Internship at Flowtech Enginners

Report for
EC5512 SUMMER INTERNSHIP

College of Engineering Guindy

ANNA UNIVERSITY

CHENNAI – 600025.

Report Submitted By:
HARISH M R
2020105529.

DEPARTMENT OF ELECTRONICS AND COMMUNICATIONS ENGINEERING.

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Acknowledgement

I am very glad to **Flowtech Engineers** for giving me the opportunity to undertake my summer internship. It was a good learning experience for me in this quality workspace.

I would like to convey my gratitude to **Mr. Manoharan Sakthivel** (MD), **Mr. M.V. Ramesh Babu** (Project Head). I would also convey my thanks from the bottom of the heart to my guide **Mr. Ramesh (Head-valves), Mrs. Sharmila**, **Mrs. Kaarthika**, **Mrs. Divya**, **Mr. Parthiban**, who gave guidance to me in the best quality in the easiest way and also for giving their precious time.

I am extremely thankful to **Dr. J Kamala, Professor at the Department of Electronics and Communication, CEG, Anna University, Guindy for her guidance and motivations.**

Last but not least, I would like to thank all Flowtech Engineers staff and family for providing the best facilities.

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ABOUT THE COMPANY

TAGLINE: Flow Solution Masters

Flowtech engineers was established in the year 2006 who is an authorized distributor for Flowserve pumps and JC valves. Flowtech Engineers are certified by TUV Nord Management system as per ISO 9001 2015.

Recently they have evolved from a distributor to a manufacturer by setting up a manufacturing plant for Industrial valves and assembling pumps with further ideas to expand their business.

Apart from pumps and valves Flowtech also purchases motors, mechanical seals, VFD from reputable companies like Siemen, ABB, Bharat Bijlee and assemble it with their pumps and produce a finished product to their customer.

They have been supplying their products to various segments like Food / Chemical / Pharma / Beverages / Petrochemical / Fertilizer / Sugar / Paper / Oil & Gas / Power / Boiler / Water / Fire Fighting / Cement / Tyre / Steel / Textile companies

Now they are in the process of integrating IOT in their pumps in order to detect faults and to prevent the break down failure and improve the plant operation efficiency.

Also, they will arrange the required spares parts in advance to minimize the down time of the equipment & plants and improving the productivity. This IOT tool is providing further customer satisfaction and improving the business

INTERNSHIP OBJECTIVES

- **To learn about the IoT product developed by the company and see how it is being used in companies.**

- **To develop the ability to understand what kind of product or solution would be feasible at the given industries, and other manufacturing plants.**

- **To broaden my horizons beyond ECE and find out how ECE based concepts are used in other fields.**

- **To get used to the industry and to develop work habits and attitude for a job.**

INTRODUCTION

Pumps and Valves are the heart of some production plants, and a failure of one pump due to cavitation, corrosion etc can lead to compromising production rates and loss of production.

An example would be Boiler Feed Pump which is a highly sophisticated equipment used to handle the amount of pressure an operation needs, and a small failure of this pump it will seriously endanger the safety of the boiler's operation, and severely will also lead to major accidents.

So production plants tend to have people on the site constantly to monitor the various pumps & motor. Also, plant is having several extra pumps on standby to avoid the plant operation down.

So in order to detect the malfunctioning of such critical elements of the manufacturing plant, a sensors are installed to detect the vibrational and temperature changes for various critical assets pumps and continuously monitor, analysing and storing the data safely and securely .

The output of these sensors could be transferred to a cloud portal through wired or wireless networks from which the original equipment supplier and employees of the customer company can access the data or the output could be directly transferred to laptops or even mobile phones.

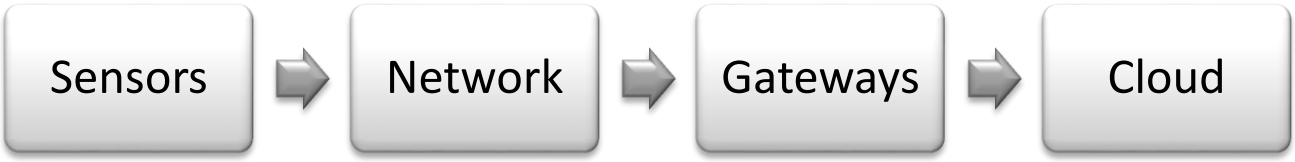
Hence, the equipment supplier or plant can take immediate precautionary measures to prevent equipment failures minimize downtime and improve productivity, reduce total cost of ownership, improve safety

WORK FLOW

The first step would be the installation of vibrational sensors which detect the vibration levels in pumps that can indicate whether the pump is experiencing any malfunctions or not.

We use LoRa Network as our network of transmission for this signal, as LoRa enables the signals to be transmitted to Long Distances while consuming low power while ensuring the security of the data

Then we use the LoRaWAN Gateway consisting of LoRa chip and internet chip, the LoRa chip gathers information from Lora based devices and transmits to the internet based chip which transmits the data to the cloud.



COMPONENTS USED AND SPECIFICATIONS

NODE ER VIBRATIONAL SENSORS:

10 : 1000 Hz (x & y)

10 : 500 Hz (axial)

Overall RMS (vel)

0 – Peak (vel & acc)

FFT – 8 Peaks (vel & acc)

FFT – 1/3rd Octave (vel & acc)

Transmission Range About 1.6 km (1 mile)

Transmission Rate 30 minutes (1 min to 1 day)

Battery Duration 4 years (@ 30 minutes transmission)

LoRaWAN Class A EU868, US915, AS923

LoRaWAN GATEWAY

Dual core Arm® Cortex®-M4 & M0+ up to 48 MHz

256 Kbytes of Flash and 64 Kbytes of SRAM

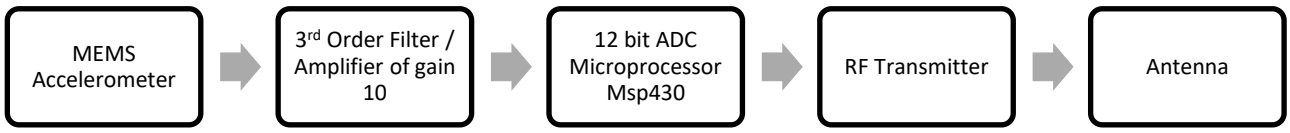
Ultra-low power Sub-GHz radio

Multi-modulation LoRa, (G)SFSK, (G)MSK and BPSK

VIBRATIONAL SENSORS

Components Used in this are MEMS Accelerometer, 3rd Order filter, Amplifier with Gain 10, 12 bit ADC Microprocessor Msp430, RF Transceiver, Antenna.

BLOCK DIAGRAM



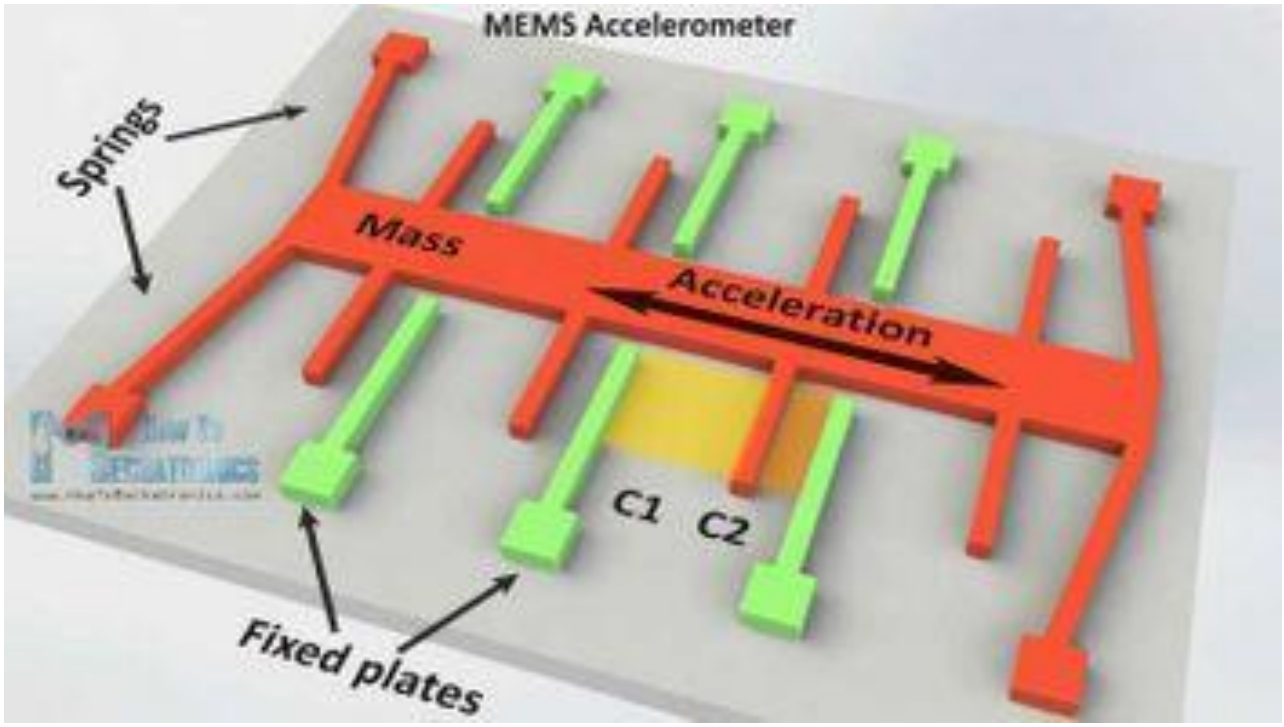
MEMS ACCELEROMETER:

Mems (Micro Electrical Mechanical Systems) Accelerometer is a device which is used to convert vibrations into an analog voltage signal

It is simple and cheap, the springs present in the accelerometer expand and compress due to which the distance between the moving plates and the fixed plates changes which induces capacitance, this can be used to find the acceleration due to the vibrations experienced by the pumps and valves.

This Accelerometer can be on boarded on PCB boards etc. and such accelerometers are placed on all 3 axis x, y, z to get the precise value of the vibration experienced by the pumps and acceleration is measured in terms of acceleration due to gravity

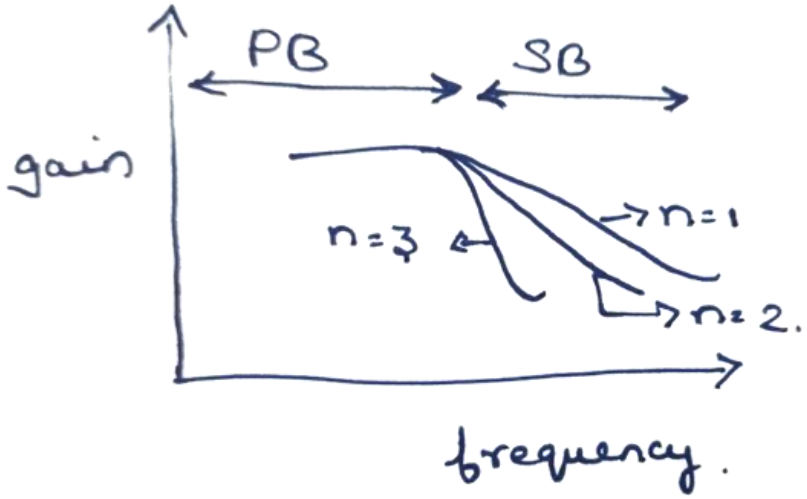
Then the received analog signal is then amplified by a simple BJT amplifier with gain 10, the signal is amplified to increase the signal strength so that it will be viable for transmission.



3rd ORDER FILTER:

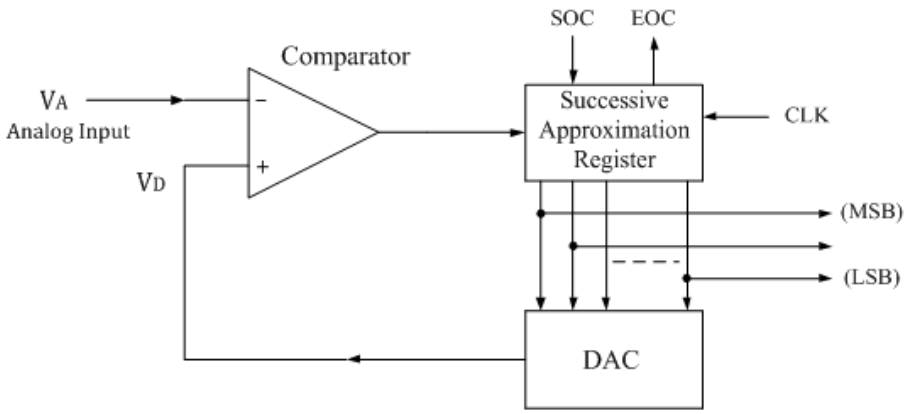
The manufacturing plants can at times be extremely noisy, and noise from sound alone is a few mg if the sensor is not properly isolated from the noise. In order to get accurate values we need the vibrations corresponding to that pump alone. Any measured vibrations due to other equipments will contribute to error.

Filtering signals above 50Hz with a low pass filter can eliminate sound noise significantly thereby increasing the efficiency of pump. We use a 3rd order filter in order to increase the roll off rate. The roll off rate is the rate of change of the output of the filter versus frequency.



12 BIT ADC MICROPROCESSOR MSP430:

The ADC converters are used to convert analog signal to digital signal. We do this conversion because digital has a defined amount of noise immunity due to having a dead band between the logic-0 range and the logic-1 range, while analog tends to accumulate noise. The MSP430 uses Successive Approximation Method (SAR) to convert analog to digital.



The input voltage is sampled by the sampler, for the first iteration the SAR produces MSB-1 all other bits as 0 to the DAC which in turn

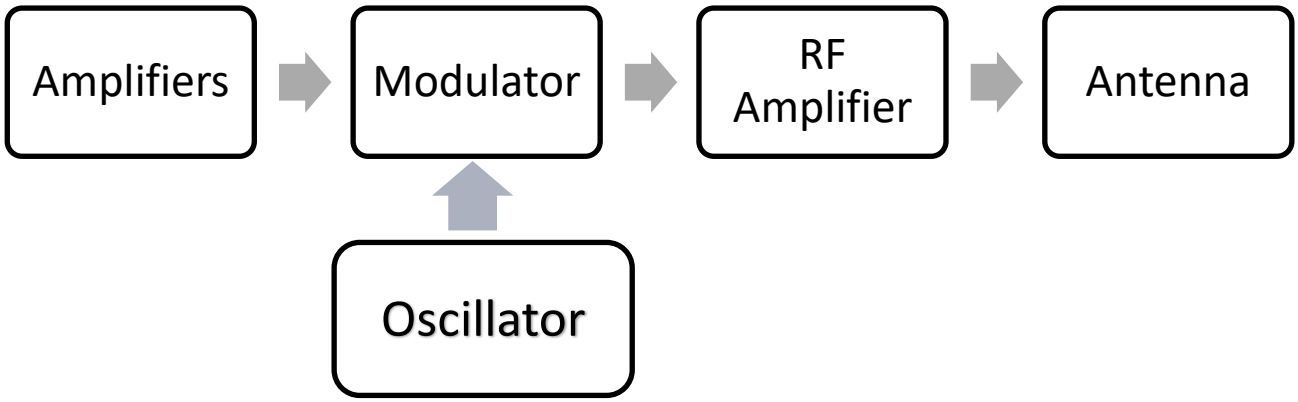
produces analog voltage signal whose value is found using the formula given below in the figure.

Then this voltage is compared with the Vin (input voltage) if Vin>Vdac the MSB remains same and the successive bit is set.

If Vin<Vdac then the MSB is reset and the successive bit is set. This process goes on till the LSB is either set or reset. Then the final answer we get at the end of this process is our digital signal.

RF TRANSMITTER:

It consists of an amplifier which amplifies the digital signal produced by the msp430, then the signal is modulated along the carrier wave which is produced by the oscillator so that the signal can travel long distances, finally an RF amplifier further amplifies the signal increasing the distance the signal can cover before finally sending the signal to the antenna which transmits this signal.



TRANSMISSION NETWORK CONSTRAINTS

WIRED NETWORKS

Initially the idea was to connect the sensors to the systems using wires which can be connected from the Arduino board in the sensor to the computer. In which the signal is transmitted at 4-20 mA current loop as it is very easy to troubleshoot for common problems like broken wires,

For eg: if 0 current we don't know if fault is due to sensor or broken wire etc. These days' modern semiconductor chips need nearly 3mA current so we use 4-20mA. But this is simply not feasible in manufacturing plants when certain pumps extend up to 1km on its own.

WIFI OR 4G CELLULAR NETWORKS

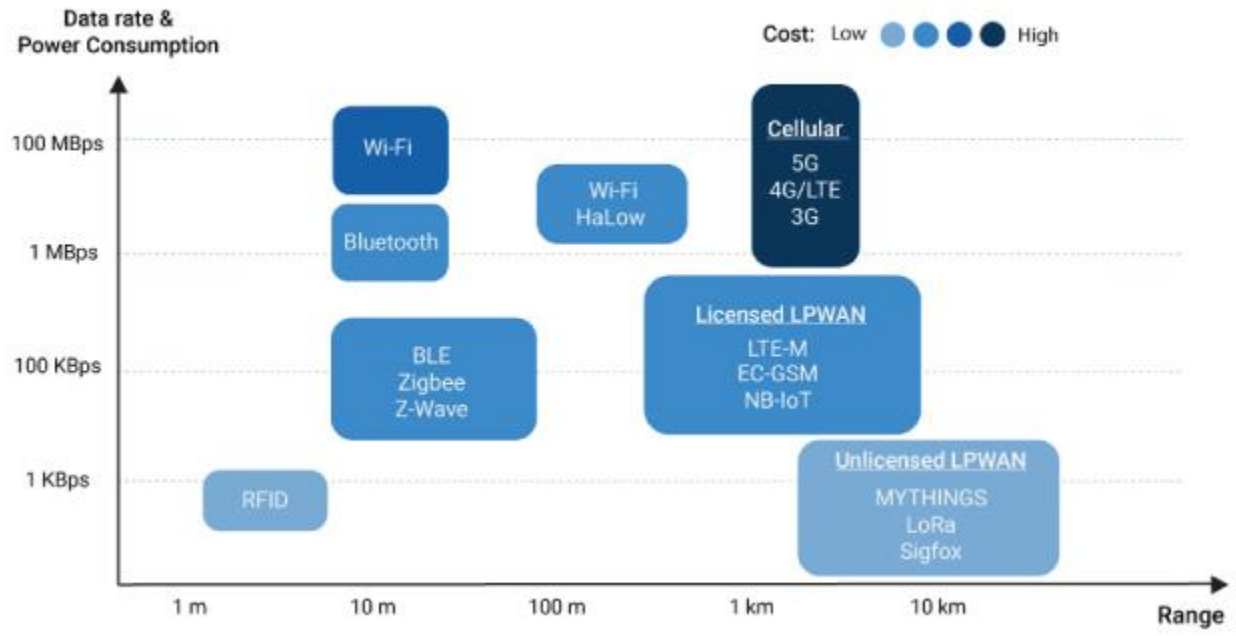
So the network of transmission was decided to be wireless. But WIFI couldn't be used as a network of transmission because the range of transmission of WIFI is very less and isn't feasible.

Mobile networks such as 4G overcome this issue but they consumes a lot of power, and sensors which are devices that are charged perhaps once a year cannot afford such high power consumption networks.

LoRa NETWORK

LoRa network is an upcoming technology which is mainly used in agricultural fields. The key defining characteristics of LoRa is Low power and Wide Range. This network is capable of transmitting data for long distances (1-10 kilometer) while consuming low power which is ideal for this industry.

In addition to this LoRa network is completely free unlike WIFI or other cellular networks. The disadvantage of LoRa network is low data rates , hence they cannot be used to transfer video files etc. But that's not a problem here as sensor transmit simple data such as vibrational values in our case after all.



The LoRa Network is able to transmit long distances with low power consumption because LoRa network has a wider bandwidth (not a large bandwidth) hence this makes LoRa network to consume less power as well as protects the signal from noise.

The technique used to spread the bandwidth is "CHIRP SPREAD SPECTRUM"

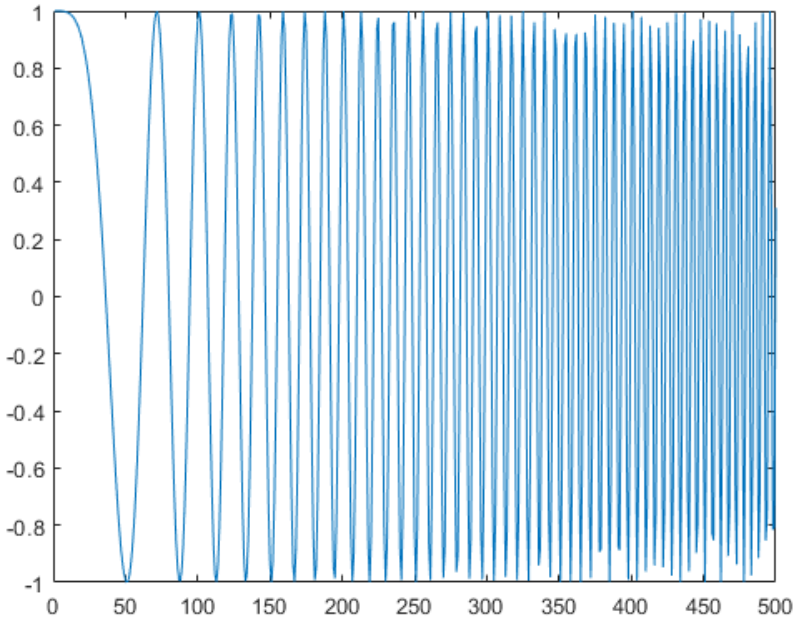
Chirp spread spectrum is a spread spectrum technique that uses wideband linear frequency modulated chirp pulses to encode information. In this method, the signal is deliberately spread in the frequency domain.

The chirp produces signals which either increases with time or decreases with time, these signals act as our carrier wave.

MATLAB SIMULATION OF CHIRP SPREAD SPECTRUM

CODE:

```
hchirp = dsp.Chirp( ...
    'InitialFrequency', 0,...
    'TargetFrequency', 10, ...
    'TargetTime', 10, ...
    'SweepTime', 100, ...
    'SampleRate', 50, ...
    'SamplesPerFrame', 500);
chirpData = (step(hchirp))';
evenFlag = mod(minute(datetime('now')),2);
if evenFlag
    chirpData = fliplr(chirpData);
end
Use plot to plot the chirp signal.
plot(chirpData);
```



LoRaWAN GATEWAY

The main use of the Gateway is to convert the low power LoRa signal to a cellular network such as 4G or Wifi so that the data can be transferred to a computer or cloud as the modern computers have inbuilt receivers for WIFI and cellular networks and not for RF signals.

The Gateways are essential in the LoRa technology, forming a bridge between the end-devices (sensors) and the user application, where the messages are delivered and displayed.

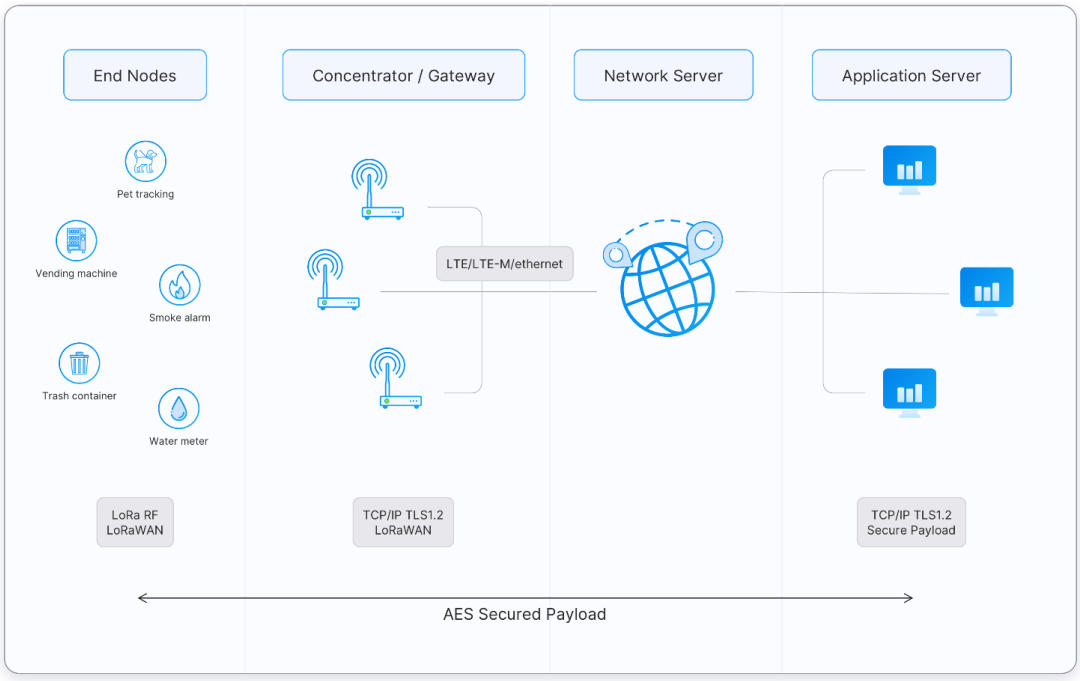
Gateways uses high bandwidth networks like Wi-Fi, Ethernet or Cellular to connect to the IoT platform due to the large traffic that can be collected from the connected Nodes.A Gateway can communicate with hundreds or thousands of sensors. If more Gateways are in the sensors, all the

Gateways will receive the messages and forward them to the IoT platform. Thus, using a specialized algorithm, the IoT platform will filter the duplicated or unwanted messages and will select the best Gateway to forward any messages queued for downlink

Ra-02 module is used as a receiver to receive the LoRa signal and The ESP8266 module enables microcontrollers to connect to 2.4 GHz Wi-Fi.

The LoRaWAN Gateway receives the correct and approximate LoRa network through a THINGS SERVER.

Things server is basically a free to use platform where we can go to register our gateway and enter the specifications of the sensor and frequency and bandwidth details to receive the appropriate receiver signals



CLOUD COMPUTING

Cloud Computing is a network of remote servers hosted on the internet for storing and retrieving data. The cloud provides a number of IT services such as servers, databases, software, virtual storage, and networking, among others. In layman's terms, Cloud Computing is defined as a virtual platform that allows you to store and access your data over the internet without any limitations.

Companies that offer all the services mentioned above are called cloud providers. They provide you with the ability to store and retrieve data and run applications, managing them through configuration portals. Two of the best cloud providers available today are Amazon and Microsoft Web Services .

We transfer the data present in the TTN server to this cloud server who manages our data and enables us to access the data at any time. These data are accessed by the platform who continuously monitor our devices to ensure that there are no faults that are present in it.

SPECIAL FEATURES

Security of their data: LoRa whose security is improved vastly by spread spectrum technique in order to a long range is required of communication is the specialty of this LoRa network.

Coating of Sensors: The pumps may be kept at highly hostile environments and liquid flowing through the pumps can be highly viscous or can generate lot of heat, so the sensor must have proper coating and outer layer so that it can function effectively at such environments.

Service Reliability: Flowserve offers to provide a panel of product, design ,Engineering expert who would exclusively monitor the data and provide necessary preventive action to avoid the failure , equipment and plant down time.

Data analytics: Data is collected across the entire plant and these data's are cleaned using SQL and Python Pandas and displayed in the form of user friendly graphs for further analysis which are designed using Power-Bi or Tableau.

AI : Based on this various data collected and analyzed by the sensors, the criteria for failure is constantly analyzed and updated by the AI tools thus the accuracy of the tool is constantly evolving and is constantly adapting.

CONCLUSION

From this intern I have learnt about the various types of communication models used its advantages and disadvantages and the Gateways module used for interfacing these devices. Also on what kind of specifications would the customers want and which technique is to be used for which situation. etc.

Also, I have learnt how IOT platform are using by the industries to increase the productivity and improving the profit.

REFERENCES

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https://nptel.ac.in/courses/106/105/106105166/

Week 6 and week 7 might be useful

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https://projects.raspberrypi.org/en/projects/getting-started-with-picamera

Opencv installation on raspberry pi:

How to Install OpenCV on your Raspberry Pi!! | Step by Step Tutorial | Using Cmake

https://www.jeremymorgan.com/tutorials/raspberry-pi/how-to-install-opencv-raspberry-pi/

https://robu.in/how-to-install-opencv-in-raspberry-pi/

https://singleboardbytes.com/647/install-opencv-raspberry-pi-4.htm

Face detection using raspberry pi:

Raspberry Pi Camera Face Detection Using OpenCV Python3

Sending an email using raspberry pi:

https://github.com/Kalyan-Koppula/Face-recognition-based-attendance-system/blob/master/face%20recognition%20source%20code/emailing.py

Face recognition-based attendance system (for reference):

https://github.com/Kalyan-Koppula/Face-recognition-based-attendance-system/tree/master/face%20recognition%20source%20code

YouTube videos for scanning qr code and entering in a csv file using rpi:

https://www.youtube.com/watch?v=ns4hKNXvNlo