IMPLEMENTATION OF LORA WITH TEMPERATURE SENSORS IN IRRIGATION AREA (CASE STUDY: MARTAPURA CITY)

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Abstract

This study applies to the concept of a Wireless Sensor Network (WSN) consisting of a transmitting instrument and a receiving instrument using Long Range (LoRa) data transmission with a frequency of 915 MHz and LoRa 920 MHz. The test is divided into 2 tropical weather conditions, namely when the weather is sunny and rainy. The test results show that the maximum distance that the LoRa transmitter can reach is 1 kilometer. The QoS (Quality of Service) parameters used to consist of Delay, Throughput, RSSI, & SNR. Based on the test results of the QoS parameters, both frequencies affect tropical weather conditions and increase as the distance of data collection increases. LoRa Frequency 915 MHz and Frequency 920 MHz have their respective differences and advantages, which are uncertain on weather conditions and data transmission distances.

Keywords:*LoRa Protocol, Wireless Sensor Network, Quality of Service*

1. PRELIMINARY

Data transmission is the process of sending (spreading) data from the sender (transmitter) to the receiver (receiver). Data transmission occurs between the transmitter and receiver through several transmission media. The function of the data transmission and the transmission medium is important when used in some electronic equipment. The existence of data transmission to connect between the sender and receiver in order to communicate or exchange data, such as by telephone, computer, television, or radio. Along with the development, a concept emerged, namely Wireless Sensor Network (WSN), which can provide information between connected devices so that they can exchange or just send data. This WSN consists of a minimum of two nodes that are interconnected and exchange data over a wireless network. The node can consist of devices for monitoring or for forwarding received data. Therefore, in transmitting sensor data, it must be able to cover long distances, use low power and have the ability to withstand noise, for that reason, LoRa or Long Range data transmission technology is used.[1].

Panjaitan said "LoRa (Long Range) not only has low power, LoRa technology has resistance to noise or interference in the process of receiving and sending data. LoRa technology also has several different frequency variations and is also considered capable of overcoming these problems, because LoRa is a wireless communication system designed to send small data and offers long distance communication, also low power. LoRa technology can be used to monitor an object so that it requires an antenna to transmit”[2]. One of the LoRa radio frequencies (Long Range) is a type of radio frequency that has the ability to transmit data far away, namely 15 km, LoRa works at certain frequencies, namely 433 MHz, 868 MHz, 915 MHz, and 920 MHz, one of which is often widely used in Indonesia.[3].

The way a radio signal propagates from a radio transmitter to a radio receiver is very important when planning a radio communication network or system. Most are controlled by the region of the atmosphere they pass through. One of the factors that cause the signal path to disappear depends on the conditions or the weather. The conditions produced by different weather have an impact on the quality of radio signals in our environment. Amajama said “weather is a factor that affects the propagation of radio waves. Wind and rain can cause additional attenuation of signal propagation in the environment. Many wireless sensor networks operating outdoors are exposed to changing weather conditions, which can result in decreased system performance. Therefore,[4].

In general, it is important to identify the problems this effect poses for researchers when designing sensor networks that span long distances. However, to date the amount of literature on the impacts and effects of weather on the LoRa network is still limited[5]. One of the meteorological observations made by the Meteorology, Climatology and Geophysics Agency (BMKG) utilizes weather sensors to measure weather elements, among these weather elements are air temperature, humidity, and air pressure. For this reason, a reliable measurement method is needed to obtain accurate and fast data[6].

In a study conducted by Dvornikov, "the application of Long Range on a sensor network requires Quality of Service (QoS), which is a method of measuring how good the network is and is an attempt to define the characteristics and properties of a service so that the message is received. Simple QoS (Quality Of Service) such as bandwidth, packet error rate, packet delay, delay jitter”[7]. In addition, the research believes that RSSI (Received Signal Strength Indicator), SNR (Signal to Noise Ratio), and packet delay.

In this study, we will apply the concept of Wireless Sensor Network (WSN) to test the QOS (Quality Of Service) value by comparing the performance of LoRa data transmission at 915 Mhz and LoRa 920 Mhz frequencies as a medium for sending air temperature sensor data to tropical weather factors that include weather. sunny and rainy weather.

2. RESEARCH METHODOLOGY

The stages in this research can be seen in Figure 1.

Figure 1 Research Flow

2.1. Study of literature

Literature study was conducted to obtain information that supports the final thesis in the form of basic theories and concepts obtained from books, internet, and journals.

2.2. Hardware Design (Hardware)

The electronic components used in the test include the LoRa TTGO Esp32 module, air temperature sensor (DHT11), breadboard, and power supply. All electronic sensor components used are assembled using a breadboard and then jumper with cables from the breadboard to the LoRa TTGO Esp32 microcontroller with 915 MHz and 920 MHz frequencies. Time information is obtained from the microcontroller via internet wifi connection to retrieve real time. Parameters measured by air temperature sensor. The data is stored in the microcontroller. The power supply uses a battery/power bank for the transmitter and a laptop for the receiver. The programming language used is C language. The preparation of the programming language is done in the Arduino IDE.

For the design of the hardware circuit for the receiver and sender can be seen in the following figure.

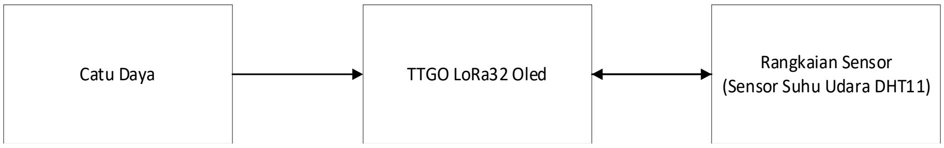


Figure 2 Circuit design on the sender or sender

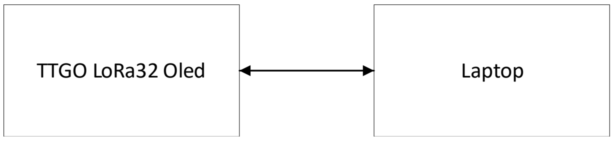
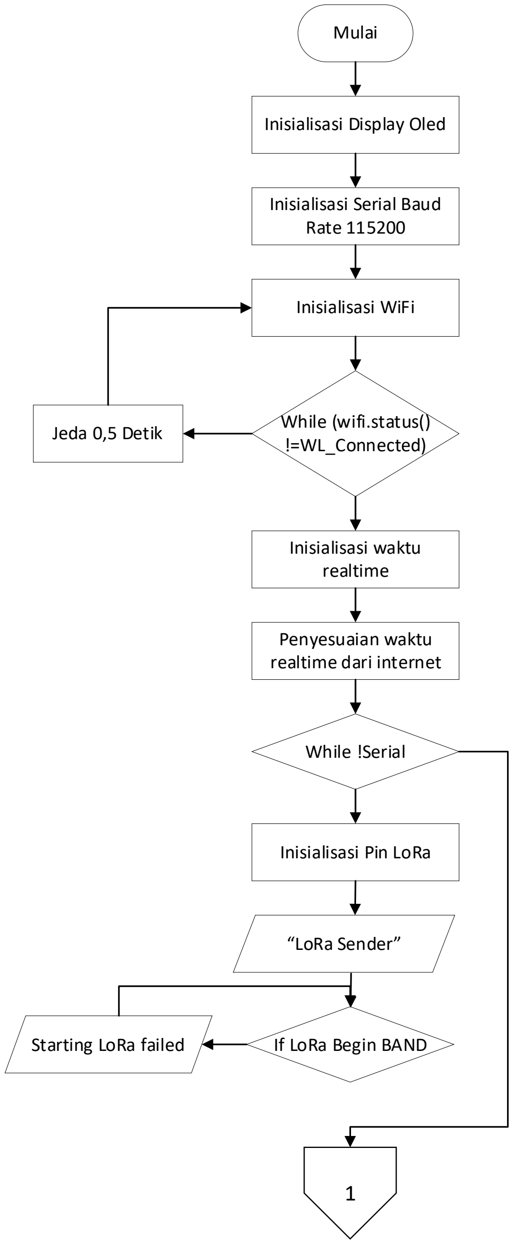


Figure 3 Circuit design on the receiver or receiver

2.3. Program Flowchart Design

The flow diagram below illustrates how the instrument or program will work when tested.



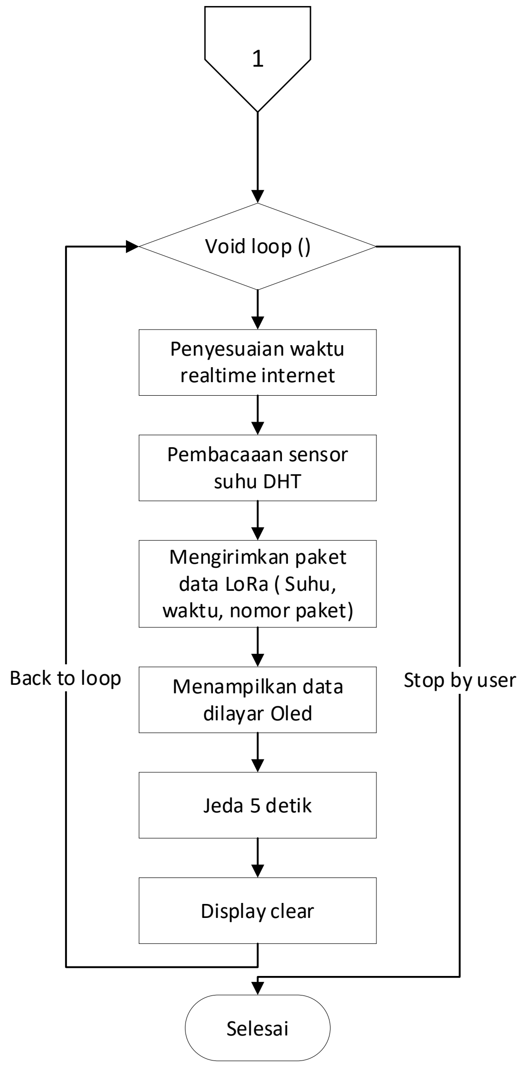


Figure 4 Flowchart of the sensor instrument (sender)

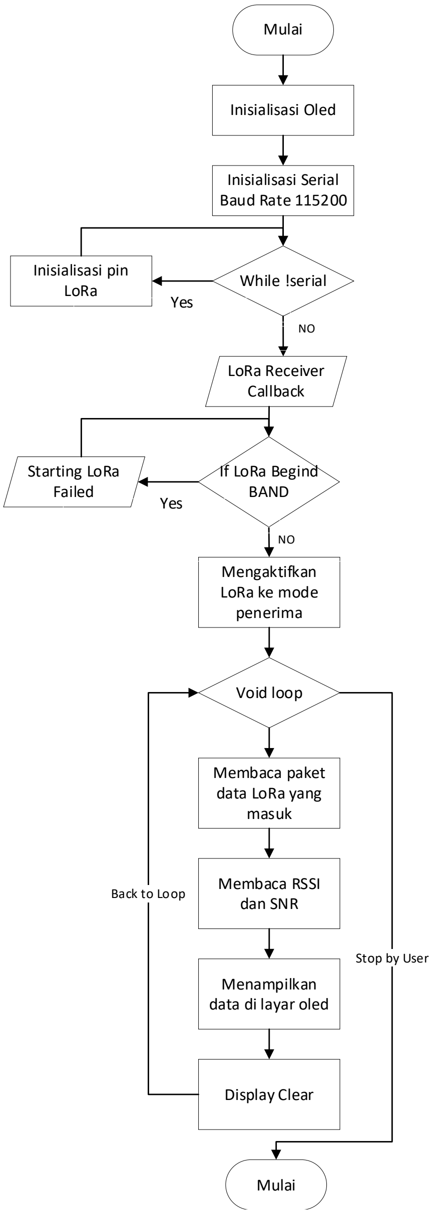


Figure 5 Flow diagram of the instrument receiver

2.4. Testing Scenario

The following is a test scenario, where data transmission only uses a point to point topology or between nodes. The starting node is a transmitter (data sender) and the end node is a receiver (data receiver). There are 2 types of scenarios, namely using a 915 MHz and 920 MHz LoRa connection when the weather is sunny. Initially, the first task was carried out by the transmitter, namely taking data using sensors to get the air temperature, then the data was processed by the LoRa Esp32 TTGO Module for the data transmission connection, and as a timekeeper when data transmission occurred, sending data with transmission distances varying from 100m, 500m and the best maximum distance. After the transmitter sends the data, now the second task is done by the receiver to receive the data sent, the receiver here consists of a TTGO LoRa 32 module as a data receiver.

The following is a table of test scenarios.

Table 1 Test Scenario

No.	Testing Scenario
1.	In this case, the scenario that will be used is to compare the transmission of data from the sensor node to the receiving node, which only applies a point to point topology or can be called between nodes.
2.	So for the application based on weather conditions and the comparison distance between 100m, 500m and 1km to get the best distance from sending data between nodes with better results according to the specified distance.
3.	The node uses LoRa 915 MHz and 920 MHz data transmission protocols which are divided into different scenarios, session 1 uses LoRa data transmission with a frequency of 915 MHz and session 2 uses LoRa transmission with a frequency of 920 MHz based on sunny weather conditions.
4.	Each trial of the application of the sensor will send as much as 500 data with an interval of 5 seconds.
5.	The data sent is in the form of package number, time, and air temperature.

3. RESULTS AND DISCUSSION

3.1 Results

3.1.1 Parameter Delay Pengujian Test Results

Test result*delay*shown in the table below, based on data transmission distances of 100 meters, 500 meters and 1,000 meters in ms.

Table 2. Delay Test Results (ms)

LoRa . Frequency	Distance (m)		
	100	500	1,000
915 MHz	36	54	217
920 MHz	34	63	247

3.1.2 Throughput Parameter Test Results

Test result*throughput*shown in the table below, based on data transmission distances of 100 meters, 500 meters and 1,000 meters in bps units.

Table 3. Throughput Test Results (bps)

LoRa . Frequency	Distance (m)		
	100	500	1,000
915 MHz	27079.55	5506.09	973.39
920 MHz	12888,13	3278.01	809.99

3.1.3 RSSI Parameter Test Results

RSSI (Received Signal Strength Indicator) test results) are shown in the table below, based on data transmission distances of 100 meters, 500 meters and 1,000 meters in dBm units.

Table 4 RSSI Test Results (dBm)

LoRa . Frequency	Distance (m)		
	100	500	1,000
915 MHz	-72.31	-91.47	-87.87
920 MHz	-88,40	-100,60	-86.50

3.1.4 SNR . Parameter Test Results

SNR (Signal to Noise Ratio) test results) are shown in the table below, based on data transmission distances of 100 meters, 500 meters and 1,000 meters in dB units.

Table 5 SNR Test Results (dB)

LoRa . Frequency	Distance (m)		
	100	500	1,000
915 MHz	-72.31	-91.47	-87.87
920 MHz	-88,40	-100,60	-86.50

3.1.5 Test Results Average Temperature on the DHT11 . Air Sensor

Based on the test results with the average air temperature sensor data (DHT11) it is known that for the average air temperature packet delivery to the sensor, a distance of 100 meters with a frequency of 915 MHz obtained is 41 C with a maximum temperature value of 44 C and a minimum temperature value of 32 C. while the frequency of 920 MHz obtained is 32 C with the highest temperature value of 32 C and the lowest temperature of 31 C. The distance of 500 meters with a frequency of 915 MHz is 44 C with the highest temperature of 47 C and the lowest value of 40 C while the frequency of 920 MHz is 39 C with the highest temperature of 40 C and the lowest value of 34 C. And a distance of 1 kilometer with a frequency of 915 MHz is 39 C with the highest temperature value of 42 C and the lowest value of 35 C while the frequency of 920 MHz is 38 C.

3.2 Discussion

Based on the test results with the delay parameter, it can be concluded that with the increase in the number of distances, it can be seen that for the average packet delivery in sunny weather at a distance of 100 meters to 1 kilometer that both frequencies experience an increase in delay. The following is a graph of the results of the delay test against the distance and frequency used.

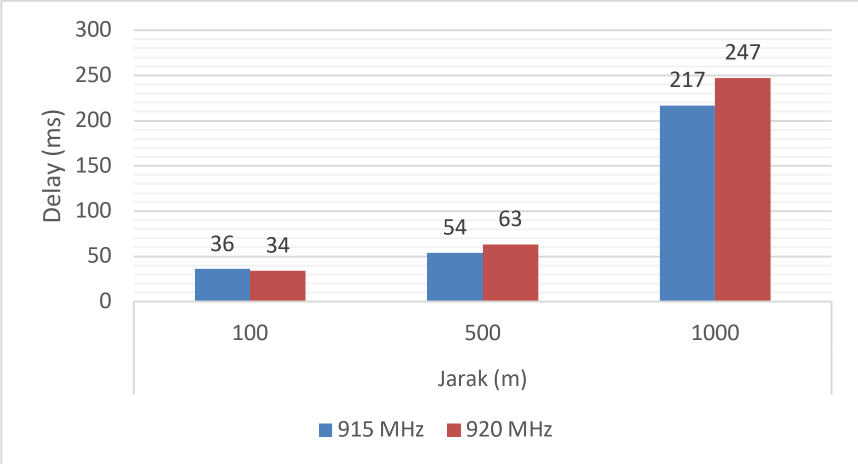


Figure 6 Graph of test results delay

The discussion for the average data transmission distance of the QoS Delay parameter is divided into 3, namely:

1. The distance is 100 meters, the frequency of 915 MHz has a delay value of 36 ms which is higher than the frequency of 920 MHz which has a delay value of 34 ms and according to the Tiphon standard < 150 ms, the two frequencies can be categorized as Very Good with a difference in the frequency delay value of5.56%,
2. The distance is 500 meters, the frequency of 920 MHz has a delay value of 63 ms which is higher than the frequency of 915 MHz which has a value of 54 ms which according to Tiphon standards <150 ms can be categorized as very good frequencies with a difference in the frequency delay value of 14.29%.
3. A distance of 1 kilometer, the frequency of 920 MHz has a delay value of 247 ms which is higher than the frequency of 915 MHz which has a delay value of 217 ms which according to the Tiphon standard of 150 ms to 300 ms can be categorized as both good frequencies with a difference in the frequency delay value of 12.15 %.

Besides that,The results of testing with throughput parameters can be concluded that with increasing the number of distances it can be seen that for the average throughput packet delivery in sunny weather at a distance of 100 meters to 1 kilometer that both frequencies decrease. The following is a graph of the throughput test results against the distance and frequency used.

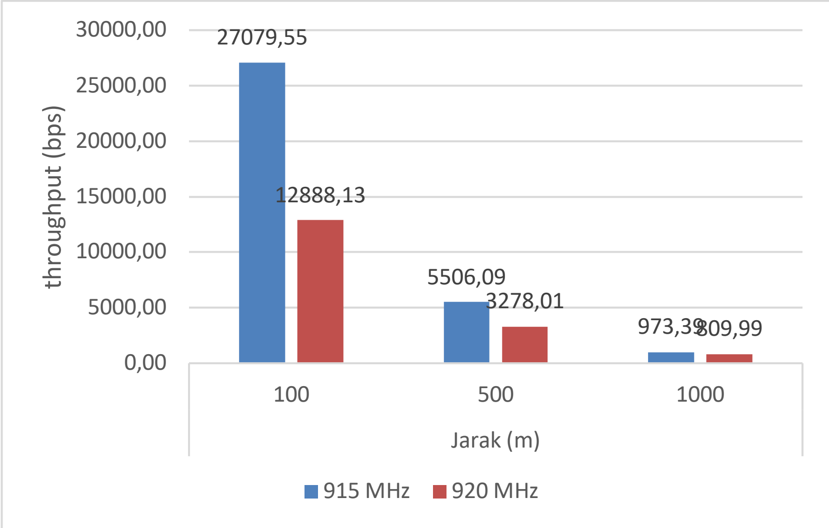


Figure 7 Graph of throughput test results

The discussion for the average data transmission distance of the QoS throughput parameter is divided into 3, namely:

1. Distance of 100 meters, the frequency of 915 MHz has a throughput value of 27079.55 bps which is higher than the frequency of 920 MHz which is worth 12888.13 bps with a difference in throughput value of 52.41%.
2. The distance is 500 meters, the frequency of 915 MHz has a throughput value of 5506.09 bps which is higher than the frequency of 920 MHz which is worth 3278.01 bps with a throughput value difference of 40.47%.
3. 1 kilometer distance, 915 MHz frequency has a throughput value of 973.39 bps which is higher than 920 MHz which is 809.99 bps with a difference of 16.79% in value.

For RSSI test results,it can be seen that for the RSSI average in sunny weather at a distance of 100 meters to 500 meters that both frequencies have decreased, but at a distance of 1 kilometer it has increased due to the amount of data received at the 915 MHz frequency as much as 310 data and 920 MHz as much as 169 data from 500 data sent. The following is a graph of the results of the RSSI test against the distance and frequency used.

Figure 8 RSSI Graph of test results

The discussion for the average data transmission distance of the RSSI QoS parameters is divided into 3, namely:

1. A distance of 100 meters with a frequency of 920 MHz has an RSSI value of -88.40 dbm which is lower than the frequency of 915 MHz which is a value of -72.31 dbmand by Tiphon standar standards-70 dBm to -85 dBm can be categorized both frequencies Goodwith a difference in value of 18.21%.
2. For a distance of 500 meters the 920 MHz frequency has an RSSI value of -100.60 dbm which is lower than 915 MHz which is -91.47 dbm andby Tiphon standar standards-86 dBm s / d -100 dBm can be categorized both frequencies Medium valuewith a difference in value of 9.08%.
3. While at a distance of 1 kilometer, the 915 MHz frequency has an RSSI value of -87.87 dbm which is slightly lower than the 920 MHz frequency which has an RSSI value of -86.50 andby Tiphon standar standards-86 dBm s / d -100 dBm can be categorized both frequencies Medium valuewith a difference in value of 1.56%.

Based on the test results, it can be seen that for the average SNR in sunny weather at a distance of 100 meters to 1 kilometer that both frequencies experience a decrease in value. The following is a graph of the results of the SNR test against the distance and frequency used.

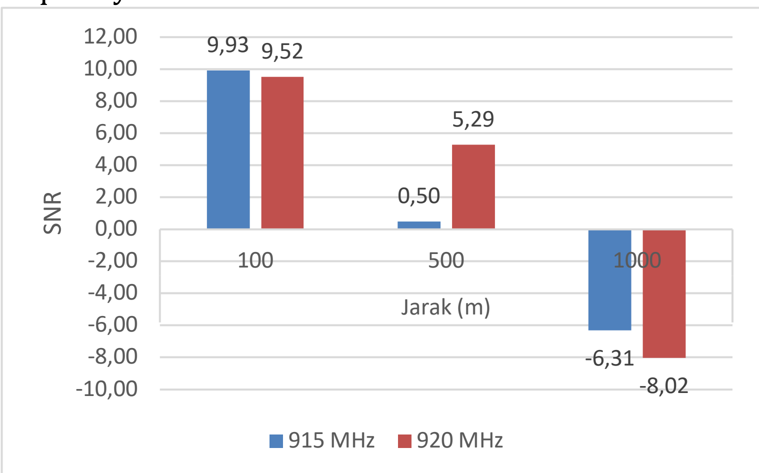


Figure 9 Graph of SNR test results

The discussion for the average data transmission distance of the QoS SNR parameters is divided into 3, namely:

1. A distance of 100 meters with a 915 MHz frequency has an SNR value of 9.93 db which is slightly higher than the 920 MHz frequency which is 9.52 db andby Tiphon standar standards07.0 dB to 10.9 dB can be categorized as both frequencies are Enoughwith a difference in value of 4.11%.
2. For a distance of 500 meters, the 920 MHz frequency has an SNR value of 5.29 db which is greater than 915 MHz which is 0.50 db andby Tiphon standar standards< 06.9 dB can be categorized both frequencies are Bad valuewith a difference in value of 90.62%.
3. While at a distance of 1 kilometer, the 920 MHz frequency has an SNR value of -8.02 db which is lower than the 915 MHz frequency which has an RSSI value of -6.31 dbm andby Tiphon standar standards< 06.9 dB can be categorized both frequencies are Bad valuewith a difference in value of 21.29%.

In the delay parameter, overall the best value is at the 915 MHz frequency which has a difference of 10.76% lower than 920 MHz. In the throughput parameter,based on the average throughput and data transmission distance, the 915 MHz frequency is 49.41% higher than the 920 MHz frequency at all data retrieval distances because the higher the throughput value, the higher the quality. The RSSI parameter is assessed based on the RSSI average and data transmission distance, the 915 MHz frequency is 8.66% higher than the 920 MHz frequency, because the lower the RSSI value obtained, the worse the quality. In the SNR parameter, it can be seen that the higher the SNR value, the better the quality based on the average SNR and data transmission distance, the 920 MHz frequency is 39.41% higher than the 915 MHz frequency.

4. CONCLUSION

Based on the results of this study, it can be concluded that for each parameter, namely the delay parameter with the best value at a frequency of 915 MHz with a difference of 10.76% lower, the throughput parameter with the best value is at a frequency of 915 MHz with a difference of 49.41% more. high, the RSSI parameter with the best value is at 915 MHz with a difference of 8.66% higher and the SNR parameter with the best value is at 920 MHz with a 39.41% higher difference. From these results it can be concluded that the use of 915 MHz frequency is better than 920 MHz. For the average air temperature at the sensor, a distance of 100 meters with a frequency of 915 MHz obtained a value of 41 C with a maximum temperature of 44 C and a minimum value of 32 C while the frequency of 920 MHz is obtained with a value of 32 C with the highest temperature value of 32 C and the lowest temperature of 31 C. The distance of 500 meters with a frequency of 915 MHz is 44 C with the highest temperature of 47 C and the lowest value of 40 C while the frequency of 920 MHz is 39 C with the highest temperature of 40 C and the lowest value of 34 C. And a distance of 1 kilometer with a frequency of 915 MHz is 39 C with the highest temperature value of 42 C and the lowest value of 35 C while the frequency of 920 MHz is 38 C. The distance of 500 meters with a frequency of 915 MHz is 44 C with the highest temperature of 47 C and the lowest value of 40 C while the frequency of 920 MHz is 39 C with the highest temperature of 40 C and the lowest value of 34 C. And a distance of 1 kilometer with a frequency of 915 MHz is 39 C with the highest temperature value of 42 C and the lowest value of 35 C while the frequency of 920 MHz is 38 C. The distance of 500 meters with a frequency of 915 MHz is 44 C with the highest temperature of 47 C and the lowest value of 40 C while the frequency of 920 MHz is 39 C with the highest temperature of 40 C and the lowest value of 34 C. And a distance of 1 kilometer with a frequency of 915 MHz is 39 C with the highest temperature value of 42 C and the lowest value of 35 C while the frequency of 920 MHz is 38 C.

The suggestions for this research are that data collection can be done using distances in multiples of 100m, using different types of antennas to get better transmit power and longer distances, and conducting further research by combining other protocols.

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