemented on vehicles to receive and send back signals. Li-Fi facilitates data connection in closed, controlled environments such as aircraft cabins as light wave does not interfere with radio frequency signals.

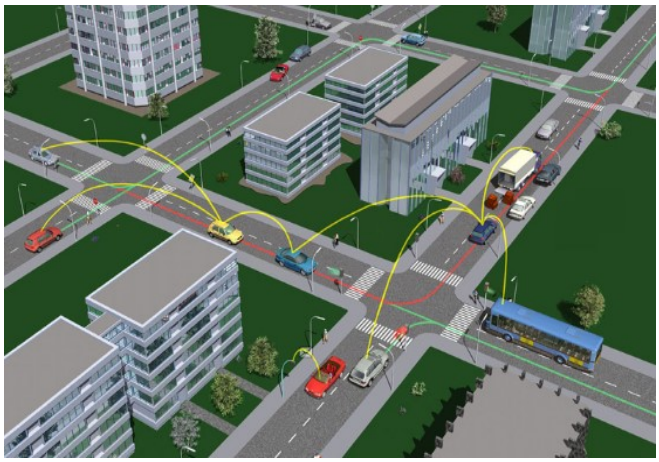

Figure 4. Li-Fi enhancing automobiles connectivity and road safety

IV. CONCLUSION

As this paper has demonstrated, Li-Fi is a promising technology that can be used to provide affordable wireless technology access to unreachable areas, where light can reach. The throughput set to be achieved by Li-Fi technology shows that Li-Fi is the perfect tool in IoT networks as it (Li-Fi) offers higher speed compared to conventional Wi-Fi. Though it offers high-speed, IoT systems are not constraints

exempt, some challenges arise such as security, signaling and omnipresent detection. With Li-Fi, IoT systems can overcome signaling and security related challenges and with a proper monitoring of IoT systems connected over LiFi, the omnipresent detection can be tackled. The features of not passing through walls, less radiation, and the possibility of having a good number of access points make Li-Fi suitable for IoT.

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