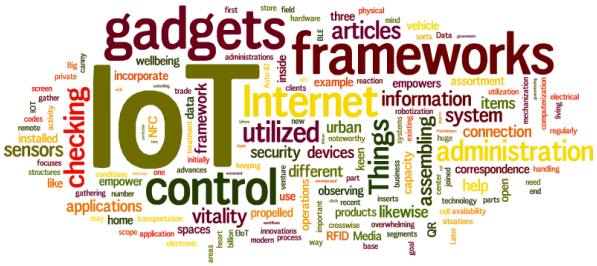
CS578: Internet of Things

Smart Home Monitoring and Control
Using
LoRaWAN and Webserver



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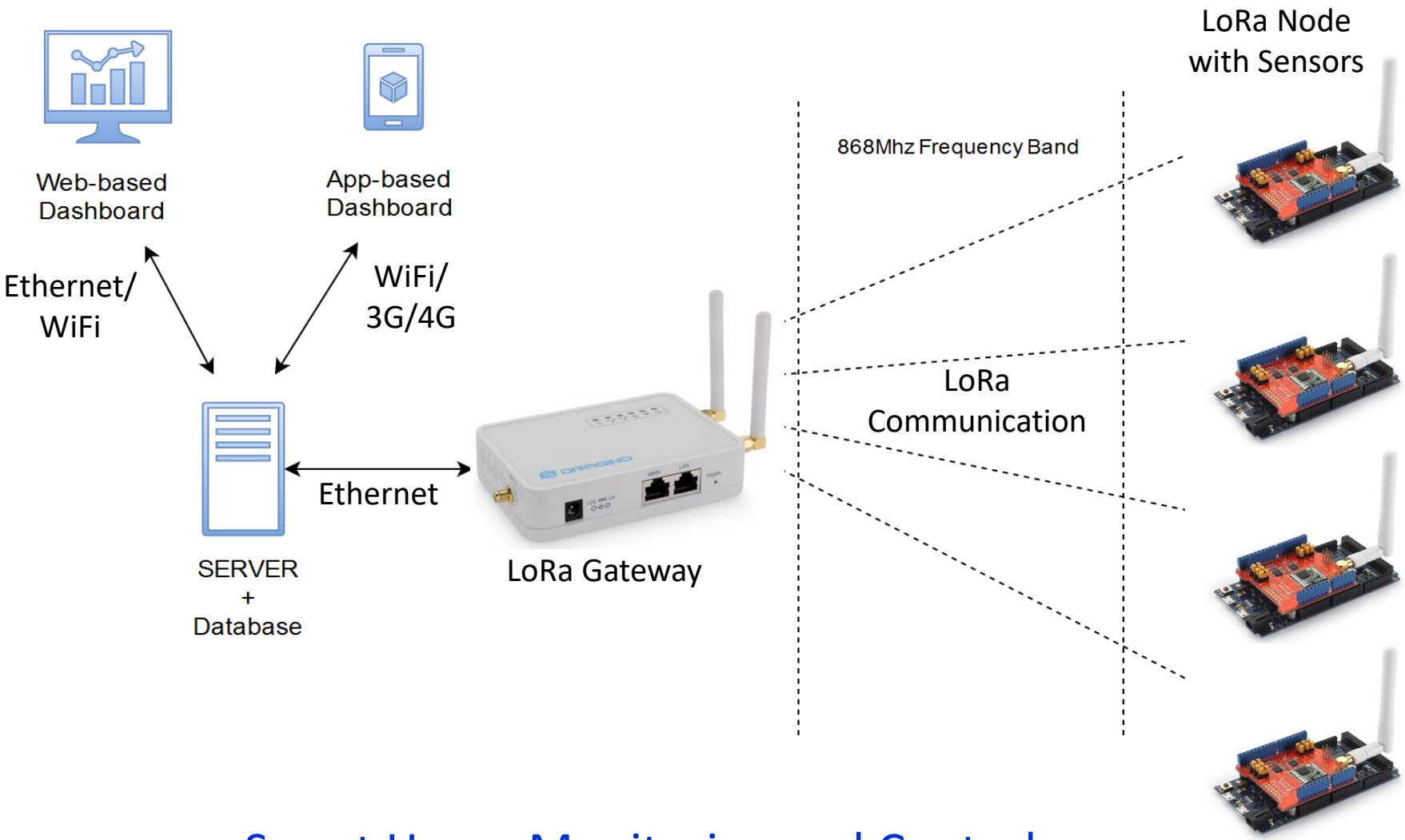
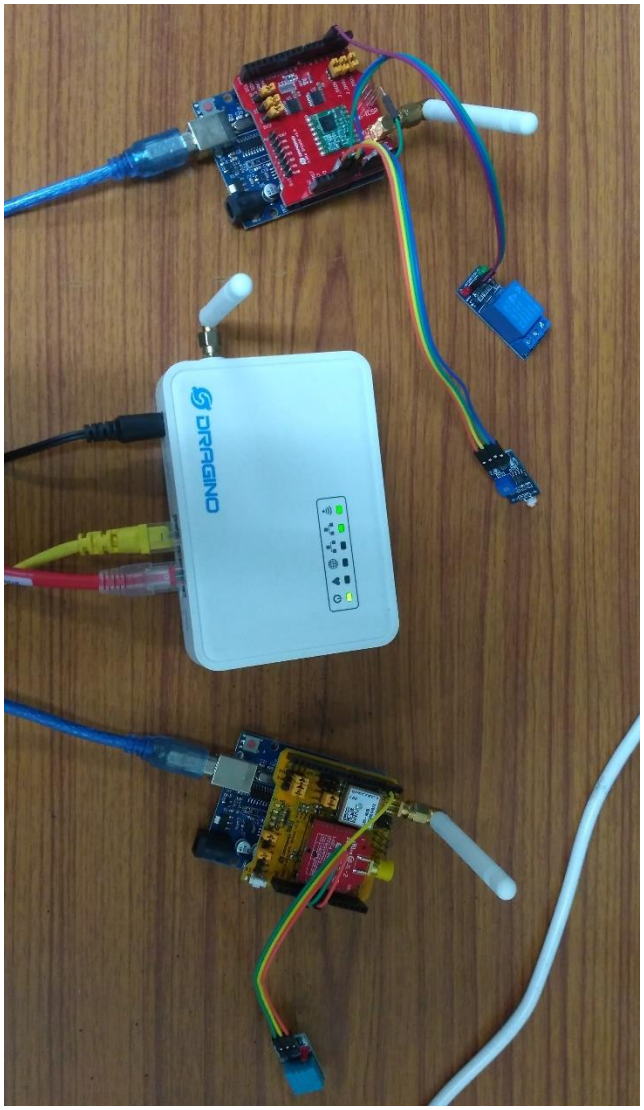
"If you want peace of mind, do not find fault with others. Rather learn to see your own faults." – **Sarada Devi**

System Diagram

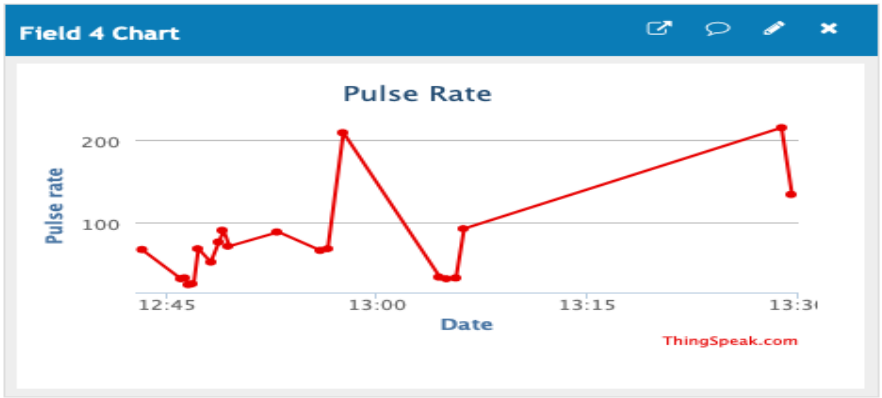


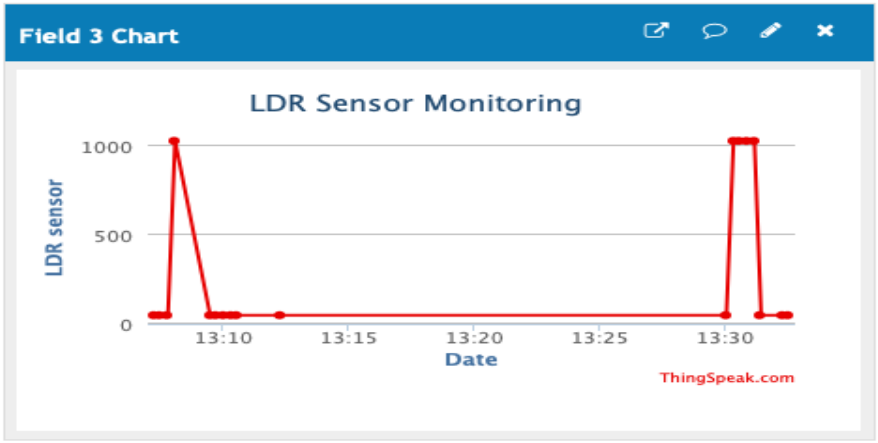
Smart Home Monitoring and Control

Physical Setup



Application Dashboard running in **Web server** accessing from a Laptop/PC/Smartphone





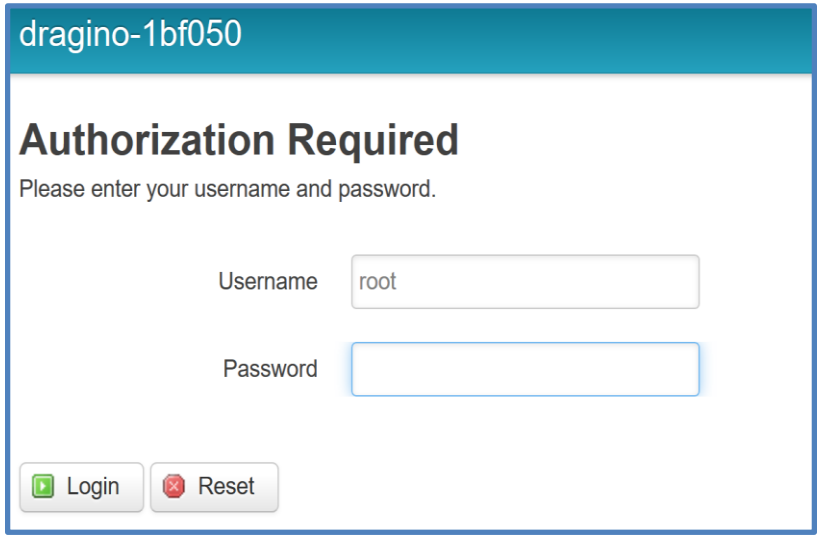
LoRa Gateway / Router Configuration To Connect with IITG Internet

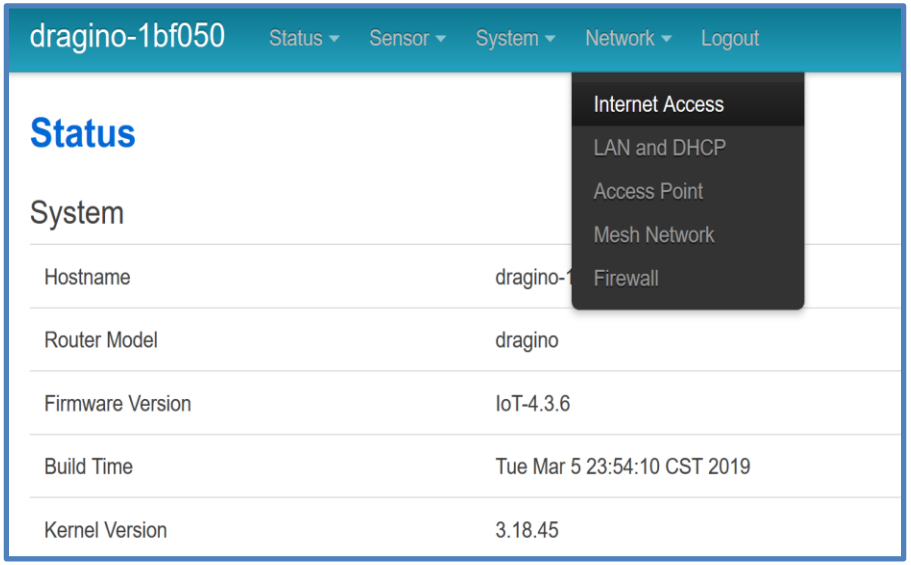
Router Configuration

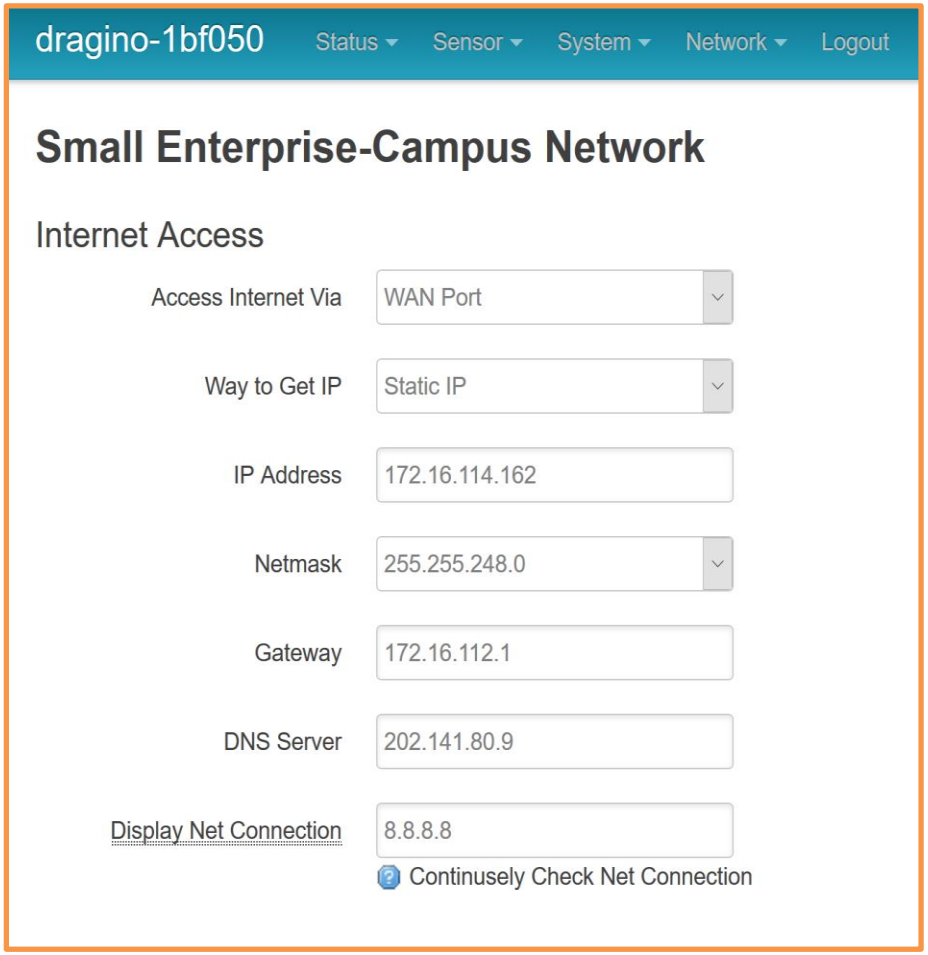
- This is **LoRA Gateway**
- LoRa sensor nodes will be connected to this Gateway
- Internet connection will be accessible through it.

- Connect IITG LAN to the Gateway WAN port using Ethernet Cable
- Connect your PC/Laptop to the Gateway LAN port using Ethernet Cable
- Login LoRa gateway using given IP (**10.130.1.1**) and user ID (**root**) and password (**dragino**)
- Do the following:
  - Gateway WiFi SSID and Password under "Wireless" tab
    - **SSID**: dragino-1bf050; **Password**: 12345678
  - Time and Date settings
  - You can change admin password
  - Setup Internet Connection by Network → Internet access
    - Set the **Static IP**, **Subnet Mask**, **Default Gateway**, **DNS Server**, **Alternate DNS Server**
  - Reboot the gateway

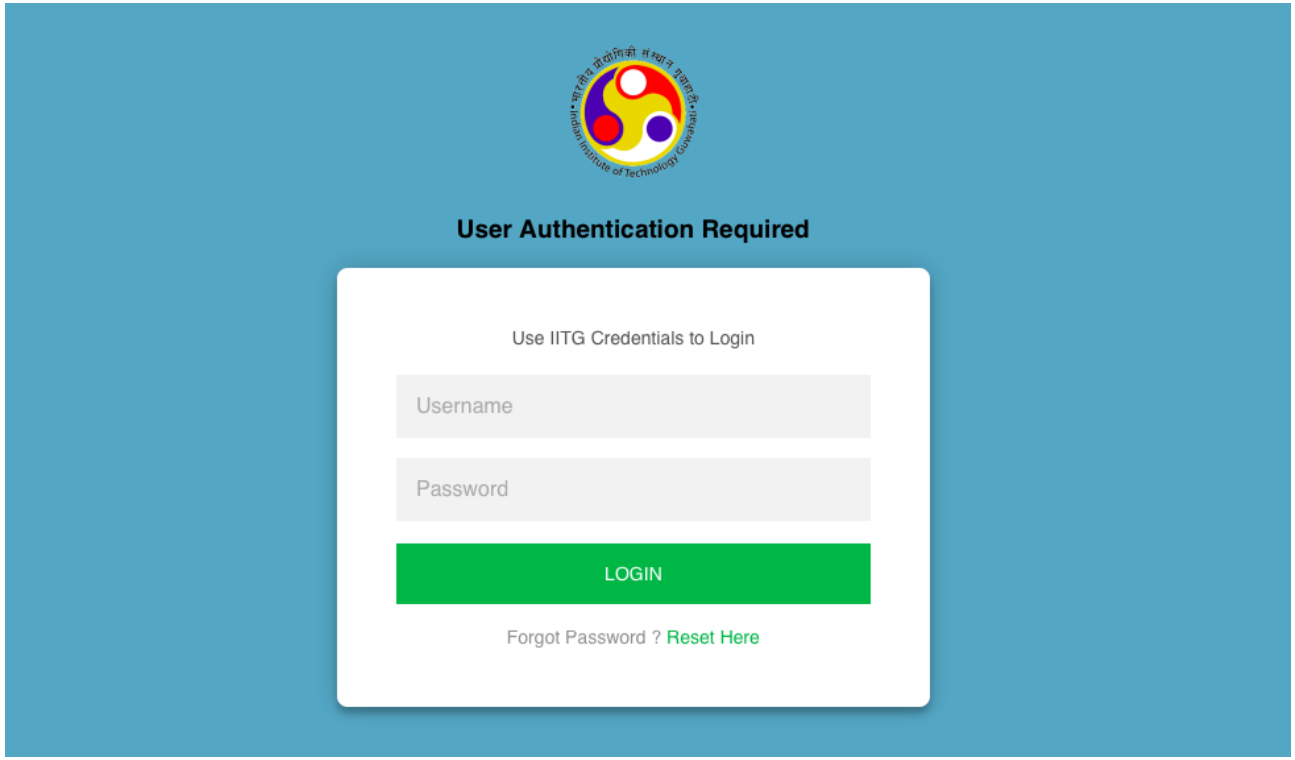
Cont…


dragino-1bf050
Authorization Required
Please enter your username and password.
Username
root
Password
Login
Reset


dragino-1bf050
Status
Sensor
System
Network
Logout
Internet Access
LAN and DHCP
Access Point
Mesh Network
Firewall
Status
System
Hostname
dragino-1
Router Model
dragino
Firmware Version
IoT-4.3.6
Build Time
Tue Mar 5 23:54:10 CST 2019
Kernel Version
3.18.45


dragino-1bf050
Status
Sensor
System
Network
Logout
Small Enterprise-Campus Network
Internet Access
Access Internet Via
WAN Port
Way to Get IP
Static IP
IP Address
172.16.114.162
Netmask
255.255.248.0
Gateway
172.16.112.1
DNS Server
202.141.80.9
Display Net Connection
8.8.8.8
Continusely Check Net Connection

Connecting with Internet



- You should be able to access Internet in your PC/Laptop using LoRa Gateway

Web Server Configuration to Access Web Service

Configure to use Web Server

- The server configuration is done on an Ubuntu 16.04 system. It can be implemented on any OS with a web server and PHP support.

- Run the following commands on Ubuntu Terminal:
  - sudo apt-get update
  - sudo apt-get install apache2 -y
  - sudo apt-get install php libapache2-mod-php -y

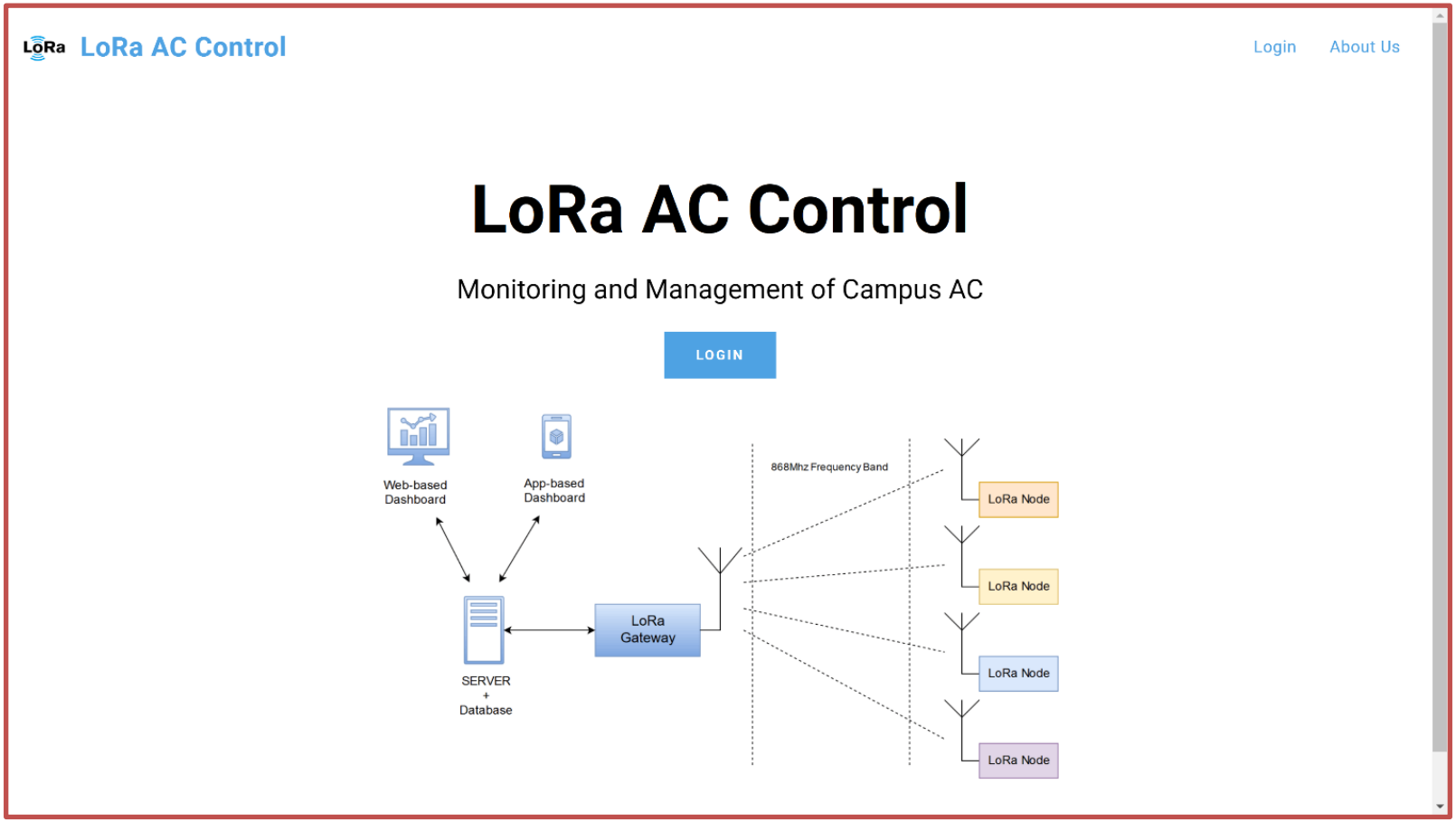
  - sudo rm /var/www/html/index.html
  - sudo chown <user>:<user> /var/www/html ##change <user> to your Ubuntu username

- Server configuration will be required multiple libraries and javascripts.
- Download all files from https://jayanta525.github.io/server.zip
- Extract the files in /var/www/html directory with the correct permission.
- Run the commands:
  - sudo chmod –R 777 /var/www/html
  - sudo systemctl restart apache2

- Check proper connection by going to **localhost** in a web browser.

Cont…

- Check proper connection by going to **localhost** in a web browser.
- Dashboard should be opened as shown below:



Arduino
Tool Configuration

Install and Configure Arduino IDE

- Download and Install Arduino IDE from https://www.arduino.cc/en/Main/Software

- Download the installation archive file
- Extract the downloaded file
- Make the install file executable with “chmod +x install.sh”
- Run “sudo ./install.sh”
- Provide root password and ArduinoIDE will be installed.

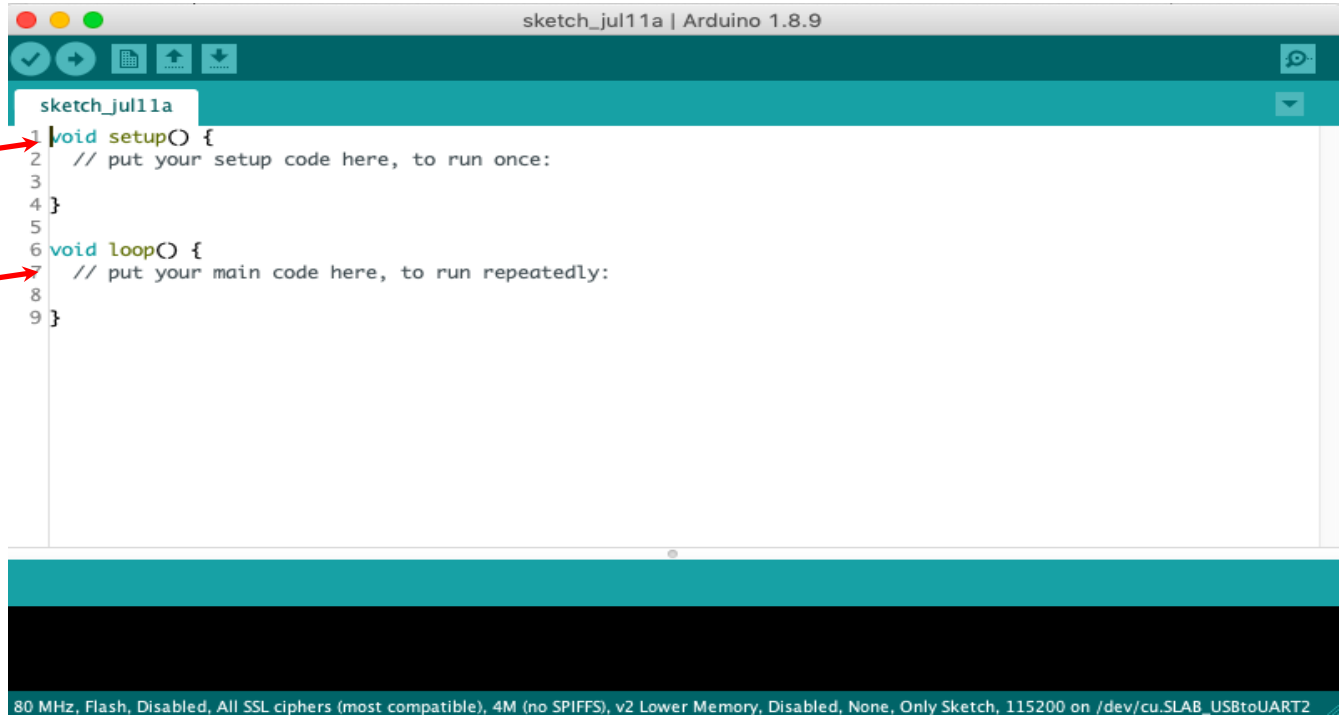
- To open ArduinoIDE, run “arduino” in terminal
- It is suggested to run ArduinoIDE as root user with “sudo arduino”.

Cont…

- When the Arduino IDE first opens, this is what you should see:

setup()

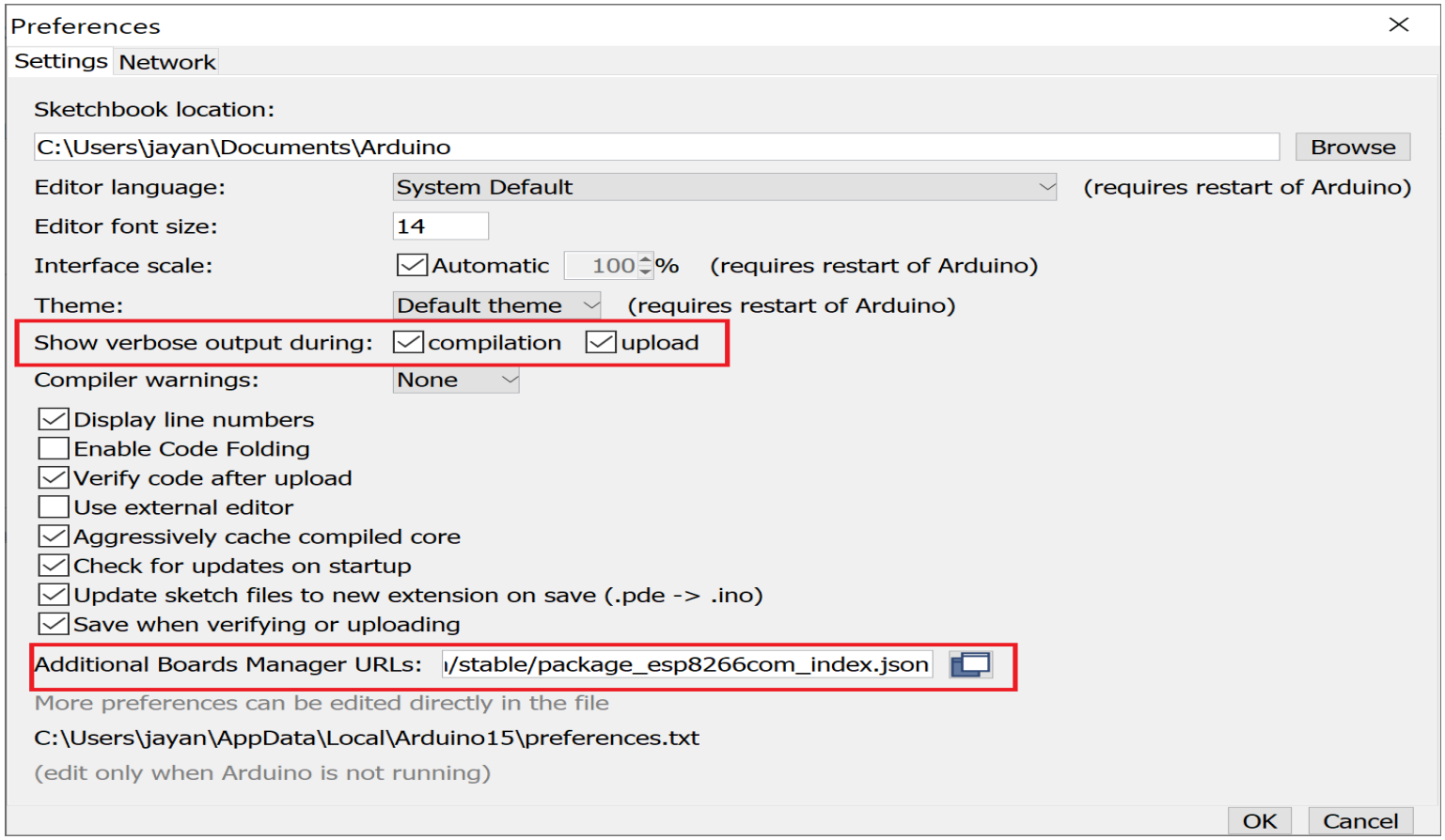
loop()



- Two functions exist in the programme: setup () and loop ()
  - **setup():** This function runs once when ESP first boots
  - **loop():** This function reads the sensor value and connects to server, and then sends data to server

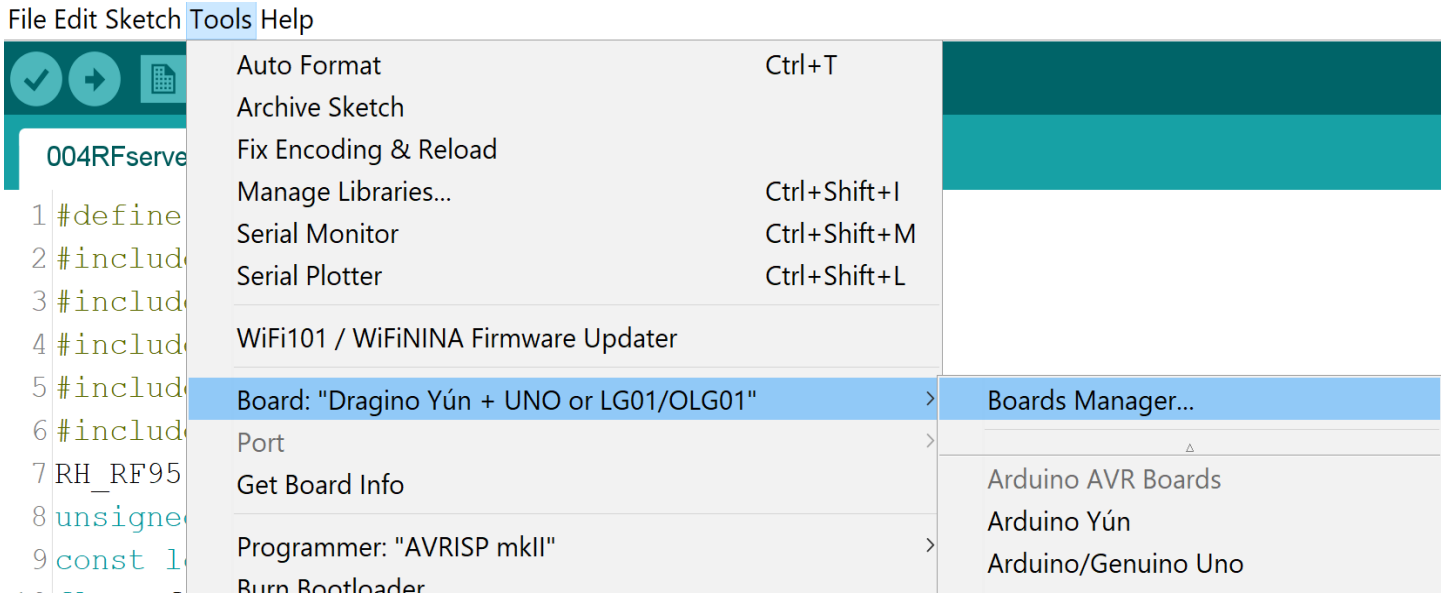
Install Libraries in IDE

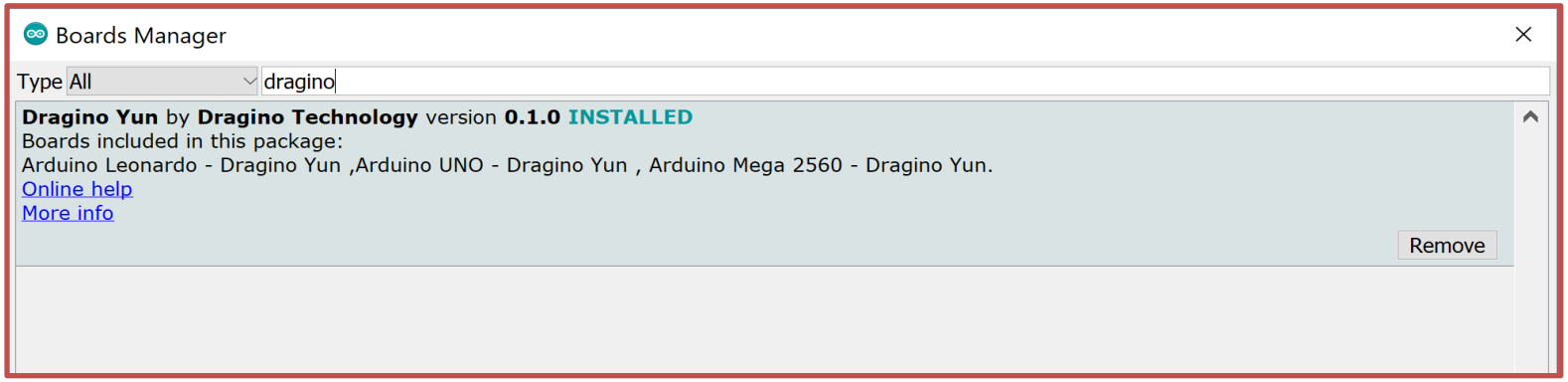
- Go to **File --> Preferences**
- Check Show Verbose output during, **compilation** and **upload**
- Enter the below URL into **Additional Board Manager URLs** field and press the "OK" button
  http://www.dragino.com/downloads/downloads/YunShield/package_dragino_yun_test_index.json



Cont…

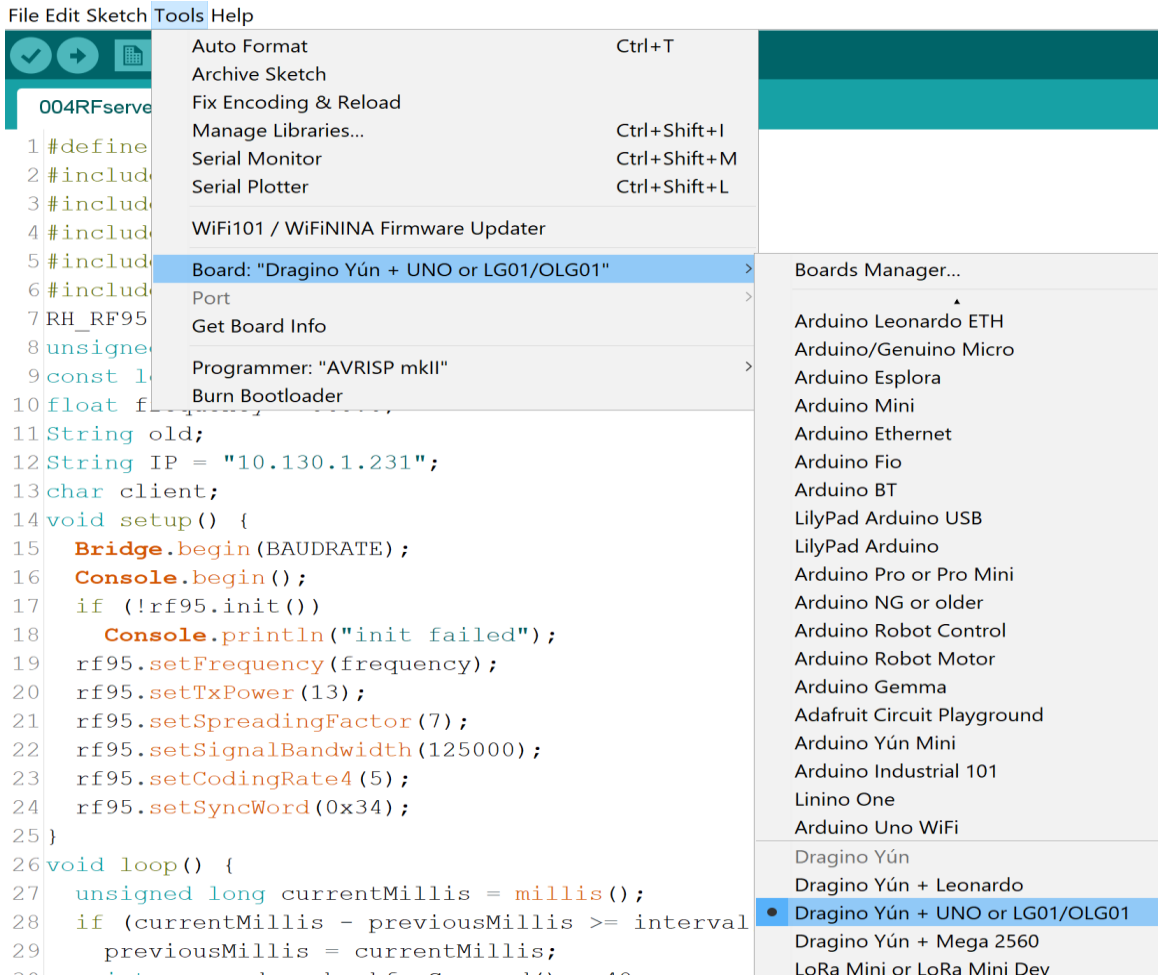
- Go to **Tools > Board > Board Manager**
- Search for Dragino board and install latest version of "Dragino Yun by Dragino Technology"





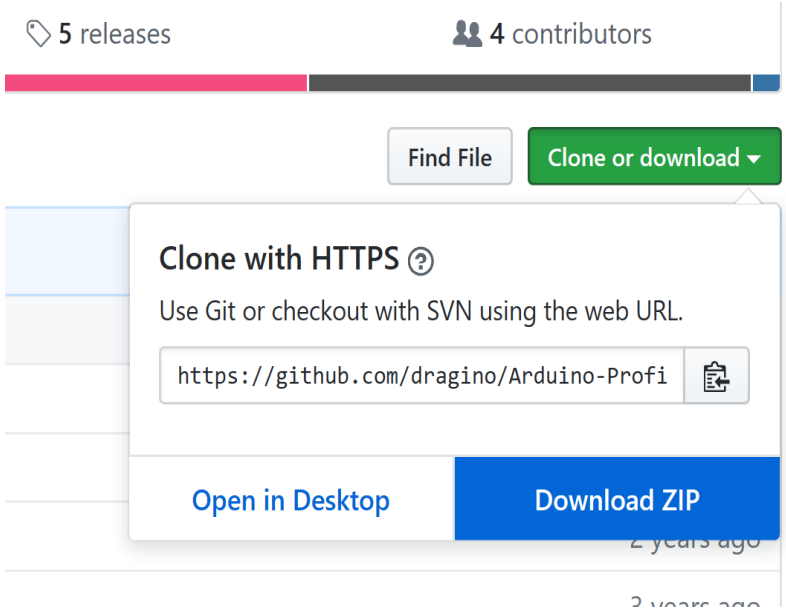
Cont…

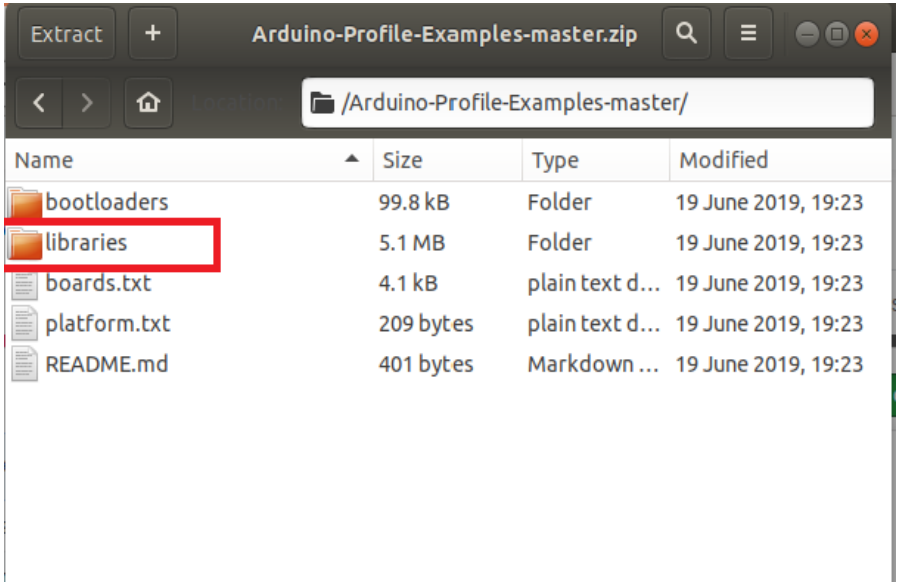
- Select the appropriate board after installation
  - Go to **Tools >Board > Dragino Yun + UNO or LG01/OLG01**



Install Dragino Custom Libraries

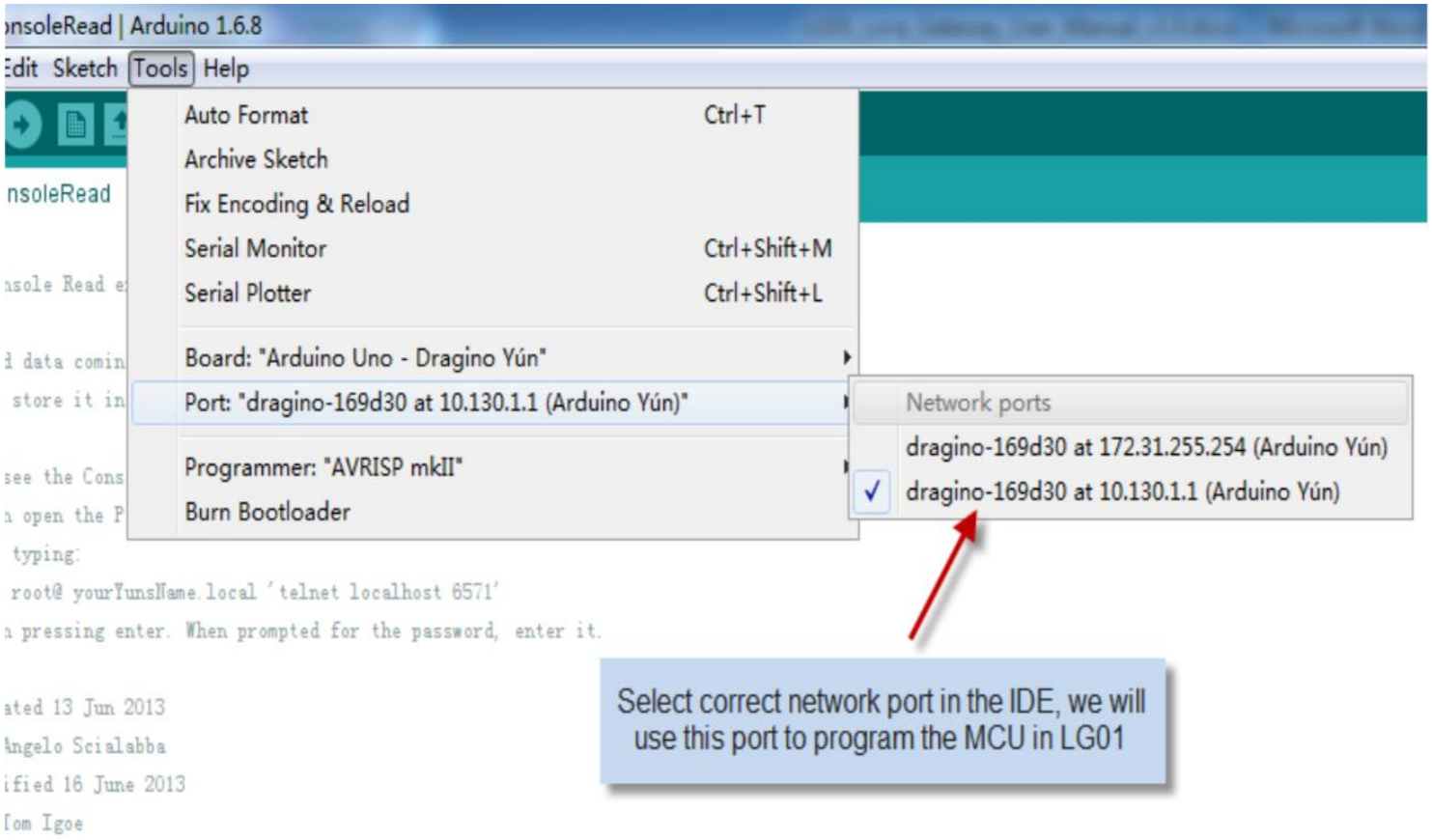
- Download libraries from https://github.com/dragino/Arduino-Profile-Examples
- Extract and put the "libraries" folder only into Arduino folder of the ubuntu system
  - Run the File Manager application as root user by the command "sudo nautilus"
  - Paste the "libraries" folder into /root/Arduino/libraries.
- Restart ArduinoIDE





Cont…

- Check whether network port is discovered at Tools > Port of ArduinoIDE
- Select network port at “10.130.1.1”

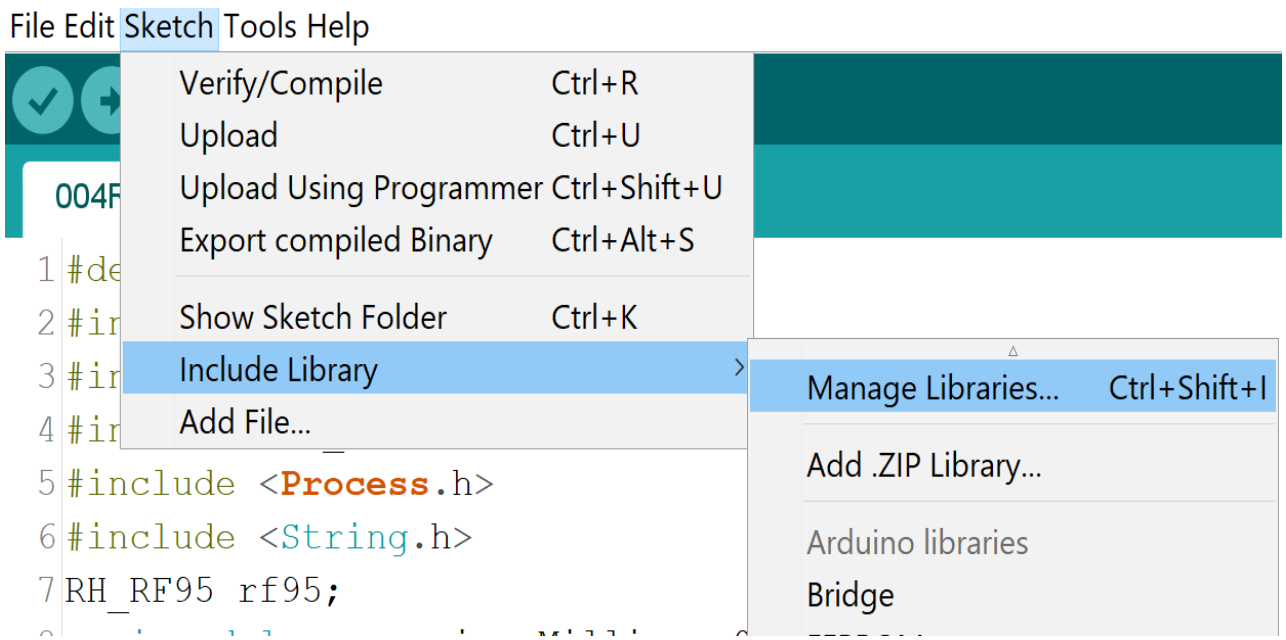


- If the network port doesn’t show up, refer “ALTERNATE UPLOAD” section.

Install Sensor Libraries

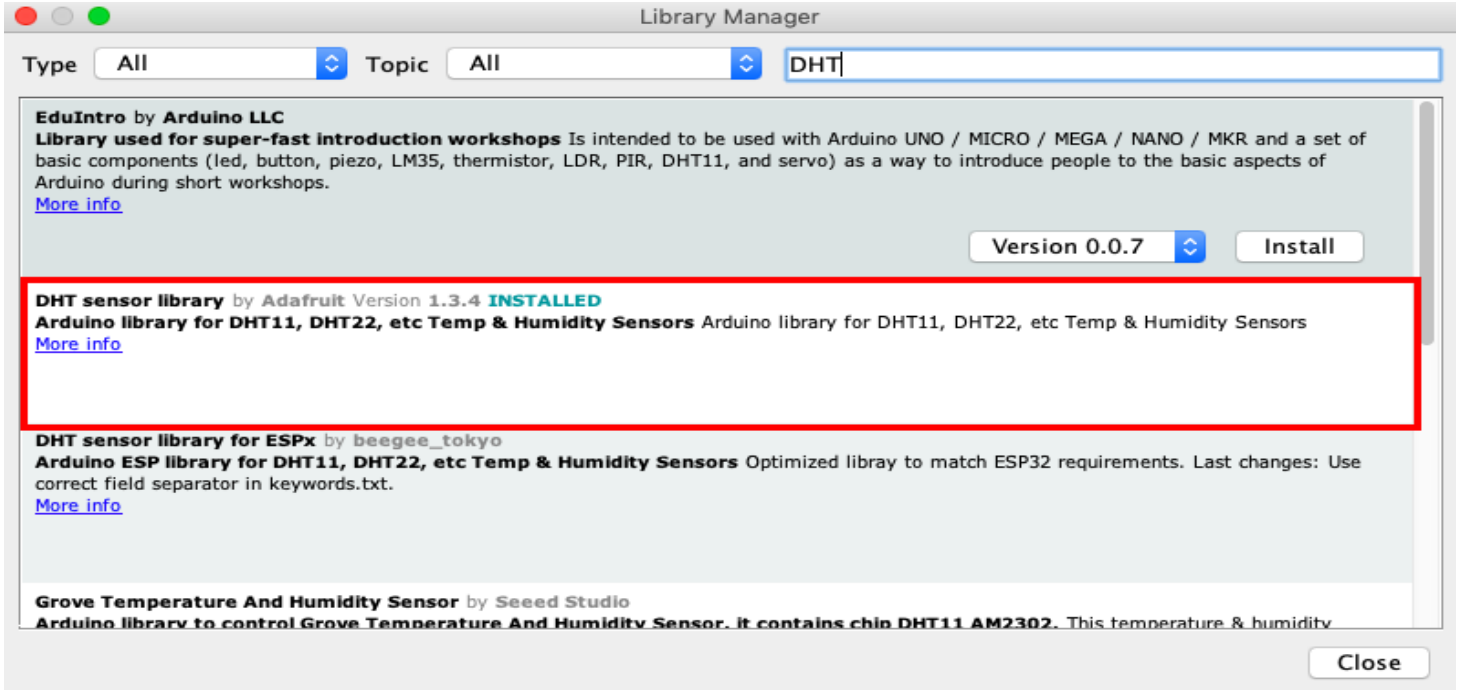
- In this demo, we use few sensors for which we need to install few corresponding libraries.

- Install Using the Library Manager
  - click to **Sketch** menu then **Include Library > Manage Libraries**

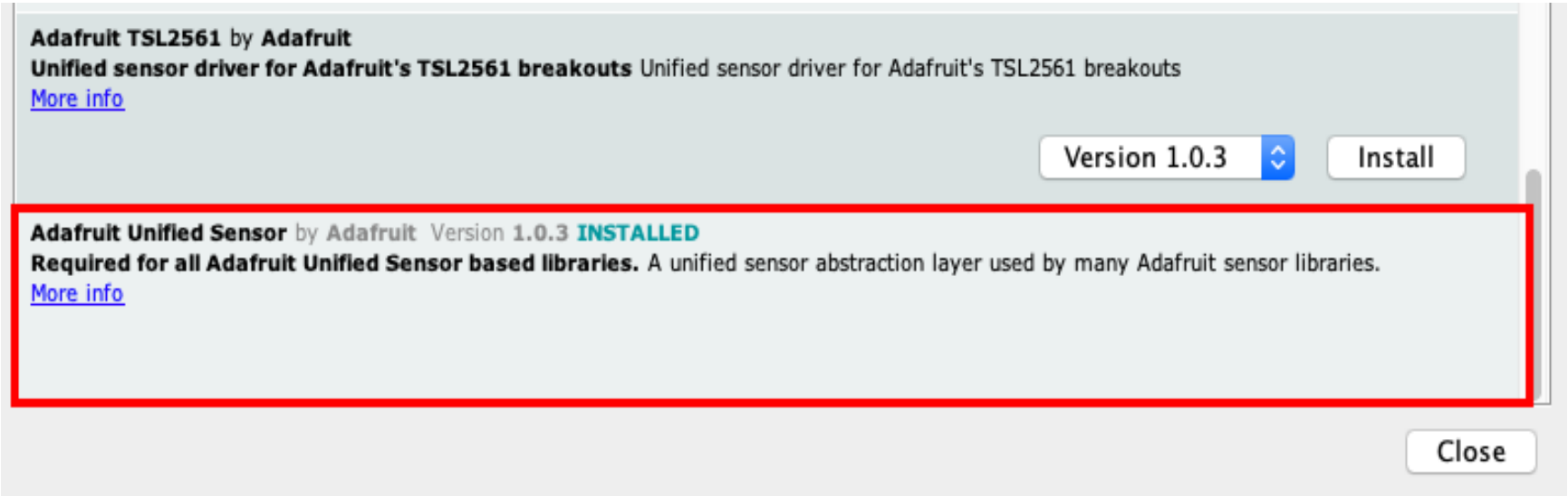


Cont…

- Install the following:
  - https://github.com/adafruit/DHT-sensor-library
  - https://github.com/adafruit/Adafruit_Sensor
  - https://github.com/mikalhart/TinyGPS
  - https://github.com/dragino/RadioHead

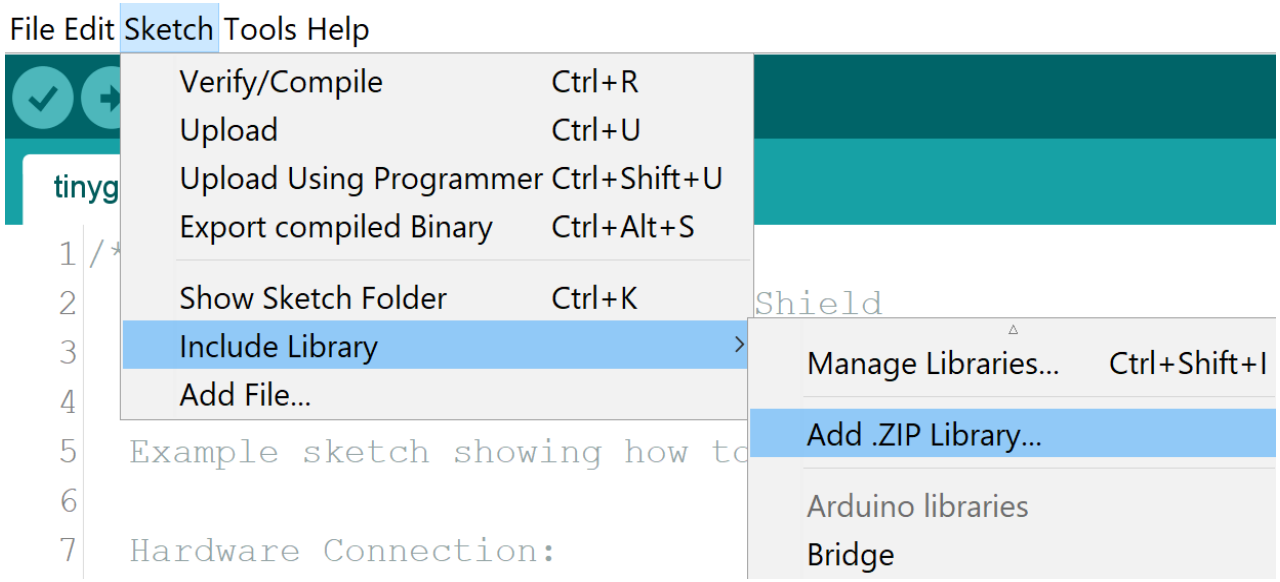


Cont…


Adafruit TSL2561 by Adafruit
Unified sensor driver for Adafruit's TSL2561 breakouts Unified sensor driver for Adafruit's TSL2561 breakouts
More info
Version 1.0.3
Install
Adafruit Unified Sensor by Adafruit Version 1.0.3 INSTALLED
Required for all Adafruit Unified Sensor based libraries. A unified sensor abstraction layer used by many Adafruit sensor libraries.
More info
Close

Cont…

- There exist **other methods** for installing libraries
  - **Importing .zip Library**
    - Sketch --> Include Library --> Add .Zip Library

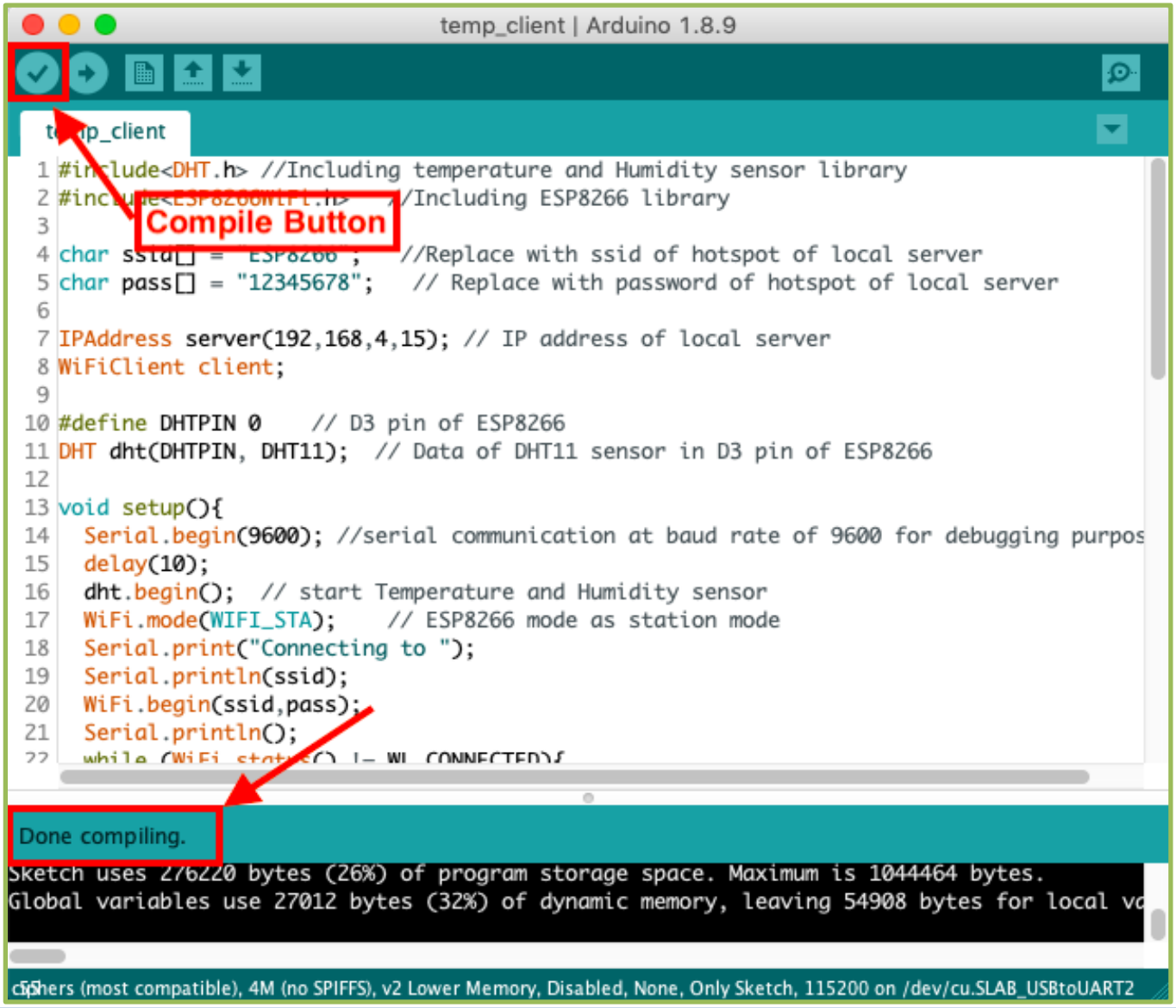


  - **Manual Installation of Library**
    - Download the library as .Zip --> extract it
    - Place the files in File --> Preferences --> Sketchbook location
    - Restart Arduino IDE

Code Compilation & Upload
Observe Output in Serial Monitor

Code Compilation

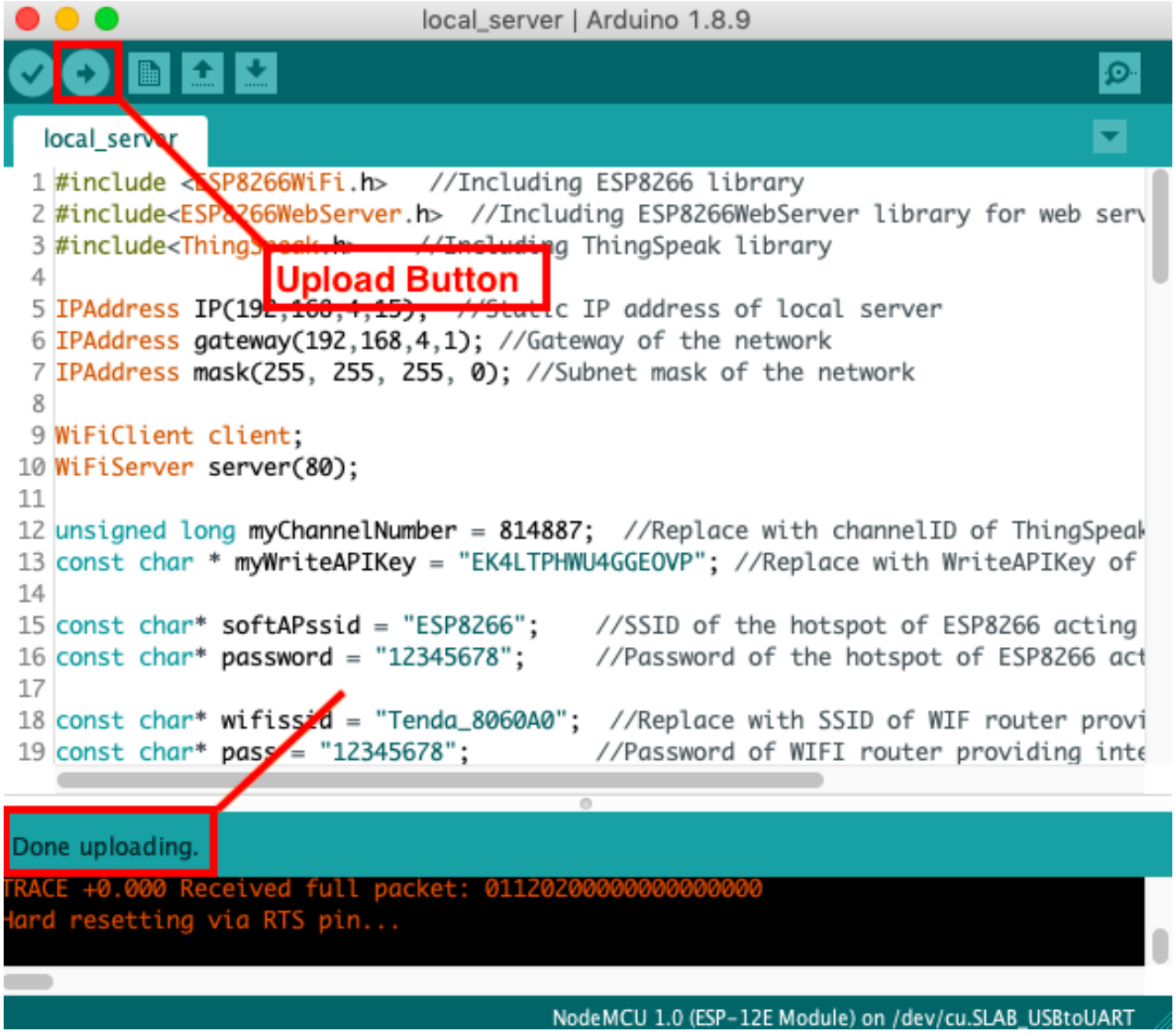
Compilation successful message will appear in bottom left corner.



Code Compilation + Upload

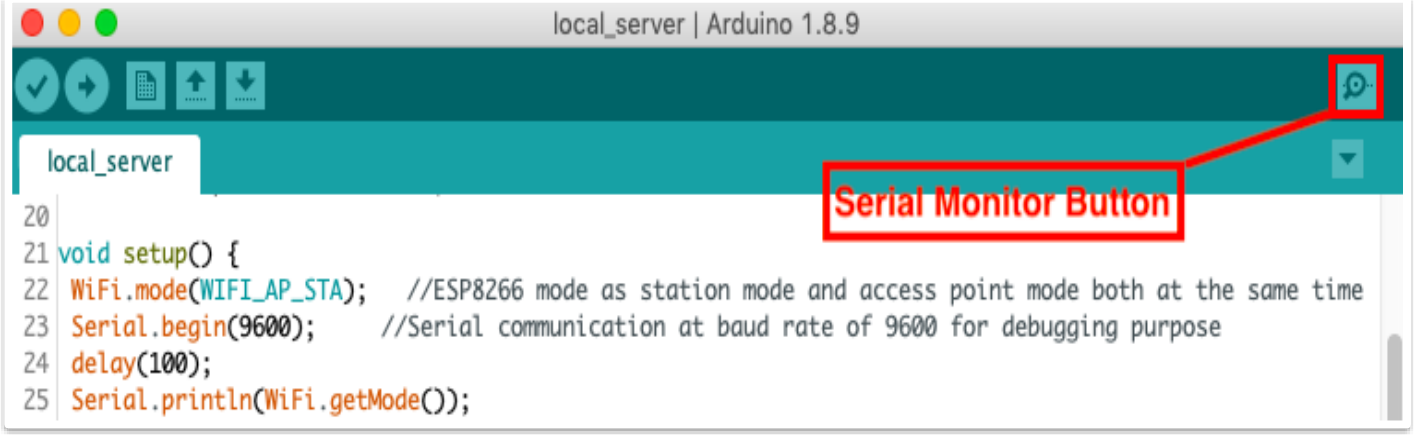
Done uploading message will appear in bottom left corner.

Note: select appropriate Board and Port to upload code

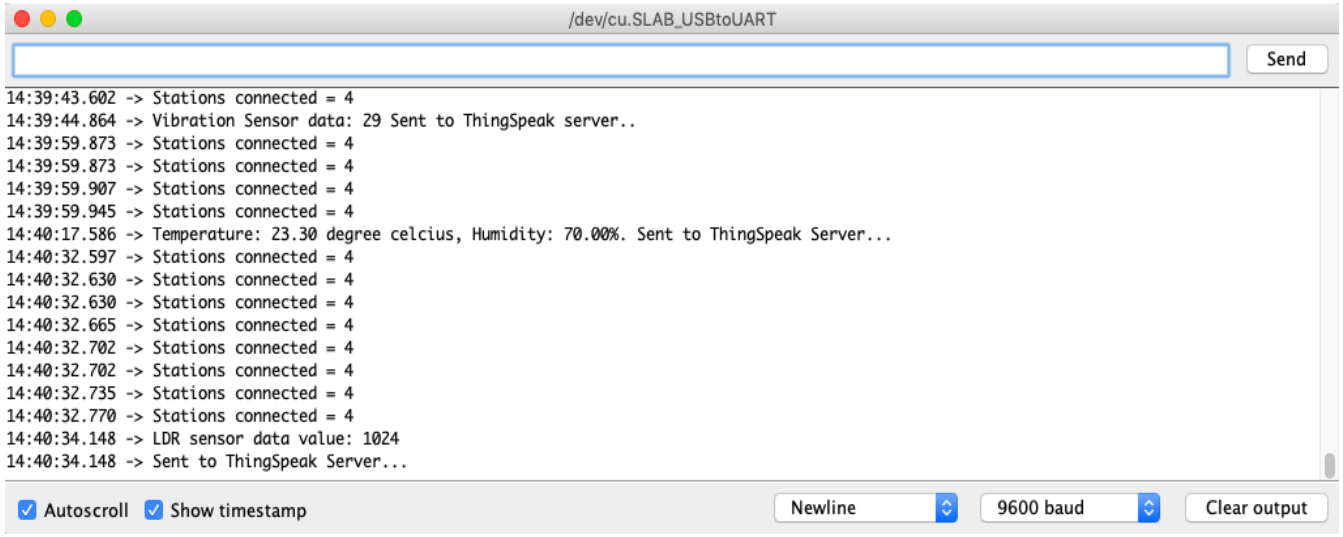


Open Serial Monitor

- First **select the board and port** from which the ouput will be taken.
- Click the icon of **Serial Monitor** on the top right side of the Arduino IDE.

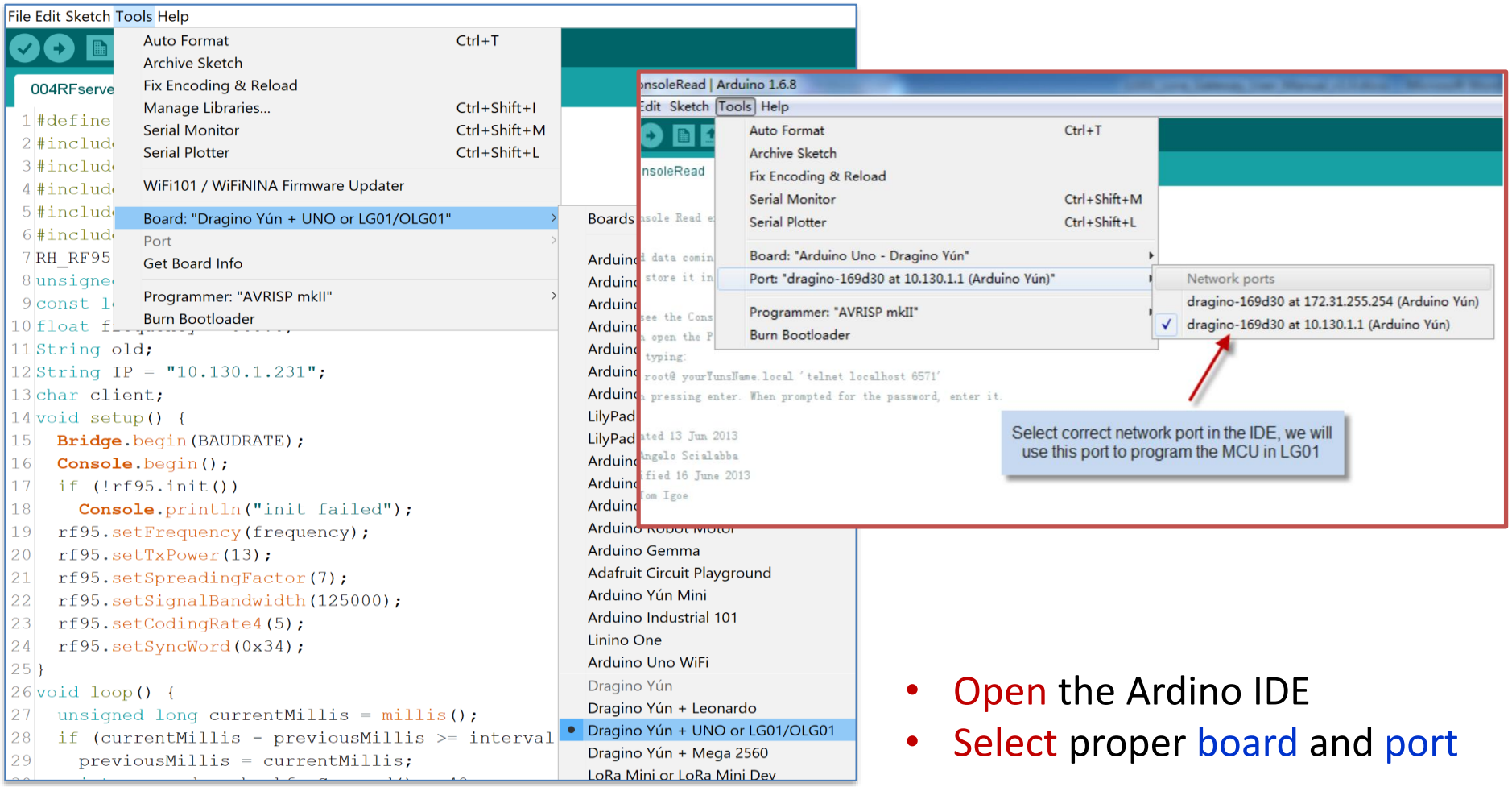


Serial Monitor of Server



Initial Testing
of
LoRa Nodes and Gateways

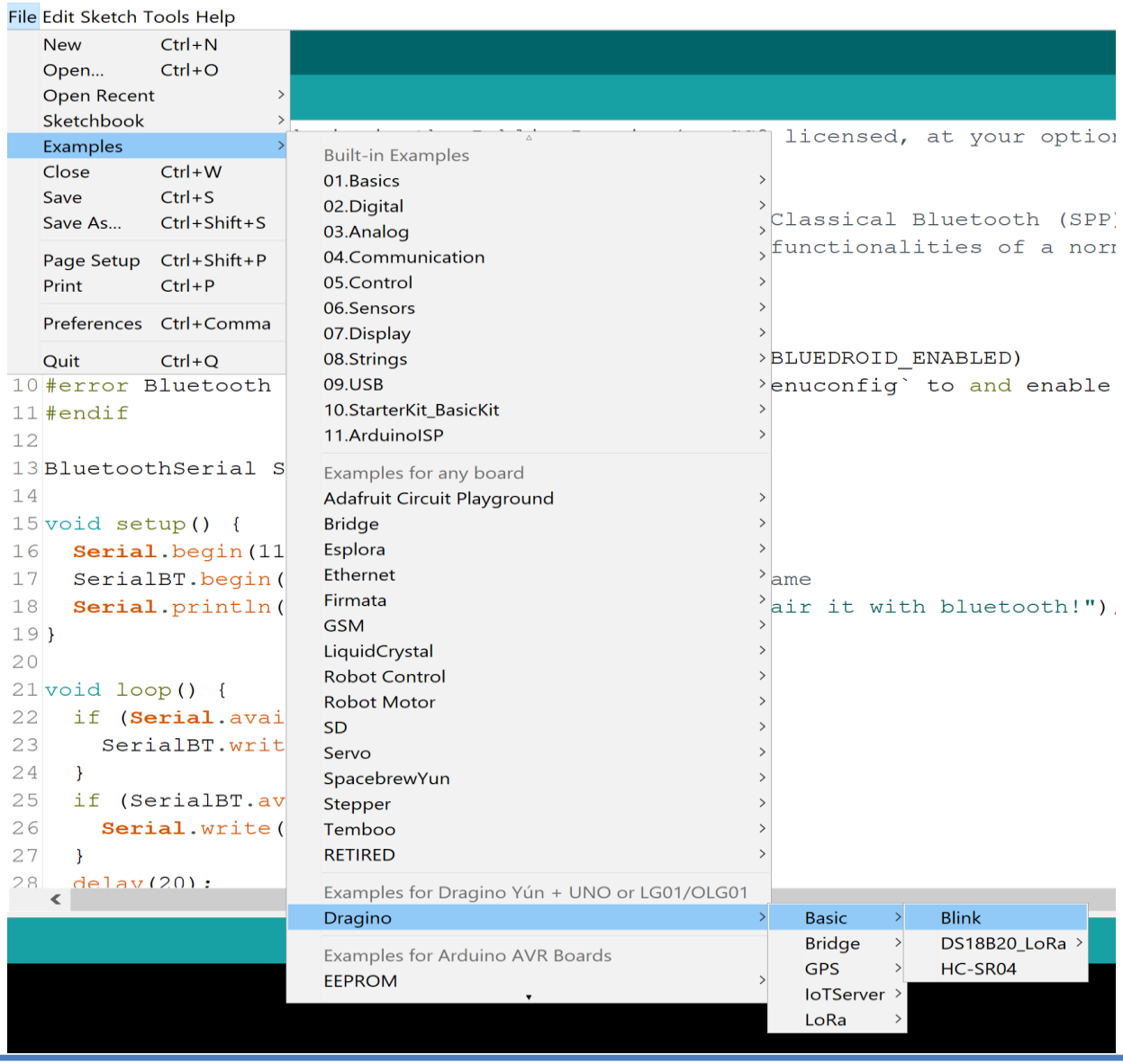
Testing LoRa Gateway



- Open the Ardino IDE
- Select proper board and port

Cont…

- Open test Example from File -> Examples -> Dragino -> Basic -> Blink
- Compile and Upload



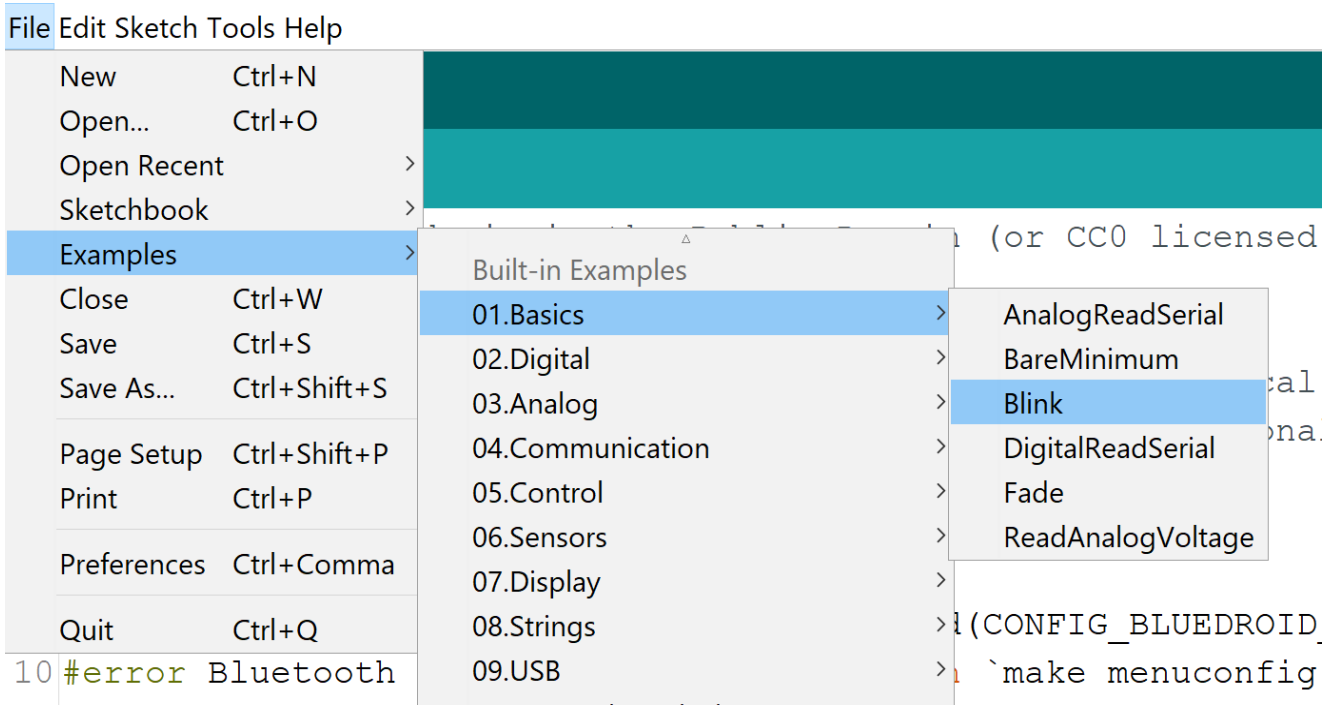
Cont…

On successful upload, the heart shaped LED on the Gateway will blink at the interval of 1 second.

Testing Arduino Uno + Lora Shield

- Connect the UNO with the LoRa Shield and to the PC
- Open Arduino IDE
- Select the board as “Arduino/Genuino Uno”
- Select the respective USB COM port (e.g. “COM3”)
- Open Examples -> Basics -> Blink
- Compile and Upload

Built-in LED on LoRa shield should blink at an interval of 1 second

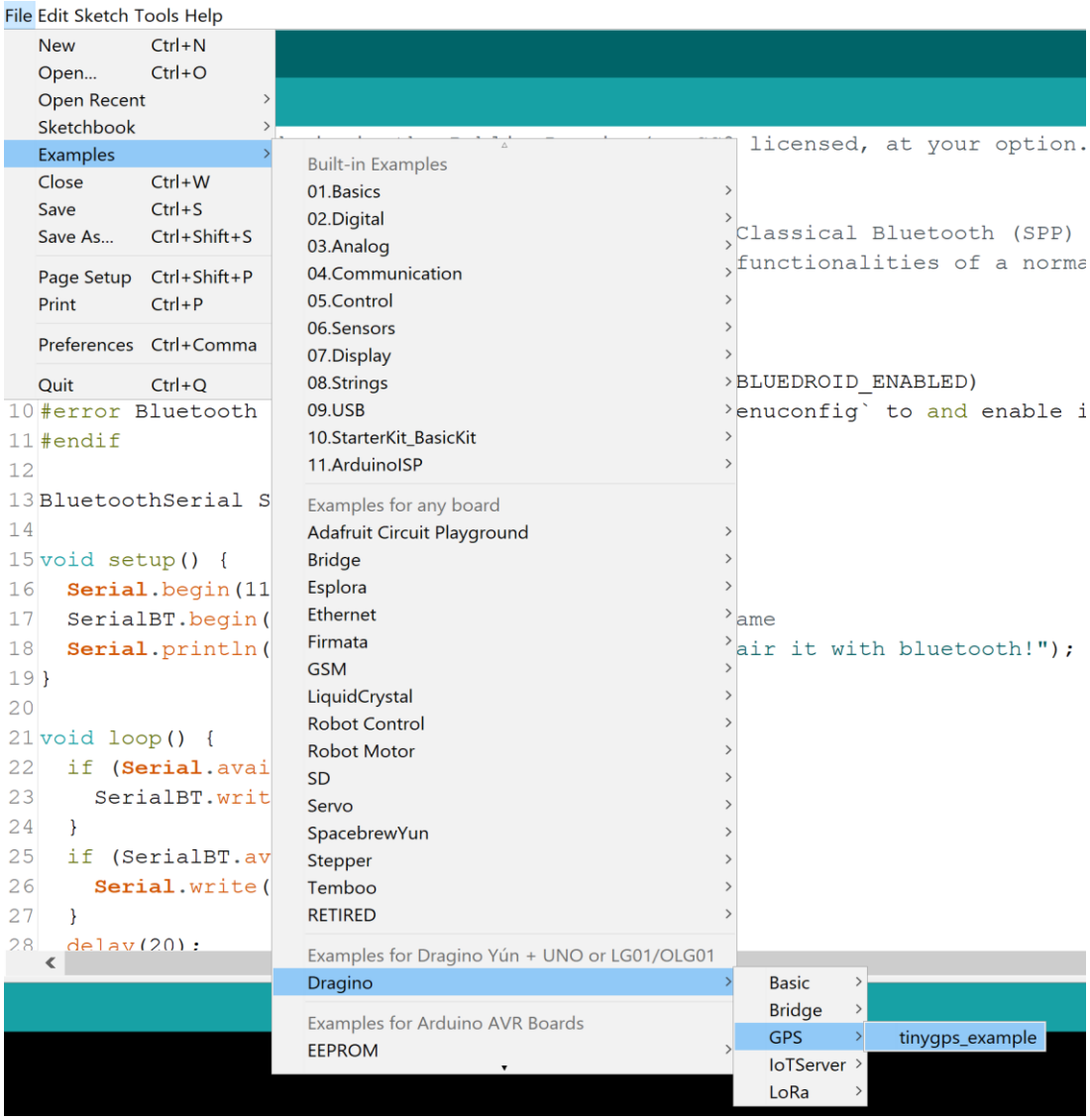


Testing Arduino Uno + GPS/Lora Shield

- Connect the UNO with the GPS/LoRa Shield and to the PC
- Open Arduino IDE

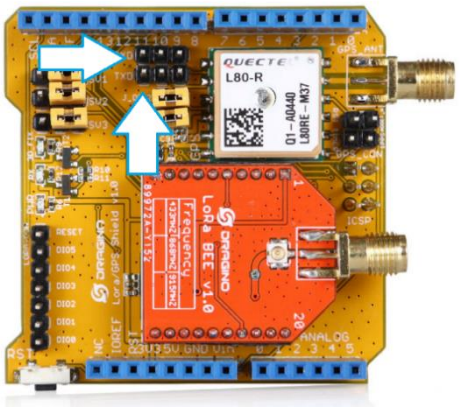
- Select the board as “Arduino/Genuino Uno”
- Select the respective USB COM port (e.g. “COM3”)

- Open Examples -> Dragino -> GPS -> tinygps_example



Cont…

- Before uploading the program, unplug two jumpers from the board as shown



- Connect GPS TX/RX as shown to digital pin 3 and 4 of the Arduino UNO board
  - GPS_RX -> Digital pin 4
  - GPS_TX -> Digital pin 3

- Compile and Upload

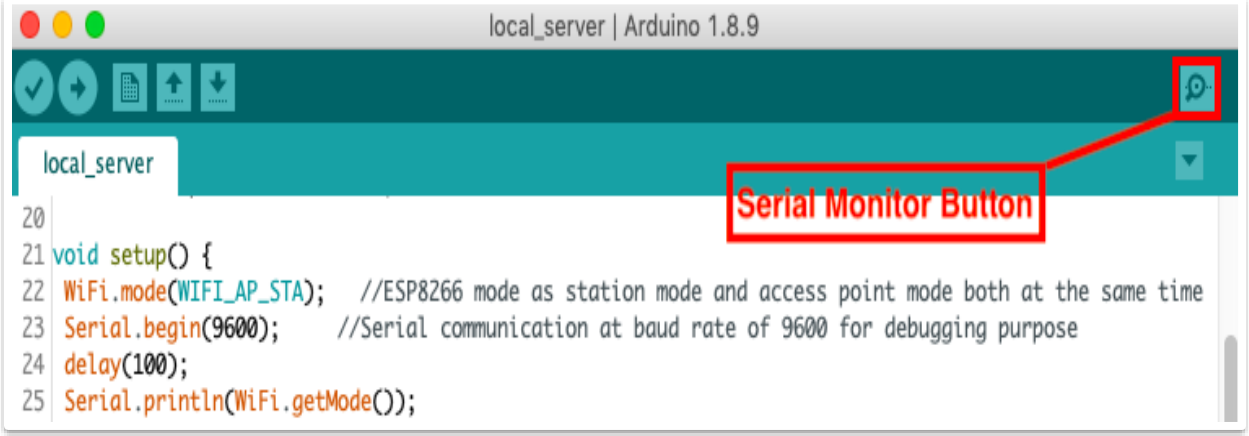
- Open Serial Monitor and choose the correct baud rate as written in the program

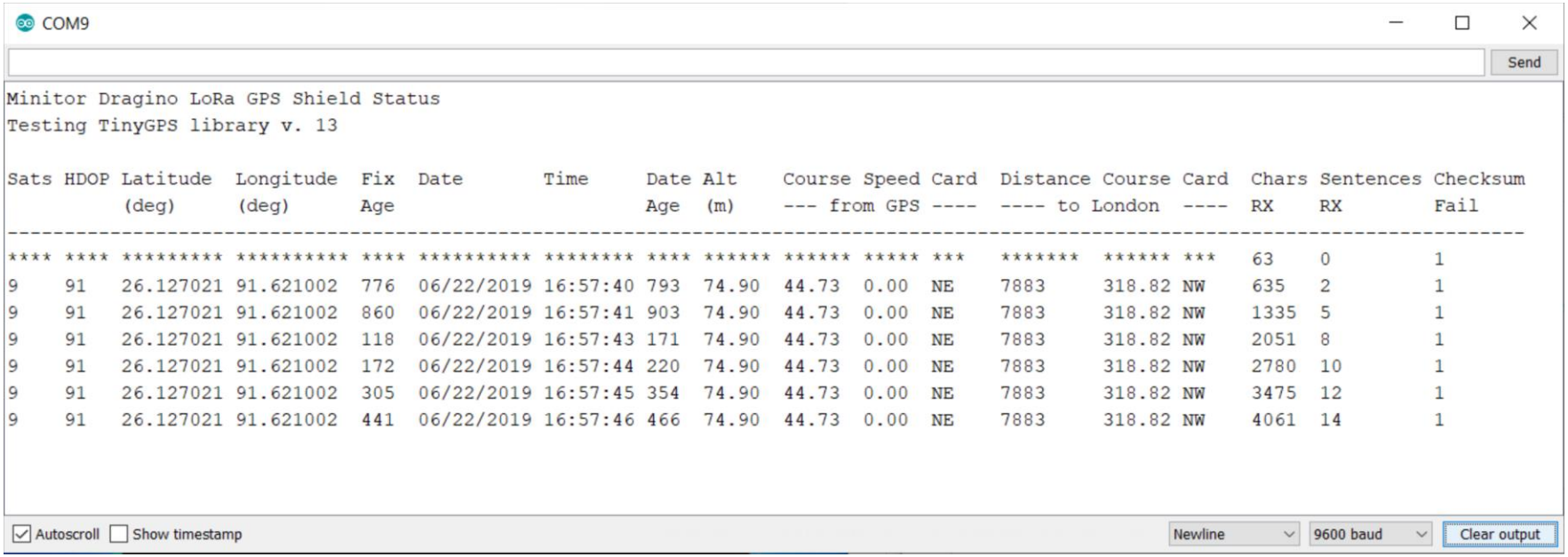
```
void setup() {
  // initialize serial communication at 9600 bits per second:
  Serial.begin(9600);
}
```

Note: GPS takes some time to have a signal fixed, works quicker if placed outdoor environment.

Cont…

- Open the serial monitor
- The Serial Monitor should output GPS location and GPS time





Initial Testing of Communication between LoRa node and LoRa gateway

Gateway configuration

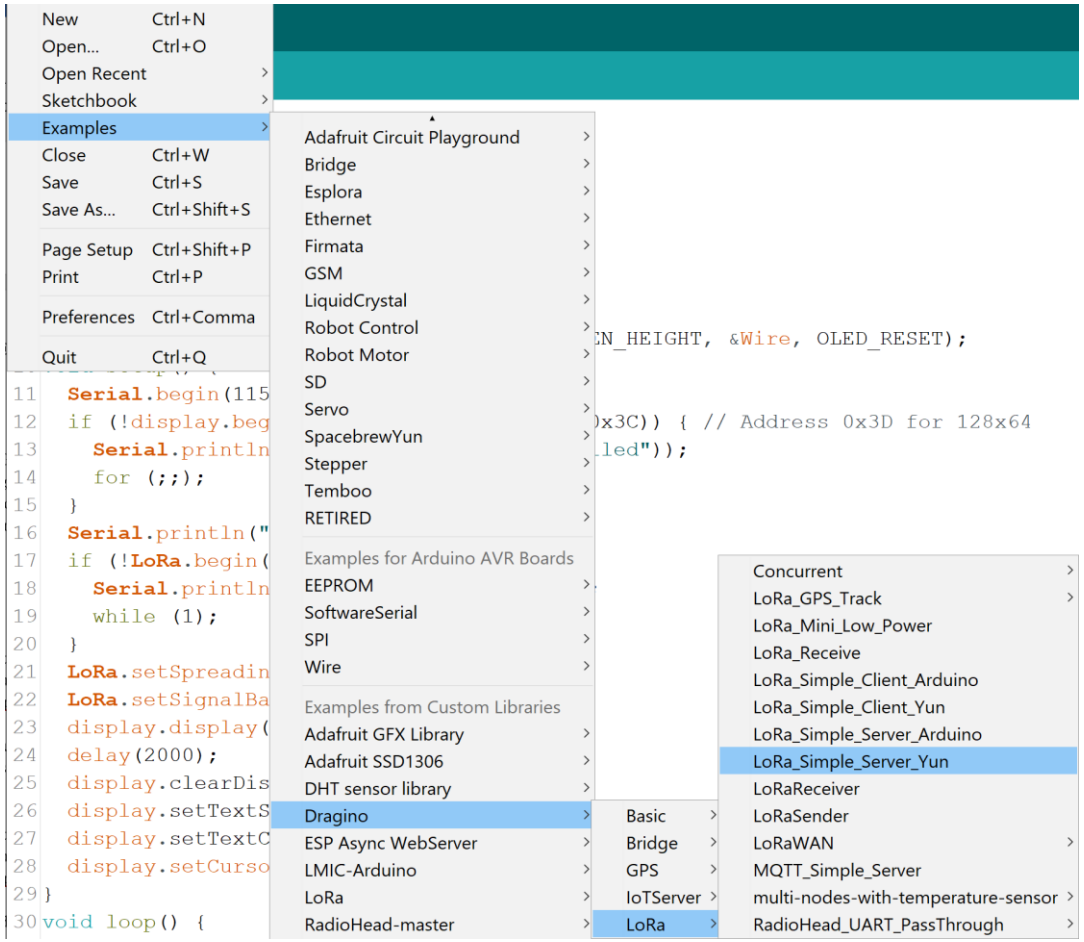
- Power on the Dragino Gateway
- Connect PC with the LAN port of Gateway
- Check whether PC has IP lease from Dragino Gateway in the network 10.130.1.0/24

- Open ArduinoIDE
- Select the Gateway board as "Dragino Yun + UNO or LG01/OLG01"
- Select network port as "dragino at 10.130.1.1 (Arduino Yun)"

- Open Examples from File -> Examples -> Dragino -> Lora -> Lora_Simple_Server_Yun

- Compile and Upload

Output: The Gateway will now start to listen on the specified frequency and Spreading Factor (SF).

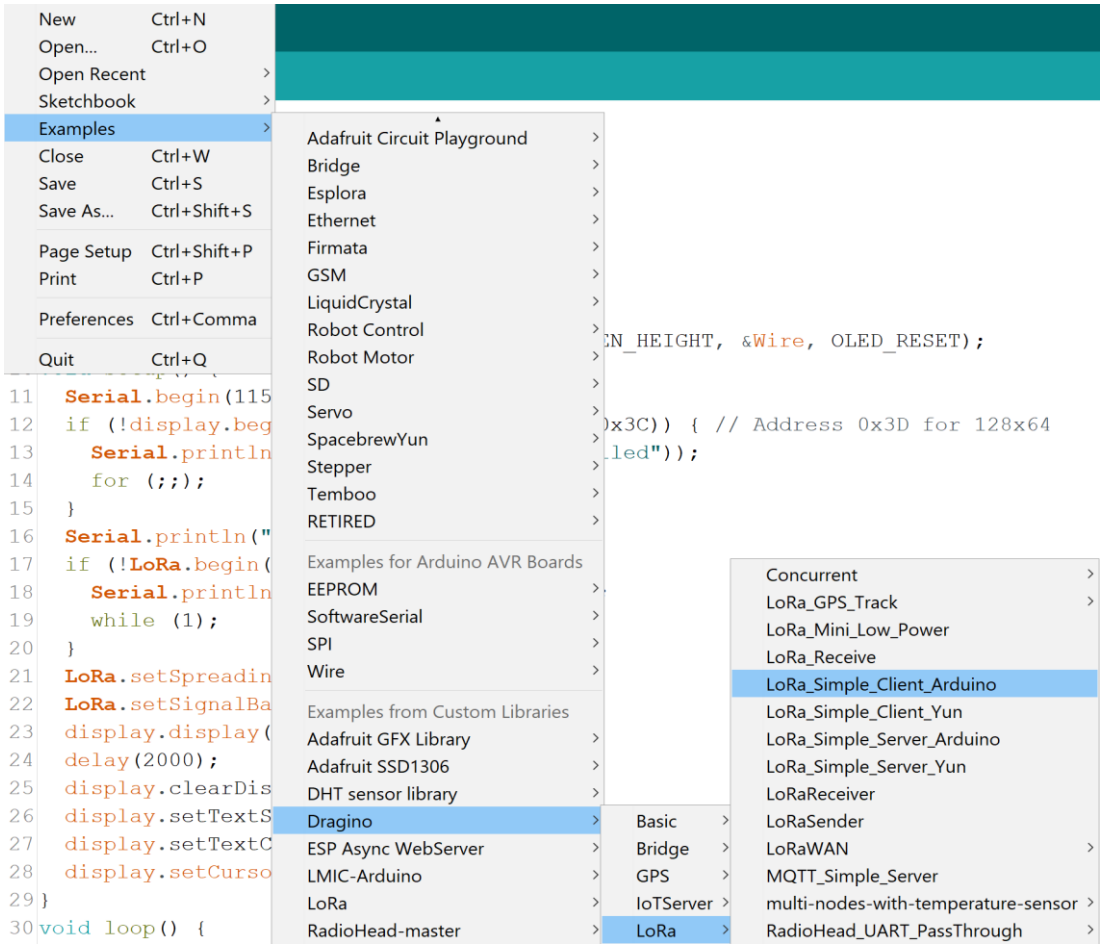


LoRa Node Configuration

- Connect the UNO with the LoRa Shield, and to the PC using USB cable
- Open Device manager to check the COM port in use for this device
- Open ArduinoIDE and select the board as “Arduino UNO” and the “port”

- Open Examples -> Dragino -> Lora -> Lora_Simple_Client_Arduino
- Compile and Upload
- Open Serial Monitor and choose the correct baud rate as that of the program

Output: The Node will be sending and receiving replies from the Gateway



GPS LoRa Node Configuration

- Connect the UNO with the GPS LoRa Shield, and to the PC using USB cable
- Open Device manager to check the COM port in use for this device
- Open ArduinoIDE and select the board as “Arduino UNO” and the “port”

- Open Examples -> Dragino -> Lora -> Lora_Simple_Client_Arduino
- Change the device ID display in loop function
- Compile and Upload
- Open Serial Monitor and choose the correct baud rate as that of the program

Output: The Node will be sending and receiving replies from the Gateway

```
void loop()
{
  Serial.println("Sending to LoRa Server");
  // Send a message to LoRa Server
  uint8_t data[] = "Hello, this is device 2";
  rf95.send(data, sizeof(data));

  rf95.waitPacketSent();
  // Now wait for a reply
  uint8_t buf[RH_RF95_MAX_MESSAGE_LEN];
  uint8_t len = sizeof(buf);
```

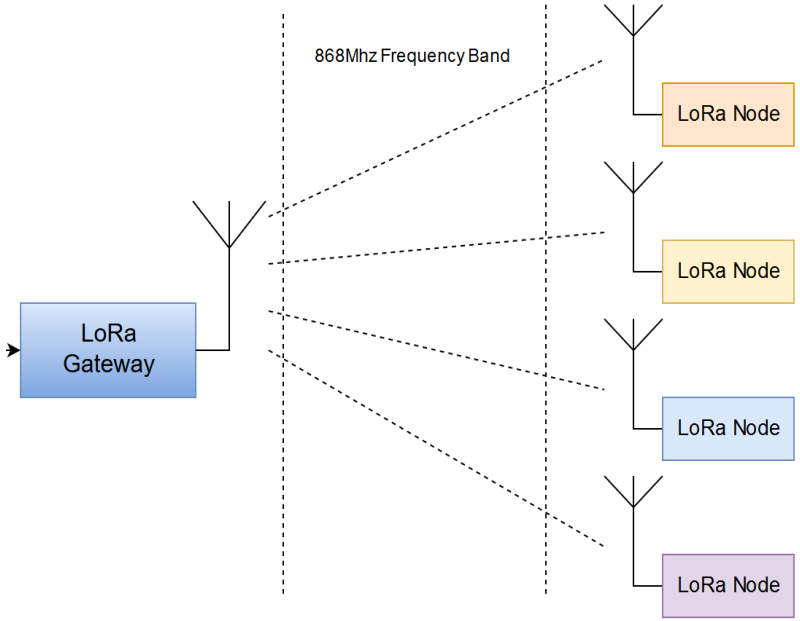
Project Implementation

Smart Home Monitoring and Control

IoT Network Configuration

- There are two LoRa nodes and one LoRa gateway
  - LoRa nodes are connected with sensors.

- LoRa1- ESP8266 with temperature & humidity sensor
- LoRa2- ESP8266 with Light sensor



Note: Unique ID for each LoRa node will be needed in programming

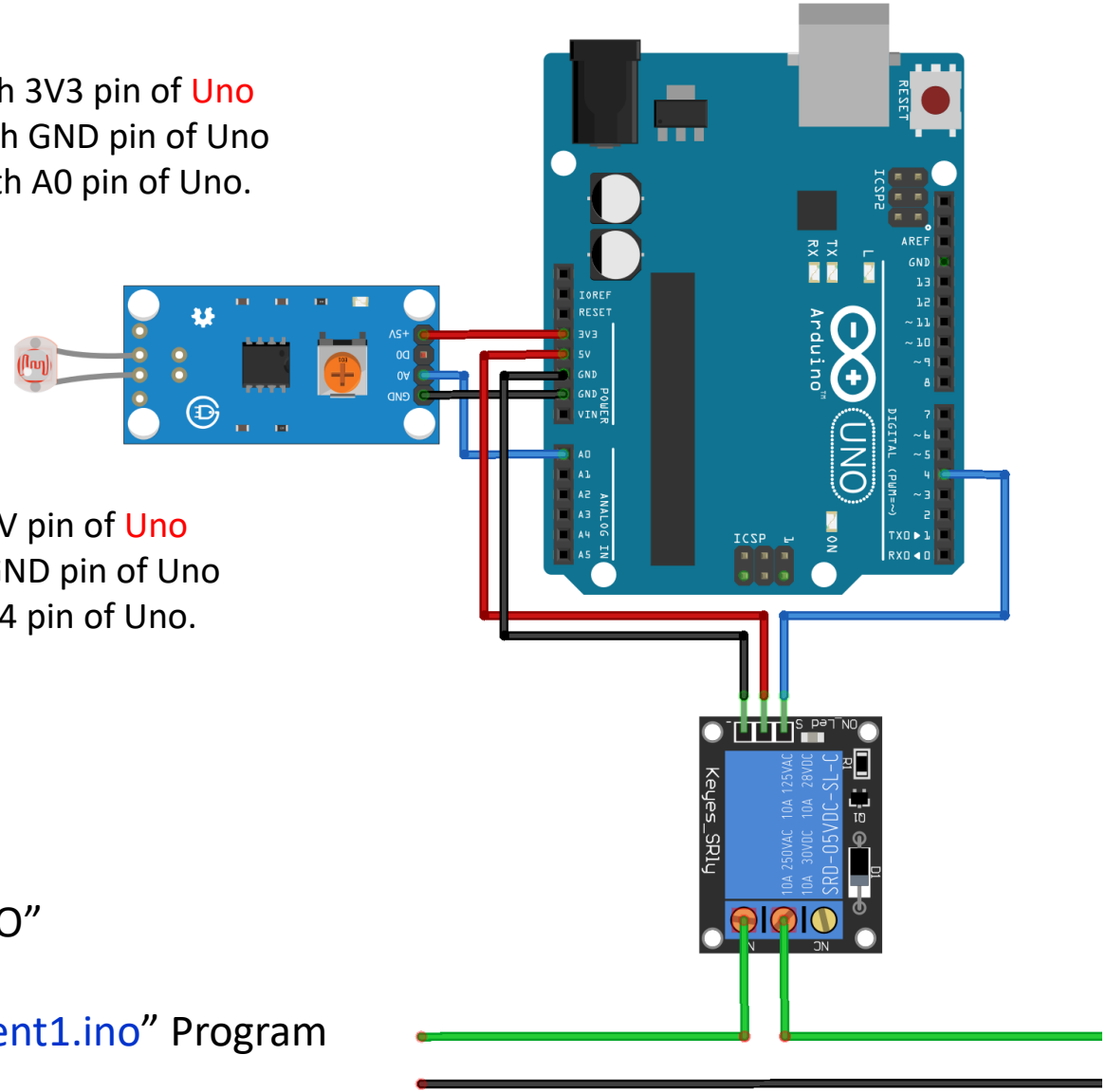
Configure LoRa with LDR Sensor & 5V Relay

Arduino Uno with LDR Sensor

- Connect +5V pin of LDR sensor with 3V3 pin of Uno
- Connect GND pin of LDR sensor with GND pin of Uno
- Connect A0 pin of LDR sensor with A0 pin of Uno.

Arduino Uno with 5V Relay

- Connect VCC pin of Relay with 5V pin of Uno
- Connect GND pin of Relay with GND pin of Uno
- Connect IN pin of Relay with D4 pin of Uno.



- Connect Board to PC
- Open ArduinoIDE
- Select board as “Arduino UNO”
- Select appropriate Port
- Compile and Upload the “client1.ino” Program

client1.ino Programme

```
#include <SPI.h>                          //load required libraries
#include <RH_RF95.h>
int ac = 4;                               //digital pin 4 to connect relay
int client = 2;                           //client id
unsigned long previousMillis = 0;
const long interval = 30000;              //duration to send sensor value
RH_RF95 rf95;

void setup()
{
  Serial.begin(9600);                     //Serial connection baud rate
  Serial.println("Start LoRa Client");
  if (!rf95.init())
     Serial.println("init failed");
  rf95.setFrequency(868.0);               //LoRa frequency
  rf95.setTxPower(13);                    //LoRa TX power
  rf95.setSpreadingFactor(7);             //Spreading factor
  rf95.setSignalBandwidth(125000);        //Channel Bandwidth
  rf95.setCodingRate4(5);
  rf95.setSyncWord(0x34);                 //LoRa sync word
  pinMode(ac, OUTPUT);                    //digital pin mode
  sendUpdates();
}
```

Cont…

```
void loop()
{
  unsigned long currentMillis = millis();
  if (currentMillis - previousMillis >= interval) {
    previousMillis = currentMillis;
    sendUpdates();
  }
  receiveCommand();
}
```

```
void receiveCommand()
 {                                          //function to receive commands
  if (rf95.available()) {
    uint8_t buf[RH_RF95_MAX_MESSAGE_LEN];
    uint8_t len = sizeof(buf);
    if (rf95.recv(buf, &len)) {
      Serial.print("Client: ");
      Serial.println(buf[0] - 48);
      if (buf[0] - 48 == client) {          //verify client id
        Serial.print("Relay Status: ");
        Serial.println(buf[1] - 48);
        String relay = String(buf[1] - 48);
        digitalWrite(ac, relay.toInt());    //setting relay status
        delay(300);
        sendUpdates();                      //send back acknowledgement
      }
      else
        Serial.println("Message Not for Me");
    }
  }
}
```

Cont…

```
void sendUpdates()
{                                        //function for sending updates
  Serial.println("Sending to LoRa Server");
  String temp = String(client);
  temp += String(getACstate());
  temp += String(getSensorData());
  uint8_t data[temp.length() + 1];
  temp.getBytes(data, temp.length() + 1);
  rf95.send(data, temp.length());
  rf95.waitPacketSent();
}

int getSensorData()
{                                        //function for reading sensor
  int sensorValue = analogRead(A0);
  return sensorValue;
}

int getACstate()
{                                        //function for reading pin status
  int acState = digitalRead(ac);
  return acState;
}
```

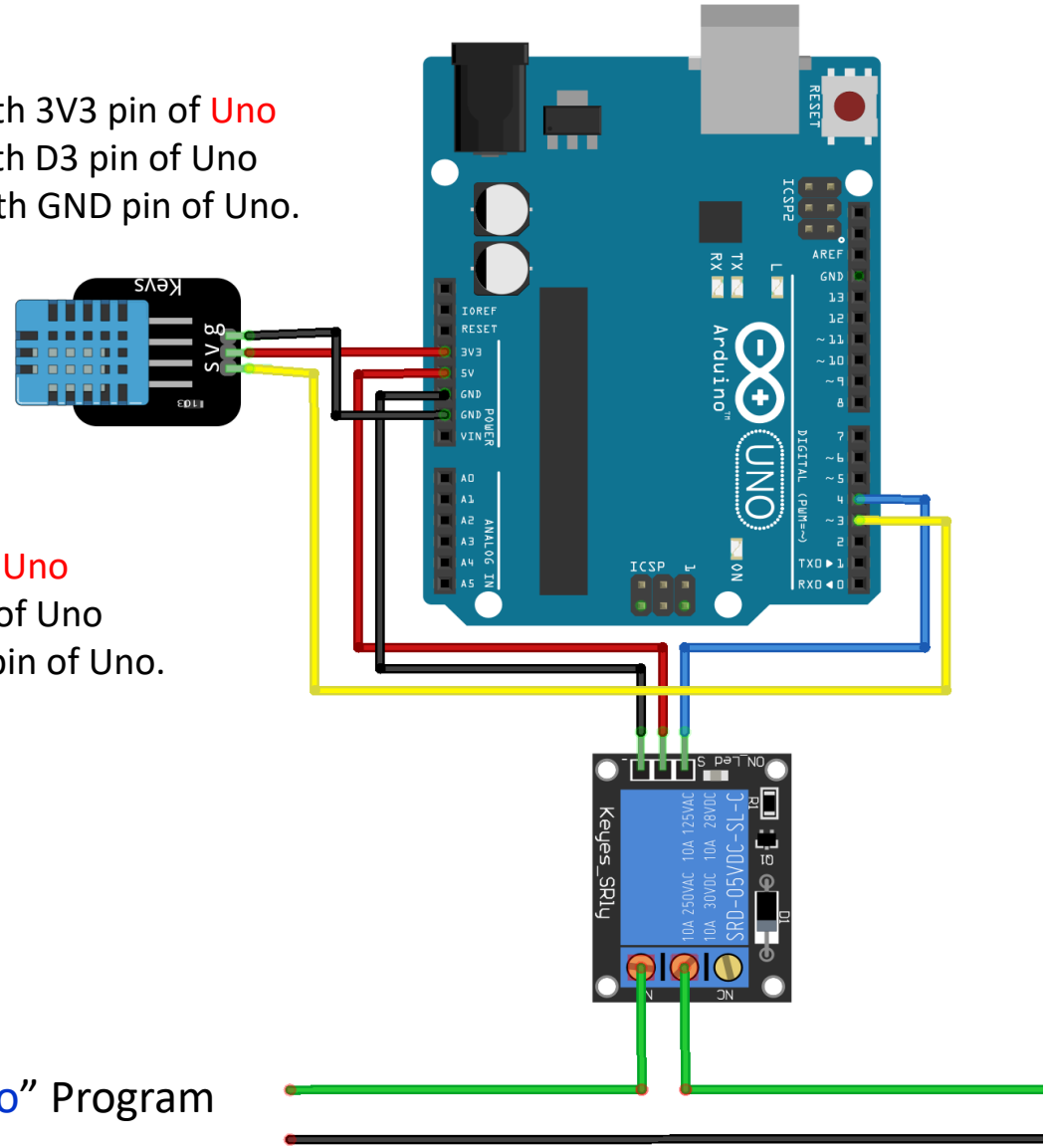
Configure GPS/LoRa with DHT11 Sensor & 5V Relay

Arduino Uno with DHT11 Sensor

- Connect VCC pin of DHT11 sensor with 3V3 pin of Uno
- Connect DATA OUT pin of DHT11 sensor with D3 pin of Uno
- Connect GND pin of DHT11 sensor with GND pin of Uno.

Arduino Uno with 5V Relay

- Connect VCC pin of Relay with 5V pin of Uno
- Connect GND pin of Relay with GND pin of Uno
- Connect IN pin of Relay with Digital 4 pin of Uno.



- Connect Board to PC
- Open ArduinoIDE
- Select board as “Arduino UNO”
- Select appropriate Port
- Compile and Upload the “client2.ino” Program

client2.ino Programme

```
#include <SPI.h>                    //load required libraries
#include <RH_RF95.h>
#include "DHT.h"                    //DHT library
#define DHTPIN 3                    //DHT to digital pin 3
#define DHTTYPE DHT11               //DHT11 selection
int ac = 4;                         //digital pin 4 to connect relay
int client = 3;                     //client id
unsigned long previousMillis = 0;
const long interval = 30000;        //duration to send updates
RH_RF95 rf95;
DHT dht(DHTPIN, DHTTYPE);
```

```
void setup()
{
  Serial.begin(9600);                    //Serial baud rate
  dht.begin();
  Serial.println("Start LoRa Client");
  if (!rf95.init())
    Serial.println("init failed");
  rf95.setFrequency(868.0);              //LoRa frequency
  rf95.setTxPower(13);                   //TX power
  rf95.setSpreadingFactor(7);            //Spreading Factor
  rf95.setSignalBandwidth(125000);       //Signal Bandwidth
  rf95.setCodingRate4(5);
  rf95.setSyncWord(0x34);
  pinMode(ac, OUTPUT);                   //digital pin mode
  digitalWrite(ac, HIGH);        //reverse for active low relay
  sendUpdates();
}
```

Cont…

```
void loop()
{
  unsigned long currentMillis = millis();
  if (currentMillis - previousMillis >= interval) {
    previousMillis = currentMillis;
    sendUpdates();
  }
  receiveCommand();
}
```

```
void receiveCommand()
{                                   //function to receive commands
  if (rf95.available()) {
    uint8_t buf[RH_RF95_MAX_MESSAGE_LEN];
    uint8_t len = sizeof(buf);
    if (rf95.recv(buf, &len))
      if (buf[0] - 48 == client) {
        String relay = String(buf[1] - 48);
        digitalWrite(ac, !relay.toInt());
        delay(300);
        sendUpdates();
      }
  }
}
```

Cont…

```
void sendUpdates()
{                                   //function to send sensor values
  String temp = String(client);
  temp += String(getACstate());
  temp += String(getSensorData());
  uint8_t data[temp.length() + 1];
  temp.getBytes(data, temp.length() + 1);
  rf95.send(data, temp.length());
  rf95.waitPacketSent();
}

float getSensorData()
{                                   //function to read sensor data
  float sensorValue = dht.readTemperature();
  Serial.println(sensorValue);
  return sensorValue;
}

int getACstate()
{                                   //function to read relay state
  int acState = !digitalRead(ac);
  return acState;
}
```

Configure LoRa Gateway

- Connect LoRa gateway to PC
- Open Arduino IDE
- Select board as “Dragino Yun + UNO or LG01/OLG01”
- Select network port at 10.130.1.1
- Update server IP address (as set in server configuration) in the Gateway program
- Compile and Upload the “gateway.ino” Program

gateway.ino Programme

```
#define BAUDRATE 115200                //Define baud rate of bridge.
#include <Console.h>                   //Bridge is the intermediate between
#include <SPI.h>                       //the Linux system and the
#include <RH_RF95.h>                   //microcontroller
#include <Process.h>
#include <String.h>                    //Include all required libraries
RH_RF95 rf95;
unsigned long previousMillis = 0;
const long interval = 2000;
float frequency = 868.0;               //Listen frequency
String old;
String IP = "10.130.1.229";            //Server IP address
char client;

void setup()
{
  Bridge.begin(BAUDRATE);
  Console.begin();
  if (!rf95.init())
    Console.println("init failed");
  rf95.setFrequency(frequency);
  rf95.setTxPower(13);                 //TX power
  rf95.setSpreadingFactor(7);          //Spreading factor
  rf95.setSignalBandwidth(125000);     //Signal Bandwidth
  rf95.setCodingRate4(5);
  rf95.setSyncWord(0x34);
}

void loop()
{
  unsigned long currentMillis = millis();
  if (currentMillis - previousMillis >= interval) {
    previousMillis = currentMillis;
    int command = checkforCommand() - 48;
    String neww = String(command);
    neww += String(client);
    if (old != neww)          //send only if new command arrives
      sendCommand(command);
  }
  receiveUpdates();
}
```

Cont…

```
void sendCommand (int relaystate)
{                                          //function to send command to node
  old = String(relaystate);
  old += String(client);
  String temp = String(client);
  temp += String(relaystate);
  uint8_t data[temp.length() + 1];
  temp.getBytes(data, temp.length() + 1);
  rf95.send(data, sizeof(data));
  rf95.waitPacketSent();
  Console.println("Sent a command");
}

void receiveUpdates()
{                                          //function to receive data from nodes
  if (rf95.available())  {
    uint8_t buf[RH_RF95_MAX_MESSAGE_LEN];
    uint8_t len = sizeof(buf);
    if (rf95.recv(buf, &len)) {
      String sensor = "";
      for (int i = 2; i < len; i++) {
        sensor += buf[i] - 48;
      }
      uploadData(buf[0] - 48, buf[1] - 48, sensor);
    }
  }
}
```

Cont…

```
void uploadData(int client, int relay, String sensor)
{
  Process p;                    //initialize linux process
  String URL = "http://";       //linux command with values
  URL += IP;
  URL += "/receive.php?client=";
  URL += String(client);
  URL += "&access=";
  URL += String(relay);
  URL += "&sensor=";
  URL += String(sensor);
  p.begin("curl");
  p.addParameter(URL);
  p.run();        //execute linux command
}
```

```
char checkforCommand()
 {                                  //function for checking from server
  char command[2] = {0};
  int count = 0;
  String URL = "http://";
  URL += IP;
  URL += "/new/";
  Process p;                        //linux process to fetch command
  p.begin("curl");
  p.addParameter(URL);
  p.run();
  while (p.available() > 0){   //if linux command outputs command
    command[count] = p.read();
    count++;
  }
  client = command[0];
  return command[1];          //return client address and access
 }
```

Configure Web Server

send.php
==========

```
<html>
<body>
<?php
   $client = $_GET["client"];
   $access = $_GET["access"];
   $file = fopen('new/index.html', 'w+');
   ftruncate($file, 0);
   $content = $client.$access. PHP_EOL;
   fwrite($file , $content);
   fclose($file );
   die(header("Location: ".$_SERVER["HTTP_REFERER"]));
?>
</body>
</html>
```

receive.php
==========

```
<html>
<body>
<?php
   $client = $_GET["client"];
   $access = $_GET["access"];
   $sensor = $_GET["sensor"];
   $var = $client.'/index.html';
   $file = fopen($var, 'w+');
   ftruncate($file, 0);
   $content = $access.$sensor. PHP_EOL;
   fwrite($file , $content);
   fclose($file );
   die(header("Location: ".$_SERVER["HTTP_REFERER"]));
?>
</body>
</html>
```

Cont…

index.html

```
==============
<html>
<head></head>
<body onload="init()">
<center>
  <div style="width:450px;border:3px solid black;padding:20px">
    <h1>LoRa AC Control</h1>
    <div id="main">
      <div id="updateMe">
        <div style="width:400px;border: 3px solid black;padding:20px">
          <h2>UNO with LoRa Status:</h2>
          <h3 id="uno2"></h3>
          <h3 id="uno21"></h3>
          <form action="send.php" method="GET" target="hidden-form">
            <input type="hidden" name="client" value="2">
            <button type="submit" onclick="shows();setTimeout(hides,3000)" name="access" value="1" style="padding:10px" id="button1">TURN ON</button>
          </form>
          <div id="stat" style="display:none"></div>
        </div>
        <div style="border: 5px;padding:20px"></div>
        <div style="width:400;border: 3px solid black;padding:20px">
          <h2>UNO with LoRa/GPS Status:</h2>
          <h3 id="uno3"></h3>
          <h3 id="uno31"></h3>
          <form action="send.php" method="GET" target="hidden-form">
            <input type="hidden" name="client" value="3">
            <button type="submit" onclick="showss();setTimeout(hidess,3000)" name="access" value="1" style="padding:10px" id="button2">TURN ON</button>
          </form>
          <div id="stat2" style="display:none"></div>
        </div>
      </div>
    </div>
  </div>
</center>
</body>
```

Cont…

```
<IFRAME style="display:none" name="hidden-form"></IFRAME>
<script type="text/javascript">

function refresh() {
   var req = new XMLHttpRequest();
   console.log("Grabbing Value");
   req.onreadystatechange = function () {
      if (req.readyState == 4 && req.status == 200) {
         document.getElementById('uno2').innerText = "Relay Status: "+req.responseText[0];
         document.getElementById('uno21').innerText = "Sensor Value: "+req.responseText[1]+req.responseText[2]+req.responseText[3]+" lux";
      }
   }
   req.open("GET", '2/', true);
   req.send(null);
}

function refresht() {
   var req = new XMLHttpRequest();
   console.log("Grabbing Value");
   req.onreadystatechange = function () {
      if (req.readyState == 4 && req.status == 200) {
      document.getElementById('uno3').innerText = "Relay Status: "+req.responseText[0];
      document.getElementById('uno31').innerText = "Sensor Value: "+req.responseText[1]+req.responseText[2]+"."+req.responseText[4]+req.responseText[5]+"
\u2103";
      }
   }
   req.open("GET", '3/', true);
   req.send(null);
}
```

Cont…

```
function init()
{
  refresh()
  refresht()
  update2()
  update3()
  var int = self.setInterval(function () {
    refresht()
    refresh()
    update2()
    update3()
  }, 1000);
}
function shows(){
  var x = document.getElementById("stat");
  x.innerHTML = "Sending.";
  if(x.style.display == "none"){
    x.style.display = "block";
  }
  setTimeout(function(){x.innerHTML = "Sending.."},1000);
  setTimeout(function(){x.innerHTML = "Sending..."},2000);
}
function hides(){
  var x = document.getElementById("stat");
  if(x.style.display == "block"){
    x.style.display = "none";
  }
  var x2 = document.getElementById("button1");
  if(x2.innerHTML == "TURN ON"){
    x2.innerHTML = "TURN OFF";
    x2.value = "0";
  }
  else{
    x2.innerHTML = "TURN ON"
    x2.value = "1";
  }
}
```

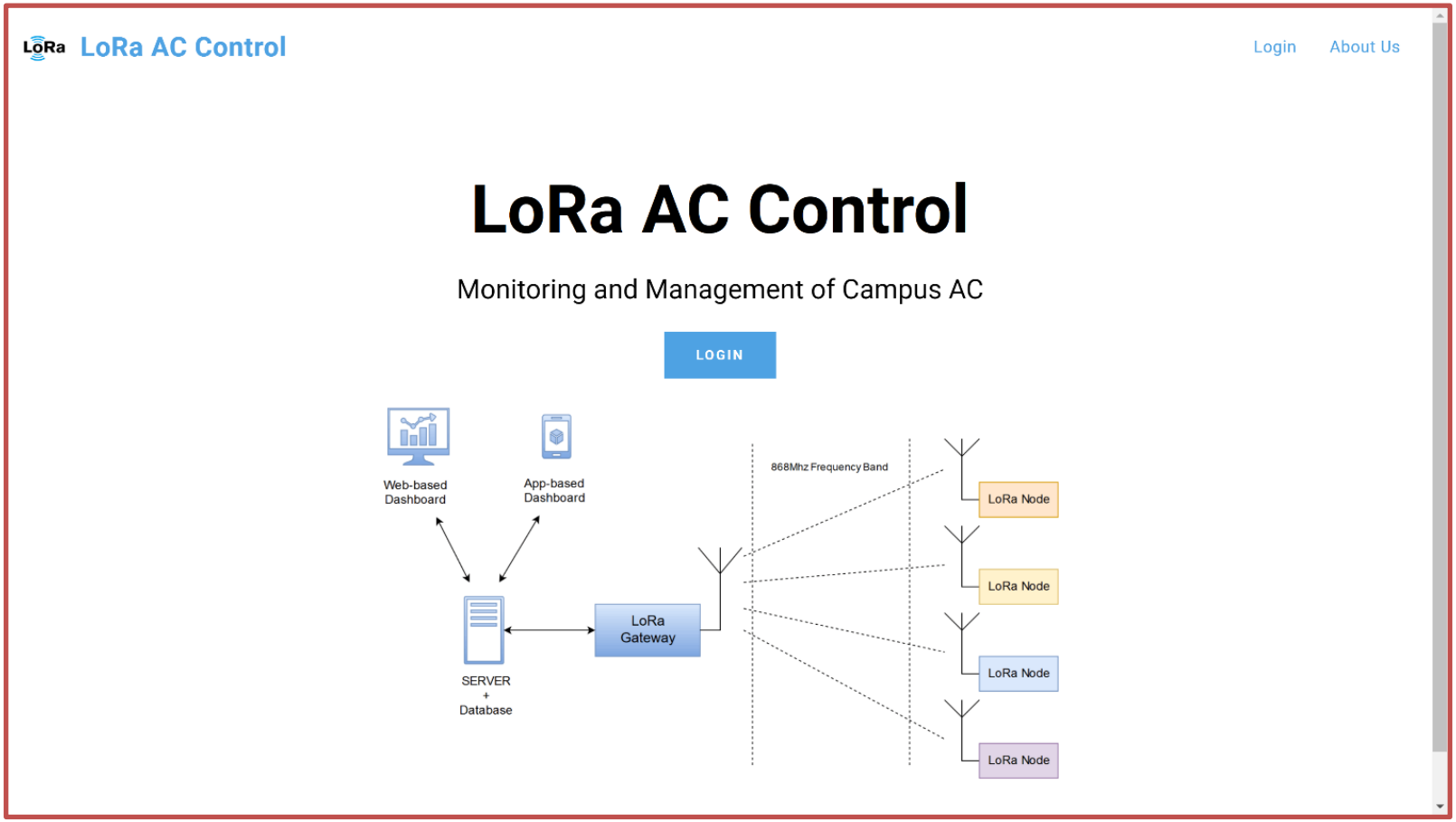
```
function showss(){
  var x = document.getElementById("stat2");
  x.innerHTML = "Sending.";
  if(x.style.display == "none"){
    x.style.display = "block";
  }
  setTimeout(function(){x.innerHTML = "Sending..."},1000);
  setTimeout(function(){x.innerHTML = "Sending..."},2000);
}
function hidess(){
  var x = document.getElementById("stat2");
  if(x.style.display == "block"){
    x.style.display = "none";
  }
  var x2 = document.getElementById("button2");
  if(x2.innerHTML == "TURN ON"){
    x2.innerHTML = "TURN OFF";
    x2.value = "0";
  }
  else{
    x2.innerHTML = "TURN ON"
    x2.value = "1";
  }
}
```

```
function update2(){
  var req = new XMLHttpRequest();
  var x2 = document.getElementById("button1");
  console.log("Grabbing Value");
  req.onreadystatechange = function () {
    if (req.readyState == 4 && req.status == 200) {
      if (req.responseText[0] == "1"){
        x2.innerHTML = "TURN OFF";
        x2.value = "0";
        }
      else{
        x2.innerHTML = "TURN ON";
        x2.value = "1";
        }
    }
  }
  req.open("GET", '2/', true);
  req.send(null);
}
function update3(){
  var req = new XMLHttpRequest();
  var x2 = document.getElementById("button2");
  console.log("Grabbing Value");
  req.onreadystatechange = function () {
    if (req.readyState == 4 && req.status == 200) {
      if (req.responseText[0] == "1"){
        x2.innerHTML = "TURN OFF";
        x2.value = "0";
      }else{
        x2.innerHTML = "TURN ON";
        x2.value = "1";}}
  }
  req.open("GET", '3/', true);
  req.send(null);
}
</script>
</html>
```

Observe Outputs

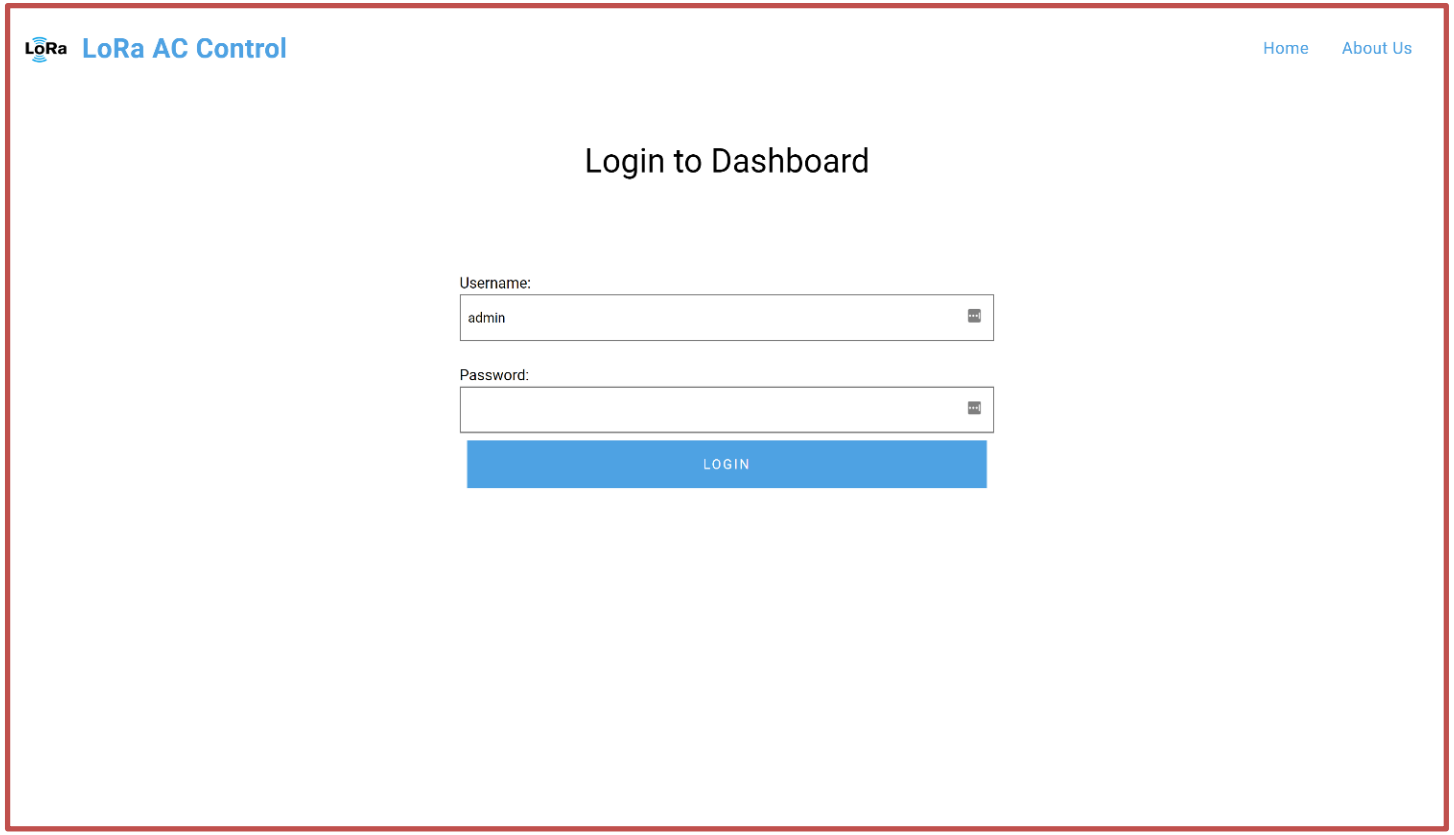
Access & Control from Web

- Check proper connection by going to **localhost** in a web browser.
- Dashboard should be opened as shown below:



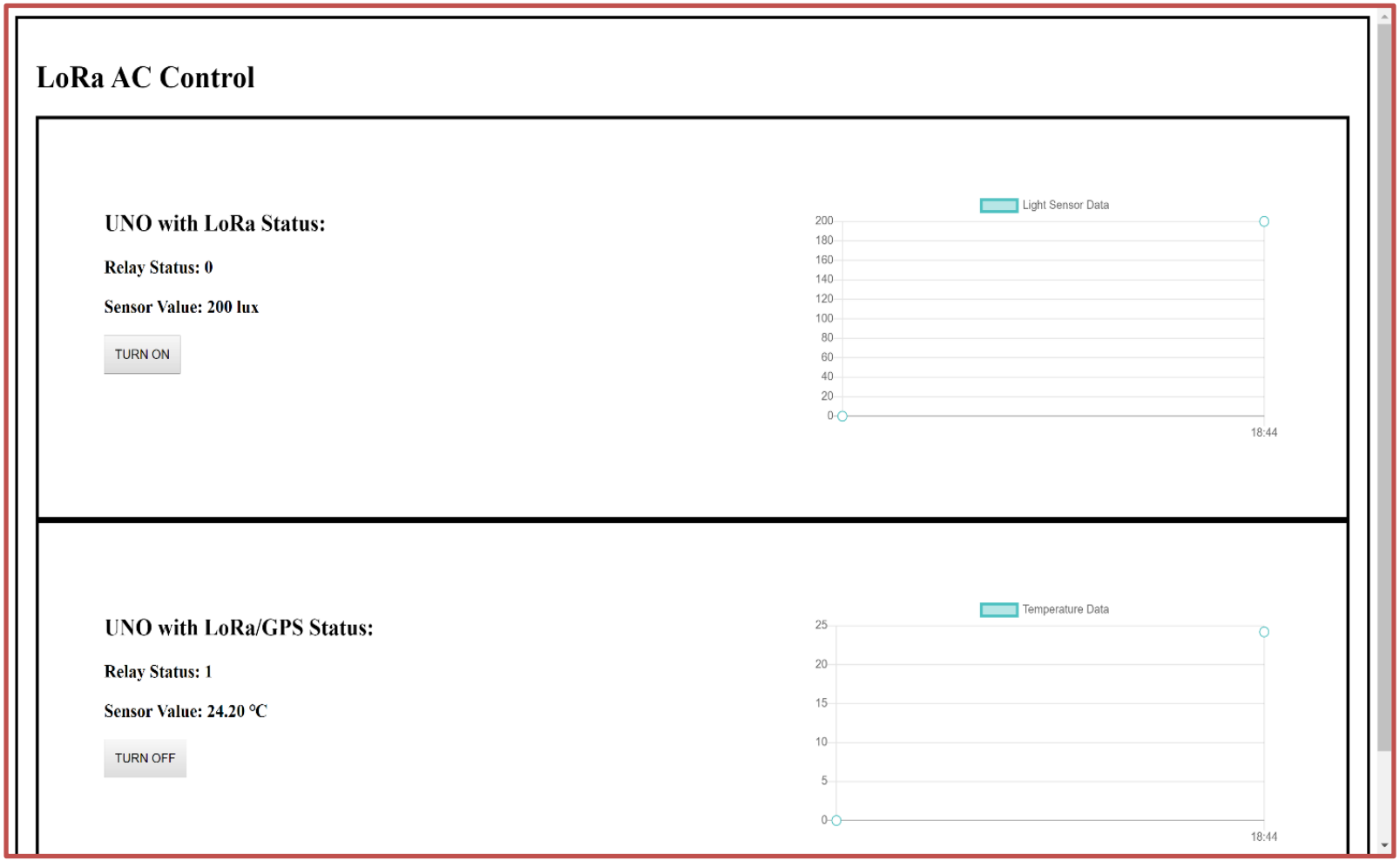
Cont…

- Login to web service:
  - Username: **admin**; Password: **123**



Cont…

- Dashboard of the application:



Thanks!