UNIVERSITY OF PERADENIYA
FACULTY OF ENGINEERING
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Networked and Automated Weather Monitoring and Alerting System

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Chapter 1 - Background of the Project

Background of the Project

Weather conditions and climate changes must be logged and analyzed by relevant authorities like meteorological department each day. They take relevant actions observing those records obtained all over the island. But in the current manual system they collect information only from main cities and taking responses manually takes much time and effort.

So in this unified project we develop a system that can be used to collect information from much many places allover Sri Lanka using an embedded system kept in those locations. The locations may be places in each district close to sea, rivers, reservoirs, tanks and other areas. The data are wind speed, rain status, rainfall, humidity, temperature etc.

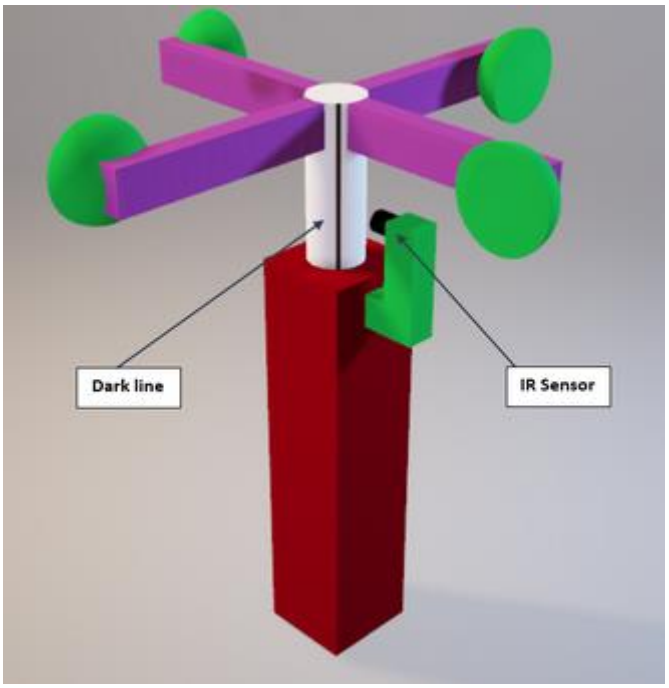
All those data taken from those sensors, are sent to a central server and processed there. If there are extreme weather cases, public must be warned. So the web application gives instant alerts to its users including relevant central authorities as well as regional authorities. The process is very quicker than manual method. So the damages due to extreme weather is reduced as well as meteorological department will have newest data from all over the country.

Chapter 2 - Plans and Designs

a Hardware Design

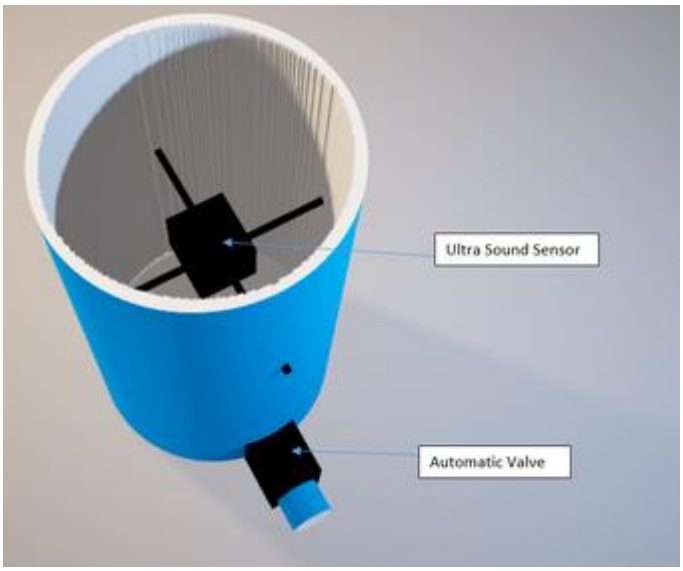
- **Wind Speed Sensing System**
  - This is a wind Vane that rotates with wind. We are making a mechanism using IR sensor to get the time taken to complete a full cycle by vane. The wind speed is calculated using that data.

  - The model wind vane expected to be build is given below.



Infrared barrier module is the IR sensor we are planning to use. It emits infra-red waves and monitor the reflected rays. It can identify black and white screens.

- **Rainfall measuring System**
  - This has a cylindrical vessel with fixed cross section that collects rain water and measure the water level using an ultrasound sensor kept few cm below top of the vessel. Sensor not having at top most is to avoid water drops to go away hitting the sensor.
  - Also this has a automatic valve to remove water daily after reporting to server, based on the sonar sensor reading.
  - Also this has a rain sensor to identify whether it is raining or not.
  - Below is the model of the system.

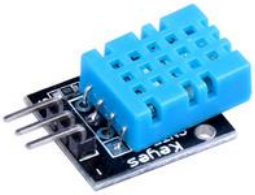


This is the ultrasonic sensor we are planning to use (HC-SR04)

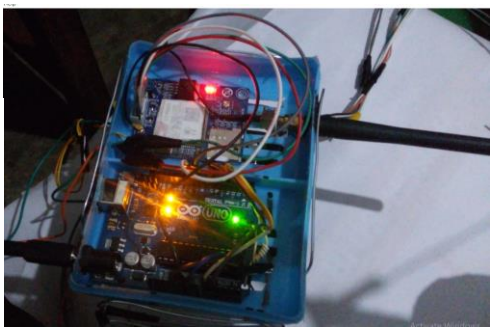
This is the automatic valve we are using. It is a plastic solenoid valve

- **Rainfall Status Sensor**
  - This is a single sensor that sense whether it is raining or not.
  - For that we use rain drop sensor given below.

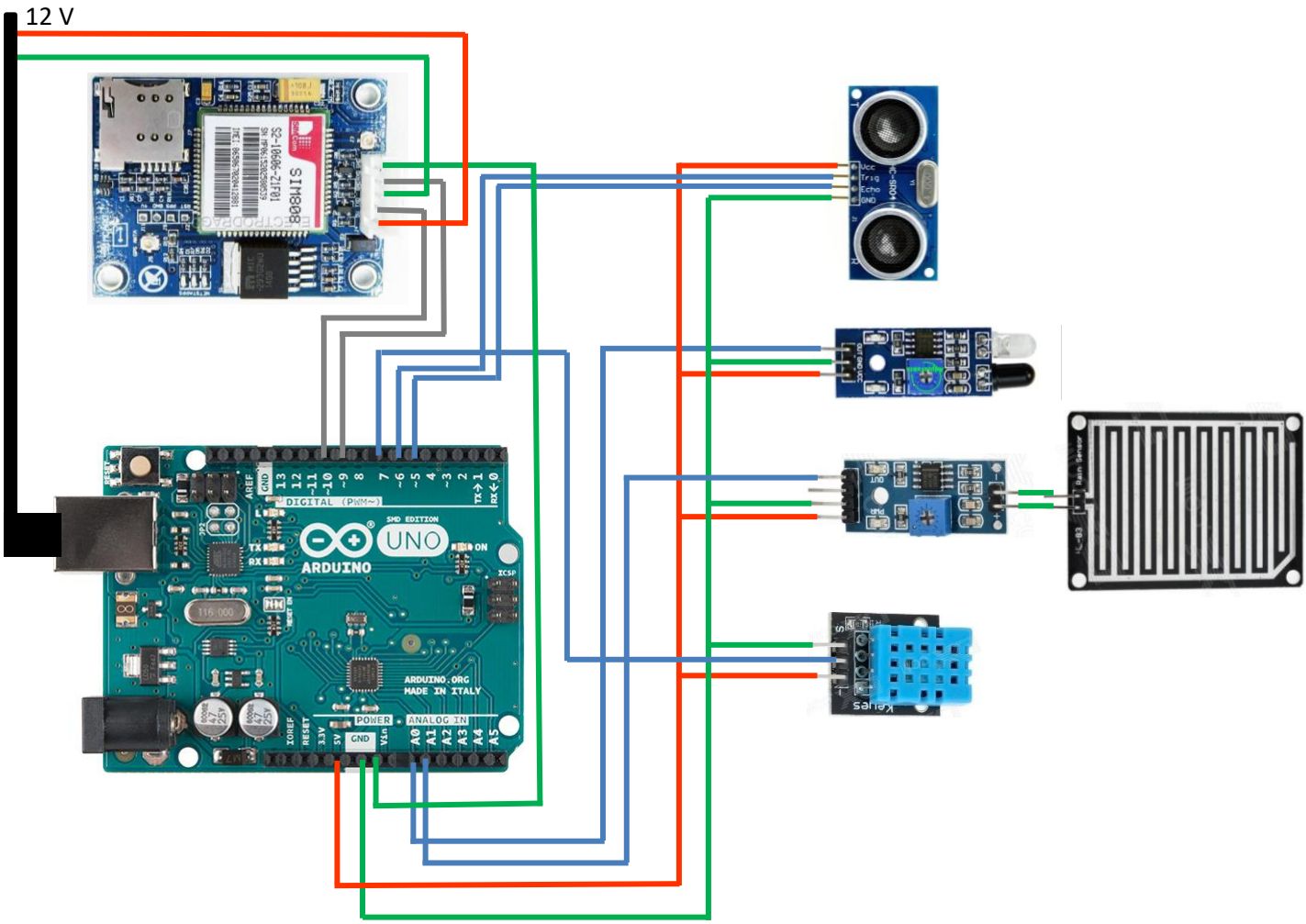
- **Temperature and Humidity measuring System**
  - This is a single sensor that sense temperature and humidity.
  - For that we use Humidity and Temperature DHT11 Module in below picture.



- **Microcontroller + GSM Module**
  - We use Atmega328p microcontroller for each node connecting all the above mentioned sub parts.
  - We will use ARDUINO UNO board which has Atmega328p microcontroller
  - As we need the embedded unit at places normally we can't expect WIFI access, we decided to use a GSM module to send data collected to the central server.
  - So the GSM module we are using is sim808 module.

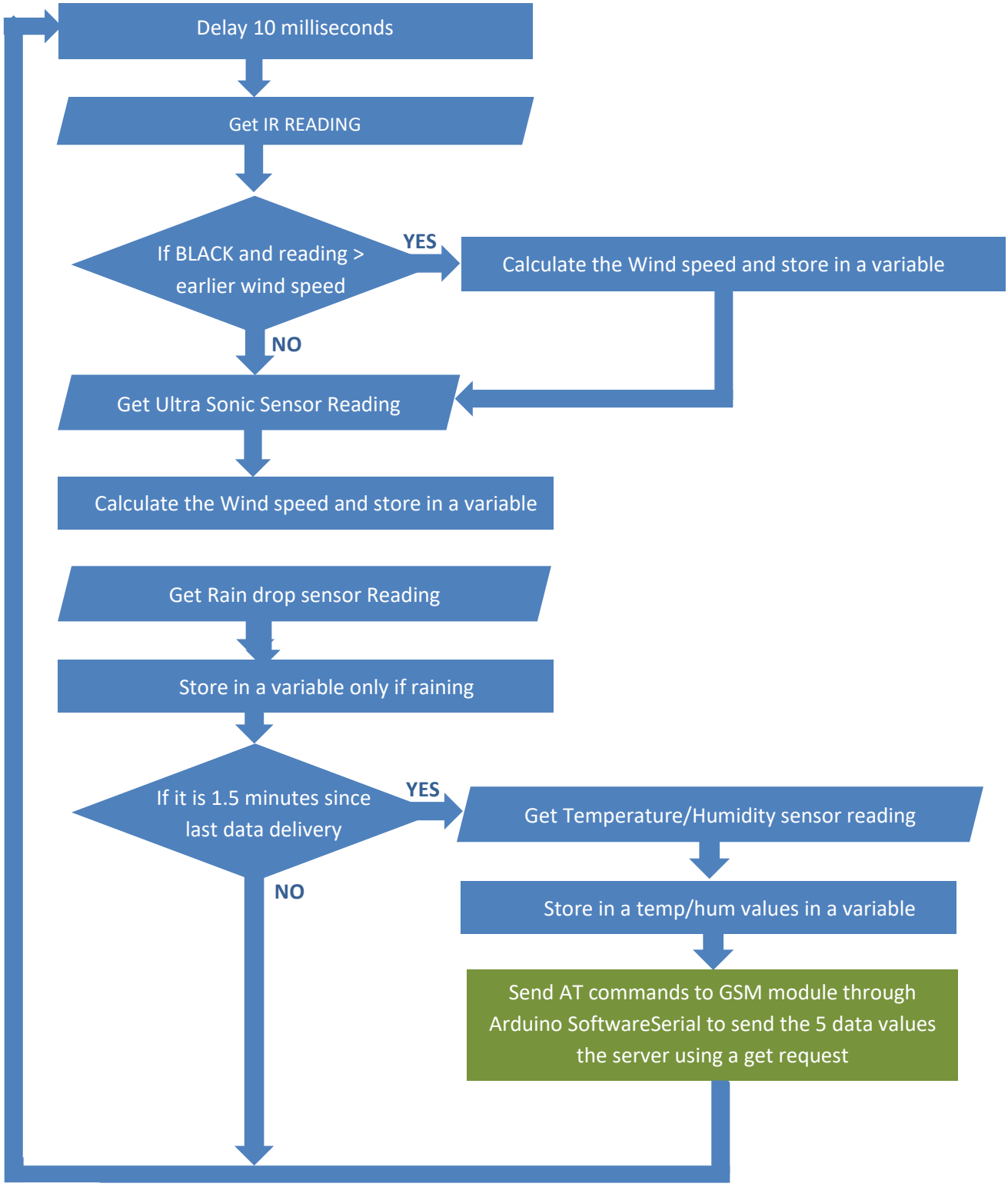


Circuit Diagram



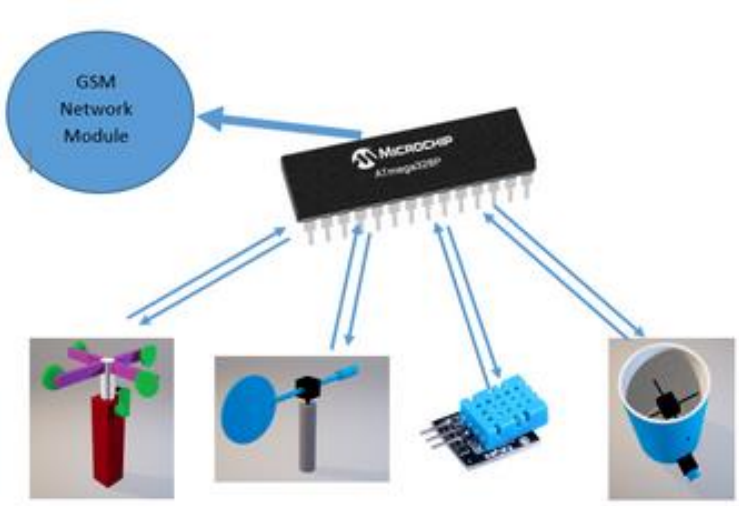
b Embedded software design

Technology - ARDUINO

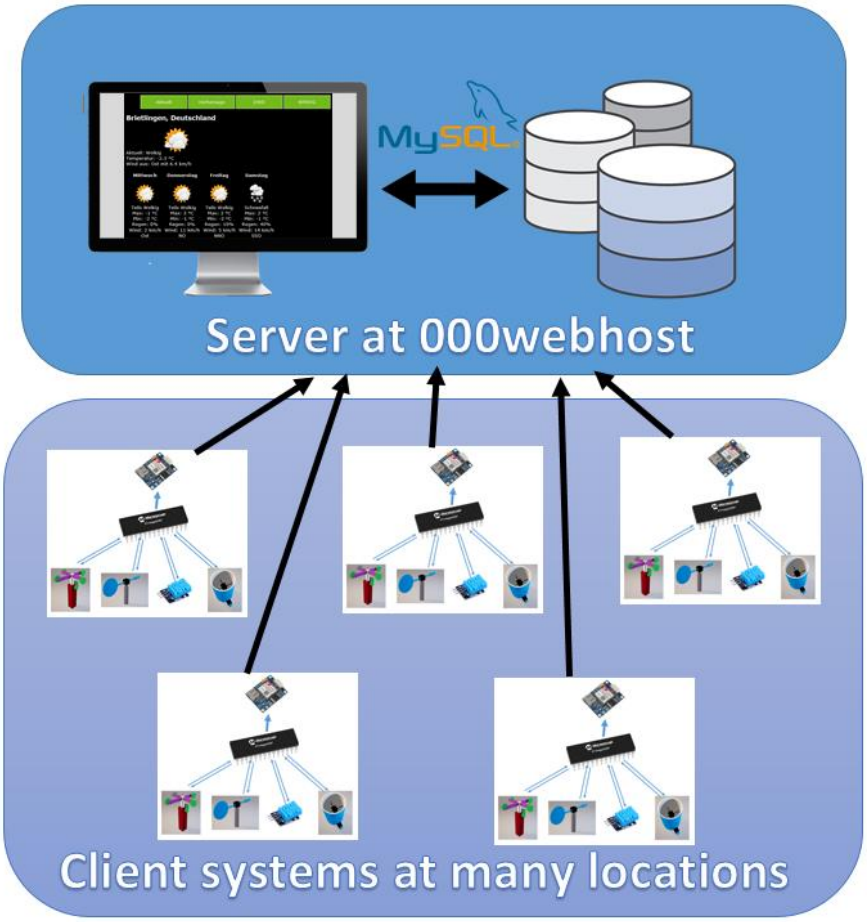


C Network Design

This is the architecture of a single node. There are many such nodes in the network.



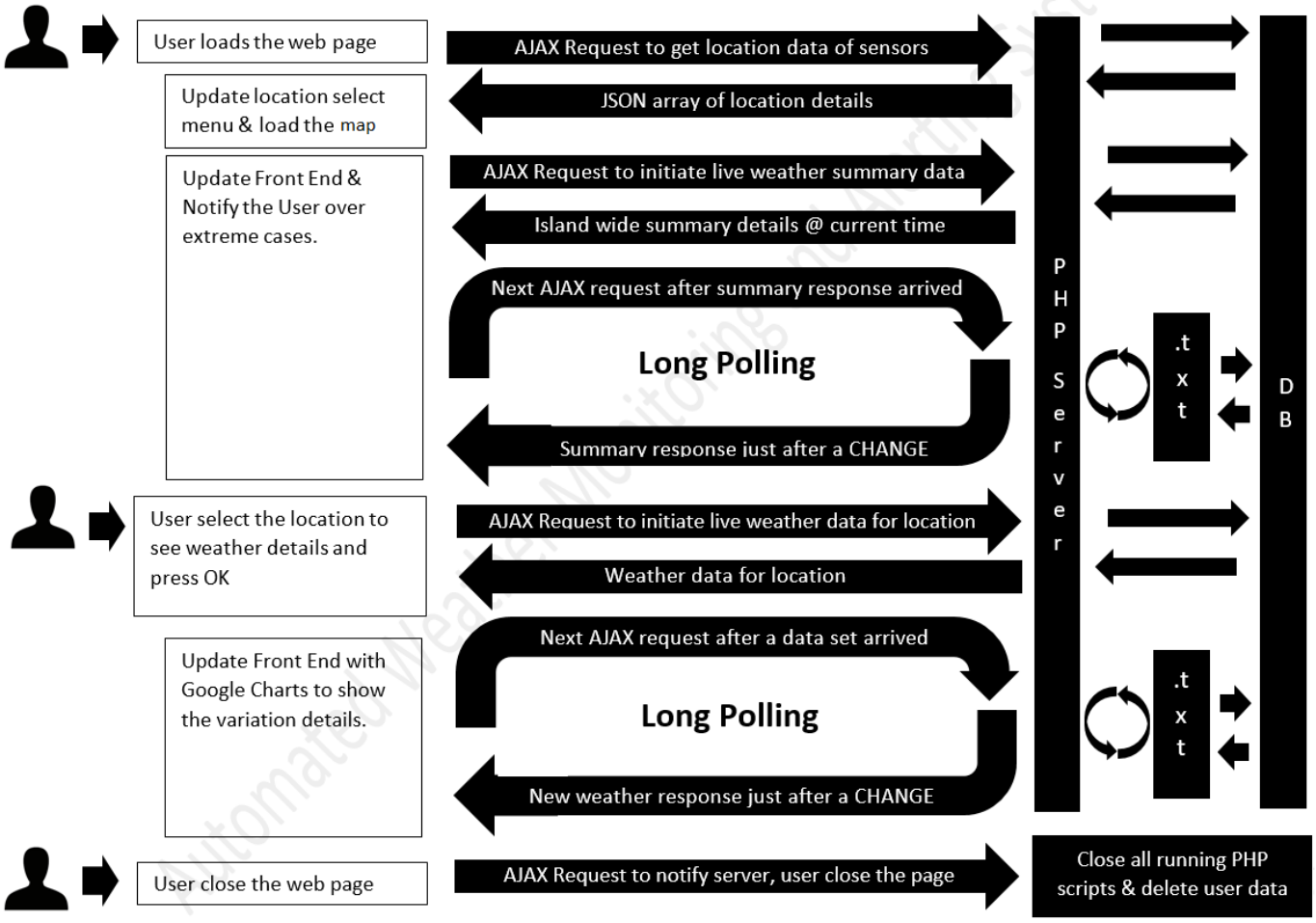
So the complete network diagram is given below



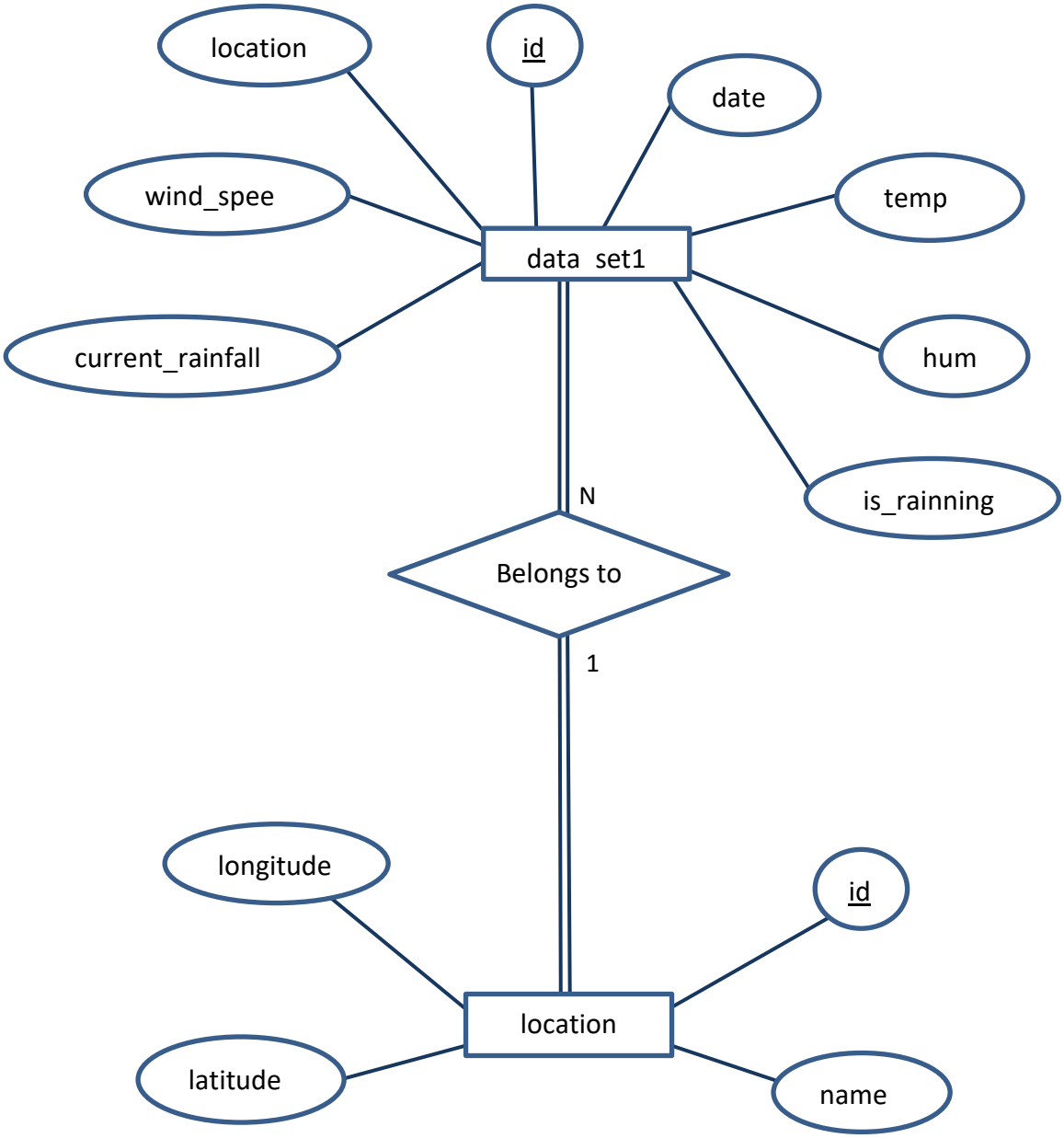
d Back-end and front-end web application software design

Technologies -

Back – End of the Web Application -Design

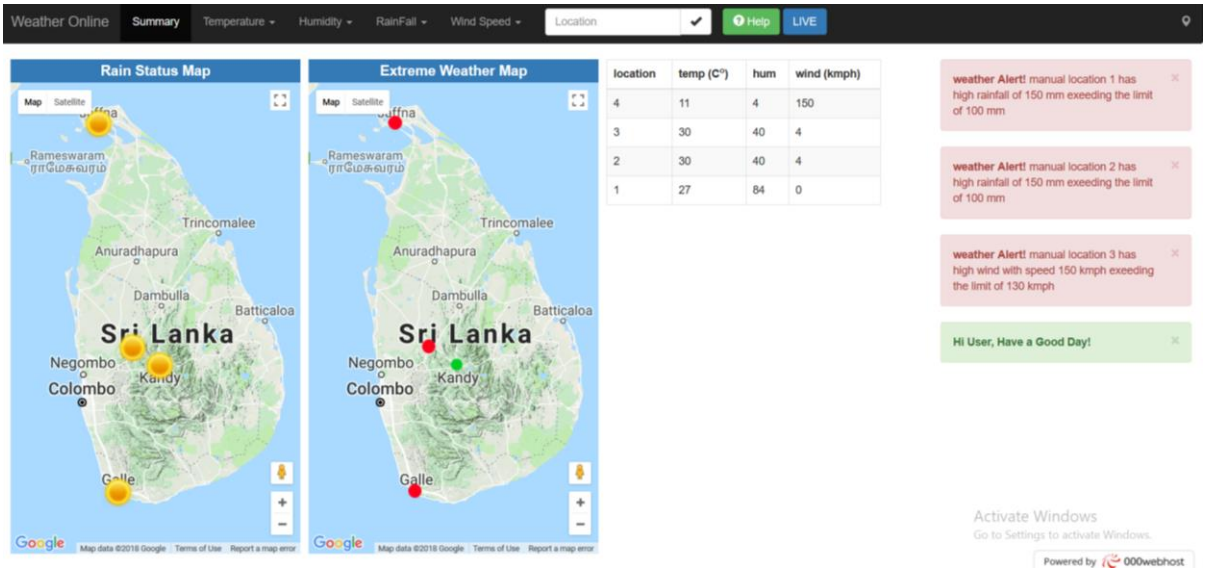


Database Design – ER diagram



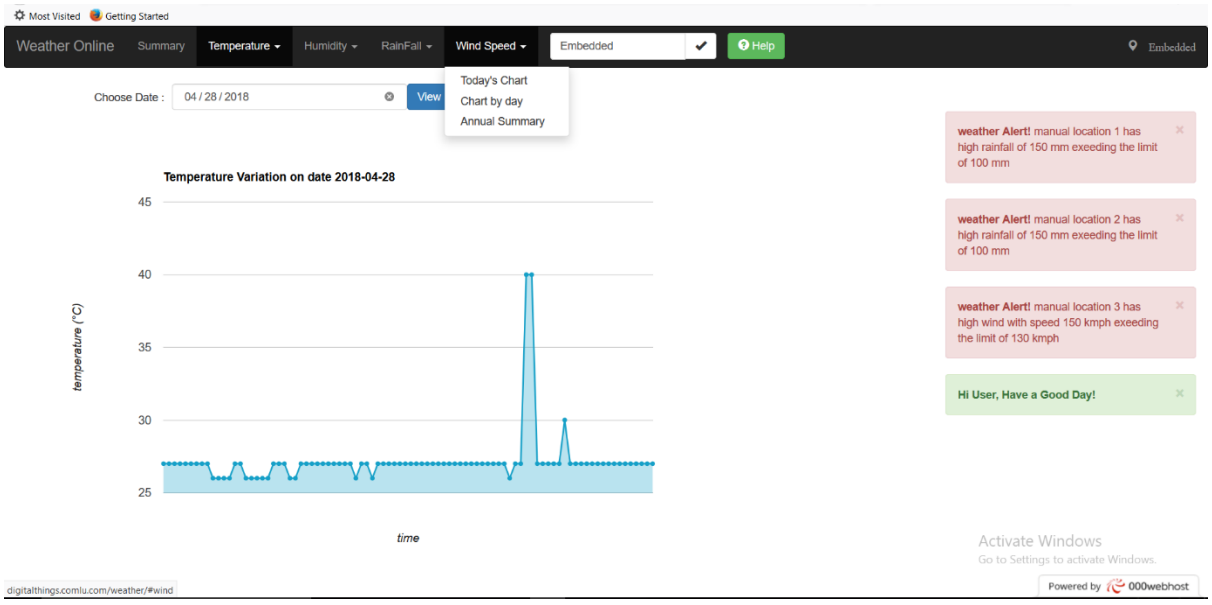
Front End Design

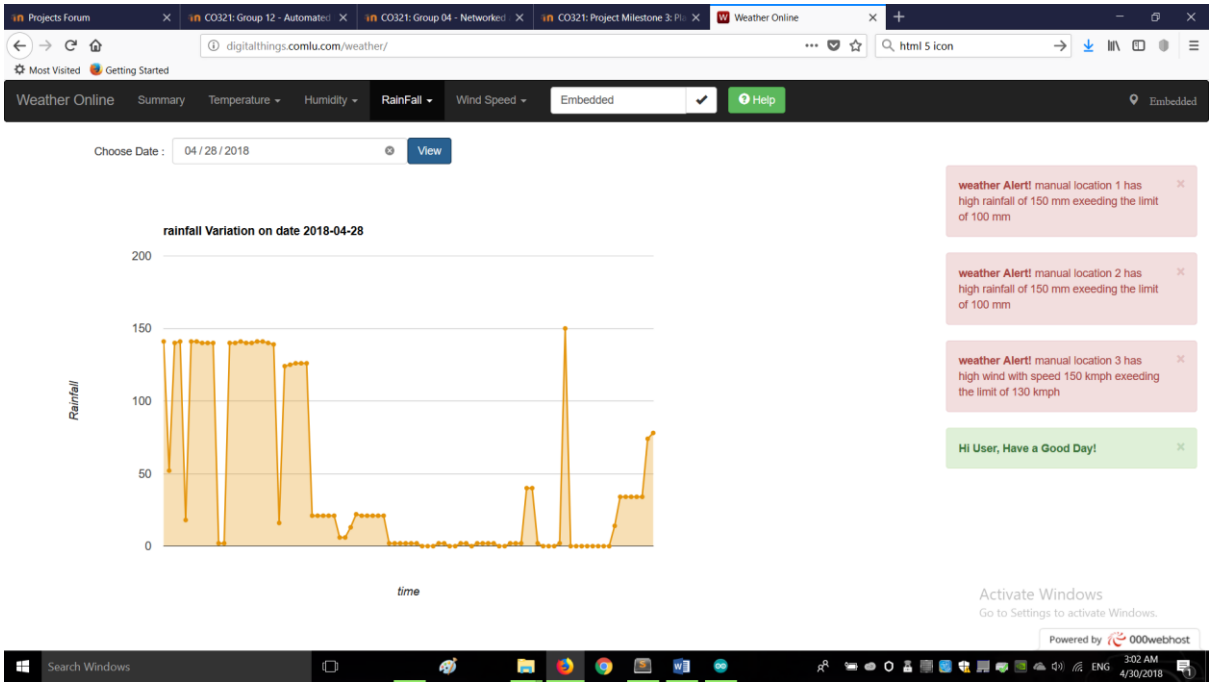
This is the front end of our system, summary page. This is the front end of our system. This map auto updates according to data given by server.



After selecting the location, Users can view the 4 parameters of that location with many details as charts.

- Live variation chart of the day.
- Variation chart of any day in history.
- Annual summary chart that gives the variation of maximum value of all days.



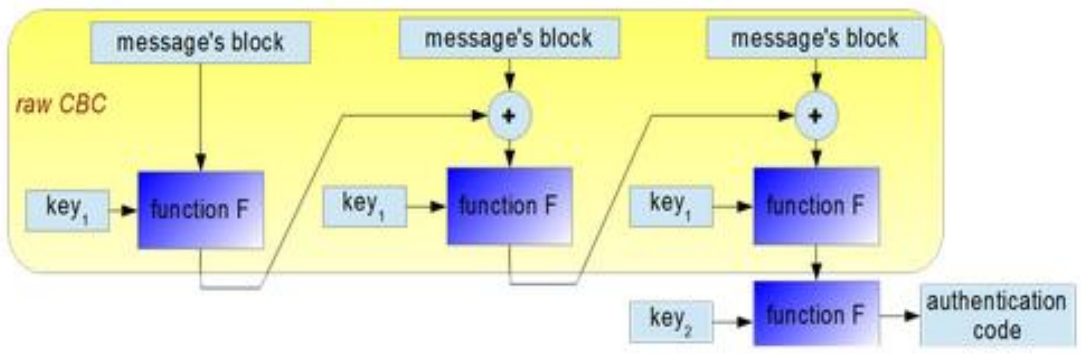


Live notifications of extreme weather cases will notify the web app users (targeted authorities) with a BEEP sound.

e Security features design

- Unauthorized third party should not be allowed to manipulate the system. Reliability and accuracy of data must be maintained.
- As the very important data are sent to the central server from systems in rural places, the security of data is a fact to consider much. As stated by the examiners of Project Milestone 1 in comments, data encryption is not required in this case because we not need to hide data from anyone. Only thing we need is to protect data from being changed externally. So we are going to use MAC -Message authentication code for the requirement.

"A message authentication code (often called MAC) is a block of a few bytes that is used to authenticate a message. The receiver can check this block and be sure that the message hasn't been modified by the third party." - http://www.crypto-it.net/eng/theory/mac.html



CBC MAC - procedure

Chapter 3 - Implementation

a Power Consumption

Following power consumption calculations are based on the relevant power parameters from data sheets of the equipment.

Ultrasonic Ranging Module HC - SR04

Working Voltage	DC 5 V
Working Current	15mA

Reference - http://www.micropik.com/PDF/HCSR04.pdf

IR Obstacle Sensor

Working Voltage	DC 5 V
Working Current	43mA

Reference - https://wiki.eprolabs.com/index.php?title=IR_Obstacle_Sensor

Temperature and humidity module - DHT11

Working Voltage	DC 5 V
Working Current	1mA

Reference - http://www.micropik.com/PDF/dht11.pdf

Raindrop Sensor

Working Voltage	DC 5 V
Working Current	0.5mA

Reference - https://www.elabpeers.com/raindrop-sensor.html

SIM808 GSM module

Working Voltage	DC 12 V
Working Current	2-500mA

Reference - http://www.communica.co.za/Content/Catalog/Documents/D3649704255.pdf

Arduino UNO

Working Voltage	DC 12 V
Working Current	34.4mA

Reference - https://www.gadgetmakersblog.com/arduino-power-consumption/

Total voltage supplied to the System = 12 V

Total estimated current drawn to the system = 34.4mA + 0.5mA + 43mA + 15mA + 1mA + 500mA

= 593.9 mA

Therefore estimated power consumption = V*I

$= 12 * 593.9 * 10^{-3}$ W

= 7.13 W

b Data Storage

The project's central server is located remotely at http://digitalthings.comlu.com/weather which is a free hosting service offered by www.000webhost.com

Server is a php server.

Following is the file hierarchy of the relevant server location

- weather
  - -beep
    - -beep.mp3
    - -beep.wav
  - -icons
    - -green.png
    - -icon.png
    - -location.png
    - -nodata.png
    - -rain.png
    - -red.png
    - -sun.png
  - -locations
    - -1.txt
    - -2.txt
    - -3.txt
    - -4.txt
    - -location_count.txt
  - -conn.php
  - -dataset1.php

- -hum_chart_annual.php
- -humChartByDate.php
- -index.php
- -locations.php
- -rain_chart_annual.php
- -rainChartByDate.php
- -summary.php
- -summary.txt
- -temp_chart_annual.php
- -tempchart1.php
- -tempChartByDate.php
- -wind_chart_annual.php
- -windChartByDate.php

Server Limitations

Reference - https://www.000webhost.com/forum/t/rate-limiting-policy/73635

Since the webhost is on a free hosting there are limitations. According to the given reference, limitations that effect this project are follows.

1. 30 concurrent connections *(per database)*
2. max_queries_per_hour = 15000 *(DB read)*
3. max_updates_per_hour = 5000 *(DB write)*

So in the embedded software implementation the minimum gap between two consecutive data set deliveries is 1 min. But normally it takes more than 1 min due to execution time of the Arduino code.

But considering the maximum concurrent connection limit, the number of locations must be less than 30 to guarantee that all data sets will be updated in database without a problem.

So if n is the number of locations, no of concurrent web application users must be 30-n assuming all connections they make happen same instant. (Worst Case)

For 30 connections, total automatic queries is 30 x 60 x 2 = 3600 in an hour (Worst Case) .So there are (15000-3600)/30 = 380 queries left for each connection in an hour.

So a web application user must keep number of weather data searches in a less amount than 380 in an hour to ensure the functioning of the application.

The maximum update queries will not exceed 5000 with 30 locations even, as 30 x 60 < 5000

The calculations are done for worst cases.

Chapter 4 - Third party software components

Google Charts by Google Developers

Google charts API was used to present the data over history as a line chart.

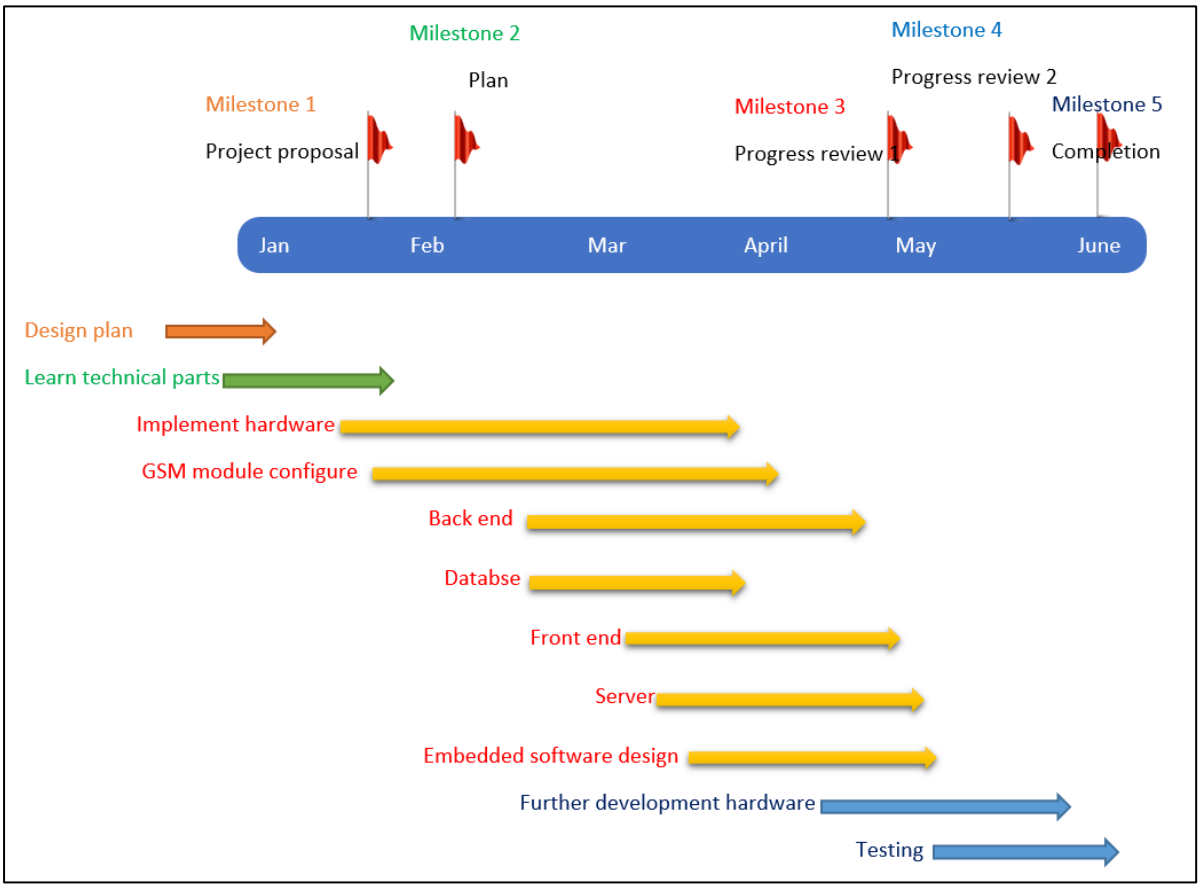
Bootstrap

Bootstrap framework used for the front end to be more responsive and nice.

Google Maps by Google Developers

Google maps API was used to present the summary weather data of all locations in two maps.

Chapter 5 - Timeline



Chapter 6 – Final Budget

Component	Price(LKR)
Sim 808 mini module	3350
12V 3A SMPS adaptor 2 pin	450
Rain drop sensor	125
5V DC relay 5 pin	45
Plastic water solenoid valves	525
Circuit wire	60
DC jack plastic	10
DC socket wire short cord	40
IPX/SMAK	180
SMA male	120
Ir sensor	110
DHT11	230
4” end cap	100
Total	**5345**

Chapter 7 – Project Links

Web Application - http://digitalthings.comlu.com/weather

Git Hub Repository - https://github.com/HishanIndrajith/Automated-Weather-Monitoring-and-Alerting-System

FEeLS Forum - https://feels.pdn.ac.lk/mod/forum/discuss.php?d=7508#p26671

Youtube –

https://www.youtube.com/watch?v=5pYDfkILeco

https://www.youtube.com/watch?v=Bitjx8XXnLc&t=29s