COMPARATIVE ANALYSIS OF LONG-RANGE WIRELESS TRANSMISSIONS FOR IOT APPLICATIONS FOR INDUSTRIAL PRACTICE

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Abstract
This article arose out of necessity for fundamental technology differentiation in terms of progressive approaches in production system. In this paper we deal with major technology solutions for data transmission in context of IoT and low-powered long-range technology. In first part of this paper we illuminate the leading transmitting technology on the market followed by qualitative comparison in the next chapter. In conclusion we are summing up the reached results followed by discussion on the topic.

Keywords:
Comparative Analysis, LoRa, LoRaWan, NB-IoT, Overview, SigFox

1 Introduction

With the reference to Luvisotto et al. (2018), Low-Power Wide-Area Networks (LPWANs) have recently emerged as appealing communication systems in the context of the Internet of Tings (IoT) (Luvisotto *et al.*, 2018). In era of IoT there is only one question left. In terms of new system of communication, with sight on efficiency of energy and performance, in industrial enterprise or even very popular start up projects, as researchers, protectants, designers, or managers we have to think about the issue, which necessarily leads us to ask: *"Which technology for long range wireless transmission is most suitable for specific kind of project?"* Sigfox, LoRa, and NB-IoT are the three leading technologies on the market. In this paper we focus on technology description and their comparation across available manufacturers.

2 Materials and Methods

In following materials, we describe briefly basic knowledge about the technology as it is presented by manufacturers. Also, main method used in this paper is analysis of qualitative properties of highlighted technology. We focus on Proprietary vs. Open Source aspect, key technology provider, area range, or bandwidth, and data transfer.

2.1 Applications

According to Luvisotto et al. (2018) in article *On the Use of LoRaWAN for Indoor Industrial IoT* Applications, we refer simple but garrulous figure which describes behaviour or simple data flow of long-range wireless transmissions for IoT applications in industrial conditions.

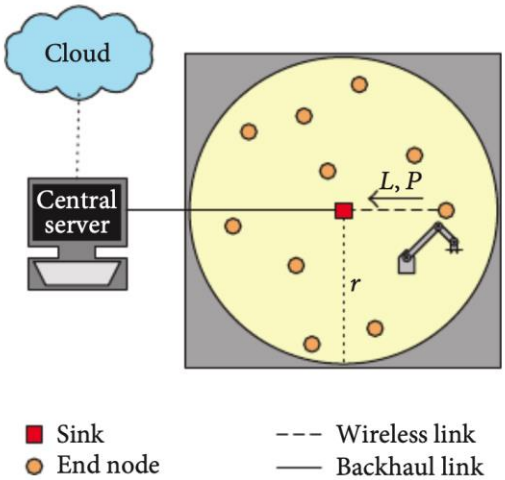

Figure 1 *A schematic representation of the indoor industrialmonitoring scenario (Luvisoto et al., 2018)*

It is clear that data flow consists of sensor, central server, cloud, but we highlight also wireless link and backhoul link. According to Luvisotto et al. (2018) LPWANs are designed to offer affordable connectivity to a high number of low-power devices distributed over large geographical areas. In this section, the most widespread LPWAN solutions are discussed, with a particular focus on LoRaWAN.

We provide authors description of the Figure 1: *„As can be seen, it refers to a monitoring network* composed by N devices (end nodes) deployed in a building where an industrial process is taking place. The devices are distributed within a circular area of radius r and periodically sample different physical quantities that allow monitoring the state of the process. Each node sends the updated sample value as a message of L bytes, with a transmission period of P seconds, to a sink node installed at the center of the building, which will be either a GW in a LoRaWAN network or, more generally, a PAN coordinator in a WPAN. The sink will in turn send the data received from the end nodes to a central server. This configuration resembles that of industrial wireless sensor networks deployed in monitoring systems.(Luvisotto et al., 2018)"

According to Rizzi et al. (2017), in industrial applications, the protocol complexity is moved into a centralized manager that regulates the behaviour of each node, which is simple and low cost. The manager constantly checks the whole network status (collecting for instance health reports from the nodes) and schedules communications with the aim of avoiding or at least limiting contentions (Rizzi *et al.*, 2017). Understanding this architecture is easy enough but crucial for designing future Industry 4.0 application. Therefore, we can move forward to specific manufacturers and products.

2.2 LoRaWAN

LoraWAN is network for Lora applications developed by Lora Alliance. On the other hand, LoRa is a spread spectrum modulation technique derived from chirp spread spectrum technology. LoRa is proprietary, open technology patented by company Semtech. A presented on Semtech.com (2019) it focuses on devices and wireless radio frequency technology with a long range, low power wireless platform that has become the de facto technology for Internet of Things (IoT) networks worldwide (Semtech.com, 2019).

LoRa mainly operates on free bands (e.g., unlicensed bands) worldwide, including 433, 868, and 915 MHz. The LoRa network basically comprises four sections: the terminal (built-in

LoRa module), gateway (or called base station), server, and cloud. The LoRa network also supports two-way transmission of application data (Arrow.com, 2017).

Sforza (2010) describes Lora as a physical layer technology that modulates the signals in sub-GHZ ISM band using a proprietary spread spectrum technique (Sforza, 2010).

LoRa Technology itself offers compelling features for IoT applications including long range, low power consumption and secure data transmission. The technology can be utilized by public, private or hybrid networks and provides greater range than cellular networks. LoRa Technology can easily plug into existing infrastructure and enables low-cost battery-operated IoT applications. Semtech builds LoRa Technology into its chipsets which are incorporated into devices manufactured by a large ecosystem of IoT solution providers, and connected to networks around the globe (Semtech.com, 2019).

2.3 SigFox

Sigfox employs the differential binary phase-shift keying (DBPSK) and the Gaussian frequency shift keying (GFSK) that enables communication using the Industrial, Scientific and Medical ISM radio band which uses 868MHz in Europe and 902MHz in the US. It utilizes a wide-reaching signal that passes freely through solid objects, called "Ultra Narrowband" and requires little energy, being termed "Low-power Wide-area network (LPWAN)". The network is based on one-hop star topology and requires a mobile operator to carry the generated traffic. The signal can also be used to easily cover large areas and to reach underground objects (Dregvaite and Damasevicius, 2016).

To brief summing up SigFox operate on proprietary LPWAN with limited free data transmissions. Approximately 140 a day transfers can be transmitted free of charge. That seems to be sufficient for some of tracking applications.

2.4 NB-IoT

With reference to gsma.com (2017), Narrow Band-Internet of Things (NB-IoT) is a standards-based low power wide area (LPWA) technology developed to enable a wide range of new IoT devices and services. NB-IoT in comparation to other manufacturers significantly improves the power consumption of user devices, system capacity and spectrum efficiency, especially in deep coverage. Also, NB-IoT is supported by all major mobile equipment, chipset and module manufacturers. According to the source, NB-IoT can co-exist with 2G, 3G, and 4G mobile networks. It also benefits from all the security and privacy features of mobile networks, such as support for user identity confidentiality, entity authentication, confidentiality, data integrity, and mobile equipment identification (gsma.com, 2017).

To conclude, NB-IoT operates on already build 2G, 3G, and 4G network. This means that NB transmissions are not free of charge. The charge depends on the owner of the telecommunication technology, in Europe it is widely known as Telekom, Orange, or Vodafone.

3 Results

We present the results in following table and diagrams. We found out that application of specific technology may affect final result of quality of appliance. Nevertheless, meaning of quality is questionable but in general we mean final working application with specific purpose. As we can see on the Table 1, we have to think first, what is the purpose of the application, and then pick suitable technology in meaning of effectiveness of costs and quality

Table 1 Comparation of the technology properties

	LoRaWAN	NB-IoT	SigFox
Bandwith	125 and 250kHz	200kHz	100Hz
Max Data rate	50kbps	200kbps	100bps
Max day transmisions	unlimited	unlimited	140
Max lenght	243b	1600b	12b
Range	5-20km	1-10km	10-40km
Interference snsitivity	very low	high	very low
Encryption	yes	yes	no
Standard	LoRa-Alliance	3GPP	SigFox-based network

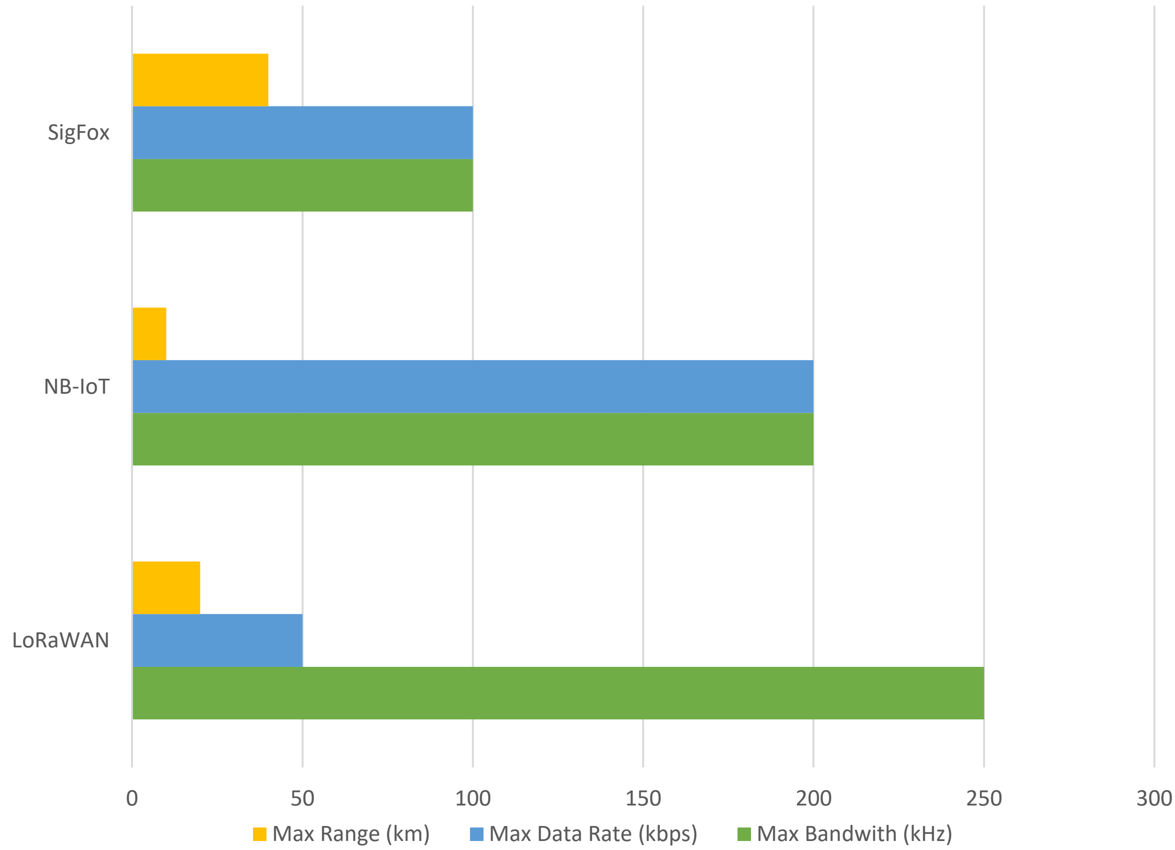

Figure 2 *Visualization of the comparation*

4 Discussion

In this paper we briefly highlighted the main properties that can affect possible IoT applications as is the area range, mobility of the object, or the necessary data transfer. The IoT factors and the technical differences between Sigfox, LoRa and NB-IoT determine their feasibility for specific applications. One technology cannot serve all IoT applications. Various applications are listed in this section as a summary of the best applications. We know that another suitable application is: smart building, smart farming, smart traffic, but in our case smart manufacturing in terms of Industry 4.0, and smart logistics. IoT is just the begging of the new area of the smart and self-sufficient objects in our daily production life and it was the reason to provide this overview.

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