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Digital Receipt System Using Mobile Device Technologies

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Digital Receipt System Using Mobile Device Technologies

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Abstract

Cell phones are the most prevalent computing devices. They come pre-loaded with many different functions such as a digital camera, a mobile web browser, a streaming media player, games, GPS navigation, and more. However, if the banks have their way, the cell phone may become the preferred method of payment for everyday purchases. When that happens, there will be a need to securely send and store the receipt information so that they can be quickly analyzed.

This thesis will demonstrate the use of a Digital Receipt system to manage transactions using Bluetooth technology to communicate between mobile devices. This expands on a previous thesis titled "Bi-Directional Information Exchange with Handheld Computing Devices." (Qaddoura, 2006) Cell phones have now been added into the setup. Thereby, expanding the Digital Receipt concept to include many more affordable computing devices, thus, increasing the likelihood that this application will be accepted by the general public.

Keywords: Digital Receipts, Bluetooth, Webservice, Mobile Computing.

Chapter 1. Introduction

1.1 Overview

The Digital Receipt system consists of two main components: 1) a dynamic "paperless receipt" XML schema and 2) the ability to perform personal data warehousing and data mining of those receipts. These concepts were introduced in the previous thesis entitled "Bi-Directional Information Exchange with Handheld Computing Devices" (Qaddoura, 2006). They were implemented using a Bluetooth connection from a Personal Digital Assistant (PDA) to a PC desktop computer and then into a Webserver.

This thesis builds upon those ideas by incorporating a standard Bluetooth enabled SprintPCS cell phone into the Digital Receipt system. Additional Windows ($C^{\#}$, ASP, .NET) and Java (J2ME) applications were written to send the digital receipts wirelessly from a PDA or ATM or Point-Of-Sale (POS) system into the cell phone. These stored receipts could then be reviewed on the phone or be transferred wirelessly to a PC or sent through the network into a Webserver where data warehousing and data mining could be performed. In addition, a more standardized XML schema was used to create and parse the digital receipts. Therefore, by using these different hardware and software implementations, this thesis makes use of standardized components that more closely resembles "real-world" conditions. This, in turn, should help make the Digital Receipt System more widely accepted and used by retailers, businesses, and individuals.

1.2 Mobile Phone History

Cell phone use has grown exponentially ever since it was first commercially introduced in 1984. It was created by Martin Cooper, the lead engineer at Motorola Inc. He was the first to place a wireless phone call using a "30 oz., brick-like contraption" (Snell, 2003). Unlike Alexander Graham Bell's first phone call from one room to another, Cooper made his wireless phone call as he was strolling down the streets of New York City. At the time, many on-lookers were curious and bewildered by this sight. However, in doing so, he started a trend that would revolutionize the way we communicate, work, and stay in touch with one another.

Today, the biggest growth areas are within the mobile space (Carew, 2007). Given the choice, people nowadays want to have the freedom to communicate wherever they go, unfettered by the limitations of the wired connections. Because of this, the cell phone has quickly overtaken the personal computer as the most prevalent computing device on the planet (Virki, 2007). They have evolved from that bulky piece of equipment into a thinner, more stylish multimedia appliance that has become essential for both businesses and individuals. Nowadays, cell phones are like "mini-computers," having more memory capacity, faster processors, higher resolution cameras and LCD's, and even a fast Internet connection (Gershberg, 2007). Manufacturers continue to pack as many features as possible into their cell phones in order to differentiate themselves from the millions of units that are sold every day. As a result of these advances, new applications are being created to harness this technology.

Several of these new services are an extension of the many desktop applications that most people use on a daily basis. By running these applications from the cell phone, users can experience a familiar service in a totally new way. These applications include emails, web surfing, GPS navigation, multimedia, and digital payments.

1.3 Mobile Applications: Email

One of the first and most successful mobile applications was the incorporation of a fully integrated email service into a cell phone. In early 1999, Research in Motion (RIM), located in Ontario, Canada, released the Blackberry, the first mobile device to allow corporate email accounts to be fully accessible from a cell phone. They integrated their mobile hardware with proprietary middleware software and a Network Operation Center (NOC) to retrieve corporate emails securely using triple DES encryption and then "pushed" that information into the connected BlackBerries (Daniel, 2000). Since then, these devices have become an integral part of the communications infrastructure for many businesses and government institutions. It gives these individuals the ability to quickly access and send emails using their mobile devices from anywhere within the wireless network. Individuals are no longer tied to their office or home computers and now can stay in constant contact with each other from anywhere at any time. This service has become so popular, that when there was a disruption in North America on April 17, 2007, it was reported by all the major news outlets (Austen, 2007). As a result, mobile emailing is now more prevalent than ever before.

1.4 Mobile Applications: Internet

The Internet has become an essential tool in many people's daily lives. For many, this does not stop when they leave their desktop computers at home or at work. According to an IBM survey released on August 22, 2007, about 19% of respondents said that they spent six or more hours a day on the Internet vs. 9% for TV, suggesting that the Internet has become more popular than the TV (Sass, 2007). Nearly 30 to 40 percent of what is done on the Web could be moved to the mobile phone (Wakabayashi, 2007). For example, Google reported that traffic to their mobile services, including maps, emails, and searches, rose 35 percent between May and June of 2007, a time when most families are on vacation and away from their home computers (Auchard, 2007). To make it even easier for cell phone users to surf the Internet, many web browser companies including Apple, FireFox, and Microsoft have made mobile browsers that are as easy to use as their desktop versions. Apple's recently released iPhone contains their Safari browser to view a webpage by zooming in and out, while FireFox has updated their Minimo, the Mozilla mobile version, to be smaller and faster than before, and Microsoft has launched a redesigned MSN portal optimized for mobile phone content on June 18, 2007 (Gohring, 2007). Others, including Yahoo and Google, have similar offering for news, sports, and entertainment. However, the ultimate goal of all these companies is to gain a foothold in the potentially lucrative market for mobile advertising. ABI Research forecasts that global mobile marketing and advertising will increase six-fold to $19 billion by 2011 from an estimated $3 billion today (Ho, 2007). Therefore, the potential for using the cell phone to access the Internet will continue to grow rapidly as newer phones are introduced and faster broadband connections are enabled.

1.5 Mobile Applications: GPS Navigation

Many cell phone manufacturers see using the Global Positioning System (GPS) for navigation as one of the next major "value-adding" services in the mobile arena (Virki, 2007). GPS, developed by the US Department of Defense, uses a network of 24 orbiting satellites to precisely determine the location, speed, and direction of a GPS enabled receiver (Meyers, 2003). For cell phone companies, this technology has been mandated by the Federal Communication Commission (FCC) since the end of 2005 to help rescue workers locate users who made emergency 911 calls (Rasch, 2005). Now wireless companies have started to make commercial use of this embedded technology to allow users to easily find their way around a strange city, rendezvous with nearby friends, or get instant directions to restaurants or shops. This application has become so useful that many users have thrown away their old paper maps and now rely solely on their phone's visual and/or verbal directions. More elaborate features include the ability to allow retailers to send targeted offers or coupons to users that are nearby their shops or restaurants. In addition, real-time traffic reports could be incorporated into the GPS directions, allowing the software to automatically determine alternate paths and help users avoid areas of congestion (Gershberg, 2007).

1.6 Mobile Applications: Multimedia

With the ability to take high resolution pictures, capture videos, and play music, the cell phone is already capable of running any multimedia application. The next step is to allow customers to download and play music, short videos, and even full-length movies from their cell phones (Paul, 2007). The mobile phone companies already see the potential profits from this and are quickly introducing new models to run these applications. For example, Motorola Inc. unveiled a new mobile phone on May 16, 2007 that can display full-motion video at 30 frames per second. Ed Zander, Motorola's CEO, described it as a "media monster" that would be able to fully use the high bandwidth 3G mobile networks currently available in Europe (Auchard, 2007). Apple's much anticipated iPhone, introduced on June 29, 2007, can download and play YouTube.com videos on its large, touch screen LCD display. In addition, its built-in iTunes player allows users to download and maintain their music and videos right off the phone, similar to their iPods (Levine, 2007). These and many other features have a lot of users calling the iPhone a revolutionary device that will hasten the drive towards a multimedia convergence by the entire cell phone industry.

1.7 Mobile Applications: Digital Payments

The first "contactless payment" system was developed by Verifone, one of the largest Point-Of-Sale (POS) equipment makers in the US (Oliver, 2000). However, it was not widely used until 1997 when ExxonMobile introduced the Speedpass system that allowed customers to simply wave a Radio Frequency Identification (RFID) enabled keychain "fob" at the gas pump to pay for a fill-up (Kageyama, 2004). Although this method is more convenient and faster than swiping a credit card, it doesn't allow the user to instantly view or manage their accounts. To accomplish this, a consortium of US banks, credit card companies, payment processors, chip makers, cell phone manufactures, and cell phone carriers have come together to turn mobile phones into "mobile wallets." (Virki, 2007) Unlike the RFID tags, these cell phones would use a Near Field Communication (NFC) chip, developed by Phillips Semiconductor and Sony, to send and receive secure payment information which could then be viewed or managed from the phone. This technology is already very popular in both South Korea and Japan where users can load cash into their phones and then buy a soft drink from a vending machine or pay for groceries or pay for a train ticket (Sappa, 2003).

In the US, the same philosophy applies, take advantage of the ubiquity of the cell phones to make payments easier and more secure, but instead, have them linked to a credit or debit card. Visa's "contactless" payment program involves having the user power on their phone solely to enter a password or PIN number to initiate a transaction, thereby adding a level of security in case the cell phone is lost or stolen (Kan, 2007). While MasterCard is exploring ways to integrate the cell phone's payment functions so that businesses can perform targeted promotional advertisements like digital coupons or rewards programs to customers (Lev-Ram, 2007). Both card companies' market research showed that users in their pilot programs consistently spent more money. In particular, because of the ease and speed of the transactions, consumers were more willing to use their cell phones for many "impulse purchases" and for "micro payment" transactions that are usually paid with cash, not credit cards (Hart, 2007). All of this will still take some time to gain wide acceptance, but once it does, there won't be a need to fumble in your wallet or purse to get a credit card or some cash, or swiping the credit card and waiting for the "Approved" message, or even the need to receive and sign a receipt. Therefore, a digital receipt standard must be used to document these new digital transactions.

Chapter 2. Digital Receipts

As defined by the Association for Retail Technology Standards (ARTS):

> "A receipt is a record of a completed retail transaction between a merchant and a consumer, wherein goods and/or services are exchanged for moneys tendered." (Krugman, 2004)

Therefore, a digital receipt is an electronic purchase verification that can be issued by retailers, financial institutions or any other industry that provides consumers with a proof of purchase. The availability of this electronic verification standard is a major step for traditional retailers to do business in a more efficient and cost-effective manner. Digital receipts follow in the footstep of two previous initiatives to move commerce and banking into the digital realm. They include, first, the creation of the Digital Signatures Law, and then later, the ability to process Digital Checks by banks.

2.1 Digital Signatures

From the signing of the US Declaration of Independence on July 4th, 1776 to the signing of a credit card slip the other day, every important document must have a signature by one or more individuals to legally bind and validate that piece of paper. This was the case for about 224 years, until on June 30, 2000 when President Bill Clinton signed the Millennium Digital Commerce Act of 2000, otherwise known as the Digital Signatures Law (Abraham, 1999). He used a specially encoded "smart" card and his dog's name as a password to sign the law that would make electronic signatures as legally binding as those signed by an ink pen or a quill (Longley, 2000). Of course, in keeping with 200 years of traditions, he still had to use an ink pen to sign the document before he could use the digital signature. However, this law paved the way for "digital contracts" to be legally executed online in order to accommodate the new era of

e-commerce brought on by the widespread use of the Internet (ABA, 2000). Similar to an ink signature, digital signatures offer both parties the ability to validate the agreement and ensure the identities of the participants. They are usually created by a cryptographic checksum of the data using a private key and then verified or recovered using a public key (Stallings, 2003). All this should make digital signatures nearly impossible to forge, thus paving the way for a secure mechanism to digitally transport sensitive information (GIPI, 2001).

2.2 Digital Checks

Everyday, millions of checks are written by individuals, businesses, and institutions to pay for goods and services rendered. The checks are then deposited into their bank's branch office or an ATM and then they are transported to one of the 12 regional Federal Reserve Banks, or clearinghouses, where the payments are processed into their respective accounts. At each step, the checks must be physically processed and then shipped to its destination by air or armored ground transport. Of course, this is a very inefficient, expensive, and error prone process that could be easily improved given today's advancements in computers and imaging technologies. For these reasons, Congress enacted a new banking law called the Check Clearing For The 21st Century Act, or Check21, in October 28th, 2003 (Ferguson, 2003). This law allows banks to legally capture the payment information on the checks and transport it electronically, a process known as "check truncation." In this process, a new negotiable instrument called a "substitute check" was created to allow the banks to transform the original paper check into a digital version for electronic transport to other banks which could then process them, and if needed, reprint and deliver them to their customers who may want to continue receiving

cancelled paper checks (Hillebrand, 2004). As a result, digital checks allow banks to process and credit accounts more quickly and reduce the cost of handling and transporting paper checks. In addition, it has become so widely used that the Federal Reserve expects that paper check processing will cease to exist by the year 2010.

2.3 Current Digital Receipt Systems

The same efficiencies obtained from digitizing signature and checks can also be gained by using a Digital Receipt System to record and organize transactions. Some of the benefits include:

1. Providing retailers with another way for marketing and promotions.
2. Helping reduce third party credit charge backs and fraudulent returns.
3. Streamlining warrantee and rebate claims processing.
4. Assisting in efficient resolution of credit card disputes.
5. Enabling the use of “contactless payment” using cell phones and PDA’s.

Several companies have developed their own Digital Receipt systems to capitalize on these potential benefits. They include the following companies:

a. Infor
b. NeatReceipts
c. AfterBOT, Inc.

2.4 Infor

Infor is a global software company specializing in developing fully integrated enterprise solutions for many different industries. One of the products that they developed is an automated expense management system that uses digital receipt filing to manage travel and entertainment (T&E) transactions (Infor, 2004). In many large corporations, their T&E policies require that receipts for certain expenses be attached to expense reports for employees to obtain reimbursements and to be in compliance with IRS regulations. The traditional process of submitting paper receipts has several inefficiencies, including:

1. High postal and copying fees.
2. High administrative and processing costs.
3. Delays in receiving receipts.
4. Inefficient auditing trails due to lost or misfiled receipts.

As a result, Infor has developed a more efficient and economical way to process these expenses digitally.

As Figure 2.1 shows, users submit receipts electronically via a fax or a copier-scan-to-email device with an electronic expense report cover sheet that contains a unique bar code. The image server interprets the bar code and automatically indexes and electronically links the receipt image with the expense report. Once attached, this information can be viewed online by management for quick approval and/or auditing. As a result, enterprises that incorporate this digital receipt filing system have gained significant efficiencies from reduced mailing costs, improved accountability, and a more streamlined auditing and approval process.

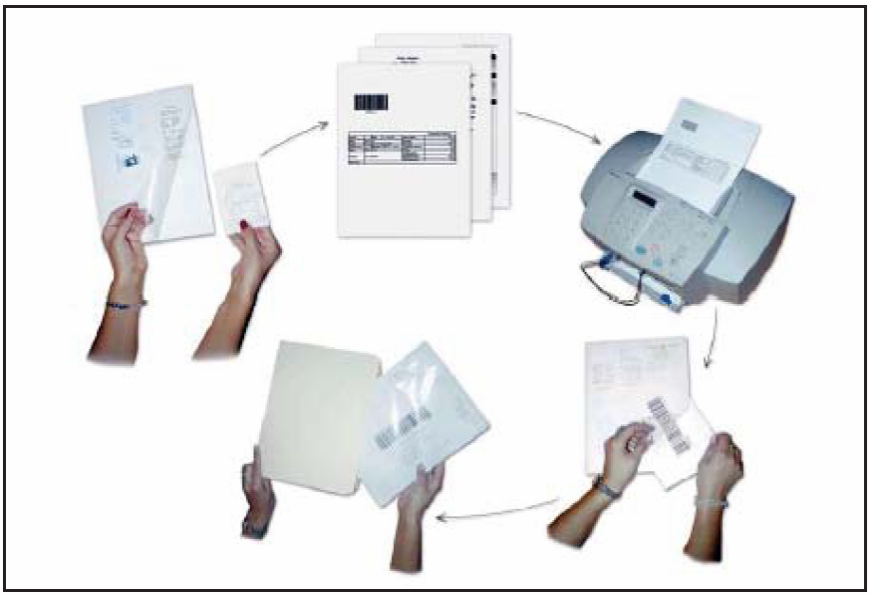

Figure 2.1 How corporate expense receipts are digitally scanned and filed.
(Taken from Infor company publications 2006.)

2.5 NeatReceipts

NeatReceipts, founded in 2002, has developed the NeatReceipts scanner and Scanalizer software (Figure 2.2) to allow individuals and businesses to digitize and organize their receipts (NeatReceipts, 2007).

Figure 2.2 NeatReceipts scanner and software to digitize expense receipts.
(Taken from NeatReceipts company publications 2007.)

This device uses Optical Character Recognition (OCR) software to extract key receipt information, such as vendor, date, amount, tax, etc., and then enters that information into the proper fields in any money management software. Additionally, NeatReceipts is IRS approved, meaning that the scanned digital receipts can be used as proof of purchase should an audit be required. This system was initially marketed to business travelers, but since then has been broadened to include individual consumers who want to organize and integrate their purchases into other money management software such as Quicken, Microsoft Money, etc.

2.6 AfterBOT, Inc.

AfterBOT, founded in 2000, has developed and implemented the first successful digital receipt solution for Smart & Fine Stores, Inc, a 241 store warehouse grocery retailer headquartered in Commerce, California. Together with the Association for Retail Technology Standards (ARTS), they have led a collaborative effort to increase the adoption and use of the Digital Receipt Schema released by the ARTS IXRetail Group in early 2002 (Krugman, 2002). AfterBot's ReceiptPLUS^{TM} was the first software and hardware solution that allowed retailers the ability to create, deliver, and archive digital receipts using in store point-of-sales transaction data. In addition, as seen in Figure 2.3, they were the first to give customers the ability to securely view their receipt details, product warranty, registration, and rebate information as well as customer feedback and targeted promotions from the retailer's website.

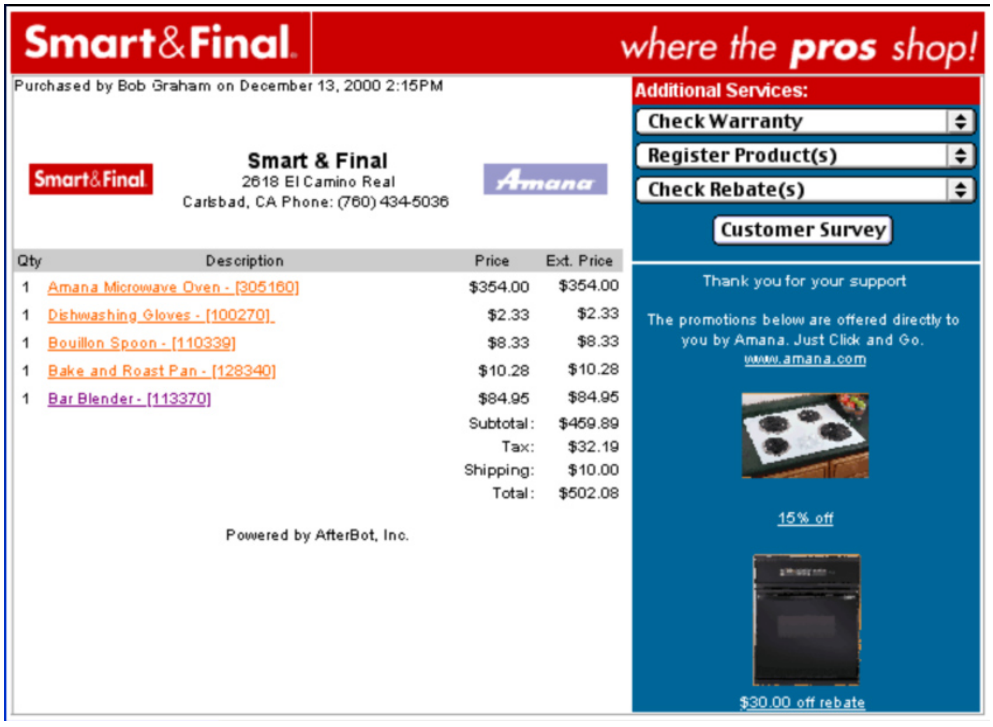

Figure 2.3 AfterBOT's online ReceiptPLUS^{TM} interface.
(Taken from AfterBOT website, www.afterbot.com.)

2.7 Analysis

These three Digital Receipt Systems have very different implementations that take advantage of the various technologies to enable businesses and individuals to streamline their expenses. Their methods include the use of faxes, scanners, and also the Internet to create the digital receipts. The benefits of using these systems include:

- increased efficiency
- reduced costs
- better auditing tools
- improved customer communications
- more interactive promotions

However, these products would benefit more by including mobile devices and a personal Webservice to view Digital Receipts from anywhere, not just from the desktop or laptop computer.

Chapter 3. Components of the Digital Receipt System

This thesis aims to create a Digital Receipt System that is different than the current methods by using mobile devices such as a Personal Digital Assistant (PDA) and cell phones. In addition, a standardized XML schema developed by the Association of Retail Technology Standards (ARTS) would be used by both the mobile devices and the Webservice to view, organize, and analyze the receipts.

In order to accomplish this, the following software tools were used:

1) File Transfer using Bluetooth Connections
2) XML schema for Digital Receipts
3) Mobile Digital Receipt Viewer
4) Personal Datastore Webservice

These software tools were used on the following commercially available mobile devices, Fig 3.1:

1) HP iPAQ hx4700 PDA
2) Samsung SPH-M500 Cell Phone
3) LG LX-550 Fusic Cell Phone

Figure 3.1 HP iPAQ hx4700 Samsung SPH-M500 LG LX-550 Fusic

3.1 File Transfer Using Bluetooth Connections

Bluetooth wireless technology is a low-cost, low-power, short-range communications protocol originally intended to replace cable connections between portable and/or fixed devices while still maintaining a high level of security. Originally developed in 1994 by Ericsson Mobile engineers to connect accessories to mobile phones, it has quickly become the global standard for wirelessly connections of laptops, printers, computer accessories, car electronics, headphones, MP3 players, cell phones, and many more (Bluetooth SIG, 2007). By enabling these connections between different devices, a short range wireless network was created, giving rise to the notion of an ad-hoc Personal Area Network (PAN). These networks enable easy and convenient connections to printers, Internet access points, and personal devices at home and at work.

Bluetooth is able to do this by offering many service profiles including:

- Advanced Audio Distribution Profiles (A2DP) for streaming stereo audio
- Basic Imaging Profile (BIP) for controlling imaging devices
- Basic Printing Profile (BPP) for devices to communicate with printers
- BNEP for common network protocols such as IPv4 or IPv6
- Dial-up Networking Profile (DUN) for Internet access
- Generic Access Profile (GAP) for connecting to other Bluetooth devices
- Headset Profile (HSP) for connecting to headphones
- Human Interface Device Profile (HID) for connecting keyboards, etc.
- Object Exchange (OBEX) for exchanging objects, ie. business cards, etc.
- RFCOMM for wireless serial connections
- File Transfer Profile (FTP) for wireless file/folder transport

This thesis uses the Bluetooth FTP service profile to wirelessly send and receive files containing digital receipt information from a PDA to a cell phone to a desktop computer (Figure 3.2). It was implemented using the Integrated Development Environment (IDE) tools from Microsoft, Sun Microsystems, and Sprint/Nextel. From Microsoft, the Visual Studios development environment was used to create a C# application. The .NET Compact Framework libraries were used to develop a Bluetooth enabled GUI interface for the HP iPAQ hx4700 PDA to simulate a Bluetooth enabled POS system. From Sun MicroSystems and Sprint/Nextel, the NetBeans IDE tools were used to create a mobile J2ME program that accesses the built-in Bluetooth features of the Samsung SPH-M500 and LG LX-550 Fusic cell phones. These programs were loaded into the phones using the Over-The-Air (OTA) wireless protocol required by the cell phone provider.

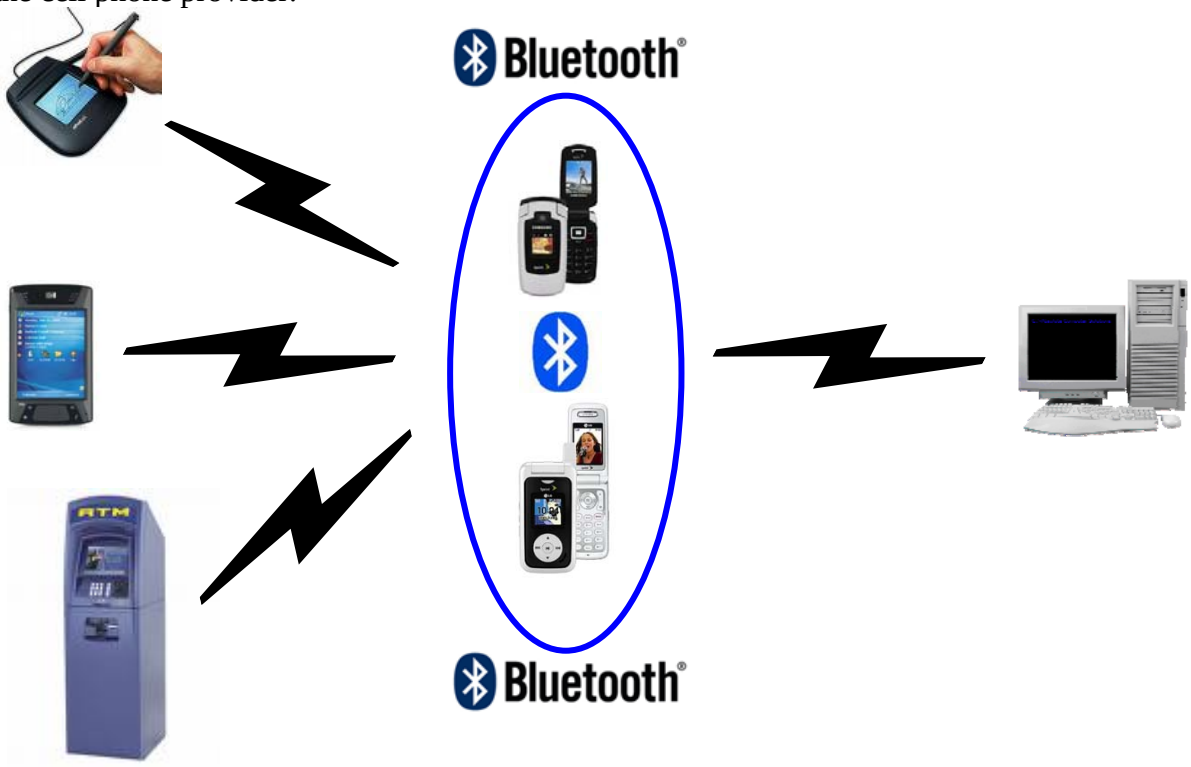

Figure 3.2 Bluetooth connections from POS, PDA, or ATM to Mobile Phone to Desktop.

3.2 XML Schema for Digital Receipts

The Association for Retail Technology Standards (ARTS) drafted the IXRetail consortium XML schema for a retail-oriented Digital Receipts in 2002 (Scheuer, 2002). In this draft, a receipt is considered a record of a completed transaction between a (1) merchant and a (2) consumer where (3) products and/or (4) services are exchanged for monies tendered. These four components are the basis for any retail transaction and are the main components of the XML schema. In addition, other contextual information including the date, time, location, discount, tax, and other marketing and promotional text have also been included into the specifications.

Therefore, a receipt can be generalized to encompass any sort of financial transaction, such as a Retail Purchase or Return, a withdrawal at an ATM, or payment of medical services and/or insurance, etc. In addition, the digital receipt must also support certain business goals in order to be financially viable. It must also:

- Support rendering to HTML for consumer viewing and promotions
- Support embedded HTML images and links for website integration
- Provide a foundation for proximity electronic payments
- Facilitate marketing and merchandising based on items sold
- Provide proof of purchase for returns, rebates, and product registration
- Support payment dispute resolution
- Support automated input to personal financial software such as Quicken, etc
- Support automated input to small business financial software such as QuickBooks

Therefore, this schema is very broad in scope. However, due to the memory constraints in the mobile devices, only the following relevant subset of the schema was used (Figure 3.3):

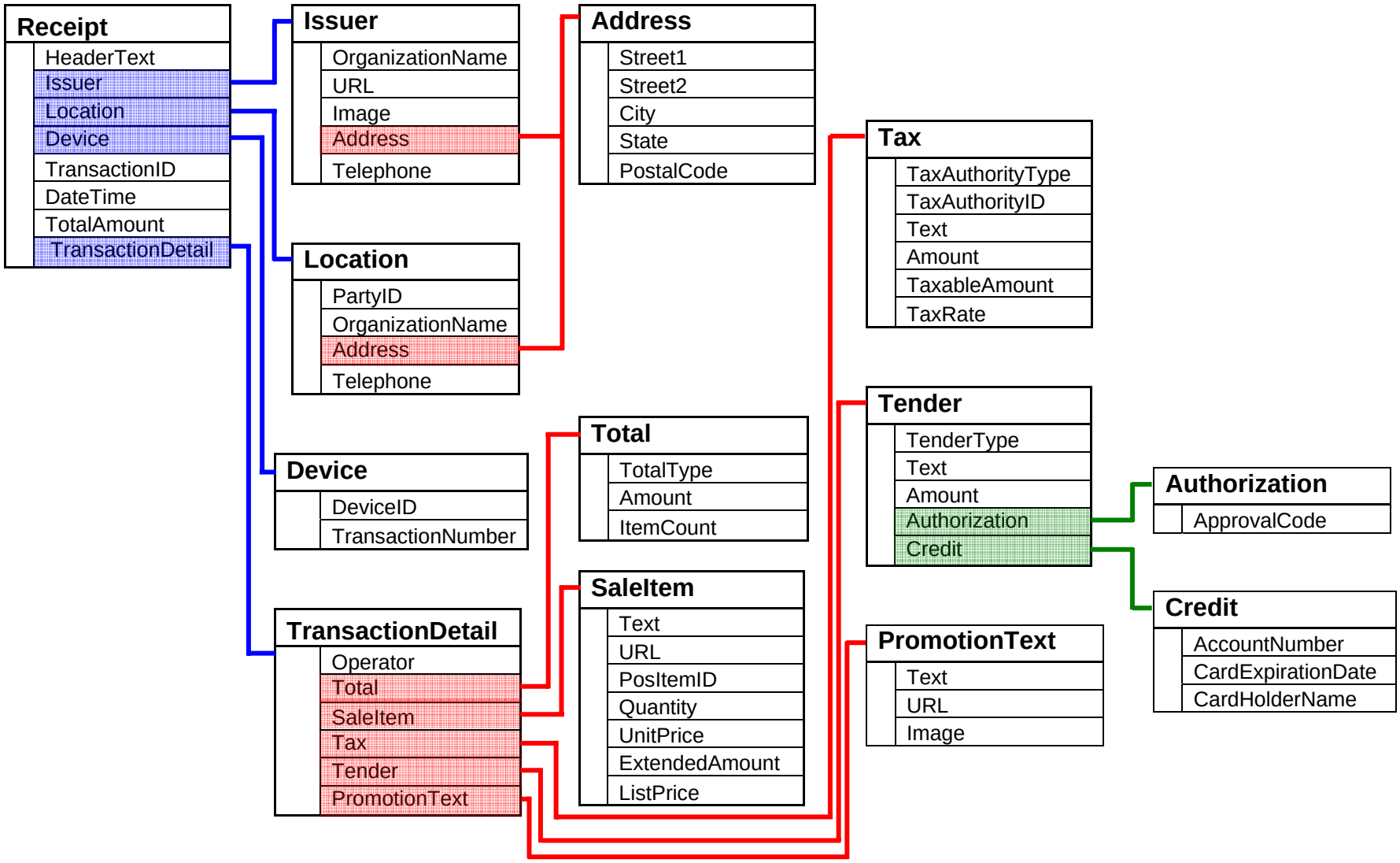

Figure 3.3 Digital Receipt XML schema subset used from ARTS.
See **Appendix A** for full XML Schema.

3.3 Mobile Digital Receipt Viewer

To allow users to instantly view their received and stored receipts, a mobile Digital Receipt Viewer was created for both the PDA and the cell phones. This was done using mobile software development tools from Microsoft, Sun Microsystems, and Sprint/Nextel. Visual Studios and the NetBeans IDE's were used to create the mobile GUI interface for the PDA and the cell phones.

This software lets the user perform the following tasks:

- Accumulate, store, and view multiple receipts
- Sort receipts according to date, time, merchant, amount, etc.
- Quick snapshot view of the total accumulated amount
- Detailed views of each stored receipt

These features allow the user to instantly perform many common tasks from anywhere at anytime. In addition, this simple interface helps to show the advantages of using stored digital receipts instead of rummaging through a pile of paper receipts. Once the user is done reviewing these receipts, he or she can simply upload them into a Webserver or Personal Computer where they can perform more complex analysis, data warehousing, and data mining operations.

3.4 Personal Datastore Webservice

By using the built-in Internet connections from the PDA's, cell phones, and desktops, the user can instantly transfer all their stored digital receipts into a web-enabled datastore (Figure 3.3). Once they are uploaded, personal data warehousing and data mining can be quickly done using a Webservice with a user interface that was developed in the previous thesis. However, this new implementation uses the more standardized IXRetail XML tags described in the previous section to view, organize, and analyze the receipts. The Webservice software was updated with new code and a new web form interface to view the receipts. This Webservice retains most of the previous features including:

- Secure Administration of Account
- Dynamic XML Parsing of Digital Receipts
- Exporting Digital Receipts to other Software or Storage

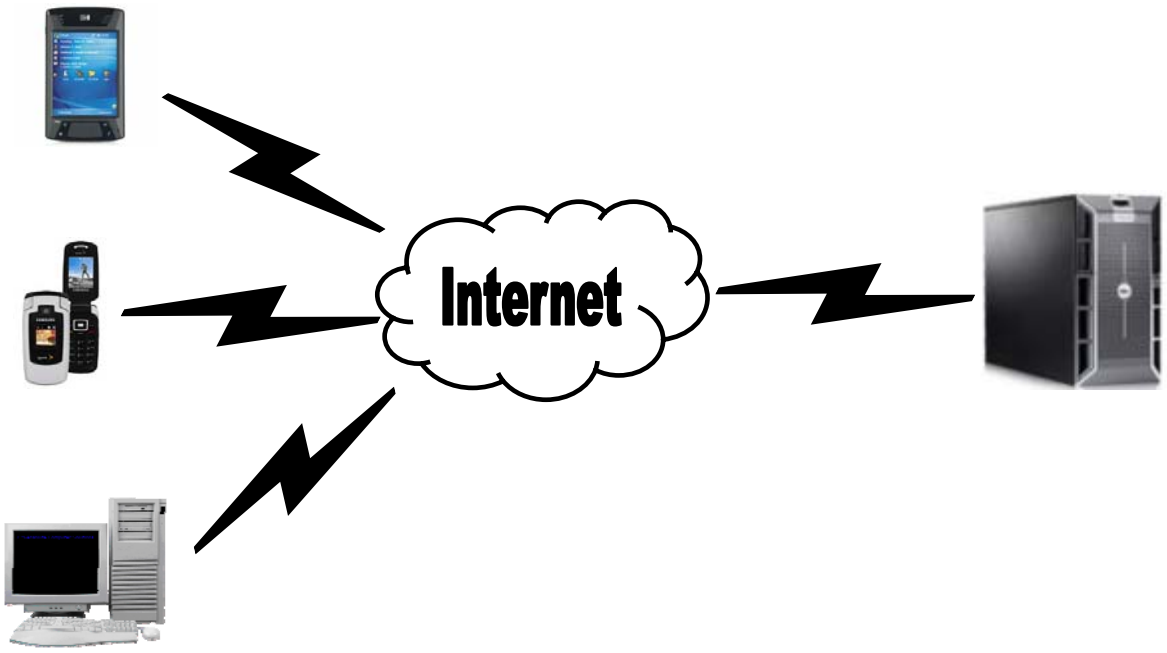

Figure 3.3 Upload Digital Receipt using an Internet connection to a Webservice.

Chapter 4. Software Development

The software for the Digital Receipt System was developed using the mobile Software Development Kit (SDK's) from both Microsoft and Sun Microsystems. This software development spanned three computing platforms with different operating systems, i.e. from the PDA to the cell phone to a desktop computer setup. The development of the software was divided into three distinct steps (Figure 4.1):

Step 1. Create a Bluetooth enabled POS device using a PDA to send a Digital Receipt to a cell phone using a Bluetooth Connection.

Step 2. Create a Mobile Digital Receipt Viewer on the cell phone to view, store, and transmit the Digital Receipts through the Internet.

Step 3. Create a Personal Webservice interface to view and analyze the uploaded Digital Receipts.

Figure 4.1 Steps in the Digital Receipt software development.

4.1 Step 1: Create a Bluetooth Enabled POS Device

The purpose of this step was to simulate a real-life POS system that would contain a digital receipt file in XML format. Then, it would be transmitted into the cell phone wirelessly using the Bluetooth file transfer protocol. This was done by creating a C# program using Microsoft's Visual Studio .NET Compact Framework 2.0 libraries on an HP iPAQ hx4700 PDA. The GUI interface was made to resemble a real-life POS system that is commonly used to capture the user's signature from a credit card transaction. In addition, this interface also allows the user to view their original receipt information before signing the pad. Once the user has signed inside the signature capture area, they are given the option to send this receipt wirelessly to the cell phone using the PDA's built-in Bluetooth antenna. Currently, there aren't any POS systems that have Bluetooth capabilities, but this setup shows the feasibility and usefulness of such a device.

As illustrated in the next Figures 4.2-6, the following events are initiated by the user with a PDA to send a Digital Receipt to the cell phone:

1. User views and signs for the receipt
2. Bluetooth Device Discovery initiates
3. Bluetooth Service Discovery initiates **(User's approval needed to continue)**
4. Bluetooth File Transfer (FTP) initiates
5. File Transfer completed

1. View & Sign Receipt

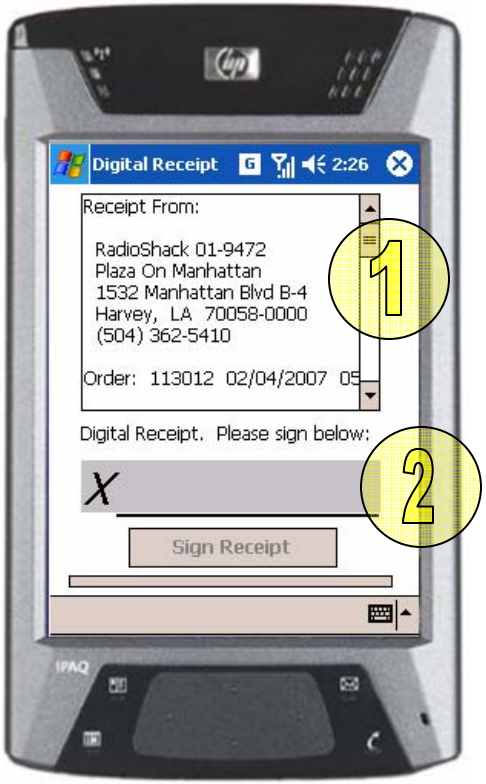

Figure 4.2:

User can view/scroll thru their Digital Receipt in **ViewBox 1**.
Then signs the **Signature Capture Area 2**.

2. Device Discovery

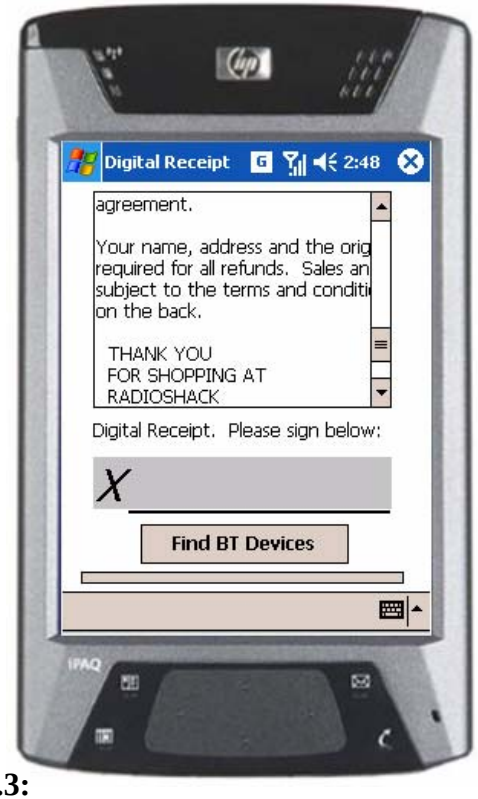

Figure 4.3:

"Find BT Devices" button is enabled.
User can then initiate Device Discover to find all Bluetooth devices within range.

Note: User's BT cell phone settings must be Visible.

Figure 4.4:

All visible devices are listed in **ViewBox 1**.
The user selects their device and **Service Discovery** is automatically initiated to detect an FTP service record.

Note: The user may be prompted to allow for this Service Discovery request.

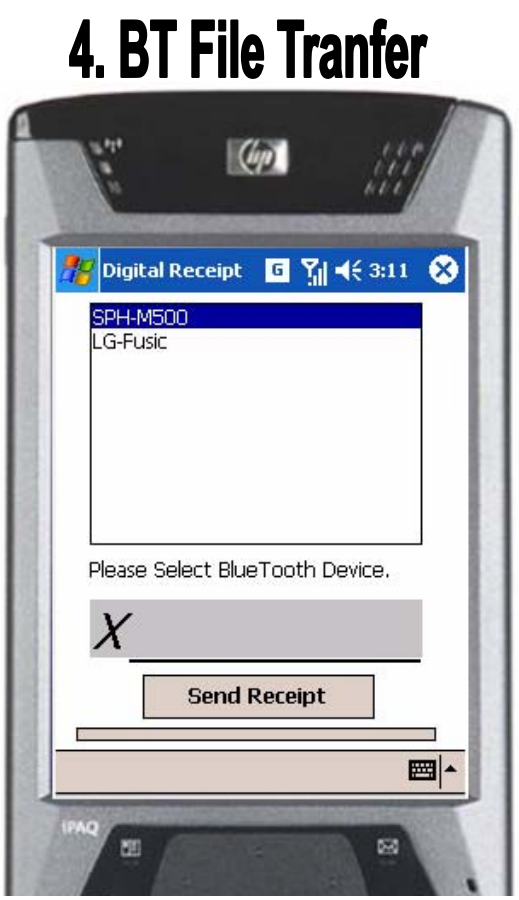

Figure 4.5:

"**Send Receipt**" button becomes enabled if FTP service is available.
The user can now initiate the file transfer.
A Progress Bar shows the status of the file transfer.

5. File Transfer Completed

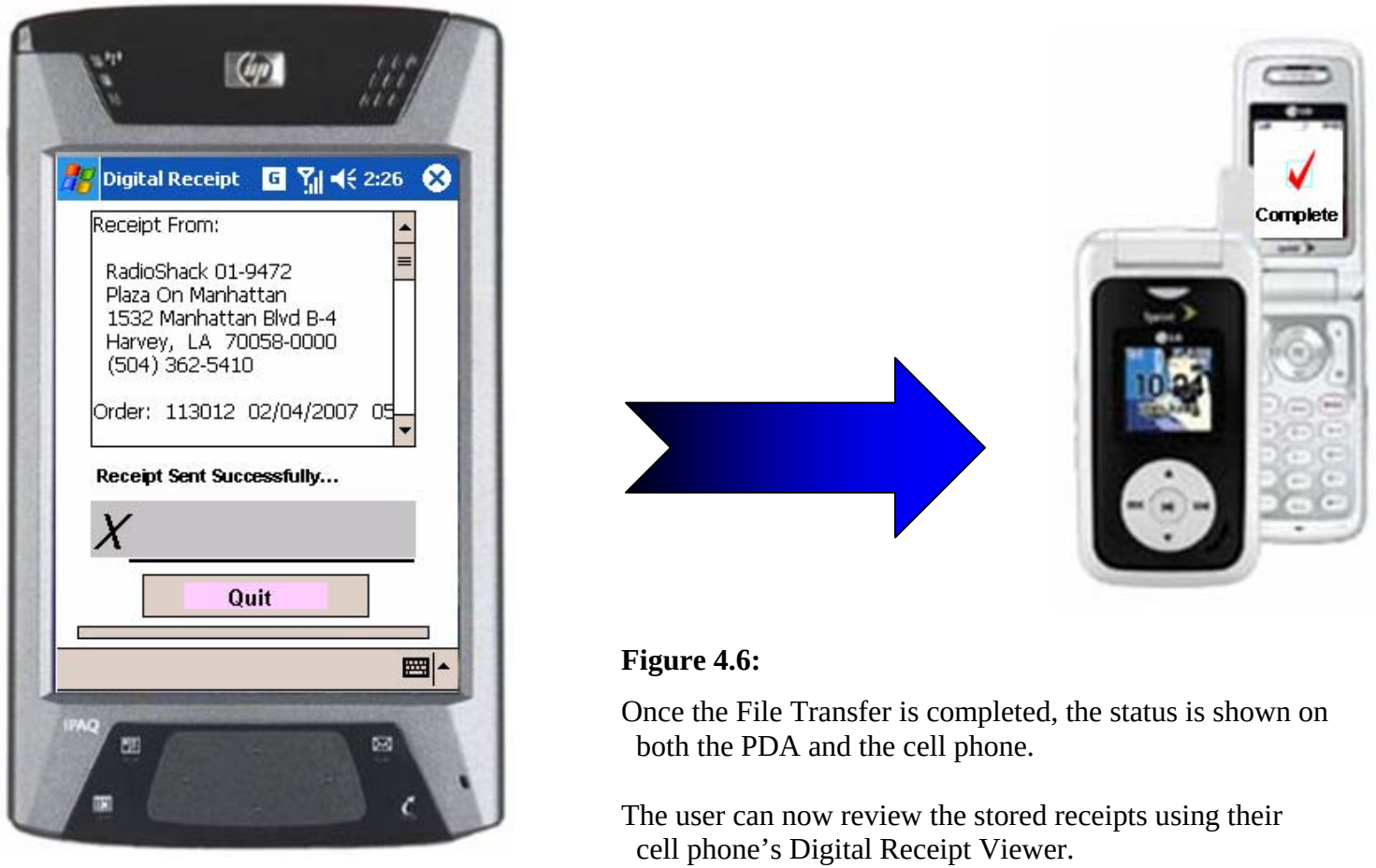

Figure 4.6:

Once the File Transfer is completed, the status is shown on both the PDA and the cell phone.

The user can now review the stored receipts using their cell phone's Digital Receipt Viewer.

Each receipt is saved as a separate file on the cell phone. They are all loaded into the cell phone's Viewer upon startup.

4.2 Step 2: Create a Mobile Digital Receipt Viewer

Once a Digital Receipt has been sent into the cell phone, the user can quickly review, organize, or analyze the transactions using a Digital Receipt Viewer on the phone. This application was written using Sun MicroSystem's Java Micro Edition (J2ME) for mobile devices. This version uses a Java Virtual Machine (JVM) that contains a subset of the full Java Platform. Due to the memory constraints of the cell phone, the Connected Limited Device Configuration (CLDC) was used. It contains the most basic set of libraries and virtual-machine features that must be present in each implementation of a J2ME application. In addition, the following Optional Packages were used to create this application:

JSR-82	Java APIs for Bluetooth and OBEX, FTP
JSR-219	Security
JSR-209	Advanced Graphics and Graphical User Interfaces

The application development was done using a customized NetBeans IDE package provided by Sprint/Nextel developer's group. It contained the J2ME packages, customized Device Emulators for various cell phones, and a Debug utility for program testing and development.

To ensure that the application was not malicious software, the wireless carrier required developers to do the following:

1. Register the cell phone(s) that will be used to receive the development software.

2. Digitally sign the application with a code-signing key from a trusted Certificate Authority.

This required purchasing a code-signing certificate from Verisign, Inc for about $400. Once it was obtained, the application could be signed with the provided key and packaged as a secure JAR file. In addition, several of the J2ME libraries could be unlocked and were available for use, including the file read/write access, Bluetooth functions, and Internet access.

However, even with these features unlocked, there was a setback encountered when the Bluetooth file transfer libraries were accessed in both the Samsung and LG cell phones. Both cell phone manufacturers did not allow any development applications to perform Bluetooth file transfers from their mobile devices. Files could only be "pushed to" or "pulled from" the cell phone using a computer to initiate the Bluetooth connection. Their decision to lock this feature was mainly due to security concerns and limited memory resources on the cell phones. Therefore, a desired feature in this thesis to send the Digital Receipt from the cell phone to the computer using Bluetooth connections could not be implemented. Instead, stored receipts were uploaded into a Webserver using a Java Socket connection. It is hoped that in the near future, the cell phone manufacturers will unlock this feature once the technology improves and their devices become more advanced.

Finally, to install the application onto the cell phone, the wireless carrier required using the Over-The-Air (OTA) program deployment method. This was done by creating a webpage that could be accessed from the cell phone's mobile Internet browser. Therefore, a homepage for the application was created and then hosted using an Apache server on a computer with a static IP address. The homepage had HTML source code that pointed to a JAD file and directed the cell phone to download and install the

application's JAR file into memory. Once installed, the application could be used to view, organize, and analyze the stored digital receipts.

As seen in Figure 4.7, this Digital Receipt Viewer allows the user to quickly review all the receipts that have been sent into the cell phone by the POS device. The main view is a table (1) containing a summary of all the stored receipts. They are ordered according to the date and time of the transactions. Because viewing space is limited in the LCD panel, initially only a subset of each receipt is shown, including the "Date", "Store", and "Amount". An expanded view of the information is displayed in the "Magnifier" region (2) when the table is traversed using the arrow keys. To view the complete receipt information, the user can press the left "View" command button (3). This will show a scrollable printout of the entire receipt on the cell phone's display. Finally, when the user is ready, they can transfer the receipts into the Webserver by pressing the right "Upload" command button (4). This initiates a Java Socket connection to the server using the cell phone's Internet connection. Once they are successfully uploaded, the stored receipts are then deleted from the cell phone's memory to make room for new transactions to be added.

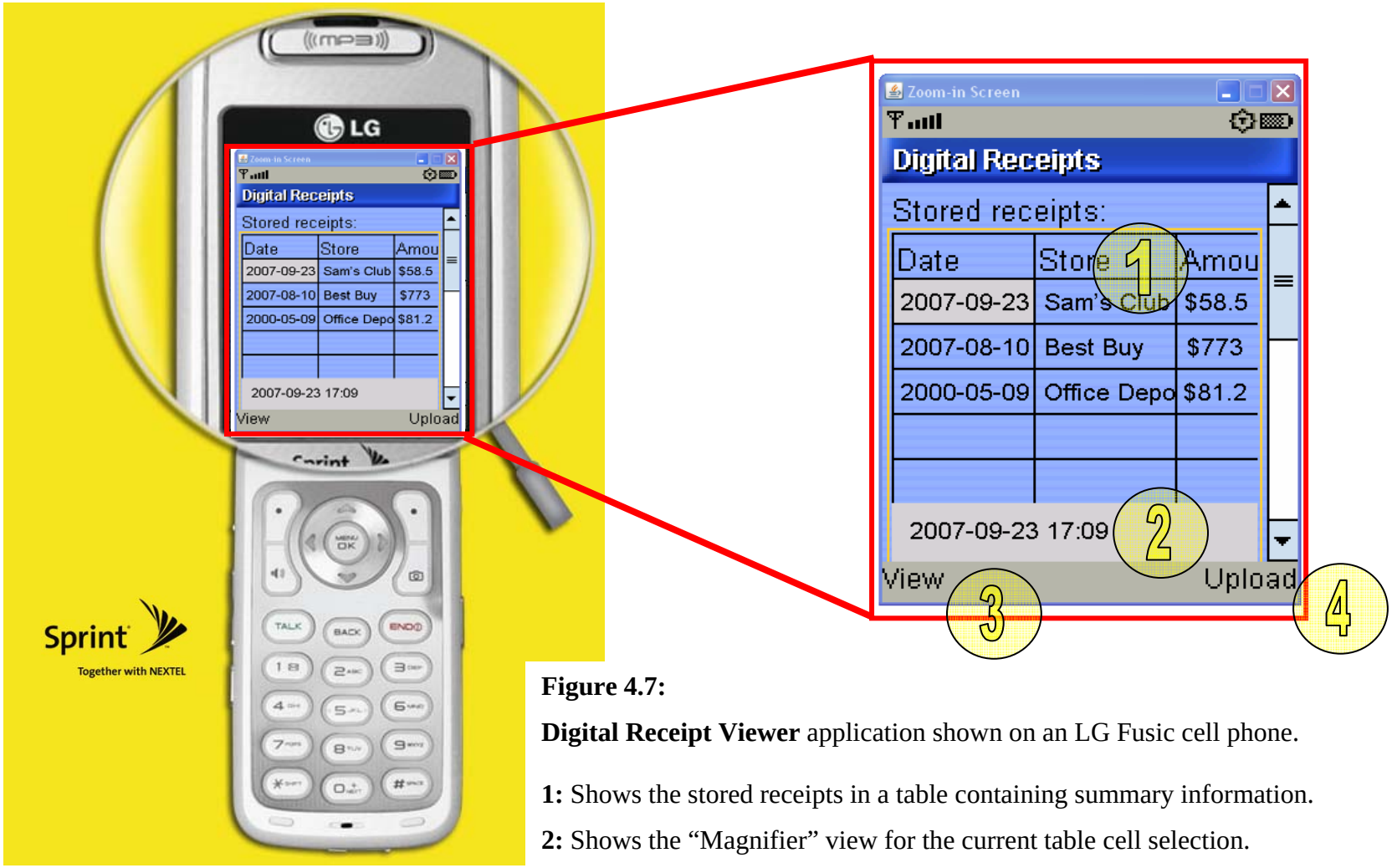

Figure 4.7:

Digital Receipt Viewer application shown on an LG Fusic cell phone.

1: Shows the stored receipts in a table containing summary information.

2: Shows the "Magnifier" view for the current table cell selection.

3: Shows the full scrollable view of current receipt.

4: Allows the user to upload the selected receipt into the Webserver.

4.3 Step 3: Create Personal Webservice Interface

Once the Digital Receipts were uploaded, the user could access them from any Web browser. The goal is to allow the user to create their own personal "Portal" where they could manage, analyze, and mine their transactions. Since the Digital Receipt files were created using a standardized XML schema developed by the Association for Retail Technology Standards (ARTS), the receipts could be easily rendered onto a webpage with an XSL stylesheet to have more dynamic content, including linked logos, promotions, and additional product/vendor information.

Therefore, a Personal Webservice Interface was created using an ASP website application developed with Microsoft's Visual Studio. Since the previous thesis already implemented security and administrative functionalities, this thesis mainly focused on the web interface for viewing and organizing the Digital Receipts. As seen in Figures 4.8-9, the webpage is similar to the Digital Receipt Viewer created on the cell phone. However, it includes additional functionalities such as, better formatting and graphics, hyperlinks, sorting operations, report generation, and data-mining. It should be noted that the report generation and data-mining buttons are for illustrative purposes and were not implemented in this thesis. They are separate webservice modules that would be implemented from another thesis and could be integrated into this webservice, and packaged as a complete Digital Receipt Solution. Together, this system provides both vendors and users the ability to securely send and receive transaction information efficiently through a totally wirelessly medium.

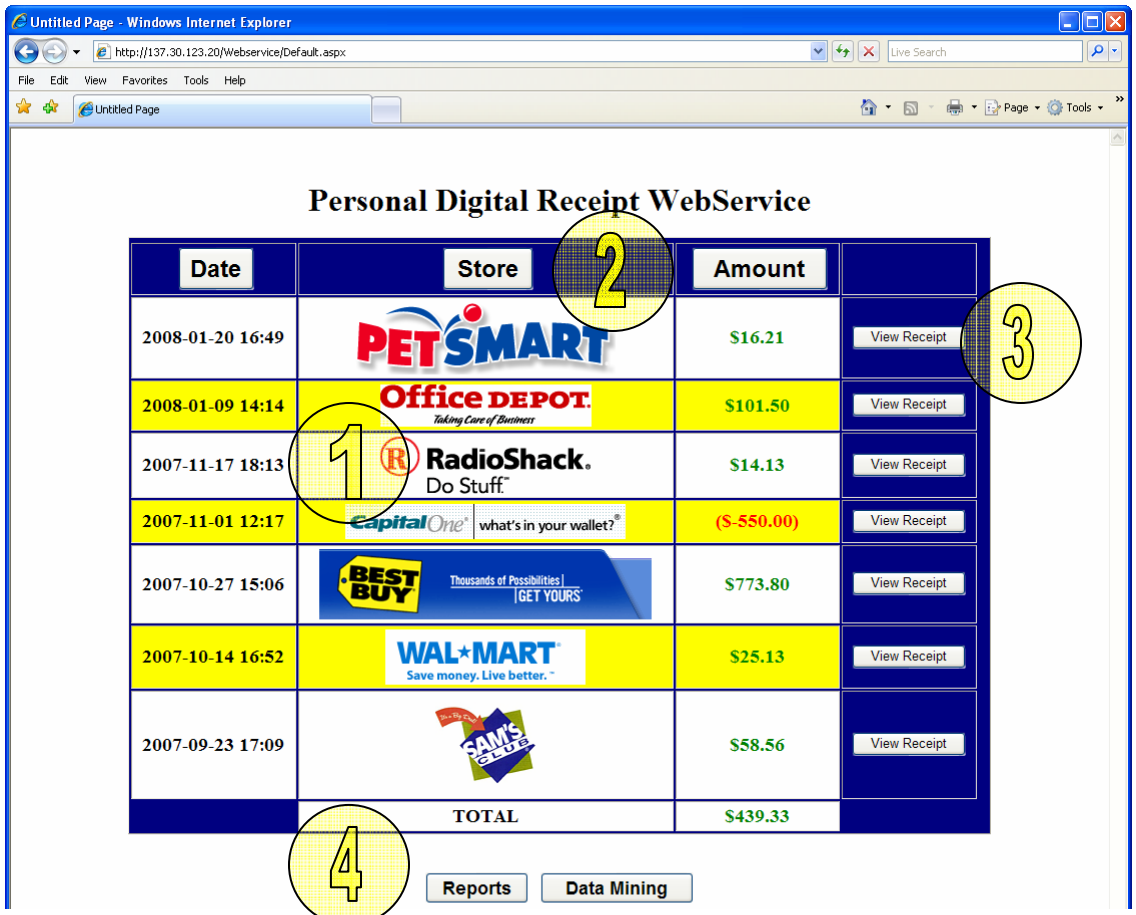

Figure 4.8: Personal Webservice Interface accessed from any web browser to view uploaded Digital Receipts.

1: Table view showing all stored receipts. It will display the store's logo if the URL is a valid image file. Transactions can also be **negative** indicating a credit (i.e. ATM bank deposit).

2: Sort buttons to view by Date, Store, or Amount.

3: Press to view original receipt rendered with stored links, logos, and images. See **Figure 4.9**

4: Future implementation of the Report generation and Data Mining operations for the stored receipts. **(From another thesis)**

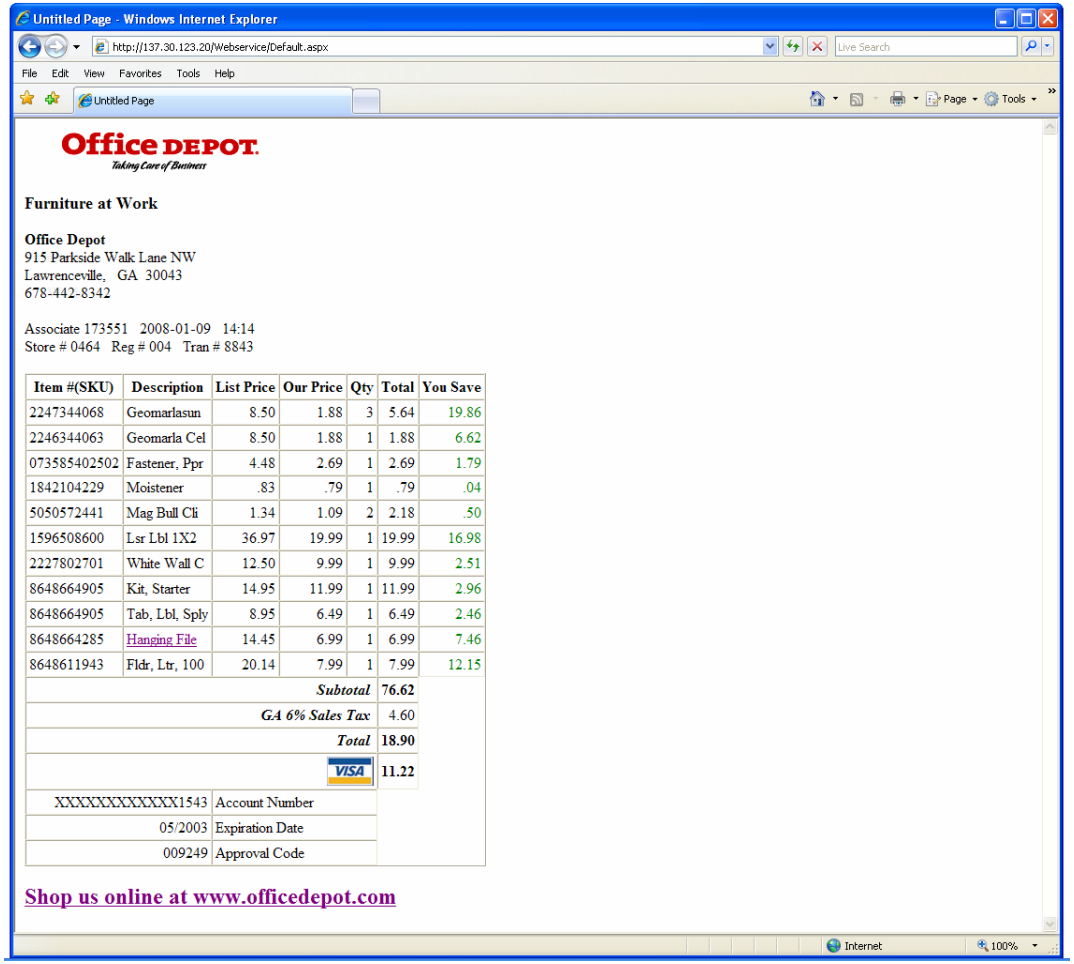

Figure 4.9: Digital Receipt Rendering with formatting and embedded hyperlink content from the XML file.

It includes the store logo, table/text formatting, website and product links, payment information, and promotional text links that were not visible in the Digital Receipt Viewer contained on the cell phone.

Chapter 5. Conclusion

5.1 Summary

In summary, this Digital Receipt System was developed to allow users to easily manage their retail transactions by using wireless Bluetooth connections and today's mobile device technologies. It uses standardized hardware and software components, such as cell phones and PDA's, a digital receipt XML schema developed by a national retail association, and various mobile applications written for the PDA, phone, and Webservice. Thus, resulting in a Digital Receipt System that is easy to use, cost effective, and can be widely accepted by both businesses and individuals.

5.2 Results

The results of this system showed that the various components of the thesis integrated very well together, forming an easy to use yet powerful solution to mange Digital Receipt information.

The simulated POS application showed that using a Bluetooth connection was very convenient. In addition, the automated Device and Service Discovery features provided the user with a quick and secure way to transmit the digital receipts to their cell phones. This setup showed how a Bluetooth enable POS device can be implemented at minimal costs so that businesses can begin issuing receipts wirelessly.

Minor setbacks were encountered during the cell phone implementations, but in the end, resulted in a very intuitive Digital Receipt Viewer for the stored data. These setbacks were mainly due to the manufacturers' reluctance to fully implement the Bluetooth libraries because of hardware limitations and security concerns. However,

these limitations are expected to be resolved once demand for these services improves. As seen in Appendix B, there are over a hundred cell phone models that include the JSR-82 Bluetooth libraries on the market already. Many of these cell phones are not sold in the US currently, but they do show that the necessary hardware will soon be available.

In the meantime, the limitations were overcome by using the cell phone's wireless Internet connection to send the receipts into the Webserver. The advantage gained by the user includes a centralized repository for the data and more flexibility in how to analyze and mine their stored information. By accessing their information through the simple Web Interface, users can now easily manage their stored data through any web browser.

5.3 Comparisons

This Digital Receipt System contains various components that are different from the three previously mentioned receipt systems. While the other systems use a fax and scanner to digitize and transfer their receipts, this system relies exclusively on the newer wireless Bluetooth and mobile Internet connections to quickly transfer the data from one device to another. By using mobile devices like cell phones and PDA's to deliver and store the receipts, this system gives users the flexibility to manage their transactions from anywhere at anytime. In addition, the standardized XML schema used allows the system to be fully portable among the various computing devices. Finally, by allowing the user to upload their receipts into a personal Webservice, this system provides users with new capabilities to instantly analyze, mine, and export their transactions simply by logging in from any web browser. These capabilities were not properly integrated in the previous systems, but have shown to be essential components toward the creation of a truly Digital Receipt Solution.

5.4 Future Work

This thesis shows the many advantages of using a totally Digital Receipt System. However, its full potentials have not yet been realized because of today's hardware and network limitations. As an integral component of this thesis, the cell phone is expected to become more powerful as new models with more resources are available. These advances should make old applications work even better and allow for the creation of new applications that have yet to be developed. Among the advances in mobile technologies include:

Faster Mobile Networks -- including Wi-Fi, Wi-Max (4G), and LTE (Long Term Evolution) initiatives to allow for up to 100Mbps wireless connections, thus matching today's wired broadband connection speeds (Lawson, 2007).

Better Hardware -- new multi-point touch screens, faster processors, more memory, biometric security features, higher resolution cameras, smaller electronic components, etc. to enhance its form and add new functionalities for more powerful applications (Williams, 2007).

Speech Recognition -- better speech recognition software being developed by Vlingo Corp in Cambridge, Massachusetts would provide users with new ways to interact with their phones, potentially making them even smaller and easier to use without the need for buttons (Levine, 2007).

Therefore, given all these potential advances, the mobile revolution still has many more innovations to offer. The challenge will be to expand this Digital Receipt System to retailers, payment processors, mobile phone companies, and individuals to use in managing their transactions. In addition, the personal Webservers can be expanded to include not just receipts, but also other useful personal information, including recipes, stocks, blogs, RSS feeds, news, etc. As a result, this will form the foundation for a Portal containing many different types of information all conveniently located for the user to access and use at anytime from anywhere.

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Appendix A: Full IXRetail XML Schema From ARTS

Receipt	HeaderText : Text
	Issuer : **Party**
	Recipient : **Party**
	CopyTo : **Party**
	Location : **Party**
	Device
	TransactionID : NameToken
	DateTime : dateTime
	TotalAmount : MonetaryAmount
	RelatedReceipt : TransactionID
	TransactionDetail

Party	PartyID : NameToken
	OrganizationName : string
	ContactName
	Address : **Address**
	Telephone : Telephone
	Email : string

Device	DeviceID : string
	TransactionNumber : nonNegativeInteger

TransactionDetail	ShipTo : **Party**
	BillTo : **Party**
	Shipment
	Operator : **Associate**
	Salesperson : **Associate**
	Total
	CustomerLoyaltyAccount
	ReturnItem : **SaleItem**
	SaleItem : **SaleItem**
	GiftCertificate: **GiftcertificateLineItem**
	Discount : **Discount**
	Shipping
	Tax
	Tender
	TenderChange
	LoyalityPointsAwarded
	TrailerText : Text
	PromotionText

ContactName	Name : string
	PersonName : **PersonName**

Address	Street1 : string
	Street2 : string
	Street3 : string
	City: string
	County : string
	State : string
	PostalCode : string
	Country : string

Shipment	Carrier : Text
	ShipmentTrackingID : NameToken
	ServiceLevel : Text

Associate	AssociateID : string
	Name : string
	PersonName : **PersonName**

Total	Text : Text
	Amount : Amount
	ItemCount : integer

CustomerLoyaltyAccount	Text
	CustomerAccountID
	EffectiveDate : date
	ExpirationDate : date
	CumulativeSales : MonetaryAmount
	CumulativePoints : integer

PersonName	Prefix : string
	Firstname : string
	MiddleName : string
	LastName : string
	Suffix : string

SaleItem	Text : Text
	POSItemID : positiveInteger
	ItemAlternateID : **ItemAlternateID**
	Quantity : float
	UnitPrice : MonetaryAmont
	ActualUnitPrice : MonetaryAmount
	ExtendedAmount : MonetaryAmount
	PackageQuantity : nonNegativeInteger
	PackagePrice : MonetaryAmount
	RegularPrice : MonetaryAmount
	ListPrice : MonetaryAmount
	DepartmentID : NameToken
	SerialNumber : string
	ItemDiscount : **Discount**
	ItemStatus
	Tax
	CustomerIdentification : **CustomerIdentification**
	Salesperson : Associate
	OriginalTransaction : TransactionReference

GiftCertificateLineItem	GiftCertificateID : NameToken
	FaceValueAmount : Amount
	UnspentBalanceAmount : Amount

Shipping	Text : Text
	Amount : Amount

ItemAlternateID	ItemID : NameToken
	ClassID : NameToken
	ManufacturerID : NameToken
	StyleCode : NameToken
	ColorCode : NameToken
	SizeCode : NameToken
	UserExtension

Discount	Text : Text
	Amount : Amont
	ReductionPercent : float

ItemStatus	PintCode : string
	Taxable : boolean
	FoodStampEligible : boolean
	WICEligible : boolean

Tax	Text : Text
	Amount : Amount
	TaxbleAmount : MonetaryAmout
	TaxRate : Percentage
	InputTaxAmount : MonetaryAmount
	TaxExempt : boolean
	TaxAuthorities : TaxAuthorityList
	TaxInclusive : boolean

Tender	Text : Text
	Amount : Amount
	ForeignCurrencyAmount : float
	CustomerIdentification : **CustomerIdentification**
	Authorization
	Cheque
	Credit : **PaymentCard**
	Debit : **PaymentCard**
	GiftCertificate : **GiftCertificateTender**
	CustomerAccount
	PurchaseOrder
	Coupon

TenderChange	Text : Text
	Amount : Amount
	TenderType : string

LoyaltyPointsAwarded	Text : Text
	PointsAwarded : integer
	PointsType

PromotionText	Text : Text
	StructuredText : StructureText

Coupon	CouponID : GTIN
	ExtendedCode : NameToken

CustomerIdentification	PersonalID : string
	BirthDate : date
	SignatureImage : base64Binary

Authorization	ProviderID : string
	ApprovalCode : string
	ReferenceID : NameToken
	ReasonCode : NameToken
	ApprovalDateTime : dateTime
	AddressVerification : <None>

Cheque	BankID : positiveInteger
	ChequeAccountNumber : positiveInteger
	ChequeNnumber : positiveInteger

PaymentCard	AccountNumber : AccountNumber
	CardExpirationDate : string
	CardHolderName : string

GiftCertificateTender	GiftCertificateID : NameToken
	FaceValueAmont : Amount
	UnspentBalanceAmount : Amount

CustomerAccount	AccountNumber : AccountNumber
	BalanceForward : MonetaryAmount

PurchaseOrder	PurchaseOrderID : NameToken
	Date : date
	AuthorizedAmount : MonetaryAmount
	Contact : Party

Appendix B: List of JSR-82 Bluetooth Enabled Cell Phones

** Indicate GSM Network only, Non-US phones

Motorola	Nokia		Sony-Ericsson	Siemens	BenQ	Samsung	Sendo
A780	2630	6600**	D750**	C65**	P30**	SGH-D720	X**
A845	2660	6611	K320**	CX70**	P31**	SGH-D730	X2**
A910	2760	6620**	K510**	CX75**	S65**	SGH-D900**	
A1000**	2865	6630	K550**	EF81**	S68**	SGH-D908**	**Qtek**
E770	2865i	6670**	K600**	M75**	S71**	SGH-E250**	XDAII**
E1000	3109	6680	K608**	S65**	S75**	SGH-E258**	
E1070**	3110 Classis	6681**	K610**	S6V**	S81**	SGH-E380**	**Panasonic**
MOTOQ q9	3230**	6682DP2**	K630**	S75**	SK65**	SGH-E388**	X701**
MOTOMING A1200	3250**	7370**	K666**	SK65**	SXG75**	SGH-E390**	
FOMO M1000**	3500	7373**	K750**	SX1**	EF81**	SGH-E500**	**HTC**
L6i	5200**	7390	K770**	SXG75**		SGH-E740**	Himalaya**
MOTOSLVR/SLVR L7	5300**	7500 Prism**	K790**			SGH-E780**	
MOTOSLVR L7i/L7e	5500	7610**	K800**			SGH-E788**	**Lenova**
PEBL/V6	5610	7700	K810**			SGH-E840**	P930**
PEBL U3	5700	7710	K850**			SGH-E898**	
PEBL U6	6021**	7900 Prism	P900**			SGH-F500	**LG**
RAZR V3x	6085**	8600 Luna	P908**			SGH-G600**	PM 235**
MOTORAZR V3**	6086**	8800**	P910**			SGH-M610**	LG 550
MOTORAZR V3i**	6103	8801**	P910a**			SGH-P260**	CU575**
MOTORAZR V3t	6110	9300**	P910c**			SGH-P520**	LX550
MOTORAZR V3x	6111	9500**	P910i**			SGH-T729**	LX570**
MOTORAZR V3xx**	6120	E50	P990**			SGH-U600**	
MOTORAZR V9	6121	E51	S500**				
MOTORAZR maxx V6	6125**	E60**	T650**				
MOTOROKR K1**	6126**	E61i**	V600**				
MOTOROKR K3	6131**	E62**	V640**				
MOTOROKR E1	6133	E65	W300**				
MOTOROKR E2	6136	E70**	W550**				

Motorola	Nokia		Sony-Ericsson
MOTOROKR E6	6151	E90	W580**
MOTOROKR U9	6155	N70**	W600**
MOTOROKR Z3**	6230**	N71**	W610**
MOTORIZR Z3	6230i**	N72	w660**
MOTORIZR Z8	6233	N73	W700**
E770	6234	N75	W710**
V1100	6255**	N76**	W800**
V197**	6260**	N77	W810**
V360/V365**	6265**	N80	W830**
V361	6265i	N81**	W850**
V80**	6267	N90**	W880**
C975	6270**	N91	W890**
W490	6275**	N92	W900**
W510**	6275i**	N93	W910**
i516	6280**	N95	W950**
i580	6282**		V600i**
i605	6288		Z520**
i615	6290**		Z525**
i870	6300**		Z530**
i875	6301**		Z550**
i880	6500		Z558**
ic902	6555		Z610**
			Z750**
			Z710**
			X710**
			JP-5**
			JP-6**
			JP-7**
			JP-8**

Vita

Doc Lap Nguyen was born in Binh Tuan, Vietnam on September 14, 1974. He attended Sherwood Forest Elementary School and Ellenor McMain Magnet High School in New Orleans, Louisiana. He attended Tulane University and graduated with a Bachelor of Science in Biomedical Engineering in May of 1997.

He worked in Louisiana State University Health Sciences Center as an IT Analyst and attended the University of New Orleans part-time to obtain a Masters of Science in Computer Science in 2004. He worked with the chairman of the department, Prof. Mahdi Abdelguerfi, and Dave Milla in the development of a prototype for the Digital Receipt System.