LoRa Data Communication For Fishing Boat Monitoring

Fadli Padriyana[1, a)]

[1)]*Bachelor of Electrical Engineering, Siliwangi University Jl. Siliwangi No. 24 Tasikmalaya West Java Indonesia.*

[a)]*Corresponding author: padriyana@gmail.com*

Abstract. Fishermen really need a monitoring system that can help when an emergency occurs at work so that it is easy to find the location of the incident so that problems can be handled immediately. In this study, a fishing boat monitoring system based on LoRa was developed, this system consists of a node device and a gateway. Node device is a device attached to a fishing boat that will continuously transmit data via LoRa communication so that the boat can be monitored. Setting Air Data Rate (ADR), data length and distance will affect the time on air (TOA) and reception of LoRa communication data. The LoRa module used is LoRa E32 with a working frequency in the 915 MHz band. The test is carried out on the shoreline to the sea in a line of sight (LOS) state. The data sent includes the rotational motion/tilt of the boat (roll and pitch), as well as the coordinates of the location of the boat (longitude and latitude). While the gateway is a device that forwards data to be displayed on the application server dashboard. The application server used in this research is thingsboard. The farthest distance that can be reached in the tests carried out is up to 2.4 km with the Air Data Rate setting at 0.3 Kbps, the data size is up to 55 bytes with an average time on air of 3.017 seconds.

INTRODUCTION

According to statistical data recorded by the National Transportation Safety Committee (KNKT), the trend of water transportation accidents increased from 2013 with 6 accidents to 2018 with 39 water transportation accidents occurred. The causes are varied, from human error to natural factors. Natural factors accounted for 38% of the causes of water transportation accidents, followed by human error with 37%, technical 23% and other factors 2% [1]. Fisherman works using conventional boats made with the skills and knowledge inherited fromtheir ancestors, not using the skills and knowledge froma ship buiding architect. Therefore the stability and and security level of conventional boats is low [2]. Fishermen also need communication devices, so that fishermen can be continously connected and monitored so that when an emergency occurs it can handled immediately.

Communication technology in maritime scenarios has been widely discussed, many methods are used to obtain a better system. LoRa is a wireless communication technology with a fairly long range by utilizing the chirp spread spectrum modulation technique so that this technique has a low power consumption [3] and works in the ISM frequency band (433, 868 and 915 MHz). LoRa packet data format consists of three main components, namely preamble, header (optional), and payload. There are two types of LoRa packet data formats (Figure 1), namely Explicit header mode and Implicit header mode. In the explicit header mode format, there is a header in which there is information on payload length, coding rate. And CRC (Cyclic Redundancy Check) serves to check for errors in digital data. Meanwhile, in implicit header mode, the parameters of payload length, coding rate, and CRC are not included in the data packet, and will reduce time on air [4].

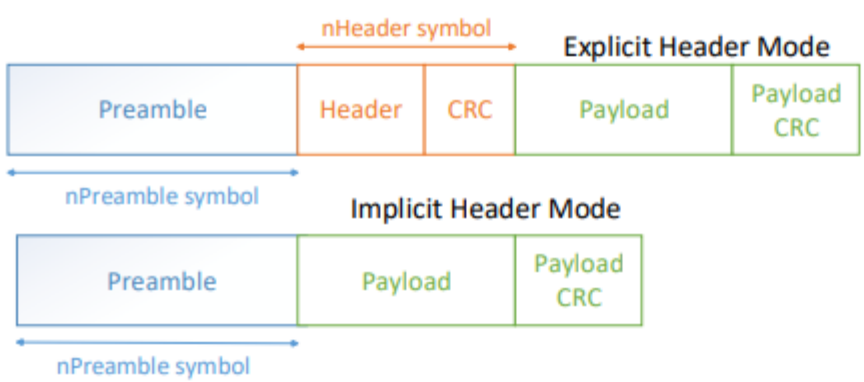


FIGURE 1. LoRa Format Packet Data

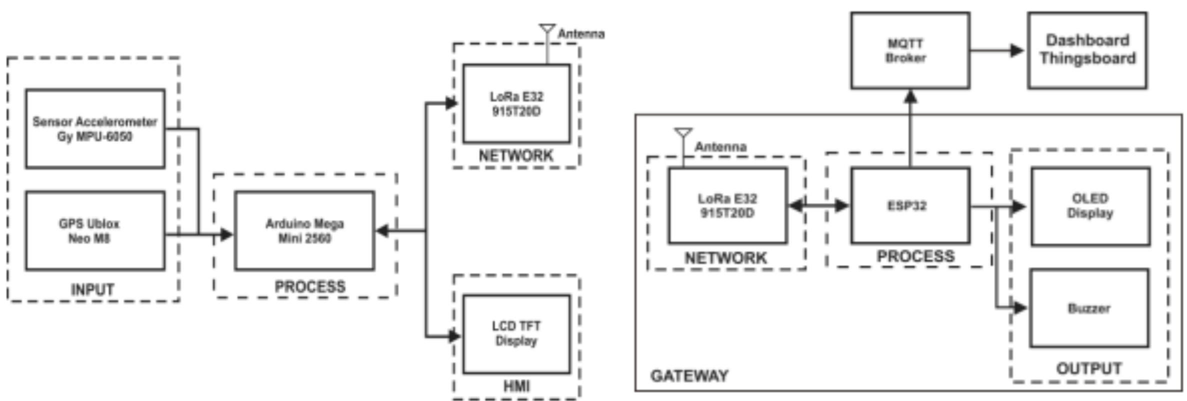
Based on the problems that have been described, with sea conditions that are free from obstacles, it will be very advantageous to apply this communication technique [5]. A lora based communication system is designed for fishing boat monitoring. This system consists of node devices and gateways that are connected point to point. The node device will send location data along with the ship's rotational motion that has been detected using the Ublox M8 GPS module and the gy-521 accelerometer sensor to the gateway. the gateway will send data using the mqtt protocol to the broker, thingsboard is set to subscribe to the same data topic as data from the device node so that data can appear on the thingsboard dashboard.

MATERIAL

Material

Building a lora-based communication system for fishing boat monitoring requires components including the LoRa E32 915T20D module as a data sender and receiver, arduino mega mini as a data processor accelerometer sensor gy-521 and ublox neo M8 GPS, and sends it to the lcd display and lora to be forwarded to the gateway, ESP32 to process data from lora, connect gateway with internet so data can be sent to mqtt broker, and also give output to oled display and buzzer.

System Block Diagram



(a) (b)

FIGURE 2. (a) System Block Diagram Node Device Figure. (b) System Block Diagram Gateway

Building a lora-based communication system for fishing boat monitoring requires components including the LoRa E32 915T20D module as a data sender and receiver, arduino mega mini as a data processor accelerometer sensor gy-521 and ublox neo M8 GPS, and sends it to the lcd display and lora to be forwarded to the gateway, ESP32 to process data from lora, connect gateway with internet so data can be sent to mqtt broker, and also give output to oled display and buzzer.

System Architecture

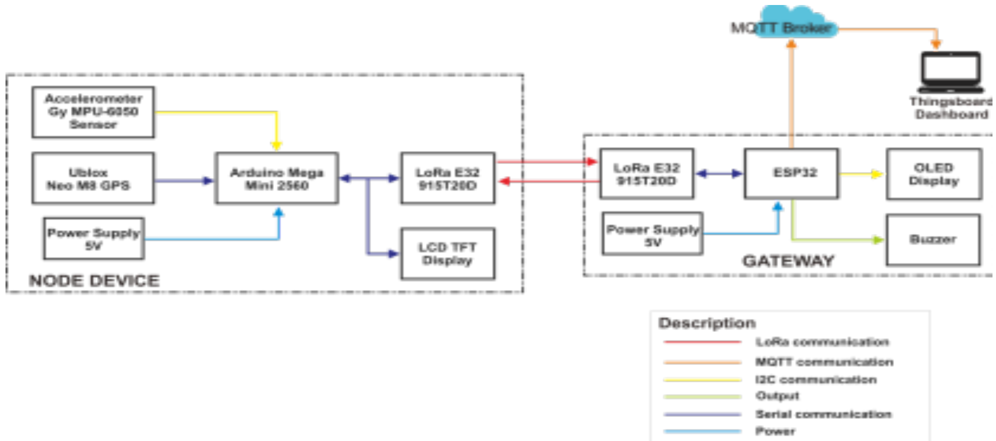


FIGURE 3. The System Architecture

The overall system architecture as shown in Figure 3, explains the interrelationships between components. in this system both devices require a power supply of 5V, on the device node the accelerometer sensor is connected to the arduino mega mini with i2c communication using the scl and sda arduino pins, namely pins D21 and D20, ublox neo m8 gps, lcd tft display and lora E32 connected using communication serial to arduino mega mini, then at the gateway, ESP32, connected to lora E32 using serial communication, oled display connected to ESP32 using i2c communication, while ESP32 connected to broker using mqtt protocol. for the use of pins described in table 1.a. and 1.b.

TABLE 1.a. Pin Node Device Configuration

No.	Microcon-troller pin	Another Component pin	Component name
1	5V	VCC	LCD *Touchscreen*
2	3.3v	VCC	LoRa, GPS, *Accelerometer*
3	GND	GND	All component
4	D32	M10	LoRa
5	D34	M1	LoRa
6	D10	RX	LoRa
7	D11	TX	LoRa
8	D36	AUX	LoRa
9	D14	RX	GPS
10	D15	TX	GPS
11	D18	RX	LCD *Touchscreen*
12	D19	TX	LCD *Touchscreen*
13	D20	SDA	*Accelerometer*
14	D21	DCL	*Accelerometer*

TABLE 1.b. Pin Gateway Configuration

No.	Microcon-troller pin	Another Component pin	Component name
1	Vin	VCC	Oled Display
2	3.3v	VCC	LoRa
3	GND	GND	All component
4	D15	M10	LoRa
5	D2	M1	LoRa
6	D4	RX	LoRa
7	D18	TX	LoRa
8	D5	AUX	LoRa
9	D21	SCL	Oled Display
10	D22	SDA	Oled Display
11	D19	Positive	Oled Display

System Flowchart

System flowchart can be seen in Figure 4.a and Figure 4.b

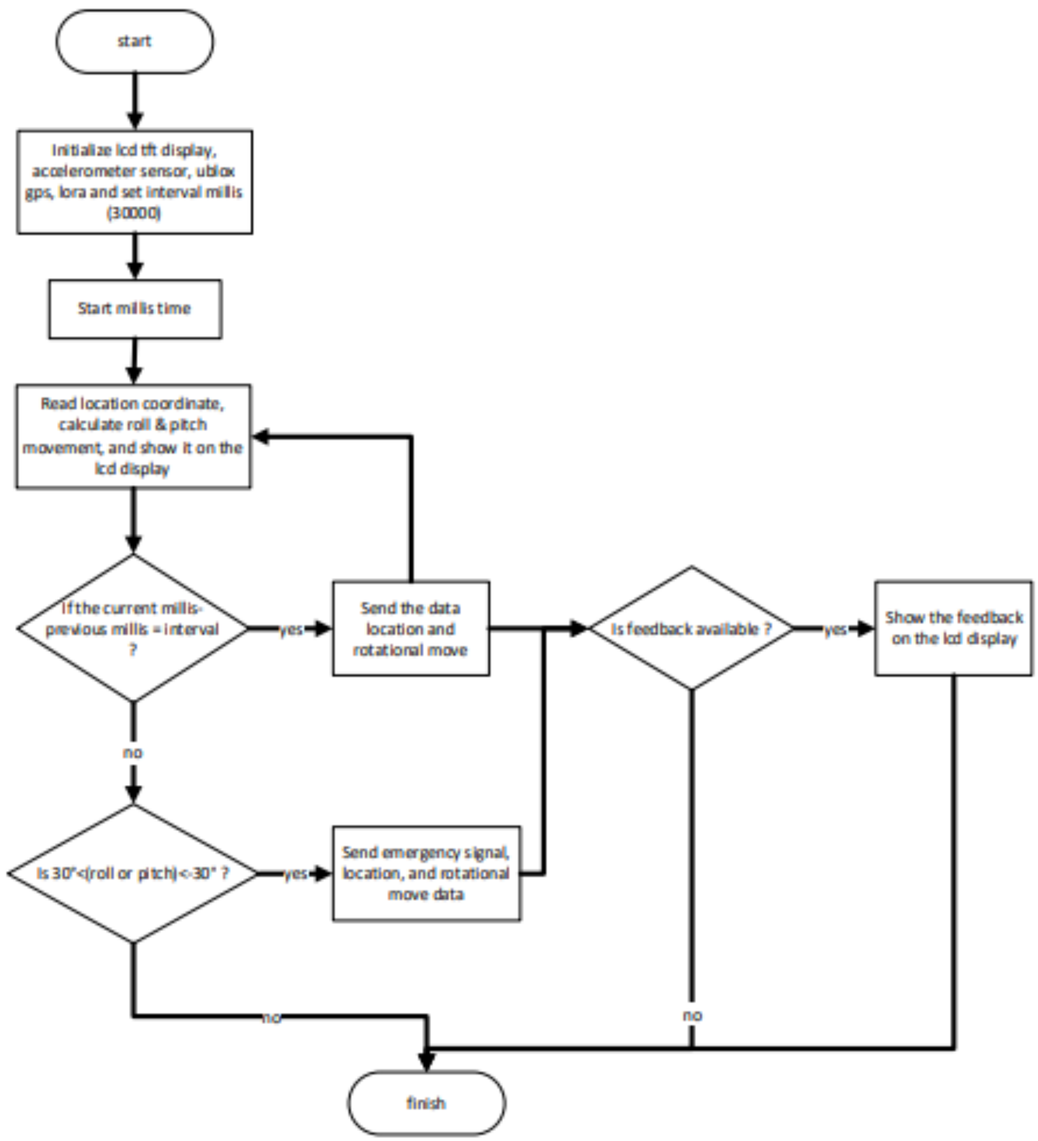


FIGURE 4.a Flowchart System Node Device

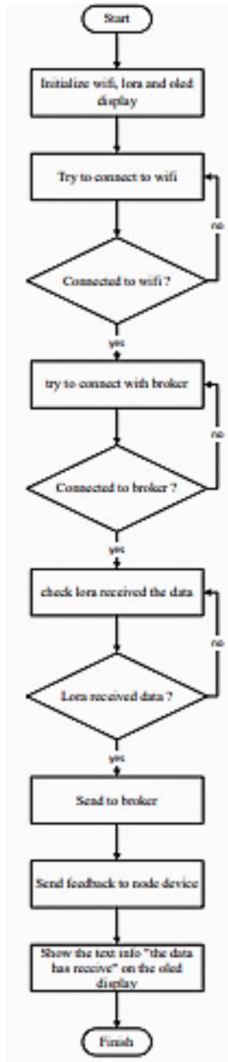


FIGURE 4.b Flowchart System Gateway

RESULTS AND DISCUSSION

LoRa Communication Test

The test focuses on the reliability of lora communication, carried out on the cipatujah beach with the gate location on the shoreline with a height of about 1 m above ground level, and the node device is carried to the sea by boat. The parameters tested are distance, data size, air data speed and its effect on time in the air. the distances tested are 0.5, 1, 1.5, 2, 2.5 km, and the air data rate is 0.3, 2.4, and 19.2 kbps, while the amount of data tested is based on the lora e32 maximum package capacity specification of 58 bytes, therefore the amount of data in this test is at 10, 25, 55 bytes. The method for calculating time on air is carried out as in equation 1.

$$\text{ToA (second)} = \frac{(Treceivefeedback\text{-}TSend}{2} \qquad (1)$$

Equations are entered into the Arduino program as in figure 5, the feedback received will be in the form of a string containing "|F|1|", and will record the current millis time and enter it into the t-receivefeedback symbolized in the program "time_terimafb", so that time on air can be calculated by using the millis on arduino.

```
if (dataIn.substring(0, 5) == "|F|1|") { // feedback
  time_terimafb = millis();
  toa = (time_terimafb - time_kirim) / 2000;
  Serial.print("waktu terima feedback : ");
  Serial.println(time_terimafb+String(" milidetik"));
  Serial.println ("toa(time on air)");
  Serial.println("toa = (waktu terima feedback - waktu kirim)/2");
  Serial.print ("toa = ");
  Serial.print(toa);
  Serial.println(" detik");
  fb();
}
```

FIGURE 5. Equation Time On Air In Arduino Program

Device placement as in Figure 6.(a) node device and (b) gateway

(a) (b)

FIGURE 6. (a) Node Device Placement Figure (b) Gateway Placement

The test method is carried out with 10 repetitions, then the values are averaged. The results are grouped by air data rate, it is 0.3, 2.4 and 19.2 kbps. test graph at a data rate of 0.3 kbps in Figure 8 and the detail of test location is showed in Figure 7.

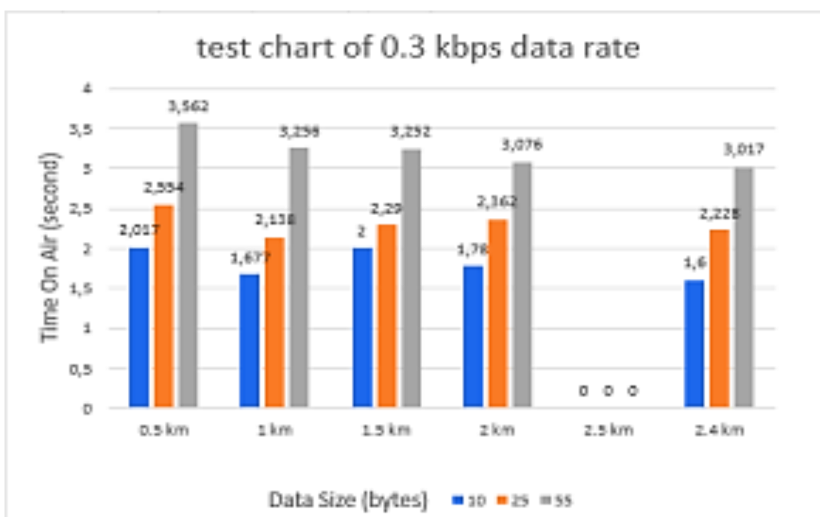


FIGURE 7. Test chart of 0.3 kbps

The graph in Figure 7 shows the results of testing with air data rate of 0.3 kpbs, the results show that it is able to reach distances of up to 2.4 km with time on air which increases as the data size gets bigger, and is not affected by distance. With the lowest time on air at a distance of 2.4 km with a data size of 10 bytes and the highest time on air at a distance of 500 meters with a data size of 55 bytes.

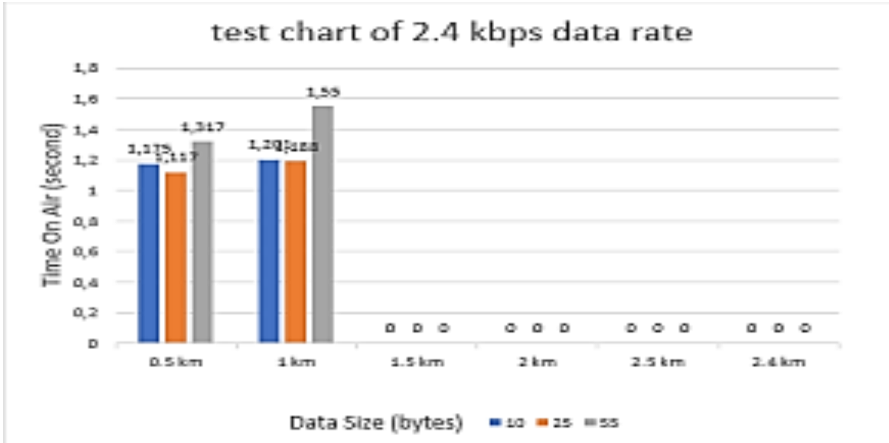


FIGURE 8. Test chart of 2.4 kbps

The graph in Figure 8 shows the results of the test with an air data rate of 2.4 kpbs, these results show that it is able to reach a distance of 1 km with greater on air time along with the increase in sending distance, and is not affected by the size of the data. With the lowest on air time at a distance of 0.5 km with a data size of 25 bytes and the highest on air time at a distance of 1 km with a data size of 55 bytes.

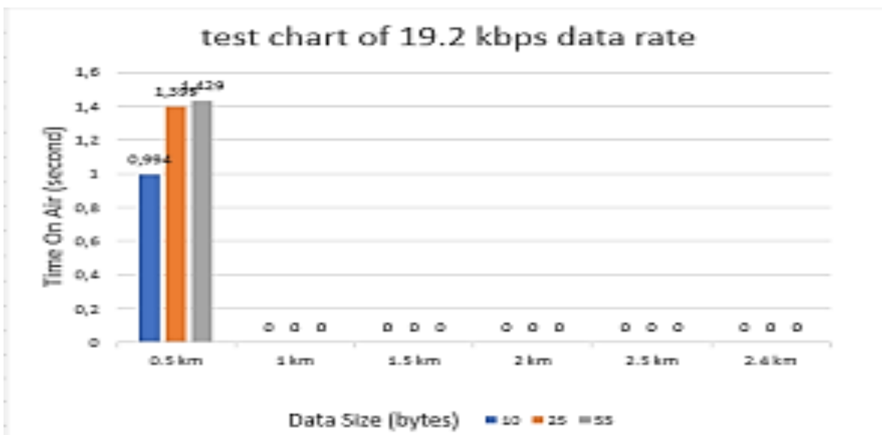


FIGURE 9. Test chart of 19.2 kbps

The graph in Figure 9 shows the test results with an air data rate of 19.2 kpbs, these results show that it is able to reach a distance of 0.5 km with greater time on air as the data increases.

MQTT Communication Test

Sending data from the gateway to the broker using the mqtt communication protocol, the broker used is iot.ee.unsil.ac.id. with a unique topic, and the Thingsboard application server is set to subscribe to the same data topic. in this case the test is intended to find out the data sent from the gateway can be received and displayed on the thingsboard dashboard. The mqtt communication test is carried out by sending data that is read by the sensor repeatedly 10 times, in Table 2 is the data received from the results of the mqtt communication test which can also be seen in the latest telemetry data on the thingsboard menu of device details as in Figure 10. and shown on thingsboard dashboard as in Figure 11.

TABLE 2. Mqtt Communication Test Results

Pengujian Ke-	Data Diterima				
	Latitude	*Longitude*	*Roll*	*Pitch*	*Status*
1	- 7.340271	108.22615	13	9	Secure
2	- 7.340271	108.22615	3	4	Secure
3	- 7.340271	108.22615	8	11	Secure
4	- 7.340271	108.22615	11	9	Secure
5	- 7.340271	108.22615	8	5	Secure
6	- 7.340271	108.22615	13	11	Secure
7	- 7.340271	108.22615	9	3	Secure
8	- 7.340271	108.22615	14	10	Secure
9	- 7.340271	108.22615	5	2	Secure
10	- 7.340271	108.22615	6	11	Secure

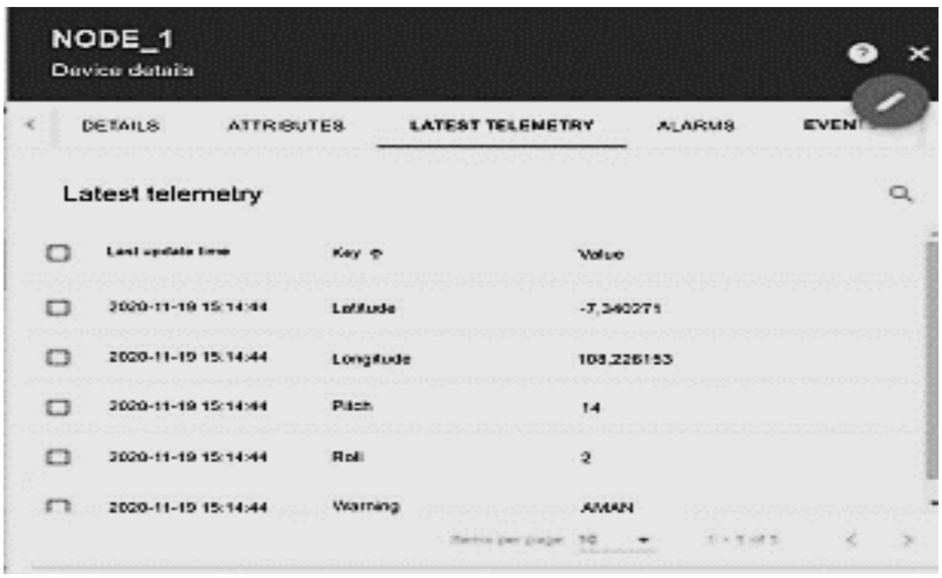


FIGURE 10. Latest Data Telemetry Thingsboard

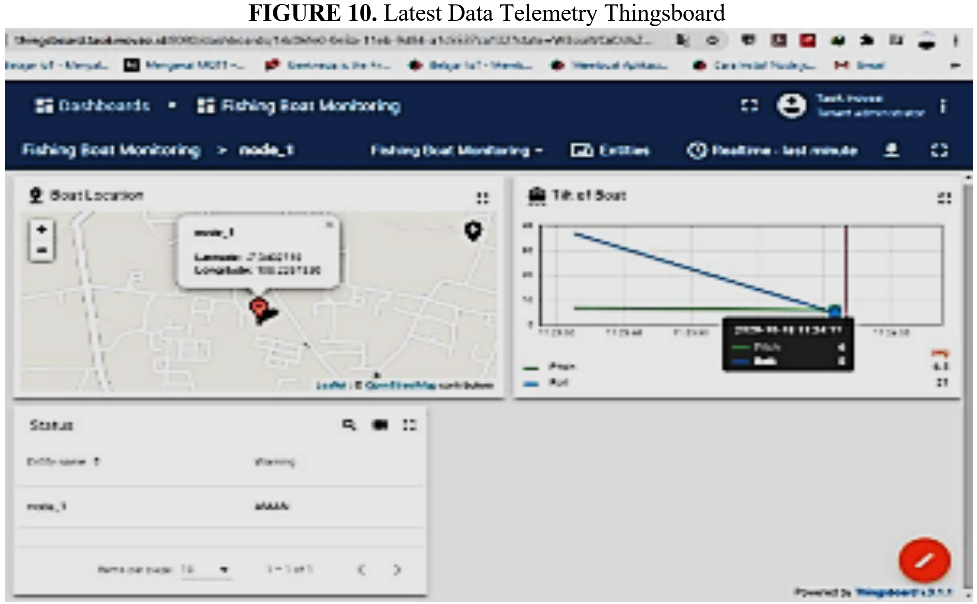


FIGURE 11. Thingsboard Dashboard

CONCLUSION

The test results show that in the 0.3 kbps data rate test, the on-air time is not affected by the distance of delivery, it is still determined by the size of the data, while the 2.4 kbps air data rate test shows the opposite result, namely the on-air time increases as the distance increases. , and is not affected by the size of the data. and in the air test the data rate of 19.2 is only able to reach a distance of 500 meters, the furthest distance that can be achieved by lora communication is 2.4 km with an air data rate setting of 0.3 kbps. and it can be concluded that the higher the air data rate used, the lower the communication distance. And the gateway is capable of forwarding data from the node to the broker.

REFERENCES

1. Komite Nasional Keselamatan Transportasi (2018) 'STATUS LAPORAN Kecelakaan Lalu Lintas dan Angkutan Jalan (LLAJ)', (November).
2. O., Yaakob, F.E., Hashim, M.R., Jalal, and M.A., "Mustapa, Stability, seakeeping and safety assessment of small fishing boats operating in southern coast of Peninsular Malaysia", *Journal of Sustainability Science and Management*, 10(1), pp.50–65 (2015).
3. I.R., Sanchez. and M.D., "Cano, State of the art in LP-WAN solutions for industrial IoT services", *Sensors (Switzerland)*, 16(5). doi: 10.3390/s16050708 (2016).
4. Semtech Corporation (2013) 'SX1272/3/6/7/8 LoRa Modem Design Guide, AN1200.13', (July), p. 9. Available at: https://www.rs-online.com/ (2013).
5. R., Sanchez-Iborra, I.G., Liano, C. Simoes, E., Counago and A.F., Skarmeta, "Tracking and monitoring system based on LoRa technology for lightweight boats", *Electronics (Switzerland)*, 8(1), pp. 1–18. doi: 10.3390/electronics8010015 (2019).