Packet Drop and RSSI Evaluation for LoRa: An Indoor Application Perspective

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***Abstract*— LoRa is widely used in the Wireless networking sector because of the unique quality such as low power, low bit rate, long-range, and single-hop wireless communication system. With the advancement of the Internet of Things (IoT), LoRa is one of the most useful technology in comparison to other wireless networking technology such as Bluetooth Low Energy (BLE), Zigbee, and Wi-Fi. In this paper, we have considered the parameter of RSSI and packet drop in the indoor environment. For the LoRa we use the Adafruit RFM95W LoRa radio module for its ability to change bandwidth and Spreading Factor (SF). In our research, we use 915 MHz bandwidth and SF7. Subsequently, we also consider SF7, because theoretically the less the SF the more the packet drops. We tried to find out how many packets will be dropped in the indoor scenario with the short distance as the SF has a higher chance to drop more massages. We have sent 800 LoRa messages from the transmitter to the five different locating receiver end devices to learn about the RSSI and packet drop.**

Keywords—LoRa, RSSI, Packet Drop, IoT

I. Introduction

With the help of wireless technology, the Internet of Things (IoT) is improving day by day. The recent variety of emerging technology such as LoRa, Sigfox, NB-IoT is rethinking the IoT revelation [1]. Among these competition systems, LoRa is one of the best technologies which has more powerful facilities to improve the IoT system. LoRa is based on the chirp spread spectrum (CSS) modulation where the basic chirp signal increase linearly with time covering the entire LoRa bandwidth. The unique quality of the LoRa has witnessed great commercial growth in the indoor and outdoor environment [2]. Application of LoRa technology includes vehicle tracking, waste management, smart parking, smart city, street lighting, environment monitoring, and precision agriculture. With the help of the LoRa network, unmanned aerial vehicles (UAV) could be facilitated in urban and suburban environments. To the air-to-ground transmission in urban areas, the LoRa network can successfully operate for up to 1.8 miles [3]. Compared to the enormous success of LoRa in an outdoor application, indoor scenarios are yet to be explored. In today's IoT system, we mainly consider Bluetooth Low Energy (BLE), Zigbee, Wi-Fi, though LoRa has some unique quality in the indoor ecosystem to facilitate our daily life. To improve the smart building or smart city we must use LoRa wireless technology as LoRa has a low cost, low power consumption capabilities, wide-coverage, and transmitting and receiving data rate is high [8].

The rest of the paper is organized as follows: Section II describes the methodology for LoRa use in an indoor scenario with hardware and experimental model setup, Section III demonstrates the results and discussion of RSSI and packet drop. Finally, section IV presents the conclusion and the future work of the LoRa network in the indoor environment.

In LoRa communication, SF has the most influence. Lower SF decreases the energy consumption, time on air but cannot be achieved in the long range. Filip et al. stated that the Spreading Factor (SF) has the most vital issue on energy consumption, time on-air, and energy coverage in LoRa wireless communication system [4]. Researchers made a comparison on communication parameters such as Received Signal Strength Indicator (RSSI), Signal-to-Noise Ratio (SNR), and Time-on-Air (ToA) by analyzing over 6500 LoRa messages in the networking system of Croatia. Experimental results concluded that by the SF7, the bigger raise occurred on RSSI and SNR. Bobkov et al. conducted an experiment for SNR and RSSI for different floors and visualized using 433 MHz and 868 MHz non-licensee LoRa band [5]. It also considered the packet delivery ratio for the different spreading factors. In their experiment, they showed that signal strength is stronger to the 433 MHz LoRa module through a higher percentage of received packets by the 868 MHz LoRa module. Though to the experiments did not use the 915 MHz ISM band. Okuda et al. established research with multiple LoRa devices to measure RSSI values in a large building [6]. In this research, the LoRa system covers the maximum part of the building though they did not cover stairs and windows. Researchers also stated that their experimental results overlapping the frequency band for packet error rate.

II. Methodology

A. Hardware Setup

LoRa module of 433MHz and 868 MHz is non-licensed, and 915 MHz industrial, scientific and medical (ISM) radio bands are licensed [7]. We have considered to our research 915MHz licensed ISM LoRa bands module. To the indoor scenario, it is yet to explore by the 915MHz ISM radio bands. We use the Adafruit RFM95W LoRa radio and Arduino Nano module. Adafruit RFM95W LoRa radio has some more advantageous options over Adafruit RFM69W LoRa radio. To the Adafruit RFM95W LoRa radio module, we can

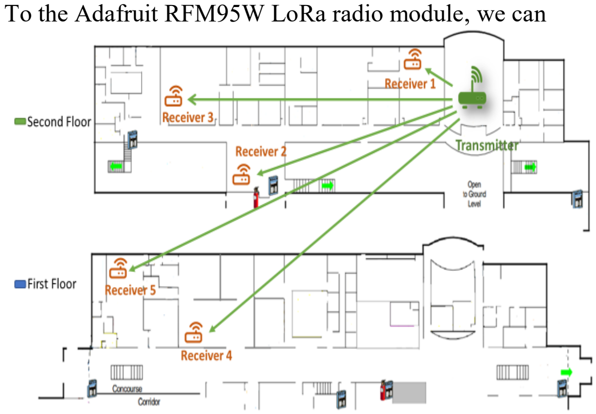

Figure 1: Experimental setup and placement of transmitter and receivers.

change bandwidth (31.25db, 125db, and 500db), also can change SF from 7- 12. By changing different bandwidth and SF, can get more accurate results from the research. We have considered bandwidth 125db and SF7 in our research.

B. Experimental Model Setup

The goal of the research is findings some parameters such as RSSI values and packet drop using the Adafruit RFM95W LoRa radio module in the indoor environment. For the indoor environment, we consider the Engineering and Technology (ET) building of Central Michigan University (CMU) and placed the receivers at five different locations as presented in Figure 1. Many walls and obstacles are available in between the transmitter to every receiver end device. We placed our transmitter device in the big hall room. From that place the distance of receiver 1, receiver 2. Receiver 3, receiver 4, receiver 5 is 15-meter, 45-meter, 65-meter, 75- meter, and 95-meter respectively. We have placed receiver 4 and 5 on the first floor, remaining receiver devices is placed on the second floor. Among all receiver devices, receiver 5 is set in the most corner of the building, where there are lots of walls and obstacles.

III. Results And discussion

Sending 800 LoRa messages from the transmitter device to the receiver devices, we get the ideas about RSSI values and packet drop. The fewer the obstacles and walls the less packet drop and better RSSI values, which we have seen to the receiver 2 end device. Receiver 2 Placed in the lobby, and from the transmitter to the receiver 2 has no way to stop messages sending by the transmitter. Figure 3 Showed the comparison between the most two parameters of LoRa which are RSSI value and packet drop. We have tested SF 7 and 125 bandwidths as, the lower the SF the better possibility to get

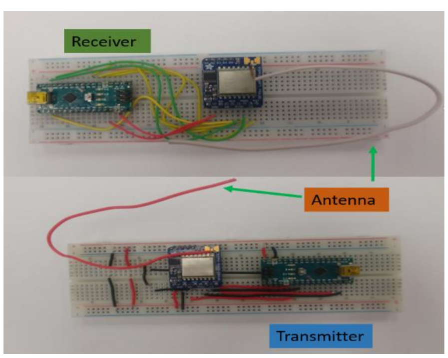

Figure 2: Transmitter and Receiver modules used in the test

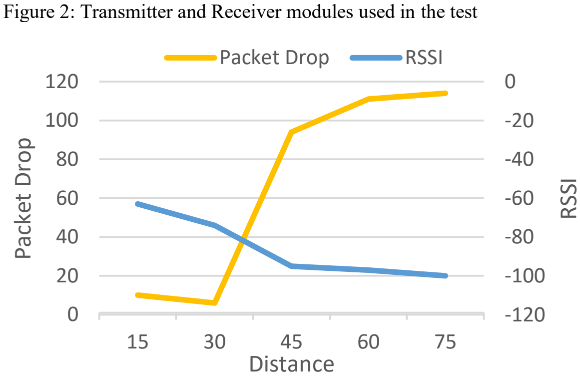

Figure 3: Comparison analysis for packet drop and RSSI

the more packet drop. As we completed our experiment within 100 meters, we tried to get better ideas about the packet drop and RSSI values with the short distance. The higher distance (for receiver 5) from the transmitter to the research which is placed in the corner of the building has the highest packet drop and RSSI values. As to the transmitter and receiver devices has lots of obstacles and congested areas. Transmitting LoRa messages need open space if it is required to send messages without loss.

IV. conclusion

LoRa is one of the most vital technology among the remaining wireless network technology for the Internet of Things (IoT) and Autonomous vehicles. Nowadays LoRa is not only used in the outdoor environment but also used in indoor scenarios such as smart cities, smart homes, etc. In-between the transmitter to the receiver end devices have lots of walls and obstacles. In this environment, we have tried to analyze the performance of RSSI, and packet drop of 915MHz LoRa licensed ISM band. This licensed 915 MHz LoRa module has opportunities to change SF and bandwidth. We have used SF7 and 125 bandwidths in this research, though in the future we can try to research with the remaining SF (8-12) and bandwidth. We also can try some experiments to the indoor situation and outdoor scenario for the longer distances. Moreover, we can make a compare the indoor resultant value with the outdoor values.

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