Chapter 13
Narrowband IoT for Internet of Everything

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ABSTRACT

Narrowband internet of things (NBIoT) is a leaner and thinner version of the IoT which needs much less resources than the other forms of the IoTs. Therefore, it is considered as a low power wide area network (LPWAN) technology. It can connect with a large number of devices with a very small amount of power and bandwidth. It has potential to connect almost all the considerable objects with the internet. Thus, it is a very powerful technology to establish internet of everything (IoE), a framework consisting of data, processes, sensing, and follow up actions for an intelligent environment. In this chapter, the authors present the IoE friendly architecture of NBIoT, its LPWAN features, principles, and its common applications in different sectors to show its versatility toward IoE. They show the layered architecture of a typical NBIoT and the main protocols used in the narrowband scenarios. They show the general applications of NBIoT for IoE and how it can provide services with limited bandwidth and power. With all these wonderful features, NBIoT is certainly an attractive technology for IoE which can provide the accelerated innovation opportunities.

INTRODUCTION

Internet has evolved to a great extent to become an integral part of modern human lives. In addition to that, now the Internet of things (IoT) has become the main enabler of digital ecosystem. IoTs are the evolved forms of the sensor networks of the 1990s. Wireless sensor networks (WSNs) were used in several applications in the past. They were very much distributed and normally had a centralized control. The popularity of the WSNs went up with the popularity of the sensors to keep track of the essential

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parameters in different application processes and environments. The densification of the sensors in WSNs was a trouble for the central control. Therefore, there were several proposals to connect the sensors in a well-defined networked framework. Most of the popular and feasible proposals suggested for the interconnection between the sensor networks and the existing communication networks preferably through the Internet and the cellular communication networks (Palattella et al., 2013). There was also a demand for these sensors to be part of the Internet or at least a large connected environment (Tsai et al., 2014; Ko et al., 2011). Both the wireless and wired sensing environments were finally brought together. WSNs were extended through the interconnection with the Internet for large scale connectivity with several objects (Keoh et al., 2014). In this new framework, Internet was connected with objects or things. This is how a new paradigm of connecting everything with the Internet was started.

IoT was proposed to have a unified approach which was almost not there for the WSNs (Gluhak et al., 2011) in the 1990s. Sensors normally do not need large amount of energy and bandwidth for their operations. Rather bandwidths of 100 kHz are enough for carrying out the sensing, measurement and control operations in a connected environment. So narrowband IoT (NBIoT) can be implemented using narrow band microwave frequencies and battery supplied power in different environments (3GPP TS, 2016). They can be broadly divided as cellular NBIoT and non-cellular NBIoT. In the cellular NBIoT, a cellular structure just like the GSM or LTE is used (Atzori et al., 2010). In the non-cellular form, it has a free topology in which the devices may or may not work as communication nodes (3GPP, 2016; 3GPP, 2017). Out of these two forms, the cellular form is preferred over the non-cellular one. Therefore, broadly, NBIoT can be regarded as an emerging cellular technology that will operate in a cellular architecture using narrow bandwidths. In April 2014, narrowband low power wide area network (LPWAN) technology was proposed for connected living (Atzori et al., 2010). It was the real driving force behind the origin of NBIoT. Now, NBIoT is considered as a LPWAN technology which will connect several objects with the Internet for connected living environment. Narrowband deployment of IoT provides several advantages such as wide coverage, high longevity of the sensors and actuators, fast deployment, low bandwidth, and low power connectivity (Routray & Sharmila, 2017).

In the Internet of everything (IoE) paradigm, the main aim is to connect all the possible objects with the Internet which are required in our day to day activities (Taylor, 2013; Stankovic, 2014). The purpose it to utilize the information of interconnected objects for better quality of living. Connecting so many devices and objects needs a lot of resources. The fundamental resources required such as the power for coverage and the bandwidth for the uplink and downlink communications are scarce for the IoE applications. Therefore IoE framework needs a special form of the IoT which can overcome these limitations. NBIoT needs a very small amount of power and provides coverage over a very large area. The bandwidth needed is also very small in comparison to the other forms of IoTs. Therefore, it can be considered as the main solution for the IoE requirements.

The remaining parts of this chapter are organized as seven different sections. In section 2, literature review on the contemporary issues of NBIoT and its fitting characteristics with IoE are presented. In section 3, the architectural aspects of NBIoT are presented which makes it suitable for IoE. In section 4, the physical and MAC layers and their functions are explained. In section 5, the upper layers and their functions are presented. In section 6, several applications of NBIoT have been presented with some appropriate examples. In section 7, we present the future research directions of NBIoT for IoE. In the last section, we conclude the chapter with the mention of some future directions.