# Study of data format for small vessel tracking based on LPWAN network

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**Abstract.** Implementation of LPWAN very large application, such as remote location, agriculture, mining, and transportation. This paper discusses for data format on implementation small vessel tracking for traditional fisherman. data format is very important for tracking system can be monitoring vessel simple. data format can be optimized perform on IoT network, such as delay, bandwidth, range and power consumption energy. Data format with 68 Bytes Strings stream to gateway Lora every 3 seconds. Data format for gateway to Broker server utilize MQTT format with 4-way connection, such as connect, connect ack, publish data and disconnect. Based on experiment, data format can use robust for small vessel and can implemented on this application.

## 1. Introduction

Fishermen activity 40 – 50 miles nautical from coastline utilize AIS transponder utilize VHF frequency [1]. ExactTrax [2] are system for implementation cost-effective, efficient tracking, and monitoring vessel class B AIS transponder and vessel management system (VMS). AIS transponder also utilize [3] for detection emergency on small vessel. Usually for standardization, ship tracking utilizes satellite communication utilize Inmarsat mobile earth station (MES) Solution [4]. Inmarsat coverage on Indonesia Indian ocean region and Pacific ocean region [5].

In this paper, we also propose the study for implementation tracking small vessel with Lora (long Range) technology with the data format. Other methode for fish detection utilize data camera using underwater video for detection of fish [6]. Vessel tracking system (VTS) for enhancing maritime domain awareness (MDA) [7]. This study can result the how much range can covert with technology and how data can send with Lora Technology.

## 2. System design and architecture

The research method used in this study is to use experimental research methods by changing several parameters on the Lora device. The study was conducted by using end devices consisting of sensors and sending to the gateway with several variables to be tested.

The system is built using LoRaWAN with 868 Mhz band as a gateway and LoRa Shield as a client, for input information using Arduino uno, LoRa Wireless module, GPS Sensor, RTC (Real Time Clock) and Sensor Accelerometer and Gyroscope. Arduino functions as a processor of each connected component (RTC, GPS Sensor, Accelometer and Gyroscope Sensor). For an overview of the system built it can be seen in Figure 2.

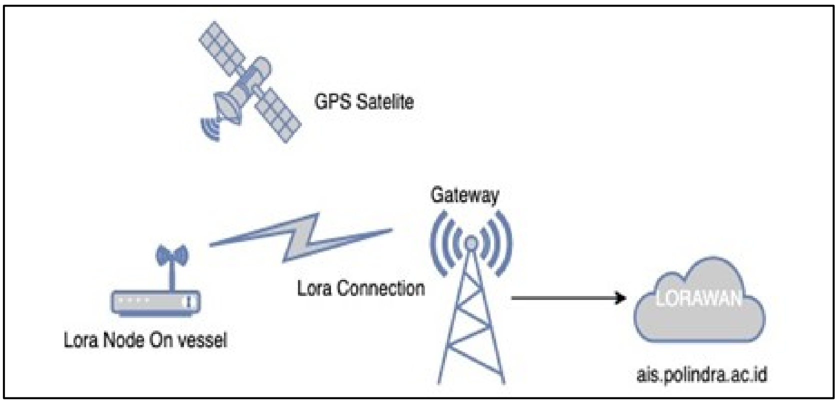


**Figure 1.** System design small vessel tracking LPWAN.

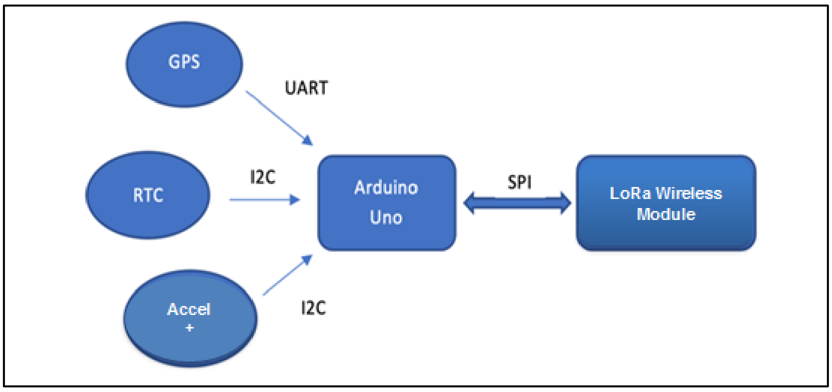


**Figure 2.** Lora node design.

The format of the data to be sent is Device ID, Online Status, Latitude, Longitude, RSSI, Roll, Pitch, Battery Voltage, Compass, Speed, Time. The data format can be found in Figure 4. Data is sent stream to the gateway with the encapsulation data format can be seen in Figure 5. The data stream that is sent is a maximum of 73 Bytes, the amount of lenght depends on the readable sensor value. This is caused by the process of sending from Lora Node to Gateway using stream strings.

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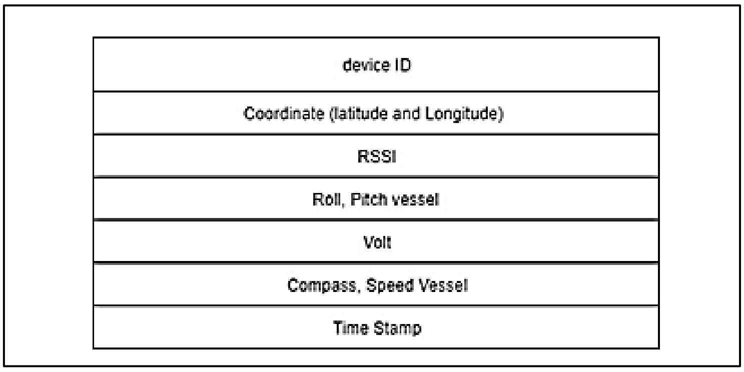


**Figure 3.** Data lora node format.

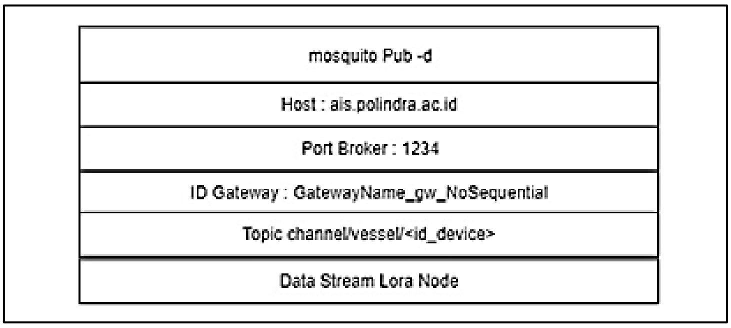


**Figure 4.** Data gateway format.

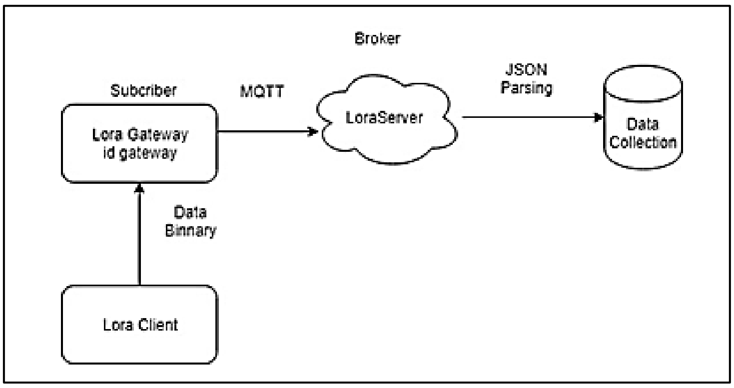


**Figure 5.** Connection LoRa node with LoRa server.

The process that occurs between the LoRa client and the gateway is that if the delivery process reaches the LoRa Gateway, the LoRa Client will receive a success reply from the LoRa Gateway. LoRa Gateway includes two tools, the LoRa Wireless module and the Dragino Linux module that are interconnected using an SPI connection for data communication. When the LoRa Wireless module on the Gateway gets data from the LoRa Client, the next process is sending data through a Linux module that is connected to the internet using the MQTT (Message Queuing Telemryry Transport). When the data has arrived at Brokets (Lora Server) it will be parsed to be stored in the database.
For configuration Lora Node to connection on gateway, we utilize on Table 1.

**Table 1.** Configuration lora.

| No | Parameter | Value |
|---|---|---|
| 1 | Frequency | 868 MHz |
| 2 | Spreading Factor | 7 |
| 3 | Bandwidth | 125 KHz |
| 4 | Coding Rate | 4:5 (5) |
| 5 | Tx Power | 13 dBm |

Based on configuration, we configure for medium range and medium bandwidth. Reason this configuration for range can moderate and the power consumption on device can reduce.

## 3. Implementation and results

For the implementation of this system, using two devices, namely the gateway side using the Lora Gateway Outdoor and from the client side using Arduino as the processor and Lora as the data communication media based on radio frequency with long range distance. For more details about the tools used in the research process can be seen in Figure 6 and Figure 7.

**Figure 6.** OLG01 out door LoRa gateway 868Mhz – dragino.

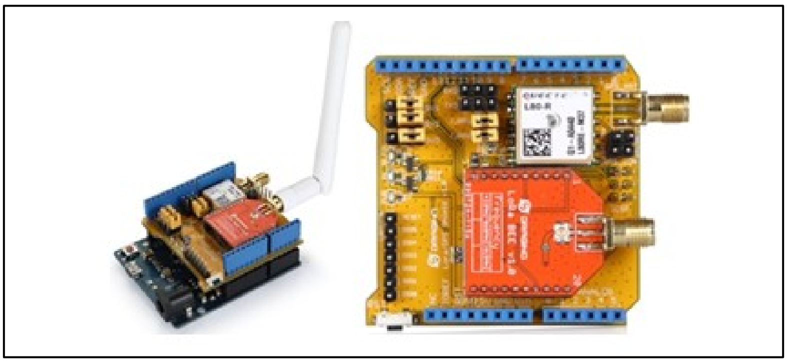

**Figure 7.** LoRa 868Mhz GPS shield for arduino – dragino.

Lora Node configuration based on the settings in the previous discussion can be seen in Figure 8. Settings include frequency, Spreading Factor, Bandwidth, Coding rate and Tx Power.

```
  rf95.setFrequency(frequency);
  rf95.setSpreadingFactor(7);
  rf95.setSignalBandwidth(bandwidth[7]);
  rf95.setCodingRate4(5);
  //rf95.setTxPower(13); // Setup Power,dBm
  rf95.setTxPower(20, false);
  Console.print("Listening on frequency: ");
  Console.println(frequency);
}

void radioReceivePacket(){
  if(rf95.available()){
    uint8_t buf[RH_RF95_MAX_MESSAGE_LEN];
    uint8_t len = sizeof(buf);
    if(rf95.recv(buf, &len)){
      preProcessingData(buf);
      radioReply();
    } else {
      Console.println("Recv failed");
    }
  }
}
```

**Figure 8.** Configuration lora radio.

In the process of sending data from the end device to the gateway using the format of the data we create according to the application from the boat tracking. The Figure below shows the process of sending the data Lora Node to gateway. Data communication with 4-ways for establish connection Lora node and gateway.

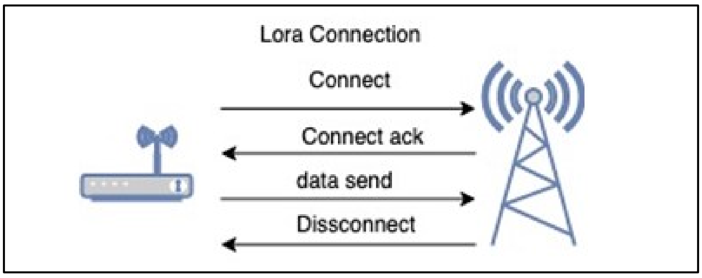


**Figure 9.** Lora node connection to gateway.

```
void loop() {
  /* Format Data
  ==========================================================================
  no_seri, online_status, lat, lon, rssi, roll, pitch, volts, compass, speed, time
  ==========================================================================*/
  getTimeRTC();
  getGyro(roll, pitch, yaw, hdm);

  if(flat != 1000.000000) getLastSpeed();
  /*-----------------------------------------------------------*/
  /**           |0| 1| 2| 3| 4| 5| 6| 7| 8| 9|   10    |   ***/
  /*-----------------------------------------------------------*/
  sprintf(
    sbuf, "%s,%d,%s,%s,%d,%s,%s,%s,%s,%s,%d:%d:%d",
      String(_CLIENT_ID).c_str(),        //idx[0] no_seri
      online_status,                     //idx[1] online status
      String(flat,5).c_str(),            //idx[2] Lat
      String(flon,5).c_str(),            //idx[3] Lon
      rssi,                              //idx[4] RSSI
      String(roll).c_str(),              //idx[5] roll
      String(pitch).c_str(),             //idx[6] pitch
      String(volts()).c_str(),           //idx[7] battery volts
      String(hdm,2).c_str(),             //idx[8] compas
      String(vessel_speed).c_str()       //idx[9] speed
      __jam__,__menit__,__detik__        //idx[10] time
    );
```

**Figure 10.** Data stream lora node.

```
void sendDataMQTT(String id, String m){
  Process p;
  p.begin("mosquitto_pub");
  p.addParameter("-d");
  p.addParameter("-h");
  p.addParameter(_BROKER_HOST);
  p.addParameter("-p");
  p.addParameter(_BROKER_PORT);
  p.addParameter("-i");
  p.addParameter(_CLIENT_ID);
  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();
}

void radioInit(){
  if(!rf95.init()){
    Console.println("Radio init failed");
    while(1);
  }
```

**Figure 11.** Lora server broker configuration.

The results of sending data can be seen in Table 2.

**Table 2.** Data results from the client.

| DEVICE ID | STATUS ONLINE | LAT | LON | VOLT | TIME |
|---|---|---|---|---|---|
| D12345 | 1 | -6.41 | 108.28 | 3.45 | 4:50:13 |
| D12345 | 1 | -6.41 | 108.28 | 3.48 | 4:51:34 |
| D12345 | 1 | -6.41 | 108.28 | 3.43 | 4:51:42 |
| D12345 | 1 | -6.41 | 108.27 | 3.46 | 5:1:17 |
| D12345 | 1 | -6.41 | 108.28 | 3.46 | 4:51:32 |
| D12345 | 1 | -6.41 | 108.28 | 3.49 | 5:2:1 |
| D12345 | 1 | -6.41 | 108.28 | 3.45 | 4:55:43 |
| D12345 | 1 | -6.40 | 108.27 | 3.42 | 5:0:44 |
| D12345 | 1 | -6.41 | 108.27 | 3.48 | 5:1:20 |
| D12345 | 1 | -6.41 | 108.28 | 3.45 | 4:51:29 |
| D12345 | 1 | -6.41 | 108.27 | 3.48 | 5:1:25 |
| D12345 | 1 | -6.41 | 108.27 | 3.46 | 5:1:22 |
| D12345 | 1 | -6.41 | 108.28 | 3.48 | 4:50:10 |
| D12345 | 1 | -6.41 | 108.28 | 3.49 | 5:2:10 |
| D12345 | 1 | -6.41 | 108.28 | 3.43 | 5:2:24 |
| D12345 | 1 | -6.41 | 108.28 | 3.41 | 5:2:16 |
| D12345 | 1 | -6.41 | 108.28 | 3.44 | 5:2:19 |
| D12345 | 1 | -6.41 | 108.28 | 3.44 | 5:2:22 |
| D12345 | 1 | -6.41 | 108.28 | 3.49 | 4:50:7 |
| D12345 | 1 | -6.41 | 108.28 | 3.45 | 5:2:7 |

Data send contains id device, status the Lora Node, Latitude vessel, Longitude vessel, volt Lora node for detection node healthy, and time stamp. Data send every 3 seconds for connection real-time between

Lora node and gateway for connection to Lora Server. Connection Lora Node and Gateway utilize 4 ways.

## 4. Conclusions

From the results of the implementation above, Lora WAN client to server transfer research can be seen clearly the movement, the server can receive data with real time and then get into the web server. In this study, we have not discussed the maximum distance of LoRa that can be traced and the maximum delay, error rate and bandwidth of the system. The research will be continued by considering the variables above.

## 5. References

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