IJARCCE

ISSN (Online) 2278-1021
ISSN (Print) 2319 5940

International Journal of Advanced Research in Computer and Communication Engineering
ISO 3297:2007 Certified
Vol. 5, Issue 9, September 2016

High Speed Wireless Data Transmission Using LEDs (Light-Fidelity)

M. Rama Krishnan[1], Dr. M. Rajasenathipathi[2]

Research Scholar, Department of Computer Science, N.G.M, College, Pollachi, India[1]

Assistant Professor, P.G. Department of Computer Applications, N.G.M, College, Pollachi, India[2]

Abstract: Whether you’re using wireless internet in a coffee shop, stealing it from the guy next door, or competing for bandwidth at a conference, you’ve probably gotten frustrated at the slow speeds you face when more than one device is tapped into the network. As more and more people and their many devices access wireless internet, clogged airwaves are going to make it increasingly difficult to latch onto a reliable signal. But radio waves are just one part of the spectrum that can carry our data. What if we could use other waves to surf the internet? One German physicist, DR. Harald Haas, has come up with a solution he calls “Data Through Illumination”—taking the fiber out of fiber optics by sending data through an LED light bulb that varies in intensity faster than the human eye can follow. It’s the same idea behind infrared remote controls, but far more powerful. Haas says his invention, which he calls D-Light, can produce data rates faster than 10 megabits per second, which is speedier than your average broadband connection. He envisions a future where data for laptops, smart phones, and tablets is transmitted through the light in a room. And security would be a snap—if you can’t see the light, you can’t access the data. Li-Fi is a VLC, visible light communication, technology developed by a team of scientists including Dr Gordon Povey, Prof. Harald Haas and Dr Mostafa Afgani at the University of Edinburgh. The term Li-Fi was coined by Prof. Haas when he amazed people by streaming high-definition video from a standard LED lamp, at TED Global in July 2011. Li-Fi is now part of the Visible Light Communications (VLC) PAN IEEE 802.15.7 standard. “Li-Fi is typically implemented using white LED light bulbs. These devices are normally used for illumination by applying a constant current through the LED. However, by fast and subtle variations of the current, the optical output can be made to vary at extremely high speeds. Unseen by the human eye, this variation is used to carry high-speed data,” says Dr Povey, Product Manager of the University of Edinburgh's Li-Fi Program ‘D-Light Project’.

Keywords: Wireless-Fidelity (Wi-Fi), Light Fidelity (Li-Fi), Light Emitting Diode (LED), LDR (Light Dependent Register).

1. INTRODUCTION

Communication is one of the integral parts of anybody’s life for exchanging information on devices in wired or wireless networks. With the introduction of new mobile devices, wireless communications have become the basic necessity of the lives.

Commercially, the Wi-Fi as the wireless communication standard. Similarly, Li-Fi (Light-fidelity) is also wireless communication system based upon Visible Light Communication with higher data rate than Wireless Fidelity (Wi-Fi). Due to increasing demand for wireless communications, Wi-Fi is facing many challenges namely-capacity, availability, efficiency and security. So, the term “Li-Fi” in TED Global talk on visible light communication, to limit these challenges faced by Wi-Fi.

LiFi is a wireless optical networking technology that uses light-emitting diodes (LEDs) for data transmission. Li-Fi is designed to use LED light bulbs similar to those currently in use in many energy-conscious homes and offices. However, Li-Fi bulbs are outfitted with a chip that modulates the light imperceptibly for optical data transmission.

Figure 1: Beam of LED‟s

Li-Fi data is transmitted by the LED bulbs and received by photoreceptors. LiFi's early developmental models were capable of 150 megabits-per-second (Mbps). Some commercial kits enabling that speed have been released. In the lab, with stronger LEDs and different technology, researchers have enabled 10 gigabits-per-second (Gbps), which is faster than 802.11ad. They can be switched on and off very quickly, which gives nice opportunities for

IJARCCE
ISSN (Online) 2278-1021
ISSN (Print) 2319 5940
International Journal of Advanced Research in Computer and Communication Engineering
ISO 3297:2007 Certified
Vol. 5, Issue 9, September 2016

transmitted data. It is possible to encode data in the light by varying therate at which the LEDs flicker on and off to give different strings of 1s and 0s. 1 Most of us are familiar with Wi-Fi (Wireless Fidelity), which uses 2.4-5GHz RF to deliver wireless Internet access around the homes, schools, offices and in public places. To 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). This is a good match to the speed of most current Internet services, but insufficient for moving large data files like HDTV movies, music libraries and video games.

2. LI-FI SYSTEMS

Li-Fi is well-defined as the networked, mobile, high-speed VLC solution for wireless communications. To facilitate pervasive indoor wireless access, each Li-Fi system requires:

High speed:
The exponential growth of wireless data demand is not only due to the growing number of users, but also the availability of high-rate downlink services, such as video streaming and file download—both of which require large amounts of bandwidth. Li-Fi systems, therefore, must be high-speed to maintain currently offered network services and user expectations.

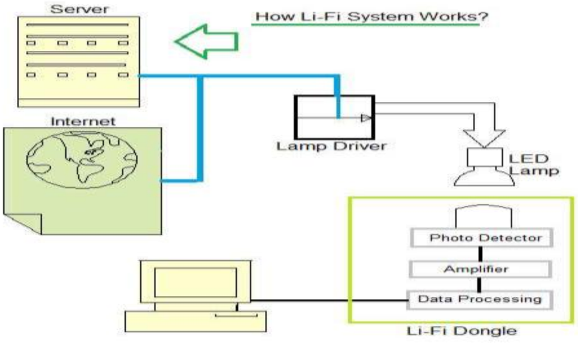

Fig 2.Li-Fi system work

Bi-directionality:
To provide modest Internet access, there must be a reverse link from the device to the network which allows the device to request and/or modify information—and in a large data crazed world — upload photos and videos. Thus, bi-directional communication is essential for full network operation and a user friendly experience.

Multiple Accesses:
RF networks to serve an abundant volume of users, each cellular base station (BS) (100's of mobile users) and each Wi-Fi access point (AP) (10's of user devices) shares its time and/or frequency resources among the connected parties. Given that a defined area, theoretically housing multiple users/devices, could be illuminated by single luminaries, adding Li-Fi to the light will necessitate a similar sharing of resources. This is called multiple access, it is needed to extend wireless access to all desired use rs within the illuminated space, and hence the network.

Mobility/Handover:
Finally, due to the inherent directionality of light (as opposed to RF signals), any space (generally indoor, but also outdoor) that is to be illuminated needs several light fixtures to sufficiently cover the area. Since in a Li-Fi network every light source is a wireless AP, it is essential for network operation that the communications link is unbroken while a user is moving: the network must hand-over the user from one AP to the next. Without such functionality, a mobile user will need to constantly re-establish connection with each network AP, and re-start its running information transfer on the device

3. APPLICATIONS OF LI-FI

Applications of Li-Fi can broaden in areas where the Wi-Fi technology lacks its potential like medical technology, power plants, underwater applications and other diverse areas. All the street lamps can be converted to Li-Fi lamps to transmit data and information [12]. Some of the future applications of Li-Fi are as follows.

Internet everywhere:
Street lamps, vehicular headlights can be modified by LEDs to access internet anyplace in public footpaths, roads, malls, etc. where light source is available.

Underwater ROV's:
One of the applications of the Li-Fi is in under-water ROVs, those beloved toys of treasure seekers, function from huge cables that provide them power and permit them to collect signals from their pilots above. ROVs work great, except when their hop isn't extended adequate to investigate an area or when it gets jammed on something. If their wires are cut and substituted with light – say from some submerged, high-powered lamp – then they would be much freer to explore. They could use their headlamps to keep in touch with each other, analyzing data autonomously and referring their findings from time to time back to the surface. Li-Fi even works underwater where Wi-Fi completely fails, thereby giving open everlasting opportunities for military operations.

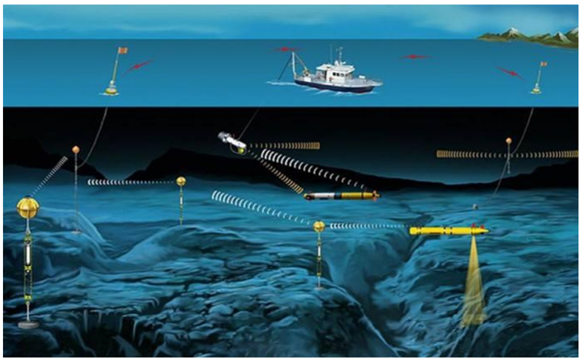

Fig 3. Underwater communication

Health sector and medical applications:
As Wi-Fi is harmful to be used in hospitals and at other several health care areas as it can penetrate through human body *18+. Wi-Fi is prohibited in operation theatres (OTs) because of its radiation effect. Wi-Fi signals intervenes with the tablets & personal computer (PCs) which interrupts the signals for monitoring gadgets. Li-Fi technology can be helpful for accessing internet and in medical equipment's. This can also be useful in robotic surgeries and other automatic procedures.

Fig 5. Healthcare center

Traffic control:
Li-Fi can be used in traffic control wherein data can be exchanged among vehicles and traffic lights to improve road safety. It can also be used to revise traffic information at roughly every instant and it will be trouble-free for traffic police to pact with traffic and catch the one who disobeys the rules. In traffic signals, Li-Fi can be used which will communicate with the LED lights of the vehicles which can help in organization of the traffic in an improved way and the accidents can be avoided [1].

Inter Vehicle Communication:
Vehicles headlights and their headlights are gradually being substituted with LED's. This offers the hope of vehicle-to-vehicle communication through Li-Fi, and thus allowing development of the anti-collision systems and swap over of the information at time of driving between vehicles. Traffic lights now already use LED lights, so that there is also the vision presented of city wide traffic organization systems [2].

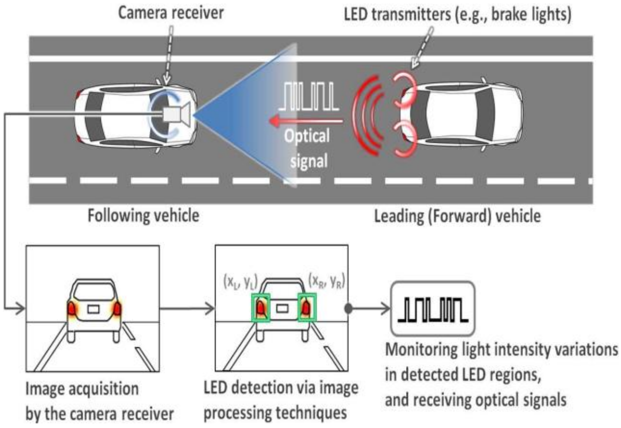

Fig. 6. V2V communication system. [3]

Replacement for other technologies:
Li-Fi doesn't work using radio waves. So, it can be easily used in the places where Bluetooth, infrared, Wi-Fi, etc. are banned.

4. ORTHOGONAL FREQUENCY DIVISION MULTIPLEXING

Multipath propagation is the main cause for signal fading in radio reception. The problem is exaggerated, if the receiver and/or the transmitter is/are mobile as the added dimension of mobility will introduce more sever temporal characteristics of the channel. In frequency selective fading, part of the frequency band will experience severe attenuation while in others the response may be enhanced. If the signal is narrowband and falls within a band where attenuation is high, it will result in a significant reduction of the received SNR.

If the bandwidth of the signal is less than the coherence bandwidth of the channel, the distortion is minimized and this is called a frequency flat or a 'flat' fading channel. However there is a significant chance that the signal will be subject to severe attenuation on some occasions, i.e. temporal fading. A wideband signal will experience more distortion, but will suffer reduced variations in terms of the total received power. OFDM overcomes multipath propagation by transmitting a large number of narrow band digitally modulated signals over a large bandwidth. Consequently, each channel experiences 'flat' fading.

Consider a typical channel with a deep null in the frequency response. A single carrier system, such as QAM, will need some form of time domain equalization. Linear equalization will increase noise, while a Decision Feedback equalizer (DFE) will be more complex and its ultimate performance is limited by error propagation. A Maximum Likelihood Sequence Estimator (MLSE) will be even more complex. Since multicarrier systems, such as OFDM, approximate a constant transfer function for each sub-channel, equalization becomes very simple. Recently there have been proposals to use frequency domain equalization for SC systems (SC/FDE), for example [3, 4, 5]. The complexity of the SC/FDE system is similar to the OFDM system, but the method requires training symbols (also known as unique words) to be sent periodically to train the equalizers. Other advantages of MTM methods are the reduced effects of impulsive noise as a result of the extended symbol duration, the flexibility to not transmit in corrupted sub-channels in the case of narrowband interference and the ability to transmit important data in sub-channels with a high SNR. If the frequency separation between the sub-channel carriers, Δf is chosen to be 1=T , where T is the symbol duration of the sub-channel carriers, then the complexity can be minimized by using FFT techniques for implementation.

The receiver may be viewed as a bank of demodulators translating each sub-channel carrier to baseband and integrating over the bit period. The sub-channel carrier

IJARCCE

ISSN (Online) 2278-1021
ISSN (Print) 2319 5940

International Journal of Advanced Research in Computer and Communication Engineering
ISO 3297:2007 Certified
Vol. 5, Issue 9, September 2016

frequencies are selected such that the sub-channel spacing is an integral multiple of symbol periods (i.e. the carriers are orthogonal over the symbol period). Thus when integrated over the bit period, the other carriers yield a zero contribution.

5. VISIBLE LIGHT SYSTEM MODEL

The main building blocks of an OFDM-based transmitter and receiver systems are illustrated in Fig. 7. Since OFDM is based on IFFT and FFT algorithms, the implementation on the DSP is straightforward. On the OFDM T_x board, Forward error correction (FEC) coding is based on a rate 1/2 convolution encoder. A time inter leaver is applied. At the receiver, Viterbi decoding with hard decision output is used.

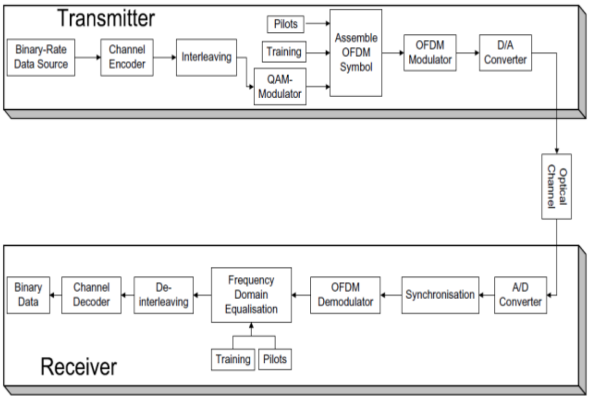

Figure 7: Visible light OFDM transmission model

In general a time varying, flat fading channel is assumed. It is further assumed that the channel remains constant within one OFDM frame. Since, however, no well established models for this particular propagation system exist; some over provisioning in the system design is accepted. With this approach the above made assumptions are to be confirmed.

For the purpose of channel estimation and synchronization, training sequences and pilots are used [6, 7]. Concretely the OFDM frame as implemented in the experimental system is formed by a time synchronization signal (sinusoidal signal), four OFDM symbols for the training sequence, and 20 OFDM symbols with data sub-channels carrying the modulated information (see Fig. 8). The channel transfer factors are obtained using the training sequence and averaging over the four training sequence periods for every subcarrier.

In addition, pilots at specific sub-channels are added to correct the residual channel estimation and synchronization errors. A cyclic prefix of fixed length is added to the transmitted signal. Root raised cosine pulse shaping filters with a roll-off of 0.2 are used at the transmitter and receiver. Frequency domain equalization is realized using conventional OFDM zero-forcing (ZF) detection. With the particular implementation the high PAR in OFDM is exploited to intensity modulate the white LED. Therefore, only real valued signals can be transmitted. This is accomplished by dividing the OFDM symbol in two halves. The second half carries the conjugate complex copy of the first half. As a consequence, after the IFFT operation, only real valued samples are obtained. These samples are fed into the root raised cosine pulse shaping filter and the resulting signal is then D/A converted.

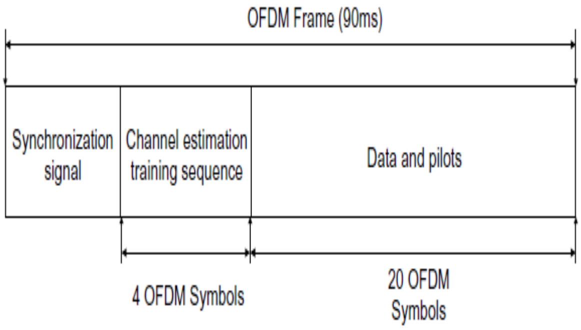

Figure 8: OFDM frame structure: Four OFDM symbols carrying a training sequence are used for channel estimation. The data symbols are transmitted in the consecutive 20 OFDM symbols. Each of these symbols uses four subcarriers for pilot transmission.

6. OPTIMAL RESOURCE ALLOCATION WITH PROPORTIONAL FAIRNESS

The DF relaying, if a sub-channel is assigned a relaying path for a user, the BS transmits during the first sub-frame while a RS listens; and if the RS can decode the source message successfully, it re-encodes the message and then forwards it to the user during the second sub-frame. However, for a direct path, the BS transmits data to the destined user during both sub-frames. Therefore, the BS is always in the transmitting mode during downlink frames while all users are always in the receiving mode. Only RSs need to change their modes between receiving and transmitting when a sub-frame starts.

First formulate the instantaneous resource allocation into an optimization problem which can achieve proportional fairness in the long-term. Proportional fairness provides a reasonable function to trade the total system throughput with users' fairness. The problem is a NP-hard combination optimization problem with non-linear constraints.

To reduce the computational complexity on solving the problem, it assume a constant uniform power allocation to line arise the problem, and then use a void filling method to fulfill any unoccupied resource caused by unbalanced data rates on the two hops of a relaying path. Combining the constant power allocation and voiding filling, to propose a low-complex resource allocation algorithm named 'VF w PF'. Moreover, to solve the original

IJARCCE
ISSN (Online) 2278-1021
ISSN (Print) 2319 5940
International Journal of Advanced Research in Computer and Communication Engineering
ISO 3297:2007 Certified
Vol. 5, Issue 9, September 2016

problem is first introduce some new variables, and then use continuous relaxation and a dual decomposition approach to solve the primary problem efficiently in the Lagrangian dual domain. A modified iterative water-filling algorithm named ’PA w PF’ is proposed to find the optimal joint path selection, power allocation and sub-channel scheduling under the proportional fairness.

7. FRAME STRUCTURE

In frame-based networks, the timeline is divided into consecutive frames, each of which further consists of a downlink (DL) sub-frame and an uplink (UL) sub-frame. Figure 6 illustrates a multi-hop MAC frame structure which is proposed for relay enhanced IEEE 802.16 networks. MS can compete for transmission opportunities in the uplink sub-frame. The standards such as 802.16j define the mechanism on how to compete and how to avoid collision in the uplink. After a MS gets a transmission opportunity successfully, it can send the QoS requirements gathered from applications to the BS, and then the BS can allocate resources according to users’ requirements.

A DL sub-frame is further divided into two subframes since the cooperative selection diversity works in the half-duplex relaying pattern. In the downlink direction, BS first broadcasts a control message, which contains a DL-MAP and a UL-MAP messages. With these mapping messages, single-hop users and RSs are notified of the corresponding resources assignments. After receiving messages successfully during the DL subframe 1, each RS converts from receiving mode to transmitting mode in a time gap, and then broadcasts its control message at the beginning of the DL subframe 2, which also includes a mapping message, with which every two-hop user gets the resource allocation information.

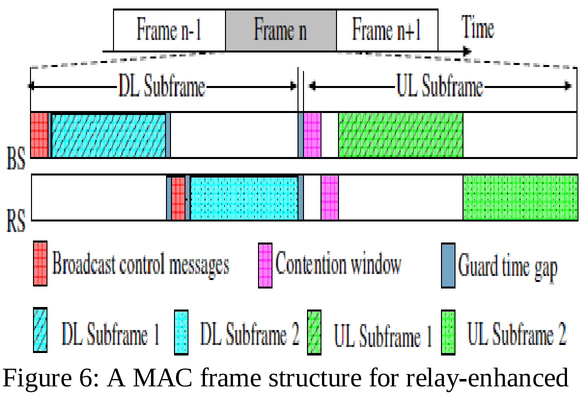

Figure 6: A MAC frame structure for relay-enhanced IEEE 802.16 networks.

8. OPTIMIZATION APPROACHES VS. HEURISTIC SOLUTIONS

Resource allocation in OFDMA relay-enhance cellular networks including power allocation, path selection, and slot or sub-channel scheduling, can be formulated into an optimization problem with an objective to optimize system performance such as the sum-rate maximization, proportional fairness and so on. However, under different assumptions, the problem formulation has different constraints. One way to solve the problem for optimal resource allocation is using optimization approaches such as dual decomposition, sub gradient method and so on. However, most optimization problem for resource allocation in OFDMA relay-enhanced networks are very difficult to be solved by using optimization approaches, some efficient heuristic solutions need to be finding to achieve sub-optimal allocations.

9. CONCLUSION

The objective of the research work is to maximize energy efficiency (EE) under the constraints of the overall transmit power of each remote access unit (RAU), proportional fairness data rates, and bit error rates (BERs).

The optimization objective of the former is generally to minimize the required power under given rate requirements of users, while algorithms for rate adaptive usually try to maximize an OFDM system’s throughput under transmission power limitation.

To improve energy efficiency by implementing joint sub-channel algorithms and avoid barrier problems using fast barrier method.

REFERENCES

[1] Giriraj Kr. Patidar, “Li-fi technology in wireless communication”, International Journal of Science, Engineering and Technology, and ISSN: 2348-4098, Vol 2 issue 8 nov-dec 2014.
[2] P.Nandhakumar, S.Dinesh Kumar, “Incredible Innovation in Visible Light Communication- Light Fidelity (Li-Fi)”, International Journal of Engineering Sciences & Research Technology ISSN: 2277-9655.
[3] ETSI, Broadband Radio Access Networks (BRAN); HIPERLAN2; Physical Layer, December 2001.
[4] A. Gusmao, R. Dinis, and N. Esteves, “On frequency-domain equalization and diversity combining for broadband wireless communications,” IEEE Transactions on Communications, vol. 51, pp. 1029–1033, July 2003.
[5] H. Witsching, T. Mayer, et al., “A different look on cyclic prefix for SC/DFE,” in Proceedings of the IEEE International Symposium on Personal, Indoor and Mobile Radio Communications, vol. 2, pp. 824–828, September 2002.
[6] H. Schober, F. Jondral, R. Gallacher, and Z. Wang, “Adaptive Channel Estimation for OFDM Based High Speed Mobile Communication Systems,” IEEE International Conference on Third Generation Wireless and Beyond 2001, pp. 392–397, May 2001.
[7] H. Arslan and T. Ycek, “Estimation of Frequency Selectivity for OFDM Based New Generation Wireless Communication Systems,” World Wireless Congress, May 2003.
[8] http:// smart each. blogspot.in / 2013 / 07 /gi-fi technology-ppt-free-download.html
[9] http://1000projects.org/seminarprojects/ThreadDownload-Gi-Fi-Seminar-Report-PPT-628
[10] http://www.tutorialspoint.com/wimax/what_is_w imax.html
[11] http://www.independent.co.uk/news/science/lifirevolution - internet - connections - using-lightbulbs-are-250-times-faster-than-broadband- 8909320.html
[12]. http://thefutureofthings.com/3898-the-future-ofwimax
[13] http://www.dbmarketing.com/telecom/wimaxfut ure.html

IJARCCE

ISSN (Online) 2278-1021
ISSN (Print) 2319 5940

International Journal of Advanced Research in Computer and Communication Engineering
ISO 3297:2007 Certified
Vol. 5, Issue 9, September 2016

BIOGRAPHIES

M. Rama Krishna received his MCA (Master of Computer Applications) from Bharathiar University Arts and Science College valparai, India; presently he is a Research Scholar at Department of Computer Science, NGM College, and Pollachi, India. He presented a paper about Network security in Third international conference on the **"Advances in Information Technology and Networking (ICATN'16)"** in G.R.D COLLEGE FOR SCIENCE; His area of interest includes Computer Network.

M. Rajasenathipathi is a third year Doctoral Research Scholar in the Research and Development Centre of Bharathiar University. He received his Master degree in computer Applications and M.Phil degree in computer science from M.K. University, and Ph.D. degree in Computer Science from Bharathiar University, Coimbatore. He is also working as an Assistant Professor of Computer Science at N.G.M. College, Pollachi, India. He has been an active developer of systems for people with disabilities for the past 18 years.

Copyright to IJARCCE
DOI 10.17148/IJARCCE.2016.5917