



Signs With Smart Connectivity for Better Road Safety

IBM

PROJECT REPORT

Submitted by

TEAM ID: PNT2022TMID19266

KISHOR M [722819104062]

KISHORE S M [722819104063]

KRISHNA M [722819104064]

NAVEEN V [722819104087]

In partial fulfilment for the award
of the degree Of

BACHELOR OF ENGINEERING

In

COMPUTER SCIENCE AND ENGINEERING

TABLE OF CONTENT



TABLE OF CONTENT

1. INTRODUCTION

- 1.1 Project Overview
- 1.2 Purpose

2. IDEATION PHASE

- 2.1 Literature Survey
 - 2.1.1 The Safe System Approach
 - 2.1.2 References
- 2.2 Empathy Map
- 2.3 Ideation and Brainstorming
- 2.4 Problem Statement

3. PROJECT DESIGN PHASE - I

- 3.1 Proposed Solution
- 3.2 Problem Solution Fit
- 3.3 Solution Architecture

4. PROJECT DESIGN PHASE - II

- 4.1 Customer Journey
- 4.2 Requirement Analysis
 - 4.2.1 Functional Requirements
 - 4.2.2 Non-Functional Requirements
- 4.3 Data Flow Diagram
- 4.4 Technology Architecture

5. PROJECT DESIGN

- 5.1 Milestone and Activity List
- 5.2 Sprint Delivery Plan

6. PROJECT DEVELOPMENT PHASE

- 6.1 Delivery of Sprint – 1
- 6.2 Delivery of Sprint – 2
- 6.3 Delivery of Sprint – 3
- 6.4 Delivery of Sprint – 4

7. CONCLUSION

ABSTRACT



ABSTRACT

The Safe System (SS) approach to road safety emphasizes safety-by-design through ensuring safe vehicles, road networks, and road users. With a strong motivation from the World Health Organization (WHO), this approach is increasingly adopted worldwide. Considerations in SS, however, are made for the medium-to-long term. Our interest in this work is to complement the approach with a short-to-medium term dynamic assessment of road safety. Toward this end, we introduce a novel, cost-effective Internet of Things (IoT) architecture that facilitates the realization of a robust and dynamic computational core in assessing the safety of a road network and its elements. In doing so, we introduce a new, meaningful, and scalable metric for assessing road safety. We also showcase the use of machine learning in the design of the metric computation core through a novel application of Hidden Markov Models (HMMs). Finally, the impact of the proposed architecture is demonstrated through an application to safety-based route planning.

CHAPTER 1

INTRODUCTION

The primary method of connecting cities and villages is through roads. Due to how simple it is to go by road, cars are now the most common mode of transportation. The vehicle accidents (Vas) are more likely now since there are more automobiles on the road. When travelling, especially in inclement weather, one never knows what may happen on the next road (BWC). Due to the poor sight, driving can be challenging in this circumstance and may result in an accident. Additionally, it was shown that in BWC, informational delays might lead to multiple vehicle accidents (MVCs), which are dangerous.

According to one research by the Islamabad police, there were 9582 accidents between 2016 and 2017 involving 11,317 cars nationwide in Pakistan, which resulted in 5047 fatalities and 12,696 injuries.

Road safety regulations are changing as a result of digital technology like the Internet of Things (IoT). Around the world, several technological projects are being done to create smarter, safer roadways that can communicate with both vehicles and pedestrians. Several technology-based solutions have been created upon the presumption that accidents may be avoided by providing the driver with information about vehicle technology. The Internet of Things provides the foundation for the newest technologies that academics are developing (IoT). Data is the key to IoT. The world is starting to value data as a resource.

IoT has being embraced by many sectors and companies to enhance communication, manufacturing, energy, and health care performance while reducing mistakes. In its "Save LIVES: Road Safety Technical Package," the WHO lists many actions that can be taken with little financial impact. Realizing economic systems for "monitoring road safety by enhancing data systems" is a cornerstone of these measures.

Meanwhile, a prominent element in the package is encouraging the use of a Safe System approach, which is a comprehensive approach to road safety that differs from standard management methods by stressing safety by design.

Mobile phone applications identify the speed limit depending on environmental conditions using built-in sensor data.

The main contributions of this research are

1. A brief overview of the state of the art in pre-accident and post-accident models, frameworks, and techniques;
2. Identifying and disclosing limitations in prior research on accident detection;
3. The notion of a smart road with event sensing capabilities, as well as its implementation and testing through numerous tests;
4. An innovative and contemporary technique for communicating with adjacent vehicles and EOCs and promptly detecting accidents is demonstrated.

If an incident is not reported to an EOC in a timely manner, there may be an increased risk of fatalities, injuries, and other harm. By delivering timely accident information via an automated process, lives can be saved. Additionally, an alarm system and speedy car collision detection are needed to safeguard approaching automobiles from an MVC. In order to prevent accidents, a number of strategies have been used in advanced vehicles (Avs). A threat of an accident is identified using either smartphone sensors or sensors fitted in automobiles. Accelerometers, smoke detectors, IR obstacle sensors, proximity sensors, and biosensors have all been employed by earlier researchers to identify accidents.

1.1 Project Overview:

The main goal of this project is to assist people in automating the roads by giving them access to a Web App that allows them to track road conditions like temperature, speed limit, and visibility. Additionally, they provide services for displaying signage for restaurants, hospitals, and school guides.

1.2 Purpose:

Many scholars and practitioners are engaged in extensive research in the areas of accident prevention and accident alarms. Numerous methods are used to improve safety in order to prevent accidents. The literature on accident detection and avoidance is divided into stand-alone, cooperative, and hybrid techniques for convenience of reference. While cooperative systems rely on V2X technology and hybrid approaches, stand-alone approaches employ sensors for accident avoidance and detection, such as radar and light detection and ranging (LiDAR).

CHAPTER 2

IDEATION PHASE

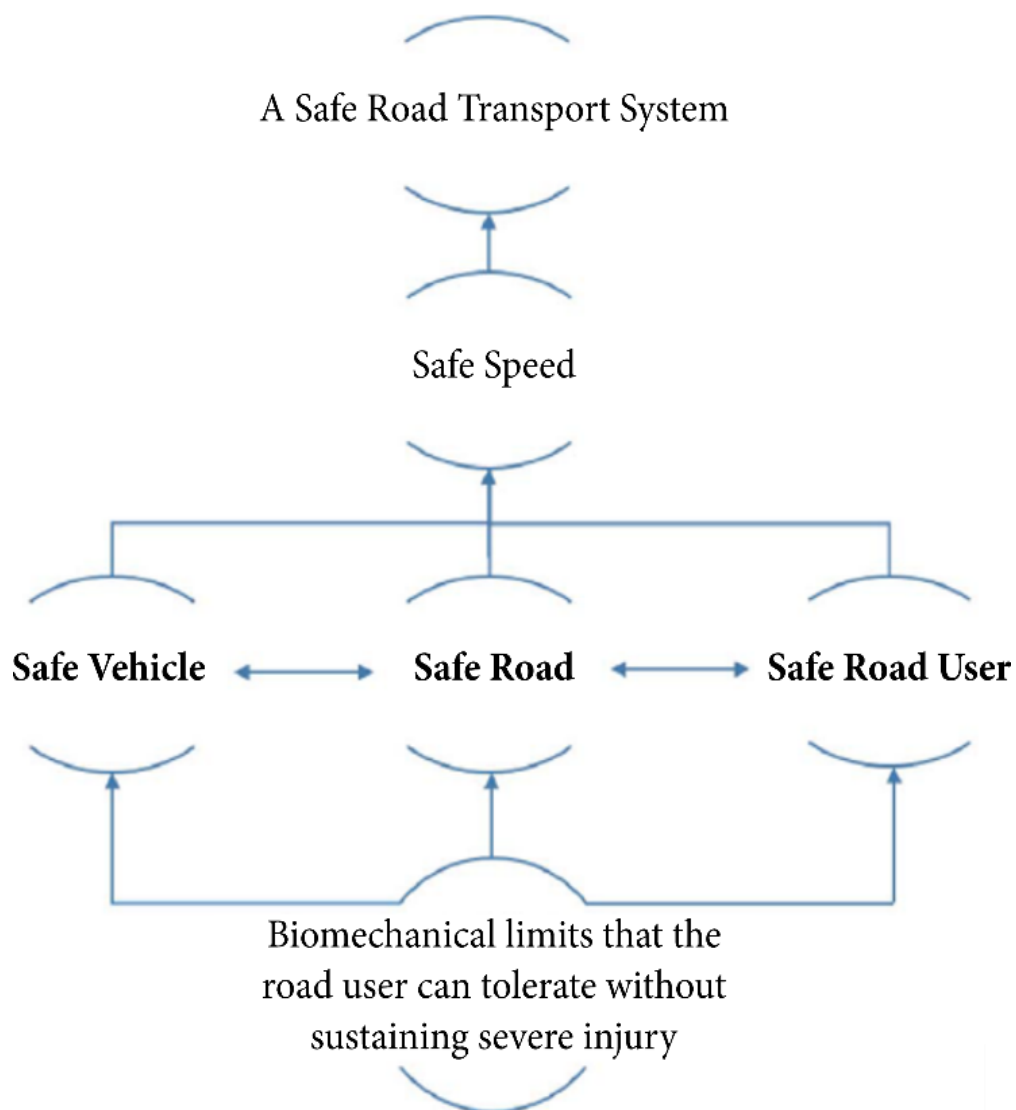
2.1 LITERATURE SURVEY

In its Global Status Report on Road Safety – 2015, the World Health Organization (WHO) noted that the worldwide total number of road traffic deaths has plateaued at 1.25 million per year, with tens of million either injured or disabled. Different initiatives, such as the United Nations’ initiative for the 2011-2020 Decade of Action for Road Safety, have led to improvements in road safety policies and enforcements. However, the WHO notes that the progress has been slow and has maintained the call for urgent action to reduce these.

Added to the losses in human lives and wellbeing, considerable monetary losses are incurred in medical expenses, infrastructure repair, and production downtime. While the worldwide figures have plateaued, the Global Status Report does indicate higher road fatalities and injuries in low-income countries. Such disparity, as noted in, signals a barring-limitation in low-income countries to improve road-safety by adopting solutions implemented in high-income countries.

2.1.1 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 for 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.

Elements of the SS approach are as follows:

(1) Safe Vehicle: Emphasis on vehicle safety is verified through mandated regulatory testing and rating, as well as technologies such as electronic stability control. Beyond this, enforced checks (e.g., upon license renewals) combined with on the road reporting work to review the status of vehicle safety.

(2) Safe Road: The assessment of road (or road network) safety is multifaceted. Road inspection enables clear and direct observation of the state of the road and assesses the need for repairs or modifications. The structure of the road network is amenable to safety assessment through partitioning into what is called “Traffic Analysis Zones (TAZs)”. In addition, considerations for crash data and other supporting data offer further insights into general safety assessment. In 2011, the European Road Assessment Programme (EuroRAP) generated the European Road Safety Atlas for EU countries. The atlas indicated the safety level of roads with a star rating based on specially equipped vehicles for multimedia-based data aggregation. The EuroRAP efforts continue to implement an SS approach across the EU, along with several other national programmers within the International RAP, or iRAP, initiative.

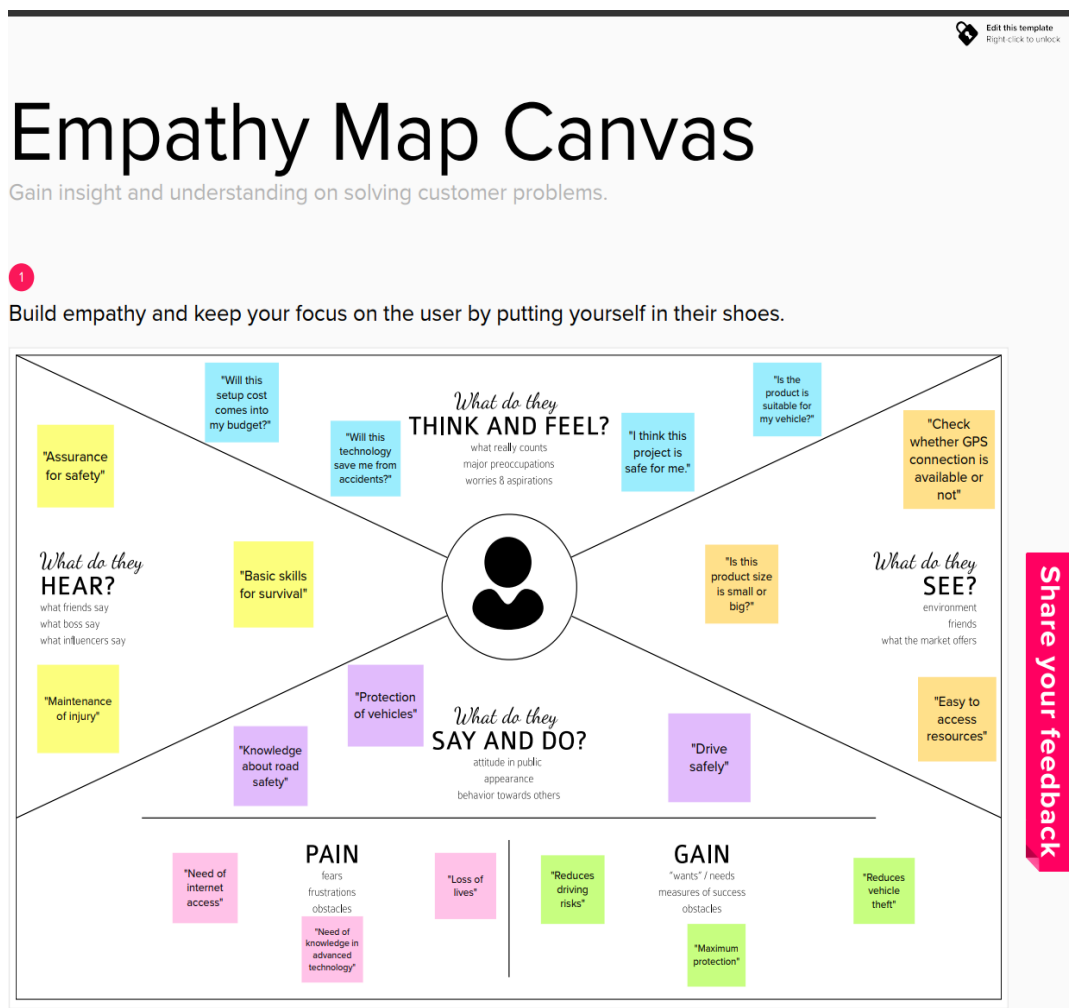
(3) Safe Road User: There are several aspects to road user safety, including measures for education and awareness, travel distance, exposure, licensure, enforcement, and sober driving. The need for such characterization rises substantially as the findings of crash report analysis in cities typically note a critical dependence on either driver behavior or driver awareness. A great need is further established in these studies for innovative mechanisms to instill safe driving at the licensing and post-licensing stages.

2.1.2 References

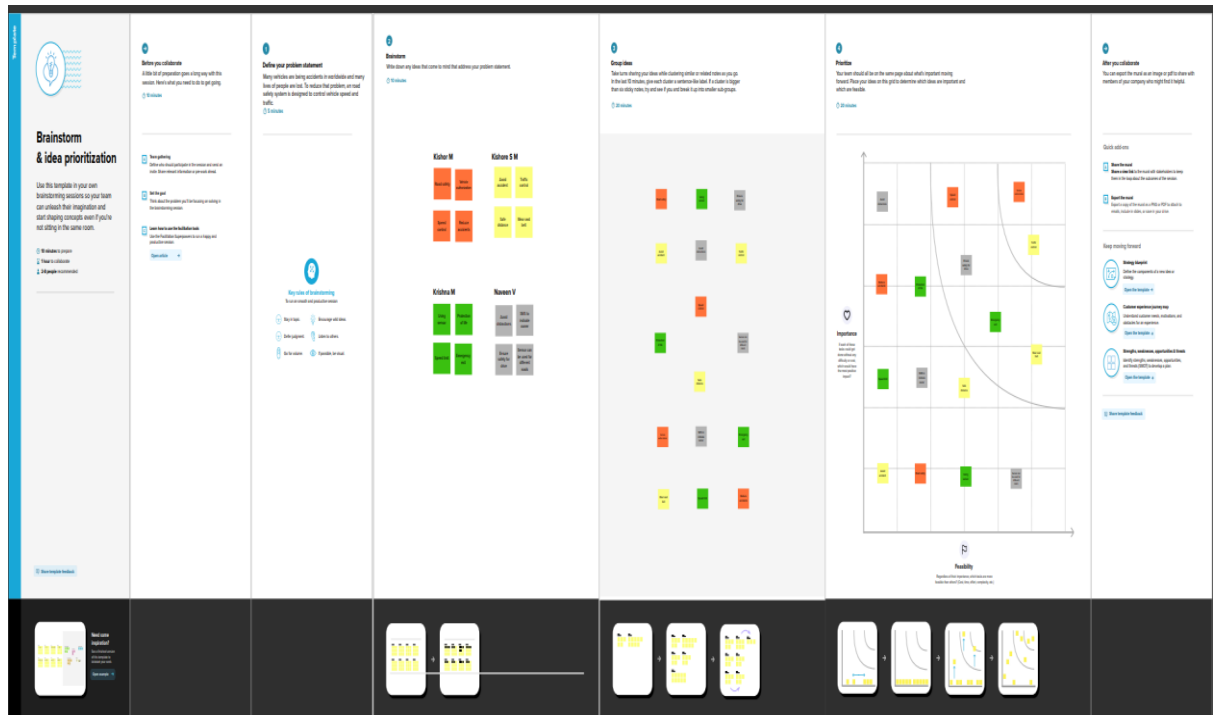
1. World Health Organization, “Global status report on road safety 2015,” https://www.who.int/violence_injury_prevention/road_safety_status/2015/en/. View at: Google Scholar
2. World Health Organization, “Decade of Action for Road Safety 2011-2020 seeks to save millions of lives,” http://www.who.int/roadsafety/decade_of_action/en/. View at: Publisher Site | Google Scholar
3. F. Wegman, “The future of road safety: A worldwide perspective,” *IATSS Research*, vol. 40, no. 2, pp. 66–71, 2017. View at: Publisher Site | Google Scholar
4. World Health Organization, “Save LIVES - A road safety technical package,” 2017. View at: Google Scholar
5. W. E. Marshall, “Understanding international road safety disparities: Why is Australia so much safer than the United States?” *Accident Analysis & Prevention*, vol. 111, pp. 251–265, 2018. View at: Publisher Site | Google Scholar
6. “Open Street Maps, with New York County highlighte,” <https://www.openstreetmap.org/relation/2552485>. View at: Google Scholar
7. United States Census Bureau, “TIGER/Line® Shapefiles:Roads,” <https://www.census.gov/cgi-bin/geo/shapefiles/index.php?year=2018&layergroup=Roads>. View at: Google Scholar
8. X. Wang, X. Wu, M. Abdel-Aty, and P. J. Tremont, “Investigation of road network features and safety performance,” *Accident Analysis & Prevention*, vol. 56, pp. 22–31, 2013. View at: Publisher Site | Google Scholar
9. European Road Assessment Program (EuroRAP), “European Road Safety Atlas,” <http://atlas.eurorap.org/>. View at: Google Scholar
10. European Road Assessment Programme (EuroRAP), “Star Ratings,” <http://www.eurorap.org/protocols/star-ratings/>. View at: Google Scholar
11. International Road Assessment Programme (iRAP), “iRAP,” <https://www.irap.org/>. View at: Google Scholar
12. H. M. Hassan and H. Al-Faleh, “Exploring the risk factors associated with the size and severity of roadway crashes in Riyadh,” *Journal of Safety Research*, vol. 47, pp. 67–74, 2013. View at: Publisher Site | Google Scholar

- 13.E. Ahmed, I. Yaqoob, A. Gani, M. Imran, and M. Guizani, "Internet-of-things-based smart environments: State of the art, taxonomy, and open research challenges," IEEE Wireless Communications Magazine, vol. 23, no. 5, pp. 10–16, 2016. View at: Publisher Site | Google Scholar
- 14.Y. Mehmood, F. Ahmad, I. Yaqoob, A. Adnane, M. Imran, and S. Guizani, "Internet-ofThings-Based Smart Cities: Recent Advances and Challenges," IEEE Communications Magazine, vol. 55, no. 9, pp. 16–24, 2017. View at: Publisher Site | Google Scholar
- 15.AARONIA, "GPS Logger including Gyro / Tilt / Compass & Accelerometer," <https://www.aaronia.com/products/spectrum-analyzers/gps-logger/>. View at: Google Scholar

2.2 Empathy Map



2.3 Ideation and Brainstorming



2.4 PROBLEM STATEMENT

In this modern world, the people want everything to be faster than the usual speed. In case of road traffic, the people want to decrease their time to travel to their destination. Also, there are some crazy people who likes doing stunts using motorcycles in public roads. As a result, many people died due to such activities. The main reason for 90% of road accidents that are happened in the world is overspeed. To reduce such accidents our project will be the best solution. This project is based on IoT Arduino which senses the road and identify what type of road it is. Like a Highway or an Offroad or a city road. Based on the roads the sensor scans, the limit of the top speed of the vehicle will be changed. So that the people can't drive the vehicle more than the top speed. This project is used for the avoiding the road accidents made by overspeed. Also, the project has an additional feature which can avoid vehicle theft. The project contains an

authorization system through which the vehicle can be accessed using the person's driving license. By implementing this project to the world, the rate of road accidents will be reduced and the theft rate of high-cost vehicle will become 0. This project will be the best solution for such road transport activities.

CHAPTER 3

PROJECT DESIGN PHASE – I

3.1 Proposed Solution

| S.No | Parameter | Description |
|------|--|--|
| 1. | Problem Statement (Problem to be solved) | The real issue is that motorists cannot determine whether the road conditions are safe for travel or not. Therefore, there will be a need for guide data to ensure safety and to prevent inconveniences when travelling to the location. |
| 2. | Idea / Solution description | The solution to this issue is introducing the IR and GPRS Modules Traffic-sensing camera and sensor intensity even in shadowy places. Indicating weather on the same sign boards for drivers in areas where the weather is unpredictable and replacing the painted, man- made signs with digital ones that are more visible than the current ones. |
| 3. | Novelty / Uniqueness | The location of the display board is adjusted to the traffic signal area, and voice indications are put nearby. As soon as it detects surrounding vehicles, it will alert the general public to any potential traffic hazards. |
| 4. | Social Impact / Customer Satisfaction | If people are informed about traffic indicators, they are unaware that it digitally displays signs to avoid. Based on the accidents and weather indicators IOT is used to prevent accidents and primarily benefits two-wheeler riders. |
| 5. | Business Model (Revenue Model) | Both public and commercial sectors can use the systems, which generates considerable money. |

| | | |
|----|-----------------------------|--|
| 6. | Scalability of the Solution | It improves the quality of life for both drivers and passengers. By including more features, the product may be scaled to generate more revenue. |
|----|-----------------------------|--|

3.2 Problem Solution Fit

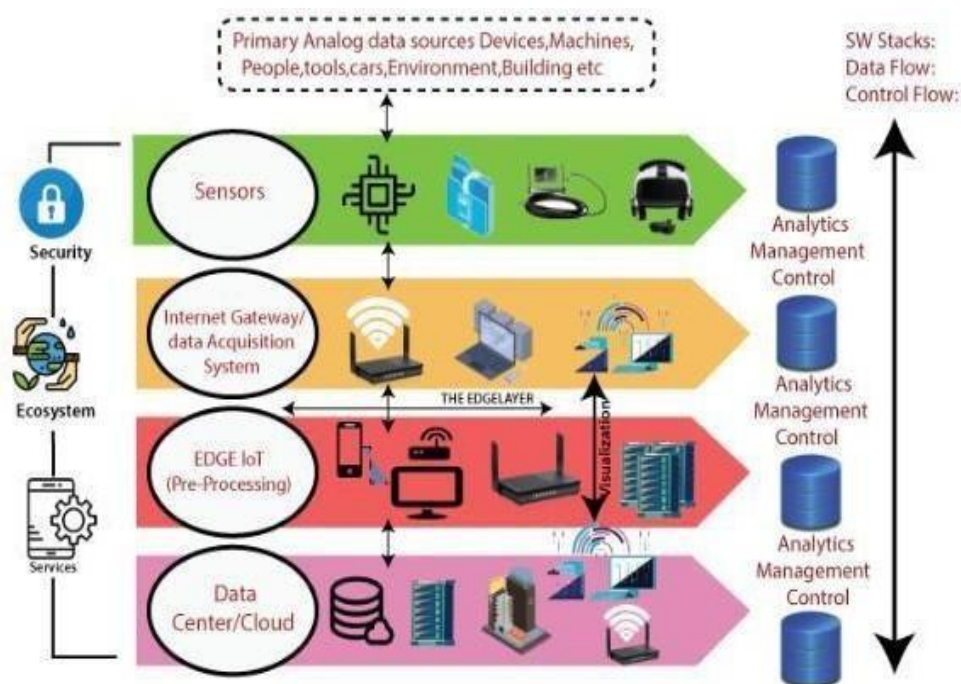
| Project Title: Signs With Smart Connectivity for Better Road Safety | | Project Design Phase-I - Solution Fit Template | | Team ID: PNT2022TMID19266 | |
|---|--|---|---|-----------------------------------|---|
| Define CS, fit into CC | 1. CUSTOMER SEGMENT(S) <small>Who is your customer? i.e. working parents of 0-5 y.o. kids</small> CS | 6. CUSTOMER CONSTRAINTS <small>What constraints prevent your customers from taking action or limit their choices of solutions? i.e. spending power, budget, no cash, network connection, available devices.</small> CC | 5. AVAILABLE SOLUTIONS <small>Which solutions are available to the customers when they face the problem or need to get the job done? What have they tried in the past? What pros & cons do these solutions have? i.e. pen and paper is an alternative to digital notetaking</small> AS | Explore AS, differentiate | |
| | 1.Traveller 2. This is helpful for drivers who are using various types of road infrastructure. | 1. A crucial and unanticipated aspect of the experiments was the network's impact. 2. This IoT-based system was successful in mimicking a large-scale smart agricultural environment given the number of sensors. | Static signs with clear directions are placed as viable solutions along roads. | | |
| Focus on J&P, tap into | 2. JOBS-TO-BE-DONE / PROBLEMS <small>Which jobs-to-be-done (or problems) do you address for your customers? There could be more than one; explore different sides.</small> J&P | 9. PROBLEM ROOT CAUSE <small>What is the real reason that this problem exists? What is the back story behind the need to do this job? i.e. customers have to do it because of the change in regulations.</small> RC | 7. BEHAVIOUR <small>What does your customer do to address the problem and get the job done? i.e. directly related: find the right solar panel installer, calculate usage and benefits; indirectly associated: customers spend free time on volunteering work (i.e. Greenpeace)</small> BE | Focus on J&P, tap into | C |
| | 1. It educates people about traffic signs who are travelling in roads 2. The Smartboard Connectivity is responsible for a variety of tasks, including maintaining accurate temperature sensor readings and telling the board of the speed of the customer's car. | If there was no internet connection, the speed limit wouldn't change based on weather sensor readings. Some persons may cause issues by hitting the accident indicator button unnecessarily. | The smart weather condition detection and digital signs that educate the public aid the client in resolving issues and completing tasks. | | |
| Identify strong TR & EM | 3. TRIGGERS <small>What trigger customers to act? i.e. seeing their neighbour installing solar panels, reading about a more efficient solution in the news.</small> TR | 10. YOUR SOLUTION <small>If you are working on an existing business, write down your current solution first, fill in the canvas, and check how much it fits reality. If you are working on a new business proposition, then keep it blank until you fill in the canvas and come up with a solution that fits within customer limitations, solves a problem and matches customer behaviour.</small> SL | 8. CHANNELS OF BEHAVIOUR 8.1 ONLINE <small>What kind of actions do customers take online? Extract online channels from #7</small> CH | Extract online & offline CH of BE | |
| | The weather conditions can be unpredictable at times. So that those using the roads or highways can see temperature figures. 4. EMOTIONS: BEFORE / AFTER <small>How do customers feel when they face a problem or a job and afterwards? i.e. lost, insecure > confident, in control - use it in your communication strategy & design.</small> EM | 1. As an alternative to static signboards, we use smart linked sign boards. These smart connected sign boards automatically update with the most recent speed limits thanks to a web app and weather API. Depending on the weather, the speed may increase or decrease. 2. Traffic and possibly fatal circumstances dictate whether or not diversion signs should be displayed. | 8.2 OFFLINE <small>What kind of actions do customers take offline? Extract offline channels from #7 and use them for customer development.</small> Customers can SMS or call a toll-free hotline to provide feedback. | | |

3.3 SOLUTION ARCHITECTURE

- Smart connected sign boards are used to replace static signboards.
- These intelligent, connected sign boards receive automatic updates of the speedlimits from a web application using weather API
- The speed could go up or down depending on the weather.
- The display of the diversion signs depends on the flow of traffic and potential fatalities.

Additionally, the appropriate guide (for schools), warning (for hospitals), and service(for restaurants) signs are posted.






Example - Solution Architecture Diagram:



CHAPTER 4

PROJECT DESIGN PHASE - II

4.1 CUSTOMER JOURNEY

| |  Entice How does someone initially become aware of this process? |  Enter What do people experience as they begin the process? |  Engage In the core moments in the process, what happens? |  Exit What do people typically experience as the process finishes? |  Extend What happens after the experience is over? |
|--|---|--|--|--|---|
| Stages What does the person (or group) typically experience? | Customer sees multiple traffic signs and data Customer must have sign-off before road driving | They were got ready to follow a route that guides them through towards safety Get prepared at road of construction | Road display condition of road will be updated with the help of data along sensor Provide a collection of data about traffic area Speed limits also be submitted | People have information with regard to published instruction Lane that present and automatic updates are displayed Record traffic, offenses & provide existing data | |
| Interactions What interactions do they have at each step along the way? • People: Who do they see or talk to? • Things: What digital touchpoints or physical objects would they use? | Interaction with digital sign board Sign boards, connected with sensor data | Features include access about the road People will get updates with the traffic condition | Provide geo-functional record of specific voice note Collecting information displayed on LED display | Dynamic sign board system helps to allow people pending day in day complexities Updates are done with two main pages & auto updates through sensors Monitoring road events & display even in dark & low light area Provide traffic sensor along key detours | |
| Goals & motivations At each step, what is a person's primary goal or motivation? ("Help me," "Let help me avoid...") | Help to reduce road condition & safe to ride Help to know the condition and other about the way | Make a feel as possible Enable the customer to know an early warning, making necessary | Customer will be able to report their journey with their updates on traveling | To provide a communication warning to the road city monitor Help to reduce the condition safety or fast time To provide a communication from traffic management | |
| Positive moments What steps does a typical person find enjoyable, productive, fun, motivating, enlightening, or exciting? | Get more responses of road city monitoring Visual effect makes right information | Make a travel possible | Prediction of data gives them a fair understanding help them to travel with a level of speed | Flow of updates is quick and easy Getting more information Make good decision into movement | |
| Negative moments What steps does a typical person find frustrating, confusing, angering, costly, or time-consuming? | It is so difficult to understand, when are connected to sign | Accessing of information takes some time | Lack of notes describing the analysis into confusing route | Maintenance only There is chance of error in the transfer of data Is it trust worthy? | |
| Areas of opportunity How might we make each step better? What ideas do we have? What have others suggested? | Help to measure different moments the responses of road | Making the travel safe through the road navigation | Improve the road safety measures | Data is useful in understanding the road user behavior & flow of traffic To alert the drivers to reduce delay & congestion while traveling time | |

4.2 REQUIREMENT ANALYSIS

4.2.1 FUNCTIONAL REQUIREMENTS

Following are the functional requirements of the proposed solution.

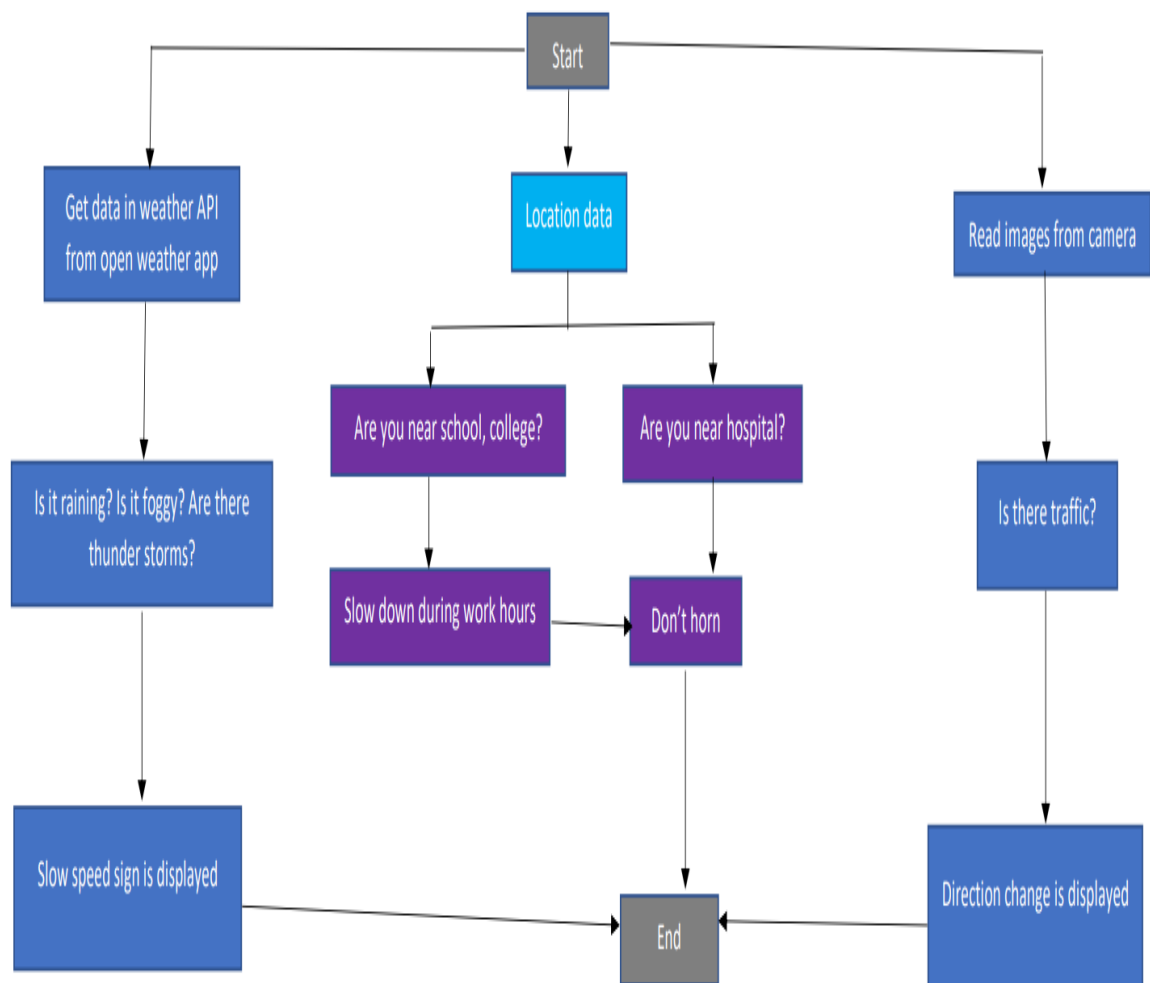
| FR No. | Functional Requirement (Epic) | Sub Requirement (Story / Sub-Task) |
|---------------|--------------------------------------|---|
| FR-1 | User Visibility | Sign boards should be built with LEDs that are colorful and brilliant in order to catch drivers' attention, but they shouldn't be too distracting or dazzling because that could cause accidents. |
| FR-2 | User Need | To reduce user confusion when travelling, smart sign boards should be put more frequently where they are needed and less frequently where they are not. |
| FR-3 | User Understanding | The signs should be big, clear, and legible to help the motorist understand them. They can also incorporate images to help the driver understand the instructions even better. |
| FR-4 | User Convenience | The display ought to be large enough to be readily visible even from a distance. |
| FR-5 | User Confirmation | Phone Confirmation, Email confirmation, OTP authentication. |

4.2.2 Non-Functional Requirements

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

| FR No. | Non-Functional Requirement | Description |
|---------------|-----------------------------------|---|
| NFR-1 | Usability | Will offer a self-explanatory product that is easy to use and clear product instructions. |
| NFR-2 | Security | Cloud data needs to stay within the network, collapsing needs to be avoided in real time, and the board will be closely watched at all times. |
| NFR-3 | Reliability | Hardware will undergo regular testing. |
| NFR-4 | Performance | The user experience on the smart board must be improved, and the output must be accurate. |
| NFR-5 | Availability | Depending on the requirements of the client, all features and user requests will be met. |
| NFR-6 | Scalability | It should be simple to modify and update in response to changes in requirements and needs. |

4.3 Data Flow Diagram



4.4 Technology Architecture

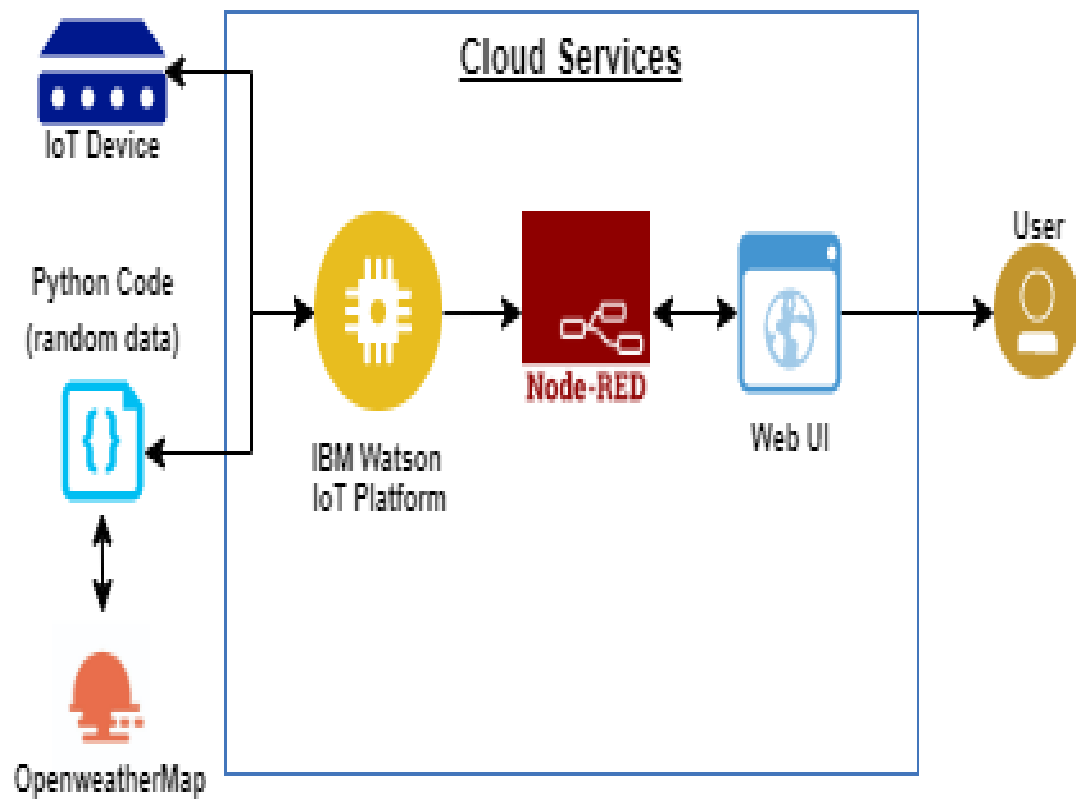


Table 1: Components & Technologies

| S.No | Component | Description | Technology |
|------|---------------------|---|----------------------------|
| 1. | User Interface | How must we communicate with the application | Python |
| 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. | Cloud Database | Cloud service with a database | IBM DB2, IBM Cloudant etc. |
| 6. | External API-1 | Purpose of External API used in the application | IBM Weather API, etc. |

Table 2: Application Characteristics

| S.No | Characteristics | Description | Technology |
|------|--------------------------|--|---|
| 1. | Open-Source Frameworks | List the open-source frameworks used | Technology of Opensource framework |
| 2. | Security Implementations | No one will have access to this without login information with very high security system | Firebase, Firewall, Cyber resiliency strategy |
| 3. | Scalable Architecture | By expanding the operating system's bandwidthrange may be expanded | IOT Internet |
| 4. | Availability | Available 24/7 | IBM Cloud |
| 5. | Performance | It can accommodate many users at once.utilising the technologies | IBM Cloud |

CHAPTER 5

PROJECT PLANNING PHASE

5.1 Milestone and Activity List

| TITLE | DESCRIPTION | DATE |
|-----------------------------|---|-------------------|
| Literature Survey | Literature Survey is done with help of some research paper which is available in websites. | 15 SEPTEMBER 2022 |
| Empathy Map | Empathy Map design is fully based on customer point of view. | 15 SEPTEMBER 2022 |
| Ideation | Our teammates work were work together to provide conceptual ideas towards brainstorm and idea prioritization. | 17 SEPTEMBER 2022 |
| Problem Statement | Problem Statement is entirely made with different perspective of customer requirement and issue based. | 17 SEPTEMBER 2022 |
| Proposed Solution | The proposed solution contains information such as ideas for satisfying customer satisfaction and providing a highly scalable business model as parameters. | 19 SEPTEMBER 2022 |
| Problem Solution Fit | Problem Solution Fit explore the customer behaviour and experience. | 24 SEPTEMBER 2022 |

| | | |
|--------------------------------------|--|-------------------|
| Solution Architecture | Solution Architecture fully focused on components and technology of our project. | 19 SEPTEMBER 2022 |
| Customer Journey | Customer Journey helps to analyze user interaction and kind of moments to attain the needs. | 12 OCTOBER 2022 |
| Functional Requirement | It is accomplished with task classification of functional requirement and non-functional requirement. | 18 OCTOBER 2022 |
| Data Flow Diagram | According to Data Flow Diagram exhibits the program architecture. | 3 OCTOBER 2022 |
| Technical Architecture | A technical architecture is a better understanding of the solution in which different technologies should be implemented in a project. | 20 OCTOBER 2022 |
| Milestone & Activity List | It shows our statistical data progress of our project deliverable state. | IN PROGRESS.. |
| Sprint | A type of planning is defining what can be delivered in a sprint and what work needs to be done on a time basis. | 18 CTOBER 2022 |

5.2 Sprint Delivery Plan

Product Backlog, Sprint Schedule, and Estimation:

| Sprint | Functional Requirement (Epic) | 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 Open Weather API. | 1 | Low | Krishna M, Kishore S M, Kishor M, Naveen 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 | Krishna M, Kishore S M, Kishor M, Naveen 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 | Krishna M, Kishore S M, Kishor M, Naveen 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 | Krishna M, Kishore S M, Kishor M, Naveen V |
| Sprint-4 | UI/UX Optimization & Debugging | USN-5 | Optimize all the shortcomings and provide better user experience. | 2 | Low | Krishna M, Kishore S M, Kishor M, Naveen V |

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 | 02 Nov 2022 |
| Sprint-3 | 20 | 6 Days | 07 Nov 2022 | 12 Nov 2022 | 20 | 09 Nov 2022 |
| Sprint-4 | 20 | 6 Days | 14 Nov 2022 | 19 Nov 2022 | 20 | 17 Nov 2022 |

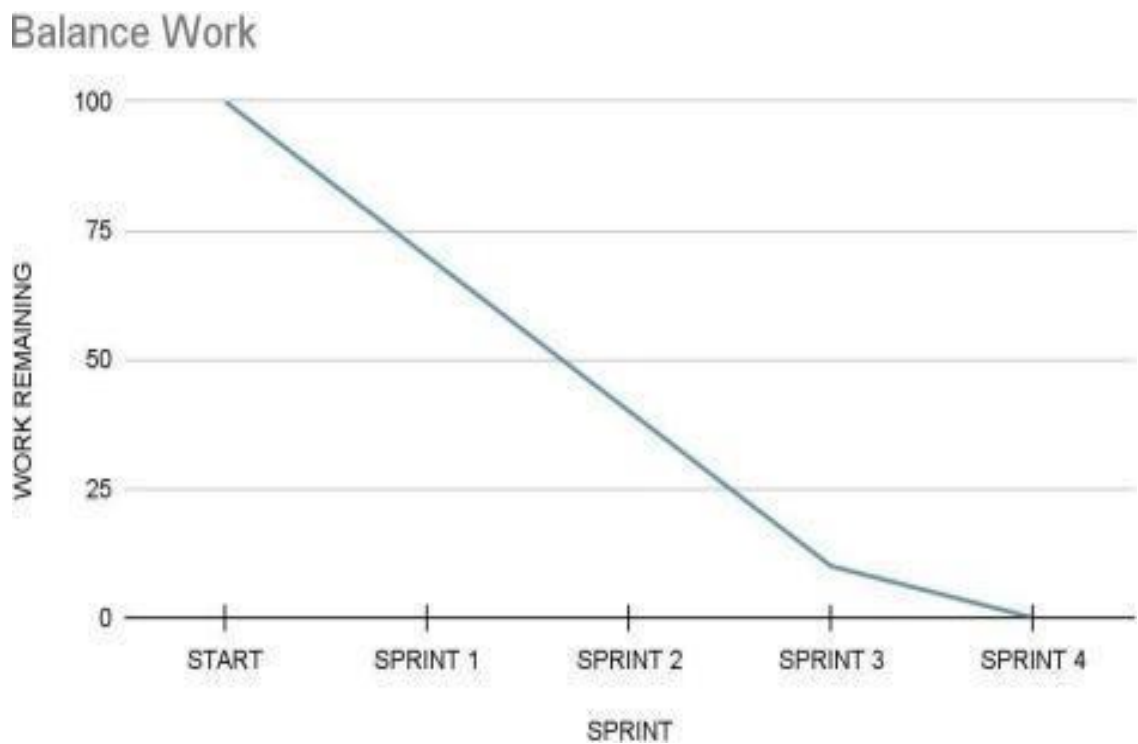
Velocity:

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).

$$AV = \frac{\text{sprint duration}}{\text{velocity}} = \frac{20}{10} = 2$$

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.



CHAPTER 6

PROJECT DEVELOPMENT PHASE

6.1 Delivery of Sprint - 1

SPRINT TARGETS:

| Sprint | Functional Requirement (Epic) | User Story Number | User Story /Task | StoryPoints | Priority | Team Members |
|----------|-------------------------------|-------------------|---|-------------|----------|--|
| Sprint-1 | Dynamic Speed Limit | USN-1 | Knowing the speed limit when travelling is crucial. | 10 | High | Kishor M Kishore S M Krishna M Naveen V |
| Sprint-1 | Priority Vehicle | USN-2 | Experimentation and circuit simulation. | 2 | High | Kishor M Kishore S M Krishna M Naveen V |
| Sprint-1 | Weather SpeedLimit | USN-3 | I should be aware of how the weather affects the speed limit for a ride as an observer. | | Medium | Kishor M Kishore S M Krishna M Naveen V |

WOKWI Simulation:

The screenshot displays the WOKWI simulation interface. On the left, the Arduino IDE shows a sketch for an ESP8266 module connected to a DHT22 sensor. The code includes libraries for WiFi and PubSubClient, and defines constants for the sensor pin and type. It sets up an MQTT client to connect to an IBM Watson IoT Platform, publishing temperature and humidity data to a specific topic. The right side of the interface shows a 3D simulation of the hardware. Below the simulation, a console window displays the following output:

```
temp:37.40
humidity:86.00
Sending payload:
{"temp":37.40,"humidity":86.00,"North":0,"South":0,"East":0,"West":0}
Publish ok
Reconnecting client to psh4py.messaging.internetofthings.ibmcloud.com
.....
```

IoT Device – IoT Platform

4571

Connected

alert-device

Device

Identity

Device Information

Recent Events

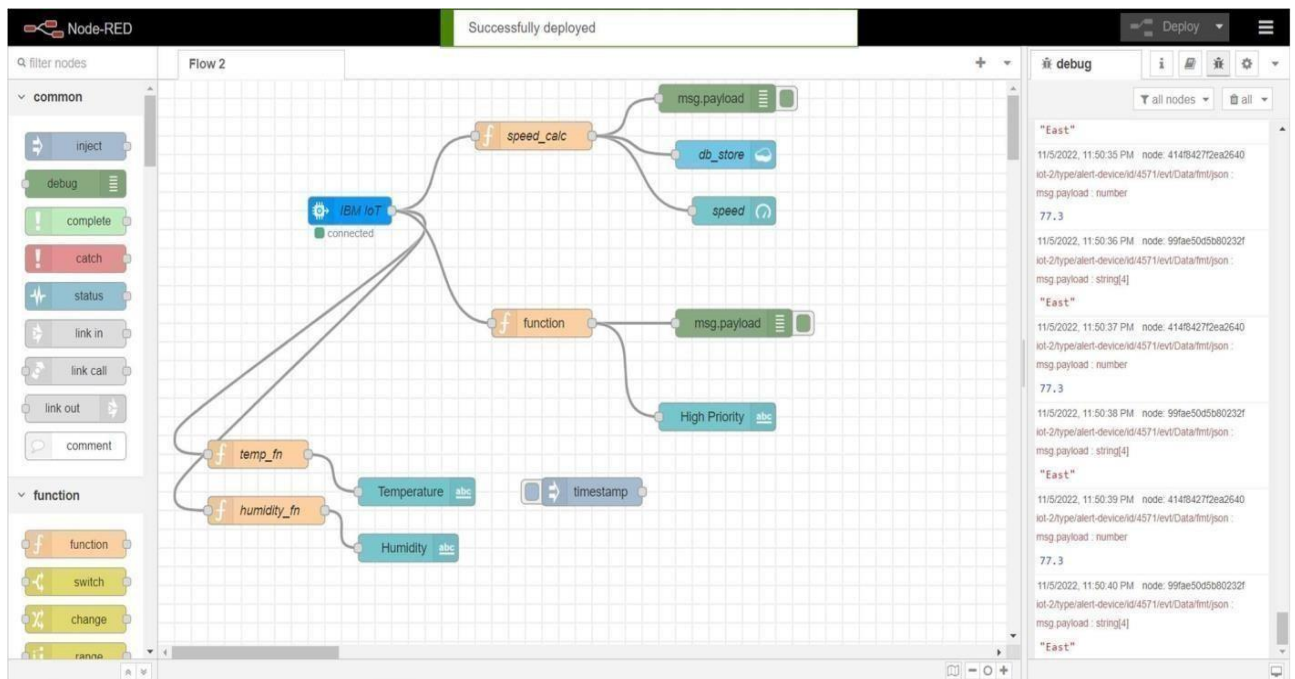
State

Logs

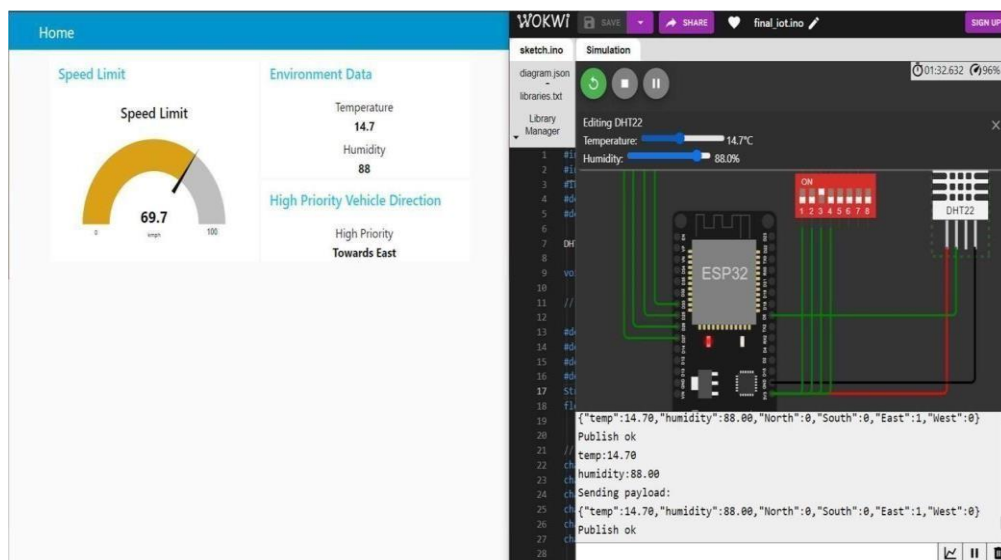
The recent events listed show the live stream of data that is coming and going from this device.

| Event | Value | Format | Last Received |
|-------|--|--------|-------------------|
| Data | {"temp":23.4,"humidity":63,"North":1,"South":0,... | json | a few seconds ago |
| Data | {"temp":23.4,"humidity":63,"North":1,"South":0,... | json | a few seconds ago |
| Data | {"temp":23.4,"humidity":63,"North":1,"South":0,... | json | a few seconds ago |

Node Red




Node Red Web UI



Home

Speed Limit



70.5
km/h

Environment Data

Temperature
15.5

Humidity
91.5

High Priority Vehicle Direction
High Priority
Towards South

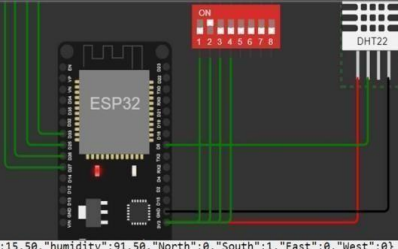
WOKWI

SAVE SHARE final_iotino SIGN IN

sketch.ino diagram.json libraries.txt Library Manager

Simulation 02:23:068 91%

Editing DHT22
Temperature: 15.5°C
Humidity: 91.5%



```
1 #I
2 #I
3 #T
4 #d
5 #d
6
7 DHT
8
9 vo
10
11 //
12
13 #d
14 #d
15 #d
16 #d
17 St
18 fl
19
20 {"temp":15.50,"humidity":91.50,"North":0,"South":1,"East":0,"West":0}
21 Publish ok
22 temp:15.50
23 humidity:91.50
24 Sending payload:
25 {"temp":15.50,"humidity":91.50,"North":0,"South":1,"East":0,"West":0}
26 Publish ok
27
28
```

Cloudant Database

data_iot

Document ID Options {}JSON

All Documents Query Permissions Changes Design Documents

Table Metadata {}JSON

Create Document

| _id | payload |
|----------------------------------|---------|
| 060cc88d44faf11288e9cdfd7d8de45a | 35 |
| 060cc88d44faf11288e9cdfd7d904e58 | 60 |
| 060cc88d44faf11288e9cdfd7d90c3f9 | 45.5 |
| 060cc88d44faf11288e9cdfd7d92a313 | 60 |
| 2314e7571ab5925365e082f191bb2c9c | 52.5 |
| 26939bb99e5c84bed4f6a20342a22ab2 | 35 |
| 26939bb99e5c84bed4f6a20342a7ccd5 | 44 |
| 3ffa1240575d0cd0d7f848833802e389 | 55 |
| 48a3afbcf5f840466e09ed279d3c3451 | 53 |
| 48a3afbcf5f840466e09ed279d3c5b7c | 53 |
| 48a3afbcf5f840466e09ed279d3c9545 | 53 |
| 52730057f2d5fde2d21dfaaaabc10dc8 | 55 |

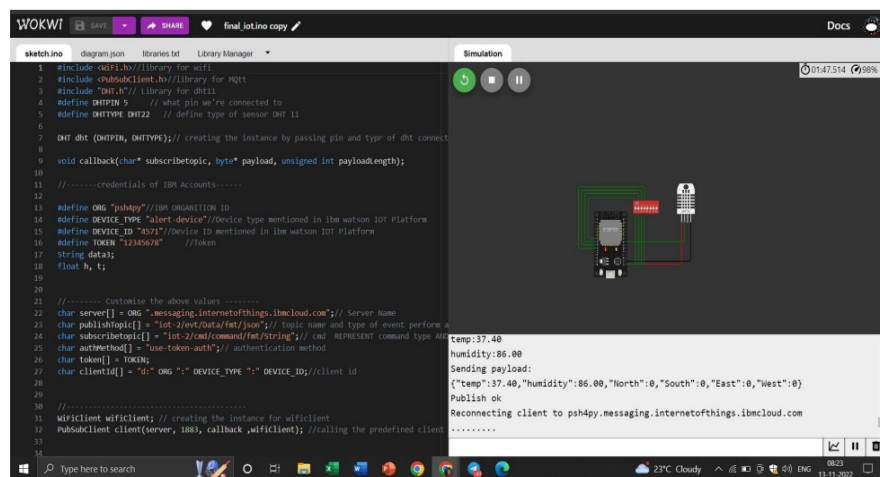
Showing 2 of 3 columns. Show all columns. Showing document 1 - 20. Documents per page: 20

6.2 Delivery of Sprint – 2

SPRINT TARGETS:

| Sprint | Functional Requirement (Epic) | User Story Number | User Story/Task | StoryPoints | Priority | Team Members |
|----------|-------------------------------|-------------------|--|-------------|----------|--|
| Sprint-2 | Safe Ride | USN-4 | I should experience a hustle-free voyage as a traveller. | 20 | Medium | Kishor M Kishore S M Krishna M Naveen V |

WOKWI Simulation:



The screenshot displays the WOKWI simulation interface. On the left, the Arduino IDE shows a sketch with the following code:

```
1 #include <WiFi.h> //library for wifi
2 #include <PubSubClient.h> //library for MQTT
3 #include "DHT.h" //library for dht11
4 #define DHTPIN 5 // what pin we're connected to
5 #define DHTTYPE DHT22 // define type of sensor DHT 11
6
7 DHT dht (DHTPIN, DHTTYPE); // creating the instance by passing pin and type of dht connect
8
9 void callback(char* topic, byte* payload, unsigned int payloadlength);
10
11 //-----credentials of IBM Accounts-----
12
13 #define ONE "psh4py" //IBM organization ID
14 #define DEVICE_TYPE "alert-device" //device type mentioned in the watson IoT Platform
15 #define DEVICE_ID "4371" //device ID mentioned in the watson IoT Platform
16 #define TOKEN "12345678" //Token
17 String data;
18 float h, t;
19
20 //----- Customise the above values -----
21
22 char server[] = ONE ".messaging.internetofthings.ibmcloud.com"; // Server Name
23 char publishTopic[] = "iot-2/evt/data/fmt/json"; // topic name and type of event perform a
24 char subscribeTopic[] = "iot-2/cmd/command/fmt/string"; // cmd REPRESENT command type AND
25 char authMethod[] = "use-token-auth"; // authentication method
26 char token[] = TOKEN;
27 char clientId[] = "d:" ONE ":" DEVICE_TYPE ":" DEVICE_ID; //client id
28
29 //-----
30
31 WiFiClient wifiClient; // creating the instance for wifiClient
32 PubSubClient client(server, 1883, callback, wifiClient); //calling the predefined client
33
34
```

On the right, the Simulation window shows a 3D model of an Arduino Uno board connected to a DHT22 sensor. The console output displays the following data:

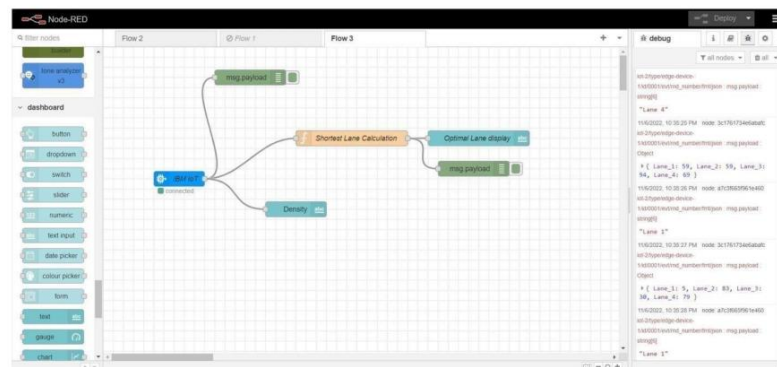
```
temp:37.40
humidity:86.00
Sending payload:
{"temp":37.40,"humidity":86.00,"North":0,"South":0,"East":0,"West":0}
Publish ok
Reconnecting client to psh4py.messaging.internetofthings.ibmcloud.com
*****
```

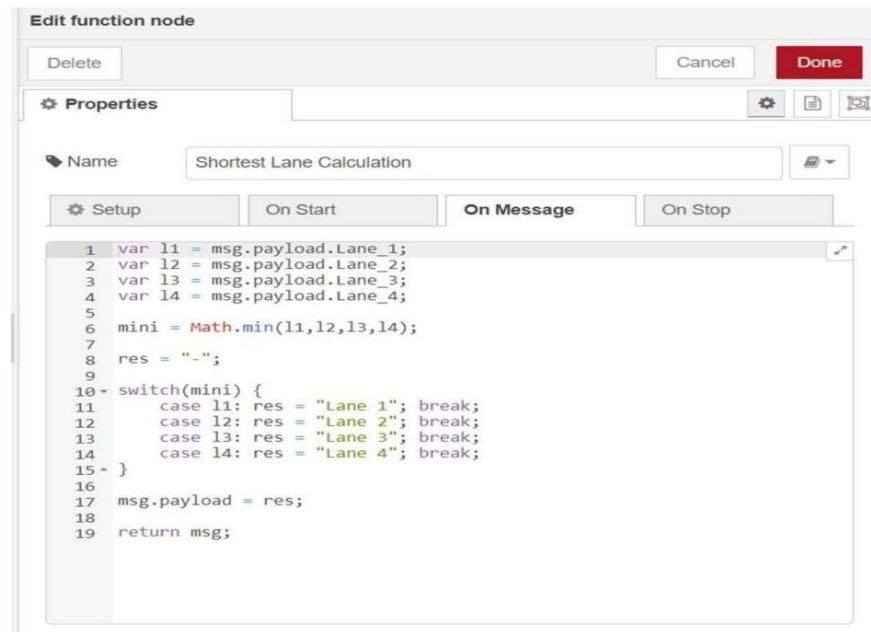
IoT Device – IoT Platform

The screenshot displays the IoT Platform interface for a device named '0001'. The device is currently 'Disconnected' and is an 'edge-device-1'. The interface shows a table of recent events, which are live-stream data points coming from the device. The events are listed in a table with columns: Event, Value, Format, and Last Received. The events are all 'md_number' and represent lane data points. A status bar at the bottom indicates '1 Simulation running'.

| Event | Value | Format | Last Received |
|-----------|---|--------|-------------------|
| md_number | ["Lane_1":5,"Lane_2":83,"Lane_3":30,"Lane_4":... | json | a few seconds ago |
| md_number | ["Lane_1":59,"Lane_2":59,"Lane_3":94,"Lane_4":... | json | a few seconds ago |
| md_number | ["Lane_1":93,"Lane_2":88,"Lane_3":69,"Lane_4":... | json | a few seconds ago |
| md_number | ["Lane_1":2,"Lane_2":61,"Lane_3":23,"Lane_4":... | json | a few seconds ago |
| md_number | ["Lane_1":70,"Lane_2":11,"Lane_3":69,"Lane_4":... | json | a few seconds ago |

Node Red





Node Red Web UI

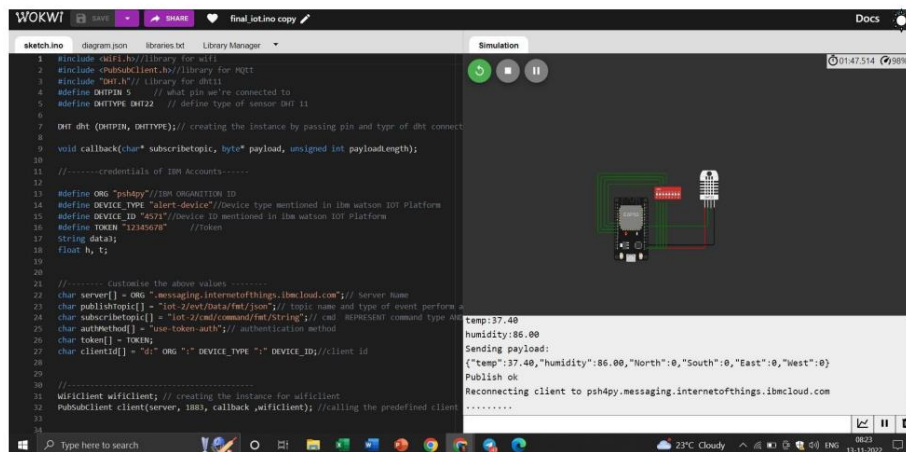


6.3 Delivery of Sprint – 3

Sprint Targets:

| Sprint | Functional Requirement (Epic) | User Story Number | UserStory /Task | Story Points | Priority | Team Members |
|----------|-------------------------------|-------------------|--|--------------|----------|--|
| Sprint-3 | Login | USN-5 | I need a website account because I'm the administrator. | 7 | Low | Kishor M Kishore S M Krishna M Naveen V |
| Sprint-3 | Dashboard | USN-6SSS | I should be able to watch over and add sign nodes as an administrator. | 13 | Medium | Kishor M Kishore S M Krishna M Naveen V |

WOWKI Simulation:



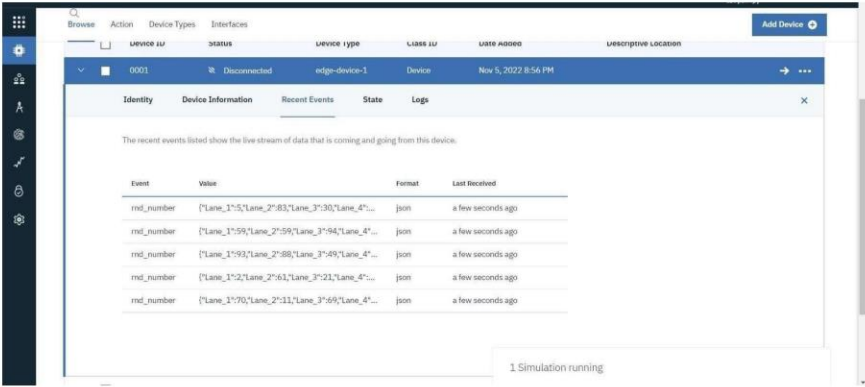
The screenshot displays the WOWKI simulation environment. On the left, a code editor shows the following C++ code:

```
1 #include <WiFi.h> //library for wifi
2 #include <PubSubClient.h> //library for MQTT
3 #include <Arduino.h> // library for arduino
4 #define DHTPIN 5 // what pin we're connected to
5 #define DHTTYPE DHT22 // define type of sensor DHT 11
6
7 DHT dht (DHTPIN, DHTTYPE); // creating the instance by passing pin and type of dht connect
8
9 void callback(char* topic, byte* payload, unsigned int payloadLength);
10
11 //-----credentials of IBM Accounts-----
12
13 #define ORG "ps4py" //IBM ORGANIZATION ID
14 #define DEVICE_TYPE "alnet-device" //device type mentioned in the Watson IoT Platform
15 #define DEVICE_ID "4371" //device ID mentioned in the Watson IoT Platform
16 #define TOKEN "12345678" //Token
17 String data;
18 float h, t;
19
20 //-----Customise the above values -----
21
22 char server[] = ORG ".messaging.internetofthings.ibmcloud.com"; // server name
23 char publishTopic[] = "iot-2/evt/data/fmt/json"; // topic name and type of event perform
24 char subscribeTopic[] = "iot-2/cmd/command/fmt/string"; // cmd. direction command type Al
25 char authMethod[] = "use-token-auth"; // authentication method
26 char token[] = TOKEN;
27 char clientId[] = "d:" ORG ":" DEVICE_TYPE ":" DEVICE_ID"/client_id
28
29 //-----
30
31 WiFiClient wifiClient; // creating the instance for wifiClient
32 PubSubClient client(server, 1883, callback, wifiClient); //calling the predefined client
33
34
```

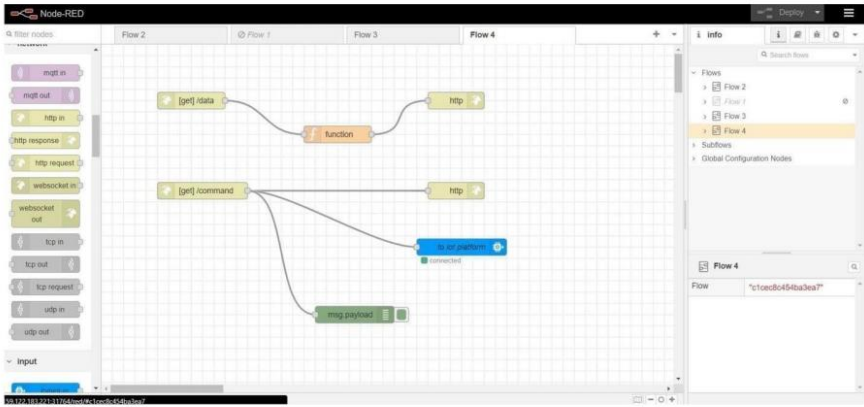
On the right, the simulation window shows a visual representation of the hardware and the output console. The console displays the following log:

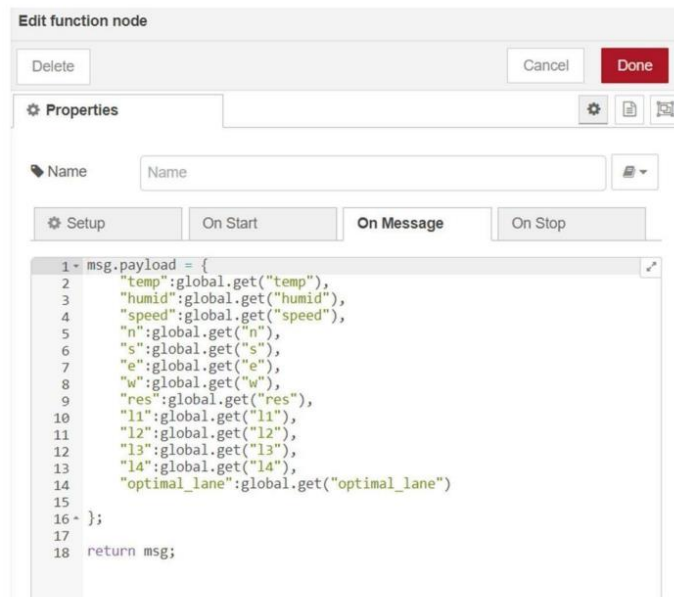
```
Temp:37.40
Humidity:86.00
Sending payload:
{"temp":37.40,"humidity":86.00,"North":0,"South":0,"East":0,"West":0}
Publish ok
Reconnecting client to ps4py.messaging.internetofthings.ibmcloud.com
.....
```

IoT Device – IoT Platform

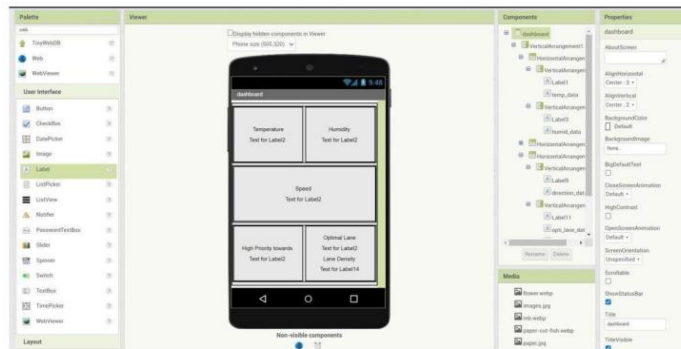


Node Red – Connect with MIT App Inventor:

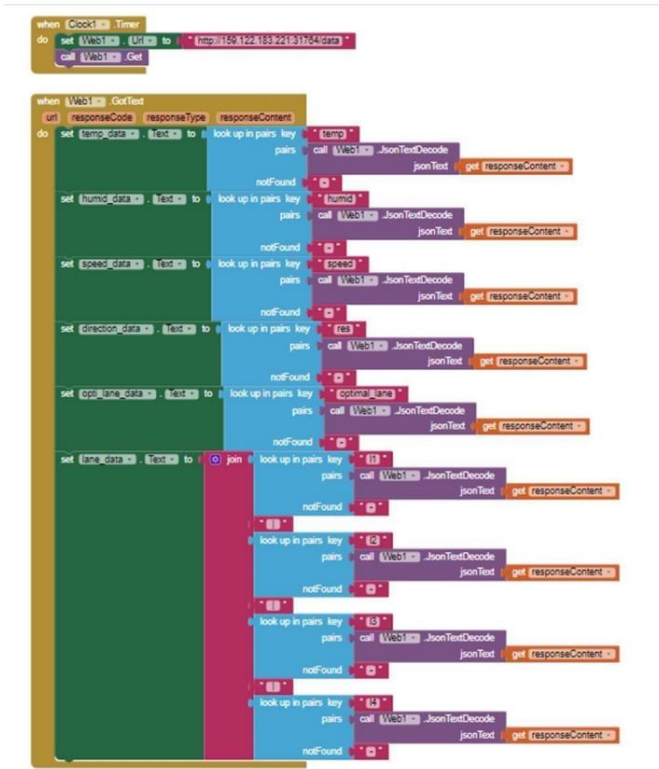




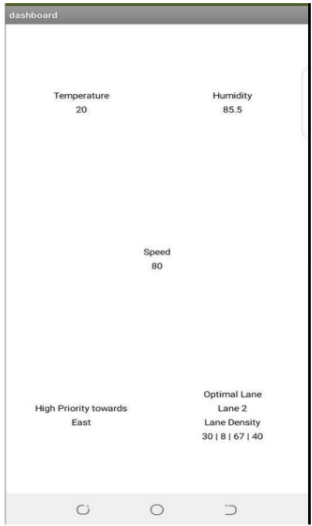
MIT App Inventor UI design:



MIT App Inventor Backend design:



(OUTPUT) Display from MIT App:



6.4 Delivery of Sprint - 4

**Code for print the random temperature, Road signs, Speed limit, Message :
(RandomValues.py)**

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

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

#Receiving callbacks from IBM IOT platformdef
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, '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()

```

Python Simulation:

```

C:\Random\iotpy.py: C:\BMA\Others\Project Development Photos\Iotpy\Random\iotpy.py (3.6.3)
File Edit Format Run Options Window Help

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

myConfig = {
    #Configuration
    "identity": {
        "orgId": "n6r19n",
        "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']

```

Import wiotp-sdk & ibmiotf:

```

C:\Users\DHILEEP>pip install wiotp-sdk
WARNING: pip is being invoked by an old script wrapper, this will fail in a future version of pip.
Please see https://github.com/pypa/pip/issues/799 for advice on fixing the underlying issue.
To avoid this problem you can invoke Python with '-m pip' instead of running pip directly.
Defaulting to user installation because normal site-packages is not writeable
Collecting wiotp-sdk
  Downloading wiotp-sdk-0.11.0.tar.gz (90 kB)
    100% |#####| 10.1k 100kB/s
Preparing metadata (setup.py) ... done
Collecting ibmiotf==1.1.0
  Downloading ibmiotf-1.1.0-py2-none-any.whl (9.9 kB)
Requirement already satisfied: paho-mqtt==1.3.0 in c:\users\dhileep\appdata\local\programs\python\python36\site-packages (from wiotp-sdk) (1.3.0)
Collecting pyserial==3.4
  Downloading pyserial-3.4-cp36-cp36m-win32.whl (153 kB)
    100% |#####| 15.4k 100kB/s
Requirement already satisfied: paho-mqtt==1.3.0 in c:\users\dhileep\appdata\local\programs\python\python36\site-packages (from wiotp-sdk) (1.3.0)
Requirement already satisfied: requests==2.21.0 in c:\users\dhileep\appdata\local\programs\python\python36\site-packages (from wiotp-sdk) (2.21.0)
Collecting requests-toolbelt==0.9.1
  Downloading requests-toolbelt-0.9.1-py2.py3-none-any.whl (14 kB)
    100% |#####| 14.4k 100kB/s
Requirement already satisfied: charset-normalizer==2.0.4 in c:\users\dhileep\appdata\local\programs\python\python36\site-packages (from requests==2.21.0->wiotp-sdk) (2.0.4)
Requirement already satisfied: ibmiotf==1.1.0 in c:\users\dhileep\appdata\local\programs\python\python36\site-packages (from requests==2.21.0->wiotp-sdk) (1.1.0)
Requirement already satisfied: certifi==2017.4.17 in c:\users\dhileep\appdata\local\programs\python\python36\site-packages (from requests==2.21.0->wiotp-sdk) (2017.4.17)
Requirement already satisfied: urllib3==1.24.2 in c:\users\dhileep\appdata\local\programs\python\python36\site-packages (from requests==2.21.0->wiotp-sdk) (1.24.2)
Using legacy 'setup.py install' for wiotp-sdk, since package 'wheel' is not installed.
Installing collected packages: requests-toolbelt, pyserial, ibmiotf, wiotp-sdk
  Running setup.py install for wiotp-sdk ... done
Successfully installed ibmiotf-1.1.0 pyserial-3.4 requests-toolbelt-0.9.1 wiotp-sdk-0.11.0

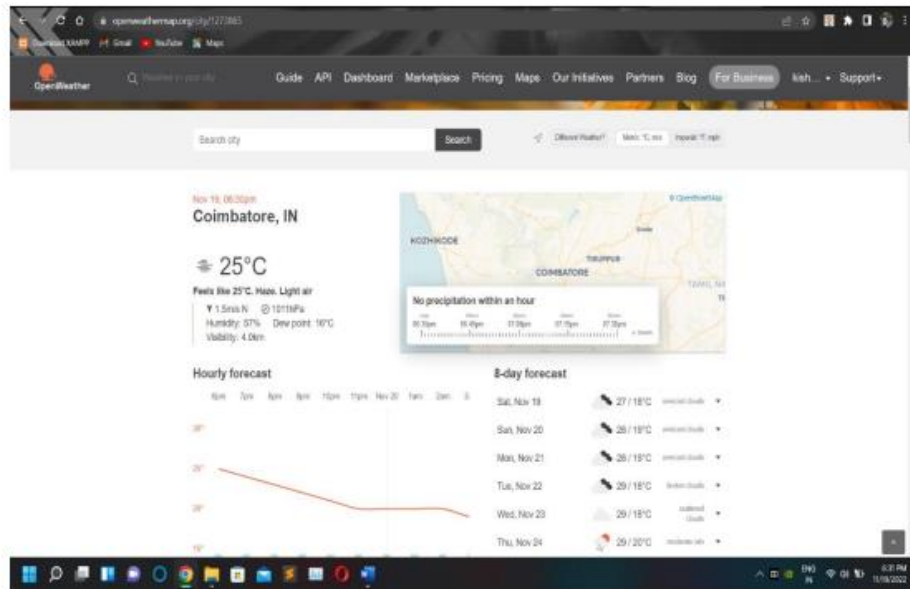
```

```

C:\Users\DHILEEP>pip install ibmiotf
WARNING: pip is being invoked by an old script wrapper, this will fail in a future version of pip.
Please see https://github.com/pypa/pip/issues/799 for advice on fixing the underlying issue.
To avoid this problem you can invoke Python with '-m pip' instead of running pip directly.
Defaulting to user installation because normal site-packages is not writeable
Collecting ibmiotf
  Downloading ibmiotf-1.1.0-py2-none-any.whl (9.9 kB)
    100% |#####| 10.1k 100kB/s
Preparing metadata (setup.py) ... done
Requirement already satisfied: paho-mqtt==1.3.0 in c:\users\dhileep\appdata\local\programs\python\python36\site-packages (from ibmiotf) (1.3.0)
Requirement already satisfied: pyserial==3.4 in c:\users\dhileep\appdata\local\programs\python\python36\site-packages (from ibmiotf) (3.4)
Requirement already satisfied: paho-mqtt==1.3.0 in c:\users\dhileep\appdata\local\programs\python\python36\site-packages (from ibmiotf) (1.3.0)
Requirement already satisfied: requests==2.21.0 in c:\users\dhileep\appdata\local\programs\python\python36\site-packages (from ibmiotf) (2.21.0)
Requirement already satisfied: certifi==2017.4.17 in c:\users\dhileep\appdata\local\programs\python\python36\site-packages (from requests==2.21.0->ibmiotf) (2017.4.17)
Requirement already satisfied: urllib3==1.24.2 in c:\users\dhileep\appdata\local\programs\python\python36\site-packages (from requests==2.21.0->ibmiotf) (1.24.2)
Requirement already satisfied: charset-normalizer==2.0.4 in c:\users\dhileep\appdata\local\programs\python\python36\site-packages (from requests==2.21.0->ibmiotf) (2.0.4)
Using legacy 'setup.py install' for ibmiotf, since package 'wheel' is not installed.
Installing collected packages: ibmiotf
  Running setup.py install for ibmiotf ... done
Successfully installed ibmiotf-1.1.0

```

OpenWeatherMap - (Ex., Coimbatore, IN):



Python IDLE Output:

```
Python 3.9.0 Shell
File Edit Shell Debug Options Window Help

Published data Successfully: ('Temperature': 26.03, 'Message': 'EMERGENCY, HOSPITAL NEARBY', 'Sign': 'Speed Breaker', 'Speed': 'Limit Exceeded', 'Visibility': 'Clear Weather')

Published data Successfully: ('Temperature': 26.03, 'Message': 'GO SLOW, SCHOOL / COLLEGE ZONE AHEAD', 'Sign': 'Right Diversion', 'Speed': 'Moderate', 'Visibility': 'Clear Weather')

Published data Successfully: ('Temperature': 26.03, 'Message': 'PETROL BUNK NEARBY', 'Sign': 'Speed Breaker', 'Speed': 'Limit Exceeded', 'Visibility': 'Clear Weather')

Published data Successfully: ('Temperature': 26.03, 'Message': 'EMERGENCY, HOSPITAL NEARBY', 'Sign': 'Speed Breaker', 'Speed': 'Slow', 'Visibility': 'Clear Weather')

Published data Successfully: ('Temperature': 26.03, 'Message': '', 'Sign': '', 'Speed': 'Limit Exceeded', 'Visibility': 'Clear Weather')

Published data Successfully: ('Temperature': 26.03, 'Message': 'EMERGENCY, HOSPITAL NEARBY', 'Sign': '', 'Speed': 'Moderate', 'Visibility': 'Clear Weather')

Published data Successfully: ('Temperature': 26.03, 'Message': 'EMERGENCY, HOSPITAL NEARBY', 'Sign': '', 'Speed': 'Slow', 'Visibility': 'Clear Weather')

Published data Successfully: ('Temperature': 26.03, 'Message': 'NEED HELP, POLICE STATION AHEAD', 'Sign': 'Left Diversion', 'Speed': 'Moderate', 'Visibility': 'Clear Weather')
```

CHAPTER 7

CONCLUSION

The world does not change on its own, but we can modify it to be safer, better, and more harmless. Since the road is not stated to be safe, let us make it safer using the technology that are currently accessible to us. One of the technologies that can bring us to safer roadways is the Internet of Things. So let us work together to build a better world with no accidents and a smart road for the next generation.