

GAS LEAKAGE MONITORING & ALERTING SYSTEM FOR INDUSTRIES

Category: INTERNET OF THINGS

A PROJECT REPORT

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FROM

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In fulfillment of project in IBM-NALAYATHIRAN 2022

Team Id: PNT2022TMID36788

PROJECT GUIDES

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GAS LEAKAGE MONITORING AND ALERTING SYSTEM

1.INTRODUCTION:

Nowadays, home safety detection systems play a significant part in people's security. Since everyone in the household works every day, it is impossible to check on the household appliances, particularly the LPG gas cylinder, wired circuits, etc. Liquefied petroleum gas (LPG) and natural gas demand has significantly increased during the past three years. LPG and natural gas are recommended to meet this high level of energy demand and to substitute oil or coal due to those fuels' negative environmental effects. Large-scale applications for these gases include industry, heating, home appliances, and motor fuel. The system has a MQ6 gas sensor to monitor this leakage gas. This sensor detects how much leak gas is there in the environment around it.

Explosions or being harmed by gas leaks could be avoided in this way.

2.LITERATURE SURVEY:

Prof. M.Amsaveni, A.Anurupa, R.S.Anu Preetha, C.Malarvizhi, M.Gunasekaran; they told in their research paper on “GSM based LPG leakage detection and controlling system” the leakage of LPG gas is detected by the MQ-6 gas sensor. Its analog output is given to the microcontroller. It consists of predefined instruction set. Based on this, the exhaust fan is switched on. So, the concentration of gas inside the room gets decreased. Then, the stepper motor is rotated thus closing the knob of the cylinder. Because of this process, the leakage of gas is stopped. The relay is switched to off the power supply of the house. The buzzer produces an alarm to indicate the gas leakage. Then, the user is alerted by SMS through the GSM module.

B. B. Did paye, Prof. S. K. Nanda; in this paper they told about their research on leakage detection and review of “Automated unified system for LPG using microcontroller and GSM module”. Their paper proposed an advance and innovative approach for LPG leakage detection, prevention and automatic booking for refill. In advance, the system provides the automatic controlling of LPG regulator also if leakage is detected the system will automatically turn off the main switch of power supply. Hence it helps to avoid the explosion and blast.

Srinivasan, Leela, Jeya bharathi, Kirthik, Rajasree; in this research paper they told about gas leakage detection and control. In this paper, the gas leakage resulting into fatal inferno has become a serious problem in household and other areas where household gas is handled and used. It alerts the subscriber through the alarm and the status display besides turning off the gas supply valve as a primary safety measure.

Hitendra Rawat, Ashish Kushwah, Khyati Asthana, Akanksha Shivhare, in the year 2014 planned a framework, They gave security issues against hoodlums, spillage and fire mishaps. In those cases their framework sends SMS to the crisis number gave to it.

P. Meenakshi Vidya, S. Abinaya, G. Geetha Rajeswari, N. Guna, “Automatic LPG detection and hazard controlling “ published in April 2014 proposed the leakage detection and real time gas monitoring system. In this system, the gas leakage is detected and controlled by means of exhaust fan. The level of LPG in cylinder is also continuously monitored. Ch. Manohar Raju and N. Sushma Rani, 2008, they introduce an android based automatic gas detection and indication robot.

3.PROPOSED SOLUTION:

IDEATION PROPOSED SOLUTION:

S.No	Parameter	Description
1.	Problem Statement (Problem to be solved)	<ul style="list-style-type: none">○ Gas Leakage Monitoring and Alerting System.
2.	Idea / Solution description	<ul style="list-style-type: none">○ Using a variety of sensor, the environmental parameters such as concentration of the gas can be monitored in real time○ If the concentration of gas reaches hazardous level an alert message can be sent to the user.
3.	Novelty / Uniqueness	<ul style="list-style-type: none">○ Device being developed can monitor a wide range of gases that are highly used in industries.○ Apart from notifying the user, Safety personnel are also notified in case of emergencies.○ User friendly in nature.
4.	Social Impact / Customer Satisfaction	<ul style="list-style-type: none">○ As the device is small, it is easy to install them in various locations based on necessity.
5.	Business Model (Revenue Model)	<ul style="list-style-type: none">○ Device can be obtained by paying for the subscription.○ It can be yearly or monthly.○ Based on the term of subscription 5 – 8% discount shall be made available.
6.	Scalability of the Solution	<ul style="list-style-type: none">○ In future more variety of gas can also be monitored, by adding the necessary sensor and monitoring the data obtained from it.

PROPOSED METHOD:

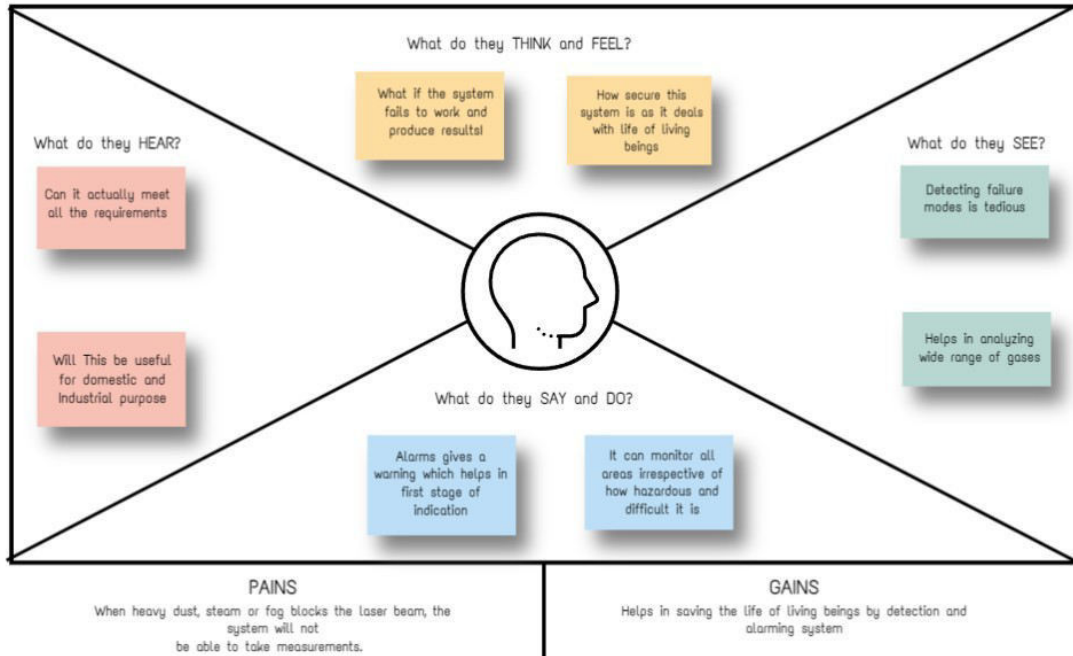
The core component of the system, the Arduino UNO (Atmega-328), carries out the following functions. The output signal of the sensor, which serves as input to Arduino, performs signal conditioning. Results of the detection were shown on LCD. warns individuals of risk at work, in factories, and at home. There is buzzer activity and a beep (siren) sound. Additionally, using a GSM modem, send an alarm SMS to the plant manager whose phone number is saved on the SIM card. The SMS you receive is based on whether there is a gas leak in the sensor's field of detection.

EMPATHY MAP CANVAS:

An empathy map is a simple, easy-to-digest visual that captures knowledge about a user's behaviours and attitudes.

- It is a useful tool to help teams better understand their users. Creating an effective solution requires understanding the true problem and the person who is experiencing it.
- The exercise of creating the map helps participants consider things from the user's perspective along with his or her goals and challenges.

Gas leakage monitoring and alerting system



IDEATION AND BRAINSTORMING:

Step-1: Team Gathering, Collaboration and Select the Problem Statement

Brainstorm & idea prioritization

Use this template in your own brainstorming sessions so your team can unleash their imagination and start shaping concepts even if you're not sitting in the same room.

10 minutes to prepare
1 hour to collaborate
2-4 people recommended

Share template feedback

Before you collaborate

A little bit of preparation goes a long way with this session. Here's what you need to do to get going

10 minutes

- Team gathering**
Define who should participate in this session and send an invite. Share relevant information or pre-read ahead.
- Set the goal**
Come about the problem you're focusing on solving in the brainstorming session.
- Learn how to use the facilitation tools**
Use the Facilitation Tools to run a happy and productive session.

Open article

Define your problem statement

What problem are you trying to solve? Frame your problem as a How Might We statement. This will be the focus of your brainstorm.

5 minutes

How might we [your problem statement]?

Key rules of brainstorming
To run an smooth and productive session

- Stay in topic
- Defect judgment
- Go for volume
- Encourage wild ideas
- One idea to others
- If possible, let's visual

Step-2: Brainstorm, Idea Listing and Grouping

2 Brainstorm

Write down any ideas that come to mind that address your problem statement.

10 minutes

Keerthana V

- Device must be capable of working in all environments.
- Data should be made available only to the authorized users.
- User must be alerted and for monitoring the users who have accessed the data.

Keerthana S

- Messaging service should be made available.
- Network must be available at all times.
- Latency in delivering the message should be minimal.
- Product should be made of high-quality materials.

Lakshitha S

- Small amount of gas should be enough to detect.
- Wide range of gases should be detected.
- Cost of sensor should be economical.
- Ease of installation and maintenance.

Kaviyan T

- Ease of Mobility.
- The proposed system must be affordable.
- Sensors communication via Internet.
- Rate of detection must be high.

3 Group Ideas

Take turns sharing your ideas while clustering similar or related notes as you go. Once all sticky notes have been grouped, give each cluster a sentence-like label. If a cluster is bigger than six sticky notes, try and see if you can break it up into smaller sub-groups.

20 minutes

Environment

- Device must be capable of working in all environments.
- Constant power source should be available.
- Ease of Mobility.

Authentication

- Data should be made available only to the authenticated users.
- Modifications on device configurations can only be done by an authenticated user.

Data

- Log must be maintained for monitoring the users who have accessed the data.
- Messaging service should be made available.
- Backup data should be made available.

Network

- Network must be available at all times.
- Latency in delivering the message should be minimal.
- Sensors communication via Internet.

Cost

- Cost of sensor should be economical.
- The proposed system must be affordable.

Quality

- Product should be made of high-quality materials.

Performance

- Accuracy of detection must be high.
- Rate of detection must be high.
- Wide range of gases should be detected.
- Small amount of gas should be enough to detect.

Step-3: Idea Prioritization

4 Prioritize

Your team should all be on the same page about what's important moving forward. Place your ideas on this grid to determine which ideas are important and which are feasible.

20 minutes

Importance

Feasibility

Ideas prioritized (Important and Feasible):

- Device must be capable of working in all environments.
- Constant power source should be available.
- Backup data should be made available.
- Small amount of gas should be enough to detect.
- Ease of Mobility.
- Log must be maintained for monitoring the users who have accessed the data.
- Latency in delivering the message should be minimal.
- Product should be made of high-quality materials.
- Data should be made available only to the authenticated users.
- Backup power should be made available in case of emergency.
- Network must be available at all times.
- Cost of sensor should be economical.
- The proposed system must be affordable.
- Secure communication via Internet.
- Messaging service should be made available.
- Wide range of gases should be detected.
- Accuracy of detection must be high.
- Rate of detection must be high.
- Ease of installation and maintenance.

PROPOSED SOLUTION FIT:

Project Title: Gas Leakage Monitoring and Alerting System

Project Design Phase-I - Solution Fit Template

Team ID: PNT2022TMID14295

1. CUSTOMER SEGMENT(S) CS <ul style="list-style-type: none"> Industrialists Engineers Safety Control Personals 	6. CUSTOMER CONSTRAINTS CC <ul style="list-style-type: none"> Network Connection Complexity in Installation 	5. AVAILABLE SOLUTIONS AS <ul style="list-style-type: none"> Upgrading to a premium network plan. Availing network connection from a reliable Service provider.
2. JOBS-TO-BE-DONE / PROBLEMS J&P <ul style="list-style-type: none"> Capability of the device to withstand in harsh environment is questionable. Due to network issue data couldn't be uploaded to the cloud at all times. 	9. PROBLEM ROOT CAUSE RC <ul style="list-style-type: none"> Quality of the material using which the device is made up of plays a vital role in the capability of the device to work in harsh environment. Location of the device installation and the network plan used by the user are the cause of Network issue. 	7. BEHAVIOUR BE <ul style="list-style-type: none"> Harsh environment is prevailing only on certain industry; thus, the frequency of the said problem is low. In such a case the customer complains multiple times to get the attention. Network issue is very common as most of the industries are located at the country side. Here the contact both the developers and the service providers

Explore AS, differentiate

Focus on J&P, map into BE, understand RC

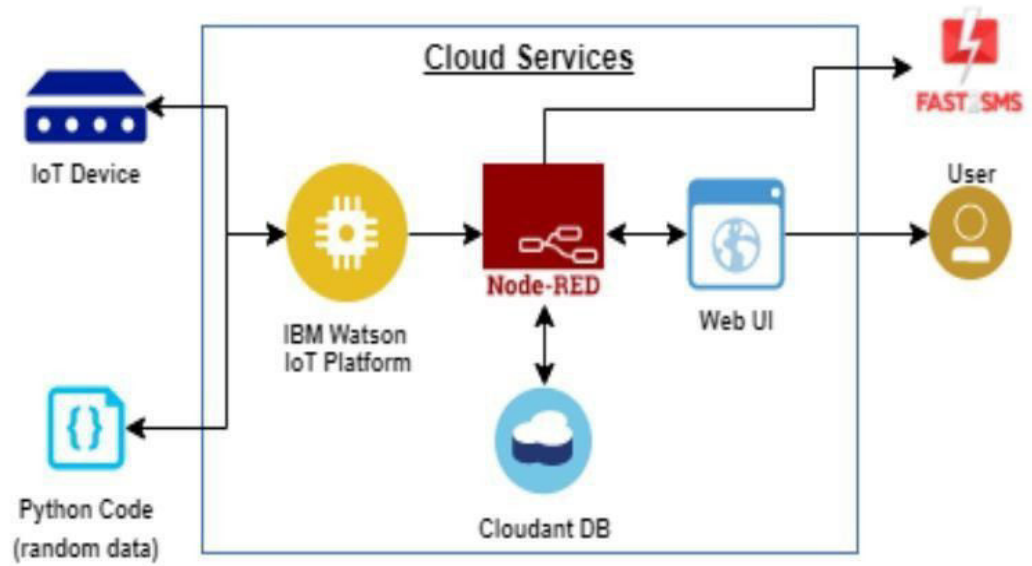
3. TRIGGERS TR <ul style="list-style-type: none"> Usage of the device is portrayed in the news. In real life situation, the device has helped in saving number of individuals. 	10. YOUR SOLUTION S <ul style="list-style-type: none"> Network strength must be boosted in the device Device can be manufactured in multiple standards based on the environment. 	8. CHANNELS OF BEHAVIOUR CH 8.1 ONLINE <ul style="list-style-type: none"> E-Mail to developers Online Community 8.2 OFFLINE <ul style="list-style-type: none"> Complaint Letters
4. EMOTIONS: BEFORE/AFTER EM <ul style="list-style-type: none"> Before the action is taken, the user feels deceived and cheated. After the problem is resolved, user feels the sincerity of the developers. 		

S.No.	Parameter	Description
1.	Problem Statement (Problem to be solved)	To detect the gas in the industry and prevent from making hazardous damages.
2.	Idea / Solution description	To detect the gas in the industry and prevent from making hazardous damages.
3.	Novelty / Uniqueness	Sensor automatically restores the gas and saves the data in IoT cloud.
4.	Social Impact / Customer Satisfaction	Customer feel great about this invention because, huge damage is prevented.
5.	Business Model (Revenue Model)	The cost is very low for manufacturing this product.
6.	Scalability of the Solution	It is more reliable and flexible.

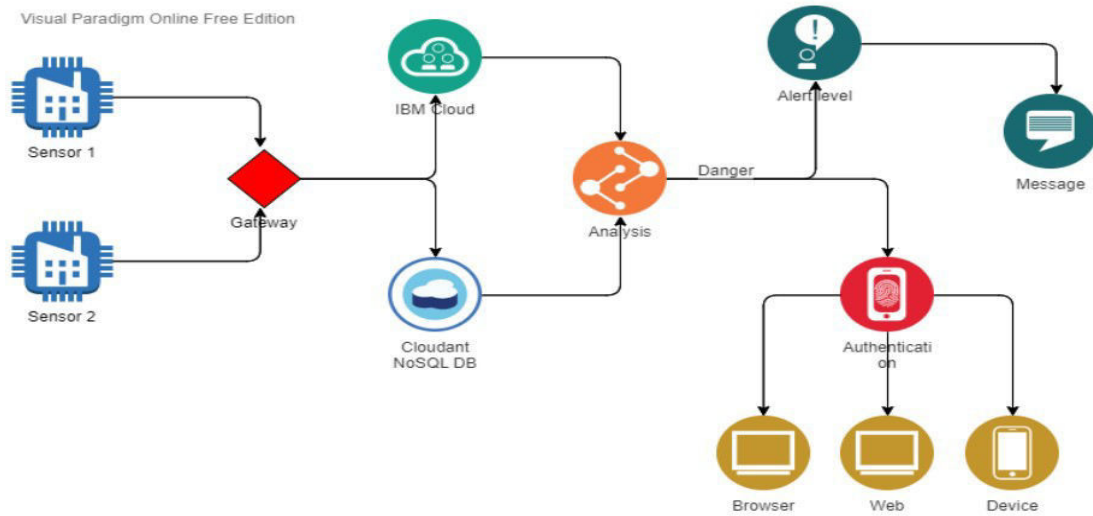
4.REQUIREMENT ANALYSIS:

SOLUTION ARCHITECTURE:

The system can be taken as a small attempt in connecting the existing primary gas detection methods to a mobile platform integrated with IoT platforms. The gases are sensed in an area of 1m radius of the rover and the sensor output data are continuously transferred to the local server. The accuracy of MQ sensors are not upto the mark thus stray gases are also detected which creates an amount of error in the outputs of the sensors, especially in case of methane. Further the availability and storage of toxic gases like hydrogen sulphide also creates problems for testing the assembled hardware. As the system operates outside the pipeline, the complication of system maintenance and material selection of the system in case of corrosive gases is reduced. Thus the system at this stage can only be used as a primary indicator of leakage inside a plant.



Solution Architecture Diagram:

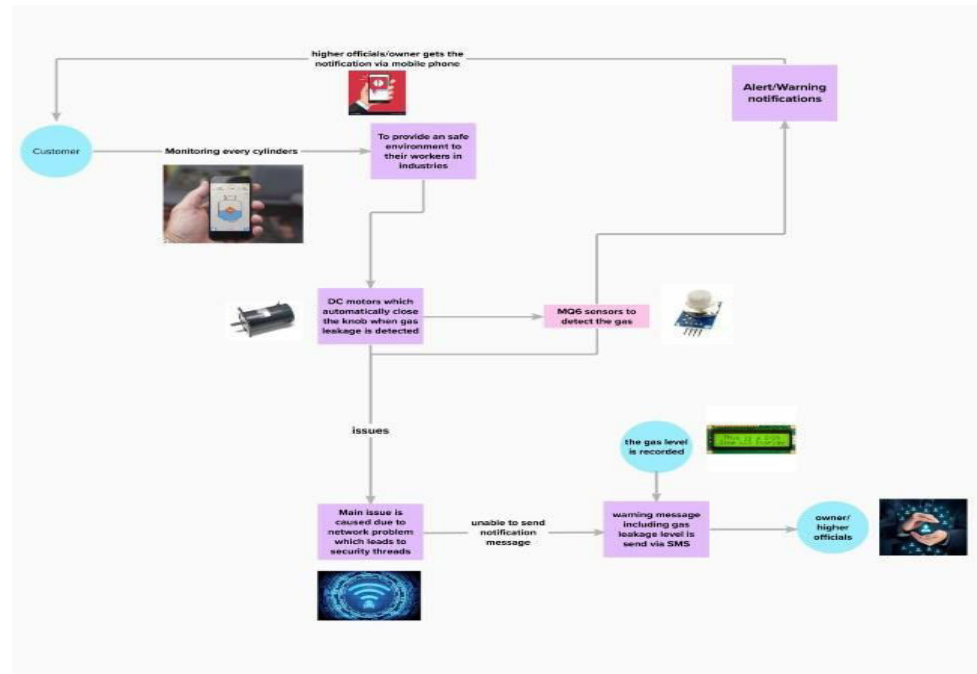


FUNCTIONAL REQUIREMENT:

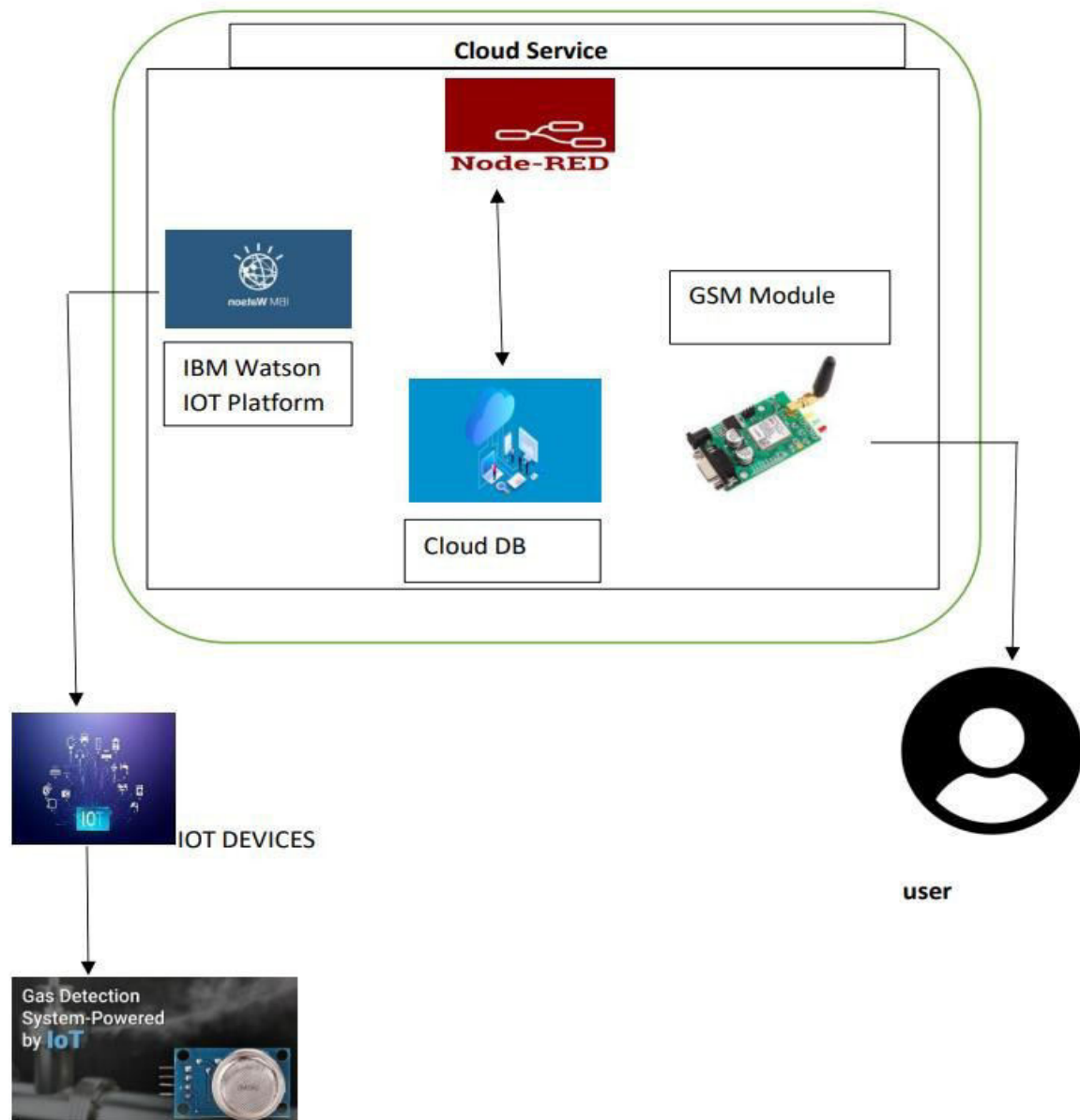
Business Requirements	User Requirements	Product Requirements
<p>The mentioned system is usable in residences, hotels, industrial settings, LPG cylinder storage places, etc. The ability to detect leakage and transmit the information to a location is the primary benefit of this IoT and Arduino-based application. It is observable, and precautions can be taken to avert any catastrophe.</p>	<p>The gas leakage detection system can be upgraded with smoke and fire detectors to detect the presence of smoke and fire in addition as being optimised for detecting dangerous gases. Although ensuring worker safety is critical, adopting the appropriate technology is even more crucial.</p>	<p>Regardless of your professional position or personal goals, gas detection is essential. Such IoT devices are what they are due to certain technologies in use, therefore understanding these technologies and the functions they can serve is necessary if you want to engage in IoT application development.</p>

5.PROJECT DESIGN:

DATA FLOW DIAGRAM:



SOLUTION AND TECHNICAL ARCHITECTURE:



6 PROJECT PLANNING PHASE

PROJECT PLANNING TEMPLANT (PRODUCT BACKLOG, SPRINT PLANNING, STORIES,STORY POINTS)

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

Use the below template to create product backlog and sprint schedule

Sprint	Functional Requirement (Epic)	User Story Number	User Story / Task	Story Points	Priority	Team Members
Sprint-1	Objective	USN-1	As a system, the gas sensor should detect the gas	8	High	JEEVITHA
Sprint-1	Features	USN-2	As a system, the gas sensor values should be displayed in a LCD screen	2	Low	AMOS DANIEL
Sprint-1	Features	USN-3	As a system, as soon as the detected gas reaches the threshold level, the red color LED should be turned ON.	5	High	ANITHA
Sprint-1	Features	USN-4	As a system, as soon as the detected gas reaches the threshold level, the siren should be turned ON.	5	High	ARUNKUMAR

Sprint-2	Focus	USN-5	As a system, it should they send the location where the gas is detected	8	High	SHALINI
Sprint-2	Focus	USN-6	As a system, it should also send the alerting SMS to the registered phone number	2	Low	VELU

Sprint	Functional Requirement (Epic)	User Story Number	User Story / Task	Story Points	Priority	Team Members
Sprint-2	Features	USN-7	As a system, the gas leakage pipe should be closed automatically once there it attains the threshold value	5	Medium	JEEVITHA
Sprint-2	Features	USN-8	As a system, it will indicate that the gas leakage pipe is closed in the LCD screen and send SMS to the registered mobile number.	5	Medium	AMOS DANIEL
Sprint-3	Data Transfer	USN-9	As a program, it should retrieve the API key of the IBM cloud to send the details of the system.	2	Low	ANITHA
Sprint-3	Data Transfer	USN-10	As a system, it should send the data of sensor values along with latitudes and longitudes to the IBM cloud	5	Medium	ARUNKUMAR
Sprint-3	Data Transfer	USN-11	As a cloud system, the IBM cloud should send the data to Node Red	2	Medium	SHALINI
Sprint-3	Data Transfer	USN-12	As a system, it should collect the data from the Node Red and give it to the backend of the mint app.	3	Medium	VELU

Sprint-3	Data Transfer	USN-13	As an application, it should display the details of the gas level and other details to the user through the frontend of the mint app.	8	High	Jeevitha
Sprint-4	Registration	USN-14	As a user, I must first register my email and mobile number in the website	2	High	Amosdaniel

Sprint	Functional Requirement (Epic)	User Story Number	User Story / Task	Story Points	Priority	Team Members
Sprint-4	Registration	USN-15	As a user, I must receive confirmation mail and SMS on registration	2	Medium	Anitha
Sprint-4	Login	USN-16	As a user, I can login into the web application through email and password.	3	High	Arunkumar
Sprint-4	Dashboard	USN-17	As a user, I can access the dashboard and make use of available resources.	2	Medium	Shalini
Sprint-4	Focus	USN-18	As a user, I must receive an SMS once the leakage is detected.	5	High	Velu
Sprint-4	Allocation	USN-19	As an admin, I must receive information about the leakage along with location and share exact location and route to the person.	3	High	Jeevitha
Sprint-4	Allocation	USN-20	As an admin, I must allot particular person to look after the leakage in a particular location.	3	High	Amosdaniel

Project Tracker, Velocity & Burn down Chart: (4 Marks)

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

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

per iteration unit (story points per day)

7- CODE FOR IBM Watson IoT Platform:

```
import time import sys

import

ibmiotf.application

import ibmiotf.device

import random

#Provide your IBM Watson Device Credentials

organization = "jjrtf7" deviceType = "ESP32"

deviceId = "1234" authMethod = "token"

authToken = "12345678" # Initialize GPIO def

myCommandCallback(cmd):

print("Command received: %s" %

cmd.data['command']) status=cmd.data['command'] if

status=="switchon": print ("Switch is on") else :

print ("Switch is off") #print(cmd)

try:

deviceOptions = {"org": organization, "type": deviceType, "id": deviceId, "auth method": authMethod,

"auth-token": authToken} deviceCli =

import time import sys

import

ibmiotf.application

import ibmiotf.device

import random

event of type "greeting" 10 times deviceCli.connect() while True:

#Get Sensor Data from DHT11
```

```

temp=random.randint(0,100)

Humid=random.randint(0,100)

gasconcentration=random.randint(0,100) data = { 'temp' :
temp, 'Humid': Humid, "gasconcentration":
gasconcentration} #print
data def
myOnPublishCallback():

print ("Published Temperature = %s C" % temp, "Humidity = %s %" % Humid,
"gasconcentration = %s %" % gasconcentration, "to IBM Watson") success =
deviceCli.publishEvent("IoTSensor", "json", data, qos=0,
on_publish=myOnPublishCallback)

if notsuccess: print("Not connected to IoT")

time.sleep(1) deviceCli.commandCallback =
myCommandCallback # Disconnect the device and
application from the cloud deviceCli.disconnect()

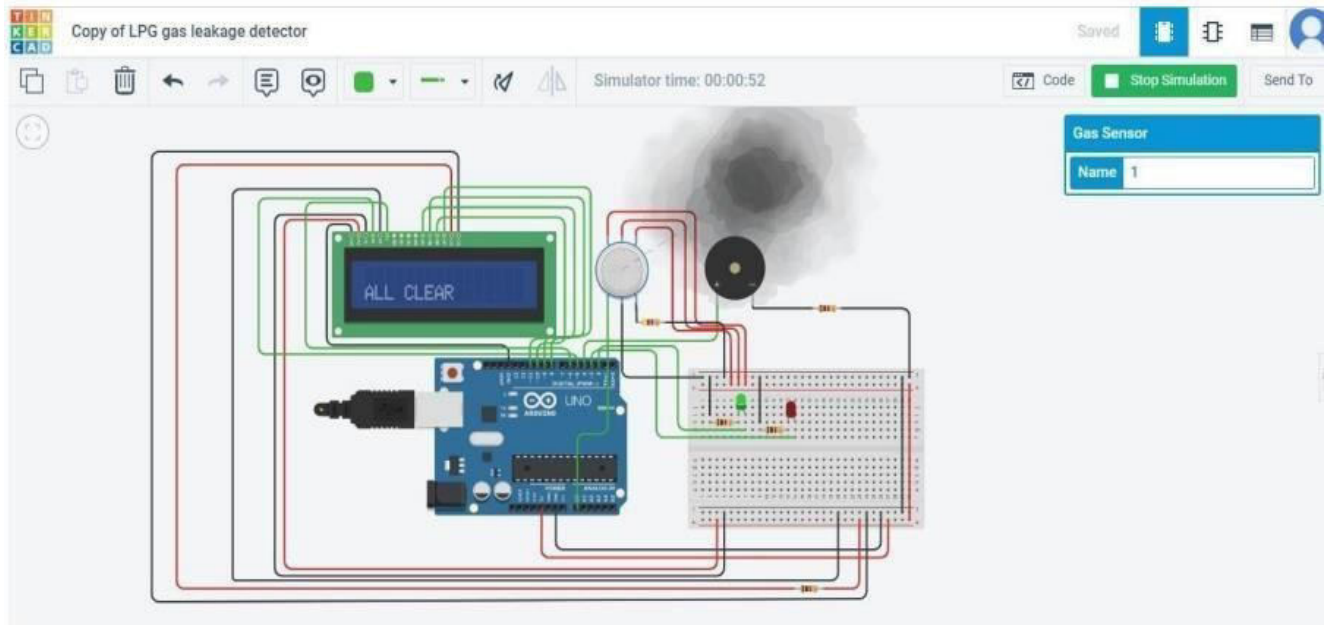
```

SOLUTION STATEMENT:

The system might be viewed as a modest attempt to link up the principal gas detection techniques now in use with a mobile platform coupled with IoT platforms. One metre around the rover, the gases are detected, and the sensor output data is continually sent to the nearby server. Stray gases are also detected because of the sensors' subpar precision, which introduces some inaccuracy into their results, particularly in the case of methane. Additionally, the storage and availability of hazardous gases like hydrogen sulphide makes it difficult to test the integrated gear. The complexity of system maintenance and material selection for the system in the event of corrosive gases is reduced because the system operates outside the pipeline. The system can only be used as a primary indicator of leakage inside a plant at this point.

8 & 9 - TESTING & RESULTS:

TINKERCAD:



PYTHON CODE EXECUTION:

```
code.py - C:\Users\bala\AppData\Local\Programs\Python\Python36-32\code.py
File Edit Format Run Options Window Help
import time
import sys
import ibmiotf.application
import ibmiotf.device
import random

#Provide your IBM Watson Device Credentials
organization = "s9xrcm"
deviceType = "ESP8266"
deviceId = "1234"
authMethod = "token"
authToken = "12345678"

# Initialize GPIO

def myCommandCallback(cmd):
    print("Command received: %s" % cmd.data['command'])
    status=cmd.data['command']
    if status=="sprinkleron":
        print ("Sprinkler is on")
    else :
        print ("Sprinkler is off")

    #print(cmd)

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

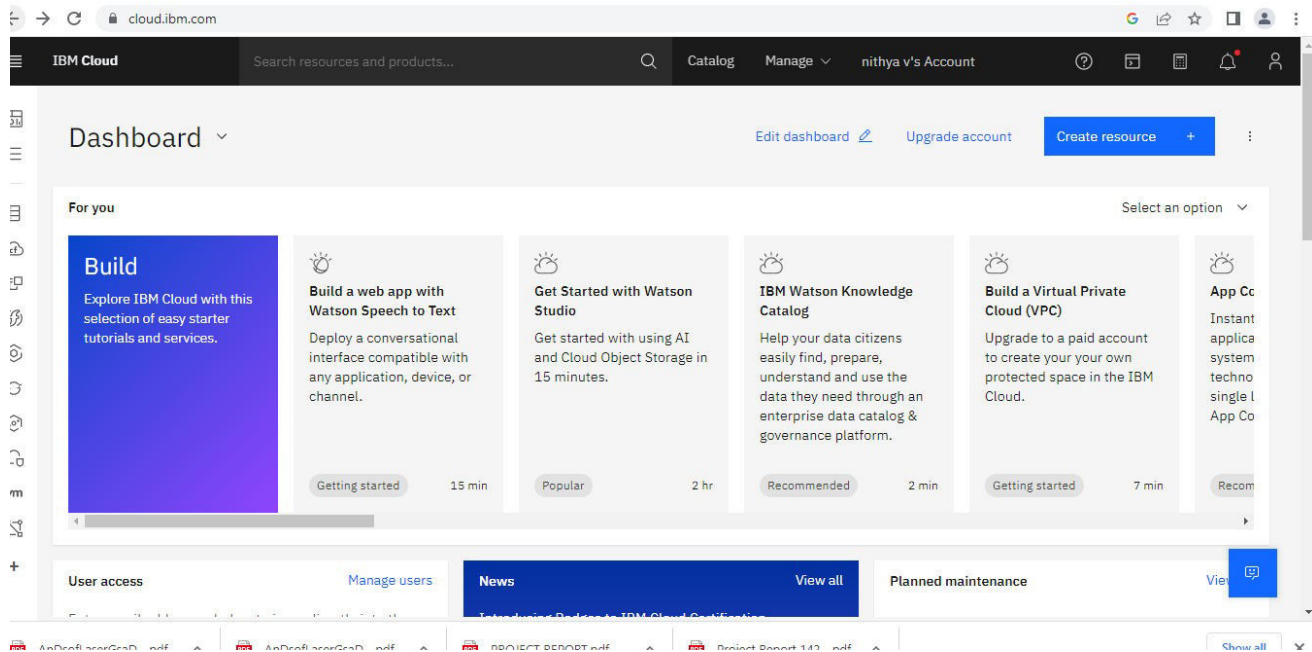
except Exception as e:
    print("Caught exception connecting device: %s" % str(e))
    sys.exit()

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

While True:
    #Get Sensor Data from DHT11
    temperature, humidity = DHT11.read()
    #Send data to cloud
    deviceCli.publishEvent("temp_humid", "hello", "world")
    time.sleep(10)
```

```
*Python 3.6.0 Shell*
File Edit Shell Debug Options Window Help
Python 3.6.0 (v3.6.0:41df79263a11, Dec 23 2016, 07:18:18) [MSC v.1900 32 bit (I
ntel)] on win32
Type "copyright", "credits" or "license()" for more information.
>>>
-- RESTART: C:\Users\bala\AppData\Local\Programs\Python\Python36-32\code.py --
2022-11-16 02:20:17.408 ibmiotf.device.Client INFO Connected successf
ully: s9xrcm/ESP8266/1234
Published Temperature = 88 C Humidity = 59 % gasconcentration = 78 % to IBM Wat
son
Published Temperature = 28 C Humidity = 99 % gasconcentration = 87 % to IBM Wat
son
Published Temperature = 32 C Humidity = 60 % gasconcentration = 8 % to IBM Wats
on
Published Temperature = 41 C Humidity = 54 % gasconcentration = 67 % to IBM Wat
son
Published Temperature = 81 C Humidity = 64 % gasconcentration = 17 % to IBM Wat
son
Published Temperature = 51 C Humidity = 95 % gasconcentration = 38 % to IBM Wat
son
Published Temperature = 5 C Humidity = 1 % gasconcentration = 79 % to IBM Wats
on
Published Temperature = 44 C Humidity = 88 % gasconcentration = 69 % to IBM Wat
son
Published Temperature = 76 C Humidity = 54 % gasconcentration = 27 % to IBM Wat
son
Published Temperature = 37 C Humidity = 78 % gasconcentration = 10 % to IBM Wat
son
Ln 5 Col 0
```

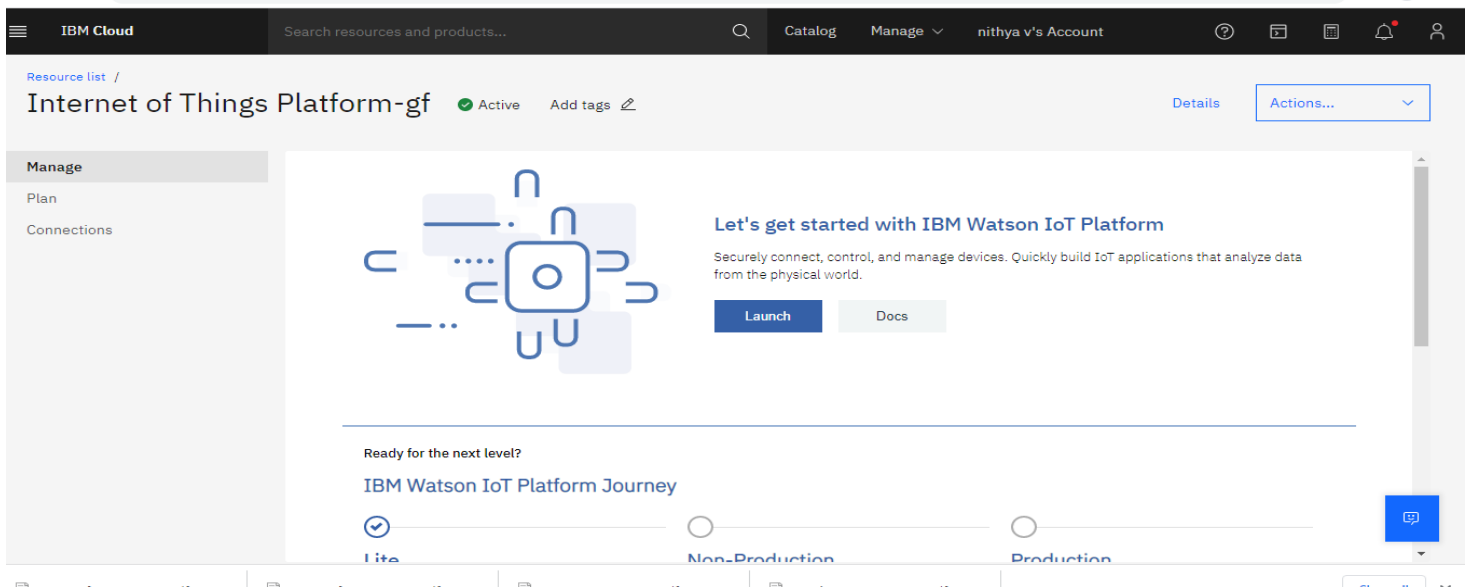
RECENT EVENTS IN IBM WATSON IOT PLATFORM:



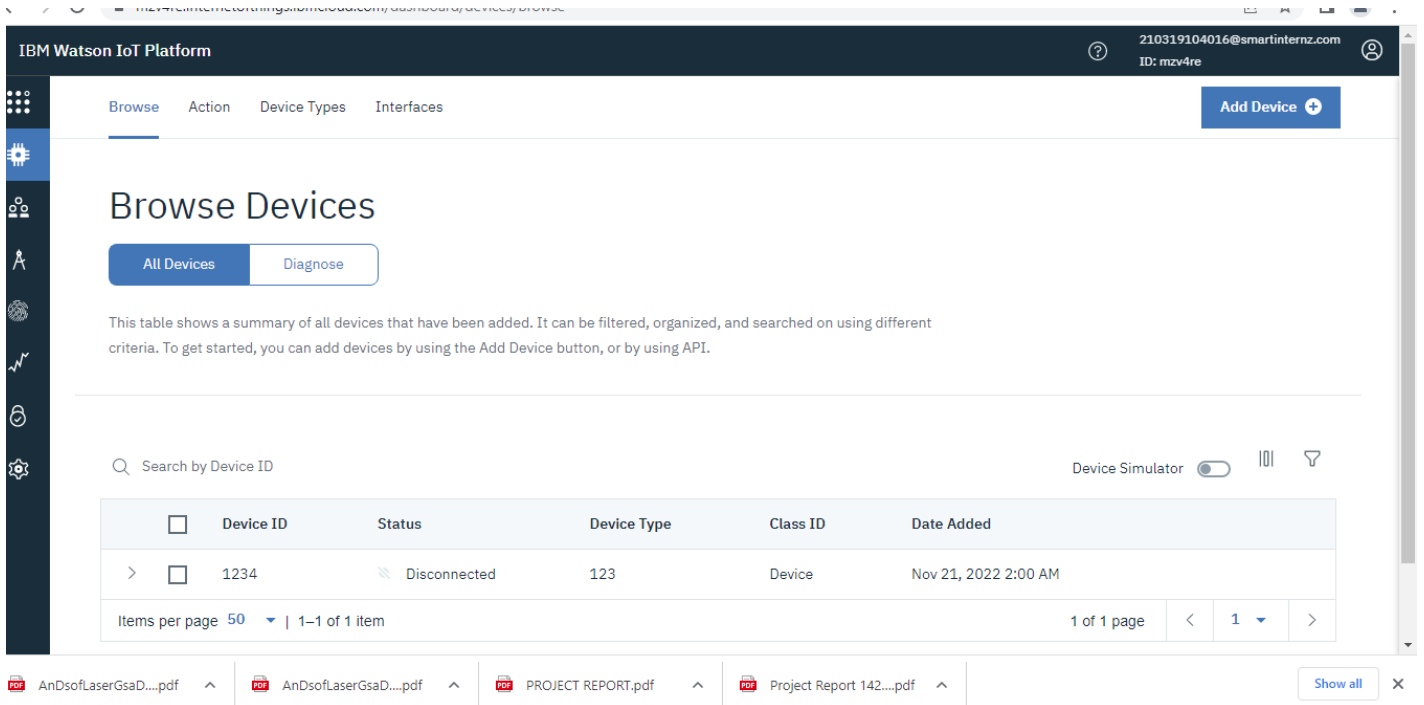
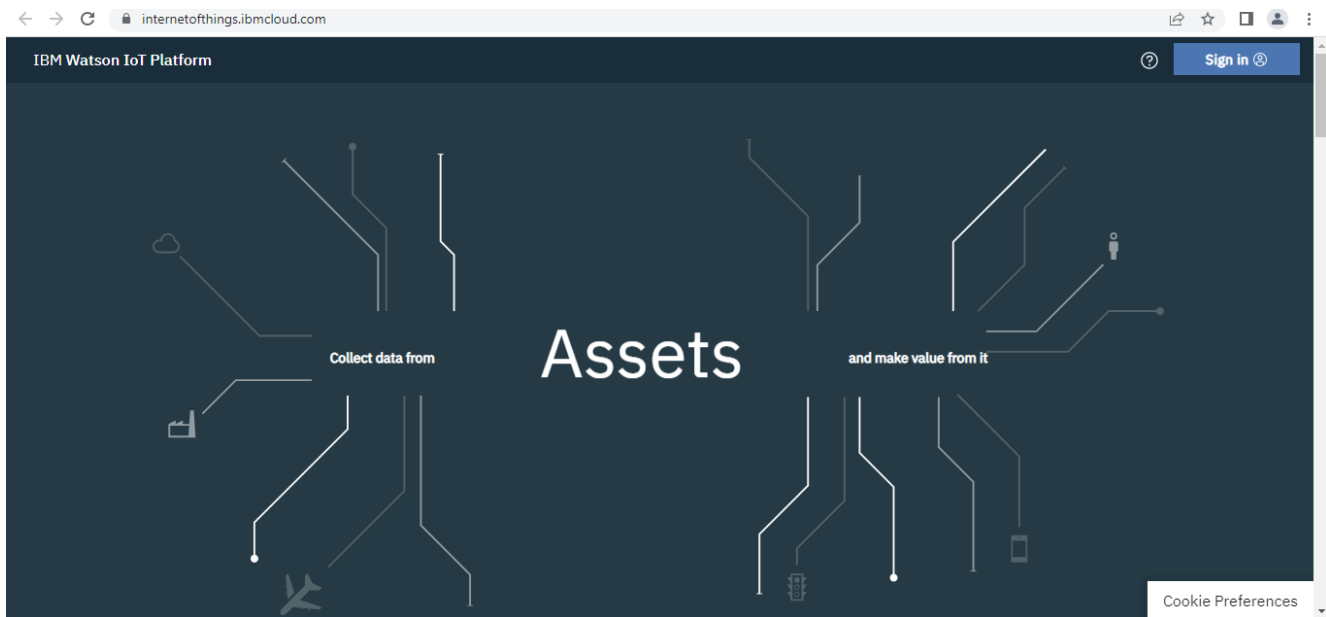
The screenshot shows the IBM Cloud Dashboard. The top navigation bar includes the IBM Cloud logo, a search bar, and links to Catalog, Manage, and the user's account (nithya v's Account). The main content area is titled "Dashboard" and features a "For you" section with several recommended actions:

- Build**: Explore IBM Cloud with this selection of easy starter tutorials and services.
- Build a web app with Watson Speech to Text**: Deploy a conversational interface compatible with any application, device, or channel. (Getting started, 15 min)
- Get Started with Watson Studio**: Get started with using AI and Cloud Object Storage in 15 minutes. (Popular, 2 hr)
- IBM Watson Knowledge Catalog**: Help your data citizens easily find, prepare, understand and use the data they need through an enterprise data catalog & governance platform. (Recommended, 2 min)
- Build a Virtual Private Cloud (VPC)**: Upgrade to a paid account to create your own protected space in the IBM Cloud. (Getting started, 7 min)
- App Cloud**: Instant application system technology single line of code. (Recommended, 2 min)

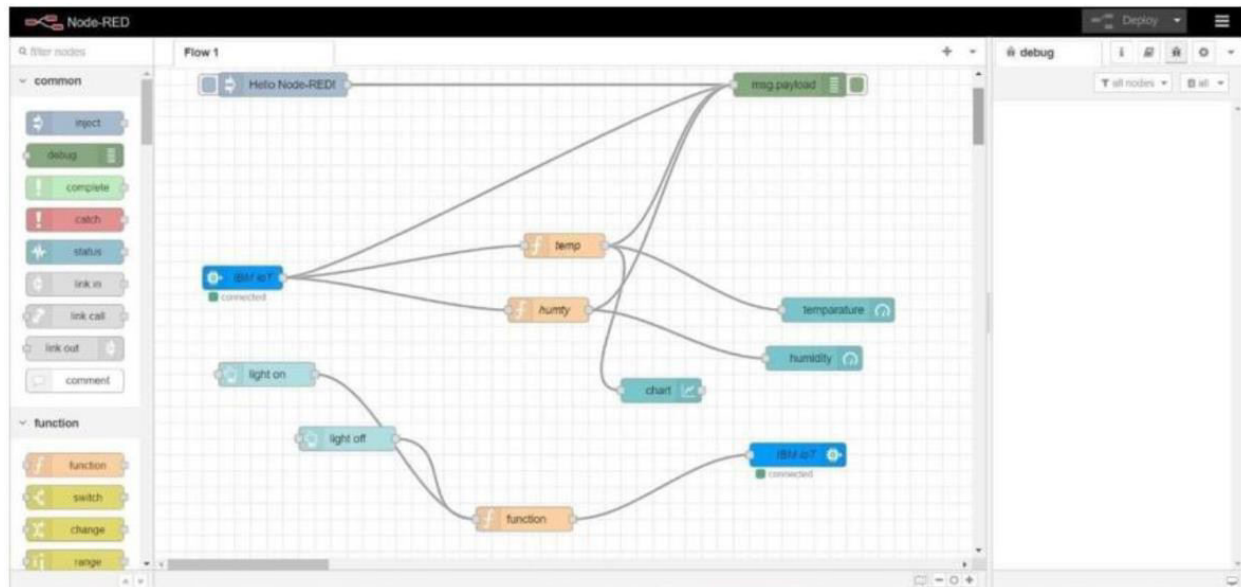
Below the "For you" section, there are links for "User access", "Manage users", "News", "View all", and "Planned maintenance".



The screenshot shows the "Internet of Things Platform-gf" page in the IBM Cloud console. The page is marked as "Active" and has a "Details" link. The main content area is titled "Let's get started with IBM Watson IoT Platform" and includes a "Launch" button and a "Docs" link. Below this, there is a section titled "Ready for the next level?" with the heading "IBM Watson IoT Platform Journey". This section features a progress bar with three stages: "Lite", "Non-Production", and "Production". The "Lite" stage is currently selected and marked with a checkmark.



NODE RED FLOW:



DASHBOARD CREATED USING NODE:



10. The Advantages and Disadvantages gas leakage monitoring & alerting

Advantages:

- Because of the very narrow 0.3 nm line width of the laser emission, there is no interference from other gases.
- Response times are in the order 1 second. This allow for fine resolution/control when making process measurements.
- The intense laser light concentrated at the absorption wavelength enables path lengths up to 1 km to be measured.
- An average measurement is taken over the total path so that a narrow plume of gas has less chance of escaping detection.
- The range of measurement can be up to 4 orders of magnitude, enabling concentrations of 0.1 ppm to 1000 ppm to be measured.
- Because of the internal reference cell, the system is self calibrating.
- There is no 'poisoning' or degradation of the instrument with long term exposure to a gas.
- Can easily be conformed to be 'Intrinsically Safe'.
- Low maintenance and low operating costs.
- Reliable technology.

Disadvantages:

- Only one gas can be measured with each instrument.
- When heavy dust, steam or fog blocks the laser beam, the system will not be able to take measurements. This is also the case when a person or vehicle blocks the path.

11 CONCLUSION:

We can conclude from the project's performance that the system's detection of LPG gas leakage is remarkable. Useful for both residential and commercial purposes. We can use this technique to save lives in dangerous situations. The GSM module indicates an alert. Propane, CO₂, and other gases are detected by a sensor node. Power usage and transmission range estimates are made. The sensor was constructed using straightforward techniques and an Arduino UNO Micro controller.

12 APPENDIX:

SOURCE CODE:

```
#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("ALERT");

            delay(1000);    lcd.clear();

            lcd.setCursor(0,1);

            lcd.print("EVACUATE");

            delay(1000);

        }

    else

        {

            digitalWrite(greenled,HIGH);

            digitalWrite(redled,LOW);

            noTone(buzzer);
```

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

GITHUB LINK: <https://github.com/IBM-EPBL/IBM-Project-55269-1667971560>