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Introduction to indoor networking concepts and Li-Fi

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ABSTRACT
LiFi known as light fidelity was introduced first time by Prof. Harald Haas on July 2011 at TED Global Talk. LiFi is based on Visual Light Communication (VLC) that using light emitting diodes (LEDs) to fully networked wireless system .LiFi enables the electronic device to connect to the internet with no wire. In order to make a communication line between node, a LiFi will need a transceiver to transmit and receive the data. This transceiver will have a modulation technique to make the LED enable to carry the data using the light. The emergence of LiFi is to overcome the shortage of the current technology. We all know that right now WiFi is the most used technology to connect many devices to the internet. As time comes by, the use of internet based devices is increased. This increasing made the capacity of WiFi is reduced due the limitation of radio frequency resources.

I. INTRODUCTION

BeforeAlexanderGrahamBellinventedthetelephone, hehadalreadydemonstratedthephotophonewhereheusedsunlight to transmit voice over more than 200 m in 1880. Sunlight was reflected by a vibrating mirror, which was connectedto amicrophone.Atthereceiver,aparabolicmirrorwithasele-niumcellinthecentercapturedtheintensityvariationsofthe reflectedlightandconvertedthemintoanelectricalsignalthat wasconnectedtoaloudspeaker.Thiswasthefinalpiece ofthejigsawtowardthewhiteLED,a developmentthatdrasticallychangedtheapplicationlandscape ofLEDsfrommeresignalingdevicestoilluminationdevices, replacing the highly energy-inefficient incandescent light bulb. Bell's vision to use light for wireless communications, but nowartificialwhitelightfordigitalwirelesscommunication and at very high transmission speeds, moved significantly closertoreality.

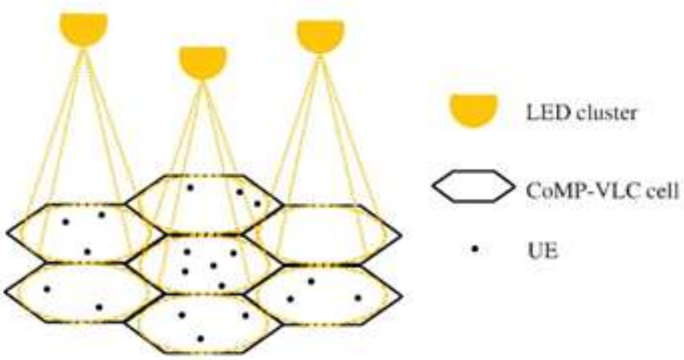

Fig. 1. Here we illustrate a LiFi network. Each light acts as an opticalaccesspoint,whichservesmultipleuserequipmentwithinitsilluminationarea/cell.Userscanalsomove,andtheywillbeservedbydifferentlightbulbsastheyroam.Thischangeofservingaccesspointhappensseamlessly.Severalcellsformacluster,UEsatthecell edgescanbeservedbymultipleaccesspointstoavoidinterference. This technique is referred to as cooperative multipoint (CoMP) transmission.

This LiFi network is also referred to as an opticalattocell

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network.Anopticalattocellnetworkaimstoaddressthe looming spectrum crisis in radio frequency (RF) communi- cations where the important metric is not link data rate but data density. This is defined as the bits per second per unit area. It was shown that a LiFi network can increase the data density by three orders of magnitude while completely avoidinginterferencewithexistingRF-basednetworks.ThismeansthattheLiFinetworksimplyaddscapacitytothe existingRFnetworks.Mostimportantly,itcanusetheexisting lighting infrastructure. From a lighting industryperspective, thisdevelopmenthasbeenwelcomedbecausethe20–30yearlifetime of an LED light bulb means that business models inevitablyhavetomovefromsalesoflightingdevicesto ser- vices,andlight-as-a-service(LaaS)hasbecomeadominating business theme in the lighting industry. The LiFi network exploitsthelightingsystemandturnslightingintoawireless communicationnetworkthatpotentiallyenableshundredsof services.

Webelieveallthesecontributionsarenovelanddistinctfrom existingliteratureonLiFinetworkingandVLC.Theexperi- mentalnetworkingresultsinthispaperprovidenovelinsights into key areas that could be optimized to improve wireless networking performance. We also note that other light com- munication technologies, such as OCC, free-space optical, and more general VLC, are not the focus of this paper, and theinterestedreaderisreferredtoarecentsurveyonthewider topicofopticalwirelesscommunications.

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CHANNEL MODELS IN VLC ANDLIFI

One of the most important factors that determines the per-formanceofVLCtransmissionsystemsandLiFinetworksis the quality of the communication channel. In an incoherent IM/DD optical system, the transmission channel istypically composed of two parts. One part is related to the filteringof front-end elements, and the second part is related to indoor free-spacepropagation,asshowninFig.2(a).Regarding thelatter,thereisalargebodyofliteratureforinfraredchannel models,butthereareonlyafewstudiesonvisiblelight channelmodels.Theworkshow- cases the impact of these differences on the channel model. Followingonfromthis,UysalhasdevelopedVLCreference channel models for the IEEE 802.11bb task group on light communication

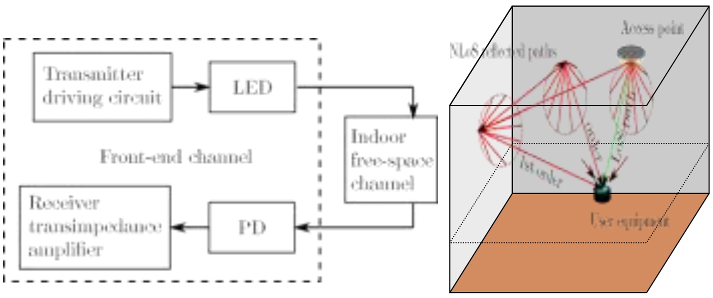

Fig.2. (a)LiFichannelblockdiagram.(b)Illustrationoftheindoorfree-spaceVLCchannel.

Impact of Optical Front-Ends on VLC and LiFiChannels

The typical optical front-ends for incoherent IM/DD optical wireless systems include LEDs at the transmitter and pho- todiodes (PDs) at the receiver. In addition, for the design of practical systems, the effects of front-end electronics, such as LED drivers at the transmitter and optics as well as transimpedanceamplifiersatthereceiver,shouldbeincluded inthechannelmodel;seeFig.2(a).Thesedevicesexhibit low- pass characteristics, which can limit maximum achievable data rates.Thefront-endchannelofaspecifiedVLCsystemcanbe obtained experimentally by measuring the channel response of a short-range point-to-point link . The exact transfer function depends on the actual devices. Therefore, it is very difficulttocharacterizethiselementofthechannelbygeneric models, until good parametrized models become available. Thisrequiresmoreresearch.Manyresearchershavetriedtouse simplemodelsusingcurve-fittingtechniquestoapproximate the characteristics of the front-end channel .This approach shows acceptable accuracy compared to measured results but is very time consuming and renders comparative studies difficult. Most of the existing studies on the optical wireless channel consider a

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Lambertian radiation pattern because it is simple to use and widely accepted by the VLC research community.

Impact of Indoor Free-Space Light Propagation on VLC and LiFiChannels

Opticalsignalsexperienceconsiderableattenuationwhenthey travelinfreespace.Inaddition,thesignalcomponentsarrive atthedetectorviadifferentpaths,includingphysicaleffects, suchasreflectionandscattering.Theseeffectscause differenttimedelaysforthearrivingsignals,therebyleading touniquechannelpowerdelayprofiles.Theprimarychannel componentinfree-spacelightpropagationisthetransmission viaaline-of-sight(LoS)path,asshowninFig.2(b),whichcan be characterized by a simple analytical model .Because mostofthedetectedsignalpowerisfromaLoSpathandthe calculationofthecorrespondingpathlossissimple,thelight.propagationwithonlyLoStransmissionhasbeenusedinmany VLC and LiFi studies. However, the detected signal power from non-line-of-sight (NLoS) paths has been found to be significant in certain scenarios, especially in small and reflectiveindoorenvironments.

2. LIFI NETWORKS

LiFi falls under the larger umbrella of VLC. Much ofVLC research focuses on point-to-point communication. Furthermore,mostVLCresearchassumesthatthevisiblelight spectrum is used for both uplink and downlink communica-tion.Incontrast,LiFiencompassesbroadernetworkedsystems, including multiuser, bidirectional, multicast, or broadcast communication. While it uses the visible light spectrum for downlink,LiFiusestheinfraredspectrumfortheuplink. LiFiisenabledbyanecosystemofmultiusertechniques, resource allocationalgorithms,andsecuritystrategies.Theseessential systemcomponentsareillustratedinFig.3.LiFinetworkswere designedfromthestarttoworkseamlesslywithRFwireless networks, e.g., Wi-Fi, to enable efficient, opportunistic load balancing,andaugmentedcapacityinheterogeneousnetworks.

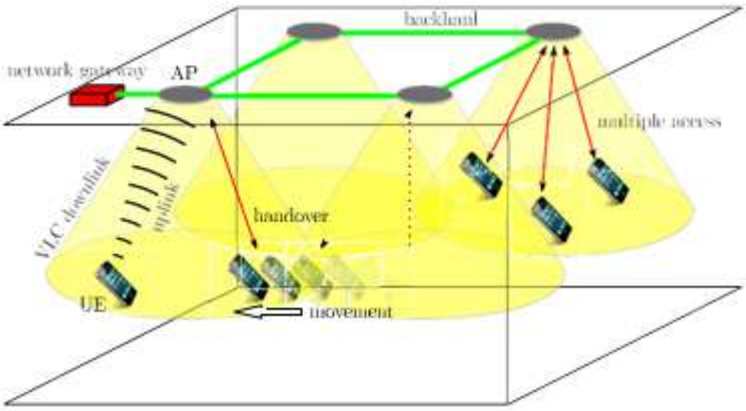

Fig. 3. LiFi network illustration. A complete LiFi network includes downlink, uplink, and backhaul connections. In addition, the system should provide a handover function, mobility support, and multiple access capability.

II. CONCLUSIONS

Thispaperhasshownthatitispossibletobuildf uturecellu- larsystemsbasedonfree-spacelightcommunication.Inthis context,ithashighlightedthatinordertoachievethisobjec- tive, the focus in free-space light communications has to be shiftedfrompoint-to-pointlink-leveldatarateimprovements inVLCtooptimizingdatadensitiesinawirelessnetwork..LiFiprovides significant economic opportunities, but at the same time, there are many interesting scientific challenges to improve LiFisystemsinordertofullyleveragethevastamountofthe unlicensedspectrumintheinfraredandvisiblelightdomains.

REFERENCES

[1]. N. Zheludev, "The life and times of the LED—a 100-year history," Nat. Photonics **1**, 189–192 (2007).

[2]. T.-S. Chu and M. Gans, "High speed infrared local wireless com- munication,"IEEECommun. Mag. **25**(8), 4–10 (1987).

[3]. F. R. Gfeller and U. Bapst, "Wireless in-house data communication via diffuse infrared radiation,"Proc. IEEE **67**, 1474–1486 (1979).

[4]. J. R. Barry, J. M. Kahn, E. A. Lee, and D. G. Messerschmitt, "High- speed nondirective optical communication for wireless networks," IEEE Netw. **5**, 44–54 (1991).

[5]. J. M. Kahn and J. R. Barry, "Wireless infrared communications," Proc. IEEE **85**, 265–298 (1997).

[6]. N. Holonyak, S. F. Bevacqua, C. V. Bielan, F. A. Carranti, B. G. Hess, and S. J. Lubowski, "Electrical properties of Ga(As1-xPx) p-n junctions,"Proc. IEEE **51**, 364(1963).

[7]. S. Nakamura, T.Mukai, and M. Senoh, "High-power GaN p- n junction blue-light-emitting diodes,"Jpn. J. Appl. Phys. **30**, L1998–L2001(1991).

[8]. H. Amano, M. Kito, K. Hiramatsu, and I. Akasaki, "p-type conduc- tion in Mg-doped GaN treated with low-energy electron beam irra- diation (LEEBI),"Jpn. J. Appl. Phys. **28**, L2112–L2114 (1989).

[9]. Y. Tanaka, T. Komine, S. Haruyama, and M. Nakagawa, "Indoor visible communication utilizing plural white LEDs as lighting," in Proceedings of the 12th IEEE International Symposium on Personal, Indoor and Mobile Radio Communications (2001), vol. **2**, pp.81–85.

[10]. Y. Tanaka, S. Haruyama, and M. Nakagawa, "Wireless optical transmissions with white colored LED for wireless home links," in Proceedings of the 12th IEEE International Symposium on Personal Indoor and Mobile Radio Communications (PIMRC) (2000), vol. **2**, pp.1325–1329.