Unit II

Embedded IoT Platform Design Methdology
Outline

- Purpose and Requirement Specification
- Process Specification
- Domain model specification
- Information Model Specification
- Service specifications
- IoT Level Specifications
- Functional view specification
- Operational View Specification
- Device and Component integration
- Application development
Steps involved in IoT System Design Methodology

- **Purpose & Requirements**
  Define Purpose & Requirements of IoT System

- **Process Model Specification**
  Define the usecases

- **Domain Model Specification**
  Define Physical Entities, Virtual entities, Devices, Resources and Services in IoT System

- **Information Model Specification**
  Define structure (e.g. relations, attributes) of all the information in the IoT System

- **Service Specification**
  Map Process and information model to services and define service specifications

- **IoT level Specification**
  Define IoT Level for the system

- **Functional view Specification**
  Map IoT Level to functional groups

- **Operational view specification**
  Define communication options, service hosting options, storage and device options

- **Device & Component integration**
  Integrate devices, develop and integrate the components

- **Application development**
  Develop applications
Advantages of Using Design methodology

• Reducing the design, testing and maintenance time
• Provide better interoperability
• Reduce the complexity
Step 1 : Purpose and Requirement Specification

Defines

• System purpose
• behavior and
• Requirements (such as data collection requirements, data analysis requirement, system management requirements, data privacy and security requirements, User interfaces requirements)
Step 1: Purpose and Requirement Specification

• **Purpose**: An automated irrigation mechanism which turns the pumping motor ON and OFF on detecting the moisture content of the earth without the intervention of human

• **Behavior**: System should monitor the amount of soil moisture content in soil. In case the soil moisture of the soil deviates from the specified range, the watering system is turned ON/OFF. In case of dry soil, it will activate the irrigation system, pumping water for watering the plants.

• **System Management Requirements**: system should remotely provide monitoring and control functions
Step 1 : Purpose and Requirement Specification

• **Data Analysis Requirements**: system should perform local analysis of data

• **Application Deployment Requirement**: Deployed locally on device, but acts remotely without manual intervention.

• **Security**: Authentication to Use the system must be available
Step 2 : Process Specification

• Define the process with the help of use cases
• The use cases are formally described based on Purpose & requirement specification
• In this use case :
  – Circle denotes a state or an attribute
Step 2 : Process Specification

- Draw the use case

```
Threshold

Exceed

Signal
Low
High
Motor State : On
Motor State : Off

Not Exceed

Motor State
State : On
Motor On
State : Off
Motor Off
```
• Describes the main concepts, entities and objects in the domain of IoT system to be designed
• It defines the attributes of the objects and relationships between them
• Entities, Objects and Concepts include the following: Physical entity, Virtual entity, Device, Resource, Service
Step 3 : Domain Model Specification

• **Physical Entity:**
  – Discreet identifiable entity in physical environment
  – For eg. Pump, motor, LCD
  – The IoT System provides the information about the physical entity (using sensors) or performs actuation upon the Physical entity (like switching a motor on etc.)
  – In smart irrigation example, there are three Physical entities involved:
    • Soil (whose moisture content is to be monitored)
    • Motor (to be controlled)
    • Pump (To be controlled)

• **Virtual Entity:**
  – Representation of physical entity in digital world
  – For each physical entity there is a virtual entity
Step 3 : Domain Model Specification

• Device:
  – Medium for interactions between Physical and Virtual Entities.
  – Devices (Sensors) are used to gather information from the physical entities.
  – Devices are used to identify Physical entities (Using Tags).
  – In Smart Irrigation System, device is soil moisture sensor and buzzer as well as the actuator (relay switch) attached to it.
In smart irrigation system, there are three services:

- A service that sets the signal to low/high depending upon the threshold value
- A service that sets the motor state on/off
- A controller service that runs and monitors the threshold value of the moisture and switches the state of motor on/off depending upon it.

When threshold value is not crossed, the controller retrieves the motor status from database and switches the motor on/off.
Step 4 : Information Model Specification

- Defines the structure of all the information in the IoT system (such as attributes, relations etc.)
- It does not describe the specifics of how the information is represented or stored.
- This adds more information to the Virtual entities by defining their attributes and relations
- I: e, Draw Class diagram
Step 4 : Information Model Specification
Step 5 : Service Specification

• Define the services in IoT System, service types, service inputs/outputs, service endpoints, service schedules, service preconditions and service effects

• Services can be controller service, Threshold service, state service for smart irrigation system

• These services either change the state/attribute values or retrieve the current values.

• For eg.
  – Threshold service sets signal to high or low depending upon the soil moisture value.
  – State service sets the motor state : on or off
  – Controller service monitors the threshold value as well as the motor state and switches the motor on/off and updates the status in the database
• Decide the deployment level of IoT System. Here I am using Deployment Level 1.
Step 7: Functional View Specification

- Define the functions of IoT System grouped into various functional groups.
- These functional groups provide functionalities for interacting with the concepts defined in Domain model specification.
Step 7 : Functional View Specification
Step 8 : Operational View Specification

• Define the Operations/options related to IoT System development

• Such as Device options, Storage options, Application hosting option
Step 8: Operational View Specification of automated irrigation system

• Application
  – Web App: PHP WebApp
  – Application Server: Google App engine
  – Database Server: MySQL

• Services
  • Native: Controller Service
  • Web: REST

• Communication
  – Communication APIs: REST SPIs
  – Communication Protocol:
    • Link Layer: 802.11
    • N/w: IPV6
    • Transport: TCP
    • Application: HTTP
Step 8: Operational View Specification of automated irrigation system

- **Management**
  - Device Management: Arduino device management
  - Application Management: PHP App Management
  - Database Management: MySQL Db Mgmt

- **Security**
  - Login Management
Step 9: Device and Component Integration

- Integrates the devices and components and draw a schematic diagram showing the same.
Device and Component Integration: Alternate Diagram
Step 10: Application development

- GUI / Screenshot of IoT Application