# KONGUNADU COLLEGE OF ENGINEERING AND TECHNOLOGY

**DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING**

**HX 8001-PROFESSIONAL READINESS FOR INNOVATION,**

**EMPLOYABILITY AND ENTREPRENEURSHIP**

# SIGNS WITH SMART CONNECTIVITY

# FOR BETTER ROAD SAFETY

**NALAIYA THIRAN PROJECT REPORT 2022**

***Submitted by***


| | |
|---|---|
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**Team ID : PNT2022TMID13488**

**NOVEMBER 2022**

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## 1. INTRODUCTION :

Road signs provide details to drivers to help them operate their vehicles safety. To be efficient, road signs must be visible and legible at a sufficient distance to allow drivers to take particular actions. However, static road signs are frequently missed by drivers making it difficult for them to respond in time.

The purpose of this study was to develop a system that uses a web application to notify drivers about road signs ahead. The development of the web application was motivated by the fact that internets are widely used nowadays. Web application include features such as a global positioning system (GPS), a database, microelectronic systems, and an inertial measurement unit (IMU). These web application features can be used to provide details about the location of road signs, the vehicle's speed, and the time required to reach the road signs ahead. As a result, web application provide a golden opportunity for enhancing vehicle safety.

**The main contributions of this research are :**

- A brief survey on the state of the art related to pre-accident as well as post-accident models, frameworks, and algorithms.
- Identification and reporting of disadvantage in previous studies related to accident detection.
- The concept of a smart road with an event-sensing capability, plus implementation and testing through various projects.

### 1.1 Project Overview :

The main aim of this project is to help people automate the roads by providing them with a Web Application through which they can display the parameters of the road like temperature, speed limit, and message, visibility of the roads. They also show guides for schools, colleges and provide services of displaying hospital zone, and restaurant signs accordingly.

### 1.2 Purpose :

A lot of research is being carried out in the domain of accident avoidance and accident alarms by a large amount of researchers and practitioners. To avoid accidents, many approaches are utilized to enhance safety measurements. For ease of reference, the literature on accident detection and avoidance is separated into three approaches: stand-alone, cooperative, and hybrid. Stand-alone approaches use sensors, such as radar and light detection and ranging (LiDAR) sensor, for accident avoidance and detection, whereas cooperative approaches rely on V2X technology.

## 2. LITERATURE SURVEY :

**[1] Topic :** Proposing lane and obstacle detection algorithm using YOLO

**Author :** Phat Nguyen Huu

**Year of Publication :** 2022

The paper mentions two main problems, namely, lane detection and obstacle detection (road signs, traffic lights, vehicles ahead, etc.,) through image processing algorithms. To solve problems such as low detection accuracy of traditional image processing methods and poor real-time performance of methods based on deep learning methods, lane and object detection algorithm barriers for smart traffic are proposed. We first convert the distorting image caused by the camera and use a threshold algorithm for the lane detection algorithm. The image with a top-down view is then determined through the extraction of a region of interest and inverse perspective transform. Finally, we implement the sliding window method to determine pixels belonging to each lane and adapt it to a quadratic equation. YOLO algorithm is suitable for identifying many types of obstacles for identification problems. Finally, we use real-time videos and the TuSimple dataset to perform simulations for the proposed algorithm.

**[2] Topic :** The potential of emerging digital technologies for improving road safety

**Author :** ManuSasidharan, Leila C.W.Muchanga

**Year of Publication :** 2022

In this paper, the results show that digital technologies such as AI, Image processing and IoT have been widely applied to enhance road safety, due to their ability to automatically capture and analyse data while preventing the possibility of human error. Moreover, the results show that digital technologies such as AI, Image processing and IoT have been widely applied to enhance road safety, due to their ability to automatically capture and analyse data while preventing the possibility of human error. However, a key gap in the literature remains their effectiveness in real-world environments. This limits their potential to be utilised by policymakers and practitioners.

**[3] Topic :** Cyberabad Traffic Police from the official website about Nehru Outer Ring Road

**Year of Publication** : 2017

It focused on road safety funding and seemed to provide an insight into how funding factors may affect both the effectiveness and the efficiency or road safety management. The paper presented a systematic analysis for the assessment of road safety management applicable in countries where financial resources are limited or reduced, focusing on road safety funding and seeking to provide an insight into how appropriately designed funding mechanisms may affect both the effectiveness and the efficiency of road safety management.

**Abstract :**

Road traffic accident is a major issue worldwide resulting in significant morbidity and mortality. Advanced driver assistance systems are one of the salient features of intelligent systems in vehicle transportation. They improve vehicle safety by providing real-time traffic details to the drivers. To be effective, road signs must be shows at a distance that enables drivers to take the essential actions. However, static road signs are often seen too late for a driver to respond accordingly. In this case, a system for alerting drivers about road signs has been developed and tested using a web application. The study was carried out in Tanzania along an 60 km highway stretch from Arusha to Moshi. The Haversine formula was used to measure and estimate the distance between two pairs of coordinates using the web-based navigation application, The application provides a voice alert to a needed action that enhances driver's

attention. We propose an alternative method that identifies and modifies a specific class of energy inefficiencies. According to the experimental results, the proposed methodology has the

benefits of high accuracy within a user radius of 10 meters, minimum bandwidth, and low-cost application. Furthermore, the system application was secured by limiting access to the application program interface key to avoid unauthorized access to sensitive information.

**Introduction :**

**2.1 Existing problem :**

**The Safe System Approach :**

The Safe System (SS) approach to transport networks originated with the "Safe Road Transport System" model developed by the Swedish Transport Agency. In its essence, the approach migrates from the view that accidents are largely and automatically the driver's fault to a view that identifies and evaluates the true causes of accidents. Through the categorization of safety into the safety of three elements (vehicle, road, and road user), SS minimizes fatalities and injuries by controlling speeds and facilitating prompt emergency response. The model has been widely adopted since its introduction and is currently motivated by the WHO as a basis for road safety planning, policy-making, and enforcement.

**2.2 Reference :**

1.C.Torfs, K.Areal, A.Goldenbeld, C.Vanlaar, S.Jankowska-Karpa: Car drivers 'roadsafety performance: a benchmark across 32 countries. IATSS Re. 44(3), 166-179 (Published : 2020).

2. D.Babic, A.Scukanec, D.Babic: Determining the correlation between daytime and night-time road markings visibility Baltic J. Road Bridge Eng., 11 (Published : 2020).

3. R.Saleh, H.Fleyeh: Factors affecting night-time visibility of Retro reflective road traffic signs: a reviewInt. J. Traffic Transp.Eng., 11 (Published : 2020).

4. AnanyaRoya1, MoinulHossainb, YasunoriMuromachic: A deep reinforcement learning-based intelligent intervention framework for real-time proactive road safety management Author links open overlay panel 18(11), 3006-3016 (Published : 2021)

5. PanelKhaledShaaban, MazenElamin, MohammedAlsoub: Intelligent Transportation Systems in a Developing Country: Benefits and Challenges of Implementation: 21 July 2021, Version of (Published:21 July 2021).

6.Dhaya Kanthavel, S.K.B.Sangeetha, K.P.Keerthana: An empirical study of vehicle to infrastructure communications - An intense learning of smart infrastructure for safety and mobility, 29 July 2021, (Published:29 July 2021).

7. Qunwei Tang, Guangqing Liu, Haiyang Wen: Triboelectric sensor array for internet of things based smart traffic monitoring and management system19 November 2021, Version of (Published: 22 November 2021).

8. Francesco Rundo, Ilaria Anfuso, Maria Grazia Amore: Advanced eNose-Driven Pedestrian Tracking Pipeline for Intelligent Car Driver Assisting System: Preliminary Results. (Published : 16 January 2022).

9. Roshani Raut, Khushi Desarda, Saylee Gulve: Traffic Signs Recognition and Detection using Deep Convolution Neural Networks for Autonomous Driving (Published : 08 June 2022).

10. Paule Kevin, Vitalice Oduol, George N. Nyakoe : Roadside Units for Vehicle-to-Infrastructure Communication: an Overview. (Published 05-04-2022).

**2.3 Problem Statement Definition :**

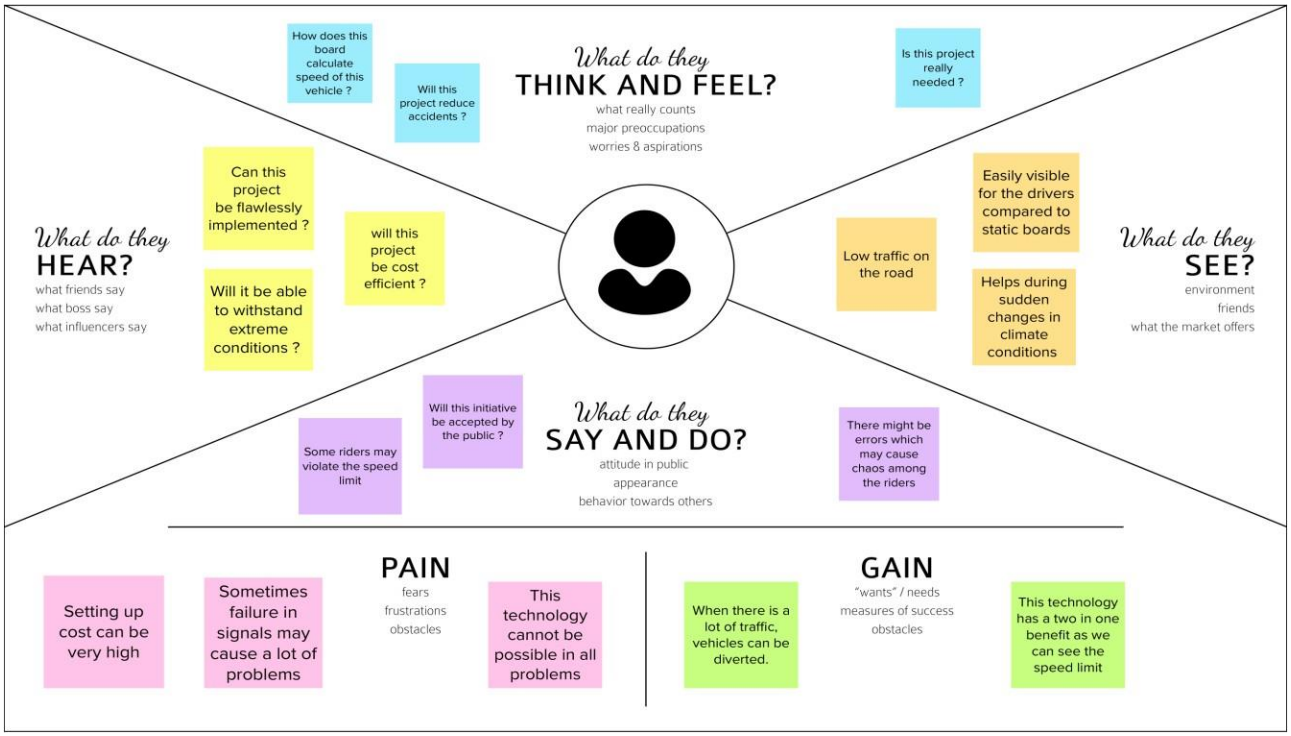
A problem statement is a concise description of an issue to be addressed or a condition to be improved upon. It identifies the gap between the current (problem) state and desired (goal) state

of a process or product. Focusing on the facts, the problem statement should be designed to address the Five. The first condition of solving a problem is understanding the problem, which can be done by way of a problem statement.

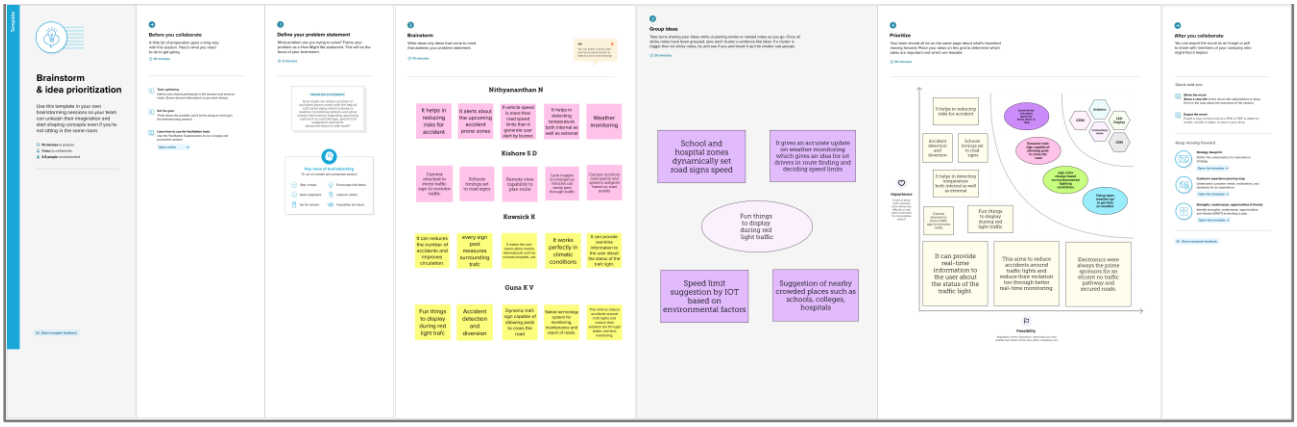
In present Systems the road signs and the speed limits are Static. But the road signs can be changed in some cases. We can consider some cases when there are road diversions due to heavy traffic or due to accidents then we can change the road signs accordingly if they are digitalized. This project proposes a system that has digital signboards on which the signs can be changed dynamically. If there is rainfall then the roads will be slippery and the speed limit would be decreased. There is a web app through which you can enter the data on road diversions, accident-prone areas, and information sign boards can be entered through the web app. This data is retrieved and displayed on the signboards accordingly.

## 3. IDEATION & PROPOSED SOLUTION :

### 3.1 Empathy Map Canvas :



## 3.2 Ideation & Brainstorming :




## 3.3 Proposed Solution :

The project team shall fill in the following information in the proposed solution template.

**Signs with smart connectivity for better road safety :**

| S.No. | Parameter | Description |
|---|---|---|
| 1. | Problem Statement (Problem to be solved) | To replace the static signboards, smart connected sign boards are used. These smart connected sign boards get the speed limitation 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, Restaurant) signs are also displayed accordingly. Different modes of operations can be selected with the help of buttons. |
| 2. | Idea / Solution description | By preparing a smart signs using IOT instead of regular signs hung on the road. Smart signs are built with IOT and LED are used. |
| 3. | Novelty / Uniqueness | Since LED's are used which is visible from afar. The smart signs consists of temperature,humidity,wind speed. These information are received from weather monitoring app. It also gives information about nearby places such as hospitals,schools etc., So that the users can decide their speeding according to that information. |

**3.4 Problem Solution fit :**

## 4. REQUIREMENTS ANALYSIS :

Requirements analysis, also called requirements engineering, is the process of determining user expectations for a new or modified product. These features, called requirements, must be quantifiable, relevant and detailed. In software engineering, such requirements are often called functional specifications. Requirements analysis is an important aspect of project management. Requirements analysis involves frequent communication with system users to determine specific feature expectations, resolution of conflict or ambiguity in requirements as demanded by the various users or groups of users, avoidance of feature creep and documentation of all aspects of the project development process from start to finish. Energy should be directed towards ensuring that the final system or product conforms to client needs rather than attempting to mold user expectations to fit the requirements. Requirements analysis is a team effort that demands a combination of hardware, software and human factors engineering expertise as well as skills in dealing with people. The purpose of the Requirements Analysis Phase is to transform the needs and high level requirements specified in earlier phases into unambiguous (measurable and testable), traceable, complete, consistent, and stakeholder approved requirements.

### 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 | Static signboards will be replaced with smart linked sign boards that meet all criteria. |
| FR-2 | User Registration | User Registration can be done through a Website or Gmail |
| FR-3 | User Confirmation | Phone Confirmation, Email confirmation, OTP authentication |
| FR-4 | Payments options | Bank Transfers |
| FR-5 | Product Delivery and installation | The installation fee will be depend upon the length of the road. |
| FR-6 | Product Feedback | Will be shared through a website via Gmail |

## 4.2 Non-Functional requirements :

**Non-functional Requirements:**

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

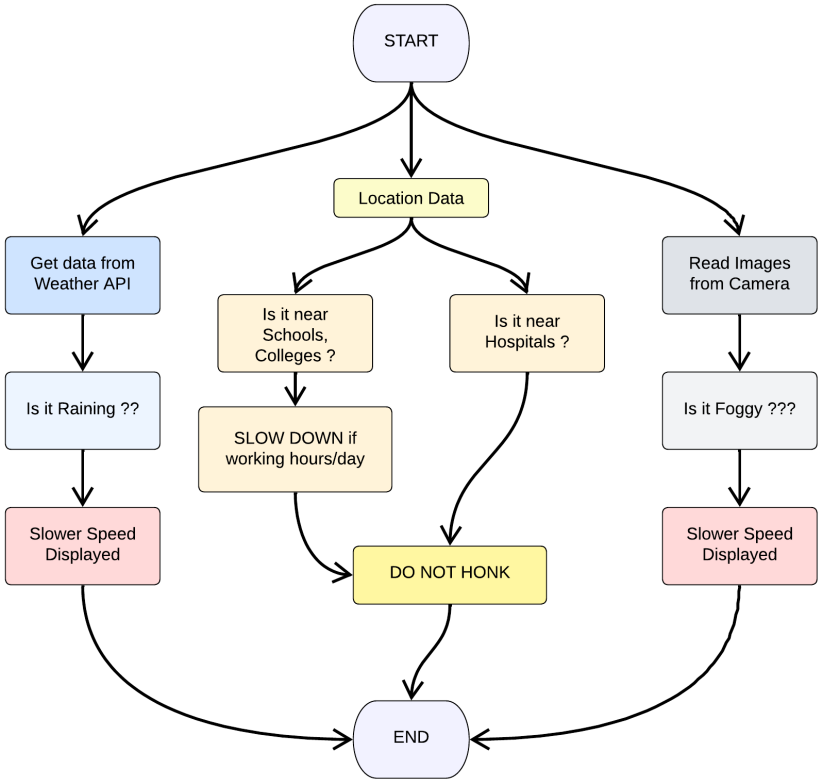
| FR No. | Non-Functional Requirement | Description |
|---|---|---|
| NFR-1 | Usability | Will provide the clear product instructions and a self-explanatory product which is simple to use. |
| NFR-2 | Security | Cloud data must be contained within the network, collapsing to be the real-time avoidance should be avoided, and the board will be monitored constantly. |
| NFR-3 | Reliability | Hardware will be frequently tested. |
| NFR-4 | Performance | The smart board must provide a better user experience and deliver the accuracy output. |
| NFR-5 | Availability | All of the functions and the user demands will be provided, depend upon the customer needs. |
| NFR-6 | Scalability | The product is based on road safety and should cover the entire highway system. |

# 5. PROJECT DESIGN :

Project design is an early phase of the project lifecycle where ideas, processes, resources, and deliverables are planned out. A project design comes before a project plan as it's a broad overview whereas a project plan includes more detailed information.

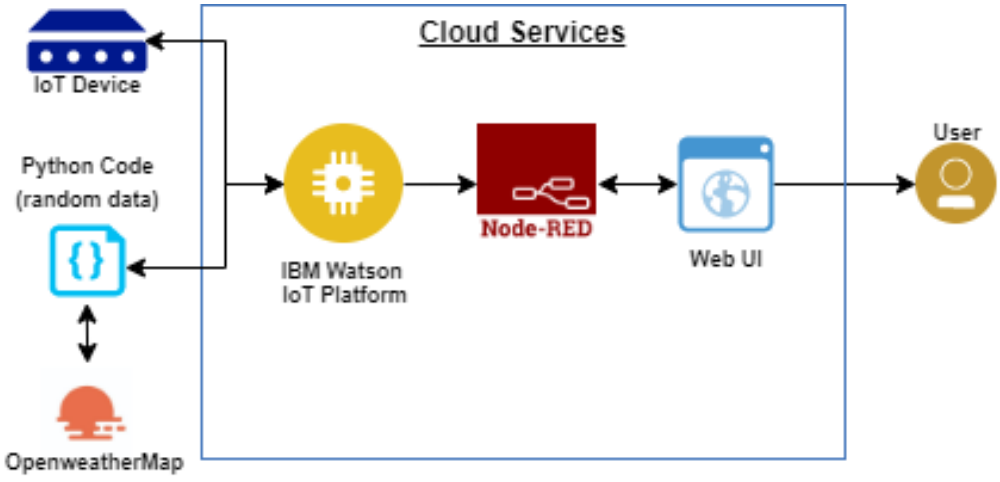
## 5.1. Data Flow Diagrams :

A Data Flow Diagram (DFD) is a traditional visual representation of the information flows within a system. A neat and clear DFD can depict the right amount of the system requirement graphically. It shows how data enters and leaves the system, what changes the information, and where data is stored.




### 5.2. Solution & Technical Architecture :

The diagram makes it simple to understand how the data you gather about the environment relates to both the physical and logical decisions you make for your design.



### 5.3. User stories :

A user story is the smallest unit of work in an agile framework. It's an end goal, not a feature, expressed from the software user's perspective. A user story is an informal, general explanation of a software feature written from the perspective of the end user or customer. The purpose of a user story is to articulate how a piece of work will deliver a particular value back to the customer. Note that "customers" don't have to be external end users in the traditional sense, they can also be internal customers or colleagues within your organization who depend on your team. User stories are a few sentences in simple language that outline the desired outcome. They don't go into detail. Requirements are added later, once agreed upon by the team.

| Sprint | Functional Requirement | User Story Number | User Story / Task | Story Points | Priority | Team Members |
|---|---|---|---|---|---|---|
| Sprint-1 | Resources Initialization | USN-1 | Create and initialize accounts in various public APIs like OpenWeather API. | 1 | Low | Nithyananthan.N<br>Kishore.S.D<br>Kowsick.K<br>Guna.K.V |
| Sprint-1 | Local Server/Software Run | USN-2 | Write a Python program that outputs results given the inputs like weather and location. | 1 | Medium | Nithyananthan.N<br>Kishore.S.D<br>Kowsick.K<br>Guna.K.V |
| Sprint-2 | Push the server/software to cloud | USN-3 | Push the code from Sprint 1 to cloud so it can be accessed from anywhere | 2 | Medium | Nithyananthan.N<br>Kishore.S.D<br>Kowsick.K<br>Guna.K.V |
| Sprint-3 | Hardware initialization | USN-4 | Integrate the hardware to be able to access the cloud functions and provide inputs to the same. | 2 | High | Nithyananthan.N<br>Kishore.S.D<br>Kowsick.K<br>Guna.K.V |
| Sprint-4 | UI/UX Optimization | USN-5 | Optimize all the shortcomings and provide | 2 | Medium | Nithyananthan.N |

## 6. PROJECT PLANNING & SCHEDULING :

The definition of a sprint is a dedicated period in which a set amount of work will be completed on a project. It's part of the agile methodology, and an Agile project will be broken down into a number of sprints, each sprint taking the project closer to completion.

### 6.1 Sprint Planning & Estimation :

Use the below template to create product backlog and sprint schedule.

| Sprint | Functional Requirement | User Story Number | User Story / Task | Story Points | Priority | Team Members |
|---|---|---|---|---|---|---|
| Sprint-1 | Resources Initialization | USN-1 | Create and initialize accounts in various public APIs like OpenWeather API. | 1 | Low | Nithyananthan.N<br>Kishore.S.D<br>Kowsick.K<br>Guna.K.V |
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| Sprint-4 | UI/UX Optimization | USN-5 | Optimize all the shortcomings and provide | 2 | Medium | Nithyananthan.N |

| Sprint | Functional Requirement | User Story Number | User Story / Task | Story Points | Priority | Team Members |
|---|---|---|---|---|---|---|
| | & Debugging | | better user experience. | | | Kishore.S.D<br>Kowsick.K<br>Guna.K.V |

## 6.2. Sprint Delivery Schedule :

Project Tracker, Velocity & Burndown Chart :

| 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 | 6 Days | 24 Oct 2022 | 29 Oct 2022 | 20 | 29 Oct 2022 |
| Sprint-2 | 20 | 6 Days | 31 Oct 2022 | 05 Nov 2022 | 20 | 31 Oct 2022 |
| Sprint-3 | 20 | 6 Days | 07 Nov 2022 | 12 Nov 2022 | 20 | 07 Nov 2022 |
| Sprint-4 | 20 | 6 Days | 14 Nov 2022 | 19 Nov 2022 | 20 | 14 Nov 2022 |

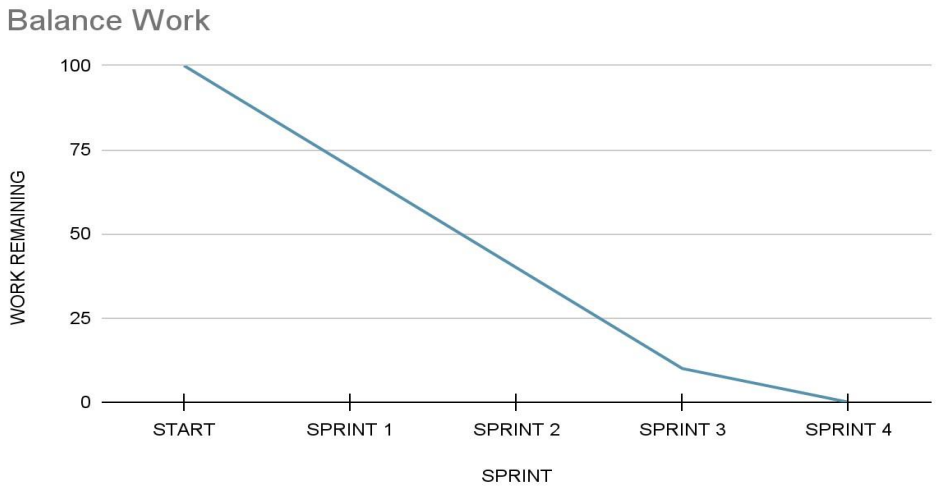
**Velocity :**

Imagine we have a 10-day sprint duration, and the velocity of the team is 20 (points per sprint). Let's calculate the team's average velocity (AV) per iteration unit (story points per day)

( AV = Sprint duration / Velocity )

**Burndown Chart :**

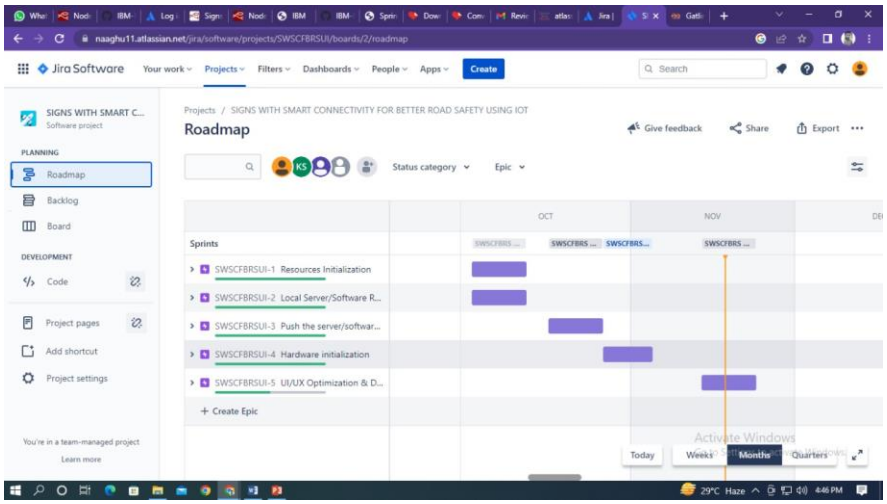
A burn-down chart is a graphical representation of work left to do versus time. It is often used in agile software development methodologies such as scrum. However, burn-down charts can be applied to any project containing measurable progress over time.




**Reference :**

https://naaghu11.atlassian.net/jira/software/projects/SWSCFBRSUI/boards/2/roadmap

## 6.3 Reports from JIRA :




## 7. CODING & SOLUTIONING :

### 7.1 Feature 1 :

(Coding and Output):

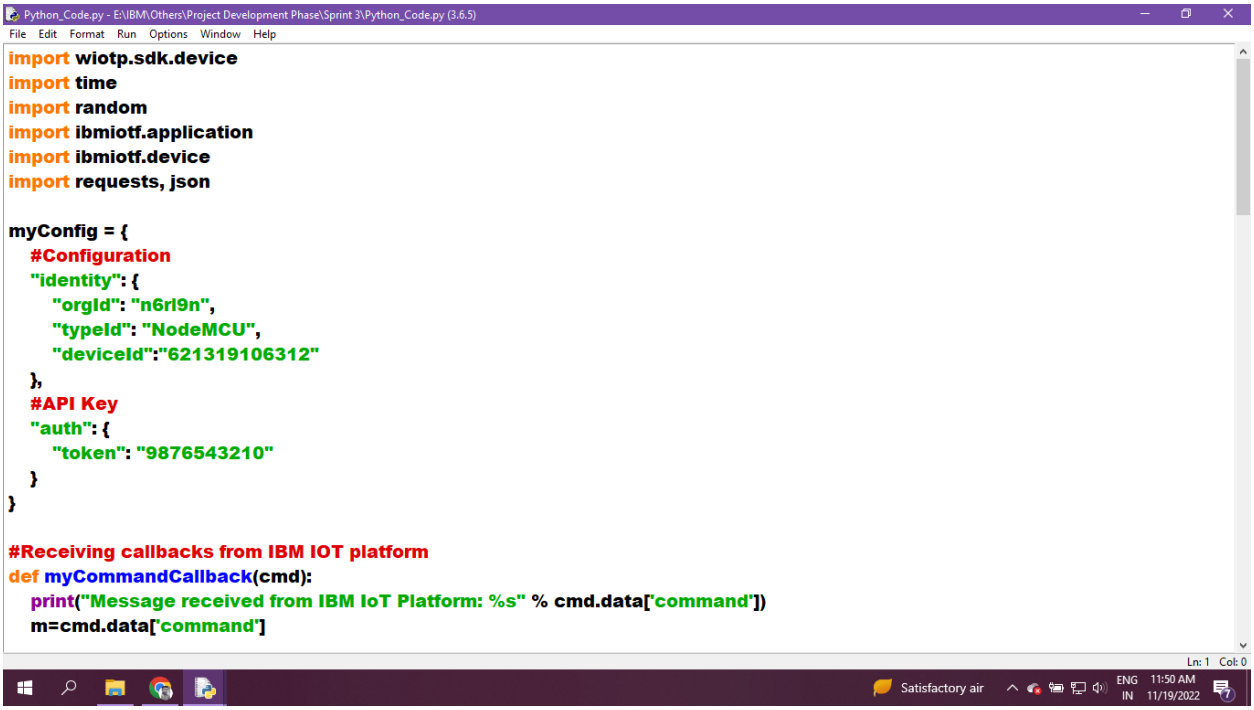
```
import wiotp.sdk.device
import time
import random
import ibmiotf.application
import ibmiotf.device
import requests, json

myConfig = {
    #Configuration
    "identity": {
        "orgId": "n6rl9n",
        "typeId": "NodeMCU",
        "deviceId":"621319106312"
    },
    #API Key
    "auth": {
        "token": "9876543210"
```

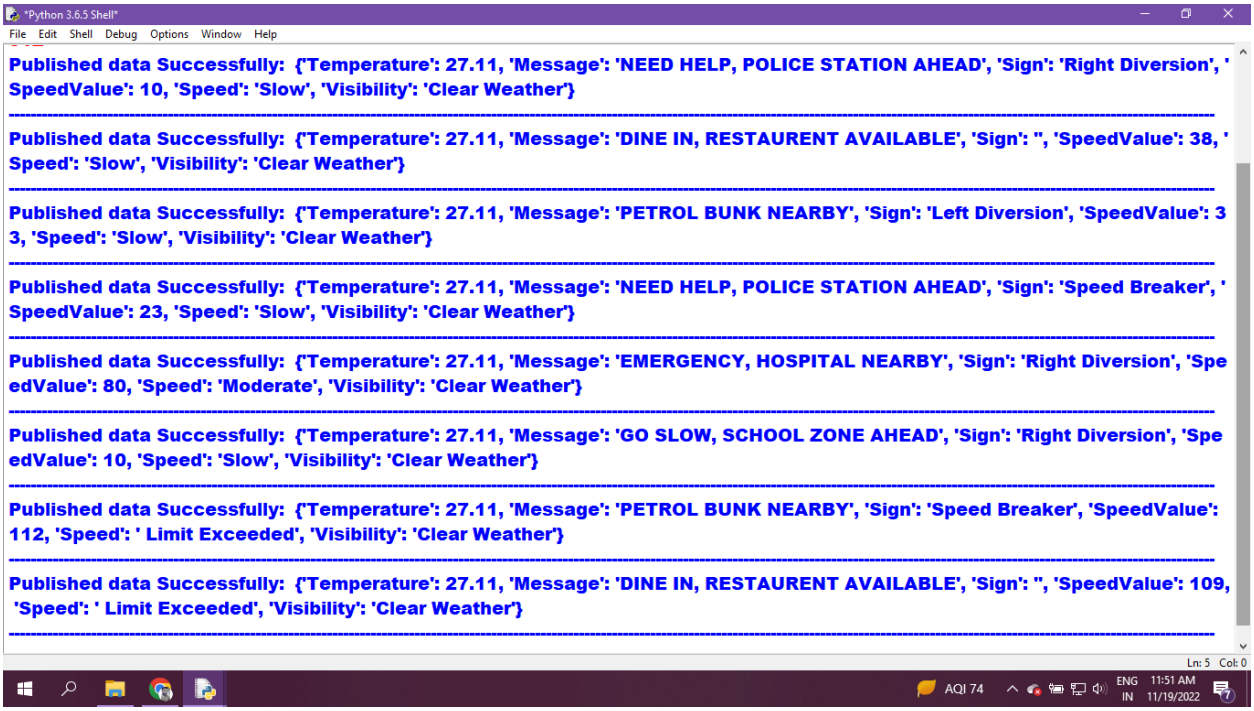
```
    }
}

#Receiving callbacks from IBM IOT platform
def myCommandCallback(cmd):
    print("Message received from IBM IoT Platform: %s" %
cmd.data['command'])
    m=cmd.data['command']

client = wiotp.sdk.device.DeviceClient(config=myConfig,
logHandlers=None)
client.connect()

#OpenWeatherMap Credentials
BASE_URL = "https://api.openweathermap.org/data/2.5/weather?"
CITY = "Salem, IN"
URL = BASE_URL + "q=" + CITY + "&units=metric"+"&appid=" +
"f58e4720c739a54c439aba9b05176839"

while True:
    response = requests.get(URL)
    if response.status_code == 200:
       data = response.json()
       main = data['main']
       temperature = main['temp']
       humidity = main['humidity']
       pressure = main['pressure']
       report = data['visibility']

       #messge part
       msg=random.randint(0,5)
       if msg==1:
           message="GO SLOW, SCHOOL ZONE AHEAD"
       elif msg==2:
           message="NEED HELP, POLICE STATION AHEAD"
       elif msg==3:
           message="EMERGENCY, HOSPITAL NEARBY"
       elif msg==4:
         message="DINE IN, RESTAURENT AVAILABLE"
```

```
        elif msg==5:
            message="PETROL BUNK NEARBY"
        else:
            message=""

         #Speed Limit part
        speed=random.randint(0,150)
        if speed>=100:
            speedMsg=" Limit Exceeded"
        elif speed>=60 and speed<100:
            speedMsg="Moderate"
        else:
            speedMsg="Slow"

         #Diversion part
        sign=random.randint(0,5)
        if sign==1:
            signMsg="Right Diversion"
        elif sign==2:
            signMsg="Speed Breaker"
        elif sign==3:
            signMsg="Left Diversion"
        elif sign==4:
            signmsg="U Turn"
        else:
             signMsg=""

         #Visibility
        if temperature < 24:
            visibility="Fog Ahead, Drive Slow"
        elif temperature < 20:
            visibility="Bad Weather"
        else:
            visibility="Clear Weather"
    else:
        print("Error in the HTTP request")
    myData={'Temperature':temperature, 'Message':message,
'Sign':signMsg, 'SpeedValue': speed, 'Speed': speedMsg,
'Visibility':visibility}
```

```
    client.publishEvent(eventId="status", msgFormat="json",
data=myData, qos=0, onPublish=None) #PUBLISHING TO IOT WATSON
    print("Published data Successfully: ", myData)
    print("-----------------------------------------------------------
------------------------------------------------------------------------
------------------------------------------------------------------------
----------------------")
    client.commandCallback = myCommandCallback
    time.sleep(5)
client.disconnect()
```

**Output** :




*Python 3.6.5 Shell*
File Edit Shell Debug Options Window Help
Published data Successfully: {'Temperature': 27.11, 'Message': 'NEED HELP, POLICE STATION AHEAD', 'Sign': 'Right Diversion', ' SpeedValue': 10, 'Speed': 'Slow', 'Visibility': 'Clear Weather'}
Published data Successfully: {'Temperature': 27.11, 'Message': 'DINE IN, RESTAURENT AVAILABLE', 'Sign': '', 'SpeedValue': 38, ' Speed': 'Slow', 'Visibility': 'Clear Weather'}
Published data Successfully: {'Temperature': 27.11, 'Message': 'PETROL BUNK NEARBY', 'Sign': 'Left Diversion', 'SpeedValue': 3 3, 'Speed': 'Slow', 'Visibility': 'Clear Weather'}
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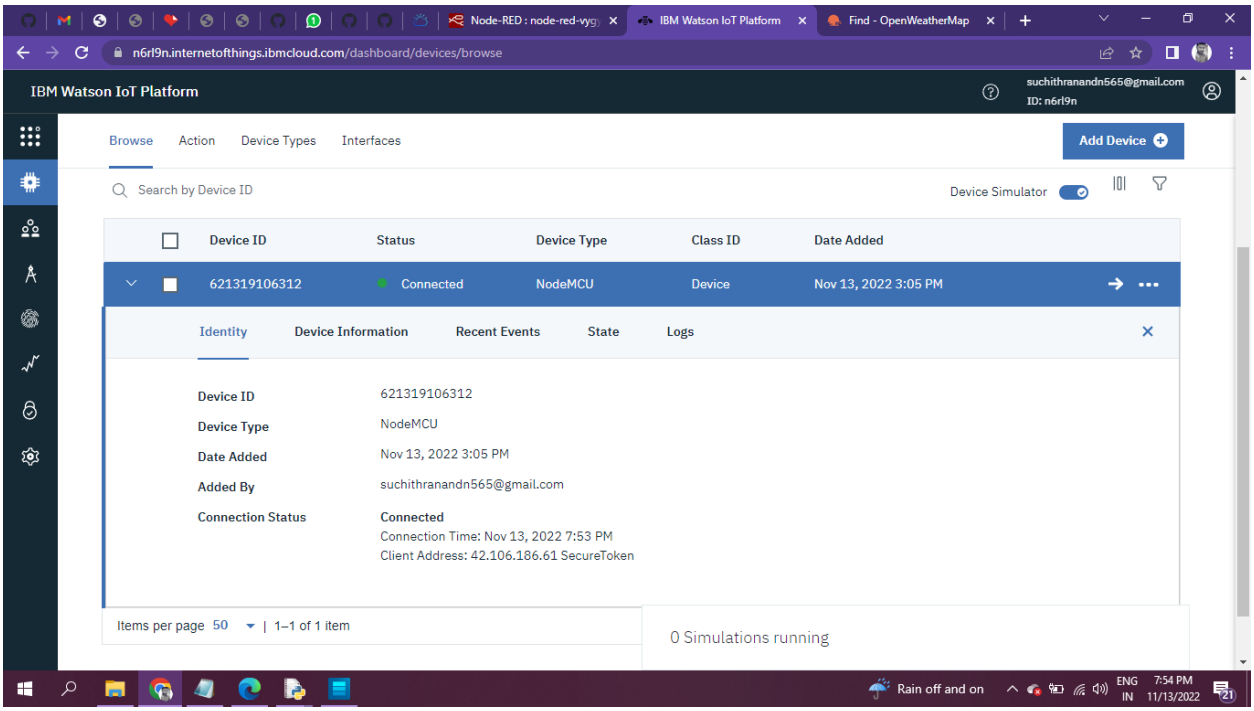
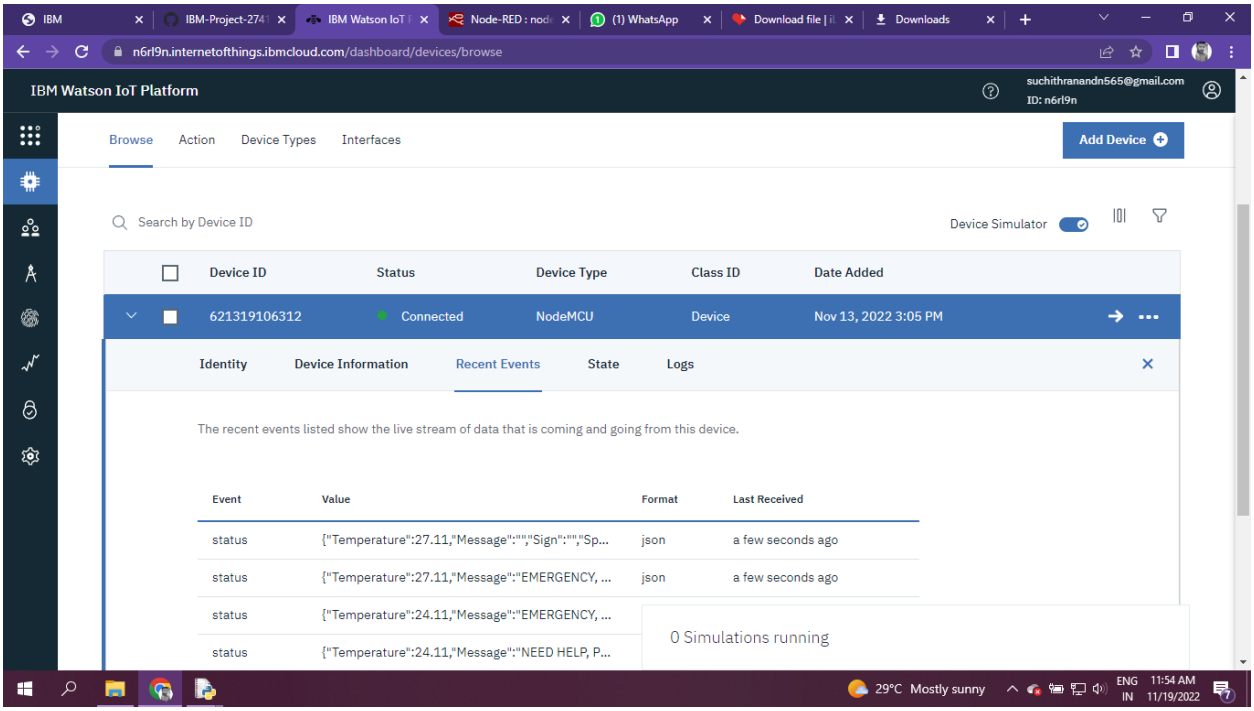
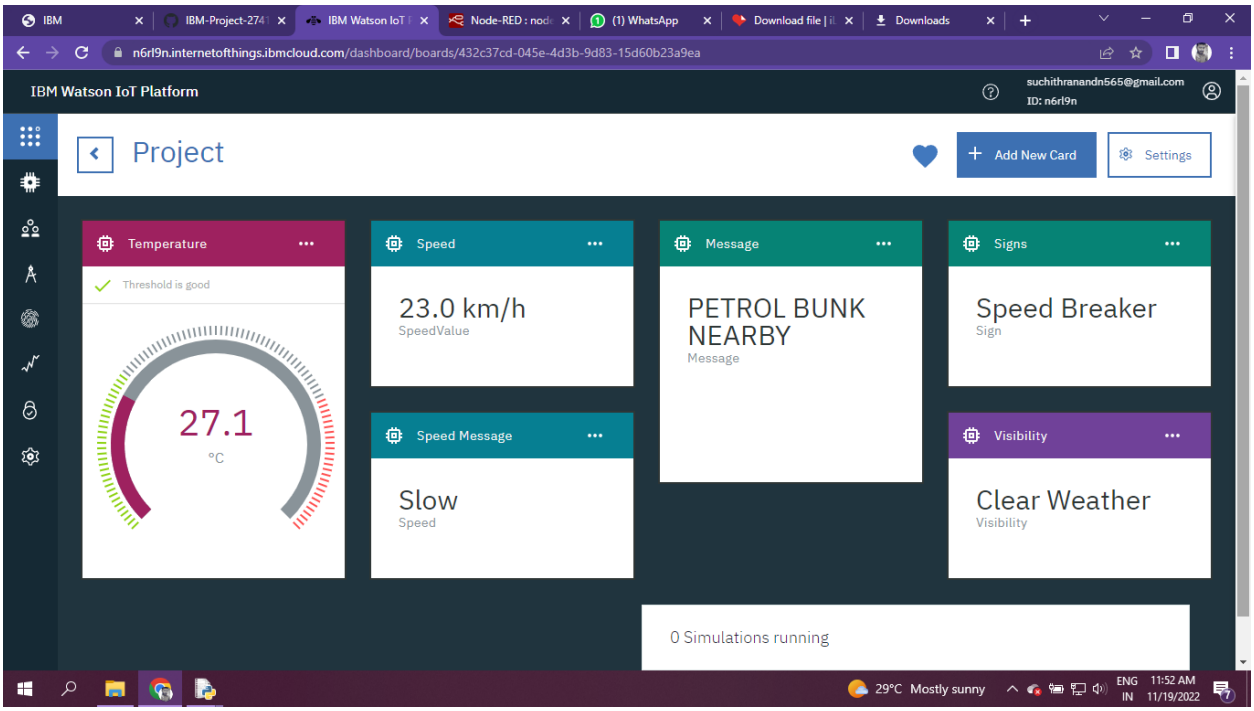
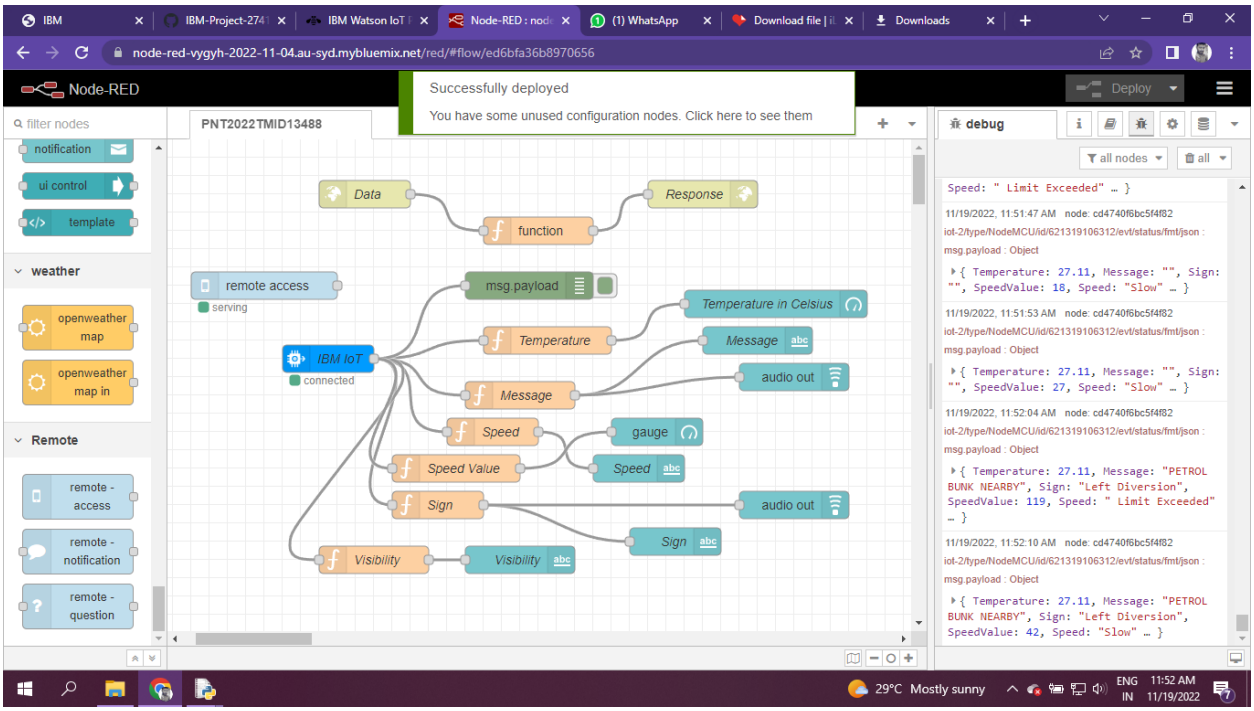
Published data Successfully: {'Temperature': 27.11, 'Message': 'DINE IN, RESTAURENT AVAILABLE', 'Sign': '', 'SpeedValue': 109, 'Speed': ' Limit Exceeded', 'Visibility': 'Clear Weather'}
Ln: 5 Col: 0
AQI 74
ENG IN 11:51 AM 11/19/2022

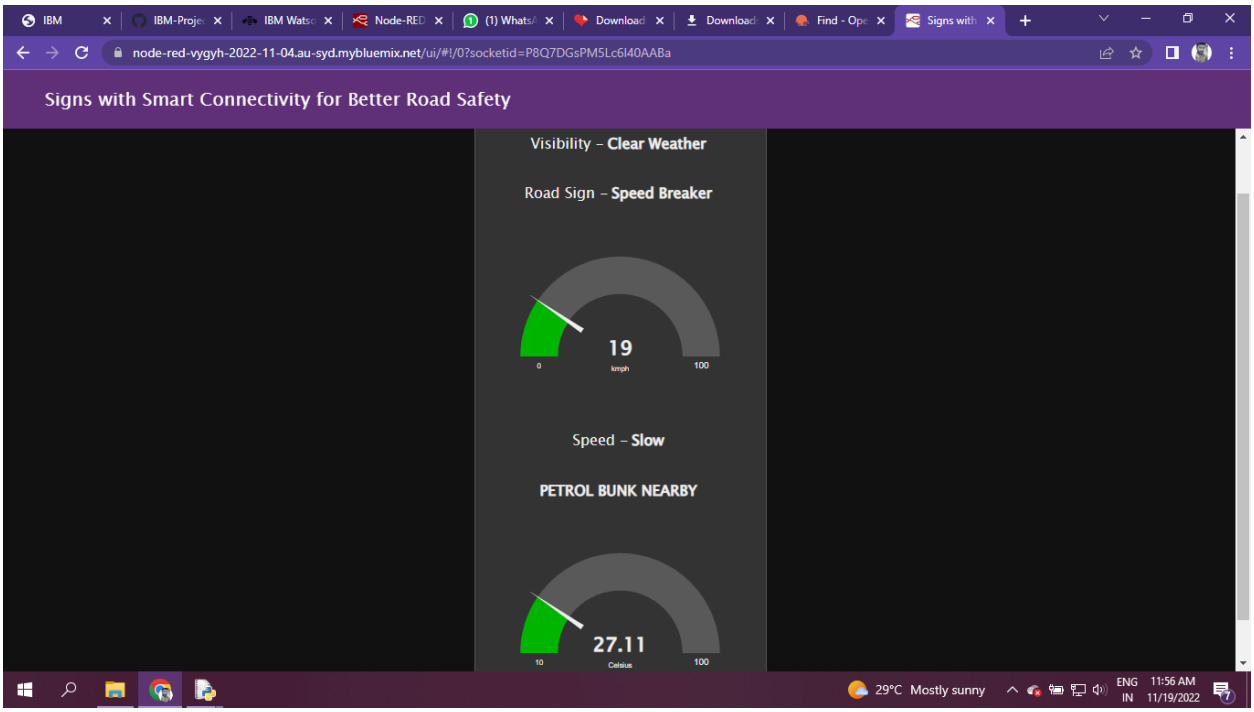

Node-RED : node-red-vyg
IBM Watson IoT Platform
Find - OpenWeatherMap
n6rl9n.internetofthings.ibmcloud.com/dashboard/devices/browse
IBM Watson IoT Platform
suchithranandn565@gmail.com
ID: n6rl9n
Browse Action Device Types Interfaces
Add Device
Search by Device ID
Device Simulator
Device ID Status Device Type Class ID Date Added
621319106312 Connected NodeMCU Device Nov 13, 2022 3:05 PM
Identity Device Information Recent Events State Logs
Device ID 621319106312
Device Type NodeMCU
Date Added Nov 13, 2022 3:05 PM
Added By suchithranandn565@gmail.com
Connection Status Connected
Connection Time: Nov 13, 2022 7:53 PM
Client Address: 42.106.186.61 SecureToken
Items per page 50 | 1–1 of 1 item
0 Simulations running
Rain off and on
ENG IN 7:54 PM 11/13/2022


IBM Watson IoT Platform
suchithranandn565@gmail.com
ID: n6rl9n
Browse
Action
Device Types
Interfaces
Add Device
Search by Device ID
Device Simulator
Device ID
Status
Device Type
Class ID
Date Added
621319106312
Connected
NodeMCU
Device
Nov 13, 2022 3:05 PM
Identity
Device Information
Recent Events
State
Logs
The recent events listed show the live stream of data that is coming and going from this device.
Event
Value
Format
Last Received
status
{"Temperature":27.11,"Message":"","Sign":"","Sp...
json
a few seconds ago
status
{"Temperature":27.11,"Message":"EMERGENCY, ...
json
a few seconds ago
status
{"Temperature":24.11,"Message":"EMERGENCY, ...
status
{"Temperature":24.11,"Message":"NEED HELP, P...
0 Simulations running
29°C Mostly sunny
ENG
IN
11:54 AM
11/19/2022


IBM Watson IoT Platform
suchithranandn565@gmail.com
ID: n6rl9n
Project
Add New Card
Settings
Temperature
Threshold is good
27.1
°C
Speed
23.0 km/h
SpeedValue
Message
PETROL BUNK NEARBY
Message
Signs
Speed Breaker
Sign
Speed Message
Slow
Speed
Visibility
Clear Weather
Visibility
0 Simulations running
29°C Mostly sunny
ENG
IN
11:52 AM
11/19/2022

## 7.2 Feature 2 : (Node-red web UI Output)



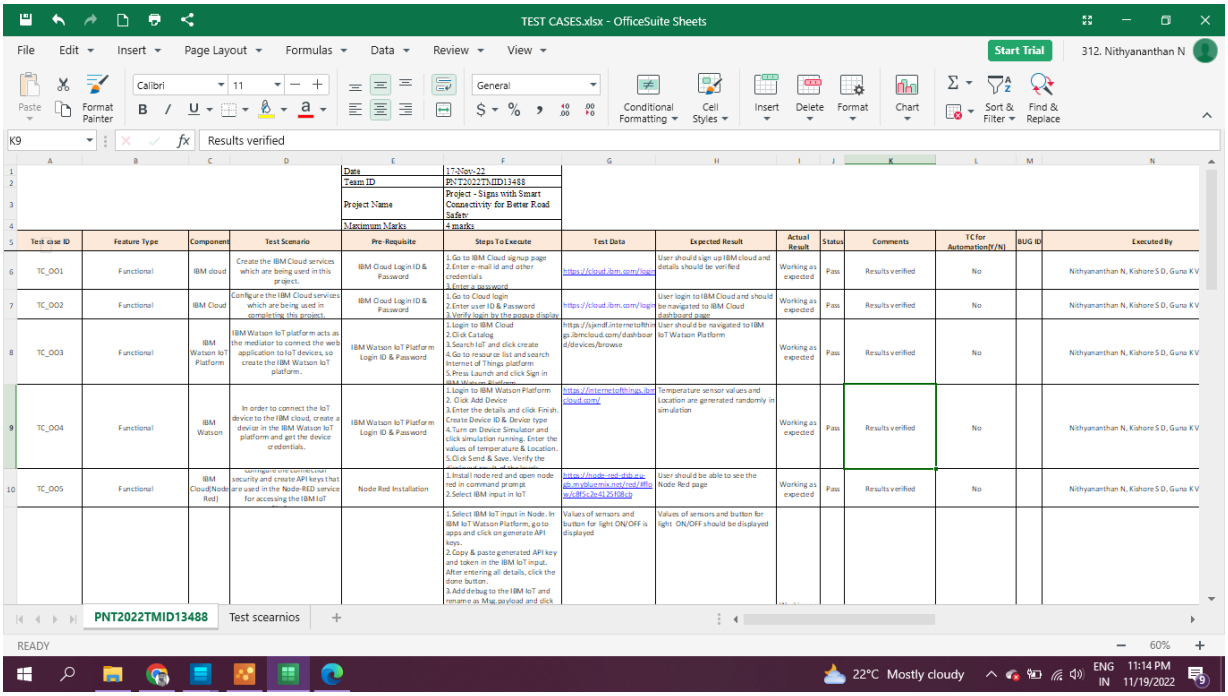






## 8. TESTING :

Test cases help guide the tester through a sequence of steps to validate whether a software application is free of bugs, and working as required by the end-user. Learning how to write test cases for software requires basic writing skills, attention to detail, and a good understanding of the application under test (AUT).

### 8.1 Test Cases :




## 8.2 User Acceptance Testing :

User Acceptance Testing (UAT), also known as beta or end-user testing, is defined as testing the software by the user to determine whether it can be accepted or not. This is the final testing performed once the functional, system and regression testing are completed. The main purpose of this testing is to validate the software against the business requirements. This validation is carried out by the end-users who are familiar with the business requirements. UAT, alpha and beta testing are different types of acceptance testing. As the user acceptance test is the last testing that is carried out before the software goes live, obviously this is the last chance for the customer to test the software and measure if it is fit for the purpose. Need for user acceptance testing arises

once software has undergone Unit, Integration and System testing because developers might have built software based on requirements document by their own understanding and further required changes during development may not be effectively communicated to them, so for testing whether the final product is accepted by client/end-user, user acceptance testing is needed. • Developers code software based on requirements document which is their “own” understanding of the requirements and may not actually be what the client needs from the software. • • Requirements changes during the course of the project may not be communicated effectively to the developers.

Defect Analysis :

This report shows the number of resolved or closed bugs at each severity level, and how they were resolved

| Resolution | Severity 1 | Severity 2 | Severity 3 | Severity 4 | Subtotal |
|---|---|---|---|---|---|
| By Design | 10 | 3 | 2 | 2 | 17 |
| Duplicate | 1 | 1 | 3 | 0 | 5 |
| External | 2 | 1 | 1 | 1 | 5 |
| Fixed | 9 | 2 | 3 | 18 | 32 |
| Non Reproduced | 1 | 1 | 1 | 0 | 3 |
| Skipped | 1 | 1 | 2 | 1 | 5 |
| Won't Fix | 0 | 2 | 1 | 2 | 5 |
| **Totals** | **24** | **11** | **13** | **24** | **72** |

Test case Analysis :

This report shows the number of test cases that have passed, failed, and untested

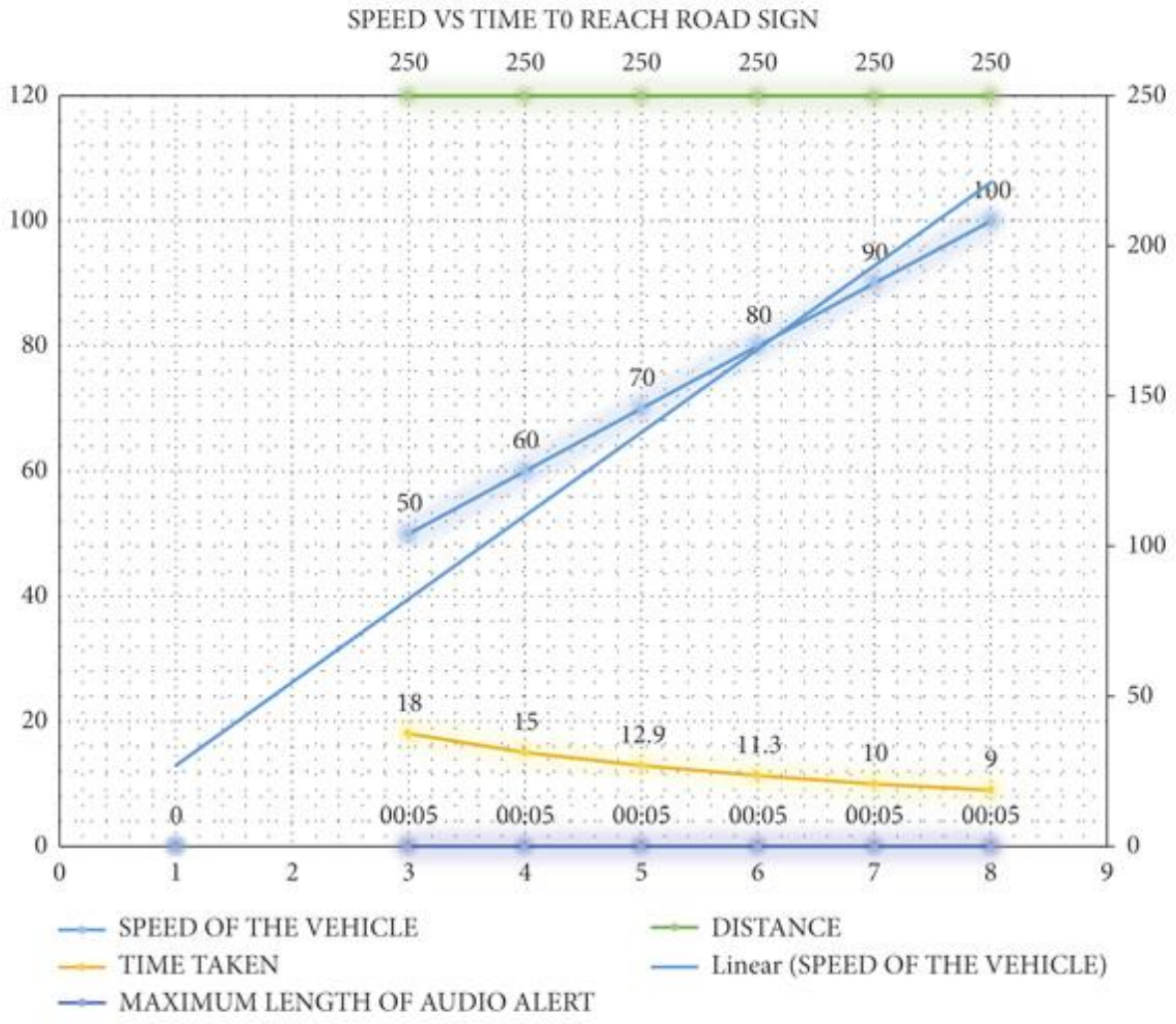
| Section | Total Cases | Not Tested | Fail | Pass |
|---|---|---|---|---|
| Print Engine | 4 | 0 | 1 | 3 |
| Client Application | 42 | 0 | 3 | 39 |
| Security | 3 | 0 | 0 | 3 |
| Outsource Shipping | 3 | 0 | 0 | 3 |
| Exception Reporting | 12 | 0 | 3 | 9 |
| Final Report Output | 6 | 0 | 1 | 5 |
| Version Control | 2 | 0 | 0 | 2 |

The main purpose of UAT is to validate end-to-end business flow. It does not focus on cosmetic errors, spelling mistakes, or system testing. User Acceptance Testing is carried out in a separate testing environment with a production-like data setup. It is a kind of black box testing where two or more end-users will be involved.

## 9. RESULTS :

### 9.1 Performance Metrics :

Performance metrics are defined as figures and data representative of an organization's actions, abilities, and overall quality. There are many different forms of performance metrics, including sales, profit, return on investment, customer happiness, customer reviews, personal reviews, overall quality, and reputation in a marketplace. Performance metrics can vary considerably when viewed through different industries. Performance metrics are integral to an organization's success. It's important that organizations select their chief performance metrics and focus on these areas because these metrics help guide and gauge an organization's success. Key success factors are only useful if they are acknowledged and tracked.



## 10. ADVANTAGES & DISADVANTAGES :

### Advantages :

Connected vehicles have various benefits such as,

- It will manage road conditions, creating a more sustainable environment within cities.
- Multimodal sensors and edge computing help speed up the flow of traffic with real-time processing, reducing congestion and emissions.
- Smart road technology can assist in optimizing traffic flow
- Improved control and safety can be achieved through IoT-enabled cars. In case of over-speeding, the notification gets displayed.
- Ensuring a safe driving experience with real-time assistance, navigation, and even monitoring driving patterns and any emergency. Additionally, along with the state of the traffic, IoT drivers can receive updated information on the state of the roads, i.e., potholes, ice, grade changes, black spots, etc.,

### Disadvantages :

- Security and privacy. Keeping the data gathered and transmitted by IoT devices safe is challenging, as they evolve and expand in use.
- Technical complexity. /
- Connectivity and power dependence.
- Integration.
- Higher costs (time and money)

## 11. CONCLUSION :

The world doesn’t change on its own but we humans can change the world to be safe, better, and harmless. Since the road isn’t said to be safe let’s make it safer with the technologies present and available to us. The Internet of Things is one of the technologies that can lead us to travel on enhanced safe roads. So let's come together to create a better world with no accidents and a smart road for the future generation.

## 12. FUTURE SCOPE :

IoT obtains the majority of its data with the help of connected cars. These incorporate a large number of sensors that establish communication with the cloud, other vehicles, and devices. Thanks to this it provides data and information of great utility for the improvement of road safety. The safe system approach to road safety emphasizes safety by design ensuring safe vehicles, road networks, and road users. Evolving towards the future, the road needs to boil with advanced sensors and antenna systems to have peace with the new era.

## 13. APPENDIX :

### 13.1. Source Code :

```
import wiotp.sdk.device
import time
import random
import ibmiotf.application
import ibmiotf.device
import requests, json

myConfig = {
    #Configuration
    "identity": {
        "orgId": "n6rl9n",
        "typeId": "NodeMCU",
        "deviceId":"621319106312"
    },
    #API Key
    "auth": {
        "token": "9876543210"
    }
}

#Receiving callbacks from IBM IOT platform
def myCommandCallback(cmd):
    print("Message received from IBM IoT Platform: %s" %
cmd.data['command'])
    m=cmd.data['command']

client = wiotp.sdk.device.DeviceClient(config=myConfig,
logHandlers=None)
client.connect()
```

```
#OpenWeatherMap Credentials
BASE_URL = "https://api.openweathermap.org/data/2.5/weather?"
CITY = "Salem, IN"
URL = BASE_URL + "q=" + CITY + "&units=metric"+"&appid=" +
"f58e4720c739a54c439aba9b05176839"

while True:
    response = requests.get(URL)
    if response.status_code == 200:
       data = response.json()
       main = data['main']
       temperature = main['temp']
       humidity = main['humidity']
       pressure = main['pressure']
       report = data['visibility']

       #messge part
       msg=random.randint(0,5)
       if msg==1:
           message="GO SLOW, SCHOOL ZONE AHEAD"
       elif msg==2:
           message="NEED HELP, POLICE STATION AHEAD"
    elif msg==3:
           message="EMERGENCY, HOSPITAL NEARBY"
       elif msg==4:
           message="DINE IN, RESTAURENT AVAILABLE"
       elif msg==5:
           message="PETROL BUNK NEARBY"
       else:
           message=""

        #Speed Limit part
       speed=random.randint(0,150)
       if speed>=100:
           speedMsg=" Limit Exceeded"
       elif speed>=60 and speed<100:
           speedMsg="Moderate"
       else:
           speedMsg="Slow"

        #Diversion part
       sign=random.randint(0,5)
       if sign==1:
           signMsg="Right Diversion"
       elif sign==2:
```

```
            signMsg="Speed Breaker"
        elif sign==3:
            signMsg="Left Diversion"
        elif sign==4:
            signmsg="U Turn"
        else:
             signMsg=""

         #Visibility
        if temperature < 24:
            visibility="Fog Ahead, Drive Slow"
        elif temperature < 20:
            visibility="Bad Weather"
        else:
            visibility="Clear Weather"

    else:
       print("Error in the HTTP request")
    myData={'Temperature':temperature, 'Message':message,
'Sign':signMsg, 'SpeedValue': speed, 'Speed': speedMsg,
'Visibility':visibility}
    client.publishEvent(eventId="status", msgFormat="json",
data=myData, qos=0, onPublish=None) #PUBLISHING TO IOT WATSON
    print("Published data Successfully: ", myData)
    print("------------------------------------------------------------
------------------------------------------------------------------------
------------------------------------------------------------------------
---------------------")
    client.commandCallback = myCommandCallback
    time.sleep(5)
client.disconnect()
```

**13.2. GitHub & Project Demo Link :**

**GitHub Link :**

https://github.com/IBM-EPBL/IBM-Project-2741-1658481981

**Demo Link :** https://youtu.be/2kNmil-wOEg