HAZARDOUS AREA MONITORING FOR INDUSTRIAL PLANT POWERED BY IOT

A PROJECT REPORT

Submitted by

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1.INTRODUCTION

1.1 Project Overview

There are various types of industries in existence today, where each of them have different purposes like processing or manufacturing of items like vehicles, devices, microcontrollers, snack items, textiles, etc. Regardless of what the industry does, they are usually large in magnitude and have various sections or sites. Such industries might or might not have similarities and some differences, though it is very common for such industries to have sites that can lead to detrimental consequences if there is an unintentional rise or drop in temperature; there is a high chance of equipment exploding, leading to loss of life and capital. Here, understandably, the temperature takes some time to rise or drop before it reaches the point of inescapable danger. If the temperature is monitored meticulously, it is possible for employees to take actions to control the situation or at the very least give the workers an opportunity to escape within a particular time frame. This project helps with this necessary process of intimidating concerned employees about abnormal temperature levels.

1.2 Purpose

The purpose of the project is to monitor the temperature parameters of the hazardous areas, or otherwise, in industrial plants. Sites are integrated with smart beacon devices which will be broadcasting the temperature of that particular area to every employee in its proximity who will be given smart wearable devices. This reduces the risk of losing lives, suffering injuries and capital damage. This also gives us an opportunity to innovate the security devices.

2. LITERATURE SURVEY

2.1 Existing problems

The risk of a catastrophic explosion within a hazardous area (gas, vapor, or dust) is significantly increased if it is not managed correctly and inspected/maintained on a regular basis by competent personnel.Currently there is no proper surveillance and provision for deploying cobots and surveillance robots.The frequency of occurrence of short circuiting and fire is more in power plants and so alarms should be placed wherever possible.But there is no collection of data from the alarms for future references and analysis.The studies and mistakes of the past and similar incidents are not analyzed thoroughly.Since humans beings tend to make errors ,continuous monitoring by AI should be done.In conclusion is there limited real-time knowledge regarding the provisioning of safety equipments for hazardous area worker and there is no proper utilization of latest technologies to create proper monitoring softwares.

2.2 References

[1] S. Sirasanagandla, M. Pachipulusu and R. Jayaraman, "Development of Surveillance Robot to Monitor the Work Performance in Hazardous Area," 2020 International Conference on Communication and Signal Processing (ICCSP), 2020, pp. 1559-1562, doi: 10.1109/ICCSP48568.2020.9182126.

[2] M. U. Khan, A. Shaheen, M. Zeeshan, Asad-ur-Rehman, M. Adnan and M. T. Rehman, "Real-Time Design of HMI for Hazardous Gas Control and Monitoring System in Pakistani Mines, Natural Gas Areas and Fertilizer Plants," 2021 6th International Multi-Topic ICT Conference (IMTIC), 2021, pp. 1-6, doi: 10.1109/IMTIC53841.2021.9719710.

[3] L. Oliveira, M. Castro, R. Ramos, J. Santos, J. Silva and L. Dias, "Digital Twin for Monitoring Containerized Hazmat Cargo in Port Areas," 2022 17th Iberian Conference on Information Systems and Technologies (CISTI), 2022, pp. 1-4, doi: 10.23919/CISTI54924.2022.9820434.

[4] S. Ingle, S. Salankar and S. Prasad, "To design and develop LoRa-based system for remote safety monitoring," 2022 10th International Conference on Emerging Trends in Engineering and Technology - Signal and Information Processing (ICETET-SIP-22), 2022, pp. 01-05, doi: 10.1109/ICETET-SIP-2254415.2022.9791546.

[5] P. Aravinda, S. Sooriyaarachchi, C. Gamage and N. Kottege, "Optimization of RSSI based indoor localization and tracking to monitor workers in a hazardous working zone using Machine Learning techniques," 2021 International Conference on Information Networking (ICOIN), 2021, pp. 305-310, doi: 10.1109/ICOIN50884.2021.9334026.

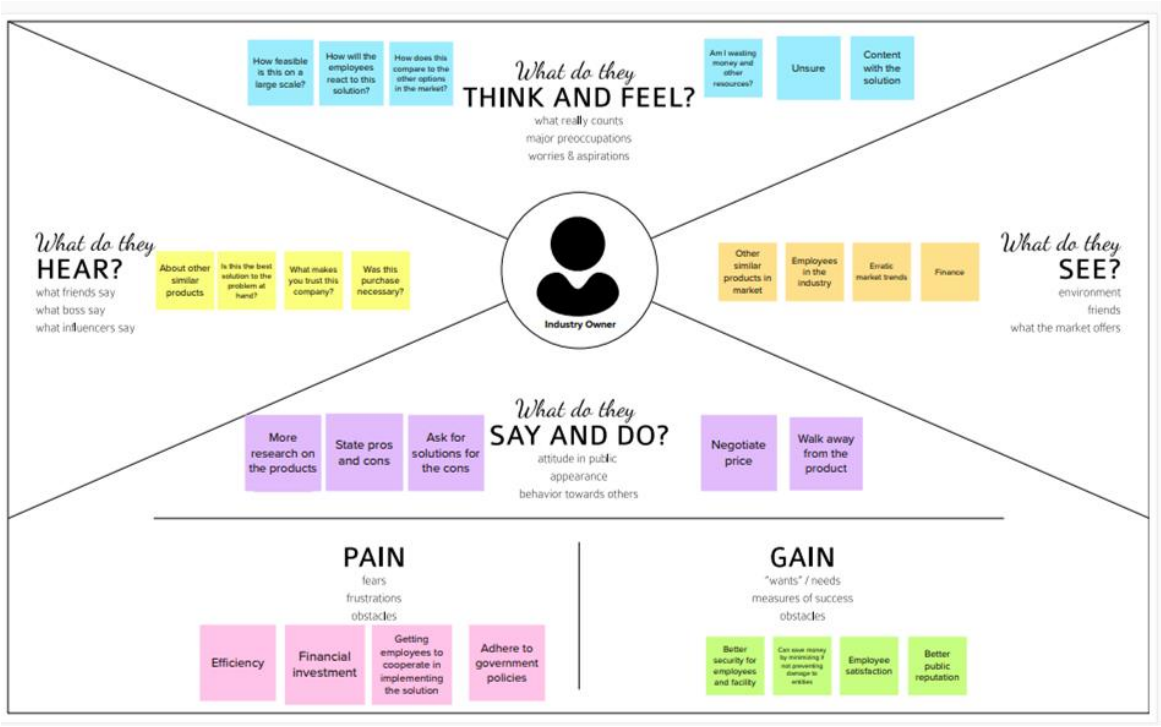
2.3 Problem Statement Definition

The workers deployed in the hazardous zone for monitoring need proper safety devices and measures. They also need proper, reliable software for assistance. There should be provision to collect and store the alarm signals and temperature information for future analysis and research. These details could be helpful in developing a more secure software and stronger mitigation techniques. Evacuation, security measures and disaster management can be promptly and professionally handled. This system is developed so as not to compromise any lives due to improper functioning.

3.IDEATION & PROPOSED SOLUTION

3.1 Empathy Map Canvas

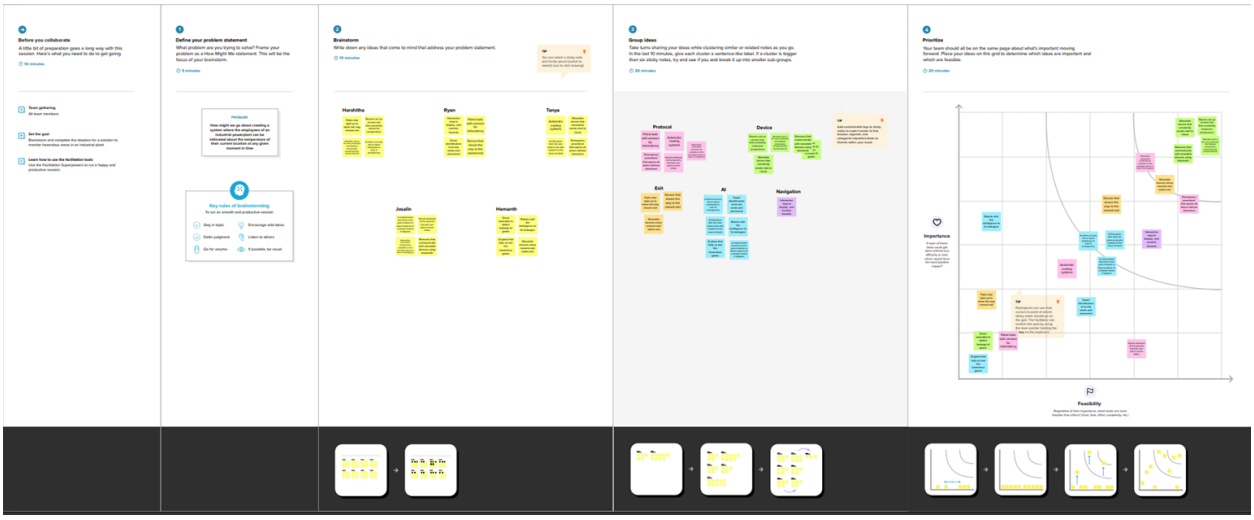
An empathy map is a simple, easy-to-digest visual that captures knowledge about a user's behaviors and attitudes. It is a useful tool to help teams better understand their users. Empathy mapping is a simple workshop activity that can be done with stakeholders, marketing and sales, product development, or creative teams to build empathy for end users. For teams involved in the design and engineering of products, services, or experiences, an empathy mapping session is a great exercise for groups to "get inside the heads" of users.



3.2 Ideation & Brainstorming

Ideation essentially refers to the whole creative process of coming up with and communicating new ideas. Ideation is innovative thinking, typically aimed at solving a problem or providing a more efficient means of doing or accomplishing something.

Ideation is often closely related to the practice of brainstorming, a specific technique that is utilized to generate new ideas. A principal difference between ideation and brainstorming is that ideation is commonly more thought of as being an individual pursuit, while brainstorming is almost always a group activity.



3.3 Proposed Solution

Problem Statement :

- Workers in Industrial Plants that deal with hazardous materials are subject to a large number of occupational hazards.
- Effective early warning systems are essential to their safety as they allow for timely location, containment and evacuation.
- Such details as nature of hazard, location, environmental conditions in unsafe locations are required to take informed actions.
- This system aims to create a solution which satisfies these criteria

Idea/Solution:

This solution aims to provide the following:

- Localization and intimation of hazard using BLE beacons.
- Environmental conditions (temperature, toxicity, etc) of the contaminated area.
- Monitoring using a mobile app.

Novelty/Uniqueness:

- The main highlight of this system is its modularity and unobtrusiveness.
- The hardware used is small, silent, and has a low power draw. It will not interfere with daily operations.
- Integrating new units and removing existing ones is easy.

All information can be accessed remotely.

Social Impact / Customer Satisfaction

- The system implements IoT concepts and technologies effectively to save lives.
- It could prevent another Bhopal Gas Tragedy by alerting people as early as possible to hazardous containment breaches.
- It could help workers evacuate on time or perform the necessary actions to mitigate the dangers of the situation.
- It could provide information about areas that humans cannot safely enter.
- The low cost, ease of use will also definitely improve customer satisfaction

3.4 Problem Solution fit

The Problem-Solution Fit simply means that you have found a problem with your customer and that the solution you have realized for it solves the customer's problem. It helps entrepreneurs, marketers and corporate innovators identify behavioral patterns and recognize what would work and why.

Purpose:

❑ Solve complex problems in a way that fits the state of your customers.

❑ Succeed faster and increase your solution adoption by tapping into existing mediums and

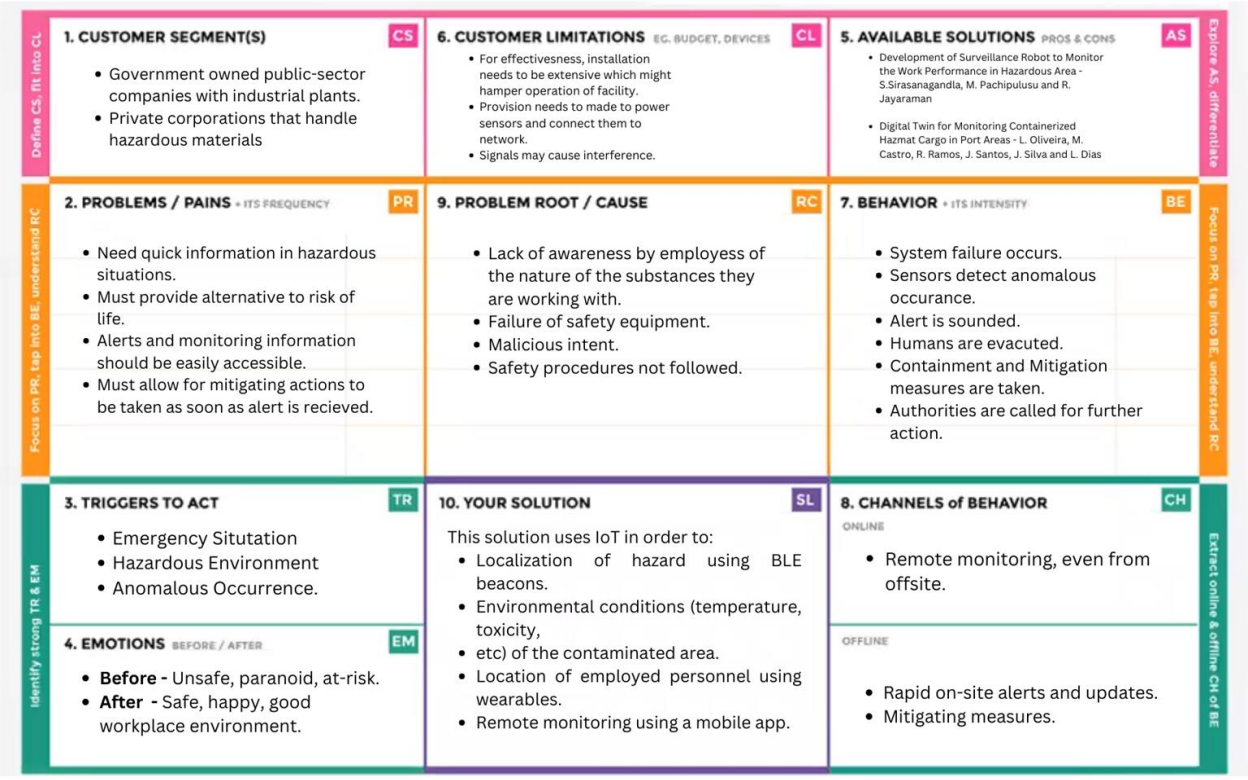
channels of behavior.

❑ Sharpen your communication and marketing strategy with the right triggers and messaging.

❑ Increase touchpoints with your company by finding the right problem-behavior fit and building

trust by solving frequent annoyances, or urgent or costly problems.

❑ Understand the existing situation in order to improve it for your target group.



4.REQUIREMENT ANALYSIS

4.1 Functional requirement

Following are the functional requirements of the proposed solution

FR No.	Functional Requirement (Epic)	Sub Requirement (Story / Sub-Task)
FR-1	User Registration	Registration using email Registration through Gmail
FR-2	User Confirmation	User gets confirmation email
FR-3	Actuation function	Display temperature of current site
FR-4	Notification	Sending notification for high level temperature breach
FR-5	Saving and organizing data	Save temperature details of site to cloud

4.2 Non-Functional requirements

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

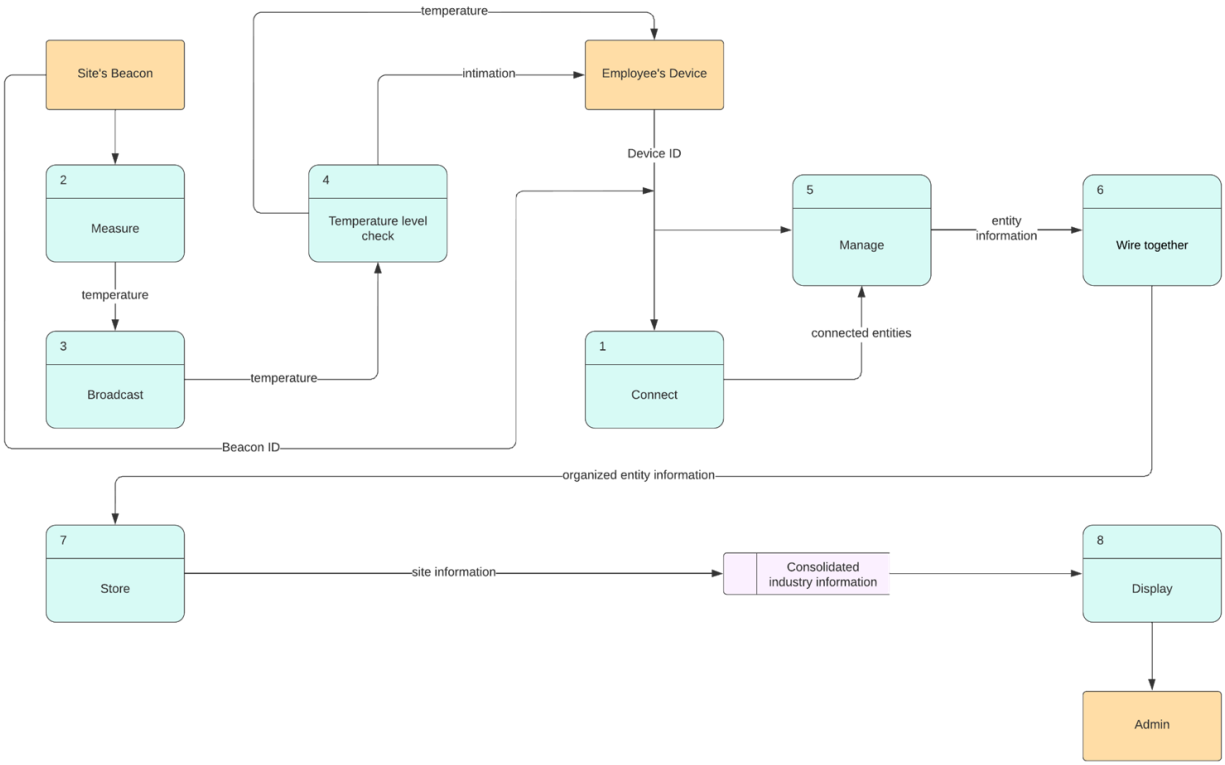
NFR No.	Non-Functional Requirement	Description
NFR-1	Usability	Ease of use and durability of the system
NFR-2	Security	Secure and resistant to attacks
NFR-3	Reliability	High accuracy
NFR-4	Performance	Faster response
NFR-5	Availability	Availability of the systems for industrial plants and other public
NFR-6	Scalability	It supports easy modification and accommodation for various requirements

5. PROJECT DESIGN

5.1 Data Flow Diagram

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.

DFD Level 0:



5.2 Solution & Technical Architecture

Solution:

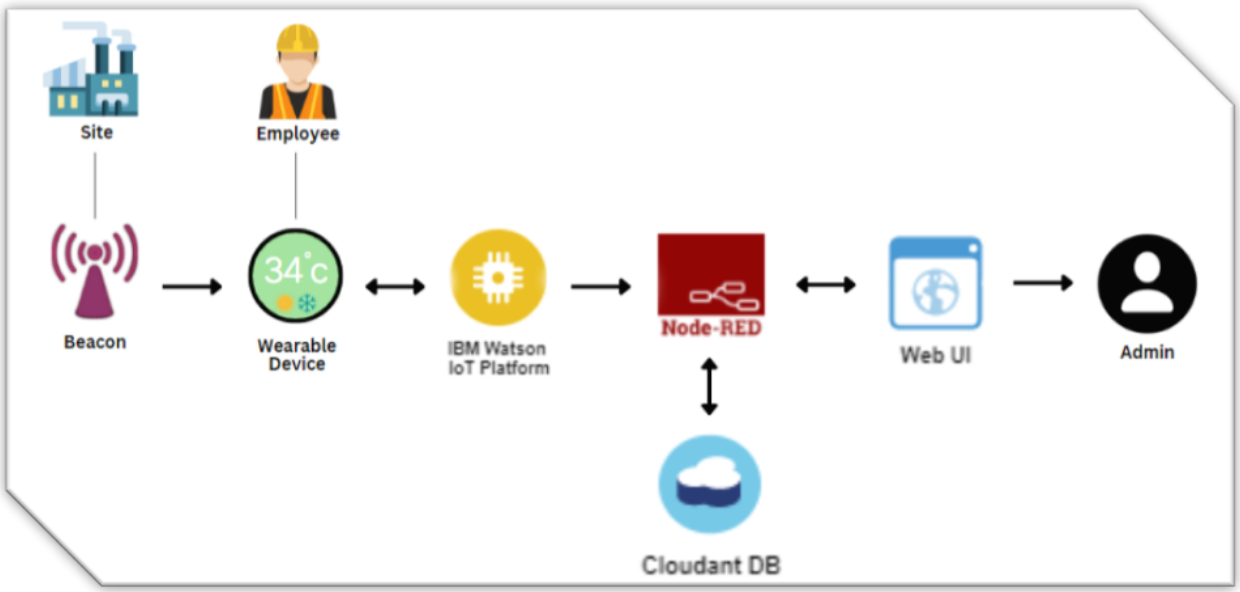
Our solution is to send alert messages to the users once the beacons detect temperature breach. The necessary evacuation steps could be followed when the message is triggered. Our system design also enables the users to maintain the record of the temperatures read, alarm signals and the beacon signals.This enables the organization or the user to :

- Take quick actions
- Mitigate future mistakes
- Implement proper strategies.

By registering to this system, the user could get notifications periodically from the beacons.This solution supports remote usage and thus remains as a safety focused application.

Technical Architecture:

Technical architecture which is also often referred to as application architecture includes the major components of the system, their relationships, and the contracts that define the interactions between the components. The goal of technical architects is to achieve all the business needs with an application that is optimized for both performance and security.



Components:

- **Site:** Each site has a beacon associated with it
- **Beacon:** Each beacon contains Raspberry pi, sensor, light, power source and other relatively minor components
- **Employee:** Each employee has a wearable device at all times
- **Wearable device:** This device will constantly show the temperature of the current site and intimate the user if the temperature rises or drops beyond normal levels that are set
- **IBM Watson IoT Platform:** It is a hub for all things IBM IoT. One can setup and manage all connected devices
- **Node-RED:** Serves as a programming tool for wiring together hardware devices, APIs and online services
- **Web UI:** Serves as user interface
- **Cloudant DB:** Applications are created to interpret accessed data
- **Admin:** View gathered data and take necessary action if required

5.3 User Stories

USER TYPE	FUNCTIONAL REQUIREMENT (EPIC)	USER STORY NUMBER	USER STORY/TASK	ACCEPTANCE CRITERIA	PRIORITY	RELEASE
User	Authentication	USN-1	As a user, I can register for the application by entering my email, password, and confirming my password.	I can access my account via email	High	sprint-2
User	Authentication	USN-2	As a user, I will receive confirmation email once I have registered for the application	I can verify my registration through my email	High	sprint-2
User	Authentication	USN-3	As a user, I can register for the application through Gmail	I can access my account via email	low	sprint-2
User	Authentication	USN-4	As a user, I can activate my device by entering email & password	I can login the page	High	sprint-2
User	Employee usage	USN-5	As a user, I can view the temperature of the site I'm at on my device	I will know the temperature of my surrounding	High	sprint-1
User	Remote staff usage	USN-6	As a user, my device should constantly transmit the temperature of the site to the cloud	I could get the processed data.	High	sprint-4

User	Remote staff usage	USN-7	As a user, I should be able to view all the data transmitted from the various devices of an industrial power plant	I am aware of my surrounding temperature.	High	sprint-4
User	Employee usage	USN-8	As a user, my device and UI should be user friendly	I can access the app easily	High	sprint-3
User	Employee usage	USN-9	As a user, my device should get details from the beacon at my site	I could be helped by the personnels	High	sprint-1
User	Employee usage	USN-10	As a user, my device should notify if there is an unusual rise on drop in the temperature	I get to know my surrounding temperature	High	sprint-3
User	Employee usage	USN-11	As a user, my device should show me which my closest exist is	I can get out of the room if I know the exit	low	sprint-3

6. PROJECT PLANNING & SCHEDULING

6.1 Sprint Planning & Estimation

RELEASE	FUNCTIONAL REQUIREMENT (EPIC)	USER STORY NUMBER	USER STORY/TASK	PRIORITY	STORY POINTS	TEAM MEMBERS
sprint-2	Authentication	USN-1	As a user, I can register for the application by entering my email, password, and confirming my password.	High	3	Josalin, Tanya
sprint-2	Authentication	USN-2	As a user, I will receive confirmation email once I have registered for the application	High	2	Josalin, Tanya
sprint-2	Authentication	USN-3	As a user, I can register for the application through Gmail	low	1	Hemanth
sprint-2	Authentication	USN-4	As a user, I can activate my device by entering email & password	High	2	Josalin, Tanya
sprint-1	Employee usage	USN-5	As a user, I can view the temperature of the site I'm at on my device	High	5	Harshitha, Ryan
sprint-4	Remote staff usage	USN-6	As a user, my device should constantly transmit the temperature of the site to the cloud	High	5	Josalin, Tanya
sprint-4	Remote staff usage	USN-7	As a user, I should be able to view all the data transmitted	High	3	Harshitha, Ryan

			from the various devices of an industrial power plant			
sprint-3	Employee usage	USN-8	As a user, my device and UI should be user friendly	High	1	Harshitha, Ryan
sprint-1	Employee usage	USN-9	As a user, my device should get details from the beacon at my site	High	3	Harshitha, Ryan
sprint-3	Employee usage	USN-10	As a user, my device should notify if there is an unusual rise on drop in the temperature	High	2	Harshitha, Ryan
sprint-3	Employee usage	USN-11	As a user, my device should show me which my closest exist is	low	5	Harshitha, Ryan

6.2 Sprint Delivery Schedule

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	8	6 Days	24 Oct 2022	29 Oct 2022	8	29 Oct 2022
Sprint-2	8	6 Days	31 Oct 2022	05 Nov 2022	8	05 Nov 2022
Sprint-3	8	6 Days	07 Nov 2022	12 Nov 2022	8	12 Nov 2022
Sprint-4	8	6 Days	14 Nov 2022	19 Nov 2022	8	19 Nov 2022

Velocity:

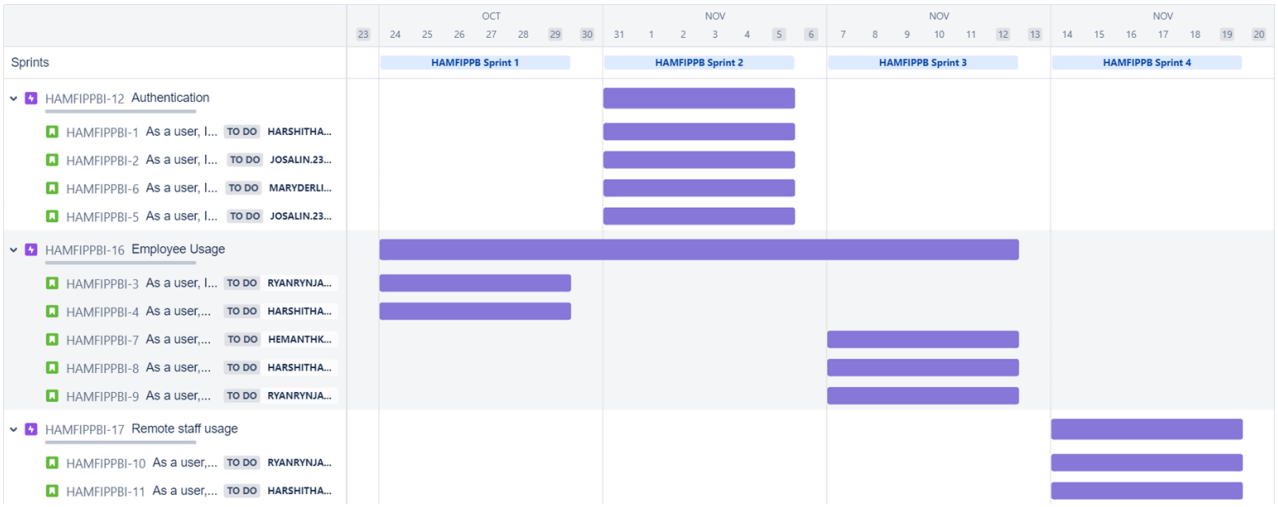
Let's calculate the team's average velocity (AV) per iteration unit (story points per day)

$$\text{AV} = \frac{story\ points}{duration} = \frac{8}{6} = 1.3$$

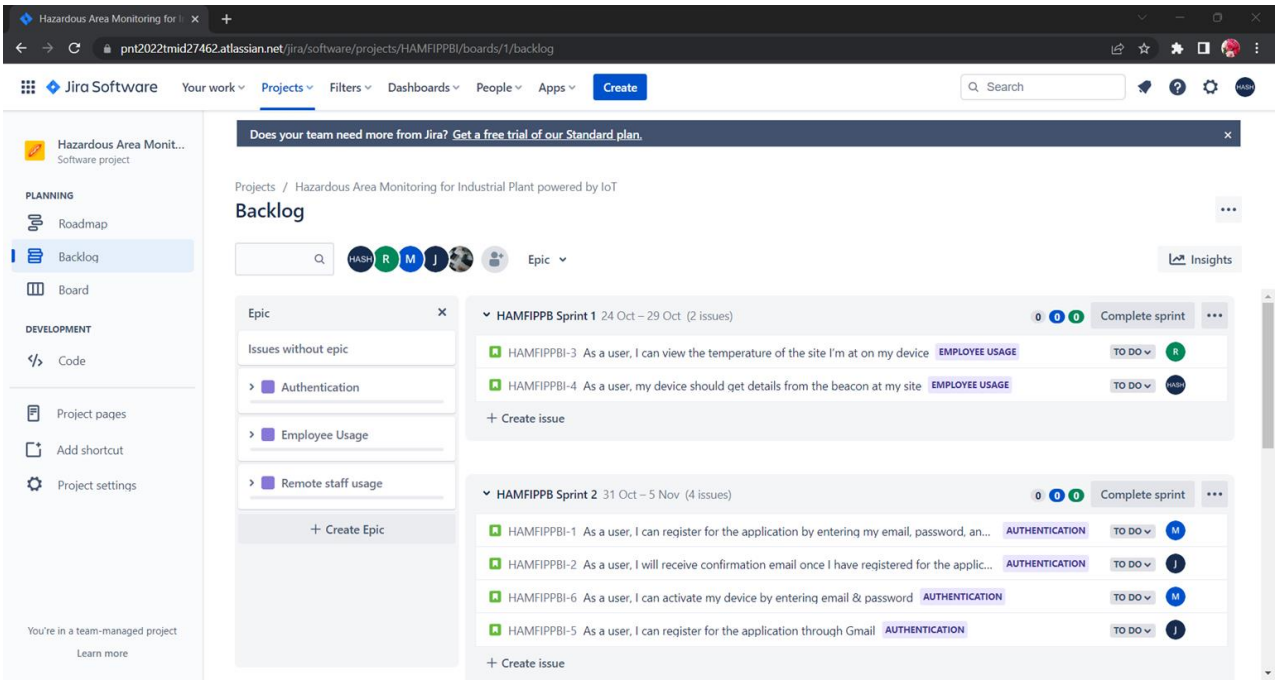
6.3 Reports from JIRA

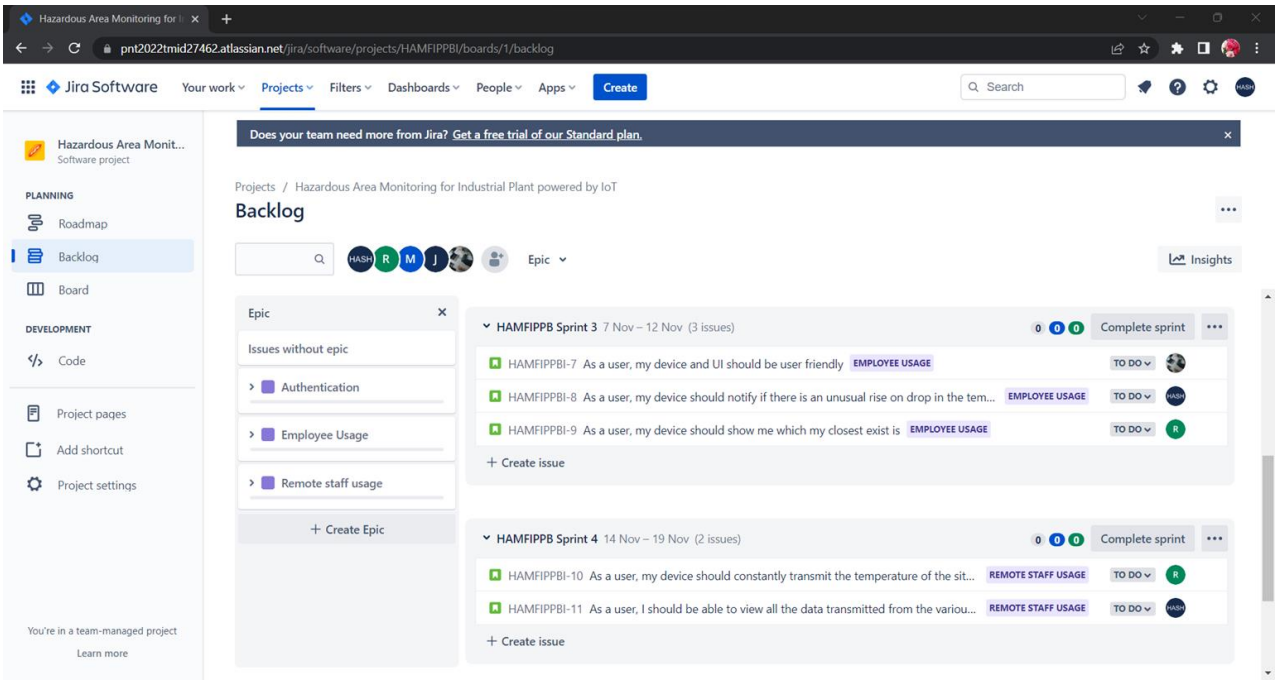
PLAN

- Roadmap

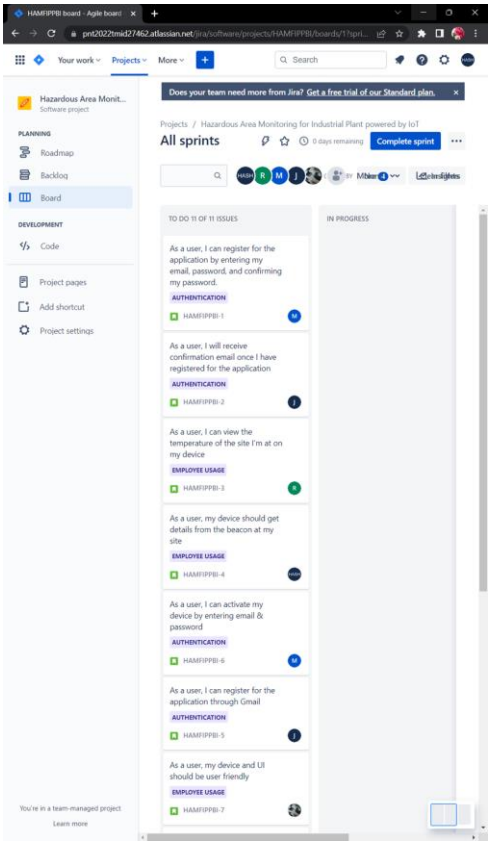


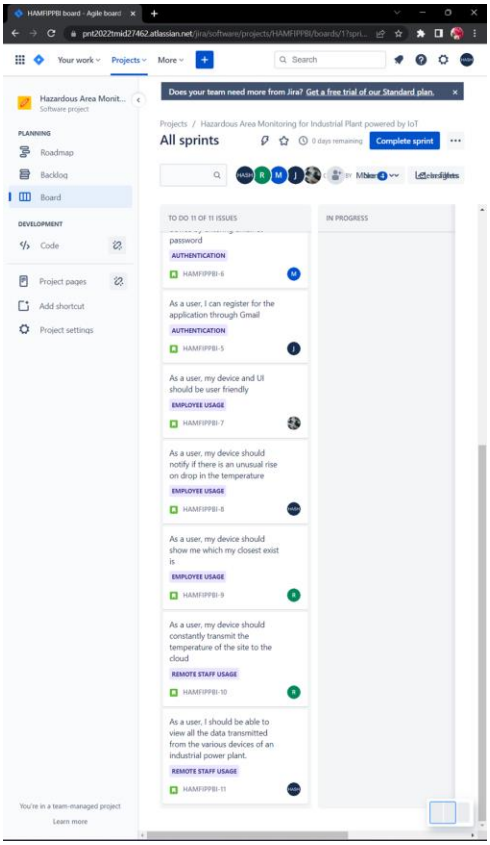
- Backlog




Hazardous Area Monitoring for I
pnt2022tmid27462.atlassian.net/jira/software/projects/HAMFIPPBI/boards/1/backlog
Jira Software
Your work
Projects
Filters
Dashboards
People
Apps
Create
Search
Hazardous Area Monit...
Software project
PLANNING
Roadmap
Backlog
Board
DEVELOPMENT
Code
Project pages
Add shortcut
Project settings
You're in a team-managed project
Learn more
Does your team need more from Jira? Get a free trial of our Standard plan.
Projects / Hazardous Area Monitoring for Industrial Plant powered by IoT
Backlog
Epic
Insights
Epic
Issues without epic
Authentication
Employee Usage
Remote staff usage
+ Create Epic
HAMFIPPB Sprint 3 7 Nov – 12 Nov (3 issues)
Complete sprint
HAMFIPPBI-7 As a user, my device and UI should be user friendly EMPLOYEE USAGE TO DO
HAMFIPPBI-8 As a user, my device should notify if there is an unusual rise on drop in the tem... EMPLOYEE USAGE TO DO
HAMFIPPBI-9 As a user, my device should show me which my closest exist is EMPLOYEE USAGE TO DO
+ Create issue
HAMFIPPB Sprint 4 14 Nov – 19 Nov (2 issues)
Complete sprint
HAMFIPPBI-10 As a user, my device should constantly transmit the temperature of the sit... REMOTE STAFF USAGE TO DO
HAMFIPPBI-11 As a user, I should be able to view all the data transmitted from the variou... REMOTE STAFF USAGE TO DO
+ Create issue

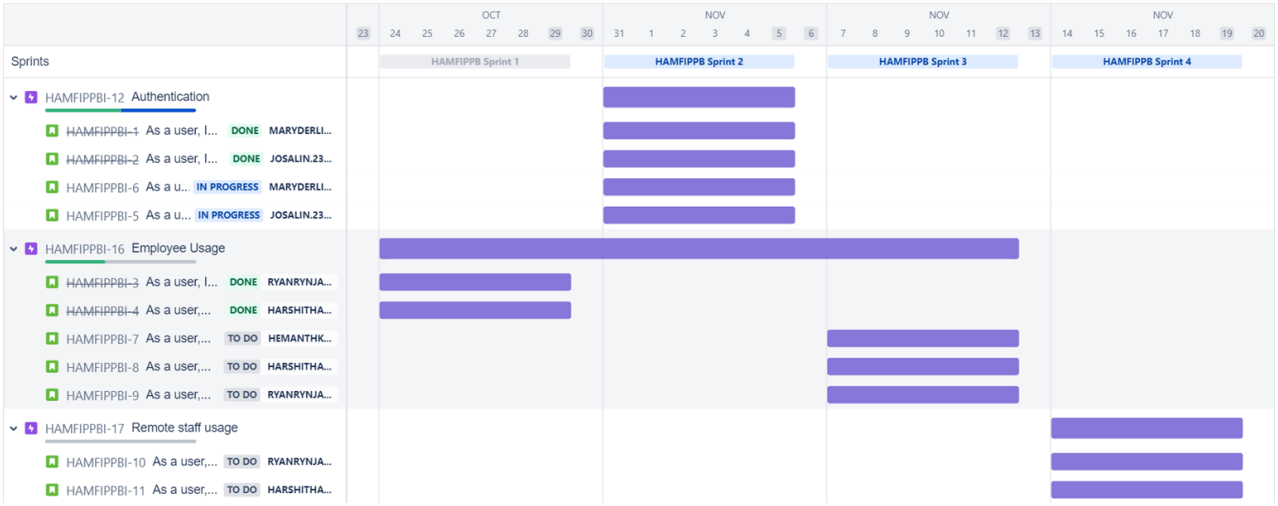
- Board


All sprints
Complete sprint
TO DO 11 OF 11 ISSUES
IN PROGRESS
As a user, I can register for the application by entering my email, password, and confirming my password.
AUTHENTICATION
As a user, I will receive confirmation email once I have registered for the application
AUTHENTICATION
As a user, I can view the temperature of the site I'm at on my device
EMPLOYEE USAGE
As a user, my device should get details from the beacon at my site
EMPLOYEE USAGE
As a user, I can activate my device by entering email & password
AUTHENTICATION
As a user, I can register for the application through Gmail
AUTHENTICATION
As a user, my device and UI should be user friendly
EMPLOYEE USAGE

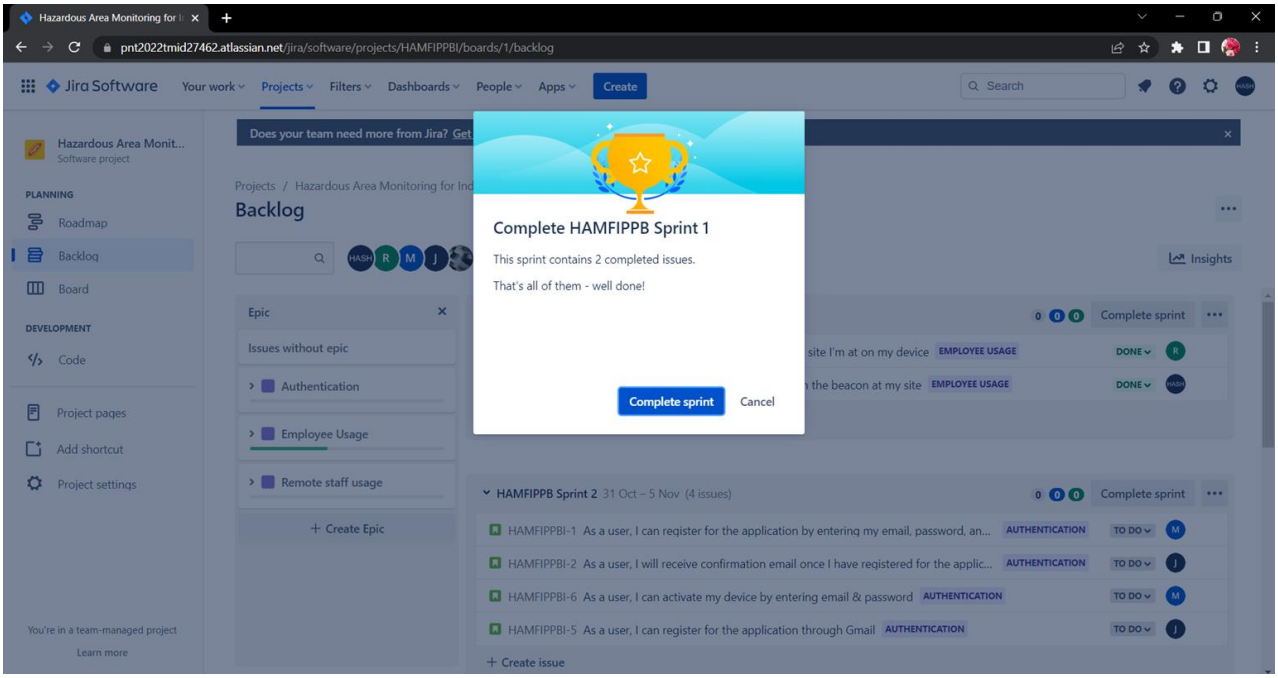

All sprints
Complete sprint
TO DO 11 OF 11 ISSUES
IN PROGRESS
AUTHENTICATION
As a user, I can register for the application through Gmail
AUTHENTICATION
As a user, my device and UI should be user friendly
EMPLOYEE USAGE
As a user, my device should notify if there is an unusual rise on drop in the temperature
EMPLOYEE USAGE
As a user, my device should show me which my closest exist is
EMPLOYEE USAGE
As a user, my device should constantly transmit the temperature of the site to the cloud
REMOTE STAFF USAGE
As a user, I should be able to view all the data transmitted from the various devices of an industrial power plant.
REMOTE STAFF USAGE

IN PROGRESS

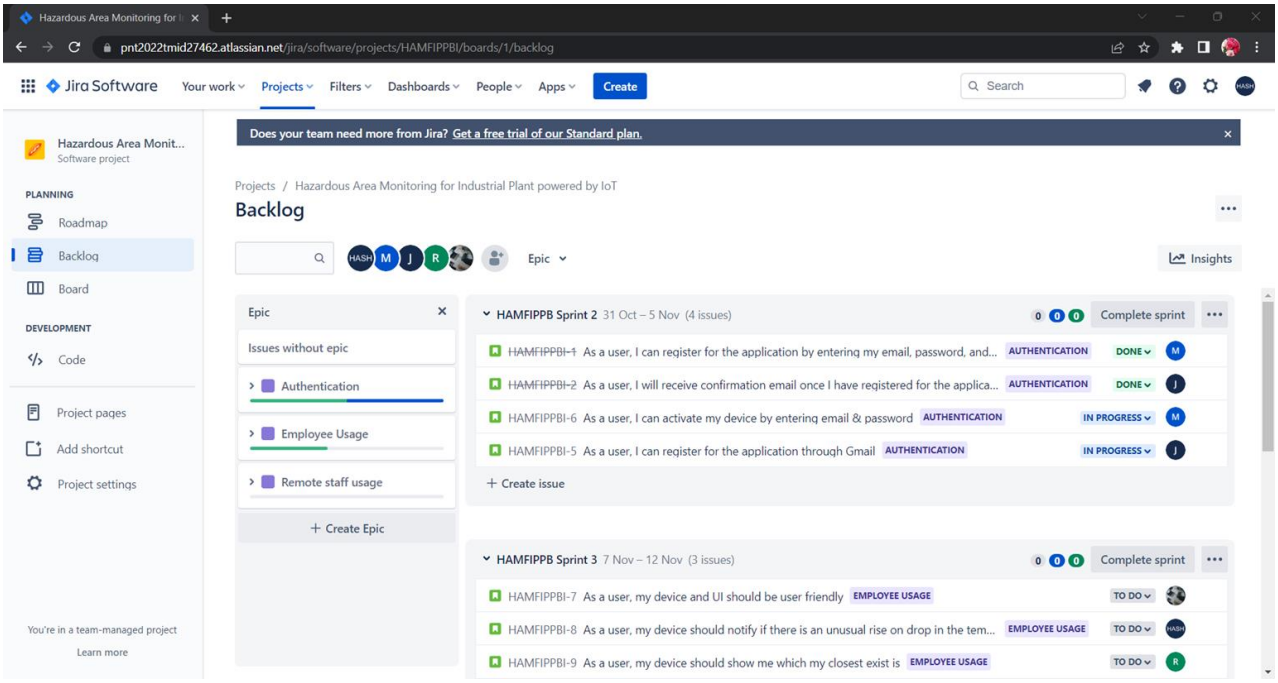
- Roadmap



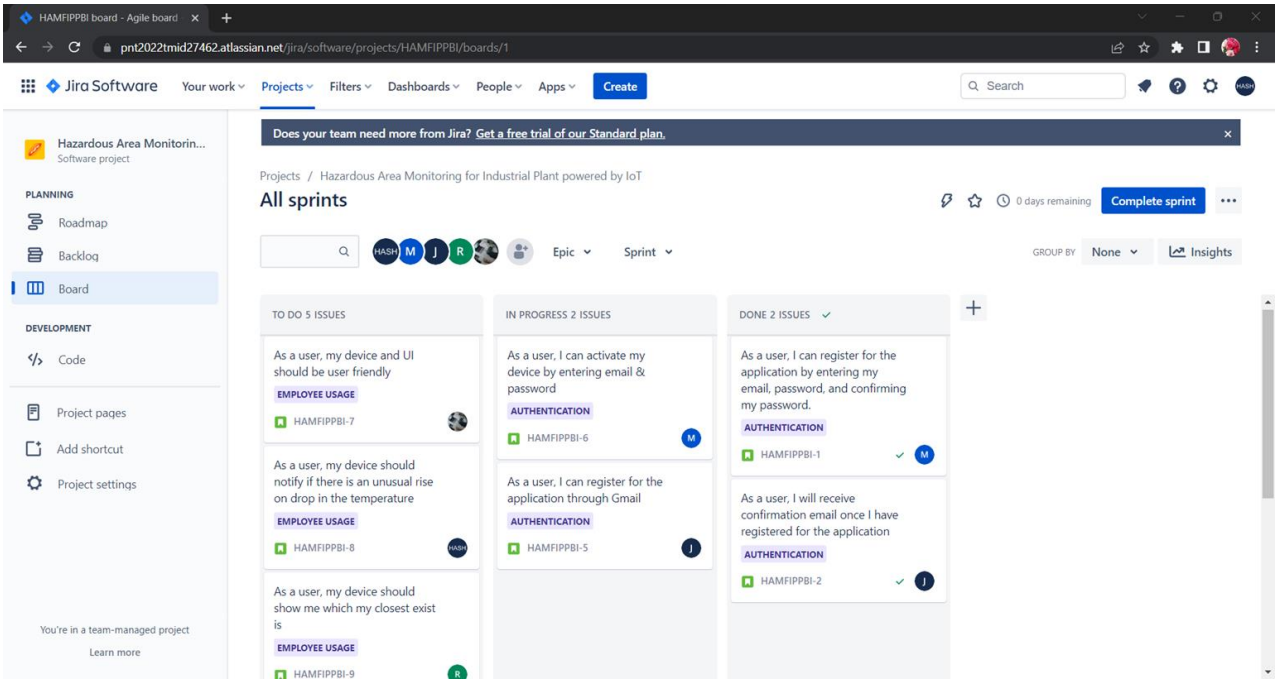
- Completed sprint

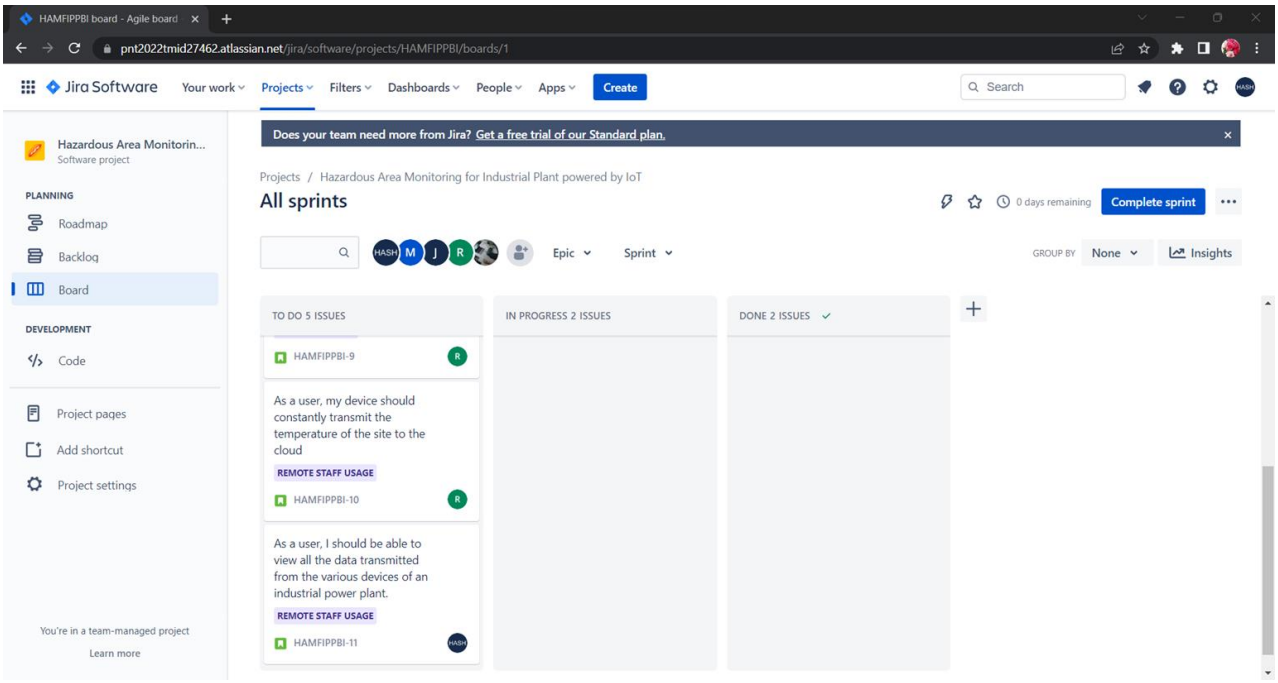


- Backlog



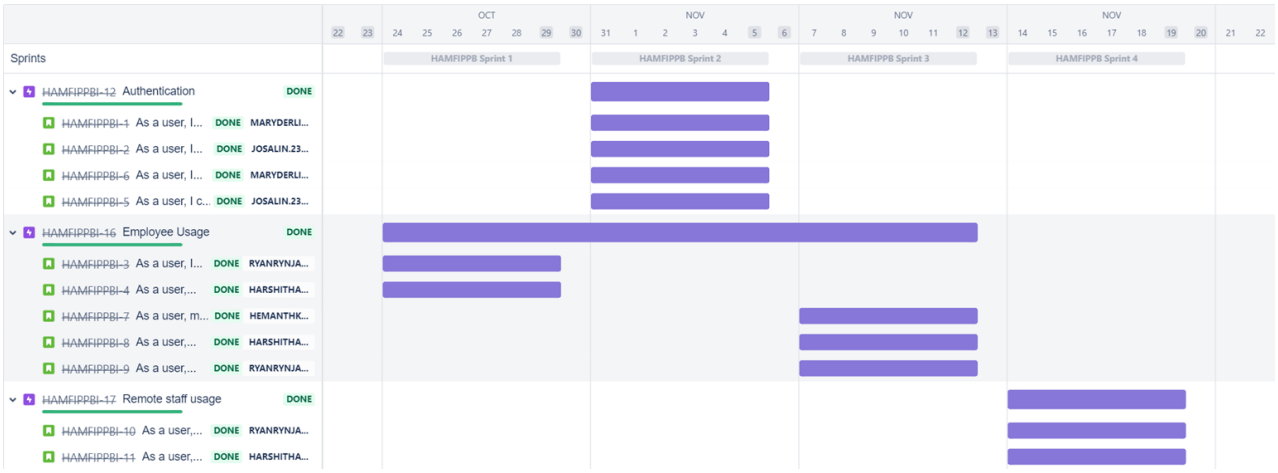
- Board



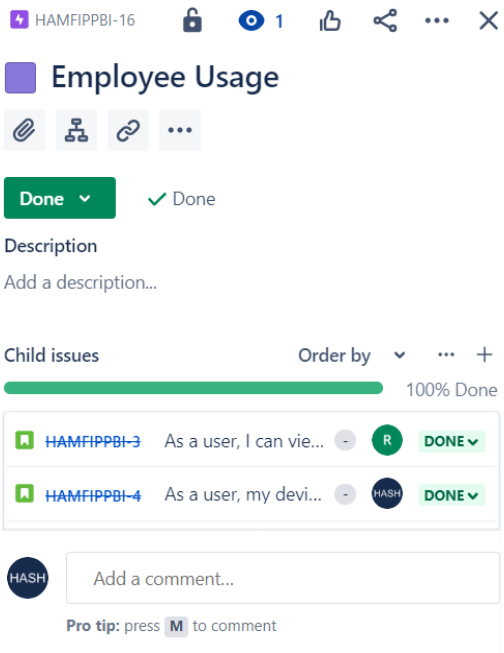


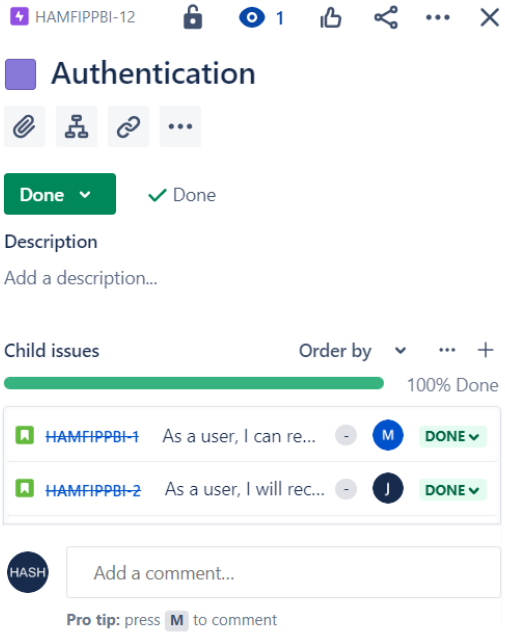
COMPLETED

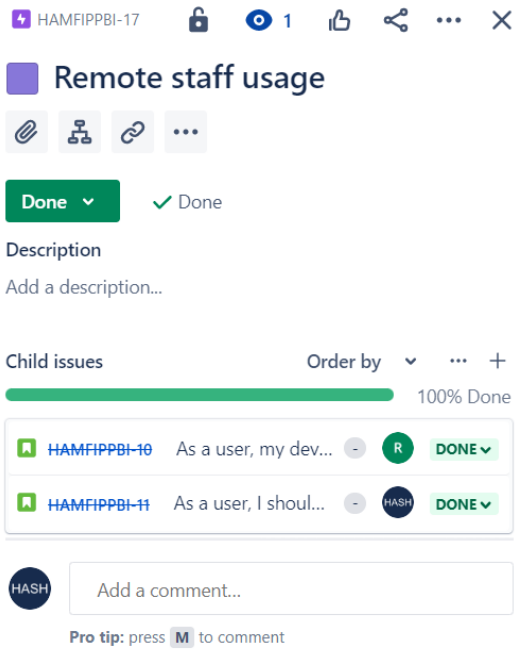
- Roadmap



- Epics


HAMFIPPBI-16
1
Employee Usage
Done
Done
Description
Add a description...
Child issues
Order by
100% Done
HAMFIPPBI-3 As a user, I can vie... R DONE
HAMFIPPBI-4 As a user, my devi... HASH DONE
HASH
Add a comment...
Pro tip: press M to comment

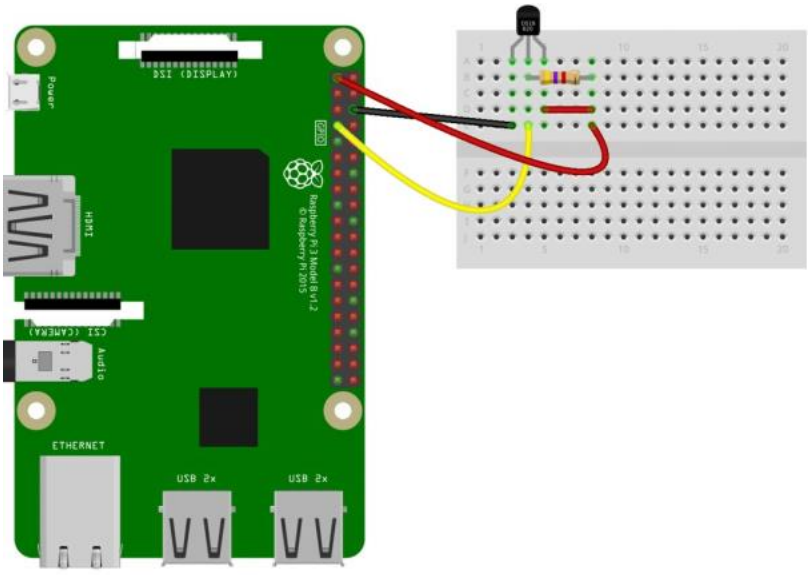

HAMFIPPBI-12
1
Authentication
Done
Done
Description
Add a description...
Child issues
Order by
100% Done
HAMFIPPBI-1 As a user, I can re... M DONE
HAMFIPPBI-2 As a user, I will rec... J DONE
HASH
Add a comment...
Pro tip: press M to comment


HAMFIPPBI-17
1
Remote staff usage
Done
Done
Description
Add a description...
Child issues
Order by
100% Done
HAMFIPPBI-10 As a user, my dev... R DONE
HAMFIPPBI-11 As a user, I shoul... HASH DONE
HASH
Add a comment...
Pro tip: press M to comment

7.CODING & SOLUTIONING

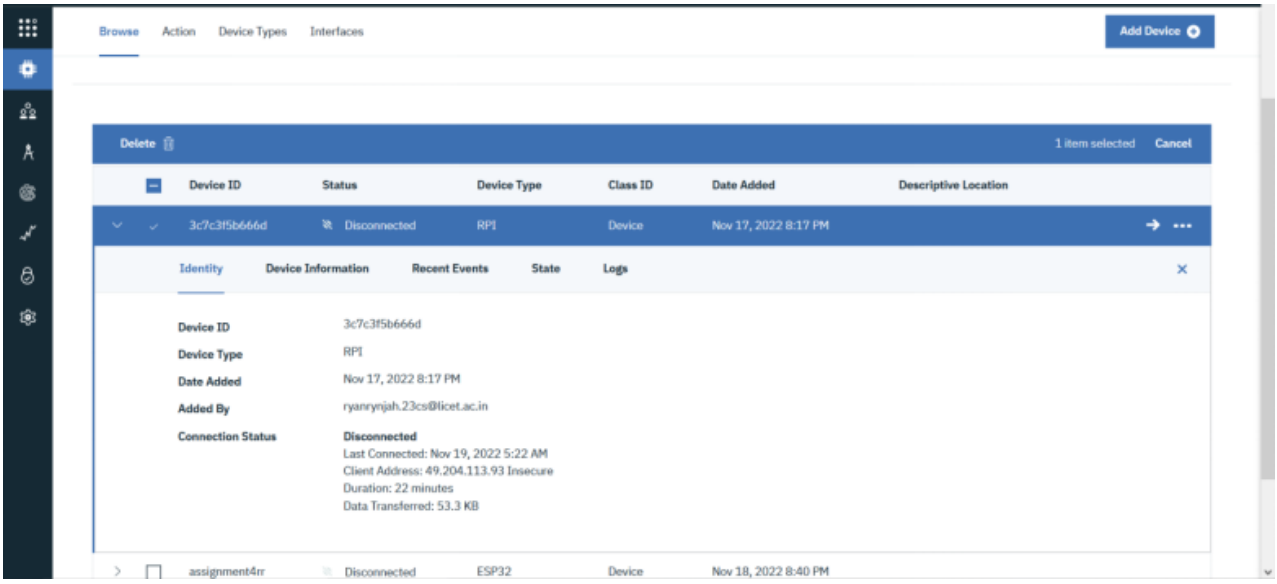
7.1 IoT Device

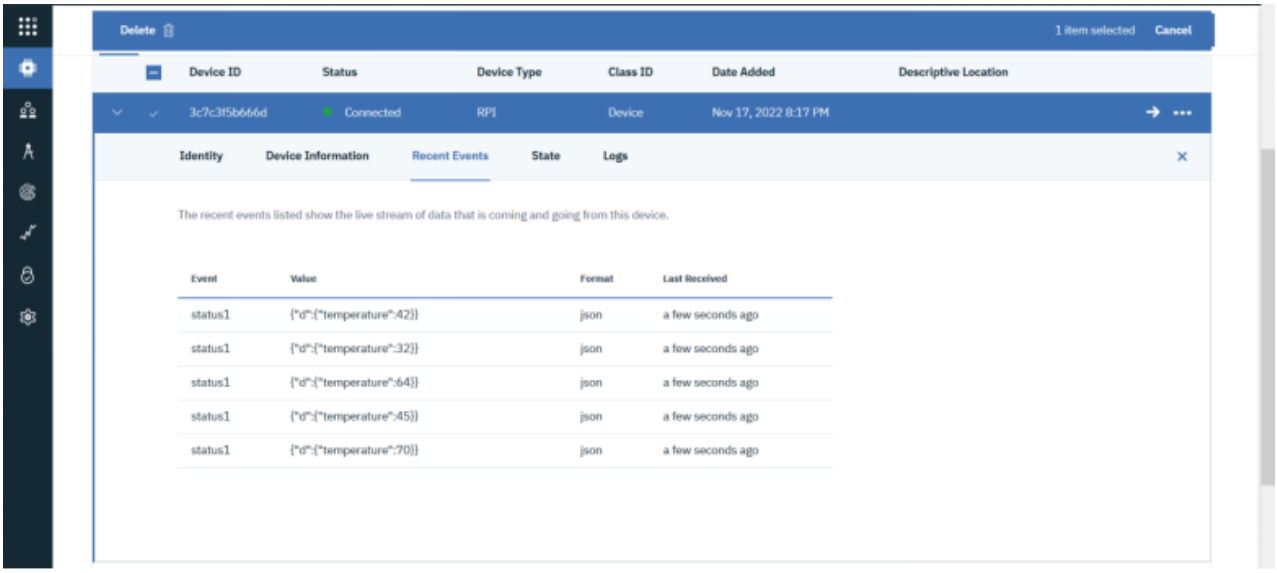
Solution:



The IoT device used throughout is a Raspberry Pi 3B+ with `DS18B20` temperature sensor. It is provided with network connectivity and continuous power supply.

Devices are interconnected through IBM Cloud IoT platform.





Code:

```
import time

import random

import paho.mqtt.client as mqtt

import json
```

```
#from w1thermsensor import W1ThermSensor

#sensor = W1ThermSensor()

#def Temp():

    #return temperature = sensor.get_temperature()


#The above lines of code would be used when getting temperature data from a
DS18B20 sensor.

#Due to hardware limitations we are simulating values using random
function.


def Temp():

    return random.randint(0,99);


ORG = "csgusn"

DEVICE_TYPE = "RPI"

TOKEN = "1123581321"

DEVICE_ID = "3c7c3f5b666d"  #Credentials of device as per created on IBM
IoT platform.


server = ORG + ".messaging.internetofthings.ibmcloud.com";

pubTopic1 = "iot-2/evt/status1/fmt/json";   #event named status 1 in JSON
format


authMethod = "use-token-auth";

token = TOKEN;

clientId = "d:" + ORG + ":" + DEVICE_TYPE + ":" + DEVICE_ID;
```

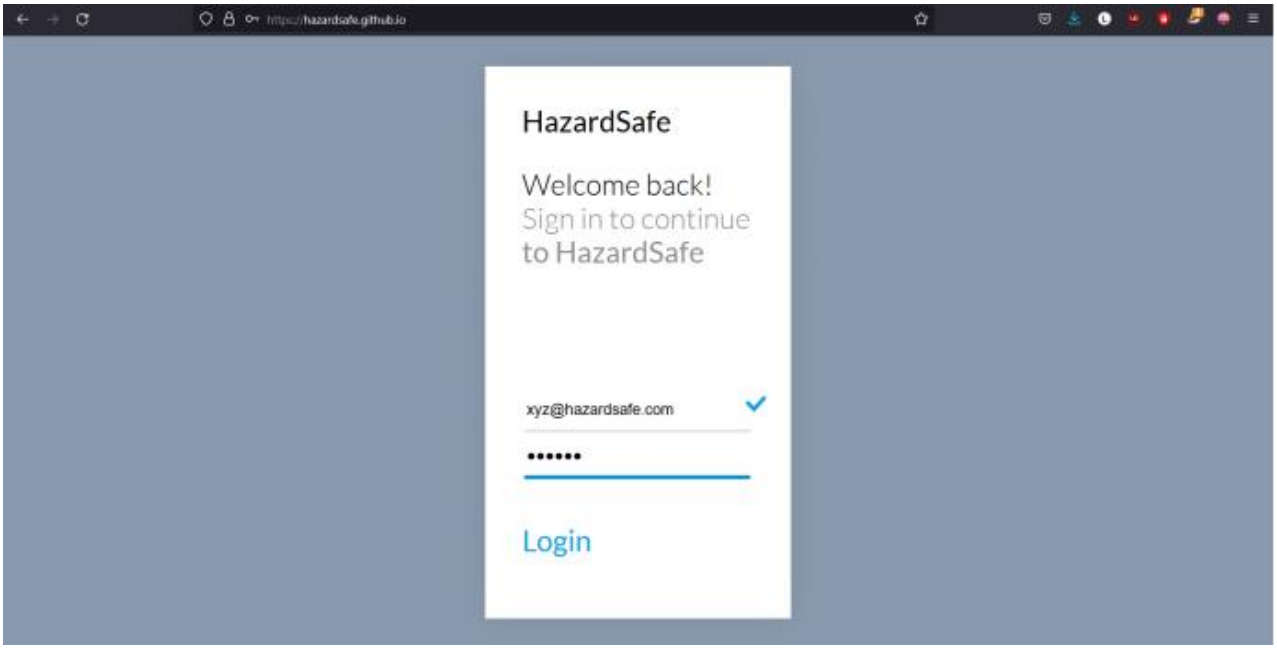
```
mqttc = mqtt.Client(client_id=clientId)

mqttc.username_pw_set(authMethod, token)

mqttc.connect(server, 1883, 60)          #Connecting using MQ Telemetry
Transport Protocol


while True:


    tempDict = { "d": {"temperature": Temp()} };     #Temporary storage in a
dictionary


    tempJson = json.dumps(tempDict);     #Conversion from dictionary to JSON


    mqttc.publish(pubTopic1, tempJson)       #Publish payload

    print("Reading Taken");


    time.sleep(5);
```

7.2 Web App

Admin or whomsoever possesses authentication credentials can login to access temperature related data about the site

1)Login page

Solution:



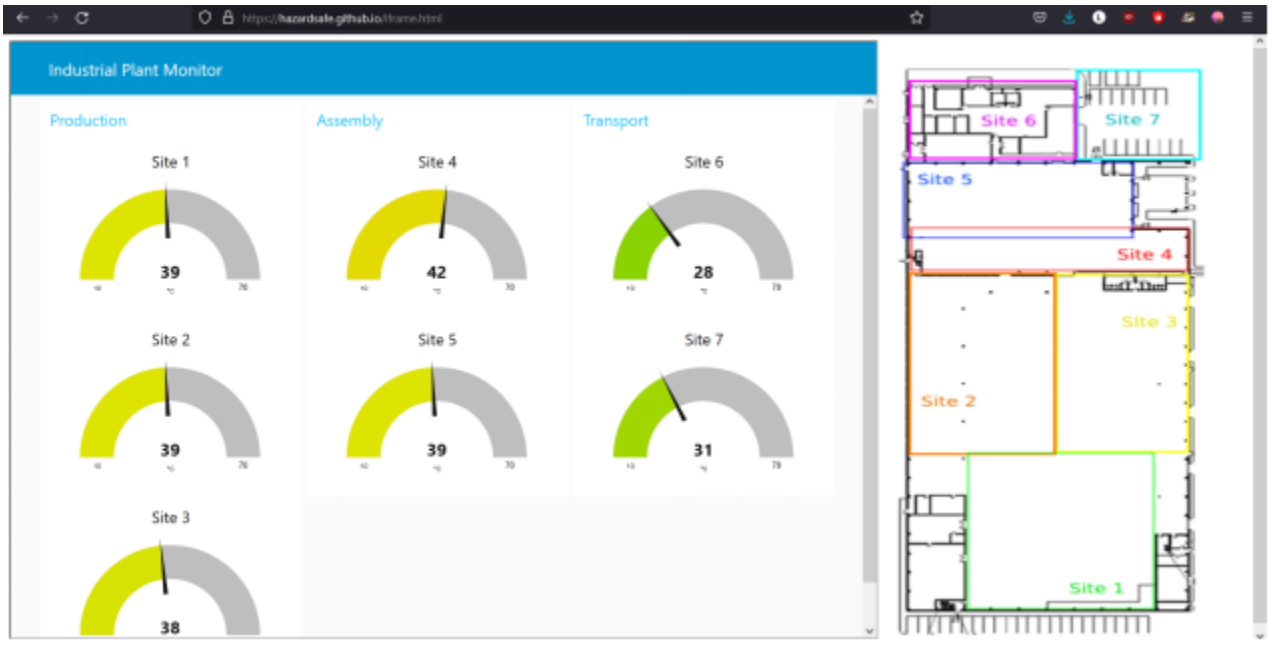
Code:

```
<!DOCTYPE html>

<html>



<head>

  <title>Hazard Safe</title>

  <link rel="stylesheet"
href="https://cdnjs.cloudflare.com/ajax/libs/normalize/5.0.0/normalize.min.
css">

  <link rel="stylesheet" href="./style.css">



</head>



<body>

<!-- partial:index.partial.html -->

<div class="route" id="welcome"></div>

<div id="app">

  <div class="app-view">

    <header class="app-header">

      <h1>HazardSafe</h1>

      Welcome back!<br/>

      <span class="app-subheading">

        Sign in to continue<br>

        <b>to HazardSafe</b>

      </span>

    </header>
```

```
    <input type="email" required pattern=".*\.\w{2,}"
placeholder="email@hazardsafe.com" />

    <input type="password" required placeholder="Password" />

    <a href="./iframe.html" class="app-button">Login</a>

  </div>

</div>



</body>

</html>
```

2) Dashboard View

Solution:



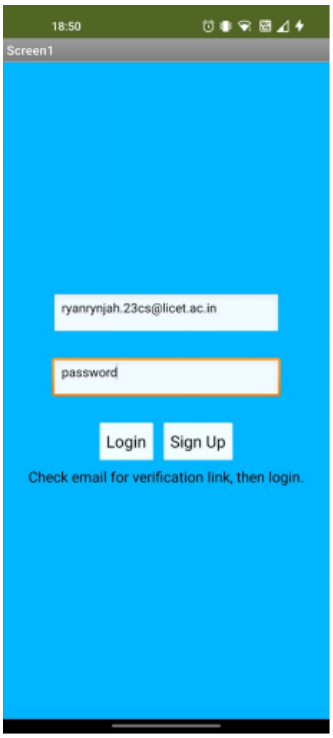
Code:

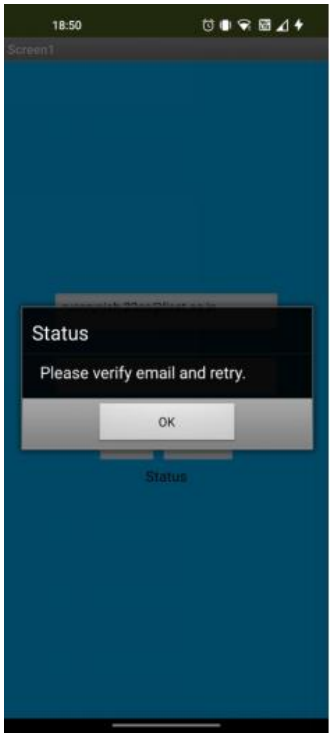
```
<!DOCTYPE html>

<html>



<head>

    <title>HazardSafe | IoT Industrial Safety Solution</title>

</head>



<body height="100%" width="100%">

    <iframe src="https://licet-nr-iot.eu-gb.mybluemix.net/ui" width="70%"
height="100%" ></iframe>

    <img src="./plan.png" width="400" height="700"></img>

</body>



</html>
```

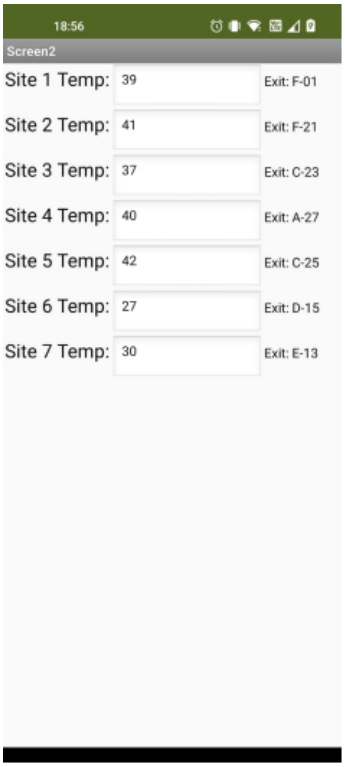
7.3 Android App

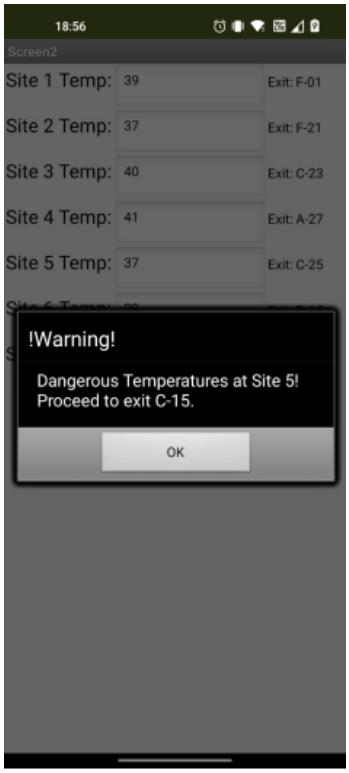
- New employees may use register using the android application
- Employees with an account can log in to view the temperature of the site they are on
- Users will be notified of abnormal temperature activity

Solution:






18:56
Screen2
Site 1 Temp: 39
Exit: F-01
Site 2 Temp: 41
Exit: F-21
Site 3 Temp: 37
Exit: C-23
Site 4 Temp: 40
Exit: A-27
Site 5 Temp: 42
Exit: C-25
Site 6 Temp: 27
Exit: D-15
Site 7 Temp: 30
Exit: E-13


18:56
Screen2
Site 1 Temp: 39
Exit: F-01
Site 2 Temp: 37
Exit: F-21
Site 3 Temp: 40
Exit: C-23
Site 4 Temp: 41
Exit: A-27
Site 5 Temp: 37
Exit: C-25
!Warning!
Dangerous Temperatures at Site 5!
Proceed to exit C-15.
OK

8.TESTING

8.1 Test Cases

Test Case	Precondition	Test Steps	Test Data	Expected Result
Verify login with credentials	User should have a network connection	1.Launch URL 2.Enter valid user name and password 3.Click on “Login” button	Username:acde Password:nasb xagxqu	User should be able to login successfully
Verify login with invalid credentials	User should have a network connection	1.Launch URL 2.Enter invalid user name or password 3.Click on “Login” button	Username:cade Password:nasb xagxqu	User should not be able to login successfully
Beacon sensing the temperature	Beacon should be in a working condition	1.Set up beacon in the hazardous environment 2.Integrate with the software	Sensor1:Tempe rature-23	Beacon should be able to sense the temperature accurately
Collecting beacon signals	The beacon should have temperature sensors	1.Integrate the beacon with the software and cloud 2.Process the continuously received data	Sensor-1: 34 Sensor-2:33 sensor-3:30	The software should be able to collect the sensors data successfully
Generation of warning message	Integration of beacon and the software	1.Integrate the beacon with the software and cloud 2.Process the continuously received data 3.Check for temperature breach 4.If detected send the trigger messages to the registered devices	Software:”ZON E-3 is under danger”	The software should be able to generate the warning message successfully
Reception of warning message by the worker’s device	Integration of the software and the worker’s device	1.Register the worker’s device in the software 2.Integrate the beacon with the worker’s device 3.Enable the provision to	Worker’s Device:”EVACU ATE IMMEDIATELY”	The worker’s device should be able to receive the warning message successfully

		receive messages from the software and the beacon		
Storage of data on cloud	Availability of cloud storage	1.Setup a cloud storage 2.Integrate the beacon with the software and the cloud 3.Process the sensor's data 4.Store the processed data in cloud	Sensor data,beacon signals, linked devices,Trigger warning messages	The cloud storage should be compatible to store all the processed data

8.2 User Acceptance Testing

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	12	5	3	1	21
Duplicate	1	0	3	0	4
External	2	3	0	1	6
Fixed	19	8	3	20	50
Not Reproduced	1	0	1	0	2
Skipped	1	1	1	1	4
Won't Fix	0	4	2	1	7
Totals	36	21	13	24	171

Test Case Analysis

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

Section	Total Cases	Not Tested	Fail	Pass
Client Application	7	0	0	7
Temperature	15	0	0	15
Monitor	2	0	0	2
Notification	2	0	0	2
Reporting	2	0	0	2
Final Report Output	4	0	0	4
Version Control	2	0	0	2

9.RESULTS

9.1 Performance Metrics

S NO	Parameter	Performance
1	Response time	0.1(20 trials)
2	Workload	400 users(Calculated based on the cloud spaces)
3	Revenue	Industrial Power plants
4	Efficiency	Simple and straightforward workflow which makes the process efficient
5	Down Time	Almost no down time due to IBM cloud enabled solutions

10.ADVANTAGES & DISADVANTAGES

Advantages:

- **Open source access:** The application is easily available and can be accessed through a pc or a mobile device.
- **Easy Navigation:** The UI is user friendly and offers easy access and navigation across the website.
- Increases user alertness with alarms and triggers
- Keeps record of all the information for future reference and analysis

Disadvantages:

- Only limited users can access the software
- Not a generalized model
- Large number of rules
- Needs continuous monitoring
- Can detect the abnormalities only when the data is continuously fed

11.CONCLUSION

There are many ways to monitor a hazardous area in a power plant.Various techniques and technologies strive to provide properly secured softwares and devices.Our system aim to provide that protection by adopting the latest IoT technologies.We eliminated the delay in the transfer of signals by using beacons.The data is continuously processed and trigger messages are sent in case of detecting a temperature breach.

12.FUTURE SCOPE

In future we intend to build add-ons for our system by sending trigger messages to the cobots.These robots could help with quickening the evacuation process.Once temperature breach is detected the sprinkler sensors could be immediately activated,electricity could be cut off.The measure of the employees' vitals could also added as a separate function.

13.APPENDIX

13.1 Source Code

Python Device Code

```
import time

import random

import paho.mqtt.client as mqtt

import json



#from w1thermsensor import W1ThermSensor

#sensor = W1ThermSensor()

#def Temp():

    #return temperature = sensor.get_temperature()



#The above lines of code would be used when getting temperature data from a
DS18B20 sensor.

#Due to hardware limitations we are simulating values using random
function.



def Temp():

    return random.randint(0,99);



ORG = "csgusn"

DEVICE_TYPE = "RPI"

TOKEN = "1123581321"

DEVICE_ID = "3c7c3f5b666d"  #Credentials of device as per created on IBM
IoT platform.
```

```
server = ORG + ".messaging.internetofthings.ibmcloud.com";

pubTopic1 = "iot-2/evt/status1/fmt/json";    #event named status 1 in JSON
format



authMethod = "use-token-auth";

token = TOKEN;

clientId = "d:" + ORG + ":" + DEVICE_TYPE + ":" + DEVICE_ID;



mqttc = mqtt.Client(client_id=clientId)

mqttc.username_pw_set(authMethod, token)

mqttc.connect(server, 1883, 60)          #Connecting using MQ Telemetry
Transport Protocol



while True:



    tempDict = { "d": {"temperature": Temp()} };     #Temporary storage in a
dictionary



    tempJson = json.dumps(tempDict);     #Conversion from dictionary to JSON



    mqttc.publish(pubTopic1, tempJson)       #Publish payload

    print("Reading Taken");



    time.sleep(5);
```

Web App HTML

1)Login page

```
<!DOCTYPE html>

<html>



<head>

  <title>Hazard Safe</title>

  <link rel="stylesheet"
href="https://cdnjs.cloudflare.com/ajax/libs/normalize/5.0.0/normalize.min.
css">

  <link rel="stylesheet" href="./style.css">



</head>



<body>

<!-- partial:index.partial.html -->

<div class="route" id="welcome"></div>

<div id="app">

  <div class="app-view">

    <header class="app-header">

      <h1>HazardSafe</h1>

      Welcome back!<br/>

      <span class="app-subheading">

        Sign in to continue<br>

        <b>to HazardSafe</b>
```

```
      </span>

    </header>

    <input type="email" required pattern=".*\.\w{2,}"
placeholder="email@hazardsafe.com" />

    <input type="password" required placeholder="Password" />

    <a href="./iframe.html" class="app-button">Login</a>

  </div>

</div>



</body>

</html>
```

2) Dashboard View

```
<!DOCTYPE html>

<html>



<head>

    <title>HazardSafe | IoT Industrial Safety Solution</title>

</head>



<body height="100%" width="100%">

    <iframe src="https://licet-nr-iot.eu-gb.mybluemix.net/ui" width="70%"
height="100%" ></iframe>

    <img src="./plan.png" width="400" height="700"></img>

</body>
```

```
</html>
```

13.2 GitHub & Project Demo Link

GitHub link:

https://github.com/IBM-EPBL/IBM-Project-37778-1660324642

Demo link:

https://youtu.be/6DRhiTVgirk