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## Bi-Directional Information Exchange with Computing Handheld Devices

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# Bi-Directional Information Exchange with Computing Handheld Devices

A Thesis

Submitted to the Graduate Faculty of the  
University of New Orleans  
in partial fulfillment of the  
requirements for the degree of

Masters of Science  
in  
The Department of Computer Science

by

Fady A. Qaddoura

B.S, University of New Orleans, 2004

May 2007

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This thesis is dedicated to my parents,  
my wife,  
Sajida,  
and my in-laws and family.

## **Acknowledgment**

I would like to thank my advisor Prof. Mahdi Abdelguerfi for the time and resources he provided to make this project come to life.

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## **Abstract**

### **Bi-Directional Information Exchange with Handheld Computing Devices**

The “Bi-Directional Information Exchange with Handheld Computing Devices” project introduces two new concepts: dynamic “digital receipts” and “personal data warehousing.” Dynamic digital receipts means digitalizing paper transactions generated from points of sale. Personal data warehousing means organizing and collecting data for later viewing and analysis.

The consumer will be able to use a handheld device such as a cell phone or PDA to receive and store a transaction in XML format. Later on, the user can upload the receipt through a web application to a personal data warehouse for storage or management of receipts. The web interface also allows users to export the receipts to money management software. The digital receipt is transferred from the point of sale to the handheld device using Bluetooth technology.

The implementation of the digital receipt concept will allow users to manage their receipts and store them neatly without restrictions on manipulating their own data.

# **Chapter 1 Introduction**

## **1.1 The Bi-Directional Exchange System Components**

The “Bi-Directional Information Exchange System” components consist of the following:

### **Hardware:**

- Bluetooth “antenna”
- Personal Digital Assistant (PDA)

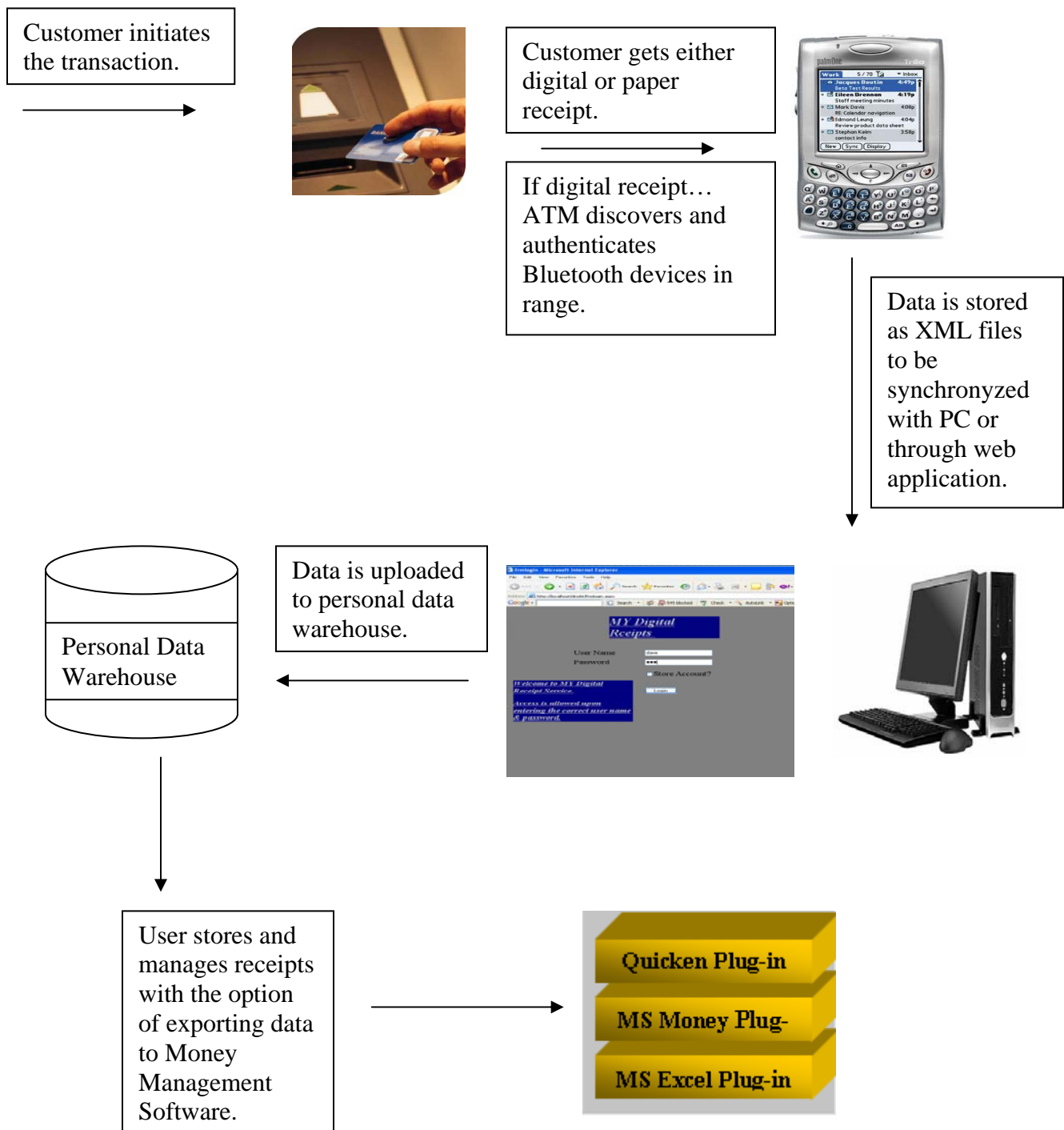
### **Software:**

- Bluetooth stack software
- “Virtual” point of sale
- Personal data warehouse
- Data base administrator web application
- Client web access application
- Client data export utility

### **Development Environment Tools:**

- Bluetooth Stack Software 2.0
- Oracle Enterprise 9i
- Microsoft Visual Studio .Net 2003
- ERWIN Data Modular

Figure 1.1: The Architecture of the Bi-Directional Information Exchange System



## 1.2 Motivation “Business Niche”

The components of the digital receipt project -- such as the Bluetooth technology, data warehouse, web applications, and handheld devices -- were technologies introduced in the past decade. However, none of these technologies were used together in introducing a digital receipt concept. The uniqueness of this project comes from the creativity of combining such technologies to ease the life of the consumer and benefit retail business owners. This section explains the advantages of using such technology and briefly compares the digital receipt system and the other technologies that have cropped up in the market.

### Why Using Mobile Devices

In his article “A Nation Locked in Its Cells,” Peter Leo<sup>1</sup> says, “Cell phone users in the United States have increased from 34 million a decade ago to more than 203 million, which comes very close to fulfilling the Supreme Court's one man-one cell phone mandate. World-wide, there are an estimated two billion cell phones. ... According to a 2004 MIT survey, the cell phone is the invention people hate the most but can't live without, beating out the alarm clock and the television. Maybe even the Ron Popeil Pocket Fisherman. In a 2005 University of Michigan study, 83 percent said cell phones have made life easier, choosing it over the Internet.”

In this project, there is no need to deploy new hardware technology or make any modification to the existing devices to participate in the digital receipt services provided by any vendor. Today Bluetooth software and hardware ships with almost every kind of handheld device.

According to Gartner<sup>2</sup>, “Annual sales of Bluetooth phones will top 140 million in 2005 and near 583 million in 2009, as Bluetooth becomes a standard part of new handsets in Western Europe and North America.”

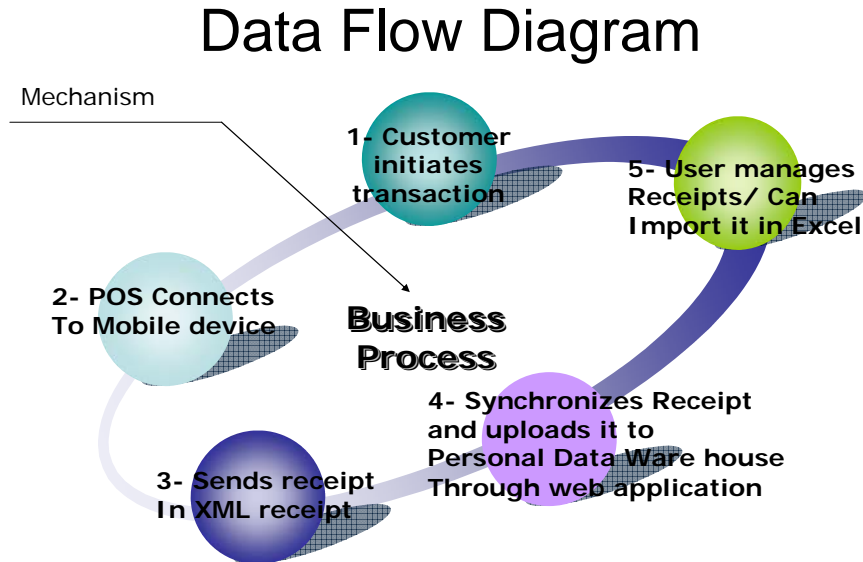
With that number of handheld devices in the United States and around the world, the coverage and the spread of such technology can be a real business opportunity for retail business owners, banks, grocery stores, airports, government agencies, and others.

### Advantages

The dynamic digital receipt project is more suitable for business than are other technologies in the market for these reasons:

- This principle can apply to individuals who want to look at their personal spending habits and trends.
- This new method eliminates the need for paper receipts by providing customers with receipts at the point of sale. Moreover, less time is required to complete the transaction.
- Personal data warehousing technology will enable vendors to provide all purchase information in a digital format that can be captured by a mobile computing device (PDA, cell phone, etc.) and then be shared with other software applications. This results in less paper and time to complete a transaction -- a more profitable move in the business world.
- This previously unavailable flow of digital data from vendors will allow consumers to track and use their personal purchase information in ways previously unavailable.
- With the information in a digital format, users will not have to retype the information into a financial software package.

Figure 1.2 shows the digital information flow from the point when the transaction is initiated until it is uploaded to the personal data warehouse.



*Digital information flow explained:*

The POS software will send the itemized purchase information to a new type of printer device, which will allow the receipt information to be transmitted to a portable computing device via Bluetooth. On the handheld device, the customer will capture the receipt information in digital format. She will then have itemized receipt information in a digital format that she can migrate into an existing desktop software application (like Quicken or MS Money) or into a personal data warehouse.



## *Why Using Personal Data Warehouse*

Personal data warehousing is very new and different -- possibly the only concept of its type currently under development. This presents an extraordinary market opportunity for any company to become the pioneer in this field. So what is data warehousing? According to "Course Technology"<sup>3</sup>, an online resource, "Data warehousing is a collection of data gathered and organized so that it can easily be analyzed, extracted, synthesized, and otherwise be used for the purposes of further understanding the data. It may be contrasted with data that is gathered to meet immediate business objectives such as order and payment transactions, although this data would also usually become part of a data warehouse."

Advantages of such technology include these:

- Improved end-user access to a wide variety of data with a high level of privacy
- Increased data consistency
- Lower computing costs
- A place to combine related data from separate sources
- Creation of a computing infrastructure that can support changes in computer systems and business structures
- Empowerment for end-users to perform any level of ad-hoc queries or reports without affecting the performance of the operational systems, giving them control to view their data based on criteria such as receipts with certain items, receipts from certain stores, or items per transaction

In addition, the personal data warehouse designed in this project is flexible enough for any receipt structure. In other words, the design of the data warehouse is independent of the number or types of items on the receipt. During the upload process of any receipt, the database tables are customized based on the store's profile and receipt structure.

### Why Using Bluetooth

Bluetooth has its place in today's business market, whether in printing servers, personal access networks, or file transfers between handheld devices and/or computers. Moreover, Bluetooth is in a variety of products that people use daily, such as phones, modems, headsets, and cars, and is acceptable for situations when two or more devices are near each other and do not require high bandwidth. It is most commonly used in transferring files or documents with cell phones to computers.

The advantages of using Bluetooth in this project include the following:

- Bluetooth requires no cables. End users can benefit from the digital receipt service independently of the type of device they own as long as it has the Bluetooth technology.
- Deploying a Bluetooth antenna in any POS or ATM is as easy as plugging a Bluetooth USB device into the USB slot, which is similar in size to the USB memory thumb drive.
- Communication of a Bluetooth device can go up to 720 kbits/s on 2.4 GHz frequency. A Bluetooth device will use 79 individual frequencies at random and jump from frequency to frequency 1,600 times a second. This communication happens automatically, making conflicts between two different devices very unlikely.
- Security can be ensured if the Bluetooth device is correctly configured.

- Bluetooth hardware and software cost less than \$100.

### Comparison between Digital Receipt System and Other Technologies

- ARTS System
- Neat Receipt Scanner

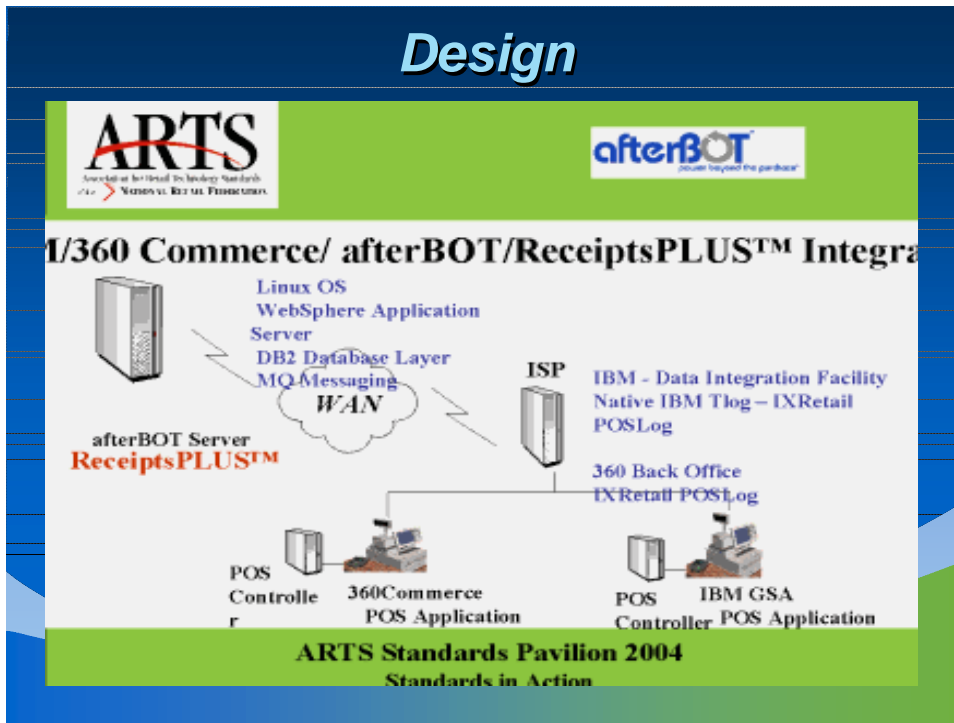
### ARTS System

On January 17, 2005, the Association for Retail Technology Standards (ARTS), a division of the National Retail Federation <sup>4</sup>, announced that it had completed the design phase for a digital receipt schema/digital receipt system. Among the ARTS members involved in the ARTS digital receipt system are IBM, Microsoft, HP, Infrared Data Association, etc. IBM was responsible for the design of the system database using DB2, 360 Commerce for the POS application, AfterBot for servers, and other vendors for the other parts of the system, as shown in figure 1.3.

The digital receipt system, as shown in figure 1.3, has not been implemented yet. However, the design is extremely complicated and expensive and will not be free to the regular consumer. The disadvantages of such a system are that it was designed not for customers to get their receipts on the fly digitally but for retail business owners to control consumers' financial data. Personal data access will be given to consumers at a certain charge.

Even if this system provides a digital receipt solution, the solution is not suitable for small to medium businesses or financially feasible for consumers to participate in. The advantage of the proposed system, however, is that customers have control over their personal data and freedom to manage and store their receipts.

Figure 1.3 ARTS System



### Neat Receipt Scanlizer

Figure 1.4: Taken from <http://www.neatreceipts.com><sub>5</sub>



Net Receipts Scanlizer, founded in 2002<sub>6</sub>, has invented a scanner that reads paper receipts and converts them into a digital format capable of being exported to other software applications.

However, this scanner has limitations and does not provide practical solutions to the following issues:

1. Providing an enterprise solution for businesses to assist a company in getting real-time financial spending data from its remote employees.
2. Allowing the customer to store and manage receipts based on which store the receipts came from.
3. Eliminating expensive hardware and software, which not all handheld devices' users can afford to purchase.
4. Eliminating high maintenance needed to ensure high-quality scanning resolution.
5. Avoiding the problem of carrying the equipment to scan the receipt on the spot.

This is tedious for these reasons:

- A waiting time is required until Internet access is available to send the receipt to the company.
- A person at the company has to download the receipt, import it in the scanner's software, and sort it based on the type of receipt.

For a company or retail business with hundreds of employees around the globe, this process is virtually impossible, especially considering the amount of human interaction required by remote employees just to track a company's financial spending.

Here are more advantages of the digital receipt system over the scanner:

- The system provides a faster rate of receipt uploads, while the scanner can scan approximately three to four receipts per minute.
- Users do not need any hardware besides their handheld device, while the Neat Scanner requires the scanner, a laptop with USB 1.1 and 2.0 Interface, a USB cable, and more.
- The system does not have limitations on the size of the receipt uploaded, while the Neat Scanner can scan paper receipts with the scan area 1" x 1" to 8.5" x 11".

### **1.3 Overview**

This technology and accompanying business model envisions the creation of a new way for individuals to retrieve and manage their personal information. The product concept enables the digital exchange of information to and from handheld computing devices in targeted markets that provide useful information to consumers in a paper-only format.

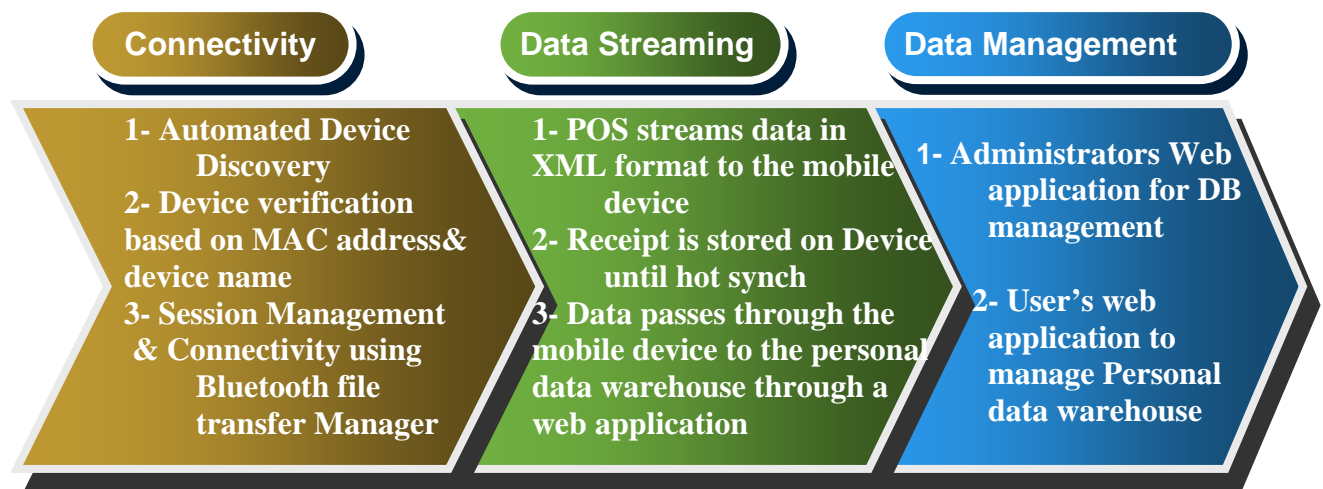
This newly-created mechanism will allow individuals to receive formerly printed data (boarding passes, sales receipts, event tickets, etc.) in a digital format. This will require the development of digital printing hardware for vendors and mobile computing software for consumers' handheld devices.

## Chapter 2 Architecture and Design

### 2.1 Architecture Explained

Individuals typically spend more time and effort maintaining and manipulating paper-based transactions to make them of any use. Digitalizing paper-based transactions brings a financial value to the consumers and business owners because of less time required for storing, interpreting, and managing receipts. Digital receipts require less storage space and less time to extract data and are easier to maintain for future referencing. The architecture is explained below.

Figure 2.1 Explanation of Digital Receipt Architecture

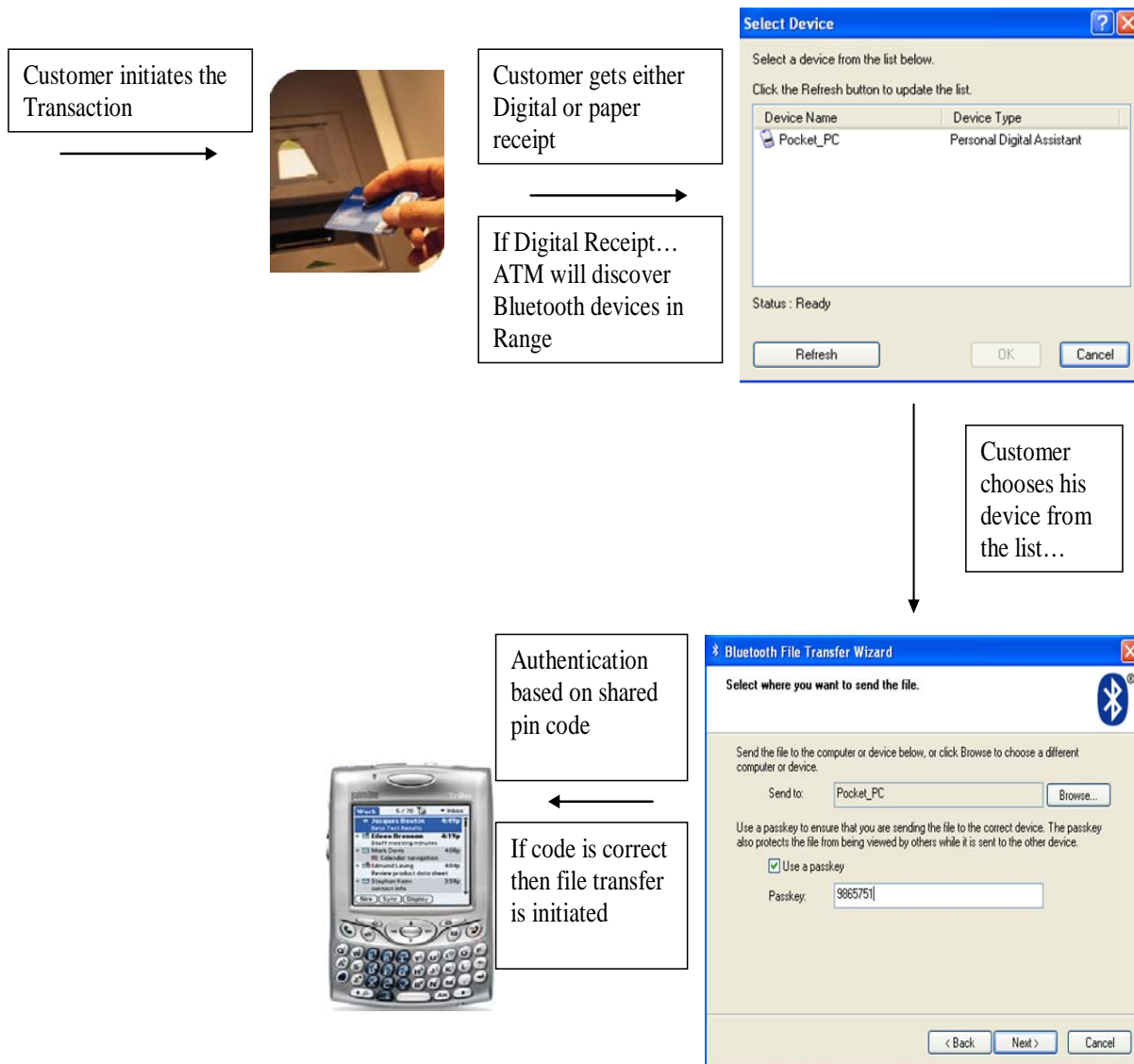


The Digital Receipt System architecture is divided into three major components:

Part I – Connectivity Framework –

1. A framework for the system, which includes these:
  - a. Automated device discovery and device verification
  - b. Session management and connectivity

Figure 2.2 Device Discovery and Session Management



## Part II – Data Streaming –

1. Streaming of data and receiving it by the mobile device:
  - a. The point of sale or ATM streams data in XML format to the mobile device.
  - b. The data passes through the mobile device to the personal data warehouse through a web application. If there is no connection, the receipt will be cached.
2. Data is stored in the personal data warehouse.



### Part III – Data Management –

1. The import utility imports data from the local machine and uploads it to the personal data warehouse.
2. Since the structure of the data is generic, it can be exported to different applications such as Microsoft Excel.
3. A detailed view gives the user the option to view the receipt based on criteria such as issuing store, receipt date, and receipt number.

## 2.2 Bluetooth Technology Overview

Bluetooth provides a way to connect and exchange information between devices like cell phones, laptops, printers, personal digital assistants (PDA's), headsets, Voice over IP (VOIP), and many other devices. Bluetooth, or IEEE 802.15.1, is an industrial specification for wireless personal area networks (PAN's).

According to Wikipedia <sup>(7)</sup>, a free online encyclopedia, “Bluetooth is a radio standard and communications protocol primarily designed for low power consumption, with a short range (power class dependent: 1 meter, 10 meters, 100 meters) based around low-cost transceiver microchips in each device. Bluetooth lets these devices communicate with each other when they are in range. The devices use a radio communications system, so they do not have to be in line of sight of each other, and can even be in other rooms, so long as the received power is high enough.”

The communication or connection relationship between any two or more Bluetooth devices can be described as a master/slave relationship. When a Bluetooth device wants to inquire, communicate, or pair with other devices, the slave device must transmit information about itself to the master device, such as its device name, class, list of services available, device features, manufacturer, and other information. A Bluetooth master can communicate with up to seven devices interchangeably in an ad hoc network format or in a round robin pattern. The Bluetooth network is named a “PICONET,” and two or more “PICO Nets” can connect to form a “SCATTERNET.”

The development tools for the Bluetooth applications vary from one development environment to another. WIDCOMM Corporation offers different Bluetooth development kits for developers based on the type of application to be developed. PDA's, mobile phones, Bluetooth embedded systems, and PC's Bluetooth applications are all developed using specialized development kits.

## **2.3 Bluetooth Software and Hardware Used**

Many Bluetooth packages are available for different platforms by different vendors. The Bluetooth package used in the Digital Receipt System is the BCM1000-BTW package from WIDCOMM. This package, easily integrated with any device, is designed to operate on any computer with a Windows operating system. Moreover, BCM1000-BTW supports most Microsoft Windows operating systems from Windows 98SE to XP Professional x64 Edition.

The BCM1000-BTW package includes the following:

1. A thumb-sized Bluetooth USB adapter
2. Device driver
3. Integrated user interface:
  - My Bluetooth Places
  - A shell namespace extension application similar to Network Neighborhood
  - Bluetooth Tray, a system tray utility
  - Bluetooth Security Manager, which configures the access and discovery permissions to the Bluetooth device
  - Server Spy Lite utility, which ships with the Bluetooth package and gives the user an option to trace and log messages -- very useful during debugging -- from the WIDCOMM Bluetooth Stack protocols such as HCI, RFCOMM, L2CAP, OBEX, TCS, and SDP
  - Bluetooth control panel, or configuration panel, a control panel application

- Bluetooth printer sink function, which allows the PC to function as a printer server
  - Integration of Bluetooth functions for Microsoft Office applications
4. A documentation package with the installation and configuration instructions
  5. A protocol stack that includes the following:
    - Bluetooth communication protocols and utilities.
    - The specifications of the Bluetooth applications included in the Bluetooth software package.
    - A special development kit that provides the programmer with the suitable API's.

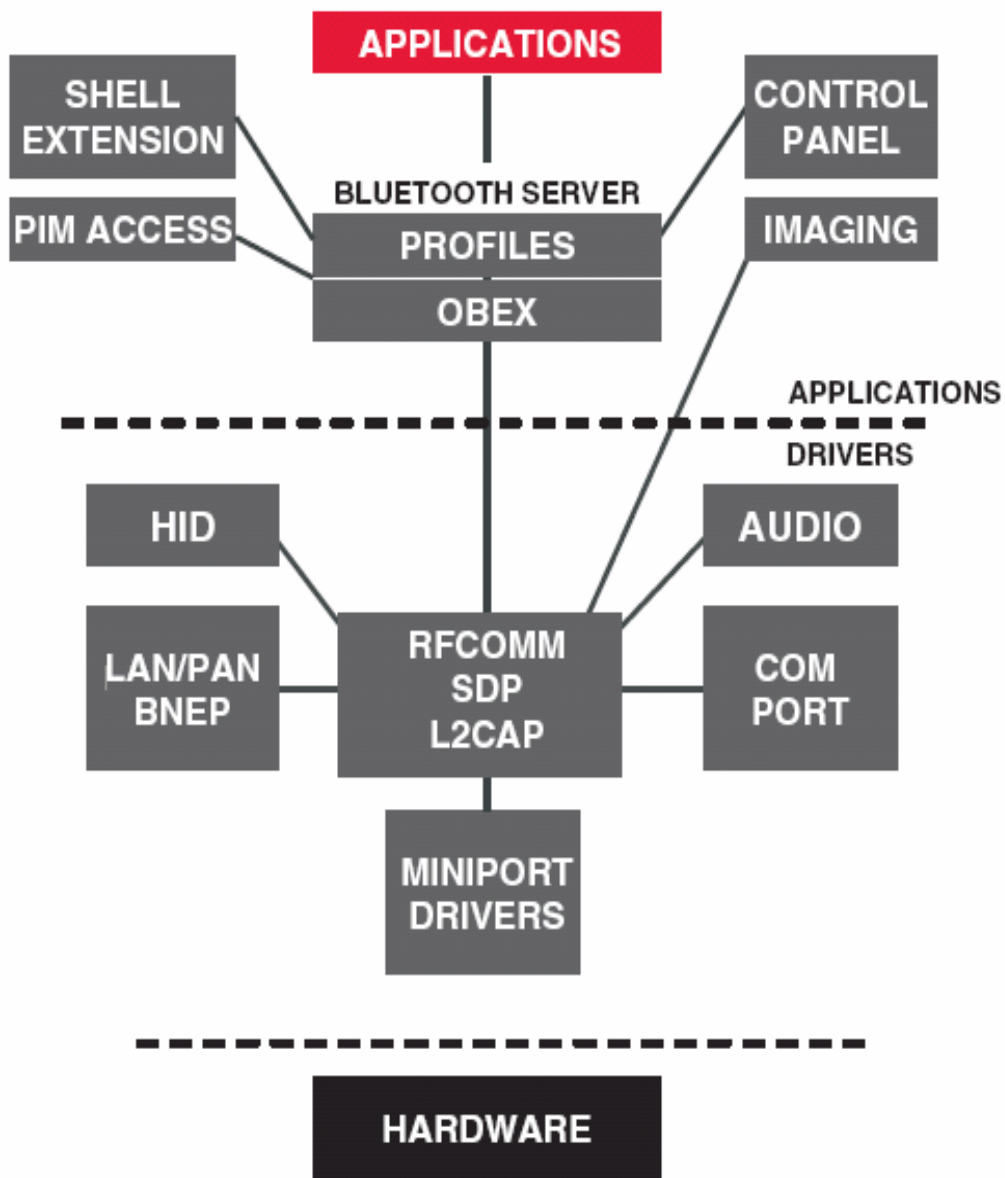
For the digital receipt system, Microsoft Visual Studio 2003 with C# .NET programming language was used to develop an intermediate application to run on top of the protocol stack.

6. The Bluetooth File Transfer Manager, which controls the transfer process of files between the POS and the mobile device. The file transfer procedure between the POS and the mobile device is more sophisticated than the regular file transfer procedure offered by the Bluetooth file transfer wizard.

## 2.4 Bluetooth Software Stack and Applications

According to the documentation shipped with the Bluetooth package, the Bluetooth stack consists of device drivers and Bluetooth applications or utilities. Figure 2.3 presents the general view of the Bluetooth stack.

Figure 2.3 BCM1000-BTW Protocol Stack Overview Taken from WIDCOMM<sup>(8)</sup>.



## **Protocol Stack Components:**

- Logical Link Control and Adaptation Protocol (L2CAP)
- RF Communications Protocol (RFCOMM)
- Service Discovery Protocol (SDP)
- Telephony Control Specification (TCS)
- Object Exchange Protocol (OBEX)
- Serial Port Profile (SPP)
- Generic Access Profile (GAP)
- Bluetooth Management Entity (BTM)
- Headset Profile (HSP)
- Synchronization Profile (SYNC/IrMC)
- Dial-up Networking Profile (DUN)
- Fax Profile (FAX)
- Service Discovery Application Profile (SDAP)
- Generic Object Exchange Profile (GOEP)
- Object Push Profile (OPP)
- File Transfer Profile (FTP)
- LAN Access Profile (LAP/PPP)
- Cordless Telephony Profile (CTP)
- Intercop Profile (ICP)

## 2.5 Bluetooth Security

With each new technology introduced to the market, new security threats follow. Users need to be aware of the security threats, bugs, or disadvantages of using a digital device to protect sensitive data and keep the device from being hacked. Many business professionals carry Bluetooth-enabled PDA's and mobile phones with a visible discovery mode and unsecured data access permissions. When the discovery mode is set to "visible," any other enabled Bluetooth device in range can see this device.

Moreover, PDA's and mobile phones have a Bluetooth Tray Security Manager that controls and manages Bluetooth security. It determines what devices can access a PC and what they can do once they have access. In addition, it gives the option for encrypting transmitted data that the receiver can only decrypt if it has the same PIN code that the data was encrypted with -- an authentication mechanism that makes it very difficult for the eavesdropper to capture transmitted data.

WIDCOMM Bluetooth offers the following:

1. A pairing and bonding option that allows the establishment of a trust relationship between devices based on the device name and address
2. Service-level security that allows manual start and stop of the Bluetooth services
3. Bluetooth security that is enforced through an encryption option for transmitted data.
4. Authentication and access authorization features that can be accessed through the Bluetooth configuration panel

It is also important to be aware of possible attacks and threats a Bluetooth device can experience.

According to **F-Secure** (formerly Data Fellows) <sup>9</sup>, an anti-virus and computer security software company based in Helsinki, Finland, researchers performed hundreds of Bluetooth security-related experiments in real-life environments and discovered major threats associated with the use of a Bluetooth-enabled device. In F-Secure's article "Going Around with Bluetooth in Full Safety" <sup>(10)</sup>, published in 2006, Bluetooth devices encounter four major attacks. Below is a list from this article of the most common threats associated with Bluetooth:

- **BlueSnarf:** This type of attack bases itself on the OBEX push service, which is commonly used to exchange electronic business cards. Easy to set in place when a cellular has Bluetooth set on visible mode, BlueSnarf allows a user to connect to a cellular phone and access the phone book and agenda without authorization.

- **Bluejacking:** Taking advantage of the ID's that devices exchange at the beginning of a connection, an intruder can send short, deceitful text messages during that time. A user could be invited to dial a code to solve network problems and unconsciously authorize an aggressor to acquire all the necessary privileges to access a phone book, agenda, or file and potentially compromise information and data residing on the device.

- **BlueBug:** This vulnerability allows access to the cellular phone's *AT Commands*, a set of commands that gives instructions to the phone, allowing an intruder to use phone services without the user's knowledge. These services include incoming and outgoing calls, sent, received, or deleted SMS messages, and many more intrusive operations as well as possible modifications to the device's configuration parameters.

- **BlueBump:** This type of attack takes advantage of the vulnerability linked with the Bluetooth connection type that is always active, possibly giving unauthorized cellular phones continued access if they are still part of the list of authorized phones. Besides leading to the theft of data on the cellular phone, this attack can allow aggressors to use WAP services without the owner's knowledge.

## Chapter 3 System Catalog

A system catalog consists of sets of tables that are created and maintained for different databases. These tables contain information about the definitions of the database objects, such as views, security information, and users' privileges to access these objects.

### 3.1 System Catalog Tables

The system catalog proposed in this thesis comprises five database tables. The tables in the system catalog are listed in Table 3.1 below:

Table 3.1 System Catalog Tables

Table Name
TB_USER
TB_STORE
TB_USER_STORE
TB_ADMINISTRATORS
TB_STORE_RECEIPTS
TB_HISTORY
TB_SERVICES

These are the main tables in the system catalog:

**TB\_ADMINISTRATORS:** This table lists the names of the database administrators who have access to all the database tables. Administrators can have different views and access privileges, which are set by the top-level administrator through oracle enterprise management console.



**TB\_USER:** This table has the user's accounts, which contain data such as the first name, last name, user login name, and password. The user status determines whether the user is active or inactive; these values are stored in the "TB\_USER\_STORE.UserInactive," a table that defines which stores a user can access.

**TBSTORE:** This table is used whenever a new business, corporation, or enterprise subscribes to benefit from the digital receipt service.

**TB\_STORE\_RECEIPTS:** This table maintains a list of the stores that have a fixed receipt structure so that if a user uploads a new receipt structure for that specific store, the structure will be updated.

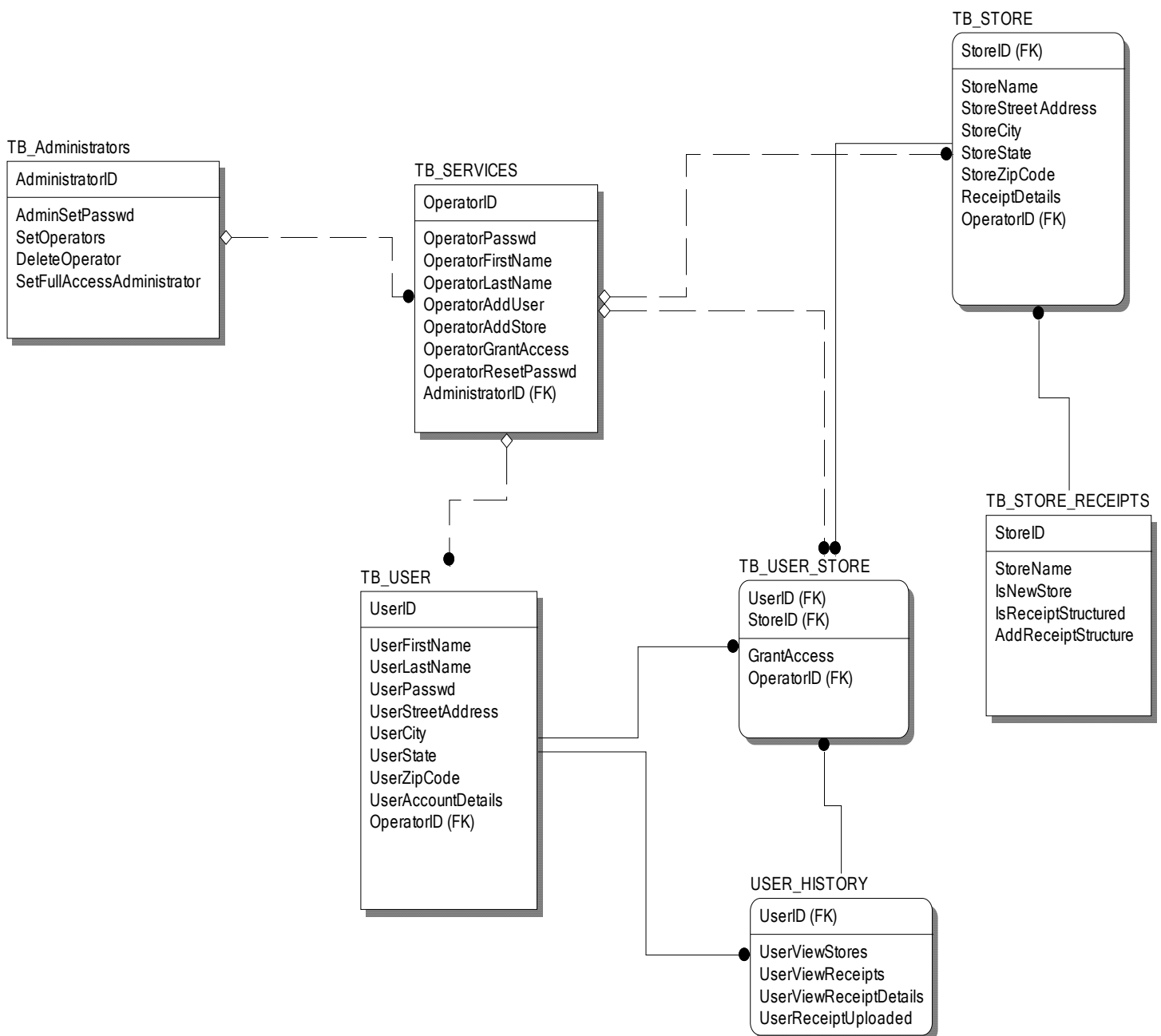
**TB\_SERVICES:** This table gives an operator the functionality to insert, update, or delete users' or stores' related data. An operator interacts with a web interface to perform the action, but only the administrator is allowed to interact with the database.

**TB\_HISTORY:** This table stores the history of the stores that the user visited, including the receipts and their details.

## 3.2 System Catalog E/R Diagram

With AllFusion ERwin Data Modeler Software, a product of Computer Associates Inc., data structures can be visualized as entity relationship diagrams that make it easier to organize and manage data, database technologies, and the deployment environment. Data in the system catalog are logically separated because the database is divided based on user schemas and participating stores' own users and receipt structures.

Figure 3.1 System Catalog Entity Relationship Diagram



In figure 3.1, there are a few things to mention:

1. A dashed line represents a non-identifying relationship between two entities, with the child entity not identified through its association with a parent entity. In other words, the child entity does not depend on the parent entity for its identity. In a non-identifying relationship, one instance of the parent entity is related to multiple instances of the child.
2. A solid line means an identifying relationship between two entities in which a child entity is identified through its association with a parent entity. In other words, the child entity depends on the parent entity for its identity. In an identifying relationship, one instance of the parent entity is related to multiple instances of the child.

Example: For a user to have access to a collection of receipts from a certain store, the user first has to exist in the table TB\_USER, and the store in the table TB\_STORE. If users or stores are added to the TB\_USER or TB\_STORE tables respectively, they will be added to the TB\_USER\_STORE table automatically, though pending an operator's approval to grant access to the user to view the receipts of certain stores.

While not all users will participate in all stores registered for the digital receipt service, it is unwise to grant access for all users to view every available store offering the digital receipt service. Some enterprises, such as government agencies, may offer the digital receipt service only for their employees to track their job-related spending; therefore, it is important to maintain the privacy of the participating enterprises.

## **Chapter 4 Bluetooth File Transfer Manager**

Every Bluetooth software ships with different utilities to assist the user in performing simple tasks such as exchanging or copying small files and transferring objects over a short range. Bluetooth file transfer is optimal when no network is available. The utility responsible for the file transfer between Bluetooth devices is the Object Exchange Utility (OBEX). However, for the purpose of the digital receipt system, the OBEX had to be modified to automate the exchange process between the POS and the handheld device.

### **4.1 Bluetooth File Transfer**

As in the diagram in figure 1.2, once the customer chooses to receive the receipt in a digital format, the Bluetooth Software integrated in the POS will initiate an automated device service discovery within the given range. Once the service discovery is done, the modified “Bluetooth Send Utility,” developed specifically for the digital receipt system, will start an automated process to send the specified receipt from the POS to the PDA in XML format. The user will receive the receipt under “My Documents” in the PDA file structure.

Whether one uses the Bluetooth file transfer application shipped with any Bluetooth software or the digital receipt automated Bluetooth file transfer developed for the digital receipt system, initial system configuration setup steps are required to ensure the functionality and the security of the Bluetooth file transfer. The setup includes several stages, such as discovering, pairing, and communicating with other devices.

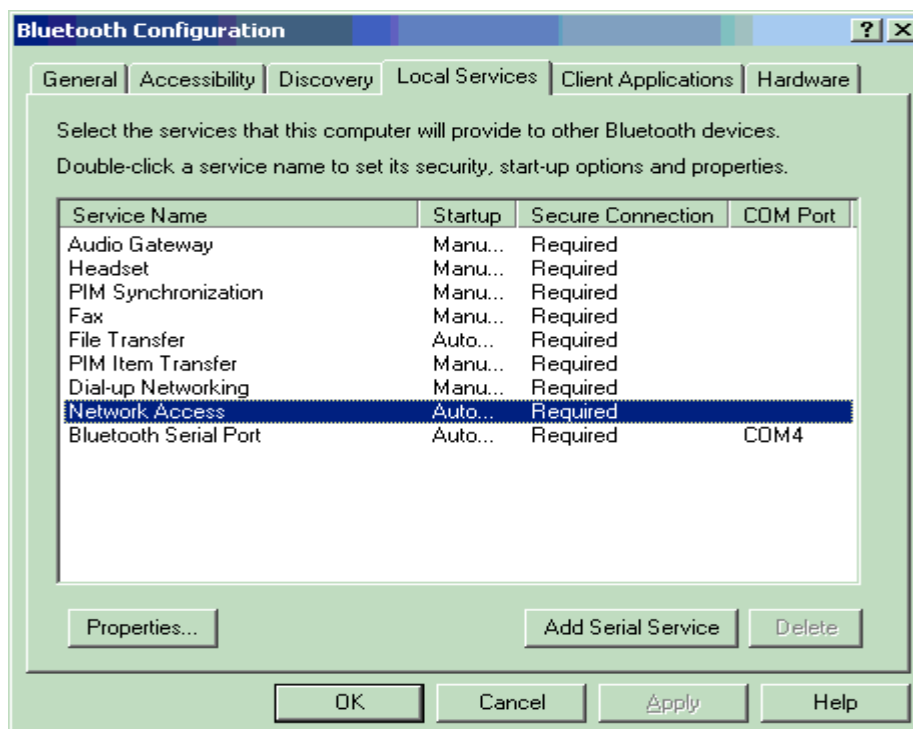
## Bluetooth Initial Setup

To use any Bluetooth device with a Windows XP operating system, the Bluetooth software has to be installed on the Windows PC. Using a Bluetooth wizard, one can add Bluetooth-enabled devices to the computer. Once the Bluetooth USB antenna is connected to the computer and the drivers are installed, a few steps are required to configure the Bluetooth software to ensure communication availability and security. A Bluetooth configuration utility, which is shipped with all Bluetooth software, enables the user to perform the initial setup, as shown in figures 4.1.1 and 4.1.2

Figure 4.1.1 Bluetooth Configuration Utility at the System Tray

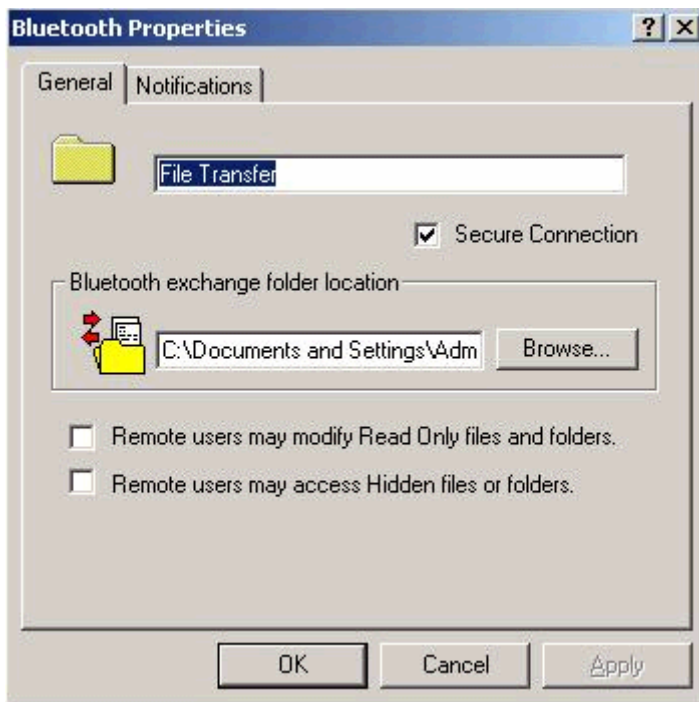


Figure 4.1.2 Bluetooth Configuration Utility



For any Bluetooth device to communicate with a Windows XP PC with Bluetooth radio antenna, ports have to be set up correctly to allow incoming and outgoing communication. The incoming port receives a connection from a Bluetooth device, while an outgoing port makes the connection. COM ports have to be configured manually in some programs that use Bluetooth communication, such as Bluetooth Sync, to match the Bluetooth COM ports configured on the Bluetooth device. Also, in the properties under the Bluetooth configuration utility, file transfer can be set to a secure communication, and the file transfer destination can be specified and set to hidden for remote users, making transfer more secure.

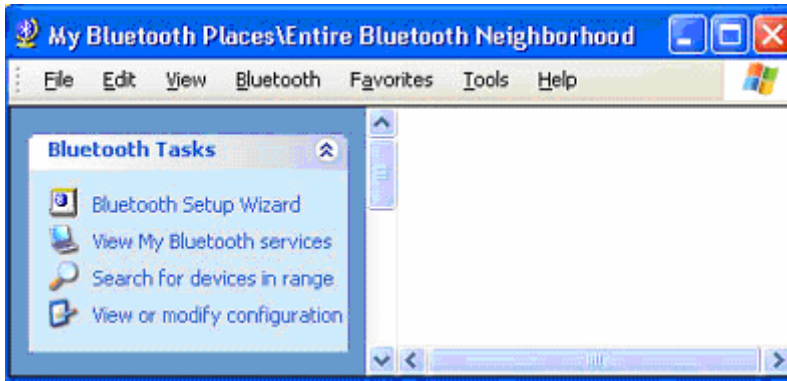
Figure 4.2 File Transfer Folders



## Discovery

Any Bluetooth device connected to this computer will be listed under "My Bluetooth Places." If there are no devices connected or paired, the entire Bluetooth neighborhood will be empty.

*Figure 4.3 Discovered Devices Screen*



## Pairing

When two devices pair, they both maintain a profile or history of the other device for future reference. In other words, pairing is best described as establishing a trust relationship between two or more devices.

## Communicating

Bluetooth software offers different communication services on a PC or a PDA, as shown in figures 4.4.1 and 4.4.2.

Figure 4.4.1 Services Offered by the Bluetooth Software Installed on the PC



Figure 4.4.2 Services Offered by the Bluetooth Software Installed on the PDA





## 4.2 Digital Receipt Automated Bluetooth File Transfer Manager

The Bluetooth file transfer that comes with the Bluetooth software is not 100 percent suitable for ensuring the flow of the business process of the digital receipt system. More enhancements had to be done for the receipt transfer process to be automated. The enhancements were in two parts:

- **The automated device discovery:** Once the customer chooses to receive a digital receipt by pressing the digital receipt option on the ATM or POS, the digital receipt system will initiate a discovery process, listing the available devices in range. The customer can then choose his device based on its name and type. This process is different from the device discovery utility shipped with the Bluetooth software, which requires users to search manually for devices in range by going to the “Wireless Manager > Bluetooth > Services > Discover Devices.”

Moreover, for security purposes, the Bluetooth device on the POS or ATM is set to “un-discoverable.” An option exists under the “Discovery” tab in the Bluetooth configuration utility for other devices to discover this device or not.

- **The automated file transfer process:** To transfer a file between two devices, the user must search for the file to be transferred, right click on it, choose "send to," then specify which device the receipt is going to. However, in the digital receipt system, once the customer chooses the digital receipt option, the discovery and file transfer process are done back-to-back automatically.

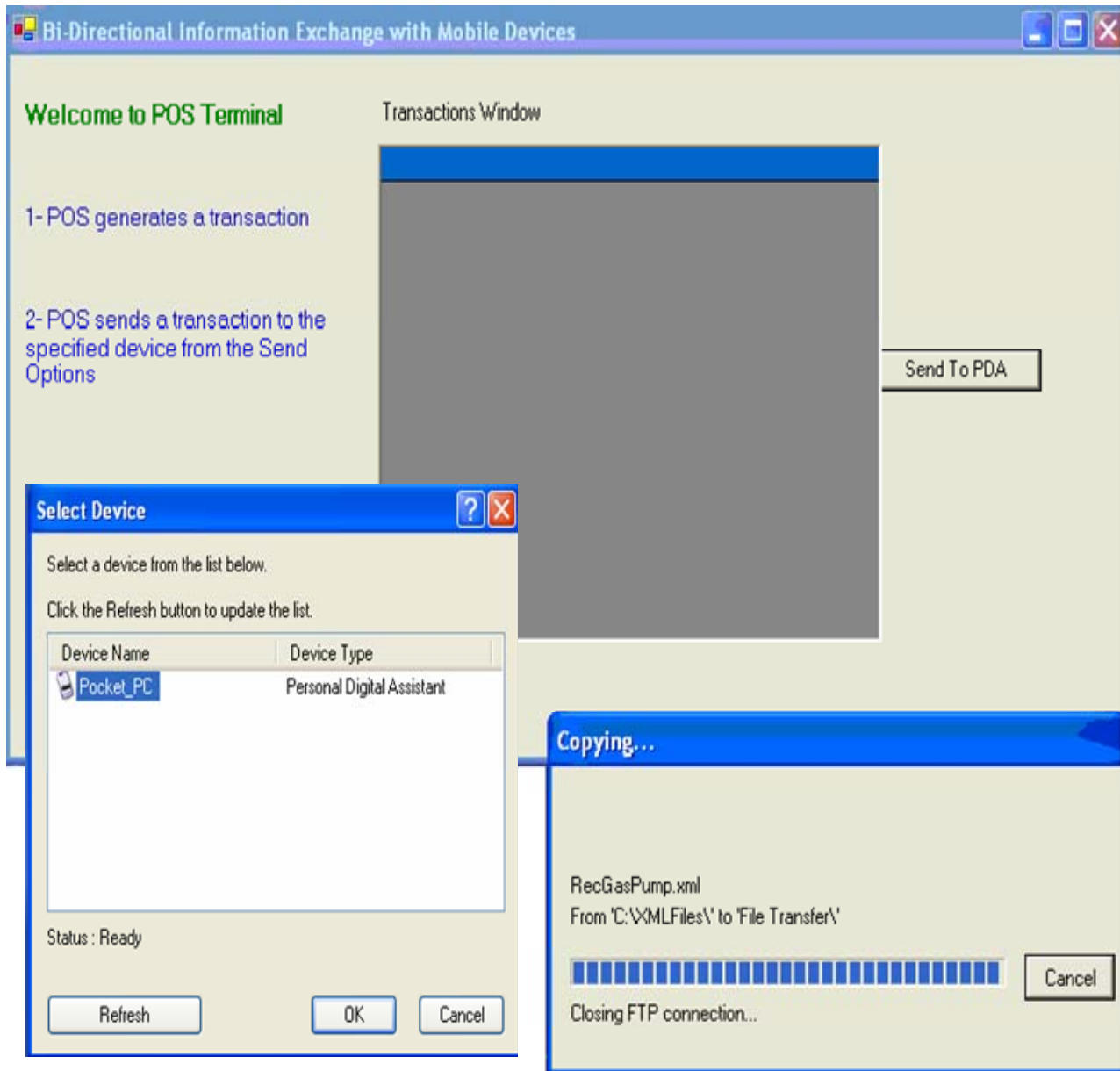
For security purposes, the “Digital Receipt Bluetooth File Transfer Utility” will prompt the user to choose any PIN code and enter it on the POS or ATM machine before the file transfer is started. Once the PIN code is entered, the user will be prompted to enter the same code on the PDA or any other device receiving the receipt. If the PIN code does not match, the file transfer will not be initiated. This protects the user from committing errors like sending receipts to an unauthorized device. The next section will explain the coding part, which is unique and different from the regular Bluetooth file transfer code.

### **4.3 Design and Implementation**

The method below is part of the digital receipt Bluetooth file transfer application running on the POS or ATM with the Windows operating system. The device discovery protocol in any Bluetooth software discovers devices based on their unique Machine Access Code (MAC) address. By using the machine address “00:00:00:00:00:00” -- if no other machines had such a MAC address -- the Bluetooth device discovery protocol would initiate the search process for this address and/or any other addresses in range. This allows the customer to discover her device without having to go through a series of manual steps as described in section 4.2.

The second unique attribute of this process is automating and controlling the file transfer process by developing a Windows XP-based tool called “bt\_sendto\_explorer.exe,” which consists of Windows commands. Combined, those commands automatically find the intended receipt and send the receipt to the intended device that the user has chosen previously from the available devices list in the previous step.

Figure 4.5 Developed Automated Bluetooth File Transfer



## **Chapter 5 Web Administration Portal**

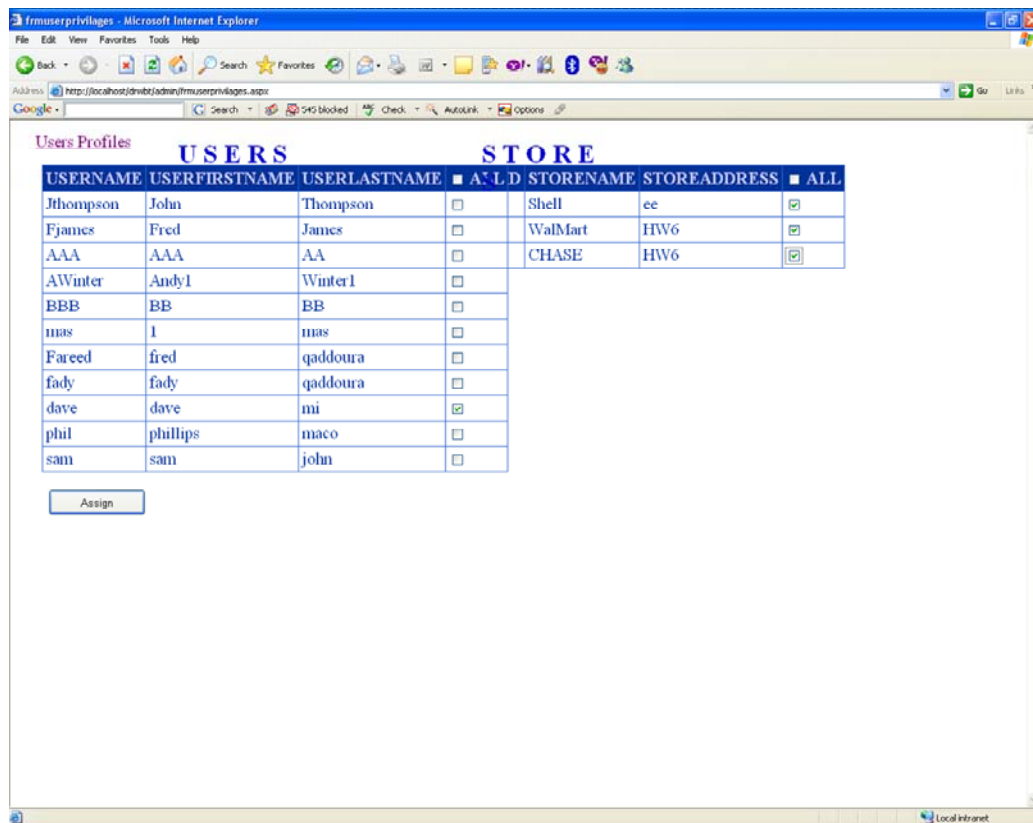
The web administration portal is responsible for providing access to the authorized database administrators. This portal provides services such as assigning operators or other administrators to maintain the database, adding stores or users who are interested in the digital receipt service, and assigning user access privileges to decide which store this customer can have access to.

### **5.1 Access Privileges and Functionality**

The digital receipt concept is designed to serve not only a specific business model but government agencies, large enterprises, airports, and many others who use paper-based transactions. Based on the enterprise providing the digital receipt service, user access privileges, privacy, and transaction history must maintain a certain level of privacy.

To achieve privacy during the digital receipt system phases, the database administrator assigns user privileges to allow enterprises listed as authorized to participate in the digital receipt service. This level of privacy is not provided by paper-based transactions; however, with the digital receipt system, the database administrator can determine the user access privileges.

Figure 5.1 Administrator's View for "User Access Privileges"



Once a new user or enterprise joins the digital receipt system, the name of the user or the enterprise will be added automatically to the TB\_USER\_STORE, pending an administrator's interaction. The administrator can add all new users and services at once by checking a box that will identify new users and enterprises. Once the administrator assigns which stores a user can access, the user will not be able to access or use the service provided by other enterprises not assigned to that user. Moreover, the administrator will be able to assign many stores to one user or many users to one store at once.

## 5.2 Design and Implementation

Any users or enterprises who are interested in the digital receipt system have to fill out a registration form or request to be eligible to participate in the service. After the request or registration application is submitted, an administrator's interaction is required. Below is the "Database Administrator Interaction Manager" web page, which allows the operator or the administrator to perform the functions listed in the introduction of this chapter. The super administrator's user name is set to "system" and the password is set to "password."

Figure 5.2 Database Administrator Interaction Manager Login Page

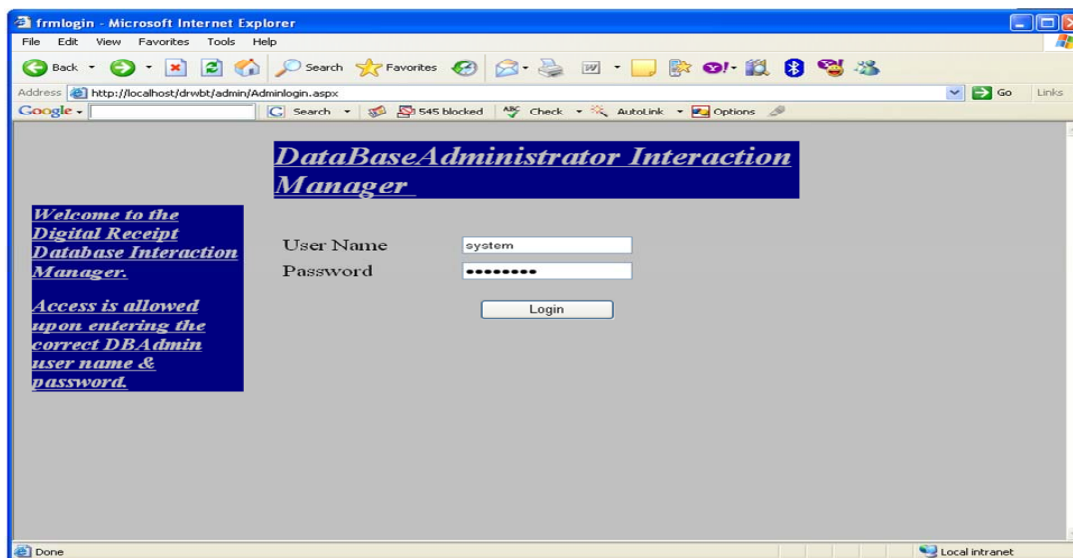


Figure 5.3 Database Administrator's Options to View, Edit, or Add Users and Stores

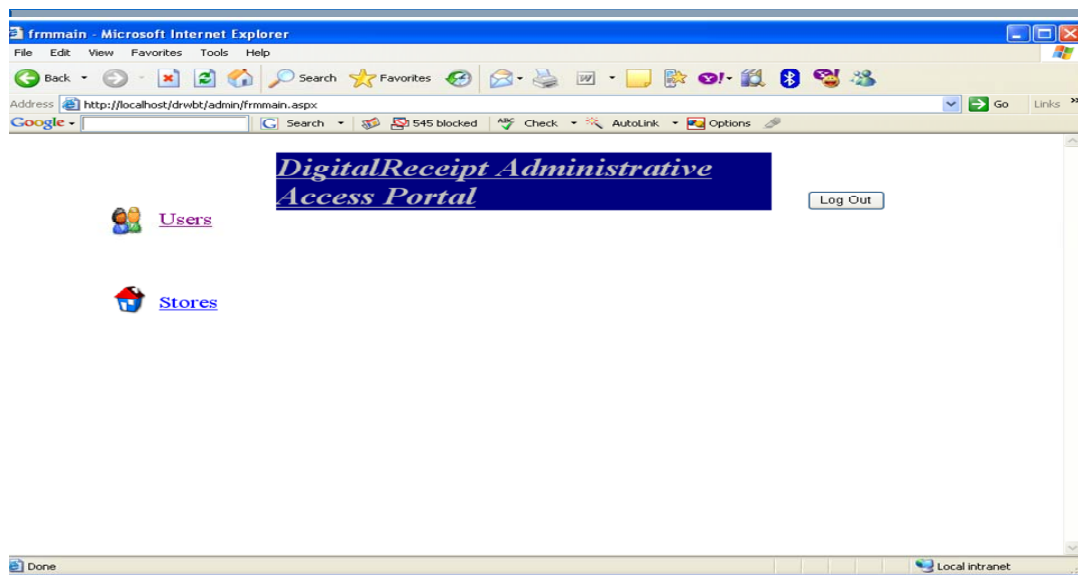
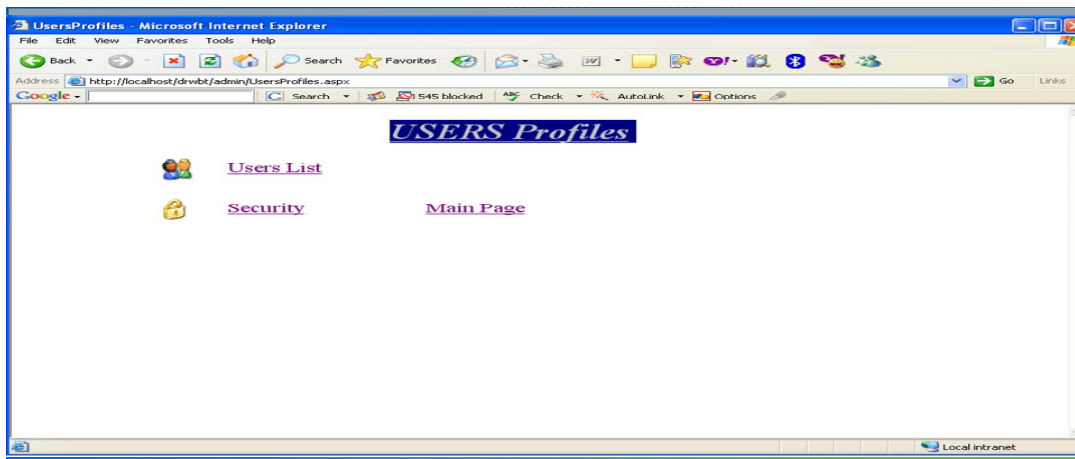


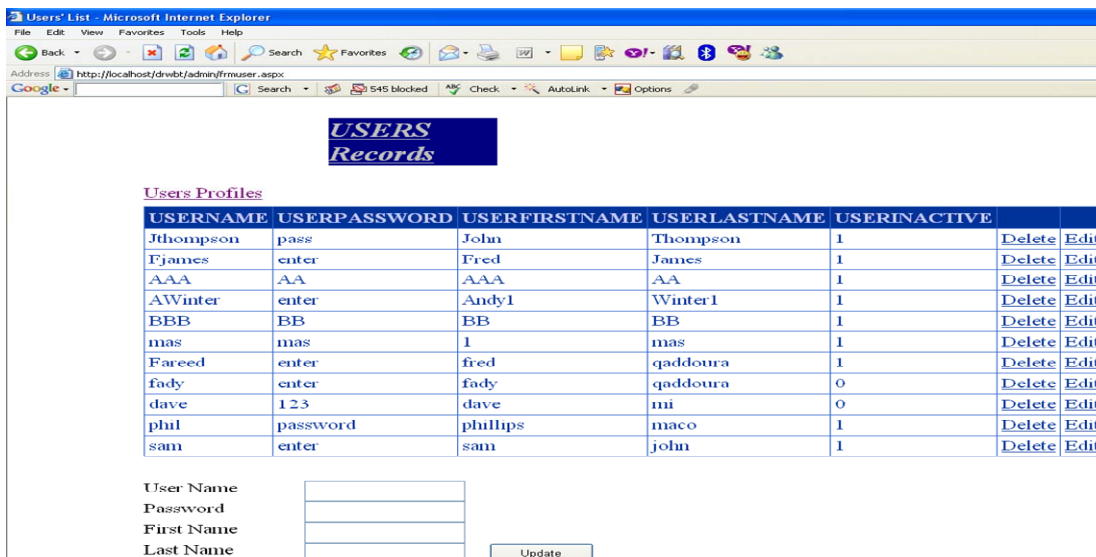
Figure 5.3.1 Database Administrator's Options to View, Edit, or Add Users.



The security option is provided to the administrator to activate/deactivate a user. Thus, if the user decides to stop participating in this service or freezes his account, the database administrator will be able to keep the account and the user's profile stored in the database. However, the user will not be able to use the digital receipt service. Code “1” in the USERACTIVE column means the user is active; a zero (“0”) means the user is inactive.

The “Users' List” option on the USERS profiles page is used to add or edit users’ profiles manually. As shown in figure 5.3.2, the administrator also has the option to delete a user’s profile or edit the settings.

Figure 5.3.2 Database Administrator's USERS Records Web Page



The administrator also has a view of stores' profiles to manage stores participating in this service. Under the stores' profiles service, the administrator will be directed to the "STORES' Records" page to add, edit, deactivate, or delete a store from the digital receipt system, as shown in figures 5.3.3 and 5.3.4 respectively. This table saves stores' profiles, such as the store's ID, name and password, address, city, state, and zip code.

Figure 5.3.3 Database Administrator's Stores Option

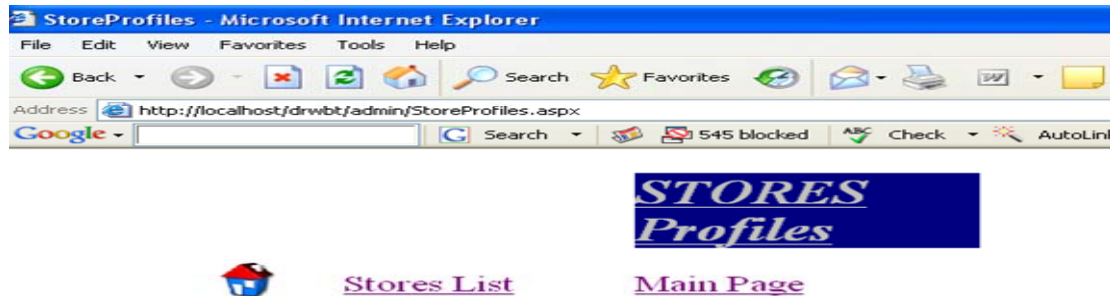


Figure 5.3.4 Database Administrator's STORES Records View

STOREID	STORENAME	STOREADDRESS	STORESTATE	STORECITY	STOREZIPCODE	STORELOGIN	STOREPASSWORD		
2	Shell	ee	ww	bb	qq	dd	ff	Delete	Edit
3	WalMart	HW6	TX	Houston	77083	sWalmart	pass	Delete	Edit
4	CHASE	HW6	TX	Houston	77083	sATM	pass	Delete	Edit

Store ID   
Store Name   
Login   
Password   
Address   
City

State   
Zip Code



### **5.3 Session Management**

Users' sessions and the login information are maintained and recorded in the database for auditing and security purposes. The auditing is done by inserting the user login information in the TB\_HISTORY table. A history of the user activities, such as user session events when a user is terminating or invalidating the session by closing the browser or logging out of the system, is also maintained in the same table. If the user stays logged onto the web application but remains idle, the session will time out after 15 minutes of inactivity. However, this can be customized based on the type of business the digital receipt system uses.

## **Chapter 6 Clients' Web Portal**

The clients' web portal is responsible for providing access to the authorized database user, who is registered and authorized to participate in the digital receipt service. This web portal provides services such as uploading receipts, viewing statements, viewing receipt details, and exporting data to different applications.

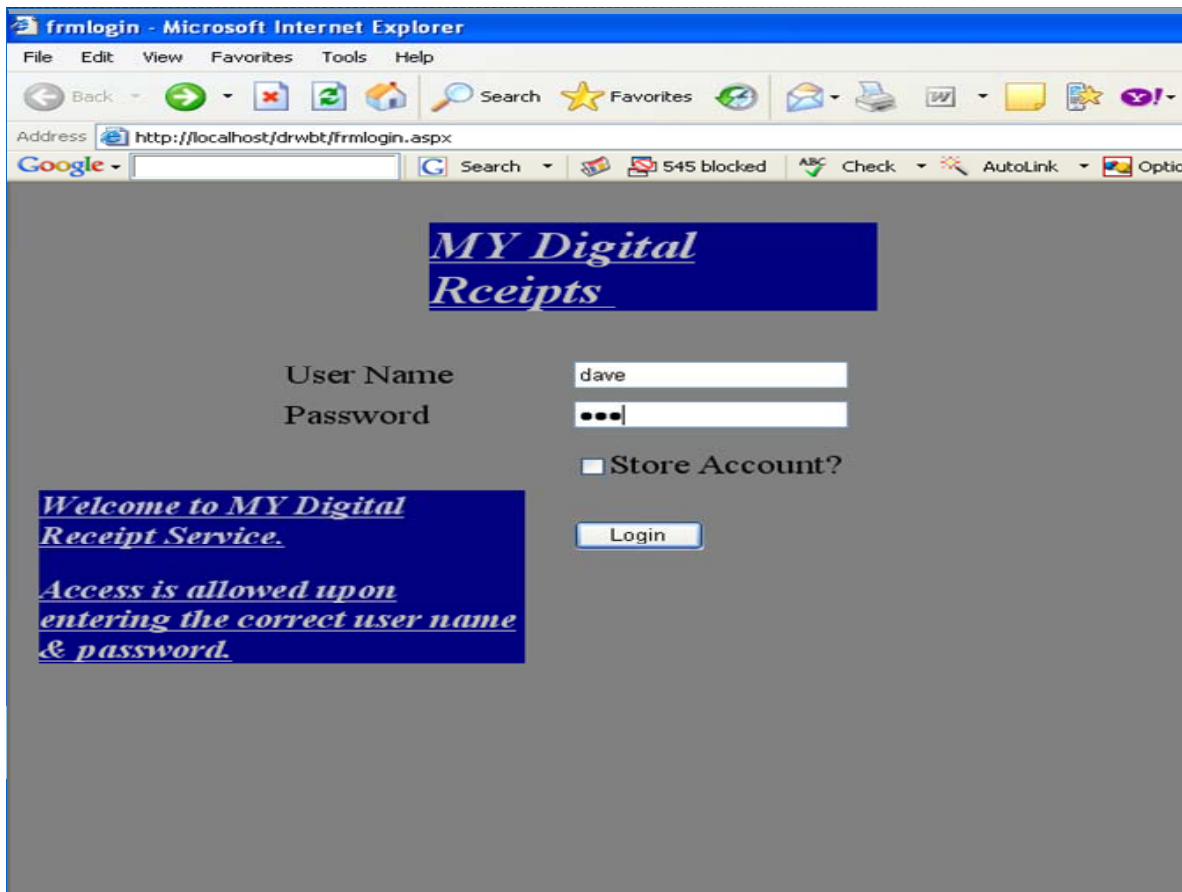
### **6.1 Access Privileges and Functionality**

To achieve privacy during the digital receipt system phases, the database administrator assigns user privileges to allow authorized enterprises to participate in the digital receipt service. Once a new user joins the digital receipt system, the name of the user will be added automatically to the TB\_USER\_STORE, pending an administrator's interaction. Once the administrator assigns which stores a user can access, the user will have access to the pre-assigned stores and will be prohibited from accessing unassigned stores.

### **6.2 Design and Implementation**

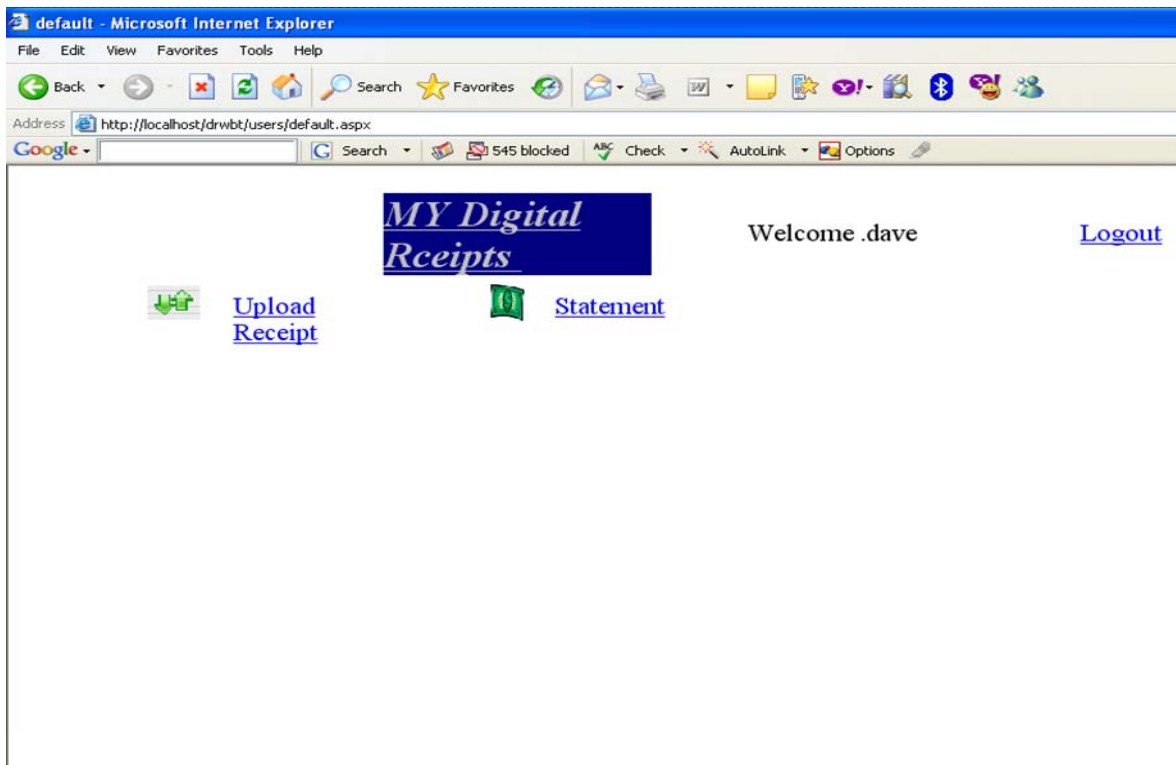
Any users interested in the digital receipt system have to fill out a registration form or request eligibility to participate in the service. After the request or registration application is submitted, an administrator's approval is required. Below is the "Client Web Portal Access" web page, which allows the user to perform the functions listed in the introduction of this chapter. The user will be assigned a temporary password to access the system with the option to change the password to a new one.

Figure 6.1: Client Web Portal Access Page



The "Client Access Portal" page also provides a store account access option to allow participating enterprises or stores to log on and perform authorized actions, such as uploading a new receipt structure, updating profiles like address and contact information, and viewing participating users and their status, whether or not they are active. Once the user logs in through the client web portal, two options will be available for use. The first is to upload a receipt, while the second is to view the statements based on the store chosen, as illustrated in the next few figures.

Figure 6.2: Client Web Portal Options



The upload receipt option will prompt the user to browse for the storage location of the receipt to be uploaded and then upload it by clicking on the upload button. The XML receipt will be uploaded to the table TB\_STORE\_RECEIPTS. A major technical challenge, however, is uploading receipts with different structures into the same table. In other words, how does the upload utility insert receipts or records with different data in the same table with pre-defined columns?

As a case study, if a user has a receipt from one vendor that lists the store's location, ID, name of item, and receipt total while another vendor lists all the previous information and adds to it the taxes, discounts, receipt number, and many other fields, how would the upload utility deal with this situation?

The digital receipt system provides a dynamic digital receipt solution to this challenge. The XML receipt has tags to identify each item on the receipt; therefore, the XML file structure of the receipt will determine how the receipt will be uploaded, as follows:

- If the user uploads a receipt for the first time, the upload utility will compare the names of the columns with the XML tags in the receipt. If the XML tags match the columns' names in the TB\_STORE\_RECEIPTS table, then the data from the XML file will be inserted into the table in an organized fashion. In other words, the data will be inserted in the database table under the columns that match the names of the XML tags in the receipt file.
- If the user uploads a receipt for a particular store where some or all XML tags of the receipt do not match the columns' names in the database table, the upload utility will add new columns to the table based on the new XML tags' names to accommodate the newly arriving data.

After being thoroughly tested, this solution proved to be efficient in accommodating any receipt structure regardless of the type of business. The dynamic receipt solution allows the user to upload any receipt regardless of the number or the types of items listed or where and how the receipt was generated. This provides easy deployment of the digital receipt system without customizing the database tables to accommodate different vendors who have different receipt structures. Figure 6.3 shows the upload receipt process.

Figure 6.3: Client Web Portal Upload Receipt Page

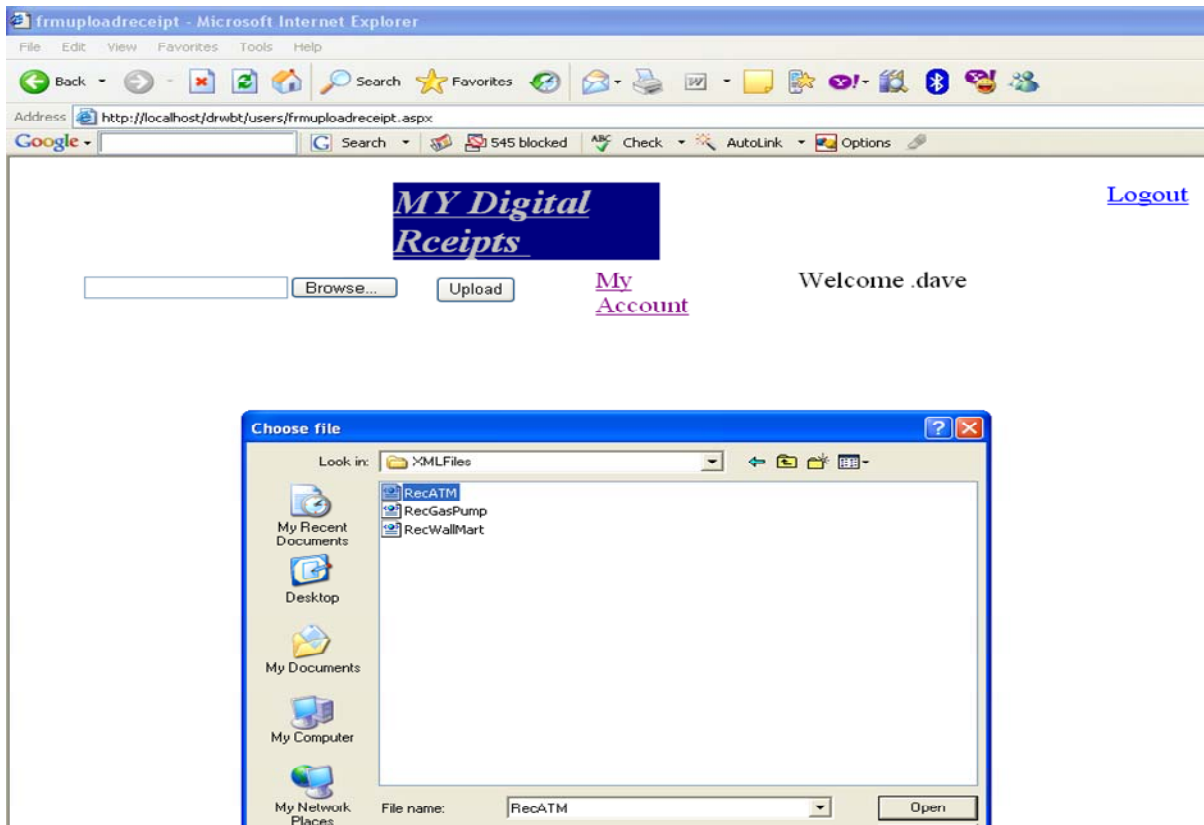


Figure 6.4: Client Web Portal: Successful Receipt Uploading

The file has been uploaded.

**MY Digital Receipts** [Logout](#)

[My Account](#) Welcome .dave

RecStorename	RecDate	RecReceiptNo	RecItemName	RecItemPrice	RecItemTax	RecSubTotal	RecTotal	dataroot_Id
WalMart	2/2/2006 12:00:00 AM	111	Milk	4	0	10	10	0
WalMart	2/2/2006 12:00:00 AM	111	Sugar	4	0	10	10	0
WalMart	2/2/2006 12:00:00 AM	111	Eggs	2	0	10	10	0

Going back to the user's general options page, if the user chooses the "view statement" option, a new screen will be displayed providing the user with the option to view the receipts based on the store name or to view all stores at once. After the user chooses which store to view on the drop-down menu, all collected receipts to be uploaded to the database for that store will be displayed. On the left corner of the grid that displays the receipts, there is a receipt "details" link corresponding to every receipt to allow the users to view the receipt details, such as in figure 6.6.

Figure 6.5: Client Web Portal: Store Statement

	RECSTORENAME	RECDATE	RECRECEIPTNO	RECITEMNAME	RECITEMPRICE	RECITEMTAX	RECSUBTOTAL	RECTOTAL
<a href="#">Details</a>	WalMart	2/2/2006 12:00:00 AM	111	Milk	4	0	10	10
<a href="#">Details</a>	WalMart	5/2/2006 12:00:00 AM	444	Salt	1	0	5	5
<a href="#">Details</a>	WalMart	5/2/2006 12:00:00 AM	555	Juice	3	0	5	5

Figure 6.6: Client Web Portal: Detailed Receipt View

RECSTORENAME	RECDATE	RECRECEIPTNO	RECITEMNAME	RECITEMPRICE	RECITEMTAX	RECSUBTOTAL	RECTOTAL
WalMart	2/2/2006 12:00:00 AM	111	Milk	4	0	10	10
WalMart	2/2/2006 12:00:00 AM	111	Sugar	4	0	10	10
WalMart	2/2/2006 12:00:00 AM	111	Eggs	2	0	10	10
WalMart	2/2/2006 12:00:00 AM	111	Milk	4	0	10	10
WalMart	2/2/2006 12:00:00 AM	111	Sugar	4	0	10	10
WalMart	2/2/2006 12:00:00 AM	111	Eggs	2	0	10	10

## 6.3 Data Export and Storage

In the detailed receipt view, the user will have the option to export the receipt's details to Microsoft Excel. The digital receipt system can export and can also be customized to export the data into different file formats so that they can be imported later on to different program such as Microsoft Money or any other money tax programs. Exporting is illustrated in figures 6.7 and 6.7.1.

Figure 6.7: Client Web Portal: Receipt Export Option


Welcome .dave [Logout](#)

Export XSL

RECSTORENAME	RECDATE	RECRECEIPTNO	RECITEMNAME	RECITEMPRICE	RECITEMTAX	RECSUBTOTAL	RECTOTAL
WalMart	2/2/2006 12:00:00 AM	111	Milk	4	0	10	10
WalMart	2/2/2006 12:00:00 AM	111	Sug				10
WalMart	2/2/2006 12:00:00 AM	111	Egg				10
WalMart	2/2/2006 12:00:00 AM	111	Mil				10
WalMart	2/2/2006 12:00:00 AM	111	Sug				10
WalMart	2/2/2006 12:00:00 AM	111	Egg				10

File Download

Do you want to open or save this file?

 Name: frmreceiptdetails.xls  
Type: Microsoft Excel Worksheet, 1.74 KB  
From: localhost

Open Save Cancel

☒ Always ask before opening this type of file


 While files from the Internet can be useful, some files can potentially harm your computer. If you do not trust the source, do not open or save this file. [What's the risk?](#)



Figure 6.7.1: Client Web Portal: Receipt Export Complete

frmreceiptdetails - Microsoft Internet Explorer

file Edit View Favorites Tools Help

Back Forward Stop Home Search Favorites RSS Print Mail News Groups Feeds

Address http://localhost/drwbtl/users/frmreceiptdetails.aspx?s=WalMart&n=111&d=2/2/2006%2012:00:00%20AM

Google Search 545 blocked Check AutoLink Options

Welcome .dave [Logout](#)

Export XSL

RECSTORENAME	RECDATE	RECRECEIPTNO	RECITEMNAME	RECITEMPRICE	RECITEMTAX	RECSUBTOTAL	RECTOTAL
WalMart	2/2/2006 12:00:00 AM	111	Milk	4	0	10	10
	2/2/2006						10
							10
							10
							10
							10
							10
							10

Download complete

Download Complete

Saved:  
frmreceiptdetails.xls from localhost

Downloaded: 1.74 KB in 1 sec  
Download to: C:\Documents a...\frmreceiptdetails.xls  
Transfer rate: 1.74 KB/Sec

☐ Close this dialog box when download completes

Open Open Folder Close

File Download

Do you want to open or save this file?

Name: frmreceiptdetails.xls  
Type: Microsoft Excel Worksheet, 1.74 KB  
From: localhost

Open Save Cancel

☒ Always ask before opening this type of file

While files from the Internet can be useful, some files can potentially harm your computer. If you do not trust the source, do not open or save this file. [What's the risk?](#)

## **Chapter 7 Results and Competitive Analysis**

### **7.1 Results**

The digital receipt system is unique because of the simplicity of deploying the required hardware and software to the target machine. Users do not need to deploy new hardware technology or make any modification to the existing mobile devices to participate in the digital receipt system besides connecting the Bluetooth to any USB slot within the POS or the ATM machine and then configuring the device to work properly with the POS or the ATM.

The dynamic digital receipt project is more suitable for business than other technologies available in the market because it gives customers the chance to look at their personal spending habits and trends. This new method for providing customers with receipt information at the point of sale eliminates the need for paper receipts; moreover, it reduces the time required to complete the transaction.

Another unique aspect of the digital receipt system that makes it different from other technologies is the use of personal data warehousing technology. This technology provides the consumer data storage and management utilities to store, view, and export data to other software applications. As a result, having the information in a digital format does not require users to retype the information into a finances software package such as tax preparation or money management software. This previously unavailable flow of digital data from vendors will allow consumers to track and use their personal purchase information in ways that were previously unavailable.

In addition to the previously mentioned advantages, the personal data warehouse designed in this project is flexible enough for any receipt structure. The design of the data warehouse is independent of the number or types of items on the receipt -- something not available in other available digital receipt solutions. During the upload process of any receipt, the database tables are customized based on the store's profile and receipt structure.

The use of personal data warehousing is not available in current developments of a digital receipt system, which gives this digital receipt system advantages over what is available in the market. This presents an extraordinary market opportunity for any company to become the pioneer in this field.

## **7.2 Competitive Analysis**

There have been many attempts by different universities and business associations to develop a digital receipt solution; however, nothing has been released as a standard or accepted solution yet. Moreover, the digital receipt solutions under development focus on developing a digital receipt for e-commerce, which will allow consumers to receive a receipt after completing an online purchase order. This online digital receipt is transmitted to the consumer via an email message. In this section, a competitive analysis will show how this digital receipts system is unique and has a better chance of being implemented in the business industry over other available digital receipt systems such as these:

- ARTS System
- Neat Receipt Scanalizer

### ARTS System:

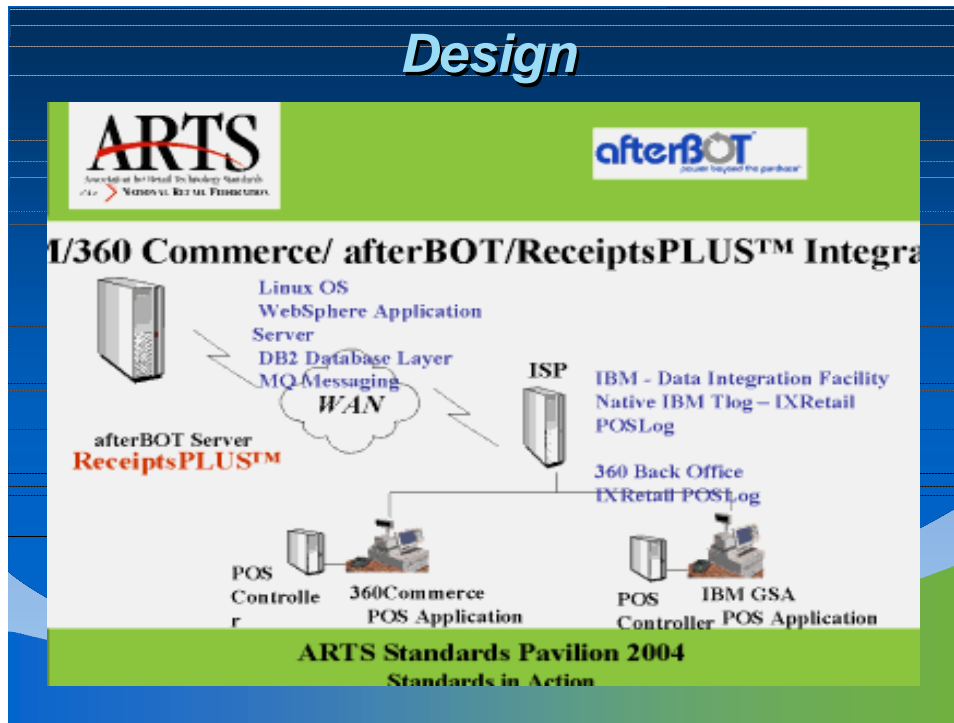
On January 17, 2005, the ARTS, a division of the National Retail Federation, announced that it had completed the design phase for a digital receipt schema/digital receipt system. Among the ARTS members involved in the ARTS digital receipt system are IBM, Microsoft, HP, Infrared Data Association, etc. IBM was responsible for the design of the systems database using DB2, and 360 Commerce for the POS application. Servers were provided by AfterBot, and other parts of the system by other vendors, as shown in figure 7.1.

The digital receipt system, as shown in figure 7.1, is a design that has not been implemented yet. However, the design is extremely complicated and expensive and will not be offered free of charge to the regular consumer. The disadvantages of such a system are that it is not designed for customers wanting to get their receipts digitally on the fly, but it is designed so consumers' financial data is under the control of retail business owners. Personal data access will be given to the consumers for a certain fee.

Therefore, even if this system provides a digital receipt solution, the solution is not suitable for small to medium businesses, nor is it feasible for the consumer to participate in it because of the financial burden. The advantage of this system is that the customers have control over their personal data and the freedom to manage and store their receipts.

One major disadvantage of the ARTS system is IT infrastructure required to get the system running, such as the need to have dedicated database and network servers, Web Sphere application servers, messaging and auditing servers, dedicated wireless and wired networks, and tens of employees to maintain that infrastructure daily.

Figure 7.1 ARTS System



These are the advantages of the technology in the proposed digital receipt system over the ARTS design:

- Improved end-user access to a wide variety of data with a high level of privacy. Moreover, consumers have control over their data, which is not available in the ARTS system.
- Lower computing costs: Less hardware, software, and human resources are needed to deploy and maintain the system.
- Creation of a computing infrastructure that can support changes in computer systems and business structures.
- Empowering end-users to perform any level of ad hoc queries or reports without affecting the performance of the operational systems. End users want to have the control of viewing their data based on certain items, receipts from certain stores, or items per transaction.

### Neat Receipt Scanalyzer

Figure 7.2: Taken from <http://www.neatreceipts.com> (11)



Net Receipts Scanalyzer invented a scanner that reads paper receipts and converts it to a digital format with the capability to export the receipt to other software applications. However, this scanner has limitations and did not provide practical solutions to issues such as these:

1. Providing an enterprise solution for businesses to assist the company in getting real-time financial spending data from its remote employees.
2. Solving personal data warehousing to allow customers to store and manage their receipts based on which stores the receipts came from.
3. Providing inexpensive hardware and software that all handheld devices' users can afford to purchase.
4. Maintaining scanners to ensure high-quality scanning resolution.
5. Carrying the scanner during travel. The scanner has to be carried on with the user for him or her to be able to scan the receipt on the spot. This is tedious, however, for these reasons:
  - a. A waiting time is required until Internet access is available to send the receipt to the company.
  - b. A person in charge in the company has to download the receipt, import it in the scanner's software, and sort it based on the type of receipt.

For a company or retail business with hundreds of employees around the globe, this process is virtually impossible, especially considering the human interaction required just to track a company's financial spending by remote employees.

The following are more advantages of the digital receipt system over the scanner:

- The system provides a faster rate of receipt uploads, while the scanner can scan approximately three to four receipts per minute.
- Users do not need any hardware besides their handheld device, while the Neat Scanner requires the scanner, a laptop with USB 1.1 & 2.0 Interface, a USB cable, and more.
- The proposed system does not have limitations on the size of the receipt uploaded, while the Neat Scanner can scan paper receipts of the scan area 1"x1" to 8.5"x11."

## Chapter 8 Future work and conclusions

This chapter discusses the project results, its possible uses, and conclusions.

### 8.1 Future work

Future work includes, but not limited to, the following:

- Enhancing the database's administrator's access website.
- Enhancing the users' access website.
- Providing more options of exporting data to different finances software by modifying the export utility to generate files with different formats.
- Testing the database in a distributed environment and optimizing the SQL queries.
- Testing the Bluetooth communication utility by testing it with Bluetooth enabled mobile devices from different manufacturers.
- Implementing reporting utilities to allow the consumers to track their personal spending habits such as:
  - Counting the number of visits to the same store within a given time frame.
  - Comparing the prices of purchased items from different vendors or retail stores.
  - Viewing the items purchased the most, their prices, and where the store purchased from.

A major factor which determines the future work and the behavior of the digital receipt system is the application it is being used for and the business environment. This is important to make the digital receipt system work with public domain (apache, my sql, ... etc) and open source software to reduce any cost for hosting Oracle, MySQL, or SQL server .. etc.



## 8.2 Conclusions

The digital receipt system has a framework built on two projects. Both projects are coded by C# .NET programming language using Microsoft Visual Studio 2003. The first project is responsible for the Bluetooth communication and receipt transfer between the Windows application that will be deployed on the ATM machine or the POS and the mobile device. The second project, which is web-based, provides access to the database administrators, enterprises providing the digital receipt service to their clients, and the customers benefiting from the service. Total number of forms, classes, and web applications developed for the entire project are 15 C# classes composed of almost 3,000 lines of code. The system catalog has six tables. All of this accomplishes the following:

- a. To provide a new service where consumers can monitor their personal spending habits and trends.
- b. To offer a new method for providing customers with receipt information at the point of sale, eliminating the need for paper receipts and reducing waiting time to complete the transaction.
- c. To provide a personal data warehousing technology that will enable vendors to provide all purchase information in a digital format that can be captured by a mobile computing device (PDA, cell phone, etc.) and then be shared with other software applications. This results in reducing the amount of paper used and the time required to complete a transaction, which is considered more profitable in the business world.
- d. To provide a new flow of digital data from vendors to allow consumers to track and use their personal purchase information in ways previously unavailable.
- e. To eliminate retyping the information into a financial software package.

Some of the applications that will benefit the most by using the digital receipt system:

- a. **Retail business industry:** Supermarkets, grocery stores, cafés, the clothing industry, and any other businesses that depend on paper transaction receipts will be able to enhance their performance and quality of service and will reduce expenses associated with paper transactions. The same benefits can be generalized to all other industries. Moreover, this will help the retail business managers to better understand their consumers demands by getting more accurate information from the digital receipts on the number of items most sold
- b. **Banks, ATM machines, and finances software.**
- c. **Government agencies:** Government employees can exchange data with different Bluetooth-enabled devices and then upload the data to the database on the fly to make it available for different offices or departments to view the data quickly.
- d. **Boarding ticket machines in airports:** The flyer can check in, receive the ticket digitally, and board without any customer service interaction.
- e. **Large enterprises with many distributed locations and remote employees:**  
The digital receipt system will allow the enterprise to track employees' job-related spending habits and get real-time data of how much they spent. This will reduce the time needed to update the enterprise with transaction details from remote users.

The enterprise does not have to wait anymore for a statement from the credit card company or the bank to view the details.

The proposed digital receipt system is running and was tested thoroughly. It is a contribution towards introducing the digital receipt concept to the business world. Also, it is the foundation for the “digital wallet” concept that provides the consumer with a convenient way of not only exchanging digital receipts but also placing orders and making payments using mobile devices. The system's implementation will ease the life of many people.

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## **Vita**

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