Chapter 3
An Introduction to LiFi and Review of Prototypes Designed on FPGA and Other Hardware

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ABSTRACT

The current wireless networks are highly deficient when it comes to catering to the needs of the modern world with applications such as IoT and online interactive gaming. LiFi (visible light communication) has attracted interest as a solution to this problem due to its high data rate, wider spectrum, low power consumption, higher security, lower cost, and immunity to EMI. The idea behind LiFi is to use LED lights already available for space lighting for the purpose of transmitting. The chapter begins with a brief introduction to LiFI and then takes the reader through the history and market status of the technology all the way through to popular modulation techniques and finally ends with summarizing the transceiver prototypes designed previously with special emphasis on FPGA-based prototypes. The chapter provides a starting point for young budding researchers interested in LiFi and its implementation.

DOI: 10.4018/978-1-5225-9767-4.ch003

INTRODUCTION

It has been three decades since the wireless mobile communication systems became commercially available and the technology has already become an essential part of our everyday life, becoming a fundamental commodity. The past two decades have seen an exponential increase in mobile data traffic and have gone through a massive deployment of wireless communication systems. Technology advancements such as Internet of Things and Virtual reality have put huge pressure on currently available Radio frequency spectrum and the limited availability of RF spectrum is pointing towards a looming 'RF spectrum crisis' (Ofcom, 2013 ; Tsonev, Videv & Haas, 2013). This has prompted researchers to look to move towards higher frequencies and smaller cell sizes, exploring the millimeter wave part of the spectrum. While a smaller cell size is not a problem as far as system performance is concerned as it significantly improves performance. It does create other problems. Providing infrastructure to each cell and increased power consumptions are major issues in such networks. One of the possible solutions suggested to these problems is Visible Light Communication (VLC). It is just the next logical step in the move towards higher frequencies and takes one into the Nanometer range. VLC has attracted particular interest because lighting has virtually become a basic commodity for every home and place of work. Especially since LED has become a common device for illumination, it has made the dream of combining communication and illumination a reality. The existing infrastructure means the VLC Access points area readily available and existing technologies like Power Line Communication (PLC) and Power over Ethernet (PoE) mean the technology required for backhaul connectivity is also ready at hand. Also because light is on most of the times in indoor environment, the technology is power efficient since data is piggy backing illumination in most cases. Other benefits of VLC in addition to these include inherent security and immunity to Electromagnetic Interference (EMI).

Li-Fi is a relatively new subclass under the larger umbrella of VLC. Most of the research available is simulation based. However, some prototypes have been developed on various platforms that shall be discussed later in this chapter. Designers have implemented prototype Li-Fi/VLC transceivers on microcontrollers, FPGAs, Raspberry Pi and Arduino using a range of physical layer devices from expensive LED packages including drive circuits to cheap off the shelf devices. Data rates of around 1 Gbps and 3.4 Gbps have been reported using phosphorous coated white LED (Khalid, Cossu, Corsini,