# HANDHELD DEVICE BASED DESKTOP CONTROL SYSTEM USING BLUETOOTH

By

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(2002-NUST-BIT-175)


A project report submitted in partial fulfillment of

the requirement for the degree of

**Bachelors in Information Technology**

In

**NUST Institute of Information Technology**

**National University of Sciences and Technology**

**Rawalpindi, Pakistan**

**(2007)**

# CERTIFICATE

Certified that the contents and form of thesis entitled "**Handheld Device Based Desktop Control System Using Bluetooth**" submitted by Wajid Ali Khan have been found satisfactory for the requirement of the degree.

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# DEDICATIONS

To Almighty **ALLAH**, Who helped me
any and everywhere.

# ACKNOWLEDGEMENTS

All praise to Almighty Allah who blessed me all the time and helped me in the best manner, and made me capable of doing the things. He is the lord of all the things and He Himself controls them without the help of any one because Allah is great and absolute. I am deeply grateful to my supervisor Mr. Saad Liaquat Kiani for his motivation, assistance and encouragement. Similarly I am very much thankful to my co-advisor Mr. Ali Sajjad whose support never let me think of the provision of all kinds of requirements for project accomplishment. The ability of management and the foresightedness of both supervisor and co helped me a lot in myself to manage my own life in my own way in the future inshallah. Also with support of such an experienced committee member Mr. Nasir Mehmood I think I was the luckiest guy in NIIT because the way he pointed out the weaknesses and mistakes I made during development and project design era. But the most interesting thing which I learned was their guidance in a friendly environment. I would also like to offer my thanks and prayers to my friends, colleagues, teachers and specially parents. Also kind responses from Mr. Abdul Ghafoor during presentation and proposal defense.

I would like to say thanks to my course mate Nauman Nasir Yousafzai for supporting me during development phase of the project and guided me during the design era.

Also I am very much thankful to all the pupils of the administration department by helping me with all kind of the issues and never let me to think of being at an ordinary institute. The helped me in best manner and were always there for handling any kind of system's hardware and software issues.

At last I would like to say thanks to myself for considering me as capable of doing this and I think this is the most important factor of all.

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# ABSTRACT

Since the technology is getting into hands and everything is coming to the mobility because of which every user wants the whole functionality of his/her desktop computer in his/her hand in a small device which is provided through mobile phones. Since not all functionalities are provided by early phones because of their low processing, low RAM and not having a powerful OS, to get those all functionalities some of the powerful operating systems were developed and one of them is SYMBIAN OS.

Our mobile phones or PDA's usually have BLUETOOTH devices. In this project, we have developed a Desktop control application for Mobile Phones that can be used to control basic functionalities of the desktop systems such as presentation, media player and controlling the main desktop etc, also extended according to the time available. New learning took place by how to control the desktop using BLUETOOTH on both mobile and desktop sides. The mobile device act as a remote control for Desktop systems and laptops with support of BLUETOOTH at a single time, making it a great utility application for the mobile. This application is developed for SYMBIAN OS which is not often selected for development.

Developing even a simple application for SYMBIAN OS was a challenge for us but not anymore. So this developed application which will use BLUETOOTH as an output device for transmission and getting and knowing about the BLUETOOTH bit patterns on which the receivers will operate was definitely tough task that is done, I shall mention another important aspect here and that is Java is used for both desktop and mobile devices as developing language, for mobile phone API's are limited but BLUETOOTH API is available with almost all support.

Different kind of issues regarding limitations and support were raised during the development but handled easily by us. Now the complete product is ready to be used and also can further be extended according to needs.

*Chapter 1*

# INTRODUCTION

Increasing pace of technologies and increasing facilities provided by these technologies made a lot of new and more complexities to the human life. With the passage of time different kind of solution for single problem has/had been seen by the people just because of the technology which has taken the world towards the new and complex life.

Also with facilities provided by the technologies created one of the biggest problems for human beings and that is computer addiction and dependencies on these machines. Laziness has become second nature of man. Many products have come up with the passage of time to exploit this human attribute. Desktop computer has become a house hold utility. Demand for easy to use interface and easy to control devices has been increasing day by day. Keeping this hot demand in view "Handheld device based Desktop Control System using Bluetooth" has decided to introduce a remote application which will control every desktop computer through any Bluetooth enable mobile to facilitate every single mobile user as our aim is to make computer technology a game of hands.

The going era which is fully merged with information and knowledge is the main focus of the entire world as an economic activity. Since before this there were other main focuses for economic activity those were agricultural activity and industrial. Since with small knowledge industrial activity took shift from agricultural activity, but now with extreme knowledge and technology which is now called the IT era has become the main focus as an economic activity.

On the basis of the current era going on and also due to the second nature of the man it is concluded to take advantage of both. Since man wants each and every thing on hands and everywhere and technology era is making this dream to come true then why not to take advantage of this. So on this background study this project is selected for development in which one can control main desktop functionalities i-e file management, power point presentation control, media player

control and others. This can be done through communication device i-e Bluetooth which will be on both sides mobile and desktop. It is divided into client-server architecture, detail of which will be provided later.

Cell phones evolved in the market less than a decade ago and this going to be one of the largest technologies in the world. These phones are getting more and more advance and becoming more than just a phone.

"Handheld device based Desktop Control System using Bluetooth" is a solution to cash the laziness of the men and technological era. The main concept behind this title is how to manage the whole desktop just through mobile phones and how to provide all the functionalities of the desktop system to mobiles. That's why we have selected Bluetooth as a communication device between the desktop system and mobile.

Since Bluetooth has the following features like no line of sight required. Furthermore Bluetooth also have greater range as compared to infrared and the transmission is also bit faster than infrared. It has also got reliability and scalability.

## 1.1 DOCUMENT PURPOSE

The purpose of this document is to provide comprehensive details of the project and how it is implemented, so that the users and developers can use and understand our system with ease.

The document is divided into chapters in which the details, background studies, SRS and technology used in the project and how it can be further improved has also been mentioned in the documentation. The summary of the chapters is given below.

### 1.1.1 Chapter 1

Of the “Handheld device based Desktop Control System using Bluetooth” gives a little background, problem identification and gives details of tool used during project implementation and gives details of what the project will do.

### 1.1.2 Chapter 2

Mentions the requirement specification of the proposed system and tells about main function provided by the software and goes that comprise the system. Also it gives the all requirements and constraints of the software. This chapter also tells about the quality requirements of the software.

### 1.1.3 Chapter 3

Explains wireless communication technology with respect to J2ME (Java 2 Micro Edition) and J2SE (Java 2 Standard Edition) used in the implementation of the project and how they the communication took place between these too through Bluetooth devices.

### 1.1.4 Chapter 4

Gives the detail of the technology study which is done and emphasizes on Bluetooth technology that why it is selected as communication device. How different kind of issues handled during development phase with Bluetooth.

### 1.1.5 Chapter 5

This chapter gives details about the technologies used on desktop side during development and devices, their details, issues implementation, tools and others.

This chapter also gives details about the technologies used on mobile side during development and devices, their details, issues implementation, tools and others.

### 1.1.6 Chapter 6

This chapter discusses the implementation of the software "Handheld device based Desktop Control System using Bluetooth". It states the steps taken to implement the solution. This chapter also tells about the system design, system requirement model, flow diagram, and flow diagram and use cases.

*Chapter 2*

# PROBLEM FORMULATION

This chapter mentions the requirement specification, scope of the proposed system and tells about main function provided by the software and goes that comprise the system. Also it gives detail of all the requirements and constraints of the software. This chapter also tells about the quality requirements of the software. In short it formulates all the requirements for "Handheld device based Desktop Control System using Bluetooth".

## 2.1 PROJECT SCOPE

"Handheld device based Desktop Control System using Bluetooth" is mainly divided into two main parts. In simple it is client/server architecture based project, means two applications will be developed. One application will be for developed for desktop while other will be developed for mobile. Desktop application will act as a server for mobile application since requests will come from mobile device and will be handled by the server on the desktop. Since this communication will be done through Bluetooth device, which will be on both desktop and mobile side. Both the application will work using this device. Desktop application will continuously listen for requests through this device and will pass the specific request to the application; application will formulate the request and will ask the system to execute such command. Similarly mobile application will wait for specific application selected by the user and the will then is waiting for specific event for that application on the desktop by mobile application. Following three types of applications were supposed to be controlled in this project.

- Microsoft PowerPoint Presentation
    - Start / Stop presentation
    - Next Slide
    - Previous Slide

        - Right Click
        - Go to Slide number
        - Save / Exit / Discard presentation etc.
- Windows Media Player
        - Open windows media player
        - Start payer
        - Stop Player
        - Next Clip
        - Previous Clip
        - Pause Player
        - Open Files
        - Exit Player
- Desktop File Management (navigation Control)
        - Click on files
        - Double Click on files
        - Right Click on files
        - Cut
        - Copy
        - Paste
        - Pointer right move
        - Pointer left move
        - Pointer up move
        - Pointer down move
        - Pointer up-right move
        - Pointer down-right move
        - Pointer up - left move
        - Pointer down-left move

## 2.2 PROJECT FEATURES AND LIMITATIONS

The features and limitations of this project "Handheld device based Desktop Control System using Bluetooth" are given as below.

- Application on the server is a window based application; in fact it's a GUI. User will be asked to start / stop Bluetooth using buttons and will be a part of client server architecture. This application will be server.
- Required operating system for this to run would be Windows XP or Windows 2000.
- For client application there should be Java enabled phone, on which it will be deployed.
- Same Phone should also be facilitated with Bluetooth device.
- Same phone with Symbian OS 8 or higher is recommended for this application else can also work on latest s40 mobile phone.

## 2.3 COMPLETE DISCRIPTION

This portion of the system provides us an overview of all the factors that affect the product and its requirements.

### 2.3.1 Project Perspective

Since this project is divided into two parts. One is desktop application and other is mobile application so the detail of these two will be defined separately. As already mentioned above that user now a day's wants each and every thing with mobility and this research project provides certain functionality of the desktop computer on mobile, but how this is achieved and how all the features mentioned works through mobile are discussed here. In the first part all the details of the mobile application will be mentioned and then in the second part all the information about desktop application is discussed under the "user interfaces" title. These will explained through snap shots.

### 2.3.2 User Interfaces

#### 2.3.2.1 Mobile Application

Mobile application “BlueControl” is developed and installed using java wireless tool kit support, since it creates the installation file with .jar extension and when installed comes in the application portion of the mobile as shown below in figure 1.0.

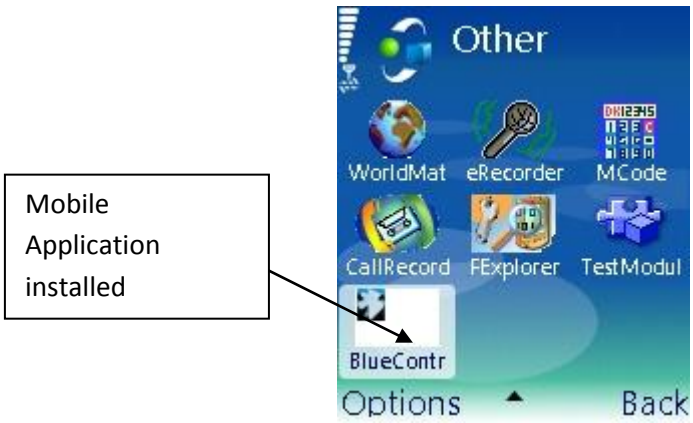


Figure 1: Installed Mobile Application

After opening the application its main interface will come to user where it will ask user to search Bluetooth devices as shown in figure 2.0.

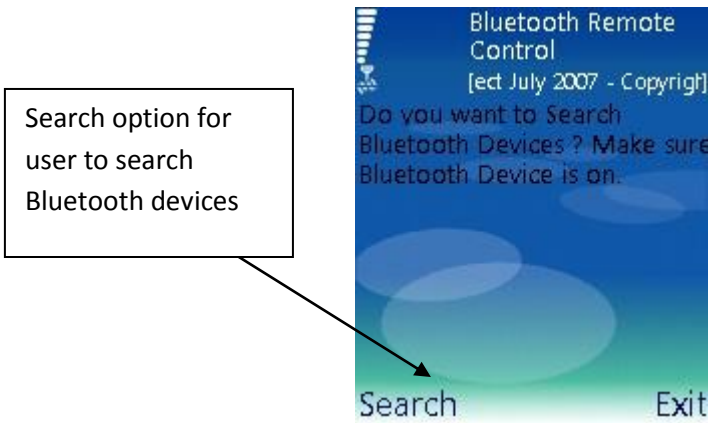


Figure 2 : Search option for user to search Bluetooth devices

After hitting the search option it will start searching and will ask for waiting from 8 – 10 seconds as displayed in figure 3.0 below.


Figure 3 : Searching Devices

Once searching is done, this application will provide the entire available Bluetooth devices in range for communication. In the figure 4.0 below is the Bluetooth device with name “ECTL – 130” is shown which is the friendly name of the Bluetooth device attached with system during development. Only one device shown because one device is there at that time.


Figure 4 : Device List

Once that device is selected for communication it is then application requires the confirmation from the user whether really want to communicate with that device through Bluetooth or not, figure 5.0 clearly shows the request below.


Figure 5 : Connectivity

Now once connection is established user can select any of the application on the desktop i-e Microsoft power point presentation, windows media player or desktop for file management. Other three applications cut/copy/paste, search system and write to desktop are additional features added by us. Figure 6.0 clears the doubts below.

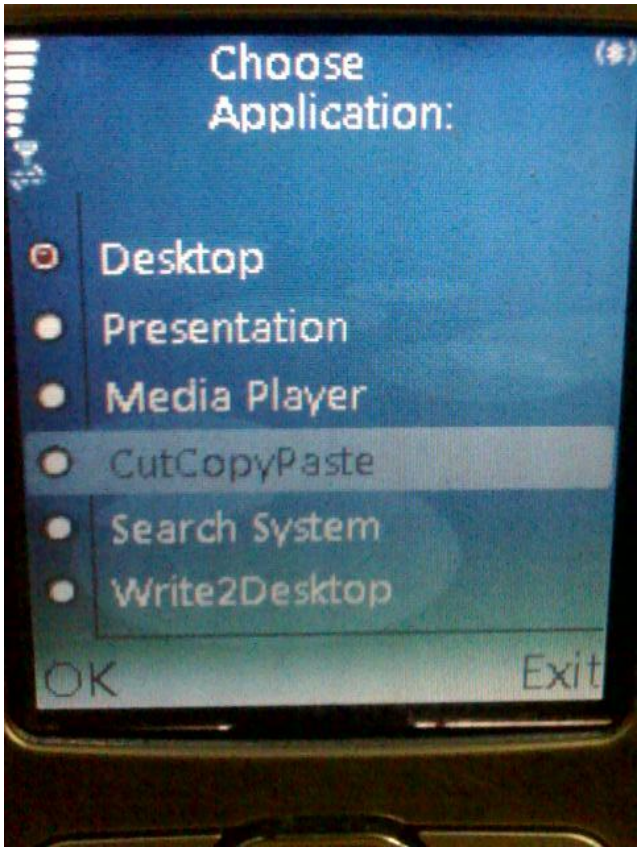


Figure 6 : List of Applications

In the above figure, through radio buttons only one application can be selected at a time. Once certain application is selected its whole control through mobile key pad would be shown to him as in figure 7.0 below. Pointer can also move during using the presentation functionalities.


Figure 7: Graphics

This shows with button 2 on mobile keypad you can move up and with 8 you can go down similarly the other buttons, like with * you can show the desktop if multiple documents are opened and with # you can right click anywhere. From here if someone wants to go back to application selection list he/she can just press 0 and can press ‘Back’ to get there. Figure 8.0 shows it clearly below.

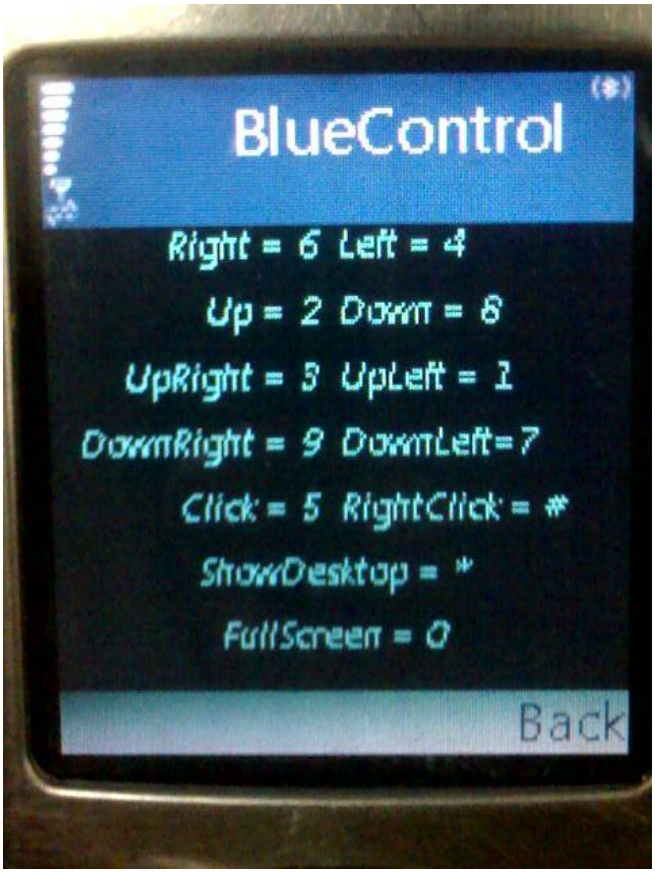


Figure 8 : Options regarding Desktop

If presentation is selected from the application list then following functionalities of start/stop presentation, next slide, previous slide and other can easily be controlled. Pointer can also move during using the presentation functionalities. Figure 9.0 easily demonstrates them in a column below.


Figure 9: Options regarding Presentation

If media player is selected from the list then functionalities of play, pause, stop, next, previous and open files can be controlled. Pointer can also move during using the media player functionalities. As in figure 10.0 these are clearly shown.


Figure 10 : Options regarding Media Player

If Cut/copy/paste is selected from the list then functionalities of cut, copy, paste, right click, double clicks and full screen can be controlled. Pointer can also move during using these functionalities. As in figure 10.0 these are clearly shown.


Figure 11 : Options regarding Cut/Copy/Paste

If Search System is selected from the list then functionalities of Searching System, right click, double clicks and full screen can be controlled. Pointer can also move during using these functionalities. As in figure 11.0 these are clearly shown.


Figure 12 : Options regarding Searching Desktop

At last the most interesting part of the project which is an additional part of the project is to write anything to the desktop from mobile except special characters. Through this feature you can write any text to any active window of the desktop which would be opened for writing text for example word pad, internet explorer etc. figure 12.0 clears the doubts below in which it is clearly mentioned that instruction given in the mobile for user and also in figure 13 it is clearly mentioned that the functionalities of the send, enter, undo, redo, back space, tab and close are also there, which shows that you can also undo you work from mobile on desktop, means if someone wants to remove the text from desktop he has written he can easily remove it and can also close that window with close option. Also can enter on the desktop from mobile with enter option. Figure 13.0 shows them well.

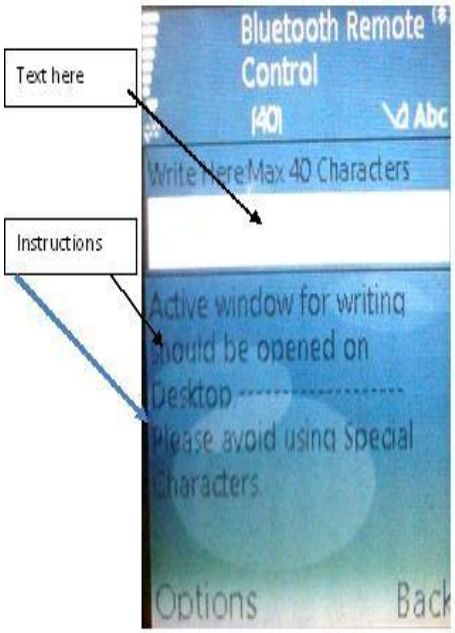


Figure 1 - write to Desktop

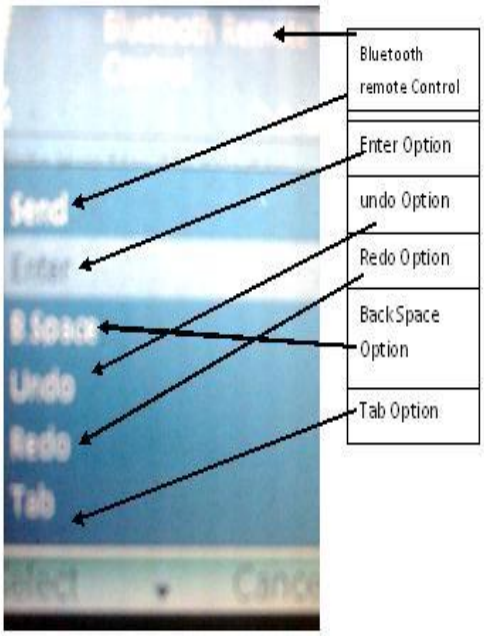


Figure 2 - Options for writing

### 2.3.2.2 Desktop Application

Desktop application continuously listens to the requests from the connected client. As there would only be one client at a time so only one client can send requests to the server which is Desktop application. When it receives request it first checks it whether it's for selecting an application if not then checked for the specific event. But it is made very simple to the user; it has just got the three things in there on the main GUI. Two of them are buttons i-e for starting and stopping the Bluetooth and third item is a combo box in which all the available communication port will be there. Since the desktop side application communicates with mobile client through virtual COM ports so in this combo box all the available communication ports will be there. It would be easy if the selected port is chosen for communication because it is selected by the application itself in a specific part of code. Figure 15.0 easily explains each and every thing below.

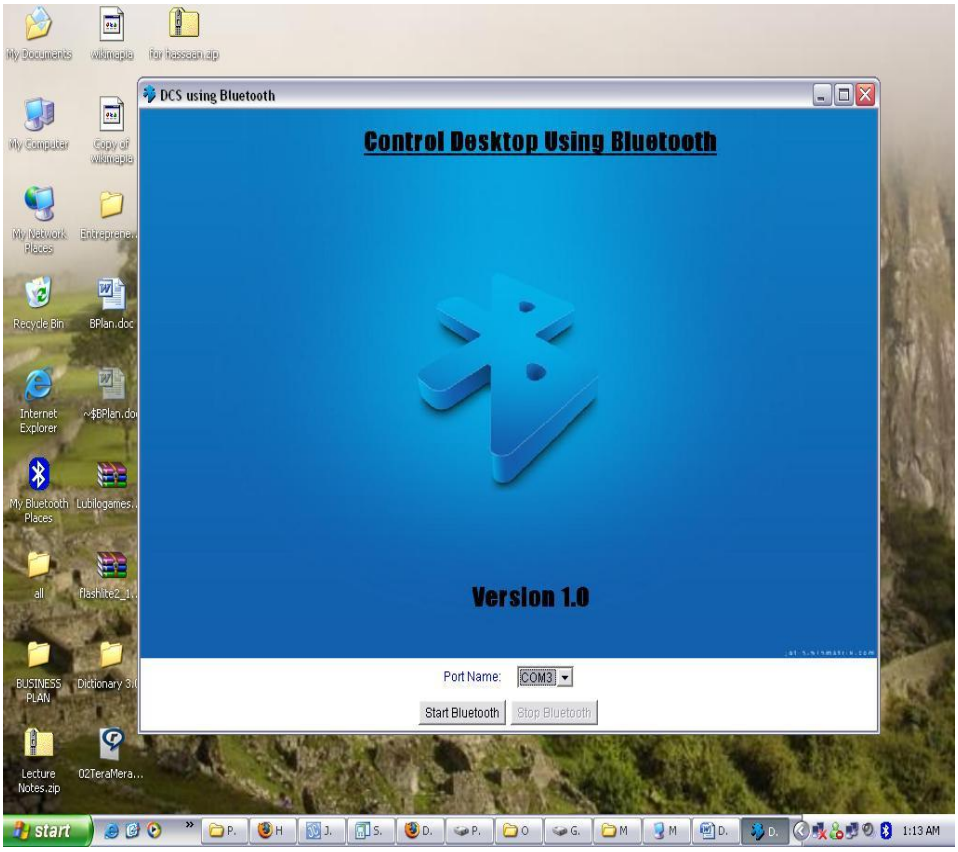


Figure 13: Desktop Application before Starting Bluetooth

Figure 16.0 shows the application when Bluetooth has been started as stop Bluetooth button is enabled.

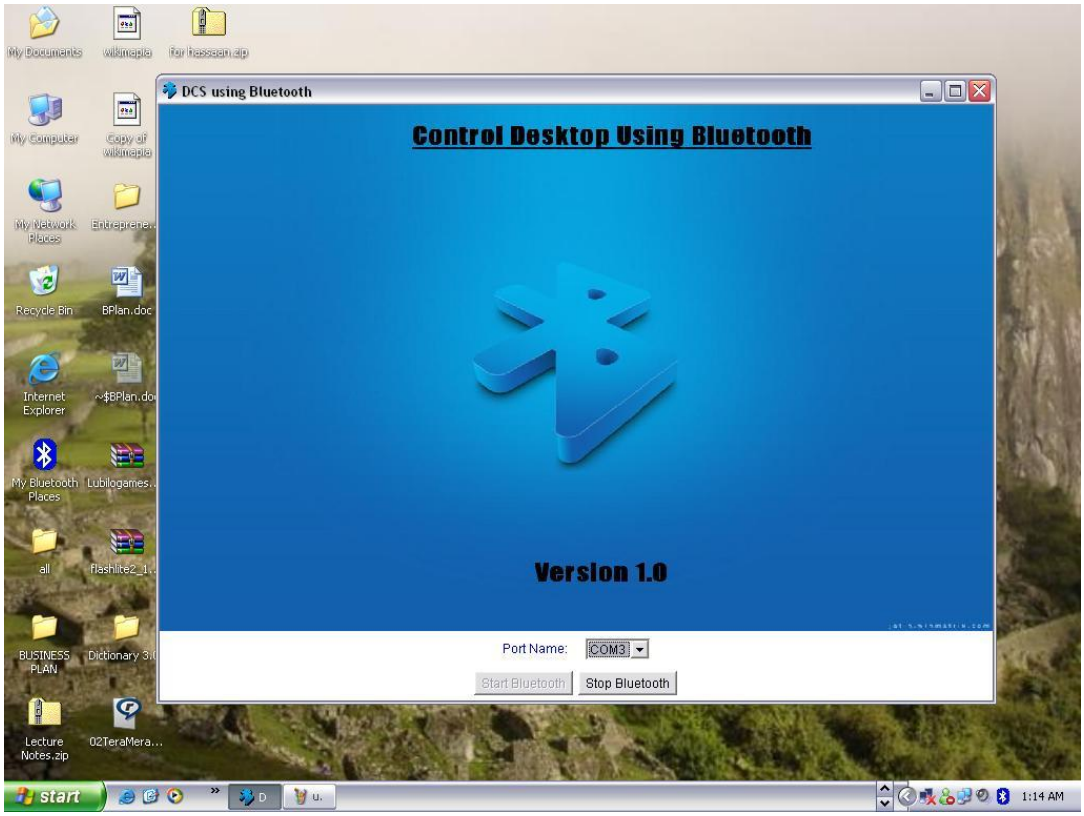


Figure 14 : Desktop Application After Starting Bluetooth on Com3

Figure 17.0 shows the application with multiple com ports available, either can be chosen for communication.


Figure 15 : shows multiple com ports available

Com3 port

And Com4 port

### 2.3.3 Network interface

The application which is deployed on the mobile, while running will continuously send the request using its built-in Bluetooth to the desktop application which will server. The Bluetooth device in mobile will try to communicate with Bluetooth device attached with desktop from which the desktop application will get the request as it would continuously be hearing to the requests. The inputs from the mobile will firstly be checked for opening specific application then subsequent request would be for functionality usage of the particular application.

Note: Mobile device would be java enabled and Bluetooth enabled mobile phone and will have MIDlet application running on it.

### 2.3.3 Communication interface

Bluetooth connection will required to connect to the server on the desktop, which elaborates that there should be at least two Bluetooth devices. One on desktop and other on mobile side. With out Bluetooth devices it's impossible to communicate.

## 2.4 PROJECT CONSTRAINTS

As "Handheld device based Desktop Control System using Bluetooth" project is merged solution of two soft wares or can be said as deliverables. One is desktop side application and other is mobile side application. That's why the constraints for both of them are separate.

Desktop application:

- The desktop application which is called "Desktop Control System using Bluetooth" is developed in Java 2 Standard Edition (J2SE).
- Bluetooth device is required with desktop.
- Bluetooth drivers are required in desktop since application communicates through Bluetooth communication ports.
- Windows XP Service Pack II is required for desktop application.

Mobile application:

- The mobile application which is called "BlueControl" is developed in Java 2 Micro Edition (J2ME).
- Mobile Phone required, should be enabled with
    - Java
    - Bluetooth
- Preferable mobile operating system for this application is Symbian 8.0 or higher.

## 2.5 PRODUCT FUNCTIONAL REQUIREMENTS

The services which will be provided to the end user and what are functionalities that can be used be the user comes under one roof of functional requirements. This roof contains both mobile and desktop application functionalities. They are described together as following.

After opening the application its main interface will come to user where it will ask user to search Bluetooth devices. After hitting the search option it will start searching and will ask for waiting from 8 – 10 seconds as displayed. Once searching is done, this application will provide the entire available Bluetooth devices in range for communication. In the figure 4.0 below is the Bluetooth device with name "ECTL – 130" is shown which is the friendly name of the Bluetooth device attached with system during development. Only one device shown because one device is there at that time. Once that device is selected for communication it is then application requires the confirmation from the user whether really want to communicate with that device through Bluetooth or not, figure 5.0 clearly shows the request. Now once connection is established user can select any of the application on the desktop i-e Microsoft power point presentation, windows media player or desktop for file management. Other three applications cut/copy/paste, search system and write to desktop are additional features added by us. Figure 6.0 clears the doubts, through radio buttons only one application can be selected at a time. Once certain application is selected its whole control through mobile key pad would be shown to him as in figure 7.0 below. Pointer can also move during using the presentation functionalities. This shows with button 2 on mobile keypad you can move up and with 8 you can go down similarly the other buttons, like with * you can show the desktop if multiple documents are opened and with # you can right click anywhere. From here if someone wants to go back to application selection list he/she can just press 0 and can press 'Back' to get there. Figure 8.0 shows it clearly. If presentation is selected from the application list then following functionalities of start/stop presentation, next slide, previous slide and other can easily be controlled. Pointer can also move during using the presentation functionalities. Figure 9.0 easily demonstrates them in a column. If

media player is selected from the list then functionalities of play, pause, stop, next, previous and open files can be controlled. Pointer can also move during using the media player functionalities. As in figure 10.0 these are clearly shown. If Cut/copy/paste is selected from the list then functionalities of cut, copy, paste, right click, double clicks and full screen can be controlled. Pointer can also move during using these functionalities. As in figure 10.0 these are clearly shown. If Search System is selected from the list then functionalities of Searching System, right click, double clicks and full screen can be controlled. Pointer can also move during using these functionalities. As in figure 11.0 these are clearly shown. At last the most interesting part of the project which is an additional part of the project is to write anything to the desktop from mobile except special characters. Through this feature you can write any text to any active window of the desktop which would be opened for writing text for example word pad, internet explorer etc. figure 12.0 clears the doubts below in which it is clearly mentioned that instruction given in the mobile for user and also in figure 13 it is clearly mentioned that the functionalities of the send, enter, undo, redo, back space, tab and close are also there, which shows that you can also undo you work from mobile on desktop, means if someone wants to remove the text from desktop he has written he can easily remove it and can also close that window with close option. Also can enter on the desktop from mobile with enter option. Figure 13.0 shows them well. Desktop application continuously listens to the requests from the connected client. As there would only be one client at a time so only one client can send requests to the server which is Desktop application. When it receives request it first checks it whether it’s for selecting an application if not then checked for the specific event. But it is made very simple to the user; it has just got the three things in there on the main GUI. Two of them are buttons i-e for starting and stopping the Bluetooth and third item is a combo box in which all the available communication port will be there. Since the desktop side application communicates with mobile client through virtual COM ports so in this combo box all the available communication ports will be there. It would be easy if the selected port is chosen for communication because it is selected by the application itself in a specific part of code. Figure 14.0 easily explains each and every thing below.

## 2.6 SOFTWARE SYSTEM ATTRIBUTE

### 2.6.1 Reliability

The producers will try their best to deliver the perfectly working product with time and limits. There would not be any faults in the end product and must pass a previously created set of tests.

### 2.6.2 Maintainability

Maintenance of the software and documentation of the software will be done by the NUST once it's ready. Later maintained through constant reviews.

### 2.6.3 Portability

Because of the Java's platform independency there is no need of anything else but one should stay away from Microsoft's products about Java because those comprise with Java standards.

### 2.6.4 Software Generation and Integration

Instead of generating automatic code all the code should be written by the developer himself with proper comments and should be documented. The process for building the finished products and all its sub-components from source code must be documented.

*Chapter 3*

# JAVA 2 MICRO EDITION (J2ME)

In this chapter a little bit of an over view will given about J2ME and wireless communication in J2ME.

## 3.1 OVERVIEW OF WIRELESS COMMUNICATION

Wireless communications is a huge field, encompassing from radio and television broadcasting through pagers, mobile phones, and satellite communications. The field of mobile phones is expanding very fast at the same time that standards and protocols are being adopted, used updated and sometimes discarded. The other rapidly expanding part of the wireless world is that of wireless local area networks (LANS).Driven by widespread acceptance of the IEEE 802.15 standard, wireless local networking through Bluetooth for computers and other devices is spreading rapidly.

Although wireless may seem like special case, it is actually more intuitive and more natural then wired networking. Someday soon the need to plug a laptop into a network physically will seem quaint and antiquated, since Bluetooth and other like wi fi are changing the world scenario. The notion that you could walk into a room with your own cell and have it unable to interact with other devices in the room will seem unbelievably primitive. The future will reveal that wired networks are the special case.

Conceptually, wireless communications can be split into two types, local and wide area communication. A local device is similar to a key fob with a button that unlocks a car with Bluetooth, a 900 MHz cordless phone, a radio control toy, or WI FI networks. All of these devices operate over short distances, typically just a few meters.

Wide area wireless devices operate effectively over much greater area as compare to local area wireless networks. A pager or any mobile phone is a good example; you can talk to any mobile phone from your mobile phone with GSM standards. These devices greater range relies on a trick, however: a more elaborate land based network. A mobile phone doesn't have that much power as like radio power toy. What it does is having a network of carefully placed radio antennas (cell towers); the phone can continue to operate as long as it is with in range of at least one tower. The mobile phone device receives service from a wireless carrier, a company that operates the land based network.

## 3.2 OVERVIEW OF THE JAVA 2 PLATFORM

The Java platform is mainly divided into 3 parts as following.

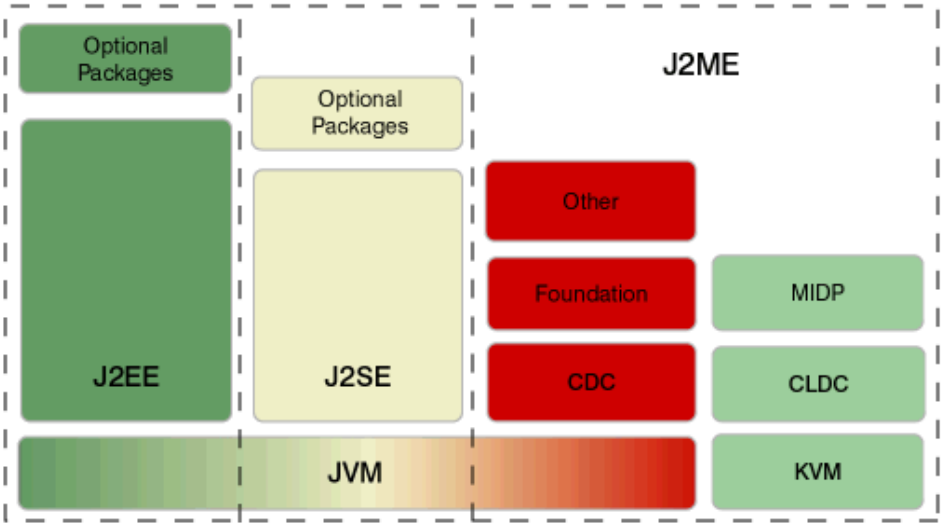


Figure 16 : Java Platform

- J2SE (Java 2 Standard Edition). This version is for desktop computers normally runs on Linux and Microsoft Windows.
- J2EE (Java 2 Enterprise Edition). This version is for servers and for catering multiple users. It has got additional API's with J2SE for server.
- J2ME (Java 2 Micro Edition). This version is for small devices such as mobile phones, PDA's, pagers and others. It uses small set of the whole

J2SE API's for development. Such devices have got small virtual machines.

## 3.3 OVERVIEW OF THE JAVA 2 MICRO EDITION (J2ME)

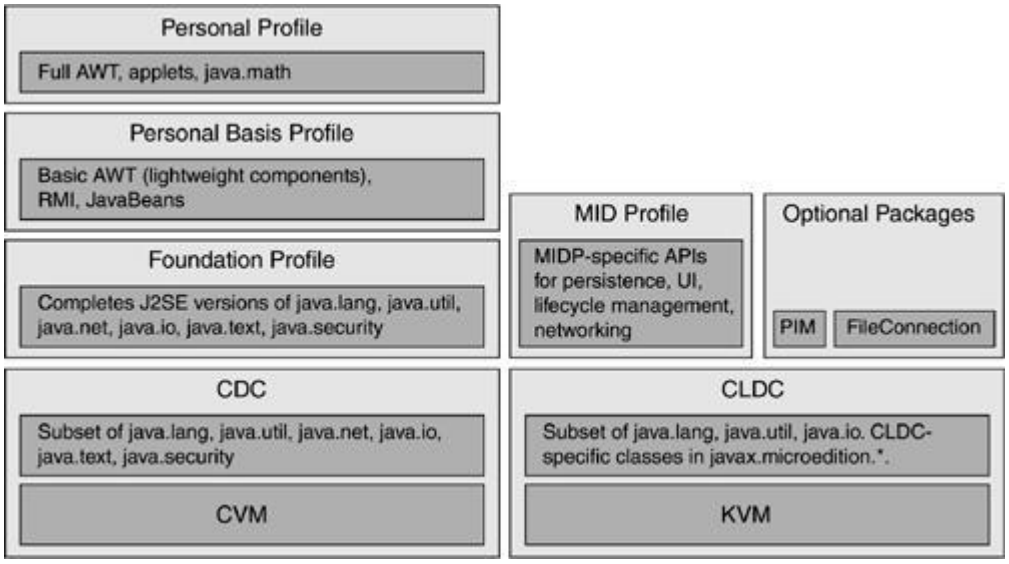


Figure 17 : J2ME overview

The combination of the profiles, configurations and optional packages completes that structure of the J2ME. The details of configuration, profiles and optional packages are given below.

*Configuration:* These are specifications in which detail about virtual machine and root set of API's can be used with certain type of device. For Example, It (Configuration) might be for the devices that have less than 512 KB of memory and an intermittent network connection. The virtual machines for such kind of devices are called KVM means kilo virtual machine. It can either be fully functional virtual machine or can be sub part of the complete JVM. Such API's are sub part of the API's of the J2SE.

*Profile:* Another layer comes on top which build on a configuration are called profiles. These profiles include specific API's for making the complete environment. These profiles are for building applications as they provide the complete environment for development. Since with configuration one cant detail himself for developing an application because configuration describes JVM and only basic set of API's while profiles provides API's for development and for application life cycle. User interface and complete persistent storage.

*Optional Package:* Optional package can be come up with extra API's that can further extend the functionality of the mobile application during development.

## 3.4 CLDC, MIDP AND CDC

Since from the figure 18.0 it's fine and clear that J2ME is mainly divided into two main braches and those are CLDC and CDC. Following is the detail of these two main configurations.

### 3.4.1 CLDC:

- Short for Connected Limited Device Configuration.
- A configuration for small devices with very little memory such as in KB's.
- Contains KVM, a kilo virtual machine. In which virtual machine can max be up to 1000KB.
- A configuration for small devices having very low processing power.
- Pagers, mobile devices and low level PDA's.

### 3.4.2 CDC:

- Short for Connected Device Configuration.
- A configuration for large devices with very large memory such as 2MB or more.
- Contains CVM, a Compact virtual machine. In which virtual machine can be in MB's.
- A configuration for large devices having high processing power.
- Set top boxes and high level PDA's.

- Foundation profile extends CDC and serves as the basis for other several profiles. It provides the basic API's which are from J2SE, it can have classes, can also have interfaces.
    - Java.util
    - Java.security
    - Java.lang
    - Java.IO etc

### 3.4.3 MIDP

- Short for Mobile Information Device Profile.
- A CLDC based profile.
- A first available environment which is finished and available for J2ME-CLDC based development.
- All the basic required functionality is available in it.
- MIDP complaint devices are available in the market in very large number.

## 3.5 SCOPE OF WIRELESS JAVA TECHNOLOGY

Wireless java technology came into being with the merger of the two big platforms, those are data communication and the Java platform. It is infact the intersection of the these two. Wireless Java technology distributed in the whole of four parts of java those are: J2ME, J2SE, J2EE, and Java Card. Some of the common misconceptions about Java Wireless technology should be cleared.

- Wireless Java technology and J2ME are not the same things.
- J2ME encompasses more than wireless devices while some parts of the J2ME are explicitly designed for wireless communication.
- Some parts are not like CDC, which is having standard Ethernet connections.
- Wireless Java technology is not confined to j2ME alone.
- Your laptop running J2SE application can connect to other computers via 802.11.

- MIDP is not overall J2ME. MIDP is the first finished profile and has the installed root of devices out in the world, so people sometimes assume that you are talking about MIDP which is wrong.
- MIDP just happened to cross the finish line first which can be seen in figure 18.0 which has got its facets.

The MIDP is not all of the wireless Java technology. The Java platform offers plenty of choices for wireless programming: Personal Profile, J2SE on wireless devices, PDA profile.

*Chapter 4*

# LITRATURE REVIEW

This chapter includes all the study which is done for the accomplishment of the project. The technologies used, hardware used and protocols used in the project for communication.

## 4.1 DISCUSSION

On the basis of the certain criteria the whole project's modules will be measured, whether they are technology based or any other. The comparison and criteria is mentioned below:

### 4.1.1 Project Overview

Since project is divided into three main modules. Desktop application and Bluetooth device. Mobile application and Bluetooth device, the bridge between the mobile and desktop system for communication is Bluetooth. The figure 19.0 shows it very clear.

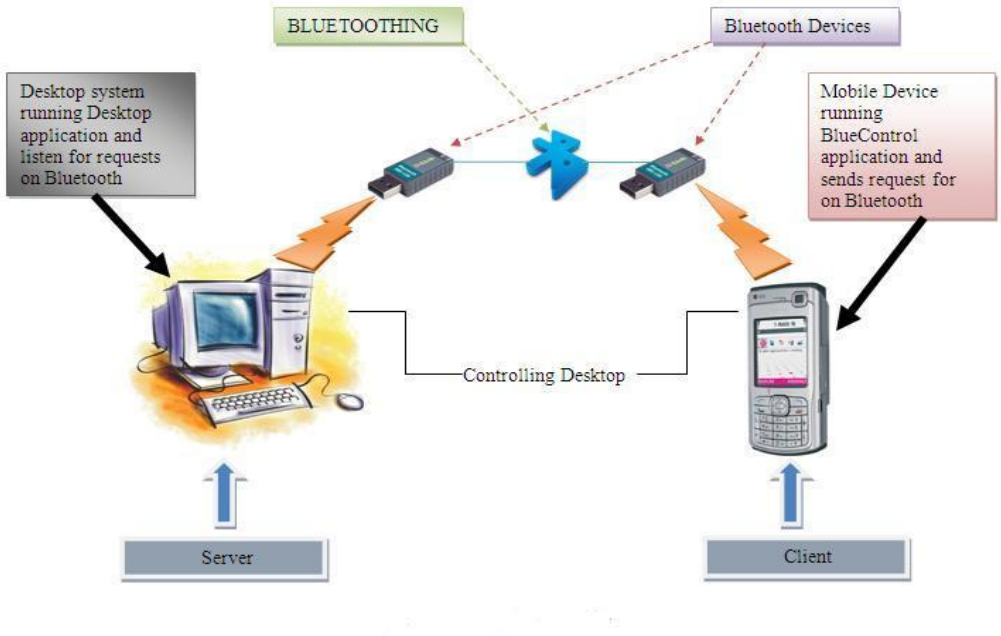


Figure 18: Project Overview

From the figure 19.0 it's quite clear that without Bluetooth all the system would be flopped. So for basic definitions and details we will firstly be defining the Bluetooth's basic, its standards, acronyms, protocols solutions and other main and basic functionalities. Later then we will be discussing the server and mobile.

### 4.1.2 Bluetooth Overview, Structure and Working

What is a Bluetooth normally comes as a question to mind, how it works, its reliability, feasibility, range, efficiency are the sub sequent questions. All these would certainly be cleared from following details.

By definition Bluetooth is a standard in the wireless connectivity atmosphere. It is for phone and PC users. It's mainly manufactured for data transfer and voice transfer between personal computers and communication devices such as phones, PDA's etc.

It has got to do the same working as done by IrDA but the style of working is different. Bluetooth is a technology which uses radio frequency working on 2.5 GHz industrial scientific Medical band. Following figure shows its physical structure.

Figure 19 : Bluetooth device internal structure

Bluetooth creates PAN instead of LAN. That is Personal Area Network. IrDA can transfer from only 1 m while Bluetooth can transfer 10 m and can also extend till 100m depends upon the transmitters power, if its enhanced it can send even from 100 meter. Also IrDA which is direct competitor of Bluetooth needs line of sight while Bluetooth don't need any line of sight can communicate from anywhere but should be in range.

One of the main drawbacks of the technologies with same attributes is their high cost, as Bluetooth cost is almost around 5$. The transmission speed of a

normal Bluetooth device is around 780Kbps and another best attribute of Bluetooth is simultaneously handling two things i-e data and voice transmission, but the latest Bluetooth device ranges about 2 Mb/s transmission rates which is called Bluetooth 2. Bluetooth is a perfect technology because it has got the ability of supporting asynchronous and synchronous channels. For data there is one asynchronous channel while for voice there are three synchronous channels. There is also one channel for supporting both of them. The ad-hoc connection which Bluetooth has the ability to establish with above features makes the Bluetooth as the best solution that should be used for mobile devices and internet software. These features of Bluetooth brought such a new and nice solutions like mobile hands free headset for calls, printing from mobile phone through Bluetooth, synchronizing the contacts and messages of your mobile with laptop through Bluetooth, setting calendar entries and their synchronization through Bluetooth device with desktop or laptop system. Common Bluetooth device shown in the figure below.


Figure 20 : Bluetooth Device

Up till now we have been getting knowledge about Bluetooth and its benefits and advantages of Bluetooth over other same featured technologies. But how the Bluetooth in real communicate with other Bluetooth device, what is the protocol, how the data is transferred how it is managed how the quality is assured we don't know about these so such things would clearly be focused now under protocol of Bluetooth on which the real communication takes place.

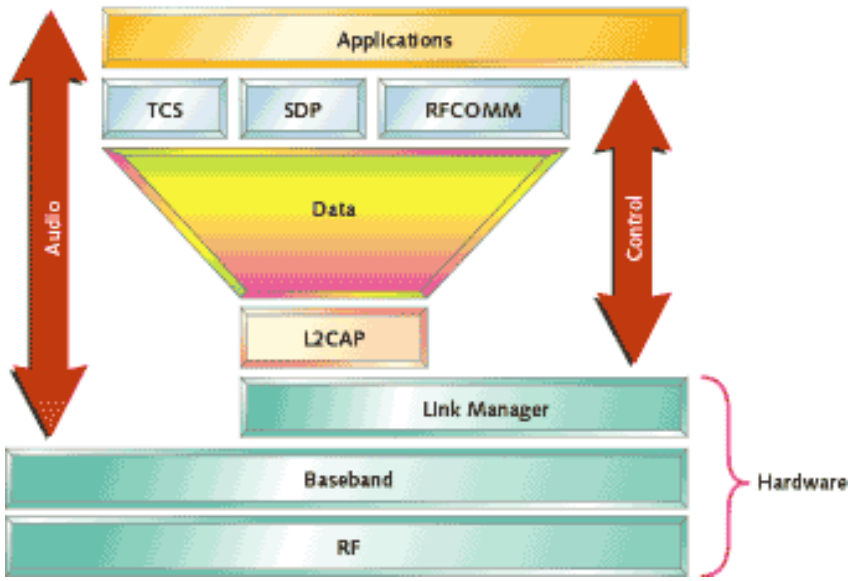


Figure 21 : Bluetooth Architecture

From the above figure it's quite clear that if something that has to be sent through Bluetooth that would go through certain protocols which are inside in the whole architecture of the Bluetooth. From figure there are three hardware layers those are Link Manager, Baseband and RF. The RF module is implemented by baseband module while Link Control is integrated on 1 chip or this is integrated as a radio module. The RF module is hardware and it controls radio transmission and it also receives the data and gives it to baseband module. It tries to establish connection, and has got the complete support for data and voice, authentication and error correction. These can be synchronous and asynchronous channels. Other module called Link manager is loaded with normal Bluetooth features i-e discovery of devices, setting the link, authorization, configuring the link and other. Since architecture says that all the included protocol will have to go through link manager which means that without link manager everything is useless. As through link managers two devices communicates, they communicate through protocol named as link manager. It uses the baseband services and it uses HCI. Now the

protocol description should be focused one by one. One of them is L2CAP protocol which has got following features.

- L2CAP means Logical Link Control and Adaptation Layer Protocol.
- It is placed over Baseband protocol and it remains in data link layer. In between there is link manager.
- Provides connectionless and connection oriented services for data to the layers above it.
- Does segmentation, reassembly, multiplexing and abstraction of group.
- It allows upper protocol and also the applications to receive and transmit from L2CAP in 64KB in size.
- Only support for Asynchronous Connection-Less links, no support for others.

Similarly other protocol is RFCOMM. It does the following things.

- RFCOMM is for RF communication.
- Up there on L2CAP protocol the serial ports enumerated by RFCOMM.

Remaining two protocols are TCS and SDP. Their functionalities are mentioned below.

- SDP is short for service discovery protocol.
- Allows application to discover what services are available on other device.
- Also the properties of those services are told by SDP.
- Since because of the dynamic nature of PAN, it rapidly checks for the available devices and resources.
- TCS stands for Telephony Control Specification.
- A protocol with a bit orientation.
- Call control signaling for making possible the speech and data calls between 2 Bluetooth devices.
- Point to point and point to multipoint signal usage by TCS.
- Mobility management procedure is defined by TCS.

Up there on them is the application layer from all kind of data will come and have to go through these all protocols. All the required features are added to it and then communication is made possible through the RF module which is the physical layer of Bluetooth protocol.

### 4.1.3 Bluetooth and JAVA

Because of the spreading of the Bluetooth in the market and its wide range of quality with respect to price and it's commonly availability in mobile phones Java didn't missed the chance for utilizing such beneficial hardware with its own style. That's why Java provided the complete support for Bluetooth in all of its flavors whether its J2SE or even if its J2ME or J2EE. All kind of API's are available for them through which an application which is developed for using Bluetooth can easily communicate with Bluetooth through these API's. A very friendly and easiness is provided by Java. Here in this section we will explain the interaction, working and communication of the Java with Bluetooth through API's. How J2SE communicates with Bluetooth, how it gets access, what are the limitations J2SE has to face if communicating with Bluetooth, what JVM says and a lot more in this section.

Also explanation of the interaction, working and communication of the Java (Mobile side i-e J2ME) with Bluetooth through API's. How J2ME communicates with Bluetooth, how it gets access, what are the limitations J2SE has to face if communicating with Bluetooth, what KVM (Kilo Virtual Machine) or CVM (Compact Virtual Machine) says and a lot more in this section. What are different kinds of exceptions it can produce during the execution.

What are the possible solutions for the raised problems and raised exceptions in both J2ME and J2SE, if there isn't any solution then what the alternatives are also to be mentioned here. So let's start with J2SE, J2ME and Bluetooth:

#### 4.1.3.1 BLUTOOTH with J2SE and J2ME (JAVA)

In the Java 2 Platform there are number of API's which hides the most complex operations in a very easy to use manner. There is no need of going into

details and don’t even need the root level details for using the Bluetooth services. These Java API’s provides common functionalities which a normal Bluetooth device can do through these API’s such as inquiry, service, discovery, communication. These all are done through Bluetooth channels and through the creation of Bluetooth services. These API’s are named as JABWT which is short for Java APIs for Bluetooth Wireless Technology. It’s the set of API’s which to be used for interacting with Bluetooth device through J2SE application or can be through J2ME MIDlet.

Just imagine if we able to control the doors of our house, controlling your DVD player through Bluetooth. To bring up the vision as true these API’s supposed to be used and JSR is one of JABWT. Details JSR is given below.

- JSR is short for Java Specification Request (JSR).
- JSR makes the Java API’s standard and let the Java enabled devices to make possible the integration into a Bluetooth environment.
- Contains the communication API’s for two devices.

The JSR provides majority of the services which are supposed to be available for Bluetooth. Such services are mentioned below.

- Service of checking the state of the Bluetooth device in which it is checked whether device is available and ready or not.
- Services of checking the discovery agent and discovery listener are also there check if there is any device or to check if some wants to connect.
- Services of keeping the record of the local device and the remote device are also there.

Figure 23.0 clears and tells about the JSR-82 fitting in the J2ME structure. Although here it is shown with MIDP profile but that doesn’t mean that JSR-82 rely on MIDP API’s. just shows it stays out there with MIDP profile.

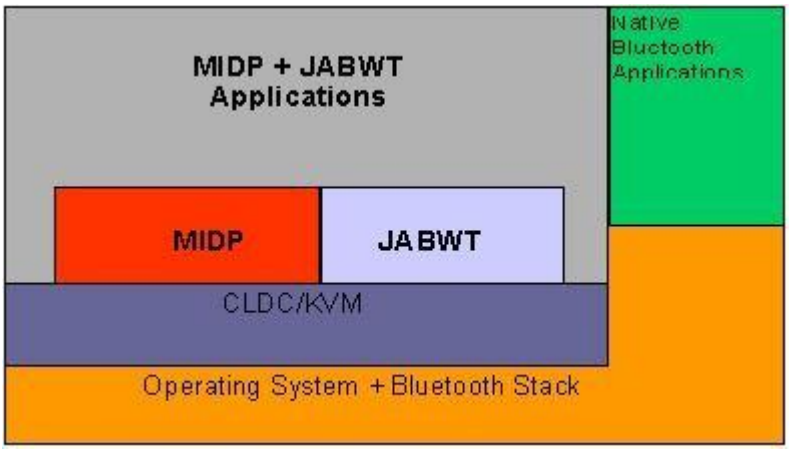


Figure 22 : JABWT

Furthermore it should be clear that three kind of functionalities are provided by this Java Bluetooth API's means by JSR -82. These can be categorized into three which are mentioned below.

- Discovery
- Communication
- Device Management

In the discovery section discovery of the device, service and registration of the service included. While in communication section establishing the connection between two devices, their usage for data transfer and closing them later is adjusted. These connections depend upon many internal protocols such as RFCOMM, OBEX, and L2CAP.

Now coming to the third section of device management in which managing and controlling of the created connections dealt. It also manages the local state and properties of the local device and state and properties of the remote device. Device management also deals with security issues and deals them. The coding and featuring of the J2ME and J2SE is almost same for developing the Bluetooth application for both. As J2ME is baby of the J2SE so what all thing of Bluetooth is

having by J2SE is available easily in J2ME that’s why both of them are discussed together instead of explaining the Bluetooth working for them separately.

*Chapter 5*

# TOOLS AND TECHNOLOGIES

Since Java is the mostly adopted language all over the world for development of any kind of application whether it's a desktop application or whether its server application or even if it's a mobile application. The reason being for adopting Java as a development language is its simplicity and support for majority of required functionalities. For example support for database access, retrieval, deletion and vice versa is available in Java. Similarly support for developing a network based application is there, it's not concerned about the edition of the Java because all of them development is same. Even if someone wants to develop a web based or internet based application he/she can also develop. Even though through Java Server Pages (JSP) a fully fledged website can be developed. So simply to say that Java has got almost 90 % of the support for every technology. If we talk about the latest technology i-e RFID for that Java has got the API's to interact with it.

From above explanation it is supposed to be explained that selecting Java for the project in which two main things are involved was not a bad selection. Those two things are:

- J2SE with Bluetooth
- J2ME with Bluetooth

The reason being for selecting Java for these is already mentioned further more obviously there would be a huge support available for Bluetooth in Java in both mobile side and desktop side and certainly there was. The JABWT API's for Bluetooth clearly prints a very simple and interesting picture of development in mind. This is because these API's made the development very easy or you can say in fact Java made development as a piece of cake, just take out API, read it and inhale it means develop your application. For reminding the detail of the Java platform should be shown

again over here clarification as Java has division according to platforms and now a day's requirements. Check figure 24.0 below.

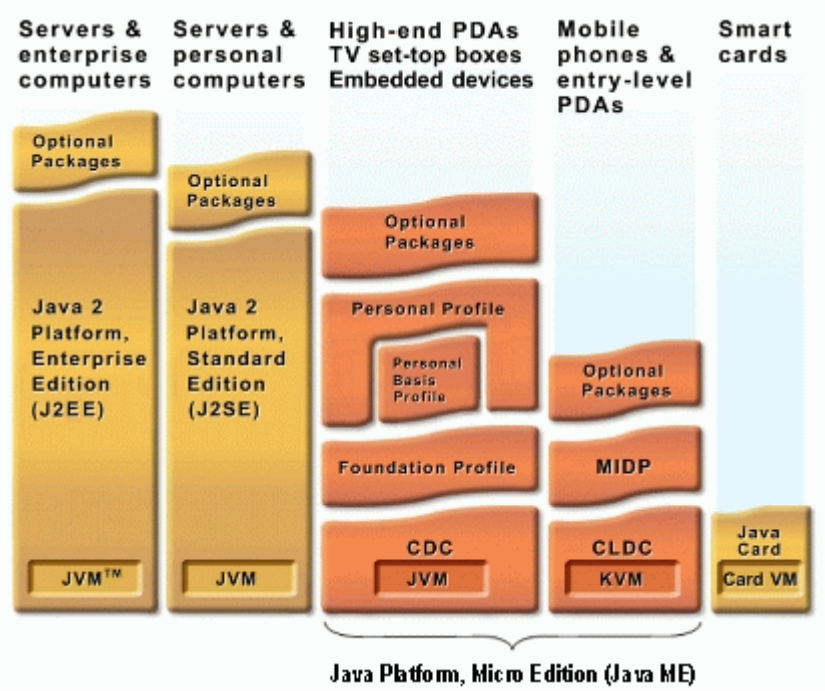


Figure 23 : Java Platform Detailed

Java complete platform including all the API's and Platform support is given below in figure 25.0. Since J2ME and J2EE are the sub parts of the J2SE so both of them are by default included in this figure.

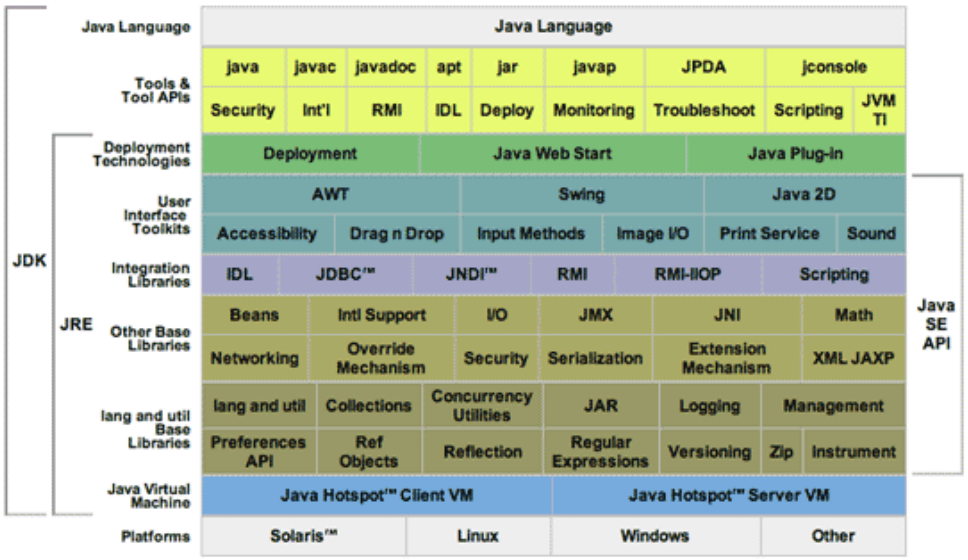


Figure 24 : Java API's detail

## 5.1 TOOLS AND TECHNOLOGIES

Since whole project is divided into three main parts and each of them will be described separately with respect to tools used for it and technology used in it also there would be an explanation for the tools and technologies to make them understandable here in this document.

### 5.1.1 Desktop Application

Desktop application was based upon the following technologies and tools during the development.

- Java Development Kit (JDK)

Version 1.5 or later is required for the desktop application because Java technology is an OO, platform independent and a multithreaded programming environment. Since Java was foundation for the application of network but later on extended for other technologies like Bluetooth etc. so with out JDK its impossible to develop and reason being for this is developing robust applications for mobile devices.

- JCreator

JCreator is tool used which has got a friendly environment for Java development. It has got features syntax coloring editor, code completion and browsing the class functionality is their and is best for development and compatible with all JDK versions. Figure 26.0 shows the JCreator environment.

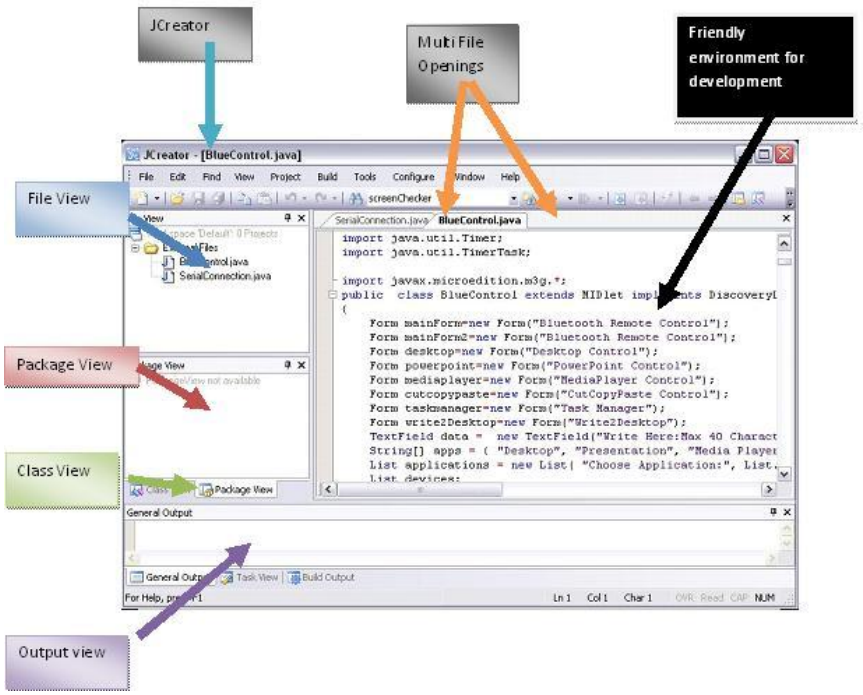


Figure 25 : JCreator Pro v4.0

JCreator has got two versions available for development. These are

- JCreator Pro v4.0
- JCreator LE v4.0

Pro version has got all the facilities available in it including all the API details , methods, static members description and others because its for professionals who hasn't got the time to learn and understand what certain

function do or what ever while in LE version its for learners it hasn't got all the facilities just for the sake of the learning. In this project first LE version was used because of the learning then later when project reached to the 75 % completion pro version is adopted for development just for the sake of the saving time. Else it provides building, debugging, processing and execution facility in a very handsome manner.

- Alternatives

Instead of using JCreator we can also use KAWA Pro for the development of the project if its desktop application development. Since KAWA is also a user friendly environment for Java, also provides the syntax coloring editor, code completion, debugging, building, processing and execution facilities in an excellent manner as like JCreator. Its also compatible with all sort of JDK's. JBuilder 2005 is also another option for doing the same job.

### 5.1.2 Bluetooth Hardware

The second most important part of the project is Bluetooth device which has to be there with desktop application for communication. As mobile devices has got the Bluetooth devices built-in but with desktop and the one that should be used with J2SE must have been their physically. So two kinds of Bluetooth devices were tried to be used during the development. A Bluetooth device with low data rate and price and other with high price and high data rate. Since the project is developed in such a way that its not a Bluetooth device dependent. As for project Bluetooth com ports should available for making possible the communication on server side. So if we install any of the Bluetooth device driver whether its expensive or even if its cheap it will work as both of them are tested during the development. Both kinds of devices should be mentioned here for details.

- DBT-122 Wireless Bluetooth USB Adapter
- Billionton Long Range Bluetooth USB Adapter

Below two figures 28.0 and 29.0 shows the devices which were used for the communication propose during development.


Figure 26 : Dlink Wireless Bluetooth USB Adapter


Figure 27 : Billionton Long Range Bluetooth USB Adapter

### 5.1.2.1 DBT-122 Wireless Bluetooth USB Adapter specification

| | |
|---|---|
| **Interface** | • USB 2.0*<br>• EDR |
| **Wireless Signal Rates**** | • 2.1Mbps (Bluetooth 2.0) and 723.2Kbps (Bluetooth 1.x) |
| **Link Mode** | • ACL, SCO |
| **Wireless Transmit Power** | • 4dBm |
| **Wireless Frequency Range** | • 2.1GHz to 2.485GHz |
| **Wireless Operating Range**** | • Up to 10m (33 ft) |
| **Modulation** | • GFSK (Gaussian Frequency Shift Keying)<br>• DQPSK<br>• DPSK |
| **Security** | • 128-bit encryption<br>• Pairing<br>• Authentication |
| **Spectrum** | • FHSS (Frequency Hopping Spread Spectrum) |
| **LEDs** | • Link<br>• Power |
| **Certifications** | • FCC Class B |
| **Receiver Sensitivity** | • -80dBm @ 01% BER |
| **Operation Current** | • 50mA (max) |
| **Operating Temperature** | • 32°F to 131°F (0°C to 55°C) |
| **Dimensions** | • Item (WxDxH): 0.7" x 1.8" x 0.4"<br>• Packaging (WxDxH): 6.3" x 8.3" x 1.5" |
| **Weight** | • Item: 0.21 lbs<br>• Packaging:0.3 lbs |
| **Warranty** | • 1 Year Limited*** |
| **Minimum System Requirements** | • Computer with:<br>  • Windows® XP SP2 or Windows 2000 SP4**** or MAC OS® X (v10.4/ v10.3)2 with USB 1.1 Support<br>  • Available USB Port<br>  • CD-ROM Drive |

Figure 28: Dlink Bluetooth Dongle Specifications

### 5.1.2.2 Billionton Long Range Bluetooth USB Adapter specification

## Hardware

1. Bluetooth v2.0 EDR compliant (Class 1)
2. Protocol : Bluetooth 2.4 GHz ISM band frequency hopping
3. High Speed data transfer up to 3Mbps
4. Piconet: Supports 7 slaves
5. Certifications: FCC, CE
6. Sensitivity: -80dbm@0.1% BER
7. Power: Typical: 70mA/5V; Maximum: 210mA/5V; Idle: 25mA/5V

## Software

1. Toshiba Software
2. Protocol Stack: Bluetooth specification V2.0
3. Security: paring, encryption, authentication
4. Profiles:

- Serial port profile (SPP),
- Hard Copy Replacement Profile (HCRP)
- Service discovery app profile (SDAP),
- Generic object exchange profile (GOEP),
- Object push profile (OPP),
- File transfer profile (FTP),
- Dial-up network profile (DUN),
- LAN access profile (LAP),
- Fax profile (FAX),
- Advanced Audio Distribution Profile (A2DP)
- Personal Area Network(PAN)
- A/V Remote Control Profile (AVRCP)
- Headset Profile (HSP)
- Human Interface Device Profile (HID)
- Basic Imaging Profile (BIP)

## System Requirments

1. Windows 98/ME/2000/XP
2. USB port
3. 4Mb of storage memory for installation

Figure 29 :Billionton Bluetooth Dongle Specifications

### 5.1.3 Mobile Application

During the development mobile application was developed using the following tools and technologies.

- Sun Java(TM) Wireless Toolkit 2.5 for CLDC
- JCreator Pro V4.0

The whole code of the mobile side is written using JCreator pro v4.0 but it wasn't complied, and executed in JCreator as JCreator hasn't got support of such options for J2ME. So for debugging, compiling, building, and executing Sun Java(TM) Wireless Toolkit 2.5 is used. As it has got the emulator, which shows user interface of mobile on desktop system, and makes it easy during development as it shows the results. Figure 32.0 shows the toolkit snap.

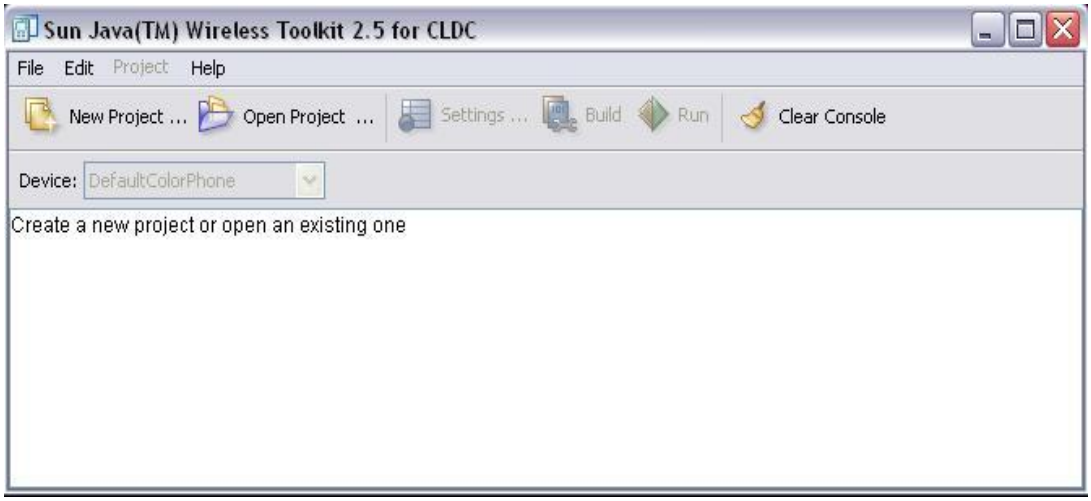


Figure 30 : Sun Java Wireless Toolkit 2.5 for CLDC

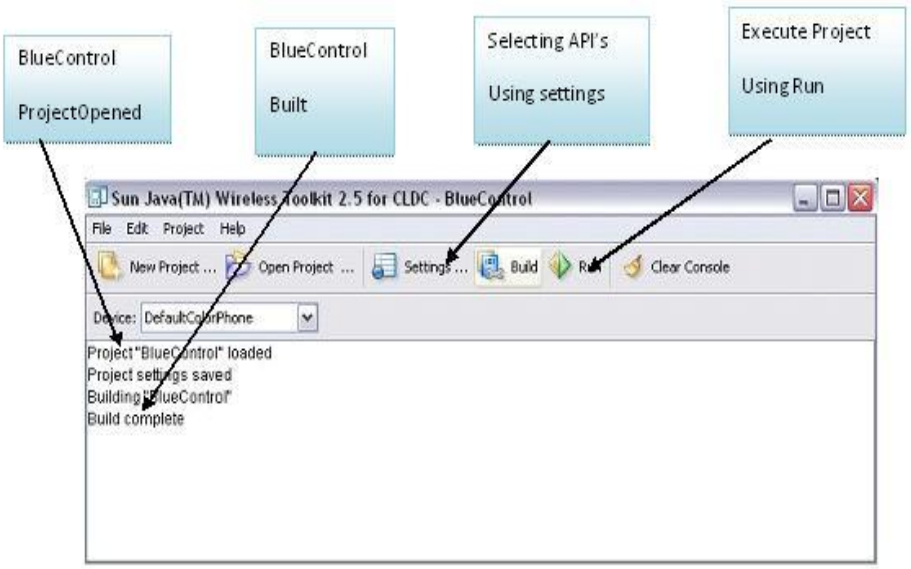


**Figure 1 - Sun Java Wireless Toolkit 2.5 for CLDC**

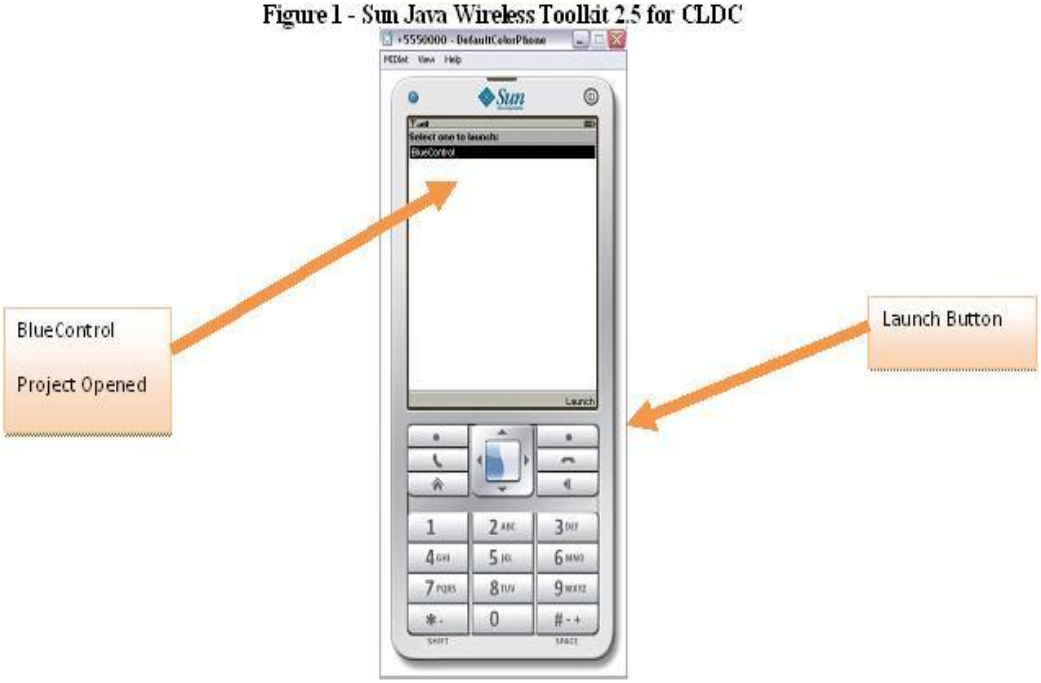


Figure 31 : Sun Java Wireless Toolkit 2.5 for CLDC emulator

*Chapter 6*

# IMPLEMENTATION

The last and the most important chapter of the whole document has begin now. In this chapter it will be described how the task was accomplished. How the work was distributed and how the modules were developed. How many classes were used, what was the work break down structure, what was the common code, what is the project flow what was the block diagram of the project. What was the sequence of the events? These all kind of questions that comes to mind rapidly once we hear about implementation. So before starting how things happened we should use the divide and conquer rule in order to clear define the code and style of code, nature of code and execution of code. As it is clear that there were four parts of the whole code and those were:

- Client Code

    1. User request related code
    2. Code used for the Bluetooth usage

- Server Code

    1. Code that server has to process for request from client
    2. Code used for the Bluetooth usage

## 6.1 SERVER CODE EXPLANATION

Because of the four main code modules it's now clear and easy to explain each of them and to provide their classes' details and flow. So we will start with Server code. It should be quite clear that server will receive the request through attached hardware i-e Bluetooth Dongle. Now how we will get that request from Dongle as its hardware, so Java has provided the standard code for communicating with hardware through and application. That code would try to get request bytes from hardware will verify it through protocols and then the code which will

process the requested bytes will get it from Bluetooth code in order to full fill the user request. Figure 35.0 makes it quite clear how the request will come to Bluetooth, from Bluetooth how its fetched by Bluetooth standard code and from Bluetooth standard code how Server code is getting.

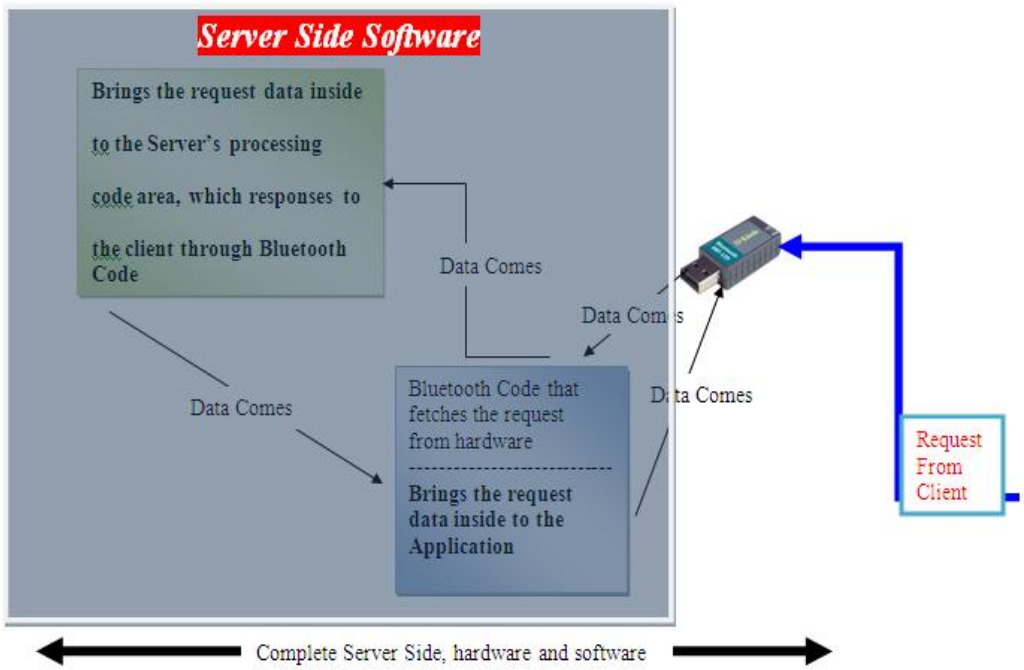


Figure 32 : Server side code executions

Above in the figure the big gray box shows the software that would be running on the server. It has got two modules; one code module fetches and send data to the Bluetooth device. Then from that part of the code data is retrieved to the other processing part of the code. This gives back the response to the Bluetooth code which further returns it back to the Bluetooth device.

Now the main classes that have to be used here are:

- BlueDesktop.java
- Connection.java
- Parameters.java

- Port.java
- MouseHook.java
- keyHook.java
- ImageLabel.java

Total of 7 classes are used on the server out of them only one class is related to do the Bluetooth code and the remaining six classes are related to the processing request code. Bluetooth code related class is Connection.java in which port is opened and then listened for request before that port is set according to following parameters.

- Setting the Port selected by user.
- Setting the Baud Rate.
- Setting the data bits
- Setting the stop bits and Parity

Also it checks the hardware i-e Bluetooth whether connected to the system or not. If not then gives the indicator to plug it in.

Connection class also stores the values which comes from the users because on the basis of those values each and every thing happens on the desktop, these values identifies the application selected and also it identifies the specific event for that. Excluding this class simply means that throwing away the whole project to the dust bin because only through this class we have got the access to the Bluetooth device.

Remaining other six classes works on the basis of the data that is stored by the Connection class and executes the required event. Working of each class through bullets is explained below.

- BlueDesktop.java
    - Creates GUI
        - Populates all the buttons and configuration setup
    - Lets user to start Bluetooth
        - Uses connection class for this
    - Sets the parameters for Communication

        - Uses parameter class for this
    - Used for Debugging during development
    - Includes Graphics
        - Uses ImageLabel.java class for this
- Parameters.java
    - Receives parameters from BlueDesktop.java
    - Those parameters are adjusted accordingly
    - Gets port names from system and make them available to BlueDesktop.java
- Port.java
    - Makes available the ports
    - If any other process requests the came port gives option
        - By providing the GUI
        - User selects for acceptance or rejection
- MouseHook.java
    - Provides all the functionality of mouse
        - Left pointer move
        - Right pointer move
        - Up pointer move
        - Down pointer move
        - Up right pointer move
        - Up left pointer move
        - Down left pointer move
        - Down right pointer move
    - Click options
        - Right click
        - Left click
        - Double click
    - Show Desktop option
    - Uses Java.awt.Robot API
        - To accomplish all the movements

- keyHook.java
    - provides the facility of key combination
        - virtually, with hitting the keyboard
    - Controls the presentation
        - Start show
        - Stop show
        - Next slide
        - Previous slide
    - Controls Media player
        - Play
        - Pause
        - Stop
        - Next
        - Previous
        - Open files
    - Miscellaneous
        - Cut file or blocked text
        - Copy file or blocked text
        - Paste copied file or blocked text
    - Searching
        - Searching system
        - Opens searching window
    - Writing to desktop
        - Write any text to desktop
        - To the active writing window i-e notepad
        - No special characters accepted
        - Enter option from mobile
        - Send text option from mobile
        - Undo option from mobile
        - Redo option from mobile
        - Back space option from mobile

        - Tab option from mobile
        - Closing application option from mobile
        - Max 40 characters can be written at a time including numerical values.
- ImageLabel.java
    - Provides the 2D graphics to BlueDesktop.java
        - To populates the GUI with graphical image
        - To populates the GUI with graphical string i-e text
    - Uses Graphics and ImageIO API

This is a little bit summary of the implementation done on the server side in which its explained how the request comes how it is catered with two code modules. How each code behaves and gives the response. How software and hardware works together on the server side.

## 6.2 CLIENT CODE EXPLANATION

Unlike server side code on the client side only one class is used for implementation. But it imported a lot of API's for the usage. Some of them are listed below.

- java.io.IOException;
- java.io.InputStream;
- java.io.OutputStream;
- java.util.Vector;
- javax.bluetooth.BluetoothStateException;
- javax.bluetooth.DeviceClass;
- javax.bluetooth.DiscoveryAgent;
- javax.bluetooth.DiscoveryListener;
- javax.bluetooth.LocalDevice;
- javax.bluetooth.RemoteDevice;
- javax.bluetooth.ServiceRecord;

- javax.bluetooth.UUID;
- javax.microedition.io.Connector;
- javax.microedition.io.StreamConnection;
- javax.microedition.lcdui.Command;
- javax.microedition.lcdui.CommandListener;
- javax.microedition.lcdui.Display;
- javax.microedition.lcdui.Displayable;
- javax.microedition.lcdui.Form;
- javax.microedition.lcdui.List;
- javax.microedition.lcdui.Graphics;
- javax.microedition.midlet.MIDlet;
- javax.microedition.midlet.MIDletStateChangeException;
- javax.microedition.lcdui.CommandListener;
- javax.microedition.lcdui.Command;
- javax.microedition.lcdui.*;
- javax.microedition.lcdui.Image;
- javax.microedition.lcdui.ImageItem;

On the client side both code modules i-e user request related code and code which is supposed to be used for Bluetooth usage are included in one java file called BlueControl.java. The user request code gets information from user process its accordingly the it passes it to the code related to the Bluetooth usage where that code forwards the request to server through attached hardware i-e Bluetooth. So like server client request has also got to go through Bluetooth code. Figure 36.0 makes the doubts clear as follows.

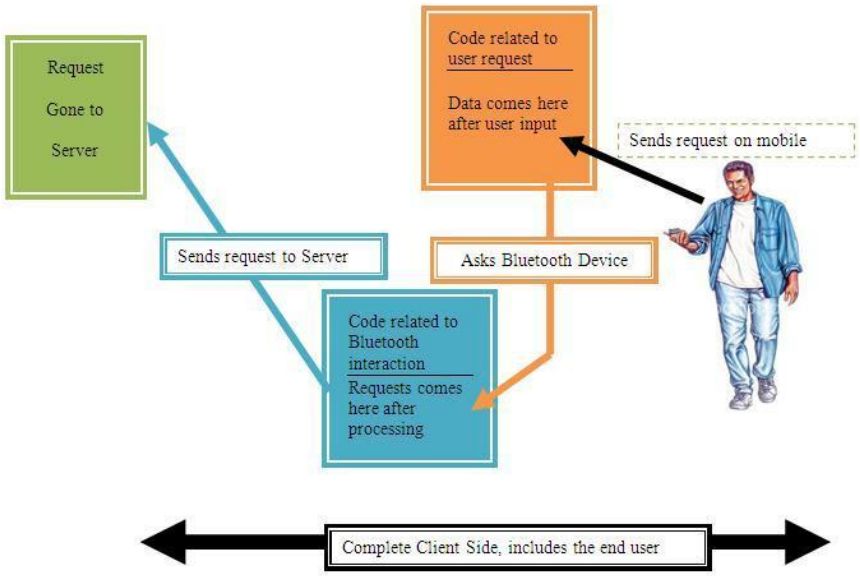


Figure 33 : Client Side

Client side use two main classes for the whole system usage and those are

- BlueControl.java
    - Implements Discovery Listener interface for using Bluetooth functionality
    - Implements Command Listener interface for using MIDP functionalities and getting events details.
    - Uses KeyPadListener class for events
    - Uses Bluetooth code
        - For Bluetooth device discovery
        - For Bluetooth connection establishment
        - For Bluetooth devices list managing
        - For Bluetooth Communication
        - For Bluetooth Connectivity
    - Multiple forms used in order differentiate which application should be selected.
- KeyPadListener

- Extends from Canvas in order to capture mobile keypad events
- Has got functionality to put in the graphics in midlet.
- Used by BlueControl.java for getting event type
    - Event could be button pressed
- Checks which form is selected in BlueControl.java

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