

# FPT UNIVERSITY

## Capstone Project Document

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### ZigBee for Remote Management

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## List of abbreviations and acronyms

No.	Abbreviation& Acronym	Definition
1	ZFRM	ZigBee for remote management
2	LR-WPAN	Low-Rate Wireless Personal Area Networks
3	IEEE	Institute of Electrical and Electronics Engineers
4	MAC	Medium Access Control
5	PHY	Physical
6	AES	Advanced Encryption Standard
7	PCB	Printed circuit board
8	RF	Radio frequency
9	UI	User interface
10	DM	Digital Multimeter
11	DIA	Device Integration Application
12	GUI	Graphic User Interface
13	IDE	Integrated Development Environment
14	DBMS	Database Management System
15	SVN	Subversion

Table 1: List of abbreviations and acronyms

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## A. Introduction

### I. Scenario

The mobile equipment is now pretty widespread, and they help us a lot in communication. But regarding to remotely controlling appliances and machines in general, there're still many drawbacks:

- Usually, each machine has its own remote control (if it has one), and using its own system to control the commands taking from the user.
- They cannot cross-use with each other, or if they can, very limited.
- The area of effect, or in other words - the distance between the remote and the machine, is also very difficult problem that very few can solve.
- Most importantly, there are not many appliances out there that can “communicate” with the user.

From our research, we notice some basic needs of a normal customer:

- They want a device that can help them to connect to the appliances with less effort and more effective control.
- That device should have a long battery life
- People also want to have a system that is simple, yet usable and stable, to help them to “communicate” with the appliances every time, and vice versa.

For the investors, they need a system can manage and supply best services for customer.

They need a system that can:

- Manage system (customers, devices) in easy and advantage way.
- Can supply for many type of customer so the device in system can be expanded in future.
- System can supply service that customer can use to remote their devices in real time.

So, based on real needs, we would like to develop a product that can help people with high rate of mobility becoming more comfortably control their appliances.

### II. Existing solutions

#### 1. BKAU SmartHome SH-D2:

Turn off the lights Equipment SH-D2 intelligent technology works by infrared temperature sensors. When used in the sensor, the device will automatically turn on the lights and turn off the lights when no one. Device features integrated light sensor and the ability to flexibly adjust the time automatically turn off after no use. Equipment will also incorporate smart features switch to operate according to the script of the user. Features of smart devices bring comfort, safety and energy saving for the user.

Disadvantage:

- Only turn ON/OFF the power of device when user in the place of the device
- Can't remote in a far distance
- Can't manage all of the devices in home or building(the status of device in each room and control the power of them)
- Difficult to manage and control the power (energy) of many devices in the large system such as in high building or in system has a great number of end devices.

## 2. RCL Lighting: Take control with iDirect

iDirect is a design and manufacture of remote controlled spotlights, designed specifically for the iPad, the app allows RCL fixtures to be controlled in pan, tilt and dim level using simple gestures.

- Light plans: select lights from a reflected ceiling plan.
- Gesture Pad: Control spotlights using simple gestures
- Dimming: Centralized dimming for individual areas
- Scenes: Record scenes to save you time

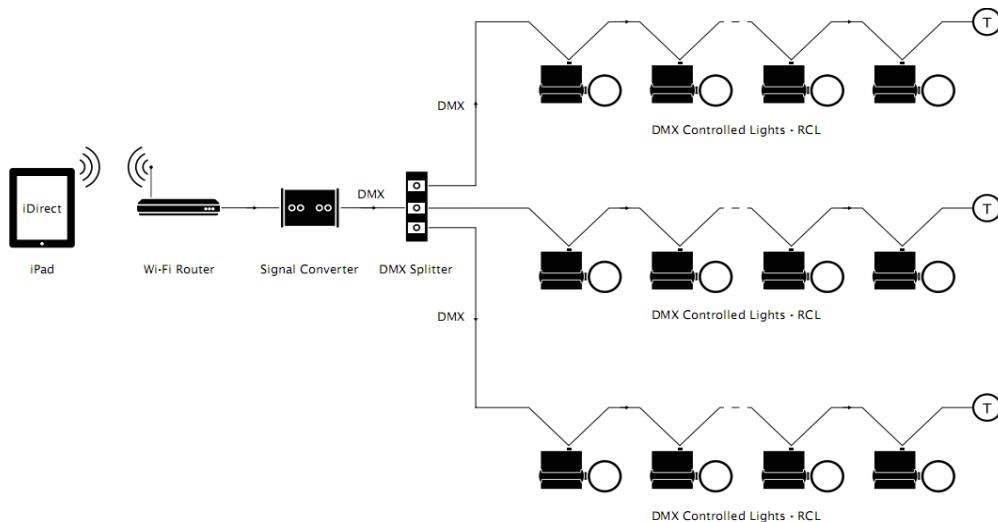


Figure 1: Overview of iDirect System

### Disadvantage:

- Only use for lighting system, can't expand the system with multi-purpose end devices
- Using DMX standard so it use cable to connect between each end device to transfer data to router. Cable faults can occasionally lead to intermittent problems such as random triggering. Unexpected fixture behavior is caused by addressing errors, cable faults, or incorrect data from the controller.
- The end devices (spotlights, remote) using in this system is only supply by sole agent so it is difficult for other choices of user.
- The cost for using this system is also high for developing countries.

### III. Proposed solution and Approach

Our team proposed a new wireless system has some advantages like:

- Devices have long battery life (2 – 3 years)
- Low cost between the connections of all devices in the whole system.
- Self-forming and self-healing network
- Ability to locate the location of each end device in the whole system.
- Interoperability: devices can interact with each other regardless of manufacturing origin.
- Security: the data in network would be authenticated and confidential.
- Ability to control the whole system remotely.

So that, our team choose ZigBee technology as a main approach combine with some client application like web application or phone application to control all over the system.

### IV. Project overview

#### 1. Technology overview

ZigBee is a protocol specification and industry standard for a type of wireless communications technology generically known as Low-Rate Wireless Personal Area Networks (LR-WPAN). It is an open global standard built on the IEEE 802.15.4 MAC/PHY.

“ZigBee” is the name for:

- Short-range
- Low-power
- Low-cost
- Low-data-rate wireless multi-hop networking *technology standard*.

The features of ZigBee networks include self-organization, support for multi-hop routed networking topologies (mesh network), interoperable application profiles, and security based on the Advanced Encryption Standard (AES)

#### 1.1 ZigBee network topology

These topologies indicate how the radios are logically connected to each other. There are four major ZigBee topologies:

- **Pair:** The simplest network is one with just two radios, or nodes. One node must be a coordinator so that the network can be formed. The other can be configured as a router or an end device.
- **Star:** This network arrangement is also fairly simple. A coordinator radio sits at the center of the star topology and connects to a circle of end devices. Every message in the system must pass through the coordinator radio, which routes them as needed between devices. The end devices do not communicate with each other directly.

- **Mesh:** The mesh configuration employs router nodes in addition to the coordinator radio. These radios can pass messages along to other routers and end devices as needed. The coordinator (really just a special form of router) acts to manage the network. It can also route messages. Various end devices may be attached to any router or to the coordinator. These can generate and receive information, but will need their parent's help to communicate with the other nodes.
- **Cluster tree:** This is a network layout where routers form a backbone of sorts, with end devices clustered around each router. It is not very different from a mesh configuration.

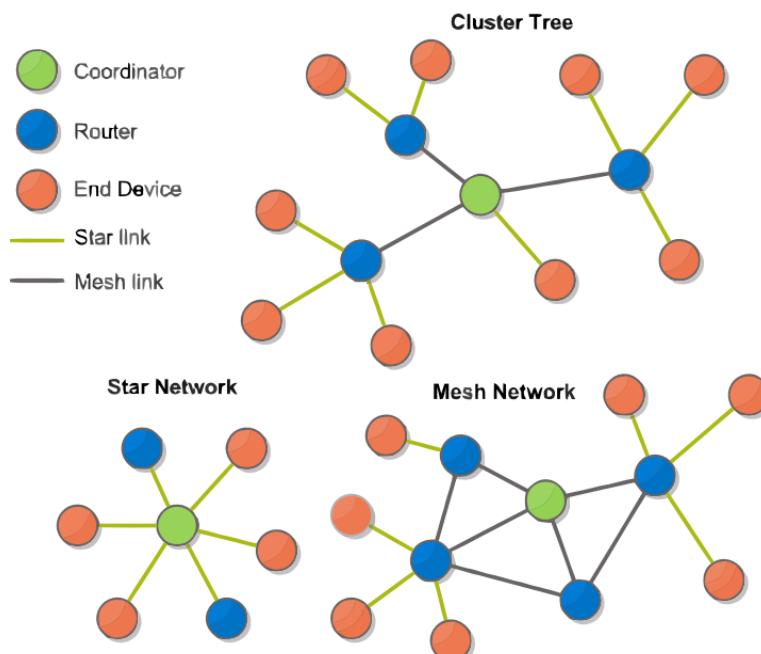


Figure 2 : ZigBee network topology

### 1.2 Roles in ZigBee network

There are three roles in a ZigBee network

- **Coordinator:** This is the module that establishes the network. Every network must have one (and only one) of these types in it. Think of this device as similar to a wireless internet router. Because this device is constantly administering the network, it consumes more power than other types. It is recommended that this module is not powered by battery.
- **Router:** This device is similar to the Endpoint, but also specializes in passing data around the network. Data sent from one endpoint to another may pass through several routers on its way to the destination.

- **Endpoint (End device):** This is the module that connects in running devices such as temperature sensor, plug...It can be battery powered, and doesn't consume much energy unless it needs to transmit or receive.

### **1.3 Addressing basics**

If you want to send a ZigBee message, you need to know the address of the destination radio. For starters, each radio has a unique and permanently assigned 64- bit serial number. No other ZigBee radio on earth will have that same serial number. Then there's a shorter 16-bit address that is dynamically assigned to each radio by the coordinator when it sets up a network, similar local host in IP addressing schema. This address is unique only within a given network, but since it's shorter, many more of them can be manipulated in the very limited memory available on a ZigBee chip.

### **1.4 Personal Area Network (PAN) Address**

Each coordinator forms a ZigBee network creates a virtual "area", and labels that area with a number; this is the Personal Area Network (PAN) address. This is another 16-bit address. There are 65,536 different PAN addresses available, each having the capability to generate another 65,536 16-bit radio addresses below it. In theory, therefore, this addressing scheme has room for more than 4 billion total radios.

### **1.5 Channels**

ZigBee network uses 12 different channels. All the radios in that network must use the same channel. In some ZigBee modules origin like XBee from Digi, channel selection handling is done automatically.

## **2. System overview**

- There is a server that can manage all the operations in the system. Server will manage the information of users and their device. It also receives and sends command to get the status of device and control the power or status of devices in system
- There is a ZigBee module acts as a master controller for the entire network. It's also a gateway which offers connection to the internet via Ethernet.
- There are several ZigBee modules act as routers to connect the master controller to end devices.
- The end devices are integrated which ZigBee modules can send data and receive command from other ZigBee modules.
- The master controller will provide information of the system to a cloud service and also receive commands from it.
- The end users use the Device Manager (web application on PC/Laptop or Application on Mobile phone) connects with the cloud service to control the whole system: configure security key, update devices' status, send commands to devices...
- Using the system, end users can:

- Manage the status and information of each device in the whole system.
- Remote and control the device in system easily by using web application on PC/Laptop or Mobile phone using Android platform.
- Saving energy and money by control the power of device(ON/OFF) actively
- Increases the efficiency, low cost and maintenance
- When expand the system in future, the remote management system easily meet the increasing necessity of a great number of vending machines with multi-purpose functions (the system is designed with ZigBee for a good control of network for vending machines as well as hardware design technology for stability and low power)



Figure 3: System overview

## V. Scope of project

The scope of this project is a prototype of for a “Remote management system using ZigBee”, includes both hardware and software.

The final product must satisfy the following specifications:

### ZFRM server

- Manage and handle all information of users and their devices in system.
- Can send/receive commands to/from devices to manage the remotely.
- Can update status of devices (online/offline) also state and value of devices (temperature, state of plug)
- Users can control and remote devices in system by server in real time.
- Warning when temperature is not in the safe range of temperature or plugs in wrong state

### ConnectPort X2 ZB with Ethernet WAN connection

- Receive and process data transmitted from XBee modules of other devices.

- Send stored data about state of other devices to Server.
- Send data/command that received from server to XBee modules of other devices.
- Control the connection of each node in the whole system

### End devices

- Temperature sensor: take the temperature of the place where it's placed.
- Electric switch: turn ON/OFF the power of electric device.
- PIC Microcontroller: connect the temperature sensor/electric switch to XBee module. Data (signal) that sent and received is controlled by PIC.

**XBee Modules:** Modules provide wireless end-point connectivity to device

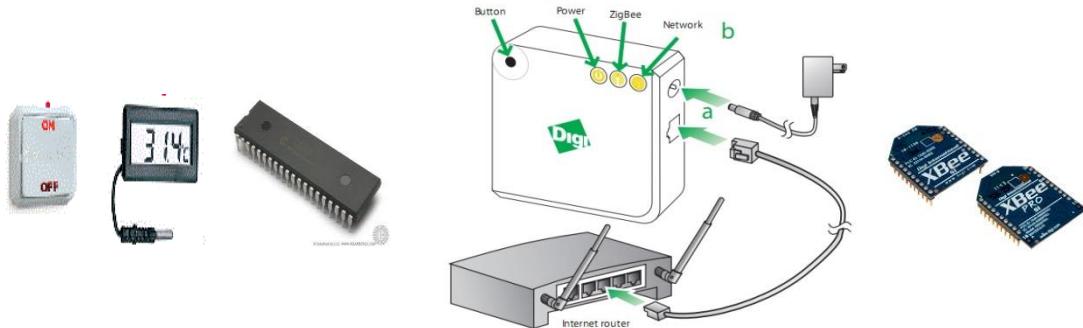


Figure 4: Project devices

**Application on Android platform:** for use on mobile phone.

- Connect to the server, get and receive data from server.
- Have graphic user interface for user to control system in an easy and simple way.
- Have basic functions for end user to control and manage the system:
  - View how many devices in system and detail information, status of each device.
  - Turn ON/OFF the power of end device by remote.
  - Manage the temperature in room and warning when it isn't in safe range.
- Have user navigation and user help when having trouble

**Web application:** for use on PC/Laptop.

- Connect to the server, get and receive data from server.
- Have graphic user interface for user control system.
- Have full functions for end users to control and manage the system:
  - Auto scan for new Devices when user selects "Scan" function.
  - Add new/Edit/Delete Gateway or Device.
  - Manage how many devices in system and detail information, status of each device.
  - Turn ON/OFF the power of end device by remote.
  - Manage the temperature in room and warning when it isn't in safe range.
- Have user navigation and user help when having trouble.

## VI. Team introduction

Roles and Responsibility:				
No	Full name	Role	Position	Contact
1	Nguyễn Trọng Phúc	Project owner	Instructor	PhucNT@fpt.edu.vn
2	Lê Nam Phương	Project manager/Developer	Team leader	PhuongLN60565@fpt.edu.vn
3	Trương Hoàng Yến	Developer/Tester	Team member	YenTH60576@fpt.edu.vn
4	Võ Phát Hưng	Developer	Team member	HungVP60423@fpt.edu.vn
5	Xinh Thanh Thuận	Developer	Team member	ThuanXT60354@fpt.edu.vn

Table 2: Team member and role in the project

## B. Project Management Plan

### I. Problem Definition

#### 1. Capstone Project Name

- Project full name: Zigbee for remote management
- Project code: ZFRM

#### 2. Problem Abstract

Recent advances in information and communication technology opened the perspective of embedding “intelligence” in a number of components in our home, our building and transforming it into devices that can help us control and manage our life actively, usually referred to as “Smart Remote management”. People need more control of the system they are using as well as more energy saving options. Based on this idea, we developed a system using ZigBee technology so that people can remotely manage devices in the system easily. Besides, it is also a way to save money by saving the energy they used.

With our system:

- Devices have long battery life (2 – 3 years)
- Low cost between the connections of all devices in the whole system.
- Self-forming and self-healing network
- Ability to locate the location of each end device in the whole system.
- Interoperability: devices can interact with each other regardless of manufacturing origin.
- Security: the data in network would be authenticated and confidential.
- Ability to control the whole system remotely

### 3. Project Overview

#### 3.1 The Current Systems

We all use electricity in our homes every day for almost devices such as lights, fans... More and more electrical devices are used day by day, that's good for our life but we assume that we get 100 lights at 100 different places and when we want to turn off any of them, we have to go to its place and turn it off. We take a lot of time to do this with all 100 lights. The question is that if we have a good way to turn on or off all 100 lights by just standing in one place.

#### 3.2 The Proposed System

We design a control system which allows people control their home devices by android application or web application remotely. This is a wireless control system. People could control almost all the facilities at home including lights, fans or even back ground music. The purpose of it is to make people's lives more convenient. To replace turn on or turn off

on switches by hand for current product, our system is controlled by mobile phone or PC/Laptop. That should be a trend for the future 5-10 years which we believe that it is coming to real product soon. How to make people's life safer, more convenient, more comfortable and less energy consumption will be the series of questions we will care, discuss and design in our project.

### 3.3 Boundary of the System

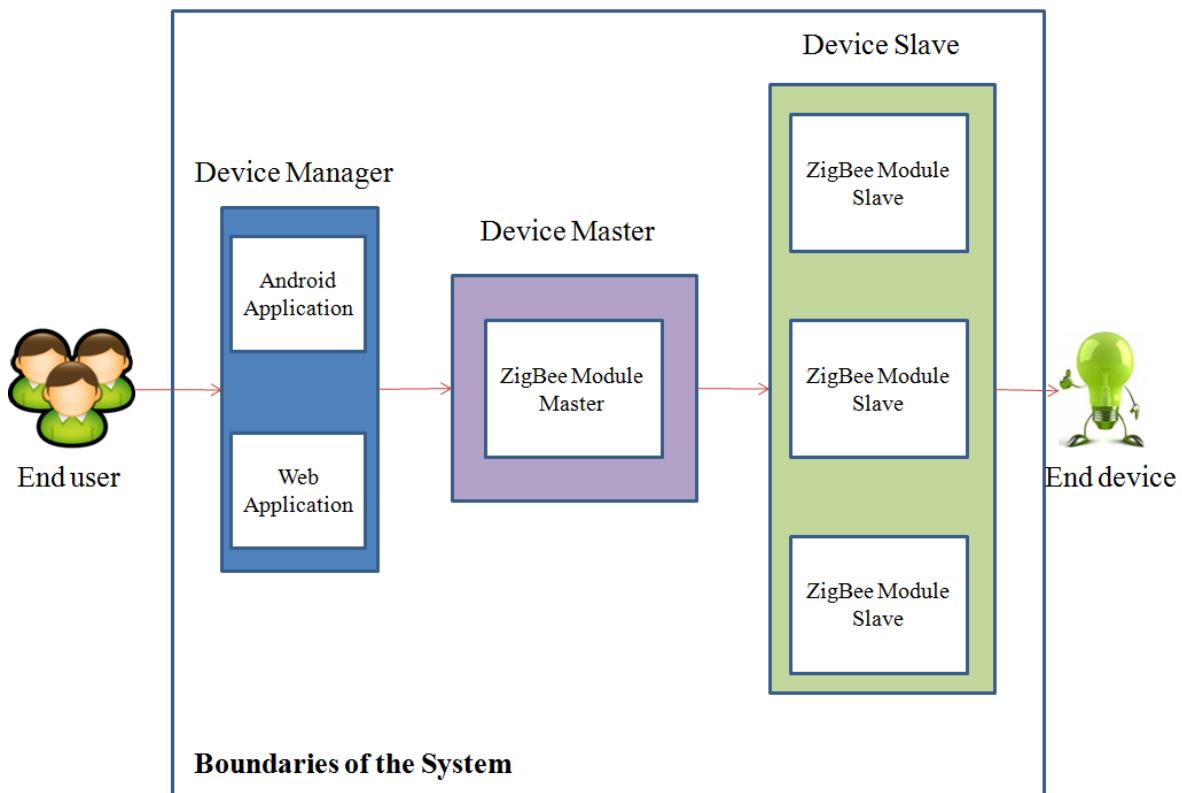


Figure 5: Boundaries of the System

#### 3.4.a Hardware Requirements

- Internet connected computer (ADSL 4Mbps)
- Digi Connect port X2, Digi Xbee modules
- Sparkfun usb connectors
- Temperature sensor, switch
- Microprocessor: PIC 16f877a
- Printed circuit board (PCB) making tools

#### 3.4.b Software Requirements

- Operating System: Windows 7
- IDE: Digi ESP development tool, Visual Studio 2012, Eclipse, PIC C Compiler

- DBMS: SQL Server Express 2012
- Subversion Client: Tortoise SVN, Visual SVN
- Source Control: Assembla Free Private Subversion® Repository<sup>1</sup>

## II. Project Organization

### 1. Software Process Model

Project is developed under agile model.

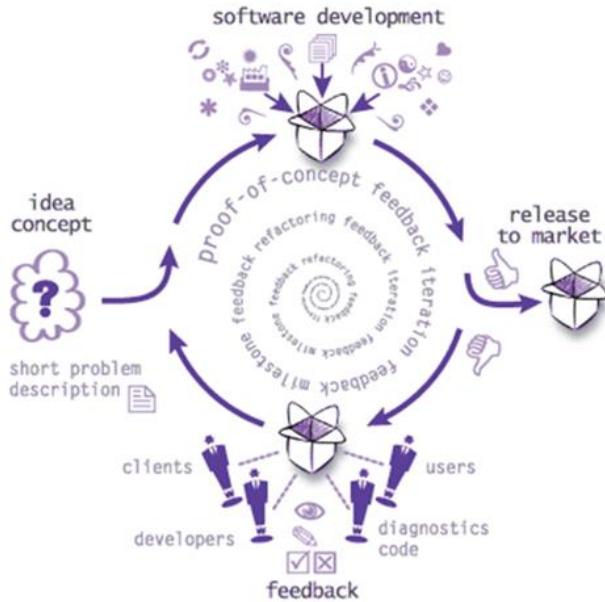


Figure 6: Agile development model

The reasons why we choose agile model in our project are:

- In agile model we can only create a high-level design of the application before we actually begin to build the product and define the design solution for the entire product. Later on we can design and built a skeleton version of that, and then evolved the design based on what had been built.
- The product is built and improved step by step. Hence we can track the defects at early stages. This avoids the downward flow of the defects.
- We can get the reliable user feedback. When presenting sketches and blueprints of the product to users for their feedback, we are effectively asking them to imagine how the product will work.
- Less time is spent on documenting and more time is given for designing.

<sup>1</sup> [https://www.assembla.com/spaces/free-private-subversion-repository-only/prepare\\_copy?type=private](https://www.assembla.com/spaces/free-private-subversion-repository-only/prepare_copy?type=private)

## 2. Roles and Responsibilities

No	Full name	Role in Group	Responsibilities
1	Nguyễn Trọng Phúc	Project Owner	<ul style="list-style-type: none"> <li>- Specify user requirement</li> <li>- Control the development process</li> <li>- Give out technique and business analysis support</li> </ul>
2	Lê Nam Phương	Project manager, developer, tester	<ul style="list-style-type: none"> <li>- Managing process</li> <li>- Designing database</li> <li>- Clarifying requirements</li> <li>- Support technique</li> <li>- Prepare documents</li> <li>- Coding</li> <li>- Testing</li> </ul>
3	Trương Hoàng Yến	Business analyst, developer, tester	<ul style="list-style-type: none"> <li>- Designing database</li> <li>- Clarifying requirements</li> <li>- Support technique</li> <li>- Coding</li> <li>- Creating test cases</li> <li>- Testing</li> <li>- GUI design</li> </ul>
4	Võ Phát Hưng	Business analyst, developer, tester	<ul style="list-style-type: none"> <li>- Coding</li> <li>- Clarifying requirements</li> <li>- Circuit Design</li> <li>- Creating test plan and test cases</li> <li>- Testing</li> </ul>
5	Xinh Thanh Thuận	Business analyst, developer, tester	<ul style="list-style-type: none"> <li>- Coding</li> <li>- Clarifying requirements</li> <li>- Circuit Design</li> <li>- Creating test plan and test cases</li> <li>- Testing</li> </ul>

Table 3: Roles and responsibilities

## 3. Tools and Techniques

- o Microcontroller programming tools: PIC C Compiler
- o Circuit supporting tools: Proteus 7.8, Orcard 9.2
- o ZigBee development: Digi ESP development tool
- o Front-end: html, css, javascript, json, jQuery, AJAX, Android 4.0
- o Back-end: MVC4, .NET framework 4.5, Entity Framework 5, log4net
- o Web server: Microsoft IIS 7
- o DBMS: SQL Server Express 2012

### III. Project Management Plan

#### 1. Project Iterations

Phase/Iteration	Description	Deliverables	Resources Needed	Dependencies and Constraints
<b>1. Preliminary study and planning</b>	<ul style="list-style-type: none"> <li>- Study about ZigBee</li> <li>- Identify and research about end devices to consume ZigBee network</li> <li>- Make project's plan</li> </ul>	<ul style="list-style-type: none"> <li>- Notes about ZigBee</li> <li>- End devices' circuit design</li> <li>- Project's plan</li> </ul>	<ul style="list-style-type: none"> <li>- 20 man-days</li> </ul>	<ul style="list-style-type: none"> <li>- N/A</li> </ul>
<b>2. Design and develop the system</b>	<ul style="list-style-type: none"> <li>- Buy material for end devices</li> <li>- Develop end devices</li> <li>- Test end devices</li> <li>- Set up ZigBee network</li> <li>- Testing, fix bug and report</li> </ul>	<ul style="list-style-type: none"> <li>- ZigBee network</li> <li>- End devices circuit design</li> <li>- End devices hardware</li> </ul>	<ul style="list-style-type: none"> <li>- 100 man-days</li> </ul>	<ul style="list-style-type: none"> <li>- N/A</li> </ul>
<b>3. Develop server and web application</b>	<ul style="list-style-type: none"> <li>- Provide a web server to manage the entire system</li> <li>- Implement a web application with friendly GUI for users to view and setup their own network via internet</li> </ul>	<ul style="list-style-type: none"> <li>- Web Server and web application</li> </ul>	<ul style="list-style-type: none"> <li>- 40 man-days</li> </ul>	<ul style="list-style-type: none"> <li>- Depend on ZigBee network and end devices</li> </ul>
<b>4. Develop android application</b>	<ul style="list-style-type: none"> <li>- Implement an android application for users to view and setup their own network on phone</li> </ul>	<ul style="list-style-type: none"> <li>- Android application</li> </ul>	<ul style="list-style-type: none"> <li>- 30 man-days</li> </ul>	<ul style="list-style-type: none"> <li>- Depend on ZigBee network, end devices and web server</li> </ul>

<b>5. Integration and system test for the behavior in system</b>	<ul style="list-style-type: none"> <li>- Create test plan, test cases and expected result</li> <li>- Execute test cases and collect test result</li> </ul>	<ul style="list-style-type: none"> <li>- Integrated system</li> <li>- Test plan, test cases and test result</li> </ul>	- 20 man-days	- Depend on the entire system from previous phases
<b>6. Improve the quality of product and performance of system.</b>	<ul style="list-style-type: none"> <li>- Check the behavior of system</li> <li>- Find the method to optimize the current system for quality and performance.</li> <li>- Do acceptance test</li> </ul>	<ul style="list-style-type: none"> <li>- The optimized system</li> </ul>	- 20 man-days	- N/A

Table 4: Projects iterations

## 2. Risk management

Risk	Description	Category	Root cause	Triggers	Potential Responses	Probability
<b>Communication</b>	People in project cannot understand each other well.	People	Project members lack of communication	Misunderstanding, delay of project	Meeting frequently, communicate face to face	High
<b>Team spirit and attitude</b>	Team spirit go down and do not want to do everything or thinking not creative	People	Difficult problems, busy with personal stuffs	Team members become tired and lazy Delay of project	Change to other environments or built a team-building meeting to encourage and motivate the team spirit	High

<b>Circuit</b>	In printing circuit process, sometime the circuit failed and can't run.	Process	Design wrong circuit Don't have experiment in printing circuit	Delay a phase of project	Check the problem Print circuit again	High
<b>Sickness</b>	Project members out of work because of sickness	People	Sickness	Delay a phase of project	Arrange backup plan, buffer workload	Medium
<b>Material quality</b>	The quality of device that supply in Vietnam sometimes not good enough	Material	Depend on suppliers	Delay a phase of project	Find others suppliers	Medium
<b>Material supplying</b>	The supplier not supply the material on time In project, material can be broken by wrong action of member in team. So need time to request from supplier and time for supplying	Material	Don't have experiment on choosing the prestige supplier Don't have experiment on manipulation of device	Delay a phase of project	Ask supervisor for advice	Medium
<b>Not meet deadline</b>	Not meet the deadline that plan in project management plane	Process	A lot of root causes	Delay a phase of project	Work overtime to meet deadline	Medium
<b>Money</b>	Lack of money for buying material	Budget	Shortage of money	Delay a phase of project	Loan from friends, investigator	Low

Table 5: Project's risks

### 3. Iteration Detail

#### 3.1 Phase 1: Preliminary study and planning

Task	Description	Author
- Study about ZigBee	- Study about ZigBee definition, its infrastructure and how it works. - Pros/cons of ZigBee	PhuongLN, YenTH, ThuanXT, HungVP
- Research the current system/project use ZigBee in our life.	- Home automation - Health care system - Smart energy system - Study Digi development tool	PhuongLN, YenTH, ThuanXT, HungVP
- Identify and research about end devices	- Choose which end devices should be made - Research about needed circuits	ThuanXT, HungVP
- Planning	- Make plan, schedule and assign task - Identify risk and how to manage	PhuongLN
- Document	- Make team's report: Introduction, SRS	YenTH, PhuongLN, ThuanXT, HungVP

Table 6: Phase 1 – Preliminary study and planning

#### 3.2 Phase 2: Design and develop the system

Task	Description	Author
- Identify requirement and planning	- Which end devices should be made - What materials are needed	PhuongLN, ThuanXT
- Buy material for end devices	- PIC 16f877a microcontroller - ZigBee / 802.15.4 Modules XBee ZB w/PCB Ant AT - Connect Port X2 ZB ethernet - Others electronic devices	ThuanXT, HungVP
- Design and implement end devices (hardware)	- Design circuit - Draw schematic of circuit - Print circuit and make devices	ThuanXT, HungVP
- Implement chip controller	- Implement controller for end devices - Test in simulation - Test in real hardware	PhuongLN, YenTH, ThuanXT, HungVP
- Set up ZigBee network	- Research in Digi development document - Configure ZigBee network appropriately	PhuongLN, YenTH
- Testing, fix bug and report	- Connect end devices with ZigBee network - Test if all devices work correctly	PhuongLN, YenTH, ThuanXT, HungVP
- Document	- Make team's report: SRS, SDD	YenTH, PhuongLN, ThuanXT, HungVP

Table 7: Phase 2 - Design and develop the system

### 3.3 Phase 3: Develop server and web application

Task	Description	Author
- Identify requirement and planning	- Which feature/services the web server should provide	PhuongLN, YenTH, ThuanXT, HungVP
- Design database	- Design database to store users and their devices	PhuongLN
- Implement backend for the web	- Allow web server receive information and send commands to interact with ZigBee network	PhuongLN, ThuanXT
- Security	- Implement authentication and authorization - Provide method to secure the ZigBee network	PhuongLN
- Implement GUI for the web application	- Allow user to view, search, add, remove, edit information of devices	YenTH, HungVP
- Testing	- Test system behavior and performance	PhuongLN, YenTH, ThuanXT, HungVP
- Document	- Make team's report: SRS, SDD	PhuongLN, YenTH, ThuanXT, HungVP

Table 8: Phase 3 - Develop server and web application

### 3.4 Phase 4: Develop android application

Task	Description	Author
- Identify requirement and planning	- Which feature the application should provide	PhuongLN, YenTH, ThuanXT, HungVP
- Implement communication package	- Implement how application communicate with server	PhuongLN
- Implementation GUI and Interaction	- Implement application on Android platform that can communicate with web server to control the system	YenTH, ThuanXT, HungVP
- Testing	- Test system behavior and performance	PhuongLN, YenTH, ThuanXT, HungVP
- Document	- Update SRS, SDD; add Installation Guide, Manual Guide	PhuongLN, YenTH, ThuanXT, HungVP

Table 9: Phase 4 - Develop android application

### 3.5 Phase 5: Integration and system test for behaviors in system

Task	Description	Author
- Identify requirement and planning	- Which feature the system should have and how to test them	PhuongLN, YenTH, ThuanXT, HungVP
- Create test case	- Create test cases to cover	YenTH, PhuongLN
- Execute test case	- Execute all test cases in the system	YenTH, HungVP, ThuanXT, PhuongLN

- Check the result and fix bug	- Collect test result - If any bug occurred, fixed them	PhuongLN, YenTH, ThuanXT, HungVP
- Document	- Add test plan and test result	YenTH, PhuongLN, ThuanXT, HungVP

Table 10: Phase 5 - Integration and system test for behaviors in system

### 3.6 Phase 6: Improve the quality of product and performance of system.

Task	Description	Author
- Identify requirement and planning	- Which feature the system can be improved	PhuongLN, YenTH, ThuanXT, HungVP
- Test performance	- Check the performance of system	ThuanXT, HungVP
- Risk tolerate	- Check the behavior of system when risk occurred	YenTH, HungVP
- Optimize	- Find the method to optimize the system	PhuongLN, ThuanXT
- Testing	- Test the system after optimized	YenTH, HungVP
- Document	- Update SDD	PhuongLN, YenTH, ThuanXT, HungVP

Table 11: Improve the quality of product and performance of the system

## IV. Coding Convention

Follow coding conventions from these documents:

- Microsoft Recommendation for C# (Microsoft MSDN, n.d.).
- PEP8 for python
- GNU coding standard for C

## C. Requirements Specifications

### I. User Requirement Specification

The ZFRM system should be a system which uses an appropriate wireless technology to achieve:

#### 1. Ability to control entire system remotely

- Users can add, remove and manage all their devices everywhere (inside, outside of the place where end devices are set up).
- Users can send commands to their devices to perform some specific tasks.
- Users can update status of each device in the whole system.

#### 2. Low energy consumption

- All devices in the system have to have a long battery-life (2 – 3 years).
- The energy for operating the system should be low as much as possible.

#### 3. High security

- Users have to be authenticated before using the system.
- A user can only manipulate their own devices (not others' devices).
- Data and packet commands that exchanged by wireless connection should be protected in case of the stranger or hacker attack the system.

#### 4. Interoperability

- New end devices can be added to the system and interact with other ones regardless of manufacturing origin.

## II. Hardware Requirements

### 1. Microcontroller

- Power input: 3V to 5V DC
- Operating speed: DC – 4MHz to 20 MHz clock input
- Memory: 8K x 14 words of Flash Program Memory, 368 x 8 bytes of Data Memory (RAM), 256 x 8 bytes of EEPROM Data Memory
- Timer0: 8-bit timer/counter with 8-bit prescaler
- Timer1: 16-bit timer/counter with prescaler, can be incremented during Sleep via external crystal/clock
- Universal Synchronous Asynchronous Receiver Transmitter USART with 9-bit address detection
- 10-bit, 2-channel Analog-to-Digital Converter (A/D)
- In-Circuit Serial Programming™ (ICSP™)
- Single-supply 5V In-Circuit Serial Programming

## 2. ZigBee

### 2.1 Coordinator: Digi Connect Port X2

- Power input: 5V to 12V DC
- Management: HTTP/HTTPS web interface, Password access control, IP service port control, Optional secure enterprise management via Device Cloud
- Protocols: TCP/UDP, HTTP
- Memory (User-available memory varies by firmware and OS version): 8 MB RAM, 4 MB Flash
- Ports: 1 RJ-45 port
- Physical Layer: 10/100Base-T
- Data Rate: 10/100 Mbps (auto-sensing)
- Mode Full or half duplex (auto-sensing)
- Ethernet Isolation: 1500VAC min per IEEE802.3/ANSI X3.263

### 2.2 Xbee Module

- Power input: 3V to 5V DC
- Indoor/Urban Range: up to 133 ft. (40 m)
- Outdoor RF line-of-sight Range: up to 400 ft. (120 m)
- RF Data Rate: 250,000 bps
- Data Throughput: up to 35000 bps
- Serial Interface Data Rate: 1200 bps - 1 Mbps
- Operating Current: 35 mA – 40 mA
- Idle Current: < 15mA
- Power-down Current: < 1uA
- Operating Frequency Band: ISM 2.4 GHz
- I/O Interface: 3.3V CMOS UART
- Supported Network Topologies: Point-to-point, Point-to-multipoint, Peer-to-peer, and Mesh
- Channels: 11 to 26
- Addressing Options: PAN ID and Addresses, Cluster IDs and Endpoints

## 3. Temperature Sensor

- Power input: 3V to 5V DC
- Calibrated directly in ° Celsius (Centigrade)
- Temperature range: -55 to +150°C
- 0.5°C accuracy guaranteed
- Suitable for remote applications

#### 4. Relay

- Nominal Voltage : 5V DC
- Nominal Power Consumption : 360 mW
- Contact Arrangement : 1 form C
- Contact Rating : 10A 250V AC/30V DC or 10A 125V AC/28V DC

### III. Functional Requirements

#### 1. System features overview

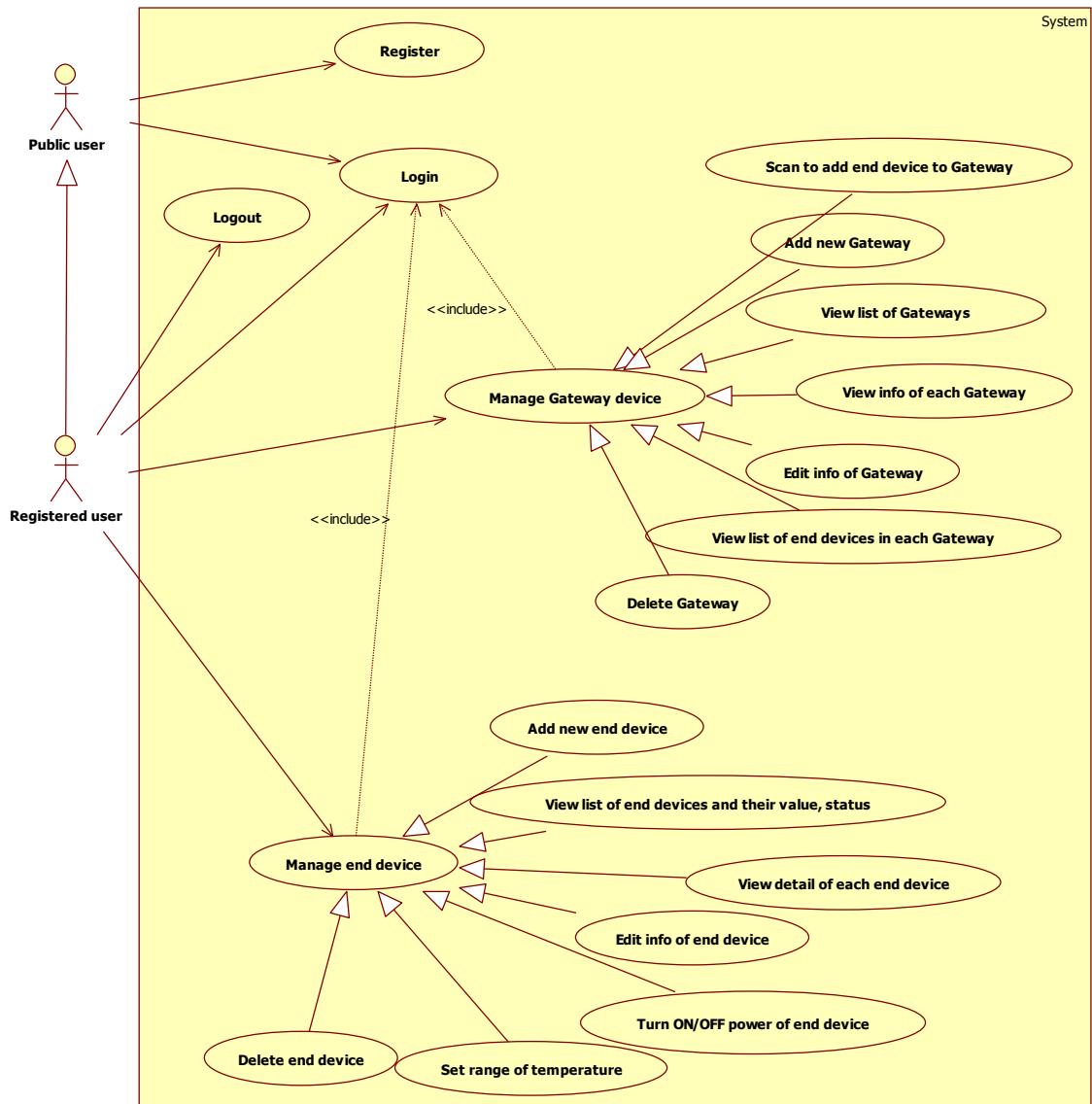


Figure 7: System features overview for web application

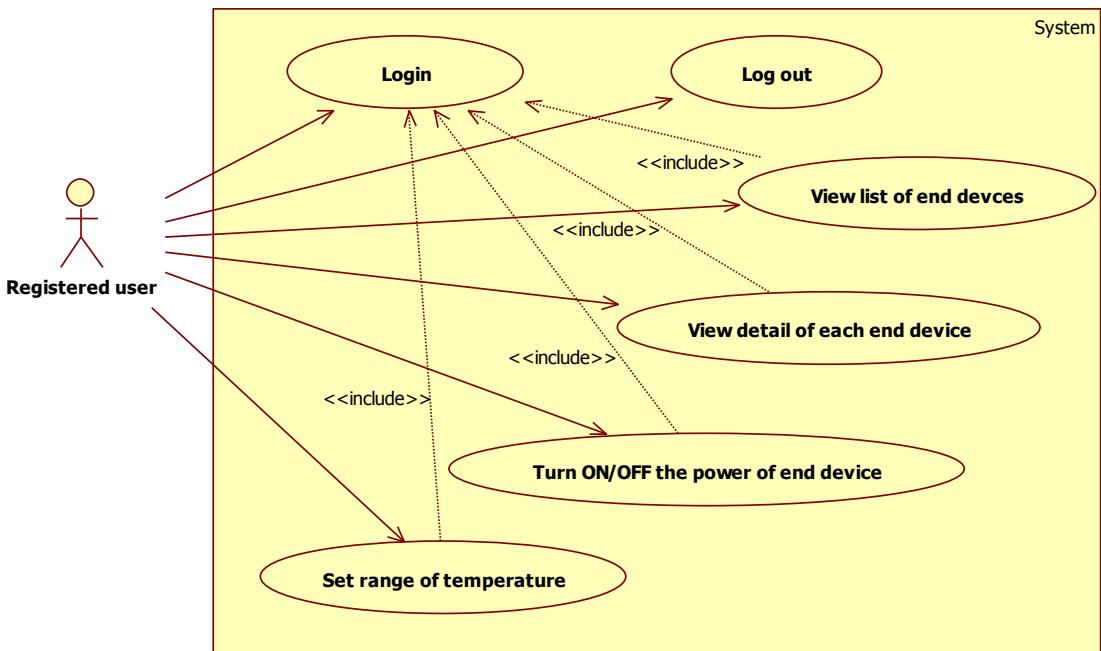


Figure 8: System features overview for mobile application

## 2. Public User

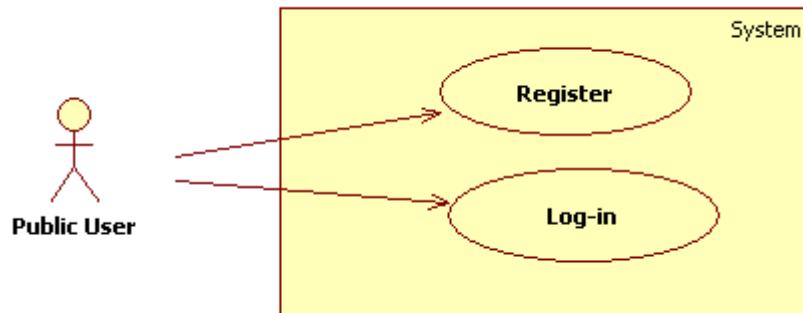


Figure 9: Public user features

### 2.1 Register

#### 2.1.a Use case specification

USE CASE - Register SPECIFICATION			
Use-case No.	UC001	Use-case Version	1.0
Use-case Name	Register		
Author	Trương Hoàng Yến		
Date	May-29-2013	Priority	Normal

**Actor:**

Public User

**Summary:**

A visitor wants to be “User” of the system. He/she must register with some information: email, password.

**Goal:**

End user becomes “User” of the system

**Triggers:**

End user clicks the button “Get Started today” in home page or clicks the “Sign up” link in sign in page.

**Preconditions:**

Home page is displayed with the button for register without any errors.

**Post Conditions:**

End user becomes “User” of system. He/she can use all functions of “User” role.

**Main Success Scenario:**

Step	Actor Action	System Response
1	User visits Register page	Shows all fields in form: email, password, retype password
2	Fills mandatory fields and click “Register” button	Does validation, checks conflict and saves data into database.  Sends email to user email to confirm the registration.  Navigates backs to login page

**Alternative Scenario:**

Step	Actor Action	System Response
1	On home page, click “Sign in” button	Link to “Sign in” page

2	Clicks “Sign up” link in “Sign in” page to register new account	Shows all fields in form: email, password, retype password
3	Fills mandatory fields and click “Register” button	Does validation, checks conflict and saves data into database. Sends email to user email to confirm the registration. Navigates backs to login page

**Exceptions:**

Step	Actor Action	System Response
1	Same as Main Success Scenario.	
2	Does not fill all required field or enters invalid data	Input text is fulfilled and a red warning is shown.

**Relationships:**

Login Use case

**Business Rules:** N/A

**Description:**

User has to provide some information when registering an account:

Field Name	Data Type and Constraints	Required
Email	String  Valid email format (for example: efamily@fpt.edu.vn)	Yes
Password	String	Yes
Retype Password	String	Yes

Table 12: Specification of Use Case UC001 - Register

## 2.1.b Screen

## Create a new account.

- Please enter valid email address
- The password and confirmation password do not match.

Email	<input type="text" value="yenth"/>
	<small>Please enter valid email address</small>
Password	<input type="password" value="*****"/>
Confirm password	<input type="password"/>
	<small>The password and confirmation password do not match.</small>
<input type="button" value="Sign up"/>	

Figure 10: Register screen

## 2.2 Login

## 2.2.a Use case specification

USE CASE - Login SPECIFICATION			
Use-case No.	UC002	Use-case Version	1.0
Use-case Name	Login		
Author	Trương Hoàng Yến		
Date	May-29-2013	Priority	Normal
<b>Actor:</b>			
Public User			
<b>Summary:</b>			
A user want to manage and control his/her devices must log into the system			
<b>Goal:</b>			
Users can use other functions in the system after they log in.			
<b>Triggers:</b>			
End user accesses the main page and clicks the "Sign in" button.			

**Preconditions:**

User must have an account in the system.

**Post Conditions:**

After logged in, user moves to main page with the information that he/she has logged in successfully (his/her username is showed on the website).

**Main Success Scenario:**

Step	Actor Action	System Response
1	Accesses ZFRM Home page	Shows the interface of home page
2	Fills “Username” and “Password” fields and clicks [Sign in] button in the home page	<p>Check valid of data from user and password field.</p> <p>Checks the username and password of user in database.</p> <p>1. If data is matched, logs user to the system.</p> <ul style="list-style-type: none"> <li>- Navigates to main page with username is showed.</li> <li>- User can use the function in system after logged in.</li> </ul> <p>2. If data isn’t matched, return to the “Sign in” page.</p>

**Alternative Scenario:**

Step	Actor Action	System Response
1	Same as Main Success Scenario.	
2	Clicks “Register” link	Shows the Register page

**Exceptions:**

Step	Actor Action	System Response
1	Same as Main Success Scenario.	

2	Enters invalid (not registered username, wrong password) data and clicks “Login”	Shows “Username or password is invalid” message.
<b>Relationships:</b>		
Register Use case		
<b>Business Rules:</b>		
Guest who wants to use the function in ZFRM system must login the system.		
<b>Description:</b>		
The user must registered an account before, and has to enter correct (match with password stored in the system) in order to log into the system.		
When user logged into the system successfully, he/she can use other functions in ZFRM system		

Table 13: Specification of Use Case UC002 – Login

## 2.2.b Screen

- The user name or password provided is incorrect.

## Green Bee

The Email field is required.

The Password field is required.

Remember me

Sign in

[Click here](#) if you forgot the password.

Figure 11: Login Screen

### 3. Registered Users

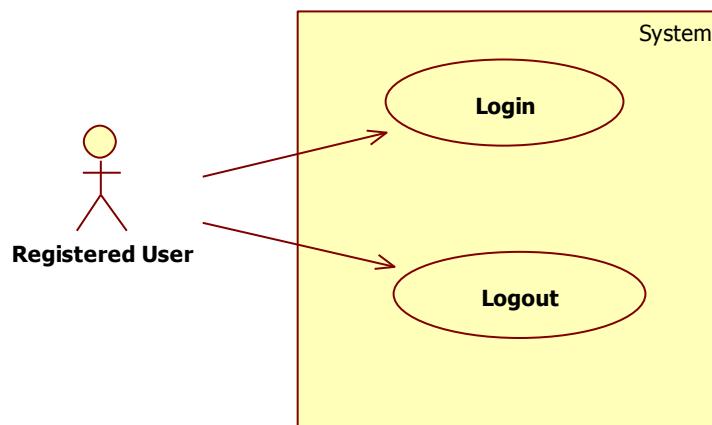


Figure 12: Registered User Login - Logout

#### 3.1 Log in

##### 3.1.a Use case specification

Same as table in section 2.1.a

##### 3.1.b Screen

Same as screen in section 2.1.a

#### 3.2 Log out

User logs out of the system and become Public user.

### 3.3 Manage Gateway Device- Add new gateway

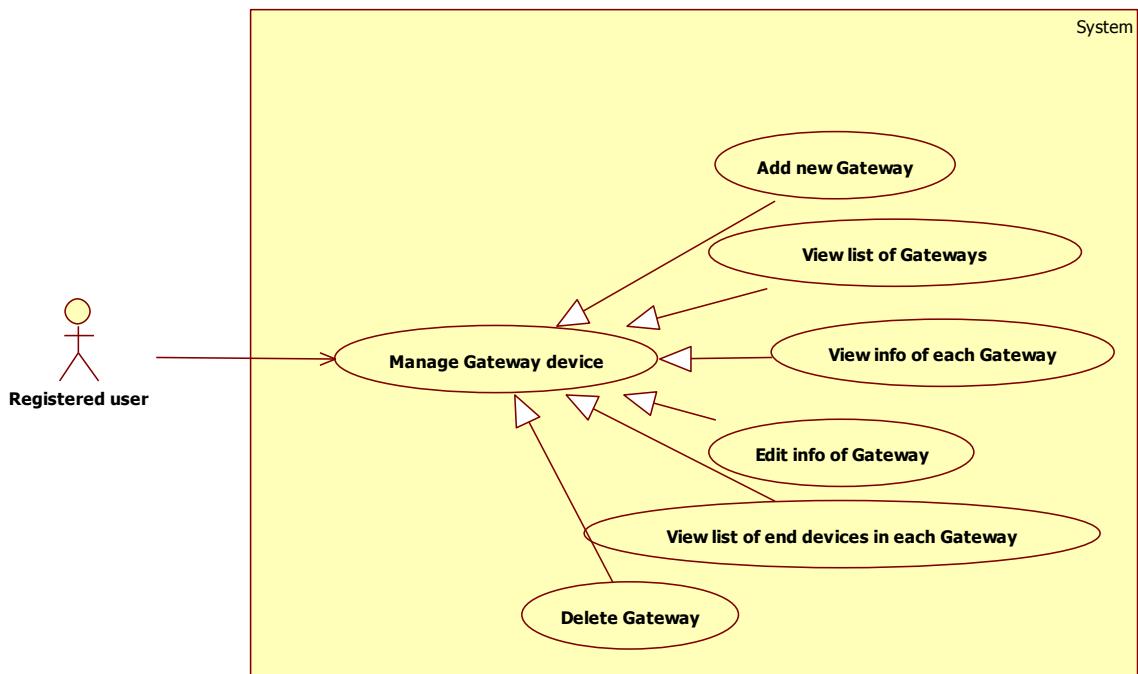


Figure 13: Logged User feature - manage devices

#### 3.3.a Use case specification

USE CASE - Add a new gateway SPECIFICATION			
Use-case No.	UC003	Use-case Version	1.0
Use-case Name	Add a new gateway to ZFRM system		
Author	Lê Nam Phương		
Date	May-29-2013	Priority	Normal
<b>Actor:</b>			
Logged User			
<b>Summary:</b>			
User can add new gateway which can control end devices to ZFRM system			
<b>Goal:</b>			
Users can use the function to add new gateway to ZFRM system successfully.			
<b>Triggers:</b>			

User logs into the system and clicks “Add Gateway” button.

**Preconditions:**

User must have an account and logged into the system.

Gateway added to the system should connect to the Internet.

**Post Conditions:**

After adding new gateway, the information of new gateway will be displayed on user screen.

**Main Success Scenario:**

Step	Actor Action	System Response
1	Click [Add Gateway] button on the Gateway index page	Shows the page of Add Gateway.
2	User fills the right information of fields: - MAC address - Gateway Name - Location - Description  And click “Create” button	Valid the data of MAC address field. Make sure no gateway has the same MAC address in database  Add new gateway to server's database and redirect to page [List Gateway].

**Alternative Scenario:**

Step	Actor Action	System Response
1	Same as Main Success Scenario.	
2	Same as Main Success Scenario.	

**Exceptions:**

Step	Actor Action	System Response
1	Same as Main Success Scenario.	
2	If MAC address is duplicate with an old one in database	Display message “Duplicated MAC address, please check your gateway's MAC address again.”

2	If user's gateway currently doesn't connect to the Internet	Display message "Gateway has been added but still offline."
2	If there is a problem with server's database which interrupts the operation	Display message "Cannot add your new gateway. Please try again"

**Relationships:** Manage gateway use case

**Business Rules:**

Users who want to add new gateway to ZFRM system must log into the system.

**Description:**

When user logged into the system successfully, he/she can use add new gateway to ZFRM system. The user need to provide some information to create new gateway

Field Name	Data Type and Constraints	Required
MAC Address	String (no Unicode)  Valid MAC address format (for example: 00:AA:BB:CC:DD:EE)	Yes
Gateway Name	String	Yes
Location	String	No
Description	String	No

After adding gateway, the information of new gateway will be displayed on the List Gateway screen of user.

Table 14: Specification of Use Case UC003 - Add a new gateway

## 3.3.b Screen

## Add Gateway

MAC Address	<input type="text"/>
Gateway Name	<input type="text"/>
Location	<input type="text"/>
Description	<input type="text"/>
<input type="button" value="Create"/> <input type="button" value="Cancel"/>	

Figure 14: Add a new gateway screen

## 3.4 Manage Gateway Device - Delete a gateway

## 3.4.a Use case specification

USE CASE - Remove a gateway SPECIFICATION			
Use-case No.	UC004	Use-case Version	1.0
Use-case Name	Delete a gateway from ZFRM system		
Author	Lê Nam Phương		
Date	May-29-2013	Priority	Normal
<b>Actor:</b>			
Logged User			
<b>Summary:</b>			
User can remove a gateway from ZFRM system.			
<b>Goal:</b>			
Users can use this function to remove a gateway from ZFRM system successfully.			
<b>Triggers:</b>			
User logs into the system, opens page [List Gateway] and clicks “Delete” button of gateway user wants to remove.			

**Preconditions:**

User must have an account and logged into system.

At least there is one gateway of that user has been added to system.

**Post Conditions:**

After delete gateway action, this gateway is removed from ZFRM system.

The name and information of removed gateway will be removed on user screen.

**Main Success Scenario:**

Step	Actor Action	System Response
1	Click [Delete] button on which gateway needs to be deleted.	A confirm page is displayed and inform the user that he/she will continue delete or not with [Delete] and [Cancel] button.
2	Click [Delete] button on confirm page	The gateway is removed from ZFRM system  The name and information of gateway will be removed from server's database

**Alternative Scenario:**

Step	Actor Action	System Response
1	Same as Main Success Scenario.	
2	Same as Main Success Scenario.	
3	Click [Cancel] button	Return to the main screen. The status and information of device is the same as before.

**Exceptions:**

Step	Actor Action	System Response
1	Same as Main Success Scenario.	

2	There is a problem with server's database that interrupts the operation.	Display message inform to user "Error! Failed to remove gateway. Please try again!"
---	--	---

**Relationships:** Manage gateway use case

**Business Rules:**

User who wants to remove gateway in ZFRM system must logged into the system.

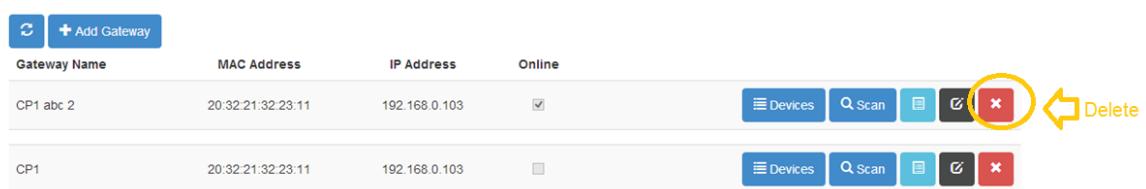
**Description:**

When user logged into the system successfully and navigated to [List Gateway] page, he/she can remove gateway in ZFRM system. After removing action, this gateway will be removed from ZFRM system. The information of removed device will be deleted from List Gateway screen and also in database.

Table 15: Specification of Use Case UC004 - Delete a gateway

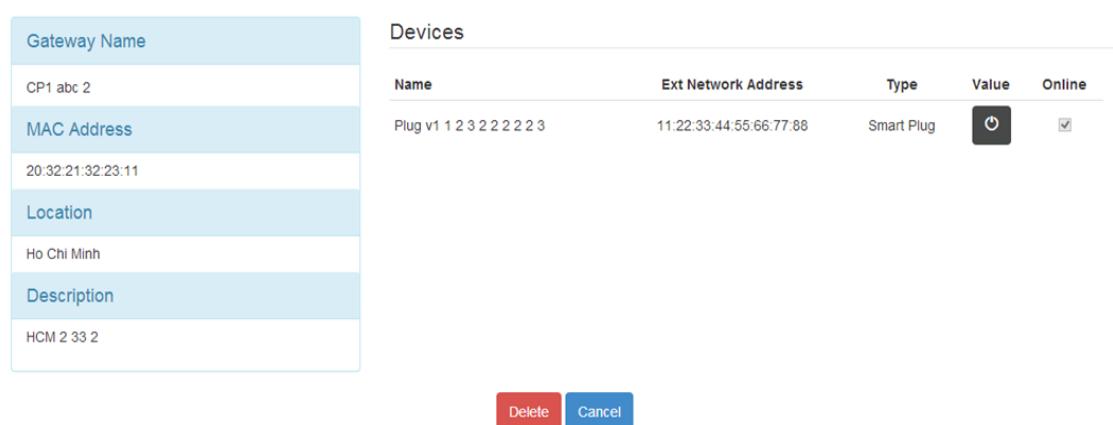
### 3.4.b Screen

#### Gateways



Gateway Name	MAC Address	IP Address	Online	Devices	Scan	Filter	Delete
CP1 abc 2	20:32:21:32:23:11	192.168.0.103	<input checked="" type="checkbox"/>				
CP1	20:32:21:32:23:11	192.168.0.103	<input type="checkbox"/>				

#### Delete Gateway



Gateway Name
CP1 abc 2

MAC Address
20:32:21:32:23:11

Location
Ho Chi Minh

Description
HCM 2 33 2

Devices				
Name	Ext Network Address	Type	Value	Online
Plug v1 1 2 3 2 2 2 2 2 3	11:22:33:44:55:66:77:88	Smart Plug	<input checked="" type="checkbox"/>	

**Delete** **Cancel**

Figure 15: Delete a gateway screen

### 3.5 Manage Gateway Device - View info of each gateway

#### 3.5.a Use case specification

USE CASE - View info of each gateway SPECIFICATION			
Use-case No.	UC005	Use-case Version	1.0
Use-case Name	View a gateway's information		
Author	Trương Hoàng Yến		
Date	May-29-2013	Priority	Normal
<b>Actor:</b>			
Logged User			
<b>Summary:</b>			
User can see the full information of each gateway added to ZFRM system.			
<b>Goal:</b>			
Users can use the function to manage the information and status of each gateway in ZFRM system.			
<b>Triggers:</b>			
User logs into the system, opens page [List Gateway] and clicks “Detail” button of gateway user wants to view.			
<b>Preconditions:</b>			
User must have an account and logged into the system.			
At least one gateway of that user has been added to the system.			
<b>Post Conditions:</b> N/A			
<b>Main Success Scenario:</b>			
Step	Actor Action	System Response	
1	In the Gateway page, user clicks the button [Detail] of one gateway.	1. The information of a gateway is displayed on the main screen with fully information of selected gateway on the left side: + Gateway Name	

		<ul style="list-style-type: none"> <li>+ MAC address</li> <li>+ Location</li> <li>+ Description</li> <li>+ Status: Online/ Offline</li> </ul> <p>2. The information of end devices that gateway controls is displayed on the right side with fully information of end devices:</p> <ul style="list-style-type: none"> <li>+ Name</li> <li>+ Ext Network Address</li> <li>+ Type</li> <li>+ Value: turn ON/OFF of Smart Plug, temperature from sensor.</li> <li>+ Status: Online/Offline</li> </ul>
<b>Alternative Scenario:</b>		
Step	Actor Action	System Response
1	Same as Main Success Scenario.	
<b>Exceptions:</b> N/A		
<b>Relationships:</b> Manage gateway use case		
<b>Business Rules:</b>		
User who wants to see the information of a gateway in ZFRM system must log into the system.		
<b>Description:</b>		
When user logged into the system successfully, he/she can open Details page of each gateway to see its information or end devices. The information of each gateway will be gotten from server's database then displayed to user.		

Table 16: Specification of Use Case UC005 - View info of each gateway

### 3.5.b Screen

#### Gateway Details

Gateway Name	
Home's gateway	

MAC Address	
00:40:9D:57:A4:E9	

Location	
Furtwangen	

Description	
Germany	

Offline	
---------	--

Devices [Q](#)

Name	Ext Network Address	Type	Value	Online
Plug v2	00:13:a2:00:40:61:bd:20	Smart Plug		<input type="checkbox"/>
Plug v1	00:13:a2:00:40:aa:17:40	Smart Plug		<input type="checkbox"/>
Sensor router	00:13:a2:00:40:61:bd:67	Temperature Sensor	30 °C	<input type="checkbox"/>

[Edit](#) | [Back to List](#)

Figure 16: View a gateway's information screen

### 3.6 Manage Gateway Device - View list of gateway

#### 3.6.a Use case specification

USE CASE - View list of gateways SPECIFICATION			
Use-case No.	UC006	Use-case Version	1.0
Use-case Name	View list of gateways		
Author	Xinh Thanh Thuận		
Date	May-29-2013	Priority	Normal
<b>Actor:</b>			
Logged User			
<b>Summary:</b>			
Display list of gateways currently stored in ZFRM system and controlled by user.			
<b>Goal:</b>			
Users can see and manage all the gateways owned by them.			
<b>Triggers:</b>			
In the home page, click the [Gateway] tab on navigation menu.			
<b>Preconditions:</b>			

User must have an account and logged into the system.

At least one gateway of that user has been added to the system

**Post Conditions:**

None

**Main Success Scenario:**

Step	Actor Action	System Response
1	On the home page, click “Gateway” tab on navigation menu.	<ol style="list-style-type: none"> <li>1. Redirect to the [List Gateway] page</li> <li>2. Display the list of Gateway devices with detail information in each row of device:           <ul style="list-style-type: none"> <li>- Gateway Name</li> <li>- MAC Adress</li> <li>- Location</li> <li>- Online status</li> </ul> </li> <li>3. The icon of “Devices”, “Scan”, “Detail”, “Edit”, “Delete” are displayed successfully in each row</li> </ol>

**Alternative Scenario:** N/A

**Exceptions:**

Step	Actor Action	System Response
3	Click the [Gateway] tab on menu	If there is no device has been added before, display message “There is no gateway has been added yet”

**Relationships:** Manage gateway use case

**Business Rules:**

User who wants to see the list of gateways in ZFRM system must login the system.

**Description:** View all devices of a user

Table 17: Specification of Use Case UC006 - View List of Devices

### 3.6.b Screen

#### Gateways

 + Add Gateway	Gateway Name	MAC Address	Location	Online	 Devices	 Scan		
	Home's gateway	00:40:9D:57:A4:E9	Furtwangen	<input type="checkbox"/>				

Figure 17: View list of gateways screen

### 3.7 Manage Gateway Device – Scan and add new end device to Gateway

#### 3.7.a Use case specification

USE CASE - Scan and add new end device to a gateway SPECIFICATION						
Use-case No.	UC007	Use-case Version	1.0			
Use-case Name	Scan and add new end devices to a gateway					
Author	Xinh Thanh Thuận					
Date	May-29-2013	Priority	Normal			
<b>Actor:</b>						
Logged User						
<b>Summary:</b>						
Check for new end devices in zigbee system and add new devices to gateway in server.						
<b>Goal:</b>						
Users can add end devices to a specific gateway.						
<b>Triggers:</b>						
In the gateway page, on a gateway device row, click the [Scan] button.						
<b>Preconditions:</b>						
User must have an account and logged into the system.						
At least one gateway of that user has been added to the system.						

**Post Conditions:** New end devices added to selected gateway in the system.

**Main Success Scenario:**

Step	Actor Action	System Response
1	On Gateway page, click [Scan] button on which gateway that user wants to add new end devices to it.	<p>1. Link to Request Devices page. Display the list of request devices with detail information in each row of device:</p> <ul style="list-style-type: none"> <li>- Name: user can fill in this field</li> <li>- Ext Network Address</li> <li>- Type</li> </ul> <p>2. The button [Accept] is displayed successfully in each row of end device.</p>
2	User fill in the “name” field and click [Accept] button on which device that want to add	<p>New end device is added to Gateway.</p> <p>The button [Accept] changes to [Accepted] button.</p>
3	User click “Back to list” link. On the Gateway Page, when user click [Device] button on Gateway row	The new end device displayed with its information successfully.

**Alternative Scenario:** N/A

**Exceptions:**

Step	Actor Action	System Response
1	Same as Main Success Scenario.	
2	If there is a problem with server's database which interrupts the operation	The row of selected device turns into red

<b>Relationships:</b> Manage gateway use case
<b>Business Rules:</b> N/A
<b>Description:</b> User can use this function for automatically scan for new end device.

Table 18: Specification of Use Case UC007 – Scan and add new end devices to a gateway

### 3.7.b Screen

#### Requesting Devices

Name	Ext Network Address	Type
Nhiet do	00:13:a2:00:40:61:bd:67	Temperature Sensor
Den cau thang	00:13:a2:00:40:61:bd:20	Smart Plug
Den nha bep	00:13:a2:00:40:aa:17:40	Smart Plug

Accept

Back to List

Figure 18: Scan and add new end devices to a gateway

### 3.8 Manage Gateway Device - View list of end devices in each Gateway

#### 3.8.a Use case specification

USE CASE - View list of end devices in each Gateway SPECIFICATION			
Use-case No.	UC008	Use-case Version	1.0
Use-case Name	View List of end devices in each Gateway		
Author	Xinh Thanh Thuận		
Date	May-29-2013	Priority	Normal
<b>Actor:</b>			
Logged User			
<b>Summary:</b>			
Display list of end devices in each Gateway.			
<b>Goal:</b>			
Users can manage all the information and status of end devices in each Gateway.			

**Triggers:**

In the Gateway page, on one Gateway device row, click the [Devices] button.

**Preconditions:**

User must have an account and logged into the system.

At least one gateway of that user has been added to the system.

**Post Conditions:** N/A

**Main Success Scenario:**

Step	Actor Action	System Response
1	On Gateway page, click [Devices] button on which Gateway that want to see the detail information of end devices in it.	<p>1. Display the list of end devices with detail information in each row of device:</p> <ul style="list-style-type: none"> <li>- Name</li> <li>- Ext Network Address</li> <li>- Type</li> <li>- Value</li> <li>- Status: Online/Offline</li> </ul> <p>2. The icon of “Detail”, “Edit”, “Delete” are displayed successfully in each row of end device.</p>

**Alternative Scenario:**

Step	Actor Action	System Response
1	In the Gateway page, user clicks the button [Detail] of one Gateway.	<p>The information of end device that Gateway controlled is displayed on the right side with fully information of end devices:</p> <ul style="list-style-type: none"> <li>- Name</li> <li>- Ext Network Address</li> <li>- Type</li> <li>- Value: turn ON/OFF of Smart Plug, temperature from sensor.</li> <li>- Status: Online/Offline</li> </ul>

<b>Exceptions:</b>		
Step	Actor Action	System Response
<b>Relationships:</b> Manage gateway use case		
<b>Business Rules:</b> N/A		
<b>Description:</b> View all end devices in a Gateway of a user.		

Table 19: Specification of Use Case UC008 - View List of end devices in each Gateway

### 3.8.b Screen

#### Gateways

Gateways		Devices			
Gateway Name	MAC Address	IP Address	Online	Devices	Scan
CP1 abc 2	20:32:21:32:23:11	192.168.0.103	<input checked="" type="checkbox"/>		
Name	Ext Network Address	Type	Value	Online	
Plug v1 1 2 3 2 2 2 2 2 3	11:22:33:44:55:66:77:88	Smart Plug		<input checked="" type="checkbox"/>	  

Figure 19: View List of end devices in each Gateway

### 3.9 Manage Gateway Device - Edit info of a gateway

#### 3.9.a Use case specification

USE CASE - Edit info of a gateway PECIFICATION			
Use-case No.	UC009	Use-case Version	1.0
Use-case Name	Edit info of Gateway device		
Author	Truong Hoang Yen		
Date	May-29-2013	Priority	Normal
<b>Actor:</b>			
Logged User			
<b>Summary:</b>			
Edit information of Gateway in ZFRM system.			

**Goal:**

Users can edit information of selected gateway.

**Triggers:**

In the Gateway page, on one Gateway device row, click the [Edit] button.

**Preconditions:**

User must have an account and logged into the system.

At least one gateway of that user has been added to the system.

**Post Conditions:** N/A

**Main Success Scenario:**

Step	Actor Action	System Response
1	On Gateway page, click [Edit] button on which Gateway that want to edit information.	<p>1. Display the old information of end devices with detail information in each row of device:</p> <ul style="list-style-type: none"> <li>- Gateway Name</li> <li>- Location</li> <li>- Description</li> </ul> <p>2. There are 2 buttons [Save] and [Cancel] for user to choose their option.</p>
2	User edits information in field to change the information of Gateway.	<p>1. If user click [Save] button on screen.</p> <p>Update new information of Gateway to database.</p> <p>In the Gateway list, the new information of Gateway also updated.</p> <p>2. If user click [Cancel] button, not update data.</p> <p>Turn back to previous screen.</p>

<b>Alternative Scenario:</b> N/A		
<b>Exceptions:</b>		
<b>Step</b>	<b>Actor Action</b>	<b>System Response</b>
1	Same as Main Success Scenario.	
2	If there is a problem with server's database which interrupts the operation	Display message "Cannot edit your gateway. Please try again"
<b>Relationships:</b> Manage gateway use case		
<b>Business Rules:</b> N/A		
<b>Description:</b> Edit information of a Gateway and update new data to the whole system.		

Table 20: Specification of Use Case UC009 – Edit info of Gateway device

3.9.b Screen

## Edit Gateway

<b>Gateway Name</b>	CP1 abc 2
<b>Location</b>	Ho Chi Minh
<b>Description</b>	HCM 2 33 2
	<b>Save</b> <b>Cancel</b>

Figure 20: Edit info of Gateway device

### 3.10 Manage End Device- Add new end device

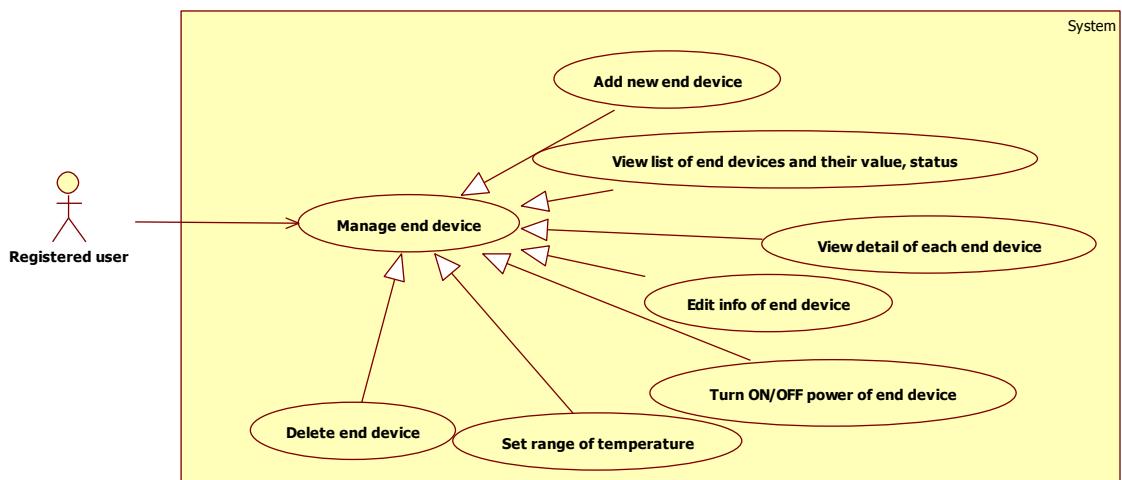


Figure 21: Logged User feature - manage end devices

#### 3.10.a Use case specification

USE CASE - Add new end device SPECIFICATION			
Use-case No.	UC010	Use-case Version	1.0
Use-case Name	Add a new end device to ZFRM system		
Author	Lê Nam Phương		
Date	May-29-2013	Priority	Normal
<b>Actor:</b>			
Logged User			
<b>Summary:</b>			
User can add new end device to ZFRM system.			
<b>Goal:</b>			
Users can use the function to add new end device to ZFRM system successfully.			
<b>Triggers:</b>			
After user logged to the system and on Device page, click “Add Device” button.			
<b>Preconditions:</b>			
User must have an account and logged into the system.			

At least one gateway of that user has been added to the system.

End device connected to system.

**Post Conditions:**

After add new end device, the information of new end device will add to system and display on user screen.

**Main Success Scenario:**

Step	Actor Action	System Response
1	Click [Add device] button on the Home page	Link to “Select Gateway” page.
2	User selects which Gateway that will add the new device and then click [Select] button.	Link to “Request Devices” page. Scenario is the same as in use case UC007.  After added new end devices successfully, the information of new end device will be displayed on “Devices” page

**Alternative Scenario:**

Step	Actor Action	System Response
1	On Gateway page, click [Scan] button on which Gateway that want to add end devices to it.	1. Link to “Request Devices” page.  Scenario is the same as in use case UC007.  After added new end devices successfully, the information of new end device will be displayed on “Devices” page

**Exceptions:**

Step	Actor Action	System Response
1	Same as Main Success Scenario.	

2	If there is a problem with server's database which interrupts the operation	The row of selected device turns into red
<b>Relationships:</b> Manage end device use case		
<b>Business Rules:</b>		
Users who want to add new device to ZFRM system must log into the system.		

Table 21: Specification of Use Case UC010 - Add a new end device

### 3.10.b Screen

#### Select Gateway

Gateway Name	MAC Address	Description	Location	
CP1 abc 2	20:32:21:32:23:11	HCM 2 33 2	Ho Chi Minh	
CP1 212	20:32:21:32:23:11	HCM as	Ho Chi Minh	
CP1 test abc	20:32:21:32:23:11	HCM s sa	Ho Chi Minh s	

#### Requesting Devices

C Re-Scan		
Name	Ext Network Address	Type
Nhiet do	00:13:a2:00:40:61:bd:67	Temperature Sensor
Den cau thang	00:13:a2:00:40:61:bd:20	Smart Plug
Den nha bep	00:13:a2:00:40:aa:17:40	Smart Plug

[Back to List](#)

Figure 22: Add a new device screen

### 3.11 Manage End Device- Delete an end device

#### 3.11.a Use case specification

USE CASE - Delete End Device SPECIFICATION

Use-case No.	UC011	Use-case Version	1.0						
Use-case Name	Delete an end device from ZFRM system								
Author	Lê Nam Phương								
Date	May-29-2013	Priority	Normal						
<b>Actor:</b>									
Logged User									
<b>Summary:</b>									
User can remove an end device from ZFRM system									
<b>Goal:</b>									
Users can use this function to remove an end device from ZFRM system successfully.									
<b>Triggers:</b>									
User logs into the system, opens page [List Device] and clicks “Delete” button of end device user wants..									
<b>Preconditions:</b>									
User must have an account and logged into the system.									
There has at least one end device has been added to the system.									
<b>Post Conditions:</b>									
After delete end device action, this end device is removed from ZFRM system.									
The name and information of removed end device will be removed on user screen.									
<b>Main Success Scenario:</b>									
<table border="1"> <thead> <tr> <th>Step</th><th>Actor Action</th><th>System Response</th></tr> </thead> <tbody> <tr> <td>1</td><td>Click [Delete] button on which device that want to delete</td><td>A confirm page is displayed and inform to the user continue delete or not with [Delete] and [Cancel] button</td></tr> <tr> <td>2</td><td>Click [Delete] or [Cancel] button on confirm dialogue</td><td>1. If user click [Delete] button, the end device is removed from</td></tr> </tbody> </table>	Step	Actor Action	System Response	1	Click [Delete] button on which device that want to delete	A confirm page is displayed and inform to the user continue delete or not with [Delete] and [Cancel] button	2	Click [Delete] or [Cancel] button on confirm dialogue	1. If user click [Delete] button, the end device is removed from
Step	Actor Action	System Response							
1	Click [Delete] button on which device that want to delete	A confirm page is displayed and inform to the user continue delete or not with [Delete] and [Cancel] button							
2	Click [Delete] or [Cancel] button on confirm dialogue	1. If user click [Delete] button, the end device is removed from							

		<p>ZFRM system</p> <p>The name and information of end device will be removed on user screen and in database of sever.</p> <p>2. If user Click [Cancel] button, return to the main screen. The status and information of device is the same as before.</p>
<b>Alternative Scenario:</b> N/A		
<b>Exceptions:</b>		
Step	Actor Action	System Response
1	Same as Main Success Scenario.	
2	There is a problem with server's database that interrupts the operation.	Display message inform to user "Error! Failed to remove device. Please try again!"
<b>Relationships:</b> Manage end device use case		
<b>Business Rules:</b>		
User who wants remove device in ZFRM system must login the system.		
<b>Description:</b>		
<p>The user has to login to the system.</p> <p>When user logs in the system successfully, link to Device page, he/she can remove end device in ZFRM system. After remove successfully, device will be removed from ZFRM system. The information of removed device will be deleted on main screen of user and also in database.</p>		

Table 22: Specification of Use Case UC011 - Delete an end device

## 3.11.b Screen

## Delete Device

Name
Plug v1
Ext Network Address
11:22:33:44:55:66.77:88
Type
Smart Plug
Gateway Name
CP1 abc 2
<input type="button" value="Delete"/> <input type="button" value="Cancel"/>

Figure 23: Delete an end device screen

3.12 *Manage End Device- View info of each end device*

## 3.12.a Use case specification

USE CASE - View info of each end device SPECIFICATION			
Use-case No.	UC012	Use-case Version	1.0
Use-case Name	View info of each end device		
Author	Trương Hoàng Yến		
Date	May-29-2013	Priority	Normal
<b>Actor:</b>			
Logged User			
<b>Summary:</b>			
User can see the full information of each end device that added in ZFRM system.			
<b>Goal:</b>			
Users can use the function to manage the information and status of each end device in ZFRM system.			
<b>Triggers:</b>			

After user logged into the system.

**Preconditions:**

User must have an account and login to system.

There has at least one end device added to system and have XBEE module connected.(If there are no end device in current system, the ZFRM will display the message “No device has been added”)

**Post Conditions:** N/A

**Main Success Scenario:**

Step	Actor Action	System Response
1	In the Device page, user clicks the button [Detail] of one end device.	<p>1. The information of device is displayed on the main screen with fully information of end device on the left side:</p> <ul style="list-style-type: none"> <li>+ Name</li> <li>+ Ext Network Address</li> <li>+ Type</li> <li>+ Value</li> <li>+ Plug/Temperature Notification</li> <li>+ Status: Online/ Offline</li> </ul> <p>2. The information of gateway controls this end device is displayed on the right side:</p> <ul style="list-style-type: none"> <li>+ Gateway name</li> <li>+ MAC Address</li> <li>+ Location</li> <li>+ Description.</li> <li>+ Status: Online/Offline</li> </ul>

**Alternative Scenario:**

Step	Actor Action	System Response
1	Same as Main Success Scenario.	

**Exceptions:** N/A

**Relationships:** N/A

**Business Rules:**

User who wants to see the information of end device in ZFRM system must log into the system.

**Description:**

When user logged into to system successfully, he/she can view all information of end devices in ZFRM system and manage base on those information. The information of each end device will get from server then displayed to user.

**Table 23: Specification of Use Case UC012 - View a device's status**

### 3.12.b Screen

#### Device Details

Device	Gateway
Name	Gateway Name
Plug v1 1 2 3 2 2 2 2 2 3	CP1 abc 2
Ext Network Address	MAC Address
11:22:33:44:55:66:77:88	20:32:21:32:23:11
Type	Location
Smart Plug	Ho Chi Minh
Description	Description
nói gì vậy ta 1 2 3 4 5 6 4	HCM 2 33 2
Gateway Name	IP Address
CP1 abc 2	192.168.0.103
Value	Port
OFF	80
Online	Online

**Figure 24: View a Gateway device's information screen**

### 3.13 Manage End Device- View list of end devices

#### 3.13.a Use case specification

USE CASE - View list of end devices SPECIFICATION

Use-case No.	UC013	Use-case Version	1.0
Use-case Name	View List of end devices		
Author	Xinh Thanh Thuận		
Date	May-29-2013	Priority	Normal
<b>Actor:</b>			
Logged User			
<b>Summary:</b>			
Display list of end devices in ZFRM system controlled by current user.			
<b>Goal:</b>			
Users can manage all the end devices owned by them.			
<b>Triggers:</b>			
In the home page, click the [Device] tab on navigation menu.			
<b>Preconditions:</b>			
Login to the system.			
<b>Post Conditions:</b>			
None			
<b>Main Success Scenario:</b>			
Step	Actor Action	System Response	
1	On the home page, click [Device] tab on navigation menu.	1. Redirect to the [Device] page 2. Display the list of end devices with detail information in each row of device: - Name - Ext Network Address - Type - Value - Status: Online/Offline	

		3. The icon of “Detail”, “Edit”, “Delete” are displayed successfully in each row.						
<b>Alternative Scenario: N/A</b>								
<b>Exceptions:</b>								
<table border="1"> <thead> <tr> <th>Step</th><th>Actor Action</th><th>System Response</th></tr> </thead> <tbody> <tr> <td>1</td><td>Click the [Device] tab on menu.</td><td>If there is no device added before display message “There is no device has been added yet”</td></tr> </tbody> </table>			Step	Actor Action	System Response	1	Click the [Device] tab on menu.	If there is no device added before display message “There is no device has been added yet”
Step	Actor Action	System Response						
1	Click the [Device] tab on menu.	If there is no device added before display message “There is no device has been added yet”						
<b>Relationships:</b> Manage end device use case								
<b>Business Rules:</b> N/A								
<b>Description:</b> View all end devices of a user								

Table 24: Specification of Use Case UC013 - View List of End Devices

### 3.13.b Screen

#### Devices

Actions		+ Add Device		Device List			
Name	Ext Network Address	Type	Value	Online	Actions		
Plug v1 1 2 3 2 2 2 2 2 3	11:22:33:44:55:66:77:88	Smart Plug		<input checked="" type="checkbox"/>			

Figure 25: View List of End Device screen

### 3.14 Manage End Device- Edit info of an end device

#### 3.14.a Use case specification

USE CASE - Edit info of an end device SPECIFICATION			
Use-case No.	UC014	Use-case Version	1.0
Use-case Name	View List of an end devices		
Author	Xinh Thanh Thuận		
Date	May-29-2013	Priority	Normal
Actor:			

Logged User

**Summary:**

Edit info of end devices that are in ZFRM system and controlled by user.

**Goal:**

Users can manage edit the information of an end device owned by them.

**Triggers:**

In the Device page, click the [Edit] button on end device row.

**Preconditions:**

Login to the system.

**Post Conditions:**

None

**Main Success Scenario:**

Step	Actor Action	System Response
1	On the home page, click [Edit] button on which device that want to edit	<p>1. Redirect to the [Edit] page</p> <p>2. Display the old information of end devices with detail information in each field of device.</p> <p>For Smart Plug v1, there are fields:</p> <ul style="list-style-type: none"> <li>- Name</li> <li>- Description</li> </ul> <p>For Smart Plug v2, there are fields:</p> <ul style="list-style-type: none"> <li>- Name</li> <li>- Description</li> <li>- Min temperature</li> <li>- Max temperature</li> <li>- Temperature Notification</li> </ul>

		<ul style="list-style-type: none"> <li>- Plug Notification</li> </ul> <p>For temperature sensor, there are fields:</p> <ul style="list-style-type: none"> <li>- Name</li> <li>- Description</li> <li>- Min temperature</li> <li>- Max temperature</li> <li>- Temperature Notification</li> </ul> <p>2. There are 2 buttons [Save] and [Cancel] for user to choose their option.</p>
2	<p>User edits information in field to change the information of end device.</p>	<p>1. If user click [Save] button on screen.</p> <p>Update new information of Gateway to database.</p> <p>In the Device list, the new information of end device also updated.</p> <p>2. If user click [Cancel] button, not update data.</p> <p>Turn back to previous screen.</p>

**Alternative Scenario:** N/A

**Exceptions:**

Step	Actor Action	System Response
1	Same as Main Success Scenario.	
2	There is a problem with server's database that interrupts the operation.	Display message inform to user "Cannot edit your device. Please try again"

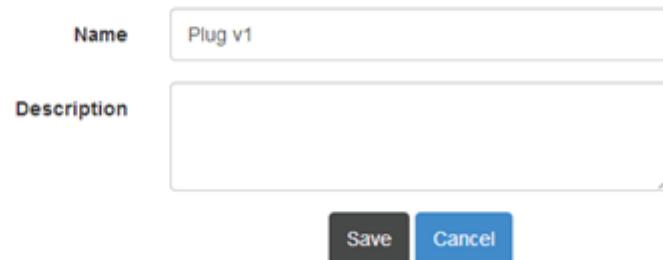
**Relationships:** Manage end device use case

<b>Business Rules:</b> N/A
<b>Description:</b> Edit information of an end device and update new data to the whole system.

Table 25: Specification of Use Case UC014 – Edit info of End Devices

### 3.14.b Screen

#### Edit Device



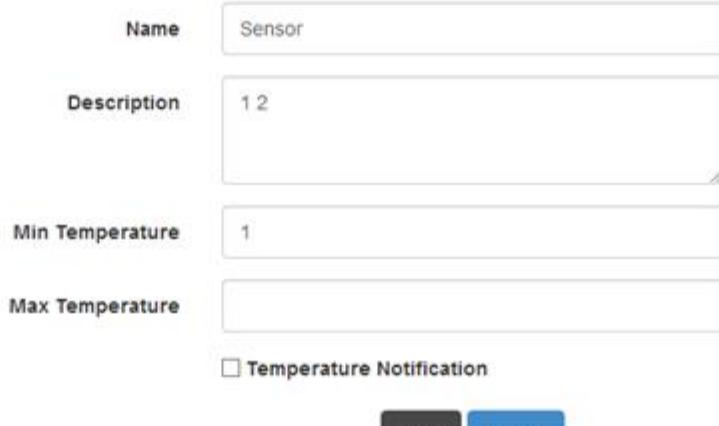
The screenshot shows a user interface for editing device information. It has two text input fields: 'Name' containing 'Plug v1' and 'Description' which is empty. At the bottom are 'Save' and 'Cancel' buttons.

Name	Plug v1
Description	

Save Cancel

Figure 26: Edit info of End Device screen – Smart Plug v1

#### Edit Device



The screenshot shows a user interface for editing device information. It has four text input fields: 'Name' containing 'Sensor', 'Description' containing '12', 'Min Temperature' containing '1', and 'Max Temperature' which is empty. Below these is a checkbox labeled 'Temperature Notification' which is unchecked. At the bottom are 'Save' and 'Cancel' buttons.

Name	Sensor
Description	12
Min Temperature	1
Max Temperature	

Temperature Notification

Save Cancel

Figure 27: Edit info of End Device screen – Temperature sensor

## Edit Device

Name	Plug v2
Description	
Min Temperature	12
Max Temperature	12
<input checked="" type="checkbox"/> Temperature Notification <input checked="" type="checkbox"/> Plug Notification	
<input type="button" value="Save"/> <input type="button" value="Cancel"/>	

Figure 28: Edit info of End Device screen – Smart Plug v2

### 3.15 Manage End Device- Turn ON/OFF power of end device

#### 3.15.a Turn ON/OFF the power of end devices specification

USE CASE - Turn ON/OFF the power of end devices SPECIFICATION			
Use-case No.	UC015	Use-case Version	1.0
Use-case Name	Turn ON/OFF the power of end devices		
Author	Trương Hoàng Yến		
Date	May-29-2013	Priority	Normal
<b>Actor:</b>			
Logged User			
<b>Summary:</b>			
User can turn ON/OFF the power of Smart Plug device that added in ZFRM system.			
<b>Goal:</b>			
Users can use the function to control the power (turn ON/OFF the power) and save energy of each device type Plug in ZFRM system.			
<b>Triggers:</b>			

User logs into the system, clicks button ON/OFF of an end device type Plug

**Preconditions:**

User must have an account and login to system.

There has at least one Smart Plug device added to system and has XBEE module connected with it.

**Post Conditions:** N/A

**Main Success Scenario:**

Step	Actor Action	System Response
1	User click on [Device] tab in home page.	Link to Device page.
2	User can turn ON/OFF the power of device by clicking the button [Turn On] or [Turn off] on Smart Plug device that user wants to control.	The button in Value column is changed depend on the status of device.  The change is executed on real device.

**Alternative Scenario:**

Step	Actor Action	System Response
1	On Gateway page, in one Gateway device row, click [Device] button.	Display the list of device in Gateway.
2	User can turn ON/OFF the power of device by clicking the button [Turn On] or [Turn off] on Smart Plug device that user wants to control.	The button in Value column is changed depend on the status of device.  The change is executed on real device.

**Exceptions:**

Step	Actor Action	System Response

1	Same as Main Success Scenario.		
2	If the end device is not connected to ZFRM system because of problem of connection or have error that interrupt the operation of device.	The button of Value will change to Red and user can't change the status of it.	

**Relationships:**  
View list of end device use case.

**Business Rules:**  
User who wants to turn ON/OFF the power of device in ZFRM system must login the system.

**Description:**  
The user has to login to the system.  
When user logins to system successfully, he/she can turn ON/OFF the power of each end device by selecting on the main screen. The request will be executed on the real end device successfully.

Table 26: Specification of Use Case UC015 - Turn ON/OFF the power of end devices

### 3.15.b Screen

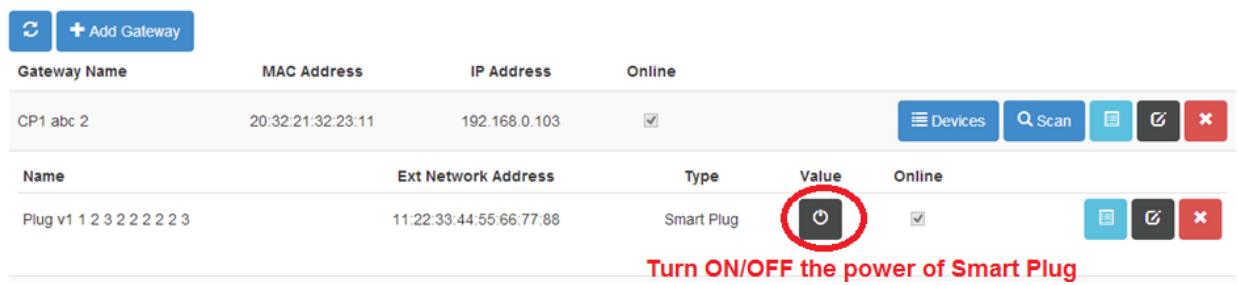
#### Devices

Name	Ext Network Address	Type	Value	Online			
Plug v1 1 2 3 2 2 2 2 2 3	11:22:33:44:55:66:77:88	Smart Plug		<input checked="" type="checkbox"/>			

**Turn ON/OFF the power of end device**

Figure 29: Turn ON/OFF the power of End Device screen in main scenario.

## Gateways

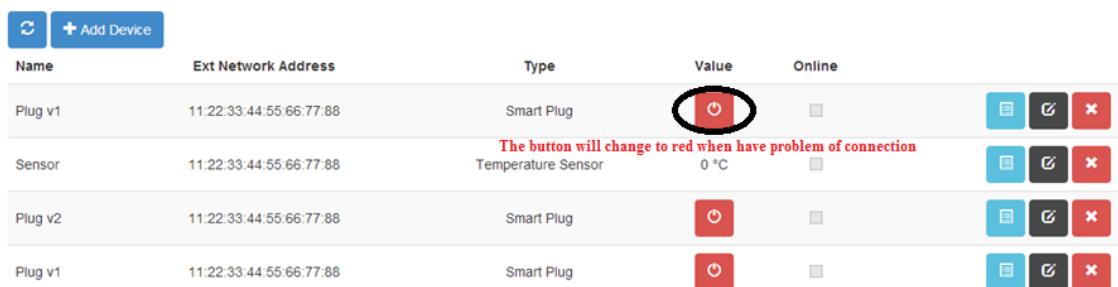


Gateway Name	MAC Address	IP Address	Online			
CP1 abc 2	20:32:21:32:23:11	192.168.0.103	<input checked="" type="checkbox"/>	<span>Devices</span> <span>Scan</span> <span>Print</span> <span>Reset</span> <span>Close</span>		
Name	Ext Network Address		Type	Value	Online	
Plug v1 1 2 3 2 2 2 2 3	11:22:33:44:55:66:77:88		Smart Plug		<input checked="" type="checkbox"/>	<span>Print</span> <span>Reset</span> <span>Close</span>

Turn ON/OFF the power of Smart Plug

Figure 30: Turn ON/OFF the power of End Device screen in alternative scenario.

## Devices



Name	Ext Network Address	Type	Value	Online			
Plug v1	11:22:33:44:55:66:77:88	Smart Plug		<input type="checkbox"/>	<span>Print</span>	<span>Reset</span>	<span>Close</span>
Sensor	11:22:33:44:55:66:77:88	Temperature Sensor	0 °C	<input type="checkbox"/>	<span>Print</span>	<span>Reset</span>	<span>Close</span>
Plug v2	11:22:33:44:55:66:77:88	Smart Plug		<input type="checkbox"/>	<span>Print</span>	<span>Reset</span>	<span>Close</span>
Plug v1	11:22:33:44:55:66:77:88	Smart Plug		<input type="checkbox"/>	<span>Print</span>	<span>Reset</span>	<span>Close</span>

Figure 31: Turn ON/OFF the power of End Device screen in exception case.

## 3.16 Set range of temperature

### 3.16.a Use case specification

USE CASE - Set range of temperature SPECIFICATION			
Use-case No.	UC012	Use-case Version	1.0
Use-case Name	Set range of temperature		
Author	Truong Hoang Yen		
Date	May-29-2013	Priority	Normal
<b>Actor:</b>			
Logged User			
<b>Summary:</b>			
Display list of end devices in ZFRM system and controlled by user.			
<b>Goal:</b>			

<p>Users can manage all the end devices that are owned by them.</p> <p><b>Triggers:</b></p> <p>In the “Devices” page, click the [Edit] button on navigation menu.</p> <p><b>Preconditions:</b></p> <p>Login to the system.</p> <p><b>Post Conditions:</b></p> <p>None</p> <p><b>Main Success Scenario:</b></p>		
Step	Actor Action	System Response
1	On the “Devices” page, click [Edit] button on temperature sensor device.	Display the field: Min temperature and Max temperature.
2	User fill value to field and click [Save] button	Update the new data to device in system.  When the temperature is not in range, there will be a warning message display on the screen to notify to user.
<p><b>Alternative Scenario: N/A</b></p> <p><b>Exceptions:</b> N/A</p> <p><b>Relationships:</b> Edit info of End device</p> <p><b>Business Rules:</b> N/A</p>		
<p><b>Description:</b> Set range of temperature of Temperature sensor in system and warning when it is not in range.</p>		

Table 27: Specification of Use Case UC015 – Set range of temperature sensor

3.16.b    Screen

Min Temperature: 1

Max Temperature:

Temperature Notification

Save Cancel

Figure 32: Set range of temperature screen

## IV. Main flow

### 1. For users

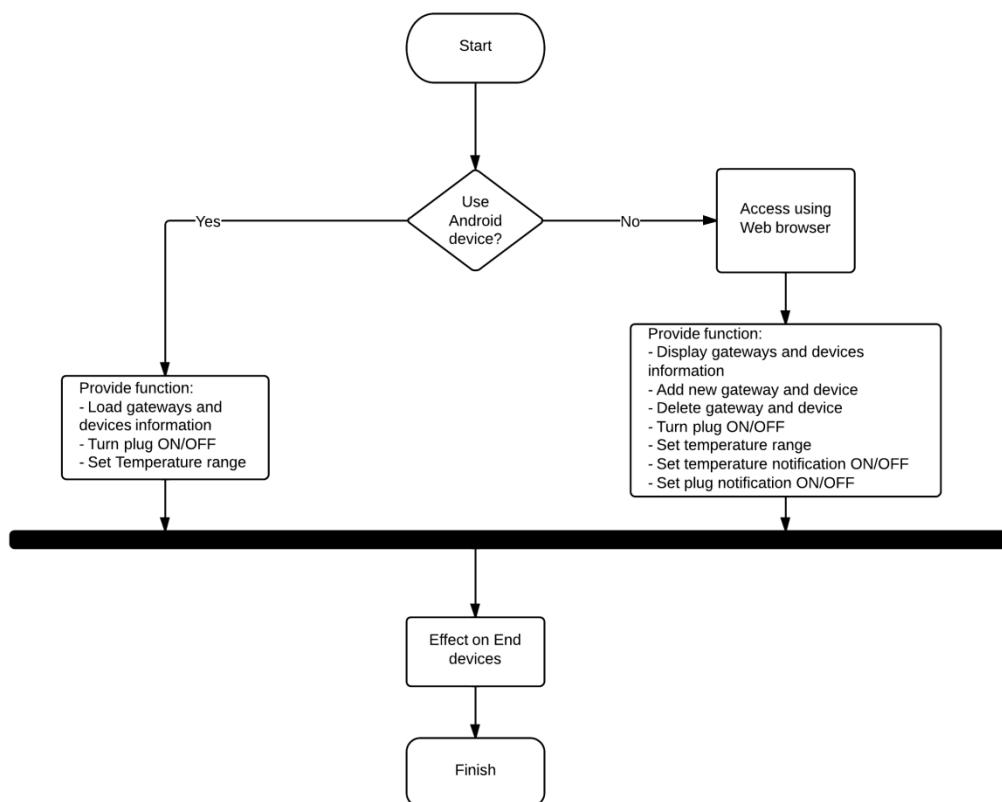


Figure 33: Main using flow of the system

## V. Non-functional Requirements

### 1. Reliability

- System is expected to run continuously for years without errors (or in some cases recover by themselves if an error occurs).
- Ensure that when system starts a “mission”, it has a high probability of completing that mission without experiencing a failure.

- System can safely be shut down for repair, or another way to repair without stopping system.
- The system shall never crash or hang, other than as the result of a network error.
- Mean Time Between Failures (MTBF): The acceptable failure is once a year.
- Mean Time To Repair (MTTR): When the failure occurs, it should take at least time as possible to repair. The acceptable mean time for a particular failure must be least than 1 minute.
- Maximum Bugs or Defect Rate: 1-2bugs/KLOC

## 2. Availability

- The server shall be working 24/7. When the system goes in under-maintenance, the page or application will display message “System is maintaining at the moment. Please check again later”

## 3. Security

- Guarantee the data and application protection from being stolen and modified by encoding and decoding data.

## 4. Maintainability

- All code shall be fully documented. All program files shall include comments concerning authorship and date of last change.
- The code shall be modular to permit future modifications.

## 5. Portability

- The system shall be designed to control and run on Web platform, Android platform. Make sure that control device must be portable device as smartphone, tablet...
- ZigBee slave device can be easy to disconnect and reconnect to another end device

## 6. Performance

This is the system's performance characteristics:

- Capacity: 1000 end users at a time.
- Response time for a transaction: less than 5 seconds
- Average: 3 seconds
- Maximum: 8 seconds

## D. Software Design Description (SDD)

### I. Design overview

This part provides for project's stakeholders multi specific views of ZFRM system such as:

- System architecture design will show the general view of ZFRM system:
  - How many layers in system and function of each layer.
  - Basic idea about operations of the system
- Component design will express the detail information of component that we use and program in system:
  - It describes all system's component: specification and feature of component when use it in system.
  - Relationships between components.
  - It describes the schematic and layout for designing circuit.
  - It also explains clearly their purposes, methods within each component.
  - It describes detailed algorithms, pseudo code to implement them.
- User interface design will represent the interface that user use to control and manage the device in system:
  - It describes Web application screens' interface and Android application screens' interface that user interact to use in system.
  - It also describes item on each screen and the meaning of each item in that screen.
  - Each screen includes which types of input, output element and used by what action.

## II. System architecture design

### 1. The whole system

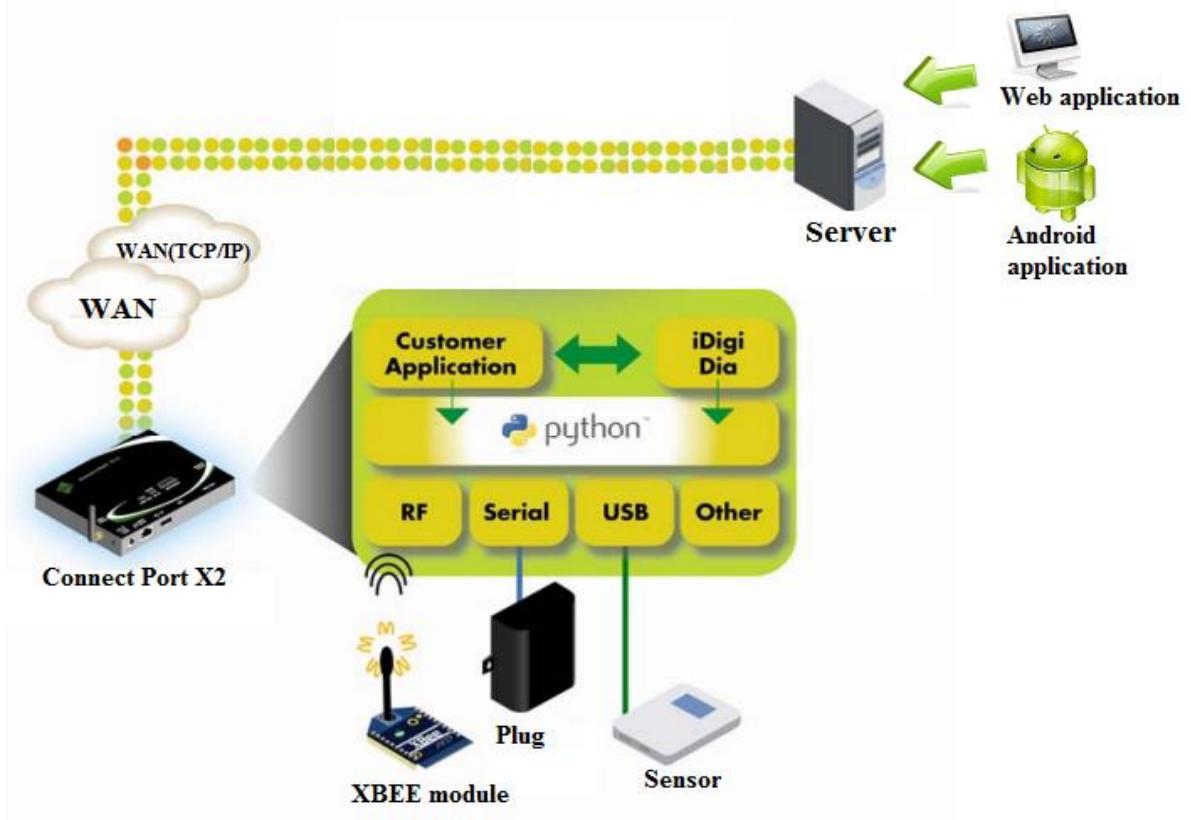


Figure 34: Overall architecture of whole system

## 2. Architecture of Connect Port X

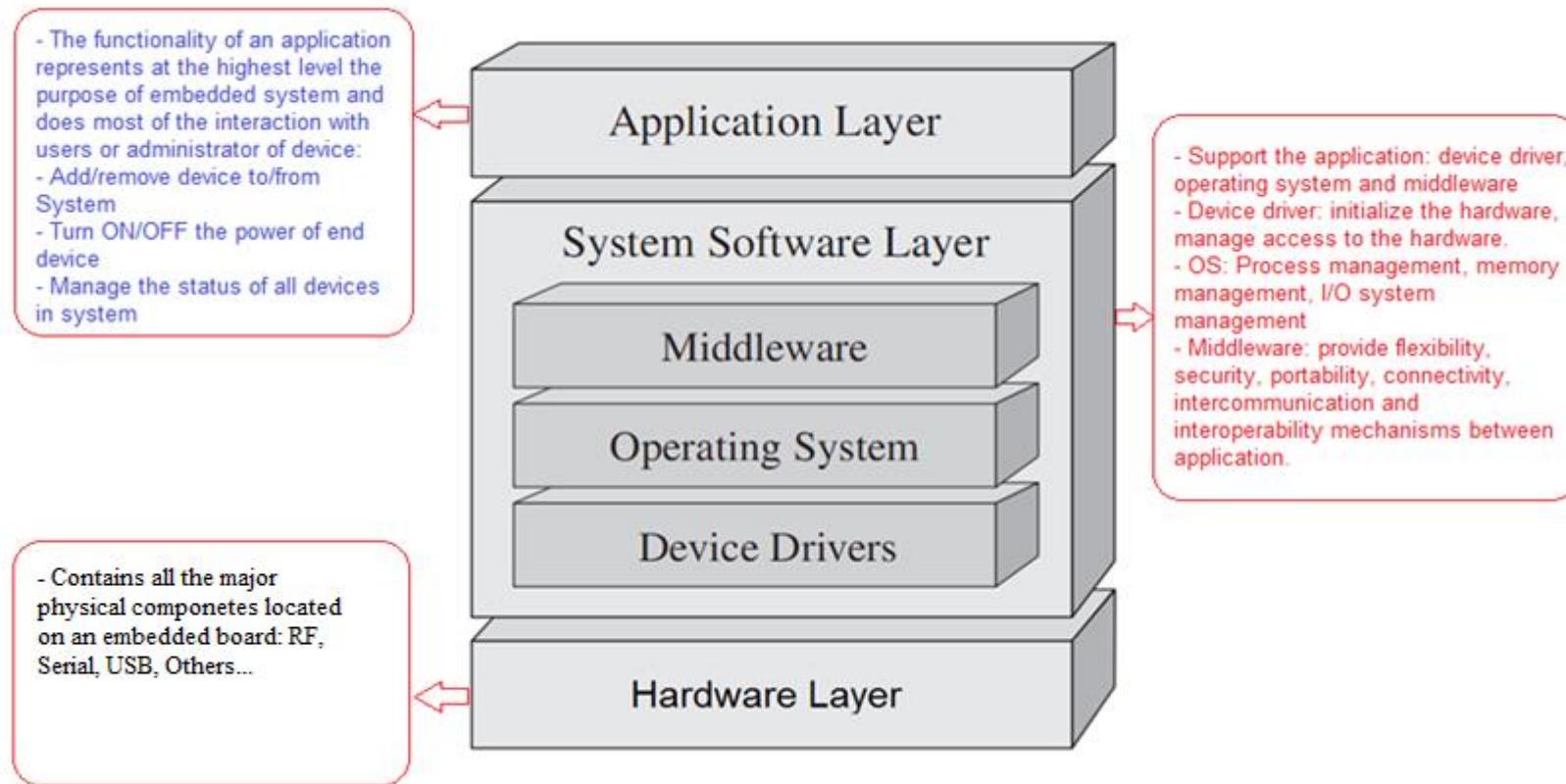


Figure 35: Connect Port system architecture overview

### 3. Architecture of Web site

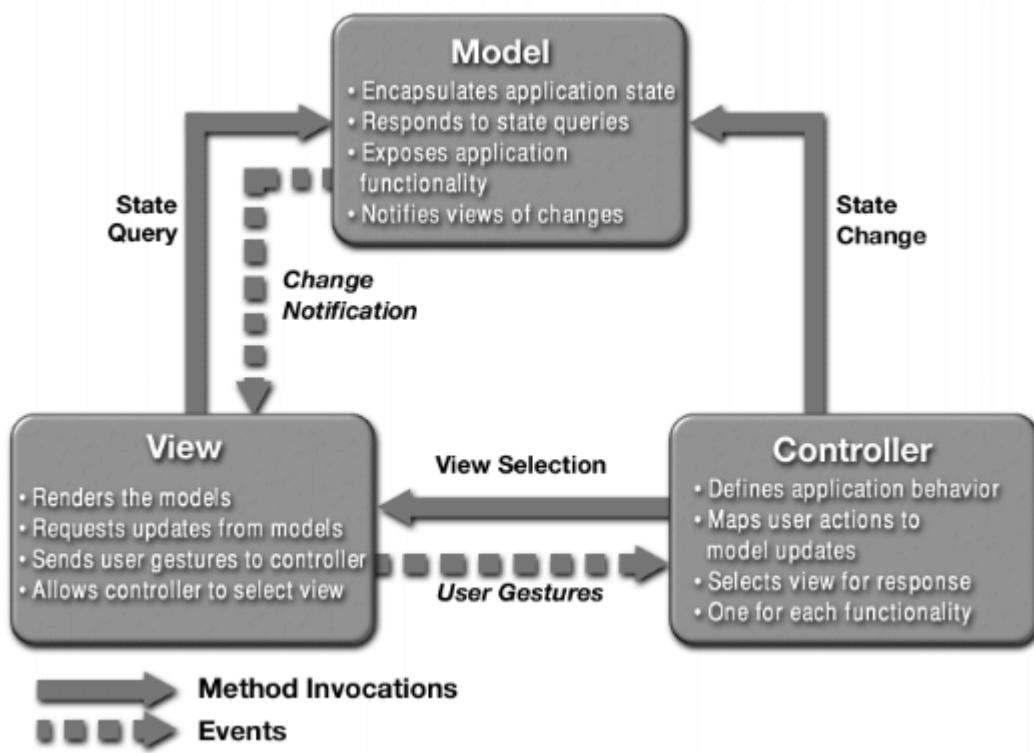


Figure 36: Web site architecture diagram

### 4. Architecture of networking

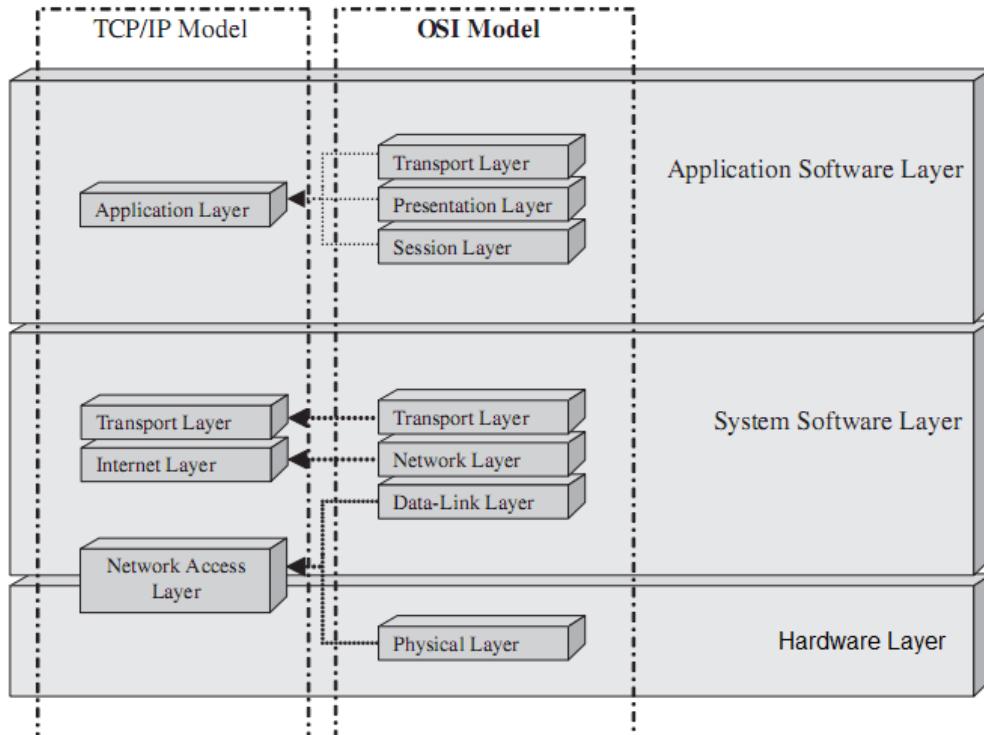


Figure 37: TCP/IP & OSI Model in ZFRM system architecture

### III. Component diagram

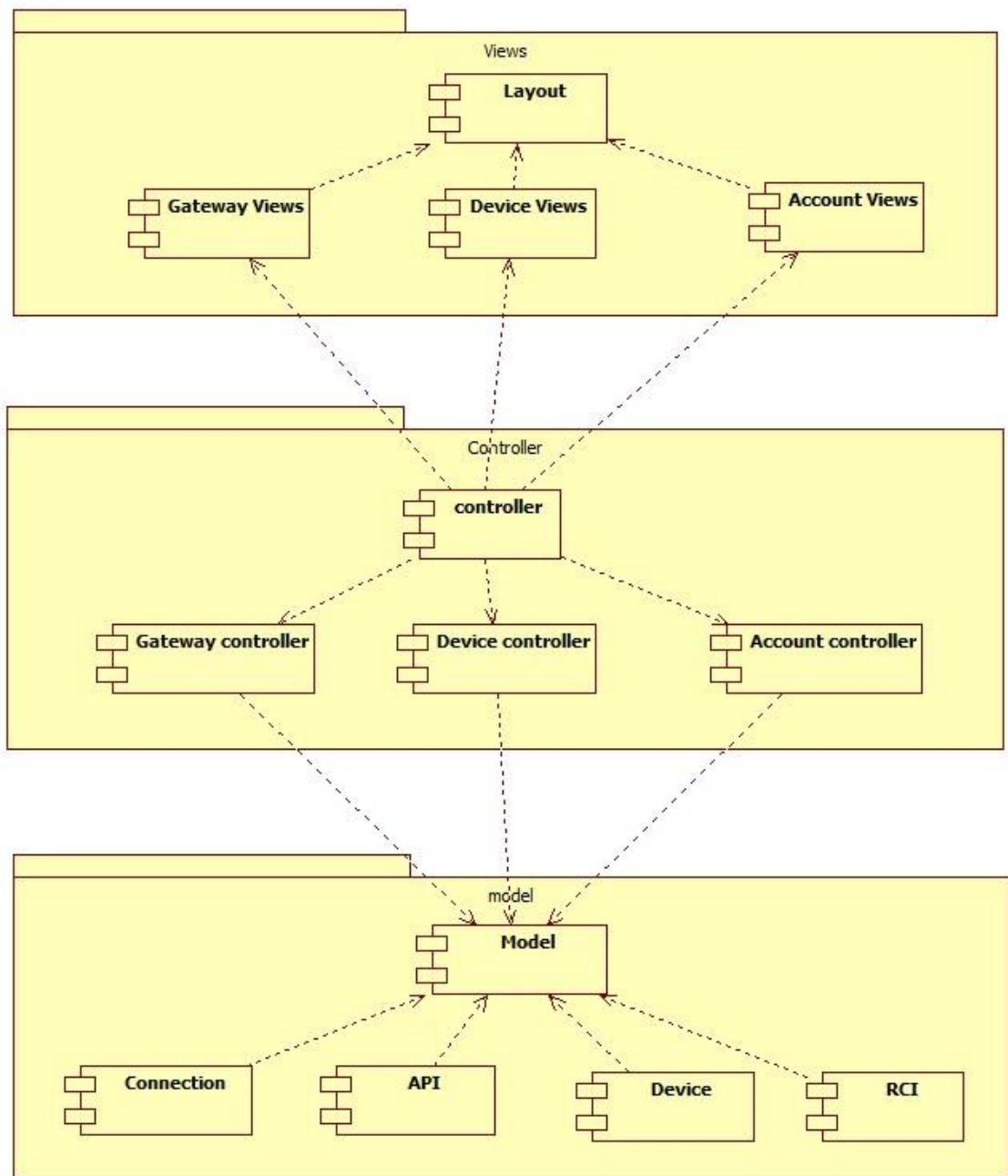


Figure 38: Component diagram of ZFRM system

## IV. Detail Description of Components

### 1. Hardware layer

#### 1.1 Connect PortX2 – Coordinator



Figure 39: Connect PortX2

Specifications	ConnectPort® X2 ZB
General	
Management	<ul style="list-style-type: none"> <li>○ HTTP/HTTPS web interface,</li> <li>○ Password access control,</li> <li>○ IP service port control, Optional secure enterprise</li> <li>○ management via Device Cloud</li> </ul>
Protocols	UDP/TCP, DHCP, SNMPv1
Total memory	4 MB Flash, 8 MB RAM
LEDs	Ethernet status, Power, ZigBee link/activity
Security	SSL tunnels
RF	ZigBee, 802.15.4
Dimensions (L x W x H)	5.50 in x 2.75 in x 1.13 in (13.9 cm x 7.0 cm x 2.9 cm) 0.44 lb (0.20 kg)
Weight	0.20 lb (0.09 kg)
Development	
ZigBee Public Application Profile	Smart Energy
Python Version	2.4.3
Memory (User-available memory varies by firmware and OS version)	8 MB RAM, 4 MB Flash
<b>Ethernet</b>	
Ports	1 RJ-45 port
Physical Layer	10/100Base-T

Data Rate	10/100 Mbps (auto-sensing)
Mode	Full or half duplex (auto-sensing)
<b>Power Requirements</b>	
Power Input	5 VDC
Power Supply	5 VDC power supply with barrel connector included
Power Consumption	Idle: 1.2 W, Max: 3.4 W
Surge Protection (with included power supply)	4 kV burst (EFT) per-4-4, 2 kV surge per EN61000-4
<b>Environmental</b>	
Operating Temperature	-30° C to +70° C (-22° F to +158° F)
Relative Humidity	5% to 95% (non-condensing)
Ethernet Isolation	1500VAC min per IEEE802.3/ANSI X3.263
Regulatory Approvals	
Safety	EN60950
Emissions/Immunity	CE, FCC Part 15 (Class A) N/A

Table 28: Connect PortX2 specification

### Implementation of Connect PortX2 in ZFRM

- Remote web applications for Android, utility hosted websites designed for customer engagement.
- Provide near real-time energy data access and control capabilities.

### 1.2 XBee module

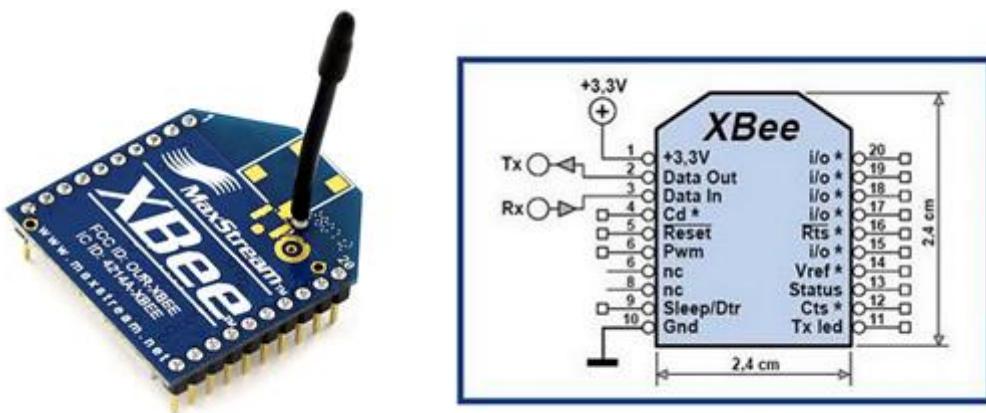


Figure 40: XBee module

The technology defined by the ZigBee specification is intended to be simpler and less expensive than other WPANs, such as Bluetooth. ZigBee is targeted at radio-frequency (RF) applications that require a low data rate, long battery life, and secure

networking.

ZigBee is a low-cost, low-power, wireless mesh networking proprietary standard. The low cost allows the technology to be widely deployed in wireless control and monitoring applications, the low power-usage allows longer life with smaller batteries, and the mesh networking provides high reliability and larger range.

### **Key Features:**

- High Performance, Low Cost
  - Indoor/Urban: up to 133' (40 m)
  - Outdoor line-of-sight: up to 400' (120 m)
  - Transmit Power: 2 mW (+3 dBm)
  - Receiver Sensitivity: -95 dBm
- Low Power(XBee Series 2)
  - TX Current: 40 mA (@3.3 V)
  - RX Current: 40 mA (@3.3 V)
  - Power-down Current: < 1  $\mu$ A @ 250C
- Advanced Networking & Security
  - Retries and Acknowledgements
  - DSSS (Direct Sequence Spread Spectrum)
  - Each direct sequence channel has over 65,000 unique network addresses available
  - Point-to-point, point-to-multipoint
  - and peer-to-peer topologies supported
  - Self-routing, self-healing and fault-tolerant
  - mesh networking
- Easy-to-Use
  - No configuration necessary for out-of box
  - RF communications
  - AT and API Command Modes for
  - configuring module parameters
  - Small form factor
  - Extensive command set
  - Free X-CTU Software
  - (Testing and configuration software)
- Free & Unlimited Technical Support

### **Worldwide Acceptance**

- FCC Approval (USA) Refer to Appendix A [p50] for FCC Requirements.
- Systems that contain XBee Series 2 RF Modules inherit MaxStream Certifications.

- ISM (Industrial, Scientific & Medical) 2.4 GHz frequency band
- Manufactured under ISO 9001:2000 registered standards
- XBee Series 2 RF Modules are optimized for use in US, Canada, Australia, Israel and Europe (contact MaxStream for complete list of agency approvals).

*Implement of XBEE Module in ZFRM*

- Receive the temperature information from microcontroller through UART
- Transmit the information to the Connect PortX2 gateway through ZigBee network

**1.3 PIC Microcontroller**

40-Pin PDIP

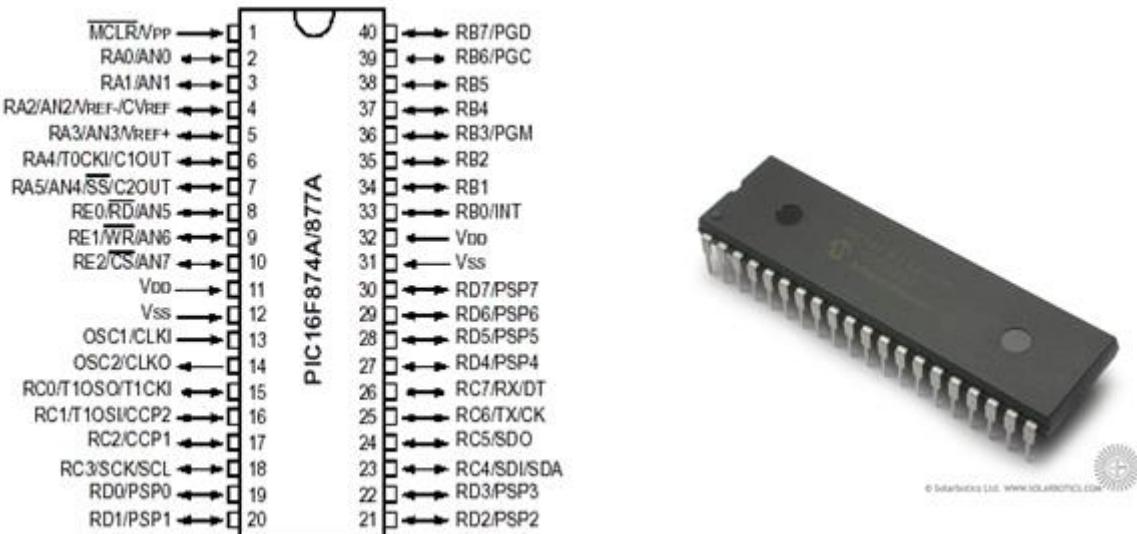


Figure 41: PIC Microcontroller 16f877a

**High-Performance RISC CPU:**

- Only 35 single-word instructions to learn
- All single-cycle instructions except for program branches, which are two-cycle
- Operating speed: DC – 20 MHz clock inputDC – 200 ns instruction cycle
- Up to 8K x 14 words of Flash Program Memory, Up to 368 x 8 bytes of Data Memory (RAM), Up to 256 x 8 bytes of EEPROM Data Memory
- Pinout compatible to other 28-pin or 40/44-pin PIC16CXXX and PIC16FXXX microcontrollers

**Peripheral Features:**

- Timer0: 8-bit timer/counter with 8-bit prescaler
- Timer1: 16-bit timer/counter with prescaler, can be incremented during Sleep via external crystal/clock
- Timer2: 8-bit timer/counter with 8-bit period register, prescaler and postscaler

- Two Capture, Compare, PWM modules
  - Capture is 16-bit, max. resolution is 12.5 ns
  - Compare is 16-bit, max. resolution is 200 ns
  - PWM max. resolution is 10-bit
- Synchronous Serial Port (SSP) with SPI (Master mode) and I2C™ (Master/Slave)
- Universal Synchronous Asynchronous Receiver Transmitter (USART/SCI) with 9-bit address detection
- Parallel Slave Port (PSP) – 8 bits wide with external RD, WRandCScontrols (40/44-pin only)
- Brown-out detection circuitry for Brown-out Reset (BOR)

#### **Analog Features:**

- 10-bit, up to 8-channel Analog-to-Digital
- Converter (A/D)
- Brown-out Reset (BOR)
- Analog Comparator module with:
  - Two analog comparators
  - Programmable on-chip voltage reference
  - (VREF) module
  - Programmable input multiplexing from device
  - inputs and internal voltage reference
  - Comparator outputs are externally accessible

#### **Special Microcontroller Features:**

- 100,000 erase/write cycle Enhanced Flash program memory typical
- 1,000,000 erase/write cycle Data EEPROM memory typical
- Data EEPROM Retention > 40 years
- Self-reprogrammable under software control
- In-Circuit Serial Programming™ (ICSP™) via two pins
- Single-supply 5V In-Circuit Serial Programming
- Watchdog Timer (WDT) with its own on-chip RC oscillator for reliable operation
- Programmable code protection
- Power saving Sleep mode
- Selectable oscillator options
- In-Circuit Debug (ICD) via two pins

#### **CMOS Technology:**

- Low-power, high-speed Flash/EEPROM technology
- Fully static design

- Wide operating voltage range (2.0V to 5.5V)
- Commercial and Industrial temperature ranges
- Low-power consumption

*Implement of PIC Microcontroller in ZFRM*

- Read the temperature from sensor
- Send the temperature information to XBee module through UART

#### 1.4 Temperature sensor



**Order Number LM35CZ,  
LM35CAZ or LM35DZ  
See NS Package Number Z03A**

Figure 42: Temperature sensor

#### Features

- Calibrated directly in ° Celsius (Centigrade)
- Linear + 10.0 mV/°C scale factor
- 0.5°C accuracy guaranteed (at +25°C)
- Rated for full -55° to +150°C range
- Suitable for remote applications
- Low cost due to wafer-level trimming
- Operates from 4 to 30 volts
- Less than 60 µA current drain
- Low self-heating, 0.08°C in still air
- Nonlinearity only  $\pm 1/4^\circ\text{C}$  typical
- Low impedance output, 0.1 Ω for 1 mA load

*Implement of Temperature sensor in ZFRM*

- Measure the temperature in the room.
- Send the temperature information to PIC microcontroller.

### 1.5 Relay

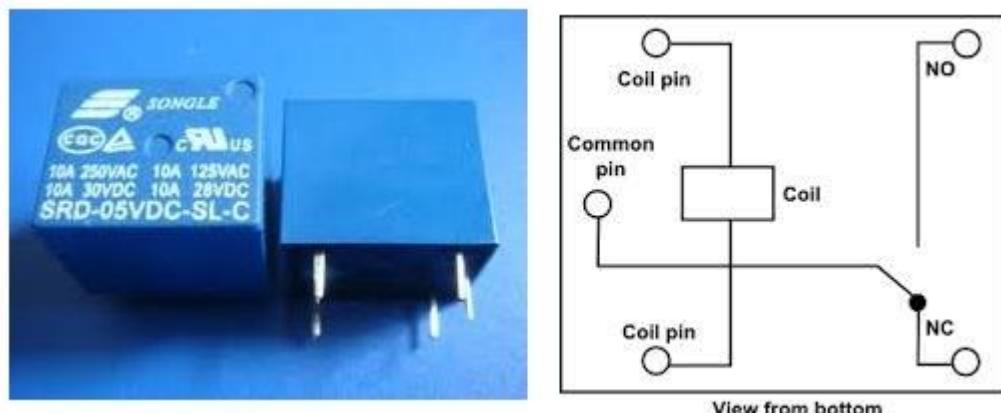


Figure 43: Relay

#### Feature:

- Switching capacity available by 10A in spite of small size design for high density P.C. board mounting technique.
- UL, CUL, TUV recognized.
- Selection of plastic material for high temperature and better chemical solution performance.
- Sealed types available.
- Simple relay magnetic circuit to meet low cost of mass production.

#### Specifications

- Coil Data:
  - Nominal Voltage: 5V DC.
  - Nominal Power Consumption: 360 mW.
- Contact Data:
  - Contact Arrangement : 1 form C
  - Contact Rating: 10A 250V AC/30V DC - 10A 125V AC/28V DC.
  - Outline L x W x H: 19.1 x 15.5 x 15.3 mm (Max)
  - Weight: 8.45g

#### Implement of Relay in ZFRM

- Receive the signal from the PIC microcontroller.
- Switch on/off a lamp automatically.

### 1.6 PIC - Temperature sensor board v1 circuit design

#### 1.6.a Schematic

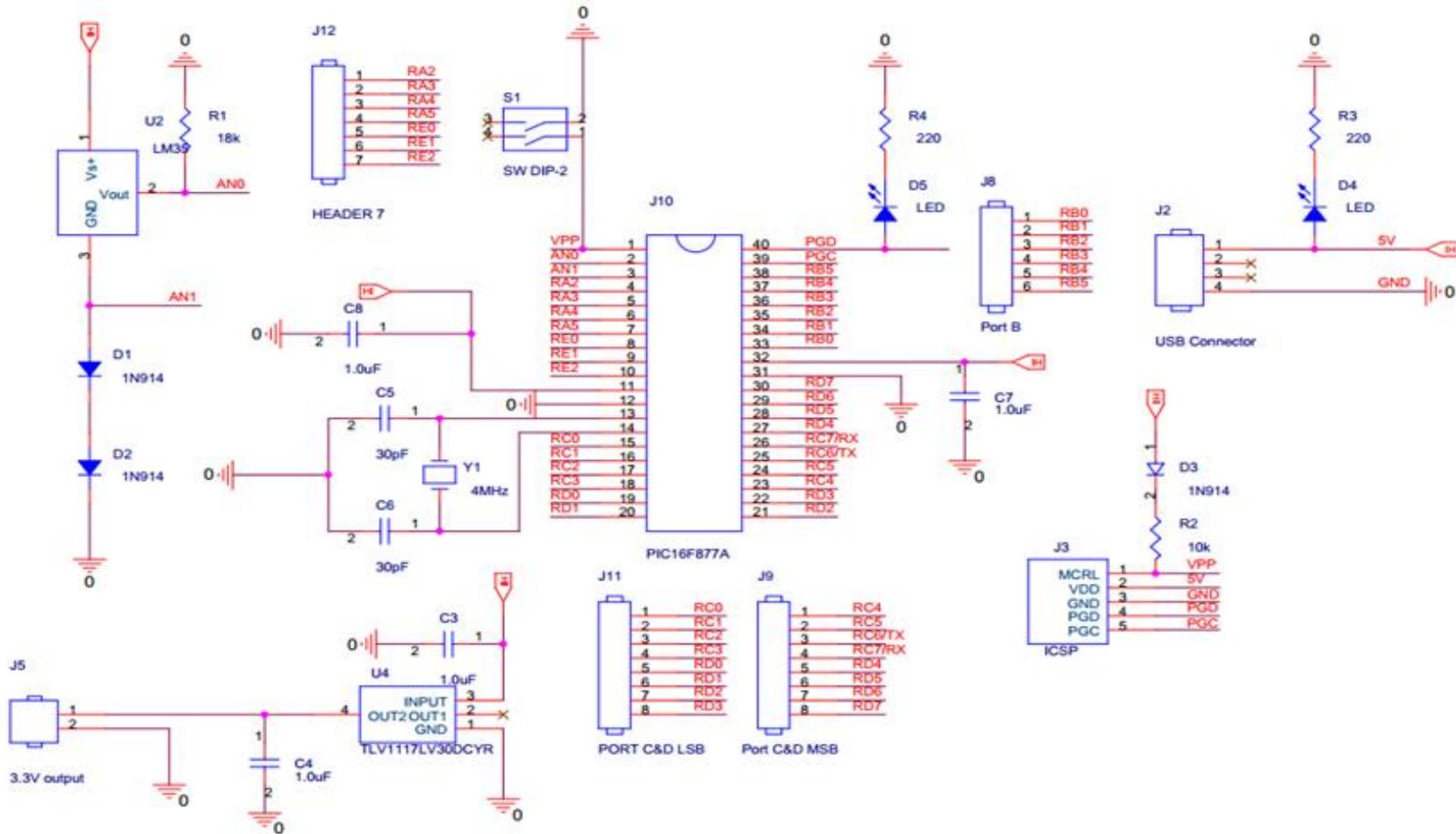


Figure 44: PIC temperature sensor board v1 schematic

1.6.b Layout

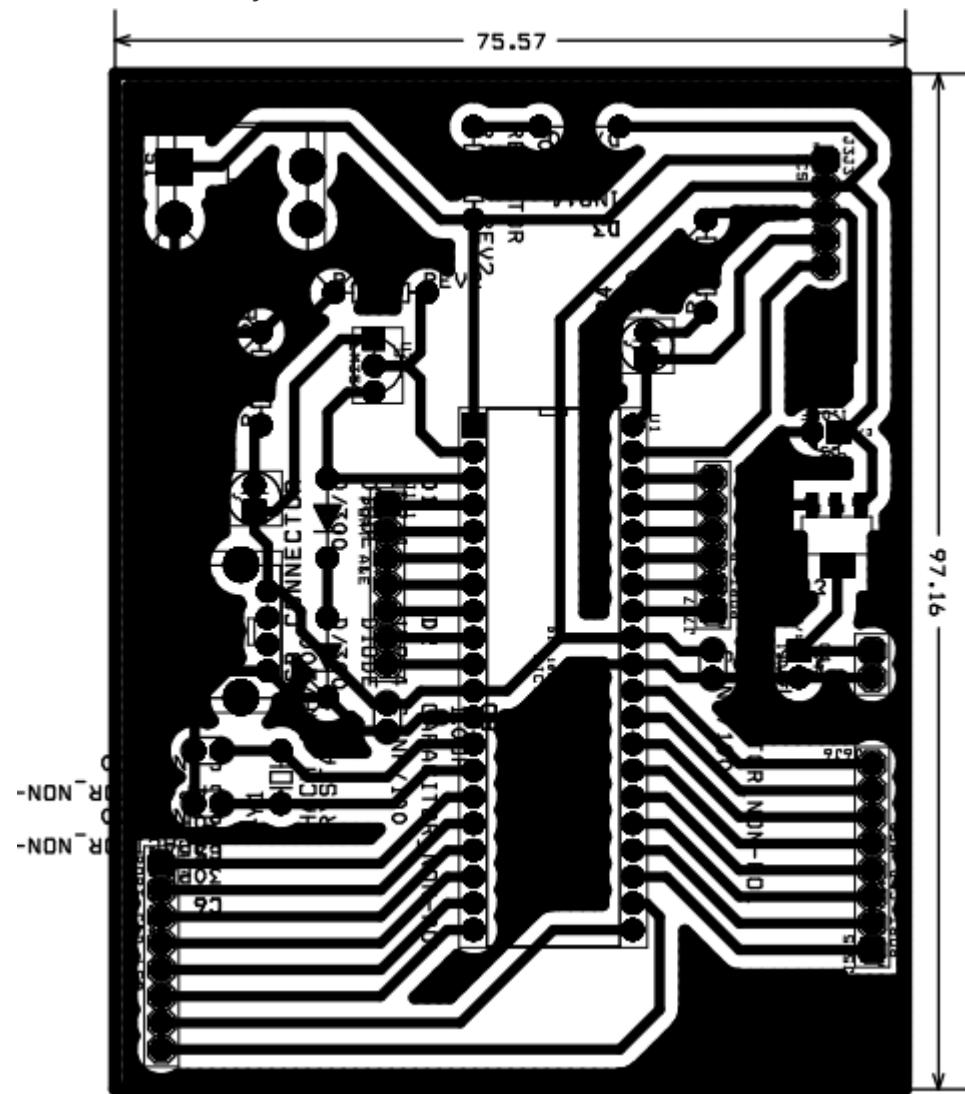


Figure 45: PIC Temperature board v1 layout design

### 1.7 PIC - Temperature sensor board v2 circuit design

#### 1.7.a Schematic

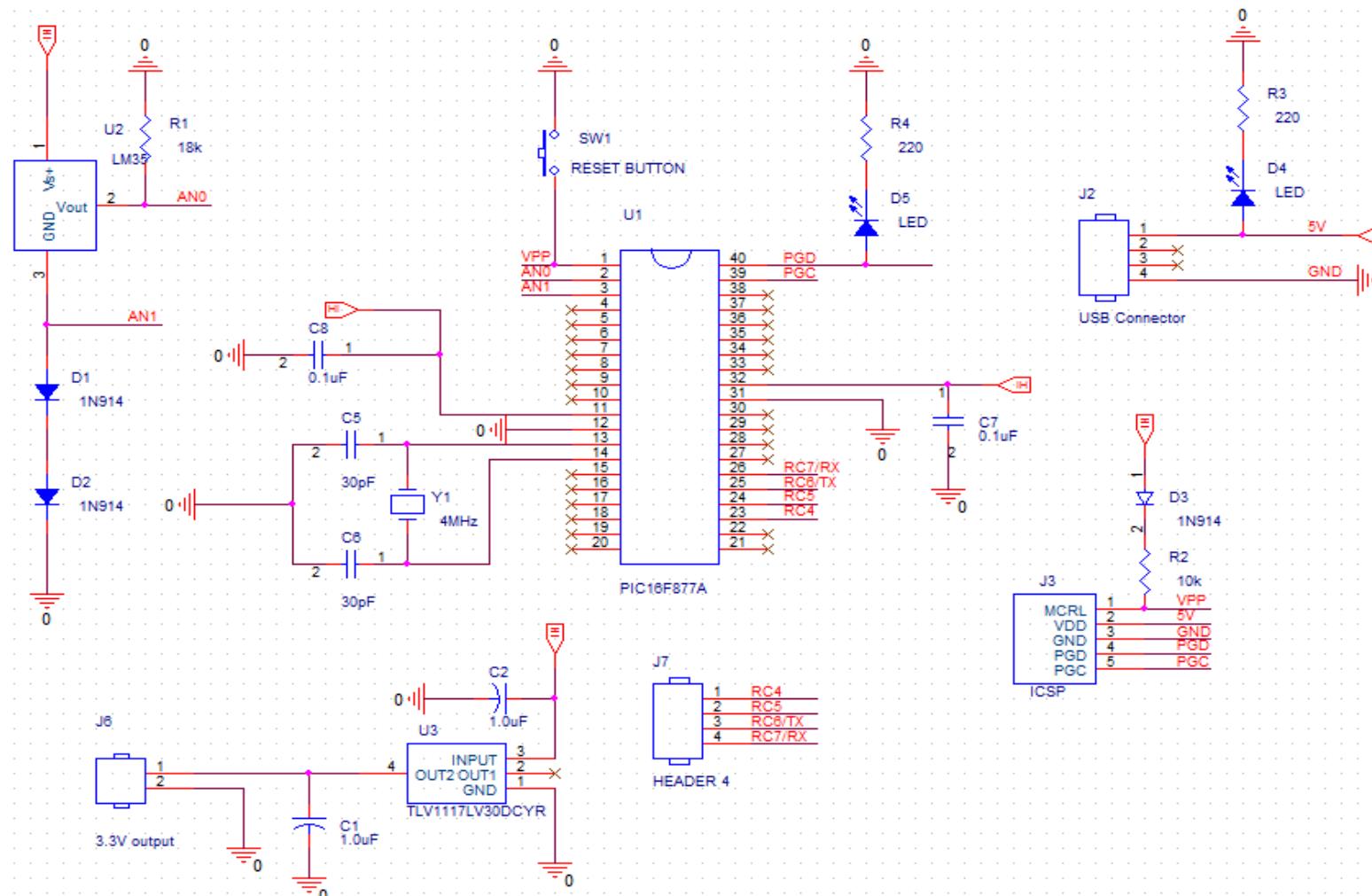


Figure 46: PIC temperature sensor board v2 schematic

## 1.7.b Layout

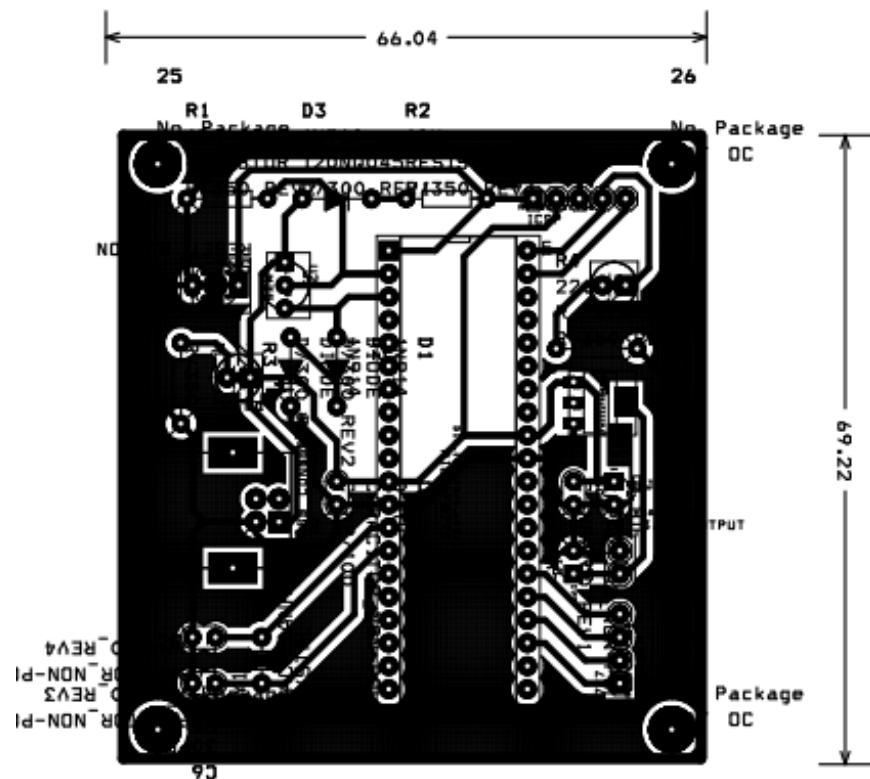


Figure 47: PIC Temperature board v2 layout design

### 1.8 XBee Relay board circuit v1 design

#### 1.8.a Schematic

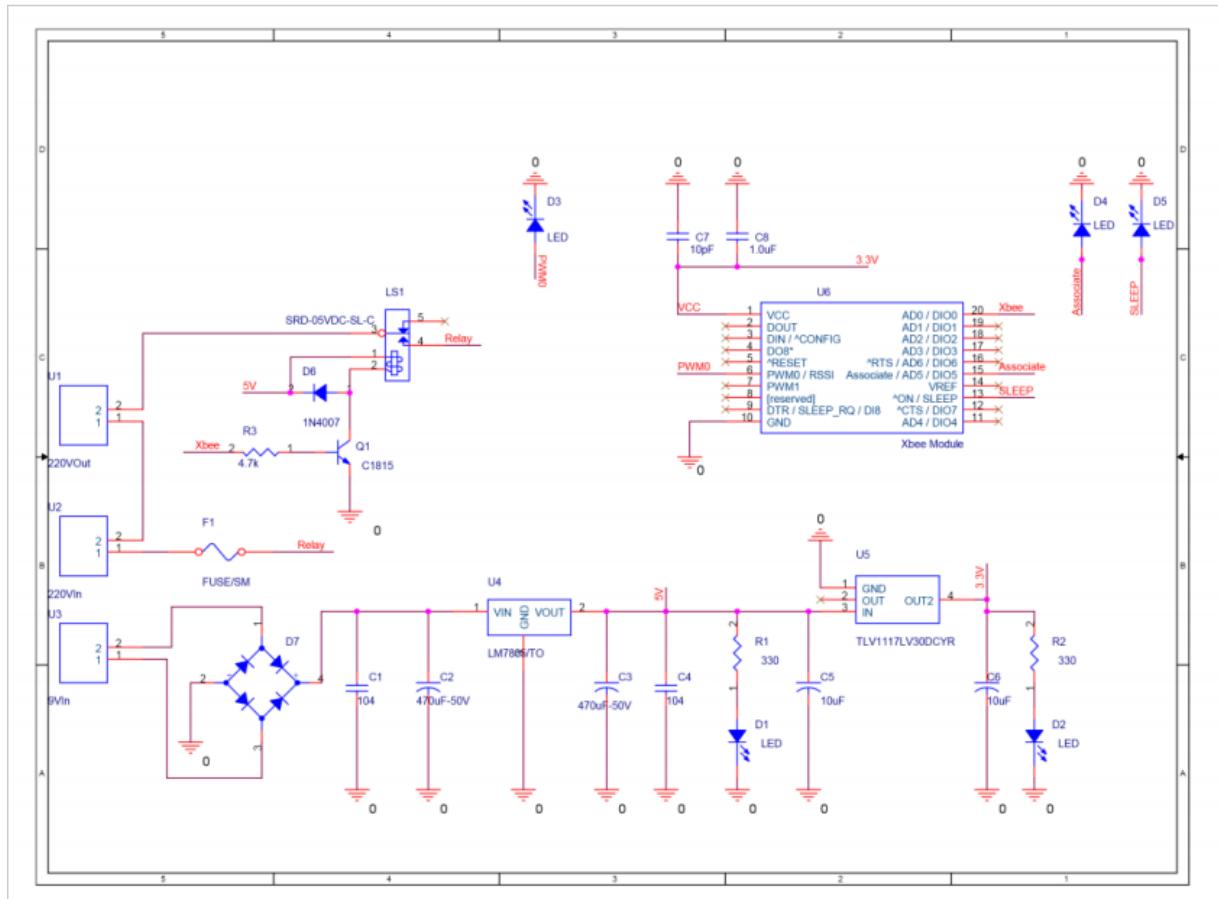


Figure 48: XBee Relay board v1 schematic

1.8.b Layout

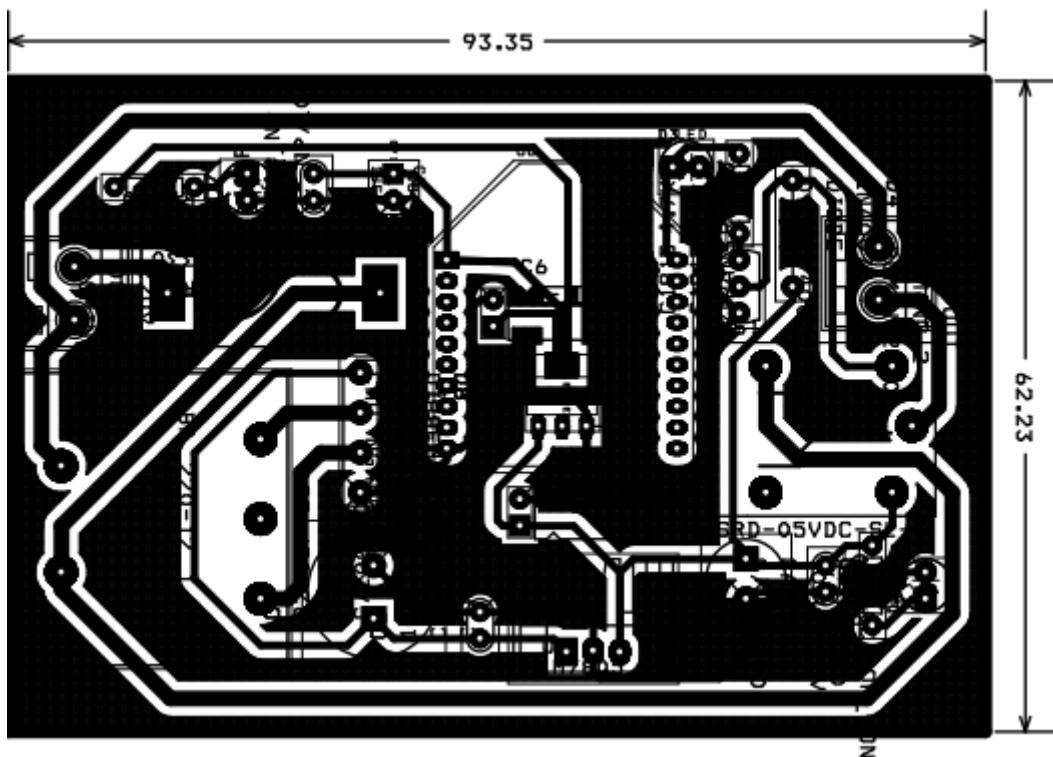


Figure 49: XBee Relay board v1 layout

## 1.9 XBee Relay board circuit v2 design

### 1.9.a Schematic

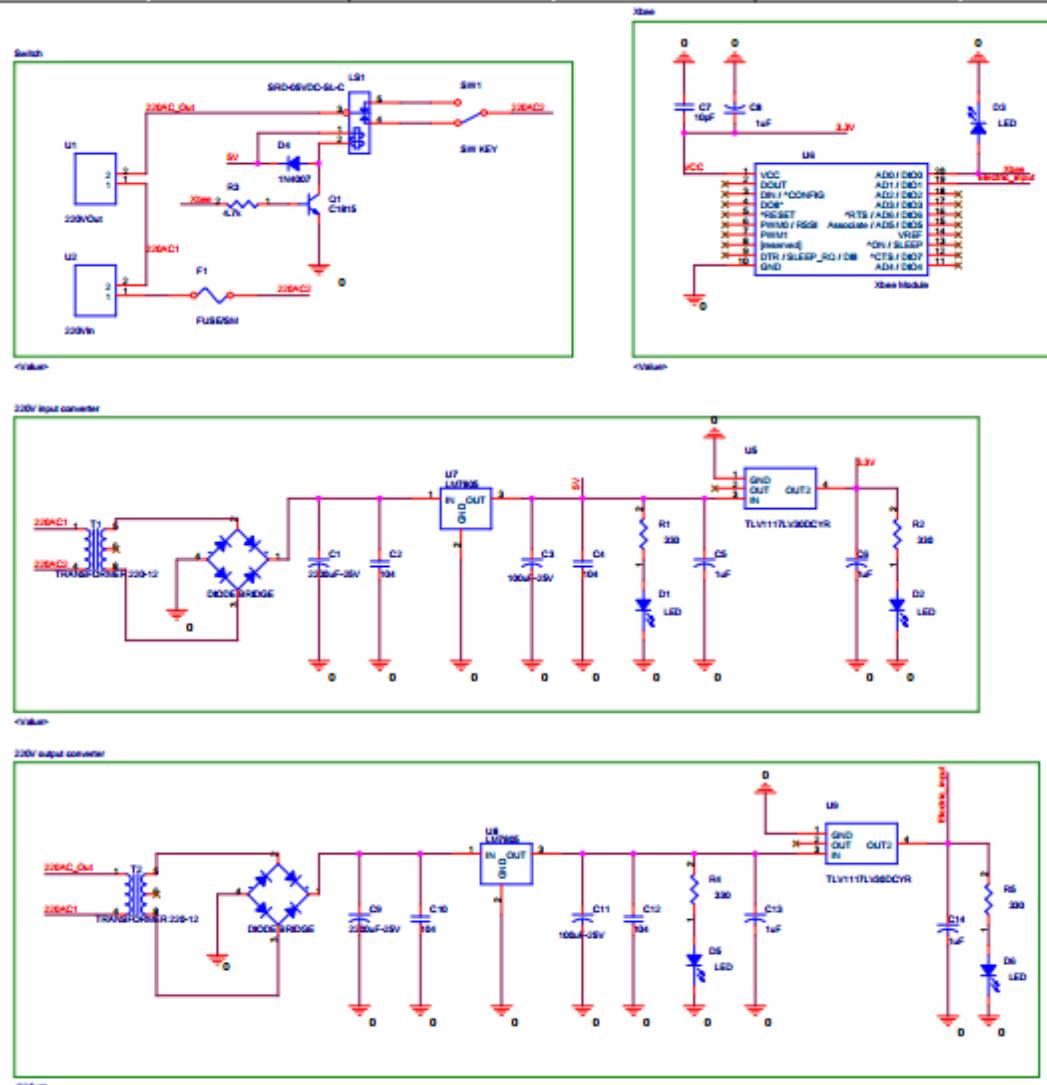
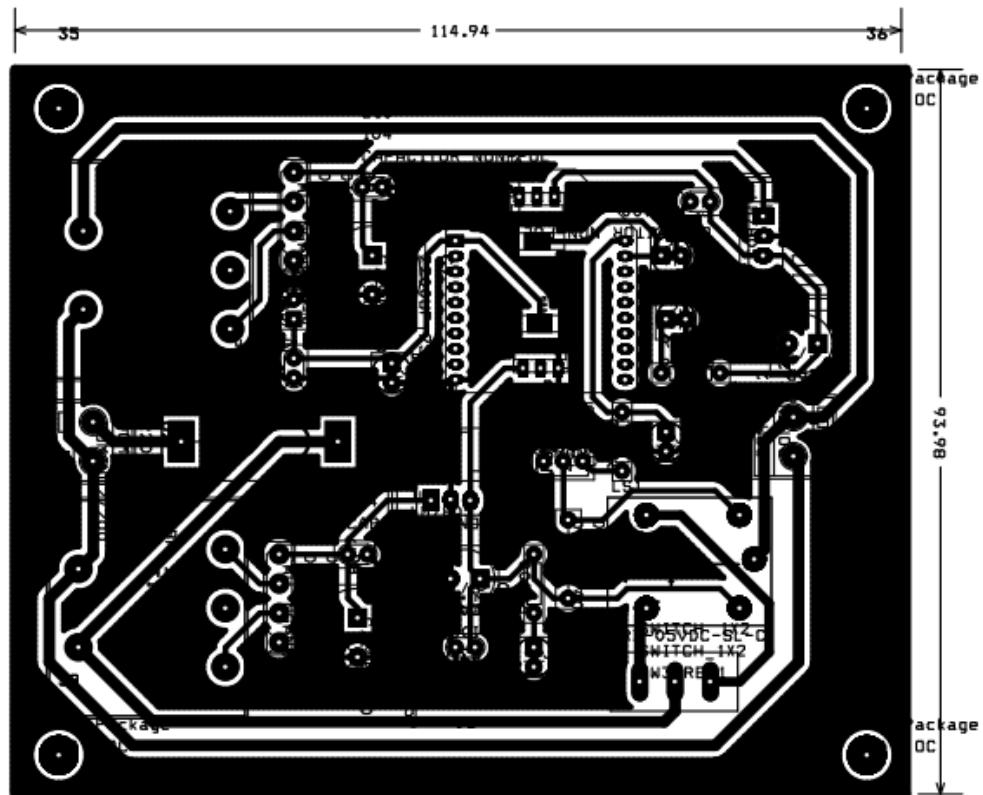


Figure 50: XBee Relay board v2 schematic

1.9.b Layout



## 1.10 XBee Relay board circuit v3 design

### 1.10.a Schematic

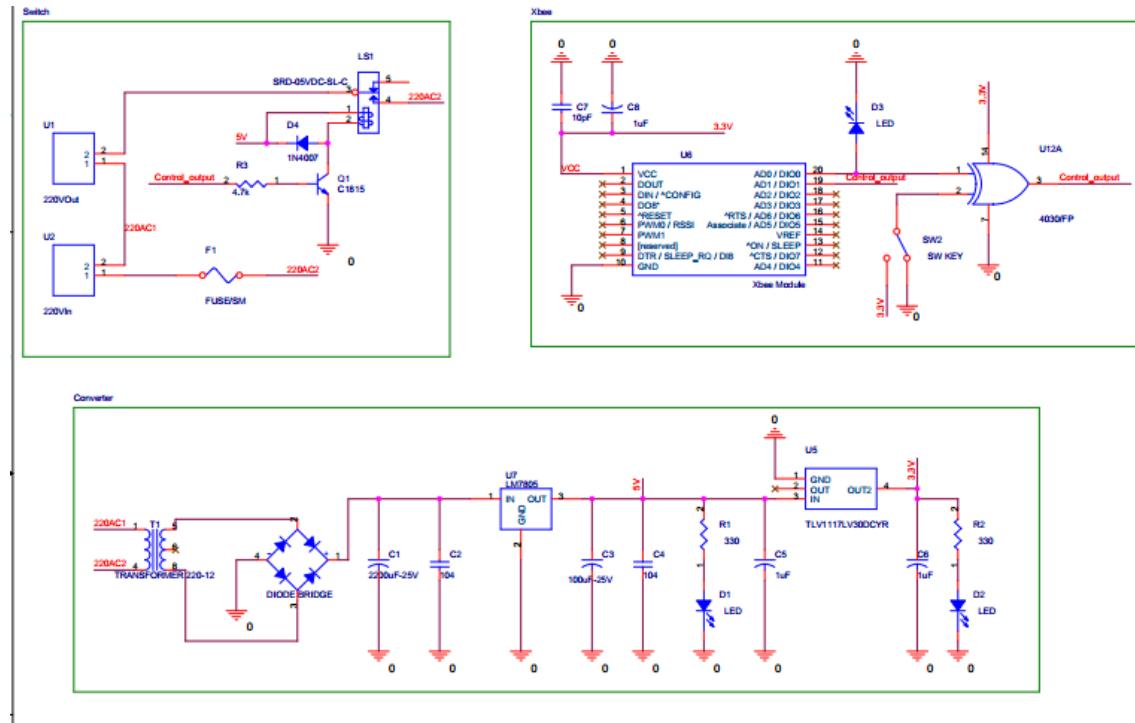


Figure 51: XBee Relay board v3 schematic

### 1.10.b Layout

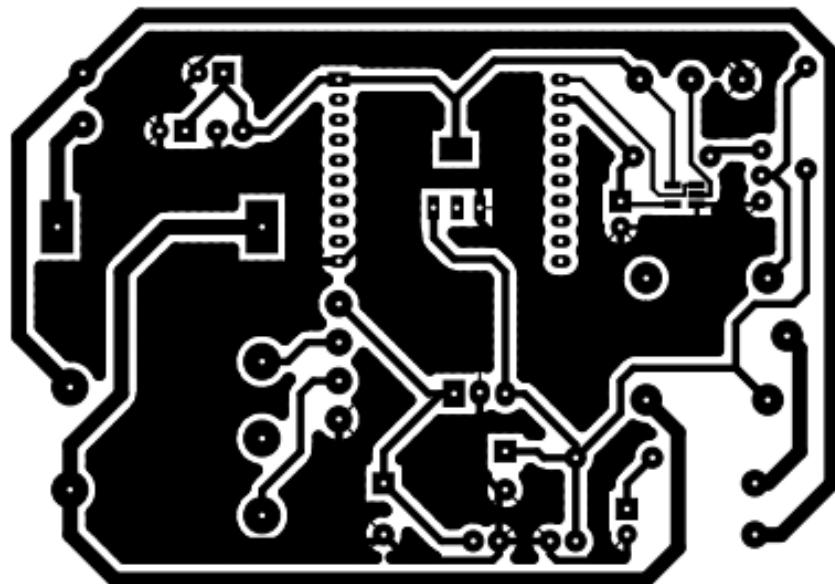


Figure 52: XBee Relay board v3 layout

## 1.11 XBee Module board circuit design

### 1.11.a Schematic

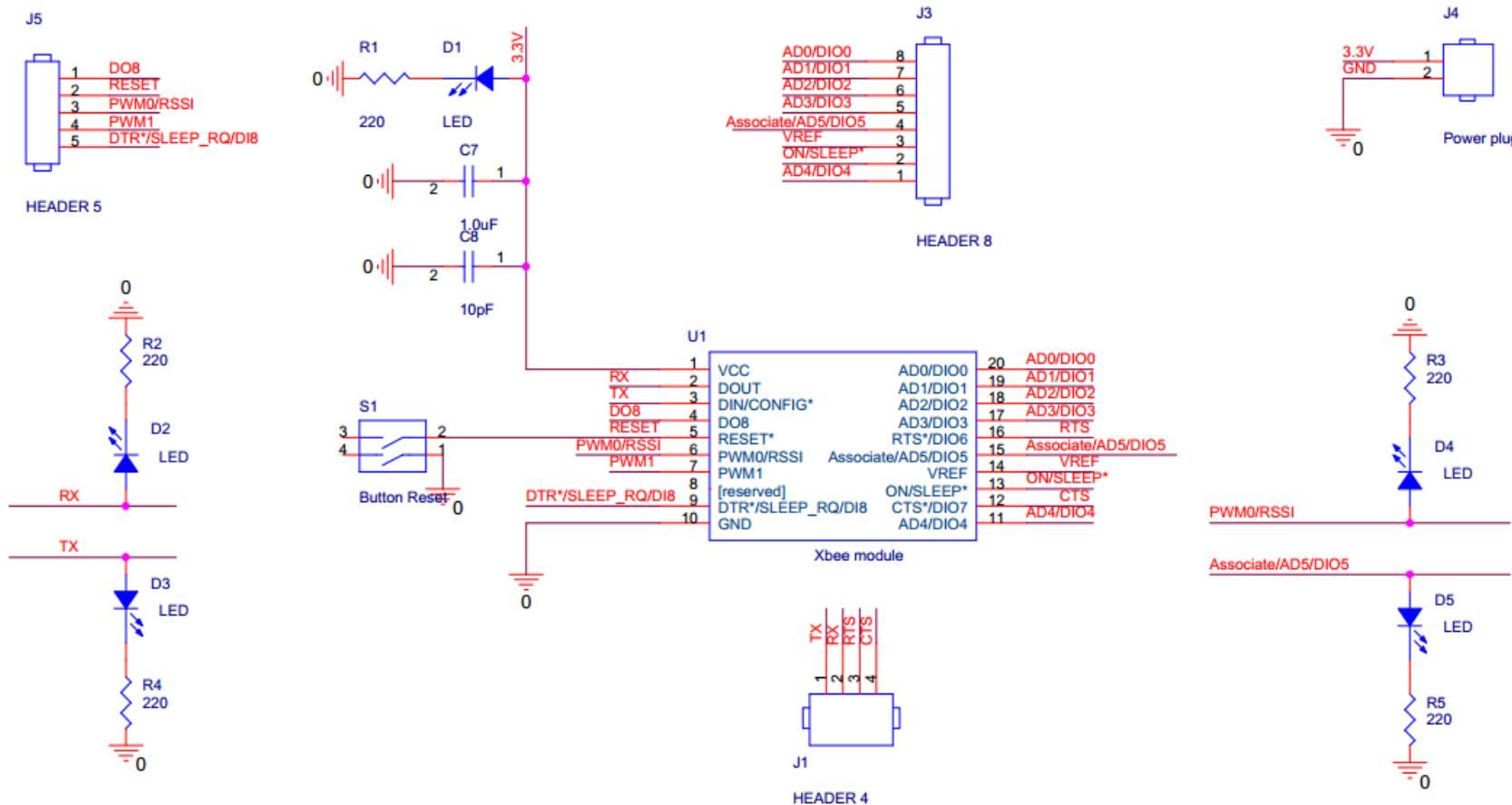


Figure 53: XBee module board schematic

## 1.11.b Layout

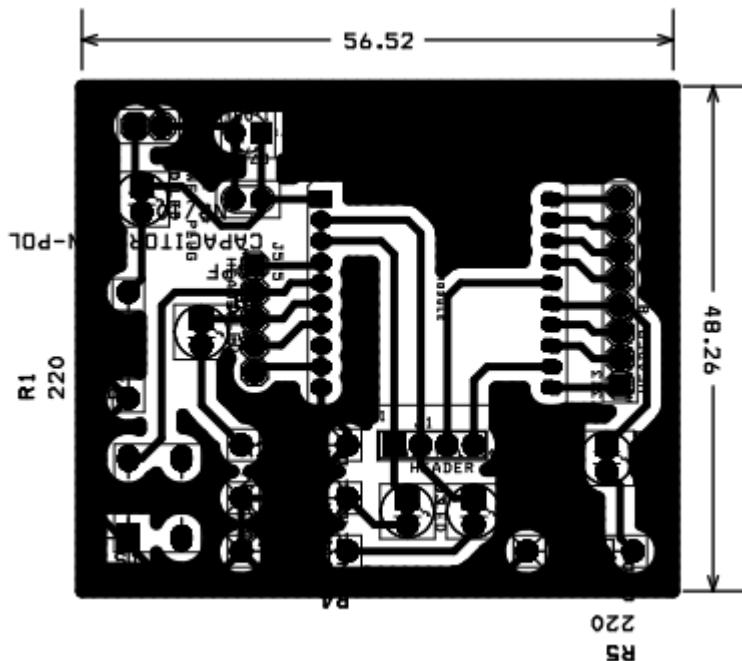


Figure 54: XBee module board layout

## 2. System software layer

## 2.1 *Operating system*

## Salvo RTOS (Real Time Operating System) for PIC 16F877a:

Salvo™RTOS is a cooperator, event driven, priority based, multi-tasking RTOS written in C with highly efficient memory utilization. It is ideally suited for use on Microchip PICmicro® devices. It is very easy to use, to employ standardized RTOS methods and terminology. This RTOS makes PIC micro programming a breeze, and includes:

- Over 40 callable user services in its API
  - Up to 16 separate dynamic task priority levels
  - Support for multiple event types
  - Timer-based services
  - Minimal call ... returns stack usage
  - Low interrupt latency and fast context switching

Every Salvo application must adhere to two “golden rules”:

1. Each task must have at least one context switch.
  2. Context switches may only occur in tasks.

For this application, Salvo was user-configured to provide the basic multi-tasking kernel, along with binary semaphore and message event services, as well as timer based delays. It automatically manages complex issues such as task scheduling, access to shared resources, inter-task communication, real-time delays, PICmicro RAM banking and interrupt control. With this multi-tasking RTOS foundation in place, the application programmer can concentrate on quickly and efficiently implementing the desired system functionality

## 2.2 DIA system

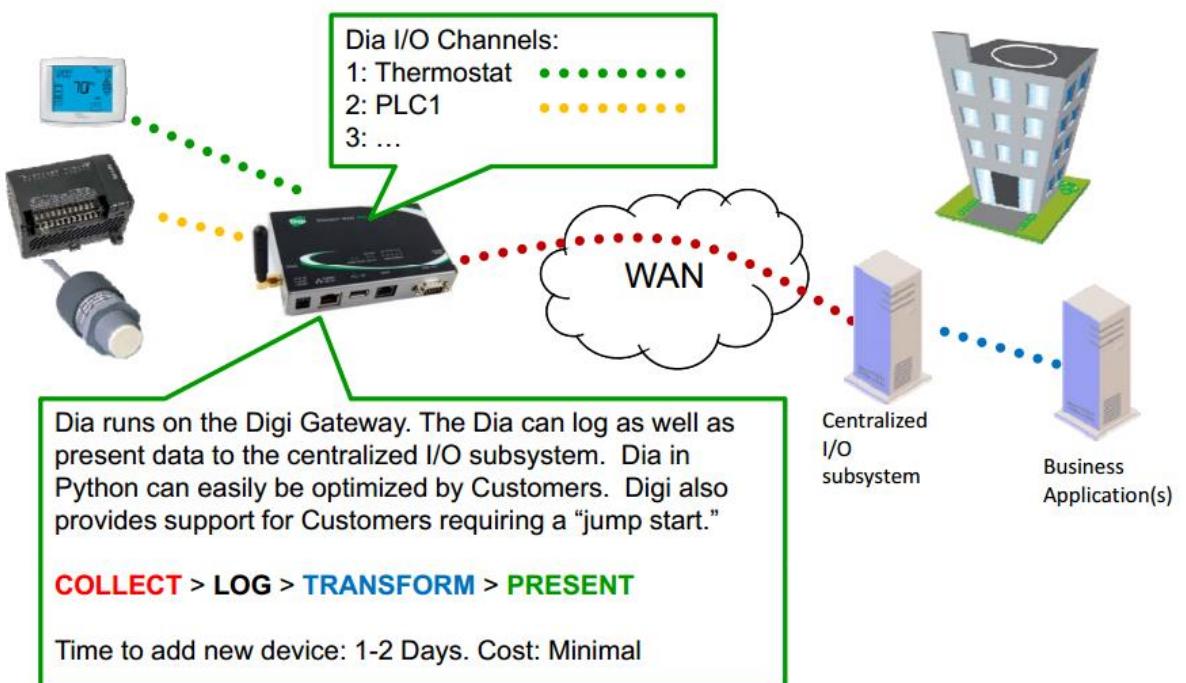


Figure 55: Overview of DIA system

iDigi Dia is software that runs on Digi gateways. It is NOT a solution in itself, but an enabler that dramatically accelerates building M2Msolutions.

Dia makes collecting and using remote data easy, providing a powerful environment for rapid M2M solution creation.

Dia collects& logs data from any device which can communicate with a Digi gateway. It also can change (transform) that data before presenting to a customer-defined application Device control further extends Dia's capabilities application. Device control further extends Dia's capabilities.

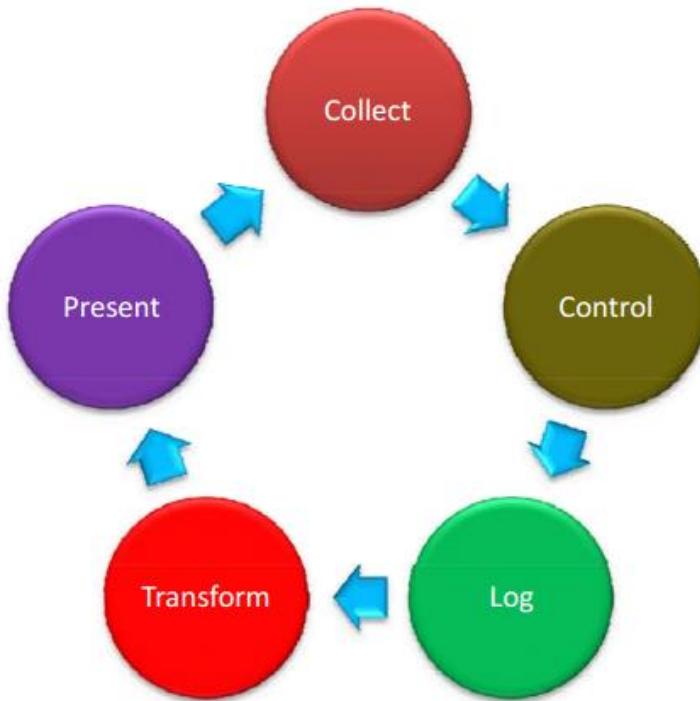


Figure 56: Operations of Dia system

Dia is written in the Python language, is supported by Digi, and is provided to customers for their use and optional customization.

Dia is free for iDigi customers to use with Digi products.

### 2.3 Middleware

**TCP/UDP, DHCP** are the protocol to transmit data from ConnnectPortX2 to host server.

**TCP**: Transmission Control Protocol

TCP is used for transmission of data from an application to the network.

TCP is responsible for breaking data down into IP packets before they are sent, and for assembling the packets when they arrive.

**DHCP**: Dynamic Host Configuration Protocol

DHCP is used for allocation of dynamic IP addresses to computers in a network.

**UDP**: User Datagram Protocol.

With UDP, computer applications can send messages, in this case referred to as datagrams, to other hosts on an IP network without prior communications to set up special transmission channels or data paths

**IEEE 802.15.4** is the protocol to transmit data from XBEE module router to Coordinator.

**IEEE 802.15.4:** is a standard which specifies the physical layer and media access control for low-rate wireless personal area networks. It is possible to build short-range wireless networking based solely on IEEE 802.15.4. **It is the protocol to transmit data from XBEE module router to Coordinator.**

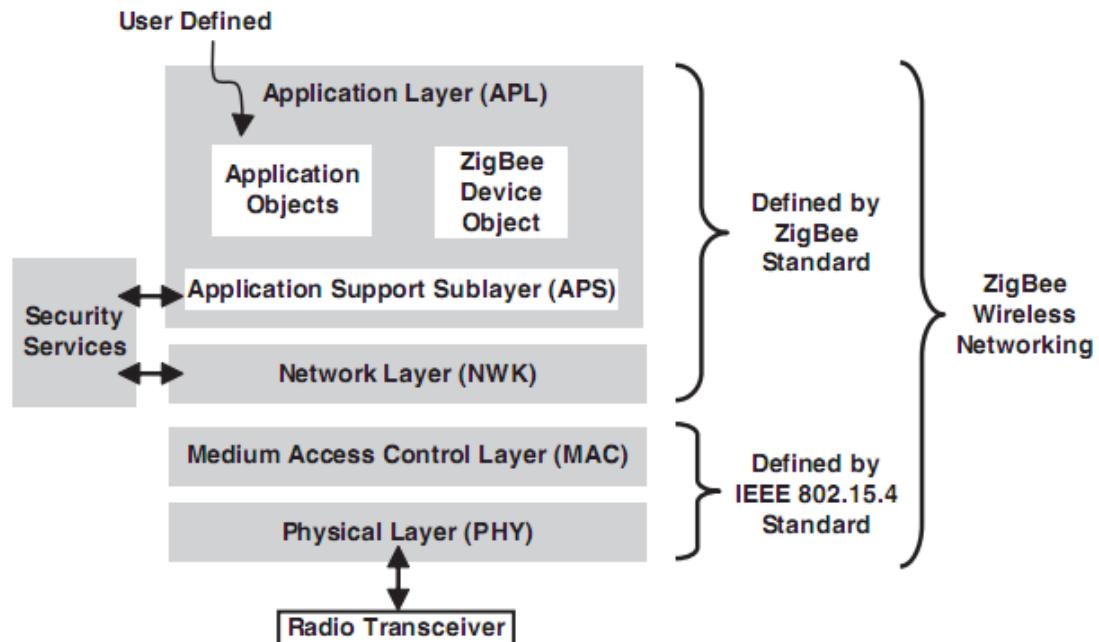


Figure 57: ZigBee Wireless Networking protocol layer

An IEEE 802.15.4 network, regardless of its topology, is always created by a PAN coordinator. The PAN coordinator controls the network and performs the following minimum duties:

- Allocate a unique address (16-bit or 64-bit) to each device in the network.
- Initiate, terminate, and route the messages throughout the network.
- Select a unique PAN identifier for the network. This PAN identifier allows the devices within a network to use the 16-bit short-addressing method and still be able to communicate with other devices across independent networks.

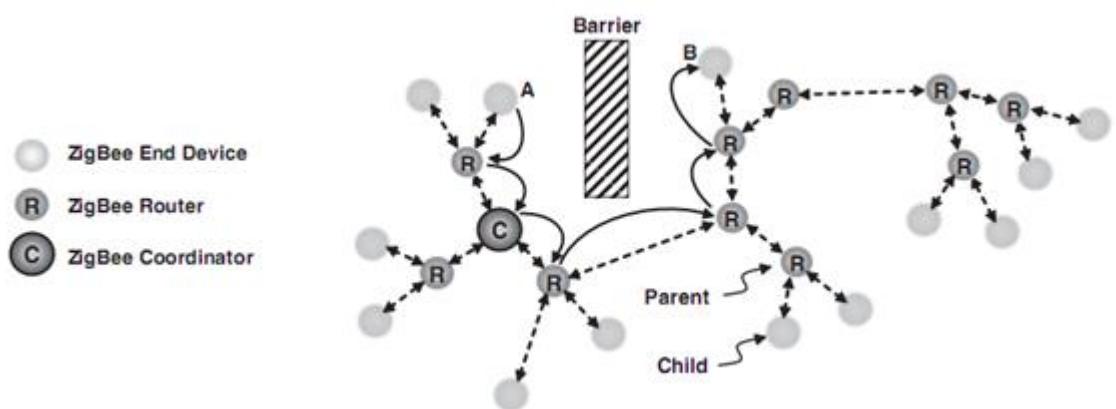


Figure 58: ZigBee tree topology

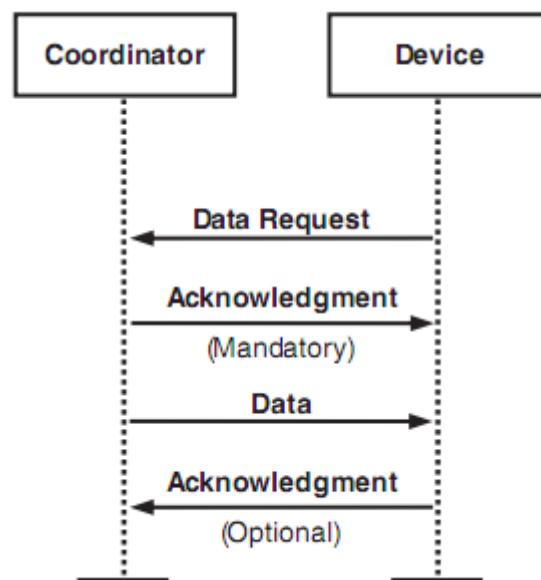


Figure 59: Data Transfer from a Coordinator to a Device using 802.15.4 protocol

## 2.4 ZigBee Routing Algorithm:

There are three types of devices in ZigBee networks. They are Coordinator, Router and End device. A ZigBee coordinator is responsible for initializing, maintaining and controlling the network. A star network has a coordinator with end devices directly connecting to the coordinator. For tree and mesh networks, ZigBee devices can communicate with each other in multi-hop fashion. The network is formed by one ZigBee coordinator and multiple ZigBee routers. A device can join a network as an end device by associating with a coordinator or a router.

Before forming a network, the coordinator determines the maximum number of children of a router ( $C_m$ ), the maximum number of child routers of a router ( $R_m$ ), and the depth of the network ( $L_m$ ) [5]. A child of a router can be a router or an end device, so ( $C_m \geq R_m$ ). Zigbee specifies a distributed address assignment using parameters  $C_m$ ,  $R_m$  and  $L_m$  to calculate the nodes network addresses. In Zigbee if a device joins a network successfully, it can obtain a network address from the coordinator or a router. The basic idea of the assignment is that for the coordinator and the routers in every layer, the whole address space is logically partitioned into  $R_m + 1$  block. The first  $R_m$  blocks are to be assigned to the router child devices and the last block is reserved for the  $(C_m - R_m)$  child end devices. In order to make the assignment easily, a function  $Cskip$  can be computed by  $C_m$ ,  $R_m$  and  $L_m$ . The value of this function is the size of address sub-block being distributed by each parent at the depth of its router child devices for a given network depth  $d$ .

$$Cskip(d) = \begin{cases} 1 + C_m(L_m - d - 1), & \text{if } R_m = 1 \\ \frac{1 + C_m - R_m - C_m R_m^{L_m - d - 1}}{1 - R_m}, & \text{otherwise} \end{cases} \quad (1)$$

$A_n$  is computed by the following formula.

$$A_n = A_{parent} + Cskip(d-1)R_m + n \quad (2)$$

Here  $A_{parent}$  denotes the address of the parents,  $n$  denotes the  $n^{th}$  end device, and  $1 \leq n \leq (C_m - R_m)$ . When Zigbee adopted the hierarchical routing algorithm and a device called  $X$  with address  $A$  and depth  $d$  received a packet, the device extracted the destination address called  $D$ .

$$N = \begin{cases} D, & \text{if } D > A + R_m \times Cskip(d) \\ A + 1 + \left\lceil \frac{D - (A + 1)}{Cskip(d)} \right\rceil \times Cskip(d), & \text{Otherwise} \end{cases} \quad (3)$$

If  $D > A + R_m \times Cskip(d)$ , the destination is the direct descendent of  $X$ , and  $X$  forward the packet to this direct descendent. If not, the destination is the indirect descendants of  $X$ , so  $X$  forward the packet to one of its child with address computed by

$$A + 1 + \left\lceil \frac{D - (A + 1)}{Cskip(d)} \right\rceil \times Cskip(d). \quad (4)$$

In this way the network address is assigned to the network elements in the Zigbee network using hierarchical routing.

### 3. Application software layer

#### 3.1 Web application

##### 3.1.a Class diagram

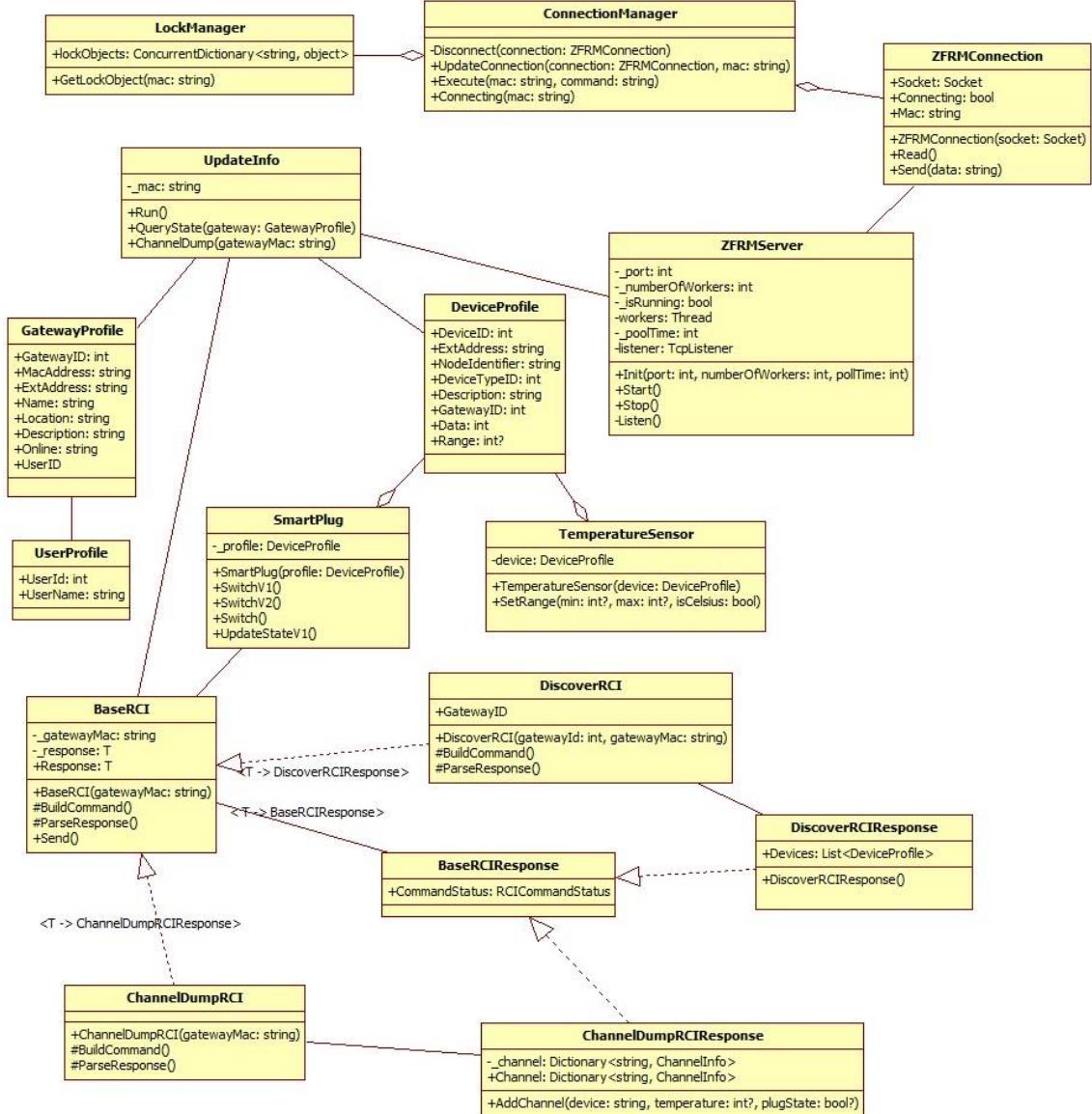


Figure 60: Class diagram of the website

### 3.1.b Update status of devices process

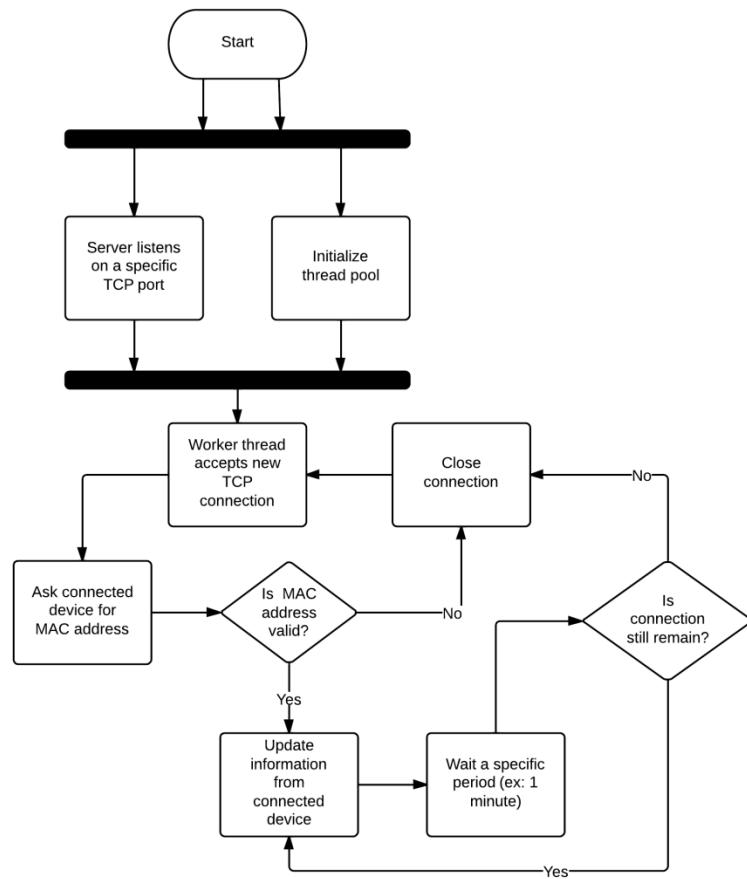


Figure 61: Update information of devices process

## 3.1.c Sequence diagram for turn ON/OFF of smart plug

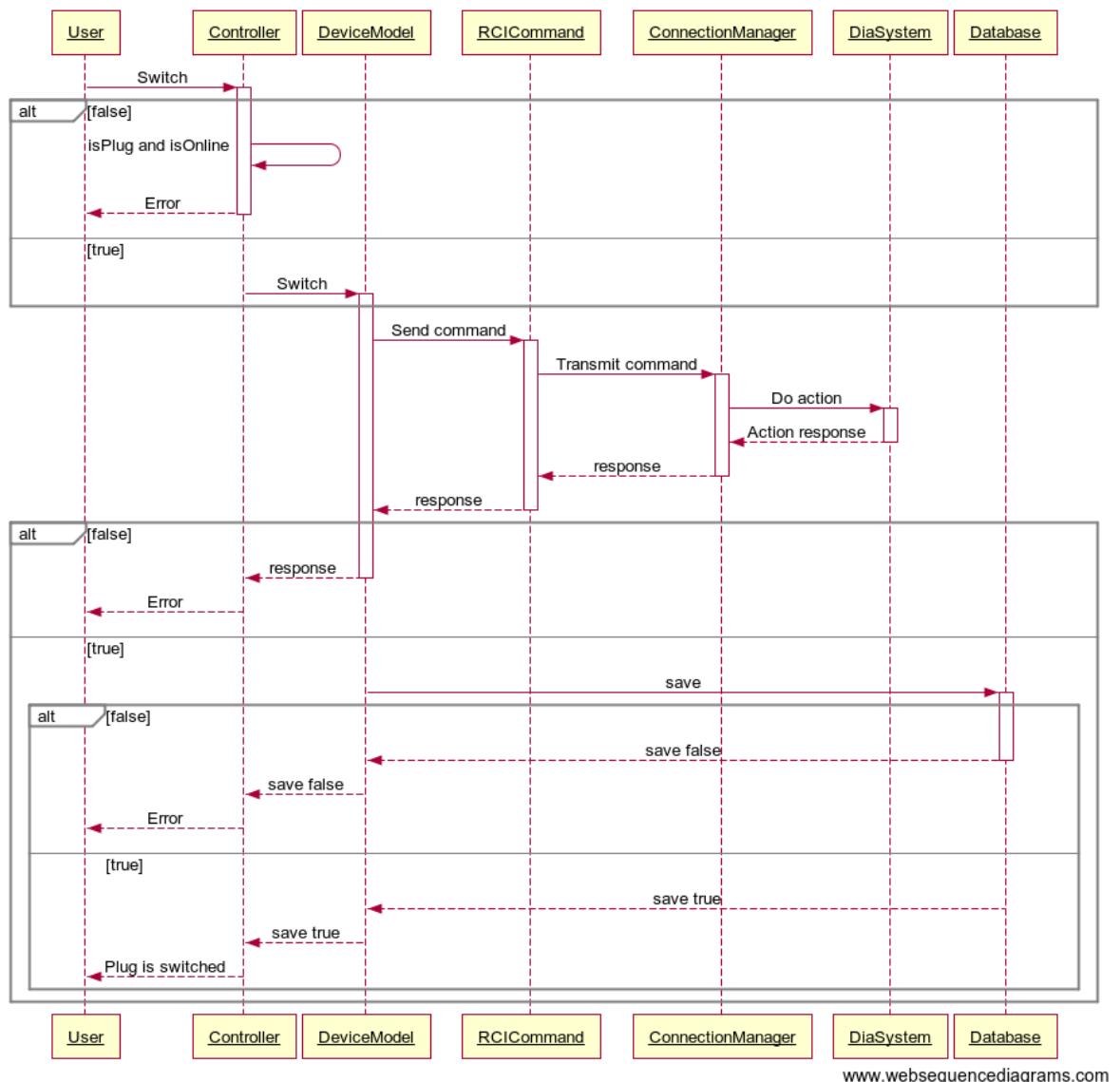


Figure 62: turn ON/OFF smart plug sequence

## 3.2 Android application

This design for user can control and manage the system by using Android device.

The user interface designed for suitable with Android smart phone. The operation method is almost the same as web application

## V. User interface

## 1. Web application

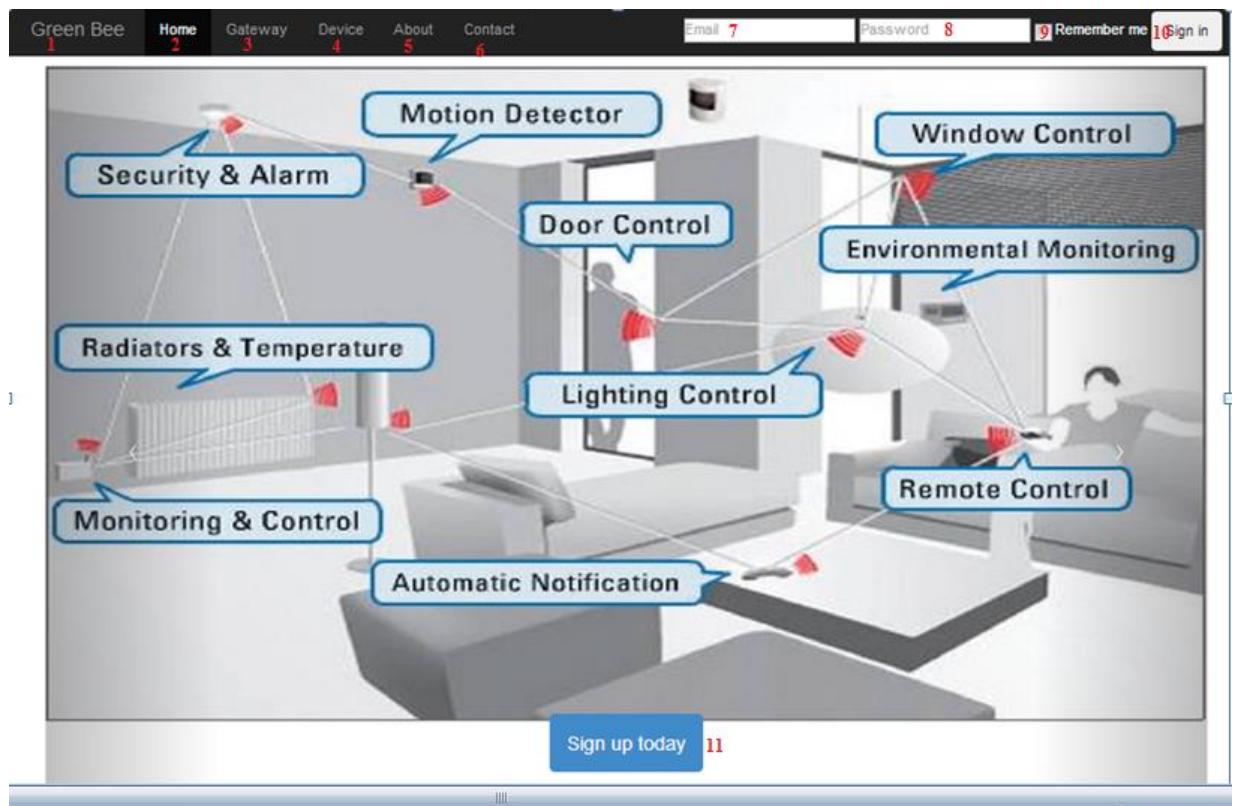


Figure 63: Web application UI – Home page screen

No.	Item	Description
1	Tab: Green Bee	Turn to the top of the page.
2	Tab: Home	Link to Home page
3	Tab: Gateway	Link to Gateway page
4	Tab: Device	Link to Devices page
5	Tab: About	Link to About page
6	Tab: Contact	Link to Contact page
7	Textbox: Email	Field for user to input email.
8	Textbox: Password	Field for user to input password.
9	Check box: Remember me	Check box for user to keep the account information
10	Button: Sign in	Sign in to system
11	Button: Sign up today	Sign up new account

Table 29: Web UI – Home page screen description

Figure 64: Web application UI – Gateway Page screen

No.	Item	Description
1	List: List of Gateway device	List of Gateway device with detail information
2	List: List of end devices	List of End devices with detail information
3	Button: Device	List of end device that Gateway have
4	Button: Scan	Scan for new device
5	Button: Detail Gateway	Detail information of Gateway
6	Button: Edit Gateway	Edit information of Gateway
7	Button: Delete Gateway	Delete one Gateway
8	Button: Detail end device	Detail information of end device
9	Button: Edit end device	Edit information of end device
10	Button: Delete end device	Delete one end device
11	Button: Add Gateway	Add new Gateway to system
12	Button: Refresh	Refresh the data and displayed updated data on screen.
13	Button: Value(ON/OFF)	Status of end devices. User can turn ON/OFF to change the status.
14	Check box: Status	The current status of end device in system. Check is for online. Uncheck is for offline

Table 30: Web UI – Gateway Page screen description

### Delete Gateway

Figure 65: Web application UI – Delete Gateway screen

No.	Item	Description
1	List: Gateway detail	List of Gateway device with detail information
2	List: Device detail	List of End devices with detail information
3	Button: Delete	Delete Gateway device
4	Button: Cancel	Cancel deleting processing.

Table 31: Web UI – Delete Gateway screen description

### Add Gateway

Figure 66: Web application UI – Add new Gateway device screen

No.	Item	Description
1	Textbox: MAC Address	MAC Address of Gateway device
2	Textbox: Gateway Name	Name of Gateway
3	Textbox: Location	Location of Gateway
4	Textbox: Description	Description about Gateway
5	Button: Create	Add new Gateway device to system
6	Button: Cancel	Cancel process.

Table 32: Web UI – Add new Gateway screen description

## Edit Gateway

Gateway Name: CP1 abc 2 **1**

Location: Ho Chi Minh **2**

Description: HCM 2 33 2 **3**

**4** **5**

Save Cancel

Figure 67: Web application UI – Edit info of Gateway device screen

No.	Item	Description
1	Textbox: Gateway Name	MAC Address of Gateway device
2	Textbox: Location	Location of Gateway
3	Textbox: Description	Description about Gateway
4	Button: Save	Save info of update data.
5	Button: Cancel	Cancel process.

Table 33: Web UI – Edit info of Gateway screen description

Green Bee Home Gateway Device About Contact

thuan@xt.com Sign out

Devices

1	2	3	4	5
Plug v1	11.22.33.44.55.66.77.88	Smart Plug	0	Online
Sensor	11.22.33.44.55.66.77.88	Temperature Sensor	0 °C	Online
Plug v2	11.22.33.44.55.66.77.88	Smart Plug	0	Online
Plug v1	11.22.33.44.55.66.77.88	Smart Plug	0	Online

Figure 68: Web application UI – Device screen.

No.	Item	Description
1	List: List of end devices	List of End devices with detail information
2	Button: Detail end device	Detail information of end device
3	Button: Edit end device	Edit information of end device
4	Button: Delete end device	Delete one end device
5	Button: Add Device	Add new end device to system
6	Button: Refresh	Refresh the data and displayed updated data

		on screen.
7	Button: Value(ON/OFF)	Status of end devices. User can turn ON/OFF to change the status.
8	Check box: Status	The current status of end device in system. Check is for online. Uncheck is for offline

Table 34: Web UI- Devices screen description

## Requesting Devices

Name	Ext Network Address	Type
Nhiệt độ 2	00:13:a2:00:40:61:bd:67	Temperature Sensor
Đèn cau thang 1	00:13:a2:00:40:61:bd:20	Smart Plug
Đèn nha bep	00:13:a2:00:40:aa:17:40	Smart Plug

Figure 69: Web application UI – Requesting End Device screen.

No.	Item	Description
1	Textbox: Name	Name of end device
2	List: List Request device	Display list of end device that are requesting
3	Button: Accept	Click to accept device to join to system
4	Button: Accepted	Status of end device
5	Button: Re-scan	Scan and update new end device that are waiting to join.

Table 35: Web UI- Requesting end device screen description

## Select Gateway

Gateway Name	MAC Address	Description	Location
CP1 abc 2 1	20:32:21:32:23:11	HCM 2 33 2	Ho Chi Minh
CP1 212	20:32:21:32:23:11	HCM as	Ho Chi Minh
CP1 test abc	20:32:21:32:23:11	HCM s sa	Ho Chi Minh s

Figure 70: Web application UI – Select Gateway screen.

No.	Item	Description
1	List: List of Gateway device	Display list of gateway device that have in system
2	Button: Select	Select Gateway that will add end device.

Table 36: Web UI- Select Gateway screen description

## Delete Device

Figure 71: Web application UI – Delete End Device screen.

No.	Item	Description
1	Button: Delete	Delete end device
2	Button: Cancel	Cancel deleting processing.
3	List: Device detail	List of end devices with detail information

Table 37: Web UI- Delete end device screen description

## Edit Device

Figure 72: Web application UI – Edit info of end device screen

No.	Item	Description
1	Textbox: Name	Name of device
2	Textbox: Description	Description of device
3	Textbox: Min temperature	The min temperature of sensor for safe.
4	Textbox: Max temperature	The max temperature of sensor for safe.
5	Check box: Temperature	Check when user want to notify about

	notification	temperature
6	Check box: Cancel notification	Check when user want to notify about plug
7	Button: Save	Save information of device
8	Button: Cancel	Cancel process

Table 38: Web UI – Edit info of end device screen description



## Contact

### Phone

Main: 083.8888.8888

After Hours: 083.7777.7777

### Email

Support: [YenTH@GreenBe.com](mailto:YenTH@GreenBe.com)

Marketing: [HungVP@GreenBee.com](mailto:HungVP@GreenBee.com)

General: [ThuanXT@GreenBee.com](mailto:ThuanXT@GreenBee.com)

Technical: [PhuongLN@GreenBee.com](mailto:PhuongLN@GreenBee.com)

### Address

Quang Trung Software City  
FPT University, Innovation Building

Figure 73: Web application UI – Contact screen



## About

### System Overview

- There is a server that can manage all the operation in system. Server will manage the information of users and their device. It also receive and send command to get the status of device and control the power or status of devices in system
- There is a ZigBee module acts as a master controller(Coordinator) for the entire network. It's also call gateway which offers connection to the internet via Wifi and Ethernet
- There are several ZigBee modules act as routers to connect the master controller to end devices
- The end devices are integrated which ZigBee modules (XBEE module) can send data and receive command from other ZigBee modules (XBEE module)
- The master controller will provide information of the system to server and also receive commands from it
- The end users use the Device Manager (web application on PC/Laptop or Application on Mobile phone) connects with the server's service to control the whole system: configure device, update devices' status, send commands to devices...

### Zigbee Network Topology

- Pair:** The simplest network is one with just two radios, or nodes. One node must be a coordinator so that the network can be formed. The other can be configured as a router or an end device
- Star:** This network arrangement is also fairly simple. A coordinator radio sits at the center of the star topology and connects to a circle of end devices. Every message in the system must pass through the coordinator radio, which routes them as needed between devices. The end devices do not communicate with each other directly
- Mesh:** The mesh configuration employs router nodes in addition to the coordinator radio. These radios can pass messages along to other routers and end devices as needed. The coordinator (really just a special form of router) acts to manage the network. It can also route messages. Various end devices may be attached to any router or to the coordinator. These can generate and receive information, but will need their parent's help to communicate with the other nodes
- Cluster tree:** This is a network layout where routers form a backbone of sorts, with end devices clustered around each router. It is not very different from a mesh configuration

Figure 74: Web application UI – About screen.

## 2. Android application

### 2.1 Main



Figure 75: Android application UI - Home screen

No.	Item	Description
1	Button: Login	Move to the login screen.

Table 39: Android UI - Home screen description

### 2.2 Login

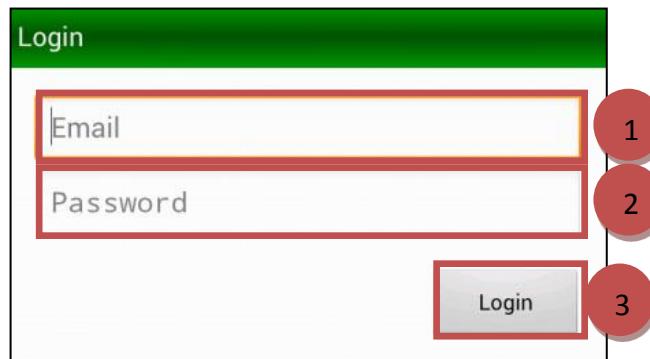


Figure 76: Android application UI - Login screen

No.	Item	Description
1	TextBox: Username	Input user name.
2	TextBox: Password	Input password.
3	Button: Login	Login account, if success, move to Home screen.

Table 40: Android UI - Login screen description

### 2.3 Home



Figure 77: Android application UI - Home screen

No.	Item	Description
1	Button: Exit	Return you to the device's "home screen".
2	Button: Device	Move to the Device Management screen.
3	Button: About	Move to the About screen.
4	Button: Help	Move to the Help screen.
5	Button: Logout	Logout account and move to the Login screen.

Table 41: Android UI - Home screen description

### 2.4 Device management



Figure 78: Android application UI - Device management screen

No.	Item	Description
1	Button: Home	Return to Home screen
2	Button: Refresh	Reload devices profile.
3	Button: Gateway	List all devices belong gateway.
4	View: Device	Display device profile.

Table 42: Android UI - Device management screen description

## 2.5 Smart plug

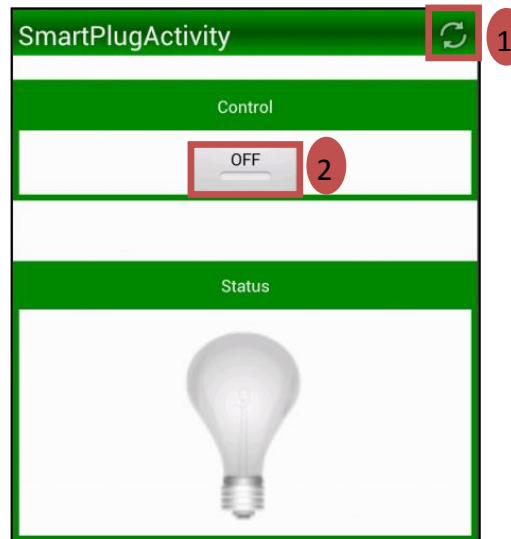


Figure 79: Android application UI – Smart Plug screen

No.	Item	Description
1	Button: Refresh	Reload device profile.
2	Button: ON/OFF	Switch on/off the light.

Table 43: Android UI - Smart Plug screen description

## 2.6 Temperature sensor

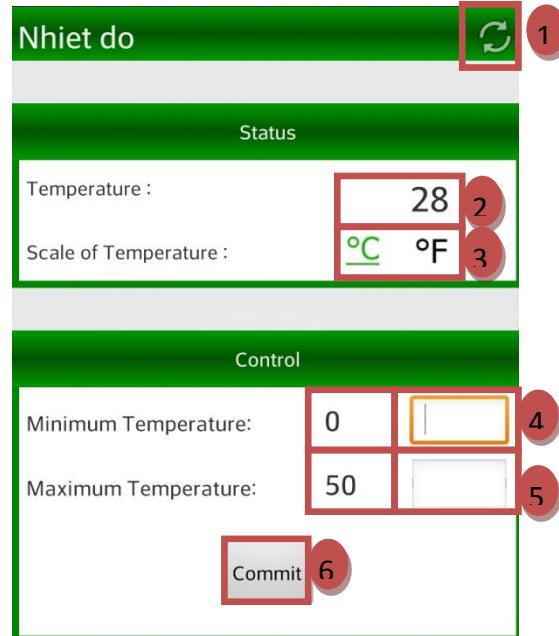


Figure 80: Android application U - View temperature screen

No.	Item	Description
1	Button: Refresh	Reload device profile.
2	TextView: Temperature	Display Temperature.
3	Radio Button: Scale of	Choose scale of temperature is °C or °F.

	Temperature	
4	TextView + Edit Text: Minimum Temperature	TextView: Display minimum temperature user was set. EditText: User input minimum teperature.
5	TextView + Edit Text: Maximum Temperature	TextView: Display maximum temperature user was set. EditText: User input maximum teperature.
6	Button: Commit	Commit maximun and minimun temperature, which were set by user to the server.

Table 44: Android UI - View temperature screen description

## E. Software Test Documentation

### I. Introduction

#### 1. System overview

In this section, there has all necessary information about test plan, test process, test approach, the environment for testing, test pass/fail criteria, test results and a checklist to check when test this system.

#### 2. Test Approach

White box testing: Developers self-test on code in which function they developed (unit test).

Black box testing: Test on each function of each module in system to ensure each module execute the right function. Then integration testing to test the function in system when integrate. Finally, system test to test the whole system.

Goal: Discover bug in system -> fix bug -> regression test-> completed system.

### II. Test Plan

The purpose of this phase is to list and verify the function in system that need to be tested and the plan for completing it. In this process, we will check to ensure that function meet specification and requirement in system. Bugs (errors) will not occur after testing.

The next content will describe which function will be tested and which will not and plan for them.

#### 1. Features to be tested

Item to Test	Test Description	Test date	Responsibilities
Real device	Test Smart Plug(+XBEE) device	20-27/7/2013	- ThuanXT
	Test Sensor(+XBEE) device	20-27/7/2013	- ThuanXT - PhuongLN
	Test Connect Port	10-15/7/2013	- PhuongLN
Web application	Test List gateway: - Add gateway - Edit - Delete - Show detail - Scan device	20-31/7/2013	- HungVP
	Test List device: - Show list device - Edit - Delete	20-31/7/2013	- YenTH

	<ul style="list-style-type: none"> <li>- Turn On/Off</li> <li>- Display temperature</li> </ul>		
Android application	<b>Test List gateway:</b> <ul style="list-style-type: none"> <li>- Show detail</li> </ul>	1/-5/8/2013	- HungHV
	<b>Test List device:</b> <ul style="list-style-type: none"> <li>- Show list device</li> <li>- Turn On/Off</li> <li>- Display temperature</li> </ul>	1/-5/8/2013	- YenTH

Table 45 - Features to be tested

## 2. Features not to be tested

Log in/Log out function

## 3. Test environment

Web application: test on Internet Explorer (version 9.0, 10.0), Firefox (newest version), Chrome (newest version), OS: Win 7

Android application: test on Android OS 4.0

## 4. Test pass/fail criteria

Depend on significant the problem is. It affects a critical function or a peripheral one.

For system testing, the criteria are:

- 90% of the test cases must pass
- All test cases dealing with critical functionality must pass
- All medium and high severity defects must be fixed
- Test coverage must be at least 90%

## III. Test Case

## 1. Test on real device: Smart Plug and Temperature sensor

### 1.1 Integration test: Functional test between Smart Plug/Temperature sensor module and XBEE module

No.	Function			Pre-condition	Step of testing	Expected result	Created by	Executed by	Result
	Large function	Medium function	Small function						
1	Operate Smart Plug(+XBEE) device	Convert voltage	Convert 220V~AC from power supply to 5V~DC to supply energy to relay	Input <220V~AC(200V-220V)	1. Connect SmartPlug device to power source. 2. Measure voltage input to the relay, by using Digital Multimeter (DM).	The result measured by DM is 5V~DC ( $\pm 0.05\%$ )	HungVP	ThuanXT	Passed
2				Input 220V	1. Connect SmartPlug device to power source. 2. Measure voltage input to the relay, by using DM.	The result measured by DM is 5V~DC ( $\pm 0.05\%$ )	HungVP	ThuanXT	Passed
3				Input >220V~AC	1. Connect SmartPlug device to power source. 2. Measure voltage input to the relay, by using DM.	The result measured by DM is 5V~DC ( $\pm 0.05\%$ )	HungVP	ThuanXT	Passed
4			Convert from 5V~DC of LM7805 to 3.3V~DC to supply energy to XBEE module	Input 5V~DC ( $\pm 0.05\%$ )	Measure voltage input to the XBEE module by using DM.	The result measured by DM is 3.3V~DC ( $\pm 0.05\%$ )	HungVP	ThuanXT	Passed
5				Input exactly 5V~DC	Measure voltage input to the XBEE module by using DM.	The result measured by DM is 3.3V~DC ( $\pm 0.05\%$ )	HungVP	ThuanXT	Passed

## ZigBee for Remote Management

6	XBEE module operates relay	XBEE module controls to turn ON device	XBEE module can receive request from server. Device is turned OFF	1. Set PIN D0 of XBEE module in Smartplug to 1. 2. Connect SmartPlug's plug to power source and household appliance (light) to SmartPlug's outlet.	Light is turned ON	PhuongLN	PhuongLN	Passed
7								
8								
9		Quality control	Open circuit	Use DM to check all PIN in board.	Circuit in board is not an open-circuit	HungVP	ThuanXT	Passed
10			Convert voltage	Use DM to check all PIN in board.	Circuit in board is not a short-circuit	HungVP	ThuanXT	Passed

## ZigBee for Remote Management

11	Operate of Temperature sensor(+XBEE) device	Convert voltage	Convert 5V~DC from USB port to 3,3V~DC to supply energy for XBEE module		1. Connect Temperature sensor device to USB port 2. Use DM to measure the input of voltage of XBEE	The result measured by DM is 3.3V~DC ( $\pm 0.05\%$ )	ThuanXT	ThuanXT	Passed
12		XBEE modules operate Temperature Sensor Device	Microcontroller get data from sensor LM35		1. Connect Temperature sensor device to USB port 2. Use bread board to connect microcontroller's pins to 7-segment LED, and display data was received from the sensor to LED	Temperature value displayed by LED approximately equals to temperature value of current environment	ThuanXT	ThuanXT	Passed
13		XBEE module receive data from Temperature sensor device	XBEE modules work properly		1. Configure XBee module A's destination address is XBee module B 2. Connect XBee module A's UART pins to microcontroller of the Temperature sensor device 3. Connect Temperature sensor device to USB port. 4. Connect XBEE module B to PC, read data received XBee module A	Temperature value read in PC approximately equals to temperature value of current environment	ThuanXT	PhuongLN	Passed
14		Quality control	Open circuit		Use DM to check all PIN in board.	Circuit in board is not an open-circuit	HungVP	ThuanXT	Passed

15			Convert voltage		Use DM to check all PIN in board.	Circuit in board is not a short-circuit	HungVP	ThuanXT	Passed
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Table 46 - Test cases for functional test of real device testing

### 1.2 Performance test (load and stress testing) of Smart Plug and Temperature sensor

No.	Pre-condition	Step of testing	Point of view	Create by	Executed by	Result
1	Put device in normal environment(30 degree C)	Connect the Smart Plug board to power supply. Turn on the Smart Plug board and keep this status for 2 days	1. Smart Plug board should operate normally. 2. The temperature of board will be kept in safe range for end user and things around it. 3. There is no problem happen with components in board such as: fire and explosion, electric shock or short circuit.	YenTH	PhuongLN	Passed
2	Put device in normal environment(30 degree C)	Connect the Temperature sensor board to the power supply. Keep its status is ON for 2 days.	1. Temperature sensor board should operate normally. 2. The temperature of board will be kept in safe range for end user and things around it. 3. There is no problem happen with components in board such as: fire and explosion, electric shock or short circuit. 4. Test the temperature display on screen is approximately equal to the temperature of real environment	YenTH	PhuongLN	Passed

## ZigBee for Remote Management

3	Put device in special environment( $30 < t < 45$ , $t < 20$ degree C)	Connect the Smart Plug board to power supply. Turn on the Smart Plug board and keep this status for 2 days	<ol style="list-style-type: none"> <li>1. Smart Plug board should operate normally.</li> <li>2. The temperature of board will be kept in safe range for end user and things around it.</li> <li>3. There is no problem happen with components in board such as: fire and explosion, electric shock or short circuit.</li> </ol>	YenTH	PhuongLN	Passed
4	Put device in special environment( $30 < t < 45$ , $t < 20$ degree C)	Connect the Temperature sensor board to the power supply. Keep its status is ON for 2 days.	<ol style="list-style-type: none"> <li>1. Temperature sensor board should operate normally.</li> <li>2. The temperature of board will be kept in safe range for end user and things around it.</li> <li>3. There is no problem happen with components in board such as: fire and explosion, electric shock or short circuit.</li> <li>4. Test the temperature display on screen is approximately equal to the temperature of real environment</li> </ol>	YenTH	PhuongLN	Passed
5	Put device in normal environment(30 degree C)	Turn ON and then turn OFF the switch of Smart Plug board. Repeat this action for 20 times.	<ol style="list-style-type: none"> <li>1. Smart Plug board should operate normally.</li> <li>2. The power that turned on or off matched with the status on/off of switch.</li> <li>3. There is no problem happen with components in board such as: fire and explosion, electric shock or short circuit.</li> </ol>	YenTH	PhuongLN	Passed

6	Put device in normal environment(30 degree C)	Plug/unplug power source of the temperature sensor for about 10 times	1. Temperature sensor board should operate normally. 2. The temperature display on screen is approximately equal to the temperature of real environment. 3. There is no problem happen with components in board such as: fire and explosion, electric shock or short circuit.	YenTH	ThuanXT	Passed
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Table 47 : Test cases for performance test of real device testing

### 1.3 Integration test: Functional test when integrate End device -XBEE module- Connect Port module

No.	Function			Pre-condition	Step of testing	Expected result	Created by	Executed by	Result
	Large function	Medium function	Small function						
1	Operatio n when integrate modules	Connection between modules	Connection between Connect port and Temperature sensor device(+XBEE module)	N/A	Turn on Connect Port X Turn on Temperature sensor and connect with XBee module	The led connect with RSSI PIN of XBEE module is turned ON	ThuanXT	ThuanXT	Passed
2			Connection between Connect port and Smart plug V1 device(+XBEE module)		1. Turn on Connect Port and provide power source for Smart Plug V1 2. Use Connect Port to set PIN 20 of XBEE module to 5 (Output High)	The led connect with PIN 20 of XBEE module in PlugV1 board is turned ON			

## ZigBee for Remote Management

3		Connection between Connect port and Smart plug V2 device(+XBEE module)	N/A	1. Turn on Connect Port and provide power source for Smart Plug V2 2. Use Connect Port to set PIN 20 of XBEE module to 5 (Output High)	The led connect with PIN 18, 19, 20 of XBEE module in PlugV2 board is turned ON	ThuanXT	ThuanXT	Passed
4	Operation between modules	Request/Receive to get status data between Connect port and Temperature sensor.	N/A	1. Turn on Connect Port and run DIA system 2. Provide power source for Temperature Sensor (attached with XBee module) 3. Send request to server RCI of Connect port( url <a href="http://[connect_ip]/UE/rci">http://[connect_ip]/UE/rci</a> ) The content of request is command [channel_dump] in xml format	Receive response in xml format; response contains information of temperature device: name, value of temperature.	PhuongL N	PhuongL N	Passed

## ZigBee for Remote Management

5		Request/Receive to get status data between Connect port and Smart Plug V1	N/A	1. Turn on Connect Port 2. Provide power source for Smart Plug V1 3. Send request to server RCI of Connect port( url <a href="http://[connect_ip]/UE/rci">http://[connect_ip]/UE/rci</a> ) The content of request is command [query_setting] in xml format	Receive response in xml format; response contains information of Smart Plug V1 device: current value of pin D0, value(5 for ON/4 for OFF)	PhuongL N	PhuongL N	Passed
6		Request/Receive to get status data between Connect port and Smart Plug V2	N/A	1. Turn on Connect Port and run DIA system 2. Provide power source for Smart Plug V2 3. Send request to server RCI of Connect port( url <a href="http://[connect_ip]/UE/rci">http://[connect_ip]/UE/rci</a> ) The content of request is command [channel_dump] in xml format	Receive response in xml format; response contains information of Smart plug V2 device: name, State (true for ON/false for OFF), value of temperature.	PhuongL N	PhuongL N	Passed

## ZigBee for Remote Management

7		Request/Receive data between Connect port and Smart Plug V1 to turn ON plug	N/A	1. Turn on Connect Port 2. Provide power source for Smart PlugV1 3. Send request to server RCI of Connect port( url <a href="http://[connect_ip]/UE/rcl">http://[connect_ip]/UE/rcl</a> ) The content of request is command [set_setting] in xml format to set pin D0 of XBee module in SmartPlug's board to 5 (output high)	Receive response in xml format; response doesn't have any tag "error". The power of Smart Plug V1 device is turned ON	PhuongL N	PhuongL N	Passed
8		Request/Receive data between Connect port and Smart Plug V2 to turn ON plug	N/A	1. Turn on Connect Port and run DIA system 2. Provide power source for Smart Plug V2 3. Send request to server RCI of Connect port( url <a href="http://[connect_ip]/UE/rcl">http://[connect_ip]/UE/rcl</a> ) The content of request is command [channel_set] in xml format to update channel "State" of SmartPlug V2's driver to true (means on)	Receive response in xml format; response doesn't have any tag "error". The power of Smart Plug V2 device is turned ON	PhuongL N	PhuongL N	Passed

## ZigBee for Remote Management

9		Request/Receive data between Connect port and Smart Plug V1 to turn OFF plug	N/A	1. Turn on Connect Port 2. Provide power source for Smart PlugV1 3. Send request to server RCI of Connect port( url <a href="http://[connect_ip]/UE/rcl">http://[connect_ip]/UE/rcl</a> ) The content of request is command [set_setting] in xml format to set pin D0 of XBee module in SmartPlug's board to 4 (output low)	Receive response in xml format; response doesn't have any tag "error". The power of Smart Plug V1 device is turned OFF	PhuongL N	PhuongL N	Passed
10		Request/Receive data between Connect port and Smart Plug V2 to turn OFF plug	N/A	1. Turn on Connect Port and run DIA system 2. Provide power source for Smart Plug V2 3. Send request to server RCI of Connect port( url <a href="http://[connect_ip]/UE/rcl">http://[connect_ip]/UE/rcl</a> ) The content of request is command [channel_set] in xml format to update channel "State" of SmartPlug V2's driver to false (means off)	Receive response in xml format; response doesn't have any tag "error". The power of Smart Plug V2 device is turned OFF	PhuongL N	PhuongL N	Passed

## ZigBee for Remote Management

11			<p>Request/Receive data between Connect port and multiple devices (Temperature sensor, Smart plug V1, Smart Plug V2, XBEE module) to:</p> <ul style="list-style-type: none"> <li>- Turn ON Smart plug V1.</li> <li>- Turn ON Smart plug V2.</li> </ul>	N/A	<p>1. Turn on Connect Port and run DIA system</p> <p>2. Provide power source for Smart Plug V2</p> <p>3. Send request to server RCI of Connect port( url <a href="http://[connect_ip]/UE/rcl">http://[connect_ip]/UE/rcl</a>) The content of request is command [set_setting] in xml format to set pin D0 of XBee module in SmartPlug V1's board to 5 (output high)</p> <p>4. Send request to server RCI of Connect port( url <a href="http://[connect_ip]/UE/rcl">http://[connect_ip]/UE/rcl</a>) The content of request is command [channel_set] in xml format to update channel "State" of SmartPlug V2's driver to true (means on)</p>	<p>Receive response in xml format; responses don't have tag "error".</p> <p>The power of Smart Plug V1, V2 device are turned ON</p>		YenTH	PhuongLN	Passed
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## ZigBee for Remote Management

12			<p>Request/Receive data between Connect port and multiple devices (Temperature sensor, Smart plug V1, Smart Plug V2, XBEE module) to:</p> <ul style="list-style-type: none"> <li>- Turn ON Smart plug V1.</li> <li>- Turn OFF Smart plug V2.</li> </ul>	N/A	<p>1. Turn on Connect Port and run DIA system</p> <p>2. Provide power source for Smart Plug V2</p> <p>3. Send request to server RCI of Connect port( url <a href="http://[connect_ip]/UE/rci">http://[connect_ip]/UE/rci</a>) The content of request is command [set_setting] in xml format to set pin D0 of XBee module in SmartPlug V1's board to 5 (output high)</p> <p>4. Send request to server RCI of Connect port( url <a href="http://[connect_ip]/UE/rci">http://[connect_ip]/UE/rci</a>) The content of request is command [channel_set] in xml format to update channel "State" of SmartPlug V2's driver to off (means off)</p>	<p>Receive response in xml format; responses don't have tag "error".</p> <p>The power of Smart Plug V1 is turned ON, Smart Plug V2 is turn OFF</p>	YenTH	PhuongLN	Passed
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## ZigBee for Remote Management

13			Request/Receive data between Connect port and multiple device (Temperature sensor, Smart plug V1, Smart Plug V2, XBEE module) to: - Turn OFF Smart plug V1. - Turn ON Smart plug V2.	N/A	1. Turn on Connect Port and run DIA system 2. Provide power source for Smart Plug V2 3. Send request to server RCI of Connect port( url <a href="http://[connect_ip]/UE/rcl">http://[connect_ip]/UE/rcl</a> ) The content of request is command [set_setting] in xml format to set pin D0 of XBee module in SmartPlug V1's board to 4 (output low) 4. Send request to server RCI of Connect port( url <a href="http://[connect_ip]/UE/rcl">http://[connect_ip]/UE/rcl</a> ) The content of request is command [channel_set] in xml format to update channel "State" of SmartPlug V2's driver to true (means on)	Receive response in xml format; responses don't have tag "error". The power of Smart Plug V1 is turned OFF, Smart Plug V2 is turn ON.	YenTH	PhuongLN	Passed
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## ZigBee for Remote Management

14			<p>Request/Receive data between Connect port and multiple device(Temperature sensor, Smart plug V1, Smart Plug V2, XBEE module) to:</p> <ul style="list-style-type: none"> <li>- Turn OFF Smart plug V1.</li> <li>- Turn OFF Smart plug V2.</li> </ul>	N/A	<p>1. Turn on Connect Port and run DIA system  2. Provide power source for Smart Plug V2  3. Send request to server RCI of Connect port( url <a href="http://[connect_ip]/UE/rcl">http://[connect_ip]/UE/rcl</a>)  The content of request is command [set_setting] in xml format to set pin D0 of XBee module in SmartPlug V1's board to 4 (output low)  4. Send request to server RCI of Connect port( url <a href="http://[connect_ip]/UE/rcl">http://[connect_ip]/UE/rcl</a>)  The content of request is command [channel_set] in xml format to update channel "State" of SmartPlug V2's driver to off (means off)</p>	<p>Receive response in xml format; responses don't have tag "error".  The power of Smart Plug V1, V2 device are turned OFF</p>	YenTH	PhuongLN	Passed
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Table 48 : Test cases for integrating 3 modules: Connect Port, XBEE and end device

## 2. Test on Web Application (Use Internet Explorer, Firefox, Chrome in OS Win 7)

No.	Function			Pre-condition	Step of testing	Expected result	Created by	Executed by	Result
	Large function	Medium function	Small function						
1	Web application	Gateway	Show list of Gateway device	At least one gateway device has been added into the system.	Log in with correct user name and password	<ul style="list-style-type: none"> <li>Link to Gateway device page.</li> <li>Get data of Gateway from server.</li> <li>The information (No. , MAC address) of each Gateway device is displayed successfully with the function: Detail, Edit, Delete, Device List, Scan Device for each device</li> </ul>	YenTH	HungVP	Passed
2				No Gateway device has been added before.	Log in with correct user name and password	<ul style="list-style-type: none"> <li>Get data of Gateway from server.</li> <li>If there is no data of Gateway in server, show the message that "No Gateway device added."</li> </ul>			

## ZigBee for Remote Management

3	Add new gateway	Log in successfully New Gateway device is running and can be connected through LAN/WAN	1. In the Gateway device page, click on "Add New Gateway" link 2. Enter the MAC address of Gateway device, Name, IP Address, Port, Username, and Password of Gateway in textbox. 3. Click "Create" button 4. Click "Back to list" link	1. Link to Create Gateway page 2. Valid the data if the data input is invalid 3. Get the data, update and then store in server 4. Update the list of Gateway device with the new Gateway device in Gateway device page.	YenTH	HungVP	Passed
4	Detail of Gateway	Gateway device has been added into the system.	In the Gateway device page, click on the "Detail" link of device	<ul style="list-style-type: none"> <li>Get data of Gateway from server.</li> <li>Display information of Gateway device: Name, MAC Address, Location, Description, Port, Status, Current IP.</li> </ul>	YenTH	HungVP	Passed
5	Edit information of Gateway	Gateway device has been added into the system.	1. In the Gateway device page, click on the "Edit" link of device 2. Edit the information of field: Name, Location, and Description. 3. Click on Save button 4. Click "Back to list" link, click "Detail" link of device	1. Link to Edit Gateway page 3. Update the new data to server 4. The information of device is updated successfully with the new data.	YenTH	HungVP	Passed

## ZigBee for Remote Management

6			Delete Gateway device	Gateway device has been added into the system.	<ol style="list-style-type: none"> <li>1. In the Gateway device page, click on the "Delete" link of device</li> <li>2. Click "Delete" button to confirm delete</li> <li>3. Click "Back to list" link.</li> </ol>	<ol style="list-style-type: none"> <li>1. Link to Delete page with warning of deleting.</li> <li>2. Delete the data of Gateway device in server</li> <li>3. Update the list of Gateway device list.</li> </ol>	YenTH	HungVP	Passed
7			List end devices of each Gateway	Gateway has been added into the system. At least one Gateway's end device has been added into the system.	In the Gateway device page, click on the "Device List" link of device	<ul style="list-style-type: none"> <li>• Link to the Device list of Gateway corresponding to the Gateway ID.</li> <li>• Get data of devices of that Gateway from server.</li> </ul> <p>The list of devices is displayed successfully</p>	YenTH	HungVP	Passed
8				Gateway has been added into the system. No end device has been added into the system.	In the Gateway device page, click on the "Device List" link of device	<ul style="list-style-type: none"> <li>• Get data of devices of that Gateway from server.</li> <li>• If there has no data of device, show the message that "No device added."</li> </ul>	YenTH	HungVP	Passed
9			Scan end devices of each Gateway	Testing Gateway device has been added in system. Testing Gateway device is running and can be connected through LAN/WAN	In the Gateway device page, click on the "Scan" icon of device	<ul style="list-style-type: none"> <li>• Scan end device -&gt;Get list of requesting device on server -&gt; List of requesting end device on Requesting Device page.</li> <li>• In the Requesting Device page, the information of DeviceID, Device Type, Description,</li> </ul>	YenTH	HungVP	Passed

## ZigBee for Remote Management

					GatewayID is displayed successfully with "Accept" link in row of each device			
10		Add new end device to Gateway	Testing Gateway device has been added in system. Testing Gateway device is running and can be connected through LAN/WAN	In the Requesting Device page, click on "Accept" link to accept the end device to system.	Add new end device to system and insert new data of end device to server.	YenTH	HungVP	Passed
11	End device (SmartPlug, Temperature sensor)	Show list of end device in all gateway	At least one device has been added into the system.	Click on "List Device" link in the navigation bar	<ul style="list-style-type: none"> <li>Link to "Device" page.</li> <li>The link "Add device" is displayed above the list of device</li> <li>Get data of all devices of from server.</li> <li>The information of DeviceID, Device Type, Description, GatewayID is displayed successfully.</li> <li>The function Edit, Details, Delete is listed in</li> </ul>	YenTH	YenTH	Passed

## ZigBee for Remote Management

						each row of each device			
12			Add new device	At least one Gateway device has been added into the system.	1. In the "Device" page, click on "Add device" link 2. Click on "Select" link to select the Gateway	1. Link to page "Add Device". The list of current Gateway (Gateway ID, MAC) in system is displayed with "Select" link in each row of item. 2. Link to "Scan Device" as in test case 9. The result of adding new device is the same as test case 9, 10.	YenTH	YenTH	Passed
13			Edit information of end device	At least one end device has been added into the system.	1. In the "Device" page, click on the "Edit" link of device 2. Edit the information of field: Name, Description 3. Click on Save button 4. Click "Back to list" link, click "Detail" link of device	1. Link to Edit Device page 3. Update the new data to server 4. The information of device is updated successfully with the new data.	YenTH	YenTH	Passed
14			Detail of End device	At least one end device has been added into the system.	In the "Device" page, click on the "Detail" link of device	<ul style="list-style-type: none"> <li>Get data of devices of that Gateway from server.</li> <li>Display information of end device: Device type, Device ID, Description, Gateway ID.</li> </ul>	YenTH	YenTH	Passed

## ZigBee for Remote Management

15	Delete end device	At least one end device has been added into the system.	1. In the "Device" page, click on the "Delete" link of device 2. Click "Delete" button to confirm delete 3. Click "Back to list" link.	1. Link to Delete page with warning of deleting. 2. Delete the data of end device in server 3. Update the list of end device list.	YenTH	YenTH	Passed
16	Turn ON/OFF Smart Plug	At least one SmartPlug device has been added in system.	1. In the "Device" page, click on the Name of Device Type. In this case, click on Name "Smart Plug". 2.1 Click ON to turn on device if it has status is "OFF" 2.2 Click OFF to turn off device if it has status is "ON"	1. Display the status of device with the option to turn ON/OFF 2.1 Get the status of device by XBEE module and send it to server. Check the status. If status is "OFF", server sends command to XBEE module to turn on device. •The end device is turned on. 2.2 Get the status of device by XBEE module and send it to server. Check the status. If status is "ON", server sends command to XBEE module to turn off device. • The end device is turned off	YenTH	YenTH	Passed
17	Display temperature of	At least one Temperature Sensor device has been	In the "Device" page, click on the Name of Device Type. In this case, click on	• Get the temperature of device by XBEE module and send it to server.	YenTH	YenTH	Passed

			sensor	added in system.	Name "Temperature sensor".	• Get data of temperature sensor and display the current temperature of sensor			
--	--	--	--------	------------------	----------------------------	--	--	--	--

Table 49 - Web application test cases

### 3. Test on Android Application

No.	Function			Pre-condition	Step of testing	Expected result	Created by	Executed by	Result
	Large function	Medium function	Small function						
1	Android application	Gateway	Show list of Gateway device	At least one Gateway device has been added into the system.	Log in with correct username and password	<ul style="list-style-type: none"> <li>• Get data of Gateway devices from server</li> <li>• Switch to screen Gateway device page. The GUI is displayed as in specification</li> <li>• The information (No., MAC address) of each Gateway device is displayed successfully with the function: Device List for each device</li> </ul>	YenTH	HungVP	Passed
2									

## ZigBee for Remote Management

3	List device of each Gateway	Android device can't connect to server		Show the message that "Please check internet connection or check your server"	YenTH	HungVP	Passed
4		Gateway has been added into the system. At least one Gateway's end device has been added into the system.	In the "Gateway device" screen, touch on the "Device List" button of device	<ul style="list-style-type: none"> <li>Get data of devices from server</li> <li>Switch to screen Device list of Gateway corresponding to the Gateway ID. The GUI is displayed as in specification</li> <li>The list of end device is displayed successfully</li> </ul>	YenTH	HungVP	Passed
5		Gateway has been added into the system. No end device has been added into the system.	In the "Gateway device" screen, touch on the "Device List" button of device	Show the message that "No end device added."	YenTH	HungVP	Passed
6		Android device can't connect to server	In the "Gateway device" screen, touch on the "Device List" button of device	Show the message that "Please check internet connection or check your server"	YenTH	HungVP	Passed
7		End device has problem and can't connect to server	In the "Gateway device" screen, touch on the "Device List" button of	Show the message that "Please check your device or device connection"	YenTH	HungVP	Passed

## ZigBee for Remote Management

					device				
8	End device	Turn ON Smart plug device	At least one SmartPlug device with status OFF has been added into the system.		<p>1. In the "Device" screen, tab on "Smart Plug XXX" item.</p> <p>2. Tab on "ON" button to turn on smart plug device</p>	<p>1. Get the status of device by XBEE module and send it to server.</p> <ul style="list-style-type: none"> <li>• Smart Plug screen is displayed successfully with the current status of device. The GUI is displayed as in specification</li> </ul> <p>2. Check the status. If status is "OFF", turn ON power on Smart Plug device. The Smart Plug device is turned ON.</p> <ul style="list-style-type: none"> <li>• Update the status in "Smart Plug" screen.</li> </ul>	YenTH	YenTH	Passed
9			Android device can't connect to server		In the "Device" screen, tab on "Smart Plug XXX" item.	Show the message that "Please check internet connection or check your server"	YenTH	YenTH	Passed
10			End device has problem and can't connect to server		In the "Device" screen, tab on "Smart Plug XXX" item.	Show the message that "Please check your device or device connection"	YenTH	YenTH	Passed

11	Turn OFF Smart plug device	At least one SmartPlug device with status ON has been added into the system.	<ol style="list-style-type: none"> <li>1. In the "Device" screen, tab on "Smart Plug XXX" item.</li> <li>2. Tab on "OFF" button to turn off smart plug device</li> </ol>	<ol style="list-style-type: none"> <li>1. Get the status of device by XBEE module and send it to server.</li> <li>• Smart Plug screen is displayed successfully with the current status of device</li> <li>2. Check the status. If status is "ON", Turn OFF power on Smart Plug device. The Smart Plug device is turned OFF. Update the status in "Smart Plug" screen.</li> </ol>	YenTH	YenTH	Passed
12					YenTH	YenTH	Passed
13					YenTH	YenTH	Passed
14					YenTH	YenTH	Passed

## ZigBee for Remote Management

					<ul style="list-style-type: none"> <li>• Get data of temperature sensor</li> <li>• Display the current temperature received from temperature sensor device.</li> </ul> <p>2. The temperature is changed to other units.</p>			
15				Android device can't connect to server	In the "Device" screen, tab on "Temperature Sensor XXX" item.	Show the message that "Please check internet connection or check your server"	YenTH	YenTH
16				End device has problem and can't connect to server	In the "Device" screen, tab on "Temperature Sensor XXX" item.	Show the message that "Please check your device or device connection"	YenTH	YenTH

Table 50 - Android application test cases

## F. System User's Manual

### I. Installation Guide

- Make sure your machine contains:
  - Window 7
  - MS SQL Server 2012 Express or higher
  - IIS feature is turned on and Application Pool support .Net framework 4.0 (See how to turn on IIS on window 7 here: <http://www.iis.net/learn/install/installing-iis-7/installing-iis-on-windows-vista-and-windows-7>)
- Open IIS manager

#### 1. Add Application Pool

- Right click on “Application Pools” then choose “Add Application Pool...”

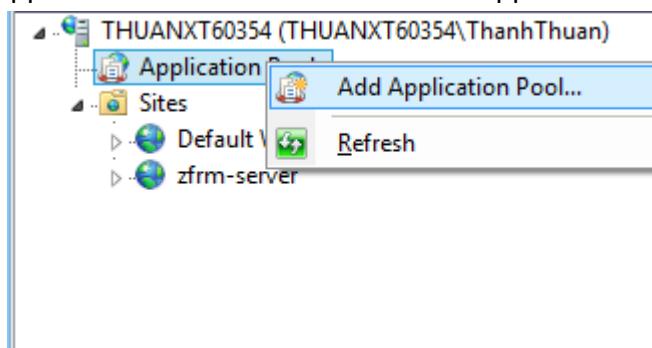


Figure 81: Configure IIS, right click on "Application Pools"

- “Add Application Pool” window appears, enter the Name, for example ZFRM, then click OK

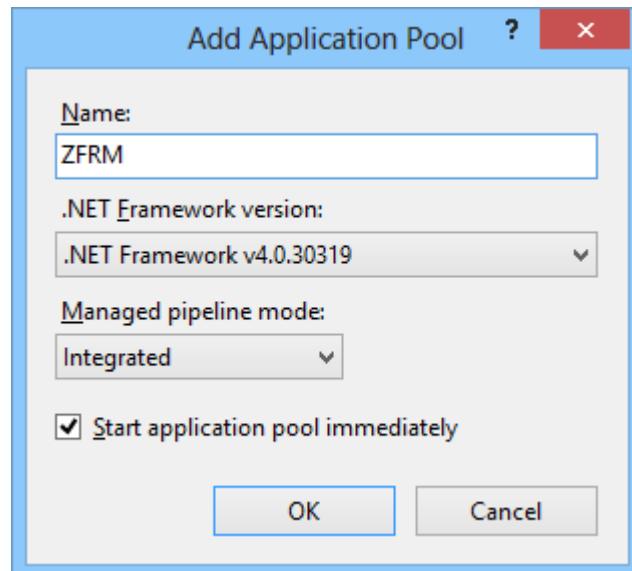
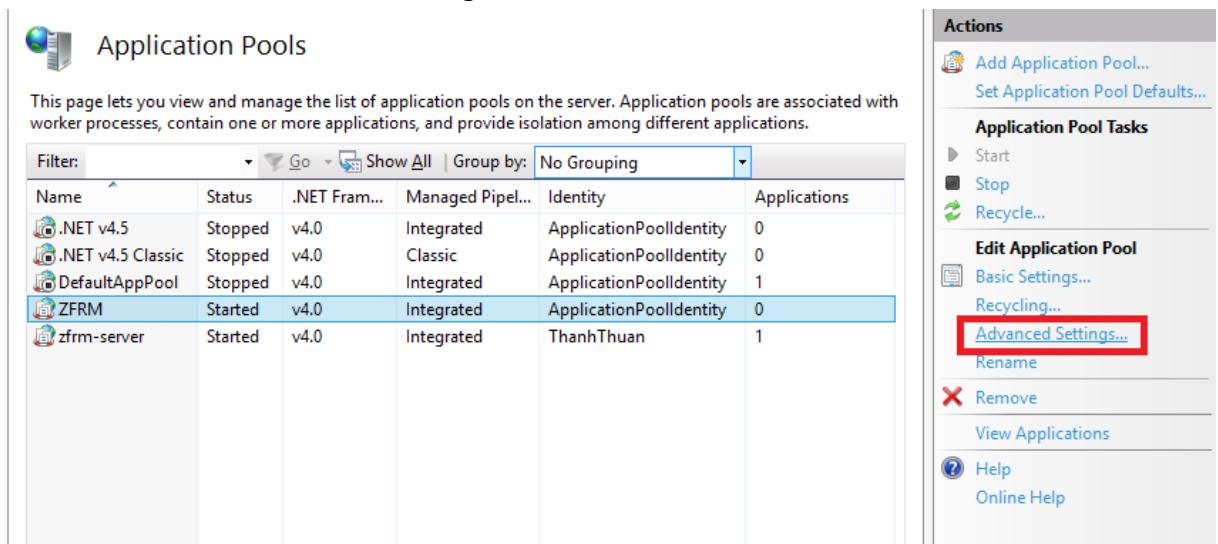


Figure 82: Configure IIS, "Add Application Pool" window

- New Application Pool will be added to the list, choose the new Application Pool then select Advanced Settings...



The screenshot shows the 'Application Pools' section of the IIS management console. A table lists application pools with columns for Name, Status, .NET Framework Version, Managed Pipeline Mode, Identity, and Applications. The 'zfrm' pool is selected and highlighted in blue. On the right, an 'Actions' pane contains links for managing application pools, with 'Advanced Settings...' highlighted by a red box.

Figure 83: Configure IIS, Application Pool “Advanced Settings”

- “Advanced Settings” window appears, find the “Identity” field and click the “...” button

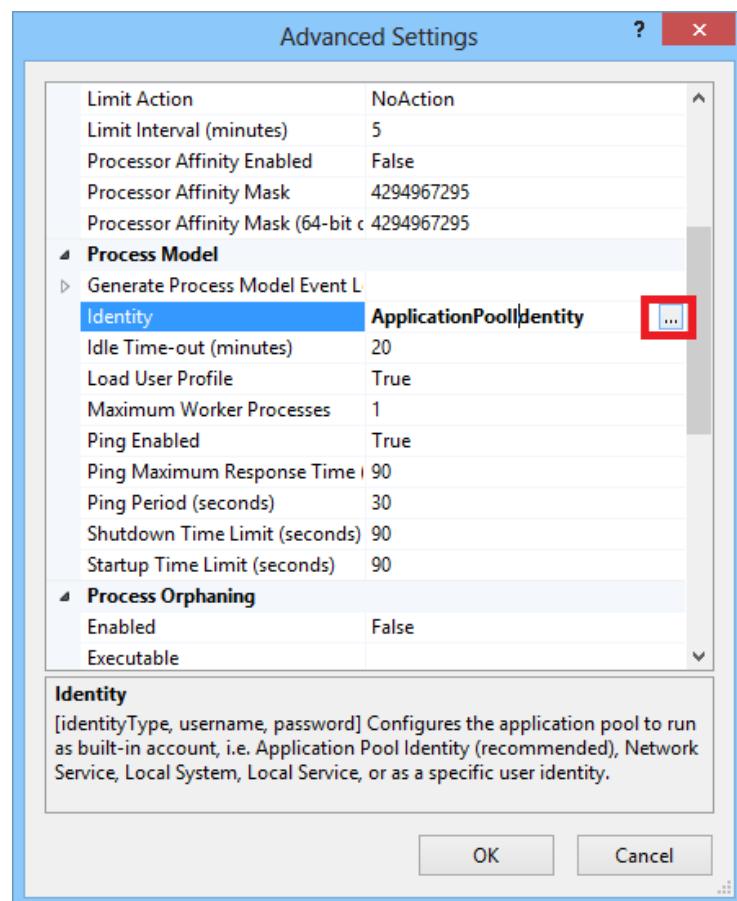


Figure 84: Configure IIS, Advanced Settings Windows

- “Application Pool Identity” window appears, Choose custom account and click button Set

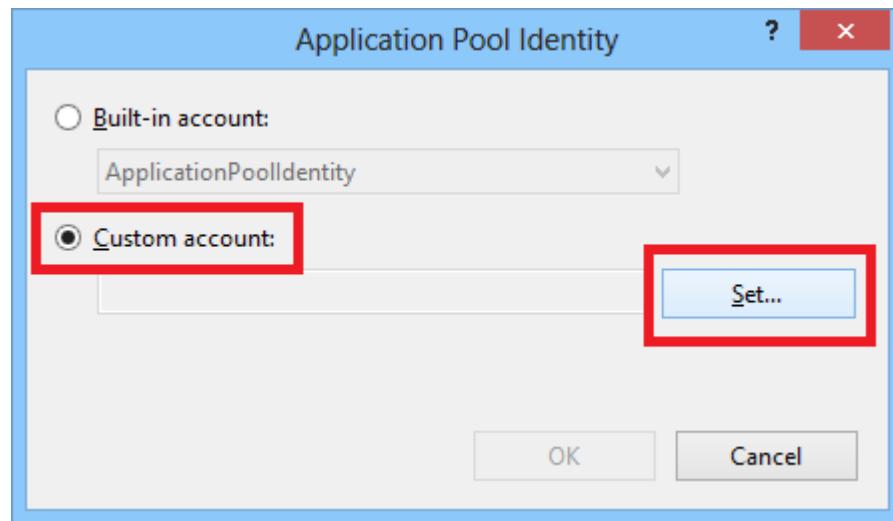


Figure 85: Application Pool Identity

- “Set Credentials” window appears, enter the SQL Express Authorization user name and password then click OK

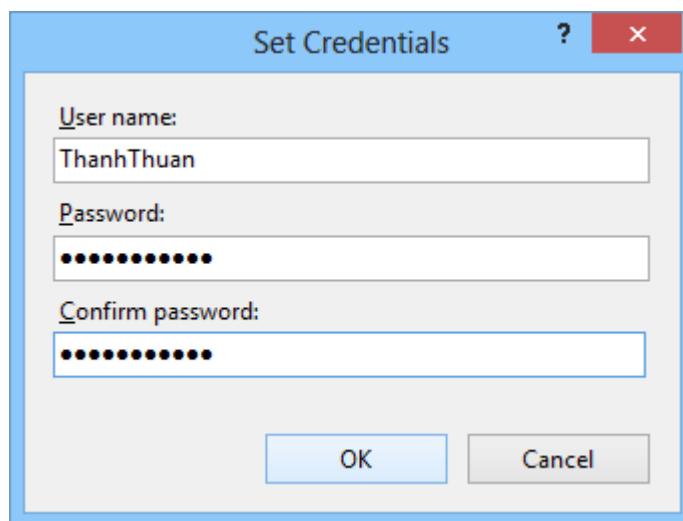


Figure 86: Set Credentials Dialogue

## 2. Add Website

- Right click on “Sites” then choose “Add Web Site...”

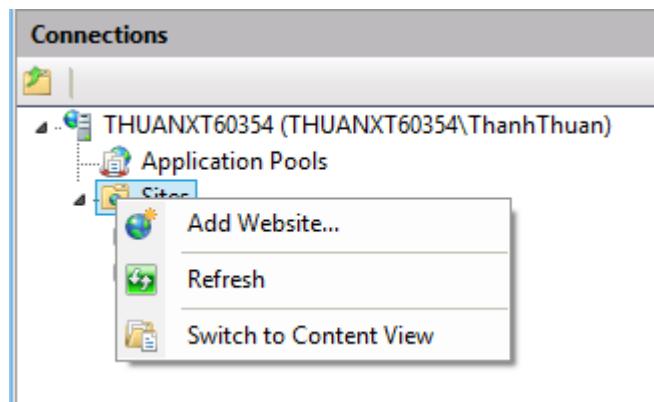


Figure 87: Configure IIS, right click on "Sites"

- A window appears, enter:
  - Site name: choose a name for your website. Example: ZFRM
  - Select the application pool that has added before, in this case is ZFRM
  - Physical path is website location where you publish
  - Port number: for example, I use port 3023

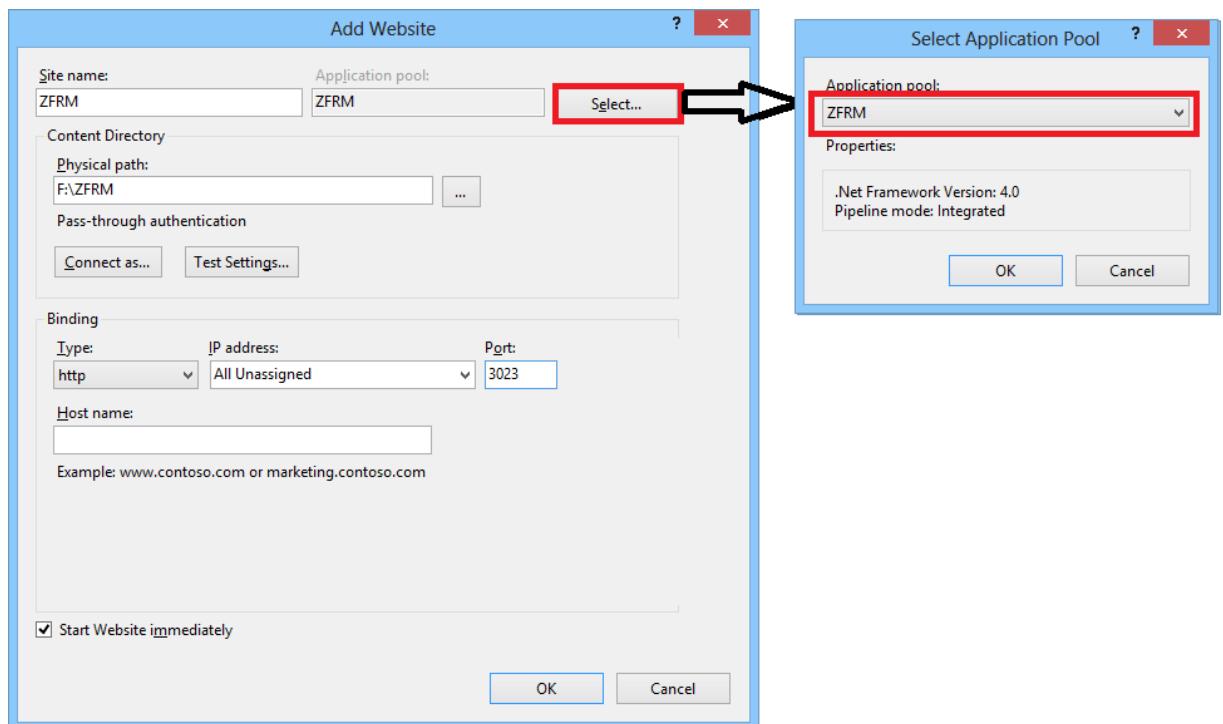


Figure 88: Configure IIS, Add Web Site window

- Click OK.
- Browse your web to check

## ZigBee for Remote Management

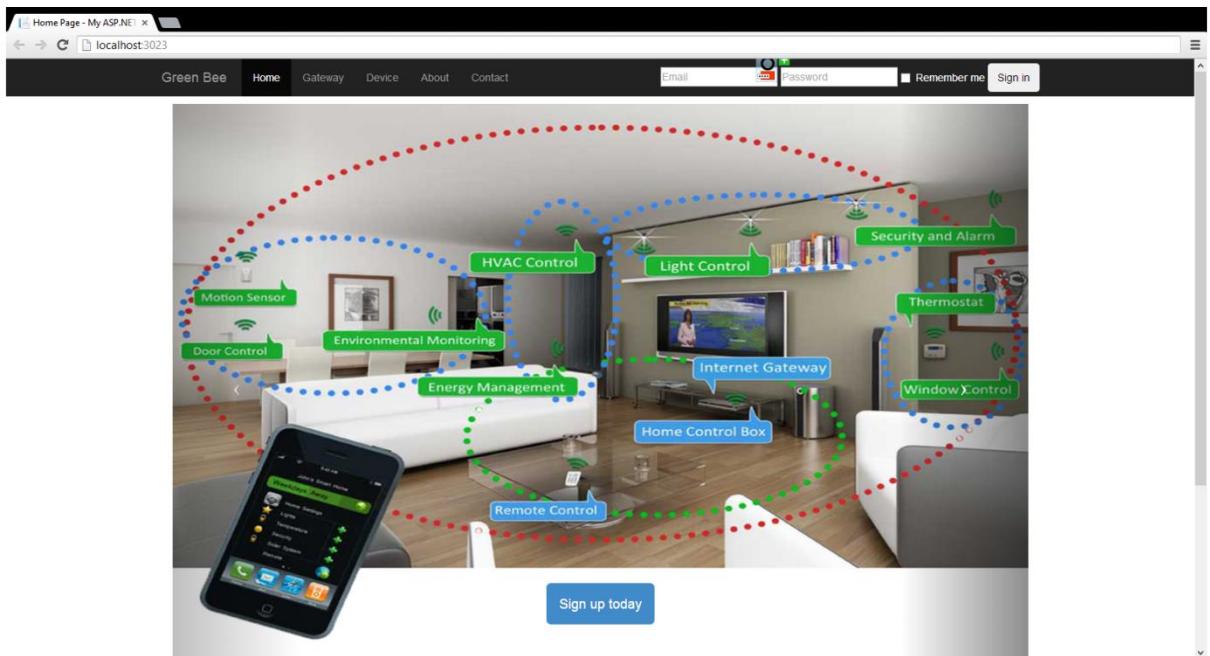


Figure 89: Configure IIS, check out your web

- If page fully load like above, you succeeded.

## II. User's Guide for Web Application.

### 1. Navigate in Web site's pages



Figure 90: Web site home page

Item No	Meaning of items
1	Home tab <ul style="list-style-type: none"> <li>Link to Home page.</li> </ul>
2	Gateway tab <ul style="list-style-type: none"> <li>Link to Gateway page: Display all information and functions for user to control and manage Gateways</li> </ul>
3	Device tab <ul style="list-style-type: none"> <li>Link to Device page: Display all information and functions for user to control and manage devices</li> </ul>
4	About tab <ul style="list-style-type: none"> <li>Link to About page: Describe general information and benefit of ZFRM system.</li> </ul>
5	Contact tab <ul style="list-style-type: none"> <li>Link to Contact page: Display phone, email, address for user can contact the administrator of this system.</li> </ul>
6	Sign up today button link <ul style="list-style-type: none"> <li>Link to Sign up page: This page is for user register to create new account to use service in system.</li> </ul>
7	Sign in button

- Valid Email and Password: Login to the system and redirect to Home page.
- Invalid Email or Password: Redirect to Login page and show the error message.

Table 51: Home page's items' meaning

## 2. Register an account in Green Bee system

On the Home page, click [Sign up today] button to register new account.

In the other way, you can click [Gateway] or [Device] tab in the navigate bar on the top of the Home page, the system will redirect to login page because of authorization, then click [Sign up] button on the logging page.

Fill in the information in field: Email, Password, Confirm password and then click [Sign up] button.

### Create a new account.

Email	xxx@fpt.edu.vn
Password	*****
Confirm password	*****
<b>Sign up</b>	

Table 52: Create account page

System will automatically send an email to that address for verifying the registration. User clicks on the activation link in the email to complete the registration.

## 3. Log-in

On every page of the website, user can fill the “Email” and “Password” in navigation bar and then click [Sign in] button to log in the system.



Figure 91: Login bar

On the other way, user can click [Gateway] or [Device] tab in the navigation bar, this will link to “Sign in” page because of authorization. User fills “Email” and “Password” in the textboxes and then click [Sign in] button on that page.

## Green Bee

xxx@fpt.edu.vn

\*\*\*\*\*

Remember me

**Sign in**

[Click here if you forgot the password.](#)

Figure 92: Login dialogue

### 4. Operation in Gateway's page

#### Gateways

1 Gateway Name	MAC Address	Location	Online	2 Devices	3 Scan	4 Detail	5 Edit	6 Delete
CP1 abc 2	20:32:21:32:23:11	Ho Chi Minh	<input type="checkbox"/>					
CP1 212	20:32:21:32:23:11	Ho Chi Minh	<input type="checkbox"/>					
CP1 test abc	20:32:21:32:23:11	Ho Chi Minh s	<input type="checkbox"/>					
a	20:32:21:32:23:11	Ho Chi Minh	<input type="checkbox"/>					
CP1	20:32:21:32:23:11	Ho Chi Minh	<input type="checkbox"/>					

Figure 93: Gateway's operations

Item No	Meaning of item
1	List Gateway device: List of all gateways in system and general information of each gateway.
2	Devices button: List all devices that have joined the network of that gateway.
3	Scan button: Link to Scan device page.
4	Detail button: Link to Gateway details page.
5	Edit button: Link to Edit gateway page.
6	Delete button: Link to Delete Gateway page.
7	Add gateway button: Link to Add new Gateway page.
8	Refresh button: Update new information of each gateway in the system.

Table 53: gateway's operations' meaning

#### 4.1 List Gateway device

On the main page of website, click on “Gateway” tab in navigation bar.



Figure 94: Gateway tab in navigation

The list of all Gateways in system will display with general information of each Gateway:

Gateway Name	MAC Address	Location	Online
CP1 abc 2	20:32:21:32:23:11	Ho Chi Minh	<input type="checkbox"/>
CP1 212	20:32:21:32:23:11	Ho Chi Minh	<input type="checkbox"/>
CP1 test abc	20:32:21:32:23:11	Ho Chi Minh s	<input type="checkbox"/>
a	20:32:21:32:23:11	Ho Chi Minh	<input type="checkbox"/>
CP1	20:32:21:32:23:11	Ho Chi Minh	<input type="checkbox"/>
CP1	20:32:21:32:23:11	Ho Chi Minh	<input type="checkbox"/>
CP1	20:32:21:32:23:11	Ho Chi Minh	<input type="checkbox"/>

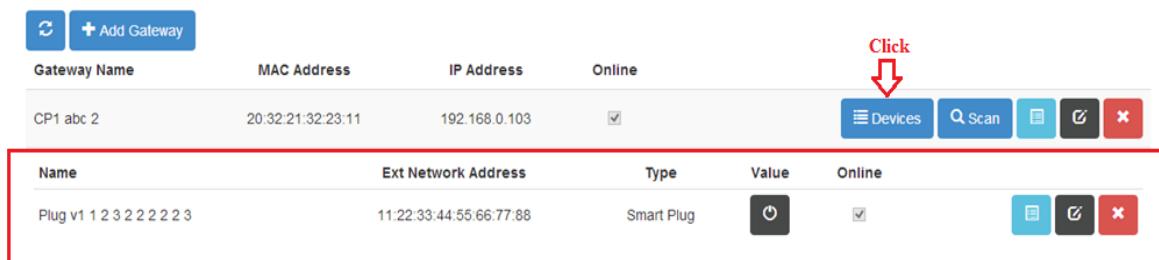
Figure 95: list of gateways page

- **Gateway Name:** Name of each Gateway.
- **MAC Address:** MAC Address of each Gateway.
- **Location:** Location of each Gateway.
- **Status:** Have two status: online and offline.
  - If device is connected to system and ready to use, the “Online” check box is checked.
  - If device is not connected to system or not ready to use, the “Online” check box is unchecked.

#### 4.2 List device in each Gateway

On the “Gateways” page, to see the list of all end devices in each Gateway, click the [Device] button of one Gateway device.

#### Gateways



Gateway Name	MAC Address	IP Address	Online						
CP1 abc 2	20:32:21:32:23:11	192.168.0.103	<input checked="" type="checkbox"/>						
Plug v1 1 2 3 2 2 2 2 2 3	11:22:33:44:55:66:77:88			Smart Plug		<input checked="" type="checkbox"/>			

Figure 96: Show list of devices in page Gateway

The general information of each end device in Gateway will be displayed:

- **Name:** The name of device. This is used for identify the end device in each Gateway in system.
- **Ext Network Address:** The network address of end device.
- **Type:** The type of device. In this system, we will have type Temperature sensor, Smart Plug V1, Smart Plug V2.
- **Value:** The state (ON/OFF) of the device.
  - ON (power on): the button is blue.
  - OFF (power off), the button is black.
- Button group on the right:
  - **Details:** edit the detail information of end device.
  - **Edit:** display the detail information of end device.
  - **Delete:** delete end device when not use in system.

#### 4.3 Scan end device and accept end device to Gateway

To see devices that request to join the system, click “Scan” button on “Gateway” page.

#### Gateways



Gateway Name	MAC Address	IP Address	Online				
CP1 abc 2	20:32:21:32:23:11	192.168.0.103	<input checked="" type="checkbox"/>				
CP1	20:32:21:32:23:11	192.168.0.103	<input type="checkbox"/>				
CP1 test abc	20:32:21:32:23:11	192.168.0.103	<input type="checkbox"/>				

Figure 97: Scan button page Gateway

The detail information of each device that request to system will be displayed in Requesting Device page:

- Name
- Ext Network Address
- Type

## Requesting Devices



Name	Ext Network Address	Type	
Nhiệt độ	00:13:a2:00:40:61:bd:67	Temperature Sensor	<input checked="" type="checkbox"/>
Đèn cầu thang	00:13:a2:00:40:61:bd:20	Smart Plug	<input checked="" type="checkbox"/>
Đèn nhà bếp	00:13:a2:00:40:aa:17:40	Smart Plug	<input type="checkbox"/>

Back to List

Figure 98: Page accept new device with accept button

Click [Accept] button in which device that want to add to Gateway.

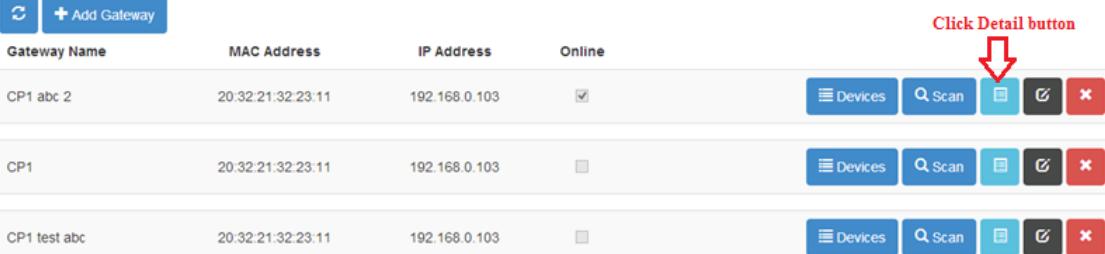
After clicked [Accept] button, new end device will join to system.

You can click [Re-Scan] button for rescan to add new device.

## 4.4 Detail information of Gateway

When you want to see the detail information of Gateway device, click “Detail” button on “Gateway” page.

## Gateways



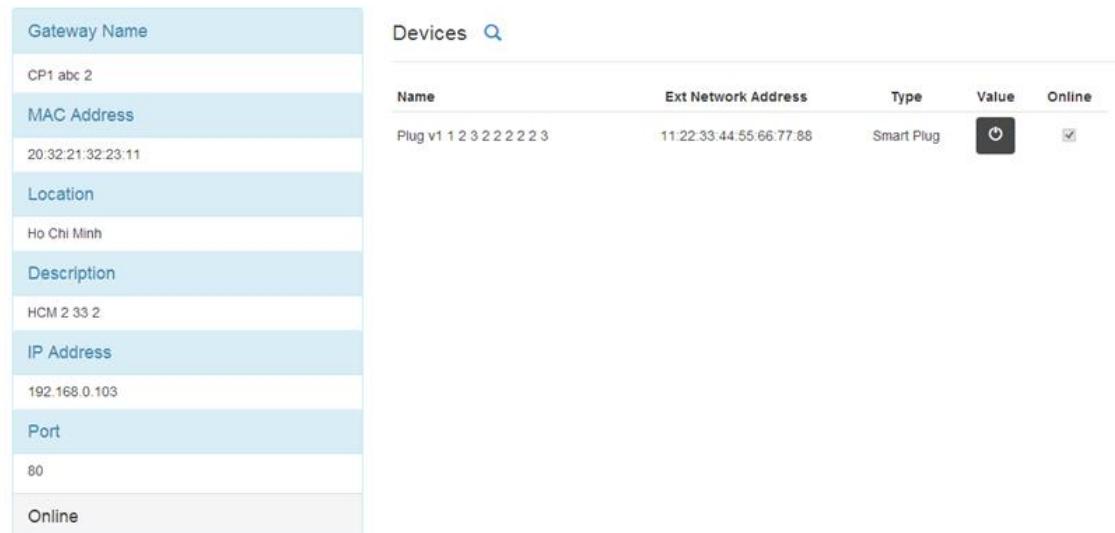
Gateway Name	MAC Address	IP Address	Online	Devices	Scan	Detail	Edit	Delete
CP1 abc 2	20:32:21:32:23:11	192.168.0.103	<input checked="" type="checkbox"/>					
CP1	20:32:21:32:23:11	192.168.0.103	<input type="checkbox"/>					
CP1 test abc	20:32:21:32:23:11	192.168.0.103	<input type="checkbox"/>					

Figure 99: Button Detail in page Gateways

The detail information of Gateway device will be displayed on the left side with information: Gateway Name, MAC address, location, Description, IP address, Port, Status.

The detail information of end device in that Gateway will be displayed on the right side: Name, Ext Network address, Type, Value, Status.

## Gateway Details



Gateway Name	CP1 abc 2
MAC Address	20:32:21:32:23:11
Location	Ho Chi Minh
Description	HCM 2 33 2
IP Address	192.168.0.103
Port	80
Online	<input checked="" type="checkbox"/>

Devices 

Name	Ext Network Address	Type	Value	Online
Plug v1 1 2 3 2 2 2 2 2 3	11:22:33:44:55:66:77:88	Smart Plug	<input type="button" value="On/Off"/>	<input checked="" type="checkbox"/>

Figure 100: Page gateway's detail

### 4.5 Edit information of Gateway device

To edit information of Gateway device, in Gateway page, click “Edit” button.

## Gateways



Gateway Name	MAC Address	IP Address	Online	Actions
CP1 abc 2	20:32:21:32:23:11	192.168.0.103	<input checked="" type="checkbox"/>	<input type="button" value="Edit"/> <input type="button" value="Devices"/> <input type="button" value="Q Scan"/> <input type="button" value="Delete"/>
CP1	20:32:21:32:23:11	192.168.0.103	<input type="checkbox"/>	<input type="button" value="Edit"/> <input type="button" value="Devices"/> <input type="button" value="Q Scan"/> <input type="button" value="Delete"/>
CP1 test abc	20:32:21:32:23:11	192.168.0.103	<input type="checkbox"/>	<input type="button" value="Edit"/> <input type="button" value="Devices"/> <input type="button" value="Q Scan"/> <input type="button" value="Delete"/>

Figure 101: Button Edit in page Gateways

There are some fields that user can edit to change information of Gateway device:

- Gateway Name
- Location
- Description

## Edit Gateway

Gateway Name: CP1 abc 2

Location: Ho Chi Minh

Description: HCM 2 33 2

Save Cancel

Figure 102: Page edit gateway

Click “Save” button to save information that user edited.

Click “Cancel” button to cancel the process edit.

### 4.6 Delete Gateway in system

To delete Gateway device in system, click “Delete” button of device that you want to delete on “Gateway List” page.

## Gateways

Gateway Name	MAC Address	IP Address	Online	Devices	Scan	Info	Config	Delete
CP1 abc 2	20:32:21:32:23:11	192.168.0.103	✓					
CP1	20:32:21:32:23:11	192.168.0.103	□					
CP1 test abc	20:32:21:32:23:11	192.168.0.103	□					

Figure 103: Button Delete in page Gateways

The “Confirm to delete” page will be displayed with button “Delete” for user to confirm their choice to delete.

## Delete Gateway

Gateway Name	Devices				
CP1 abc 2	Name	Ext Network Address	Type	Value	Online
MAC Address	Plug v1 1 2 3 2 2 2 2 2 3	11:22:33:44:55:66:77:88	Smart Plug	<input type="checkbox"/>	<input checked="" type="checkbox"/>
20:32:21:32:23:11					
Location					
Ho Chi Minh					
Description					
HCM 2 33 2					

[Delete](#) [Cancel](#)

Figure 104: Page delete gateway

Click button [Delete] to delete Gateway device.

Click button [Cancel] to cancel the process deleting.

### 4.7 Add new Gateway to ZFRM system

To add new Gateway to system, on “Gateways” page click [Add Gateway] button.

## Gateways

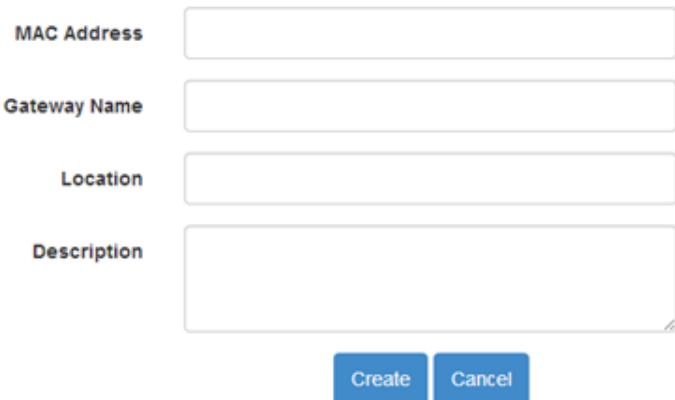
<a href="#">⟳</a>	<a href="#">+ Add Gateway</a>				
Gateway Name	MAC Address	IP Address	Online		
CP1 abc 2	20:32:21:32:23:11	192.168.0.103	<input checked="" type="checkbox"/>	<a href="#">Devices</a>	<a href="#">Scan</a>

Figure 105: Add Gateway button in page Gateways

This will link to “Add Gateway” with fields for user to fill in:

- MAC Address
- Gateway Name
- Location
- Description

## Add Gateway



The form consists of four input fields: 'MAC Address' (empty), 'Gateway Name' (empty), 'Location' (empty), and 'Description' (empty). Below the fields are two buttons: 'Create' (blue) and 'Cancel' (blue).

Figure 106: Page add gateway

After filled information, click [Create] button to add new Gateway to system.

If you want to cancel the process, click [Cancel] button.

### 4.8 Refresh to update data of gateways

If you want to refresh to reload all Gateway devices, click [Re-scan] button.



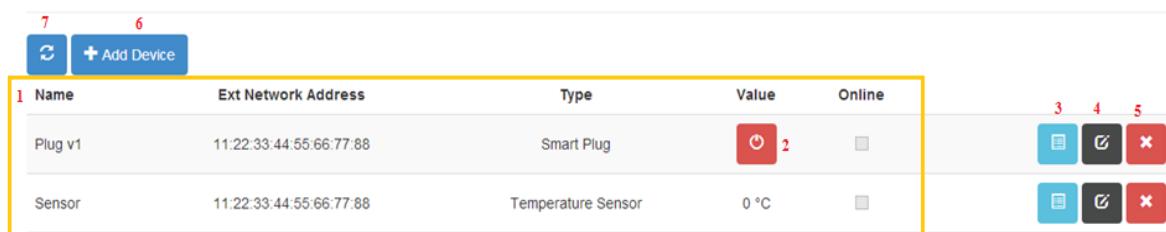
The table shows a list of gateways and devices. The 'Devices' column contains icons for managing individual devices. A red arrow points to the 'Devices' icon for the first device.

Gateway Name	MAC Address	IP Address	Online	Devices	Q. Scan		
CP1 abc 2	20:32:21:32:23:11	192.168.0.103	✓				
Name	Ext Network Address	Type	Value	Online			
Plug v1 1 2 3 2 2 2 2 2 3	11:22:33:44:55:66:77:88	Smart Plug		✓			

Figure 107: Refresh button in page Gateways

## 5. Operation in Devices' page

### Devices



The table shows a list of devices. The 'Devices' column contains icons for managing individual devices. A yellow box highlights the first device, and red numbers 1 through 7 are placed above the table headers and icons.

1 Name	Ext Network Address	Type	Value	Online	Devices	Q. Scan	
Plug v1	11:22:33:44:55:66:77:88	Smart Plug		✓			
Sensor	11:22:33:44:55:66:77:88	Temperature Sensor	0 °C	□			

Figure 108: Operations in page Devices

Item No	Meaning of item
1	List end device: List of all end devices in system and general information of each end device and display on screen.
2	Turn ON/OFF button: Turn ON/OFF the power of end device Smart plug.
3	Detail button: Display detail information of each end device.
4	Edit button: Edit information of end device.
5	Delete button: Delete end device which do not use in system.
6	Add Device button: Add new Gateway to system.
7	Refresh button: Update the new end device and new information of each end device in system.

Table 54: Operations in page Devices' meaning

### 5.1 List end device in system

On the main page of website, click on “Device” tab in navigation bar.

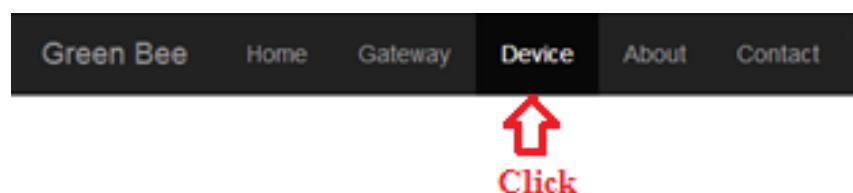
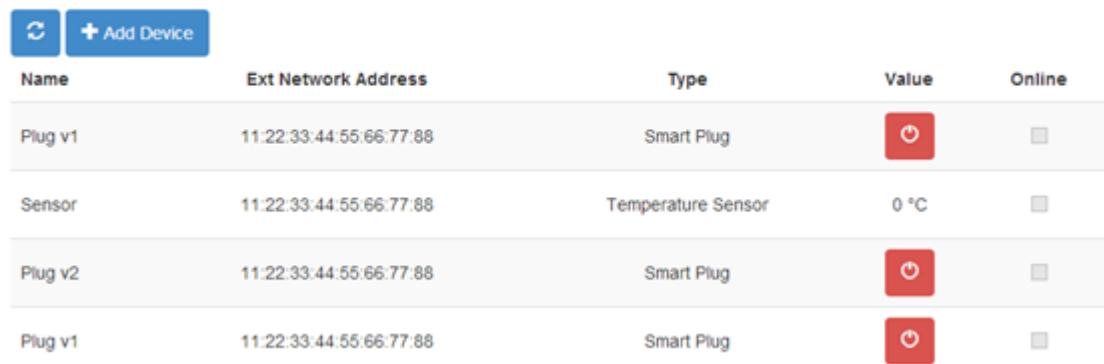


Figure 109: Button Device in navigation bar

The list of all end devices in system will display with general information of each Gateway:

- Name: Name of end device.
- Ext Network Address: Address of end device.
- Type: type of end device
- Value: ON/OFF for Smart Plug device, temperature for Temperature sensor device.
- Status: Have two status: online and offline.
  - If device is connected to system and ready to use, the “Online” check box is checked.
  - If device is not connected to system or not ready to use, the “Online” check box is unchecked.

## Devices



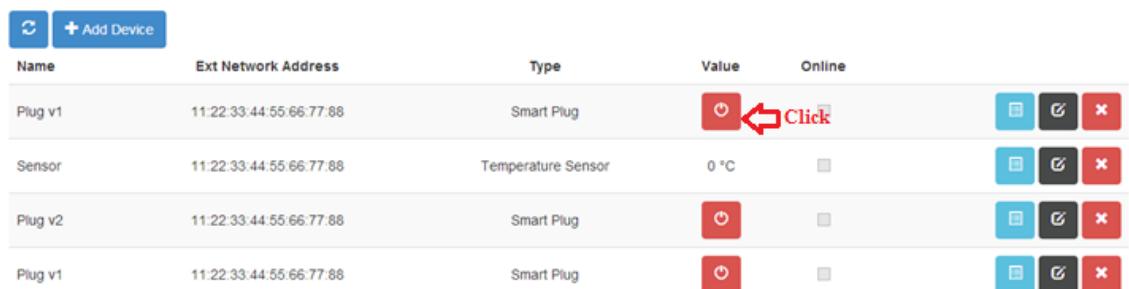
Name	Ext Network Address	Type	Value	Online
Plug v1	11:22:33:44:55:66:77:88	Smart Plug		<input type="checkbox"/>
Sensor	11:22:33:44:55:66:77:88	Temperature Sensor	0 °C	<input type="checkbox"/>
Plug v2	11:22:33:44:55:66:77:88	Smart Plug		<input type="checkbox"/>
Plug v1	11:22:33:44:55:66:77:88	Smart Plug		<input type="checkbox"/>

Figure 110: Page Devices (list of devices)

### 5.2 Turn ON/OFF the power of end device

When user wants to turn ON/OFF the power of Smart Plug device, click [On]/[OFF] button in Value column.

## Devices



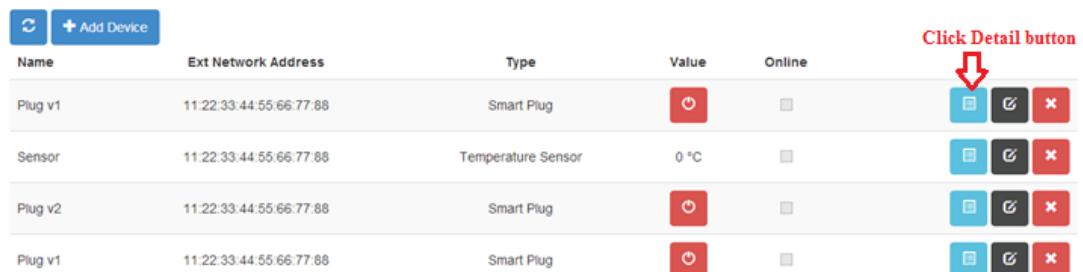
Name	Ext Network Address	Type	Value	Online
Plug v1	11:22:33:44:55:66:77:88	Smart Plug	Click	<input type="checkbox"/>
Sensor	11:22:33:44:55:66:77:88	Temperature Sensor	0 °C	<input type="checkbox"/>
Plug v2	11:22:33:44:55:66:77:88	Smart Plug		<input type="checkbox"/>
Plug v1	11:22:33:44:55:66:77:88	Smart Plug		<input type="checkbox"/>

Figure 111: Button ON/OFF in page Devices

### 5.3 Detail information of each end device

When user want to see the detail information of each end device in system, click [Detail] button on which device that want to know.

## Devices



Name	Ext Network Address	Type	Value	Online	Click Detail button
Plug v1	11:22:33:44:55:66:77:88	Smart Plug		<input type="checkbox"/>	
Sensor	11:22:33:44:55:66:77:88	Temperature Sensor	0 °C	<input type="checkbox"/>	
Plug v2	11:22:33:44:55:66:77:88	Smart Plug		<input type="checkbox"/>	
Plug v1	11:22:33:44:55:66:77:88	Smart Plug		<input type="checkbox"/>	

Figure 112: Button Detail in page Devices

The detail information of end device will display on the left side with detail information about it: Device, Ext Network Address, Type, Description, Value, Min Temperature, Temperature Notification, and Status.

The detail information of Gateway of end device will display on the right side with detail information about it: Gateway Name, MAC address, Location, Description, and Status.

Device	Gateway
Name	Gateway Name
Sensor	CP1 abc 2
Ext Network Address	MAC Address
11:22:33:44:55:66:77:88	20:32:21:32:23:11
Type	Location
Temperature Sensor	Ho Chi Minh
Description	Description
1.2	HCM 2 33 2
Value	Online
0 °C	
Min Temperature	
1	
Temperature Notification	
OFF	
Offline	

Figure 113: Page device's details

#### 5.4 Edit information of end device

On “Devices” page, click [Edit] button on which end device that want to edit.

Devices					
Name	Ext Network Address	Type	Value	Online	
Plug v1	11:22:33:44:55:66:77:88	Smart Plug		<input type="checkbox"/>	
Sensor	11:22:33:44:55:66:77:88	Temperature Sensor	0 °C	<input type="checkbox"/>	
Plug v2	11:22:33:44:55:66:77:88	Smart Plug		<input type="checkbox"/>	
Plug v1	11:22:33:44:55:66:77:88	Smart Plug		<input type="checkbox"/>	

Figure 114: Button Edit in page Devices

Depend on type of end device, there will be various screen for edit the information of device.

User edits the information and click [Save] button to save the edit information.

## Edit Device

Name: Plug v1

Description:

Save Cancel

Figure 115: Page edit device - plug v1

## Edit Device

Name: Plug v2

Description:

Min Temperature: 12

Max Temperature: 12

Temperature Notification

Plug Notification

Save Cancel

Figure 116: Page edit device - plug v2

## Edit Device

Name: Sensor

Description: 1.2

Min Temperature: 1

Max Temperature:

Temperature Notification

Save Cancel

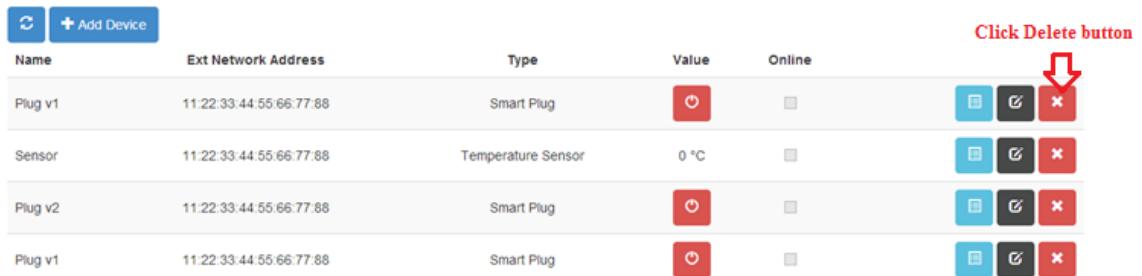
Figure 117: Page edit device - Temperature sensor

User click [Cancel] button to cancel to process edit.

### 5.5 Delete end device

On “Devices” page, click [Delete] button to delete one end device.

#### Devices



Name	Ext Network Address	Type	Value	Online	
Plug v1	11:22:33:44:55:66:77:88	Smart Plug			
Sensor	11:22:33:44:55:66:77:88	Temperature Sensor	0 °C		
Plug v2	11:22:33:44:55:66:77:88	Smart Plug			
Plug v1	11:22:33:44:55:66:77:88	Smart Plug			

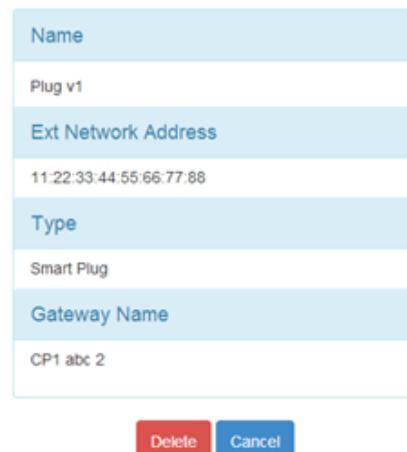
Figure 118: Button Delete in page Devices

The “Confirm to delete” page will be displayed with button “Delete” for user to confirm their choice to delete.

Click button [Delete] to delete end device.

Click button [Cancel] to cancel the process deleting.

#### Delete Device



Name	Plug v1
Ext Network Address	11:22:33:44:55:66:77:88
Type	Smart Plug
Gateway Name	CP1 abc.2

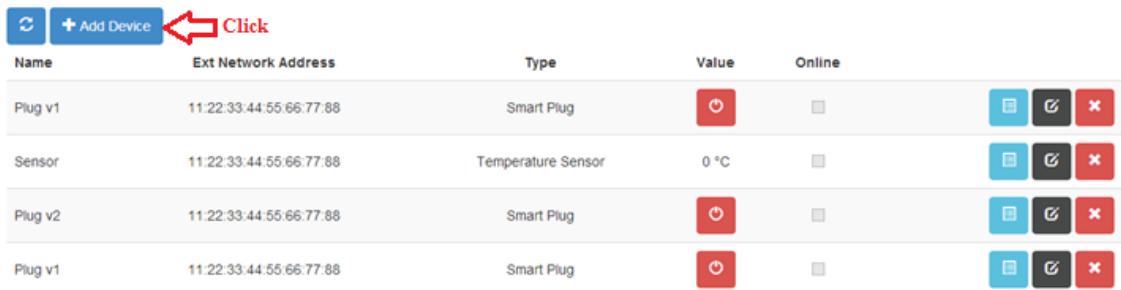
**Delete** **Cancel**

Figure 119: Page confirm delete device

### 5.6 Add new end device to system

On “Devices” page, click [Add device] button to add new end device to system.

## Devices



Name	Ext Network Address	Type	Value	Online	Actions
Plug v1	11:22:33:44:55:66:77:88	Smart Plug		<input type="checkbox"/>	
Sensor	11:22:33:44:55:66:77:88	Temperature Sensor	0 °C	<input type="checkbox"/>	
Plug v2	11:22:33:44:55:66:77:88	Smart Plug		<input type="checkbox"/>	
Plug v1	11:22:33:44:55:66:77:88	Smart Plug		<input type="checkbox"/>	

Figure 120: Button Add Device in page Devices

It will link to [Select Gateway] page, click [Select] button to select which gateway that will add the new end device.

## Select Gateway

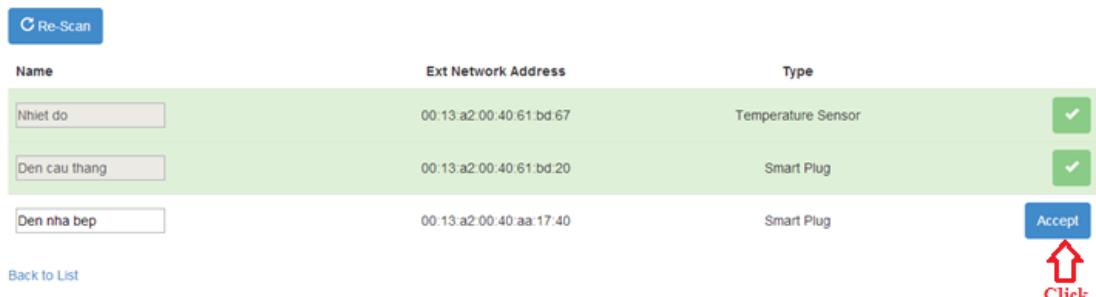


Gateway Name	MAC Address	Description	Location	Action
CP1 abc 2	20:32:21:32:23:11	HCM 2 33 2	Ho Chi Minh	Click
CP1 212	20:32:21:32:23:11	HCM as	Ho Chi Minh	
CP1 test abc	20:32:21:32:23:11	HCM s sa	Ho Chi Minh s	
a	20:32:21:32:23:11	HCM	Ho Chi Minh	

Figure 121: Button Select in page Select Gateway

On “Requesting Devices” page, fill in the Name column and click [Accept] button on which end device that want to add to system.

## Requesting Devices



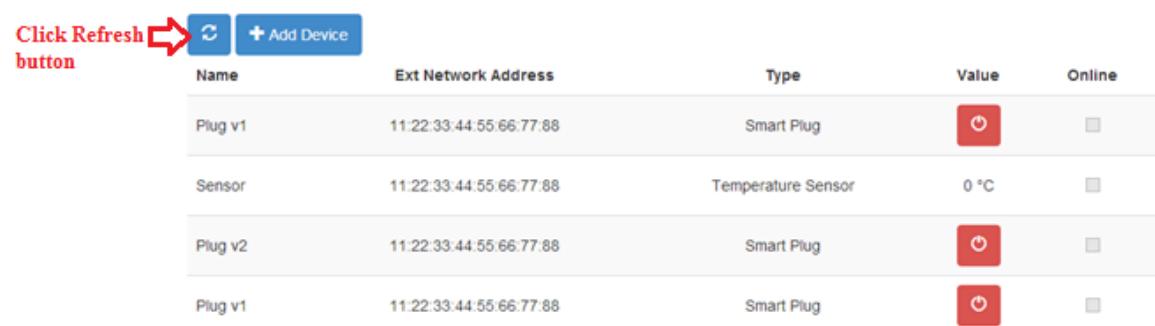
Name	Ext Network Address	Type	Action
Nhiet do	00:13:a2:00:40:61:bd:67	Temperature Sensor	
Den cau thang	00:13:a2:00:40:61:bd:20	Smart Plug	
Den nha bep	00:13:a2:00:40:aa:17:40	Smart Plug	Click

Figure 122: Button Accept in page Requesting Devices

### 5.7 Refresh to update end device in system

If you want refresh to reload all Gateway devices, click [Re-fresh] button.

Devices



Name	Ext Network Address	Type	Value	Online
Plug v1	11:22:33:44:55:66:77:88	Smart Plug		<input type="checkbox"/>
Sensor	11:22:33:44:55:66:77:88	Temperature Sensor	0 °C	<input type="checkbox"/>
Plug v2	11:22:33:44:55:66:77:88	Smart Plug		<input type="checkbox"/>
Plug v1	11:22:33:44:55:66:77:88	Smart Plug		<input type="checkbox"/>

Figure 123: Button refresh in page Devices

## 6. About page

When you want to know more information about the ZFRM system, you click “About” tab on home page.



## About

### System Overview

- There is a server that can manage all the operation in system. Server will manage the information of users and their device. It also receive and send command to get the status of devices and control the power or status of devices in system
- There is a ZigBee module acts as a master controller(Coordinator) for the entire network. It's also call gateway which offers connection to the internet via Wifi and Ethernet
- There are several ZigBee modules act as routers to connect the master controller to end devices
- The end devices are integrated which ZigBee modules (XBEE module) can send data and receive command from other ZigBee modules (XBEE module)
- The master controller will provide information of the system to server and also receive commands from it
- The end users use the Device Manager (web application on PC/Laptop or Application on Mobile phone) connects with the server's service to control the whole system: configure device, update devices' status, send commands to devices...

### Zigbee Network Topology

- **Pair:** The simplest network is one with just two radios, or nodes. One node must be a coordinator so that the network can be formed. The other can be configured as a router or an end device
- **Star:** This network arrangement is also fairly simple. A coordinator radio sits at the center of the star topology and connects to a circle of end devices. Every message in the system must pass through the coordinator radio, which routes them as needed between devices. The end devices do not communicate with each other directly
- **Mesh:** The mesh configuration employs router nodes in addition to the coordinator radio. These radios can pass messages along to other routers and end devices as needed. The coordinator (really just a special form of router) acts to manage the network. It can also route messages. Various end devices may be attached to any router or to the coordinator. These can generate and receive information, but will need their parent's help to communicate with the other nodes
- **Cluster tree:** This is a network layout where routers form a backbone of sorts, with end devices clustered around each router. It is not very different from a mesh configuration

Figure 124: Page About

## 7. Contact page

When you have problem or need to contact the administrator of system, you click “Contact” tab on home page

## Contact

### Phone

Main: 083.8888.8888

After Hours: 083.7777.7777

### Email

Support: [YenTH@GreenBe.com](mailto:YenTH@GreenBe.com)

Marketing: [HungVP@GreenBee.com](mailto:HungVP@GreenBee.com)

General: [ThuanXT@GreenBee.com](mailto:ThuanXT@GreenBee.com)

Technical: [PhuongLN@GreenBee.com](mailto:PhuongLN@GreenBee.com)

### Address

Quang Trung Software City  
FPT University, Innovation Building

Figure 125: Page Contact

## III. User's Guide for Android Application.

### 1. Log in to system

First you need to check your connection between your Android device and Internet. Be sure that your device can connect and use service in Internet.



Figure 126: First page of android application

Start the Green Bee application, on the main screen, tap on [Log in] button.

Fill your registered account to field Email and Password on “Login” screen. Then tap on [Log in] button.



Figure 127: Login dialogue in android application

## 2. Display main function of system.

After logged in user can use the main function of system.



Figure 128: Home page of android application

There are 4 main functions:

- Device management: list your gateway and end device in system. You can manage the status of each end Gateway and device, can turn ON/OFF the power of Smart Plug and get the temperature from Temperature sensor device.
- About: information about the application and system
- Help: The help information for user when have problem
- Log out: log out of the current system.

You can exit the application anytime by tap the [Exit] button on the top left of the screen.

## 3. Device management

To see list of devices in system and information of them, click on [Device] button on home screen.



Figure 129: Button Device in home page of android application

The Device List will display with fully information about the name and status of Gateway and end device in each Gateway.



Figure 130: Page Devices List of android application

#### 4. Turn ON/OFF the power of Smart Plug

To change the power of one Smart Plug device, click on which device that want to control



Figure 131: View state of plug in android application

The Smart Plug Activity is displayed. User can tap on [ON] or [OFF] button to change the state of device. This will effect on real device.



Figure 132: Page smart plug in android application

To reload/update status of end device, users can tap on [Refresh] button on top right of the screen.

## 5. Get the temperature of Temperature sensor device and set the range of temperature

To view the temperature of Temperature sensor or set the range of temperature, click on which device that want to control.



Figure 133: View temperature of sensor in android application

The “Sensor Activity” screen is displayed.

There are 2 sections: Status and Control.

In Status section, user can see the current temperature that get from Temperature sensor device. User can change the unit of temperature to  $^{\circ}\text{C}$  or  $^{\circ}\text{F}$  by tap on the icon as in screen.



Figure 134: Page detail of temperature sensor in android application

In control section, user can set the Maximum temperature and the minimum temperature by filling in the field. Tap on [Commit] button to set the value.

When the current temperature is not in safe range, application will display message to warning user about that.

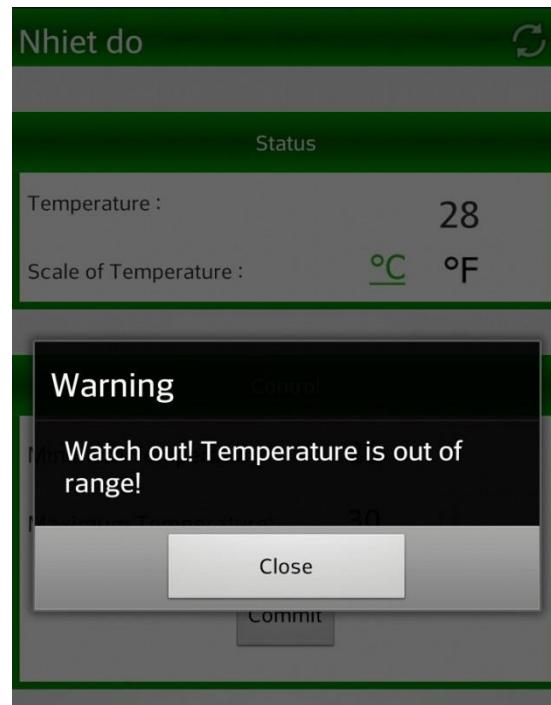


Figure 135: Notification when temperature out of range in android application

## 6. About the system

When user wants to know about the system or more information about the system they are using, tap on [About] button.



## Version 1.0.0

Green Bee is an application that help you control and manage your device in your home or department automatically.

Contact: You can contact Green Bee Group by email: greenbee@gmail.com for more information.

Figure 136: Page about in android application

## 7. Help information

When user has problem and need information for helping, user can tap on the [Help] button.



- If you can't remote device by using this app, first check your internet connection. Then check your Gateway or device is turn ON or OFF. Make sure they turned ON.

- If your device can't work properly, you can restart the Gateway or device to make it work.

- If you have any problem, you can mail to our group at email: greenbee@gmail.com

Figure 137: Page help in android application

## G. Works Cited

All information about Connect Port, XBee available at Digi web site: [digi.com](http://digi.com)

All information about ZigBee:

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- ZigBee Wireless Networking, Drew Gislason
- Wireless Sensor Networking, Robert Faludi

Information about architecture of embedded design:

- Embedded Systems Architecture, Elsevier

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- [www.eetimes.com](http://www.eetimes.com)
- <https://itunes.apple.com>
- <http://unleashpm.com/blog/?p=66>