IMPLEMENTATION OF THE MQTT-SN PROTOCOL ON THE INTERNET GATEWAY DEVICE WITH UDP DATA PACKAGE DELIVERY

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Abstract

Internet of Things (IoT) is one of the new trends in the world of technology that is likely to become a trend in the future, to be able to make this happen, communication protocols such as MQTT-SN are needed which is a variant of the MQTT protocol and the connection protocol that supports IoT is NB- IoT to support this. Unlike MQTT which uses TCP as its communication protocol, MQTT-SN uses UDP as its data communication protocol. The purpose of this study is to determine the results of Quality of Service on the value of delay and throughput at QoS levels 0, 1, and 2. There are 2 test scenarios, namely real-time test scenarios and phased test scenarios. The design of the instrument consists of sensor instruments, Raspberry Pi microcontrollers for internet gateway device, and NB-IoT modules to then be tested with scenarios to get test results. Based on the test results, the best QoS results for the delay parameter in the real-time scenario are QoS level 2 with a delay value of 1.602 seconds, while for the gradual scenario there is QoS 0 with a delay value of 1.622 seconds. Furthermore, the best QoS results for throughput parameters in real-time scenarios are found at QoS level 2 with a throughput value of 245.79 bits per second and in a phased scenario found at QoS level 1 with a throughput value of 286.42 bits per second.

Keywords: MQTT-SN, NB-IoT, *Internet Gateway Device*, QoS Level

1. INTRODUCTION

Internet of Things (IoT) is one of the new trends in the world of technology that is likely to become a trend in the future, simply with IoT, physical objects in the real world can communicate with each other using the help of networks and the internet. To be able to make this happen, we need the right communication protocols and connection protocols to support this. Of the several communication protocols commonly used in the case of IoT, the MQTT communication protocol is used more often. Where this protocol has other variants such as MQTT-SN, unlike MQTT which uses TCP communication, MQTT-SN uses UDP communication. [5].

TCP is connection oriented in sending data and guarantees the data will reach its destination. Meanwhile, UDP is a connectionless protocol in transmitting data and does not recognize errors in data transmission. UDP is very useful in client-server situations [4].

Connection protocols in IoT are also required, one of the connection protocols that supports IoT is NB-IoT. Test coverage and reliability of data transmission on NB-IoT in conjunction with UDP is very suitable for IoT applications because UDP is not susceptible to various delays and tolerates packet loss rates of less than 5%, while for TCP itself it produces packet loss rates of around 90%. [6].

To implement the MQTT-SN communication protocol coupled with the NB-IoT connection protocol, a gateway is needed. The gateway here acts as a liaison between sensors located on the local network (intranet) with cloud applications located on the global network (internet). This gateway is called the Internet Gateway Device [2].

To measure the quality of service on the MQTT-SN protocol with the NB-IoT connection protocol, it is necessary to implement Quality of Service (QoS). QoS itself is a method of measuring how well the network is and is an attempt to define the characteristics and properties of a service so that messages are received [1]. In analyzing the network using QoS (Quality of Service), especially for latency (delay) and throughput, it is able to provide good network analysis, where this aspect is often used in network analysis [7]. To ensure message reliability, MQTT supports 3 levels of Quality of Service (QoS), namely QoS level 0, QoS level 1 and QoS level 2. QoS level is an agreement between the sender of the message and the recipient of the message that defines delivery guarantee for a particular message [3].

2. RESEARCH METHODOLOGY

The research methodology in this study is as follows:

a. Literature study by collecting study data and gain theoretical understanding. The data is obtained from books, journals or previous research that discusses MQTT-SN, NB-IoT, Quality of Service, Internet Gateway Device, and QoS Level.
b. Design, at this stage the hardware design for sensors (publishers) and microcontrollers (gateways) is carried out while for software designs the cloud server (broker) that will be used. The hardware design used is as follows:

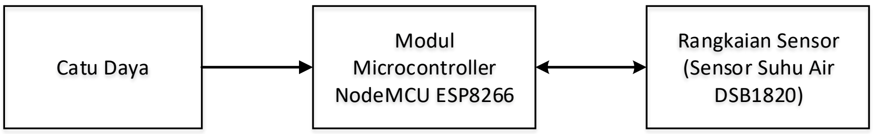

Figure 1. Design on sensor data sender

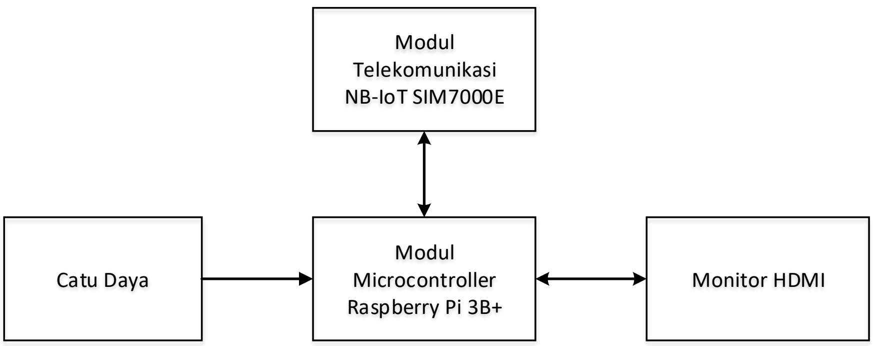

Figure 2. Design on the gateway

c. The implementation carried out is to apply the results of the design of the water temperature sensor which is processed based on an intranet using MQTT-SN data transmission and NB-IoT connection as an intermediary for sensor data to the cloud server along with 2 scenarios that will be used, namely the realtime scenario (1 second pause) and the gradual scenario (10 second pause).

d. The test is carried out by taking 100 data at each of the three levels of Quality of Service (QoS) using MQTT-SN with NB-IoT connection from 2 predetermined scenarios based on the parameters of Quality of Service (QoS) delay and throughput.
e. Record the results of data testing, the results obtained will then be entered and calculated into excel.

3. RESULTS AND DISCUSSION

3.1 Delay Test Results at QoS levels 0, 1, and 2

The results and discussion of delays at QoS levels 0, 1, and 2 are a comparison of the average value of delay at all QoS levels and also compared to 2 scenarios that are applied, namely realtime and gradual. Here are the results in the form of tables and figures.

Table 1. The average delay data for realtime and gradual scenarios at QoS level 0, 1, 2

QoS Level	Realtime scenario (second)	Gradually scenario (second)
Level 0	1,614	1,622
Level 1	1,814	1,676
Level 2	1,602	1,862

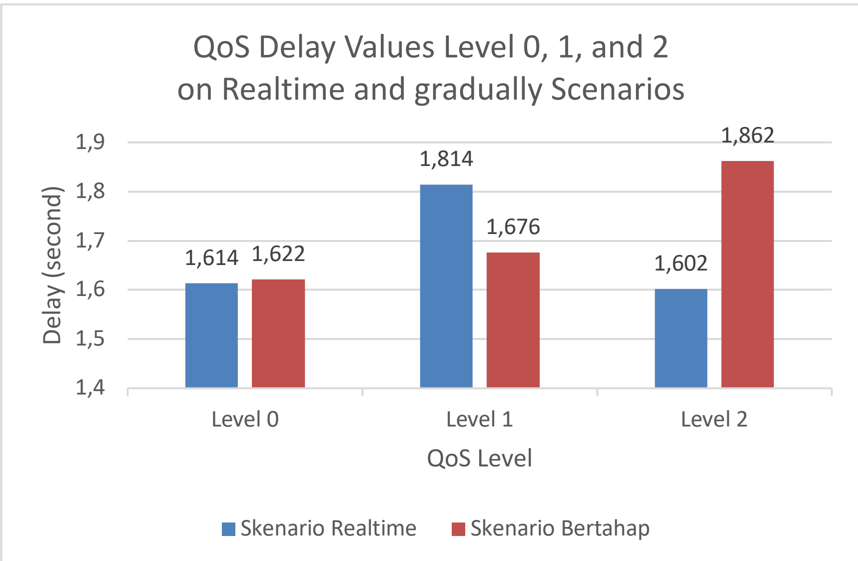

Figure 3. Average delay in realtime and gradually scenarios at QoS level 0, 1, 2

Based on the results of delay testing at QoS levels 0.1, and 2 in realtime scenarios, it can be concluded that at QoS level 0 and QoS level 1 there is a fairly high delay increase of about 0.2 seconds or about 11.03% of QoS level 0, while QoS level 1 and QoS level 2 experienced a drastic decrease in delay of around 0.212 seconds or about 11.67% of QoS level 1. Furthermore, in a gradual scenario, it can be concluded that at QoS level 0 and QoS level 1 also experienced an increase in delay of about 0.054 seconds. or about 3.21% of QoS level 0, while at QoS level 1 and QoS level 2 there is a quite drastic increase in delay of around 0.186 seconds or about 9.97% of QoS level 1. In realtime scenarios, the smallest delay or The best is at QoS level 2, and for gradual scenarios the smallest delay or the best is at QoS level 0.

3.2 Throughput Test Results at QoS levels 0, 1, and 2

The results and discussion of throughput at QoS levels 0, 1, and 2 are comparisons of the average value of throughput at all QoS levels and also compared to 2 scenarios applied, namely realtime and gradual. Here are the results in the form of tables and figures.

Tabel 2. Realtime and gradually scenario throughput average data at QoS level 0, 1, 2

QoS Level	Realtime scenario (second)	Gradually scenario (second)
Level 0	243,74	259,34
Level 1	229, 58	286,42
Level 2	245,79	260,94

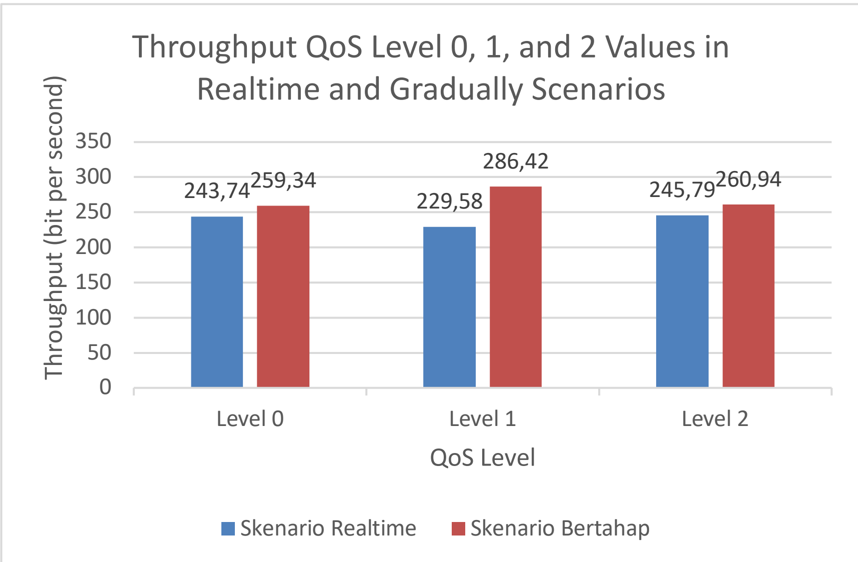

Figure 4. Average throughput of realtime and gradually scenarios at QoS level 0, 1, 2

Based on the results of throughput testing at QoS levels 0.1, and 2 in realtime scenarios, it can be concluded that at QoS level 0 and QoS level 1, throughput decreased by around 14.16 bits per second or about 5.81% from QoS level 0, while at QoS level 1 and QoS level 2 experienced an increase in throughput of around 16.21 bits per second or about 6.59% from QoS level 1. Furthermore, in a gradual scenario, it can be concluded that at QoS level 0 and QoS level 1 the throughput increased by around 27.08 bits per second or about 9.45% of QoS level 0, while at QoS level 1 and QoS level 2 the throughput decreased by about 25.49 bits per second or about 8.9% from QoS level 1. In realtime scenarios, throughput is the largest or the best lies in QoS level 2, and for the gradual scenario the largest or best throughput lies in QoS level 1.

4. Conclusion

Based on the results of the implementation test obtained from the test scenario, it is known that at QoS level 0 for the delay value in the realtime scenario (1.614 s) it has a better value of 0.52% compared to the gradual scenario (1.622 s), then at QoS level 1 the delay value at the gradual scenario (1,676 s) has a better value of 7.61% than the realtime scenario (1,814 s), and at QoS level 2 for the delay value in the realtime scenario (1,602 s) it has a better value of 13.92% compared to the phased scenario (1,862 s). The test scenario for the throughput value at QoS level 0 is known for the gradual scenario (259.34 bps) to have a better value of 6.02% than the realtime scenario (243.74 bps), the throughput value at QoS level 1 for the gradual scenario (286.42 bps) has a 19.84% better value than the realtime scenario (229.58 bps), and the throughput value at QoS level 2 for the phased scenario (260.94 bps) has a 5.81% better value than the realtime scenario (245, 79 bps).

The best QoS results for the delay parameter in the realtime scenario are QoS level 2 with a delay value of 1.602 seconds, while for the gradual scenario there is QoS 0 with a delay value of 1.622 seconds. Furthermore, the best QoS results for throughput parameters in realtime scenarios are found at QoS level 2 with a throughput value of 245.79 bits per second and in a phased scenario found at QoS level 1 with a throughput value of 286.42 bits per second.

In testing the data sampling in the field and processing data, especially at the QoS level data 0, 1, and 2, there are data with delay and throughput values that do not match the QoS level explanation. Because the higher the QoS level that the test data takes, the higher the delay value obtained, as well as the throughput, which is influenced by the delay value obtained. So it can be concluded that the value of delay and throughput based on field test data is strongly influenced by the existing cellular network on the SIM7000E module.

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