Retrieval of UTP Final Exam Result via SMS

by

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Dissertation submitted in partial fulfillment of
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CERTIFICATION OF APPROVAL

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A project dissertation submitted to the
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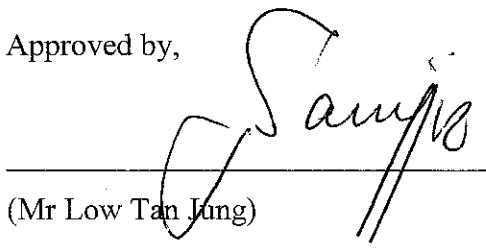
Approved by,



(Mr Low Tan Jung)

UNIVERSITI TEKNOLOGI PETRONAS
TRONOH, PERAK
April 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.

NURUL BAITY BINTI TUPON

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ABSTRACT

This paper deals with matter pertaining on building a system to allow students of University Technology Petronas to retrieve their examination results using Short Messaging Service (SMS) via their respective cellular device. The system consists of the database which stores students' information, an application which can link the database and the service provider and also the broadcasting operation which will distribute the SMS containing the examination results to the students. Currently students can check their examination results via online and examination result slips. In order to increase the efficiency and utilizing the current technology which is widely used nowadays, that is the mobile phone, retrieving the exam result via SMS is one good option. This project aims to allow students and UTP community to have another mean of getting information specifically to retrieve their examination results from UTP from anywhere at their fingertips. Four-month has been allocated for the project and the author followed Software Development Lifecycle model to accomplish the project.

CHAPTER 1

INTRODUCTION

1.1 BACKGROUND OF STUDY

The Short Messaging Service (SMS) is one of the popular methods for users to send and retrieve information not only from one mobile phone to another but also from one mobile phone to other applications. One of the examples is accessing various kinds of information from another computer in a network.

This project revolves around getting to know the architecture of mobile service network and also building the application to link the database with the service provider. The main concern of the project is to introduce an alternative way to access Final Examination Result for UTP students which is more convenient compared to the two current methods which are the traditional Exam Slip and also via online access.

SMS has the following characteristics which had contributed to the rapid growth of its usage around the globe. It has low cost compared to other methods such as Internet messaging and much cheaper than accessing Internet via WAP. Other than that, it has "anytime" and "anywhere" availability which gives the convenience to users worldwide. This paper also discusses SMS applications used by government sectors, private organizations and education bodies.

1.2 PROBLEM STATEMENT

Currently, students in UTP can check their final examination results using exam result slips and via online access. Students will only receive their examination result slips when they are back in UTP or a few days after the result has been announced in the UTP website. This will cause and an unnecessary delay for the students to obtain their examination results. Another method is for the students to check their results online from the UTP website. However, not all students have the internet access at home and again this will prevent them from getting their results immediately.

By having another mean to access examination results, this will increase the effectiveness and efficiency of accessing student's individual result and giving them the chance to get the result quickly at their fingertips.

1.2.1 Significance of the Project

- The convenience of "anytime and anywhere"

SMS messaging has two special characteristics: "anytime" and "anywhere" availability. A switched-on mobile device is able to receive or send a message at "anytime" regardless of whether a voice or data call is in progress. Messages sent to a switched-off phone are guaranteed to deliver when the handset is on again. Because SMS messages are tied to a personal mobile device they inherit the "anywhere" availability.

- Lower the cost for students to retrieve information from UTP (i.e., to check examination results)

The cost of sending SMS messages is lower than other data oriented mobile services such as WAP. Mobile service incurs two kinds of cost: the one-time cost of purchasing a mobile device; and the ongoing cost of using the services. Nowadays, almost all mobile phones are SMS enabled but WAP phones are still relatively expensive. The cost of sending a SMS message is low and relatively much cheaper

than accessing Internet via WAP. Affordability greatly enhances the suitability and potential of applying SMS to the commerce arena.

1.3 OBJECTIVES

This project aims to allow students and UTP community to have another mean of getting information specifically to retrieve their examination results from UTP from their own fingertips. This project has the following objectives:

1. To understand the architecture of broadcasting SMS result from a database.
2. To design an application that calls information from student database and link it with the service provider.
3. To implement a system for the convenience of students to get their results instantaneously on their mobile phones.

1.3.1 Feasibility of the project within the scope and time frame

For this project, the time frame given is around 4 months. The author will spend one month to carry out research and writing paperwork. The remaining three months will be allocated in developing the system. The project will be divided into several phases. The author needs to develop the student database. Next the author needs to develop the application to link the database and sending the student results to mobile phone.

1.4 SCOPE OF STUDY

The scope of this project is to understand the architecture of mobile services network and the distribution of SMS to cellular devices containing messages from a remote database. During this project the author will build a database containing student's information and build the application to capture the database. The next stage the author has to create system which will capture the student's result and integrate it with another application which can send the student's result via SMS. For this project, the author focuses on

building a prototype that can simulate how an SMS can be sent to hand phones containing information from a database.

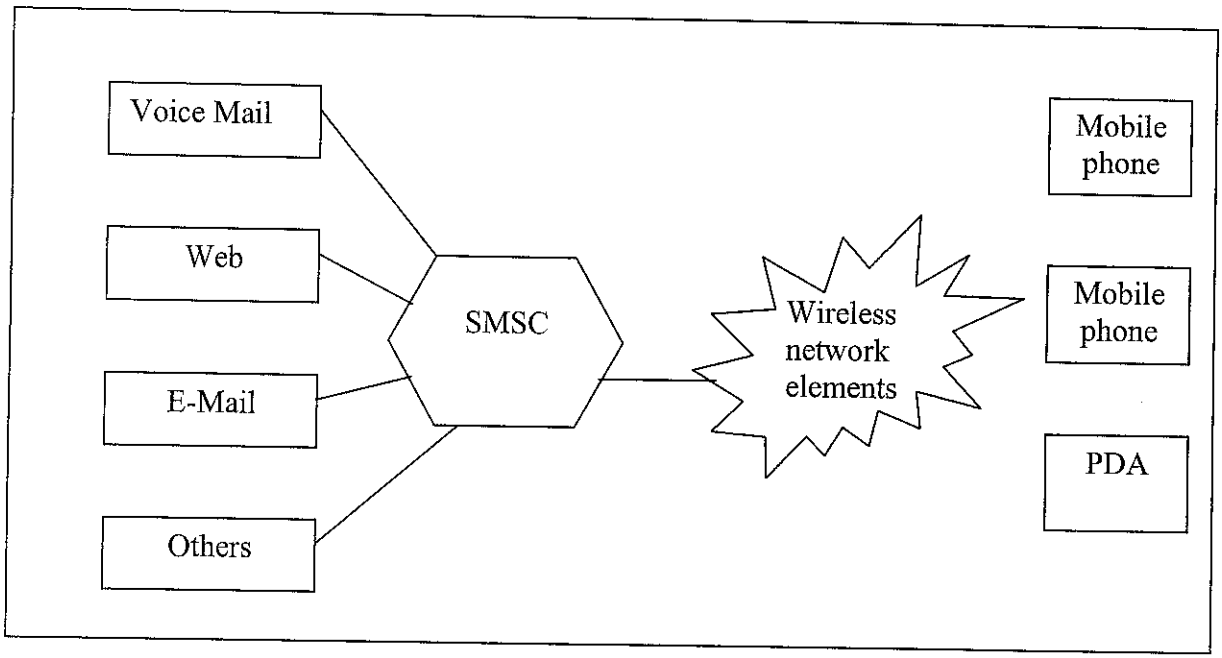


Figure 2-1: Illustration of SMS network

SMS - A system for sending short (256 bytes or less) text messages between wireless devices. Global System for Mobile Communications (GSM) and narrowband Time Division Multiple Access (TDMA) support message lengths of 160 characters. GSM supports two-way messaging, while TDMA enables messages to be received from the network only. CDMA supports messages of 256 bytes and two-way messaging. By definition, SMS enables limited-size messages. This is because in digital systems, the SMS messages run in the same control channel as the call setup data. We could view the restriction on message length as a hindrance or a blessing. If you are the wordy sort, you might be frustrated by the length limits. But for the delivery of notifications and alerts, SMS provides a low-cost communications mechanism that can take place at the same time users are talking on their digital cellular phones.

2.1.1 SMS Characteristics

SMS messaging has the following characteristics:

1) Convenience of "anytime and anywhere"

SMS messaging has two special characteristics: "anytime" and "anywhere" availability. A switched-on mobile device is able to receive or send a message at "anytime" regardless of whether a voice or data call is in progress. Messages sent to a switched-off phone are guaranteed to deliver when the handset is on again. Because SMS messages are tied to a personal mobile device, they inherit the benefits of "anywhere" availability. Hence, SMS could be used in the following context:

• *Information alerting services.*

SMS can be used to deliver an extensive variety of information to SMS users, including weather reports; flight, train and bus information; news headline; lottery results, etc. Existing applications include news alerts over SMS and discount coupons over SMS offered by the Straits Times newspaper in Singapore, and examination result notification via SMS by Australia's Monash university.

• *Marketing campaigns.*

SMS supports instant and onsite feedback collection from customers over SMS.

Customers can complete a survey or provide feedbacks right after the completion of transactions and on their move. Compared to the choice of filling in the paper forms on the spot and the choice of mailing back surveys, the SMS approach shortens the duration of feedback collections and saves respondents' time.

• *Real-time auctions.*

SMS allows buyers to learn the instant updates on bids and offer bids at their move.

2) "Personal" characteristic

SMS messaging is obviously "personal" as it is invariably tied to a mobile phone. A mobile phone is a personal device, always handy and available. An active mobile phone has a globally unique number (identified by its country and region code) and carries the identity of its user. This leads to the following implications:

SMS can be used for identification purposes in information inquiries and reservation services. Mobile users can send SMS messages to enquire particular information, such as a flight schedule or to book movie tickets. In the retail arena, SMS can be effectively used to provide remote points of sale services. For example, consumers can purchase a can of coke through the widely deployed automatic vending machines enabled with a "Dial-a-Coke" feature. Consumers pay by sending SMS messages and are billed through their regular mobile phone bills. Since mobile phones are personal devices, SMS makes identification and authentication much easier for payment purposes.

3) Support for "location-awareness".

With the Global Positioning System (GPS), the location of a GPS-enabled mobile phone can be determined. SMS thus can be sent or received depending on the location of mobile users. One application is in the selective advertising business for promotional purpose. For example, restaurant operators can entice customers by sending them advertisements and promotional information messages when they are in the vicinity of restaurants.

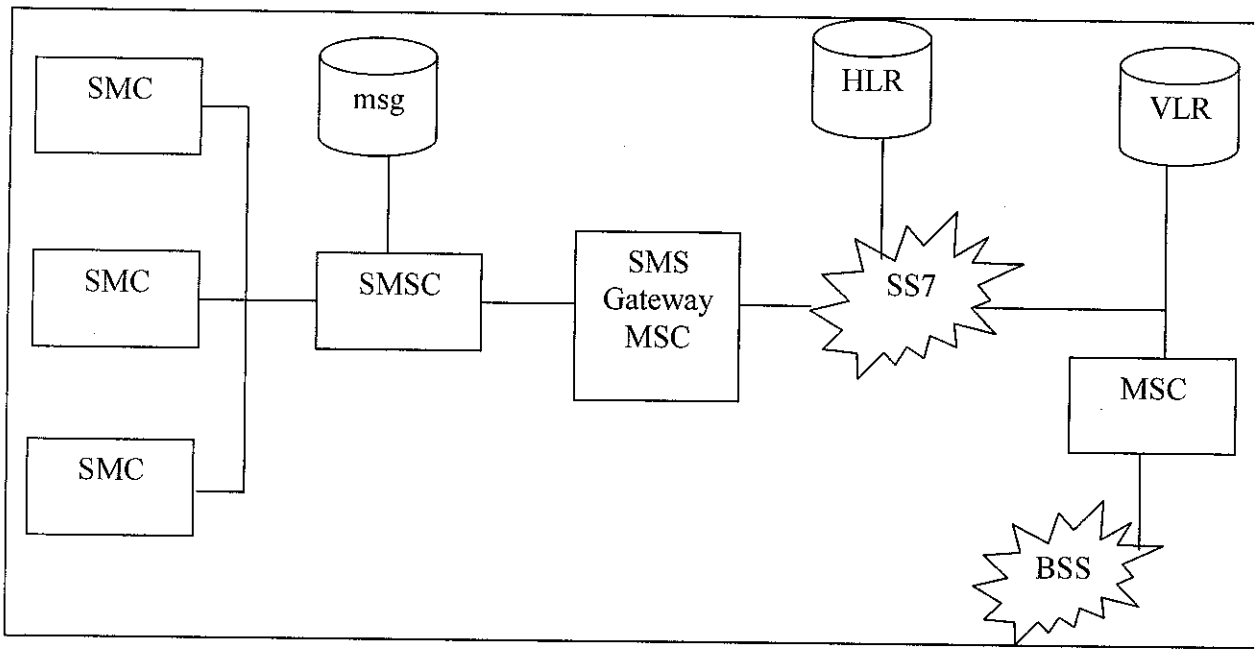
4) Low cost

The cost of sending SMS messages is lower than other data oriented mobile services such as WAP. Mobile service incurs two kinds of cost: the one-time cost of purchasing a mobile device; and the ongoing cost of using the services. Nowadays, almost all mobile phones are SMS enabled but WAP phones are still relatively expensive. The cost of sending a SMS message is low and relatively much cheaper than accessing Internet via WAP. The cost of sending a message is 0.02 Euro in Philippines, 0.04 Euro in Japan and 0.11 Euro in Western Europe. Affordability greatly enhances the suitability and potential of applying SMS to the commerce arena.

2.2 ARCHITECTURE OF SMS NETWORK

According to Joachim Tisal, a short message centre is an element of the network capable of receiving alphanumeric messages. This element is located in the fixed part of the network. Figure shows the architecture of a GSM network offering the short message service.

2.2.1 The elements of the network



SMC: Short Message Centre

SMSC: Short Message Service Centre

SMSC gateway: gateway between data and the mobile network (GSM)

HLR: Home Location Register

VLR: Visitor Location Register

MSC: Mobile Switching Centre (GSM Switch)

BSS: Base Station System

MS: Mobile Station (GSM terminal)

Figure 2-2: Architecture of a GSM network offering the short message service

A short message centre is a data base. It stores a received message before delivering it to the destination terminal. This is a repeater between the calling station and the called station. It introduces asynchronism between transmission and reception of a message. It permits recorded delivery of a message. A message is characterized by a period of validity and priority. The period of validity determines the duration of storage of a message before its destruction.

The Mobile Switching Centre (MSC) is the interface between the radio subsystem and a wired network. It realizes all the required management of communication with the mobile terminals. To obtain radio coverage of a territory, a mobile network switch controls a group of switches.

A Gateway MSC (GMSC) is an interconnecting switch between a mobile network and another network. When a network initiating a call cannot interrogate the nominal database of a mobile subscriber Home Location Register (HLR), it directs the call to consults the database then routes the call to the destination. The operator of a GSM network alone decides the list of switches which can interrogate the HLRs of his network.

SMS interworking MSC is the interface across which a message sent by a terminal arrives in the short message database.

SMS gateway MSC is the interface between a short message data base and a GSM network. This interface enables messages to reach the destination terminals.

The Base Station System (BSS) is the subsystem managing the radio transmitter receiver delays. The MSC switch talks to the subsystem through the interface A. A BSS consists of a station controller Base Station Center (BSC) and one or more cells and hence one or more Base Transceiver Station (BTS).

A BSC station controller manages a group of BTS base stations.

A BTS base station covers one cell of a GSM network.

A mobile station (MS) is the element of the network used by a subscriber. A mobile terminal, Mobile Equipment (ME) and a SIM together form a mobile station. The mobile terminal divides into two entities, the Mobile Termination, MT and the Terminal Equipment, TE. The characteristics of the mobile termination determine the applications and services supported by a mobile station.

2.2.2 Reception of a Message by a terminal

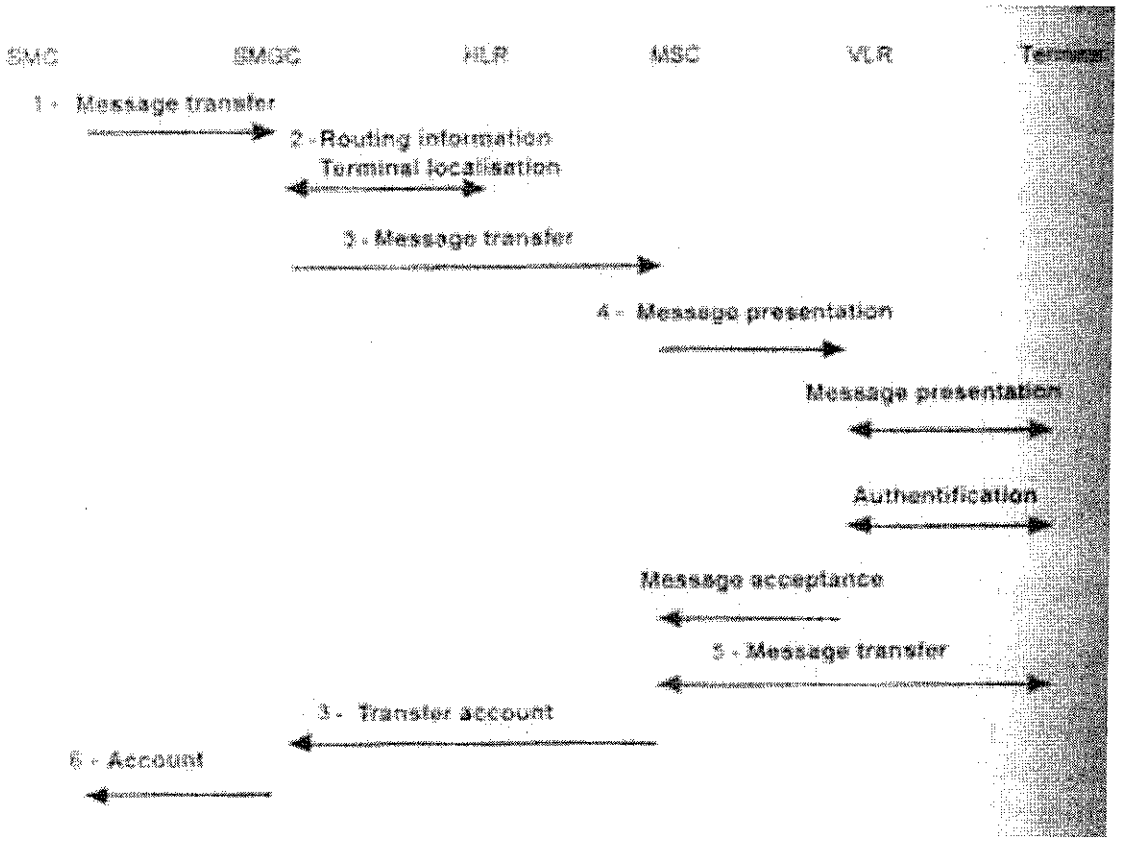


Figure 2-3: Signal exchanges for reception of a message

- The source of the message (SMC) sends a message to the message server (SMGC) which records the message and its characteristics (transmitter, destination, priority, limiting date of validity)

- The message server (SMGC) interrogates the HLR of the mobile subscriber to localize it. The HLR provides the references to the switch (MSC) in charge of the mobile subscriber.
- The message server transmits the message and the subscriber references to the switch (MSC) which manages the domain in which the mobile subscriber is located.
- The switch interrogates its visitor data base Visitor Location Register (VLR) to obtain the most recent coordinates of the subscriber. This request is accompanied by a procedure for message presentation, verification of the state of the terminal, identification and then authentication of the subscriber.
- The switch can finally deliver the message to the terminal.
- The switch provides a detailed account to the message server.
- The message server in turn sends an account to the transmitter.

2.2.3 Transmission of a message by a terminal

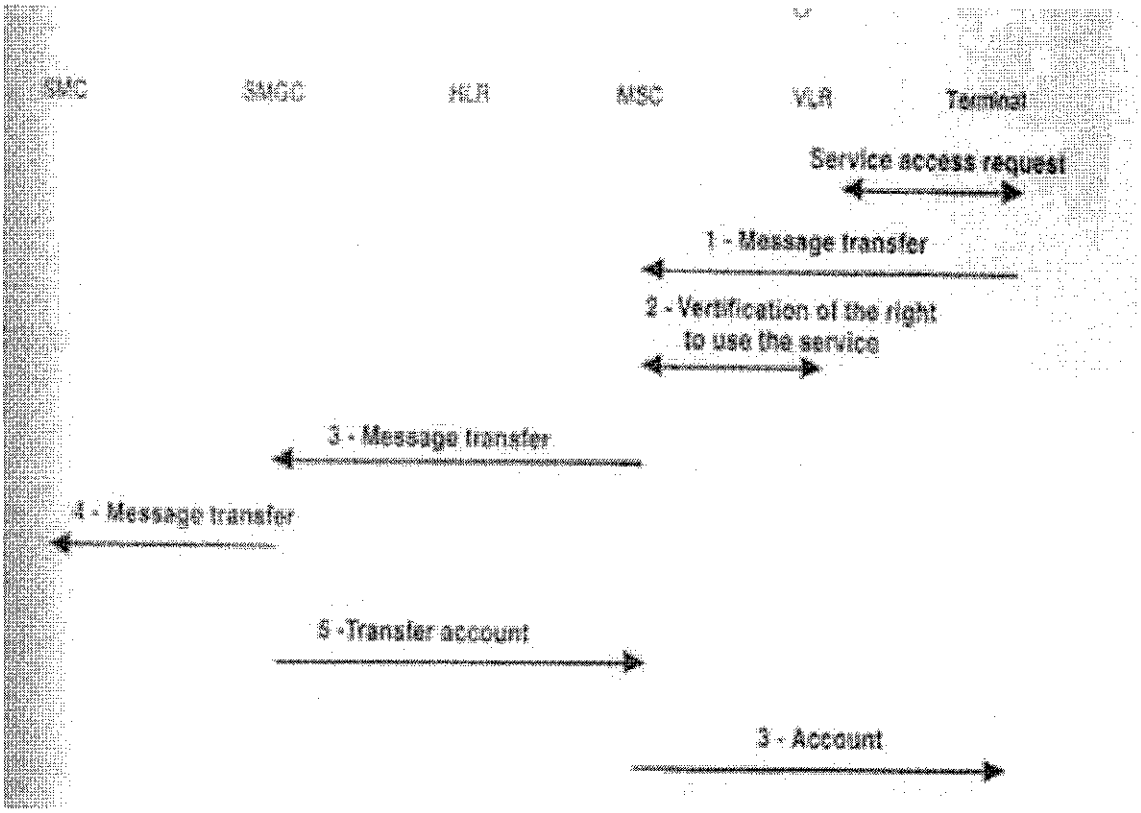


Figure 2-4: Signal exchanges for transmission of a message

- The mobile terminal is the source of the message (MS); it requests authorization to transmit to the VLR. The latter knows the subscriber options and gives authorization.
- The terminal transmits the message to the switch (MSC).
- The switch updates the subscriber register in the VLR, and notes the date and time of the transmission of the message together with the references. The switch can, with this information, deliver an account to the subscriber.
- The switch routes the message to the server centre which stores it and records its characteristics.
- The server retransmits the message to the destination.
- The server provides a detailed account to the switch.
- The switch informs the subscriber of the delivery of the message to the destination.

2.3 SMS USAGE AND APPLICATION

Recently, the growing influence of SMS has attracted significant attention. As a convenient and low-cost mobile communication technology, SMS is experiencing very rapid growth. In 2001, 700 million mobile phone users worldwide sent an average of 20 billion SMS messages every month. Indeed, the volume of SMS messages sent in December 2001 was 30 billion worldwide and it is expected to grow to 100 billion by the end of 2002. In Japan, SMS is also called *short mail*. In Europe, Norway leads the region with an average of 47 messages sent per month per user in 2001 while Philippines leads the Asia-Pacific region with 336 SMS messages (Marcussen C.H, 2002)

The worldwide increasing growth of SMS messaging services has spurred the developments of SMS commerce applications. Emerging SMS commerce applications mainly cover consumer-orientated business, such as alerting, ticket booking and retailing. Given that the huge SMS messaging customer base could potentially serve as the potential SMS-commerce customer base [1], many commerce providers have begun to show interest in SMS commerce applications. For example, in a survey of 200 European direct marketers, 21% of respondents use SMS marketing at least occasionally, and 12% have at least attempted to. 5% of respondents plan to use SMS regularly in 2003, and devote 7% of their budgets to SMS commerce applications. On average, marketers using SMS could achieve a remarkable response rate of 11% at a reasonably low campaign cost of 24,000 Euro. Hence, SMS offers great economical value to marketers. (Poropudas T, 2002)

According to Forrester Research, in some European countries the mobile phone market is beginning to reach its saturation with coverage rates of about 80%. This shows that mobile phones are a technology that has become accepted and almost omnipresent.
The short message service (SMS), which is supported by virtually all mobile phones in Europe has become an overwhelming economic success and is widely used. According to Marcussen, 78.7 billion SMS messages were sent in Western Europe in the year 2001.

In this paper we concentrate on interactions with smart objects based on short text messages that are sent via SMS. In contrast to speech, SMS messages usually have a simple structure and often follow repeating interaction patterns. This means, the difference in communicating with human and artificial counterparts via SMS can be small.

For Malaysia, we can see a phenomenal growth of usage of SMS and gathered from an article, the total of SMS traffic hitting 300 million in August 2002. SMS is no longer a novelty but it is now considered as a way of Malaysian's life due to its convenience and availability. With more than 8.6 million mobile subscribers and a penetration rate of more than 30% of the population rapid the multiplication of mobile devices.

Table 2-1: Amount of subscribers for mobile operators in Malaysia

Mobile Operator	Subscriber Base	Monthly SMS Volume	Estimated Monthly Revenue
Celcom	2.212 million	135 million	> RM20 million
DiGi	1.400 million	70 million	> RM10 million
Maxis	2.700 million	80 million	> RM12 million
TimeCel	0.600 million	15 million	> RM2 million
TM TOUCH	1.280 million	30 million	> RM4 million
TOTAL	**8.192 million**	**330 million**	**RM48 million**

Source: The Star, 10 August 2002

2.3.1 SMS Application- Instant Messaging

One of the most straightforward application of the usage of mobile devices as educational supporting tool is messaging. Again few different educational bodies made experiments in this area.

At Kingston University (UK) an experiment was undertaken to research the effectiveness of a two-way SMS campaign in the university environment. The team has

developed a system that sends SMS to students, registered to the service, about their schedule, changes in it, examinations dates and places, student's marks and etc. After registering the students were automatically separated in 5 different groups. One group was receiving announcements via e-mail, other 3 groups via SMS (but different interaction was necessary in every group) and the last – via web. The conclusions of the experiment were that the students in certain scenarios where a certain type of response is required preferred SMS as a medium to e-mail or web-based announces.
They feel the data is more personal and they like this. SMS could be efficiently used in education (m-learning) as a complementary media. As the technology improves (i.e. EMS and MMS, potential more user-friendly interface) the potential increases too.

At the University of Helsinki the *LIVE* (*Learning in Virtual Environment*) experiments, made with SMS system and with WAP phones, were very positive. The project went on by introducing digital imaging and sharing photos between the participants (teachers). The conclusions were that it is very possible that the introduction of MMS and the other 3G services in the large scene will lead to more and more possibilities for m-learning.

Another project on evaluation of a Short Messaging System (SMS) to support undergraduate students was done at Sheffield Hallam University. The experiment was with 67 undergraduate psychology students. The implemented system was again not for learning, but for managing learning activities (to guide, prompt and support the students in their learning). The findings were overwhelmingly positive, with students perceiving the system to be 'immediate, convenient and personal'. Positive results we re underlined and after the outcomes from a survey in Norway - almost 100% of the students in that University have cell phones and SMS system would be widely accepted. Once again an SMS system was considered to be used to spread information about lectures and classes, corrections in the schedule and etc. In certain cases students find it more convenient than e-mail or WWW as the information this was comes always on time.

From what we can see from the research done previously, these projects open two very important issues to be considered in doing further research in the mobile learning

domain. The first one is that the current technology gives enough powerful instruments to support some new forms of auxiliary learning tools. They also show the enthusiasm of the students to accept such new technologies. Once again an SMS system was considered to be used to spread information about lectures and classes, corrections in the schedule and etc. In certain cases students find it more convenient than e-mail or WWW as the information this was comes always on time.

2.4 SMS SUCCESS FACTORS

Heng Xu, Hock Hai Teo, Hao Wang had done a research to determine the possible success factors of emerging SMS commerce. For this they had chosen 3 countries to describe the key factors contributing or inhibiting the success of SMS, namely Japan, Finland and the U.S. They chose country as the unit of analysis because of two reasons:
1) SMS messaging is a domestic service and competitions among wireless network operators are normally local to a country;
2) Cost measurement and public policies are consistent in a country
From the content analyses, we found three consistent success indicators for SMS messaging:

- Cost-effective and interoperable wireless infrastructure

In short, the proliferation of SMS usage and its interoperability in Japan and Finland is greatly attributed to the existence of a wireless industry standard and cost-effective network infrastructure. In contrast, the problems of fragmented infrastructure and interoperability in the U.S. have led to extremely low usage of SMS messaging. Hence, all other things being equal, countries with an effective network infrastructure are more likely to experience higher success of SMS messaging usage than countries that do not.
Apart from that, all other things being equal, countries with an interoperable network infrastructure are more likely to experience higher success of SMS messaging usage than countries that do not.

- High penetration of mobile phones

The rapid growth of SMS is dependent on the penetration of mobile phone since it is the main conduit by which SMS messages are sent and received. All three countries have a high penetration rate for mobile phones. The high penetration of mobile phones could potentially be converted into a large SMS messaging customer base. Since SMS messaging is for communication, more mobile phones indicate more potential messaging destinations and this leads to more messages sent per user.

- Relatively low cost of messaging services

Cost is an important factor on the usage of SMS services. The cost is compared to other electronic communication alternatives in the same country. In Japan, the cost of mobile services is much lower compared to that of the wired Internet. SMS is thus considered as a lower cost, convenient, and easy-to-use alternative than chatting tools on the wired Internet. Consequently, the usage of SMS messaging is relatively high in Japan. Similarly, SMS messaging service is proliferating in Finland partly because of low pricing. Many Finnish use SMS as low-cost mobile email solutions and send SMS messages more often than the wired Internet emails and instant messaging. Unlike Japan and Finland, the charge for the wired Internet in the United States (U.S.) is relatively low compared to that of the wireless services. In the U.S., wired Internet technologies were developed at a much earlier stage and is very well established in terms of its reach and functionalities compared to other countries. Hence, most people prefer using Internet emails and instant messaging tools rather than wireless services for communications and exchanging information.

From the research conducted, we can apply all the success factors of SMS for Malaysia. Relatively the cost-effectiveness of wireless infrastructure in Malaysia is still on its way as we can only see the booming of mobile industry for the past 2 years where more and more service providers emerge in Malaysia. Apart from that, Malaysia also has high penetration of mobile phones which is SMS-enabled. Messaging services in Malaysia is different from one service operator to another. The lowest SMS charge is RM0.10 and the highest is RM0.20 imposed by Maxis. Other than that the common charge is RM0.15 for other service operators. These charges are quite low resulting people to use SMS rather than calling the other party.

CHAPTER 3

METHODOLOGY USED

3.1 PROCEDURE IDENTIFICATION

For this project, the author is going to implement the System Development Lifecycle Model (SDLC) and use the Prototyping approach. The SDLC model is chosen as it is the most suitable model in order to accomplish the project. The phases are all important and will be applied throughout the development lifecycle. A systems development life cycle (SDLC) model is one of a number of structured approaches to information system development, created to guide all the processes involved, from an initial feasibility study through maintenance of the completed application.

3.1.1 Software Development Life Cycle (SDLC)

In general, these are the phases for Software Development Lifecycle:

- **Identifying problems, opportunities and objectives**

  The existing system is evaluated. Deficiencies are identified. This can be done by interviewing users of the system and consulting with support personnel.

- **Determining information requirements**

  Strive to understand what information users need to perform their jobs. This phase serves to fill in the picture that the analyst has of the organization and its objectives.

- **Analyzing system needs**

  This phase involves analyzing system needs and analyzes structured decision made.

- **Designing recommended system**

  Use the information collected earlier to accomplish the logical design of the system.

- **Developing and documenting system**

  During this phase, the author works with the users to develop effective documentation for the system.

- **Testing the system**

  Before the system can be used, it must be tested. It is less costly to catch problems before the system is signed over to users.

- **Evaluating and implementing the system**

  Evaluation takes place in every single phase to ensure that one phase of the system development is finished and can proceed with the next phase.

3.1.2 Prototype Approach

Issues about going through the SDLC center around two interrelated main concerns. The first concern is the extended time required to go through the development life cyde. As the investment of analyst time increases, the cost of the delivered system rises proportionately.

The second concern about using the SDLC is that user requirements change over time. The two concerns are interrelated, because they both pivot on the time required to complete the SDLC and the problem of falling out of touch with user requirements during subsequent development phases.

To overcome these problems, prototyping is an approach used to complement the SDLC model. This way, it effectively shortens the time between ascertainment of information requirements and delivery of deliverable of a workable system. With prototype, users can actually see what is possible and how their requirements translate into hardware and software.

3.2 TOOLS USED

3.2.1 Software

- Visual Basic 6.0

This programming language is chosen due to author's familiarity with the system. Apart from that, it has several components that can be integrated with Nokia PC Connectivity 3.0. Some of the libraries needed from Nokia PC Connectivity for the programming of the application can be added to Visual Basic 6.0 by adding the project reference properties.

- Microsoft Access 2000
- Nokia PC Connectivity 3.0
- ActiveXperts SMS and Pager Toolkits
- Windows XP

3.2.2 Hardware

- Laptop equipped with IrDA
- Mobile phones – Nokia 8310, Nokia 8210, and Nokia 6610.

3.3 NOKIA PC CONNECTIVITY 3.0

Nokia PC Connectivity SDK 3.0 is a sophisticated and easy-to-use programming interface for Nokia Global Systems for Mobile Communications (GSM) and Time Division Multiple Access (TDMA) phones. The SDK allows communication with Nokia GSM and TDMA phones and development of PC applications that utilize the features supported by the phones. The Nokia PC Connectivity SDK library consists of several separate libraries, each performing a special set of tasks related to GSM or TDMA phone functionalities. The included libraries are:

3.3.1 Library Description

Library	Description
STTNGS3A_Slib	General Settings Library: adjusting settings on the GSM phone (Stngs3AS.dll).
SMS3AsuiteLib	Short Message Library: sending and receiving of messages and SMS memory management (Sms3aS.dll).
PhonebookAdapterDS3	Phonebook memory, speed-dial key, and caller group management (SCM3aS.dll).
CALADAPTERLib	Calendar management (Cal3aS.dll).
NOKIACLWAP	WAP Settings Library, handling WAP settings and groups (NclWAP.dll).
NokiaCLMessaging	Messaging Library, sending and receiving of messages and SMS memory management (NclMsg.dll).
NokiaCLSettings	Settings Library (NclSet.dll).
NokiaCLCall	Voice call management (NclCall.dll).
NokiaCLCalendar	Calendar management (NclCal.dll).

Table 3-1: Components and interfaces of SMS3AsuiteLib

All of the libraries are implemented as Component Object Model (COM) Libraries. COM is the name of the specification for Microsoft's basic object technology that defines the standard for integration between software components.

A client application exploits these libraries through object libraries, which are also called type libraries in some contexts. An object library can be considered a binary description of the component library. The object libraries that correspond to the libraries of Nokia PC Connectivity SDK libraries are mentioned in parenthesis in the library table above. Many environments support object libraries: Visual Basic, Visual C++, Delphi, Visual J++, and others.

Each library in Nokia PC Connectivity SDK contains one or more functional entities called components. These reusable software components present their functionality through a defined set of interfaces. An interface contains a collection of related properties, methods, and functions that are grouped together under one name. A client application creates an instance of a component and a component object, sets a reference to the desired interface, and accesses interface methods through this reference.

Interfaces are divided into two categories according to which party has invoked the interface methods: incoming and outgoing interfaces. Methods of incoming interfaces are implemented on the component object and receive calls from external clients. The object performs the desired service and then returns the results to the client. Most interfaces in this component library are incoming interfaces that are called by the client application.

Meanwhile, methods (events) of outgoing interfaces are implemented on the client's sink and receive calls from the object. The object defines an interface it would like to use, and the client implements it. Thus, outgoing interfaces enable the object to talk back to its client. Outgoing interfaces are usually used to notify the client when something important happens in its sphere or to inform the client when some asynchronous

operation has been completed. Outgoing interfaces are also often called connection points, event interfaces; notify interfaces, or source interfaces.

3.3.2 Pre-requisites

To be able to use Nokia PC Connectivity SDK a user needs:

- DLR-3P connection cable (available separately) or
- IrDA connection or
- Compatible Bluetooth connection or
- DKU-2 USB connection cable (available separately) or
- DKU-5 USB connection cable (available separately) or
- DKU-6 USB connection cable (available separately)

For this project, IrDA connection is chosen to connect between the hand phones and the laptop where the application resides.

Nokia PC Connectivity 3.0 supports the following phones:

Phone	Type
Nokia 3320	NPC-1
Nokia 3360	NPW-1
Nokia 6210	NPE-3
Nokia 6250	NHM-3
Nokia 6310	NPE-4
Nokia 6310i	NPL-1
Nokia 6340	NPM-2
Nokia 6360	NPW-2
Nokia 6370	NHP-2
Nokia 6385	NHP-2
Nokia 6510	NPM-9
Nokia 6590	NSM-9
Nokia 6610	NHL-4U
Nokia 6650	NHM-1
Nokia 7110	NSE-5
Nokia 7160	NSW-5
Nokia 7190	NSB-5
Nokia 7210	NHL-4
Nokia 8210	NSM-3
Nokia 8290	NSB-7
Nokia 8310	NHM-7
Nokia 8390	NSB-8
Nokia 8810	NSE-6

- Nokia 8850 NSM-2
- Nokia 8890 NSB-6
- Nokia 8910 NHM-4

3.3.3 Using libraries with Visual Basic

The description of the interfaces exposed by the component library is published in the object library (i.e., in the type library). The object library defines the methods along with their parameters and return values in standard binary format. Object libraries can be viewed in readable format with the OLE/COM Object Viewer or with Visual Basic's Object Browser. The OLE/COM Object Viewer is distributed with the Microsoft Platform SDK.

Before starting the whole development using Visual Basic 6.0, a reference to its object library must be set. Other than that, only the needed libraries are selected in order to minimize the number of object references Visual Basic must resolve, thus reducing the time it takes the project to compile.

3.3.4 Short Message Library (SMS3ASUITELIB)

For this project, the library that will be used is Short Message Library (SMS3ASUITELIB). The Short Message Library contains components for handling GSM Short Messages (SMSs). Components contain interfaces for sending messages, adjusting SMS settings on the phone, handling SMS memory on the phone, and receiving SMS-related notifications from the phone.

The figure below represents the Sms3aS.dll module. The module contains implementation for three objects: SMS_SuiteAdapter, ShortMessage, and GMSPicture. SMS_SuiteAdapter offers methods for handling message traffic with the phone. ShortMessage and GMSPicture are pure data components for short messages and graphical messages.

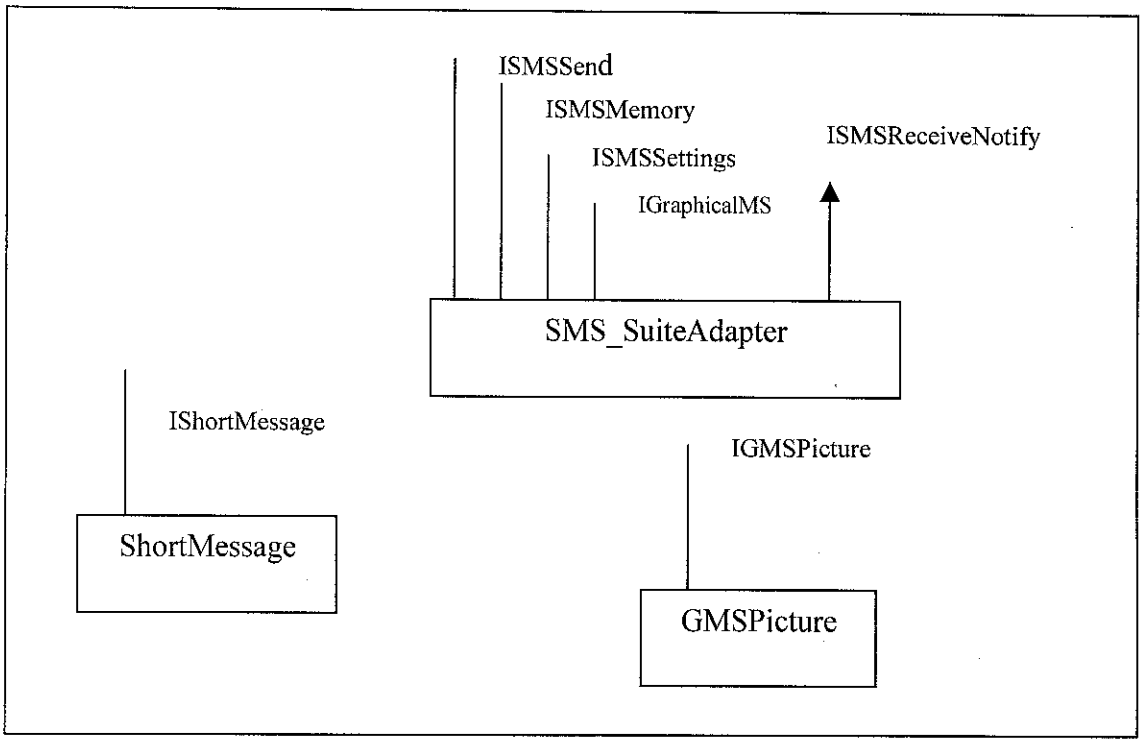


Figure 3-1: Components and interfaces of SMS3AsuiteLib

Among the 3 components, the one that is used extensively in this project is the SHORTMSGADAPTER component. This component contains IMessage, IMemory, IFolder and IShortMsgNotify interfaces. IMessage contains method for sending, receiving, reading and saving SMS messages. IMemory contains method for handling SMS memory and settings. IFolder contains method for handling SMS folders in memory. IShortMsgNotify contains method for receiving SMS events.

One of the libraries use in the project is NokiaCLMessaging which contains NCLMsg.dll module. The components of the library are illustrated in the figure below:

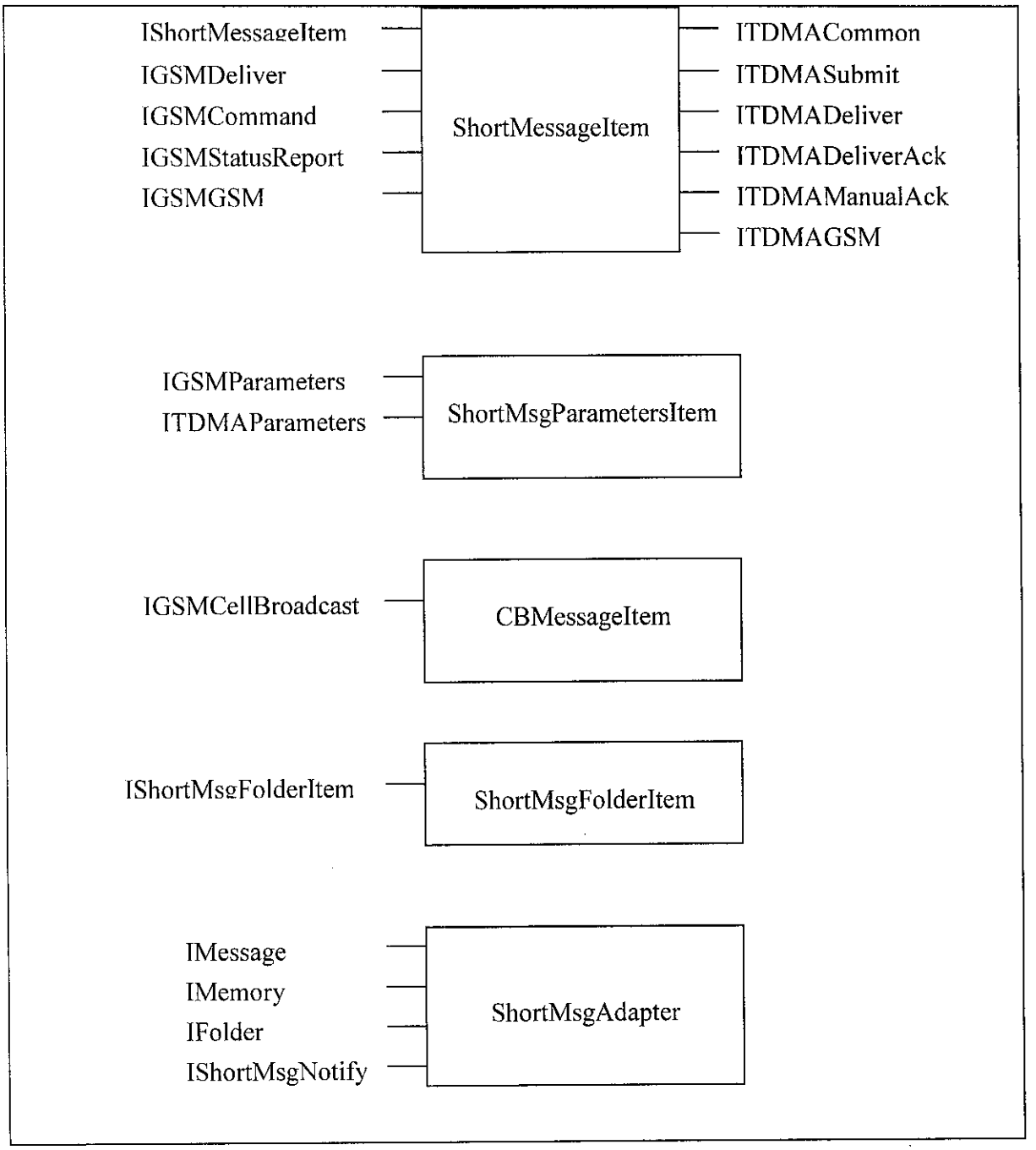


Figure 3-2: Components and interfaces of NclMsg.dll module

3.4 ActiveXperts SMS AND PAGER TOOLKIT

SMS and Pager Toolkit is a COM component, and provide SMS and Pager messaging capabilities through a serial port. SMS and Pager Toolkit can send SMS messages directly through a Hayes compatible mobile phone (like Nokia 20, Nokia 30, Nokia 6310, Ericsson F221 and many more), or through an SMSC ("Short Message Service Center") dial-in service provider. In order to send SMS/Pager messages through a provider, a standard Hayes compatible modem (no GSM) is provided.

ActiveXperts SMS and Pager Toolkit features:

- SMS through Hayes compatible GSM mobile phones, using a serial data cable, InfraRed or BlueTooth;
- SMS through SMSC ("Short Message Service Center") dial-in providers;
- Support for TAP and UCP compatible SMSC providers;
- Normal messages and Flash messages are supported;
- High Level Application Program Interface (API) to send basic SMS messages, and an Low Level API to have complete control over the modem or GSM;
- Trace Log. All modem operations can be written to a log, making troubleshooting easier.

ActiveXperts SMS and Pager Toolkit can fit different purposes. The followings are some examples of the functions:

- To provide an SMS interface on an intranet web server, so employees can send SMS messages to colleagues.
- Add SMS/Paging capabilities to Front Office applications, like Word, Excel and so on.
- Add SMS/Paging capabilities to scripts, enabling SMS notifications when the scripts has an error

- Ideal for network and system administrators, who usually rely on batch jobs
- Send out SMS messages in batches, to notify groups of people.
- To control your mobile phone with your PC, adding phonebook entries, sending SMS messages and so on.

This project concentrates more on the last function of the ActiveXperts SMS and Pager Toolkit. The project is about sending students' results via SMS to respective cellular devices. The result is gathered from a database and the information is sent to requesting users. The project is simulated by a prototype that follows the flow of transmission of SMS to cellular devices. The mobile phone acts like a GSM modem while the computer acts like a server with ActiveXperts SMS and Pager Toolkit installed in it. The computer used is a laptop with wireless capability and communicate with the mobile phone via infrared connection.

CHAPTER 4

RESULTS AND DISCUSSION

4.1 ANALYSIS PHASE

During this phase data and information is gathered. Valuable information is gained by reviewing some websites and journals and followed by completing the literature review. The author also managed to use another method for information gathering. A survey was conducted by distributing some questionnaires to students of UTP. For this survey purpose, the sample consists of 75 students picked randomly from different programmes ranging from Foundation Year students to the Final Year Students.

The purpose of the survey is to determine 2 factors:

- To determine the level of acceptance of UTP students of the proposed idea: Retrieval of UTP examination results via SMS.
- To determine the number of mobile phone users in UTP.

After the data gathered have been analyzed, the result of the analysis is reflected by using the pie chart and a graph.

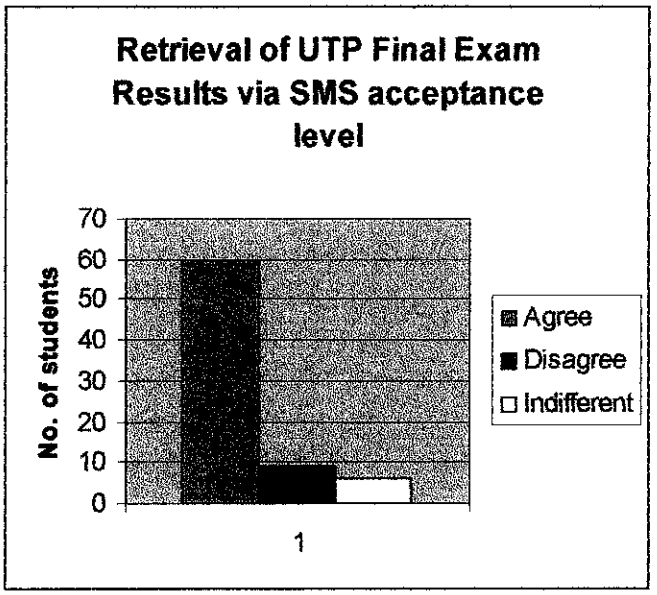


Figure 4.1: Graph of the total students' acceptance level

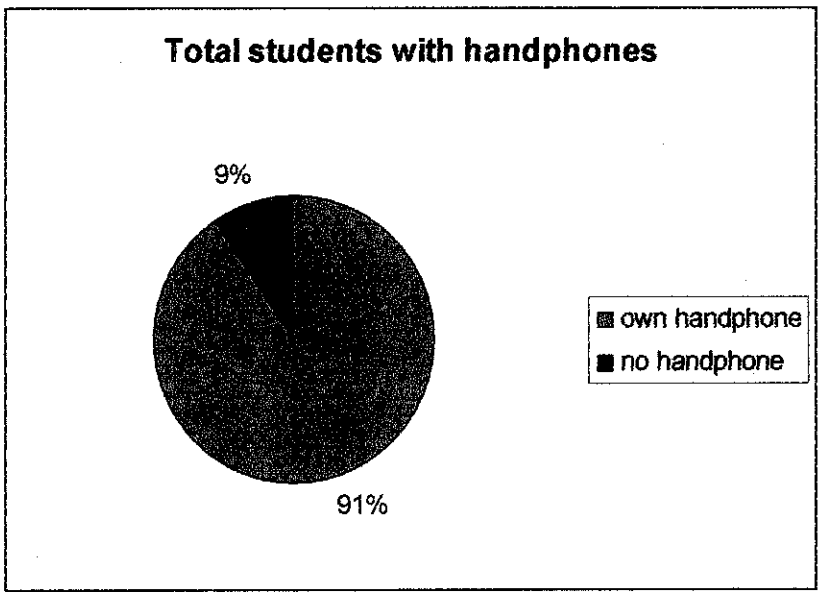


Figure 4.2: Student's percentage on handphones ownership.

Based from the data gathered, it shows that 80% agree to accept SMS as another method for UTP Final Examination Retrieval. Apart from that, the total number of students with handphones is high as 68 out of 75 students in UTP own their mobile phones. As stated in the Literature Review, the higher the penetration of mobile phones the higher it contributes to SMS usage.

4.2 DESIGN PHASE

Before developing the application for sending the student's examination result using Visual Basic 6.0, a data flow diagram for the system is sketched. The system refers to the application developed using Visual Basic and Nokia PC Connectivity that connects between the laptop and the mobile phone. This system will send the data containing the student's result to the mobile phone connected with the laptop via IrDA connection that acts like a Global System for Mobile Communications (GSM) modem. This GSM mobile phone will then forward the SMS to the SMS Centre Server via GSM network. Then, it will process the SMS before send it to the destination end which is the hand phone numbers stated in the system.

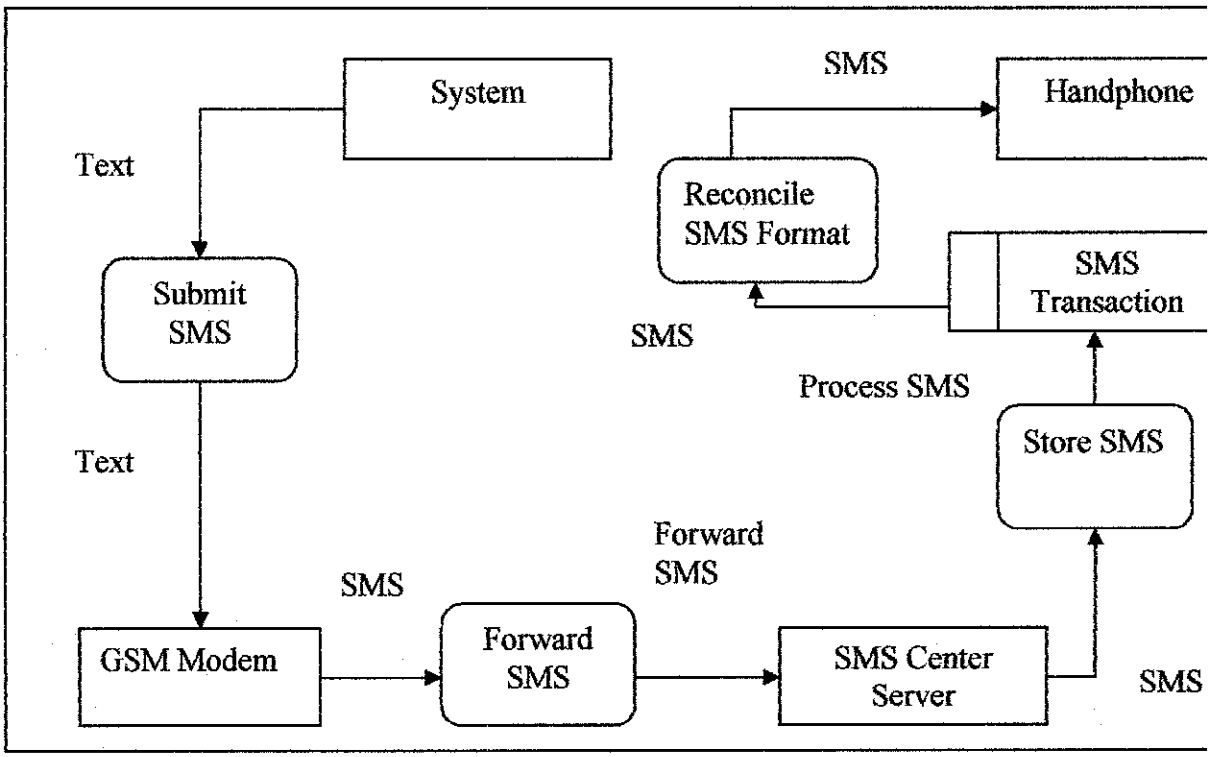


Figure 4-3: SMS Sending Data Flow Diagram

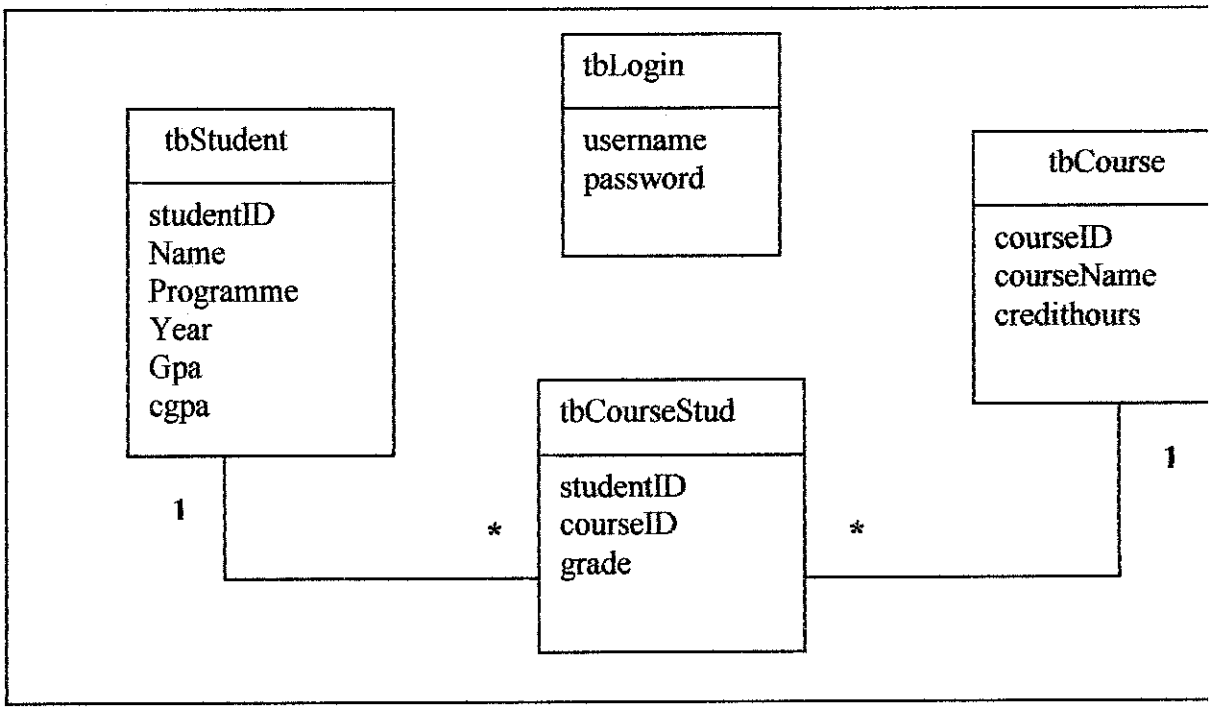


Figure 4-4: Class diagram for the student's examination result database

As the project concentrates more on the SMS architecture, and not on the development of a complex student's database, the database developed is a simple database consisting of 4 class diagrams. The database created for this project is Login.mdb. In this database, several tables are created. The tbLogin table is developed for verification of the administrators of the system. If the password entered by user is not correct, the system will not gives access for users. Another 3 tables, which are tbStudent, tbCourseStud and tbCourse are the tables that store respective student's information which will be manipulated to be sent to requesting users.

4.2 DEVELOPMENT PHASE

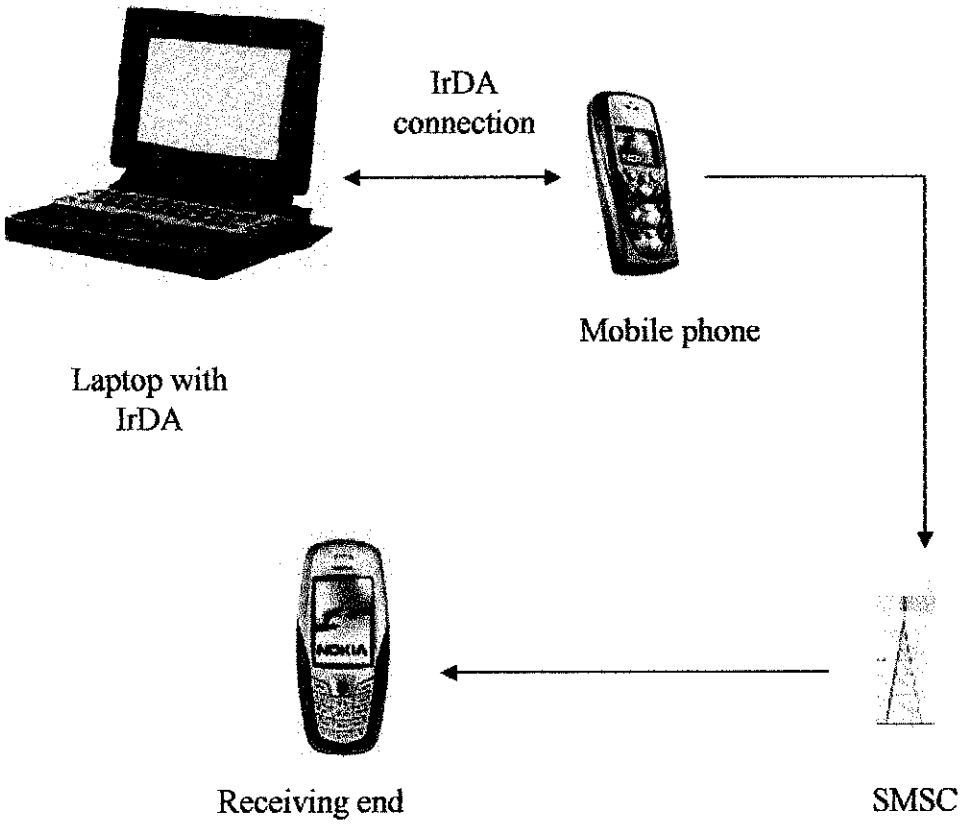


Figure 4-5: The flow of prototype

The project is about sending students' results via SMS to respective cellular devices. The result is gathered from a database and the information is sent to requesting users. The project is simulated by a prototype that follows the flow of transmission of SMS to cellular devices. For this project, the mobile phone acts like a GSM modem while the computer acts like a server with ActiveXperts SMS and Pager Toolkit installed in it. The computer used is a laptop with wireless capability and communicate with the mobile phone via infrared connection.

Basically the system will send the student's results data from the computer to the mobile phone that acts like a GSM modem via IrDA connection. Later, the GSM modem will

send the data via GSM network to the SMSC. SMSC will store and transmit the data to the receiving end or the destination number specified by the system.

4.3 TESTING PHASE

The testing is done in stages depending on the progress of the development process. The testing is done in phases synchronized with the development processes. During the first stage, the author developed the student's database. Later, the application is built using Visual Basic 6.0. The first stage of testing is done between the application and the database. This testing is done to ensure that the database is linked with the application and the right data is being called from the application. This data is the output from the database and will be the input to the requesting mobile phone (destination end).

During the next phase, the author tested the connection between the laptop and the cellular device using Nokia PC Connectivity 3.0. The testing is done to check on the distance allowed for the laptop with IrDA connection and the mobile phone that acts like a GSM modem to be aligned in order to be connected. Some objects are put between the laptop and cellular device to check whether the connection is interrupted. From the tests done, if the mobile phone is not aligned with the laptop IrDA port the connection is interrupted. The cellular device does not have to be next close to the port as long it is aligned with it. The connection is also interrupted when there is a thick object put between the laptop and the mobile phone.

Apart from the mentioned tests above, several phones were tested in order to test their compatibility with Nokia PC Connectivity. The author used Nokia 8310, Nokia 8210, Nokia 6610, Nokia 8250, Nokia 6100 and Samsung. From the tests conducted the author will use Nokia 8310, Nokia 8210, and Nokia 6610 for testing purposes as Nokia PC Connectivity does not support other initial models stated earlier.

After the second stage of testing and there is no error between the application and the database, then the next stage is to complete the application using Visual Basic 6.0 and

Nokia PC Connectivity. The final stage of testing is done by checking the functionality of the system. After all the bugs from the program have been fixed, the function of the system is checked. The testing phase is completed when the application managed to send student's result to respective cellular device based on the destination number stated in the application.

4.4 FINDINGS

4.4.1 Methods of SMS Sending

After some information gathering made, there are actually different ways to send or to receive a SMS. The methods of sending SMS are using SMS Gateway and GSM modem. The simplest way is GSM modem. Faster and more comfortable is the direct link to the SMSC. With a direct access, user can reach up to 600 SMS per minute.

There are some requirements for this method of SMS sending. In order to use this approach, it required to identify setup of the client (handset) and specify the SMS center for connection to the network. Besides that, it needs to identify the type of address of client, such as server name or IP address which is used to connect to network. The protocol connection between SMS and the application is required to be defined in this SMS sending approach.

In this section, I will describe on SMS Gateway and also GSM modem. For this project, I have used Nokia PC Connectivity as an intermediate between the computer and the mobile phone that acts like a GSM modem.

- **GSM Modem**

GSM has been the backbone of the phenomenal success in mobile service over the last decade. Now, at the era of true broadband services, GSM continue to evolve to meet new demands. One of GSM's great strength is its international roaming capability,

giving consumers a seamless service in about 160 countries. This has been a vital driver in growth, with around 300 million GSM subscribers currently in Europe and Asia.

A GSM modem can be a PC card installed in a notebook computer, such as the Nokia Card Phone. A GSM modem could also be a standard GSM mobile phone with the appropriate cable and software driver to connect to a serial port on personal computer. Phones such as the Nokia 7710 with a DLR-3 cable, Nokia 8310 with IrDA, or other various types of phones are often used for this purpose. (GSM Modem from ihub, 2002)

A dedicated GSM modem (external or PC Card) is usually preferable to a GSM mobile phone. This is because of some compatibility issues that can exist with mobile phones. For example, if mobile phone is able to receive inbound messages with particular gateway, and it is using a mobile phone as a modem, then it must utilize a mobile phone that does not use WAP push. This is because the mobile phone automatically processes the messages without forwarding them via the modem interface. Similarly, some mobile phones will not be allowing SMS text messages to be received longer than 160 bytes (known as "concatenated SMS" or "long SMS"). This is because these long messages, and the phone attempts to reassemble the message before forwarding via the modem interface.

- **SMS Gateway**

The gateway service allows system application to connect to the GSM Network for sending and receiving of SMS. The gateway provides the necessary software components for applications to connect to GSM servers through industry standard network protocols like TCP/IP. It manages the business critical message queuing, switching from the applications to the mobile operators' Short Message Service Centers.

SMS Gateway is a unique Short Message Service (SMS) messaging tool. It facilitates complete two-way messaging capabilities over GSM networks for Windows 95/98/NT/2000/XP based applications through the use of Dynamic Data Exchange

(DDE), Object Linking and Embedding (OLE) Automation, Simple Mail Transfer Protocol (SMTP), Post Office Protocol 3 (POP3), HTTP, XML and the Command Line Interface (CLI). SMS Gateway connects a PC to a GSM handset (Mobile Terminal), via a PCMCIA "Cellular Data Card", or specialized cable connected to a COM port or Infrared. Through this connection all messages currently stored in the mobile terminal can be retrieved, new messages sent, and new incoming messages be sent straight to the PC. Other facets such as radio signal strength and error rates may also be read from the Mobile Terminal over this interface.

SMS Gateway comes with an interactive two way messaging utility named SMS Messenger, which demonstrates some of the capabilities of SMS Gateway when using the OLE interface. According to the article from WinSMS, this utility may be used for ad-hoc messaging alongside a common Dynamic Data Exchange (DDE) and Object Linking and Embedding Automation (OLE Automation) specifications to allow the transmission and reception of SMS messages directly from any application supporting standards. Applications supporting DDE & OLE Automation include; Delphi, Paradox, FoxPro, WordPerfect, Excel, Word, Access, Visual Basic and many more. SMS Gateway also supports the sending of messages to individual or groups of destinations directly from the Windows Command Line Interface (CLI). This facility is useful for easy integration with Network Management utilities that are able to issue Windows commands under certain prescribed circumstances, e.g., to send a message to a technician when a certain equipment alarm is raised.

Additionally from article of WinSMS, SMS Gateway supports a powerful bidirectional HTTP based eXtensible Markup Language (XML) interface that enables easy integration with web-enabled environments, such as Active Server Pages and Java. SMS Gateway includes a set of management utilities including a HTML based diagnostic facility, generation of SNMP traps for significant events, and comprehensive logging to text files (viewable via a HTML management page). SMS Gateway is suitable for dispatch, field access to databases, telemetry, vehicle tracking, and many more such applications.

4.5 DISCUSSION

For this project, the author did not use SMS Gateway, instead used the GSM phone that acts like a GSM modem. The functions are basically the same, however with some limitations. The number of messages that can be stored in GSM phone depend on the capacity of the SIM card inserted in the GSM phone and how many messages the phone can support.

In real UTP environment, a GSM modem is more suitable for retrieval of student's examination result as currently there are about 6000 students pursuing their degree here. GSM modem still manage to handle the capacity but with few limitations. However if the numbers of students increase to more than 10,000 SMS gateway is needed in order to handle the SMS transactions effectively.

4.5.1 Cost issue

For this system to be implemented, both the students and UTP itself need to bear some costs. As the author has stated one of the common characteristics of SMS that has contributed to its common growth is the low cost. However, not everyone will favor the idea of having to pay for this service.

Firstly, in order for the real system to be implemented, UTP has to invest in either the GSM modem or SMS gateway. As stated earlier, the number of UTP students is still small and UTP can invest in GSM modem instead of SMS gateway. Some fees need to be paid to the service provider such as Maxis, Celcom, DiGi or TMTouch.

For the students, the normal rate of one SMS is from 10 cents to 20 cents depending on the service provider. However, for this kind of service, each student needs to pay higher rates which range around 40 to 50 cents.

From the facts above, we can gather that both UTP and students have to incur some cost in order to benefit from the convenience that everyone can gain from the service. The value of 40 cents might be big to certain people and might be small to some. However, the retrieval of the examination results via SMS is an alternative for students. This method is to increase the efficiency and saves the students' time in accessing their results. As there are another 2 methods, the students are free to choose which method is most satisfactory to them.

In the literature review section, the author has given some examples of how SMS has helped some education bodies to manage the learning activities. UTP can also enjoy the benefits from SMS not only by offering the service to check the students' examination results but also some other services such as:

- Registered Course Detail

  Students can check the courses they have successfully registered for via SMS

- Notification of Class Schedules

  Students are able to retrieve their class schedules as and when needed via their mobile phones. The students are able to check their class schedules by day or course.

- Application Status

  Those who have applied to MMU can check their application status via SMS.

CHAPTER 5

RECOMMENDATIONS AND CONCLUSIONS

5.1 PROBLEMS ENCOUNTERED

Throughout the Final Year Project period, there are some complications experienced by the author which actually gave lots of beneficial knowledge. The problems encountered were treated as part of learning process.

5.1.1 Difficulty in downloading the software needed

For the first two months the Internet connection in UTP was not stable. Due to this the process of getting Nokia PC Connectivity 3.0 was hard and time-consuming. Each time the downloading session, the session had to be restarted due to connection to server was reset. Because of the unavailability of Nokia PC Connectivity not much can be done during the early stage. This resulted to time limitation in trying to get familiarization with the software.

5.1.2 Problem getting GSM modem

Initially, the author wanted to use the real GSM modem for building the prototype. However, the author did not do an early research on functions and the quotation of GSM modem. Finally, the author opts for GSM phone which has limited capability than a GSM modem.

5.1.3 Time constraint

As the time is quite limited, it was quite hard for the author to learn Nokia PC Connectivity as it is a very new application. Trial and error was one of the learning processes and this was time consuming.

5.2 RELEVANCY TO THE OBJECTIVES

Basically, the author managed to fulfill the objectives of this project. Upon completion of the project, the author managed to understand the architecture of sending SMS via mobile network specifically on how to send a data from a database to requesting destination numbers. Other than that, an application to call data from the student's database and link it with the mobile network has been successfully implemented. Lastly, this system was developed for the convenience of students to get their results instantaneously on their mobile phones. By successfully implementing the system, the author truly believe that it will give convenience to the students of UTP in retrieving their examination result.

5.3 LIMITATIONS OF THE SYSTEM

As this project is reflected by developing a prototype, the system has its limitations and weaknesses.

5.3.1 Security features

As we all know, examination result is considered as vital information for an individual. Due to that, the published results should always be accurate and correct. If a student receives wrong examination results due to human error or malicious intent, the impact to the student might not be desirable and the capability of UTP Exam Unit might be questioned. For this system, there is no mechanism to filter whether the result that is

being sent via SMS is correct or not. In order to ensure the data integrity, a filter mechanism must be integrated with the system.

5.3.2 Interactive messaging

For this project, the author simulates the topic with only the sending method of the student's results. In the system, the author does not show how the system processes the request of the students.

5.4 RECOMMENDATIONS FOR FUTURE EXPANSION

For future expansion, the limitations of the systems should be solved and improved. This is to ensure the smooth operation of the system in the future.

5.4.1 Security features solution

For this system, the result is taken from the database updated and created by the UTP Examination Unit. Whatever that is kept in the database will be the results that will be published in the UTP Website and sent to the students via exam result slips. The first step to ensure data integrity is to ensure the data inside the students' database that has the students' results is consistent and correct. In order to ensure that the SMS contains the correct results of each student, then the data in the database should be correct. If the data in the database is not accurate or wrong then the result that will reach the students via exam results slip, online access or SMS will not be correct. For the retrieval of Final Examination Results via SMS, naturally, the system will capture the information from the database and send the information from the database to respective students via SMS. If the data from the database is correct, it is unlikely that the SMS received by the students is inaccurate.

Another security feature that should be incorporated for this system is students' authentication. This is to avoid other students from getting another student's

examination results. The system will only process the request of a student if the students include the right information in the SMS to request for their results. For example, in the SMS containing the request of the student, the student should include their Exam ID, Matrix ID and also their IC Number. After the system has verified the information, then the system will reply the request by sending their examination results via SMS only if the particulars sent by the student matched with the students' information in the database. This can avoid any students from getting their friend's results.

In order to avoid students from getting pranks from their friends, the system is handled only by the administrators and they have to log in by entering their username and passwords.

5.4.2 Interactive Messaging solutions

There is lots of room for improvement for this project. Basically, the output of this Final Year Project topic is a prototype developed to show the SMS architecture as discussed in Chapter 4. Instead of using GSM modem, GSM phone is used to replicate the function of the real GSM modem. As we all know, GSM phone has its own limitation then GSM modem. The prototype only simulates how an application submit data from database to requesting users (destination phone number) using a GSM phone connected via IrDA. The author managed to simulate the SMS architecture itself but does not really stress on the functionality of the system and does not simulate the real environment.

In the future, this system will be more effective using GSM modem which can perform an interactive messaging application. For future expansion, functionality of the system can be improved by having both ability to request and automatic reply of SMS to requesting party. The system should function on itself where it can automatically send the result of the student requesting it to the destination number.

In order to accomplish this, a strong knowledge on AT command is needed in order to program the GSM modem with the application chosen for example Visual Basic 6.0.

Apart from that, extra knowledge on Visual basic is needed to support the added features to be programmed.

CONCLUSIONS

Overall, the author manages to complete the project within the timeframe with some improvements that can be done in the future. Based from the observation and some interviews done, 80% of the sample students welcome another method in retrieving their Final Examination Result via SMS apart from the traditional methods which are the examination slip and the online result checking. Based on the problem statement, the 2 methods have their own limitations. The examination slips usually arrive 2 weeks after the result is announced while the online result checking is only accessible to people with Internet connection at their house. By having another method for the students, UTP can provide additional service with more efficiency.

Other than that, the retrieval of UTP examination result via SMS will be very much welcomed based on the supporting facts that SMS are very much in the trend right now and it has its own success factors such as cost-effectiveness, the "anytime and anywhere" trait and the high penetration rate of mobile phones in Malaysia generally and UTP specifically. From the interview conducted to 15 random students from each year which totals up to 75 students, 90% of the sample owns their own mobile phones. Due to this, retrieving examination result via SMS will definitely ease the UTP students in getting hold of their results.

Even though SMS incurs lower cost for retrieving the examination results, some students might not favor the idea. However, for the students who think that the convenience outweighs the cost that they have to bear will be willing to part some money to support SMS as another method to access their examination results. The retrieval of UTP Final Examination Results via SMS is an alternative for students while another two methods are still available for students. Based from the survey conducted, 80% supports the idea and if it is implemented, the students have three choices and they can select which options suit them best.

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APPENDIX

System Interface

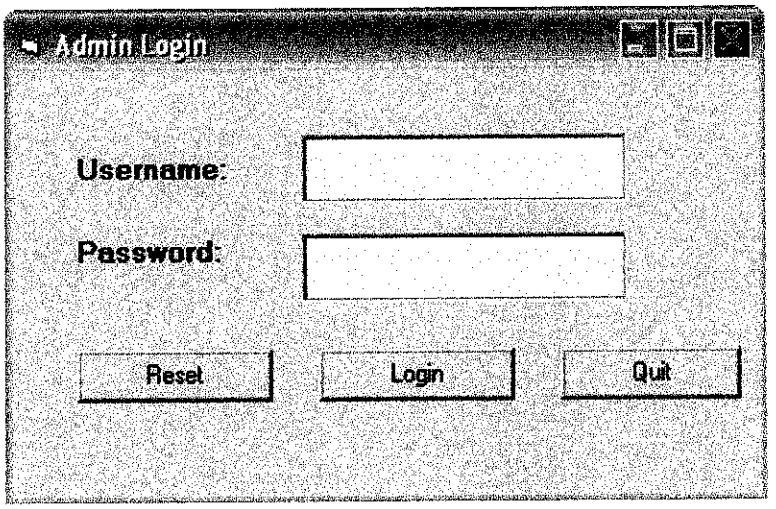

Figure A: Login Page

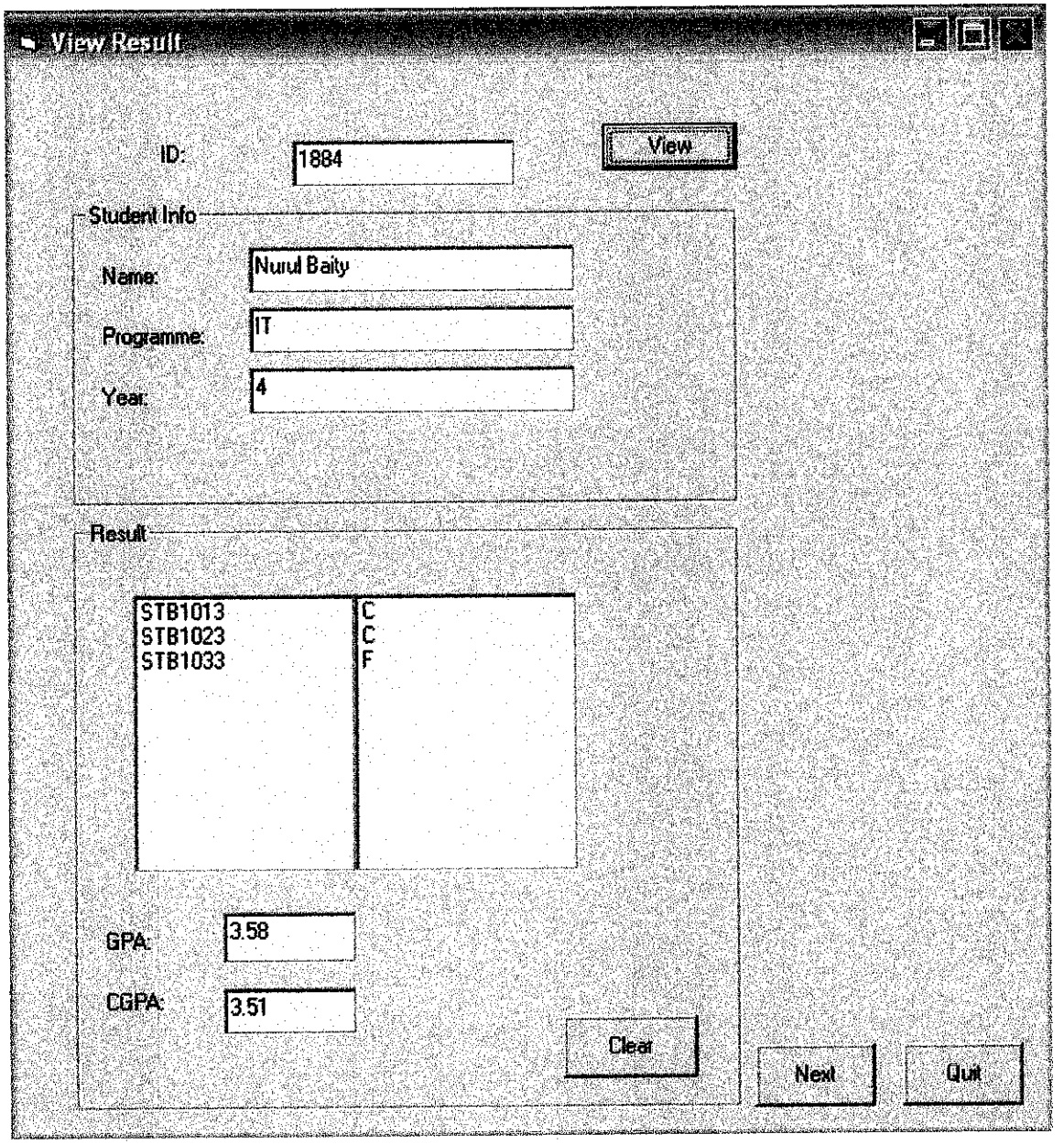

Figure B: View Result Page

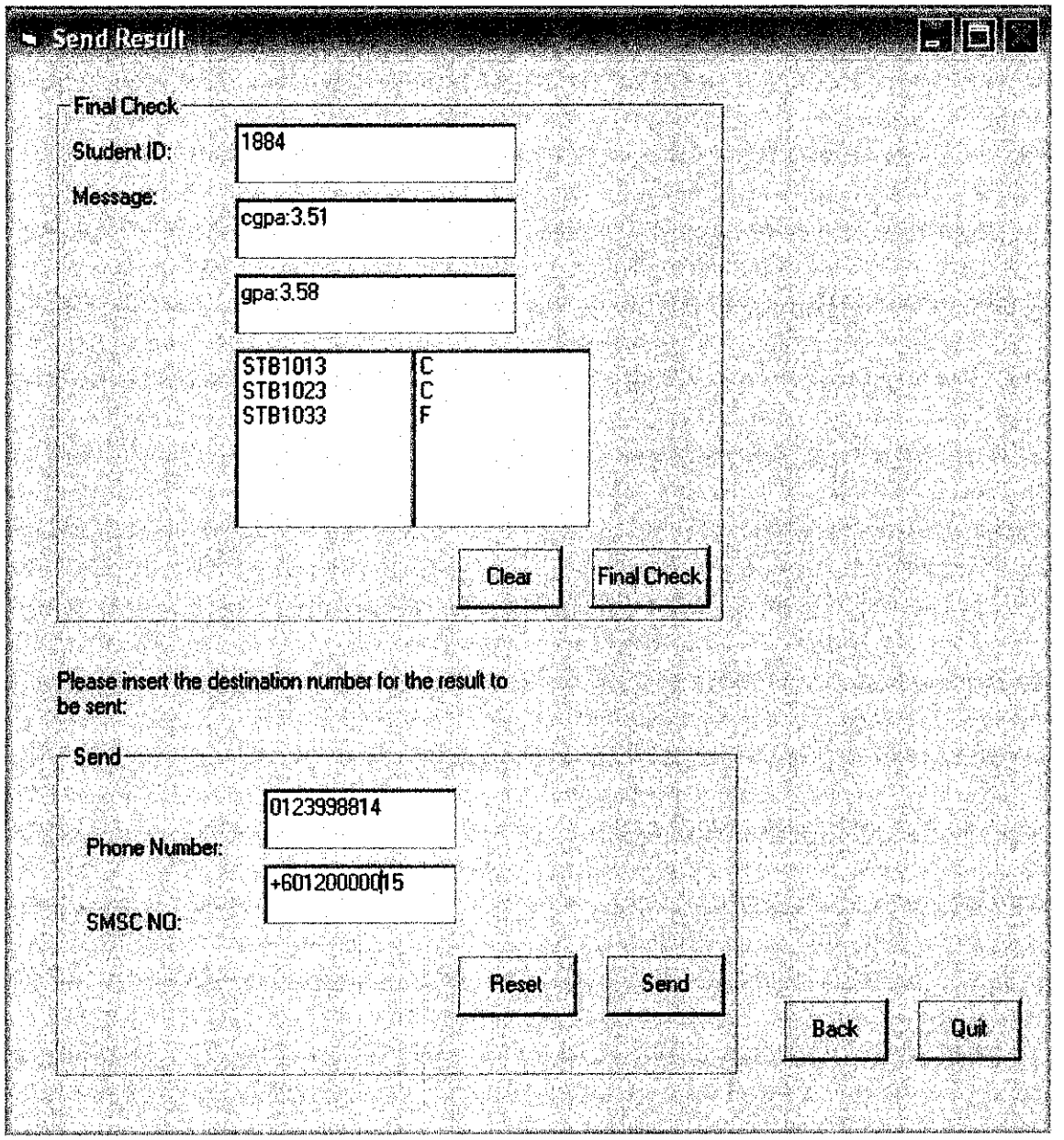

Figure C: Send Message Page

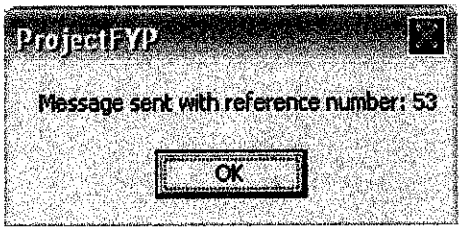

Figure D: Message sent Page