LoRaWAN Energy Optimization with Security Consideration

Ala Khalifeh[1], Khaled Aldahdouh[1] and Sahel Alouneh[1,2]
[1]School of Electrical Engineering and Information Technology, German Jordanian University, Jordan
[2]College of Engineering, Al Ain University, UAE

Abstract: *Long Range Wide Area Network (LoRaWAN) is an emerging wireless technology that is expected to be widely deployed and implemented in several applications, especially with the promising widespread use of the Internet of Things (IoT) and its potential applications within the Fifth Generation (5G) communication technology. LoRaWAN consists of a number of nodes that monitors and senses the environment to collect specific data, and then sends the collected data to a remote monitoring device for further processing and decision-making. Energy consumption and security assurance are two vital factors needed to be optimized to ensure an efficient and reliable network operation and performance. To achieve that, each of LoRaWAN nodes can be configured by five transmission parameters, which are the spreading factor, carrier frequency, bandwidth, coding rate and transmission power. Choosing the best values of these parameters leads to enhancing the network deployment. In this paper, we shed the light to the security aspect in LoRaWAN network. Then, we introduced an algorithm that depends on the reinforcement learning approach to enable each node in the network to choose the best values of spreading factor and transmission power such that it leads to a lower energy consumption and higher packets' delivery rate. The results of the simulation experiments of our proposed technique showed a valuable increase in the packet reception rate at the gateway and a significant decrease in the total consumed energy at the end nodes compared with the most related work in literature.*

Keywords: *LoRaWAN, transmission parameters, reinforcement learning, power consumption, Security, Confidentiality, Authentication.*

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1. Introduction

Nowadays, remote monitoring systems became a necessary requirement in many applications and systems, especially with IoT services. Furthermore, the revolution in semiconductors and microelectronics helped to design enhanced modules, which can be used to overcome the limitations of the current remote monitoring applications [8]. Fifth Generation (5G) is the revolution that supports the future of IoT applications, where more than 50 billion nodes will be connected to the internet [16]. It is expected that the future connected IoT density will exceed 10^6 nodes per km^2 [6]. Many wireless technologies have been examined to implement remote sensing and monitoring applications in the fifth generation of communication systems. Low Power Wide Area (LPWA) technologies like LoRaWAN, SigFox, and Narrow Band IoT (NB-IoT) are good technologies, which are tested to be used within the Fifth Generation system [15].

LoRa technology was introduced in 2015 to meet the requirements of long communication range with low data rate. LoRa technology eliminate the need to use repeaters between the end device and receiver, which in turn leads to decrease the cost of the communication links between the sensor nodes and the gateway, reduce the power consumptions, and increase the lifetime of the network [14]. LoRa technology utilizes the Industrial, Scientific, and Medical (ISM) frequency band that varies between the regions (e.g., EU: 868MHz and 433MHz, USA: 915MHz and 433MHz) [14].

LoRa protocol utilizes Chirp-Spread Spectrum (CSS) modulation scheme to obtain lower consumed energy and longer communication range compared to other technologies. This modulation supports the communication over long distances due to its ability to overcome the noise and interference level in the communication link. Therefore, it is commonly used in several military applications. These specifications make LoRa technology proper to implement IoT networks [21]. It must be mentioned that LoRa is the Local Area Network (LAN), while LoRaWAN is the global protocol that connects LoRa networks [26]. Each one of LoRa nodes must be configured using five different transmission parameters. The values of these parameters determine the specifications of the network, in terms of bandwidth, transmission range and speed. These parameters are:

- Transmission Power (TP): It is the power of the signal transmitted from the node, its value ranges from -4 dBm to 20 dBm in 1dBm step, but due to the hardware constraints, its range becomes from 2dBm