A comparative study on LPWAN standards: Nb-IoT and LTE-M

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Abstrac*t*—Given the proliferation of connected objects as well as the rise of Low Power Wide Area Network (LPWAN) technologies designed to enable communication with low energy, the main ones being NB-IoT and LTE-M in our daily life. This is why in this article; our study will focus on the evaluation of the specificities of these two standards: NB-IoT and LTE-M

Keywords— Internet of Things, IoT, LPWAN, NB-IoT, LTE-M

1. Introduction

The Internet of Things (IoT) is an ecosystem of connected devices from different environments, which exchange data over a wired or wireless network, with the aim of collecting, processing and exchanging data via Internet protocols or other defined interfaces.

The IoT represents a revolution in telecommunications by connecting different technologies and billions of objects in order to support intelligent decisions, realization and remote control of different objects [1, 2].

Internet of Things (IoT) technologies have improved production efficiency and the quality of human life. These technologies address many of the challenges humans face today, such as population growth, energy concerns, and the growing demand for better ways to sense our environment [3].

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Currently, The rapid development of the Internet of Things (IoT) has enabled ubiquitous connectivity between machines through wireless communication, an increasing number of practical applications can be found in many fields including security, monitoring asset management, agriculture, smart meters, smart cities and smart homes [4], smart transportation, garbage monitoring, etc. IoT devices sense surrounding information and share it with each other as well as with humans to provide services [5].

IoT applications have specific requirements such as long range, low data rate, low power consumption and cost effectiveness [6]. Widely used short-range radio technologies (eg, ZigBee, Bluetooth) are not suitable for scenarios that require long-range transmission. Solutions based on cellular communications (for example, 2G, 3G and 4G) can provide wider coverage, but they consume too much power on the devices. Therefore, the demands of IoT applications have led to the emergence of a new wireless communication technology: Low Power Wide Area Network (LPWAN).

LPWAN operates in licensed and unlicensed frequency bands, and is preferred in many use cases due to its low power requirements, low cost (the cost of a radio chipset being less than $2 and an operating cost of €1 per device per year) as well as its ability to achieve long-range communication between 10 and 50 km in rural areas and 0.3 to 5 km in urban areas [7]. In addition, it is very energy efficient (i.e. 10+ years of battery life). Among the technologies of low energy consumption wide area networks (LPWAN) operating on license-free spectra, we can mention among others Lora AND Sigfox then those operating on licensed spectra such as NB-IoT and LTE-M which are proposed solutions by cellular network operators. The unique benefits of LPWAN have attracted many researchers to perform further study on them. In this article we will talk about the different studies made by researchers on Nb-IoT and TLE-M technology and make a comparison between the two in order to draw a conclusion and talk about our next work.

2. The specificities of NB-IoT technology

NB-IoT is a narrowband IoT technology specified in 3GPP Release 13 in June 2016 that enables the deployment of Internet of Things (IoT) devices and services. It is designed to meet most IoT requirements, such as very good internal coverage, very low-cost connectivity and low power consumption, as well as supporting a large number of devices. connected devices. It is often used for applications such as smart meters, smart parking and asset tracking, it can also be used for more complex applications such as smart cities and autonomous vehicles [8]. Operating on licensed spectrums, NB-IoT uses the same frequency bands as LTE subdivided into 12 subcarriers of 15 kHz each in the downlink (DL) by the OFDM access method and

3.75 or 15 kHz in the uplink (UL) using the single-carrier FDMA (SC-FDMA) access scheme. It is also important to note that NB-IoT uses a PSK which is the same modulation technique used in LTE [9].

One of the many advantages of NB-Iot is the ease with which it can be deployed. It can be deployed on any available frequency spectrum as long as there is at least 200 kHz of available bandwidth. This advantage notably makes it easy to use on the LTE network, for example. Indeed, this results in three possible operating modes depending on the location of the block in the LTE spectrum. The three modes of operation include:

- In-band operation corresponds to deployment within the LTE band by occupying a Resource Block for NB-IoT communications. In other words, NB-IoT communications are transmitted in the same frequency band as LTE communications.

- Guard-Band operation, the NB-IoT signal is transmitted outside the LTE frequency band using unused spectral resources.

- Standalone operation, the possible scenario of which is the use of the GSM frequencies currently used. With their 200 kHz bandwidth, there is still a 10 kHz guard interval left on both sides of the spectrum.

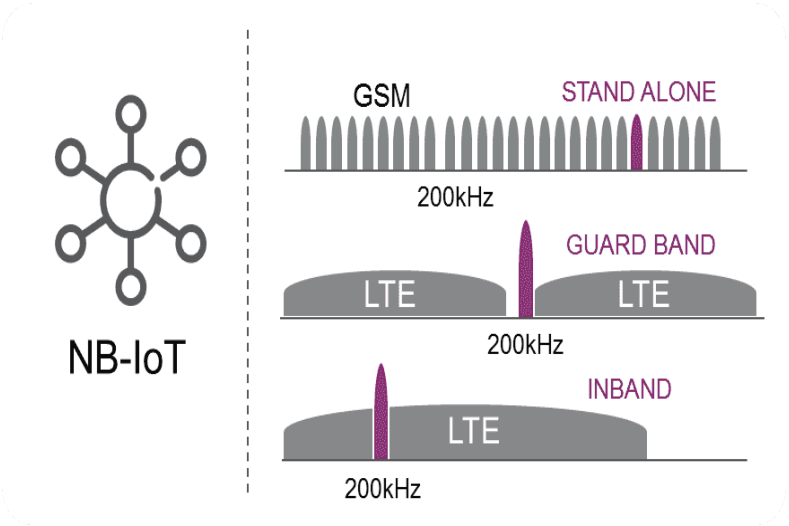

Fig-1: NB-IoT deployment modes (source Ericsson).

3. The specificities of LTE-M technology

The LTE-M standard stands for "Long Term Evolution of Machines". It was adopted by the 3GPP organization in 2016. It is part of the LPWAN cellular networks and allows telecom operators to operate in the field of the Internet of Things (IoT) using existing cellular networks such as 4G. LTE-M benefits from all the features offered by 4G such as real-time connectivity and international roaming [10]. LTE-M facilitates the exchange of enriched data (Data, Voice, etc.) with objects whether they are on board or in industrial sites. This technology is designed for the IoT and dedicated to connected objects, LTE-M uses low frequencies and a protocol (CAT-M1) to optimize the accessibility of objects [2]. This solution thus appears reliable and sustainable for many years to come since it will eventually be integrated directly into 5G.

Unlike other LPWA connectivity, LTE-M does not require the physical deployment of antennas. Indeed, only a software update of the antennas is necessary for the objects to have access to the LTE-M network. Penetration in buildings is very important and allows connection in hard-to-reach places such as car parks or elevators.

Thanks to this technology, connected objects also have a greater autonomy, which can range from 5 to 10 years. LTE-M provides access to voice in addition to data and SMS exchanges, which could be useful in elevator-type emergency service applications [11].

4. Comparison Nb-IoT and LTE-M

As we defined earlier, both NB-IoT and LTE-M are the origin of wireless network communication technologies, particularly developed in favor of the Internet of Things for LPWAN networks. The two technologies are complementary and represent an effective solution for IoT, especially over large distances [12]. However, LTE-M and NB-IoT differ in terms of their respective functionalities, in particular concerning throughput and latency, their cost is also to be taken into consideration.

Throughput represents the amount of data exchanged during a specific time. This is essential to guarantee the good functionality of the network and in this case of the service. At this level, LTE-M offers a speed of 375kb/s against 50Kb/s only for NB-IoT.

Latency or response time is the response time between data collection and transmission. Note that the lower the latency, the better the quality of service. At this level, NB-IoT technology offers the highest latency, up to 1 second, unlike LTE-M which has a lower latency of 10 ms.

	LTE-M	NB-IoT
Max. System Bandwidth	1.4 MHz	200KHz
Peak Data Rate	1 Mbps	~ 200 Kbps
Latency	50 – 100 msec	1.5 – 10 seconds
Power Consumption	Best at medium data rate	Best at low data rate
Mobility	Yes	No, stationary only
Voice	Yes	No
Antenna	1	1

Fig-2 : NB-IoT vs LTE-M [12].

5. Conclusion

The LPWAN network is a solution to overcome the problems caused by connected objects concerning long-range transmissions and low energy consumption. Indeed, our study was based on these two flagship technologies which are NB-IoT and LTE-M. In this article, we have to discuss the specificities of these two standards, in terms of their technical performance, the prospects of their frequency band, their method of communications as well as their difference in speed and latency. Thanks to this study, we can say that NB-IoT and LTE-M are both complementary, and the choice between the two is made according to our needs. For example, NB-IoT offers a much more efficient solution that accommodates parking management using a centralized system. While LTE-M stands out as the appropriate solution for sending both geolocated information and telematics data (vehicle status, tire inflation, fuel consumption, speed) in real time and all places.

Therefore, our next study will focus on how to manage the thousands of objects connected by the NB-IoT.

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