



## **UNIT- III**

### **DEVELOPING INTERNET OF THINGS**

IoT platforms Design Methodology: Introduction-IoT design Methodology-Step 1:Purpose and Requirements specification, Step 2:Process specification, step 3:Domain model Specification, step 4:Information Model Specification ,step 5:Service Specifications, step 6:IoT Level Specification, Step 7:Functional view specification, step 8:Operational view specification, step 9:Device and Component Integration, Step 10:Application Development-Case study on IoT system for weather Monitoring-Motivation for using Python-IoT systems-Logical Design using Python-Introduction- Installing Python-Python data Types & Data Structures- Numbers, Strings, Lists, Tuples, Dictionaries, Type Conversions- Python Packages of interest for IoT- JSON, XML, HTTP Lib & URL Lib ,SMTP Lib.

### **IOT Platform Design Methodology**

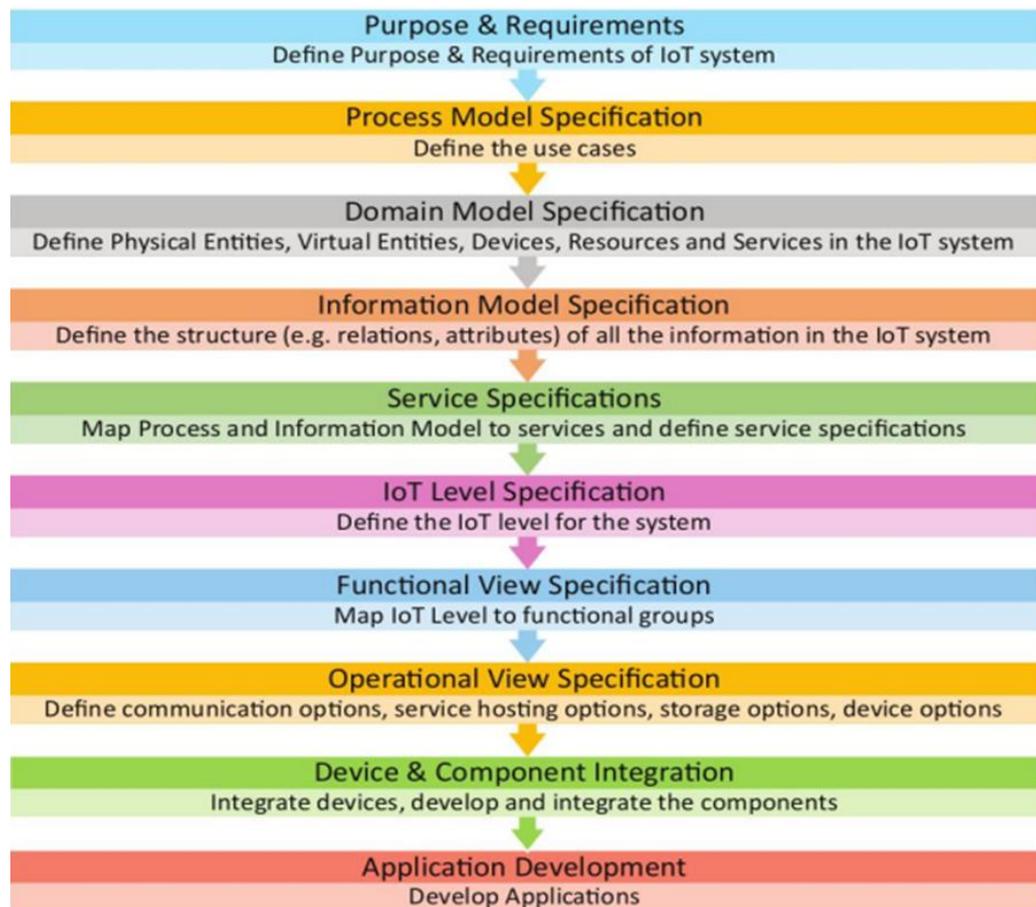
Designing IoT systems can be a complex and challenging task as these systems involve interactions between various components. A wide range of choices are available for each component. IoT designers often tend to design the system keeping specific products in mind.

We will look at a generic design methodology which is independent of specific product, service or programming language. IoT systems designed with this methodology will have reduced design time, testing time, maintenance time, complexity and better interoperability.

The steps involved in the designing of an IoT system or application can be summarized as shown in the below figure:



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### Step 1: Purpose & Requirements Specification

First step is to define the purpose and requirements of the system. In this step, the system purpose, behavior and requirements are captured. Requirements can be:

- Data collection requirements
- Data analysis requirements
- System management requirements
- Security requirements
- User interface requirements

For home automation system the purpose and requirements specification is as follows:

<b>Purpose</b>	A home automation system that allows controlling the lights remotely using a web application
<b>Behavior</b>	Home automation system should support two modes: auto and manual <b>Auto:</b> System measures the light level in the room and switches on the light

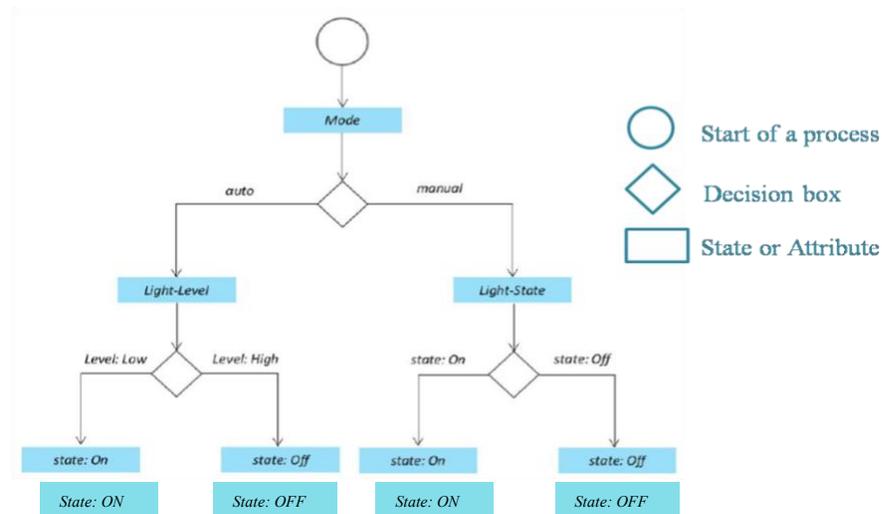


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	when it is dark <b>Manual:</b> Allows remotely switching lights on and off
<b>System Management</b>	System should provide remote monitoring and control functions
<b>Data Analysis</b>	System should perform local analysis of the data
<b>Application Deployment</b>	Application should be deployed locally, but should be accessible remotely
<b>Security</b>	Should provide basic security like user authentication

### Step 2: Process Specification

This step, formally described the **Process specifications** of the IoT system. In this step, the use cases of the IOT system are formally described based on the derived from the purpose and requirement specification. In the following process diagram, the circle denotes the start of a process, the diamond denotes a decision box and the rectangle denotes a state or attribute (design flow chart).



### Step 3: Domain Model Specification

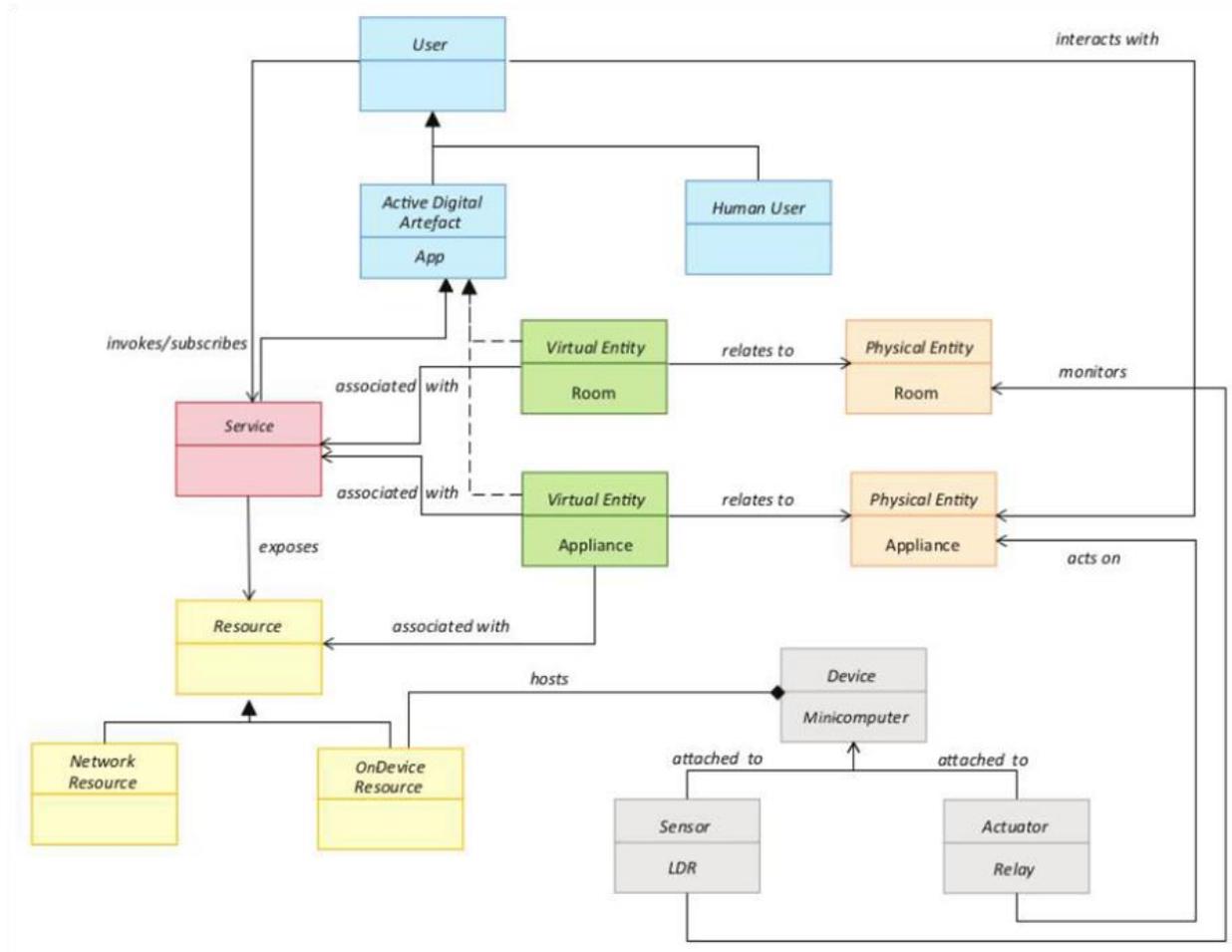
The domain model describes the **main concepts, entities** and objects in the domain of the IoT system to be designed. Domain model defines the **attributes** of the objects and **relationships** between objects. The domain model provides an abstract representation of the concepts, objects and entities in the IOT



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domain, independent of any specific technology or platform.

Using domain model, system designers can get an understanding of the IoT domain for which the system is to be designed. The entities, objects and concepts defined in the domain model of home automation system include the following:



Webbased Application

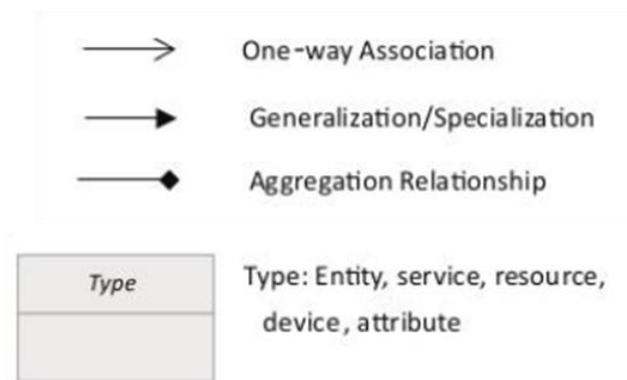
Smartphone user –application

Light sensor

On/off-Actuator



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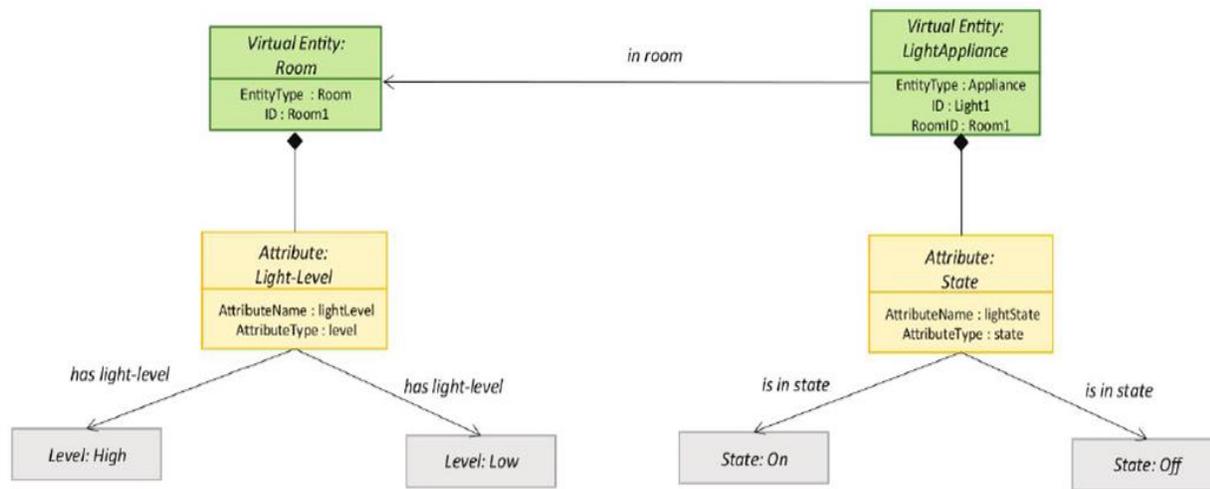
<b>Physical Entity</b>	<ul style="list-style-type: none"><li>• The physical identifiable objects in the environment( eg. A room, a light, an environment etc.,)</li><li>• IoT system provides information about the physical entity (using sensors) or performs actuation upon the physical entity ( eg. Switching on a light).</li></ul>
<b>Virtual Entity</b>	<ul style="list-style-type: none"><li>• Virtual entity is a representation of the <b>physical entity</b> in the digital world</li><li>• For every physical entity there is a virtual entity.</li></ul>
<b>Device</b>	<ul style="list-style-type: none"><li>• Devices provide a medium for interaction between physical and virtual entities.</li><li>• Devices are used to gather information from or perform actuation on physical entities.</li></ul>
<b>Resource</b>	<ul style="list-style-type: none"><li>• Resources are software components which can be either on-device or network-resources</li><li>• On-device resources are hosted on the device and provide sensing or actuation (eg: operating system)</li><li>• Network-resources include software components that are available on the network (eg: database)</li></ul>
<b>Service</b>	<ul style="list-style-type: none"><li>• Services provide an <b>interface</b> for interacting with the physical entity</li><li>• Services access resources to perform operations on physical entities</li></ul>

#### Step 4: Information Model Specification

This step defines Information Model. The Information Model defines the **structure** of all the information in the IoT system, example, attributes of Virtual Entities, relations, etc. The information model does not describe “how the information is represented or stored”. The information model defines the list of the Virtual Entities, their attributes, and the relations of the domain model.



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### Step 5: Service Specifications

In this step, Service specifications define the services in the IoT system such as service types, service inputs/output, service endpoints, service schedules, service preconditions, and service effects. These services either change the state or attribute values or retrieve the current values. The Mode service is a RESTful web service that sets the mode to auto or manual (PUT request), or retrieves the current mode (GET request). The mode is updated to/retrieved from the database. The State service is a RESTful web service that sets the light appliance state to on/off (PUT request) or retrieves the current light state (GET request). The state is updated to/retrieved from the status database. The Controller service runs as a native service on the device.



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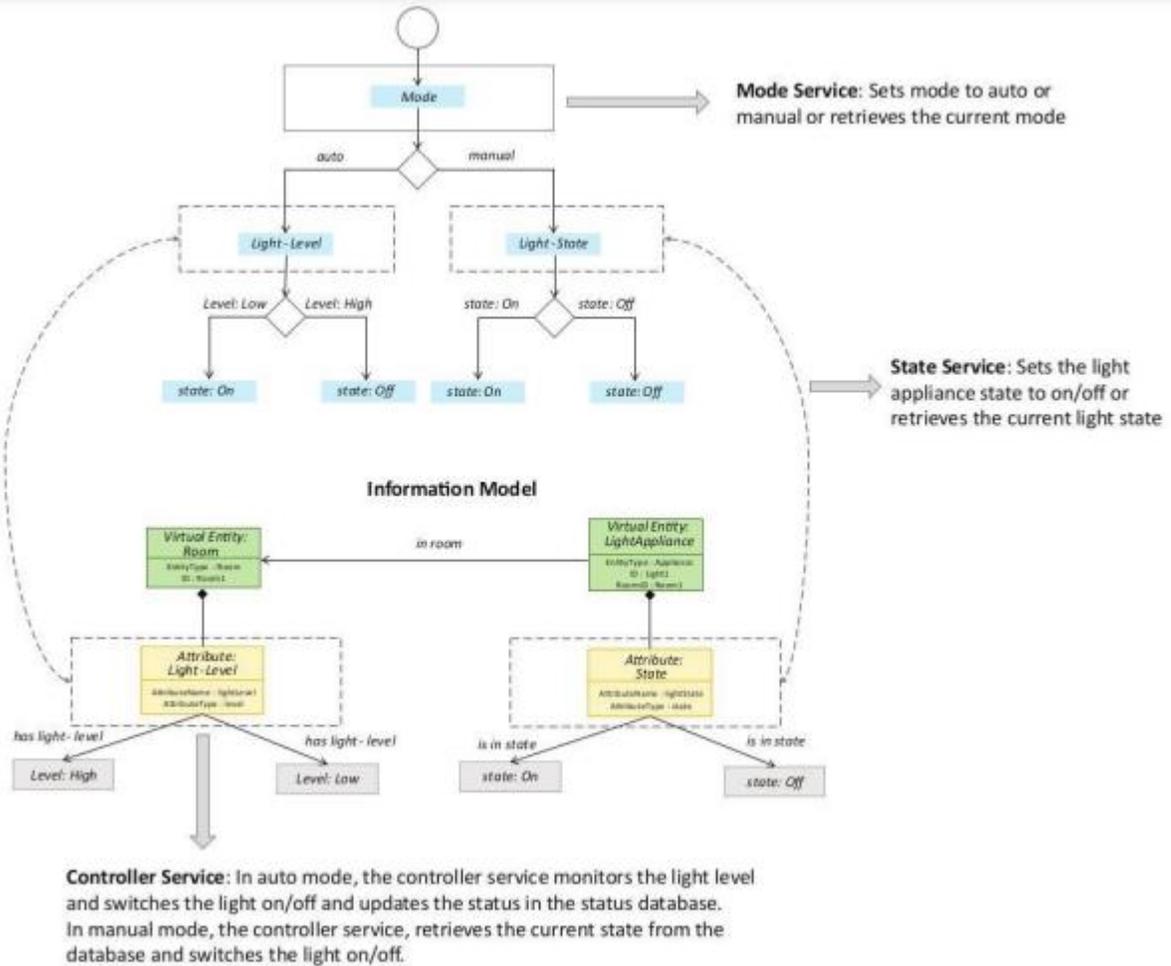
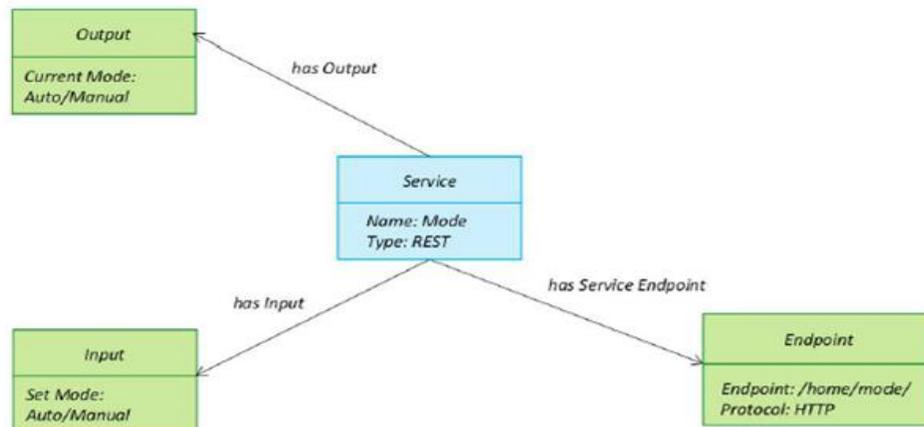


Fig. Deriving services from process specification and information model for Home automation system





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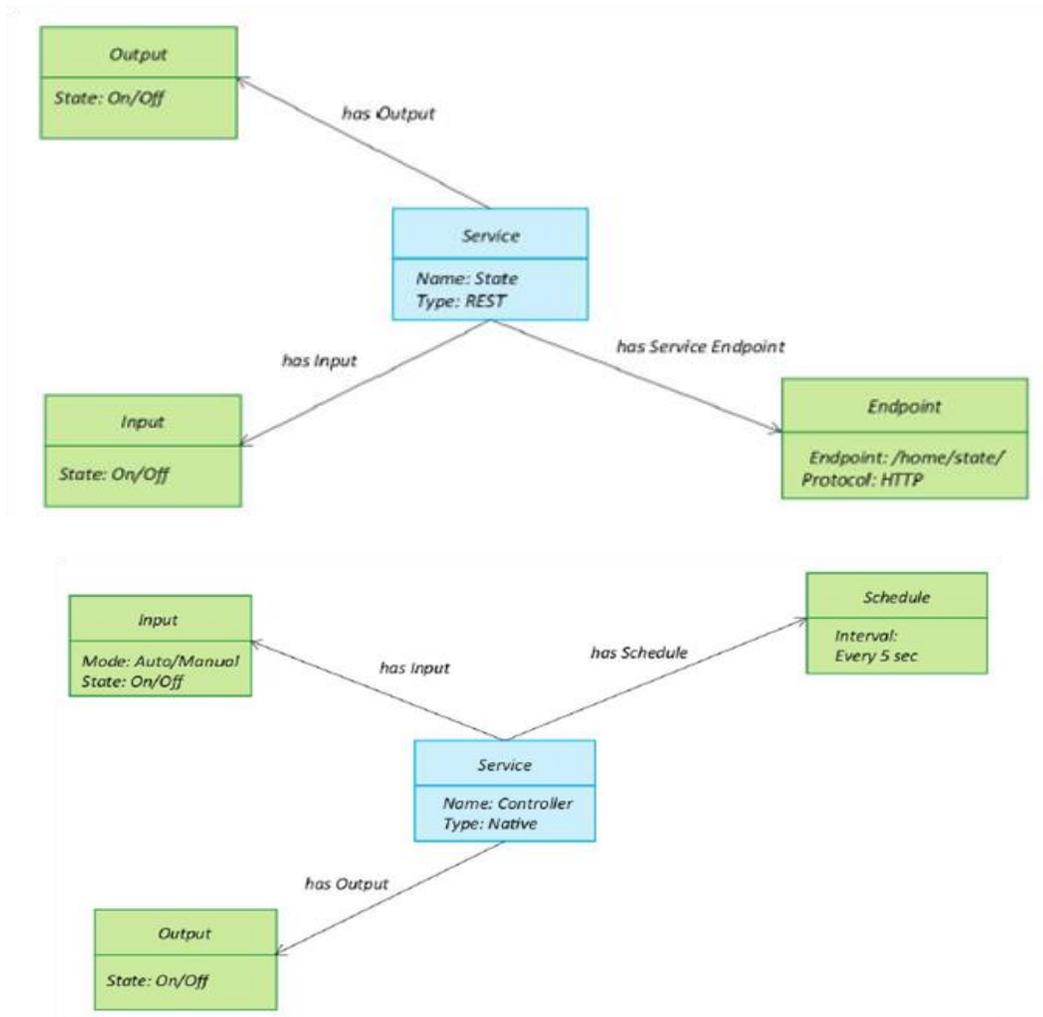


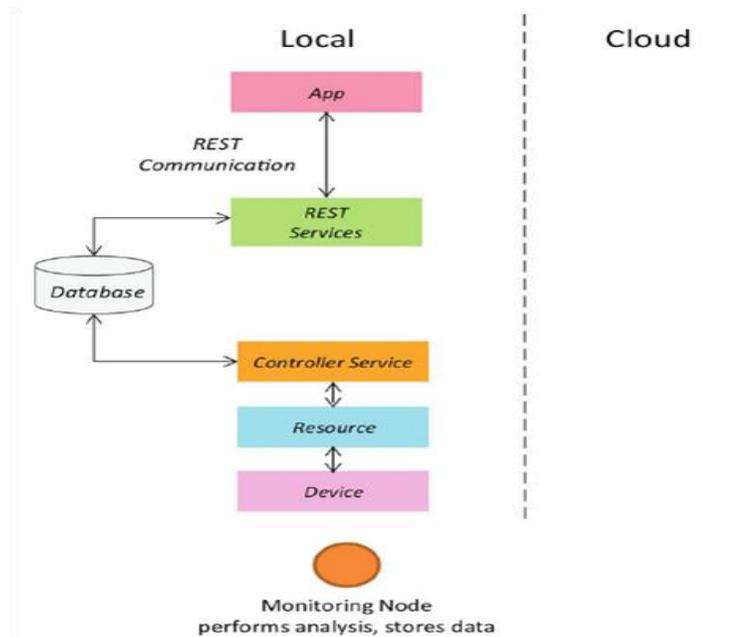
Fig: Mode Service , state service and controller service.

### Step 6: IoT Level Specification

**In this** step define the IoT level for the system. Five types of IoT deployment levels are used according to different conditions.



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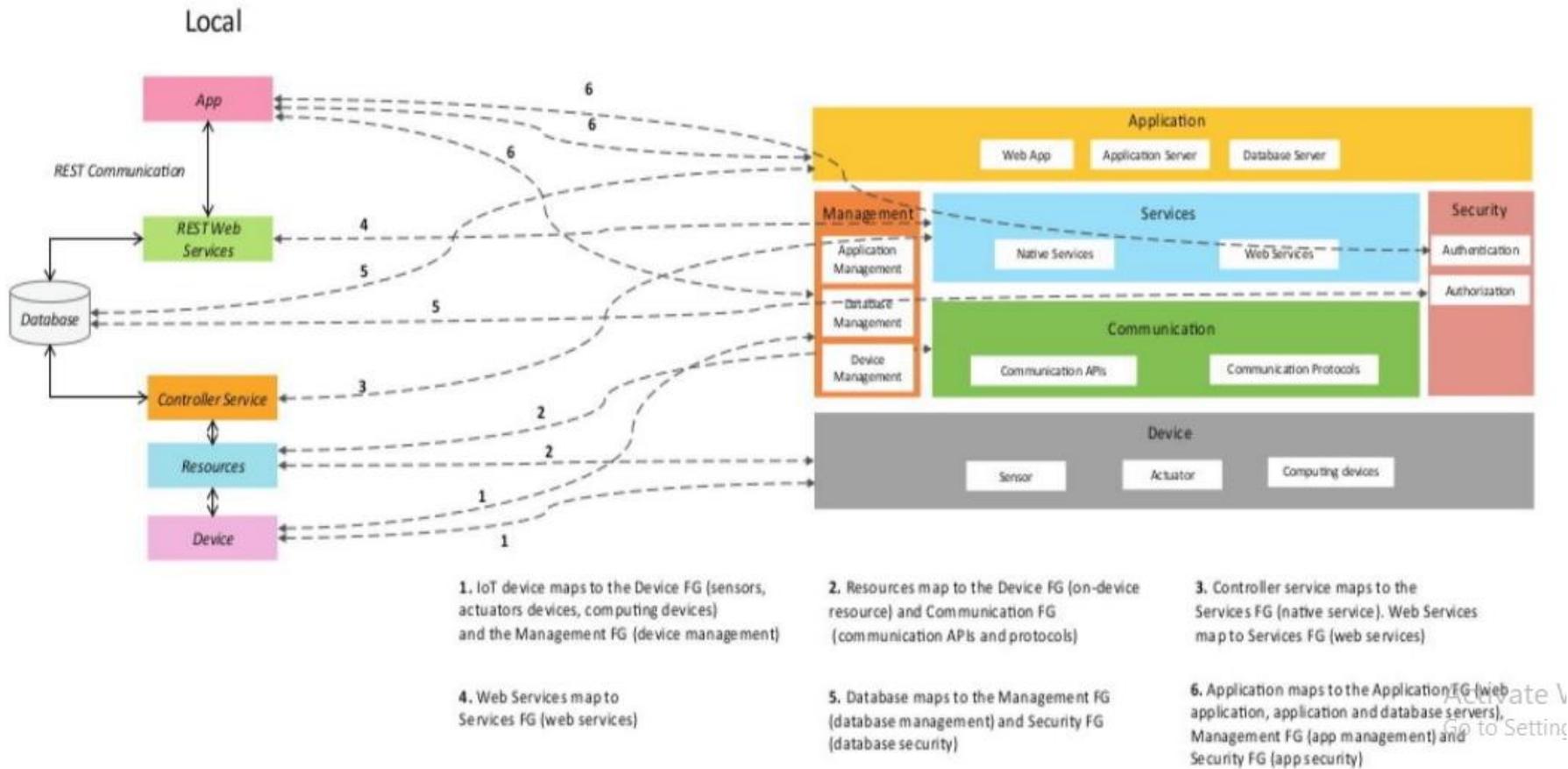


### Step 7: Functional View Specification

In the seventh step define the Functional View. The Functional View (FV) defines the functions of the IoT systems grouped into various Functional Groups (FGs). Each Functional Group either provides functionalities for interacting with instances of the Domain Model. A Functional View includes:



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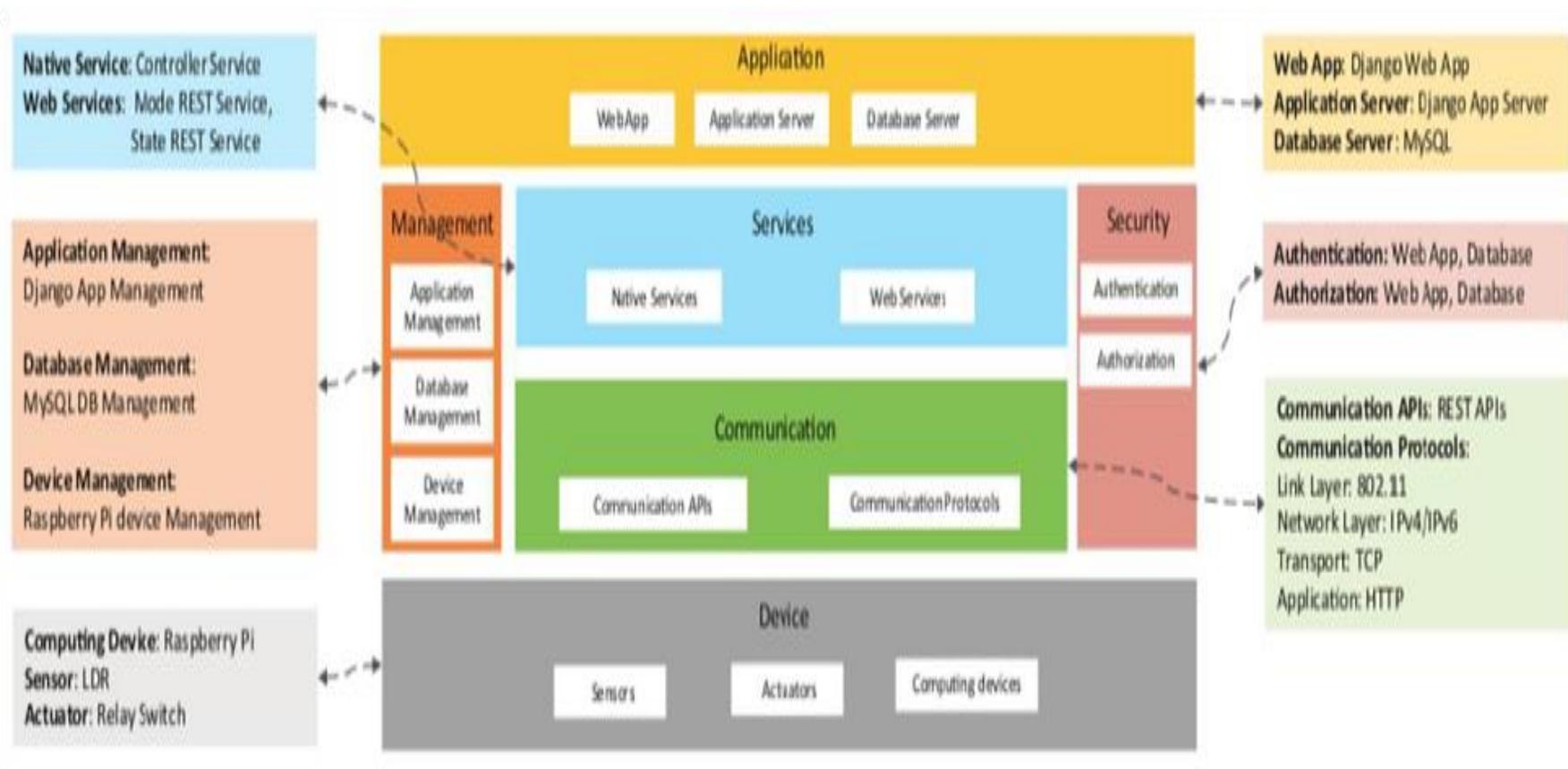
- **Device:**  
The device FG contains devices for monitoring and control.
- **Communication:**  
The communication FG handles the communication protocols and APIs (such as REST and WebSocket) that are used by the services and applications to exchange data over the network. for the IoT system. These are the backbone of IoT systems and enable network connectivity.
- **Services:**  
The service FG includes various services involved in the IoT system such as services for device monitoring, device control services, data publishing services, and services for device discovery.
- **Management:**  
The management FG includes all functionalities that are needed to configure and manage the IoT system.
- **Security:**  
The security FG includes security mechanisms for the IoT system such as authentication, authorization, data security, etc.
- **Application:**  
The application FG includes applications that provide an interface for the users to control and monitor various aspects of the IoT system. Applications also allow users to view the system status and the processed data.

### **Step 8: Operational View Specification**

In this step define the Operational View Specifications. IoT system deployment and operation are defined, such as service hosting options, storage options, device options, application hosting options, etc.



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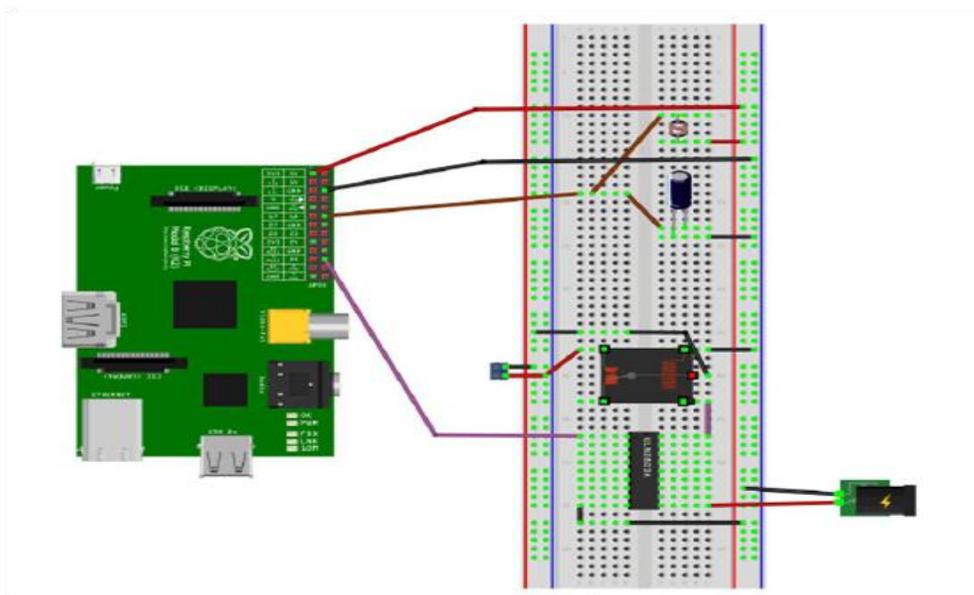


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- **Devices:**  
The computing device (Raspberry Pi), light-dependent resistor (sensor), relay switch (actuator). . Communication APIS: REST APIs
- **Communication Protocols:**  
Link Layer - 802.11. Network Layer-IPv4/IPv6, Transport -TCP, Application - HTTP.
- **Services:**
  1. Controller Service - Hosted on the device, implemented in Python, and run as a native service.
  2. Mode service - REST-ful web service, hosted on a device, implemented with Django-REST Framework.
  3. State service - REST-ful web service, hosted on a device, implemented with Django-REST Framework.
- **Application:**  
Web Application - Django Web Application, Application Server - Django App Server, Database Server - MySQL.
- **Security:**  
Authentication: Web App, Database
- **Management:**  
Application Management - Django App Management. Database Management - MySQL DB Management, Device Management - Raspberry Pi device Management.

### Step 9: Device & Component Integration

In this step integration of the devices and components design such as minicomputer, LDR sensor, and relay switch actuator.





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**Step 10: Application Development**

The final step in the IoT design methodology. It is to develop the IoT application. The application has controls for the mode (auto-on or auto-off) and the light (on or off).

