GPRS Communication with PC Client over MQTT Protocol : IOT Part 27

By Priya

In the previous tutorial, **SIM800 module** was configured as TCP-IP Client and a PC was configured as TCP-IP server. The two were setup to communicate over TCP-IP stack using an Arduino UNO as gateway. In this tutorial, the SIM800 will be configured as an MQTT Client and setup to communicate over MQTT protocol with a PC client. In the previous tutorial, the PC was configured as server to set SIM800 modem into working mode. In this project, the PC will serve as another client and communicate with the GSM GPRS modem via HiveMQ broker.

This project aims to build a communication network through which GPRS enabled IOT device could communicate with a remote PC. The IOT device is built using Arduino Mega and SIM800 GSM GPRS modem. The SIM800 chip does not have any controller inside, so it needs to be interfaced with a microcontroller to embed software intelligence for any application. On the other hand, Arduino Mega itself does not have capability to communicate with communication network (Internet). To connect the Arduino to the Internet, GPRS technology is used in this project which will provide internet connectivity to the Arduino client. Enabled with GPRS through SIM800 modem, the device does not need to connect with any Wi-Fi access point or LAN through

The implementation of the protocol on Arduino client is performed from within the firmware code of the Arduino Mega. The Arduino sketch for this is written and compiled using Arduino IDE.

A remote PC acts as another IOT device in the project. The PC connects with the broker using a chrome add-on – MQTTLens. An LED is interfaced at the Arduino Client. The PC client controls this LED by passing messages to the Arduino Client over MQTT.

Components Required –

Components	Specification	Quantity
SIM800 module	3.7 V/2A	1
Arduino Mega	-	1
LED	-	1
Resistor	220 Ω	1
Prototyping board	-	-
Jumper wires	-	-

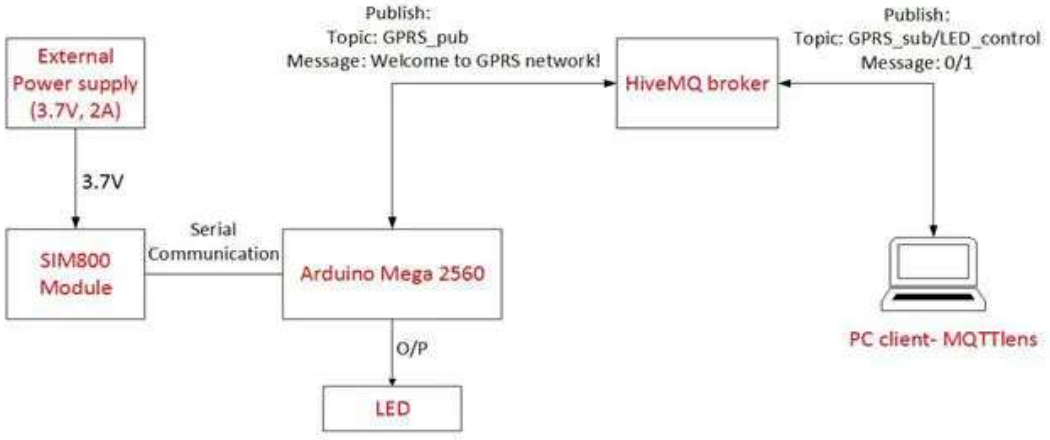
Fig. 1: List of components required for MQTT protocol based Mobile to PC IoT Communication

Software Required –

• Arduino IDE

• HiveMQ broker

Block Diagram –



Fig, 2: Block Diagram of SIM800 based GPRS Enabled Arduino LED Controller IOT Project

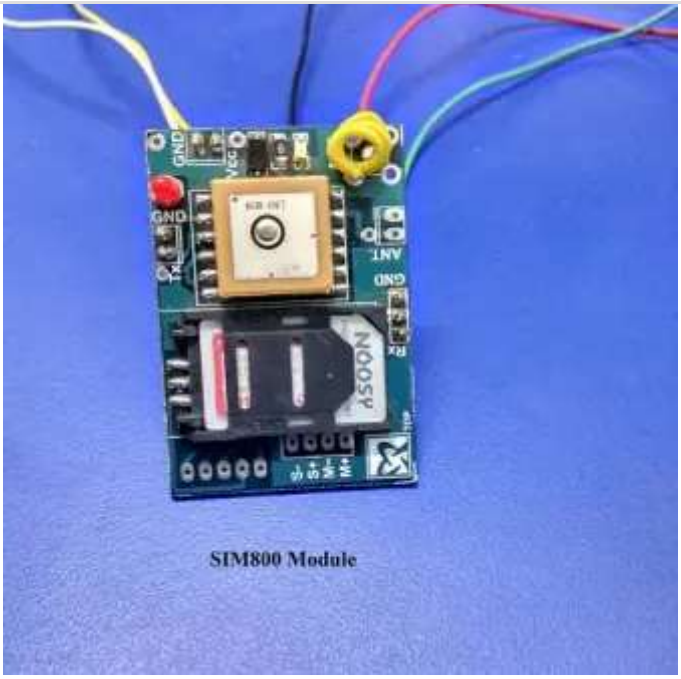


Fig. 3: Prototype of SIM800 based GPRS Enabled Arduino LED Controller MQTT Client

The Arduino client has the following circuit connections –

SIM800 GSM GPRS Modem – SIM800 is the GSM GPRS modem used in this project. SIM800 is a complete Quad-band GSM/GPRS solution. It supports Quad-band 850/900/1800/1900 MHz and can transmit Voice, SMS and data information with low power consumption. The modem has the following pin configuration –

36	Input / Output	BT_ANT	Connect Bluetooth Antenna
17	Input	FM_ANT_P	Differential Antenna for FM
57	Input	FM_ANT_N	Differential Antenna for FM

Fig. 4: Table listing pin configuration of SIM800 GSM GPRS Modem

16	Output	VSIM	Voltage supply for SIM card, Support 1.8 V or 3 V SIM card
14	Input / Output	SIM_DATA	SIM Data Input / Output
55	Output	SIM_CLK	SIM Clock
15	Output	SIM_RST	SIM Reset
54	Input	SIMPRE	SIM Card Detection
40	Input / Output	ANT	Connect GSM Antenna
36	Input / Output	BT_ANT	Connect Bluetooth Antenna
17	Input	FM_ANT_P	Differential Antenna for FM
57	Input	FM_ANT_N	Differential Antenna for FM

Fig. 5: Table listing pin configuration of SIM800 GSM GPRS Modem

36	Input / Output	BT_ANT	Connect Bluetooth Antenna
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57	Input	FM_ANT_N	Differential Antenna for FM

Fig. 6: Table listing pin configuration of SIM800 GSM GPRS Modem

16	Output	VSIM	Voltage supply for SIM card, Support 1.8 V or 3 V SIM card
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57	Input	FM_ANT_N	Differential Antenna for FM

Fig. 7: Table listing pin configuration of SIM800 GSM GPRS Modem

On a module, only some of the pins mentioned above may be available. Generally pins for audio interfacing, GPIO pins, power supply and serial communication are left available in the modules purchased from the market. The power supply (VCC and GND) and serial communication pins (TX and RX) are used to interface the modem in the circuit.

Fig. 8: Prototype of SIM800 based GPRS Enabled Arduino LED Controller MQTT Client

Power Supply – SIM800 modem needs 3.7 V and 2A to operate and connect with the Network properly. An external power supply is used to connect the modem to the network. The circuit connections of the GPRS module with the power source are summarized in the table below –

SIM800 modem	Arduino Mega
TX1	RX1
RX1	TX1
GND	GND

Fig. 9: Table listing circuit connections between SIM800 Modem and Power Supply

Arduino Mega – Arduino Mega is one of the microcontroller boards available on the Arduino platform. This controller board has Atmega 1280 as the sitting MCU and has 128 Kb flash memory, 4 Kb EEPROM, 8 Kb SRAM, onboard UART, SPI and I2C interfaces. The board has 56 GPIO pins of which 15 pins can be used for 8-bit PWM output. There are 16 analog input pins available on the board as well. The Arduino board controls the LED interfaced to it according to the data received by it over MQTT protocol. The SIM800 modem receives the data over internet using GPRS network which is passed through serial communication to the Arduino board. For serial communication, the TX1 (pin 18) and RX1 (pin 19) of the Arduino are connected with the RX and TX pins of the GSM GPRS module respectively. The circuit connections between the SIM800 module and Arduino board are summarized in the table below –

SIM800 modem	Arduino Mega
TX1	RX1
RX1	TX1
GND	GND

Fig. 10: Table listing circuit connections between SIM800 Modem and Arduino Mega

the following tutorial –

How to set up PC and Mobile as MQTT Clients

Learn about creating and subscribing topics on HiveMQ broker and publishing messages on them from the following tutorial –

Communication between PC and Mobile using MQTT Protocol Via HiveMQ Broker

While making circuit connections, the following precautions must be taken care –

1) The SIM800 module needs 3.7 V voltage and 2A current. Please use external power supply to provide power to the modem. If the module is getting enough voltage but still not getting connected to the network, then there can be issue of current rating. The module is not getting enough current to operate in working condition. So, be specific while choosing the power source.

2) The modem has 5V tolerant input level but most of the modules work on CMOS logic. So, do not connect TX and RX of Arduino to the TX and RX of GSM modem because Arduino works on TTL logic for signal voltage. A bi-directional logic converter should be used in order to work with Arduino.

3) The SIM800 modem has a network indicator LED which tells about the modem connection to the network. If module is not connected to the network, the LED blinks every 1 second which means SIM is not connected to the network and is searching for the network. If the module is connected to the network, the LED blinks every 3 seconds. If the module is connected to the TCP/IP network, the LED blinks 3 times every second.

4) Check the network coordinates of the GSM modem through AT command AT+CREG? If the modem shows +creg: 0, 1 then the modem is connected to the network and no need to change in the library. But if the modem shows +creg: 1, 1, then the CREG condition need to be changed in the SIM800.cpp file in the SIM800 library. So, first check the network coordinates through AT commands.

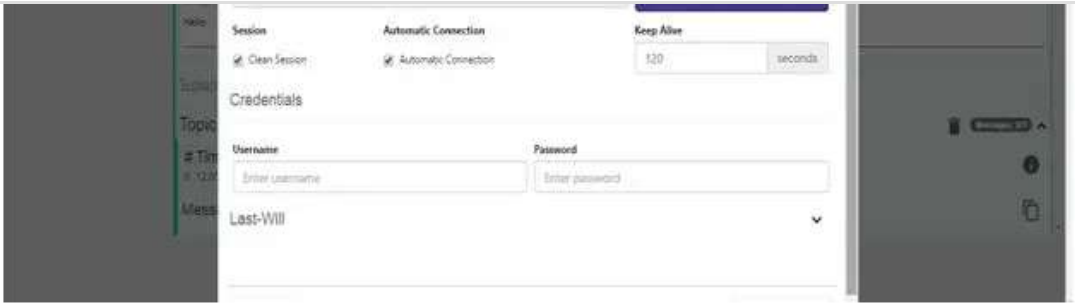


Fig. 11: Screenshot of MQTTLens New Connection Window

How the circuit works –

The Arduino client is programmed to communicate with the PC client over MQTT protocol. For the implementation of MQTT protocol, an open source library (shown as PubSubClient in the **Archive**) is used. For the serial communication between the Arduino and SIM800, another open source library (shown as sim800 in the **Archive**) is imported in the IDE. There are additional libraries imported to provide time delay functions.

After loading the firmware and circuit connections, a SIM should be inserted in the GSM GPRS modem and the Arduino client should be powered on. Now the Arduino Client is ready to receive data over MQTT protocol from the GPRS network. The PC client is also ready to send control commands via MQTTLens add-on. The Arduino and PC clients communicate and send messages to each other via a MQTT broker called HiveMQ.

The Arduino client configures as publisher for the topic “GPRS_pub” and as subscriber for the topic “GPRS_sub/LED_control”. The PC client configures as subscriber for the topic “GPRS_pub” and as publisher for the topic “GPRS_sub/LED_control”. The Arduino Client initiates connection by publishing a message ‘ Welcome to GPRS NETWORK! ‘ to the MQTT broker.

When the PC client receives the message, it can publish messages ‘1’ and ‘0’ on the topic “GPRS_sub/LED_control”. If the message 1 is published by the PC client, it will be received by the Arduino client and its firmware code interprets the message to switch on the LED light. If the

modem needs to be connected to the GPRS network and then to the Internet. The APN, username and password for the SIM card must be initialized in the code. The following code is used to define the APN, username and password.

```
//Initialize the SIM to connect to the Network
#define SIM_APN    "Airtelgprs.com"    //APN Name, We are using Airtel network
#define SIM_USER ""              //APN USER, We haven't set any username so leave it blank
#define SIM_PASSWORD "" //APN PASSWORD, We haven't set any password so leave it blank
```

The modem establishes TCP/IP connection to connect with Internet. The following function is called to initiate connection of the modem with the internet –

```
 while (!s800.TCPstart(SIM_APN,SIM_USER,SIM_PASSWORD))
 {
  Serial.println("TCPstart failed");
  s800.TCPstop();
  delay(1000);
 }
 Serial.println("TCPstart started");
```

In this way the SIM800 modem connects to the Internet and provides connectivity to the Arduino client. Now, the modem initiates the connection with the MQTT broker so that Arduino client can communicate with PC client. The following code in the Arduino sketch is used to define the MQTT broker to which the Arduino has to communicate –

```
/*
MQTT broker on which our device is going to be connected!
We are using hiveMQ public broker with unencrypted channel
We can change the broker according to our requirement
*/
```

5 seconds as the Arduino client is publishing the message in a duration of 5 sec. The following code is used to publish messages on the topic ' GPRS_pub' –

/*@fn client.publish(Topic, message);

@Param: Topic, message

Topic- The topic on which our message is going to be published

Message- Any message on the respective topic

@brief: Call this function to publish the message on MQTT broker

*/

client.publish("GPRS_pub","Welcome to GPRS NETWORK!");

The PC client has subscribed to the same topic and is receiving messages on it after connecting with the MQTT broker.

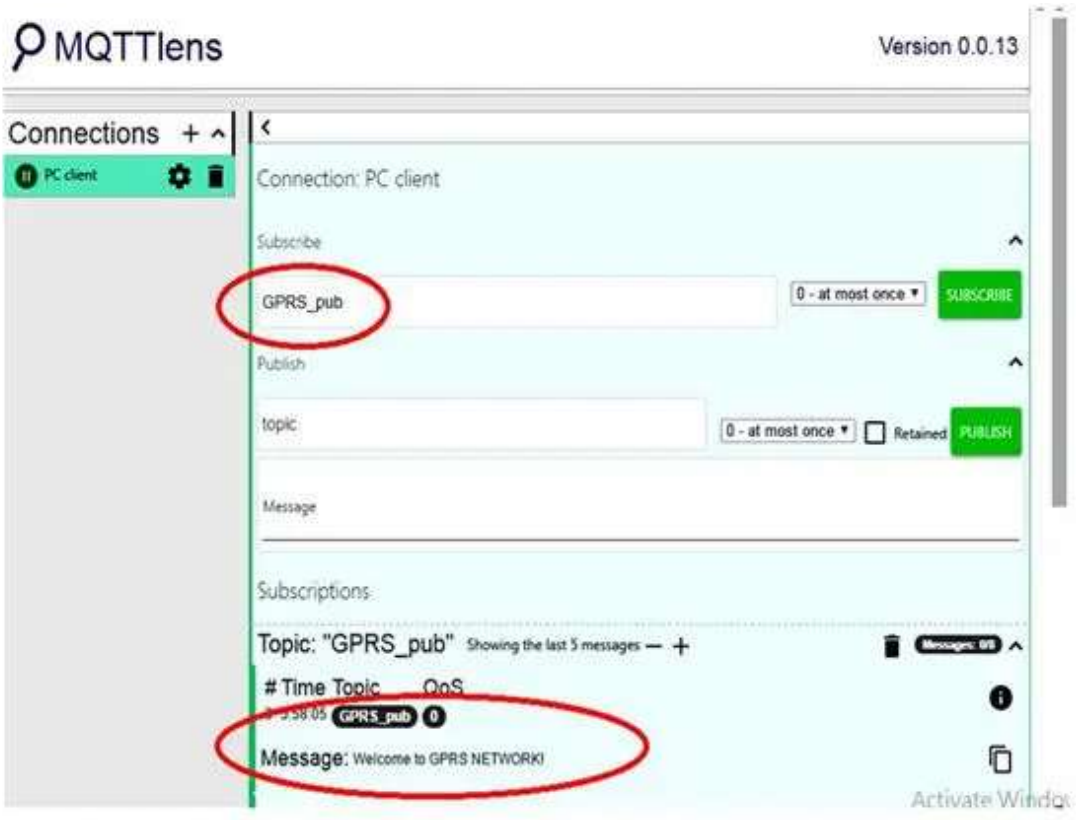


Fig. 12: Screenshot of MQTT message received on PC Client from Arduino Client via HiveMQ Broker

The following code is executed whenever the Arduino client receives the message –

```
void receive_message(char* topic, byte* payload, unsigned int length)
{
 /*
  When the client receives message 1, LED will be in ON state
  When the client receives message 0, LED will be in OFF state
 */
 if ((char)payload[0]== '1')
 digitalWrite(2, HIGH);
 else if ((char)payload[0]== '0')
  digitalWrite(2, LOW);
}
```

When the PC client publishes the message "1", the LED at the Arduino client starts glowing as the pin interfacing the LED is set to HIGH. When the PC client publishes the message "0", the LED at the Arduino client stops glowing as the pin interfacing the LED is set to LOW.

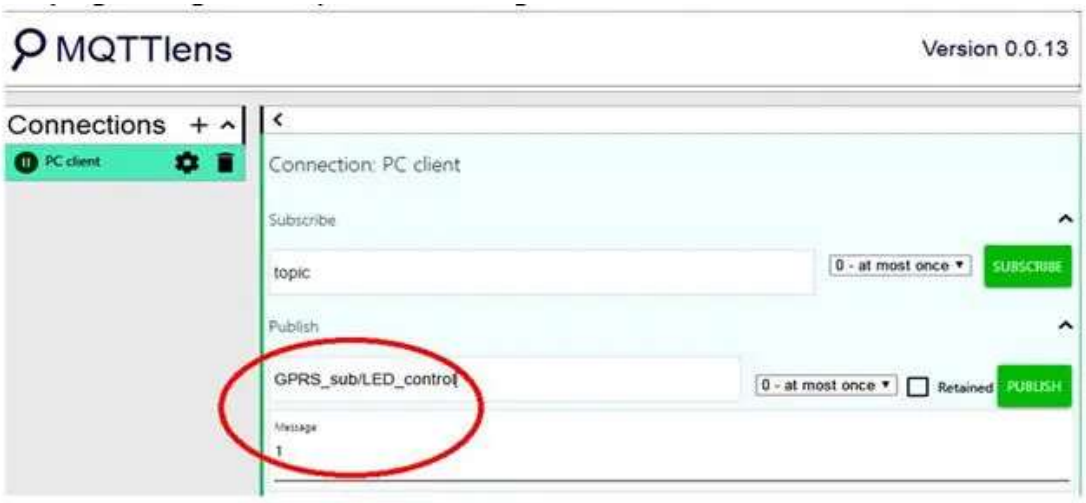


Fig. 13: Screenshot of MQTT message sent from PC Client to Arduino Client via HiveMQ Broker

In this way, the Arduino Client and the PC Client communicate over MQTT protocol. The Arduino client is sharing its message to PC client and PC client is controlling the LED of the

```
###


//Program to
 /*
  @Project: SIM800_communication_over_MQTT_protocol


  @Hardware used:
     SIM800 Module
     Arduino Mega 2560
     LED & 220E resistor
     External Power supply to provide 3.7V to SIM800 module


  @Connection:
       SIM800 VCC- External power supply 3.7V
       SIM800 GND- External power supply GND
       SIM800 TX- Arduino Serial1 RX
       SIM800 RX- Arduino Serial1 TX
       SIM800 GND- Arduino GND
       LED cathode- Arduino 2nd pin with 220E resistor in Series
       LED anode-  Arduino GND
```

```
 communication to SIM800 client.

       PC client is controlling the LED of SIM800 client & SIm800 client is publishing
the message "Welcome to GPRS NETWORK!" on topic "GPRS_pub"

*/



//Initialize the SIM to connect to the Network

#define SIM_APN        "Airtelgprs.com"           //APN Name, We are using Airtel network

#define SIM_USER       ""      //APN USER, We haven't set any username so leave it blank

#define SIM_PASSWORD    ""           //APN PASSWORD, We haven't set any password so leave it bl
ank


//Include Libraries

#include

#include                         //Include library to initialize SIM800 client

#include                    //Include library to initlize MQTT protocol

#include


//Create the instance for SIM800

sim800Client s800;

char imeicode[16];           //Array initialization for IMEI code so as to find out the device
 is valid or not.


/*

 MQTT broker on which our device is going to be connected!

 We are using hiveMQ public broker with unencrypted channel
```

```
 @Param: topic, payload, payload length
          Topic: the subsription topic, SIM800 client has subscribed
          payload: the message we receive from MQTT broker on the subcribed topic
          length: the message length
  @return: None
 @brief: This callback function will be called whenever SIM800 client receives the
 message on topic GPRS_sub/LED_control
*/
void receive_message(char* topic, byte* payload, unsigned int length)
{
  //handle message arrived
  char mypl[48];
  Serial.println(length);
  memcpy(mypl,payload,length);
  mypl[length]=char(0);
  Serial.print("receive: ");
  Serial.print(topic);
  Serial.print("->");
  Serial.println(mypl);

  /*
   When the client receives message 1, LED will be in ON state
```

```
    digitalWrite(2, LOW);
}

/*
  @Create the instace for pubsub client
  @Param: server- MQTT server which we have initialized above
          1883- The port on which MQTT broker is listening
          callback- The function for subscription which we have initialized above
          s800- SIM800 client which we have created above
*/
PubSubClient client(server, 1883, receive_message, s800);

/*
  @fn void pub()
  @Param: None
  @Brief: Created a function through which S800 client will publish the message with topic to t
he MQTT broker
          Whenever we want to change the publish topic and message, we can change from here.
  @return: None
*/
void publish_message()
{
  Serial.print("publish: ");
```

```
   @Param: Topic, message
            Topic- The topic on which our message is going to be published
            Message- Any message on the respective topic
   @brief: Call this function to publish the message on MQTT broker
  */
  client.publish("GPRS_pub","Welcome to GPRS NETWORK!");
}

void setup()
{

  pinMode(2, OUTPUT);      //Initialize LED as OUTPUT so that other client can control this LED
  Serial.begin(9600);        //Start the serial communication to debug the communication
  Serial.println("SIM800 MQTT TESTING");

  for (int i=0; i<10; i++)
  {
    delay(5000);
    Serial.println("Initialize SIM800!");

   #ifdef HARDWARESERIAL
      if (s800.init( 7, 6)) break;
```

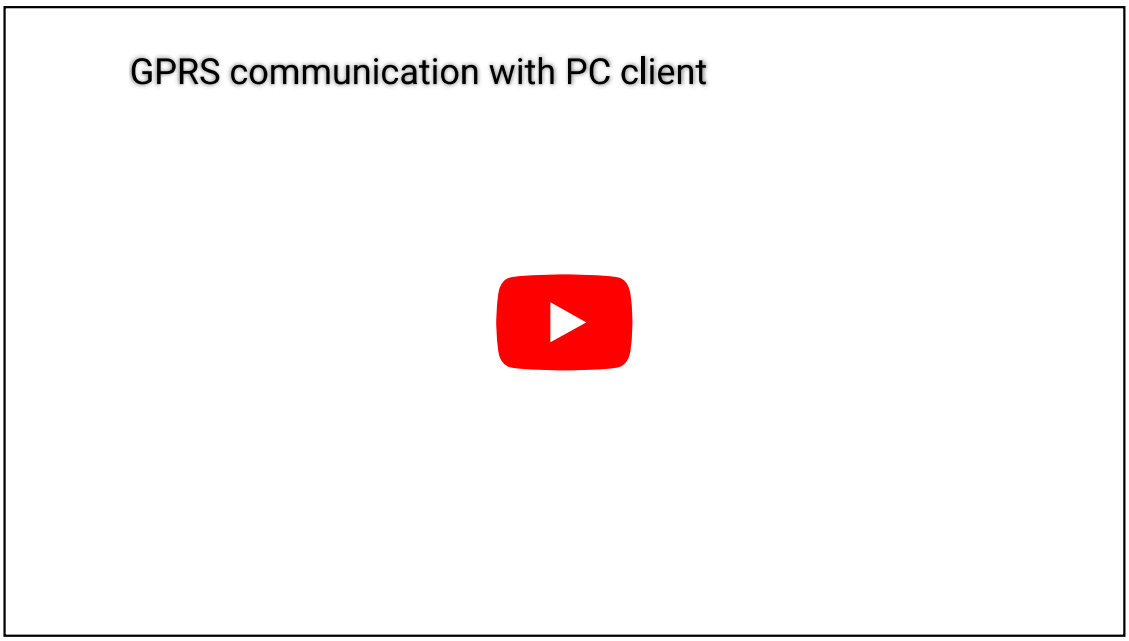
```
  s800.setup();              //Initialize setup for SIM800 client
  s800.stop();              //stop any previous network connection of the SIM800 client
  s800.TCPstop();           //Stop any previous TCP connection of SIM800 client
  s800.getIMEI(imeicode);      //Get the IMEI code of he SIM800 client
  Serial.print("IMEI: ");
  Serial.println(imeicode);

  //From this loop, Start the continuous TCP connection with APN, USERNAME and PASSWORD
  while (!s800.TCPstart(SIM_APN,SIM_USER,SIM_PASSWORD))
  {
    Serial.println("TCPstart failed");
    s800.TCPstop();
    delay(1000);
  }
  Serial.println("TCPstart started");


  //From this loop,the client will be connected to the Network
  while (!client.connect(imeicode)) {
    Serial.println("connect failed");
    delay(1000);
  }
```

```
  */
  client.subscribe("GPRS_sub/LED_control");

  //From this function, the message will be published in a repetitive period of 5 sec to the MQ
TT broker
  Alarm.timerRepeat(5, publish_message);
}

void loop()
{
    client.loop();
    Alarm.delay(100);

}

###
```

Circuit Diagrams

Circuit-Diagram-SIM800-based-GPRS-Enabled-Arduino-LED-Controller-MQTT-Client-

Project Video



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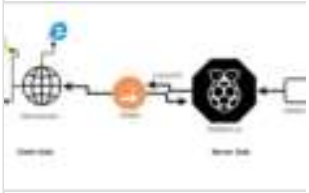

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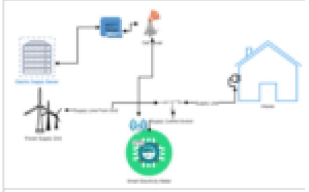

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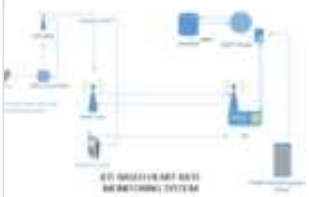

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