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5G Communication System based on PLC-VLC Design

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Abstract - *In order to counter the explosion of cellular telecommunications, the interaction range is gradually extending from the regular Radio Frequency (RF) band to the optical cellular (OW) domain. By incorporating the classic RF channel, which depends on a combination of radio technologies and optical channels, the next wave of flexible networks (headnets) is supposed to offer a possible answer for ever-increasing wireless tele-traffic. Visual Light Communications (VLC) is the ideal candidate to complement existing RF networks with improved brightness due to unlicensed spectral resources. Although VLC has many advantages, many problems arise when incorporating VLC in traditional RF headset settings, which can include different device architectures. The User-Centered (Unc) design theory for the VLC system is a new, efficient design model for HetNet's super-dense multi-layer cellular composites. The Unc concept is anticipated to become one of the groundbreaking approaches to be utilized in the next decade. The project provides a detailed overview of visible-light-assisted OW systems, with a particular focus on developing and optimizing VLC networks, which are essentially reviewing the new UC architecture. Finally, plan for the design of VLC systems have been issued. Power Line Communication (PLC) offers an interesting and cost-effective automatic meter reading (AMR) solution. If AMR device is installed in a PLC distribution system, the detection system can be easily connected to the current PLC network for unauthorized use of electricity. The next digital energy meter chip is used in the measurement system and the energy value is collected. In the case of a discrepancy between the two energy data reported, an error signal is produced and transmitted over the PLC network. The system architecture and its critical components are specified.*

***Key Words*: Visual light communications, Power line communication, cellular telecommunications, OW systems., etc**

1. INTRODUCTION

The research project explores the efficiency of a network using both OFDM and Turbo Code, which incorporates PLC and VLC systems. As the telecommunications industry have undergone a range of technological changes, such as the introduction of high-speed broadband networks, which strive not only to improve the connectivity medium, but also to make it profitable across current Power-Line (PL) network. While making use of power-line as means of communication, it can be efficient and profitable since there is no need for an external transmission line and includes all grid positions for the internal communication network. This function is very special in the sense that turbocodes are integrated amongst the integrated system to improve the visual usability of system for noise and distortion. The basic illustration of the combined PLC-VLC system is shown in below figure 1. The transmitted input data is attached to the wall socket through a power line modulator. Instead, the PLC modulator is attached to the VLC modulator for signal transmission in the air. The transmitted signal is received by VLC demodulator on the receiver side via the PLC demodulator.

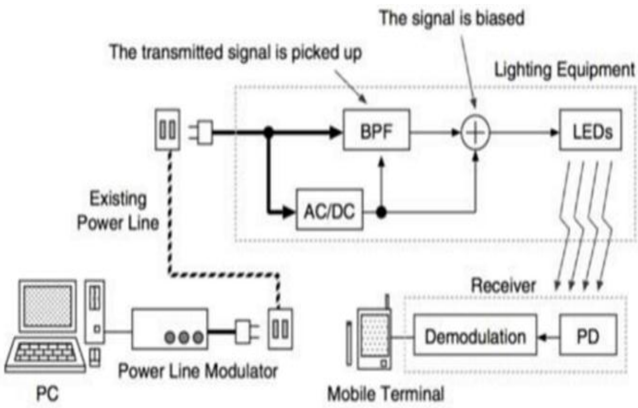

Figure 1: Visible Light Communication.

1.1 Objectives of the Project

The objective of this project are: (i) Modification strategy to satisfy the channel specifications of the 5G Hybrid PLC-VLC communication network. (ii) A thorough study of the co-use of these two techniques for data processing reveals some useful applications of integrated PLC-VLC systems and proposes a DWT and OFDM. Dynamic specifications dependent on hybrid channel properties. (iii) Theoretical bit error tests demonstrate that DWT-OFDM beats the OFDM-based PLC VLC device. (iv) The planned hybrid system can be used to construct smart buildings where VLC manages indoor/inter-building networking centered on PLC connectivity.

2. PROPOSED METHODOLOGY

Electricity is the key input for accelerating economic development in the country. Electricity thievery is a criminal offense and, in this case, power providers are losing billions of money. If a PLC automatic meter reading system is installed in a power supply system, it can be possible that Power Line Communication (PLC) will have numerous new possibilities for data transfer through power lines without the use of additional cables. AMR is very important application in this context, since each user, using power lines, connects to each other by means of modems. AMR is the technique for easing remote readings of energy consumption. With recent advancements in LED flickering frequency, VLC is emerging as the high transmission capacity wireless communication device that is primarily suitable for indoor use. The spectrum is around 400-800 THz, a vast bandwidth that does not interfere with the existing RF spectrum. The LED as well as Photo Diodes are used as transmitters and receivers in the classic VLC system. It should be noted that Line of Sight (LOS) is an important need for VLC transceivers as it seeks ready-made localization applications. In the same way, VLC technology could be easily used for underwater communication where, after some depth, Wi-Fi signals usually become weaker. Two standalone wireless and wired technologies, VLC and PLC. They have tremendous promise and appeal for future contact networks of age. The PLC has come out as a strong replacement to Ethernet for data transmission in the last decade, with the introduction of OFDM. Advantages of PLC over Ethernet connectivity are very simple, however, in other words, no new cables needed to be built to relay the data. This present power line network (together with Home-Plug) could be used for dual purposes. In addition, PLCs may also be combined with VLCs for wireless networking, similar to Wi-Fi Ethernet integration.

2.1 Power-line Communication System

The Power-Line Communications (PLC), it has come out as an secure unicast replacement to conventional Un-Shielded Twisted Pair (UTP) of categories 5 and categories 6 built in properties as well as buildings over a last few years. Advantage of using powerlines for networking is that there is a high data transmission speed and that thereafter a better network coverage is achieved. Electrical supply networks have become particularly involved in delivering a wireless communication networks across their present infrastructure. The PLC can be classified into different frequency bands: Narrow-band and Power-line communication broad-band. Also a frequency range of 150 kHz and a potential bit-rate of 2Mb/s, restricted bandwidth and coverage can be transmitted through the narrowband. Whereas broadband can run at a frequency of between 150kHz and 3MHz, with a potential bit-rate of 200Mbit/s. Also it is necessary to go for the best modulation technique precisely in order to attain the best output within the Broadband PLC (BPLC).The channel noise effect of the PLC system can be modeled with additive noise as a time-variant selective frequency fading where that could be expressed mathematically as,

$$H(f) = \sum_{l}^{L-1} g_l \, e^{-(a_0+a_1 f^k)} d_n e^{-j2\pi f\left(\frac{d_n}{v_p}\right)} \quad (1)$$

When the reflex path is g_l it represents the complex tap factors for all directions, the attenuation factor is the index, length of the path is the attenuation factor, and the velocity is the attenuation factor. The channel is influenced by certain types of noise: (i) Back-ground noises. (ii) Narrow-band noises. (iii) Periodic noises and non-periodic im-pulsive noise. In addition, the background noise mainly consists of Power Spectral Density (PSD) function from buildings and residential electronic equipment, as shown in Equation 2 below.

$$S_{n(f)} = -140 + 75 e^{\frac{|f|}{5x10^5}} \frac{dBm}{Hz} \quad (2)$$

The Power Line (PL) of the channel is vulnerable to impulsive noise intervention caused by electrical instruments. That impulsive sound can originate bit errors or blast errors in the PL for data transmission. In the case of narrow-band sound, it could be designed as the output of the AWGN manage band-pass filter over a discreet sampling area, which can further be interpreted like a low frequency sinusoid.

$$n_{nb}(k) = w(k) \, sin \, sin \, (2\pi f_c k) \quad (3)$$

On the basis of previous research, the interference carrier frequency and nnb were found to be 30dB higher yet the back-ground sound at frequencies more than 1MHz.

2.2 System of Visible-Light transmission

Due to its broad range of safety and security features, LED-based VLC as shown in figure 2 can be used in various applications. Communication of devices such as PCs, tablets and smart phones can now be easily communicated at highest data imparting rates without the intervention of the most radio frequency strips. White LED's are seen as more effective than the present fluorescent burning bulbs. Communication is given through LED`s. (i) Be cost-effective. (ii) Acquire a stable transmission across the LOS communication. (iii) Smaller shadowing executes compared to IR, as the ignites are dispensed throughout the room. (iv) It has a prolonged life.

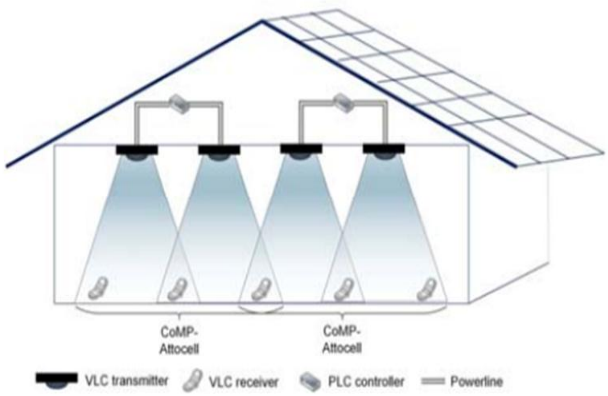

Figure 2: The Visible-Light Communication (VLC)

2.3 VLC and PLC Integration

The Power-Line Communication in the last mile as well as home contacting is becoming more common. The VLC can be used to make networks based on Power-Line Communication (PLC) is more realistic by providing strength at last inch of bearing. The ubiquitous nature and benefits of these two communications media can be exploited. In such a way that VLC offers strong complementing wireless data connectivity to current omnipresent In-House PLC interface. [3] pioneered the idea of integrating the two systems, which has now been used in a variety of applications and also tested the output of presented device that emit's LED light from power-line signal lacking demodulation. We concluded that the efficiency of the PLC also increases as the SNR increases. The drawbacks of their strategy are: (i) The method was unsuccessful to eliminate the noise inside the PL tube. (ii) Multi-way effects are not given into account in PL.

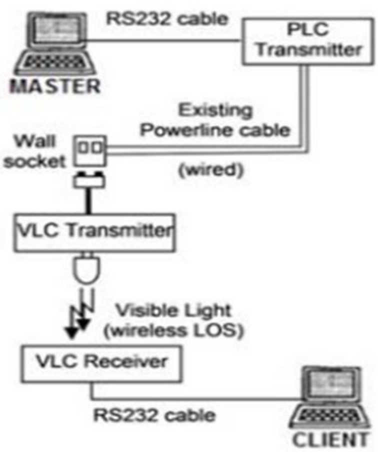

Figure 3: System design

2.4 OFDM

The original theory of OFDM which was first developed by R.W. Across the spectrum of frequencies. These sub-vectors should be immaterial functions. The accurate mathematical definition of orthogonality connecting two functions is that the prime product is zero at a given time interval. More likely, Orthogonal functions are not statistically significant. figure 4 shows how an array of parallel signals forms equally spaced N sub-vectors. Each sub-carrier is modulated with the use of QAM. These adjusted sub-carriers can be used to help independent base-band signals, but these are generally mixed to deliver highest data throughput for a single data branch.

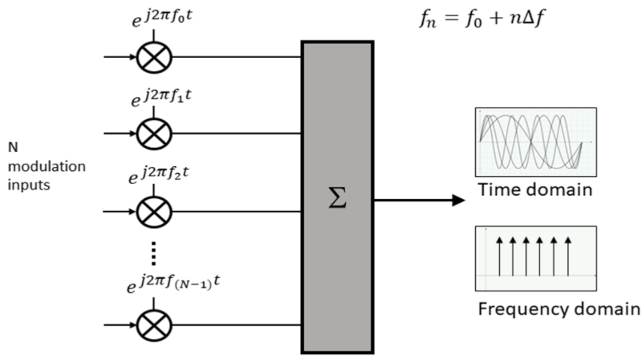

Figure 4: The OFDM intonation combines signals of the different frequencies

These sub-vectors can be mathematically characterized using a complex shape corresponding to the use of QAM.

$$x(t) = \sum_{n=0}^{N-1} c_n e^{j2\pi f_n t} \quad (4)$$

Where

$$f_n = f_0 + (n \cdot \Delta f) \quad (5)$$

The above calculations are continuous functions as well as OFDM systems are executed in analog form. Although, most present systems are digital, taking advantage of the newest semiconductor process nodes and the digital signal processing. Current OFDM systems use sub-vectors in discreet (prototype) forms with existing model rate.

$$f_s = \frac{1}{\Delta t} \quad (6)$$

Where N sub-carriers spaced,

$$\Delta f = \frac{1}{N\Delta t} \quad (7)$$

For clarity, below figure 5 explains only four unmodified sub-vectors in the time domain. The black trace F0, and other traces of high-frequency sub-vectors, have gaps in many arrows.

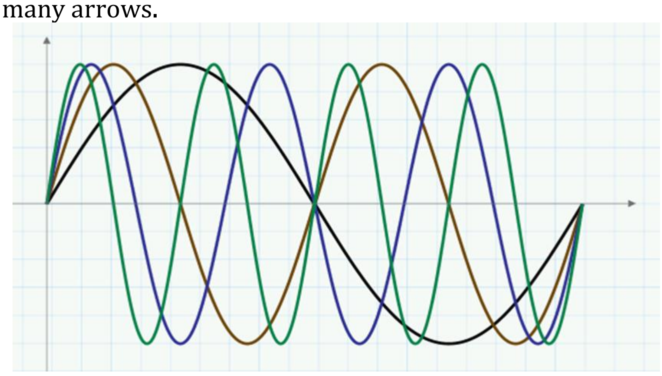

Figure 5: This OFDM signal consists of four conductors separated by F corresponding to the F0, F1, F2, F3.

Below figure 6 shows the same frequency state sub-vectors, with specific modulation bandwidth between the sub-carriers. Note that each sub-carrier crosses the center amplitude of the other sub-carrier at zero, which minimizes the effects of the adjacent sub-carrier.

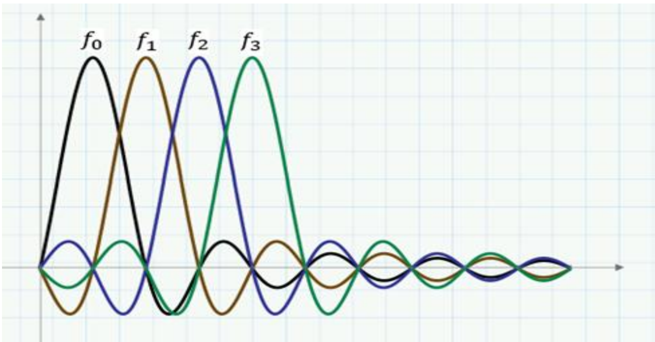

Figure 6: Frequency domain representation of OFDM four-carrier signal.

Figure 7 shows a simple block diagram involving a transmitter and receiver for a full-scale OFDM network. The bit stream on the left side of the diagram enters the system. As usual, for each of the N sub-carriers, this single bit stream is provided by Demultiplex (Demux) into smaller bit streams for individual QAM modules.

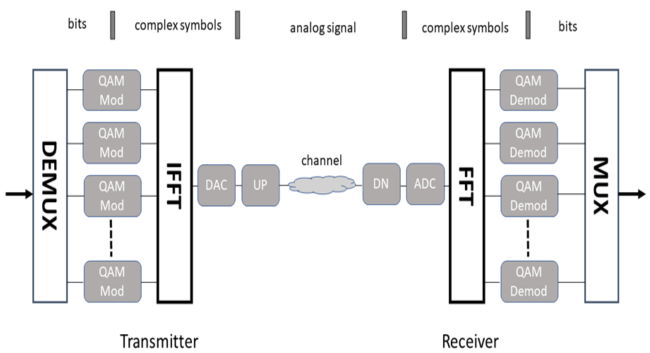

Figure 7: The full OFDM system includes the transmitter (left) and the receiver (right)

3. RESULTS

This concept of PLC and VLC which we simulated shows that by implementing the hybrid system in a practical way provides much more stability towards the communication system. Through this we can improve the lossless communication where this PLC and VLC communication can be utilized and can be easy to implement it in a short period of time. PLC modulation can be done at the power station where as VLC can be implemented in street light. Using hybrid system it makes more reliable. This making hybrid system can be implemented in the hardware by using high speed switches so that there is no delay between PLC and VLC. This leads in more invention in next decades.

3.1 VLC Simulation Results

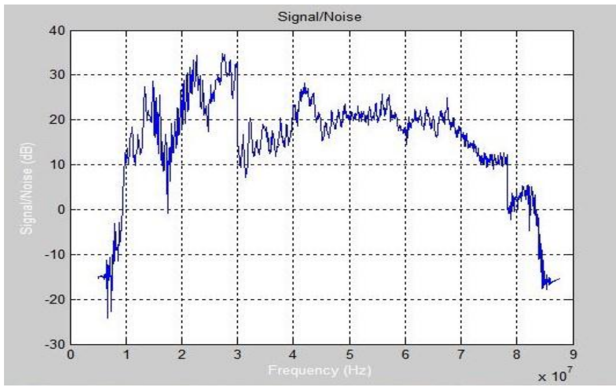

Figure 8: Signal to Noise Ratio Graph

In the below gaph we can see the top view of the LED and the output y(t) results. As we vary the half angle of incedence the output y(t) also changes. The output y(t) varies with time.

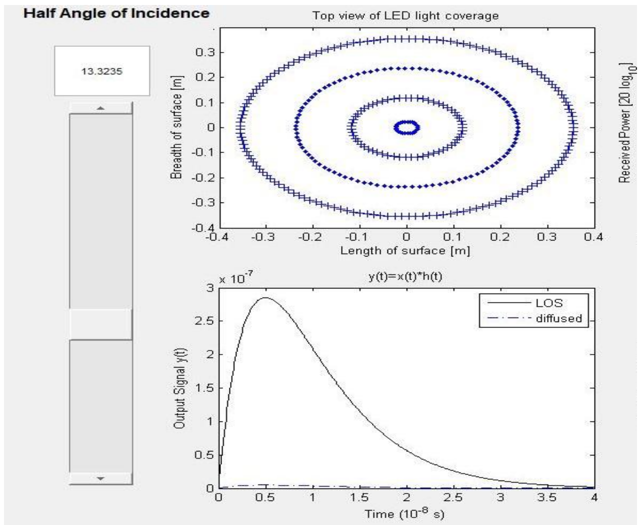

Figure 9: Top view of light

3.2 PLC Simulation Results

Any system will be more stable when its bit error rate will be less. So as we reduce the bit error rate the more stable system we get. As shown in the below table 1 the bit error rate changes for each iteration but the bit rate remains constant. Hence when the bit error rate is small the system is more stable and the accuracy of the PLC-VLC device increases.

Table 1: BER Results

Iterations	BER	BIT RATE
0	0	222342013.8889
1	1.4729e-05	222342013.8889
2	2.9459e-05	222342013.8889

4. CONCLUSION

In this methodology the complete study of the hybrid PLC-VLC 5G communication system based on two leading communication technologies, VLC and PLC. The DWMT transceiver for the hybrid PLC-VLC contact device has demonstrated that its BER output is superior to that of its comparable OFDM-based network. All analog PLC and VLC integration with amplify and push on results in a quick and efficient downlink. Frequency down the transfer of the PLC frequency before the routing capacity improves. SO-OFDM allows for a reduction of the PAPR, which translates into improved efficiency.

REFERENCES

[1] A. Ndjiongue, H. Ferreira, and T. Shongwe, "Inter-building PLC-VLC integration based on PSK and CSK techniques," in International Symposium on Power Line Communications and its Applications (ISPLC). IEEE, 20-23 March 2016, pp. 31-36.
[2] L. Yang, J. Li, and J. Zhang, "Hybrid visible light communications (VLC) and PLC system," in OptoElectronics and Communications Conference (OECC) and Photonics Global Conference (PGC), Singapore, 2017.
[3] T. Komine and M. Nakagawa, "Integrated system of white led visible-light communication and power-line communication," IEEE Transactions on Consumer Electronics, vol. 49, no. 1, pp. 71–79, 2003.
[4] M. Girotto and A. Tonello, "EMC regulations and spectral constraints for multicarrier modulation in PLC," IEEE Access, vol. 5, pp. 4954–4966, 2017.
[5] Z. Dong-Fang, Z. Yi-Jun, and Y.-Y. Z., "Multi-LED phase-shifted ook modulation based visible light communication systems," IEEE Photonics Technology Letters, vol. 25, no. 23, November 2013.
[6] A. Ndjiongue, H. Ferreira, K. Ouahada, and A. J. H. Vinckz, "Low complexity socpbfsk-ook interface between plc and vlc channels for low data rate transmission applications," in 18th IEEE International Symposium on Power Line Communications and Its Applications, Glasgow, 2014, pp. 226–231.
[7] K. e. a. Nooguri, "Performance analysis of baseband modulation techniques for visible light communication," International Journal of Engineering Technology Science and Research (IJETSR), vol. 3, no. 4, pp. 213– 219, April 2016.
[8] C. Cano, A. Pittolo, D. Malone, L. Lampe, A. M. Tonello, and A. G. Dabak, "State of the Art in Power Line Communications: From the Applications to the Medium," IEEE Journal on Selected Areas in Communications, vol. 34, no. 7, pp. 1935–1952, July 2016.
[9] S. Randel, F. Breyer, S. C. J. Lee, and J. W. Walewski, "Advanced modulation schemes for short-range optical communications," IEEE J. Sel. Topics Quantum Electron., vol. 16, no. 5, pp. 1280–1289, Sep./Oct. 2010.
[10] M. M. Zimmermann and K. Dostert, "A multipath model for the powerline channel," IEEE Transactions on Communications, vol. 50, no. 4, pp. 553– 559, April 2002.