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Long Distance Communication Analysis of Perfectness

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Abstract

Recent market studies show that the market for remote monitoring devices of different medical parameters will grow exponentially. Globally, more than 4 million individuals will be monitored remotely from the perspective of different health parameters by 2023. Of particular importance is the way of remote transmission of the information acquired from the medical sensors. At this time, there are several methods such as Bluetooth, WI-FI, or other wireless communication interfaces. Recently, communication based on LoRa (Long Range) technology has had an explosive development that allows the transmission of information over long distances with low energy consumption. The implementation of the IoT (Internet of Things) applications using LoRa devices based on open Long Range Wide-Area Network (LoRaWAN) protocol for long distances with low energy consumption can also be used in the medical field. Therefore, in this paper, we proposed and developed a long-distance communication architecture for medical devices based on the LoRaWAN protocol that allows data communications over a distance of more than 10 km.

1. Introduction

long distance communication may be perfect or may not be perfect. It may be reliable or non reliable. Reliable is one which gives perfectness. For example wired communication is reliable, whereas wireless communication is non reliable. Wired communication uses some protocols like ARP or other and gives feedback of error problems. If there is error it tries to retransmit the message again. Whereas in wireless the feedback or protocol is not provided, Hence it is non reliable communication.

With the exponential development of sensor technology and embedded devices, a wide range of gadgets/devices/wearables have been developed in order to monitor different health parameters. The studies show that the market for remote monitoring devices of different medical parameters will grow exponentially. Thus, Juniper Research Company predicted that the market for devices such as remote patient monitoring, In another study,, more than 4 million individuals will be monitored remotely from the perspective of different health parameters

The Internet of Things (IoT) concept originates back to 1982 when a soft drink machine was connected to the Internet, thus being able to report what drinks it contained but also whether they were cold or not . Later, in 1991, a contemporary view of the IoT in the form of a ubiquitous computing technique was given by Mark Weiser; however, in 1999 Bill Joy gave a clue as to what device-to-device communication could mean on the Internet of Things . In the same year, Kevin Ashton, a technology pioneer and co-founder of the

Massachusetts Institute of Technology's Auto-ID Center, proposed the term "Internet of Things" to describe a system of interconnected devices.

The basic idea of the IoT is based on the autonomous exchanges of useful data between different embedded devices around us like sensors and devices , based on technologies such as Radio-Frequency Identification (RFID) and Wireless Sensor Networks (WSN) . This data is reported by the sensor devices and subsequently processed for decision-making, based on an automated action performed . Thus, IoT appeared in order to process and store data remotely, and this led to the development of communication and sensor technologies. This also emerges from the large number of research articles that have as object of study the integration of IoT in different fields, starting from applications in the field of automotive, smart cities, logistics, etc., and finally reaching the medical field.

The "things" in the Internet of Things include physical devices with microcontrollers, digital communication transceivers, and stack protocols to make communication with each other and users possible. The Internet of Things (IoT) has found its applicability in various areas, such as smart cities, smart homes, smart agriculture, interconnected buildings and campuses, healthcare, logistics, etc. The Internet of Things aims to integrate the physical world with the virtual world using the Internet as a medium to communicate and exchange information. The IoT is defined as a system of interdependent computing devices, mechanical and digital machines, objects, animals, or humans that have a unique identifier and the ability to transfer data over a network without the need for human-to-human or human-to-computer interaction.

The evolution of the IoT starts from "Internet of People" to "Internet of Things" and through "Internet of Everything". In 2025, it is estimated that the number of IoT devices will be around 41.6 billion and will generate 79.4 zettabytes with an annual growth rate of 28.7% from 2018 to 2025].

There are many types of Low-Power Wide-Area Networks (LPWANs), where the range and computational power are the key parameters such as

High-range high-power include 2G, 3G, 4G, and 5G;

Low-range high-power include Ultra-wideband and WI-FI;

Low-range and low-power applications include Bluetooth, ZigBee, Near-Field Communication (NFC), and Bluetooth Low Energy (BLE);

High-range low-power devices include LoRa (Long Range), SigFox, LTE-M, and NB-IoT.

A key area of interest in this paper is the implementation of the IoT applications in the medical field based on Long Range Wide-Area Network (LoRaWAN) protocol for long distances with low energy consumption using LoRa technology. This technology offers an efficient, flexible, and economical solution to real-world problems in urban, rural, and indoor use cases, where cellular and Wi-Fi/Bluetooth Low Energy (BLE) based networks are ineffective.If we refer to the world problem that exists regarding this Covid pandemic, we can say that the data transmission over long distances based on LoRaWAN technology can be a solution of the future and very viable and helpful not only in the healthcare field but also in fields such as automotive, industrial, smart buildings, and in many others.The aim of this paper is to design, develop and analyze a long-distance communication architecture for medical devices based on the LoRaWAN protocol.

2. Related Works

FLoRa represents a wireless communication modulation technique, which uses a variation of Chirp Spread Spectrum (CSS—is a spread spectrum technique, where information is spread out by encoding the information onto a chirped signal which is a linear frequency sweep) to transmit messages. Many older wireless systems use Frequency Shift Keying (FSK) because it is effective for low power but LoRa offers the possibility of communicating using Gaussian Frequency Shift Keying (GFSK). Thus, we work with frequencies under the order of GHz in the unlicensed Industrial, Scientific, and Medical (ISM) band, such as 868 MHz in Europe, 915 MHz in North America, and 433 MHz in Asia]. LoRa as well as other wireless technologies using unlicensed ISM bands are limited by duty cycle (1% of communication time in Europe).

LoRa is also based on Chirp Spread Spectrum (CSS) technique, which maintains the same low power characteristics as FSK modulation but significantly increases the communication range. As I say, the transfer rate of the technology is between 300 bps and 50 kbps and it depends on the spread factor and the bandwidth of the channel. Moreover, messages transmitted using different spreading factors can be received simultaneously by LoRa base stations. The maximum payload length for each message is 243 bytes . The Long Low-Power Wide-Area (LPWA) systems operating in the Industrial, Scientific, and Medical (ISM) band have a limited transmission power of 14dBm whereas the transmission power in the cellular bands is from 20 to 23 dBm. The CSS technique has been used in military and space communications for decades, due to the long communication distances that can be obtained and robustness to interference, but LoRa is the first low-cost implementation for commercial use.

In conclusion, the advantage of the LoRa technology is the ability to cover long distances; thus, a single gateway or base station can cover entire cities or hundreds of square kilometers. The range of coverage depends largely on the environment or obstacles in a given area, but LoRa technology and open LoRaWAN protocol have greater coverage than any other standardized communication technology .

The network protocol and architecture have the greatest influence in determining the battery life of a node, the network capacity, the quality of service, the security and the variety of applications served by the network. The environmental access control mechanism offered by LoRaWAN protocol allows several end devices to communicate with a gateway using LoRa modulation .

For any Low-Power Wide-Area communication network, it is extremely important to incorporate security. LoRaWAN uses two levels of security: one for the network and one for the application. Network security ensures the authenticity of the network node, while the security level of the application ensures that the network operator does not have access to the end-user application data.

There are trade-offs in every technology choice, but the features of the LoRaWAN specification in network architecture, the device classes, security, and mobility optimization, address the widest variety of potential IoT applications.

The results obtained in the IoT domain and LoRaWAN-based communications so far have been disseminated for the Internet of Things and for the LoRaWAN-based communications protocol in the research papers such as .

After great research efforts in the field, many solutions have been proposed for transmitting data and parameters either medically or from sensors, which are transmitted either via Bluetooth, USB, Wi-Fi, GSM, or serial (which allows the transmission or reception of data on short distances), but there are very few solutions or proposals for

remote and real-time transmission. This article comes with an architectural proposal that is based on remote transmission using LoRa technology.

5. Conclusions

In this paper, we proposed a long-distance communication architecture based on LoRaWAN Protocol, which is dedicated to long-term health monitoring of users/patients in urban/rural environments without assistance and is integrated into a broader IoT infrastructure.. The connectivity with the system can be made using Bluetooth Low Energy (BLE) or LoRaWAN® module to connect the device with a smartphone or other mobile device that can display the acquisition of vital signals.

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