IJCSE International Journal of Computer Sciences and Engineering Open Access
Research Paper Vol.-6, Issue-8, Aug 2018 E-ISSN: 2347-2693

Wi-Li-Fi an Innovative Wireless Network Architecture for Future IOT Applications

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Available online at: www.ijcseonline.org

Accepted: 16/Aug/2018, Published: 31/Aug/2018

Abstract- Wi-Fi plays an important role in the current scenario. The whole world runs at the back of Wi-Fi technology for their seamless data connectivity. As the usage increases more and more the technology steps back in his performance slightly. The performance is based on the uninterrupted connectivity, the speed of data transfer and the network traffic. Researchers say Light Fidelity (Li-Fi) uses light emitting diodes (LEDs) for high-speed wireless communications. VLC (visual light Communication) is the channel for Li-Fi to transmit data nearly 200 Gigabits/sec. Since employing a different range of the electromagnetic spectrum from radio frequency (RF) communications, Li-Fi (Light Fidelity) enters in this phase of Wi-Fi to take part in the performance based upon the speed of data transfer. Hence, a combination of Li-Fi and RF networks becomes a challenging work in future indoor wireless communications. Thus the backdrops of both Li-Fi and Wi-Fi are complementing each other by their performance. Wi-Fi is used for uplink and Li-Fi can be used for downlink. With this strategy, all researchers have focused in this area by integrating the Wi-Fi and Li-Fi for seamless data transmission especially in the indoor environment. This hybrid can be called easily abbreviated as Wi-Li-Fi. There are many challenges combining the both different types of networks. A newly Hybrid Wi-Li-Fi network is proposed and its performances are compared with standalone Li-Fi and Wi-Fi networks, metrics such as Throughput, Energy consumption and data loss, when the end users are at different distance from the Access point.

Keywords **–**Li-Fi, Wi-Fi, VLC, RF, IOT

I. INTRODUCTION

Wi-Fi stands for Wireless Fidelity includes IEEE 802.11a/b/g standard. It is used for Wireless Local Area Networks (WLAN). It is used to broadcast the internet with high speed when connected to an access point (AP) or an ad-hoc mode. The use of WiFi today is summed up nicely by Rethink Wireless: "Wi-Fi performance continues to improve and it's one of the most ubiquitous wireless communications technologies in use today. It's easy to install, simple to use and economical too. WiFi Access Points are now set up at home and in public hotspots, giving convenient internet access to everything from laptops to smartphones. Encryption technologies make WiFi secure, keeping out unwanted intruders from these wireless communications.

Light Fidelity or Li-Fi, is an exciting breakthrough in 5G visual light communication systems and the future of wireless Internet access. In future 23 DVDs, Li-Fi uses light from LED bulbs to transmit internet data instead of the radio waves. The LED light bulbs flicker extremely quickly to emit a frequency of light that can transmit data at incredible speeds up to 200 Gigabits per second, which is tremendously fast. Research says Li-Fi allows speeds that are 100 times faster than WiFi. Light-emitting diode (LED) bulbs, transmit data when they are switched on and off so rapidly in nanoseconds, that the human eye cannot see it. This data is registered by special equipment, making it possible to provide wireless Internet connectivity at a current experimental speed up to 10 Gbps, which is estimated to be 250 times faster than 'superfast' broadband. The vast availability of LED light bulbs will drive the future ubiquity of connectivity even in places where Wi-Fi cannot work in an airplane, submarines etc. The following sections are organized as section II talks about co-existing techniques present by many researchers, Section III explains working principle of new technology Li-Fi, Section IV discuss about proposed architecture called Wi-Li-Fi, section V depicts the simulation results and finally with conclusion and future enhancements.

II. RELATED WORK

The advent of smartphones, tablets, and many other devices has made mobile information access a central feature of our

lives. It is estimated that more than 11 Exabyte of data traffic will be transferred through mobile networks every month by 2017 [1], which pushes the radio frequency (RF) based wireless technologies to their limits since the spectrum allocation chart has showed that most spectrum has already been allocated under license [2]. In order to accommodate more users and more data traffic, several promising solutions have been proposed. They can be classified into three groups: (1) exploring spatial resources to improve spectrum utilization, (2) establishing heterogeneous networks (HetNet) with small cells to reuse bandwidth, (3) searching for more available spectrum resources, such as millimeter waves or wireless optical bandwidth. Among the above possible solutions, visible light communication (VLC), which uses wireless optical in the wavelength interval of 380–780 nm has received much research interests recently. Recently, VLC has also drawn increasing attentions from the industrial circles and standardization organizations To offload traffic from cellular networks, the term ‘‘Light fidelity (Li-Fi)’’ which borrows the name from Wi-Fi is introduced as a subset of VLC that exhibits the high-speed, bidirectional, and fully networked communications. This term was first used by Harald Haas in his TED Global talk on VLC, and the Li-Fi Consortium was formed in Oslo, Norway in 2011 with the purpose of providing a high speed and wireless optical network [7]. However, there are several challenges to construct a Li-Fi. First, the general intensity modulation of VLC is to carry binary data by turning LED on and off quickly, in which the amplitude and phase information are lost. Accordingly, inappropriate modulation formats may lead to flicker and color variation which can largely influence the human moods. Second, the lack of multipath fading makes the optical channels strongly correlated, therefore receive diversity is hard to be achieved and traffic may be susceptibly interrupted. Third, although Li-Fi using illumination sources is naturally suited to broadcast applications, it is hard to provide the optical uplink services. It will interfere with the downlink signal and the receiver antenna must direct to the VLC TX even when mobile terminals (MTs) are moving. Fourth, optical channel will be easily influenced by the blockage of objects and suffered by shadowing. Therefore, it is necessary to have link recovery as well as handover mechanisms to be compatible with the mobile scenarios. Last but not least, the coverage of Li-Fi is limited within the opaque space. Hence, the seamless coverage is a critical issue which is worth further investigation. For providing both illumination and seamless communication coverage, attocell architecture has been proposed, which is referred from cellular network as the cell sizes are smaller than in a typical RF femtocell network. Every LED light bulb in attocell Li-Fi network is treated as an access point and an illumination source for covering a limited region or one room. In this context, Li-Fi is shown potentially to provide at least an order of magnitude improvement in the area spectral efficiency (ASE) as compared to the femtocell system [7]. It is due to the fact that there is no interference from one room to another since light does not propagate through walls unlike RF signals. In this paper we consider some of the most relevant recent works addressing present challenges. The paper is organized in explaining the Li-Fi Network working principle, Wi-Li-Fi architecture to improvise the performance of the data transmission.

III. HOW LI-FI WORKS

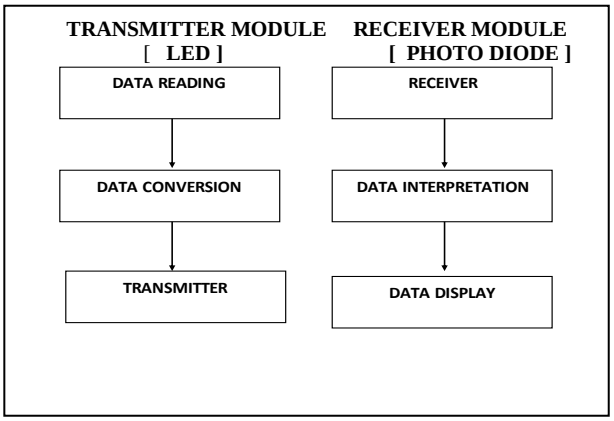

Figure 1: Li-Fi module

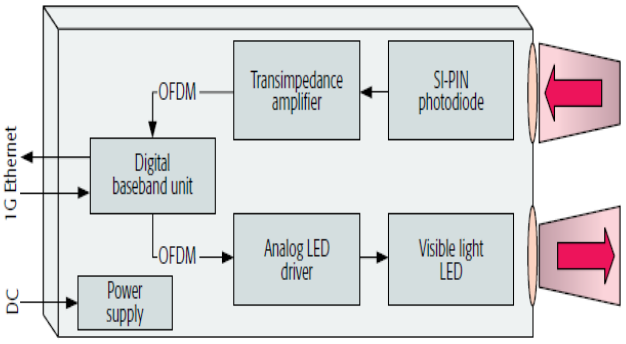

Figure 2

Figure1 represents the simple block diagram of the Li-Fi working principle. Data Conversion Module converts data into bytes so that it can be represented as a digital signal. This module is use to include the security of the data. Transmitter Module generates the corresponding on-off pattern for the LEDs. Receiver Module – has a photo diode to detect the on and off states of the LEDs. It captures this sequence and generates the binary sequence of the received signal. Data Interpretation Module converts data into the original format. This simple scheme can improvise the data transmission in more secure manner when the Li-Fi is integrated with Wi-Fi .The Digital Baseband unit in Figure 2 replaces the data conversion module where data is modulated and demodulated with OFDM (Orthogonal Frequency

Division Multiplexing) which is found more effective in Li-Fi.

IV. WI-LI-FI –ARCHITECTURE

LED-based indoor VLC has attracted great attention in recent years due to its innate physical properties including energy efficiency and lower operational cost compared to conventional Incandescent and fluorescent lighting [5]. Current research on VLC focuses mainly on physical (PHY) layer techniques such as dimming support, flicker mitigation, and advanced modulation schemes [6]. These efforts seek to achieve the highest data rates possible. However, higher-level networking topics must be addressed to enable interoperability in any practical network deployment. [4] Proposed that A hybrid solution in which the uplink challenge is resolved by the use of an asymmetric RF-VLC combination is proposed. VLC is used as a downlink; RF is used as an uplink, and the hybrid solution realizes full-duplex communication without performance glare or throughput degradation expected in an all-VLC-based approach. Experiments with the implemented prototype reveal that the integrated system outperforms conventional Wi-Fi for crowded (congested) multiuser environments in term of throughput; and demonstrate functional access to full-duplex interactive applications such as web browsing with HTTP .Based on the above works a new model is proposed as shown in figure3.

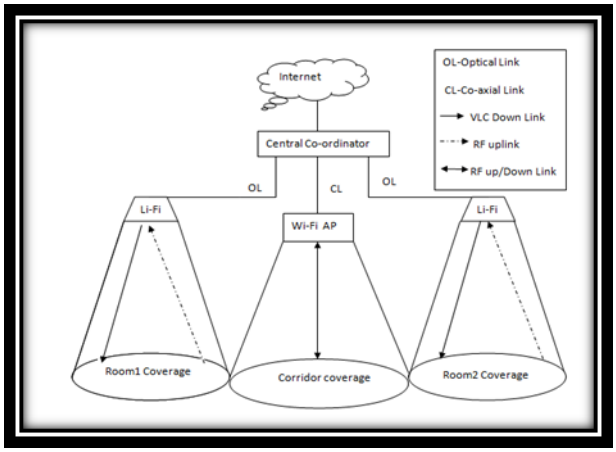

Figure 3. General Wi-Li-Fi Hybrid Network model

which illustrates the Wi-Li-Fi hybrid network model for the indoor premises is proposed. The Department of Computer Science and Engineering, Manonmanium Sundaranar University, Tirunelveli, Ground floor Premises is taken as a Experimental area is taken for the study. It consists of a central coordinator which acts as switching device cum access point for both Wi-Fi and Li-Fi Network which in turn is connected to the Internet. The Li-Fi network uses the optical link(1gbps) as the transmission medium and the Wi-Fi network uses the Coaxial Cable(10 Mbps) as the transmission medium. The users in the Room1 and Room2 accessing the Li-Fi network uses the RF as uplink and VLC as down link for their transmission and the users in corridor area of the premises uses both RF up/down link for data Transmission.

V. SIMULATION OF WI-LI-FI MODEL

Based upon the study of all the Researches made so far there are some parameter to be considered and the work should be focused more towards that area in future for implementing a Hybrid Wi-Li-Fi network.

From the Table 1 the Wi-Li-Fi architecture has been noted to perform less compare to Li-Fi considering only some parameters.. A simple Graphical representation shows how the parameters. Throughput, Energy Consumption., Data Loss may vary when the distance between the end users are not in a stable distance.

Table 1: Comparison of Li-Fi and Wi-Li-Fi

Parameter	Wi-Fi	Li-Fi	Wi-Li-Fi
Throughput	Low	High	Medium
Pow consumption	High	Less	High
Health hazardous	High	Low	Medium
Data Loss	Low	Very Low	Very Low
Energy consumption	high	Low	medium

Table 2: % of performance of networks based on throughput

Distance(in m)	Wi-Fi(in %)	Li-Fi (in %)	Wi-Li-Fi(in %)
5	100	100	100
15	90	100	90
25	80	90	85
35	70	80	75

From the Table2 the throughput of the Li-Fi and Wi-Fi decrease as the distance between the end user increases. Hence the Wi-Li-Fi network will eventually decrease.

Table 3: % of performance of networks based on energy consumption

Distance(in m)	Wi-Fi(in %)	Li-Fi(in %)	Wi-Li-Fi(in %)
5	30	10	40
15	50	30	80
25	80	90	95
35	90	100	100

From the Table 3 the power consumption is less in short distance for both Li-Fi network and Wi-Fi network whereas as the distance increases the energy is reduced and hence the power consumption increase, which proportionally increases more in Wi-Li-Fi network as the hopping between two network will increase the power consumption. The same implies to the Table 4 also.

Table 4: Performance of networks based on data loss

Distance (in m)	Wi-Fi(in %)	Li-Fi(in %)	Wi-Li-Fi(in %)
5	0	0	0
15	10	0	10
25	20	50	35
35	50	60	65

From the Table 2,3,4 it has been inferred that by average Wi-Li-Fi outperforms both Wi-Fi and Li-Fi.

VI. CONCLUSION

Apart from incredible internet speeds, Li-Fi has significant benefits. Li-Fi is more secure than Wi-Fi because light can't go through walls like Wi-Fi radio signals can Researchers are seeing Li-Fi as a solution in places where Wi-Fi signals create interference with equipment. It would be great in hospitals, for example, as Li-Fi wouldn't interfere with wireless medical equipment like Wi-Fi signals can. Thus Wi-Li-Fi overcomes all the Wi-Fi Challenges and both Li-Fi and Wi-Fi complement each other. Thus a General Wi-Li-Fi Hybrid Network model is proposed and its performance are analyzed based on all the previous research. When Integration of two networks is done there are many other challenges to be focused specially network handover on mobility, data transmission on the move is focused, Routing methodology and various other parameters are to be analyzed from previous research.

Future Enhancements

The key issue taken here is to propose a hybridized hazardous Wi-Li-Fi Architecture that can be upward compatible to the existing Wi-Fi communication Fabric, so that basic operations of Communication, Location and activity tracking may be possible with lesser communication overhead and cost. Most of the IOT Application may run based on the Proposed Wi-Li-Fi Model in future.

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