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LoRa Technology - DNA of IoT

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ABSTRACT

Although many techniques exist to transfer data from the widely distributed sensors that make up the Internet of Things (IoT) (e.g., using 3G/4G networks or cables), these methods are associated with prohibitively high costs, making them impractical for real-life applications. LoRa (Long Range) modulation together with LoRaWAN (LoRa Wide-Area Networks) communication protocol can represent a suitable candidate ensuring a high level of performance in wireless technologies. The objective is to contribute toward the realization of LoRa as a viable communication technology for applications that needs long-range links and deployed in a distributed manner. The LoRaWAN networks are the evolution of wireless sensor networks directed to the IoT concept, which entails sensor connectivity to the Internet. LoRa technology is summarized by reviewing some aspects regarding the architecture, security and application of the technology.

KEYWORDS: *LoRa; wireless communications; LPWAN; LoRa (Long Range) modulation; WSN; Internet of Things;*

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I. INRODUCTION

Short-range communication technologies, such as Wireless Sensor Networks (WSN) networks have been considered as a viable solution for implementing specific Internet of Things (IoT) services. These standards are based on multi-hop routing protocols. The limited communication range is a major drawback. A promising alternative to these multi-hop WSN networks consists in the use of communication technologies in the unlicensed ISM frequency band called sub-GHz Low-Power Wide Area Networks (LPWANs).These communication protocols are characterized by long-range radio links [3]

The Internet of Things (IoT) is a fast-growing heterogeneous network of connected sensors and actuators attached to a wide variety of everyday objects. Mobile and wireless technologies in their assortment of low, ultra-power, short and long range technologies continue to drive the progress of communications and connectivity in the IoT. The future will foresee smart and low-power networked devices connecting to each other and to the Internet using, mostly, reliable low-power wireless transmissions.[1] LoRaTM (Long Range) is a modulation technique patented by Semtech , developed by Cycleo company (Grenoble, France). LoRa technology is utilized by public, private or hybrid networks.

II. Challenges in IoT

The main obstacles that hinder the development of the IoT concept are:

Connectivity: The main challenge faced by this concept consists in assuring the interconnectivity between the devices built by different manufacturers. The main goal is to ensure the interconnectivity of the various data formats on a worldwide scale. Equally vital is the analysis of the standards used nowadays in the IoT concept.[3]

Efficient energy management: Most WSN modules are battery powered, and thus there is a constant need to reduce the energy consumption. Since the cost of these devices is rather low, the battery replacement cannot be considered efficient. This entails the development of sophisticated communication strategies focused on energy efficiency.[3]

Security: The provision of high security levels should definitely be taken into account. Thus, it is highly necessary to develop new authentication and encryption protocols that are able to use limited WSN node specific hardware resources.[3]

Complexity: The integration of the communication capabilities is also a highly complex task. Researchers are now looking for new ways to increase the efficiency and facilitate the programming of these modules.[3]

III. LoRa Features

Long Range: A single LoRa base station enables deep penetration capability for dense urban environments and indoor coverage, while also providing the ability to connect to sensors more than 15-30 miles away in rural areas.[7]

Low Power: The LoRaWAN protocol was developed specifically for low power and enables unprecedented battery lifetime of up to 20 years depending on the application

Low Cost: LoRa reduces upfront infrastructure investments and operating costs, as well as end-node sensor costs. [7]

Standardized: LoRaWAN ensures interoperability among applications, IoT solution providers and telecom operators to speed adoption and deployment.

Different technology comparison is given in below Table 1

Table1: Technology Comparison Matrix

Parameters	RFID	Bluetooth	Wi-Fi	LoRa
Coverage	3m	100m	20m	<20 km
Data Rates	400kbps	1 Mbps	100Mbps	300Kbps
Operating Frequency	13.56MHz	2.4GHz	2.4GHz	<1 GHz
Power Consumption	Very Low	High	Low-High	Low
Topology	Point to Point	Star	Star	Mesh, Star
Communication	One way	Two Way	Two Way	Two Way
Cost	Low	Low	Average	Low

IV. LORAWAN

The LPWAN (Low Power Wide Area Network) networks are the evolution of wireless sensor networks directed to the IoT (Internet of Things) concept, which entails sensor connectivity to the Internet.[1] The LoRaWAN open specification is a low power, wide area networking (LPWAN) protocol based on LoRa Technology. It is designed to wirelessly connect battery operated things to the Internet in regional, national or global networks; The LoRaWAN protocol leverages the unlicensed radio spectrum in the Industrial, Scientific and Medical (ISM) band. The specification defines the device-to-infrastructure of LoRa physical layer parameters and the LoRaWAN protocol, and provides seamless interoperability between devices. [2]

LoRaWAN Architecture

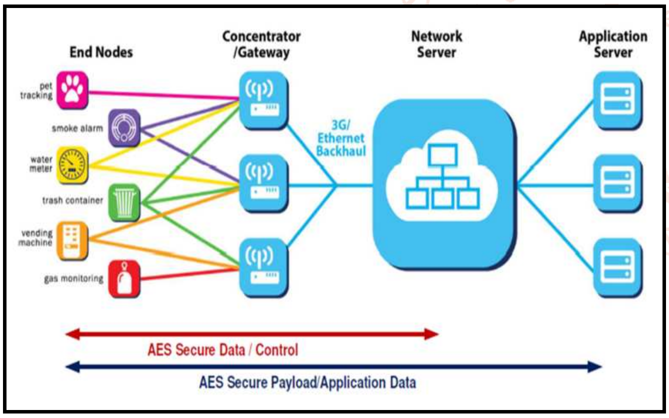

Figure1: LoRaWAN Architecture

Transceivers & End-Nodes: Transceivers configured with LoRa Technology are embedded into end-nodes, or sensor devices, designed for a multitude of industry applications. The communication between End Nodes and Gateway modules is done on different channels with different data rates. The selection of the data rate is a compromise between the distance over which communication is to be achieved and the payload of the packet. [1]

Gateways: Sensors capture and transmit data to gateways over distances near and far, indoor and outdoor, with minimal power requirement. At the base of a Gateway module sits a LoRa concentrator which is a multi-channel demodulator able to decode all versions (obtained by varying the SF parameter) of modulation Lora on several frequencies in parallel. A standard LoRa End Node can decode only one SF modulation over a single frequency. [1]

Network Server: Gateways send information via Wi-Fi, Ethernet or cellular to the network server, which is responsible for network management functions like over-the-air activation, data de-duplication, dynamic frame routing, adaptive rate control, traffic management, and administration.[1]

Application Servers: Applications interpret the data collected by LoRa-enabled devices, applying techniques like machine learning and artificial intelligence to solve business problems for a Smarter Planet.[2]

V. LoRa Device Classes

Class A: Class A devices have bidirectional communication capabilities. The time slot during which the device is transmitting is followed by two short time slots during which the device can receive information.[1]Class A devices ensure the highest energy efficiency. These are the most energy efficient class but have the biggest latency time. It also includes devices that do not need to transmit data all the time. All the LoRaWAN-capable devices must support the functionalities of this class.[2]

Class B: Devices have bidirectional communication capabilities and an additional time slot that allows them to receive data. Device can also use a series of receiving slots activated by a Beacon type of message sent by the Gateway. These are energy efficient but with a latency-controlled downlink. The communication is slotted, synchronized by an external beacon, which allows the server to know when the end device is listening.[2]

Class C: Devices have bidirectional communication capabilities and time slots during which they can receive unlimited information. The only time when a class C device cannot receive information is when it sends it. The end devices of Class C have almost continuously open receive windows, which are only closed when transmitting. [2]

The LoRa communication operates in the unlicensed frequency band [6]. Below Table 2 represents different LoRa frequency band in various countries.

Table2: LoRa Frequency Band

Country	Frequency Range(ISM Band)
EUROPA	863-870MHz
US	433MHz
China	779-787MHz
Australia	915-928MHz

LoRa Security is the most important part of any IoT solutions. LoRaWAN protocol uses 128 bit AES encryption keys assigned to each node.

LoRaWAN has two cryptographic protection levels; one located at the application level and the other located at the network layer. The network level is responsible for authenticating the data received from the End Node. The sender node is verified by a 128 bit AES secret key shared between the device and the server. Application level is responsible for ensuring data integrity between application and terminal nodes. [2]

LoRaWAN provides encryption protocol for packets using a symmetric key known by End Node and Network Server. Each node has two encryption keys, one for the network level and one for the application layer.[1]

VI. LoRa Application

Agriculture: From measuring environmental conditions that influence crop production to tracking livestock health indicators, Internet of Things (IoT) technology for agriculture enables efficiencies which reduce environmental impact, maximize yield and minimize expenses [6]

Asset Management: LoRa Technology makes it easy and affordable for smart supply chain and logistics to track highly valued assets that are in transit. Due to LoRa Technology's long range and low power consumption qualities and GPS-free geolocation abilities, cargo, vehicles and other assets can be easily monitored over large geographic regions and within harsh environments.[7]

Smart City: Everyday municipal operations are made more efficient with LoRa Technology's long range, low power, secure, and GPS-free geolocation features. By connecting city services such as lighting, parking, waste removal, and more, cities can optimize the use of utilities and personnel to save time and money. [7]

Smart Buildings: LoRa Technology's low power qualities and ability to penetrate dense building materials make it an ideal platform for IoT-connected smart home and building devices. In addition, the long range capabilities make it possible for LoRa®-enabled sensors to track assets that stray from home.[7]

VII. Conclusion

To enable the IoT vision of extending communications to anything and anywhere, the Internet must support connecting things using a variety of wireless and mobile technologies. The Internet of Things (IoT) concept entails the connection of various devices to the Internet, thus providing remote monitoring and control services. The LoRaWAN communication protocol can be considered the future of IoT concept. The use of the unlicensed communication band and high communication distances are some of this technology unsurpassed advantages.

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