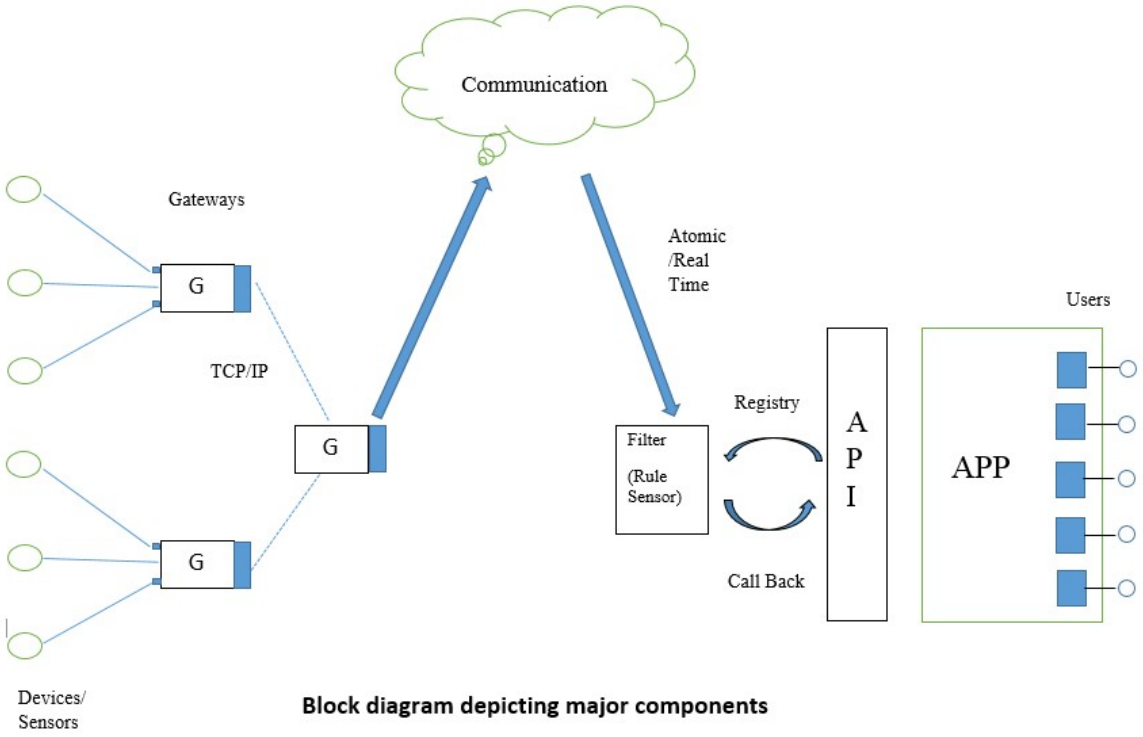
Project Requirement Scope Document

1. Introduction:

This project mainly deals with the development of platform which builds an abstract platform between heterogeneous sensory devices and user application software in IOT genre. Here since it is a simulation project sensory data will be simulated and sent to the clustered gateway from where it is pulled by the server. From users end the required data will be extracted from the server using the defined rules engine. The project will be developed using raspberry pi, mongo DB, node.js and android for user application development. This document is the brief description of the above components with real word usecases of the same project.

2. Functional Overview:



Block diagram depicting major components

List the key functions

- Sensors sends data to the gateways periodically over a continuous stream dependent on the application.
- Primary level gateway's authenticates the sensors, and collects data from cluster of sensors.
- Secondary level gateway's authenticates the primary level gateway's and collects data from clusters of primary level gateways.
- Secondary level gateway's passes the stream of data through communication channel.
- Filter Server receives raw data through communication channel at regular interval.
- Filters server parses the data and removes the noise.
- Filter Server then converts the raw data into structured format as per the predefined protocol.
- Filter server stores the above data into the database.

- API deals with the query engine and exposes the result as per the query to the requesting applications.
- The requesting end user applications, would interact with the database through API
- End user applications then performs relevant operations as per the analysis of that data.

Description of components

Sensors
A sensor is a transducer whose purpose is to sense (that is, to detect) some characteristic of its environment. It detects events or changes in quantities and provides a corresponding output, generally as an electrical or optical signal.

Gateway
Gateway acts as an interface between sensors and the server. It collects the data from various sensors and forwards it.

Communication Channel
It acts as a medium for transmitting the data from gateway to the filter server. Various gateway's communicates to the server through this channel.

Filter Server
It receives raw data from various gateways through the communication channel. It then eliminates the noise and filter out useful data into system recognizable structured format.

API
It provides an interface between end user and server. It implements various methods and functions to expose the data through the query engine.

End User Application
This application acts as the consumer of data and performs suitable action depending on the result of data generated through the API.

Major Modules

Part ONE:
It manages the interaction between **sensors and gateways**. A gateway collects data from various sensors and passes it to the next level.

Part TWO:
Filter server collects the data sent by various clusters of gateways through the communication channel. It parses the data and stores it in system recognizable structured format into the database.

Part THREE:
End user applications requests the data stored into the database through API and performs suitable actions on the basis of results obtained on processing of that data.

3. Use cases:

a. What the users can do with the solution?

This application is the one which provides platform for the communication between heterogeneous sensors and the user application through gateway and filter servers.

- The user requests his desired data (real time or aggregated) to the application using the exposed API's following the defined rules (by rules engine).
- Application gets the continuous data input from the registered sensory device where the gateway acts as an interface resolving the communication conflicts using defined protocol.
- Hence this platform provides an abstraction for the user to build his own application above this platform by getting data from it without worrying about underlying layer and data fetching complexity.

b. Usage scenarios:

1. **A/C control system:**

In A/c control sytem, temperature sensors are used to monitor temperature inside room. 4-5 sensors can be placed at various locations in a room to monitor overall temperature. Once the temperature level falls below below certain degree as detected by the sensors, the A/Cs in the room can be automatically switched off or temperature of particular A/C can be increased.

2. **Smart Street Lighting:**

It fully automates lighting based on any type of sensor, motion, ambient light and reduces energy consumption. For street lights, if the sensors placed around detects presence of a person or vehicle, the street lights can be automatically switched on. Also, according to the ambient conditions i.e. during day time, we can make sure the street lights remain switched off.

3. **Smart Waste Management:**

It all starts by installing filling sensor in street waste-recycling containers (several manufactures available) to send data to gateway and monitor containers usage. Once the waste level inside the container rises above particular level, we can create dynamic pickup routes that are sent directly to truck's on-board electronics. City government has dashboards and tools to monitor the service quality levels and plan futures resources.

4. **Smart parking:**

Magnetic sensors placed in the pavement or ultrasound sensors in the ceiling can detect the presence of cars parked and send the information to server. Server's logic combined with city parking assets data results in an application to guide car to free parking spaces.

5. **Monitoring oil and gas levels in tank/cistern:**

Sensors can be used to monitor level of water, oil and gas levels in storage tanks and cisterns. If the level reduces below a certain level, responsible team can be notified same.

3a. Primary test case for the project (that you will use to test)

a. Smart parking:

Components involved:

Thermal sensors, magnetic sensors capable of detecting cars in an area.

Communication:

Communication takes place via REST.

Location: An average of number of cars present in a parking lot is sent to server via gateway after a certain interval. Depending on the available free space in the parking lot, appropriate information can be conveyed to new incoming vehicles in the parking lot. If there is no free space, the user can be informed and of another parking lot.

Processing logic: The server will check the available spaces in the parking and all the incoming vehicles will be informed of the available space in the parking lot. The server monitors free spaces in the parking lot and same is conveyed to the user.

b. Monitoring oil and gas levels in tank.

Oil Sensors and heat sensors are used here to monitor the oil level in the moving tanks. Here the oil sensors are used to check the leakage or spillage. Whereas Thermal sensors are used to check if any hazard fire happens. Where by these sensors will send the message to the Alarm.

Components Involved: Oil Sensors, Thermal Sensors, Oil tanks, Oil and server, Alarm.

Communication: Communication will take place by Bluetooth (between sensor and broadcaster) and internet to send message.

Location: Real time longitude and latitude is used to locate the tanks from which alarm is triggered.

Processing logic: Sensors will monitor the oil level in the tank. If the Sensor sense the level is below medium it'll send the message to the user along with the location of the tank. If the level drops further Alarm is triggered and the outflow is automatically reduced to half and message is again sent to the user.

c. A/C control system:

Temperature of the room is sensed and accordingly A/C system is controlled. Application retrieves the aggregate temperature periodically and sets the cooling component of A/C system. Users need not have to worry about manually increasing or decreasing the temperature.

Components involved: Temperature sensors, Application running over A/C system capable of controlling the temperature.

Communication: Communications are taken place via Bluetooth and REST.

Location: The server retrieves data from sensors located in a particular location (room) and informs the end application present in that room.

Processing Logic: Sensors sends data to Gateways continuously via Bluetooth, Gateways sends the aggregate data to server through REST. Server triggers the application running over A/C whenever there is a need to control the A/C system by providing necessary data.

d. Smart Street Lighting:

Thermal sensors provide the heat map of the location which it is sensing based on which the lights in the location are switched on or off. This scheme helps in reducing power consumption and manual effort required to carry out the process.

Components involved: Thermal sensors, Street lights.

Communication: Communications are taken place via Bluetooth and REST.

Location: Real-time data is sent from thermal sensors to servers via gateway. Based on location of sensor from where information is obtained, server decides whether to switch on/off the light present in that location.

Processing Logic: Sensors sends the sends data continuously to gateways via Bluetooth. Gateways sends the data to servers through REST along with the location of the sensors. Server decides whether to switch on/off lights in that particular location and takes the

required action. Comparison is done between previous and current state of the light to decide the action to be taken.

e. Smart waste management:

Filling sensors provide the level of waste the container which it is sensing based on which alert is sent to person responsible for cleaning the container. This scheme helps in avoiding the overflow of the waste containers.
Components involved: Filling sensors, Device which alerts the manager.
Communication: Communications are taken place via Bluetooth and REST.
Location: Sensors are present inside the containers.
Processing Logic: Filling sensors detects the fill status and sends data to the gateway. Gateway routes the status to server. Server sends alert message to the smart app. Person in charge of container takes necessary action.

4. Overview of IoT App Platform project

a. Definitions and Scope

IoT can connect devices embedded in various systems to the internet. When devices/objects can represent themselves digitally, they can be controlled from anywhere. The connectivity then helps us capture more data from more places, ensuring more ways of increasing efficiency and improving safety and security. We can use IoT in applications like sensing temperature, waste management, smart parking etc.

b. Key subsystems in the project

1. Sensors- A sensor is a transducer whose purpose is to sense (that is, to detect) some characteristic of its environment. It detects events or changes in quantities and provides a corresponding output, generally as an electrical or optical signal.

2. **Raspberry Pi**- The **Raspberry Pi** is a series of credit card sized single-board computers developed by the Raspberry Pi Foundation.

c. Interaction involved across Subsystem:

1. Between Sensors and Gateway: Since the sensors will be the android devices, the interaction between them will be using Bluetooth.
2. Between Gateway and Filter Server: The communication between them will be basically TCP/IP and REST calls will be made to communicate.
3. Between Server and Android: Socket programming will be used to interact between these.

d. Registry & Repository:

- Registry of the sensors will be done using mac address of it and will be used for the communication.
-Repository of the data of registered device will stored in MongoDB along with timestamp and mac address.

e. Logic Server:

The main server pulls the data from gateway and stores it in repository. This data is sent to user application whenever request comes. This uses Rules Engine to communicate with users

app and Rest with Gateway.

f. Mobile Interface:

The Iot platform provides a middleware layer for application layer to get data from sensors. The application can be a cloud-based application or a mobile application. The mobile interface will be basically some application which internally invokes REST API exposed by middleware layer. The application then analyses the data recieved to execute particular action. Possibly we will be developing android based application to test the integrity of the developed iot platform.

5. Interactions & Interfaces

User Interactions

User requests for the information which is available in the servers and only those with authorization is provided the required information. Users can request information based on rules which is processed by the rule engine in the server and notifies the app as a result.

Module to Module interactions

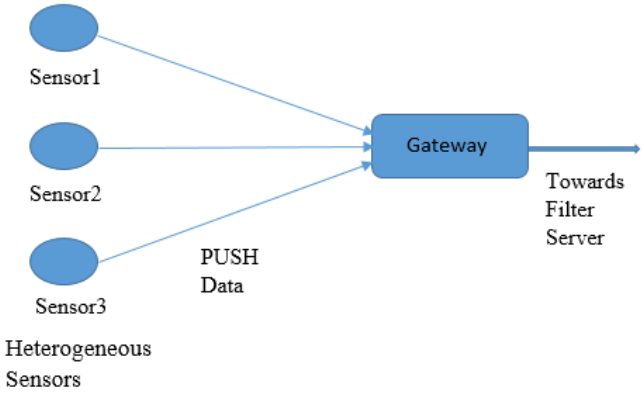
Each gateway gets all the information from different connected sensors; it removes incomplete data and converts it into the network friendly packet. The main gateway collaborates all this information and forwards it to the filter server.

API queries the filter server with its identification and specified rules. The identification is first processed by the filter server followed by which the rules are applied on the dataset on successful authentication. The end result is replied to the API which in turn provides the result to the user.

6. Brief overview of each of the modules

Three parts of the application

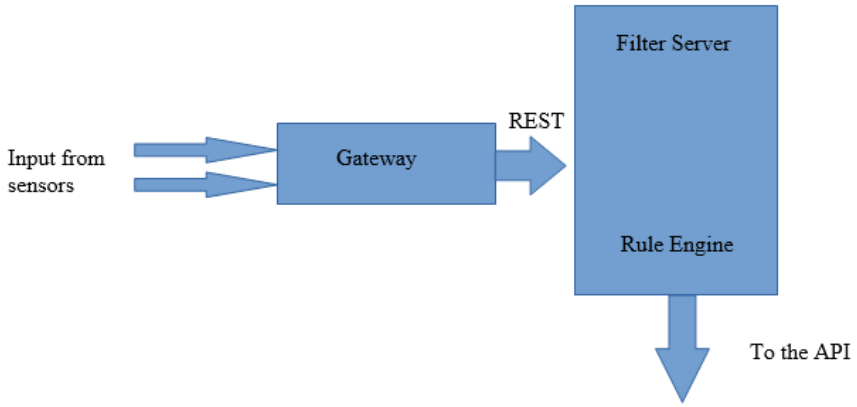
1. **Sensors and gateways part-**



In this part, the interaction between sensors and gateways are managed. Heterogeneous sensors are dumb. Therefore they cannot process data. They simply pushes data to particular

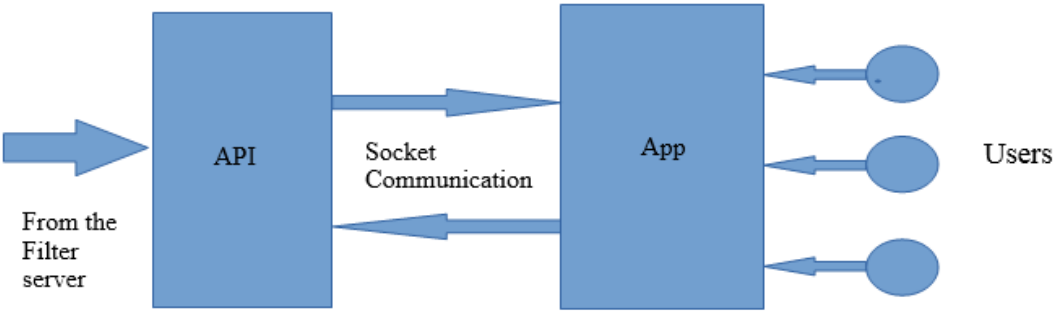
gateway. The gateway collects the information from the sensors, processes it and forwards it to the higher level.

2. **Filter server part-**



It collects the data and parses the data. It converts the parsed data into the decided data format and stores it into the database. A rule engine is also part of the Filter server which helps in processing the data according to the conditions specified by the user.

3. **End User Application part-**



It can be a standalone or a cloud application. User gets the information based on the provided APIs. Socket programming is used for communication between the application and the API.