Internet Prepaid Card

by

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CERTIFICATION OF APPROVAL

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A project dissertation submitted to the
Information Technology Programme
Universiti Teknologi PETRONAS
in partial fulfillment of the requirement for the
BACHELOR OF TECHNOLOGY (Hons)
(INFORMATION TECHNOLOGY)

Approved by,

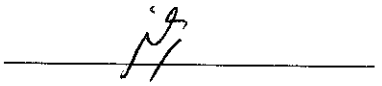
_____

(Mr. Mohammad Noor Ibrahim)

UNIVERSITI TEKNOLOGI PETRONAS
TRONOH, PERAK
June 2004

CERTIFICATION OF ORIGINALITY

This is to certify that I am responsible for the work submitted in this project, that the original work is my own except as specified in the references acknowledgements, and that original work contained herein have not been undertaken or done by unspecified sources or persons.



NOR SYARINA MOHAMAD NORDIN

ABSTRACT

The project focuses on development of a java smart card application to be used as Internet prepaid card. The main objectives of this project are to study the smart card technology architecture and to develop an Internet prepaid card application for Internet usage in Universiti Teknologi PETRONAS (UTP) using java smart card. Currently, UTP students pay a huge fixed amount for Internet fees every semester. The frequent inaccessibility of the network made this an undesirable approach as students cannot utilize the internet to its maximum as compared to the amount they paid. Furthermore students' usage of the internet varies from one student to another. Some students either uses it rarely or did not use at all while some students are heavy users. Thus, it is unfair for the students to be charged the same amount every semester. Looking at this, the author took advantage of the widely available technology that is simple and easy to use to try to solve the current problem faced. The system was developed in 6 phases throughout 5 months. For future improvement, the system can be integrated with bank so that balance will be deducted straight from user bank account. The system can also be enhanced to be a web-based system so that it will be more efficient.

ACKNOWLEDGEMENT

Firstly, I would like to express deepest gratitude to Allah S.W.T for giving the strength, wisdom and patience in order to complete this project as per time given.

I also would like to indicate that this project would have never completed without the help and support from many people. I would like to send my deepest gratitude and thanks to Mr. Mohammad Noor Ibrahim, Lecturer in Universiti Teknologi PETRONAS who was her Final Year Project Supervisor for all the guidance, support , good patience , advises and motivation which really helped and gave my inspiration and strength to complete this project.

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CHAPTER 1
INTRODUCTION

1.1 BACKGROUND OF STUDY

The project concerns with the implementation of java card that will be used as Internet prepaid card. The main purpose of the project is to ensure the efficient utilization of UTP network. There is a centralized system where each card data will be stored in one database. Students can check their card balance using their pc anywhere as long as the pc is connected to the UTP intranet.

The implementation of Internet prepaid card is not a new thing. Companies all around the world has been producing Internet prepaid card as an alternative for users who want to control their Internet usage or are not frequent users of the technology. Therefore, this project is suitable to be carried out in UTP as an attempt to solve the problem currently faced by the students and will not incur too much cost.

Currently, students pay a prefixed amount of Internet fees during their registration. Once the project is implemented, students will only pay for the amount they have used. This will cut down the huge amount students will have to pay every semester and ensure that their usage is worth for every cent they pay. Students who use the Internet heavily will have to pay more and this will be fair to students who are light users. Once their card balance is running low, they can simply reload their card using the reload kiosk stationed around the campus.

Any students that wish to log in the UTP network and use the Internet will first have to register for an account with the system administrator. They will be issued their

first Internet prepaid card to use to activate their login account. The card balance is based on the student need and must be paid during the registration for the account.

The implementation of this project requires the investment in smart card, the smart card readers and also reload kiosk. This will incur some cost but is a good investment that will benefit the students. For further enhancement, UTP can set up collaboration with the bank so that students can reload their debit card by simply deducting balance from their savings.

1.2 PROBLEM STATEMENT

1.2.1 Problem Identification

The author identified the problem from observation and own experience. To confirm the problem, the author talked to some of the colleagues. Many of them do not object to the implementation of the Internet prepaid card as it will benefit all students and solve these problems:

The frequent inaccessibility of the UTP network and the Internet

Recently, the network was down for about one month as there was a major worm attack on the UTP servers. Students could not log in to the network and use the Internet. The problem affected students as they could not surf the Internet to look for resources or log in to e-learning to check for announcements and lecture notes from the lecturers.

Students pay a huge amount of fees for Internet usage but can not utilize it to its maximum

This problem applies especially when the network is down. This is because students have paid the Internet fees but the service is not available.

Some students does not use the Internet frequently and some use more than the others

There are some students who do not use the UTP network as much as they paid. Some students are heavy users that the amount they used exceeds the fees they paid.

1.2.2 Significance of Project

Implementation of this project would mean that the users in Universiti Teknologi Petronas (UTP) will be using the smart card to login to the network and use the Internet. The current problem of not being able to use the Internet at the optimum level compared to the fees that has been paid every semester can be solved. Only users who own the smart card with sufficient balance can log in to the network and use the Internet. This way, unauthorized usage of Internet will no be allowed. The smart card will contains security features for user authentication and keeping track of user login activity.

1.3 OBJECTIVE AND SCOPE OF STUDY

1.3.1 Objectives

The project has a few objectives or goals to be met which are as follows:

- To study the smart card technology architecture
- To develop a java smart card application as Internet prepaid card for Internet usage in UTP

1.3.2 Scope of Study

The project focuses on developing a java smart card as an Internet prepaid card. The card will be used in UTP area only. The smart card will only store student ID and also their current balance. Other data such as user personal details and usage details will be stored in database.

1.3.3 Feasibility of Project within Scope and Time Frame

A time frame of about five months is given to complete the project. The system will be developed according to phases. The first month is used for problem identification phase and analysis phase. The outputs from these phases are used in the next phase which is the research phase. The research phase took one month to ensure that author will fully understand the system flow and the supporting facts so that author can proceed to the next phase. The next phase is design phase which took one month where author focused on designing the interface. Upon completion, author started developing the design and coding the smart card. The last month is dedicated to integrating the parts of the system and testing them as a whole.

CHAPTER 2
LITERATURE REVIEW

2.1 SMART CARD TECHNOLOGY

2.1.1 Overview of Smart Card

A smart card – a type of chip card – is a plastic card embedded with a computer chip that stores and transacts data between users. This data is associated with either value or information or both and is stored and processed within the card's chip, either a memory or microprocessor. The card data is transacted via a reader that is part of a computing system. Smart cards are also often called *chip cards* or *integrated circuit (IC) cards* (Mike Hendry, 1997, pp 4). Chip cards that do not contain a microprocessor are not considered a smart card by industry professionals. Chip card without a microprocessor is not a smart card since it has no intelligence for calculations and processing (Jack M. Kaplan, 1996, pp 5).

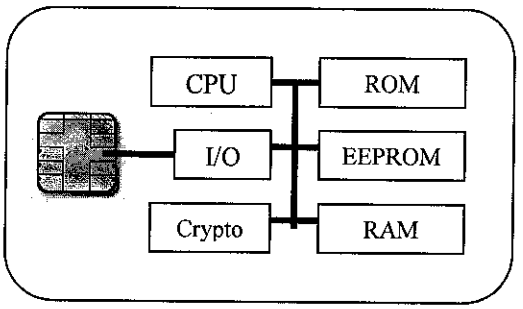

Figure 2.1 *Internal structure of a smart card*

First introduced in Europe over a decade ago, smart cards debuted as a stored value tool for pay phones to reduce theft. As smart cards and other chip-based cards advanced, people found new ways to use them, including charge cards for credit purchases and for record keeping in place of paper.

In the U.S., consumers have been using chip cards for everything from visiting libraries to buying groceries to attending movies, firmly integrating them into our everyday lives. Several states have chip card programs in progress for government applications ranging from the Department of Motor Vehicles to Electronic Benefit Transfer (EBT). Many industries have implemented the power of smart cards into their products such as the new GSM digital cellular phones to TV-satellite decoders.

2.1.2 Why Smart Card

Smart cards greatly improve the convenience and security of any transaction. They provide tamper-proof storage of user and account identity. Smart cards also provide vital components of system security for the exchange of data throughout virtually any type of network. They protect against a full range of security threats, from careless storage of user passwords to sophisticated system hacks. Multifunction cards can also serve as network system access and store value and other data.

Advantages of Smart Card

The smart card system is designed for current distributed processing systems and open communications systems. Many of the functions that reside on the magnetic stripe mainframe systems, such as rules for authorization, program logic, and restricting card usage, are transferred to the smart card itself. Additionally, the cards can be updated, made multi-functional, and can be used at locations that are not connected to dedicated networks. Thus, smart card systems offer greater data storage, processing capability, and more secure technologies; as well as being faster and less expensive to operate.

Information storage and management is the primarily use of smart cards. Simply put, smart cards are portable and robust data-storage devices. There are three operational advantages for storing data on smart cards. The first advantage is that a smart card can operate independently of a central database which allows users and system interfaces in previously impractical locations (i.e., isolated environments). The second, related, advantage is that a smart card allows real-time monitoring of user-status, independent of either the transaction or the original data repository locations. The third advantage is that a smart card's functions and applications can be combined into one multi-use data source.

Authentication is the second function of smart cards. Authentication determines whether the card allows a transaction to take place. It does this by allowing entry into the card's memory. The use of a personal-identification number (PIN) is the most common form of smart card authentication. The advantage the smart card's authentication function is that the authentication data does not have to be transmitted; the smart card offers the ability for the point of interface to enter the user-provided value directly onto the card for comparison.

This is a more secure system than the authentication function of a magnetic-stripe reading card, which requires the host system to authenticate data from the card and then compare it with a value provided by the card-user (via a PIN pad). The smart card's ability to perform the authentication within the card eliminates the need to make authentication data available to a potentially fraudulent external party.

Encryption and decryption are the final function of smart cards. Encryption and decryption allow for a highly secure transmission of sensitive information through an unsecured medium. This function is similar to the authentication function in that smart cards allow for encryption and decryption within the embedded chip. This means that the secure data does not have to be transferred from the card to a reader or other device, which reduces the chance of encryption-algorithm or private-key theft. Thus, the advantage of the encryption and decryption function of the smart card is that it can

perform remote transactions independent of the security of the system it is connected through (Jana Zamud, 1999, pp 3).

2.1.3 Types of Chip Card

Smart cards are defined according to the type of chip implanted in the card and its capabilities. There is a wide range of options to choose from when designing the system.

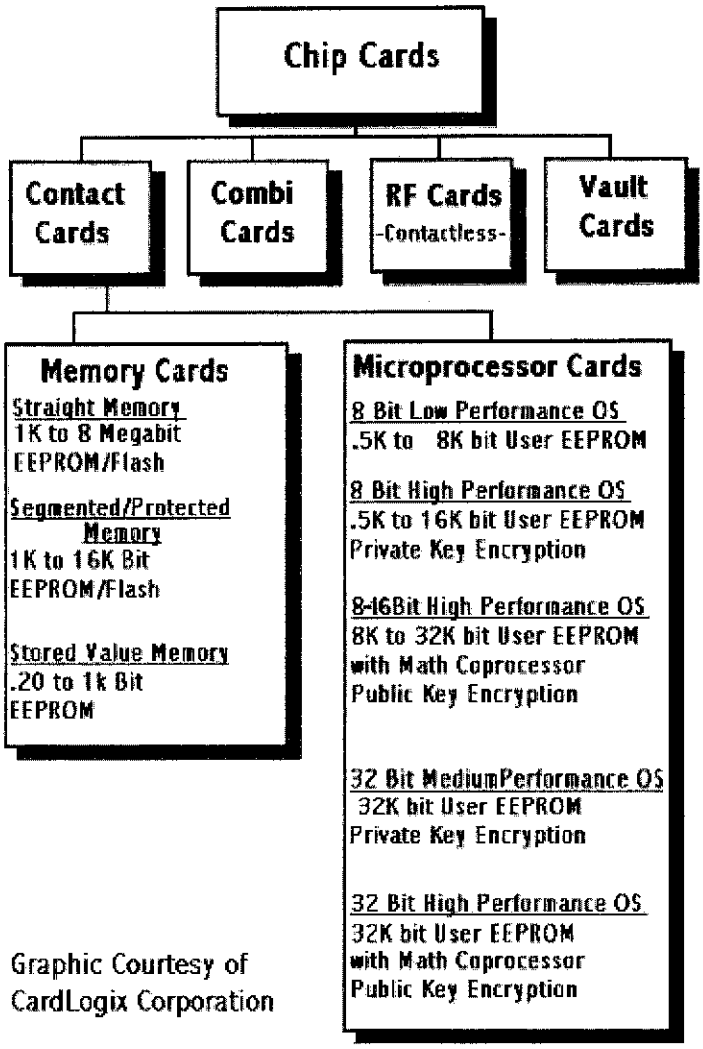

Figure 2.2 *Types of Chip Card (Source: www.smartcardbasics.com)*

Increased levels of processing power, flexibility and memory add cost. Single function cards are often the most cost-effective solution. The following chart demonstrates the general rules of thumb.

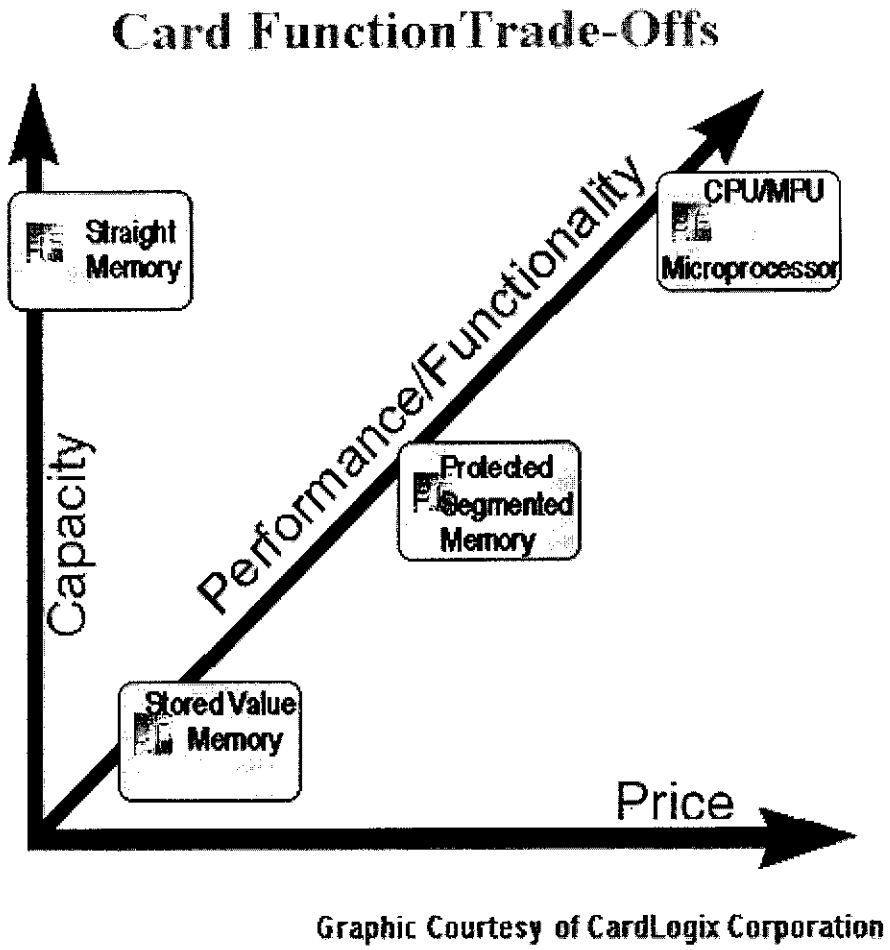

Figure 2.3 *Card Function Trade Offs (Source: www.smartcardbasics.com)*

Memory Cards

Memory cards have no sophisticated processing power and cannot manage files dynamically. All memories communicate to readers through synchronous protocols. There are three primary types of memory cards:

Straight Memory Cards

These cards just store data and have no data processing capabilities. These cards are the lowest cost per bit for user memory. They should be regarded as floppy disks of varying sizes without the lock mechanism. These cards cannot identify themselves to the reader, so your host system has to know what type of card is being inserted into a reader.

Protected / Segmented Memory Cards

These cards have built-in logic to control the access to the memory of the card. Sometimes referred to as Intelligent Memory cards these devices can be set to write protect some or all of the memory array. Some of these cards can be configured to restrict access to both reading and writing. This is usually done through a password or system key. Segmented memory cards can be divided into logical sections for planned multi-functionality

Stored Value Memory Cards

These cards are designed for the specific purpose of storing value or tokens. The cards are either disposable or rechargeable. Most cards of this type incorporate permanent security measures at the point of manufacture. These measures can include password keys and logic that are hard-coded into the chip by the manufacturer. The memory arrays on these devices are set-up as decrements or counters. There is little or no memory left for any other function. For simple applications such as a telephone card the chip has 60 or 12 memory cells, one for each telephone unit. A memory cell is cleared each time a telephone unit is used. Once all the memory units are used, the card becomes useless and is thrown away. This process can be reversed in the case of rechargeable cards.

CPU/MPU Microprocessor Multifunction Cards

These cards have on-card dynamic data processing capabilities. Multifunction smart cards allocate card memory into independent sections assigned to a specific function or

application. Within the card is a microprocessor or microcontroller chip that manages this memory allocation and file access. This type of chip is similar to those found inside all personal computers and when implanted in a smart card, manages data in organized file structures, via a card operating system (COS). Unlike other operating systems, this software controls access to the on-card user memory. This capability permits different and multiple functions and/or different applications to reside on the card, allowing businesses to issue and maintain a diversity of 'products' through the card. One example of this is a debit card that also enables building access on a college campus. Multifunction cards benefit issuers by enabling them to market their products and services via state-of-the-art transaction technology. Specifically, the technology permits information updates without replacement of the installed base of cards, greatly simplifying program changes and reducing costs. For the card user, multifunction means greater convenience and security, and ultimately, consolidation of multiple cards down to a select few that serve many purposes.

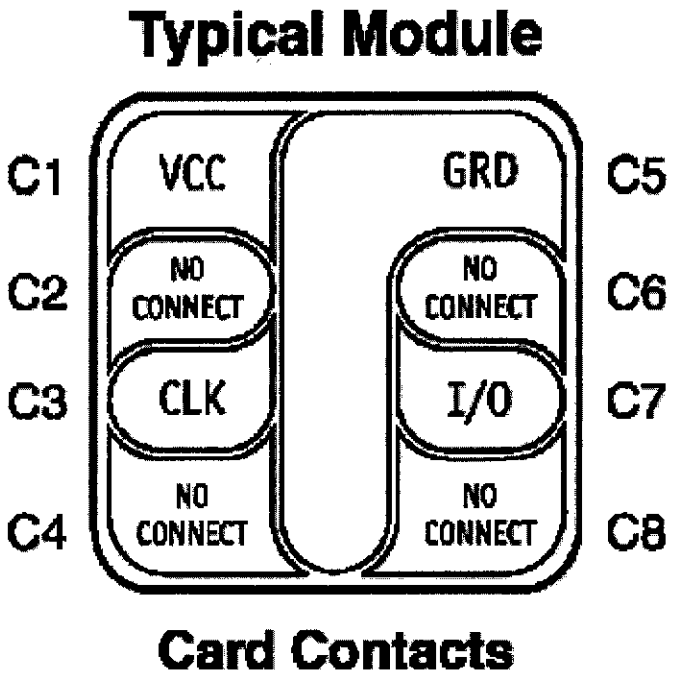

Figure 2.4 *Typical modules of microprocessor multifunction cards (Source: www.smartcardbasics.com)*

2.1.4 Areas of Smart Card Application

Smart card-enhanced systems are in use today throughout several key applications, including healthcare, banking, entertainment and transportation. To various degrees, all applications can benefit from the added features and security that smart cards provide. According to Dataquest, 1999, the worldwide smart card market will grow to 4.7 Billion units and $6.8 Billion by 2002. The use of smart cards is expected to skyrocket over the next few years (Jack M. Kaplan, 1995, pp 26).

Table 2.1 *Smart Card Market Forecast (Source: www.frost.com)*

Smart Card Market: Percent of Unit Shipment by Application (India), 2001-2005

Year	Telecom (%)	Banking & Retail (%)	Transport (%)	Healthcare (%)	Government (%)	Others (%)
2001	68.9	16.5	0.55	0.03	13.7	0.32
2002	66.5	17.9	0.53	0.03	14.7	0.34
2003	64.0	19.4	0.57	0.04	15.6	0.39
2004	62.5	20.7	0.57	0.04	15.8	0.39
2005	59.6	23.7	0.72	0.05	15.5	0.43

Note: All figures are rounded; the base year is 2001. Source: Frost & Sullivan

People worldwide are now using smart cards for a wide variety of daily tasks, these include:

Loyalty and Stored Value

A primary use of smart cards is stored value, particularly loyalty programs that track and incentivize repeating customers. Stored value is more convenient and safer than cash. For issuers, float is realized on unspent balances and residuals on balances that are never used.

For multi-chain retailers that administer loyalty programs across many different businesses and Point of sale systems, smart cards can centrally locate and track all data. The applications are numerous, from parking and laundry to gaming, as well as all retail and entertainment uses

Securing Information and Physical Assets

In addition to information security, smart cards achieve greater physical security of services and equipment, because the card restricts access to all but the authorized user(s). E-mail and PCs are being locked-down with smart cards. Information and entertainment is being delivered via to the home or PC. Home delivery of service is encrypted and decrypted per subscriber access. Digital video broadcasts accept smart cards as electronic keys for protection. Smart cards can also act as keys to machine settings for sensitive laboratory equipment and dispensers for drugs, tools, library cards, health club equipment etc.

E-Commerce

Smart cards make it easy for consumers to securely store information and cash for purchasing. The advantages they offer consumers are:

- The card can carry personal account, credit and buying preference information that can be accessed with a mouse click instead of filling out forms.
- Cards can manage and control expenditures with automatic limits and reporting.
- Internet loyalty programs can be deployed across multiple vendors with disparate POS systems and the card acts as a secure central depository for points or rewards.
- "Micro Payments" - paying nominal costs without transaction fees associated with credit cards or for amounts too small for cash ,like reprint charges.

Table 2.2 lists some of the examples of Electronic Purses around the world (Henry Dreifus and J. Thomas Monk, 1997, pp 10)

Table 2.2 Examples of Electronic Purses

United States	Zeelandkart, Netherlands
1996 Summer Olympics, Visa Cash	SEMP, Spain
Manhattan Trial, Chase Manhattan Bank	SIBS, Portugal
Ohio Dominion College	Danmont, Denmark
Oklahoma State University	Zolotaya Korona, Russia
Florida State University	
University of Michigan	**Canada**
Central Michigan University	Restaurants Normadin, Canada
Western Michigan University	
Northern Michigan University	**Australia**
Washington University in St. Louis	Freedom, Wizard Card
Citibank	
U.S Marine Crops, Parris Island	**Asia**
University of Pennsylvania	Bank of China
Movie Gold System	Thai Farmers Bank
Arksys	Nippon Telegraph and Telephone, Kochi Prefecture, Japan
Jacksonville Jaguars, Visa Cash	Wasida University, Japan
Carolina Panthers, Visa Cash	MalaysianCard, Malaysia
Lawrence Technological University	NETS, Singapore
Louisville Public Schools	CashCard, Singapore
Worldwide	
Mondex	**Middle East**
Visa Cash	Unicard, Israel
Proton	
Europe	**South America**
Eurocheque, Europe	Moeda Electonica Bradesco, Brazil
Caf— Project, Europe	
Avant, Finland	**Africa**
Quik, Austria	Mericien Biao
	Net/1 Megalink South Africa

Personal Finance

As banks enter competition in newly opened markets such as investment brokerages, they are securing transactions via smart cards at an increased rate. This means:

- This will improve customer service. Customers can use secure smart cards for fast, 24-hour electronic funds transfers over the Internet.

- Costs are reduced: transactions that normally would require a bank employee's time and paperwork can be managed electronically by the customer with a smart card

Health Care

The explosion of health care data brings up new challenges to the efficiency of patient care and privacy safeguards. Smart cards solve both challenges with secure storage and distribution of everything from emergency data to benefits status.

- Rapid identification of patients; improved treatment
- A convenient way to carry data between systems or to sites without systems.
- Reduction of records maintenance costs

Telecommuting and Corporate Network Security

Business to business Intranets and Virtual Private Networks "VPNs" are enhanced by the use of smart cards. Users can be authenticated and authorized to have access to specific information based on preset privileges. Additional applications range from secure email to electronic commerce

Campus Badging and Access

Businesses and universities of all types need simple identity cards for all employees and students. Most of these people are also granted access to certain data, equipment and departments according to their status. Multifunction, microprocessor-based smart cards incorporate identity with access privileges and also store value for use in various locations, such as cafeterias and stores.

Telephony and Telecommunications Applications (Mike Hendry, 1997, pp 145)

Most types of telephone systems suffer from some fraud and losses. True figures are difficult to establish, but the total fraud from public card telephones and analog cellular

systems in Europe is probably of the order of $1 billion a year. In North America it is reckoned to be twice that figure. The growth of subscription television has provided another opportunity for fraud and subscription evasion, this time at the expense of the broadcasters and service providers. Although much smaller than telephone fraud, some companies estimate their losses at up to $20 million a year.

Prepaid telephone cards

Requirements

Public telephones using cash are expensive to build (they must be very robust to protect the cash from theft), expensive to operate (because of the need for cash collection), and unreliable (cash mechanisms become full, jammed or vandalized). For many years now public telephone operators have exploited various forms of cards of tokens to overcome these problems.

Card telephones should have a minimum number of moving parts and must be able to operate reliably in a wide range of environmental conditions. The cards themselves must be easy to handle for all types of users, and they must be more costly to counterfeit than the maximum value on the card (typically $20 or so).

Although various forms of magnetic and optical cards have been used with success over the years, most telephone operators are now moving towards smart cards as the most effective card form.

Standards

The so-called first generation of telephone cards are simple memory cards with an issuer identification area, logic that prevents the value on the cared from being increased, and usually a relatively small maximum count (100-200 bits. The ore up-to-date cards (known as the second generation) have maximum counts of 20,000 bits or more, card

authentication mechanisms that protect against counterfeiting and emulation, and logic that protects the card in case it is removed during a transaction; many also have a user memory area allowing number storage.

Reloadable and account cards

To avoid the waste of telephone cards, the cards can be made reloadable (see Figure 2.5). Value can be added to a card either using cash (in a controlled environment such as an office or shop) or by transferring money from an account.

A subscriber who already has a telephone account may have his or her account details stored on a smart card; when the card runs out of telephone units, pressing a special button on the telephone loads a fixed value to the card and charges it to the telephone account. The transaction is stored by the telephone and transmitted to the host computer at the end of the day for processing. This method require the use of card authentication and hotlist checking it is also usual to apply limits to the use of a card; there may be a maximum usage rate at one telephone within a period, or the limits can be stored on the card together with a daily usage counter.

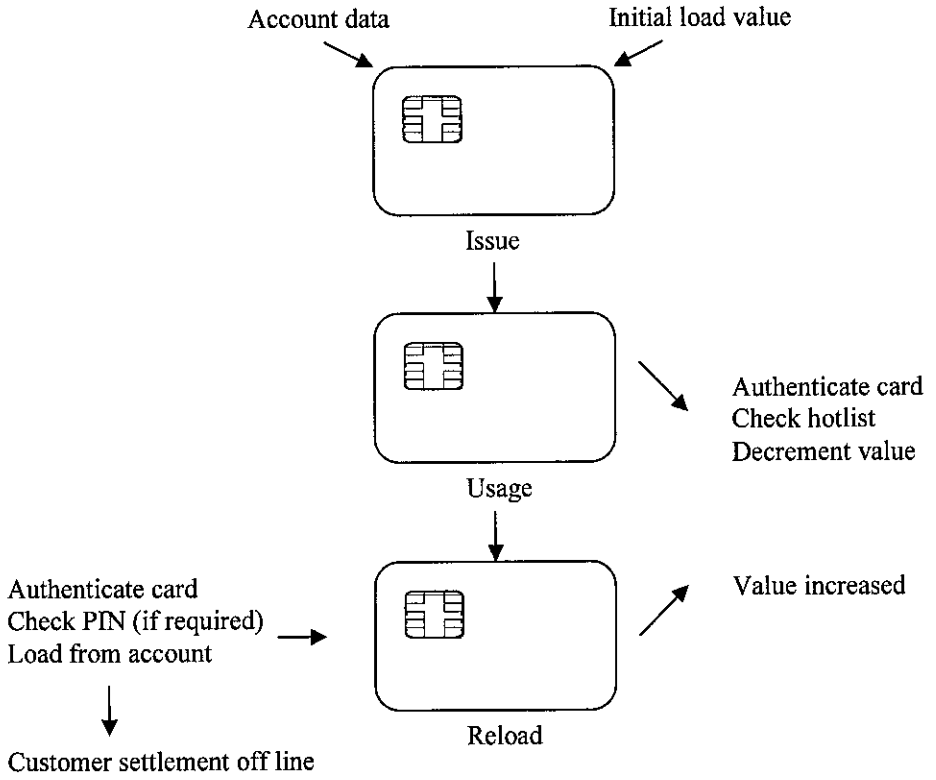

Figure 2.5 Reloadable card

2.1.5 Future of Smart Card

Barriers to Smart Card Success

Having a favorable window of opportunity is attractive, such as exclusive right to a market or with a leading distributor. If a company cannot keep other out of it faces existing entry barriers, it is unattractive. An easily overlooked issue is a company's capacity to gain distribution of its smart card services. SmartCard International assembled all the licensing rights to sell smart cards in the United States, but was unable to secure sufficient distribution for its products. Even though the company had both United States and worldwide licensing rights to sell smart cards, it had no strategic alliance with other companies to assist in the selling and distribution of its products.

A company should be aware of several entry barriers when beginning its marketing assessment of the smart card business opportunity. For the world to become a "smarter" place, these challenges must be met:
(http://www.paceintegration.com/smartCard101.cfm)

- ***Lack of Physical Infrastructure***

  Particularly in North America, there is at present an insufficient amount of terminals to accept chip cards. In a variation on the "chicken and egg" argument, retailers and other organizations may be reluctant to adopt smart cards until they see this critical mass of infrastructure.

- ***Costs***

  Switching to smart cards requires infrastructure transformation, extensive system development, and relatively long implementation lead times.

- ***Uncertainty about the Business Case***

  For some industry verticals, a more compelling business case (which will be abetted by increased physical infrastructure) is needed for adoption of chip cards on a wider scale.

- ***Lack of Consumer Education***

  Public concerns about privacy-invasive and repressive applications of smart card technology are misplaced as the technology facilitates greater security and personal control of data than previous card technologies. To achieve public confidence, people need to be reassured that they will have ultimate control over their sensitive data. The concerns over privacy and security have to be addressed to ensure that the ownership of the cards is in the hands of the cardholders and not authorities.

Disadvantages of Smart Card

Issues of safe guarding the privacy of personal information on smart cards are posing a major social concern. In order to alleviate concerns with the amount of personal information stored on smart cards, a PIN or personal identification number is needed to access information. Another disadvantage is the amount of data that can be stored on the IC chip. Fortunately, each year technological teams have been able to increase the

amount of information that can be stored on the chips. Another disadvantage is that many vendors that are not willing to participate in the smart card program lose customers to willing participants.

Smart cards are slow to read. Reading all 32K from a smart card can take 45 seconds. Writing takes even longer. It's a big disadvantage of smart cards (probably their only disadvantage), but at least they can't be "scanned" like memory cards can.

Smart Cards Gaining Acceptance among Consumers

The Smart Card Forum, an organization comprised of corporations involved in smart card technology, conducted a study of 1000 consumers entitled "Reaction to Smart Card Technology." The study indicated that two-thirds of consumers perceive smart cards as a viable option for carrying information about medical and insurance data. It also suggested that 40 percent of consumers would prefer to use smart cards for daily purchases instead of carrying cash. The major benefits that most consumers included were the convenience and security of not carrying cash, the ability to control expenditures more effectively, and the reduction of paperwork. Another major benefit cited was using one card for multiple services, thus eliminating the need for multiple cards.

Consumers indicated several potential drawbacks to using smart cards, however. For example, although they liked the idea of carrying emergency medical and insurance data, they were somewhat skeptical at having this data available on a personal basis. In fact, the issue of privacy and hackers "breaking the code" to access data was a concern to over 70 percent of respondents to the study. Yet the single most important issue on consumers' minds was what might happen to stored cash on the card if it was lost or stolen.

Practical considerations were foremost on consumers' minds. They wondered if the new technology would spread wide enough to be used on a regular basis. They also

wondered how information would be updated, deleted, and downloaded and by what means their cards would be refreshed with cash (Jack M. Kaplan, 1996, pp 271).

United States Far Behind Asia in Smart Card Usage

One conclusion is crystal clear to Smart Card and Security expert, Dr. John Butterworth -- the Asia-Pacific region is far outpacing the United States in smart card usage. Furthermore, as the U.S. lags behind in smart card deployments, a number of Asian countries and corporations will lead the market with new smart card and security innovations that solve a myriad of domestic ID, security, commerce and transportation challenges.

According to Dr. John Butterworth, Chief Scientist at Security Sciences International (SSI), as the U.S. faces increasing security concerns, the technology is available today to eliminate many of these security issues. However, Asian government agencies, corporations and end-users have shown a greater willingness to adopt smart card technologies than their counterparts in the U.S. Countries such as The Philippines, with its advanced smart card-based drivers license system, and Taiwan, where advanced smart cards are being used at Starbucks locations, show that the technology is ready for prime time.

"The United States will trail Asia in smart cards for at least 10 years, unless dramatic action is taken." said Dr. Butterworth. "As recent implementations have demonstrated, multi-application smart cards provide an unparalleled degree of flexibility and security. However, the U.S. market is plagued with customer and vendor misconceptions about the cost-benefits and unbreakable security technologies inherent in smart card designs."

Future Applications

Smart cards will quietly revolutionize most sectors of the economy. Many cars will find a core application, with additional applications being built on to the primary delivery system, such as an electronic driver's license with state and federal welfare programs launched on top of it. A comprehensive bank card may have applications ranging from merchant loyalty programs and electronic purses to debit, credit, and possibly consumer finance and lending. We also expect to see ticketless travel and frequent flyer/driver/sleeper programs on multiple-branded cards. Only our imaginations limit innovative applications of the future.

At a certain point, though, the competition and demand will dictate the applications that are developed and implemented. From the technical side, it is a question of making the appropriate trade-offs between the various technologies and being flexible enough to accommodate the future systems and technologies that will evolve on-line (or off-line).

When considering the trade-offs, we must also take note of the increased risk of putting too much information onto a single card. For example, over the next few years, JavaSoft plans to incorporate other capabilities into the Java Card API as applications become more sophisticated and the feature sets of smart cards expand including the following (Henry Dreifus, J. Thomas Monk, 1997, pp 224):

- Unicode character set
- 32- and 64-bit integers
- float and double-data types
- Unidimensional arrays of unsupported data types
- Multidimensional arrays
- Arrays of objects
- Exceptions
- Threads

2.2 JAVA CARD TECHNOLOGY

2.2.1 Overview of Java Card

Java Card is an open standard from Sun Microsystems for a smart card development platform. Smart cards created using the Java Card platform have Java applets stored on them. The applets can be added to or changed after the card is issued.

There are two basic types of smart cards. The *memory smart card* is the familiar removable memory device; it usually features read and write capabilities and perhaps security features. The more complex version, the *processor smart card*, is a very small and extremely portable computing device that could be carried in your wallet. Java-based smart cards belong to the latter category. They store data on an integrated microprocessor chip. Applets are loaded into the memory of the microprocessor and run by the Java virtual machine. Similarly to MULTOS, another smart card development technology, Java Card enables multiple application programs to be installed and coexist independently. Individual applets are protected by a firewall to preserve their integrity and prevent tampering. Applications can be updated dynamically.

In the United States, the Department of Defense, Visa, and American Express are among the organizations creating Java Card-based applications.

2.2.2 Java Card Forum

The Java Card Forum (JCF) is an interindustry initiative to promote the Java Card API specification as the industry standard. It was founded by Schlumberger and Gemplus in 1997 following JavaSoft's (a division by Sun Microsystems) announcement of the Java Card API in 1996. the members list includes chip manufacturers, card manufacturers, companies and agencies in the financial, telecommunications, health care, transportation, and information technology sectors. Current work is focused on vertical market extensions to the ore specification for GSM, banking, and information technology.

2.2.3 Existing Implementation

Table 2.3 *Summary of Java Card Implementations (Source: Java Card For E-Payment Applications)*

	Sm@rtCafé	**GemXpresso 211**	**Cyberflex Access**
Manufacturer	Giesecke & Devrient	Gemplus	Schlumberger
Resources	1,280 bytes RAM, 32 Kbytes ROM, up to 16 Kbytes EEPROM	2 Kbytes RAM, 32 Kbytes ROM, 32 Kbytes EEPROM	16 Kbytes EEPROM
Supported protocols	T = 0, T = 1	T = 0, T = 1	T = 0
Java Card version	Java Card 2.1	Java Card 2.1	Java Card 2.0
Other specifications	--	Visa Open Platfrom 2.0	--
Cryptographic algorithms	DES, DES3, RSA SHA-1	DES, DES3	DES, DES3, RSA SHA – 1
Security services	External and mutual authentication, ISO/IEC 14888-3 digital signature, session key derivation	--	External and internal authentication

Schlumberger Cyberflex Access

The Schlumberger company was the first smart card manufacturers to release a smart card programmed in the Java programming language. The latest Java Card technology smart card from Schlumberger is Cyberflex Access. Cyberflex Access is compliant with an earlier version of Java Card, namely, Java Card 2.0. The card supports only T = 0 protocol and has 16 Kbytes of EEPROM.

The cryptographic facilities of Cyberflex Access include the following:

- DES and DES3 algorithm implementation;
- RSA algorithm implementation with the key size up to 1,024 bits;
- External and internal card terminal authentication services;

- SHA-1 secure hash algorithm implementation.
- An interesting feature of Cyberflex Access is that, in contrast to other Java Card technology smart cards, it supports the ISO/IEC 7816 file system. The files are accessed an managed via the Loader application of a Cyberflex Access card. The Loader application can be regarded as an extended variation of the Java Card installation program. Besides loading applets, the Loader also supports commands for file access and management and basic security mechanisms, such as card holder verification (CHV) (Hassler, Manninger, Gordeev and Muller, 2001, pp 119).

2.2.4 Smart card trends and expectations: what 2001 holds (from Schlumberger)

The smart card industry came of age in 2000, with open platform cards achieving significant volumes for the first time, notes Schlumberger in its annual market review and forecast. Despite substantial silicon shortages, card shipments still grew 27 per cent to reach 1,790 million – confirmation of the pivotal role in portable, personal security that the smart card is playing across the spectrum of end-users.

Among the forecasts Schlumberger makes for 2001 is continued double-digit growth in demand, driven largely by wireless applications – with the beginnings of m-commerce adding a new dimension to this segment. Also of note, this year will see the first volume roll outs of USB (universal serial bus) compatible cards, and substantial growth in the emerging US market.

Looking back over 2000

The star application sector for smart cards was, as expected, SIM (subscriber identity module) cards for mobile phones, which expanded by more than 70 per cent. This surge was due to the strong demand from consumers for mobile phones and – in the high-end of the market – the intensive drive by operators to roll out value-added services based on SIM Toolkit (STK). The high-end segment of the market has effectively standardised on

Java cards, and was the major contributor to an astonishing year-on-year growth of 700 per cent in open platform technology. Java cards now account for some 15 per cent of all shipments of microprocessor-based smart cards.

"Java technology has had a radical impact on the SIM card market, and more than two-thirds of those operators deploying STK services today actively prefer to base them on Java SIMs" notes Xavier Chanay, vice president, Schlumberger Mobile Communication Products. "The latest SIM card standards – which stabilised in mid-2000 – complete the chain to ensure that the process of creation and deletion of STK applets is fully standardised."

Payphone cards, the major application category for memory chip-based cards, accounted for well over half of the industry's total card shipments: over a billion units in terms of volume, but only one-sixth of the industry's revenue. This market remained stable, predictable and very much a commodity market, now dominated by the two major suppliers

2001 opportunities

This year will witness a double-digit growth of over 20 per cent in overall smart card shipments, forecast Schlumberger (see Table 2.4)

Table 2.4 *World smart consumption and forecast for 2000-2004 (Source: www.emeraldinsight.com)*

	2001	2002	**Growth 2000-2001** (%)	2003
By market (millions)				
Payphone	1,380	1,190	10	1,410
Mobile communications	350	500	49	800
Banking	120	150	25	410
Healthcare	65	70	8	110
Transport	50	45	50	80
Others (IT, pay TV)	145	215	48	390
Totals	1,790	2,170	21	3,100
By region (millions)			**Share of total**	
Europe, Middle East, Africa	890	576	45	1,241
Asia, Pacific	465	632	30	1,024
Latin America	350	434	20	620
North America	65	108	5	216
Totals	1,790	2,170		3,100
By technology (millions)			**Share of total**	
Memory cards...	1,250	432	66	1,840
...of which have contactless interfaces	43	72	5	135
Microprocessor cards...	540	738	34	1,260
...of which are multiapplication cards	60	230	34	600
Totals	1,790	2,170		3,100

The market for financial cards is expected to grow strongly at around 25 per cent, driven primarily by a number of national programs to replace existing magnetic stripe bank cards with secure smart cards built on the EMV (Europay Mastercard Visa) standard. Affected markets this year include the UK – with its current EMV replacement program – Mexico, which is starting to see the first volumes of Proton cards, and Brazil and China. Although most smart card programs are driven primarily by the desire of banks to reduce fraud, the strong commercial success of the American Express Blue smart card program in the USA and Canada is viewed as likely to stimulate competition to release new chip-based cards.

A high spot for the industry will occur this year with the rapid rise of corporate and IT security smart card applications, which is expected to more than double. The

growth will be stimulated by the general need for intranet and Internet network security, and the particular support for smart card security tokens which is built into the Windows 2000 operating system. By 2003, Schlumberger estimates that nearly half of online transactions will be secured by smart cards, creating continued growth rates of over 40 per cent in this market.

One geographic region that stands out for 2001 is the USA, with its promise of a significant increase in smart card sales. To date, the US marketplace has always lagged the rest of the world but, for the first time, this year brings with it three separate major forces for change: the demand for IT security, the stimulus to the bank card market following the American Express Blue initiative, and the partial adoption of SIM cards by TDMA operators. Combined, these forces could result in sustained growth rates of over 50 per cent for the next three years.

"2001 could be a breakthrough year in the US market for smart cards", says Olivier Piou, president, Schlumberger Smart Cards. "With three major drivers stimulating change, we may at last see significant activity in this huge potential market".

Technologically, the major event for 2001 is likely to be the widespread availability of USB-compatible smart cards, which allow PCs and similar devices to interface with smart cards without a conventional reader.

As regards open platform cards, Java card technology has now reached true mass market maturity, while the other contenders of MULTOS and Smart Cards for Windows remain in their infancy. Whether these systems can catch up – particularly MULTOS, which has suffered from its focus on banking cards – is questionable. Both MULTOS and Smart Cards for Windows are looking to the mobile communications market, and one critical test is almost certain to be the extent of take-up there.

CHAPTER 3
METHODOLOGY

3.1 PROCEDURE IDENTIFICATION

The development of the system will be carried out through out 6 phases which are similar to System Development Life Cycle (SDLC) but has been modified accordingly to suit the project requirement.

3.1.1 Problem, opportunities and objectives identification phase

During this phase, the author studied the existing system to identify the problems faced that leads to development of the project. The output of this phase is the problem statement which has been mentioned in chapter 1. The author also identified the objectives of the project to guide the project development.

3.1.2 Analysis phase

Based on the problem statement and objectives, the author made an analysis on the proposed solution to solve the problems and simultaneously achieve the objectives outline. This phase also involved identifying the system requirements and systems functionalities.

The system requirements identified from the phase are as follows:

- User can start using the Internet after they log in to the network using the smart card
- User can view their current balance and login information after they login
- User can reload their prepaid balance

- System will keep track of the duration of Internet usage and automatically deduct balance from smart card every minute

The system functionalities identified after the analysis are as follows:

- There will be login page that will verify user name and password and log the user into the network
- A welcome page will display user current balance and their login information as last login date and time; and current login date and time
- A reload button is available for user to reload their prepaid balance. When user clicks this button, the reload balance page will appear and user can fill in their reload details
- There will be a timer to keep track of user login duration. The timer will then deduct user balance based on the duration. The balance is updated every minute

3.1.3 Research phase

During this phase, the author conducted research to get a deep insight about the project and really understand it. Then the author started compiling as much information as possible about the topic to be included in the literature review section. Next, the author identified the tools required in order to develop the project. After finalizing the platform of the project development, the author studied and familiarized the programming language that is used

3.1.4 Design phase

This phase concentrated on interface design. The interface is designed based on the system requirements and system functionalities defined in phase 2. The interface is developed according to parts and will be integrated later in next phase.

3.1.5 Development phase

During this phase, author started developing the system according to the design completed in previous phase. The system is developed in parts. Firstly, the interface designed in the previous phase is coded. Then the interfaces are linked together. Finally the smart card is coded and integrated with the interfaces.

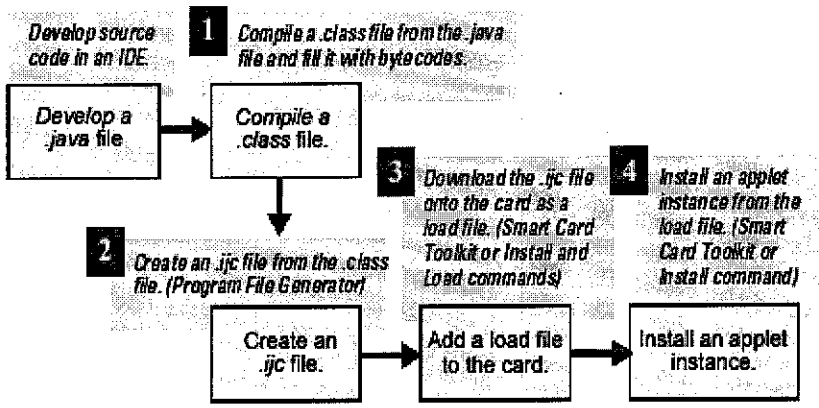

Figure 3.1 *Steps to develop java source code for use on an Open Platform Cyberflex Access card*

Figure 3.1 illustrated the steps taken to develop java source code for use on Open Platform Cyberflex Access Card. When the applet instance is installed, the card coding is complete and can be linked with the interface.

3.1.6 Integration and Testing phase

Finally, when all the interface and smart card coding have been developed, the author integrated the units and tests the functionalities of the system as a whole. When all the errors have been corrected and debugged, the system is ready for implementation.

3.2 TOOLS REQUIRED

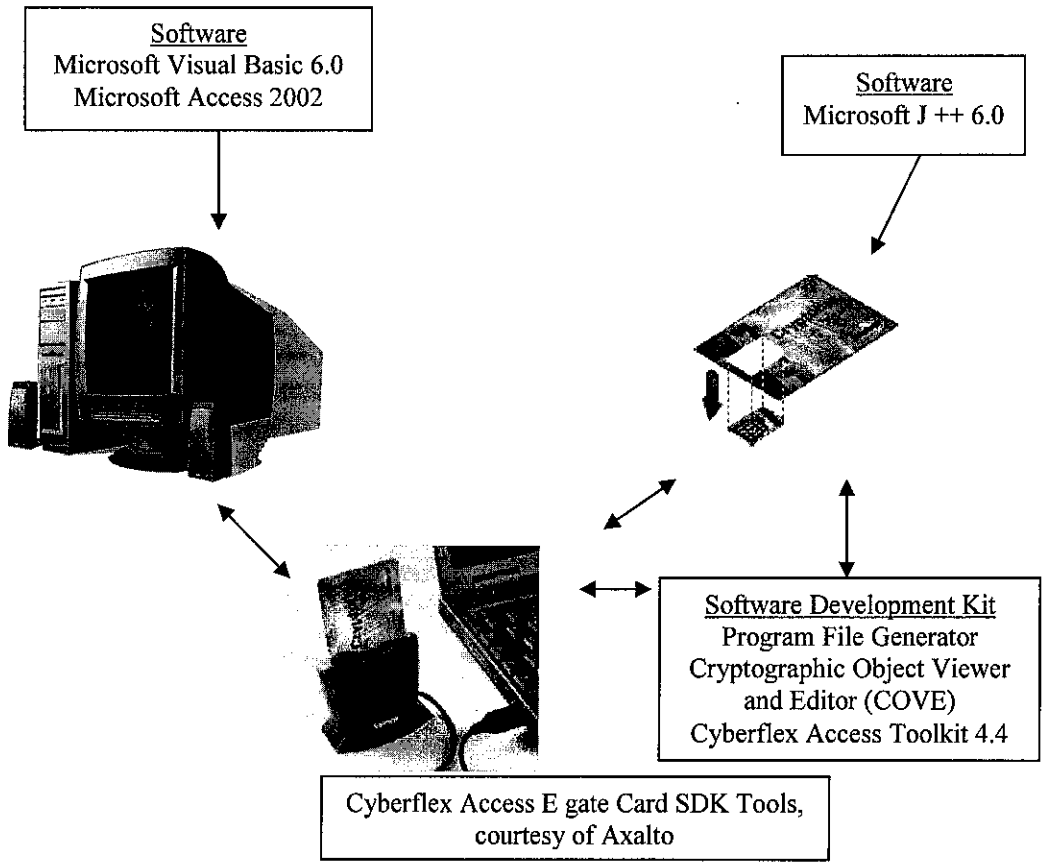

Figure 3.2 *System development tools*

Figure 3.2 illustrated the tools required for the development of the system.

3.2.1 Java Programming Language

The Cyberflex Access smart cards are information security smart cards from SchlumbergerSema that run programs written in Java, the programming language from Sun Microsystems. Therefore, the coding for the smart card application will be written in Java. One of the main ideas that encouraged the development of Java Card technology was to make smart card applications portable across different platforms.

Java is a programming language expressly designed for use in the distributed environment of the Internet. It was designed to have the "look and feel" of the C++

language, but it is simpler to use than C++ and enforces an object-oriented programming model. Java can be used to create complete applications that may run on a single computer or be distributed among servers and clients in a network. It can also be used to build a small application module or applet for use as part of a Web page. Applets make it possible for a Web page user to interact with the page.

The major characteristics of Java are:

- The programs created are portable in a network. The source program is compiled into what Java calls bytecode, which can be run anywhere in a network on a server or client that has a Java virtual machine. The Java virtual machine interprets the bytecode into code that will run on the real computer hardware. This means that individual computer platform differences such as instruction lengths can be recognized and accommodated locally just as the program is being executed. Platform-specific versions of the program are no longer needed.
- The code is robust, here meaning that, unlike programs written in C++ and perhaps some other languages, the Java objects can contain no references to data external to themselves or other known objects. This ensures that an instruction can not contain the address of data storage in another application or in the operating system itself, either of which would cause the program and perhaps the operating system itself to terminate or "crash." The Java virtual machine makes a number of checks on each object to ensure integrity.
- Java is object-oriented, which means that, among other characteristics, an object can take advantage of being part of a class of objects and inherit code that is common to the class. Objects are thought of as "nouns" that a user might relate to rather than the traditional procedural "verbs." A method can be thought of as one of the object's capabilities or behaviors.
- In addition to being executed at the client rather than the server, a Java applet has other characteristics designed to make it run fast.
- Relative to C++, Java is easier to learn.

3.2.2 Visual Basic 6.0 Programming

This programming language will be used to develop the application interface. Visual Basic is a simple but powerful tool that allows flexibility in user interface design. It is also a user friendly application.

The software is also used to retrieve and compare data in the database. Visual Basic is used as the means to access the database stored in the Microsoft Access Applications. This requires the Microsoft ADO Data Control 6.0 (ADODB). ADO communicates with data sources through the Microsoft Jet 4.0 OLE DB Provider.

3.2.3 Smart Card System

For this project, the author is using smart card programmed in Java programming language. The latest Java Card technology smart card is from Schlumberger called Cyberflex Access e-gate 32K card. The Cyberflex Access e-gate 32K card adds bytecode verification (Codeshield feature) for applets downloaded to the smart card, supports USB communication protocol, and has some differences in the implementation of the PutKey command.

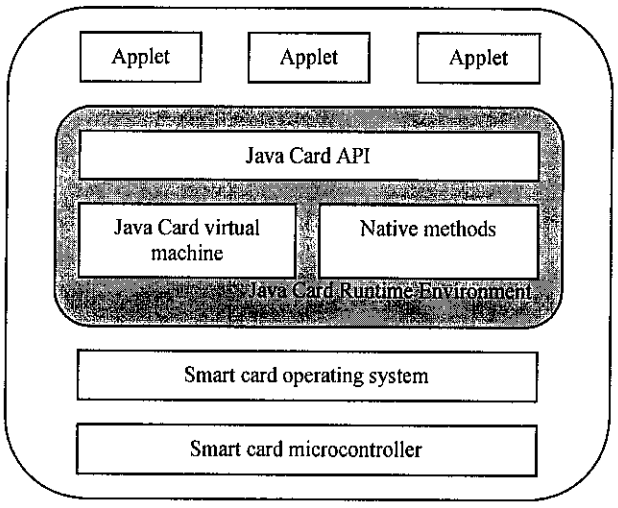

Figure 3.3 *Java card architecture*

Java Card is characterized by the following major benefits:

- *Platform independence.* Java Card applications written in accordance with the specifications are intended to run on any Java Card-compliant smart card. This feature was thought to ensure a high degree of portability of Java Card applications. Unfortunately, individual smart card manufacturers frequently introduce their own packages with a manufacturer-dependent API (especially security-related APIs) or still support different versions of Java Card. This significantly decreases the portability of Java Card applications.
- *Mutiple-application support.* More than one application can be run on a Java Card technology smart card. Furthermore, the data of each application is securely protected from any other application run on the same card.
- *Power of Java.* Java Card inherits many benefits of the Java programming language. In the particular case of smart cards, such benefits are object-oriented programming and language-level security. However, some limitations on Java introduced in Java Card frequently lead to a style of programming that is different from conventional Java. Another advantage of Java Card is that its applications can be developed using any development tool or environment for standard Java.

The Java Card architecture is illustrated in Figure 3.1. As can be seen, it looks very similar to traditional Java. The smart card operating system (OS) is layered on top of a smart card microcontroller and is aimed at providing common services like file and data management, communication, and command execution. From the communication point of view, Java Card is fully compliant with ISO/IEC 7816. In particular, Java Card supports communicaton protocols and commands in accordance with ISO/IEC 7816-3 and ISO/IEC 7816-4, respectively.

A new Cyberflex Access card contains the following elements:

- Card Manager Application
- Default key set for the Card Manager

- Card Production Life Cycle (CPLC) data
- Global Platform compatibility for Java Card Virtual Machine v2.1

The development kit that comes with the card are as follows:

- Program File Generator
- Cryptographic Object Viewer and Editor (COVE)
- Cyberflex Access Toolkit 4.4

3.2.4 Microsoft Access

This database software is used to store other data such as user personal details, current balance and usage details. These data will be retrieved through Microsoft Visual Basic interface. There will be two tables created in the database; userdetails and usagedetails. Table userdetails will store personal details such as username, password, name, year and programme. Table usagedetails contains information about user internet usage such as time in, time out and duration.

CHAPTER 4
RESULTS AND DISCUSSION

4.1 ANALYSIS PHASE

The output from this phase is the system requirements and system functionalities. From these output, the use case diagram for the system is composed, as illustrated in Figure 4.1 below. The diagram illustrated the user login process and the reload balance process.

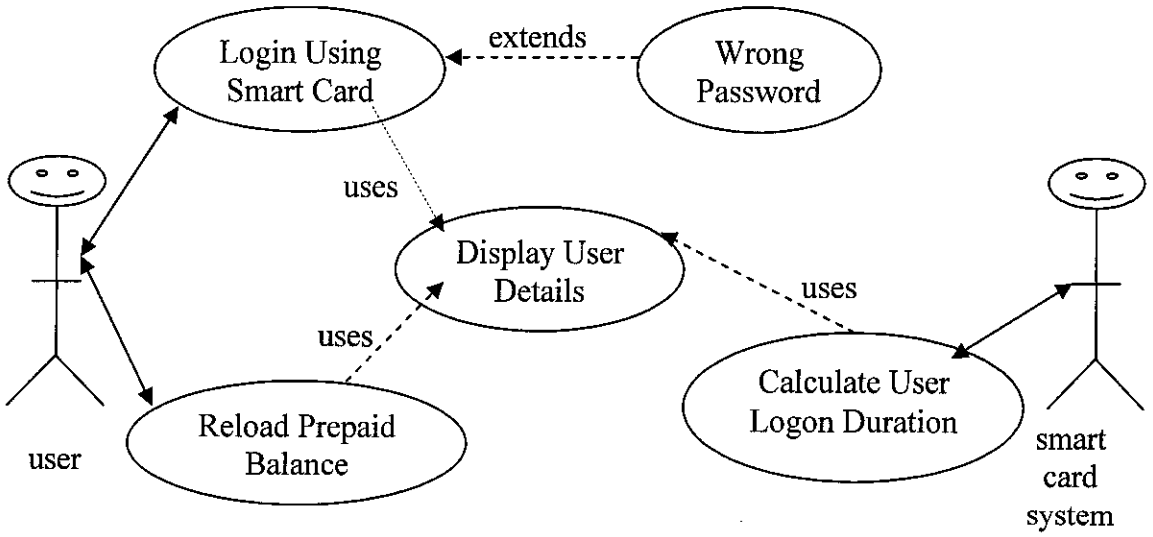

Figure 4.1 *System Use Case Diagram*

4.2 SYSTEM DESIGN

During this phase, the interface is designed to meet the system requirements and system functionalities. The flow chart for the system is as follows.

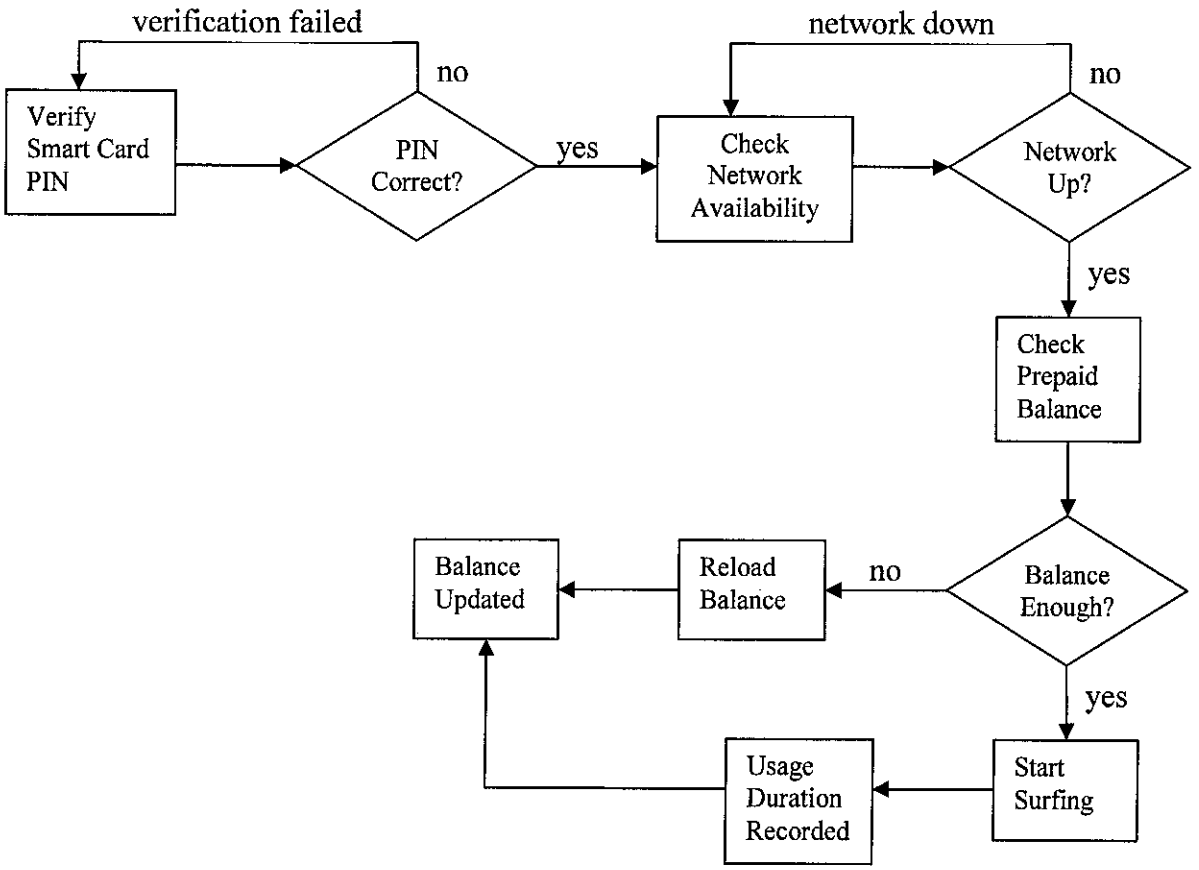

Figure 4.2 *System Flowchart*

4.3 SYSTEM DEVELOPMENT AND DESCRIPTION

The system consists of 2 main applications:

- Prepaid Card
- Administrator

4.3.1 Prepaid Card

The application consists of 6 parts:

- Smart card verification page
- About page

- New user registration page
- Login page
- Welcome page
- Timer page

Smart card verification page

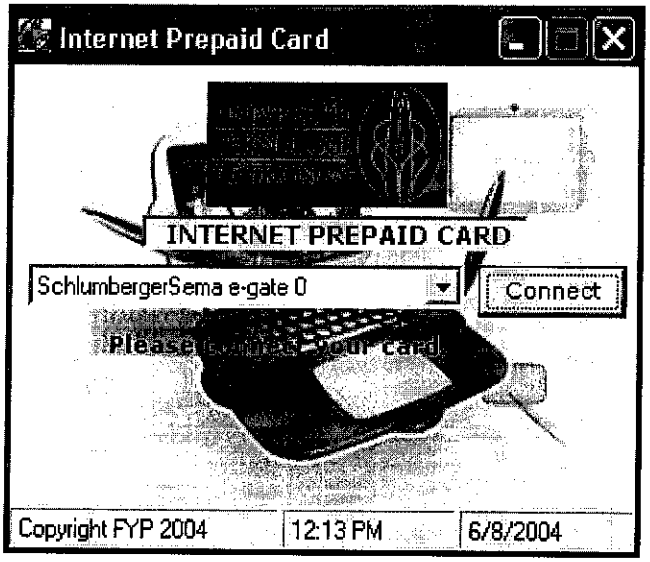

Figure 4.3 *Smart Card Verification Page*

Figure 4.3 illustrate the first window of the application. The system will prompt user to connect their smart card for system to verify it. If no card is detected, the system will display an error message (see Figure 4.4). When user click the connect button, a frame will appear as illustrated in Figure 4.5 if the card is verified.

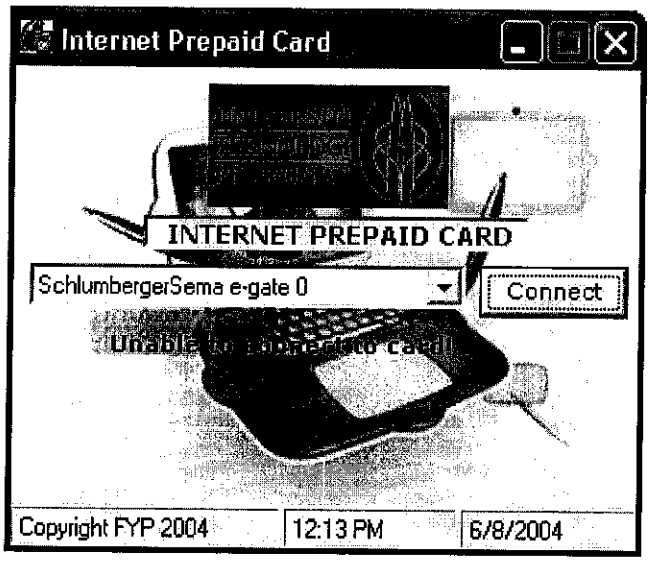

Figure 4.4 *Error connecting to card page*

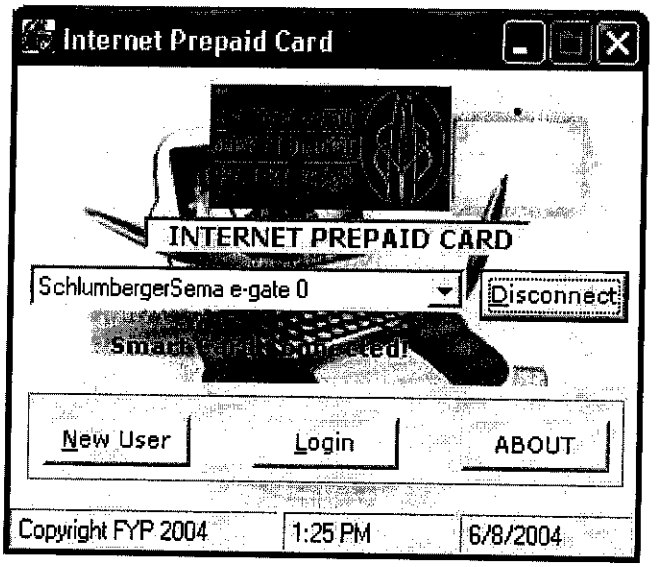

Figure 4.5 *Smart Card Connected Page*

There are three buttons on this page:

- *New User*- for first time user to register their details
- *Login* – for existing user to login and start surfing
- *About* – for users who need information about the system

About page

This page displays information about the system as illustrated in Figure 4.6

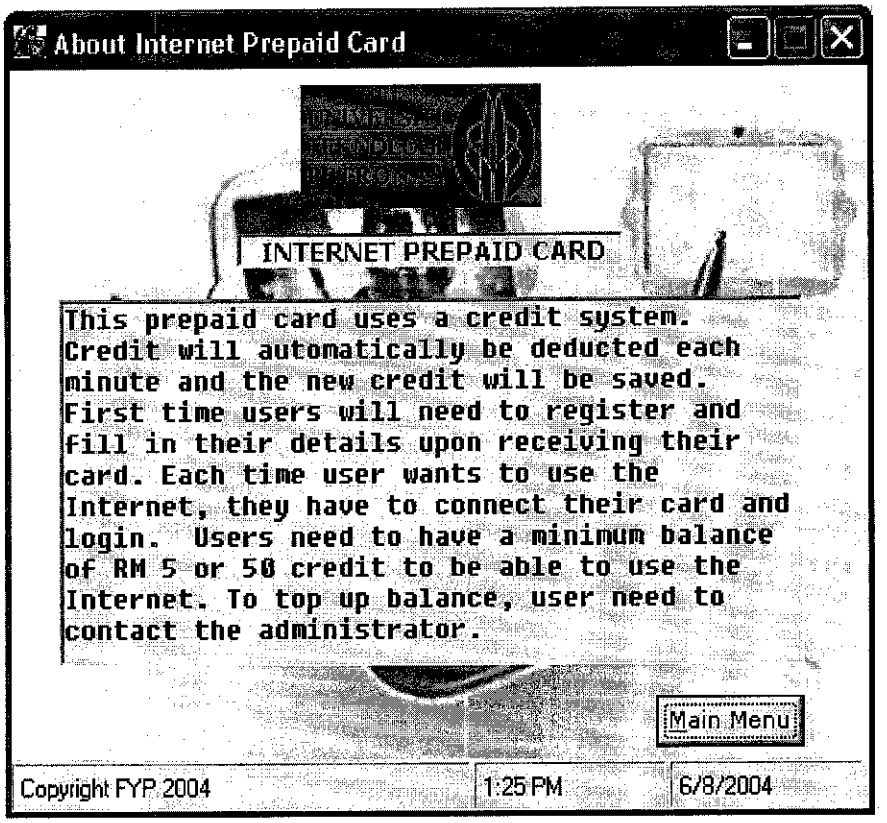

Figure 4.6 *About page*

New User Registration page

This page is for registration of first time user of the prepaid card. Upon receiving their card, new user need to register their details and reload balance before they can start using the card. This is illustrated in Figure 4.7.

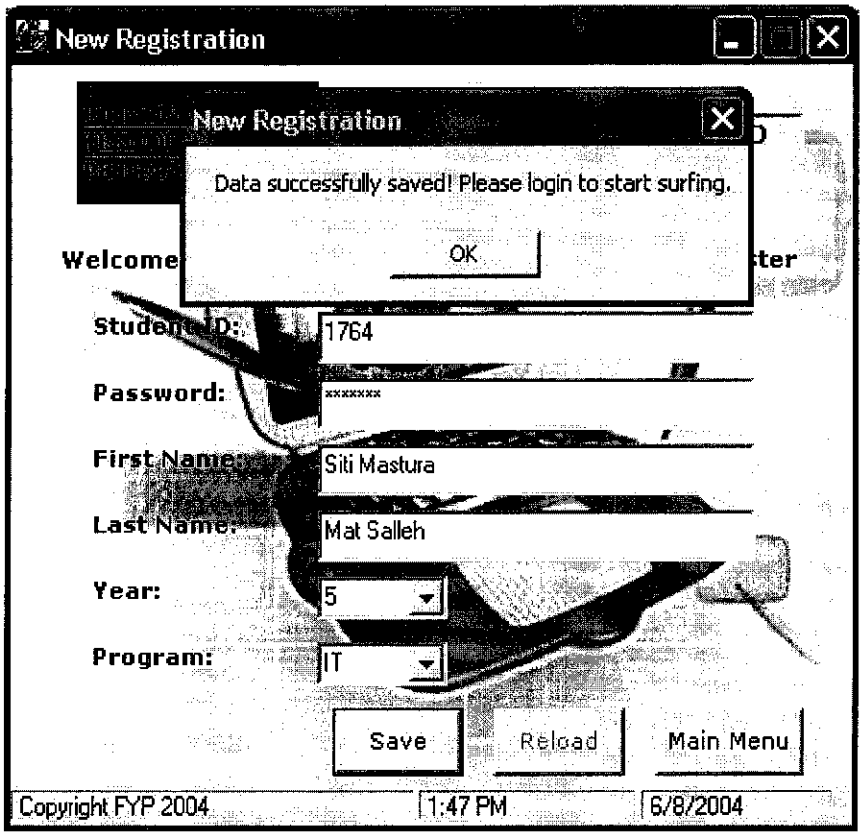

Figure 4.7 *New Registration page*

There are 3 buttons on this page:

- *Save* – to save new details entered by user
- *Reload* – to reload balance. This button is enabled after user save their details
- *Main Menu* – to go back to main menu

Reload balance page

This page will appear when user clicks the reload button. Users need to enter their reload value and new balance will be updated. This is illustrated in Figure 4.8.

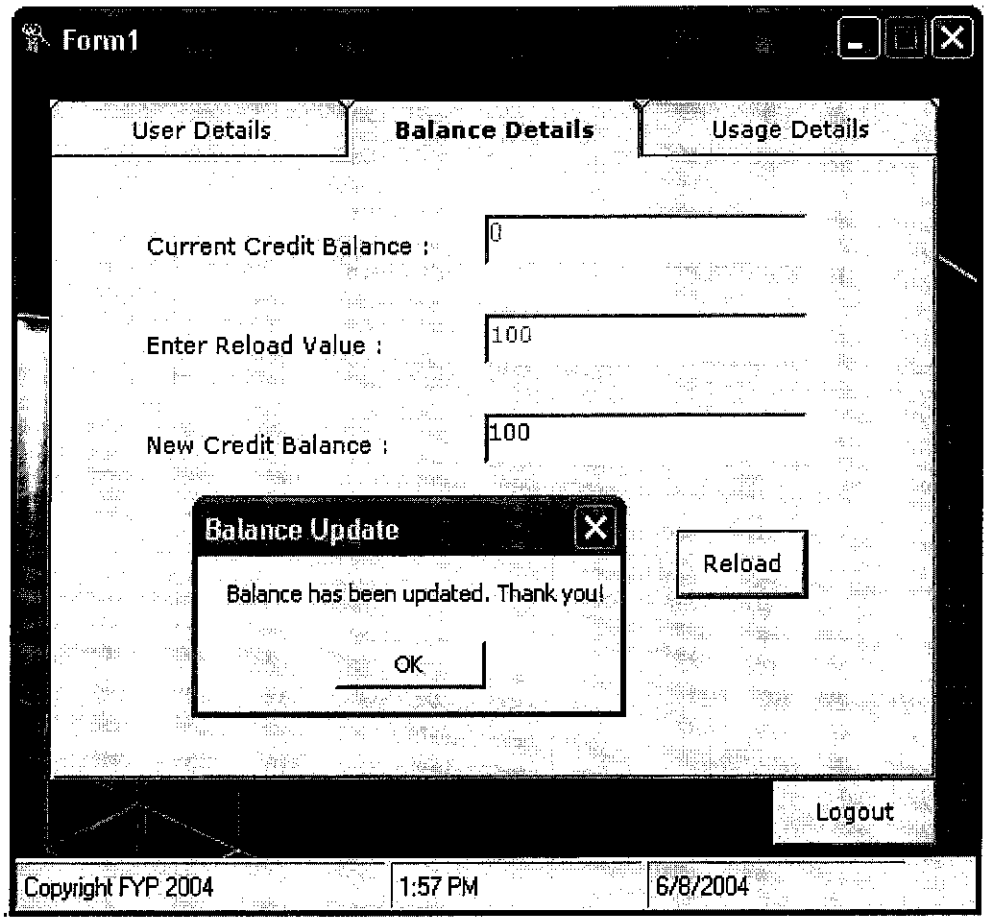

Figure 4.8 ***Reload balance page***

Login page

This page will display user's name as illustrated in Figure 4.7. User need to verify their password to login. The password is masked with "*" for security purposes. There are three buttons on this page

- *OK* – to verify user password
- *Cancel* – to cancel the transaction
- *Reset* – to reset the details entered

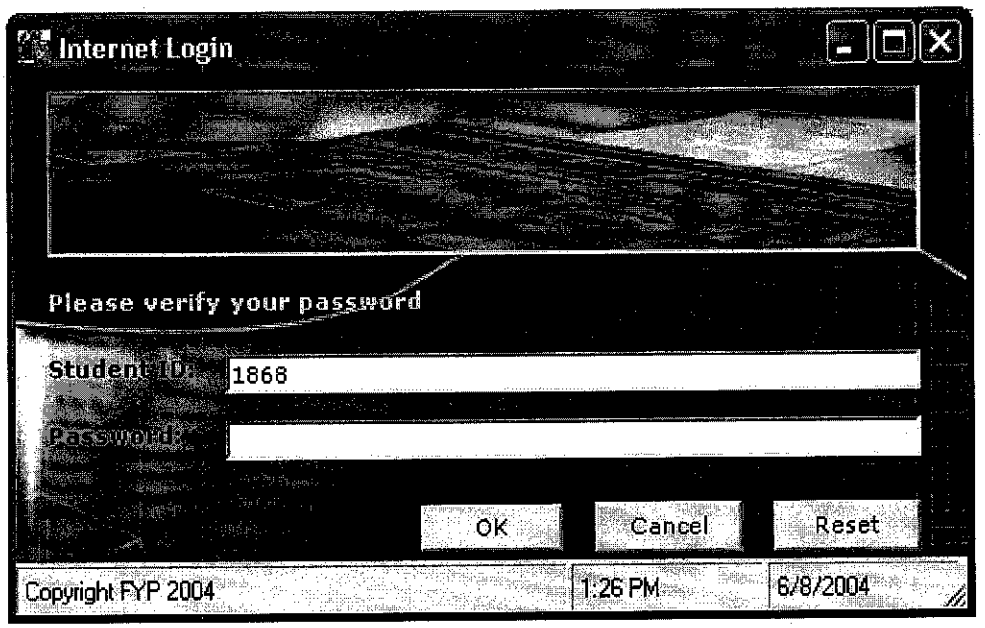

Figure 4.9 *Login Page*

If user entered the wrong password or the wrong ID, the system will display an error message as illustrated n Figure 4.10 and Figure 4.11 respectively.

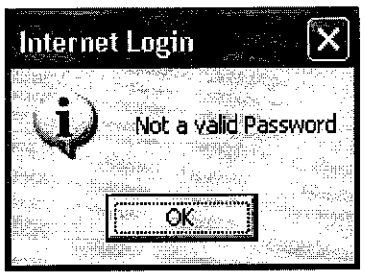

Figure 4.10 *Wrong Password*

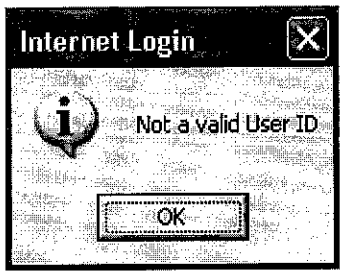

Figure 4.11 *Wrong ID*

Welcome page

This page will appear immediately when user login is verified. This page will display the user's name; their last login history, current log in date and time, and their current balance. This is illustrated in Figure 4.12

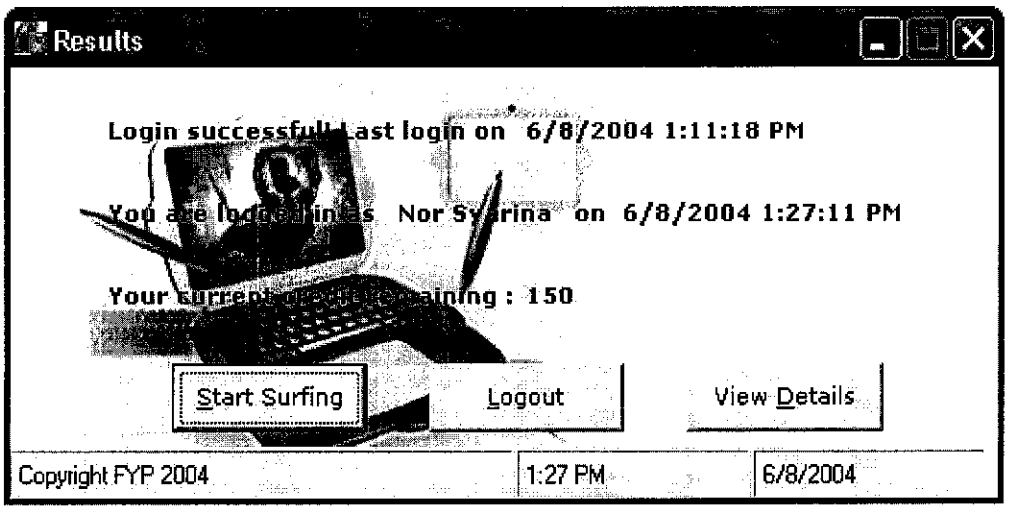

Figure 4.12 *Welcome page*

There are three buttons for this window.

- *Start Surfing* – to start using the internet
- *Logout* – to log out from the internet login
- *View Details* – to view user personal details

When user click the *logout* button, the system will confirm whether they reall y want to log out or not, as illustrated in Figure 4.13

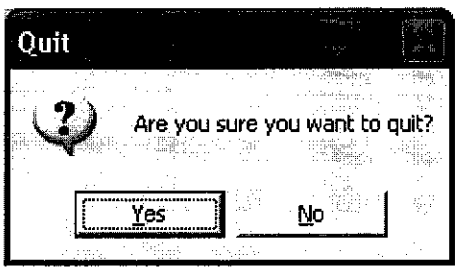

Figure 4.13 *Confirm Logout Message*

When user clicks the *view details* button, they can view their personal details, as illustrated in Figure 4.14

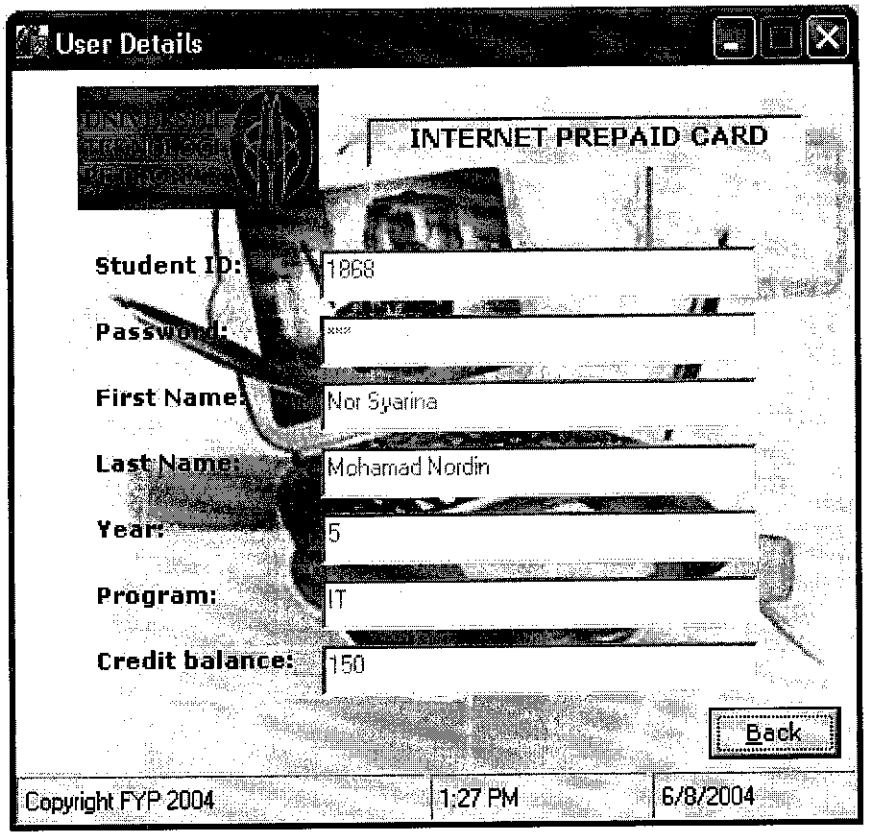

Figure 4.14 *User Details Page*

When user clicks the *Start Surfing* button, the system will first check if user current balance is sufficient. Users need to have a minimum of 50 credit or RM 5 to use the Internet. If current balance is lower than minimum amount required, the system will display an error message as illustrated in Figure 4.15

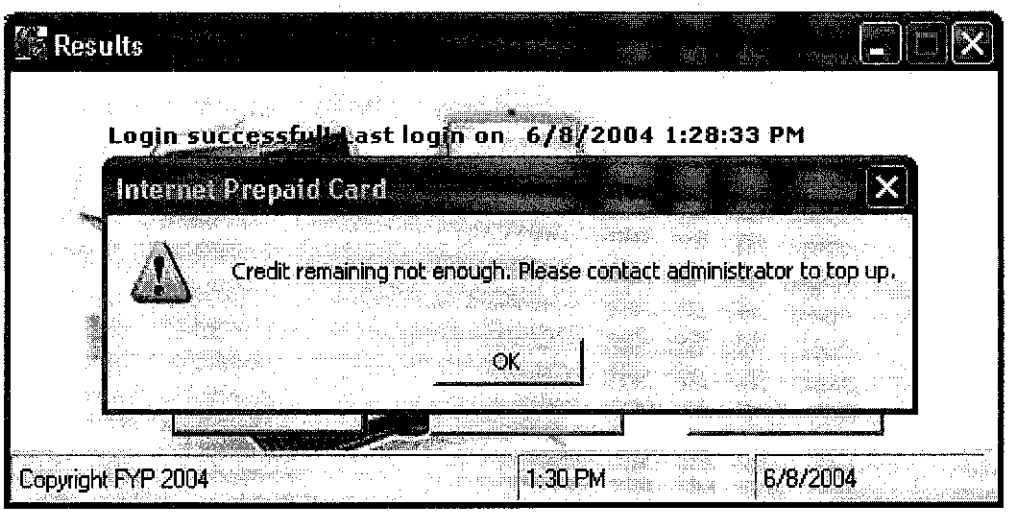

Figure 4.15 *Credit not enough error*

If current balance is enough, the system will detect the network connection. If network is up, user can start surfing. If the network is down, the system will display an error message as illustrated in Figure 4.16

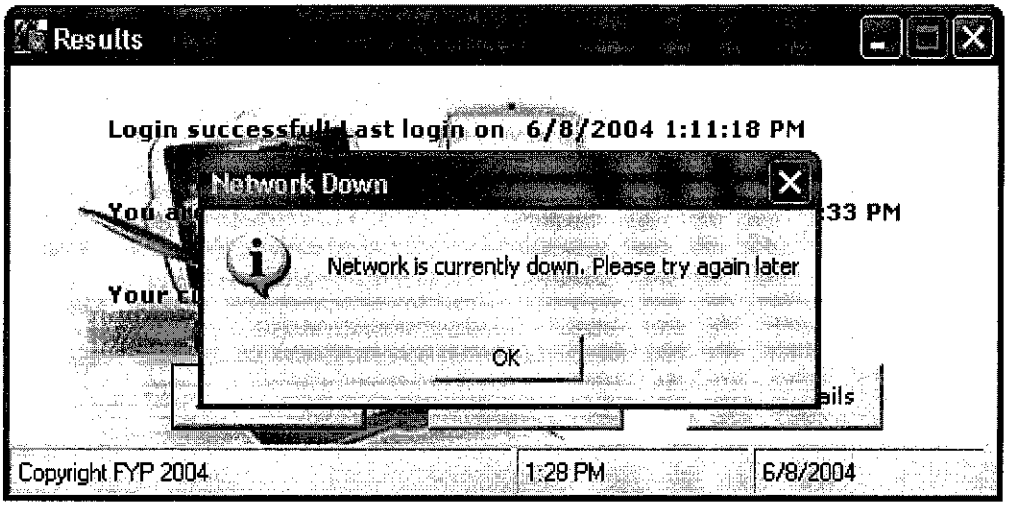

Figure 4.16 *Network down Message*

Timer page

This is the most important part of the system. The timer keeps track of the duration the user has used the internet and will deduct the balance from the prepaid accordingly. The balance is deducted and updated every minute. The timer will start as soon as user has logged in and click the button *Start Surfing* in the *Welcome* page. The timer will display the duration user has logged in and their prepaid balance. The timer is illustrated in Figure 4.15. The balance deduction is illustrated in Figure 4.16

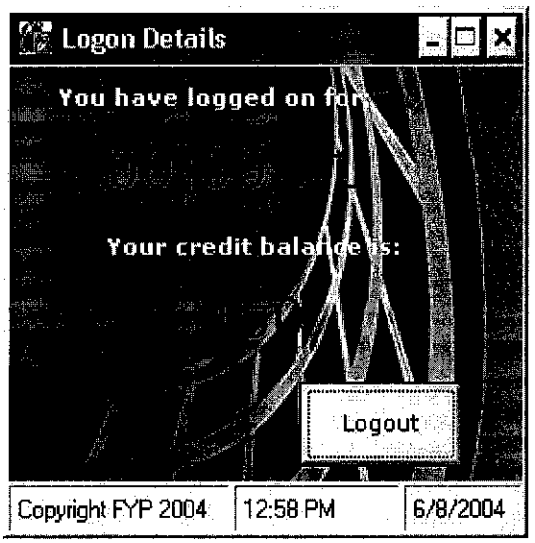

Figure 4.17 *Timer page (initial)*

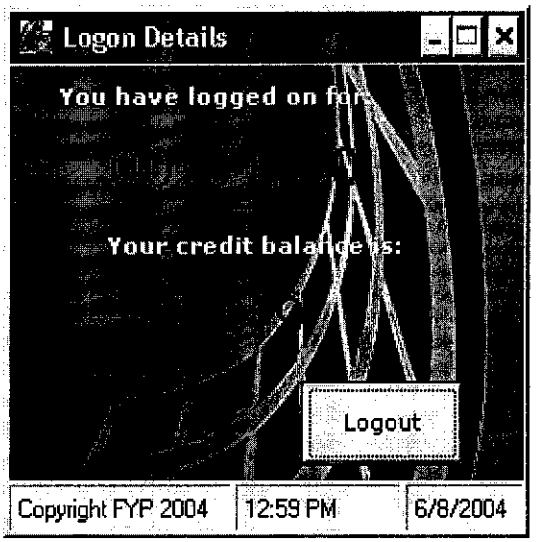

Figure 4.18 *Timer page (after 1 minute)*

This page contains one button:

- *Logout* – to log the user out of the system

4.3.2 Administrator

This application consists of 3 parts:

- Administrator login
- Smart card verification
- User information page

Administrator login

This page is for the administrator to verify the password before they can view the information stored in the smart card. This is illustrated in Figure 4.19

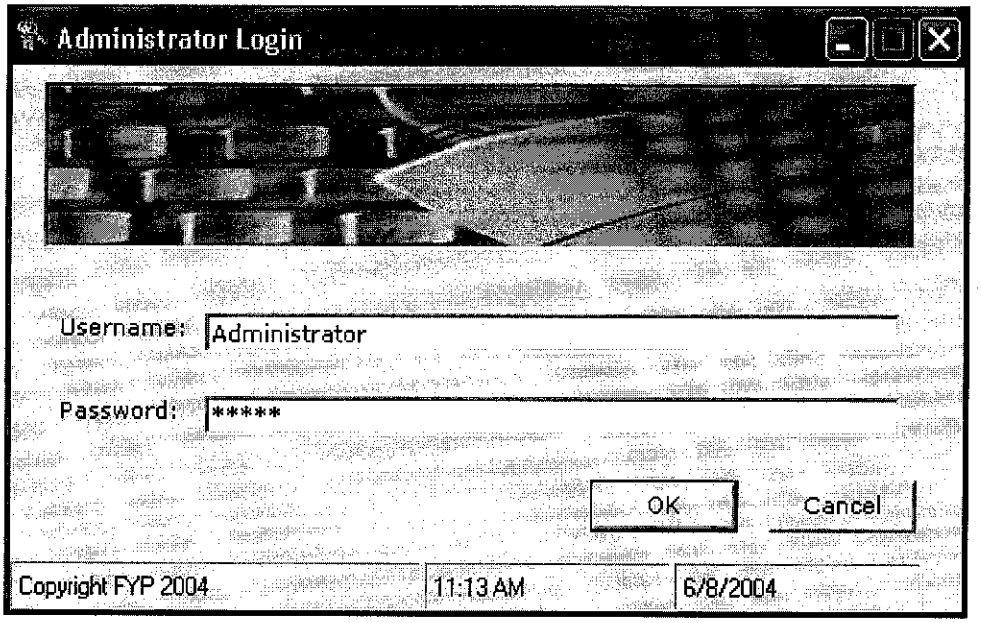

Figure 4.19 *Administrator Login*

Smart Card Verification

This page will be displayed if the administrator has verified the password. Refer to Figure 4.20

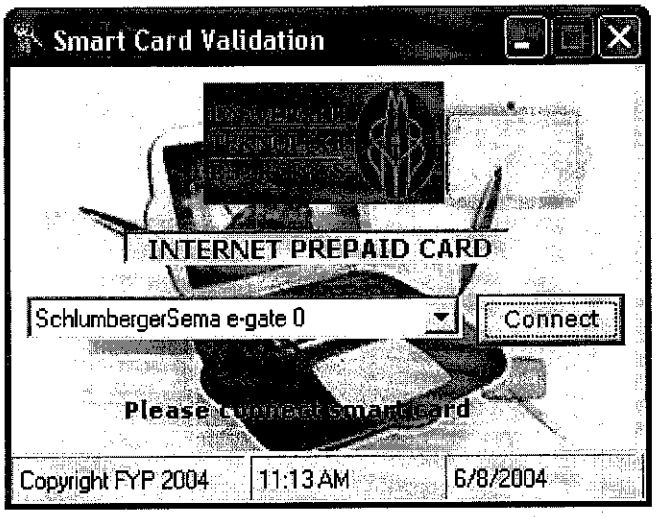

Figure 4.20 *Smart Card Verification*

User Information Page

This page consists of 3 tabs; user details tab (see Figure 4.21), balance details tab (see Figure 4.22) and usage details tab (see Figure 4.23)

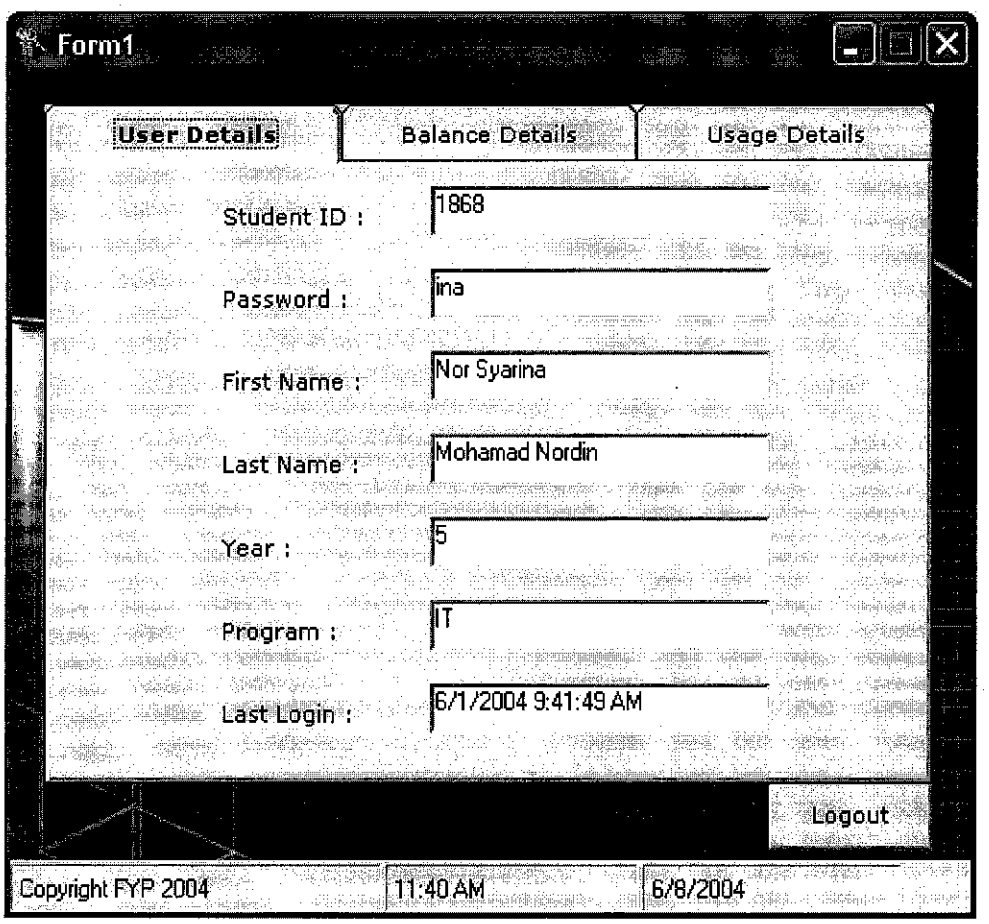

Figure 4.21 *User Details tab*

This tab displays user personal details such as username, password, name, year, and program.

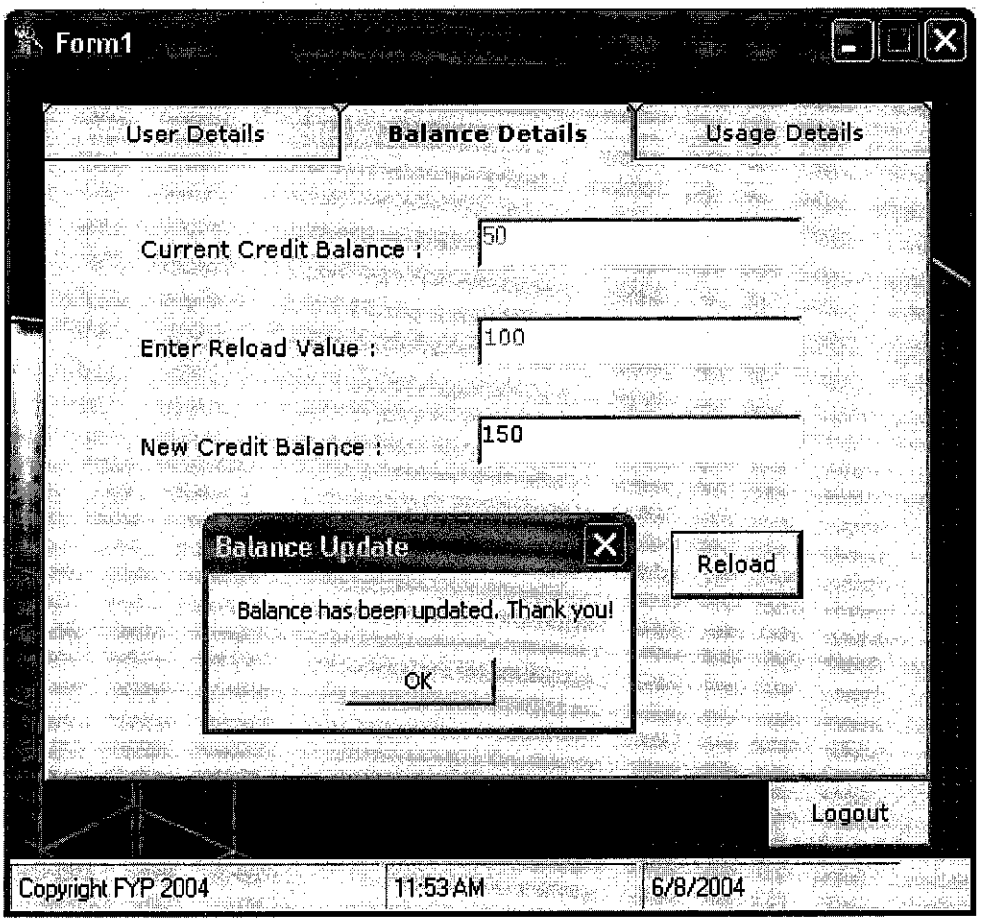

Figure 4.22 *Balance details tab*

The second tab shows the prepaid balance of a user. If user wants to top up, administrator will use this page to top up.

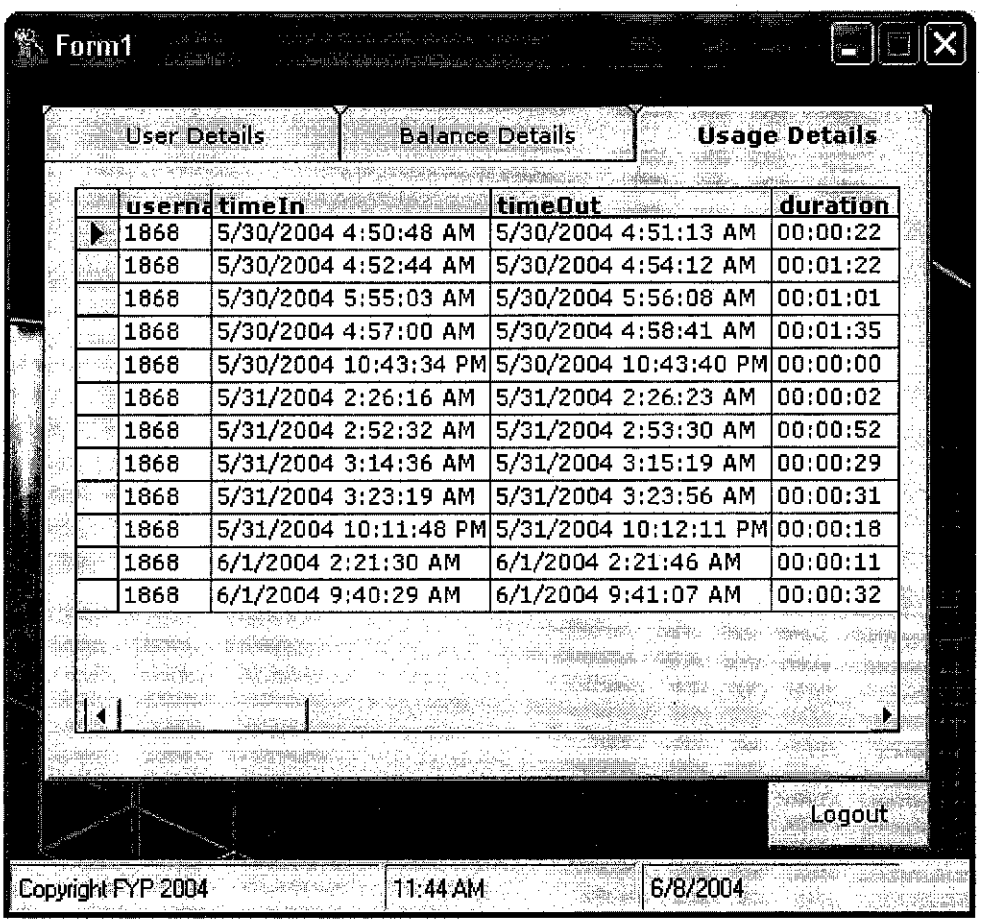

Figure 4.23 *Usage Details tab*

This tab displays user Internet usage history such as time in, time out and the duration.

CHAPTER 5
CONCLUSION AND RECOMMENDATIONS

5.1 RELEVANCY TO THE OBJECTIVES

As a conclusion, smart card is beginning to play an important role in human lives. Everywhere we go we see smart card being used in various applications. The technology is cheap and simple to implement. Thus, in the evolving world, we must take advantage of the latest technology available all around us to be used in every field possible to ease our everyday tasks.

Thus, from the research done, the author has identified one area that can be developed to take advantage of the smart card application. This paper pointed out the problem currently faced by existing system and the proposed solution for the problem. Using prepaid card for Internet access can ensure that the money paid for Internet usage is optimized.

The prototype has validated the main concept presented in this paper where users are given access to a computer using a smart card. Once user has log in the computer timer function will start and deduct the balance from the smart card every minute. Basically, author has managed to achieve the objective of developing a java smart card application as an Internet prepaid card system. Smart card technology, with its ability to verify identification and store and update information, is likely to help solve problems well beyond those of the financial services industry.

New smart card technology has always been explored and created for our ease in life. But some people would create technology for their own interest that would harm the

society. Thus, it is important for us to learn this technology, fully understand the potential and exploit the benefit that a smart card application could bring.

5.2 RECOMMENDATION FOR FUTURE ENHANCEMENT

5.2.1 Auto-reload card balance from bank account

For future enhancement, the smart card application can be designed in such a way that internet usage charges will be deducted straight away from their bank account. This can be good approach as users do not have to worry about reloading their prepaid balance. It is also a time-saving practice as users do not have to go and reload their prepaid balance at any given time as the usage charges will be deducted straight away from their account balance.

5.2.2 Web Based Smart Card System

Since this is an internet prepaid card system, it is better if it is a web-based system. To improve it, the interface can be developed using Java applet. A web-based system will be more cost effective and efficient. Users can reload their balance online instead of having to go to IT department to top up. Web-based system will also allow better monitoring of student Internet usage and maintaining the data integrity.

REFERENCES

Card Logix, Towitoko and Fargo Corporation 1999, *Smart Card Basics* <http://www.smartcardbasics.com>

Frost & Sullivan 2003, *Smart Card Market Projected To Hit 21.7 Million USD By 2005: Frost & Sullivan Study* < http://www.frost.com/prod/servlet/press-release.pag?docid=6017802>

Henry Dreifus and J. Thomas Monk 1997, *Smart Cards: A guide to building and managing smart card applications,* New York, John Wiley & Sons

Intelligent Transport Society of America 2002, *United States Far behind Asia in Smart Card Usage* <http://www.itsa.org/ITSNEWS.NSF/4e0650bef6193b3e852562350056a3a7/d124c57f0ec8ad7385256bce003ff332?OpenDocument>

Jana Zamud Aug 1999, *An Overview of Smart Card Technology* <http://www.state.fl.us/stp/whitepaperarchive/smart_card.pdf>

Jack M. Kaplan 1996, *Smart Card, The Global Information Passport: Managing A Successful Smart Card Program,* Boston, International Thomson Computer Press

Mike Hendry 1997, *Smart Card Security and Applications,* Boston, Artech House

Pace Integration 2001, *Smart Card 101, <http://www.paceintegration.com/smartCard101.cfm>*

Schlumberger Limited 1997, *Cyberflex Access Home Page* <http://www.cyberflex.slb.com>

Schlumberger Limited 2001, *Public Release Version: Smart card trends and expectations: what 2001 holds (from Schlumberger)* <http://www.emeraldinsight.com>

SearchWebServices 2001, *Definition of Java Card* <http://searchwebservices.techtarget.com/sDefinition/0,,sid26_gci843416,00.html>

Slashdot 2004, *Smart Card Limit Data Access* <http://slashdot.org/articles/00/10/21/133203_F.shtml>

Smart Card Forum 1995, *Reaction to Smart Card Technology*

Vesna Hassler, Martin Manninger, Mikhail Gordeev and Cristopher Müller 2001, *Java Card for E-Payment Applications,* Boston, Artech House

Waynica McLean *Managing Information Technology: Final Project* <http://www.pitt.edu/~wkmst2/final-project.html>

APPENDIX 1: HEXADECIMAL ASCII CODES

Hexadecimal ASCII CODE

00	01	02	03	04	05	06	07	08	09	0A	0B	0C	0D	0E	0F
NUL	SOH	STX	ETX	EOT	ENQ	ACK	BEL	BS	HT	NL	VT	NP	CR	SO	SI
10	11	12	13	14	15	16	17	18	19	1A	1B	1C	1D	1E	1F
DLE	DC1	DC2	DC3	DC4	NAK	SYN	ETB	CAN	EM	SUB	ESC	FS	GS	RS	US
20	21	22	23	24	25	26	27	28	29	2A	2B	2C	2D	2E	2F
SP	!	"	#	$	%	&	'	(	)	*	+	,	-	.	/
30	31	32	33	34	35	36	37	38	39	3A	3B	3C	3D	3E	3F
0	1	2	3	4	5	6	7	8	9	:	;	<	=	>	?
40	41	42	43	44	45	46	47	48	49	4A	4B	4C	4D	4E	4F
@	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
50	51	52	53	54	55	56	57	58	59	5A	5B	5C	5D	5E	5F
P	Q	R	S	T	U	V	W	X	Y	Z	[	\	]	^	_
60	61	62	63	64	65	66	67	68	69	6A	6B	6C	6D	6E	6F
`	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o
70	71	72	73	74	75	76	77	78	79	7A	7B	7C	7D	7E	7F
p	q	r	s	t	u	v	w	x	y	z	{	|	}	~	DEL