CHAPTER V
SYSTEM IMPLEMENTATION

System implementation is a process that converts the system requirements and design into program code. Thus, the suitable development environment helps effective implementation of the system. Using the hardware and software defined in the system development phase also helps to speed up the system development.

5.1 VPN Implementation Overview

Virtual private networking will be implemented during the Information Technology subject examination to support connection between the candidates taking examination in The Examination Center throughout the country and the examination web page located in the Examination Syndicate Server. In an ordinary web-based on-line examination, candidates of an examination will access the examination provider server to browse the examination web page and submit their responses back to the server. The server will process the responses and give score to the student response. This is a common relationship between a web server and its client in a World Wide Web activities. The Information Technology SPM examination on the other hand, due to security reason discussed in earlier chapter, requires a secure channel in the Internet connection to be established between the Examination Syndicate Server as the examination provider and the Examination Centers before the candidates can access the examination web site. Packet of data transmit between the Examination Center and The Examination Syndicate server will be routed
through this predefined channel via Internet and encapsulated with encryption algorithm. To establish VPN connection, a router-to-router VPN implementation will be deployed. The Examination Center Chief Invigilator would initiate VPN connection to the Examination Syndicate server by making a router-to-router VPN dial-up. The router-to-router VPN will enable the entire workstations from the Examination Center to access the Examination web site once the Examination Center is authenticated.

After the VPN router-to-router is established, candidates may access the Examination web site folder located in the Examination Syndicate server. As router-to-router connection will only allow the entire IP traffic of the workstations to the other end of VPN gateway, browsing to other site through the Internet is automatically blocked. This feature will prevent candidates from browsing the other site of the Internet and stop outsiders from accessing the Examination Center LAN sources.

5.2 VPN Deployment

A number of value added services provided by Microsoft would be used for VPN deployment in the Information Technology subject on-line examination. All candidates workstations in the Examination Center and The Examination Syndicate server must be configured to enable VPN connection between the two locations. As the examination would involve 20 candidates machines in the Examination Center accessing the examination web site at the same time, a router-to-router VPN
implementation approach would be implemented to connect the two networks. The Examination Center server must be set to enable a VPN connection to the Examination Center. At the same time, The Examination Syndicate server must be set to accept VPN connection from the Examination Center and grant permission to access the examination folder resources after certain authentication implemented. Proper VPN set up will ensure data transfer between the two machines is encrypted and traverse through a controlled tunnel.

The Routing and Remote Access Server (RRAS) add on for Microsoft Windows NT together with Proxy Server 2.0 are use to create VPN across the Internet. To ease congestion during authentication, Remote Authentication Dial In User Service (RADIUS) authentication service will be install at the Examination Syndicate PDC server.

The VPN setup for the on-line examination will be divided into two phases:

   a) The Examination Center VPN Gateway setup
   b) The Examination Syndicate VPN Gateway setup

5.2.1 The Examination Center VPN Gateway

The Examination Center LAN will be set as PPTP client by deploying RRAS and Proxy 2.0 together at the administrator machine. RRAS can create a router-to-router connection to a Window NT 4 with RRAS-based server. The combination of RRAS and Proxy 2.0 installation enable a single VPN dial-up connection to be shared by
the other member of the LAN. Any proxy clients behind the proxy server will also be able to use the PPTP session that has been established. This is because after the PPTP connection is up, the Proxy 2.0 server treats the PPTP connection just like another network interface. The entire workstations within the Examination Center can gain access to the examination folder resided on the Examination Syndicate machine once the Examination Syndicate PDC server authenticated the PPTP dial-up.

5.2.2 RRAS Installation

RRAS (formerly code-named Steelhead) is Microsoft’s set of enhancements to NT’s RAS and Multi-Protocol Routing (MPR) services. Among the significant enhancements that RRAS includes are:

a) Routing Information Protocol (RIP) 2.0
b) Open Shortest Path First (OSPF)
c) RADIUS client support, a graphical interface and administration tool
d) Demand-dial routing
e) PPTP server-to-server connections

RRAS will be installed to the Examination Center server operating system and The Examination Syndicate Windows NT server as a router-to-router VPN gateway to establish PPTP connection during the examination session. To initiate a VPN session, the Chief Invigilator of an Examination Center will first establish an
Internet connection. Then he can make a PPTP connection to the Examination Syndicate server from RRAS installed.

RRAS can be downloaded from Microsoft NT support web site as free wares and part of add on to the Windows NT server operating system. Follows are system requirement prior to RRAS installation:

a) Windows NT 4.0 operating system with Service Pack 3 or greater installed.

b) A 32-bit x86-based microprocessor (such as Intel 80486/50 or higher), Intel Pentium, or supported RISC-based microprocessor, such as the Digital Alpha Systems

c) One or more network adapter cards, WAN cards, or modems

d) VGA monitor

e) A 40 MB minimum free disk space on the partition that will contain the Routing and Remote Access Service system files

f) 16-MB RAM minimum

RRAS must be installed on Windows NT 4.0 or Windows 2000 Server platform with Service Pack 3 or later must be installed prior to the RRAS installation. It is also suggested to install any LAN and WAN hardware such as modem or ISDN devices for PPP connection before installing RRAS. Then install the RRAS component downloaded from the Windows NT support web site.
5.2.3 Installation

After RRAS downloaded, run the MPRI386.exe and install RRAS to an assign directory. The RRAS setup routine dialog box will prompt to delete the existing RAS, RIP, SAP, and BOOTP relay agent services if it were already installed. Opt to “yes” as their Registry settings are now a part of RRAS.

The setup will prompt for the services that RRAS will install in the system. Three services are available:

a) Remote access service
b) LAN routing
c) Demand-Dial routing

Select all three services. The figure below shows the services offers by RRAS to be selected by user.

Figure 5.1: RRAS services.
After selecting the required services, add ports to the server. To make Internet connection and PPTP connection, configure the dial-up port as:

a) RAS client
b) RAS server
c) Demand-dial router

Accept the default RAS Server TCP/IP configuration parameters when the window appears: “Let clients access the entire network, and use the Dynamic Host Configuration Protocol (DHCP) to dynamically assign addresses to clients”.

5.2.4 Router-to-router Connection

The on-line examination will be deploying router-to-router connection to traverse examination data packet between the candidates in the Examination Centers and examination web site located at the Examination Syndicate server. Both server, The Examination Syndicate server that supply the examination question, and The Examination Center server where candidates sit for the examination need to be connected to the Internet. The following tasks must be performing on each server to enable the VPN connection. There are:

a) Internet connection through RRAS.
b) PPTP connection setup.
c) Define user credentials that the servers use for validation
d) Writing routing information.
5.2.5 Internet Connection.

A dial-up connection to the Internet Service Provider (ISP) can be set in the RRAS Administration program. RRAS use a demand-dial interface to establish a router-to-router VPN connection and forward packets. The demand-dial interface is configured as follows:

a) General tab. Type the host name and IP address of the VPN server.

b) Protocols Tab.

c) Security tab. Option to select "accept only Microsoft encrypted authentication and Require data encryption" to apply encryption on all forwarding packets.

d) Credential for demand-dial interface.

In the Administrative tools group, right-click LAN and Demand Dial Interfaces to add a new demand-dial interface to connect to ISP. Select the Add Interface option and name the connection, i.e. Internet Connection. A Dial-up networking phone book entry will appear. Configure the connection to connect the ISP.

After the Internet connection is completed, a new dialog box titled IP Configuration-ISP Connection appears. For now, accept the defaults.
As the connection to the ISP is a demand-dial interface, a prompt for the name and password to use to establish your connection to an ISP will not appear. It must be provided in the Interface Credentials dialog box, instead. The figure below shows the Interface Credentials setup dialog box.

![Interface Credentials dialog box](image)

*Figure 5.2: Interface credential setup*

Define the user name, domain, and password for the particular server. This process can be neglected is the server has a dedicated connection to the Internet.

### 5.2.6 PPTP Connection

PPTP connection is a second dialup connection that must be configured in a system to establish a VPN connection over the Internet. The PPTP connection is the
gateway interface that encapsulate PPP packet and apply encryption to the packet. It also defines the control channel that the packet will be tunneled through.

A PPTP connection can be set in a RRAS by right-clicking the LAN and Demand Dial Interfaces option. Select ADD interfaces and name the Interface as PPTP connection.

In the Protocols and Security dialog box, select Route IP packets on this interface. Also select the two options Add a user account so a remote router can dial in and Authenticate a remote router when dialing out. The figure below shows the Protocols and security dialog box with appropriate check box selected.

![Protocols and Security dialog box](image)

*Figure 5.3: PPTP dial up Protocols and Security checkbox.*

At the prompts, select the RASPPPDM VPN adapter for this connection. When configuring The Examination Center PPTP connection, enter the Internet IP address of the Examination Syndicate server at the prompt for a phone number or address.
After defining the PPTP connection, define user credentials that the Examination Syndicate server and the Examination NT server can use to validate themselves against the other. User credentials are the user IDs that RRAS sets up for and that the routers use to identify each other.

There are two type of PPTP dialing credentials:

1. Dial-out credential
2. Dial-in credential.

The dial-out credentials are the first credentials must be created while configuring the Examination Syndicate server. Define a user name and password to the dial-out credential. The next window will show a prompt to create dial-in credentials for remote routers connecting in. Set the password for the dial-in authentication. User name will be given by the RRAS and cannot be changed.

Since the PPTP connection must be configured on both server, The Examination Syndicate and The Examination Center Windows NT Server to enable a router-to-router communication, therefore the dial-out and dial-up credential must be assign accordingly for mutual authentication.
5.2.7 Routing Information

There are two methods to write routing information to the routing table:

a) Manual-static route

b) Auto-static route.

Manual static route is appropriate for the Examination Center server as it deal with small number of routes information to the Examination Syndicate server. The Examination Syndicate server on the other hand may need to configured with auto-static routes as it has manage large number of routes connecting the entire Examination Centers throughout the country. The auto-static updates the static routes that are available across the router-to-router VPN connection during an examination session.

![Routing and Remote Admin](image)

Figure 5.4: Routing and Remote Admin
5.3 Managing VPN

A VPN management concern with following activities:

a) User account,
b) IP address assignment to clients,
c) Authentication
d) Session log

5.3.1 Managing User

In a Windows NT server, user to it resources can be created and given a define grant by the administrator. User can login to the server and access to the folder that it granted to. Every user will be authenticated during the login. Only user keyed-in a matched user name and password with the Windows NT user account database can access to the server. Most administrator set up a master account database at Primary Domain Controller (PDC). Many organizations set another server to act as a backup Domain Controller (BDC) as an alternative to authenticate user should the PDC is not working properly. In an examination environment, the user (the Examination Center and the candidates) account can be located in a different machine from the web server machine that stores the examination questions to ease congestion. A BDC can be set up by the Examination Syndicate to replicate the Examination Center and candidates account database.
5.3.2 Managing Address

The Examination Syndicate VPN server must have IP address available to allocate them the VPN server's virtual interface and to Examination VPN server (the client) during the IP Control Protocol (IPCP) negotiation phase of the connection establishment phase. The IP address allocated to the VPN client is assign to the virtual interface of the Examination Center.

5.3.3 Managing Access

The permission for remote access to the Examination Syndicate VPN can be configured at the dial-in properties on the user accounts. At the Examination center dial-in properties enable the GRANT dial-in permission.

5.3.4 Managing Authentication

Routing and Remote Access Service (RRAS) can be configured to use Windows NT or RADIUS as an authentication provider. As the Information Technology examination will involves many Examination Centers making remote access to the Examination Syndicate VPN server in the same time, using RADIUS server is the best solution to minimized congestion to the server.

RADIUS can responds to authentication request based on it own database or it can be a front end to another database server such as a generic Open Database
Connectivity (ODBC) server or a Window NT 4.0 PDC. On a RRAS PPTP connection initiated by the Chief Invigilator of an Examination Center, the user credentials and parameters of the connection request as a series of a RADIUS message to a RADIUS server configured at the Examination Syndicate site. It can authenticate user using it authentication database. The RADIUS server will inform the Examination Syndicate VPN server either the permission is grant or not and other applicable connection parameters such as maximum session time and static IP address assignment.

5.3.5 Session Log Management

Session log is a report of VPN connection session done. The Examination Syndicate RRAS can be configured to use RADIUS as an accounting provider. The RRAS will sent message to the RADIUS server that request accounting records at start of the call, end of the call, and at predetermined intervals during the calls.

5.4 The Router-to-router Connection Procedure in an On-line Examination

The VPN router-to-router initiated when candidates send a http request to Examination Syndicate web page during an examination session. The packets of request are routed to The Examination Center Windows NT RRAS router and the following process will follow;

a) The router checks it routing table and find a route to the Examination Syndicate server that uses the VPN demand dial interface.
b) Based on the VPN demand-dial interface configuration, the Examination Syndicate router attempts to initialize a router-to-router at the IP address of the Examination syndicate.

c) To establish a PPTP-based VPN to the Examination Syndicate server, a TCP connection must be established with the VPN server on the Examination Syndicate site. The VPN establishment packet is created.

d) The Examination Center checks its routing table and finds the Examination Syndicate route using the ISP demand dial interface.

e) The Examination Center router uses its modem to dial and establish a connection with local ISP.

f) The VPN establishment packet is sent to the Examination Syndicate router once the connection to the ISP is made.

g) A VPN is negotiated between the Examination Center router and the Examination Syndicate router. The Examination Syndicate server sends authentication credentials that are verified by Examination Syndicate router.

h) The Examination Syndicate router checks its demand-dial interfaces and finds the one that matches the user name sent during authentication and changes its interface to a connected state.

i) The Examination Syndicate router forwards the candidates packet across the VPN and the VPN server forwards the packet to the web server.
5.5 VPN Implementation

A router-to-router VPN connection had been set up and tested in The Information System Lab, Computer Science and Information Technology Faculty, University of Malaya, on Monday, 22nd of July, 2002. The implementation involves two Windows 2000 servers, efac 07 and efac 11. Both servers were configured to enable a router-to-router VPN connection. The figure below shows efac 07 Windows 2000 server and efac 11 Windows 2000 server located in the lab. The efac 07 acted as the examination web server. The VPN dial-up connection was made from efac 11 computer to the efac 7 computer through the Internet. A successful VPN connection was first recorded at 4.30pm at the same day.

![Diagram showing the configuration of efac 07 and efac 11 servers](image)

*Figure 5.5: Two routers involve in VPN connection implementation in The Information System Lab, University Of Malaya.*

5.5.1 VPN Connection Print-screen

The following figures are print-screen captured during the VPN connection. They contain dialog-boxes and pop-ups that appeared on initiating and maintaining the VPN connection.
Figure 5.6: VPN dial-up connection properties.

Figure 5.6 shows the VPN connection configuration properties. The connection properties were configured accordingly to initiate the connection.

Figure 5.7: User credential dialog box.
The Figure 5.7 on the previous page shows user credential dialog box sent by the efac 07 VPN server to efac 11 computer who were trying to initiate a VPN connection to efac 07 server. User must fill in the dialog box that will be authenticated by the efac 07 VPN server.

![Routing Interfaces](image)

Figure 5.8: Interface of Demand-dial when connecting to the remote router.

The figure above shows Routing and Remote Access Window interface on the efac 7 VPN server. It shows a remote host is connecting through VPN. The figure below on
the other hand shows that the VPN connection is accepted and is being registered to
the network.

Figure 5.9: A Window pop-up shows the registration of the remote host to the
network.

Figure 5.10: A Window pop-up shows the VPN is connected.

The Figure 5.10 is a pop-up on the VPN client stating the VPN is connected. The
user of the host may now access the granted folder located on the other end server.
Figure 5.11: A Window pop-up shows the VPN connection status.

Figure 5.12: A Window pop-up shows the details of VPN connection status.
Figure 5.11 and Figure 5.12 indicate the status of the VPN connection. Figure 5.11 shows the duration of the connection and quantity of bytes received and transferred. Figure 5.12 on the other hand shows details of the connection such as authentication and encryption protocols being used.

5.5.2 Accessing the Examination Main Page

The examination main page is located at the efac 07 web server. The figure below shows the efac 07 web server tree directory. The Information Technology examination web page is located in the spm folder.

Figure 5.13: Efac 07 web server directory.
Figure 5.14 shows the Information Technology examination main page retrieved from efac 07 web server. Candidates must fill in their user name and password to be authenticated by the server before they can access the examination question page.

![Image of the Information Technology examination main page]

**Figure 5.14: Information Technology examination main page.**

Figure 5.15 below shows the Information Technology examination question page. Candidates will respond to this web page and their answer will be sending back to efac 07 server for marking and scoring process, through the VPN connection.

![Image of the Information Technology examination question page]

**Figure 5.15: Information Technology examination web page access from efac 07 computer web server through VPN.**
5.6 The On-line Examination Web Page Development

On the proposed online examination for Information Technology subject, candidate will sit the examination by responding to the design interactive web page for the examination. The web page is written in server scripting language. The server scripting language enable the Examination syndicate server to process the response posted by the candidates. The server will compare the candidates’ answer input and compare it to the correct answer in the examination database. If the answer is matched, marks will be given. A total of the marks calculated will be inserted in the database.

5.6.1 Scripting Language

The on-line examination web page was developed using Hyper Text Markup Language (HTML) and Active Server Pages (ASP) server-side scripting language. ASP processes response to a client request via the HTTP protocol of the World Wide Web. When a client sends an HTTP request to the server, the server receives the request and directs it to be processed by the appropriate Active Server Page. The Active Server Pages does it processing (which often include interacting with a database), then return it result to it clients in the form of a HTML document to display in the client browser. An ASP web page may include HTML, DInamic HTML, ActiveX controls, client side scripts and Java applets with VB script is the de facto language for ASP scripting.[19] ASP can be written using text editor or
commercial WYSIWYG web editor. In developing this project, Visual Interdev and Macromedia Dreamweaver web editor were used together with Note Pad text editor. The table below shows the file developed for the Information Technology on-line examination.

<table>
<thead>
<tr>
<th>File Name</th>
<th>Extension</th>
<th>Task</th>
</tr>
</thead>
<tbody>
<tr>
<td>Login</td>
<td>ASP</td>
<td>Main page and candidates authentication input.</td>
</tr>
<tr>
<td>Check</td>
<td>ASP</td>
<td>Verify authentication input.</td>
</tr>
<tr>
<td>Destination</td>
<td>ASP</td>
<td>Route the browser to the particular page; Examination page if authenticated, and reroute to the login page is password and user name is incorrect.</td>
</tr>
<tr>
<td>Information technology</td>
<td>ASP</td>
<td>Display the examination question and answer response on mouse click to the choice of answer</td>
</tr>
</tbody>
</table>

*Table 5.1: Web page file description*

5.6.2 Database Connection

The database that stores the examination questions and answer and candidates authentication was developed using Microsoft Access database application. Microsoft Access provide Open Database Connectivity (ODBC) interface, which
works well with ASP. Record from the database is retrieved using Structured Query Language (SQL), a high level programming language.[20]

However in developing this on-line examination web page, Data Source Name (DSN) was use to connect to the ODBC only when the final version is developed. During the testing phase, a DSNless database connectivity approach was implemented because different machines were use for system testing. New DSN must be defined whenever a different computer was used as web server. As an alternative, a server.mappath command approach was applied to implement a DSNless database connection.

5.6.3 System Coding

As described above, ASP together with HTML, VBScript and JavaScript were used to write the dynamic on-line examination web page for Information Technology subject examination. References from books and Internet were gathered to help in developing this web page. [22] Follows are the coding used to carry out the functional part of the ASP.

5.6.3.1 Candidates Authentication.

Candidates authentication coding begins in the login.asp file. In this web page, two input box were created to receive authentication input from the input candidates. A
submission button is located below the input box, which post the input data to check.asp file.

The following login form tag define the destination of the user name and password input.

```html
<Form name=frmLogin METHOD=POST ACTION=check.asp>
```

There are two tags in the table section that retrieved input for user name and user password. There are:

1. `<Input Type="TEXT" Name="txtUserid">`
2. `<Input Type="PASSWORD" Name="txtPassword">`

5.6.3.2 Define Path to Database

In a DSN less approach, it is important to define the path use to identify the database. The following code defines the database location.

```vbs
Dim DB_CONN_STRING
DB_CONN_STRING = "DBQ=\" & Server.MapPath("quiz.mdb") & ";"
DB_CONN_STRING = DB_CONN_STRING & ";Driver=Microsoft Access Driver (*.mdb);" DB_CONN_STRING = DB_CONN_STRING & ";DriverId=25;FIL=MSAccess;"
```

The database connection was dimensioned as DB_CONN_STRING and the path to the database by the Server.MapPath object as quiz.mdb using Microsoft access driver. Any SQL statement that follows will use this database for manipulation.
For the DSN approach, an Open Database Connectivity (ODBC) connection was created at the Control Panel. A simple coding is needed to create a path to this database connection. The coding is as below:

\[\begin{align*}
\text{Dim } DB\_CONN\_STRING \\
\text{Dim } DB \\
\text{Set } DB = \text{Server.CreateObject("ADODB.Connection")} \\
\text{DB.Open "ESDSN"} \\
\text{DB\_CONN\_STRING} = \text{DB}
\end{align*}\]

The "ESDSN" is the system data source name define for the database ODBC connection.

**5.6.3.3 Using Database or Hard Code Option**

The ASP file written for this system give option to user to use database to retrieve the questions item and compare the responses or use line of code ("hard code") to write individual question and answers. Database offer flexibility to add or change new item but the trade off is increased in download time. The web page can be retrieved faster by writing "hard code" but it take a lot of work to write lines of codes. The line to select the option is:

\[\text{Const } \text{USE\_DB\_FOR\_INFO} = \text{true}\]

To use hard coded value, change the constant to false.
5.6.3.4 Retrieve Question from Database

If, Then …. Else statement was used to retrieve the question from database. If the constant to use database connection as described above was set to through, then the connection to the database will be applied using ADOB connection method.

\[ \text{If USE\_DB\_FOR\_INFO Then} \]

\[ \text{cnnQuiz} = \text{Server.CreateObject("ADODB.Connection")} \]

\[ \text{cnnQuiz.Open DB\_CONN\_STRING} \]

After the database connection was opened, a record set will be defined and SQL statement will be written, as following example:

\[ \text{Set rsQuiz} = \text{Server.CreateObject("ADODB.Recordset")} \]

\[ \text{rsQuiz.Open "SELECT * FROM questions WHERE quiz_id="} \]

\[ \text{& QUIZ\_ID & " AND question_number="} \]

\[ \text{& iQuestionNumber & ",", cnnQuiz} \]

5.6.3.5 Retrieve Question

The question item was retrieved from the question_text field of the Quiz table.

\[ \text{strQuestionText} = \text{CStr(rsQuiz.Fields("question_text").Value)} \]
5.6.3.6 Retrieve Array of Answers

Set of answers must be retrieved after the question text is displayed. To display 4 different item of answers, an array statement was coded as below:

' Get an array of answers

    aAnswers = Array(
                CStr(rsQuiz.Fields("answer_a").Value & ""), _,
                CStr(rsQuiz.Fields("answer_b").Value & ""), _,
                CStr(rsQuiz.Fields("answer_c").Value & ""), _,
                CStr(rsQuiz.Fields("answer_d").Value & ""), _

After the array, a For Next statement is used to represent the choosen response.

    For I = LBound(aAnswers) To UBound(aAnswers)
        If aAnswers(I) = "" Then
            ReDim Preserve aAnswers(I - 1)
            Exit For
        End If
    Next I

Connection to the database must be closed to avoid error after the task was complete.

    rsQuiz.Close
    Set rsQuiz = Nothing
    cnnQuiz.Close
    Set cnnQuiz = Nothing
5.6.3.7 Question Number

The following script defined the question number of total question:

```
Soalan ke <%= iQuestionNumber %> dari <%= iNumberOfQuestions %><BR>
```

5.6.3.8 Function that Convert Response to Appropriate Letter.

The following function were used to identify the letter of the input selected by the user on clicking one of the multiple choice answer. This function will convert the input to a string that will be compared to the correct answer field in the question table. Select case method were used to defined the input

```
<% \\
' Takes a integer parameter and converts it to the appropriate letter \\
Function GetLetterFromAnswerNumber(input) \\
Dim strTemp \\
Select Case input \\
Case 0 \\
strTemp = "A" \\
Case 1 \\
strTemp = "B" \\
Case 2 \\
strTemp = "C"
```
Case 3

strTemp = "D"

End Select

GetLetterFromAnswerNumber = strTemp

End Function

5.6.3.9 Function to Get the Answer String According to the Last Entered Value of the Particular Question

Function GetAnswerFromAnswerString(iQuestionNumber, strAnswers)
Dim strTemp
Dim iOffset

' Find the location of the question number we want to use
iOffset = InStrRev(strAnswers, "|" & iQuestionNumber & ",", -1, 1)

' Get our answer by using the offset we just found and then moving
' right the length of the question indicator to arrive at the
' appropriate letter
strTemp = Mid(strAnswers, iOffset + Len("|" & iQuestionNumber & "|"), 1)

' There's no way it should be anything else, but to be sure we

' convert it to a string and make sure it's uppercase

GetAnswerFromAnswerString = UCase(CStr(strTemp))

End Function

%>

5.6.3.10 Progress Bar

The progress bar was written in VBScript code. The bar length will be compared to the number of question completed. The progress bar inside the long bar will increased as the number of the question answered increase. Image with blue and red color will fill the bar to denote the progress.

<%

Const BAR_LENGTH = 160

If iQuestionNumber = 1 Then

' Since a 0 width is ignored by the browsers we need to remove the image altogether!

Response.Write "<IMG SRC=""./images/spacer_red.gif"" HEIGHT=""10"" WIDTH=""""]

Response.Write BAR_LENGTH

Response.Write ""><BR>"

Else

Response.Write ""<IMG SRC=""./images/spacer_blue.gif"" HEIGHT=""10"" WIDTH=""""]

%>
Response.Write (BAR_LENGTH /

iNumberOfQuestions) * (iQuestionNumber - 1)

Response.Write """

Response.Write """"<IMG

SRC=""""images/spacer_red.gif"""" HEIGHT=""""10"""" WIDTH="""

Response.Write (BAR_LENGTH /

iNumberOfQuestions) * (iNumberOfQuestions - (iQuestionNumber - 1))

Response.Write """"<BR>"

End If

%>

5.6.3.11 Scoring

Scoring was done by retrieving the correct answer submitted by the candidates and compare to the responses chosen by the candidates. To retrieve the correct answer, database connection must be opened first.

If USE_DB_FOR_INFO Then

' Code to use DB!

' Create DB connection and connect to the DB
Set cnnQuiz = Server.CreateObject("ADODB.Connection")
cnnQuiz.Open DB_CONN_STRING

' Create RS and query DB for quiz info
Set rsQuiz = Server.CreateObject("ADODB.Recordset")

' Specify 3, 1 (Static, Read Only) '
rsQuiz.Open "SELECT * FROM questions WHERE quiz_id=
& QUIZ_ID & _
" ORDER BY question_number;", cnnQuiz, 3, 1

Score is represent by iScore and the initial value was zero. A Do While Not looping
statement is used get the score.

    iScore = 0

    I = 1

    Do While Not rsQuiz.EOF

    If

UCase(CStr(rsQuiz.Fields("correct_answer").Value)) = _

        GetAnswerFromAnswerString(I, strAnswers)

    Then

        iScore = iScore + 1

        ' This and the Else could be used to output a

        ' correctness status for each question

        ' Also useful for bug hunting!

        'Response.Write "Right" & "<BR>" & vbCrLf

    Else

        'Response.Write "Wrong" & "<BR>" &

    vbCrLf

        strResults = strResults & I & ", "

    End If

    I = I + 1

    If

---

107
rsQuiz.MoveNext

Loop

' Close and dispose of our DB objects

rsQuiz.Close

Set rsQuiz = Nothing

cnnQuiz.Close

Set cnnQuiz = Nothing

5.6.3.12 Result

The score earned by the candidates is added to the mark field of on the spmit database. The following codes retrieved the score and update the result table.

<%
Set cnnQuiz = Server.CreateObject("ADODB.Connection")
cnnQuiz.Open DB_CONN_STRING
Set rsQuiz = Server.CreateObject("ADODB.Recordset")

rsQuiz.Open "result", cnnQuiz, 1, 2
rsQuiz.AddNew
rsQuiz("username")=CStr("session")
rsQuiz("mark")=iScore
rsQuiz.Update

rsQuiz.Close
Set rsQuiz = Nothing
cnnQuiz.Close
Set cnnQuiz = Nothing
%
}
5.7 Hardware

The on-line examination system was developed using Toshiba Satellite 2590 CDS computer. The following table lists are the devices attached to the machine:

<table>
<thead>
<tr>
<th>Hardware</th>
<th>Capability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Processor</td>
<td>400 MHz</td>
</tr>
<tr>
<td>Hard Disk</td>
<td>4.02 GB</td>
</tr>
<tr>
<td>Random Access Memory</td>
<td>192 MB</td>
</tr>
<tr>
<td>CD ROM</td>
<td>52 time speed</td>
</tr>
<tr>
<td>Monitor</td>
<td>32 bit SVGA</td>
</tr>
</tbody>
</table>

Table 5.2: Hardware used to develop the On-line examination system

5.8 Software

Different commercial software were used to implement the system. The software were used according to the need in the system development process. It can be categorized into software tools for design, web development and system documentation. Table 5.2 shows the software used to develop the system.
<table>
<thead>
<tr>
<th>Software</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Visual Interdev</td>
<td>Web editor and server side scripting tools.</td>
</tr>
<tr>
<td>Macromedia DreamWeaver</td>
<td>Web Editor</td>
</tr>
<tr>
<td>Microsoft Word</td>
<td>Documentation</td>
</tr>
<tr>
<td>Microsoft Access</td>
<td>Database development tool</td>
</tr>
<tr>
<td>Microsoft Visio</td>
<td>Charts design</td>
</tr>
</tbody>
</table>

Table 5.3: Software used to develop the On-line examination system