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# A survey on LPWA technology: LoRa and NB-IoT☆,☆☆

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**Abstract**

By 2020, more than twenty five billion devices would be connected through wireless communications. In accordance with the rapid growth of the internet of things (IoT) market, low power wide area (LPWA) technologies have become popular. In various LPWA technologies, narrowband (NB)-IoT and long range (LoRa) are two leading technologies. In this paper, we provide a comprehensive survey on NB-IoT and LoRa as efficient solutions connecting the devices. It is shown that unlicensed LoRa has advantages in terms of battery lifetime, capacity, and cost. Meanwhile, licensed NB-IoT offers benefits in terms of QoS, latency, reliability, and range.


*Keywords:* LPWA; NB-IoT; LoRa; mMTC; IoT

**Contents**



## 1. Introduction

Over the previous decades, humans have evolved drastically with the onset of the industrial revolution. The fourth industrial revolution is the era in which a new generation of wireless communication enables pervasive connectivity between machines and objects [1]. The communication systems will need to support more than twenty-five billion connected devices

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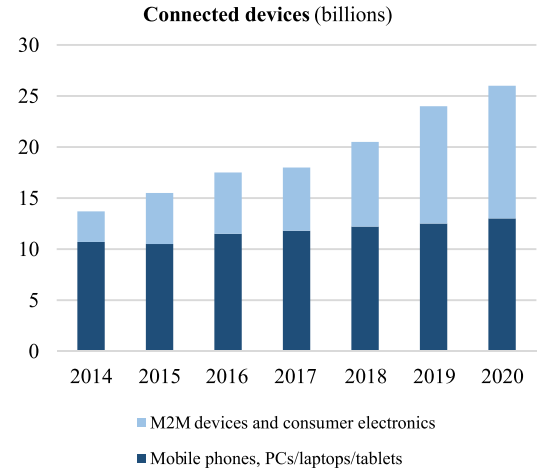


**Fig. 1.** Growth in connected devices [2].

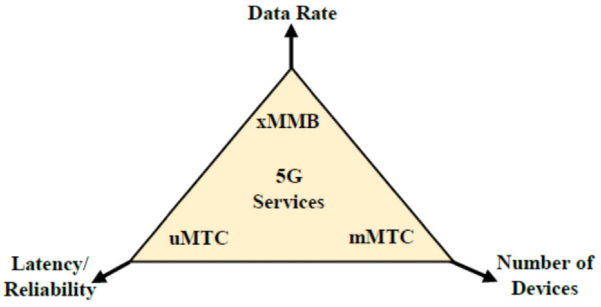


**Fig. 2.** The 5G generic services [1].

by the year 2020, as seen in Fig. 1 [2]. It is expected that the 5th generation (5G) wireless mobile communication will provide the means to allow an all-connected world of humans and objects [1]. The major question that arises is how the 5G is going to meet the challenges by the year 2020. The 5G is categorized into three generic services, namely, extreme mobile broadband (xMBB), massive machine-type communications (mMTC), and ultra-reliable machine-type communications (uMTC), depicted in Fig. 2 [1].

The xMBB provides extremely high data rates, in the range of Gbps. For example, consider a crowded stadium where all users want to enjoy 3D steaming of the on-going match on their devices through augmented reality. The uMTC deals with ultra-reliable and time efficient devices. For example, think of the safety of a pedestrian in relation with a commuting person in a vehicle. Another type of uMTC is reliable communication for manufacturing in factories. For example, at one vertical industry assembly line where products are assembled, a monitor, with the help of sensors, needs to have low end-to-end latency with 99.99% reliability. The mMTC enables 5G services to lots of devices with energy efficiency. Nowadays, sensors and actuators are widely deployed for human–machine-centric communication. The study cases are mMTC-oriented security monitoring, smart home, smart building, and smart environment.

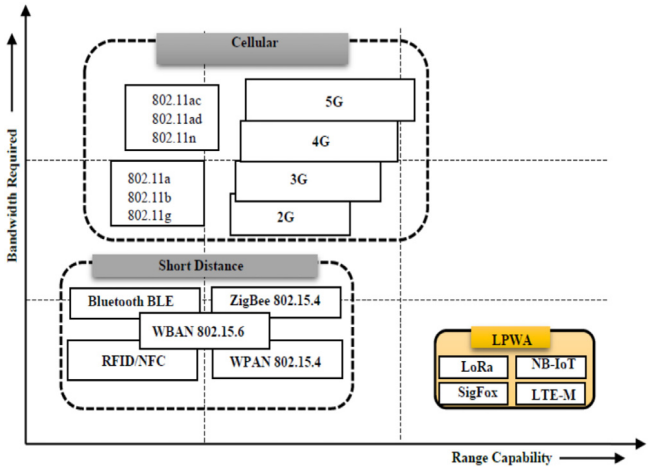


**Fig. 3.** Required bandwidth vs. range capacity of short distance, cellular, and LPWA [4].

Things are defined as objects that can be identified and integrated into communication networks. Things associate information both statically and dynamically. With the development of the internet of things (IoT), more and more practical applications can be found in many industries today. Different application areas have specific requirements and considerations, which mean that different technologies are needed. The widely installed short-range radio connectivity (e.g., Bluetooth and ZigBee) are not suitable for scenarios that require long-range performance with low bandwidth. M2M solutions based on cellular technology can provide large coverage, but they consume excessive power. IoT provides a better solution to deal with the massive number of devices constantly evolving with underlying requirements such as coverage, reliability, latency, and cost effectiveness.

Low-power, wide-area (LPWA) technologies are targeting at these emerging applications and markets. LPWA is a generic term for a group of technologies that enable wide area communications at lower cost points and better power consumption [3]. It is perfectly suitable for the IoT applications that only need to transmit tiny amounts of information in a long range. As recently as early 2013, the term ‘LPWA’ did not even exist [3]. However, as the IoT market rapidly expanded, LPWA became one of the faster growing spaces in IoT. Many of the LPWA technologies depicted in Fig. 3 have arisen in both licensed and unlicensed markets, such as LTE-M, SigFox, long range (LoRa), and narrow band (NB)-IoT. Among them, LoRa and NB-IoT are the two leading emergent technologies, which involve many technical differences.

Therefore, in this paper, we compare and describe the technical differences of LoRa and NB-IoT in terms of physical features, network architecture, and MAC protocol. In addition, we compare them in terms of IoT factors, such as quality-of service (QoS), battery life & latency, network coverage & range, deployment model, and cost. Further, we consider application scenarios and explain their current status in Korea, Japan, and China. Finally, we summarize and present our conclusions.