Small Vessel Tracking Based on Multi Gateway LORA for Indramayu Traditional Fishery

A Sumarudin\textsuperscript{1,}, W P Putra\textsuperscript{1,}, A Rifai\textsuperscript{1} and A E Putra\textsuperscript{2}

\textsuperscript{1}Department of Informatics, Politeknik Negeri Indramayu, Jl. Lohbener Lama No. 08 Lohbener Indramayu 45252.
\textsuperscript{2}Department Computer Science, Universitas Gadjah Mada, Sleman, Yogyakarta 55281.

\textsuperscript{*}shumaru@polindra.ac.id

Abstract. In this study, we use Lora-based data communication for communication between boats and database management systems for vessels. The maximum distance from the Lora is 10 km, and in order to be able to monitor fishermen along the fisherman's coast in fishing, it is necessary to have a multi-gateway Lora to increase fishermen's tracking coverage. The system is built using multi gateway Lora installed on the coast. Devices built with a Lora client are installed on a boat with GPS input, the technique of sending data on the device to the gateway uses a time base with a 1-minute period. To minimize data on the gateway that intersects the range of other gateways, a time flag is made to determine the data at a certain time to determine the trajectory of the boat. The result this research is system-monitoring vessel, which is successfully built and can provide fishing boats along the coast with long-range coverage. Based on experiment, multi-gateway can be implemented by creating an identical ID gateway, the Lora client will broadcast to the nearest gateway. The maximum distance obtained is 1.35Km NLOS and to cover 20 Km of beach length is needed 15 gateways.

1. Introduction
One-day fishing is fisherman (small fishermen who got out in the afternoon and go home early in the morning) in search of fish ranges from radius of 6 miles (9.65 km) from the shore. In this issue, data for boat tracking needs with data on the needs of the fishing boat by increasing the coverage of the tracking area of the boat using multiple gateways. Gateway is installed on the beach with a distance between gateways with the maximum distance the gateway distance. Several previous studies conducted tracking using a 2.4 GHz radio with a maximum distance of 8 KM [1] use WLAN outdoor radio. Using the Long-Range Radio is a high-power and high-power LPWAN. The length of Indramayu beach is 114 KM [2] from Sukra beach to Krangkeng. Some AIS designs are built using advanced land observing satellite (ALOS) in vessel detection [3] and use synthetic radar aperture (SAR) [4]. The technology is too expensive for the implementation of fishing boats. For the implementation of fishermen's communication successfully made with a maximum distance of 3.73 Km [5] from coast and for in NLOS the maximum distance is 2 Km [6] but this is only for the implementation of 1 gateway. AIS itself is used to increase the level of security in shipping [7] for vessel fishermen.

In this study using Lora-based data communication for communication between boats and database vessel management systems. The long-range distance is possible with Lora, and in order to be able to
monitor fisherman’s coast in fishing, it is necessary to have a multi-gateway Lora to increase fishermen’s tracking coverage.

2. System design

The design of our research propose is multigateway with the placement of gateways along the shore. Setting this can have an impact on the results. The topology design can be showed as in Figure 1.

![Figure 1. Topology multigateway lora system.](image1)

In the topology above, each lora node will send to the nearest gateway using a data format that allows the lora node to be able to be reliable even though it switches the gateway to connect. Every Lora Node has a device ID for the identity of the boat that is implemented. For Lora Node configuration, using tracking data consists of an accelerator sensor to detect speed, GPS for the position of Lora Node and RTC as time to synchronize time with the gateway. Lora Node can be seen in Figure 3.

![Figure 2. Lora node block.](image2)

From Lora this node sends the appropriate format from the tracking data in 73 Bytes format consisting of 6 Byte Device Id, 2 Byte Status, Latitude data 11 bytes, longitude 11 bytes, 5 Bytes RSSI (receive signal strength indication), 7 bytes Roll, 7 pitch, 5 Bytes Volt, 6 Bytes, 7 Bytes Speed, 8 Bytes times. This data is sent from the GPS sensor, accelerometer and ADC.

![Figure 3. Lora data format.](image3)

Data from Lora Node is sent to the gateway using wireless lora. Gateway can be seen in figure 4. Gateway consists of three main components, namely lora wireless module, microcontroller and Linux. Microcontroller with Linux communicating SPI (Serial Peripheral Interface).
Each gateway is used with each gateway id. In research using the format <name>_gw_xxxx can be seen in figure 5. This format allows for 4 digit gateways 0-9999 gateways.

### Table 1. Data format on gateway.

| Host broker   | ais.polindra.ac.id |
|---------------|---------------------|
| Port broker   | xxxxxx              |
| Client id     | {id_gateway}        |
| Topic         | channel/vessel/{id_device} |
| Payload       | {id_device},{online_status},{lat},{lon},{rssi},{roll},{pitch},{battery_volt},{compass},{speed},{time} |

The payload data is obtained from Lora Node which is sent broadcast to the gateway. For connections from multi gateways, use the 4 way MQTT protocol and publish according to the topic created by the MQTT server. Topic is made in this research channel / vessel / {id_device}.

### 3. Results and discussion

Based on our design, it is implemented using the Lora Node according to figure 6. Lora radio uses the L80-m39 Arduino Lora shield with NMEA data format with a maximum accuracy of 2.5 meters [8] with CEP -130dBm.

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**Figure 4.** Gateway lora.

**Figure 5.** Data Connection gateway to Server based on MQTT.

**Figure 6.** Lora node.
Whereas Gateway uses the Dargino LG01 Gateway Outdoor (figure 7) with Lora configuration on Arduino Yun, we connect the MQTT server using Linux to enable MQTT Protocol. By configuring the gateway id settings can be seen in Figure 8. To configure multiple gateways by providing identification of each gateway and setting on the MQTT Server side.

```c
void sendDataMQTT(String id, String m) {
  Process p;
  p.begin("mosquitto_pub");
  p.addParameter("-d");
  p.addParameter("-h");
  p.addParameter("-_p");
  p.addParameter("-_i");
  p.addParameter("-_t");
  p.addParameter("channel/vessel/"+id);
  p.addParameter("-m");
  p.addParameter(m);
  p.run();

  while (p.available() > 0) {
    char c = p.read();
    Console.print(c);
  }
  // Ensure the last bit of data is sent.
  Console.flush();
}
```

**Figure 7.** Gateway lora.

**Figure 8.** Gateway configuration.
The format of the Mosquitto MQTT Client service for sending data using the Command Line is as follows.

```
Mosquitto_pub -d
-h ais.polindra.ac.id
-p xxxx
-I id_gateway
-t channel/vessel/yyyyyy
-m D12345.1,-6.40801,108.27531,-75,-172.24,21.29,3.61,231.74,0.00,50
```

From the Lora Server side, check the boat id, if a boat id is found the data is parsed and stored.

```javascript
function broadcastDevice(data){
    var array = data.split(',');
    Device.find().where('no_seri').equals(array[0]).exec(function(err, devices){
        if(devices.length !== 0)
        {
            Perahu.find().where('id_device').equals(devices[0]._id).exec(function(err, perahus){
                var data = {
                    last_information: devices[0].last_information
                }

                client.publish('channel/perahu/' + array[0], JSON.stringify(data));
            } )
        }
    })
}
```

Connection data from the Lora client to the Lora Gateway is not based on the id gateway, with binary data streams this will allow the Lora client to communicate with any gateway closest to it to communicate. From the lora side the server will identify the gateway based on the id. When there is data sent from the two gateways this does not happen because the Lora client side can provide the data time information in real-time. Delay communication is not a problem for the reliability of the data sent. Data from the gateway is successfully sent with 4-way (figure 9), the gateway id sends connect then the broker server Lora sends the ACK Connection. After the ACK connection has been received, the payload sender will be done using the publish format in table 1.

![Figure 9. Data gateway receive.](image-url)
Server-side data as an example can be seen in table 2. The data is carried out by json parsing and stored in the database as vessel tracking data.

Table 2. Data receive on lora server.

| DEVICE ID | STAT | LAT  | LON  | RSSI  | ROLL | PITCH | VOLT | COMPASS | SPEED (Km/s) | TIME  |
|-----------|------|------|------|-------|------|-------|------|---------|-------------|-------|
| D12345    | 1    | -6.41| 108.28| -94   | -179.53| 48.74 | 3.48 | 236     | 0.31        | 4:51:34|
| D12345    | 1    | -6.41| 108.28| -93   | -177.73| 43.74 | 3.43 | 234     | 0.22        | 4:51:42|
| D12345    | 1    | -6.41| 108.27| -91   | 177.53 | 23.02 | 3.46 | 227     | 0.72        | 5:1:17 |

For testing carried out near the campus, with NLOS. Gateway is installed 10 meters seen in figure 11. From the results of this test, the maximum distance of 1.3 KM can be seen in table 3.

Table 3. Testing range result.

| No | Max Range [KM] | Derajat Radius [°] |
|----|----------------|--------------------|
| 1  | 1,38           | 78                 |

Based on the results of the above tests if it is to cover 20 km of beach length, then it is possible with 15 gateways.

Figure 10. Range test.

Figure 11. Multi gateway.
4. Conclusion

The system is built using multi gateway Lora Installed on the coast. Devices built with a Lora client are installed on a boat with GPS input. The technique of sending data on the device to the gateway uses a time base with a 1-minute period. To minimize data on the gateway that intersects the range of other gateways, a time flag is made to determine the data at a certain time to determine the trajectory of the boat. Berdasarkan percobaan diatas, multiGateway can be implemented by creating an identical ID gateway, the Lora client will broadcast broadcast to the nearest gateway. The maximum distance obtained is 1.35Km NLOS and to cover 20 Km of beach length is needed 15 gateways.

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