

BYOD Public System
BRENDA LEE MUN YEE

A REPORT
SUBMITTED TO
Universiti Tunku Abdul Rahman
in partial fulfillment of the requirements
For the degree of
BACHELOR OF COMPUTER SCIENCE (HONS)
Faculty of Information and Communication Technology
(Perak Campus)
Jan 2015

UNIVERSITI TUNKU ABDUL RAHMAN

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Address:

3, Regat Pegoh 2,
Taman Pengkalan Jaya,
Ipoh, Perak.

Dr. Oooi Boon Yaik
Supervisor's name

Date: 10 April 2015

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DECLARATION OF ORIGINALITY

I declare that this report entitled “**BYOD PUBLIC SYSTEM**” is my own work except as cited in the references. The report has not been accepted for any degree and is not being submitted concurrently in candidature for any degree or other award.

Signature : _____

Name : BRENDA LEE MUN YEE

Date : 10 April 2015

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I would like to express my sincere thanks and appreciation to my supervisor, Dr Alex Ooi who has given me guidance throughout the project development. Besides that, I would also like to thank the moderator for this project which is Dr Michael Cheng who has given me guidance on improvement of the project.

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ABSTRACT

This project build on the concept of Bring Your Own Device (BYOD) to control and navigate public interactive digital display. Public interactive digital display such as map services, advertisement and bulletin boards. This project enable user to connect to public interactive digital display by using their own mobile device. This project will be develop using Java programming language. Java programming language is mainly use in developing server side function and connection from mobile device to digital display with socket programming. Next, Java programming language is use to create the user interface of the Android application for the user side. The software development platform used to develop this project is NetBeans.

First, the display device will be broadcasting access point through the WIFI. Next, user are require to connect the access point to establish connection with the display device's server with the developed Android application in order to use the BYOD system. When user successfully connected, display device will notify the user of the successful connection. Next, user will then be able to control and navigate the display with the given set of controller in the Android application. User can control by using the directional key cursor provided in the Android application. Besides that, user can enter words or sentences to the display screen by entering at the box provided at the Android application.

The final deliverable will enable the user to control and navigate interactive digital display by using their mobile device.

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LIST OF ABBREVIATIONS

<i>UTAR</i>	University Tunku Abdul Rahman
<i>BYOD</i>	Bring Your Own Device
<i>IP address</i>	Internet Protocol Address

Chapter 1 : Introduction

1.1 Motivation and Problem Statement

Public display systems are placed in area such as shopping malls and airport allowing advertising company to advertise and convey messages to the public. Public system such as directory or map services, bulletin board or notice board are equip with button or touch screen functionality to allow user to navigate through the pages. However, public system that provide interactive device on their system are often expensive and have higher maintenance cost. It is because the input device they provide are prone to wear and tear as time past. Thus, regular maintenance are require to provide top notch services to the public. Vandalism might also occur as unethical users damage the controller provided. Thus, companies are often required to pay the replacement fee of the controller. By introducing Bring Your Own Device (BYOD) concept into public systems where it can be access with user own devices to control and navigate the contents. The BYOD approach will be able to lower maintenance cost in repairing and replacing parts of public system.

Bring Your Own Device (BYOD) concept is bringing your own devices such as smart phone and tablet to use and connect on provided networks. Thus, BYOD concept can be used as a medium to allow user to control and navigate the contents provided on the interactive digital display. Company should able to interact with public by providing screen with interactive information and entertainment for public to connect. User will also have a more personalize control as their are using their own device to control and more secure by avoiding key logging that are usually catching user information by tracking their key strokes on the keyboard or buttons provided. For example, key loggers can be installed on to the public system such as ATM machine to log keystrokes and store the keystrokes into the key logger device and be retrieve later by unethical user.

This project aims to develop a BYOD platform to control and navigate interactive digital display. By providing entertainment and information on interactive digital display for public to access through their devices.

1.2 Project Scope

This project scope is to develop a BYOD platform to control and navigate interactive digital display in university environment. At the end of the project, a mobile device that can be connected with the interactive digital display are presented. The development of this project will mainly focus on the connectivity on the BYOD platform. This project will take considerate in one to many connection and plan a solution for one to many connection. This project also explore the possible problem that will occur when using in real world. Lastly, this project will further enhance the experience of user in connecting, having entertainment and conveying messages in public.

1.3 Project Objective

The current BYOD project, which using the concept of controlling interactive digital display through mobile device, it must be able to perform actions as follow:

1. To allow user to connect and control interactive digital display with mobile devices.
2. To provide functionality that facilitates user in controlling the public display.
 - a. By providing different sets of controller interface in the mobile application.

1.4 Proposed Approach

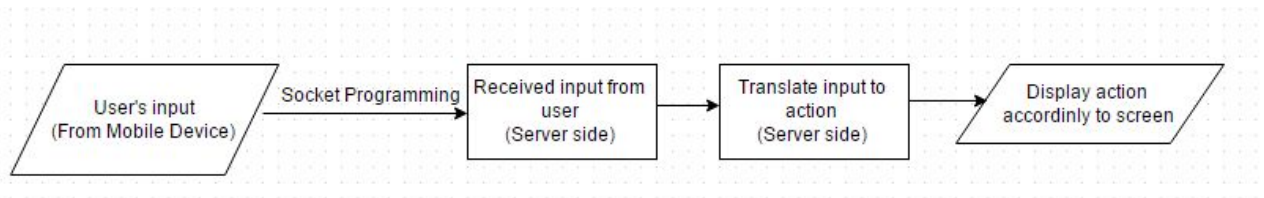


Figure 1.4.1 Proposed Approach on socket programming

The proposed approach method used in this project is socket programming in Java. Socket programming will allow user to establish connection to server through WIFI connection. Received input will be translate and determine the action perform by server. Request that involve changing the component and state of server's display will be display at server's screen accordingly.

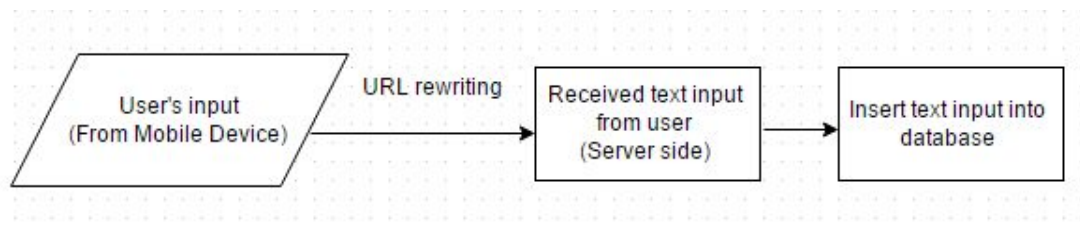


Figure 1.4.2 Proposed Approach on web servlet

Next, for text inputted at comment interface. The inputted text will be send to web servlet through URL rewriting. The received text will then be put into MySQL database for later retrieval.

1.4 Impact Significance and Contribution

In this project, the BYOD approach are explored as an interaction technique to connect to public display. By using BYOD concept, users phone acts as a remote control for the public display which able to access and interact to acquire information, entertainment and give feedback. Latency in connectivity are suspected to be the main factor that causes BYOD concept to be less favorable. Design of user interface at user mobile device are also one of the factor that are suspected to cause less user friendliness. At the end of project, if BYOD concept are successfully build and usable

in public. Interaction technique such as BYOD concept can be further deploy and enhance since user with mobile device can interact with interactive digital display to obtain information and entertainment with their own devices. Company should able to lessen the cost in maintaining the public display as no controller will be provided. Company should also able to collect feedback and responses from public through the public display.

1.5 Background Information

Nowadays, with the advancement of technology, different approach of displaying information and advisement are improvised as time past. Various type of big screen display are placed in public area to advertise and convey information to the public.

However, most of the public display can only display information but not receiving information from the users. Screen that have touch screen functionality are mostly expensive and are not a very good choice to deploy many in public as they require high maintenance cost. Different interactive technique exist in the market such as button and touchscreen. However, controller provided are sometimes damage due to long term usage or vandalism which will cause missing of controller. Thus, company suffer high maintenance cost to provide physical controller, so legitimate user are able to access and view the information the company wanted to convey.

In this project, mobile devices are required to facilitate the interactivity between users and the interactive digital display. By using BYOD concept, no physical controller are provided as user can use their own mobile phone devices. Thus, cost of maintenance of interactive digital display can be lower down. No touchscreen functionality are required for the public display as most of the current mobile devices are equip with touchscreen functionality. User will be able to controller the public display to enter input and navigate the content using their mobile devices. Thus, company should able to cut down on cost in providing and maintaining physical controller.

1.6 Report organization

First section of the report is the introduction of the project. Introduction comprises the motivation and problem statement, project scope, project objective, proposed approach, impact significance and contribution and background information. Next, the second section included the three literature reviews. The third section of the report is the system design. Next, the following section is the system implementation and testing. The last section of this project is the conclusion of the project.

Chapter 2 : Literature Review

2.1 Review on Interactive Methods

From our literature reviews, we categorize interactive methods into four category which is wired, wireless, gesture and BYOD. Wired input device such as keyboard and button are needed to place nearby the public system in order to control and navigate. Keyboard and button are traditional type of input device, people are familiar with the device, thus user can easily input information. It is widely used in the public for various input purposes. Next, wired input device normally have a limited range and have to be put around the public system to allow user to use. It is the cheapest form of interactive method provided by the service provider among the four category. However, direct interaction on controller will cause devices to wear and tear faster. Thus, frequent maintenance are require to replace the controller. Maintenance cost also increases when vandalism occur where unethical user purposely damage the device. Wire can also be damage by rodents, thus increasing the cost of maintenance.

Next, wireless input device such as wireless mouse and keyboard, Playstation 3 controller do not have attached wire. It is more convenient as there are no wire entangle issue and have a larger area of interaction range compare to wired input device. However, wireless input device are not suitable to use in public as they can be easily stolen as there are no attachment on the wireless device. User might also accidentally use and take away the wireless device. And most of the wireless device require battery, when the battery runs out the controller will not be functioning. Thus, it is not appropriate to use wireless device as an input device in the public, as it require to be functioning for a long period of time.

Besides that, gesture interactive method are method that uses gesture recognition to perform certain action. As mention by (Kayla 2014), current industries that adopt gesture interactive method are automotive sector, consumer electronic sector, transit sector and gaming sector. Gesture recognition require a camera device to capture user action and translate in order to control and navigate the display. However, it is not

suitable for public use as crowd are gather around or walking pass the camera, thus affecting the accuracy of the gesture recognition.

Lastly, BYOD concept allows user to control and navigate display though their personal mobile devices. Public system provider do not need to provide physical controller for user to control the interactive digital display. User can also have a more personalize experience when interacting with the digital display. However, user that do not own or forget to bring their mobile device will not be able to interact with the digital display. Battery of the mobile device are also a factor that will cause the user unable to interact with the digital display. Thus, BYOD platform should not be deploy for mission critical operation.

Table 2.1 Comparison between interactive method for interactive digital display

Interactive method	Advantage	Disadvantage
Wired	<ol style="list-style-type: none"> 1. Low cost device 2. Public are familiar with the input method 	<ol style="list-style-type: none"> 1. Limited interaction range 2. Wire entangle issues 3. Device can be easily vandalize 4. Frequent maintenance required to replace wear out controller
Wireless	<ol style="list-style-type: none"> 1. Portable 2. Wider interaction range than wired controller 	<ol style="list-style-type: none"> 1. Easily stolen in public areas 2. Require battery 3. Frequent maintenance to replace device battery
Gesture	<ol style="list-style-type: none"> 1. Use human parts to perform action on interactive display 2. No direct contact on interactive display, thus less wear and tear 	<ol style="list-style-type: none"> 1. Not suitable in environment with crowd walking around 2. Successful of interaction depend on accuracy of gesture recognition
BYOD	<ol style="list-style-type: none"> 1. More personalize experience 	<ol style="list-style-type: none"> 1. User that do not own mobile device will not be able to use the

		interactive display
	2. No physical controller are required to be provided by the service provider	2. Mobile device that are out of battery will not be able to use the interactive display
	3. Service provider will only focus on providing interactive digital display	3. Mobile device might be faulty, thus should not be use in mission critical operation

In this project, BYOD platform is chosen as the medium to enable interaction between users and interactive digital display. Service provider can lower their maintenance cost by not providing physical controller. Besides that, interactive digital display do not need to equip with high-end functionality such as touchscreen functionality and gesture recognition functionality which have a higher cost. User can also have a more personalize experience when using public interactive digital display and do not need to familiarize with another set of controller.

2.2 Review on Interactive Digital Signage

This paper focus on the type of interactive technique used in digital sign. As mention by (Roy & Bill 2012), most of the digital display are design to broadcast advertisement information. But when digital display are added with interaction it can become more useful as it can receive input from user. Interaction technique such as button, touchscreen, gesture interaction and mobile phone are mention in the paper reviewed.

Button are used as an input device which is physically located near the public display screen. However, pressing button for a long period can causes damage to the hardware. Thus, in a long run, button required frequently maintenance. Next, as tablet and smart phone become popular, user are familiar with touchscreen functionality. Thus, some of the public display have touchscreen interactive functionality. However, user tends to become confuse with traditional public display and expect display that does not equip with touchscreen functionally to respond.

Gesture interaction with 2D camera and 3D camera are also used as one of the interaction technique. It is used to determine digital content by detecting user physical appearance. Thus, more appropriate contents can be shown towards targeted audience. However, error can not be avoid since system might not able to interpreting the physical appearance accurately. Digital display that come with 2D camera or 3D camera also incur high cost and maintenance require technician with specific skills. Next, control display by using mobile device are mentioned by using Bluetooth technology. Bluetooth is used because it is a short-range wireless technology, thus lower the latency of interaction between user and the signage as mention in the article. However, in this project internet connection are required. The advantage is enabling multiple users to connect to the server at the same time. Thus, more diverse interaction can be achieved.

2.3 Energy Consumption in Android Phones when using Wireless Communication Technologies

This paper focus on the current available wireless communication technologies. Simple android application are developed to send and receive data continuously to gather data required. They have done a measurement study on energy consumption for 3 different wireless communication technologies which is Bluetooth, WIFI and 3G. By comparing the energy consumption and time elapsed, the result shows that Bluetooth consume the less energy when transfer data compare to WIFI and 3G. Next, energy consumption are compare with the amount of transferred data, the obtained result shows that Bluetooth and WIFI are able to transferred similar amount of data while 3G transferred the smallest amount of data. With the collected measured data, energy consumption model are produced and further verify by using mathematical function as shown in Table 2.3.1 and Table 2.3.2.

Table 2.3.1 Energy Consumption Functions in respect to the elapsed time (Kalic, 2012)

ENERGY CONSUMPTION FUNCTIONS IN RESPECT TO THE ELAPSED TIME

	Download	Upload
Bluetooth	$y = 9.53x - 0.39$	$y = 9.01x + 0.84$
WiFi	$y = 18.09x + 0.17$	$y = 21.24x - 2.68$
3G	$y = 20.59x - 1.09$	$y = 15.31x + 2.67$

Table 2.3.2 Energy Consumption Functions in respect to the amount of transferred data (Kalic, 2012)

ENERGY CONSUMPTION FUNCTIONS IN RESPECT TO THE AMOUNT OF TRANSFERRED DATA

	Download	Upload
Bluetooth	$y = 24.58x + 0.18$	$y = 17.09x - 0.53$
WiFi	$y = 17.01x - 0.93$	$y = 17.31x - 2.28$
3G	$y = 31.74x + 2.15$	$y = 71.27x - 0.03$

Chapter 3 : System Design

3.1 Methodology

The methodology that are adopt in this project is prototyping methodology. There a total of 5 stages in prototyping methodology which is planning, analysis, design, implementation and testing. In the first stage which is planning stage, motivation and problem statement are identified. One of the motivation of our project is physical controller are not suitable in public and can be replace by using BYOD concept as a medium. Objective of the project are also identified in the planning stage which is stated in this report. Next, the second stage is analysis stage. In analysis stage, further information on controller are read and analysis, literature review are done to further support the project. Energy consumption on different type of connectivity are also review in the literature review.

Third stage is design phase, different kinds of diagram are designed such as use case diagram, class diagram, activity diagram and sequence diagram to have a clearer overview on system design. Use case specification are also done to describe the activity that can be done by user to the system. Next, prototype is develop to perform testing of function and usability of the BYOD system. Lastly, detailed design, implementation and testing stage will be further in progress in final year project two.

3.2 Use Case Diagram

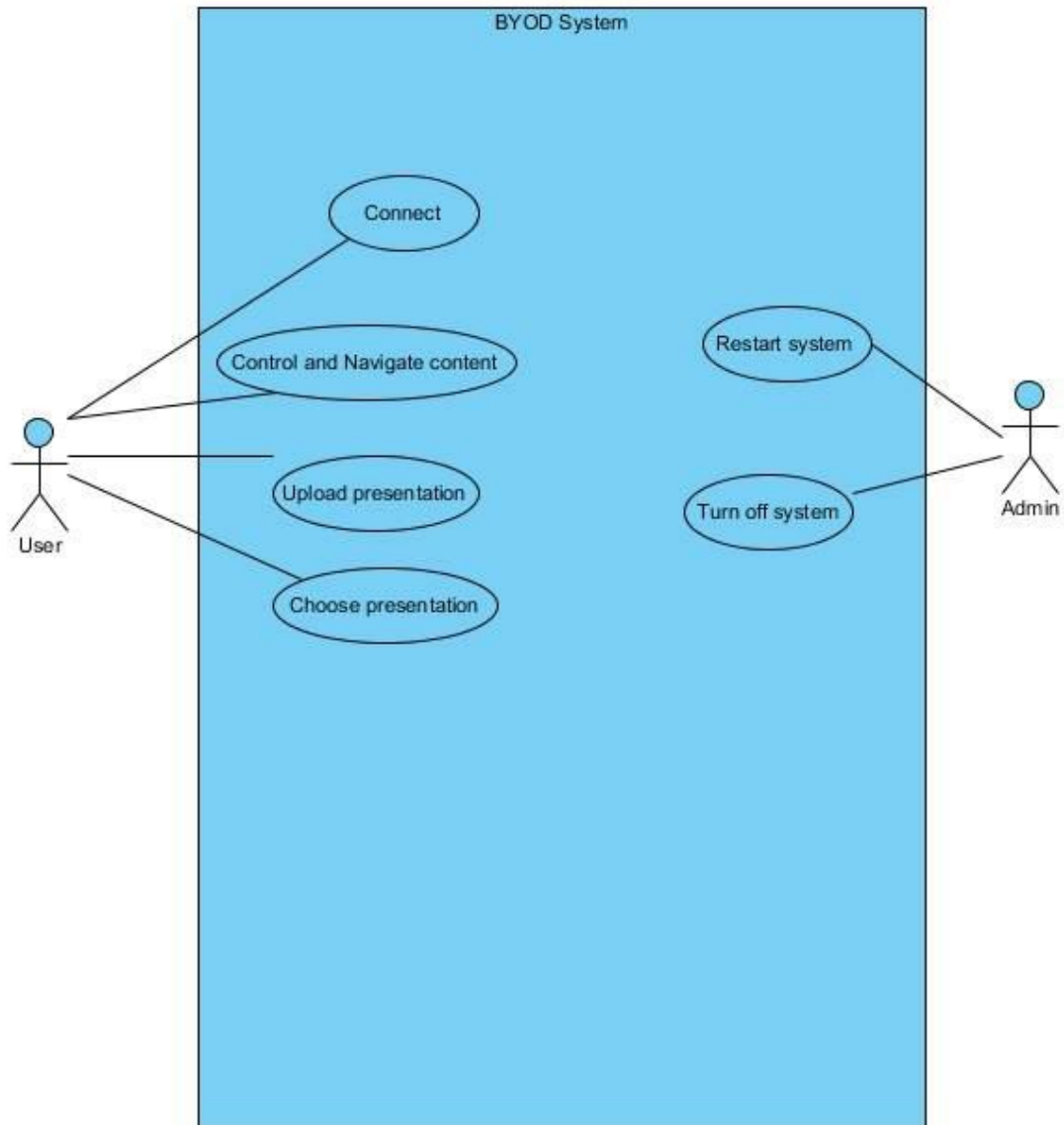


Figure 3.2.1: BYOD system use case diagram

3.3 Use Case Specification

Table 3.3.1: Connect use case specification

Use Case Name: Connect	ID: 1	Importance Level: High
Primary Actor: User	Use Case Type: Detail, Essential	
Stakeholders and Interests: User – Connect to server on mobile device to control and navigate interactive digital display.		
Brief Description: This use case describes how user connect to the system.		
Trigger: User want to connect to the interactive digital display. Type: External		
Relationships: - Association: User Include: - Extend: - Generalization: -		
Normal Flow of Events: 1. User enable WIFI functionality. 2. User search for server's WIFI SSID. 3. User connect to the server's access point. 4. User navigate to controller-like interface on their mobile device. 5. User start to control and navigate interactive digital display.		
Sub Flows: Not applicable		
Alternate / Exceptional Flows: Not applicable		

Table 3.3.2: Control and Navigate content use case specification

Use Case Name: Control and Navigate content	ID: 2	Importance Level: High
Primary Actor: User	Use Case Type: Detail, Essential	
Stakeholders and Interests: User – Control and navigate contents of interactive digital display.		
Brief Description: This use case describes how user control and navigate contents of interactive digital display.		
Trigger: User want to view and input information to the interactive digital display. Type: External		
Relationships: - Association: User Include: - Extend: - Generalization: -		
Normal Flow of Events: 1. User is connected to the server. 2. User control and navigate contents on controller-like interface provided. 3. If user press on the button provided. The S-1 By Button. 4. If user enter words on space provided. The S-2 By Words 5. Contents of interactive digital display will change accordingly to the action perform.		
Sub Flows: S – 1: By Button 1. The interactive digital display content is change accordingly S -2 : By Words 1. The interactive digital display will display the information entered.		
Alternate / Exceptional Flows: Not applicable		

Table 3.3.3: Upload presentation use case specification

Use Case Name: Upload Presentation	ID: 3	Importance Level: High
Primary Actor: User	Use Case Type: Detail, Essential	
Stakeholders and Interests: User – Upload presentation slide from mobile device to server.		
Brief Description: This use case describes how user upload presentation slide.		
Trigger: User want to upload presentation slide. Type: External		
Relationships: - Association: User Include: - Extend: - Generalization: -		
Normal Flow of Events: <ol style="list-style-type: none"> 1. User navigate to the upload presentation slide page. 2. User press on the upload presentation button. 3. Select the presentation slide for the list of file in the mobile device. 4. Wait for the presentation slide to be uploaded. 5. User will receive a notification on the upload status. 		
Sub Flows: Not applicable		
Alternate / Exceptional Flows: Not applicable		

Table 3.3.4: Choose presentation use case specification

Use Case Name: Choose Presentation	ID: 4	Importance Level: High
Primary Actor: User	Use Case Type: Detail, Essential	
Stakeholders and Interests: User – Choose presentation slide to display on the server’s display device.		
Brief Description: This use case describes how user choose presentation slide to display on server’s display device.		
Trigger: User want to display the selected presentation slide on the server’s display. Type: External		
Relationships: - Association: User Include: - Extend: - Generalization: -		
Normal Flow of Events: 1. User click on the choose presentation button. 2. User select the presentation slide’s file name to be display. 3. Wait for the presentation slide to be display on server’s display.		
Sub Flows: Not applicable		
Alternate / Exceptional Flows: Not applicable		

Table 3.3.5: Restart system use case specification

Use Case Name: Restart system	ID: 5	Importance Level: High
Primary Actor: Admin	Use Case Type: Detail, Essential	
Stakeholders and Interests: Admin – Restart system on admin mobile device.		
Brief Description: This use case describes how admin restart system using mobile device.		
Trigger: Admin want to restart system. Type: External		
Relationships: - Association: Admin Include: - Extend: - Generalization: -		
Normal Flow of Events: 1. Admin access server. 2. Admin restart server.		
Sub Flows: Not applicable		
Alternate / Exceptional Flows: Not applicable		

Table 3.3.6: Turn off system use case specification

Use Case Name: Turn off system	ID: 6	Importance Level: High
Primary Actor: Admin	Use Case Type: Detail, Essential	
Stakeholders and Interests: Admin – Turn off system on admin mobile device.		
Brief Description: This use case describes how admin turn off system using mobile device.		
Trigger: Admin want to restart system. Type: External		
Relationships: - Association: Admin Include: - Extend: - Generalization: -		
Normal Flow of Events: 1. Admin access server. 2. Admin stop server service.		
Sub Flows: Not applicable		
Alternate / Exceptional Flows: Not applicable		

3.4 Activity Diagram

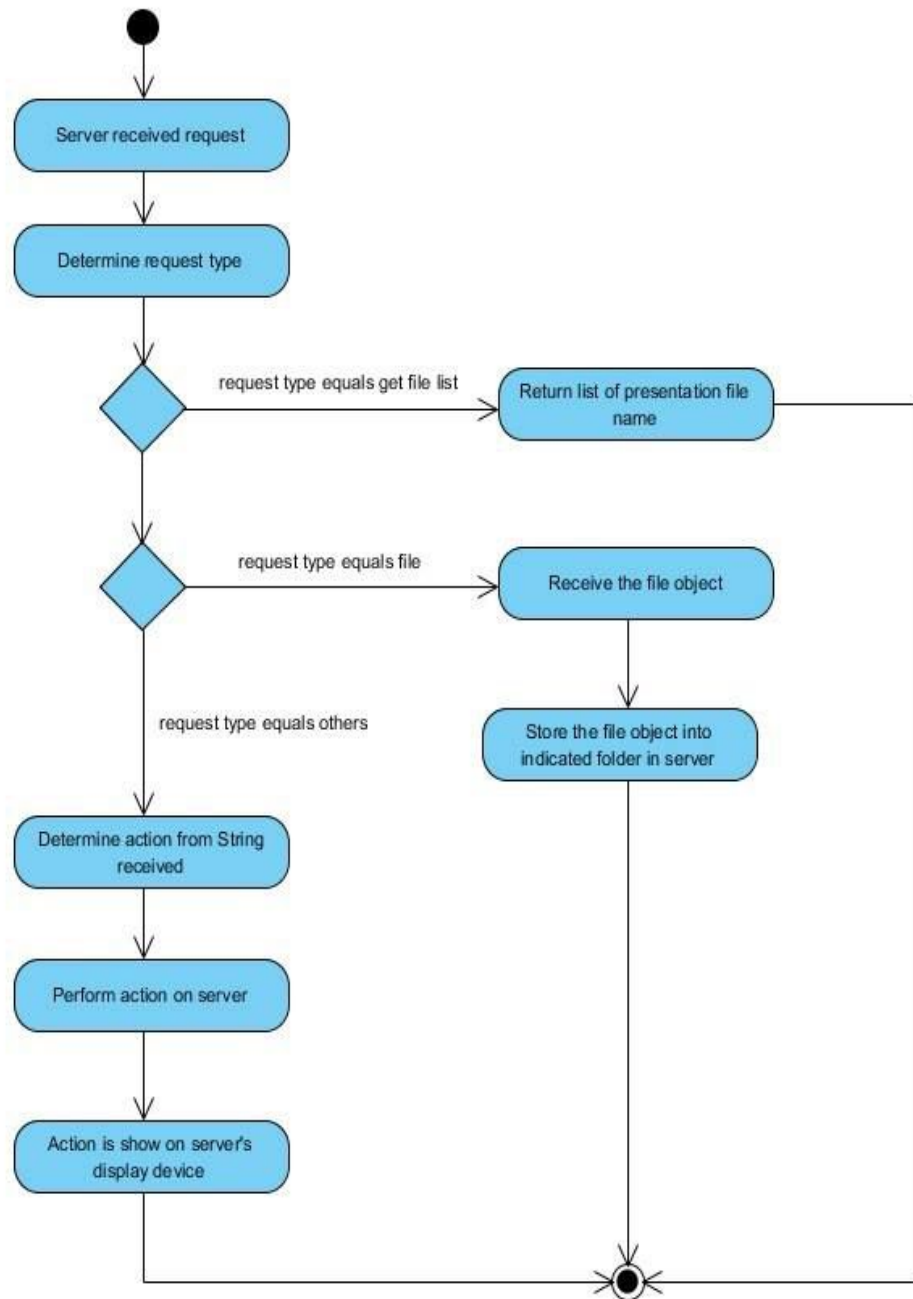


Figure 3.4.1: BYOD system activity diagram on server side

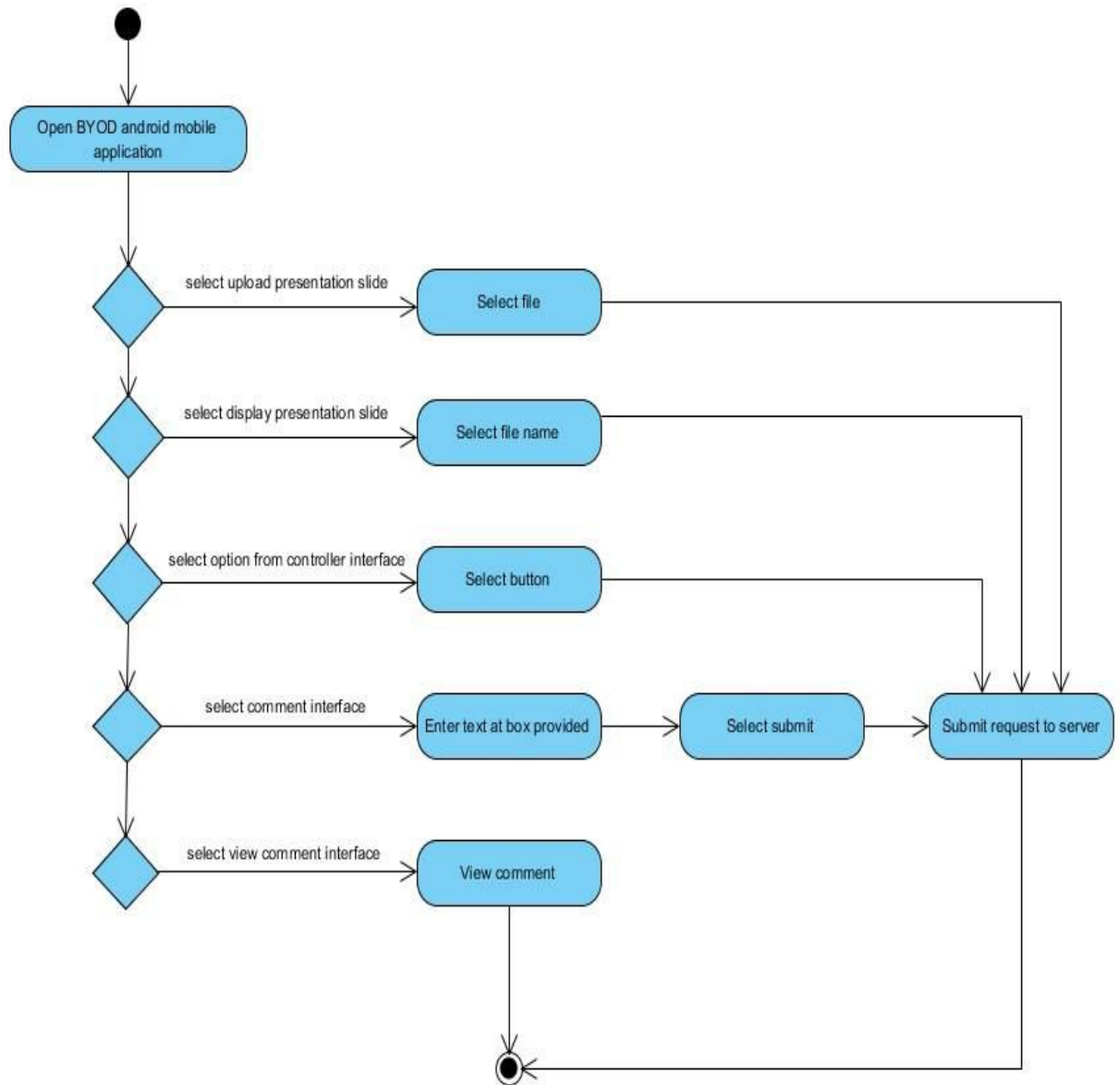


Figure 3.4.2: BYOD system activity diagram on client side

3.5 Class Diagram

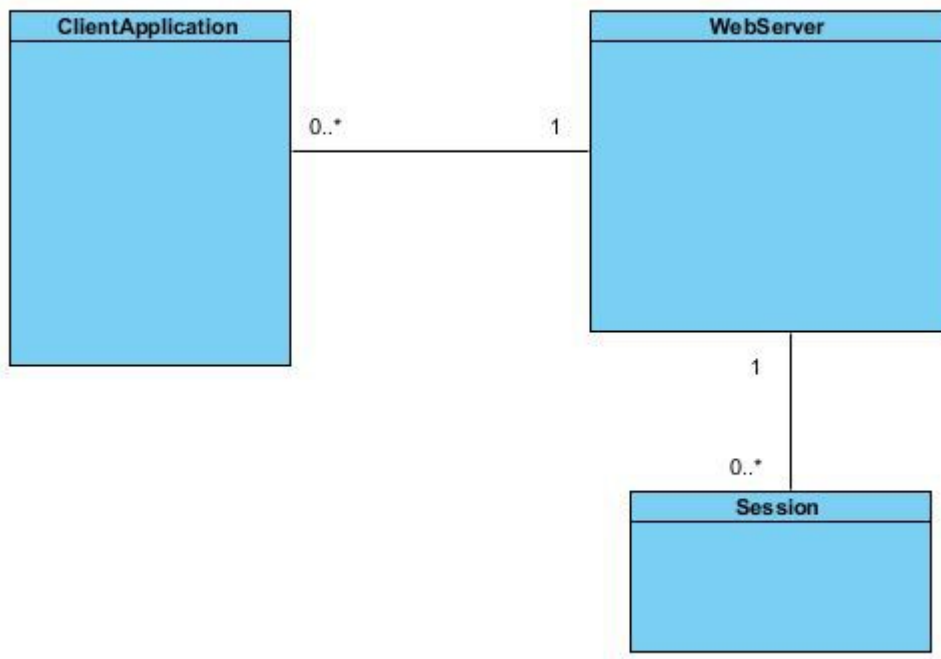


Figure 3.5.1: BYOD system class diagram

3.6 Sequence Diagram

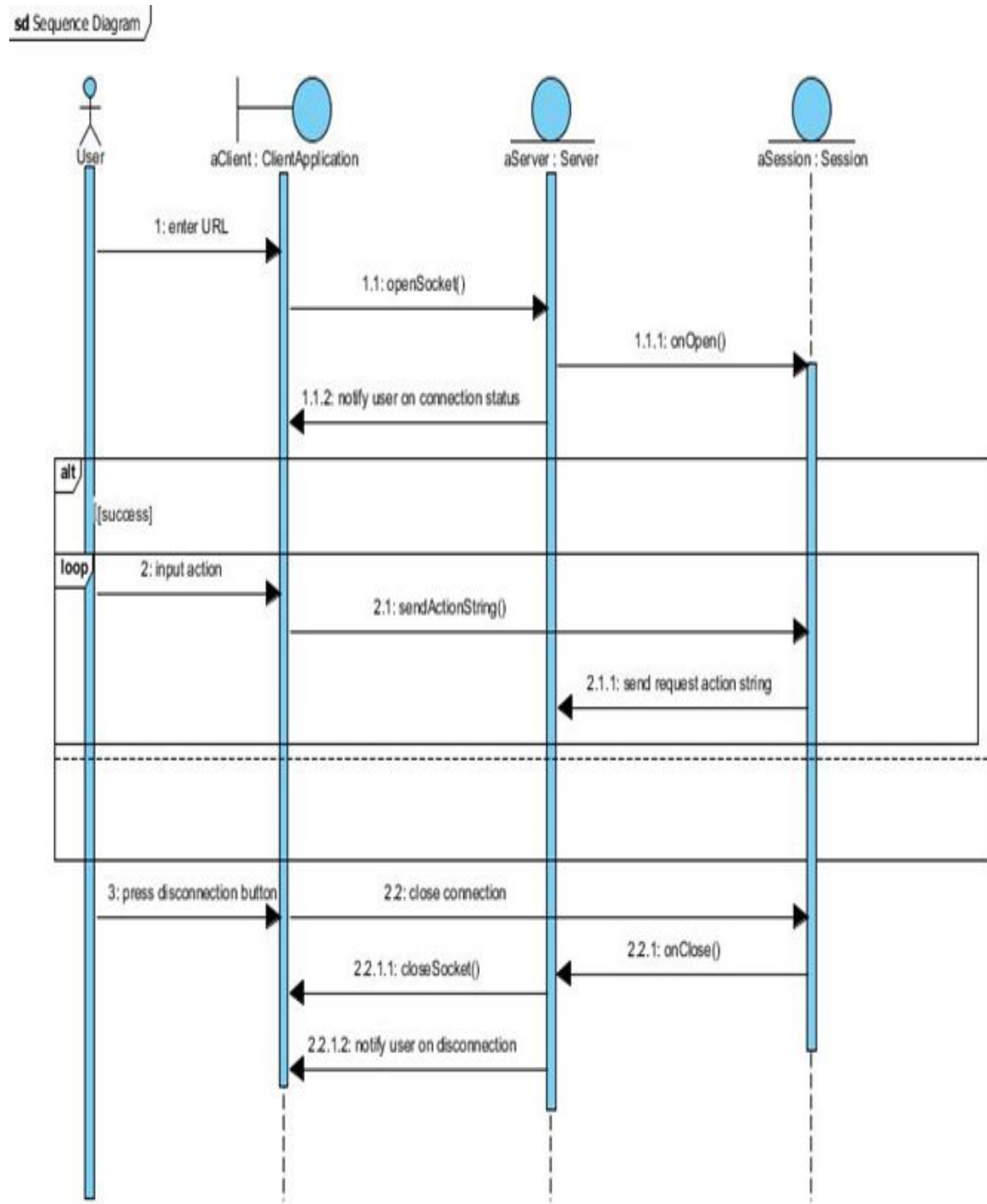


Figure 3.6.1: BYOD system sequence diagram

3.7 Technology Involved

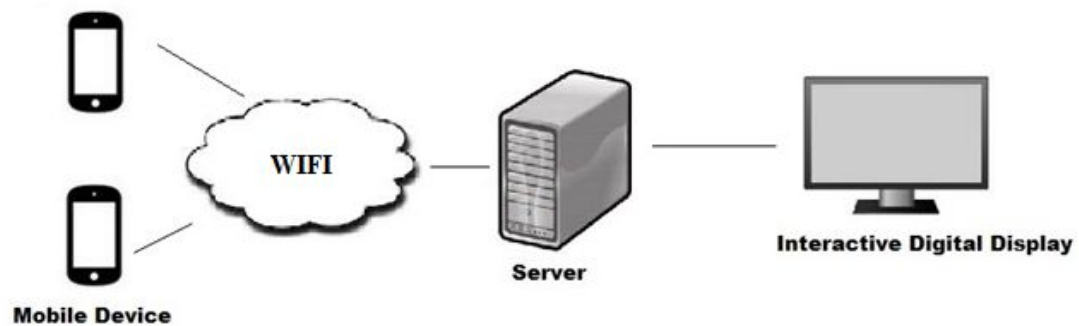


Figure 3.7.1: Device used in BYOD system

Technology involved in developing the project is Java programming language. System are differentiate into two parts which is the client side and the server side. Both client side and server side involve in web socket programming. Client side is using Java programming language for Android development to structure and create user interface to present to user. Interactive digital display will display contents accordingly to user actions. Server will constantly broadcast access point through WIFI in order to allow mobile device to access to the server through the WIFI connection. User's mobile device are required to have WIFI functionality in order to connect to the server and control and navigate the interactive digital display.

Developing tools that are used in this project is NetBeans IDE with GlassFish Server and Android for NetBean, (NBAndroid plugin). As shown in figure 3.7.1, tools that are involved in this project are mobile device, laptop and a projector as the interactive digital display.

3.8 Implementation Issues and Challenges

The project is expected to have satisfactory result when deployed in university environment. However, there are a few issues and challenges that are required to be addressed. One of the issues and challenges is that the proposed system requires to support multiple user connections to the server. The number of users connecting to the server might vary from different times, thus the computation power that is needed to handle peak amounts of users is hard to estimate. So by limiting the number of users at a time, we can estimate the computation power needed to handle the connection. However, this might give an impression of poor connectivity issues to the user.

Next, multiple users can connect to the user and navigate the public display screen. However, when a large number of people are trying to navigate and control the display, it is confusing as the page might be navigated away before another user finishes reading it. Thus, the design of the web page for public display is an important factor.

3.9 Timeline



Figure 3.9.1: Gantt Chart for Final Year Project I & II

Chapter 4 System Implementation and Testing

4.1 Approach

The approach used in this project is socket programming and server side programming using web servlet.

4.2 Tools

Hardware tools used in this project is laptop and mobile device. The following shows the hardware specification of tools used.

Laptop specification :

Table 4.2.1 Laptop Specification

Processor	Intel(R) Core(TM) i5 - 3210M CPU A 2.50GHz
RAM	4.00GB
Operating System	Window 8.1 Pro 64-bit
Graphic card	NVIDIA® GeForce® 610M
USB port	Yes

Mobile device specification :

Table 4.2.2 Mobile Device

Network Technology	GSM/HSPA
Operating System	Android OS, v4.1.2 (Jelly Bean)

Software tools used in the project is NetBean IDE.

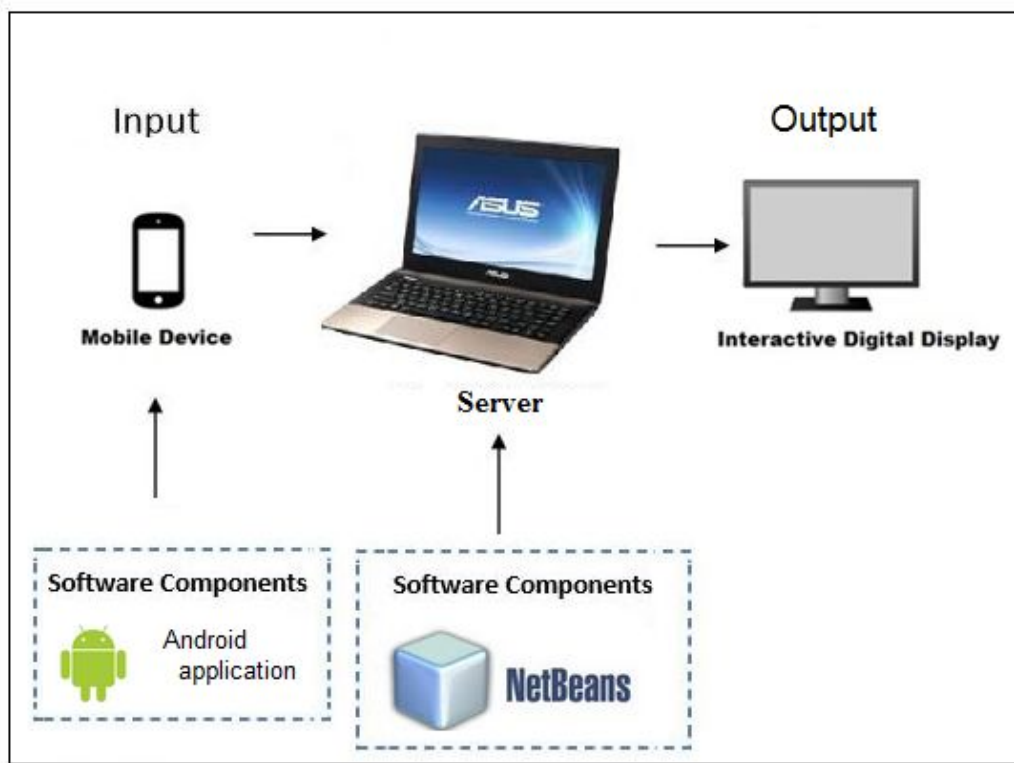


Figure 4.2 Component diagram

4.3 Requirement

The client side Android application are able to establish connection to server through WIFI connection by using socket programming. Server is placed in a device which is connected to a display screen. Server side are able to broadcast access point for Android users to connect to the server. Once connection is established, users are able to press button appear on application to perform simple action on the server's display. Users are also be able to enter words and sentences in the box provided. Besides that, server will be constantly listening for input from the android application. Server will be able to translate the input into action and perform action accordingly to the output screen. Besides that, text enter at comments section will be send to server by URL rewriting and received by web servlet to store in MYSQL database. User will be able to view the comments entered at the comment page in the Android application.

4.4 Specification

The specification of the verification plan is stated as below.

4.4.1 Analysis

Verification result has been analyzed. The first verification plan show whether the uploading of presentation slide from mobile device to server through socket programming is successful. Next, the retrieval of presentation slide's name list is verify to test whether the list of presentation slide's name is retrieve successfully to the mobile device and display on the mobile device. Besides that, opening of presentation slide through mobile application is tested whether the selected presentation slide is opening successfully by the server and display on the server's display device.

The fourth verification plan is to test whether the action perform such as button click on controller is sending request from the mobile device is received by server, and is the correct action perform by the server accordingly. Next, text is inputted at the edit text box provided by controller interface and verify whether server can received the text and display the text to the server's display device. Besides that, testing on comment functionality is done to check whether the text inputted is received by web servlet and store in database. Finally, the last verification plan is to test whether the list of comment can be retrieve from database and display on mobile device.

4.4.2 Design

The developed android mobile application of this project is installed to an Android mobile device. Next, the server build using socket programming in Java language is placed in a laptop. The mobile device installed with the project's mobile application is used to test the connectivity, functionality and the response rate of the input between server and the mobile application. Response resulted from user input will be show at server's display device.

4.4.3 Verification Plan

Seven verification plan is done to test the functionality of the developed BYOD system.

Table 4.4.1 Verification Plan and Expected Result

Verification Plan	Expected Result
1. Upload of presentation slides	Presentation slide chose by the user will be upload to server and store at indicated folder.
2. Retrieval of presentation slide's name list	Presentation slide store in server is listed out to user in the mobile application in a list of presentation slide's name.
3. Opening of presentation slide	Presentation slide chose by the user at mobile application is open at server and shown on server's display.
4. Action input from mobile application's controller interface.	Action is perform correctly by server according to user's input and show at server's display
5. Input text from mobile application's controller interface	Inputted text is display at server's display if text field is currently selected at server side.
6. Input text at comment edit text field.	Inputted text is stored into MySQL database.
7. Display of comment list in mobile application.	List of comment in the stored database is retrieved and display user's mobile device.

4.5 Implementation and Testing

Both client's mobile application and server side implementation and testing is discussed.

4.5.1 Client's mobile application implementation

When the mobile application is first started, connection is establish through socket programming by indicating the server's IP number and server's port number.

```

@Override
protected void onStart() {
    super.onStart();

    m_objThreadClient = new Thread(new Runnable() {
        public void run() {
            try {
                clientSocket = new Socket(serverIPinput, 6789);
                hostIP = serverIPinput;

                oos = new ObjectOutputStream(clientSocket.getOutputStream());
            } catch (Exception e) {}

        }
    });

    m_objThreadClient.start();
}

```

Next, mobile application can send request to server according to the user input and button clicked. For example, the left button is clicked and request is send to server by using socket programming's writeObject function.

```

left.setOnClickListener(new View.OnClickListener() {
    public void onClick(View v) {
        try {
            Main.oos.writeObject("LEFT");
        } catch (Exception ee) {
            Toast.makeText(getActivity(), ee.getMessage(), Toast.LENGTH_LONG).show();
        }
    }
});

```

Besides that, user can upload presentation by clicking on the file list of the mobile device. Only file end with .ppt is shown to user.

```
if (ff.getName().endsWith(".ppt")) {
    fls.add(new Option(ff.getName(), "File Size: " + ff.length(), ff.getAbsolutePath()));
}
```

The file list in the mobile device is show in a ListActivity layout by setting the adapter.

```
Collections.sort(dir);
Collections.sort(fls);
dir.addAll(fls);
if (!f.getName().equalsIgnoreCase("sdcard")) {
    dir.add(0, new Option("../", "Parent Directory", f.getParent()));
}

adapter = new FileArrayAdapter(FileChooser.this, R.layout.file_view, dir);
this.setAdapter(adapter);
}
```

Selected file will be be converted into array of bytes.

```
try {
    DataInputStream diStream = new DataInputStream(new FileInputStream(file));
    long len = (int) file.length();
    fileBytes = new byte[(int) len];
    int read = 0;
    int numRead = 0;
    while (read < fileBytes.length && (numRead = diStream.read(fileBytes, read,
        fileBytes.length - read)) >= 0) {
        read = read + numRead;
    }
    fileEvent.setDestinationDirectory(destinationPath);
    fileEvent.setFileSize(len);
    fileEvent.setFileData(fileBytes);
    fileEvent.setStatus("Success");
} catch (Exception e) {
    e.printStackTrace();
    fileEvent.setStatus("Error");
}
```

Selected file is then send to server.

```

try {
    oos.writeObject("FILE");
    oos.writeObject(o.getName());
    oos.writeObject(fileBytes);
    Toast.makeText(this, "File Uploaded Successfully" , Toast.LENGTH_SHORT).show();
} catch (IOException e) {
    Toast.makeText(this, "Upload failed" , Toast.LENGTH_SHORT).show();
    e.printStackTrace();
}

```

Next, user can select presentation slide they wanted to show on server's display device by choosing the list of presentation slide file available at the server. The file list is retrieved from the server by using socket programming and store the file name into a list of string.

```

oos = new ObjectOutputStream(clientSocket.getOutputStream());
ois = new ObjectInputStream(clientSocket.getInputStream());
oos.writeObject("GetFileList");

String servermsg = (String) ois.readObject();

int countfile = Integer.parseInt(servermsg);

String[] filetemp = new String[countfile];

String file_name = (String) ois.readObject();
filetemp[0] = file_name;
list.add(file_name);
for (int i = 1; i <= countfile - 1; i++) {
    file_name = (String) ois.readObject();
    filetemp[i] = file_name;
    list.add(file_name);
}

```

Besides that, text enter at comment user interface will be send to web servlet to store in database. All the text store can be retrieved and display at mobile device.

```
try {
    URL = "http://192.168.1.84:8080/HttpGetServlet/CommentServlet?com=" + comment;
    GetXMLTask task = new GetXMLTask();
    task.execute(new String[] {URL});
} catch (Exception ex) {
}
}
```

Comments stored at database is retrieve in JSON format and convert at mobile device to list of string. Next, the list of string is display on the mobile device.

```
String jsonString = output;
JSONArray jsonArray = null;
try {
    jsonArray = new JSONArray(jsonString);
} catch (JSONException e) {

    e.printStackTrace();
}
list = new ArrayList<String>();
//Convert from jsonArray to ArrayList
for (int i = 0; i < jsonArray.length(); i++) {
    try {
        list.add(jsonArray.getString(i));
    } catch (JSONException e) {
        e.printStackTrace();
    }
}
}
```

4.5.2 Server side implementation

Server is started using the stated port. Once the server is started, server will keep listening for request until the server is close.

```

try {
    server = new ServerSocket(6789, 0);
    while (true) {
        try {
            //connect and have conversation
            if (user == 0) {
                waitForConnection();
                setupStreams();
                listening();
            }
        } catch (EOFException eofException) {
            showMessage("\n Connection ended! ");
        } finally {
            if (user > 0) {
                closing_s();
            }
        }
    }
} catch (IOException ioException) {
    ioException.printStackTrace();
}

```

Server first determine the request type, then action is perform accordingly.

```
else if (message.equals("GetFileList")) {
```

```
else if (message.equals("ClickFile")) {
```

```
else if (message.equals("LEFT")) {
```

Server performing retrieval of list of presentation’s file name.

```
String[] file_name = getfilename();
int file_count = file_name.length;

String file_c = Integer.toString(file_count);
output.writeObject(file_c);

for (int i = 0; i < file_count; i++) {
    output.writeObject(file_name[i]);
}
```

Server performing opening of selected presentation slide.

```
String filen = (String) input.readObject();
showMessage("\n" + filen);

File filef = new File("C:\\Users\\Desktop\\upload\\" + filen);
Desktop desktop = Desktop.getDesktop();
try {
    desktop.open(filef);
} catch (Exception ee) { }
```

Server performing other action such as navigation.

```
Robot r = new Robot();
r.keyPress(KeyEvent.VK_LEFT);
r.keyRelease(KeyEvent.VK_LEFT);
```

4.5.3 Testing

Black box testing is performed on all functionality stated in the verification plan. Seven testing is done to test the functionality of the developed BYOD system.

Table 4.5.1 Testing and Result

Functionality	Expected Result	Actual Result	Passed	
			Y	N
1. Upload of presentation slides	Presentation slide chose by the user will be upload to server and store at indicated folder.	Presentation slide chose by user is uploaded to server and store at indicated folder.	x	

2. Retrieval of presentation slide's name list	Presentation slide store in server is listed out to user in the mobile application in a list of presentation slide's name.	Correct list of presentation slide's name is shown at mobile application.	x	
3. Opening of presentation slide	Presentation slide chose by the user at mobile application is open at server and shown on server's display.	Correct presentation slide is shown on server's display device accordingly to user selection.	x	
4. Action input from mobile application's controller interface.	Action is perform correctly by server according to user's input and show at server's display	Action is perform by server according to user's input and show at server's display	x	
5. Input text from mobile application's controller interface	Inputted text is display at server's display if text field is currently selected at server side.	Inputted text is display to server's display text field.	x	
6. Input text at comment edit text field.	Inputted text is stored into MySQL database.	Inputted text is stored into MySQL database.	x	
7. Display of comment list in mobile application.	List of comment in the stored database is retrieved and display user's mobile device.	List of comment in the stored database is retrieved and display user's mobile device.	x	

Testing on response rate is also done and it is tabulate in the table below.

Table 4.5.2 Testing on response rate on establishing connection from mobile device to server

Testing	Response rate (in seconds)
1	2
2	3
3	2
4	2
5	2
Average response rate (in seconds)	2.2

Table 4.5.3 Testing on delay of key press between the server's keyboard to server

Testing	Delay of key press (in milliseconds)
1	354
2	302
3	284
4	301
5	288
6	308
7	257
8	332
9	280
10	286
Average in delay of key press (in milliseconds)	292

Table 4.5.4 Testing on delay of key press between the mobile device to server

Testing	Delay of key press (in milliseconds)
1	954
2	872
3	869
4	895
5	904
6	881
7	864
8	873
9	900
10	891
Average in delay of key press (in milliseconds)	890.3

Chapter 5 : Conclusion

5.1 Project Review

The project is done initially by using web servlet to received all the request from user's mobile device. However, web servlet is situated in a web container, thus making controlling of the server device more difficulty. So socket programming is further explore and main server is build with the technology of socket programming as it can accept request through WIFI with the IP and port of server being identified. Request type can be determine by writing Java conditional statement and actions are perform using Java Objects.

Objective of the project is achieved with the use of various technology such as web servlet technology and socket programming. By using socket programming, mobile device can establish connection to the developed server and allow user to control and navigate the interactive display. Besides that, three different set of controller-like user interface is provided to the user to aid their navigation of interactive display in different situation.

5.2 Discussion

On server side, script is configured to executed once the server is start up. The function of the script is to ease the configuration of server in establishing access point for mobile device to connect. The script is used to configured the SSID and the password of the access point. Hence, user do not need to be tech savvy in order to use the BYOD system. The BYOD system will only allow one person to establish connection to the server to enable the controlling to the interactive display. However, the comment functionality at the mobile device can be used to view and enter text at anytime as it is sending request to web servlet.

5.3 Conclusion

As a conclusion, the project will enable user to control and navigate interactive digital display by using their mobile devices. The existing controlling device in the public for display will wear and tear as time goes. Repairing and replacing controller become a schedule work for the maintenance team. By having a physical controller, unethical user are able to vandalize and steal controller thus creating financial burden to the service provider.

By using Bring Your Own Device (BYOD) platform, service provider do not need to provide physical controller as controller will wear and tear and time goes. Thus, maintenance cost can be lower down and allow service provider to focus on providing information. Besides that, user can have a more personalize experience when interacting with the public digital display.

The final deliverable of this project will benefits public and service provider as it enhance our way of interacting with public digital display. Service provider can also lessen the cost of developing and maintaining the public digital display.

5.4 Future Work

Future development can be make in client side's mobile application and server side. The mobile application can be further enhance to suit the user need in term of type of controlling needed by the user. Different specific controller-like interface can be develop and customize. Besides that, server can be further upgraded to a more power server to receive more connection at the same time for group interaction purposes. Server can also be further develop to receive more type of input and perform different action.

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