ADDIS ABABA UNIVERSITY
SCHOOL OF GRADUATE STUDIES
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BLUETOOTH ENABLED INFORMATION PROVISION SYSTEM FOR SHOPPING CENTERS

By

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Addis Ababa University
School of Graduate Studies
Faculty of Informatics
Department of Computer Science

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Approved by:

1. Dr. Dida Midekso, Advisor_____
2. _____
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5. _____

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Abbreviations

btspp – Bluetooth Serial Port Profile

DBMS – Database Management System

IDE – Integrated Development Environment

ISM – Industrial, Scientific and Medical

J2ME – Java 2 Micro Edition

J2SE – Java 2 Standard Edition

PHP – Hypertext Preprocessor

SIG – Bluetooth Special Interest Group

Abstract

The availability and the growing number of shopping centers in Ethiopia, particularly in Addis Ababa helped many customers get access to the goods and services they want. These shopping centers host quite many shops, offices, entertainment places and other facilities that would make most customers interested to visit them.

However, the possibility of easily locating a particular facility in the shopping centers may be a challenging task. Currently, most shopping centers use signs, boards, and advertisement screens fixed in one place to provide information regarding the shopping center. However, these information provision mechanisms are not enough to allow users access relevant information while moving through the shopping center.

Considering the fact that most mobile devices are Bluetooth enabled, a Bluetooth Enabled Information Provision System can be put as a solution to facilitate access to information within the shopping centers.

Hence, in this project a Bluetooth enabled information provision system is developed to help users to access information regarding shopping center facilities using their mobile phone. Therefore, the system is organized in to three components namely: the desktop application, Bluetooth server, and administrator subsystems. The desktop application provides a mechanism to communicate with the database server and handles user's data requests. The Bluetooth server is responsible for handling the Bluetooth communication between the mobile device and the server. Moreover, the administration subsystem is used to manage the registration, edition and deletion of the information regarding the shopping facilities.

Keywords: Bluetooth, Bluetooth Enabled Information Provision

Chapter 1 Introduction

1.1 Background

Market places are where we often find goods and services we look for. Most often, shopping centers found in these market places could give us a good opportunity for shopping as they can provide different goods and services in one place. That is why shopping centers are mushrooming in big cities in Ethiopia, particularly in Addis Ababa.

However, it might be difficult to locate the shops we want to visit in these cities since a number of shops are located in one area. Therefore, most shopping centers use different signs, boards, and even advertisement screens fixed at some place to assist customers locate shops and sometimes items in a shopping center. However, these mechanisms fail to provide appropriate information as customers move through the shopping centers. This is because the signs and symbols are usually positioned at the main gates of the centers.

To alleviate the problems of providing appropriate information to customers, a Bluetooth enabled information provision system could be put in place. The Bluetooth technology could play a key role within the shopping center by providing the necessary information to customers irrespective of where they are in the shopping centers.

It is then imperative to take into consideration the potential applications of the Bluetooth technology. Besides, it is widely available on most mobile devices in Ethiopia. Consequently, this project is meant to develop an application which can provide information to people in shopping centers by making use of the Bluetooth technology.

1.2 Statement of the Problem

With the development and expansion of cities in Ethiopia, shopping centers are becoming abundantly available in order to provide the goods and services that people need. Moreover, the shopping centers host different offices including banks, insurances, ATM, cafeterias, restaurants, beauty salons, toilets and so on. So far, locating the shops, offices, ATM, toilets, and other important offices is not being automated.

However, the information provision mechanisms fail to provide appropriate information to users as they move within the shopping centers. Therefore, it is possible to handle information provision within the shopping centers by using Bluetooth as a means. One good reason for choosing Bluetooth as a mechanism is the fact that Bluetooth enabled mobile devices are abundantly available.

Hence, this project provides an automated system for handling information provision within shopping centers.

1.3 Objective

1.3.1 General Objective

The general objective of this project is to develop a Bluetooth enabled information provision system shopping centers.

1.3.2 Specific Objectives

The specific objectives of the project are to:

- Provide people with directions to locate a particular shop, office, entertainment place, ATM, toilet or lift in the shopping centers;
- Help people search for items, and services in the shopping centers;
- Update information regarding facilities within the shopping centers; and,

- Allow users to access detailed information about facilities in the shopping centers.

1.4 Document Organization

This project document is organized into six chapters including this one. Chapter 2 covers the literature review part of this project where as Chapter 3 emphasizes on the requirements and analysis of the project. The functional, non-functional and the system model are also part of Chapter 3.

Under Chapter 4, the design issues of the project are given due consideration. The design goal, architecture, subsystem decomposition, hardware/software mapping and persistent data management are discussed. Chapter 5 covers the implementation issues of the system. Hence, the development tools and prototype of the project are included in chapter 5.

Finally, under Chapter 6, conclusion and future works are presented.

Chapter 2 Literature Review

2.1 Bluetooth Technology

The Bluetooth is an open standard technology that is governed by the Bluetooth Special Interest Group (SIG) led by nine major players of the computer industry and more than 2000 additional companies as members [1]. The composition of the Bluetooth SIG is one of the major strengths of the Bluetooth technology. The mixture of both noticeable software and hardware suppliers participating in the further development of the Bluetooth technology ensures that Bluetooth products are made available to end users [2].

Bluetooth communication occurs in the unlicensed Industrial, Scientific, and Medical (ISM) band at 2.4GHz. Moreover, Bluetooth has three different defined ranges (classes), based on their output power ratings.

Class 1 devices can have a range of about 40 m - 100 m whereas class 2 devices are lower power with a range of about 15 m - 30 m. Class 3 devices use even less power with a range of about 5 m - 10 m. Most Bluetooth devices fall in Class 2 or 3 [3].

Regardless of its classes, Bluetooth supports both data channel and voice channel communications. This technology is to be used for handling different tasks including file transferring, creating ad-hoc networks and peripheral connectivity having basic characteristic features of being wireless, automatic, cheap, secure, dealing with data and voice, as well as the capacity of sending signals to multiple devices at the same time [4].

Moreover, the technology is being supported by different companies engaged in producing mobile devices as well as software that run on mobile devices. Nokia, Motorola, Sony Ericson and many other leading companies in the mobile phone industry are embedding this technology in their products

so as to help users share information by creating a wireless environment. In addition, the Bluetooth technology is intended for replacing cables (e.g. Bluetooth headset), wireless data transfer (e.g. phone ↔PC, phone ↔phone), multi-player gaming (e.g. Nokia N-Gage™game deck), and personal Ad Hoc Networks [5].

Two or more mobile devices supporting Bluetooth could create a simple wireless network referred to as piconet. A *piconet* is the usual form of a Bluetooth network and is made up of one master and one or more slaves. The device initiating a Bluetooth connection automatically becomes the master. A piconet can consist of one master and up to seven active slaves. The master device is literally the master of the piconet. When connecting two piconets the result will be a scatternet [2]. These networks allow mobile devices to create ad-hoc network without requiring prior infrastructure to be established.

2.1.1 The Bluetooth Architecture/Protocol Stack

The Bluetooth specification ensures that all the devices supporting this technology are able to communicate with each other no matter where they are. This is then achieved by a well defined protocol stack. A layer level view of the architecture of the Bluetooth technology is shown in Figure 2.1 [4][10].

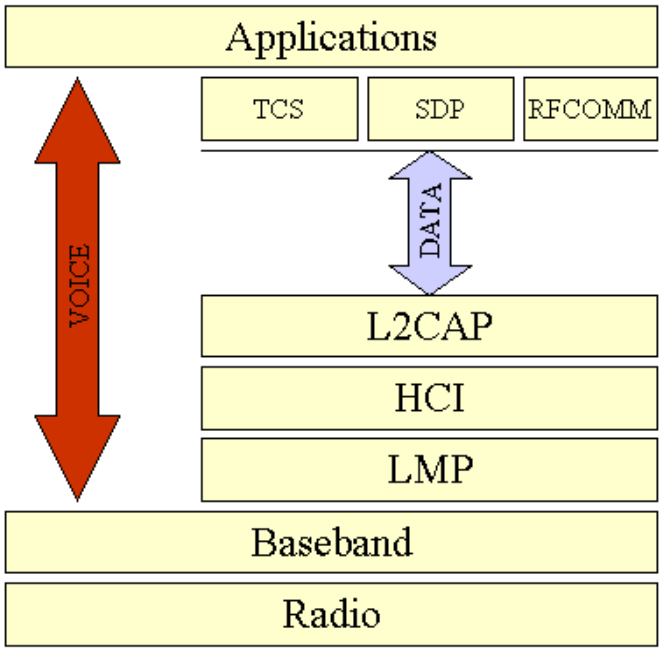

Figure 2.1 Bluetooth Protocol Suite

- *The radio layer* is the physical wireless connection. Bluetooth divides the 2.4 GHz frequency band into 79 channels 1 MHz apart (from 2.402 to 2.480 GHz), and uses this spread spectrum to hop from one channel to another, up to 1600 times a second. The standard wavelength range is 10 cm to 10 m, and can be extended to 100 m by increasing transmission power.
- *The baseband layer* is responsible for controlling and sending data packets over the radio link. It provides transmission channels for both data and voice. The baseband layer maintains Synchronous Connection-Oriented (SCO) links for voice and Asynchronous Connectionless (ACL) links for data. SCO packets are never retransmitted but ACL packets are, to ensure data integrity.
- *The Link Manager Protocol (LMP)* uses the links set up by the baseband to establish connections and manage piconets. Responsibilities of the LMP also include authentication and security services, and monitoring of service quality.
- *The Host Controller Interface (HCI)* is the dividing line between software and hardware. The L2CAP and layers above it are currently implemented

in software, and the LMP and lower layers are in hardware. The HCI is the driver interface for the physical bus that connects these two components.

- *The Logical Link Control and Adaptation Protocol (L2CAP)* receives application data and adapts it to the Bluetooth format. Quality of Service (QoS) parameters are exchanged at this layer.

2.1.2 The Bluetooth Profile

To assure interoperability among Bluetooth devices, provided by different vendors and manufacturers, a Bluetooth device must conform to a particular profile, which defines capabilities and roles for applications, defining mandatory options and parameters for each protocol of the stack. A profile can be seen then as a vertical sight of the protocol stack. Some of these profiles are shown in Figure 2.2 [4].

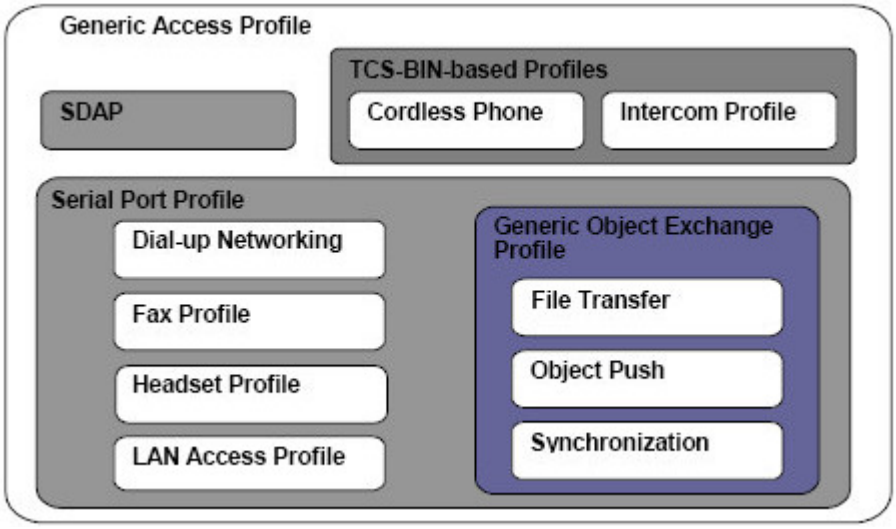

Figure 2.2 Bluetooth Profile

- *The Generic Access Profile (GAP)*: is used for defining connection procedures, as well as link management and device discovery. That is, for describing the use of the lower layers of the protocol stack (LC and LMP).
- *The Service Discovery Application and Profile (SDAP)*: is used for defining characteristics in order to discover services around and to bring available information about these services. It defines protocols and procedures to

be used by discovery applications in devices using the service discovery protocol.

- *The Serial Port Profile (SPP)* is used for establishing connections.
- *The LAN access profile*: is used for defining how to access a LAN and PPP procedures.

2.2 Related Works

Considering the advantage to easily create a wireless network and help users communicate with one another, many companies in the industry are using the Bluetooth technology for mobile and proximity advertising. These advertising mechanisms were put in place during the summer Beijing Olympic creating a perfect opportunity for international companies to launch an ad campaign using the wireless marketing network of Pioco, a Shanghai-based proximity media company [6]. Mobile users who had their phones in discoverable mode were prompted with a message whenever they passed a broadcast kiosk. Users were prompted with messages that included movie previews, popular MP3 files and, occasionally, games and cell phone screen savers.

On the other hand, the Japanese consumer electronics company Kenwood developed a PDA equipped with the Bluetooth wireless networking technology to provide cable-free Internet access as an alternative to the mobile phone [7]. Moreover, the Bluetooth shopping center introduced in Sydney Australia in 2004 uses a location-based customer service system that enables people within the shopping center to use their mobile phones to get useful information they want about their surroundings [8].

In addition to the aforementioned systems, the Bluetooth technology is being used to lock and unlock a car, operate a garage door, control a TV, VCR, DVD player, control other consumer appliances and so on [9]. This enabling technology could also be used in theatre halls, exhibitions, museums and other areas where it is appropriate.

Considering the potential application of the Bluetooth technology, this project aims to develop Bluetooth enabled information provision system in shopping centers in Ethiopia, particularly in Addis Ababa. This venture will be the first of its kind in this country as there is no such a system as far as related works are concerned. Therefore, it is believed to be of use for people going to shopping centers and working there.

Chapter 3 System Analysis

This chapter outlines the functional and non-functional requirements of the system. Both requirements are identified after a rigorous analysis is made on the currently existing similar systems. Section 3.1 and 3.2 in this chapter describe the functional as well as the non-functional requirements of the system. Moreover, this chapter also illustrates the requirement elicitation of the system using system models which include the use case diagram and its descriptions, sequence diagrams, and class diagrams.

3.1 Functional Requirements

Functional requirements describe the interactions between the system and its environment independent of its implementation. The environment includes the user and any other external system with which the system interacts [11]. Therefore, the functional requirements of this project include:

- Creating and managing accounts for system administrators;
- Inserting, editing and deleting information about shops, offices, toilets and ATM in the shopping center;
- Prompting users with information to use the system when they get into the shopping center;
- Providing information about the shopping center to users; and
- Allowing users to look for a specific information

3.2 Non-Functional Requirements

Non-functional requirements of the system are requirements that are not directly related to the functional aspect of the system. Instead, they describe user-visible features of the system.

The non-functional requirements of this system include features such as security, maintainability and expandability, user friendliness and portability.

- **Security**

Security is one of the important features of any computerized system. In this project, due attention is given to the security of the administration part of the system. Hence, administrators are required to enter valid credential in order to access the system for inserting, editing and deleting information regarding the shopping centers.

- **Maintainability and Expandability**

The system should be designed in such a way that it can be easily maintained by the system developer or any authorized professional. Moreover, the system should be flexible enough to accommodate the future needs of expansion of the shopping center.

- **User Friendliness**

The consistent user interfaces to be developed will help the system to be user friendly. For this reason, the interfaces and components of the interfaces should be designed in a user friendly fashion to help users interact easily with the system.

- **Portability**

The system should be designed in such a way that the mobile application can be installed on any mobile device that supports Bluetooth communication and JSR-82 Bluetooth specification.

3.3 System Model

The system model of the Bluetooth Enabled Information Provision system is composed of three individual models: the functional model represented by use cases, the object model represented by class diagrams and the dynamic model represented by the sequence diagrams.

3.3.1 Use Case Diagram

The use cases for The Bluetooth Enabled Information Provision System are used to represent the basic functionalities of the system as use cases focus on the behavior of the system from an external point of view. Figure 3.1 depicts the use case diagram of the system.

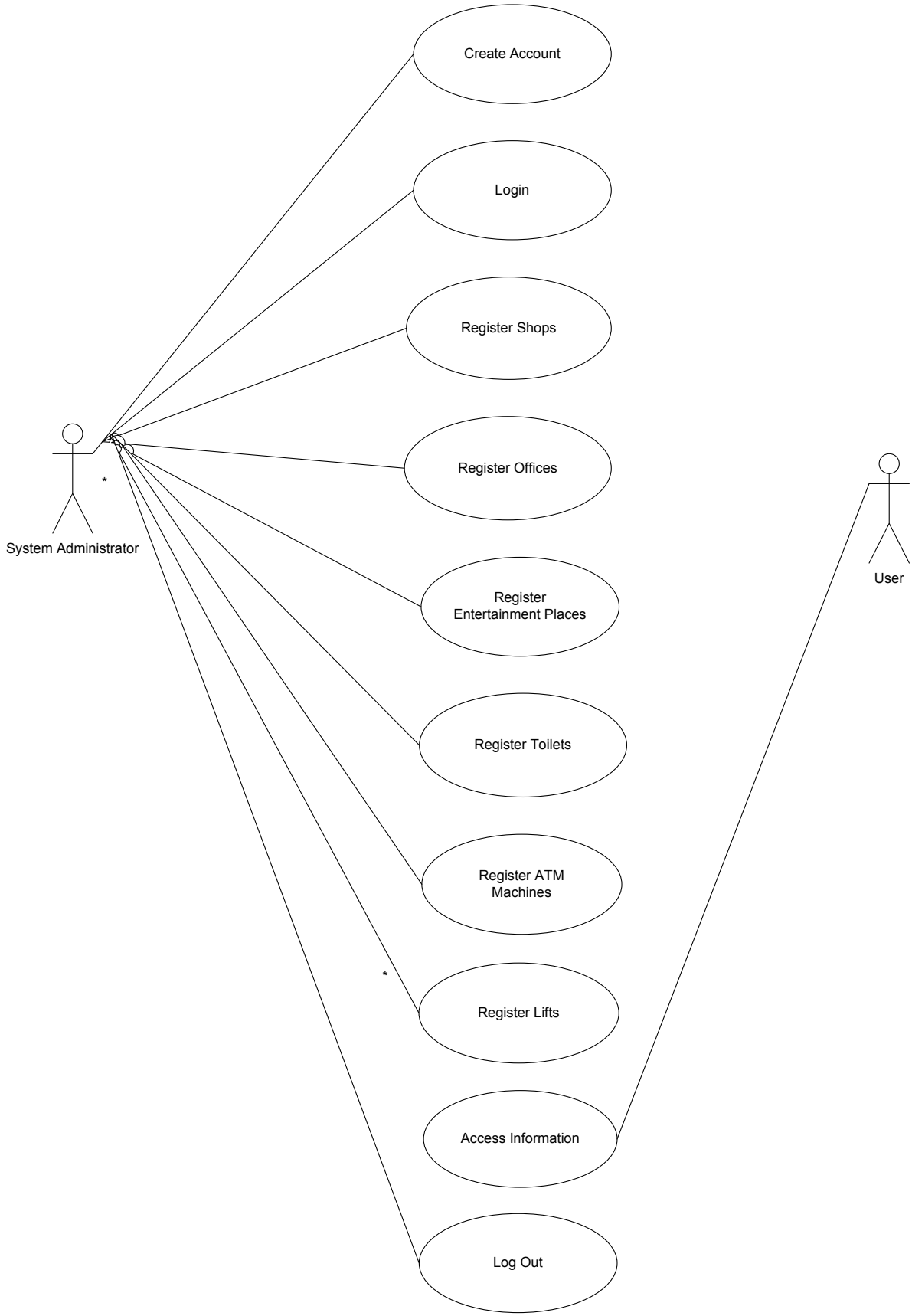

Figure 3.1: Use Case Diagram

3.3.1.1 Use Case Description

Name: Create Account

Identifier: UC 01

Actor: Administrator

Description: Allows the administrator to create an account

Precondition: The user should activate the system

Post Condition: Account will be created

Basic Course of Action:

1. The administrator activates "Create Account" option
2. The administrator completes and submits the Create Account form providing personal information (Alternative Course A: *Blank Field)*
3. The system creates the account (Alternative Course B: *Admin ID already exists*)
4. The system displays acknowledgment message
5. The use case ends

Alternate Course A: *Blank Field*

A.2 The system displays error message

A.3 The use case ends

Alternate Course B: *Admin ID already exists*

B.3 The system displays "Admin Id already exists" error message

B.4 The use case ends

Name: Log In

Identifier: UC 02

Actor: Administrator

Description: Allows the administrator to log into the administrative area of the system

Precondition: The administrator should have account

Post Condition: The system will display the administrator's page

Basic Course of Action:

1. The administrator activates the home page
2. The administrator completes and submits user ID and password (Alternative Course A: *Incorrect Admin ID or password*)
3. The system displays the administrator's page
4. The use case ends

Alternate Course A: *Incorrect Admin ID or password*

A.3 The system displays "Incorrect Admin ID or password" error message

A.4 The use case ends

Name: Register Shop

Identifier: UC 03

Actor: Administrator

Description: Allows the administrator to record information about the shops in the shopping center

Precondition: The administrator should log into the administrator's page

Post Condition: The shop will be registered

Basic Course of Action:

1. The administrator activates "Register Shops" option
2. The administrator completes and submits the Register Shops form providing detail information about the shop (Alternative Course A: *Blank Field*)
3. The system registers the shop
4. The system displays acknowledgment message
5. The use case ends

Alternate Course A: *Blank Field*

A.2 The system displays error message

A.3 The use case ends

Name: Register Offices

Identifier: UC 04

Actor: Administrator

Description: Allows the administrator to record information about Offices in the shopping center

Precondition: The administrator should log into the administrator's page

Post Condition: The Office will be registered

Basic Course of Action:

1. The administrator activates "Register Offices" option
2. The administrator completes and submits the Register Offices form providing detail information about the offices (Alternative Course A: *Blank Field*)
3. The system registers the office
4. The system displays acknowledgment message
5. The use case ends

Alternate Course A: *Blank Field*

A.2 The system displays error message

A.3 The use case ends

Name: Register Entertainment Places

Identifier: UC 05

Actor: Administrator

Description: Allows the administrator to keep information about Entertainment Places (like Restaurants, Bars, Cafés, Game Shops, Theatres, Cinemas, etc) in the shopping center

Precondition: The administrator should log into the administrator's page

Post Condition: The Entertainment Place will be registered

Basic Course of Action:

1. The administrator activates "Register Entertainment Places" option
2. The administrator completes and submits the Register Entertainment Places form providing detail information about the entertainment places (Alternative Course A: *Blank Field*)
3. The system registers the entertainment place
4. The system displays acknowledgment message
5. The use case ends

Alternate Course A: *Blank Field*

A.2 The system displays error message

A.3 The use case ends

Name: Register Toilets

Identifier: UC 06

Actor: Administrator

Description: Allows the administrator to record information regarding toilets in the shopping center

Precondition: The administrator should log into the administrator's page

Post Condition: The toilet information will be recorded

Basic Course of Action:

1. The administrator activates "Register Toilets" option
2. The administrator completes and submits the Register Toilets form providing detail information about the toilet (Alternative Course A: *Blank Field*)
3. The system registers the toilet
4. The system displays acknowledgment message
5. The use case ends

Alternate Course A: *Blank Field*

A.2 The system displays error message

A.3 The use case ends

Name: Register ATM

Identifier: UC 07

Actor: Administrator

Description: Allows the administrator to record detail information about the ATM in the shopping center

Precondition: The administrator should log into the administrator's page

Post Condition: The ATM Machine will be registered

Basic Course of Action:

1. The administrator activates "Register ATM" option
2. The administrator completes and submits the Register ATM form providing detail information about the ATM (Alternative Course A: *Blank Field*)
3. The system registers the ATM Machine
4. The system displays acknowledgment message
5. The use case ends

Alternate Course A: *Blank Field*

A.2 The system displays error message

A.3 The use case ends

Name: Register Lifts

Identifier: UC 08

Actor: Administrator

Description: Allows the administrator to record detail information about the lifts in the shopping center

Precondition: The administrator should log into the administrator's page

Post Condition: The lift will be registered

Basic Course of Action:

1. The administrator activates "Register Lift" option
2. The administrator completes and submits the Register Lift form providing detail information regarding the lift (Alternative Course A: *Blank Field*)
3. The system registers the lift
4. The system displays acknowledgment message
5. The use case ends

Alternate Course A: *Blank Field*

A.2 The system displays error message

A.3 The use case ends

Name: Accessing Information

Identifier: UC 09

Actor: User

Description: Allows the user to get information about shops, offices, toilets and ATM in the shopping center

Precondition: The user must carry a Bluetooth enabled mobile phone

Post Condition: The user gets relevant information regarding the shopping center

Basic Course of Action:

1. The system instantly prompts the user to accept the invitation to Bluetooth communication
2. The user selects "Yes" (Alternative Course A: *User Selects "No"*)
3. The user will be connected to the system
4. The user gets access to details of information about the shopping center
5. The use case ends

Alternate Course A: *User Selects "No"*

A.3 The use case ends

Name: Log Out

Identifier: UC 10

Description: Used to let the administrator log out of its page.

Precondition: The administrator should have logged into the administrator's page

Post Condition: The administrator will be redirected to Home Page

Basic Course of Action:

1. The administrator activates the "Log Out" option
2. The system redirects to the system's Home Page
3. The use case ends

3.3.2 Class Diagram

Class diagrams describe the structure of the system in terms of classes and objects. Classes are abstractions that specify the attributes and behavior of a set of objects where as objects are entities that encapsulate state and behavior [11].

In The Bluetooth Enabled Information Provision System, the Shop, Office, Entertainment Place, ATM Machine, Toilet and Lift classes are generalized to the class Shopping Center Facility. The Administrator class interacts with each of these classes.

In Figure 3.2, the class diagram for the system shows the classes with their potential attributes and methods.

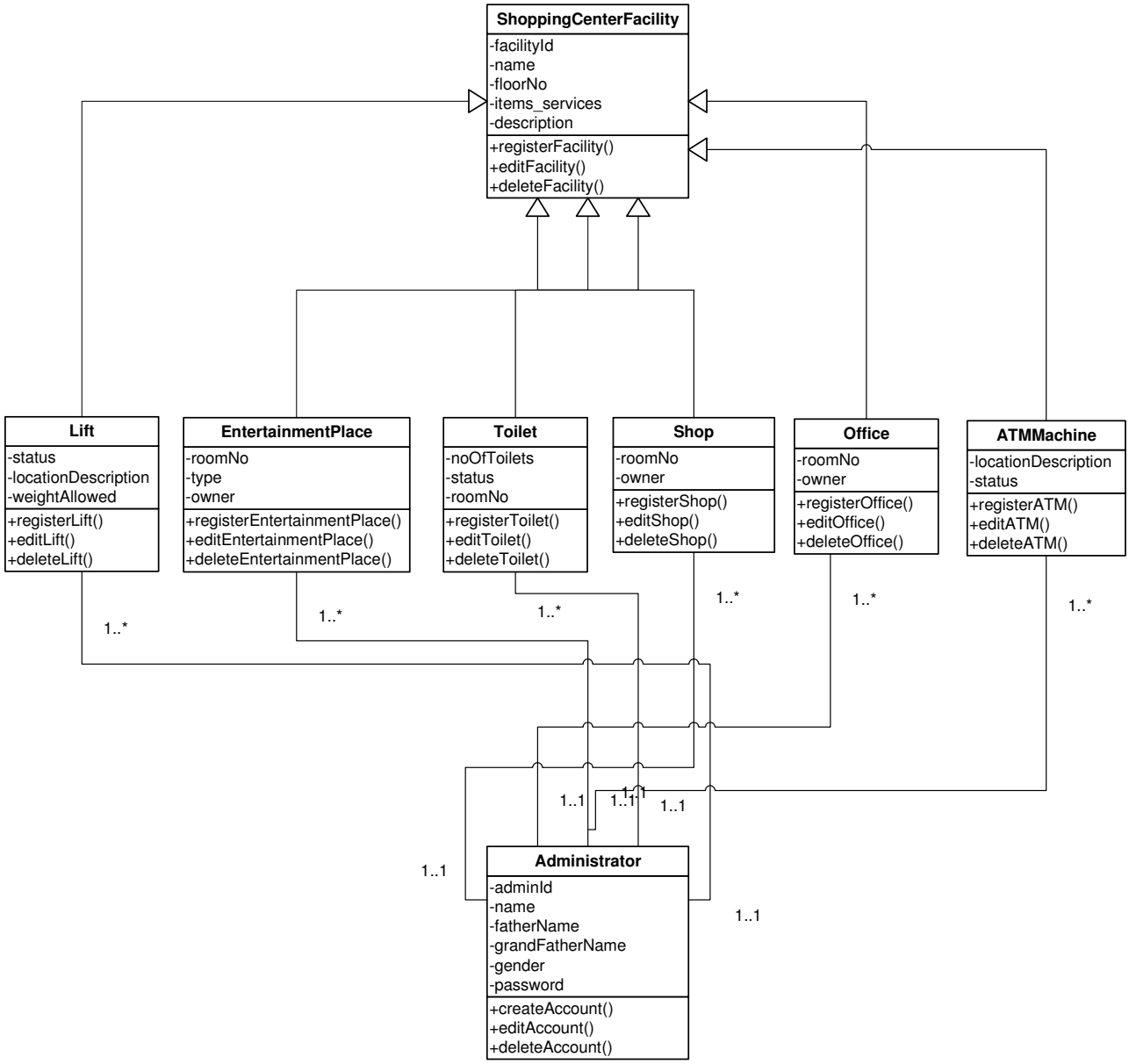

Figure 3.2: Class Diagram for Bluetooth Enabled Information Provision System

3.3.3 Sequence Diagram

A Sequence diagram is a system model that is used to depict the interaction between participating objects in a given use case. The sequence diagrams for this particular system are organized in such a way that they can clearly show the participating objects in the given use case composed of user interfaces, control objects and persistent data elements.

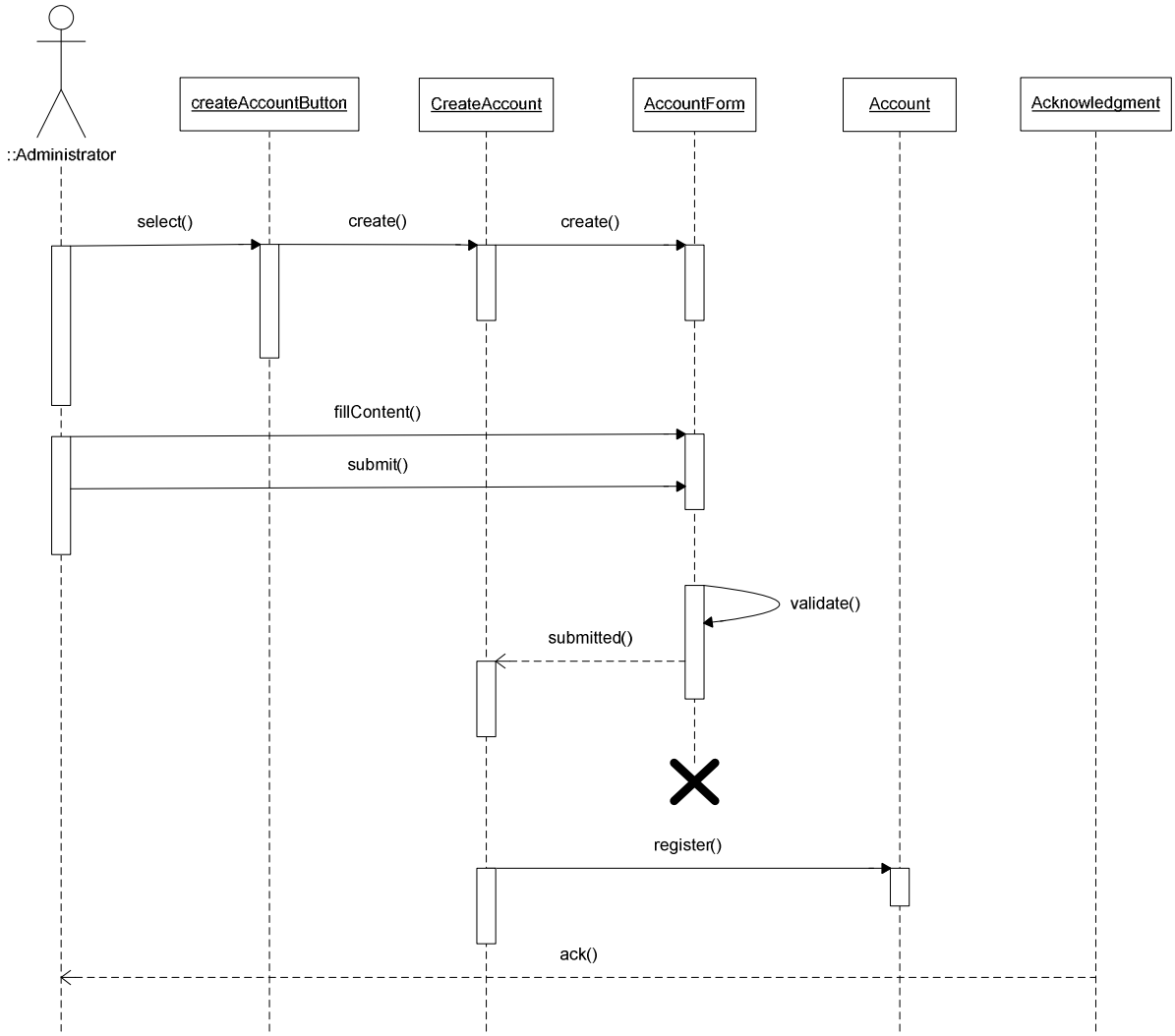

Figure 3.3: Sequence Diagram for Creating Account

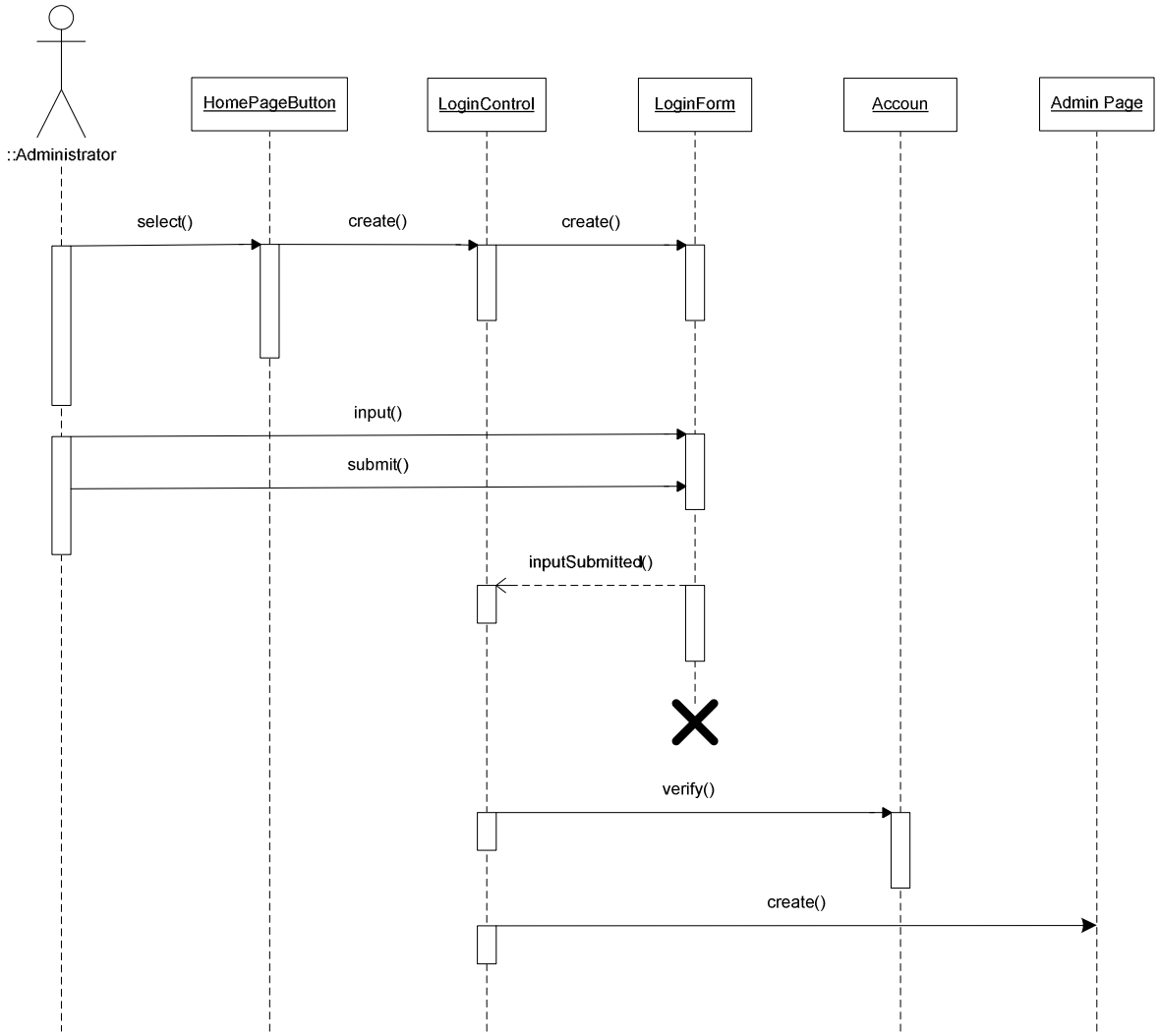

Figure 3.4: Sequence Diagram for Login

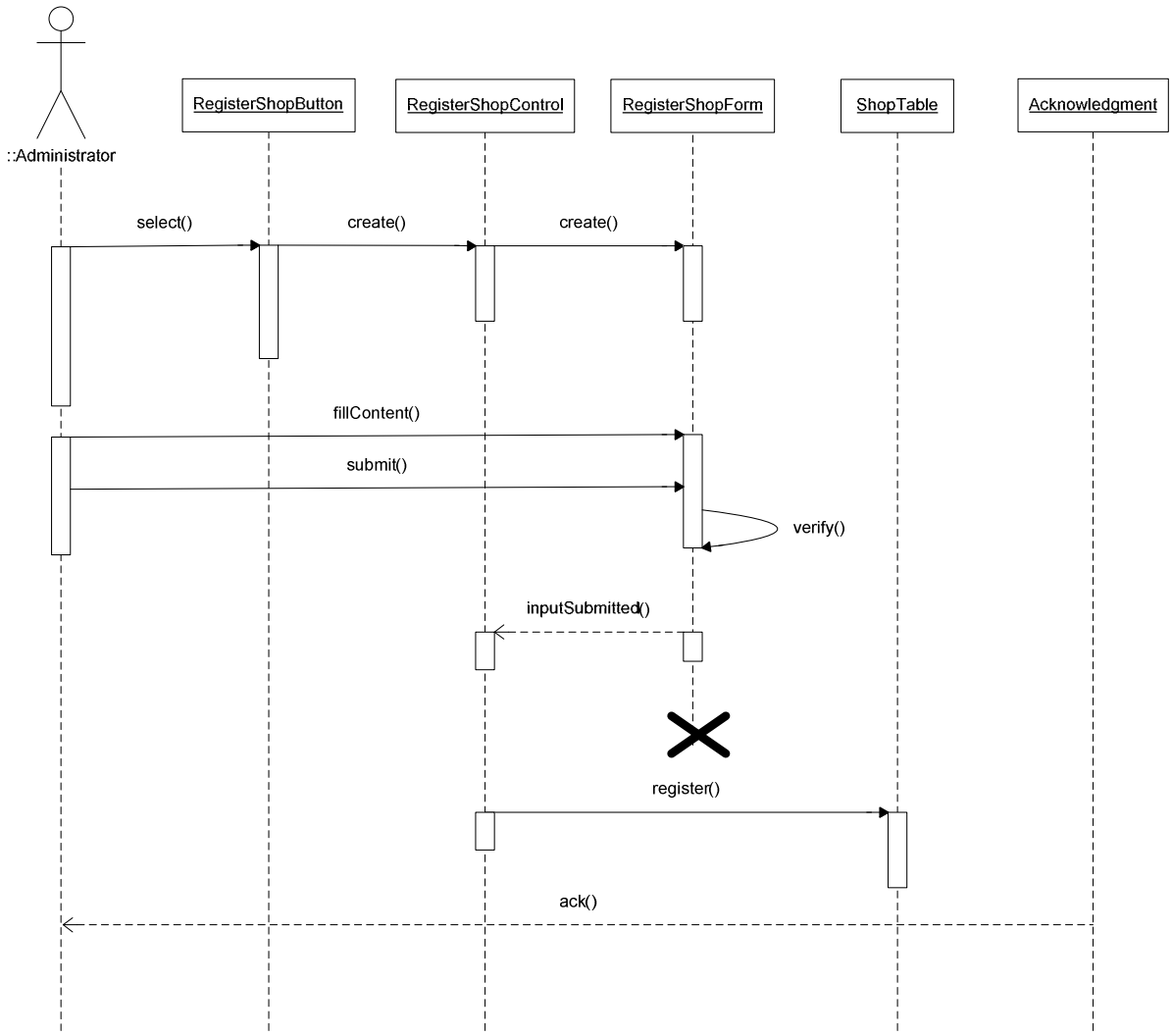

Figure 3.5: Sequence Diagram for Registering Shops

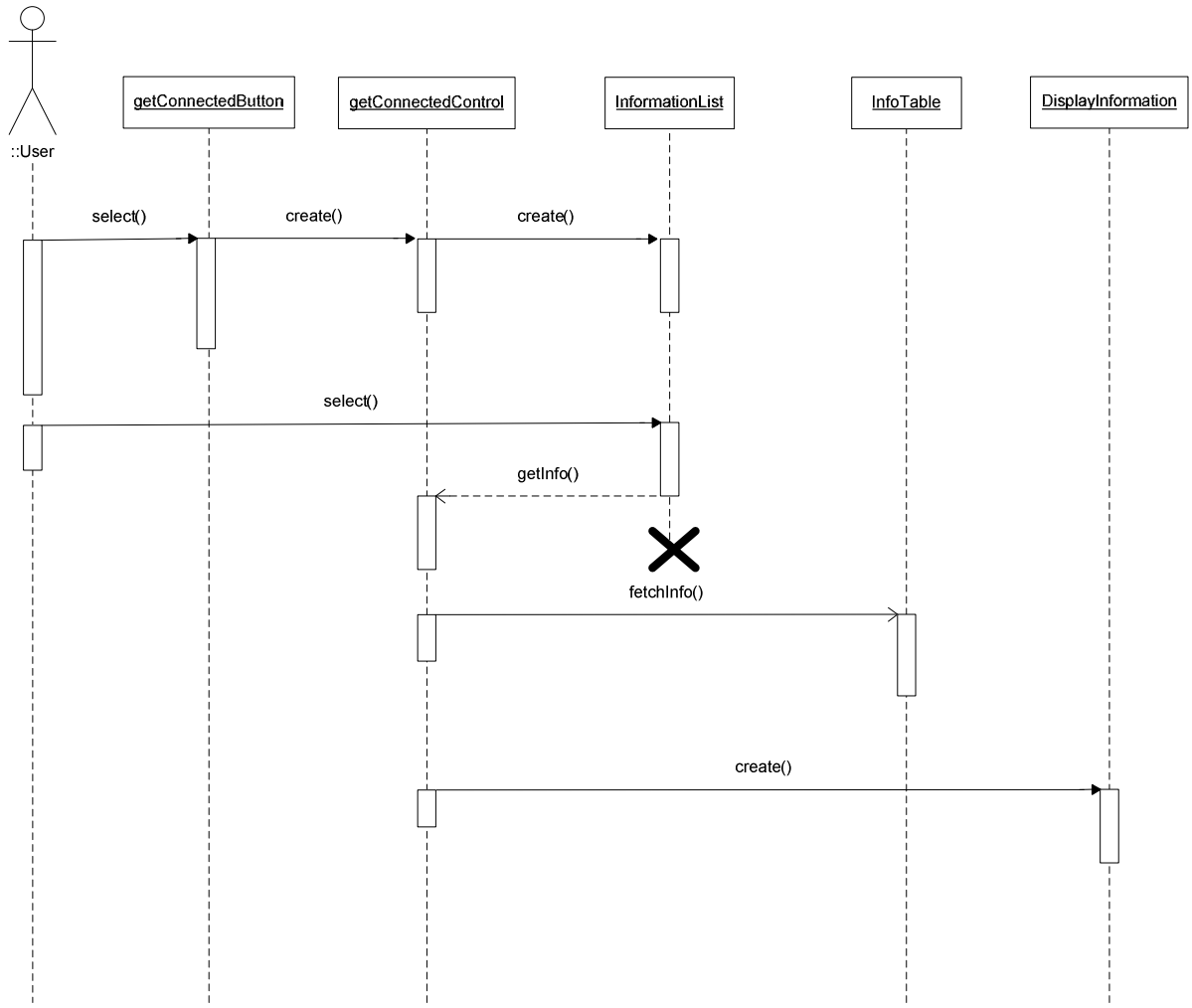

Figure 3.6: Sequence Diagram for Accessing Information

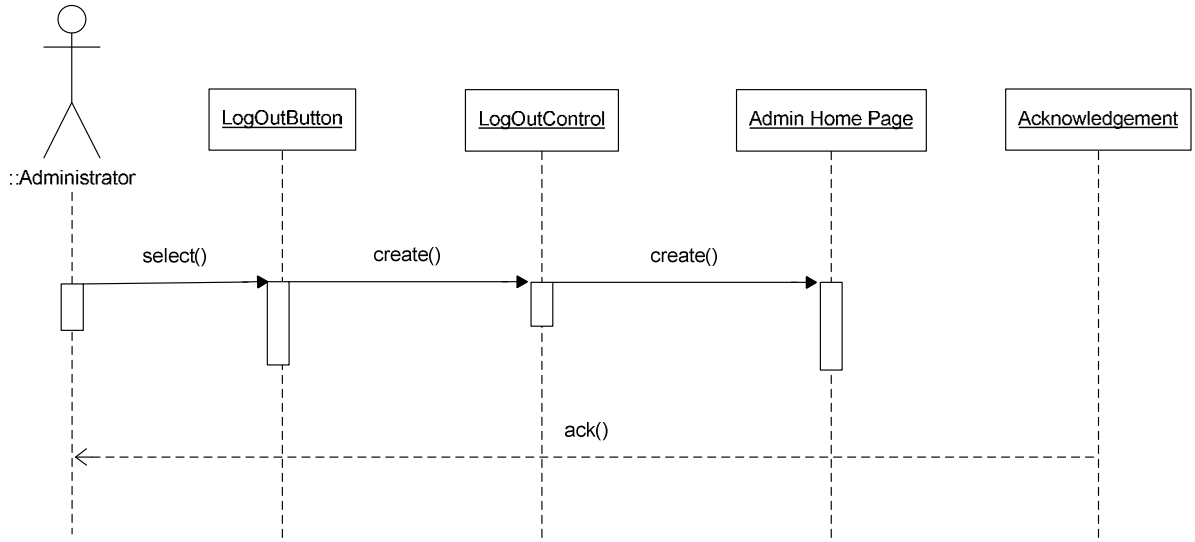

Figure 3.7: Sequence Diagram for Logging Out

3.3.4 Activity Diagram

Activity diagrams show the work flow of the system. They illustrate what activities can be done in parallel, and the possibility of alternative paths through the work flow.

The activity diagram for this system depicts the different activities involved through the course of the working with the system in terms of the actors involved. Figure 3.8 shows the activity diagram of the system.

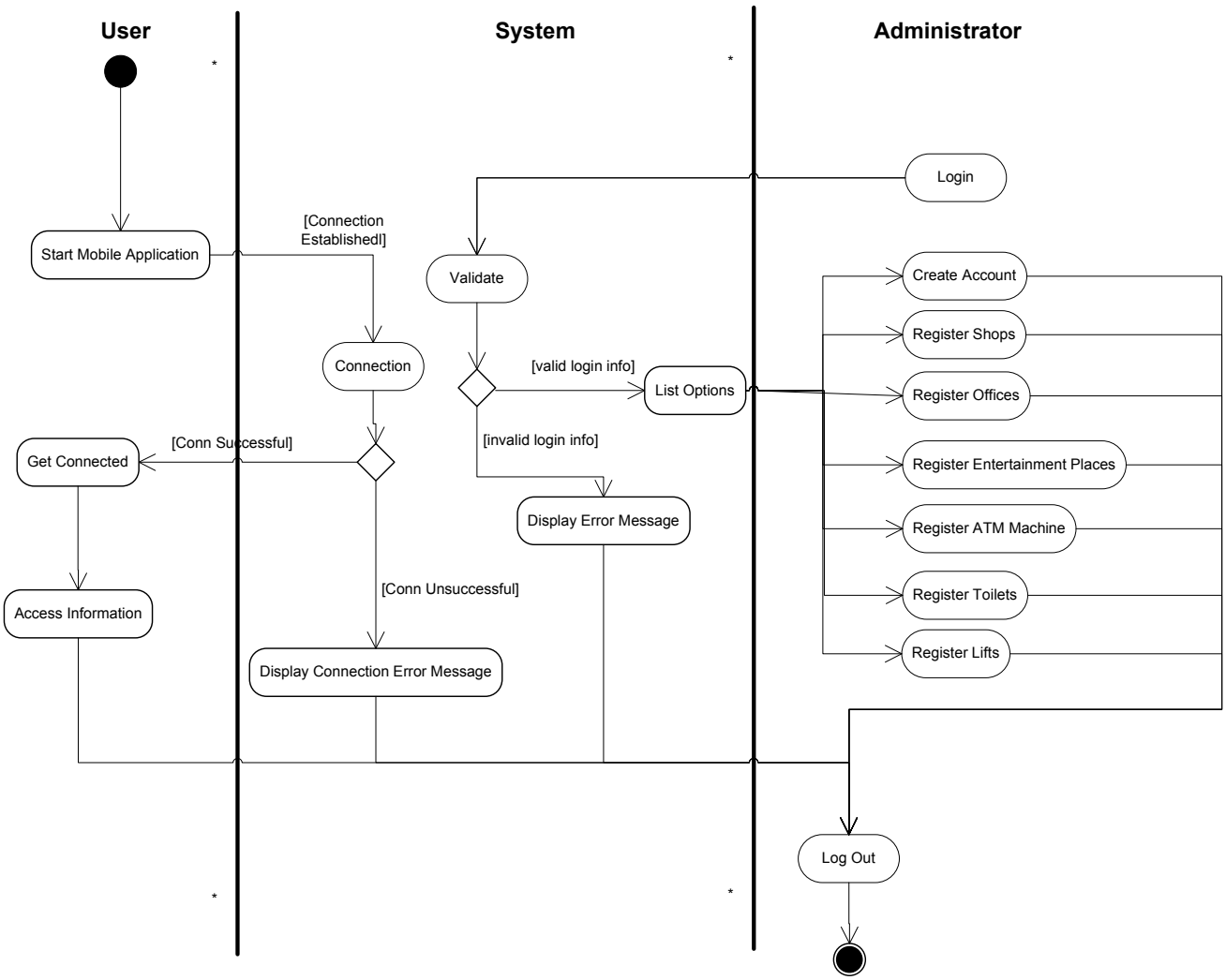

Figure 3.8: Activity Diagram of the system

Chapter 4 System Design

In the previous chapter, the functional and non-functional requirements of the system have been identified and analyzed using different system modeling diagrams.

This chapter details the design of the Bluetooth Enabled Information Provision System. It is organized into four subsections. The architecture, subsystem decomposition, hardware/software mapping and persistent data management of the system are all covered in this chapter.

4.1 Architecture

Architecture of a system is one of the major issues that should be given paramount importance. The architecture plays a pivotal role for modularizing the different components of a system. Moreover, the architecture of the system can be implemented in tiered approach. Designing the architecture in tiers is useful as it supports layering, promotes scalability and allows easy maintenance of the application.

Considering this fact into account, this system is designed to apply three-tier architecture. The architecture is composed of the data tier, Bluetooth Server tier and mobile tier.

The architecture of the system is depicted in Figure 4.1.

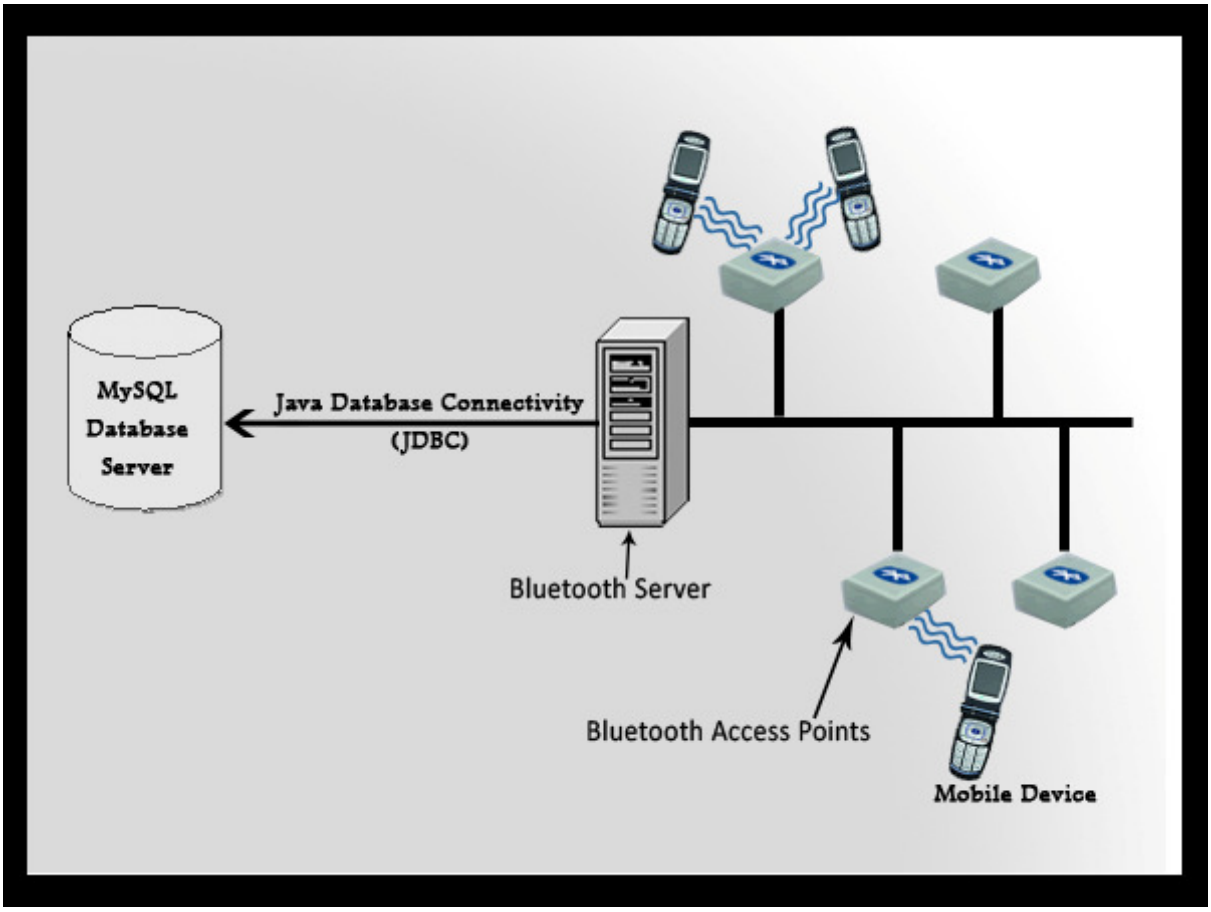

Figure 4.1: The Bluetooth Information Provision System Architecture

4.1.1 Data Tier

The data tier of the application handles all persistent data related issues. A relational database management system (DBMS) is used to manage all data in the data tier.

4.1.2 Bluetooth Server Tier

This tier is responsible for establishing a connection with the data tier as well as providing services to the mobile tier. The Bluetooth server, a desktop application, establishes connection between the mobile and the database. The connection is established using a Bluetooth serial port.

For this particular application serial port is used as a communication point between the server and the mobile device. Hence, the mobile apparatus should support Bluetooth connection.

Generally, the task of the Bluetooth server is to handle query requests from the mobile device. It accepts user's query and sends back the data from the database.

In order to help administrators control the system effectively and efficiently, the server is designed to be a desktop application providing interactive user interfaces.

Moreover, Bluetooth access points will be fixed with appropriate diameter so as to facilitate the communication between the Bluetooth server and the mobile device. The Bluetooth access points transmit signals from the Bluetooth server to the mobile device and back to the Bluetooth server enabling users to access the system within a larger diameter.

4.1.3 Mobile Tier

This tier is responsible for establishing a connection between the mobile device and the Bluetooth Server. The mobile device sends requests to the Bluetooth server and receives the data by listening to the Bluetooth serial port.

The mobile tier is, therefore, represented as a MIDlet application. Hence, this MIDlet application should be installed on Bluetooth enabled mobile devices so as to create the communication.

4.2 Subsystem Decomposition

The Bluetooth Enabled Information Provision System can be viewed from the user as well as administrator perspectives. With regards to this, the user is privileged to access information about the shopping center without any need of authentication.

On the other hand, the administrator is responsible for managing the system.

Taking these facts into account, the system can be composed of three main subsystems namely administration subsystem, Registration subsystem and Data Access subsystem. Figure 4.2 depicts the subsystem decomposition of the system.

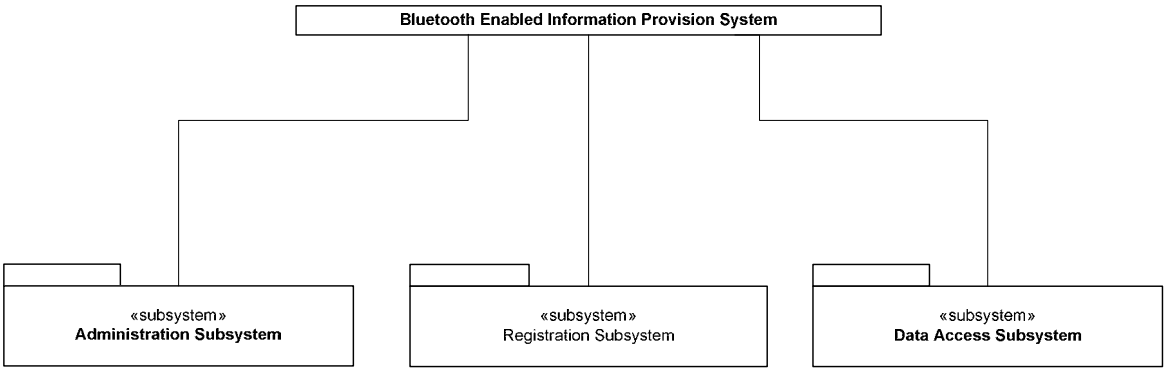

Figure 4.2 General Subsystem Decomposition of the system

4.2.1 The administration subsystem

This subsystem enables the administrator to manage the system. Hence, the administrator can create, edit and delete accounts. The subsystem also enables the administrator to log into the administrator's control panel.

4.2.2 The registration subsystem

The system administrator is responsible for recording information regarding shops, offices, entertainment places, ATM, toilets and lifts. With respect to this, the registration subsystem allows the administrator to manage information regarding the shopping center facilities.

4.2.3 The data access subsystem

This subsystem enables the user access the data stored in the database through the Bluetooth connection. Hence, the mobile device first establishes connection and sends its query to the Bluetooth server. The Bluetooth server then fetches the data from the database and sends it to the mobile device.

4.3 Hardware/Software Mapping

One of the major and important tasks in system design deals with hardware/software mapping. The hardware/software mapping describes how it is possible to realize the subsystems (i.e. hardware/software) and how the object model is mapped on the chosen hardware and software.

The client-server architecture is represented in the deployment diagram in Figure 4.3.

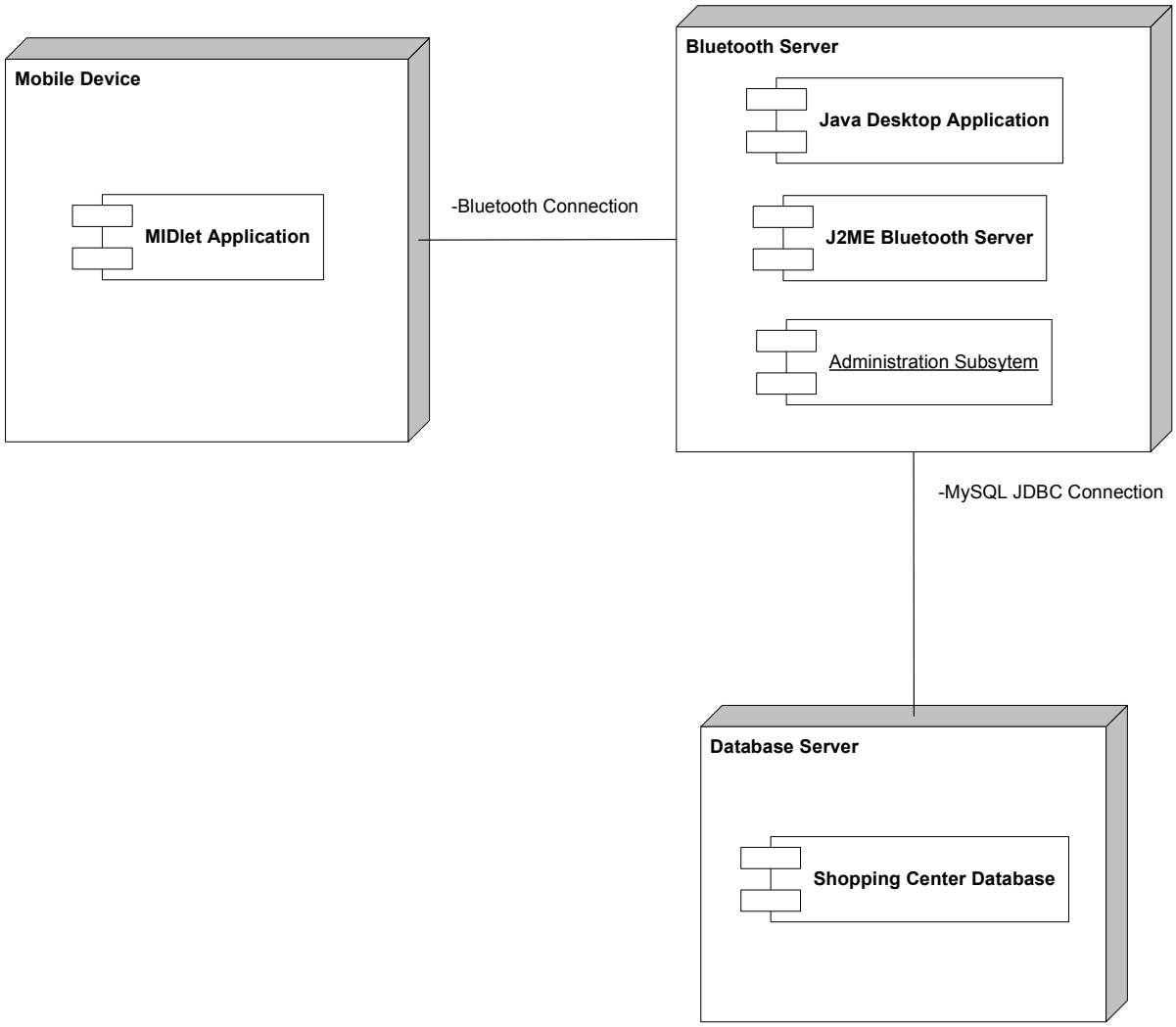

Figure 4.3 Deployment Diagram of the System

4.4 Persistent Data Management

The information regarding administrator's account, shops, offices, entertainment places, ATM, toilets and lifts is stored persistently in a relational

database by the administrator. The system administrator is also responsible for managing the information regarding the aforementioned facilities of the shopping center. Therefore, the administrator may create, edit and delete information about administrators, shops, offices, entertainment places, ATM, toilets and lifts.

4.4.1 Mapping

In order to create the persistent data management, the classes that are identified after the requirements of the system (i.e. in chapter 3) should be mapped into tables. In addition to this, the attributes of the classes are mapped into table fields.

Figure 4.4, therefore, shows the list of tables, attributes together with the data type and the relationships among tables.

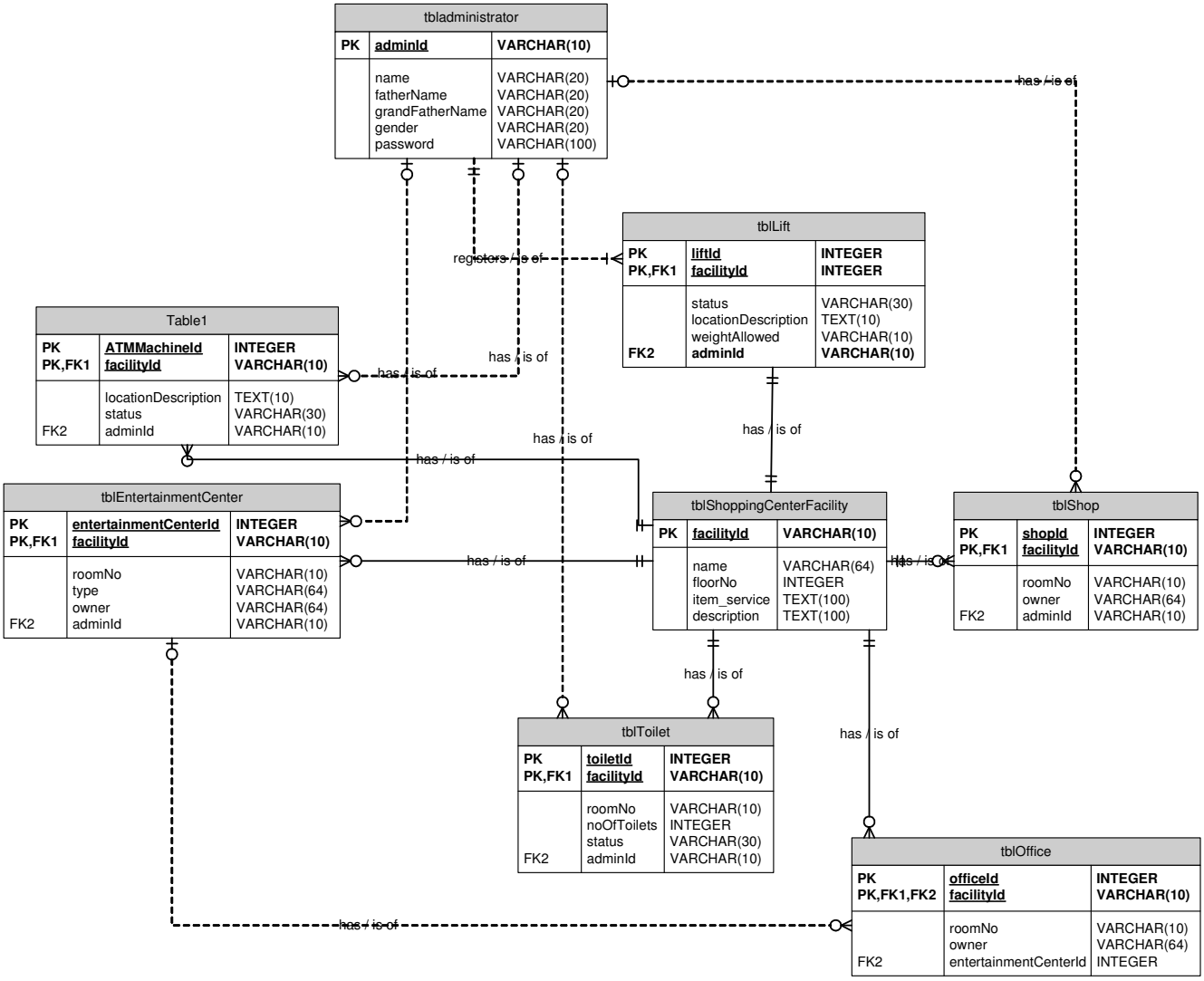

Figure 4.4 Tables and Relationship

Chapter 5 Implementation

This chapter discusses the system development tools applied for implementing the Bluetooth Enabled Information Provision System. Moreover, the prototype and testing of the system are also detailed in this chapter.

5.1 Development Tools

To make the system a reality, different tools are applied. Programming languages, Integrated Development Environment (IDE) and database server are some to mention.

5.1.1 Programming Tools

The programming language used to develop the administrator's control panel where the administrator is enabled to manage accounts and shopping center facilities (i.e. shops, offices, entertainment places etc) is the PHP (Hypertext Preprocessor) scripting language. This scripting language is very popular since it is open source, provides different methods and support object-oriented system development approach.

In addition to this, the Java programming language is used to develop the desktop Bluetooth application as well as the mobile applications. Therefore, the Java 2 Standard Edition (J2SE) and Java 2 Micro Edition (J2ME) are used for the desktop and mobile applications respectively.

The J2ME version of Java provides basic APIs that facilitate mobile application development. The edition also provides APIs for handling Bluetooth connection between the mobile device and the desktop Bluetooth application.

5.1.2 WAMP web server

A web server is required in order to execute the PHP scripting language. The web server that is mostly recommended for PHP is the Apache web server.

Hence, in this project, an application known as WAMPServer 2.0 is used to integrate the Apache web server, the PHP configuration and the MySQL database.

5.1.3 Netbeans

Among the many Integrated Development Environments (IDEs) in the Java programming world, Netbeans is one of the most widely used IDE. Interestingly enough, the Netbeans 6.5.1 version supports the standard as well as micro editions of java (i.e. J2SE and J2ME).

To facilitate the development process, Netbeans 6.5.1 integrates a mobility pack that can be used to virtually test the mobile application before deploying it on a real mobile device. This is achieved through the J2ME emulator that is integrated with Netbeans 6.5.1 version.

On top of this, the IDE also provides libraries that are important for handling different APIs both for the mobile as well as desktop application development.

5.1.4 The MySQL Database Management System (DBMS)

The MySQL database is a relational database management system (DBMS) that is being used in this project to store persistent data of the system. This DBMS is used particularly because it is open source, can be well integrated with apache web server, PHP scripting and Java programming languages.

5.2 Prototype

The Bluetooth Enabled Information Provision prototype system is composed of Administrator's control panel, desktop Bluetooth application, Bluetooth server, and a client mobile application (MIDlet). Hence, in this section, a brief overview is given regarding each component of the system. In addition to this, screen shots of the components are included to make the discussion more clear.

5.2.1 The administrator control panel

One of the major components of the system is the administrator's control panel by which administrators will have control over the system. For the sake of simplicity, all administrators of the system are provided equal privilege.

Moreover, the control panel is designed to be a web based system that can be accessed by initiating the WAMP web server and specifying its address on a web browser. Hence, the home page of the control panel can be reached at http://localhost/shoppingcenter.

The home page contains an interface where administrators enter valid admin id and password in order to log into and get access to the control panel. Figure 5.1 shows the home page of the control panel.

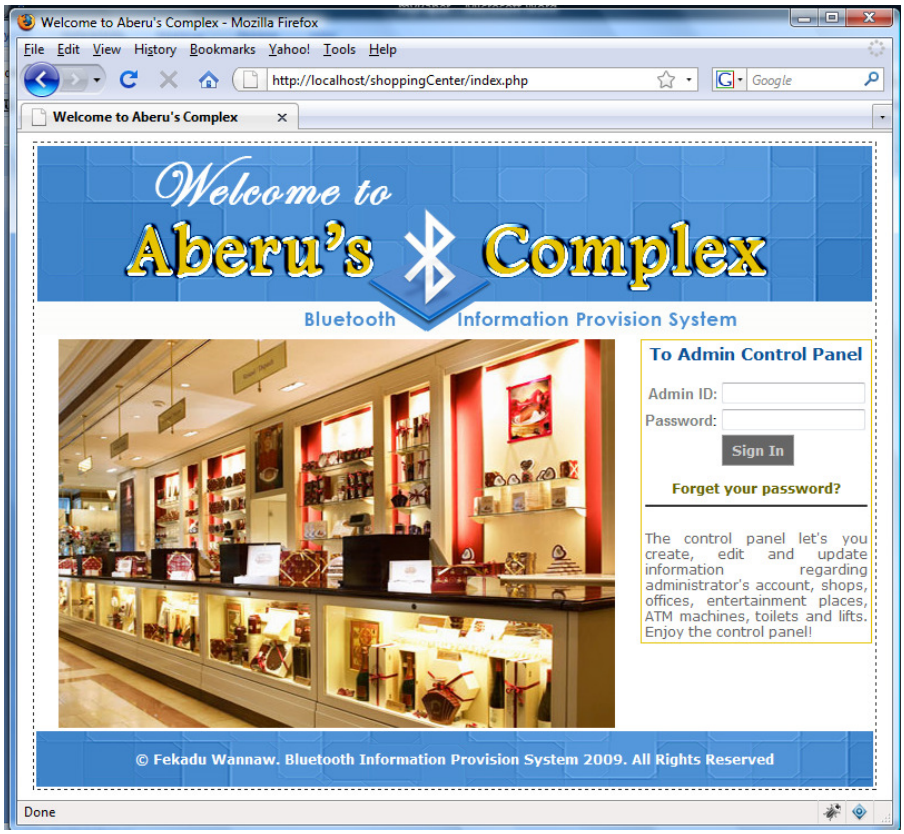

Figure 5.1: Administrator's Login Screen

The main control panel's window contains options to register, edit and delete accounts, shops, offices, entertainment places, ATM, toilets and lifts. Figure 5.2 depicts the main window of the control panel.

Figure 5.2: Main Control Panel Screen

When the administrator selects the Account option from the main window of the control panel, the page depicted in Figure 5.3 will be displayed. This page displays list of accounts that are already created as well as option to create new accounts.

Figure 5.3: List of already existing Accounts

Once the administrator selects the Create Account option, a form will be displayed so that personal as well as admin id and password related information can be entered. For this reason, the administrator is expected to fill out the form indicated in Figure 5.4.

After the registration is complete, the system displays a confirmation message and redirects the administrator to the list of accounts page.

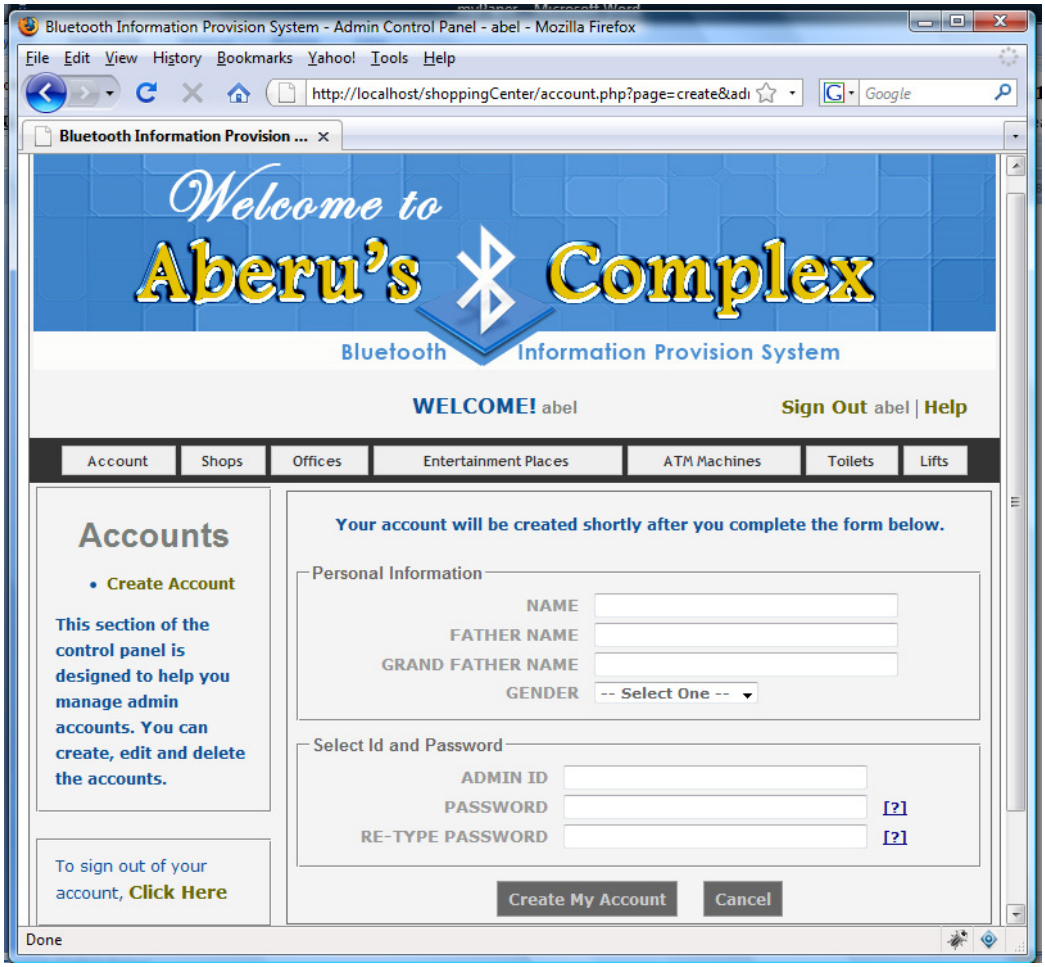

Figure 5.4: Create Account Form

Generally, information regarding the shopping center is registered, edited and deleted in the same fashion as the account information. Hence, appropriate pages are displayed to manage the facilities in the shopping centers.

5.2.2 The desktop Bluetooth application

The basic purpose of this application is to serve as a mechanism to handle all the requests of the MIDlet. Therefore, the responsibility of this application is to always listen to the serial port as the mobile devices connect to the server using the Bluetooth serial port profile (btspp). This protocol enables the devices to send as well as receive data using stream based data communication.

Hence, the code segment in Figure 5.5 opens and accesses the Bluetooth serial port.

```
try
{
        portId=CommPortIdentifier.getPortIdentifier("COM5");
        serialPort = (SerialPort)portId.open("BTServer", 3000);
}
catch (PortInUseException e)
{
        System.out.println("Port In use Error: "+e.getMessage());
}
try
{
        serialPort.setSerialPortParams(9600,
                SerialPort.DATABITS_8,
                SerialPort.STOPBITS_1,
                SerialPort.PARITY_NONE);
}
```

Figure 5.5: The code that opens access to the Bluetooth serial port

Once the serial port object is obtained, reading and writing data can be performed. For this purpose, the serial port object can be used to open input and output streams. The input and output streams are the core objects that facilitate the data communication process (see Figure 5.6).

```
try
{
        OutputStream output = serialPort.getOutputStream();
        dataOut=new DataOutputStream(output);
        InputStream input = serialPort.getInputStream();
        dataIn=new DataInputStream(input);
}
catch (IOException e)
{
        serialPort.close();
        System.out.println("Error opening i/o streams"+e.getMessage());
}
try
{
        serialPort.addEventListener(this);
}
catch (TooManyListenersException e)
{
        serialPort.close();
        System.out.println("Too many listeners added"+e.getMessage());
}
```

Figure 5.6: Input and output streams

The requests from the MIDlet application are parsed into SQL statements and this statement will be sent to the serial port using the output stream. Then after, the desktop application should have a mechanism to listen to the data on the port. Hence, the serialEvent(SerialPortEvent serialPortEvent) method implementation is used to tell the program what to do when data is available on the port (see Figure 5.7).

```
if(serialPortEvent.getEventType()==SerialPortEvent.DATA_AVAILABLE)
{
    try
    {
        int c;
        StringBuffer readBuffer=new StringBuffer();
        String sql="";
        while((c=dataIn.read())!=-1)
        {
            readBuffer.append((char)c);
        }
        sql=readBuffer.toString();
        incomeArea.setText(incomeArea.getText()+"\n----------\n");
        incomeArea.setText(incomeArea.getText()+sql);
            …
    }
}
```

Figure 5.7: Serial Event Handler

Furthermore, the desktop application establishes connection to the MySQL database using the JDBC driver as indicated in Figure 5.8.

```
Class.forName("com.mysql.jdbc.Driver").newInstance();
Connection
    conn=DriverManager.getConnection("jdbc:mysql://localhost:3306/shoppingce
    nterdb","root","");
Statement stmt=conn.createStatement();
```

Figure 5.8: JDBC Connection

In addition to this, in order to provide control to administrators over the system, a user interface is developed to start and stop the application. Figure 5.9 shows the user interface of the Bluetooth desktop application.

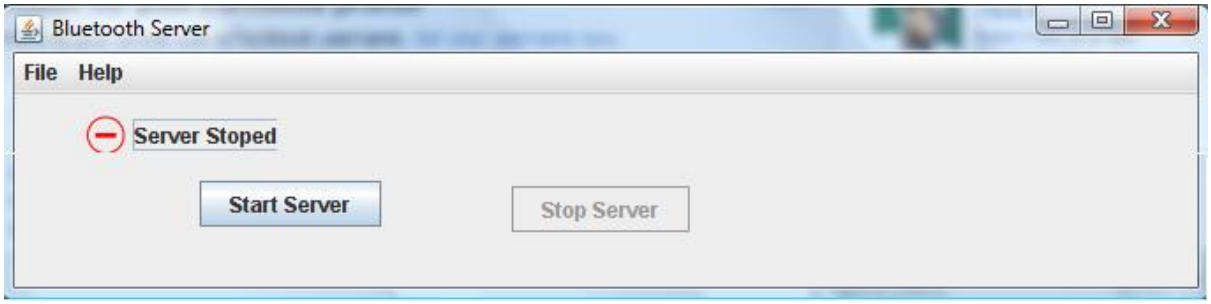

Figure 5.9: The desktop Bluetooth application

5.2.3 The Bluetooth Server

This application is the one that runs on the server. The purpose is to discover Bluetooth enabled mobile devices within the surrounding and establish connection. Hence, as indicated in the previous section, the btspp protocol is used to establish the connection with the client application (i.e MIDlet).

In order to avoid the chance of conflicts in address, a random number is generated. This random number can be, therefore, provided as part of the URL (Universal Resource Locator). The piece of code in Figure 5.10

```
String url = "btspp://localhost:A55665EE9F9146109085C2055C888B39;
name=serialconn";
```

Figure 5.10: btspp URL

demonstrates this concept

Furthermore, the Bluetooth server discovers mobile devices within the surrounding and establishes connection with the URL provided. For this particular purpose, the code segment given in Figure 5.11 is used.

```
localdevice = LocalDevice.getLocalDevice();
localdevice.setDiscoverable(DiscoveryAgent.GIAC);
StreamConnectionNotifier  notifier =
                (StreamConnectionNotifier)Connector.open(url);
servicerecord = localdevice.getRecord(notifier);
System.out.println("Server staring, name= "+localdevice.getFriendlyName());
System.out.println("Service registered.");
con = notifier.acceptAndOpen();
System.out.println("Client found");
input = con.openInputStream();
output = con.openOutputStream();
```

Figure 5.11: Bluetooth device discovery and connection

5.2.4 The Mobile Application (MIDlet)

In addition to the administrators control panel, desktop Bluetooth application and the Bluetooth server, there is the mobile application. This application runs on user's mobile devices and allows them to have access to the system.

Hence, this application should be installed on the mobile devices by the administrator and once it is available, users can automatically get access to the system as far as they are within the shopping center.

The flow of accessing information on the mobile application is shown using the wireless toolkit emulator provided by Netbeans. Therefore, when users start the application, the welcome screen, as indicated in Figure 5.12, will be displayed.

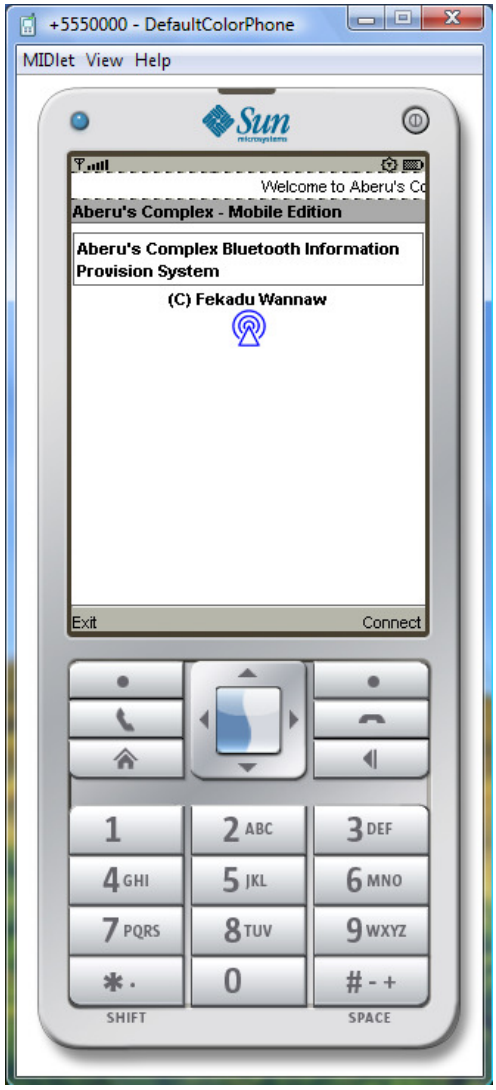

Figure 5.12: The welcome screen on the mobile application

When users select the *Connect* button, they will be prompted by another screen that will allow them connect to the Bluetooth server. This screen is presented in Figure 5.13.

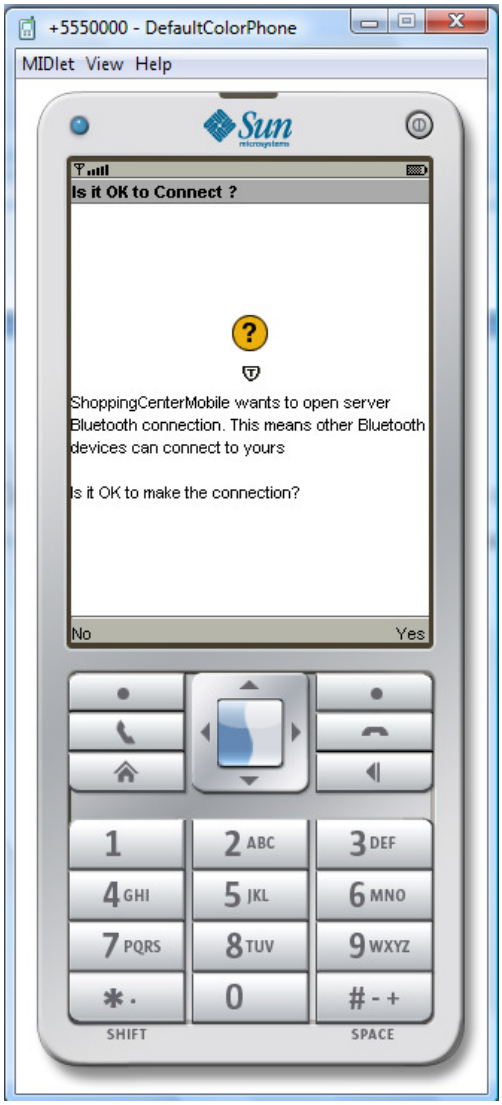

Figure 5.13: Bluetooth server connection screen on the mobile application

Once the mobile device is connected to the Bluetooth server, a screen composed of list of items within the shopping center will be displayed. The list, therefore, contains shops, offices, entertainment places, ATM, toilets and lifts. Figure 5.14 shows the list of facilities available within the shopping center.

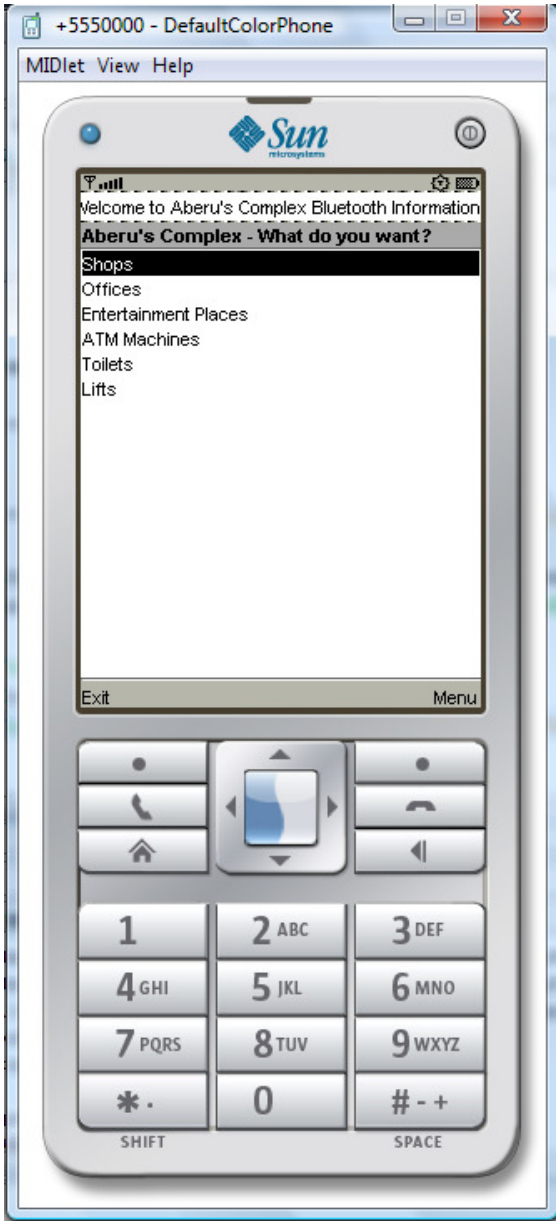

Figure 5.14: List of facilities in the shopping center

Based on the user's choice, detailed information will be displayed regarding the facility in the shopping center.

Chapter 6 Conclusion and Future Works

6.1 Conclusions

Shopping centers are being available in big cities of Ethiopia providing good opportunities to find the goods and services people need in one place.

However, it might be difficult to locate the shops we want to visit in these shopping centers since a number of shops are located in one area. Therefore, most shopping centers apply different mechanisms including signs, boards and advertisement screens fixed at some place to assist customers locate facilities in the shopping centers. However, these mechanisms fail to provide appropriate information as customers move through the shopping centers. This is because the signs and symbols are usually positioned at the main gates of the centers.

To alleviate the problems of providing relevant information, a Bluetooth enabled information provision system could be put in place. The system can play a key role in providing the necessary information to customers irrespective of where they are in the shopping centers.

Therefore, the prototype developed in this project is composed of three components; the administrator's control panel, the desktop Bluetooth server and the mobile application. The administrator's control panel is responsible for managing the information about the different facilities in the shopping center while the desktop Bluetooth application is the one that handles user requests. Besides, the mobile application will be deployed on user's mobile allowing them to interact with the desktop Bluetooth server.

In order to facilitate the communication between the mobile devices and the desktop Bluetooth application, Bluetooth access points will be fixed in appropriate diameter within the shopping center. These access points will

allow signals to reach from the mobile device to the Bluetooth server and vice versa.

The prototype of this project has been tested with the data from Aberu's Complex shopping center and it is achieved that the system successfully manages the registration, edition and deletion of the shopping center facilities. Further, it also allows users to access information effectively.

6.2 Future Works

Through the course of conducting this project, it was learned that the Bluetooth technology provides greater opportunity for short distance communication. Hence, it is possible to enhance the Bluetooth Enabled Information Provision System to incorporate additional features based on the facilities that the Bluetooth and other related technologies provide. These additional features can facilitate and make accessing information within shopping centers easy and interesting.

Therefore, the following are some of the future works identified:

- The system should be able to automatically send the mobile application (MIDlet) to the mobile devices
- Developing the Amharic version of the system and enhancing the area coverage
- Applying rigorous testing and evaluation on the system
- Allowing information access to events calendar including show synopses, video movie trailers and the possibility to buy movie tickets with the phone
- The ability to geographically locate other users who are friends and family members within the shopping centers
- Applying similar systems in Museums, sport stadiums and other places in order to provide relevant information

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Glossary

API

A*pplication* ***P****rogram* ***I****nterface* is, a set of routines, protocols, and tools for building software applications

Bluetooth Stack

A Bluetooth stack refers to an implementation of the Bluetooth protocol stack.

Btspp

Bluetooth **S**erial **P**ort **P**rofile **-** A Bluetooth profile used to establish serial port connectivity between devices using a Radio Frequency Communication (RFCOMM) or Logical Link and Control Application Protocol (L2CAP) transport.

DBMS

Data**B**ase **M**anagement **S**ystem is software that controls the organization, storage, retrieval, security and integrity of data in a database.

IDE

An **I**ntegrated **D**evelopment **E**nvironment is a software application that provides comprehensive facilities to computer programmers for software development.

J2ME

Java **2** Platform **M**icro **E**dition - A version of Java 2 for cell phones, PDAs and consumer appliances. J2ME uses the K Virtual Machine (KVM), a specialized Java interpreter for devices with limited memory.

JDBC

Java **D**ata**B**ase **C**onnectivity is a programming interface that lets Java applications access a database via the SQL language.

JSR-82 Specification

A Java ME specification for APIs that allow Java MIDlets to use Bluetooth on supporting devices. The specification was developed under the Java Community Process as JSR 82.

MIDlet

A cell phone or pager application written in the Java 2 Platform, Micro Edition version (J2ME)

PHP

Hypertext **P**reprocessor is a scripting language used to create dynamic web pages. With syntax from C, Java and Perl, PHP code is embedded within HTML pages for server side execution.

URL

Uniform **R**esource **L**ocator - The address that defines the route to a file on an Internet server (Web server, FTP server, mail server, etc.).

WAMP Web server

A form of mini-server that includes Apache 2, PHP 5, and MySQL preinstalled.

Wireless toolkit emulator

Provides emulation environments, performance optimization and tuning features, documentation, and examples that developers need to bring efficient and successful wireless applications to market quickly.

Declaration

I, the undersigned, declare that this project is my original work and has not been presented for degree in any other university, and that all sources of materials used for the project have been acknowledged.

Declared by:

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Date: July 25, 2009

Place and date of submission: Addis Ababa University, July 2009.