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Analysis of a Public and Private Networks for Nutrient Measurement System using LoRawan Network

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Abstract

Lorawan network is ideal for IoT devices that continuously monitor a device and provide information to the gateway if the monitored data is outside the permitted threshold. These devices only require a small bandwidth and are therefore capable of operating on batteries for a long period of time. This study evaluates the design of a tool to measure soil nutrients with parameters of Nitrogen (N), Phosphorus (P), Potassium (K) using NPK sensors and IoT-based systems. The microcontroller used is ESP 32 which is connected to two types of networks. And will be integrated by Antares and the Android app. The purpose of making two types of networks in order to obtain data for analysis or development of the next tool. The result of designing this system is to create a device that can help farmers or the community in the process of measuring nitrogen, phosphorus, and potassium levels directly through the Android application so that soil control and fertilization can be more effective moreover yields can be maximized.

Keywords: Antares, ESP, lora, NPK sensor.

1 Introduction

Indonesia is a country that has a vast wealth with a nickname of an agricultural country [23]. Extensive land and forests, makes the majority of the community depend on the agricultural industry. Almost all types of plants can be grown in this tropical country [4]. No wonder many other countries cooperate in import and export activities of plant and plant products. However, over time the agricultural sector has experienced quite complex challenges [15]. If you pay attention to the existing reality, the availability of land is decreasing. This is based on the number of infrastructure, housing projects, or shopping center. These problems bring out new ideas or new innovations that allow planting crops without a large enough land. For examples, hydroponics, aquaponics, and other agricultural. In addition, there are many other challenges, namely declining crop productivity, limited human resources in the agricultural sector and inadequate technology [17]. If one considers the thing that makes human resources limited in the agricultural sector is the lack of interest in youth working in agriculture. For millennials, the profession in agriculture is synonymous with rough, dirty work [31]. While millennials are very familiar with digital gadgets and technology. Therefore technology is very important for the development of the agricultural sector such as communication system [20]. Technology is needed to help the agricultural sector [26], [28]. Not only expanding the interest in human resources, but also helping to make work in the field of farming easier and yielding good crops [6], especially spinach. Spinach is a type of vegetable that is easily found around the community [13]. Because the need for spinach tends to increase, spinach cultivation is very widespread, so it's no wonder that spinach is also a source of livelihood for most Indonesian farmers [11]. However, the problem experienced is that not a few spinach vegetables can be harvested with unsatisfactory results. This is caused by a lack of nutrients or the presence of pests that interfere with the growth process of spinach [34]. Therefore we need a useful tool to help farmers to monitor and control spinach plants. Spinach is a vegetable that contains many high nutrients. One of them is the content of vitamin C. The process of biosynthesis of vitamin C is strongly influenced by photosynthesis and the reactions that accompany it. In addition, nutrients are needed such as N, P, and K because they are related to photosynthesis [30]. This requires an NPK sensor to see the nutrient levels of the plant itself [14]. In the underground to underground communication, the received signal strength decreases with increases of horizontal inter-nodes distance when the horizontal inter-nodes distance is larger than 600 cm, and the amplitude of reduction is 2 dBm to 3 dBm [32]. In addition, the tool must also have good performance to support data transfer needs so that information can reach the user's hands accurately, quickly, and efficiently. It can be concluded from previous research that testing tools on lora data transmission has a packet loss of 61%. This is one of the factors of unexpected efficiency [5]. Therefore, further analysis is needed regarding the existing network connectivity. This tool uses lora as its network connectivity. So the analysis focuses on the comparison of public lora and private lora.

2 Related Works

In previous studies focused on measuring soil nutrient levels in chili based on IoT conducted by Barik [5], the results were quite good, namely the accuracy of the sensor results reached more than 90% when compared to analog NPK sensors. The data read on the sensor has 100% accuracy with data sent and displayed on the Antares platform console. The results of the data transmission test are shown in Table 4 shows that the radius distance can affect the RSSI and SNR quality, that the first test at a distance of 700 meters has an average RSSI quality and SNR which is better than at a distance of 3.47 kilometers [5]. Then, the next studies focused on soil substance measurement system in strawberry based on IoT conducted by Perdana [18], the result that based on the test shows that packet loss on the network is not too large, the overall functionality of the device works well, delay on data transmission starting from uploading data from the device to the server until the average delay is obtained in each condition is increasing due to the existing buffer on the server but the delay distance is not too far. Based on previous research, the author has the willingness to develop tools with topics that are expected to be helpful for further research.

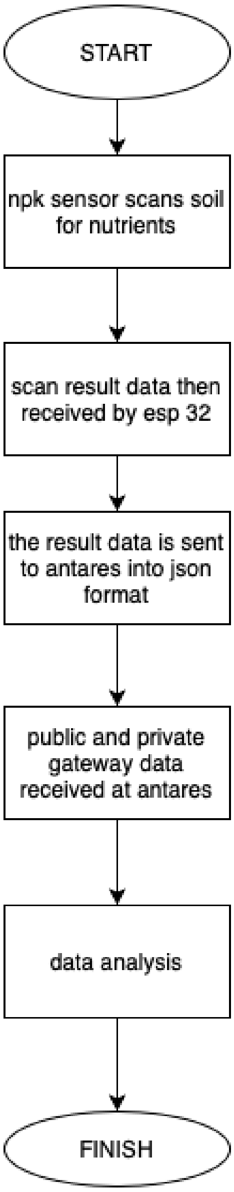


Figure 1: Flowchart System

Figure 1 shows the work of the entire system from start to finish. Starting from the sensor scanning the nutrients until the measuring parameters can be displayed in the android application installed on android.

2.1 NPK Sensor

Figure 2 shows that before determining the ADC (analog to digital converter) calibration is carried out first to get the minimum and maximum voltage values from the NPK sensor [22], then the ESP 32 microcontroller has a 12-bit ADC which means 2^{12} and is worth 4096, because it starts from 0 then the ADC becomes 0-4095, and the ADC value is adjusted 0-4095.

2.2 NPK Design

Figure 3 shows the snippet of the stress mapping. This code has a very important role. Made based on the datasheet and the existing microcontroller conditions [35].

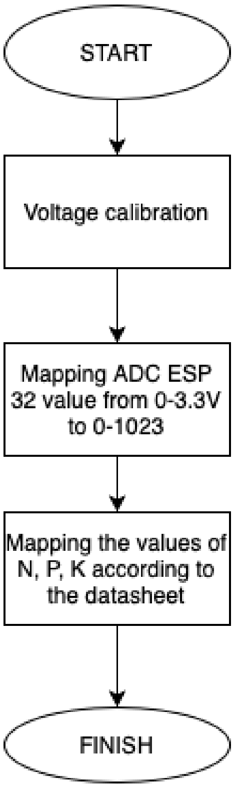


Figure 2: Flowchart Sensor

```
void maptegangan(){
  vaql = analogRead(NPKa);
  yu = map(vaql, 4095, 0, 0, 4095);
  val = map(yu, 0,4095, 1,300);
  Serial.print("Nilai ADC NPK : ");
  Serial.println(val);
  if (yu < 950){
    //val = 0;
    Nx= 0;
    Px= 0;
    Kx=0;
    }
    else {
  Nx = map(val, 1, 300, 51, 200);
  Px = map(val, 1, 300, 4, 14);
  Kx = map(val, 1, 300, 51, 185);
    }


   if (val >= 1 && val <= 50){
    soilstatus = "POOR ";
   }
    if (val > 50 && val <= 200){
      soilstatus = "IDEAL ";
    }
     else if (val >200 && val <= 300){
      soilstatus = "TOO MUCH ";
```

Figure 3: Snippet of the stress mapping

2.3 Scenario

This analysis is carried out by designing a soil nutrient measurement tool for spinach plants that will be integrated by the internet [8]. This tool is attached to an npk sensor which is connected to the ESP 32 as a microcontroller. The network used is lora which focuses on analyzing the performance of the network [29]. To get data, sensor data will be sent in the form of .json which passes through the lora gateway and then forwarded through the backhaul network to be connected to the internet [7]. And create a private network to compare data and is expected to produce analysis that can help develop further IoT tools [2].

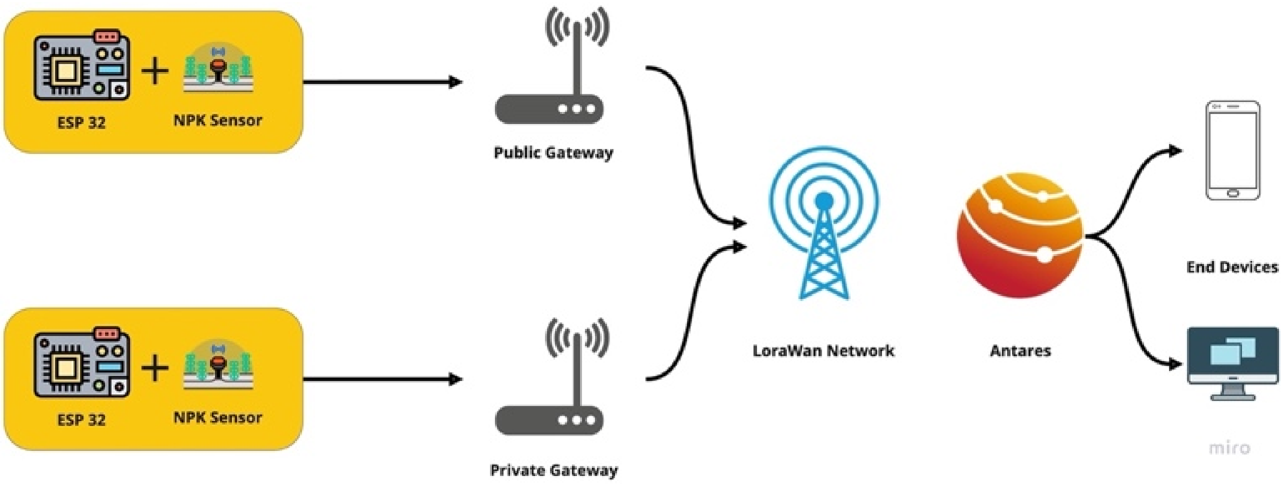


Figure 4: Scenario

2.4 Hardware

Table 1 describes the sensors and equipment for the device. There are 6 components that have different functions. For the board the author uses ESP 32 LR 201. This microcontroller features a built-in WiFi with dual-mode Bluetooth. Meanwhile, ANTARES LR-ESP201 is a Development Board developed by Antares Telkom DDS IoT Platform based on ESP32 and has also embedded the RFM95 LoRa Transceiver module to transmit data via LoRa radio access to the Gateway which has been integrated with the Antares platform [10]. All sensors or end nodes in this test use a series power supply. A power supply is an electrical device that can provide electrical energy for electric power or other electronic devices [16]. This study uses an NPK sensor, this sensor detects the presence of nutrients such as (N), phosphorus (P) and metal elements (K) using a photoelectric sensor. Sensors are needed to determine the proportion of other internal substances to be added to the soil to increase the yield of these nutrients [3]. LCD antenna, DHT 11, YL-38 and LoRa have been arranged in an acrylic box that the author has made.

Table 1: Hardware

No	Hardware	Function
1	Antares LR-ESP201 board	Microcontroller as a whole system access
2	DHT 11	Digital temperature and humidity sensor
3	Sensor NPK	Used to detect the NPK condition
4	LCD 20x4	To display the NPK condition
5	Shield antares	To terminalize the cable on the device
6	Power Supply	Energy source for the device

2.5 Software

To run a command requires software so that the tool is able to work as expected. Therefore software is important [33]. Table 2 shows a list of software used to run the tool and shows the software and platforms that can provide an interface from the database to the application.

The first software is Arduino IDE. Arduino IDE is software developed by Arduino and used to create/write programs, then compiled and flashed to microcontroller chips, such as arduino, esp8266, esp32 [25]. In addition, there is ANTARES (Application and Technology Platform as Your Trusted Solution) which is a Horizontal IoT Platform developed by Telkom Media and Digital Apart from

Table 2: Software

No	Software	Function
1	Arduino IDE	A software to configure and command Arduino as a microcontroller
2	Antares database	Used to store realtime data and historical data
3	kodular	Opensource platform to create android application

being flexible and free, Antares is also able to meet regulations related to data storage in Indonesia that have been set by the Ministry of Communication and Information (Kominfo) [9]. The last one is a website/app to design and build a fully working android based mobile app i.e. Kodular. Kodular provides code blocks that are easy to use and set up. Kodular is widely used by users in application design because of its simplicity. Kodular provides users with two separate editors. The first editor is Designer. It is used to set on and off-screen components. The second editor is the Block Editor where the user can logically program the behavior of the application by combining blocks [24].

3 Result and Discussion

In this chapter, the author explains how the results of the two gateway tests are carried out.

3.1 Integration Testing

Testing is done to find out whether the tool can work properly in accordance with the desired function or not. Starting from the basic functions and feature functions of the related tools. Table 3 shows a table of integration testing:

Table 3: Device Testing

No	Component	Function
1	Microcontroller can transmit data in real time and execute commands from arduino ide	Succeed
2	NPK sensor can detect and transmit the valueof each parameter	Succeed
3	20x4 LCD can display ground status and variable parameters	Succeed
4	DHT sensor can detect the ambient temperature	Succeed
5	Battery power supply can supply the power needed by the tool	Succeed
6	Public gateway can receive and send packets properly	Succeed
7	Private gateway can receive and send packets well	Succeed

3.2 NPK Sensor

The sensor used in this study is an analog type which is modified to become a digital signal. So, it needs to be compared with the value on the microcontroller which is analog. Therefore, this test is very necessary to get the accuracy of data from digital sensors compared to real data, namely analog.

The results of data collection from digital sensors are relatively the same as data taken from analog sensors. It can be concluded that the test is successful and the data is close to the desired accuracy.

Table 4: Sensor Comparison

Soil Sample	Comparison Data					Conclusion
	NPK Sensor Digital				NPK Sensor Analog	
	N	P	K	Status	Status	
Sand Beach	0	0	0	Poor	Poor	Succeed
Plant Soil	150	130	9	Ideal	Ideal	Succeed
Malang Sand	200	185	15	Too much	Too much	Succeed

Table 4 shows that the results of the three soil tests above can display relatively the same data. Therefore, the level of data accuracy is the same and is declared successful.

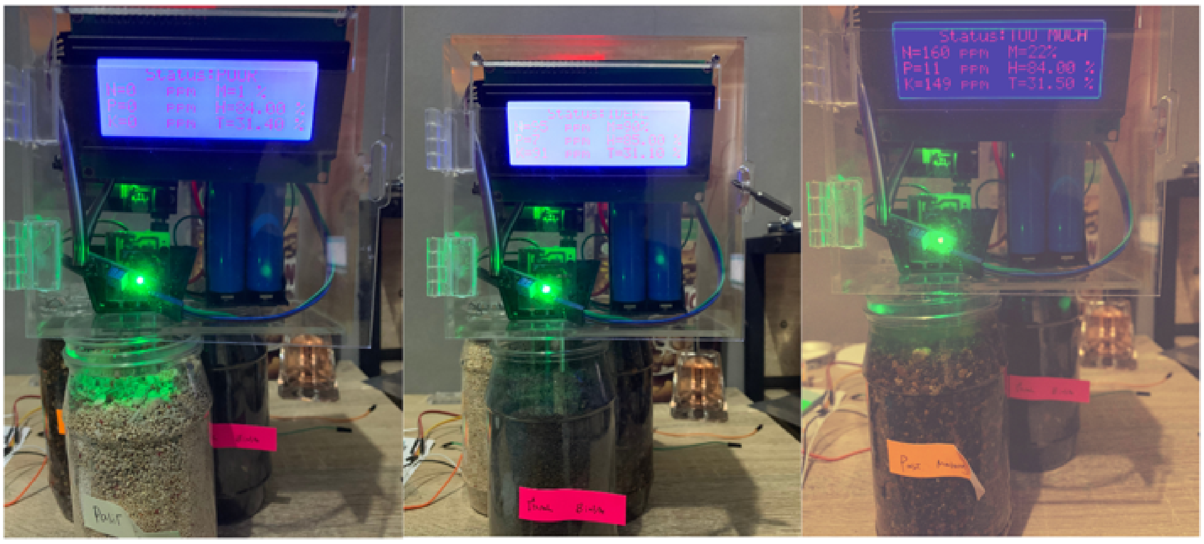


Figure 5: NPK Sensor

3.3 Plant Testing

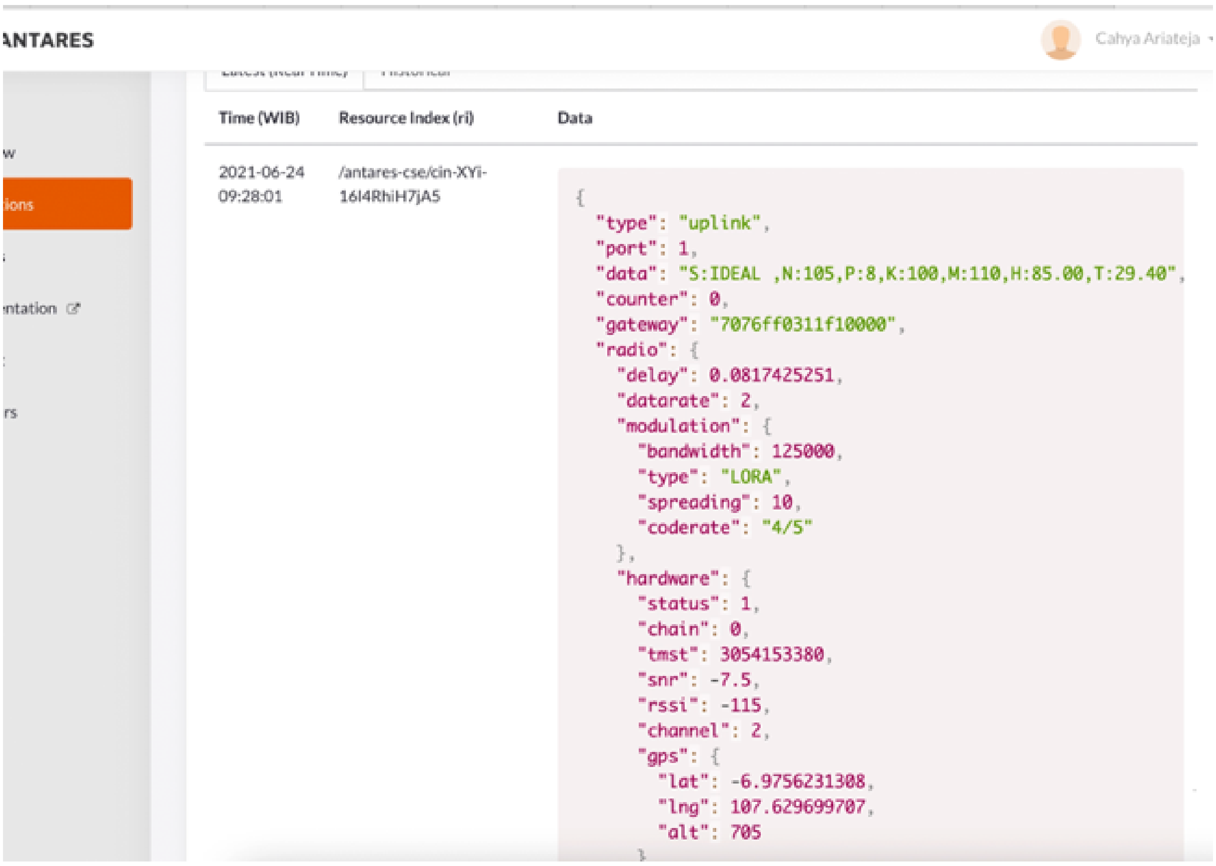


Figure 6: Antares Data

Testing on plants is also necessary to help obtain accurate data. Therefore, the authors observed plant growth with the subject of Brazilian spinach planted on ideal soil according to NPK measurements. The results are quite satisfactory when mini can grow well for 3 weeks. Planting is done from seeds in the form of stems until they are well leafed.

Figure 6 shows a web view of receiving data on the Antares server. Incoming data to the Antares server is relatively fast with a lag time of less than 1 second. Antares platform is good enough to accommodate related IoT devices.

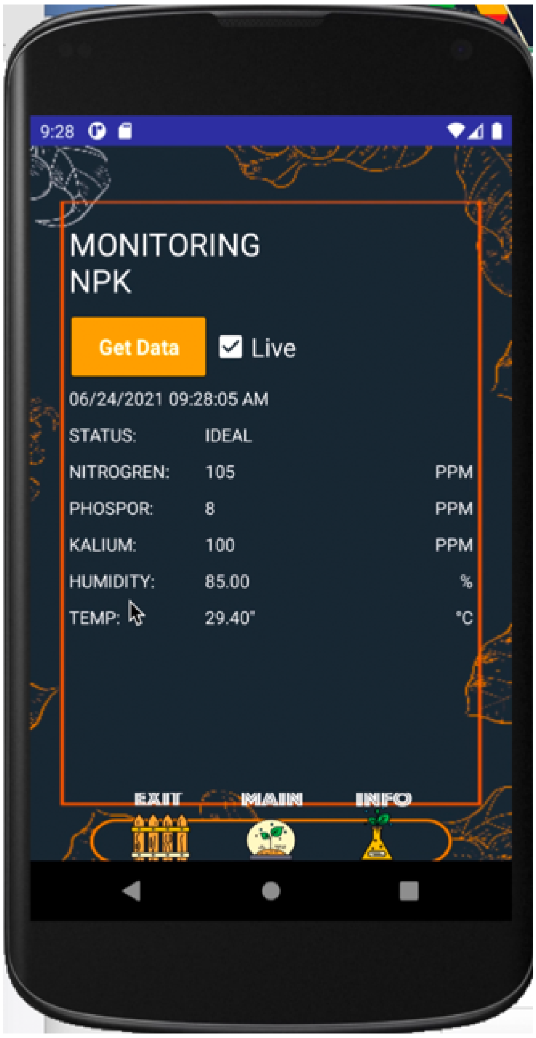


Figure 7: Application Data

From the android application can display data from Antares well. However, the time required is relatively longer with a pause of 1 second. Given the data must pass through the Antares server and then forward it to the android application. Then the data transfer takes longer because it goes through 2 stages of data transfer.

3.4 Lora Private and Public Network Testing

This test was conducted to determine the performance of the two lora gateways and the quality of the two lora networks. This test uses basic parameters such as packet loss, throughput, and delay [36], [19]. Parameters are taken based on THIPON standard reference. The data taken in the form of SNR, RSSI, and the time of sending and receiving data from the Antares server. The data is obtained by opening the radio log file from the Antares database with the help of the admin from the Telkom DDB office.

Figure 8 shows that data is obtained continuously, both private and public gateways can be received simultaneously using one device. In further testing the authors took data from 3 different location points. Both public and private gateways were in the Telkom DDB office. Data is taken in stages with a time of 20 minutes for each location point.

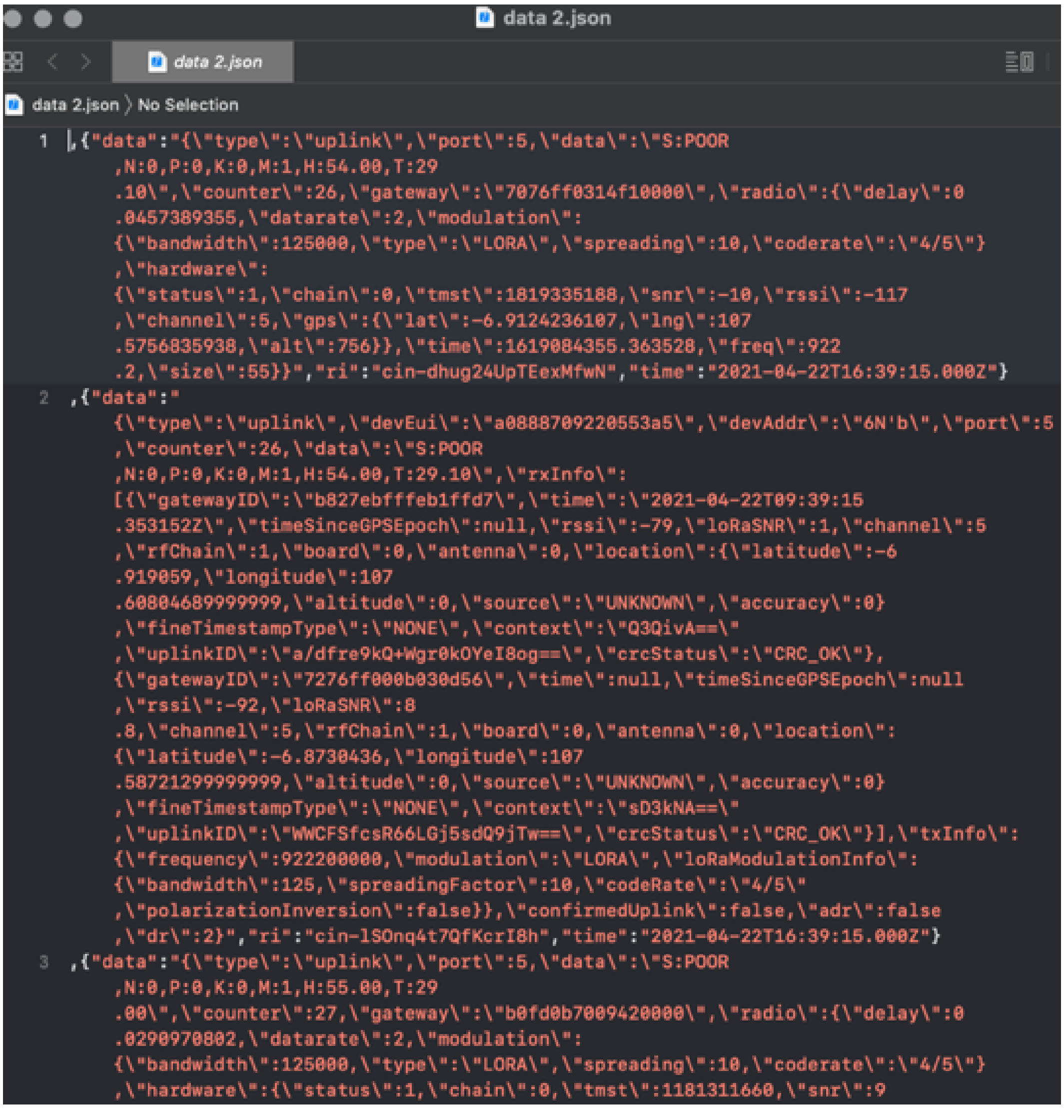


Figure 8: JSON

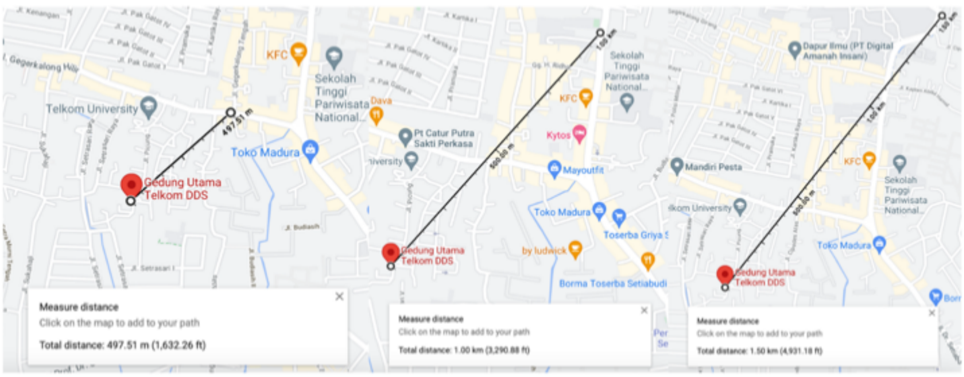


Figure 9: Data Capture Point

Figure 9 shows that at point 1 is in the Telkom Gegerkalong area with a distance of 500 m from the gateway, point 2 is at a Gacoan noodle restaurant with a distance of 1 Km from the gateway, point 3 is on Jl. dr. setiabudi with a distance of 1.5 Km from the gateway. Data retrieval at 3 points is carried out sequentially with a time of 20 minutes and data is sent from the microcontroller every 30 seconds. Figure 10, 11, and 12 shows a graph analysis of the delay of the public and private gateways.

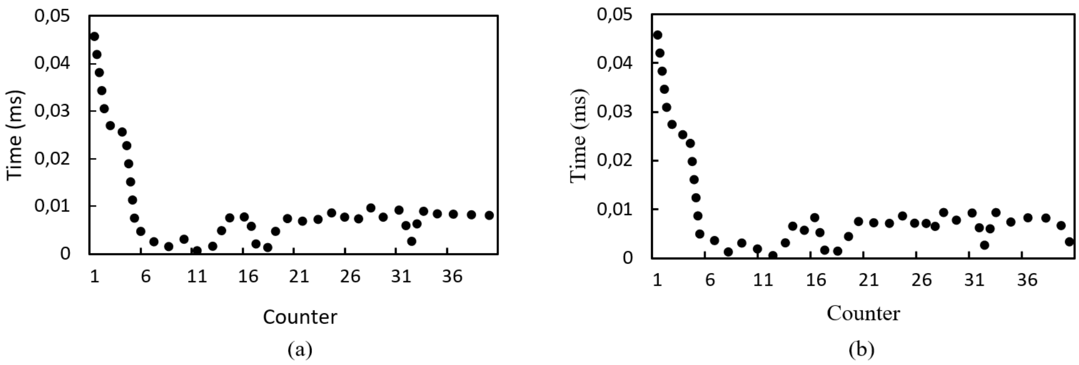


Figure 10: (a) Delay Public And (b) Private Gateway 500 m

Figure 10 shows that at a distance of 500 m at the Telkom Gegerkalong area, each gateway managed to send 40 packets for 20 minutes. For the public gateway, the average delay is 0.0086 while the private gateway is 0.0083 which is equivalent to 8.6 ms and 8.3 ms. Value is still quite good and at this point the private gateway managed to outperform.

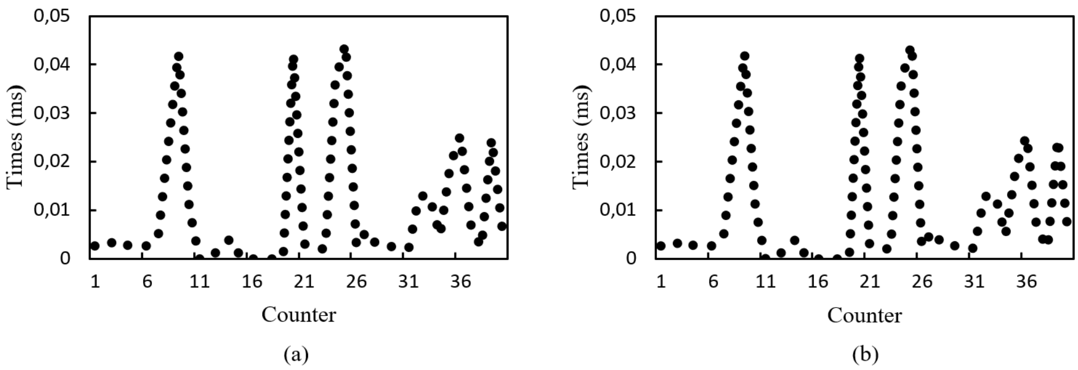


Figure 11: (a) Delay Public And (b) Private Gateway 1 km

Figure 11 shows that at a distance of 1 Km at the Mie Gacoan location, the public gateway managed to send 38 packets and the private gateway managed to send 39 packets for 20 minutes. For public gateways, the average delay is 0.0092 and for private gateways it is 0.0098 or equal to 9.2 ms and 9.8 ms. At this point the public gateway is superior to the private gateway.

Figure 12 shows that at the third point with a distance of 1.5 Km on Jl. dr. setiabudi, the public gateway can properly send 40 packets of data while the private gateway is 38 packets for 20 minutes. For public gateways, the average delay is 0.016 and private is 0.013 or equivalent to 16 ms and 13 ms. The delay is quite large due to distance factors and regional differences in terrain.

Figure 13 shows that it can be concluded that the smaller the delay, the better the network quality. In this study the private gateway outperformed in 2 places. The delay generated by the private gateway is better. At the second point the public gateway is slightly superior to the private. This research is influenced by other factors that cause the above data to change according to the environmental situation. Such as distance, regional terrain differences, etc.

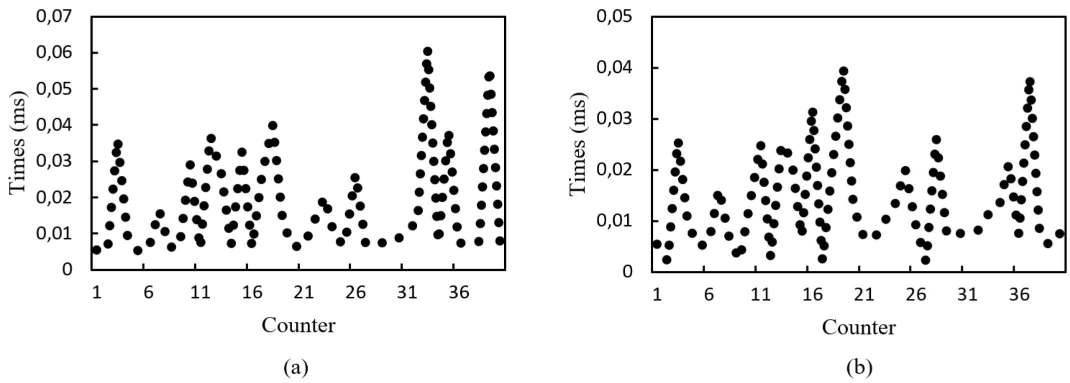


Figure 12: (a) Delay Public And (b) Private Gateway 1,5 km

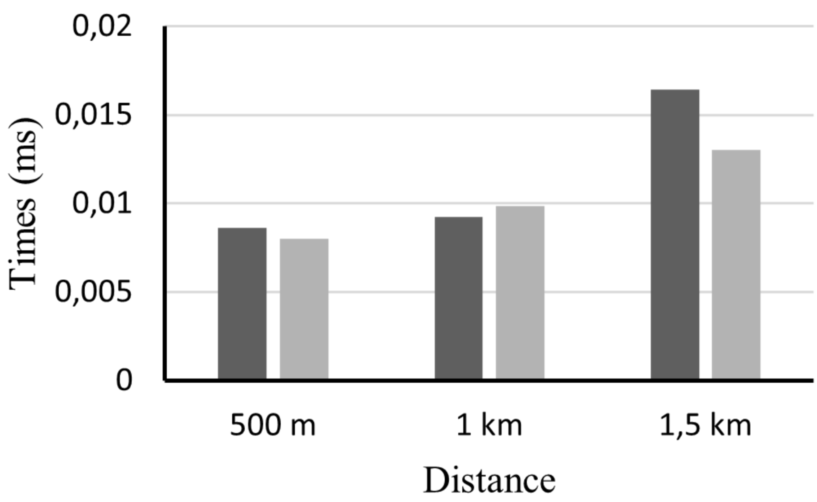


Figure 13: Delay Average; dark color for public and light color for private

3.5 Throughput

Throughput is the effective data transfer rate in bps (bits per second) [21]. Throughput is also the total packets that have been observed at the destination within a certain time interval divided by the duration of the time interval. Equation 1 determine the throughput:

$$Throughput = \frac{DataPacketReceived}{ObservationLength} \tag{1}$$

In the throughput test, data retrieval is carried out for 20 minutes for each location. The microcontroller sends data every 30 seconds. The number of packets received must be 40. It should be noted that the greater the Throughput value, the better the network quality. Table 6 shows that the packets received at the public gateway tend to be stable and the results are good.

Table 5: Throughput

Throughput Level			
Number of Packets Received	Throughput (Byte/s)	Level	Index
40	0.033	Very good	4
35	0.029	Good	3
30	0.025	Moderate	2
<20	0.016	Poor	1

Table 6: Throughput Test

Location	Received Packet (Public)	Throughput (Byte/s)	Received Packet (Private)	Throughput (Byte/s)
Telkom Gegerkalong (500 m)	40	0,033	40	0,033
Mie Gacoan (1 km)	38	0,031	39	0,032
Setiabudi Street (1 km)	40	0,033	38	0,031

Meanwhile, on a private gateway, the farther the distance, the less packets received. In the throughput gateway public is superior to private.

3.6 Packet Loss

Packet loss is a parameter that describes a situation that shows the total number of lost packets that may occur due to collisions and congestion on the network. Equation 2 determine the packet loss:

$$PacketLoss = \frac{(DataPacketSent - DataPacketReceived) \times 100\%}{DataPacketSent} \quad (2)$$

Packet loss is a packet that is lost during data transmission. Packet loss testing was carried out for 20 minutes. The microcontroller sends a packet every 30 seconds. This means that the number of packets that must be received is 40 packets. It should be noted that the greater the percentage of packet loss, the lower the quality of the network.

Table 7: Packet Loss Level

Amount of Packet Loss	Level	Index
0	Very good	4
3	Good	3
15	Moderate	2
25	Poor	1

Table 8: Packet Loss Test

Location	Received Packet (Public)	Throughput (Byte/s)	Received Packet (Private)	Throughput (Byte/s)
Telkom Gegerkalong (500 m)	40	0	40	0
Mie Gacoan (1 km)	38	0,5	39	0,025
Setiabudi Street (1 km)	40	0	38	0,05

Table 8 shows that, it can be concluded that the public gateway has minimal packet loss compared to the private gateway. The packet loss obtained by the private gateway depends on the distance factor. The farther the data retrieval distance, the more packet loss is generated. Overall, the public gateway is superior with a difference of 0.025 % from the private gateway.

3.7 SNR

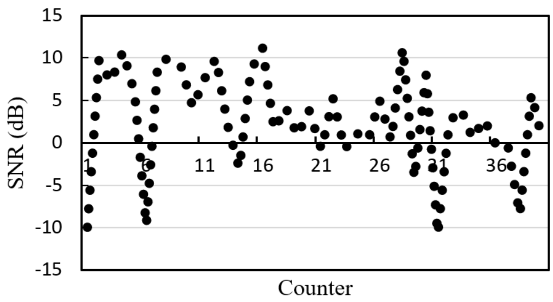
SNR or signal-to-noise ratio is the ability of the signal to the noise intensity received by the user. The smaller the SNR value, the smaller the power obtained by the user [10]. Equation 3 determines the SNR (defined in dB):

$$SNR(dB) = 10log_{10}\left(\frac{S}{N}\right) \quad (3)$$

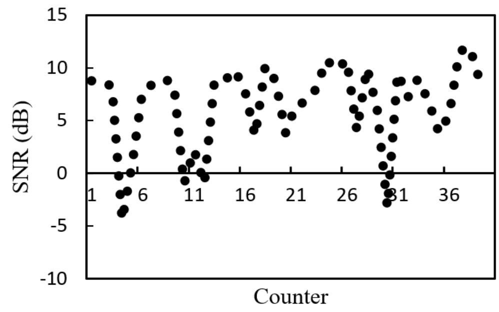
SNR testing was carried out to determine the quality of both networks. The test uses a bandwidth of 125 kHz, code rate 4/5, frequency 922.2 Mhz, and spreading factor 10. Because the spreading factor is 10, the SNR value can be said to match at least -12.5 dB. Please note that the greater the value of the SNR, the better the network quality.

Table 9: SNR

Signal Level to Noise Ratio			
Spreading Factor	Signal to Noise Ratio (dB)	Spreading Factor	Signal to Noise Ratio (dB)
7	-12	10	-12,5
8	-17,5	11	-10
9	-15	12	-7,7

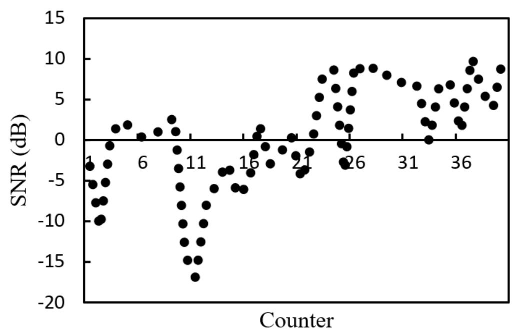


(a)

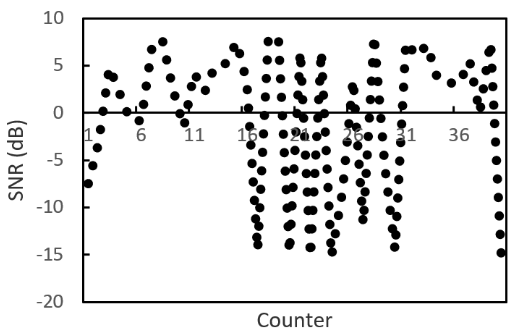


(b)

Figure 14: (a) SNR Public And (b) Private Gateway 500 m

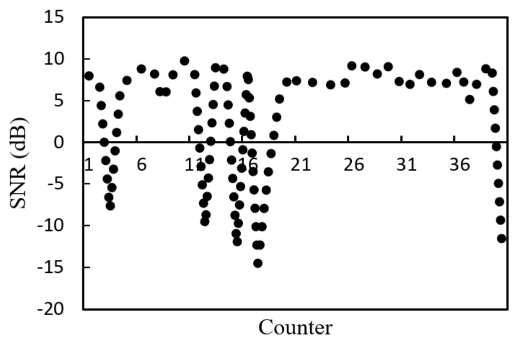


(a)

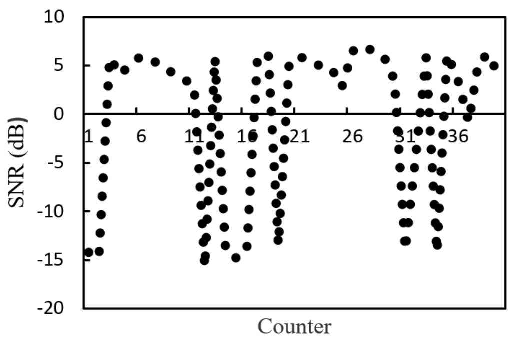


(b)

Figure 15: (a) SNR Public And (b) Private Gateway 1 km



(a)



(b)

Figure 16: (a) SNR Public And (b) Private Gateway 1,5 km

Figure 14 shows that the result of the SNR of the two networks. The average SNR at the public gateway produces a value of 2.857 dB and at the private gateway is 6.74 dB. This means that both gateways are included in the spreading factor of 10 because this value is more than -12.5 dB. It can be concluded that both have very good SNR values. Private gateways outperform at this point.

Figure 15 shows that, at the second point the average SNR at the public gateway produces a value of 1.039 dB and at the private gateway it is 0.1 dB. This means that both gateways are included in the spreading factor of 10 because the resulting value is more than the minimum value of -12.5 dB. It can conclude both gateways have a very good value. And for this point the public gateway outperformed.

Figure 16 shows that at the third point the average SNR at the public gateway produces a value of 5.15 dB and at the private gateway it is 0.15 dB. This means that both gateways are included in the spreading factor of 10 because the resulting value is more than the minimum value of -12.5 dB. It can conclude both gateways have a very good value. And for this point the public gateway outperformed.

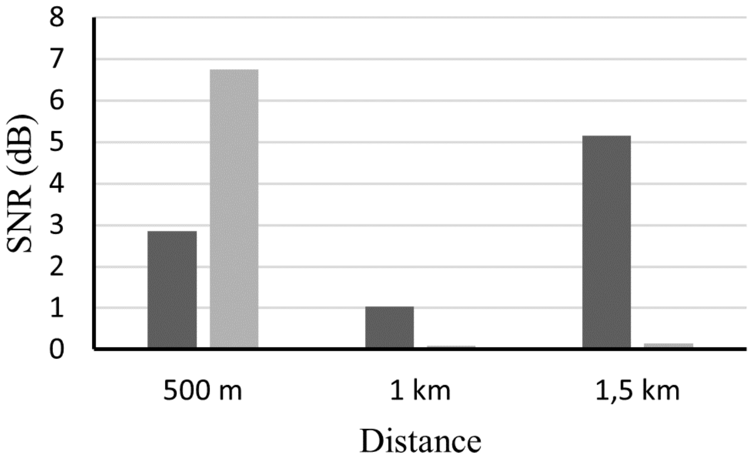


Figure 17: SNR Average; dark color for public and light color for private

Figure 17 shows that public gateways are superior to private gateways. For private gateways, the farther the distance, the less the SNR value obtained.

3.8 RSSI

RSSI testing is performed to determine the quality of both networks [12]. The test uses a bandwidth of 125 kHz, Code Rate 4/5, frequency 922.2 Mhz, and a spreading factor of 10. The RSSI value is very dependent on environmental conditions and distance. The farther the distance and the barrier, the RSSI value will decrease. Please note that the RSSI value is considered satisfactory if it is less than -120 dBm.

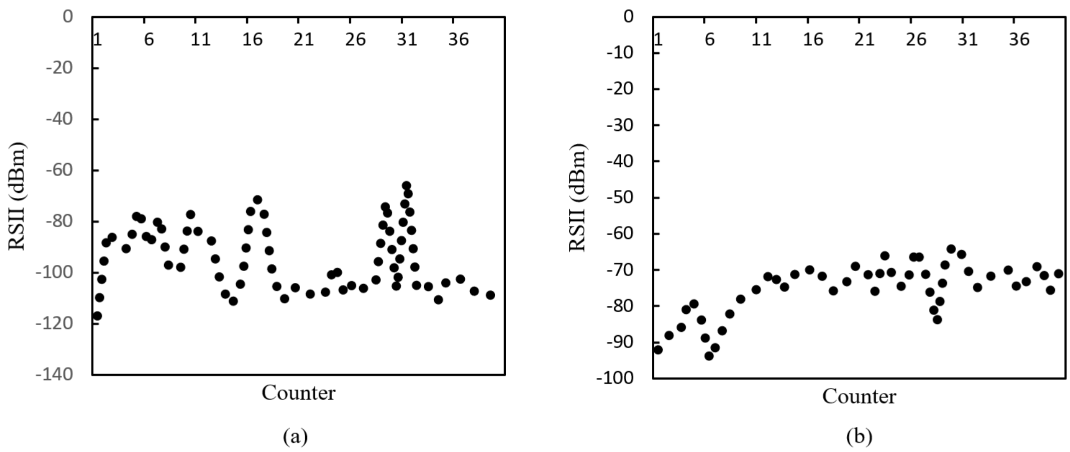


Figure 18: (a) RSSI Public And (b) Private Gateway 500 m

Figure 18 shows that at the first point the average RSSI at the public gateway produces a value of -97.425 dBm and at the private gateway is -75 dBm. This means that both gateways have good values because the resulting value is more than the minimum value of -120 dBm. It can conclude both gateways have a very good value. And for this point the private gateway outperformed.

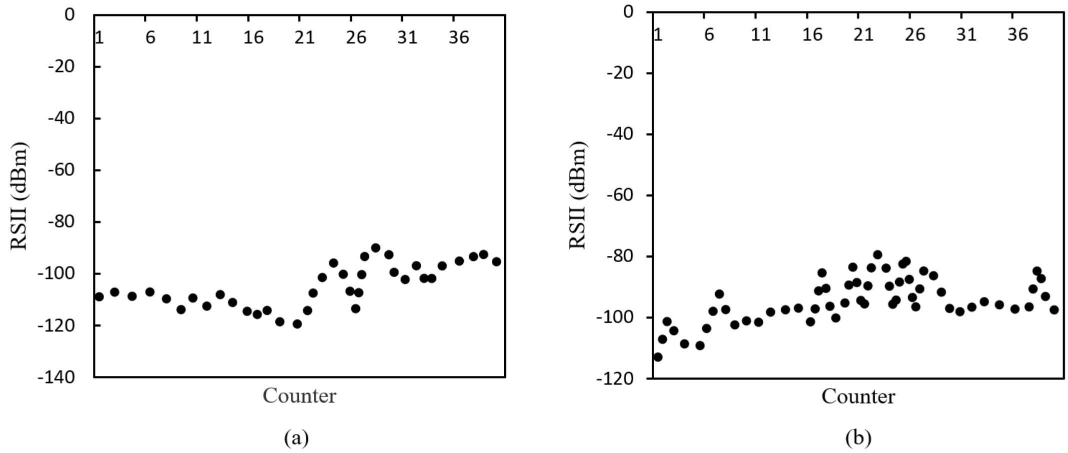


Figure 19: (a) RSSI Public And (b) Private Gateway 1 km

Figure 19 shows that at the second point the average RSSI on the public gateway produces a value of -104.94 dBm and at the private gateway of -95.84 dBm. This means that both gateways have good values because the resulting value is more than the minimum value of -120 dBm. It can conclude both gateways have a very good value. And for this point the private gateway outperformed.

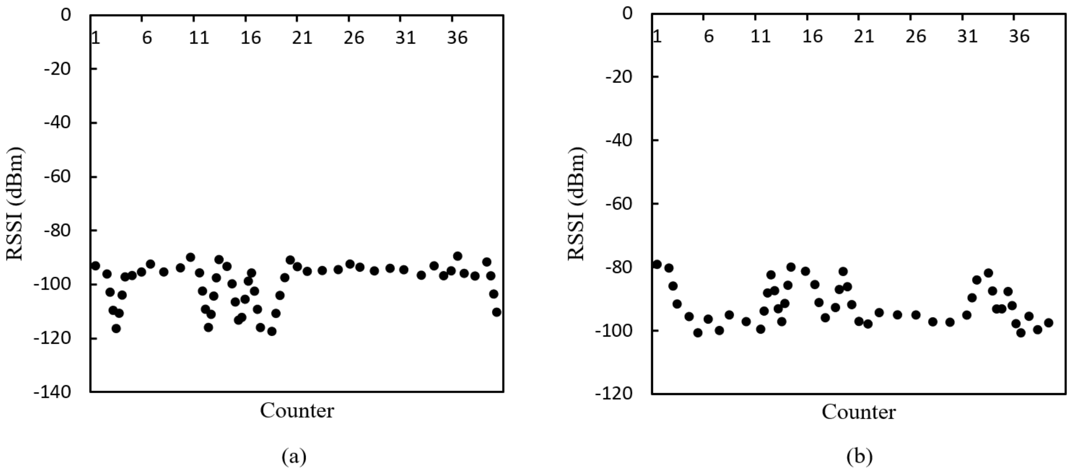


Figure 20: (a) RSSI Public And (b) Private Gateway 1,5 km

Figure 20 shows that at the first point the average RSSI at the public gateway produces a value of -97.6 dBm and at the private gateway -92.71 dBm. This means that both gateways have good values because the resulting value is more than the minimum value of -120 dBm. It can conclude both gateways have a very good value. And for this point the private gateway outperformed.

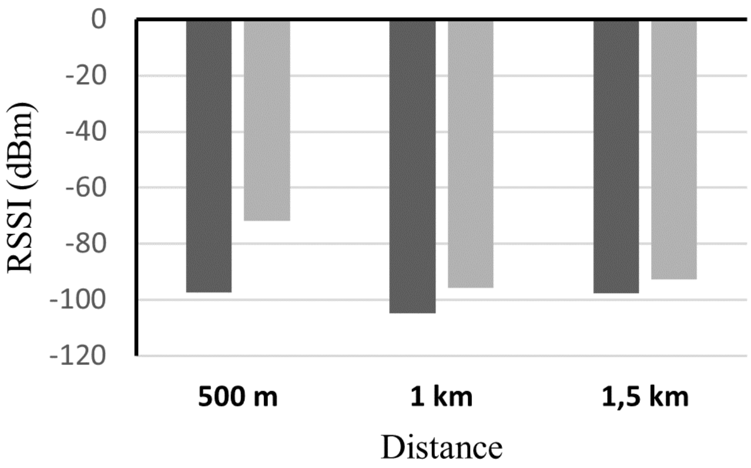


Figure 21: RSSI Average; dark color for public and light color for private

Figure 21 shows the average value of each test point. It can be concluded that the RSSI value is very good from both gateways. This is because the test distance is relatively close. The largest average value is at a distance of 500 m. If you look again, it can be concluded that the farther the distance, the worse the RSSI quality obtained. The private gateway excelled at all test points.

4 Conclusion

It can be concluded that the public gateway has minimal packet loss compared to the private gateway. The packet loss obtained by the private gateway depends on the distance factor. The farther the data retrieval distance, the more packet loss is generated. Overall, the public gateway is superior with a difference of 0.025 % from the private gateway. The conclusion from the comparison between public and private gateways in terms of QoS (quality of service) is that public gateways are superior when used at relatively far distances, while private gateways are superior when used at relatively close distances. From this problem it can be concluded that the two gateways are quite effective when used according to the right needs.

Conflict of interest

The authors declare no conflict of interest.

References

[1] Adekiya, A. O.; Aboyeji, C. M.; Dunsin, O.; Adebiyi, O. V.; Oyinlola, O. T. (2018). Effect of urea fertilizer and maize cob ash on soil chemical properties, growth, yield, and mineral composition of okra, Abelmoschus esculentus (L.) Moench, *Journal of Horticultural Research*, 26(1), 67–76, 2018.

[2] Adelantado, F.; Vilajosana, X.; Tuset-Peiro, P.; Martinez, B.; Melia-Segui, J.; Watteyne, T. (2017). Understanding the Limits of LoRaWAN, *IEEE Communications magazine*, 55(9), 34–40, 2017.

[3] Ali, M. A.; Dong, L.; Dhau, J.; Khosla, A.; Kaushik, A. (2020). Perspective—electrochemical sensors for soil quality assessment, *Journal of The Electrochemical Society*, DOI: 10.1149/1945-7111/ab69fe, 167(3), 037550, 2020.

[4] Astuti, D. (2017). Pusat rekreasi edukasi pertanian kacang tanah kabupaten Pati (Penekanan Arsitektur Tropis Ekspresionis), *Universitas Muhammadiyah Surakarta*, 2017.

[5] Barik, M. Z. A.; Hidayat, W.; Hasad, A.; Sikki, M. I.; Sujatmiko, A. (2020). Alat Penyiram dan Monitoring Tanaman Cabai Berbasis Internet of Things Menggunakan Wemos D1 R3 Dan Aplikasi Thingspeak, *JREC (Journal of Electrical and Electronics)*, 8(2), 83–90, 2020.

[6] Burhan, A. B. (2018). Pemanfaatan teknologi informasi dan komunikasi untuk pengembangan ekonomi pertanian dan pengentasan kemiskinan, *Jurnal Komunikasi Pembangunan*, 16(2), 233–247, 2018.

[7] Candra, G. B.; Pramukantoro, E. S.; Primananda, R. (2020). Implementasi Antarmuka Komunikasi Berbasis Long Range pada IoT Middleware Untuk Mendukung Network Interoperability, *Jurnal Pengembangan Teknologi Informasi dan Ilmu Komputer*, 4(1), 65–73, 2020.

[8] Dorsemaine, B.; Gaulier, J. P.; Wary, J. P.; Kheir, N.; Urien, P. (2015). Internet of things: a definition & taxonomy, *2015 9th International Conference on Next Generation Mobile Applications, Services and Technologies*, DOI: 10.1109/NGMAST.2015.71, 72–77, 2015.

[9] Fauzi, A. (2020). Penerapan smart environment berbasis internet of things dengan metode fuzzy logic, *Universitas Islam Negeri Sumatera Utara*, 2020.

[10] Firdaus, R.; Murti, M. A.; Alinursafa, I. (2019). Air quality monitoring system based internet of things (IoT) using LPWAN LoRa, *2019 IEEE International Conference on Internet of Things and Intelligence System (IoTaIS)*, 195–200, 2019.

[11] Ghifari, A. F.; Roviq, M.; Koesriharti, K. (2019). Pengaruh Dosis Pupuk Majemuk NPK terhadap Hasil dan Kandungan Vitamin C Dua Varietas Bayam (Amaranthus tricolor L.), *Jurnal Produksi Tanaman*, 7(10), 1708–1788, 2019.

[12] Goldoni, E.; Prando, L.; Vizziello, A.; Savazzi, P.; Gamba, P. (2019). Experimental data set analysis of RSSI-based indoor and outdoor localization in LoRa networks, *Internet Technology Letters*, 2(1), e75, 2019.

[13] Kurakula, P.; Kerketta, A.; Prasad, V. M. (2021). Effect of different level of organic manures and inorganic fertilizers on growth, yield and quality of Spinach (Spinacia oleracea), *Journal of Pharmacognosy and Phytochemistry*, 10(2), 1309–1312, 2021.

[14] Kusuma, W. R. P. (2021). Purwarupa Sistem Pengendalian Pemupukan Otomatis Pada Tanaman Kedelai Berbasis Internet of Things, *Telkom University*, 2021.

[15] Mentari, E.; Waluyo, T. (2017). Peran International Fund for Agricultural Development Dalam Pembangunan Perekonomian Masyarakat Indonesia Timur (Studi Kasus: Daerah Papua), *Riau University*, 2017.

[16] Munaruzzikri (2018). Pengembangan alat power supply pada praktikum elektrolisis di prodi pendidikan kimia fakultas tarbiyah dan keguruan uin ar-raniry, *Universitas Muhammadiyah Surakarta*, 2018.

[17] Parvez, B.; Haidri, R. A.; Verma, J. K. (2020). IoT in Agriculture, *2020 International Conference on Computational Performance Evaluation (ComPE)*, 3(1), 844–847, 2020.

[18] Perdana, D.; Putra, R.; Bisono, G. (2019). Analysis of Soil Substance Measurement System Based on Internet of Things (IoT) with Star Topology Network, *International Journal of Simulation: Systems Science & Technology*, 20(6), 13–18, 2019.

[19] Perdana, D.; Sari, R. F. (2013). Performance comparison of IEEE 1609.4/802.11 p and 802.11 e with EDCA implementation in MAC sublayer, *2013 International Conference on Information Technology and Electrical Engineering (ICITEE)*, DOI: 10.1109/ICITEED.2013.6676254, 285–290, 2013.

[20] Pamukti, B.; Perdana, D. (2016). Non-linear effects of high rate soliton transmission on DWDM optical fiber communication system, *2016 1st International Conference on Information Technology, Information Systems and Electrical Engineering (ICITISEE)*, DOI: 10.1109/ICITISEE.2016.7803042, 26–30, 2016.

[21] Putra, M. A. P.; Perdana, D.; Negara, R. M. (2017). Performance analysis of data traffic offload scheme on Long Term Evolution (LTE) and IEEE 802.11 AH, *Telkomnika*, 15(4), 1659–1665, 2017.

[22] Qiu, Y.; Liu, Y. J.; Zhou, J.; Zhang, G.; Chen, D.; Du, N. (2018). All-digital blind background calibration technique for any channel time-interleaved ADC, *IEEE Transactions on Circuits and Systems I: Regular Papers*, DOI: 10.1109/TCSI.2018.2794529, 65(8), 2503–2514, 2018.

[23] Ridha, R. N.; Burhanuddin, B.; and Wahyu, B. P. (2017). Entrepreneurship intention in agricultural sector of young generation in Indonesia, *Asia pacific journal of innovation and entrepreneurship*, DOI: 10.1108/apjie-04-2017-022, 11(1), 76–89, 2017.

[24] Ronaldo, R.; Ardoni, A. (2020). Pembuatan Aplikasi Mobile" Wonderful of Minangkabau" sebagai Gudang Informasi Pariwisata di Sumatera Barat Melalui Website Kodular, *Info Bibliotheca: Jurnal Perpustakaan dan Ilmu Informasi*, DOI: 10.24036/ib.v2i1.90, 2(1), 88–94, 2020.

[25] Serikul, P.; Nakpong, N.; Nakjuatong, N. (2018). Smart farm monitoring via the Blynk IoT platform: case study: humidity monitoring and data recording, *2018 16th International Conference on ICT and Knowledge Engineering (ICT&KE)*, 1–6, 2018.

[26] Simo, A.; Barbulescu, C.; Kilyeni, S.; Dragos, C. (2019). Manufacturing Process Monitoring in Terms of Energy Management Improving, *INTERNATIONAL JOURNAL OF COMPUTERS COMMUNICATIONS & CONTROL*, 14(3), 388–400, 2019.

[27] Sukendar, T.; Saputro, M. I. (2019). Analisa Jaringan LAN menggunakan Teknologi EtherChannel untuk meningkatkan performa jaringan pada SMU Panca Sakti Jakarta, *Jurnal Teknologi Informasi*, 5(2), 99–106, 2019.

[28] Taskin, D.; Yazar, S. (2020). A Long-range Context-aware Platform Design For Rural Monitoring With IoT In Precision Agriculture, *INTERNATIONAL JOURNAL OF COMPUTERS COMMUNICATIONS & CONTROL*, 15(2), 2020.

[29] Tomar, R.; Gemein, O. G. (2018). LoRa network for cities Private and complete secured by design, *2018 Global Internet of Things Summit (GIoTS)*, 1–5, 2018.

[30] Wattimena, A. Y. (2018). Pengaruhpemberian Pupuk Npk Terhadap Pertumbuhan Bibit Tanaman Pala (Myristica Fragran Houtt), *Jurnal Agriment*, 3(1), 42–46, 2018.

[31] Wiendiyati, W.; Pudjiastuti, S.; Nurwiana, I.; Kapioru, C.; Sinu, I. (2020). Determinants affecting the decision of milenial generation in the border area RI-RDTL to work in the agriculture sector, *Jurnal EXCELLINTIA*, 9(2), 170–178, 2020.

[32] Yu, X.; Zhang, Z.; Han, W. (2019). Survey on transmission performance for soil wireless sensor network signal in different communication, *IAENG International Journal of Computer Science*, 46(3), 475-484, 2019.

[33] Yuliza, Y.; Pangaribuan, H. (2016). Rancang bangun kompor listrik digital IOT, *Jurnal Teknologi Elektro*, 7(3), 141988, 2016.

[34] Zhao, F.; Zou, G.; Shan, Y.; Ding, Z.; Dai, M.; He, Z. (2019). Coconut shell derived biochar to enhance water spinach (Ipomoea aquatica Forsk) growth and decrease nitrogen loss under tropical conditions, *Scientific reports*, DOI: 10.1038/s41598-019-56663-w, 9(1), 1–8, 2019.

[35] [Online]. Available: www.espressif.com/sites/default/files/documentation/esp32_datasheet_en.pdf, Accesed on 5 December 2021.

[36] [Online]. Available: www.etsi.org/deliver/etsi_tr/101300_101399/101329/02.01.01_60/tr_101329v020101p.pdf, Accesed on 5 December 2021.

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