Chapter 3
Principles and Applications of Narrowband IoT:
Principles of Low Power Wide Area Networks

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ABSTRACT

The internet of things (IoT) brings 'life' to non-living things. In the IoT frameworks, the devices become smarter, more intelligent, become able to make decisions, and can communicate with other entities, applications, as well as human beings. According to a Gartner report, by 2020 more than 25 billion devices will be connected to the internet. Low power wireless wide area network (LPWAN) is a group of various low power, wide-area technologies such as LoRa, Sigfox, NB-IoT, DASH7, RPMA, LTE-M, designed to interconnect low bandwidth, battery-operated devices having limited processing power, limited memory, transmission speed with low bit rates at long-range using radio communication technologies. Most of these technologies provide a long battery life, low deployment cost, large capacity, and generates deeper insights of businesses. However, each technology differs in latency, data rate, handover mechanisms, quality of services, applications, and use cases. In this chapter, the authors provide the basic principles of these LPWANs and present their applications in different domains.

INTRODUCTION

The Internet of Things (IoT) is considered as the extension of the common access networks and operational technologies where the basic core is the Internet. The IoT platform connects widely dispersed, static and mobile heterogeneous objects like sensors and actuators that collect the data from environment and send them to the cloud using local gateways and network technologies where the analysis and analytics is done on the data to enhance productivity, business gain, research etc. The IoT technologies are growing at a

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faster rate and are also increasing the number of practical applications like asset tracking, agriculture, smart metering, smart cities, smart homes. To connect the sensors to gateways and to cloud, various IoT technologies are used which in turn depends on many factors like range, data rate, energy consumption, battery life, size, scalability, cost, reliability, latency, overhead, topology, constrained network and much more. There are various technologies available in market starting from short range like ZigBee, Bluetooth, Z-Wave, Thread, WirelessHART, Wireless Fidelity (operates in 2.4GHz, 915MHz, 868MHz ISM band (wiki)to medium and long-range communication solutions like cellular communications (e.g., 2G, 3G, and 4G), VSAT (Very Small Aperture Terminal), Low power wide area network (LPWAN). Among all, the LPWAN becomes an area of interest for many researches and industrial IoT applications as it supports long range communication up to 10–40 km, at a low cost, low bit rate for the constrained nodes like sensors operating on batteries, giving them a longer life (more than 10 years).Many LPWAN technologies are defined working in licensed and unlicensed frequency spectrum.

In this chapter, we present the main features and characteristics of the commonly used LPWANs. We analyze their working principles, advantages and disadvantages with respect to the application domains. We also study their applicability in different practical applications. For this work, we go through a large number of contemporary scholarly publications. This chapter presents a structured literature review of LPWAN technologies. The literature search is based on the available technical journals, conferences, whitepapers and IEEE Xplore digital library.

The rest part of the chapter is organized as follows. Section 2 discusses about the literature review of various existing LPWAN technologies. Section 3 elaborates various LPWAN technologies like Sigfox, LoRa, DASH7, Weightless, RPMA, NB-IoT, LTE-M along with their architecture, protocol stack, security features, applications, advantages and disadvantages. Section 4 represents the comparison of various available technologies. Section 5 presents the future research directions of these LPWANs. Finally, we finish this chapter with a conclusion.

LITERATURE REVIEW

LPWAN has emerged as a promising solution for a vast range of applications in Internet of Things (IoT), machine to machine (M2M) communication. LPWAN has emerged as a promising solution for a vast range of applications in the Internet of Things (IoT), machine to machine (M2M) communication. Kosari and Wentzloff (2019), presents a transmission scheme and a hardware implementation in the Multi-Use Radio Service band as an alternative for low power wide area network. Lestari et al. (2015) designed an IoT-based river water quality monitoring-system using LPWAN communication technology. Petäjäjärvi et al., (2016) propose that LPWAN can be part of enabling new human-centric health and wellness monitoring applications. Guibene et al., (2017) presents the results of the joint Intel/Nimbus Low Power-Wide Area (LPWA) technology PoC deployment in smart cities. River Water Monitoring using LPWAN communication technologies. Firdaus et al. (2019) uses LPWAN LoRa technology to monitor the condition of air quality levels. Ngamjanvaporn et al., (2019) introduced a beam-scanning array antenna for LPWAN base station. In del Campo et al., (2018) use of LPWAN communication architecture for monitoring systems in power distribution grids is described where they designed a hybrid 3G LoRa-SigFox communication architecture. Duangsuwan et al., (2019) proposed LPWAN technology to monitor the air quality in a smart city environment. The work carried by Li et al., (2017) explains the usage of LoRa LPWAN technology in Sailing Monitoring System. Chung et al. (2018) proposed an