

SMART SOLUTIONS FOR RAILWAYS BASED ON INTERNET OF THINGS(IOT)

*NALAIYA THIRAN PROJECT BASED
LEARNING ON
PROFESSIONAL READINESS FOR
INNOVATION, EMPLOYABILITY AND
ENTREPRENEURSHIP*

A PROJECT REPORT

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ABSTRACT

The explosively growing demand of internet of things (IoT) has rendered broadscale advancements in the fields across sensors, radio access, network, and hardware/software platforms for mass market applications. In spite of the recent advancements, limited coverage and battery for persistent connections of IoT devices still remains a critical impediment to practical service applications. In this paper, we introduces a cost-effective IoT solution consisting of device platform, gateway, IoT network, and platform server for smart railway infrastructure. Then, we evaluate and demonstrate the applicability through an in-depth case study related to IoT-based maintenance by implementing a proof of concept and performing experimental works. The IoT solution applied for the smart railway application makes it easy to grasp the condition information distributed over a wide railway area. To deduce the potential and feasibility, we propose the network architecture of IoT solution and evaluate the performance of the candidate Radio Access Technologies (RATs) for delivering IoT data in the aspects of power consumption and coverage by performing an intensive field test with system level implementations. Based on the observation of use cases in interdisciplinary approaches, we figure out the benefits that the IoT can bring.

1. INTRODUCTION

1.1 Project Overview

The Internet of Things (IoT) standard is a comparatively new technology that delves within the field of ever-present computing. This standard uses a network of things where in each device has its own unique identifier through which they can be addressed. This facilitates the things to communicate and exchange information and also perform requisite actions.

The concept of an IoT heralds a vision towards a fully connected world wherein users can control virtually anything from anywhere. There are many areas where leverages of IoT can be harnessed.

1.2 Purpose

Today, railways are more important than ever as country and city governments are being asked to find innovative ways to safely get back to business post-COVID, meet the changing needs of their citizens, address urban population increases, and reduce their environmental impact.

To meet these challenges and position themselves for future success, many forward-thinking governments and railway operators are looking for smart, intelligent IoT technologies to modernize their railways

2. LITERATURE SURVEY

2.1 Existing problem

- Old Track and Poor State of Rolling Stock.
- Travel without Tickets
- Railway Accidents
- Attack on Railways
- Lack of Modern Management
- Problem of Replacement.

2.2 References

1. E. Bernal, M. Spiryagin, C. Cole, Onboard Condition Monitoring Sensors, Systems and Techniques for Freight Railway Vehicles: A Review, IEEE Sensors Journal (2018) 1–1doi:10.1109/JSEN.2018.2875160. URL <https://ieeexplore.ieee.org/document/8488578/>
2. V. J. Hodge, S. O. Keefe, M. Weeks, A. Moulds, Wireless Sensor Networks for Condition Monitoring in the Railway Industry: A Survey, IEEE Transactions on Intelligent Transportation Systems 16 (3) (2015) 1088–1106. doi:10.1109/TITS.2014.2366512.
3. A. Nordrum, K. Clark, Everything you need to know about 5g (Jan. 2017). URL <https://spectrum.ieee.org/video/telecom/wireless/everything-you-need-to-know-about-5g>.
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5. R. B. Shetty, Predictive Maintenance in the IoT Era, Prognostics and Health Management of Electronics (2018) 589–612doi:10.1002/9781119515326.ch21. URL <http://doi.wiley.com/10.1002/9781119515326.ch21>

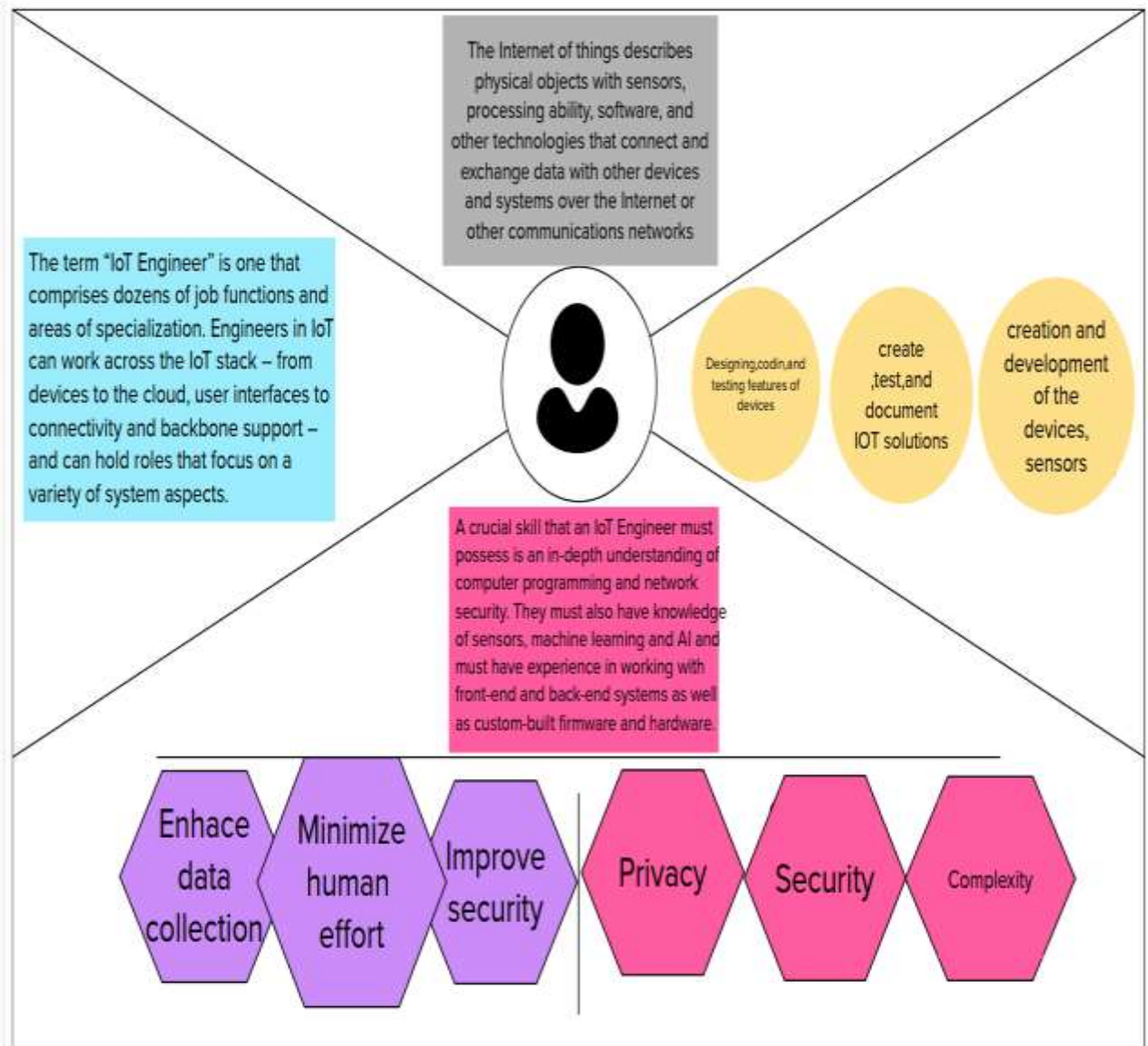
2.3 Problem Statement Definition

Problem Statement (PS)	I am (Customer)	I'm trying to	But	Because	Which makes me feel
PS - 1	User	Book a ticket through application	Unable to book ticket properly	Lack of Guidance in those application	Cofused
PS - 2	Passenger	Book a train Seat Berth	Not Sure information about the berth	Evert seating showing as same	Irritated
PS - 3	Passenger	Give a feedback or complaint about my journey	I couldn't able to do that	There is no option like that in application	Hate
PS - 4	Government	Avoid Ticketless traveling in Railways	Some people are not following the rule	There is no checking while entering the platform	Worst

3. IDEATION & PROPOSED SOLUTION

3.1 Empathy Map Canvas

Build empathy and keep your focus on the user by putting yourself in their shoes.



3.2 Ideation & Brainstorming

Brainstorm & idea prioritization

Use this template in your own brainstorming sessions to put your best ideas on paper, and then use this template to help you prioritize them. The template will help you to think about the importance of each idea, and to rank them in order of priority.

1. Brainstorm ideas

2. Rank ideas

3. Prioritize ideas

Define your problem statement

What problem are you trying to solve? What are the goals of your project? What are the constraints of your project?

Example: I want to design a new mobile app that helps people find the best places to eat in their city.

Brainstorm

Write down every idea that comes into your mind. Don't worry about whether the idea is good or bad. Just write it down. You can come back to it later.

Example: I want to design a new mobile app that helps people find the best places to eat in their city.

Group ideas

Take the ideas you have brainstormed and group them into categories. This will help you to see the big picture and to identify the most important ideas.

Example: I want to design a new mobile app that helps people find the best places to eat in their city.

Prioritize

Take the ideas you have grouped and rank them in order of priority. This will help you to see the big picture and to identify the most important ideas.

Example: I want to design a new mobile app that helps people find the best places to eat in their city.

3.3Proposed Solutions

S. No	Parameter	Description
1.	Problem Statement (problem to be solved)	“Hand Gesture Recognition Using Camera ” is based on concept of Image processing. In recent year there is lot of research on gesture recognition using kinect sensor on using HD camera but camera and kinect sensors are more costly.
2.	Idea / Solution description	Hand gestures come naturally to us. It is even found that blind people use hand gestures when speaking with other blind people. Gesturing helps you access memories. Using hand gestures while you speak not only helps others remember what you say, it also helps you speak more quickly and effectively!
3.	Novelty / Uniqueness	In this proposed system, “Kinect camera” plays the major role to gather the depth information from the skeleton.
4.	Social Impact / Customer Satisfaction	These results suggest that gesture aids the listener as well as the speaker and that gesture has a direct effect on listener comprehension.

3.4 Problem Solution Fit



4 REQUIREMENT ANALYSIS

4.1 Functional Requirements

> IBM Watson IoT Platform:

- Watson IoT Platform features Analytics and Watson APIs Completely manage your IoT landscape and make better business decisions.
- It assures delivery of messages Developer friendly libraries.
- It integrates with java environment.
- Allows development of interactive mobile messaging applications.
- Easy to use, web-based command line interfaces.
- Can be deployed on public cloud infrastructure in IBM cloud, Amazon and Azure cloud environments.

> NODE - Red Service:

- Node Red is a flow-based programming tool, originally developed by IBM's Emerging Technology Services team and now a part of the Open JS Foundation.
- The node part reflects both flow/node programming model as well as the underlying node.
- It is low code programming for event for event driven applications.
- Node-RED consists of a Node.js based runtime that you point a web browser at to access the flow editor.
- Within the browser you create your application by dragging nodes from your palette into a workspace and start to wire them together.
- With a single click, the application is deployed back to the runtime where it is run.

4.2 Non-Functional requirements:

- Performance Requirement

The performance of the system lies in the way it is handled. Proper guidance regarding how to use the system is given to the user. The other factor which affects the performance is the absence of any of the suggested requirements

- Software Requirements

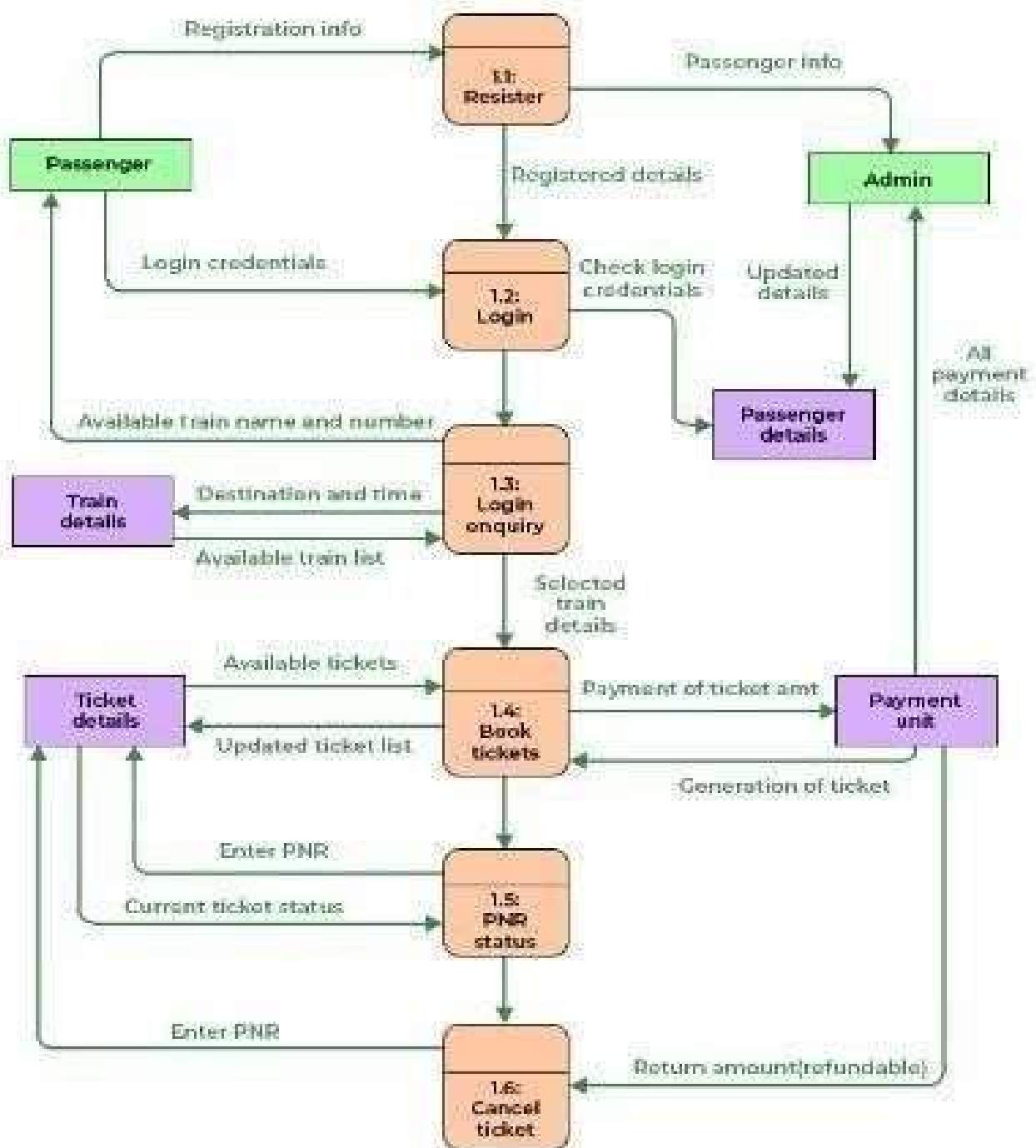
System is given to the user. The other factor which affects the performance is the absence of any of the suggested requirements

- Easy to Operate

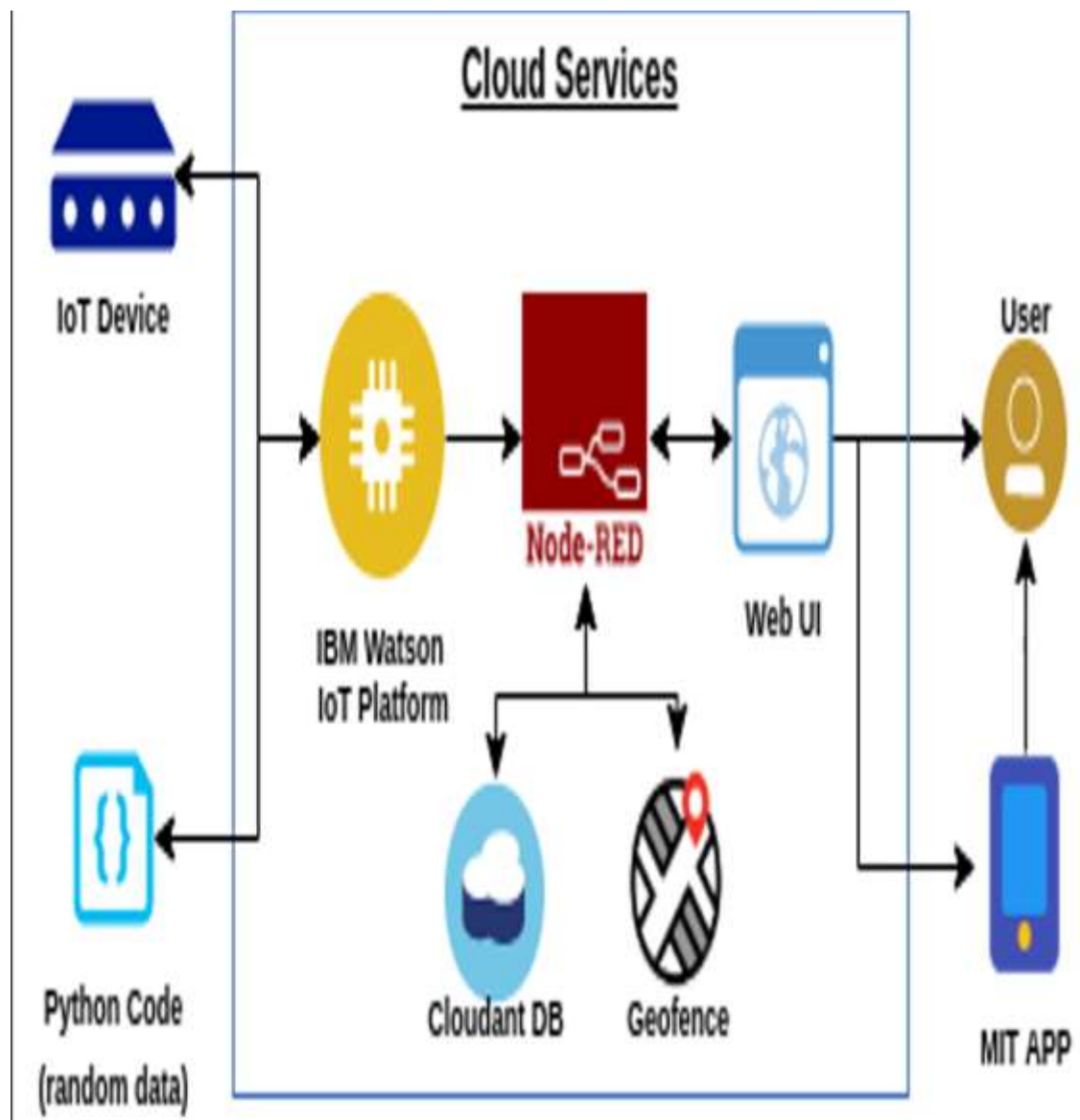
The system should be easy to operate and should be such that It can be developed within a short period of time and fit in the limited budget of the user. There should be ease of functionalities that the system should be user friendly

5.PROJECT DESIGN

5.1 Data Flow Diagram



5.2 Solution and Technical Architecture



5.3 User Stories

Phases	Phase 1 Motivation	Phase 2 Website Search	Phase 3 Choosing Preference	Phase 4 Final Confirmation	Phase 5 Payment
Activities Performed	Wants to book railway tickets for the Travel	Search for the train and Seat availability	Customer chooses the preferred seat	The chosen seat is reserved and asked for confirmation	Makes the Payment for the Prefered Ticket
Emotions	Happy and Excited	Happy as the customer finds numerous options	Happy as the customer finds it convenient	Happy to find their prefered seat	First finds little difficulty in payment . Contacts customer service and completes the transaction with helpline
Overall Experience	Good	Good	Good	Good	Average ,Little Disappointed in the first with the lagging in the payment
Customer Expectation	Easy handling and support all operating system	Less complexity for searching the seat availability	Show the available seats closest to the preference.	A web application with simple interface	Availability of numerous payment options and simple process

6. PROJECT PLANNING AND SCHEDULING

6.1 Sprint Delivery and Schedule

Sprint Date (Planned)	Sprint	Functional Requirement (Epic)	User Story / Task
4 Nov - 9 Nov 2022	Sprint-1	Registration	User can register for the application by entering my email,password, and confirming their password.
	Sprint-1		User will receive confirmation email once they have registeredfor the application
10 Nov - 16Nov 2022	Sprint-2	Ticket Reservation andtracking	User can enter their details and book tickets.
	Sprint-2		User can track the exact location of the train.
17 Nov -23 Nov 2022	Sprint-3	Connection with service	User can utilize the services like payment process byreceiving OTPs.
	Sprint-3	Queue Clearance	User can use the automatic waiting list clearance.
23 Nov -29 Nov 2022	Sprint-4	QR code generation	User able to get a QR code for ticket verification.

7. PROJECT DEVELOPMENT PHASE

7.1 Project Development- Delivery of Sprint-1

```
#include <LiquidCrystal.h>
LiquidCrystal lcd(5,6,8,9,10,11);
int redLed = 2;
int greenLed = 3;
int buzzer = 4;
int sensor = A0;
int sensorThresh = 400;
void setup()
{
  pinMode(redLed, OUTPUT);
  pinMode(greenLed,OUTPUT);
  pinMode(buzzer,OUTPUT);
  pinMode(sensor,INPUT);
  serial.begin(9600);
  lcd.begin(16,2);
}
void loop()
{
  int analogValue = analogRead(sensor);
  Serial.print(analogvalue);
  if(analogValue>sensorThresh)
  {
    digitalWrite(redLed,HIGH);
    digitalWrite(greenLed,LOW);
    tone(buzzer,1000,10000);
    lcd.clear();
    lcd.setCursor(0,1);
    lcd.print("RAILWAYS");
    delay(1000);
    lcd.clear();
    lcd.setCursor(0,1);
    lcd.print("SMART SOLUTION");
    delay(1000);
  }
  else
  {
    digitalWrite(greenLed,HIGH);
    digitalWrite(redLed,LOW);
    noTone(buzzer);
    lcd.clear();
  }
}
```

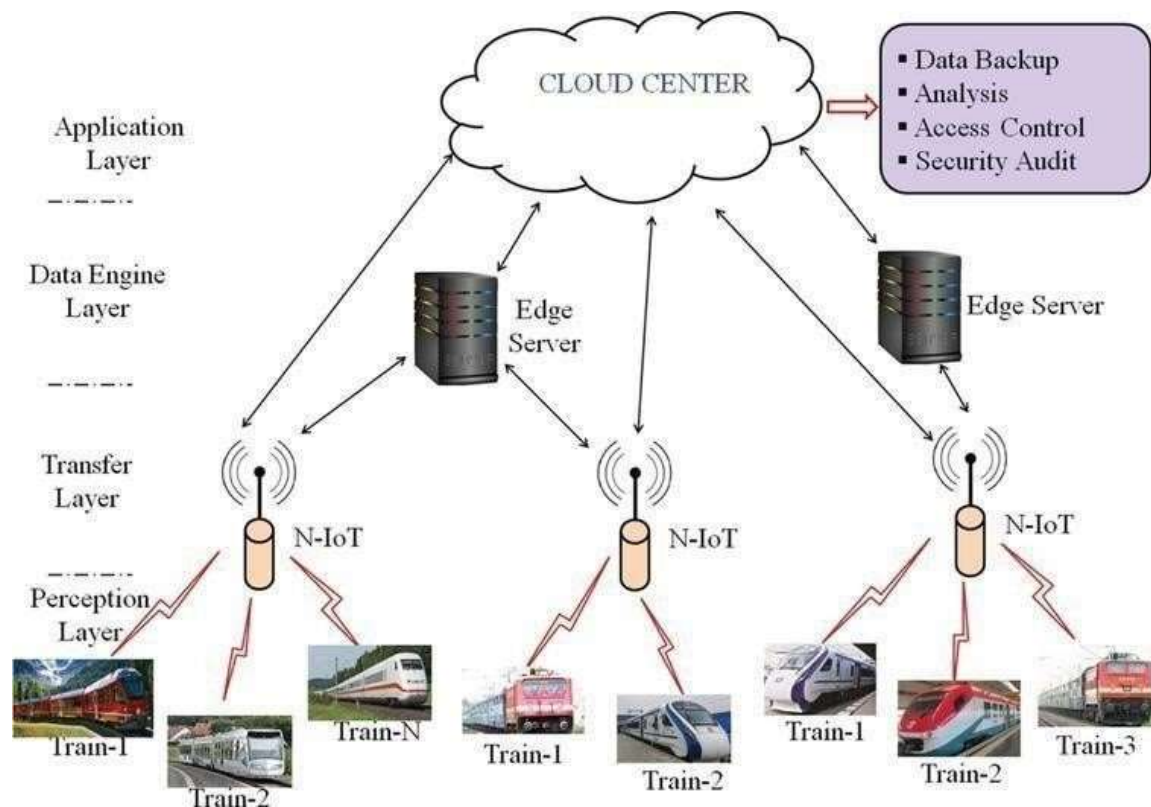
```

1cd.setCursor(0,0);
1cd.print("SAFE");
delay(1000);
1cd.clear();
1cd.setCursor(0,1);
1cd.print("ALL CLEAR");
delay(1000);
}
}

```

7.2 Project Development- Delivery of Sprint-2

Proposed architecture for smart track monitoring system



7.3 Project Development – Delivery of Sprint-3

Efficient and Secure Operation with Better Passenger Experience:

Trams and trains are an indispensable part of urban transportation. With continuous waves of urbanization, it is required that operation of the rail transit system be more intelligent and efficient. As those vehicles run in separate and closed tracks, railways entail a number of challenges and risks in terms of security and management, including engines, doors, fire control, as well as vibration and electromagnetic disturbance. Making sure everything is in good order can be a major challenge. Danger must be identified as soon as possible, as accidents mean not only revenue losses, but more importantly, life security. Meanwhile, with a large amount of time spent on the way, travel is expected to be not only convenient but also pleasant – especially in the IOT era where everything can and should be connected. Better passenger experience is the key to success in the increasingly fierce market competition. Thus, a full-functional communications system is needed for rail transportation. In Hand's Connectivity Solution.

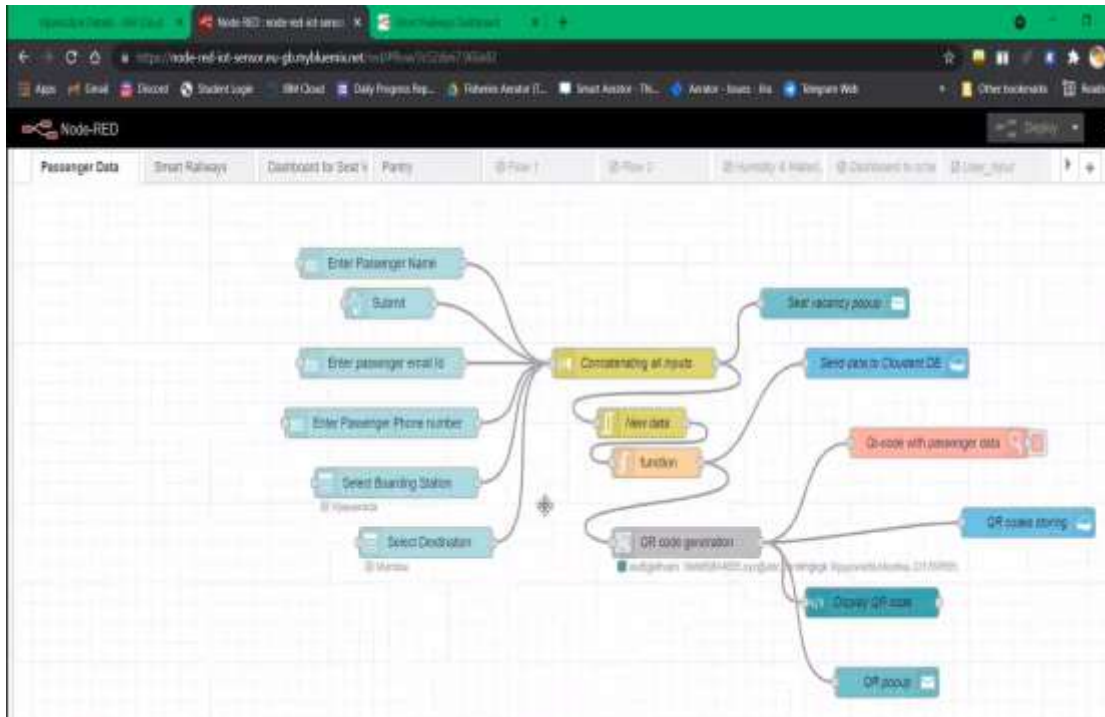
In Hand Connectivity Solution for Rail Transits:



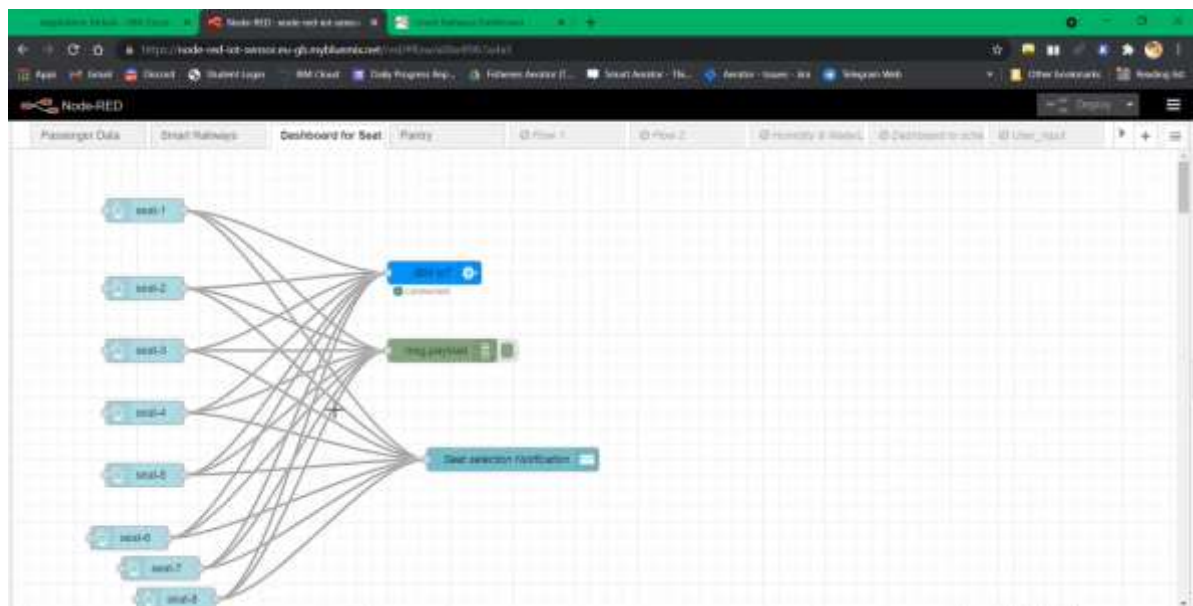
8 CODING AND Node- RED

8.1 Node RED Connections :

1. Passenger Data



2.Dash Board for Seat Selection



The screenshot shows the Node-RED web interface in a browser. The top navigation bar includes tabs for 'Passenger Data', 'Smart Airways', 'Dashboard for Seat V', and 'Pantry'. Below the navigation bar, a flow diagram is visible on a grid background. The flow consists of three input nodes on the left, each with a plus sign icon, labeled 'Choose your snack order', 'Choose your meal order', and 'Choose your drink order'. Lines from these three nodes converge into a single output node on the right labeled 'Order Sent Notification'.

8.2 Coding For QR Code Scanner:

```
from ibmcloudant import CouchDbSessionAuthenticator
from ibm_cloud_sdk_core.authenticators import BasicAuthenticator

authenticator = BasicAuthenticator('apikey-v2-16u3crmdpkghhxefdi
    kvpssoh5fwezrmuup5fv5g3ubz', 'b0ab119f45d3e6255eabb978')
service = CloudantV1(authenticator=authenticator)

service.set_service_url('https://apikey-v2-
    16u3crmdpkghhxefdikvpssoh5fwezrmuup5fv5g3ubz:b0ab119145d3e6255eabb97
    8e7e2f0')

cap= cv2.VideoCapture(0)
font = cv2.FONT_HERSHEY_PLAIN

while True:
    _, frame = cap.read()
    decodedObjects = pyzbar.decode (frame)
    for obj in decodedObjects:
        #print ("Data", obj.data)
        a=obj.data.decode('UTF-8')
        cv2.putText(frame, "Ticket", (50, 50), font, 2, (255, 0, 0), 3)

        #print (a)
        try:
            response = service.get_document(
                db='booking',
                doc_id = a
            ).get_result()
            print (response)
            time.sleep(5)
        except Exception as e:
            print ("Not a Valid Ticket")
            time.sleep(5)

    cv2.imshow("Frame",frame)
    if cv2.waitKey(1) & 0xFF ==ord('q'):
        break
cap.release()
cv2.destroyAllWindows()
client.disconnect()
```

8.3 Code For GPRS Location:

```
import time
import sys
import ibmiotf.application
import ibmiotf.device
import random
import requests
import json

#Provide your IBM Watson Device Credentials
organization = "0z828r"
deviceType = "iotdevice"      #Credentials of Watson IoT sensor simulator
deviceId = "1001"
authMethod = "token"
authToken = "prathyusha"

# Initialize the device client.
L=0

try:
    deviceOptions = {"org": organization, "type": deviceType, "id": deviceId, "auth-
method": authMethod, "auth-token": authToken}
    deviceCli = ibmiotf.device.Client(deviceOptions)
    #.....

except Exception as e:
    print("Caught exception connecting device: %s" % str(e))
    sys.exit()

# Connect and send a datapoint "hello" with value "world" into the cloud as an event of
type "greeting" 10 times
deviceCli.connect()

while True:
    overpass_url = "http://overpass-api.de/api/interpreter"
    overpass_query = """
[out:json];area[name="India"];(node[place="village"](area));out;
"""

    response = requests.get(
```



```
overpass_url,  
params={'data': overpass_query}  
)
```

```
coords = []  
if response.status_code == 200:  
    data = response.json()  
    places = data.get('elements', [])  
    for place in places:  
        coords.append((place['lat'], place['lon']))  
    print ("Got %s village coordinates!" % len(coords))  
    print (coords[0])  
else:  
    print("Error")
```

```
i = random.randint(1,100)  
L = coords[i]  
#Send random gprs data to node-red to IBM Watson  
data = {"d":{"Latitude" : L[0], 'Longitude' : L[1]}}  
#print data  
def myOnPublishCallback():  
    print("Published gprs location = ", L, "to IBM Watson")
```

```
success = deviceCli.publishEvent("Data", "json", data, qos=0,  
    on_publish=myOnPublishCallback)  
time.sleep(12)  
if not success:  
    print("Not connected to IoT")  
time.sleep(1)
```

```
deviceCli.disconnect()
```

9.RESULTS

9.1 User Registration

User Registraion

Smart Railways

Enter Passenger Name

asdfgijklhopo. Vafhlsh

Enter passenger email Id

xyz@abc.com

Select Boarding Station

Goa

Select Destination

Delhi

Enter Passenger Phone number

321764963674466

SUBMIT

9.2 Seat Selection:

Seat Selection

Seat Vacancy status

SEAT1

SEAT2

SEAT3

SEAT4

SEAT5

SEAT6

SEAT1

SEAT2

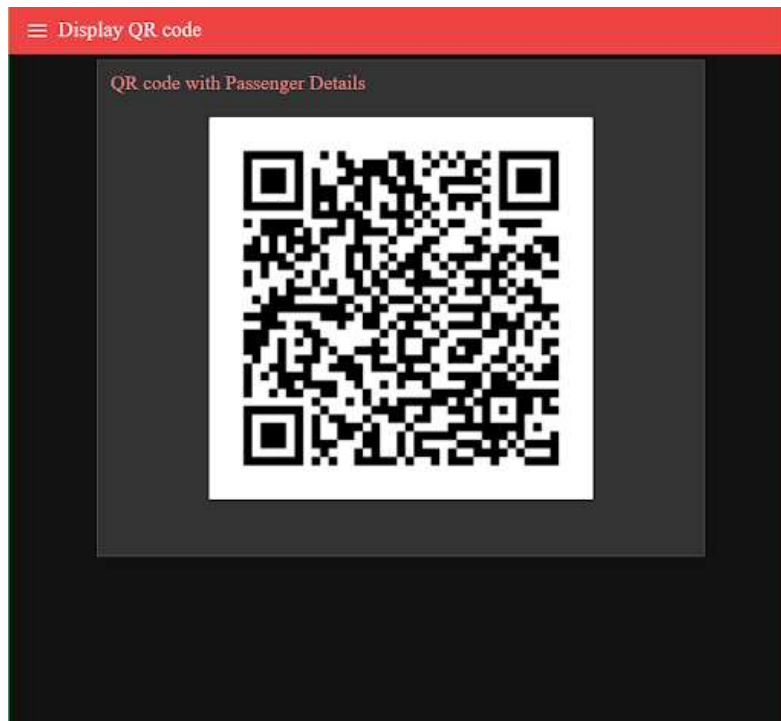
SEAT3

SEAT4

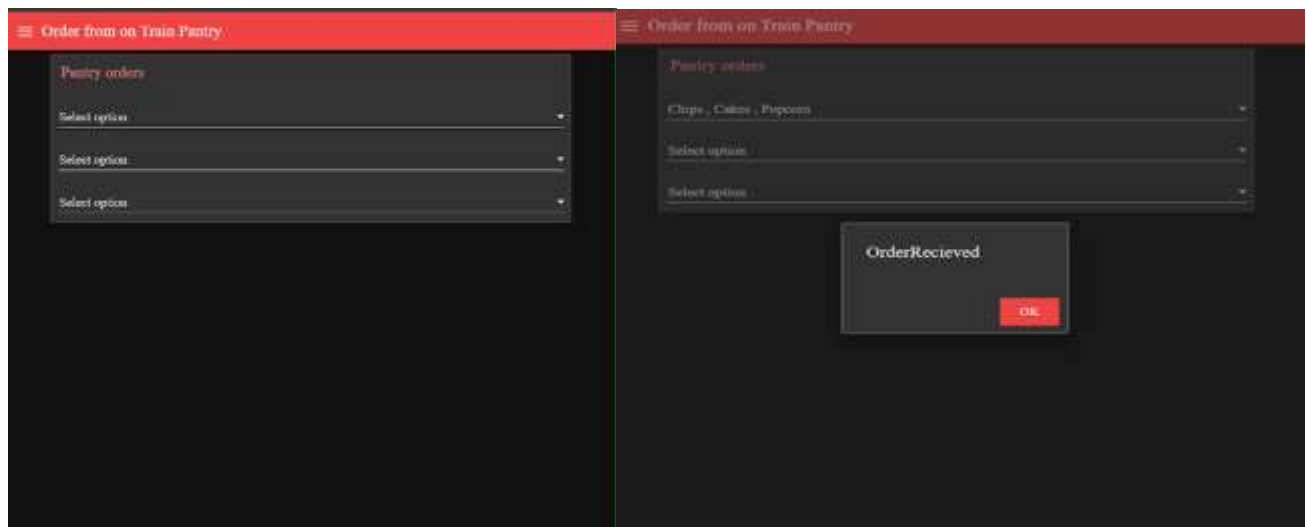
SEAT5

SEAT6

9.3 QR Code Generation:



9.4 Order Food from Pantry



10. ADVANTAGES & DISADVANTAGES

Advantages:

- Enhance Customer Experience.
- Improved Safety.
- Operational Performance.
- Environmental Improvements.
- Traffic Management.
- Toll and Ticketing.
- Connected Cars.

Disadvantages:

- The railway requires a large investment of capital.
- Another disadvantages of railway transport is its inflexibility. Its routes and timings cannot be adjusted to individual requirements.
- Railway transport is unsuitable and uneconomical for short distances and small traffic of goods.
- Rail transport cannot provide door to door service as it is tied to a particular track

11. CONCLUSION

- A Web page is designed for the public where they can book tickets by seeing the available seats.
- After booking the train, the person will get a QR code which has to be shown to the Ticket Collector while boarding the train.
- The ticket collectors can scan the QR code to identify the personal details.
- A GPS module is present in the train to track it. The live status of the journey is updated in the Web app continuously
- All the booking details of the customers will be stored in the database with a unique ID and they can be retrieved back when the Ticket Collector scans the QR Code.