



# SIGNS WITH SMART CONNECTIVITY FOR BETTER ROAD SAFETY

## IBM PROJECT REPORT

## Team ID - PNT2022TMID18146

SUBMITTED BY

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# Final Deliverables Report

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|---|---|
| **Date** | 19.11.2022 |
| **Team ID** | PNT2022TMID18146 |
| **Project Name** | Signs with Smart Connectivity for Better Road Safety |

## Team members and their Contributions:

| Name | Roll no | Contribution |
|---|---|---|
| SONIYA B | 201903156 | CREATED SOURCE CODE FOR THE WOKWI SIMULATOR AND MIT APP CODE. |
| KIRTHIKA M | 201903076 | CREATED NODE RED AND IOT WATSON PLATFORM. |
| KARUNYA VARDANA S | 201903073 | PROJECT REPORT MAKING PROCESS AND GATHERING IDEAS FOR CREATING PROJECT. |
| SINDHUJA T | 201903146 | WORKINGS IN NODE RED FLOW AND IBM CLOUD DEPLOYMENT. |

## Introduction:

1. Sprint 1 – Create and initialize accounts in various public APIs like OpenWeatherMap API, and write a Python program that outputs results given the inputs like weather and location.
2. Sprint 2 – Push data from local code to cloud
3. Sprint 3 – Hardware & Cloud integration
4. Sprint 4 – UI/UX Optimization & Debugging

# CONTENTS

# 1. INTRODUCTION

## 1.1 Project Overview

- To replace the static signboards, smart connected signboards are used.
- These smart connected sign boards get the speed limitations from a web app using weather API and update automatically.
- Based on the weather changes the speed may increase or decrease.
- Based on the traffic and fatal situations the diversion signs are displayed.
- Guide (Schools), Warning and Service (Hospitals, Restaurants) signs are also displayed accordingly.
- Different modes of operations can be selected with the help of buttons.

## 1.2 Purpose

- Smart Traffic Management is a system to monitor and control traffic signals using sensors to regulate the flow of traffic and to avoid congestion for a smooth flow of traffic.

- Prioritizing traffic like ambulances, police etc. is also one application comes under smart traffic management.

# 2. LITERATURE SURVEY


| TITLE | AUTHOR | METHODOLOGY | MERITS | DEMERITS | YEAR |
|---|---|---|---|---|---|
| Digitalization of highways for vulnerable road safety development with intelligent IoT sensors and machine learning<br><br>(IEEE) | • Rajesh Singh<br>• Rohit Sharma<br>• Shaik Vaseem Akram<br>• Anita Gehlot<br>• Dharam Buddhi<br>• Praveen Kumar Malik<br>• Rajeev Arya | ❖ IOT<br>❖ AI | ❖ Embedding the deep learning techniques in the vision node at the traffic junction and the highway lighting controller is able to deliver an intelligent system that provides sustained experience and management of the highways. | ❖ Smart reflectors, adoption of renewable energy, developing vehicle-to-vehicle communication in vehicles, and smart lamp posts are a few recommendations for the implementation of digitalizing highways | 2021 |

# LITERATURE SURVEY

| TITLE | AUTHOR | METHODOLOGY | MERITS | DEMERITS | YEAR |
|---|---|---|---|---|---|
| IOT BASED SMART TRAFFIC MANAGEMENT SYSTEM<br><br>(IJERT) | Rachana K P, Aravind R, Ranjitha M, Spoorthi Jwanita , Soumya | ❖ IOT<br>❖ Digital Image Processing<br>❖ MATLAB | ❖ IOT based traffic management easily penalize traffic violators and help officials to identify unauthorized drivers.<br>❖ Reroute the ambulance to low congestion roads to get help medical care at the earliest | ❖ Additional security measures are required<br>❖ Require High Tech network infrastructure | 2021 |

| TITLE | AUTHOR | METHODOLOGY | MERITS | DEMERITS | YEAR |
|---|---|---|---|---|---|
| RELIABLE SMART ROAD SIGNS<br><br>(IEEE) | Muhammed O. Saying, Chung-Wei Lin, Eunsuk Kang, Shinichi Shiraishi, and Tamer Basar | ❖ Machine Learning to recognize the surroundings and can use its strategic decisions on the information learnt<br>❖ Dedicated short range communication (DSRC) radios.<br>❖ Game theoretical Approaches | ❖ Road – sign classification in adversarial environments<br>❖ The detection mechanism involves multiple performance metrics | ❖ Need state of the art vision based road sign recognition algorithms for better reliability<br>❖ Relaxation to attacker's algorithm under Stackelberg Equilibrium leads to trigger of false alarm | 2019 |

| TITLE | AUTHOR | METHODOLOGY | MERITS | DEMERITS | YEAR |
|---|---|---|---|---|---|
| Incomplete Road Information Imputation Using Parallel Interpolation to Enhance the Safety of Autonomous Driving.<br><br>(IEEE) | • KAIFENG GAO<br>• BOWEN WANG<br>• LEI XIAO<br>• GANG MEI | ❖ IOT<br>❖ AI | The proposed method is capable of efficiently and effectively imputating the incomplete road point cloud data that are induced by obstacle vehicles, and outperforms other interpolation algorithms and machine learning algorithms. | By scanning road information, LiDAR sensors can obtain high-precision road point cloud information map. However, LiDAR scanning is sensitive to weather conditions. In rainy, foggy, or snowy weather, the performance of LiDAR is not ideal. In addition, LiDAR cannot detect small obstacles, such as traffic signs that are 60 meters away. Because they occupy a lower scanning angle than the resolution of the LiDAR, the LiDAR cannot detect such obstacles. | 2021 |

## 2.1 Existing problem

- Analysis of crash data has suggested a link between roadside advertising signs and safety.
- Research suggests that crash risk increases by approximately 25–29% in the presence of digital roadside advertising signs compared to control areas.
- On the other hand, static roadside advertising signs have not been linked with differences in the crash count.
- However, this finding is contrary to previous research that suggests differences in crash counts exist in the presence of static roadside advertising.
- The quantity and quality of available evidence limit our conclusion.
- Fixed object, side swipe and rear end crashes are the most common types of crashes in the presence of roadside advertising signs.
- In addition, drivers showed increased eye fixations and increased drifting between lanes on the road.

## 2.2 Problem Statement Definition

This project will replace the static boards to smart signed boards that will change the speed limits according to the weather climate and show diversion messages if there are accidents in the road and alert messages if there is hospital, schools, or any roadworks.

# 3. IDEATION AND PROPOSED SOLUTION

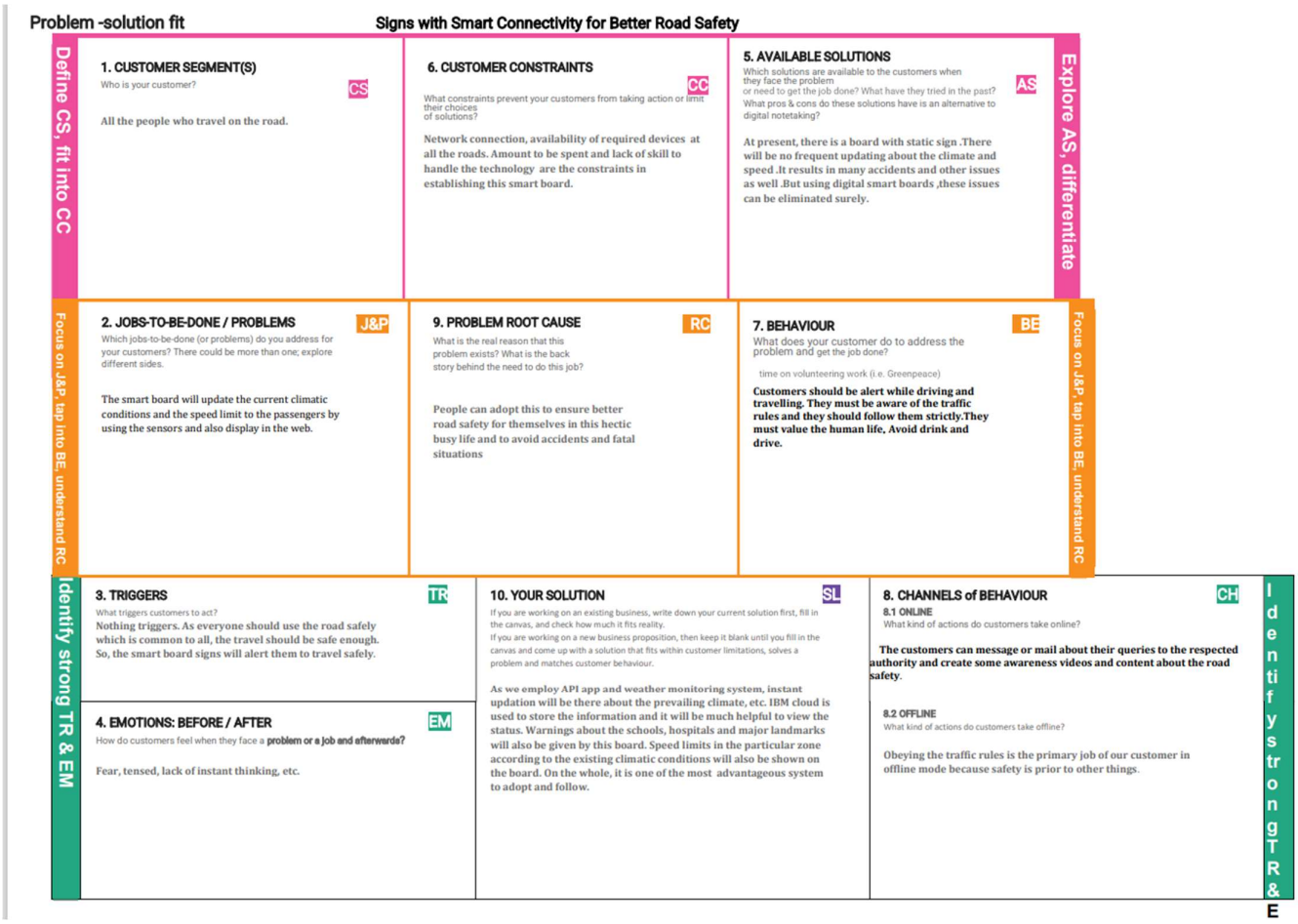
## 3.1 Empathy Map Canvas

# 3.2 Ideation & Brainstorming Map

# 3.3 Proposed Solution

| S.No. | Parameter | Description |
|---|---|---|
| 1. | Problem Statement | Replacing the static signs for roads by digital sign board for better navigation, avoid traffic and fatal situations like floods, natural calamities, etc. |
| 2. | Idea description | By setting a digital sign with the help of IoT concepts and algorithms to improvise the system to digitalize the sign boards for reliable and effective for future. |
| 3 | Novelty / Uniqueness | • As it uses real time weather conditions the signs change according to current situations.<br>• Even in extreme weather conditions these sign boards are clearly visible and help the drivers to navigate to their respective destination.<br>• The speed limits are also got vary according to weather, or with respect to roads or any other locations like school zones, hospital areas, etc.<br>• Signs will be displayed according to the locations like schools, hospitals, etc. |
| 4 | Social Impact / Customer Satisfaction | • This will useful for the traffic officers to regulate the traffic easily.<br>• The customer satisfies by this as it shows the correct routes even though there is any problem in the way to their destination.<br>• This will be useful for the beginners to learn the traffic regulations while traveling to different places. |
| 5 | Business Model (Revenue Model) | • With this model all the people get aware of the traffic rules and can drive safely.<br>• It's a budget friendly and government support this creative ideation.<br>• Every people get beneficial and can improve their lifestyle. |
| 6 | Scalability of the Solution | This model will greatly helpful in both day and night and even in extreme weather situations and reduce accidents. |

# 3.4 Problem Solution fit



# 4. 1. REQUIREMENT ANALYSIS

## 4.1 Functional Requirements

**Functional Requirements:**

Following are the functional requirements of the proposed solution.

| FR No. | Functional Requirement (Epic) | Sub Requirement (Story / Sub-Task) |
|---|---|---|
| FR-1 | User Requirements | Traditional signs are replaced with digitalized sign boards which meets all the criteria. |
| FR-2 | User Registration | The registration can be done via website or form or Gmail or LinkedIn |
| FR-3 | User Conformation | The conformation can be done by phone calls, OTPs and Gmail. |
| FR-4 | Payment Options | Payments can be done by bank transfers or net banking. |
| FR-5 | Product delivery and installation | The installation will be depend on the road length and the condition of the road. |
| FR-6 | Product feedback | Feedback can be given via forms, Gmail or websites. |

## 4.2 Functional Requirements

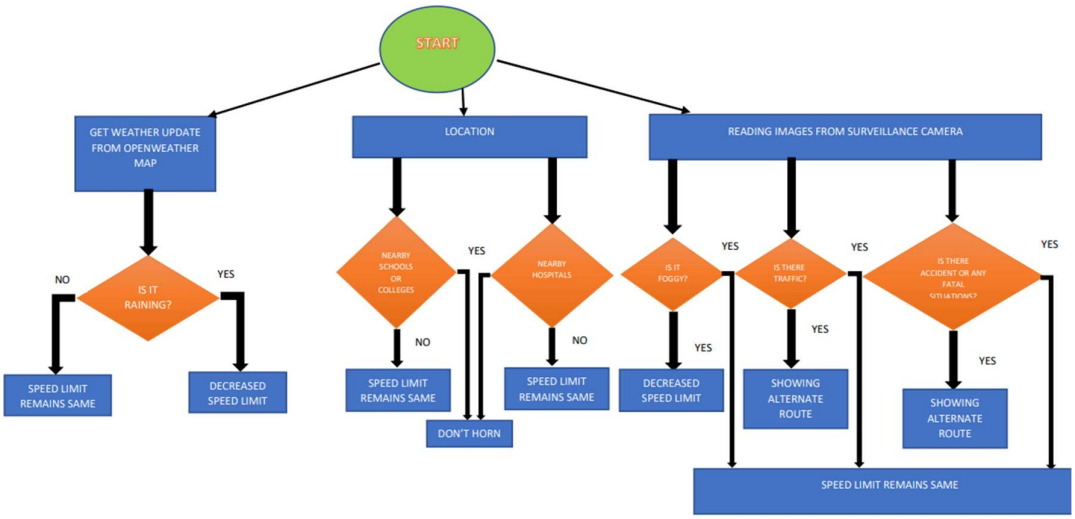
**Non-functional Requirements:**

Following are the non-functional requirements of the proposed solution.

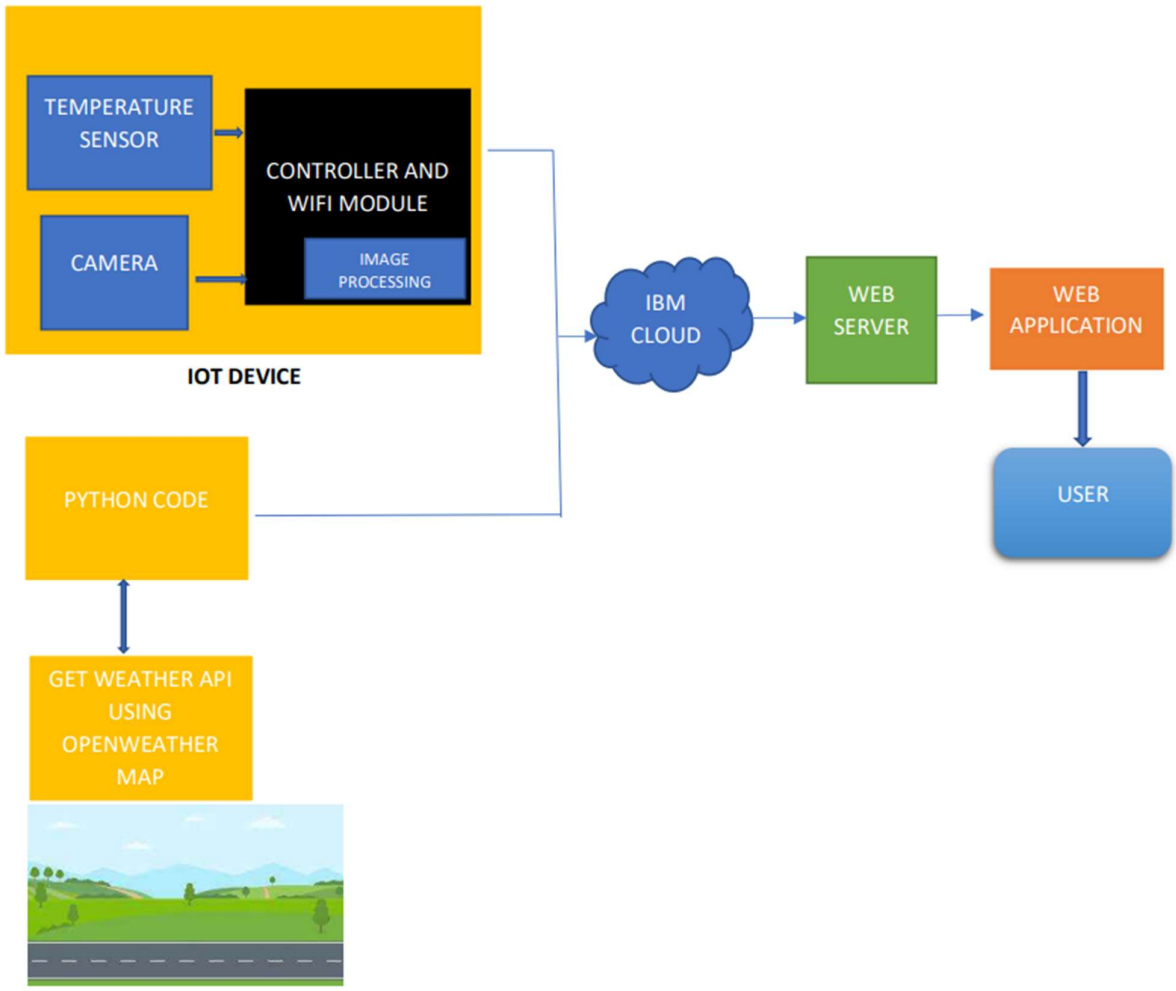
| FR No. | Non-Functional Requirement | Description |
|---|---|---|
| NFR-1 | **Usability** | Should be convenient, easy and dynamically change according to the users. |
| NFR-2 | **Security** | The Safe System approach to road safety emphasizes safety-by-design through ensuring safe vehicles, road networks, and road users. |
| NFR-3 | **Reliability** | High reliable and should convey the traffic information correctly. |
| NFR-4 | **Performance** | • Should update dynamically whenever the weather or traffic values are updated.<br>• Cost efficient<br>• Better Traffic Management and Safety and prevent accidents. |
| NFR-5 | **Availability** | This will be working 24/7 even in extreme weather conditions. |
| NFR-6 | **Scalability** | It can be moved from a smaller to a larger operating system and the larger number of users that could be handled. |

# 5. PROJECT DESIGN

## 5.1 Data Flow Diagram



# 5.2 Solution & Technical Architecture



# Following is the Solution Built

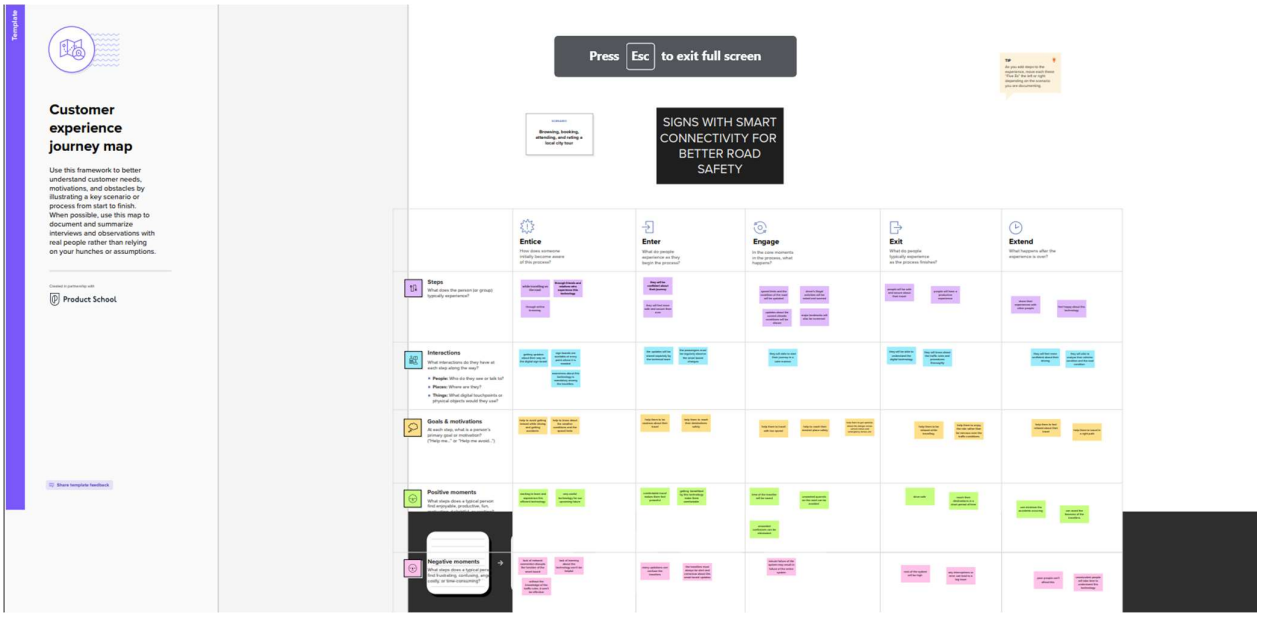
Table-1 : Components & Technologies:

| S.No | Component | Description | Technology |
|---|---|---|---|
| 1. | User Interface | User can interact with the app using MIT App | HTML, CSS, JavaScript / Angular Js /React Js |
| 2. | Application Logic-1 | Logic for a process in the application | Java / Python |
| 3. | Application Logic-2 | Logic for a process in the application | IBM Watson STT service |
| 4. | Application Logic-3 | Logic for a process in the application | IBM Watson Assistant |
| 5. | Database | Data Type, Configurations etc. | IBM Cloud |
| 6. | Cloud Database | Database Service on Cloud | IBM DB2, IBM Cloudant etc. |
| 7. | File Storage | File storage requirements | IBM Block Storage or Other StorageService or Local Filesystem |
| 8. | External API-1 | Purpose of External API used in the application | Open Weather Map API |
| 9. | External API-2 | Purpose of External API used in the application | IBM Watson Platform, Node - Red |
| 10. | Infrastructure (Server / Cloud) | Application Deployment on Local System / CloudLocal Server Configuration:<br>Cloud Server Configuration: | Local, Cloud Foundry, Kubernetes |

Table-2: Application Characteristics:

| S. No | Characteristics | Description | Technology |
|---|---|---|---|
| 1. | Open-Source Frameworks | *OpenWeatherMap, NODE-RED, IBM WATSON,MIT App Inventor* | IoT, internet |
| 2. | Security Implementations | *Powerful security system for everyone'speace of mind No access data Hackers cannot access network* | Firewall, Firebase, cyber resiliency, strategy |
| 3. | Scalable Architecture | *EASY TO EXTEND THE NETWORK WITH THEAID OF THE BANDWIDTH OF THE NETWORK* | IBM Cloud |
| 4. | Availability | *Available every time and everywhere 24/7so long as the consumer is signed into thenetwork.* | IBM Cloud |
| 5. | Performance | *AIDS MASSIVE RANGE OF USERS TO USE TECHNOLOGY* | IBM Cloud |

# 5.3 User Stories



# 6. PROJECT PLANNING AND SCHEDULING

## 6.1 Sprint Planning & Estimation

**Product Backlog, Sprint Schedule and Estimation(4Marks)**

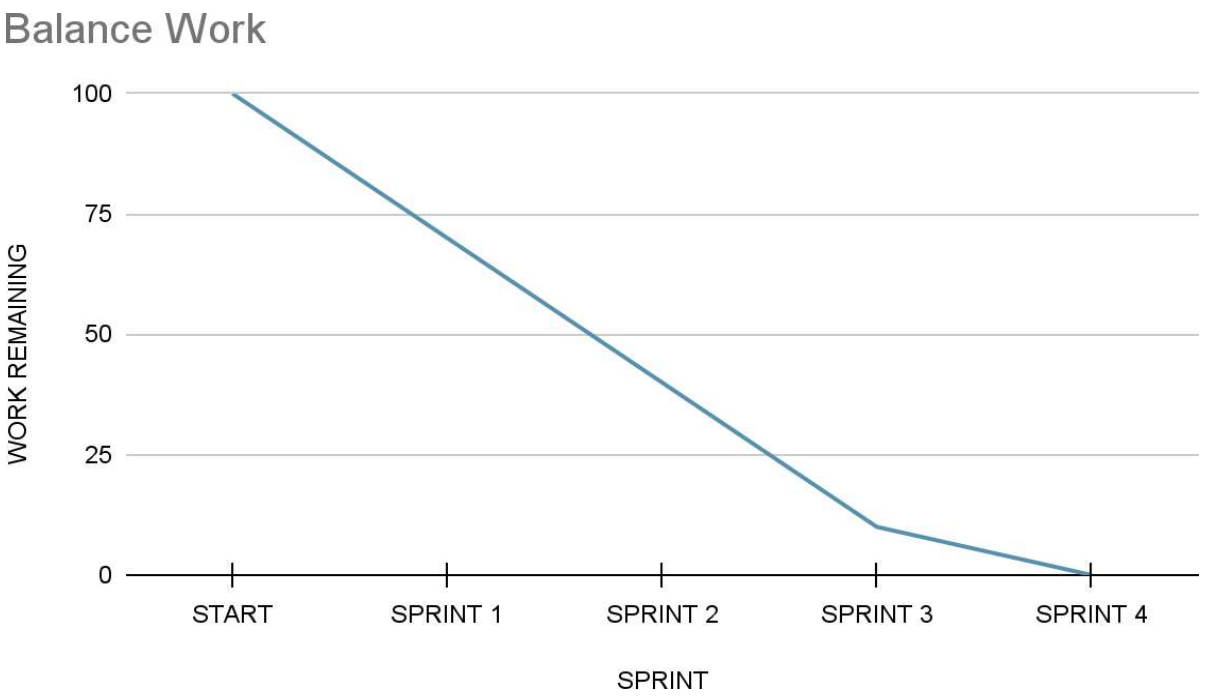
| Use the below template to create product backlog and sprint scheme **Sprint** | **Functional Requirement (Epic)** | **User Story/Task** | **Story Points** | **Priority** | **Team Members** |
|---|---|---|---|---|---|
| Sprint-1 | Resources Initialization | Create and initialize accounts in various public APIs like OpenWeatherMap API. | 1 | LOW | Soniya B<br>Karunya Vardana S<br>Kirthika M<br>Sindhuja T |
| Sprint-1 | Local Server/Softwar e Run | Write a Python program that outputs results given the inputs like weather and location | 1 | MEDIUM | Soniya B<br>Karunya Vardana S<br>Kirthika M<br>Sindhuja T |
| Sprint-2 | Push the server/software to cloud | Push the code from Sprint1 to cloud so it can be accessed from anywhere | 2 | MEDIUM | Soniya B<br>Karunya Vardana S<br>Kirthika M<br>Sindhuja T |
| Sprint-3 | Hardware initialization | Integrate the hardware to be able to access the cloud functions and provide inputs to the same | 2 | HIGH | Soniya B<br>Karunya Vardana S<br>Kirthika M<br>Sindhuja T |

# 6.2 Sprint Delivery Schedule

Project Tracker, Velocity & Burndown Chart:

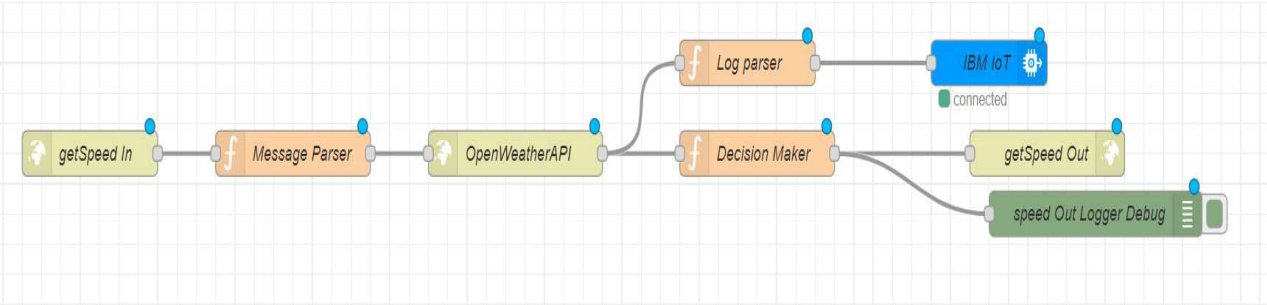
| Project Tracker, Velocity & Burndown Chart:(4Marks) Sprint | Total Story Points | Duration | Sprint Start Date | Sprint End Date(Planned) | Story Points Completed (as on Planned End Date) | Sprint Release Date(Actual) |
|---|---|---|---|---|---|---|
| Sprint-1 | 20 | 6Days | 24 Oct2022 | 29 Oct 2022 | 20 | 19 Nov 2022 |
| Sprint-2 | 20 | 6Days | 31 Oct 2022 | 05 Nov 2022 | 20 | 19 Nov 2022 |
| Sprint-3 | 20 | 6Days | 07 Nov 2022 | 12 Nov 2022 | 20 | 19 Nov 2022 |
| Sprint-4 | 20 | 6Days | 14 Nov 2022 | 19 Nov 2022 | 20 | 19 Nov 2022 |

Burndown Chart:



# 7. CODING AND SOLUTIONING

## 7.1 Feature 1 - GET SPEED FOR GIVEN LOCATION & CLIMATE



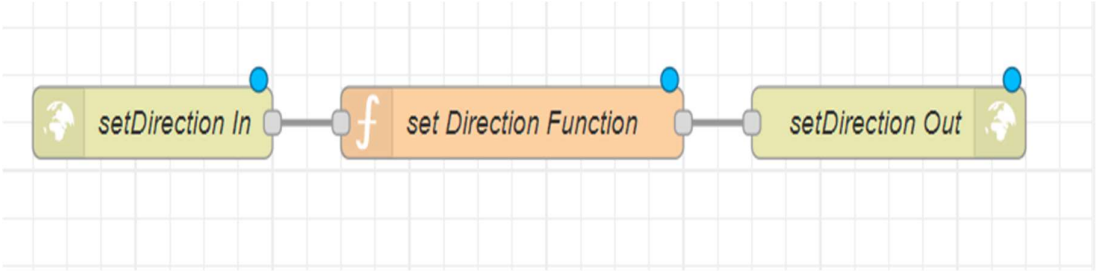

This part of Node RED flow accepts an http GET end point at **"/getSpeed"** from which the location, uid, hospital/school zone info are passed.

Message parser sets the required APIKEY for **OpenWeatherAPI** for the next block.

This data is then passed onto Decision Maker which makes all the decisions regarding the message to be output at the display and sends it as a http response.

This data is displayed at the microcontroller. Thus, a lot of battery is saved due to lesser processing time.

# 7.2 Feature 2 - SET DIRECTION REMOTELY FOR A GIVEN SIGN BOARD




This part of Node RED flow accepts an **http GET** end point at **"/setDirection"** from which the uid and direction information are passed by the respective authorities**. Set Direction** Function block adds the direction information to the database and returns the same as an http response. This data is sent to the microcontroller along with the **"/getSpeed"** path and the microcontroller displays it.

A detailed documentation of all the workflows is available at the **following link**:

# 8. TESTING

## 8.1 Test Cases

- **TEST CASE 1**

  Clear weather - Usual Speed Limit.

- **TEST CASE 2**

  Foggy Weather - Reduced Speed Limit.

- **TEST CASE 3**

  Rainy Weather - Further Reduced Speed Limit.

- **TEST CASE 4**

  School/Hospital Zone - Do not Honk sign is displayed.

## 8.2 User Acceptance Testing

Dynamic speed & diversion variations based on the weather and traffic helps user to avoid traffic and have a safe journey home. The users would welcome this idea to be implemented everywhere.

# 9.RESULTS

## 9.1 Performance Metrics

Based on the IBM pack we chose, the performance of the website varies. Built upon NodeJS, a light and high performance engine, Node RED is capable of handling up to 10,000 requests per second. Moreover, since the system is horizontally scalable, an even higher demand of customers can be served.

# 10 ADVANTAGES & DISADVANTAGES

- **ADVANTAGES**
  - Lower battery consumption since processing is done mostly by Node RED servers in the cloud.
  - Cheaper and low requirement micro controllers can be used since processing requirements are reduced.
  - Longer lasting systems.
  - Dynamic Sign updating.
  - School/Hospital Zone alerts
- **DISADAVNTAGES**
  - The size of the display determines the requirement of the micro controller
  - Dependent on OpenWeatherMap API and hence the speed reduction is same for a large area in the scale of cities.

# 11 CONCLUSION

Our project is capable of serving as a replacement for static signs for a comparatively lower cost and can be implemented in the very near future. This will help reduce a lot of accidents and maintain a more peaceful traffic atmosphere in the country.

# 12 FUTURE SCOPE

Introduction of intelligent road sign groups in real life scenarios could have great impact on increasing the driving safety by providing the end-user (car driver) with the most accurate information regarding the current road and traffic conditions. Even displaying the information of a suggested driving speed and road surface condition (temperature, icy, wet or dry surface) could result in smoother traffic flows and, what is more important, in increasing a driver's awareness of the road situation.

# 13 APPENDIX

- **GITHUB LINK**
- https://github.com/IBM-EPBL/IBM-Project-1623-1658403326

- **PROJECT DEVELOPMENT PHASE LINK**

https://github.com/IBM-EPBL/IBM-Project-1623-1658403326/tree/main/PROJECT_DEVELOPEMENT_PHASE

- **SOURCE CODE – ESP 32**

```
#include <TinyGPS++.h>
#include <SoftwareSerial.h>
TinyGPSPlus gps;
SoftwareSerial ss (3,4);
char n;
int a;
void setup() {
Serial.begin(9600);
ss.begin(9600);
pinMode (2,INPUT);
pinMode (6,OUTPUT);
pinMode(11,OUTPUT);
pinMode(10,OUTPUT);
pinMode (9,OUTPUT);
pinMode (12,OUTPUT); //apr
digitalWrite(11,HIGH);
digitalWrite(6,HIGH);
attachInterrupt (digitalPinToInterrupt (2), piezo,CHANGE);
}
void loop() {
n-Serial.read();
Serial.println(" ");
delay (200);
if (n=='3') {
digitalWrite(6,HIGH);
digitalWrite(11,HIGH);
digitalWrite(12,HIGH);
delay(200);
digitalWrite(12,LOW); }
else if (n=='2'){
digitalWrite(6,LOW);
digitalWrite(11,LOW);
digitalWrite(10,LOW);
digitalWrite(9,LOW);
digitalWrite(12,HIGH);
delay(200);
digitalWrite(12,LOW); }
else if (n=='1'){
analogWrite(11,100);
analogWrite(6,100);
```

```
digitalWrite(12,HIGH);
delay(200);
digitalWrite(12,LOW);
}
}
displayInfo()
{
if(gps.location.isValid()){
Serial.print(gps.location.lat(), 6);
Serial.print (F(","));
Serial.print(gps.location. Ing(), 6); }
else{
Serial.print("10.305125");
Serial.print(',');
Serial.print("76.389582");
}
if (gps.date.isValid())
{
Serial.print(gps.date.month());
Serial.print (F("/"));
Serial.print(gps.date.day());
Serial.print (F("/"));
Serial.print(gps.date.year());
}
else
{
Serial.print(F("INVALID"));
}
Serial.print (F(" "));
if (gps.time.isValid())
{
if (gps.time.hour() < 10)
{
Serial.print (F("0"));
Serial.print(gps.time.hour());
Serial.print(F(":"));
}
if (gps.time.minute() < 10)
{
Serial.print(F("0"));
Serial.print (gps.time.minute());
```

```
Serial.print(F(":"));
}
if (gps.time.second() < 10)
{
Serial.print(F("0"));
Serial.print(gps.time.second());
Serial.print(F("."));
```

```
}
if (gps.time.centisecond() < 10)
{
Serial.print(F("0"));
Serial.print(gps.time.centisecond());
}
}
else
{
// Serial.print (F("INVALID"));
}*/
Serial.println();
}
void piezo()
{
while (ss.available() > 0)
    if(gps.encode(ss.read()))
        displayInfo();
}
int a=0,b=0,c=0,d=0;
void setup() {
pinMode(D1, INPUT);
pinMode(D2, INPUT);
pinMode(D3, INPUT);
pinMode(D4, INPUT);
digitalWrite(D1,LOW);
digitalWrite(D2, LOW);
digitalWrite(D3, LOW);
digitalWrite(D4, LOW);
Serial.begin(9600);
}
void loop()
{
a=digitalRead(D1);
if (a==1) {
Serial.print("1"); }
b=digitalRead (D2);
if (b==1) {
Serial.print("2"); }
d=digitalRead(D4);
if (d==1)
{
Serial.print("3");
}
```