IMPLEMENTATION OF DATA TRANSMISSION WITH LONG RANGE COMMUNICATION MODULE (LORA) AND MQTT-SN PROTOCOL TO SUPPORT SOIL HUMIDITY SENSOR DATA TRANSMISSION

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Abstract

Wireless sensor network can help remote data transfer. Implementation of wireless sensor network in IoT system must be done with a good planning because IoT system typically have limited system resources. This limitation can affect performance of a wireless network sensor. The purpose of this study is to find out the effect of node range to the data transfer performance in terms of delay, throughput, RSSI, and SNR by using QOS (quality of service) analysis for LoRa and MQTT protocol. The results of LoRa's protocol delay are between 2,82 ms to 37,27 ms. Throughput between 0,61 Kb/s to 24,29 Kb/s. SNR between 2,7 dBm to 8,34 dBm, and RSSI between -74,92 dBm to -122,36 dBm. On the other hand, the results of MQTT's protocol delay are between 677,49 ms to 1182,69 ms. Throughput between 0,60 Kb/s to 1,12 Kb/s. SNR between 2,7 dBm to 8,34 dBm and RSSI between -74,92 dBm to -122,36 dBm.

Keywords: *Delay, LoRa, Protocol, Throuhgput, quality of services.*

1. INTRODUCTION

Data transmission is a 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 (Rutledge, 1999). Some electronic devices also use the data transmission function in their work systems. In this case, data transmission functions as a liaison between the sender and the receiver so that communication or data transfer can be carried out such as on internet, television, telephone, or radio connections.

WSN is a network consisting of two or more nodes that exchange data from installed sensors (Gulati et al., 2022). Nodes have different roles depending on the application and can function as both sender and receiver. Each node in the WSN is usually equipped with sensors, microcontrollers, radio transceiver devices and energy sources or energy storage. Therefore, the protocol that will be used in transmitting sensor data must be able to cover long distances, use low power and have the ability to withstand noise for that reason, LoRa (Long Range) data transmission technology is used (Susanto et al., 2019).

Message Queue Telemetry Transport or what is commonly called MQTT is a protocol for machine to machine or M2M communication and works at the seventh layer or application and is lightweight message (Saputra et al., 2017). The MQTT protocol has the advantage that data transmission can be continued when the connection is back to

normal. The MQTT protocol uses the publish/subscribe method for the data transmission process (Abelovani et al., 2018).

In this study, the WSN concept was applied and the QOS . value was tested (Quality Of Service) by integrating Lora data transmission as a medium for sending electronic sensor data that joins the MQTT – SN protocol, then testing is carried out to find out how much delay, throughput, SNR, and RSSI can be based on a minimum distance of 100 meters and a maximum of 1 kilometer in packet delivery. 600 data packets are sent between the connected sensor nodes.

2. RESEARCH METHODOLOGY

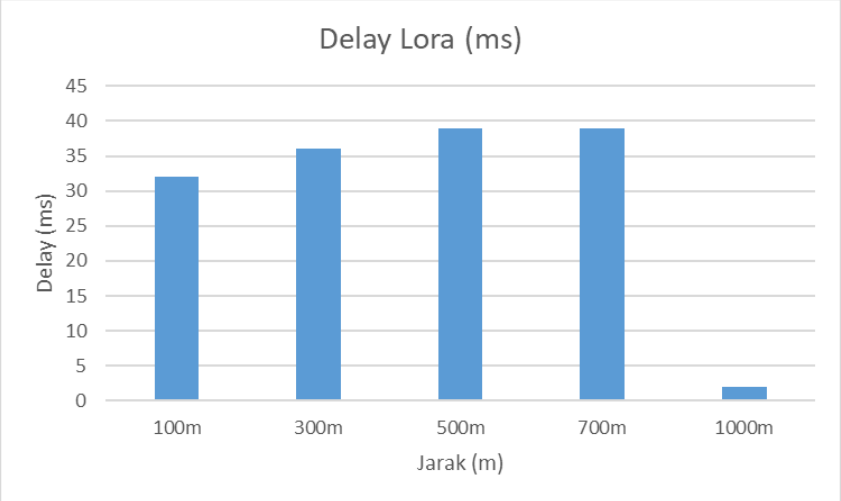
The research methodology in this study is as follows.

a. 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, the internet, and journals
b. Design
   At this stage, the design for the sensors and hardware that will be used along with the distance variations applied is from 100 m, 300 m, 500 m, 700 m, and 1 km and sends 600 data at a time interval of 2 seconds.
c. Implementation
   The implementation carried out is to apply the results of the design of the soil moisture sensor which is processed based on WSN using LoRa transmission and combining it with the MQTT-SN protocol along with the applied scenarios.
d. Test
   This stage is carried out to test the MQTT-SN-based LoRa data transmission from the scenario determined based on the Quality Of Service (QOS) parameter.
e. Conclusion
   Draw conclusions from the results of the tests that have been carried out.

3. RESULTS AND DISCUSSION

3.1. *Delay* Results LoRa scenario

The results of the delay in the LoRa scenario are shown in the following figure.

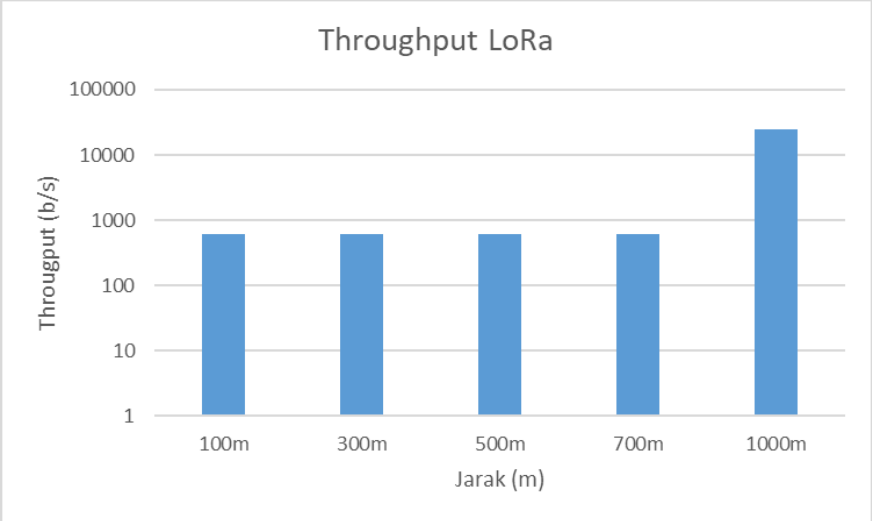


Picture 1. Graph of the relationship between the distance between nodes with delay.

Based on the data that has been obtained, it can be seen that the distance between nodes does not affect the delay during data transfer. In this case, the lowest delay is at a distance of 1000 meters with a delay of 2.82 ms and the highest delay is at a distance of 700 meters with a delay of 37.27 ms. So there is no correlation between the distance between nodes with the delay parameter.

3.2. LoRa Scenario Throughput Results

The throughput results in the LoRa scenario are shown in the following figure.

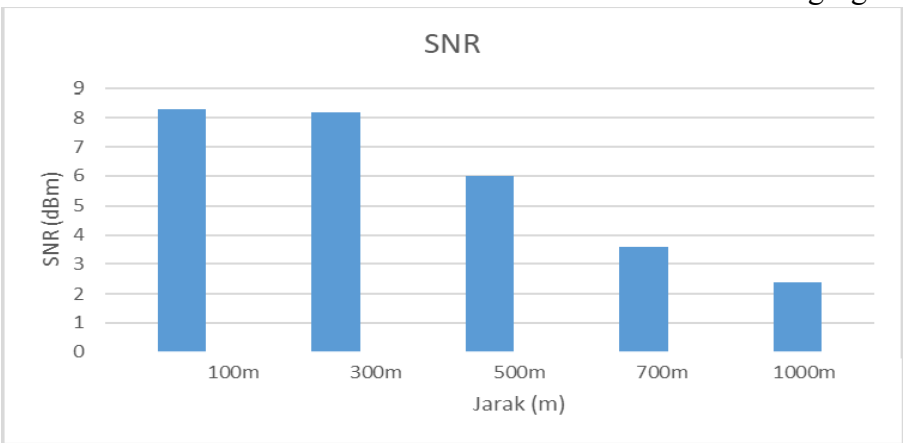


Picture 2. Graph of the relationship between the distance between nodes with throughput.

The results on the throughput parameter indicate that the distance between nodes has no effect on throughput during the data transfer process. This happens because the throughput parameter is directly related to delay where throughput is the amount of data transferred divided by the delay value. The graph in Figure 2 above shows the highest throughput is at a distance of 1000 meters with a value of 24.29 Kb/s while the lowest throughput is at a distance of 700 meters with a value of 0.61 KB/s.

3.3. SNR Results LoRa Scenario Skenario LoRa

The SNR results in the LoRa scenario are shown in the following figure.



Picture 3. Graph of the relationship between the distance between nodes with SNR.

Based on the data obtained, as shown in Figure 3 above, it can be seen that the data retrieval distance is inversely proportional to the SNR (signal to noise ratio) value on the LoRa module. This happens because at a longer distance, the received signal intensity is weaker while the intensity of the noise remains so that the ratio between signal and noise is also lower. The highest SNR value is at a distance of 100 meters with a value of 8.34 dBm while the lowest SNR value is at a distance of 1000 meters with a value of 2.7 dBm.

3.4. RSSI LoRa Scenario RSSI Results

The RSSI results in the LoRa scenario are shown in the following figure.

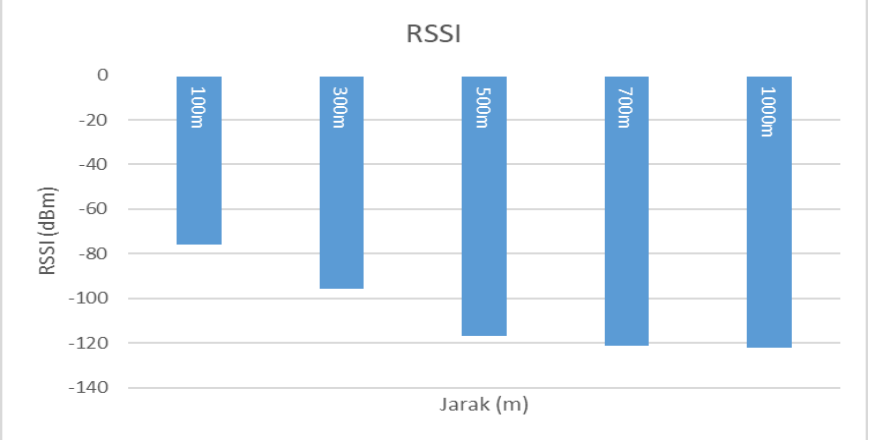


Figure 4. Graph of the relationship between the distance between nodes with RSSI.

The graph in Figure 4 above shows that the distance between nodes is inversely proportional to the RSSI value measured by the LoRa module. In this case, RSSI is a measure of radio signal strength expressed in dBm units. The highest RSSI value is at a distance of 100 meters with a value of -74.92 dBm and the lowest RSSI value is at a distance of 1000 meters with a value of -122.36 dBm.

3.5. MQTT Scenario Delay Results – SN

The results of the delay in the MQTT – SN scenario are shown in the following figure.

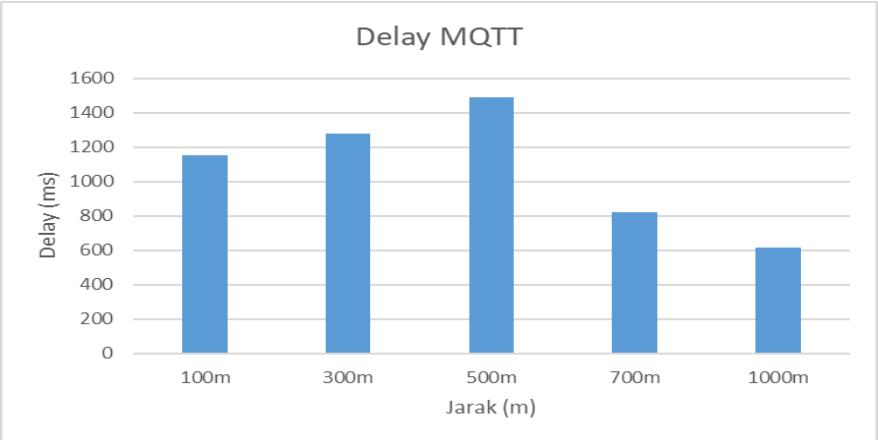


Figure 5. Graph of the relationship between the distance between nodes and delay in the MQTT – SN scenario.

The data from the graph in Figure 5 above shows that there is no correlation between the distance between nodes and the delay during data transfer. In this case, the factor that most affects the delay is not the distance between nodes but the condition of the internet connection at the time of data transfer. In this scenario, the highest delay is ata distance of 500 with a value of 1182.69 ms and the lowest delay is at a distance of 1000m with a value of 677.49 ms.

3.6. MQTT Scenario Throughput Results – SN

The throughput results in the MQTT – SN scenario are shown in the figure below.

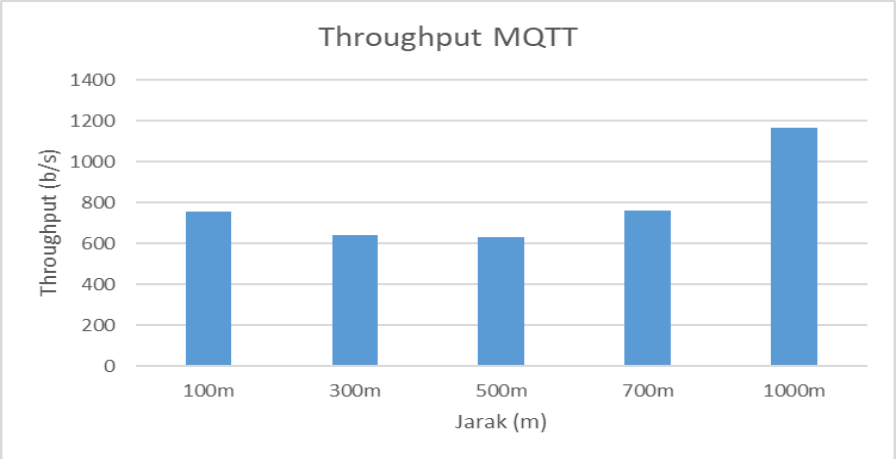


Figure 6. Graph of the relationship between the distance between nodes and throughput in the MQTT – SN scenario.

The graph in Figure 6 shows that there is no correlation between the distance of data retrieval and the throughput value when the data transfer is in progress. This is the same as for the delay parameter in the same scenario. The highest throughput value is at a distance of 1000 meters with a value of 1.12 Kb/s and the lowest throughput value is at a distance of 500 meters with a value of 0.60 Kb/s.

4. CONCLUSION

In the LoRa scenario, from the data obtained, it can be concluded that the QoS delay and throughput parameters are not affected by the data retrieval distance. While the SNR and RSSI QoS parameters are influenced by the distance of data retrieval. In this case, the farther the data retrieval distance, the lower the SNR and RSSI values. The results ofthe delay ranged from 2.82 ms to 37.27 ms. Throughput ranges from 0.61 Kb/s to 24.29 Kb/s. SNR is between 2.7 dBm to 8.34 dBm. While the RSSI is between -74.92 dBm to -122.36 dBm. Meanwhile, in the MQTT – SN scenario, from the data obtained, it can be concluded that the QoS delay and throughput parameters are not affected by distance. Fluctuations in delay and throughput are heavily influenced by the condition of the internet connection at the time of data retrieval. Meanwhile, SNR and RSSI are still influenced by the distance of data collection because the two QoS parameters are measured by the LoRa module. The delay results ranged from 677.49 ms to 1182.69 ms. Throughput ranges from 0.60 Kb/s to 1.12 Kb/s. SNR is between 2.7 dBm to 8.34 dBm. While the RSSI is between -74.92 dBm to -122.36 dBm.

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