Chapter 15
Wireless Enabling Technologies for the Internet of Things

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ABSTRACT

This Chapter provides several comparable studies of some of the major evolving and enabling wireless technologies in the Internet of Things (IoT). Particularly, it focuses on the ZigBee, 6lowpan, Bluetooth Low Energy, LTE, and the different versions of Wi-Fi protocols including the IEEE 802.11ah. The studies, reported in this chapter, evaluate the capabilities and behaviors of these technologies in terms of various metrics including the data range and rate, network size, RF Channels and Bandwidth, Antenna design considerations, Power Consumption, and their Ecosystem. It is concluded that the requirements of each IoT application play a significant role in the selection of a suitable wireless technology.

INTRODUCTION

The Internet of Things (IoT) was about a vision in which all physical objects are tagged and uniquely identified using RFID transponders or readers (Neil, 2000). Nowadays, research into the IoT has extended this vision to the connectivity of things to anything, anyone, anywhere and at any time. The IoT has grown into multiple dimensions, which encompass various networks of applications, computers, devices, sensors, actuators, smart devices as well as physical and virtual objects (Elkhodr, Shahrestani, & Cheung, 2013). Communication, collaboration and sharing of information between the various facets of the IoT are a keystone for the triumph of the IoT. In the IoT, things are interconnected together using various wireless, wired or mobile communication technologies such as ZigBee, Bluetooth, 4G, Wi-Fi, and other evolving communications technologies. The nature of the IoT communications is no longer restricted to

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human users but also extends to things-to-things communications. This paradigm of things-to-things and things-to-human communications is a major shift from an essentially computer-based network model to a fully distributed network of connected devices.

The IoT has now more potential to provide a real-world intelligent platform for the collaboration of distributed smart objects via local-area wireless and wired networks, and/or via wide-area heterogeneous network interconnections such as the Internet (Elkhodr et al., 2013). This growth can be attributed to many technological advances. Particularly, it is due to the advance of mobile and wireless communications networks, such as 4G, Wi-Fi and 802.11ah, and their wide-range or low-power wireless capabilities. The rapid development and pervasive evolution of wireless technologies have the potential to grow to accommodate the billions of things envisioned in the IoT. Traditionally, network end-users of the Internet are computers and mobile devices. In the IoT, network users will expand to include humans, things, machines, and a combination or group of them. Thus, the IoT will connect devices that we carry or wear, and devices which we interact with at homes, work, and recreational places; creating an entirely new category of connected devices. The IoT creates a proliferation of devices that until recently very few people would have considered it beneficial to connect to the Internet. Reinventing not only the way we connect to the Internet but the way objects around us are used in everyday activities. Ultimately, wireless technologies and their infrastructures will grow to meet the high demand for connectivity created by the vast amounts of IoT devices joining the Internet. The increase in connectivity demands creates new challenges in terms of communication requirements, device hardware characteristics, software, and resilience capabilities.

Nonetheless, an interesting aspect of the adoption of wireless technologies in the IoT is the incorporation of multiple long range and short range wireless technologies into the designs of IoT applications. In eHealth, for example, applications such as body area networks may develop into an autonomous world of small wireless and networked mobile devices attached to their users. They mostly connect to the Internet using a mobile phone as a gateway or via a wireless access point. Wireless technologies in the IoT need to handle a large degree of ad-hoc growth in device connectivity, structure, organization, and significant change in contextual use, including mobility as well. Many devices will constantly be connected to the energy grid such as smart appliances in the smart home application example. On the other hand, many other IoT devices suffer from limited energy resources as they are powered by small batteries or rely on energy harvesting techniques throughout their lifetime (Vecchio, Giaffreda, & Marcelloni, 2014). Examples of these devices are wireless sensors and those deployed in remote locations. Hence, finding an answer to "Which wireless technology best fits the IoT" is subjective to the application requirements and device capabilities. However, it is established that the need to accommodate the requirements for minimum energy and computation, slim and lightweight solutions in various IoT communication scenarios and applications is essential for the proliferation of the IoT (Vermesan & Friess, 2013). Indeed, most of the future growth in wireless IoT connectivity will stem from these requirements. For the real growth to occur, interactions on the IoT between various industry segments are also needed. To achieve this, interoperability of communications between classic and low-power wireless technologies is fundamental to the success of the IoT.

This Chapter investigates and compares some of the evolving and enabling wireless technologies in the IoT. It provides a brief review of the IEEE 802.15.4 technologies, Bluetooth Low Energy, and Wi-Fi in the section "IoT Wireless enabling protocols". Then the Chapter moves to provide several comparative studies between low-power wireless technologies, particularly, ZigBee, 6Lowpan, and 802.11ah, and the other variants of Wi-Fi technology (802.11a/b/g/n/ac), and LTE in the section "A comparative