Ethical Hacking Lab Series

Lab 16: SQL Injection

Certified Ethical Hacking Domains:
Hacking Webservers,
Hacking Web Applications,
SQL Injection

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Contents

Introduction

This lab is part of a series of lab exercises intended to support courseware for Ethical Hacker training. The development of this document is funded by the Department of Labor (DOL) Trade Adjustment Assistance Community College and Career Training (TAACCCT) Grant No. TC-22525-11-60-A-48.

This lab includes the following tasks:

- 1 – Extracting Information from the Database Using SQL Injection
- 2 – Making the Poison Ivy Payload
- 3 – Using the xp_cmd shell to upload and launch a Malicious Payload

Domains: Hacking Webservers, Hacking Web Applications, SQL Injection

Tools like Metasploit give hackers the ability to attack machines on the Internet. To avoid having security vulnerabilities, many organizations update and patch their operating systems. In general, vendors have done a more effective job in recent years keeping operating systems more secure. However, in many cases it is the application software, not the operating system, which leaves a company vulnerable to attack. If an SQL backend is attached to an Internet facing web server, an attacker may be able to gain access to the internal network through SQL injection if the application is unsecure.

SQL – SQL, or Structured Query Language, is a programming language that allows users to write statements that will allow them to communicate with databases and their various subcomponents, such as tables, fields, columns, and records. SQL is used in conjunction with RDBMS, or Relational Database Management Systems. Common versions of SQL include Microsoft Sequel Server and Oracle's MYSQL Server.

SQL Injection – This is a technique by which attackers will use code, which includes SQL commands, to manipulate a web front end into revealing database information.

MSSQL – This is Microsoft's version of an SQL Server. Versions include Microsoft SQL 2000, 2005, 2008, and 2012. You must purchase MSSQL, except for the Express version.

xp_cmd shell – This is a stored procedure, which will enable the DBA, or Data Base Administrator, to run operating system commands. Attackers can leverage the xp_cmd shell if it is available to run commands against an MSSQL Database Server. The xp_cmd command is vulnerability that affects Microsoft SQL servers (typically older versions).

Poison Ivy – Remote Access Trojan that has been used frequently in many high profile intrusions cases. The tool has a Graphical User Interface, or GUI, that allows the hacker to perform malicious tasks against a victim machine over an encrypted connection. Poison Ivy consists of two components, the server and the client.
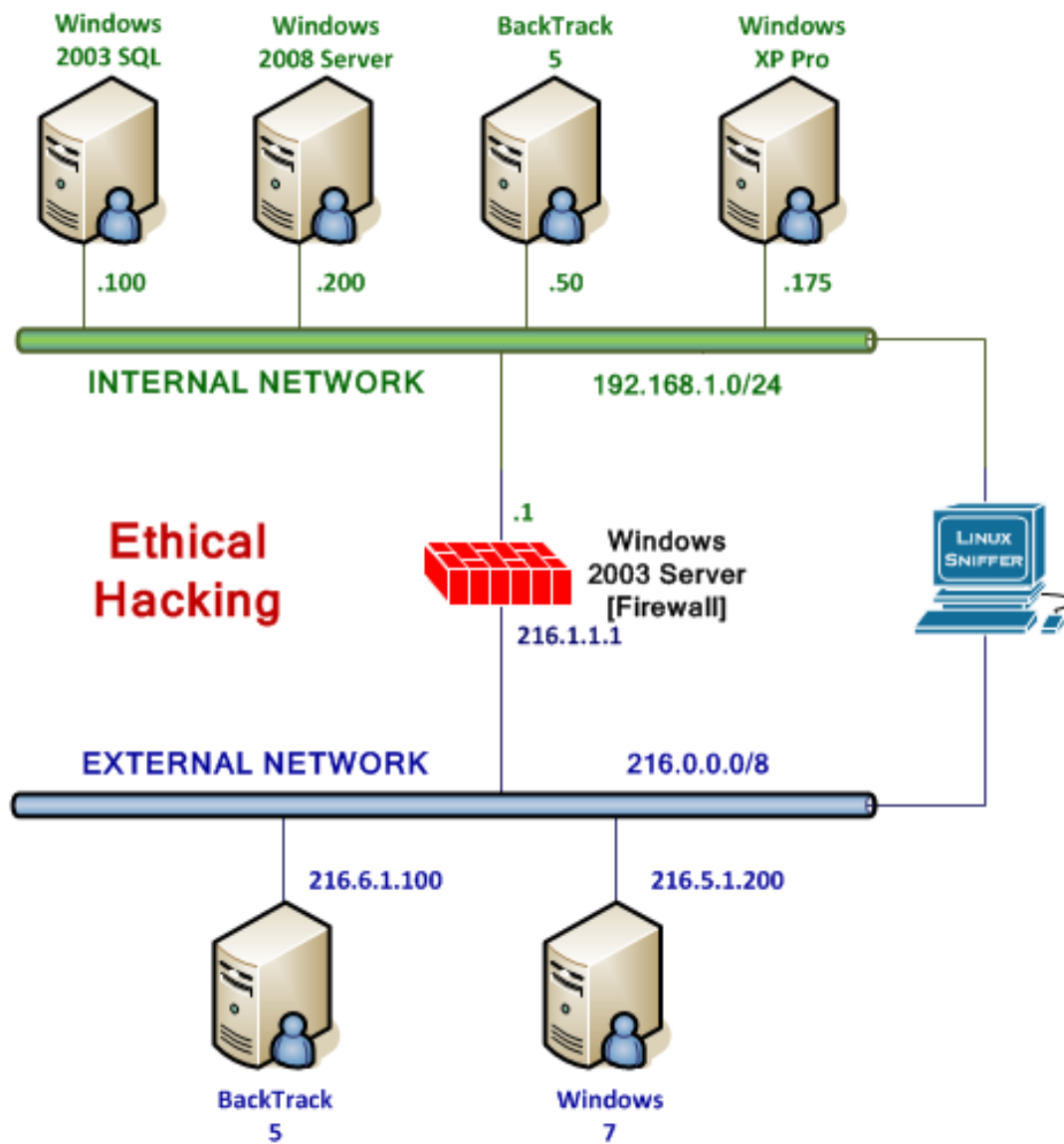
Pod Topology

Figure 1: ESXi Network Topology

Lab Settings

The information in the table below will be needed in order to complete the lab. The task sections below provide details on the use of this information.

Required Virtual Machines and Applications

This lab requires the use of the, Windows 7 and Windows Exchange SQL 2003 VMs.

Although you will not be logging on to the Firewall, the machine is also being utilized during the lab.

Windows 2003 Exchange SQL	192.168.1.100
Windows 2003 Administrator password	P@ssw0rd
Windows 7 Professional Attack	216.5.1.200 (Public IP)
Windows 7 Student Password	Password

1   Extracting Information from the Database Using SQL Injection

One of the attacks that a hacker can perform from the Internet is an SQL injection attack. If an SQL backend is attached to an Internet facing web server, an attacker may be able to gain access to the internal network through SQL injection if the application is unsecure. One of the best ways to secure a SQL backend is by performing a SQL server side validation as opposed to relying on the less secure SQL client side validation.

Before performing SQL injection, it is important that we understand a few key concepts. If a web application is connected to a backend SQL database, when the user enters information (like username and password), those values are put into an SQL statement.

Figure 2: A Web Front-End to an SQL Server

In Figure 2, **jesse** is the username and **james** is the password entered into the web form. After the web user submits the request, there input is placed into a SQL statement:
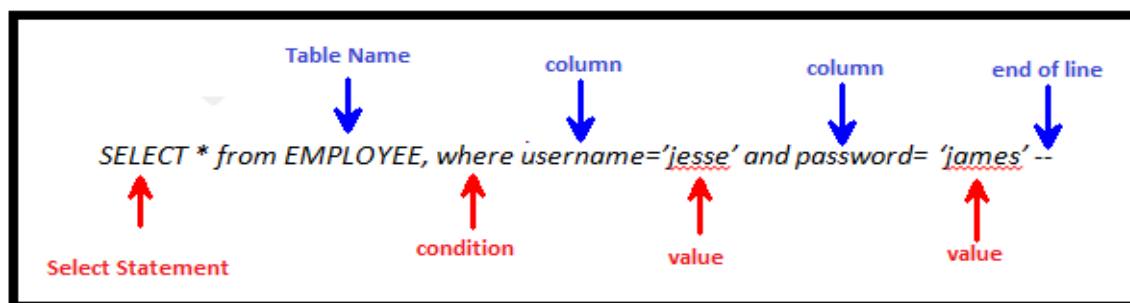

Figure 3: SQL Statement Running on Back End Server

SQL injection works by manipulating the values that will be put into the statement.
For example, in this case the attacker enters the value JESSE' OR 1=1-- for the username.
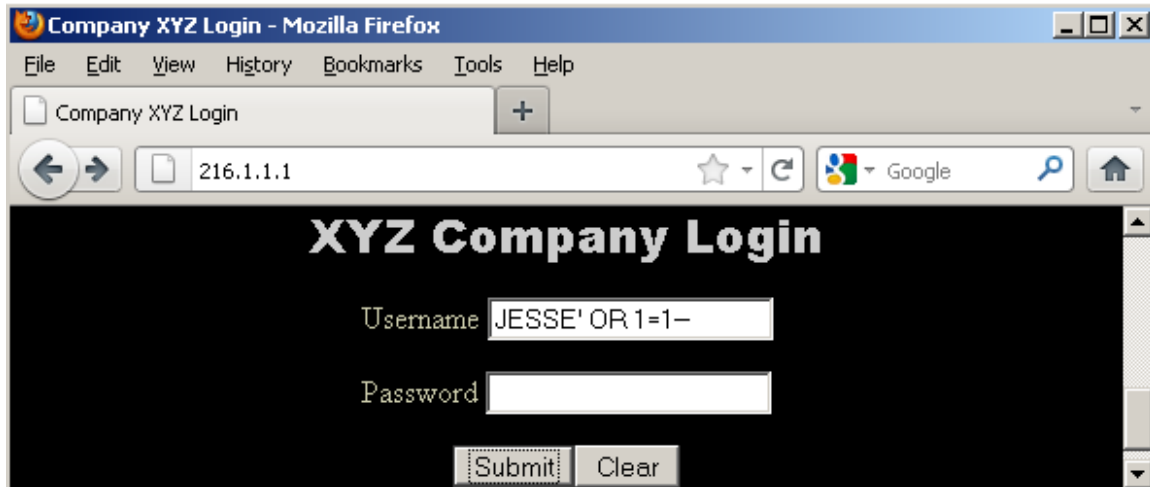

Figure 4: Manipulating the Input Fields

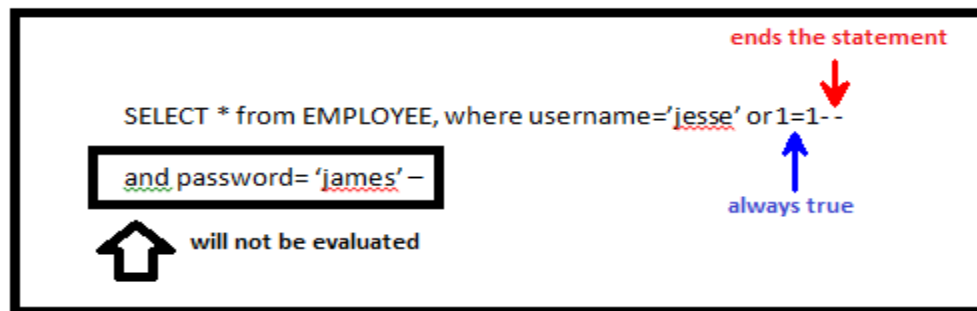Entering this string in the Username field will result in the following SQL statement:

Figure 5: Statement based on Manipulated Input

You will have a better understanding of SQL injection after you perform an attack.

1.1 SQL Injection

1. On **Windows 7**, open Firefox by clicking the **Mozilla Firefox** link on the desktop.

Figure 6: Opening Firefox

2. Go to the Public IP address of XYZ Company by typing this URL in your browser:
   http://216.1.1.1

Figure 7: Public Facing Website

3. Attempt to perform SQL injection by typing the following in the username box:
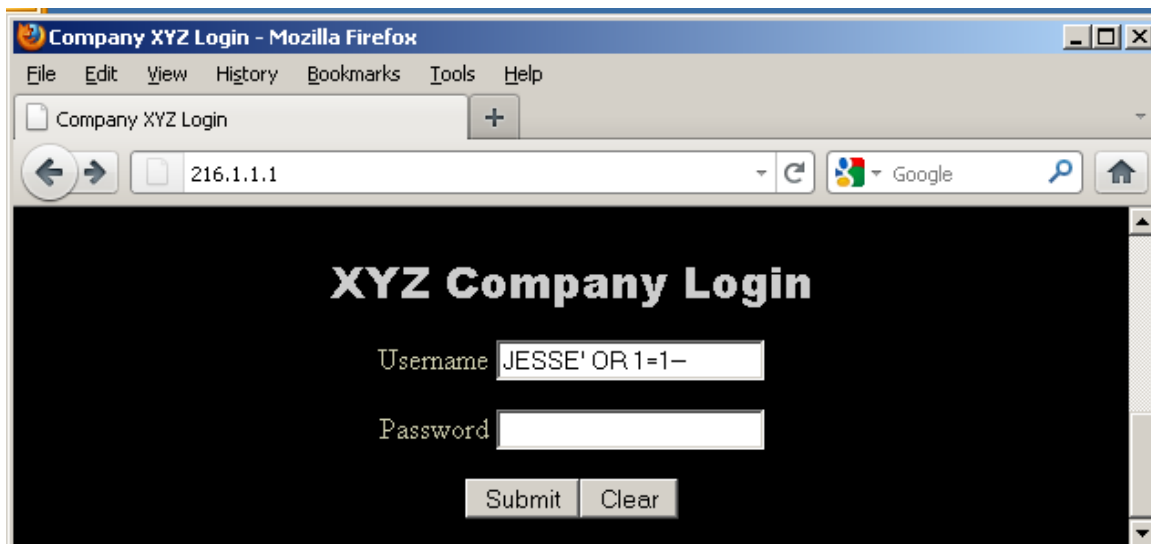   **JESSE' OR 1=1- -**

Figure 8: An SQL Injection Attempt

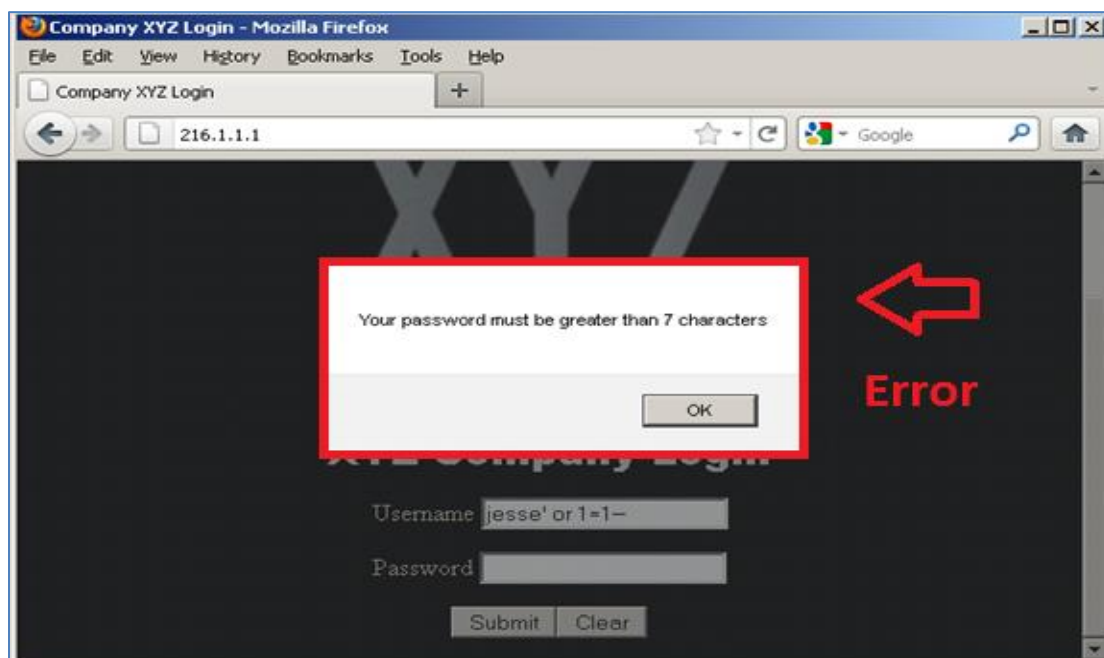You should receive an error. Your attempt at performing SQL injection is unsuccessful.

Figure 9: Failed SQL Injection Attempt

You were told if the SQL password field would not be evaluated if the username field ended with double dashes. The reason that your attempt at SQL injection was unsuccessful is that your input was validated by your browser's JavaScript.

To view the JavaScript on the web page, you will need to examine the HTML source.

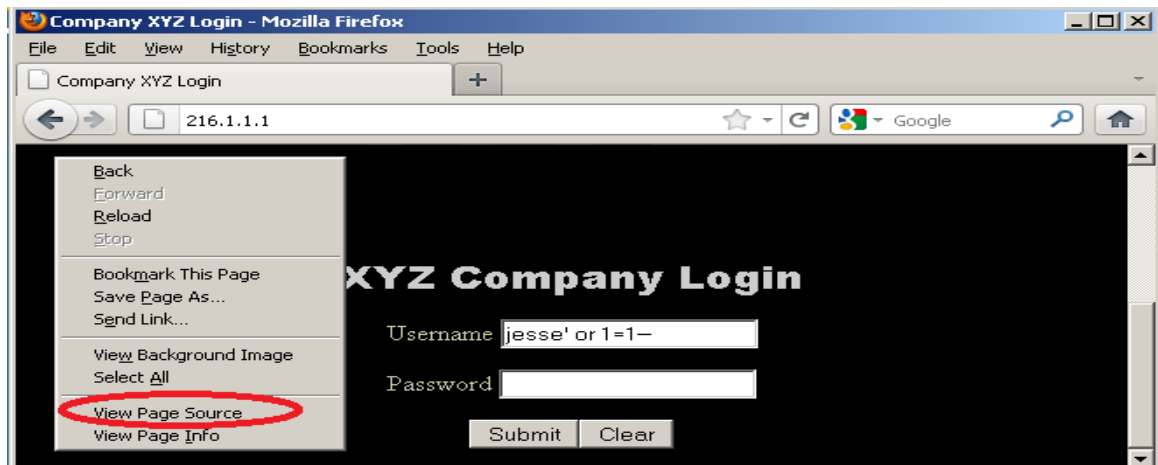4. To view the source, right-click on the page and select **View Page Source.**

Figure 10: Viewing the Source Page

Review the conditions that are required within the JavaScript within the HTML Text file.
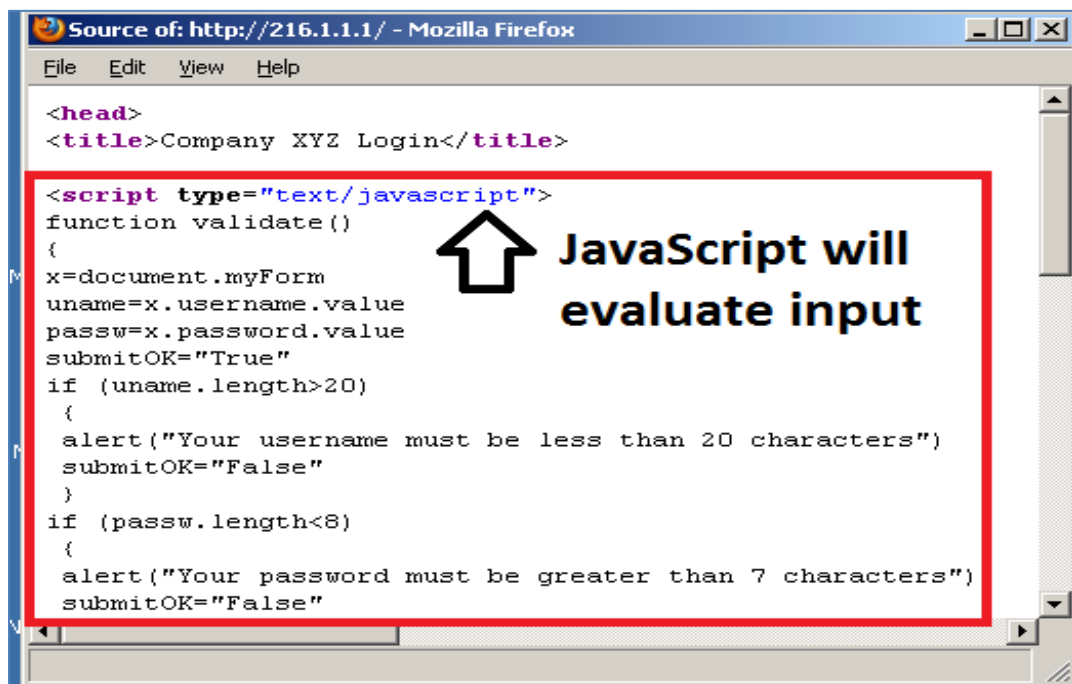

Figure 11: Viewing the Source Page

The web application is using JavaScript to check for input validation. This is a form of client side validation. So, what we will do is disable JavaScript within our browser.

5. To disable JavaScript, select **Tools** from the Firefox menu bar and go down to
    Options. Click on the **Content** button. Uncheck **Enable JavaScript** then click **OK**.
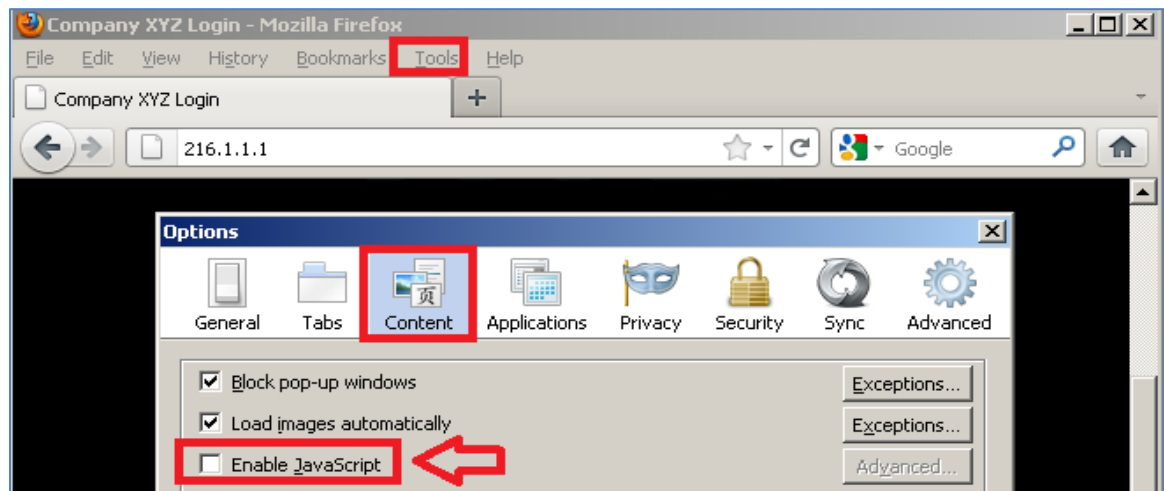

Figure 12: Disable JavaScript

6. Attempt to perform SQL injection by typing the following in the username box:
    JESSE' OR 1=1- -

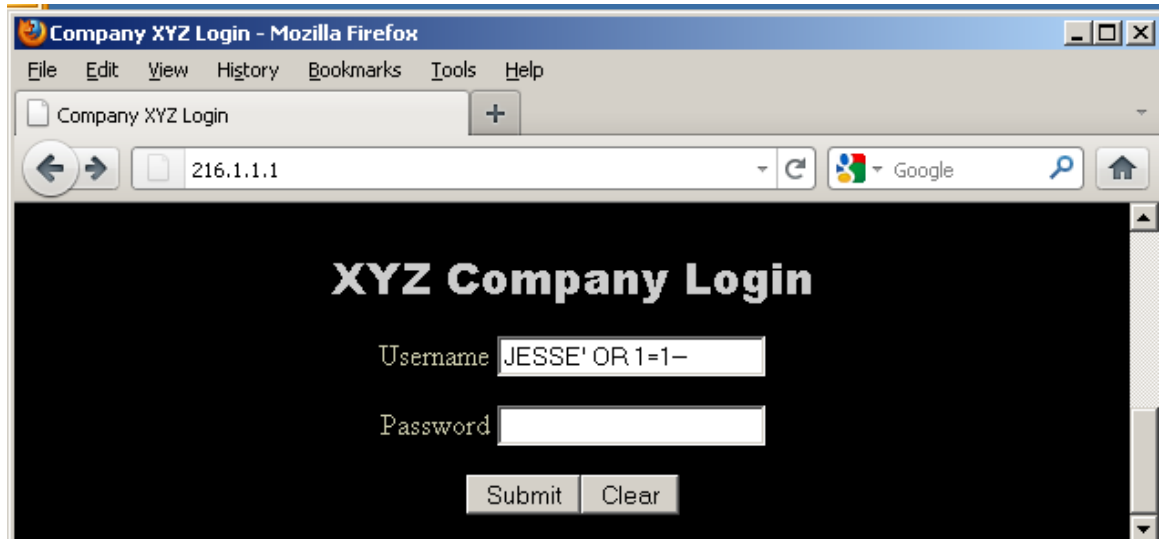You can copy the line above from the sql.txt file on the Windows 7 desktop.

Figure 13: An SQL Injection Attempt

You should receive a message stating, *Successful Login to CompanyXYZ Web Site*.
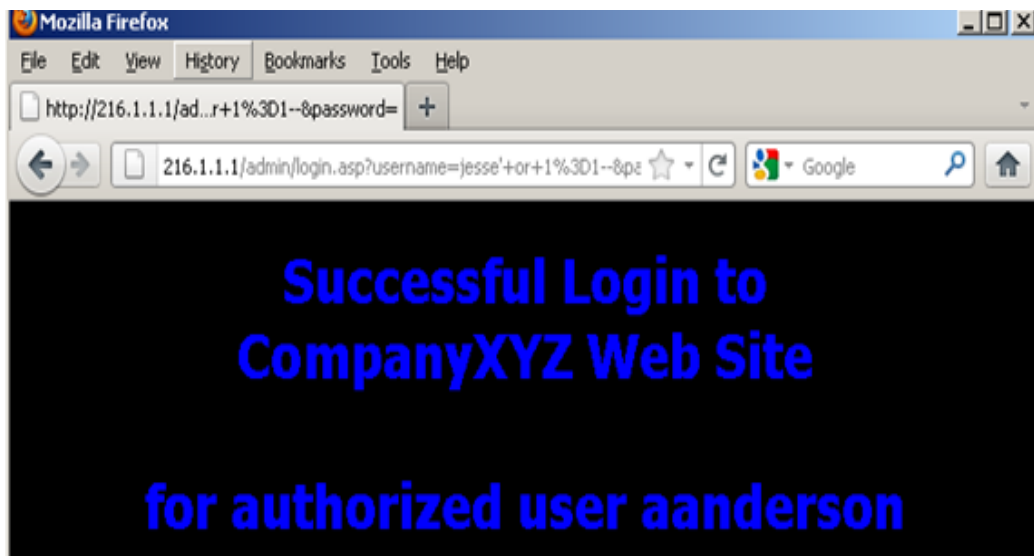
Figure 14: Opening Firefox

The likely reason that the name **aanderson** is being displayed is due to the fact that they are the first user in the column. Once 1=1 was evaluated as true, you were able to log in.

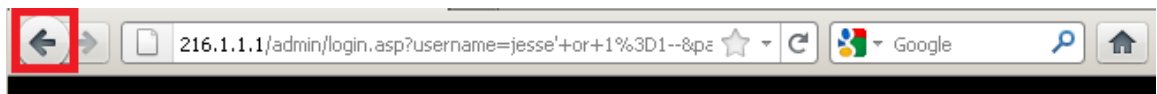7. Click the **Back** button to return to the 216.1.1.1 home page.

Figure 15: Returning to the Home Page

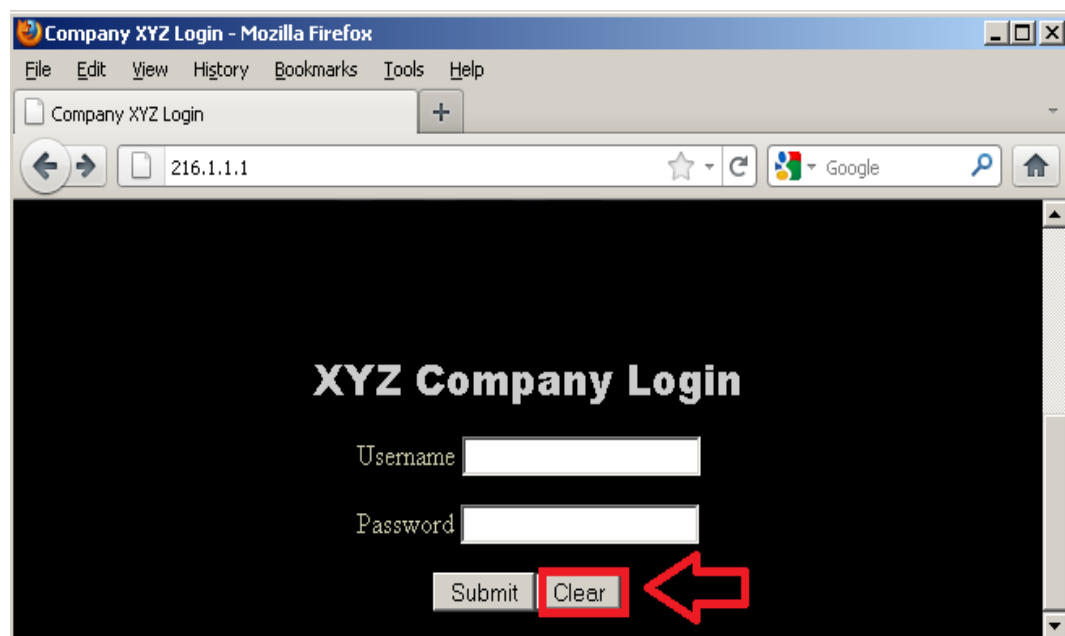8. Clear any input that was in the username box by hitting the **Clear** button.

Figure 16: Clearing the Input in the Web Form

Next, we will use a stored procedure to view all of the names and passwords in the database. The stored procedure is called **sp_makewebtask**. This stored procedure, which is only available in Microsoft SQL Server, will produce HTML output.

9. Double-click on the **sql.txt** file on the **Windows 7** desktop.

Figure 17: The SQL.TXT File

10. Highlight the second line of text in the file. Select **edit**, then **copy** from the menu.
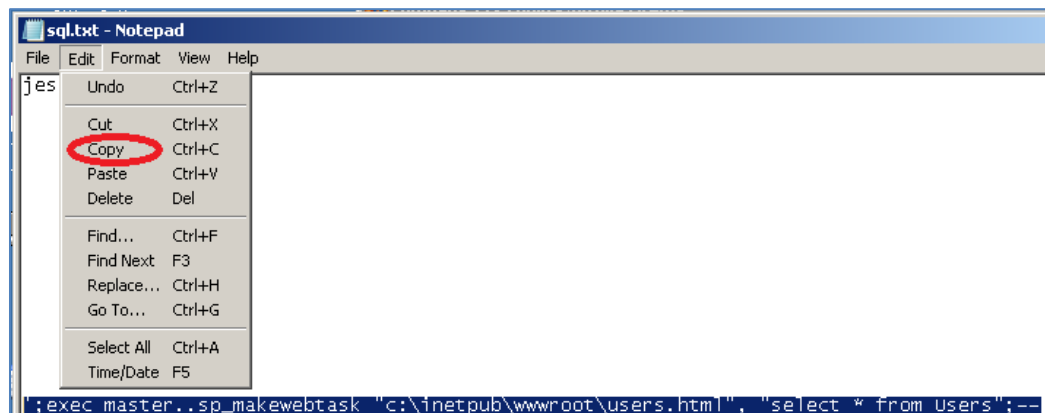

Figure 18: Copying a Line of Text

11. Right-click in the username field and select **Paste**. Click the submit button.
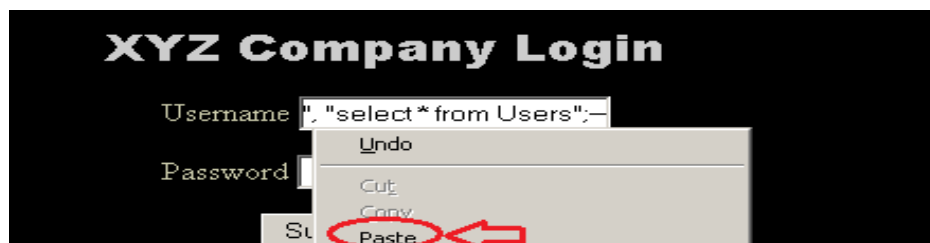

Figure 19: Inputting the Information into the Username Field

You should see a web page with the response displayed in the figure below:
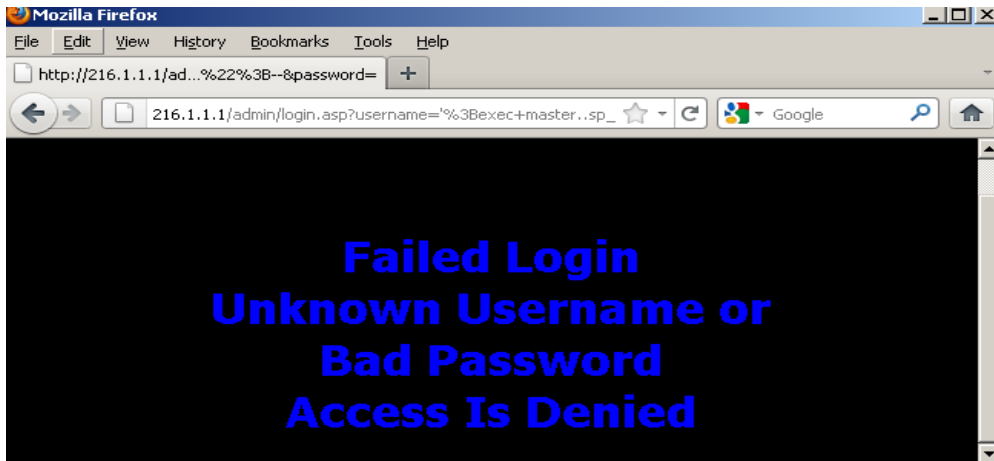

Figure 20: Inputting the Information into the Username Field
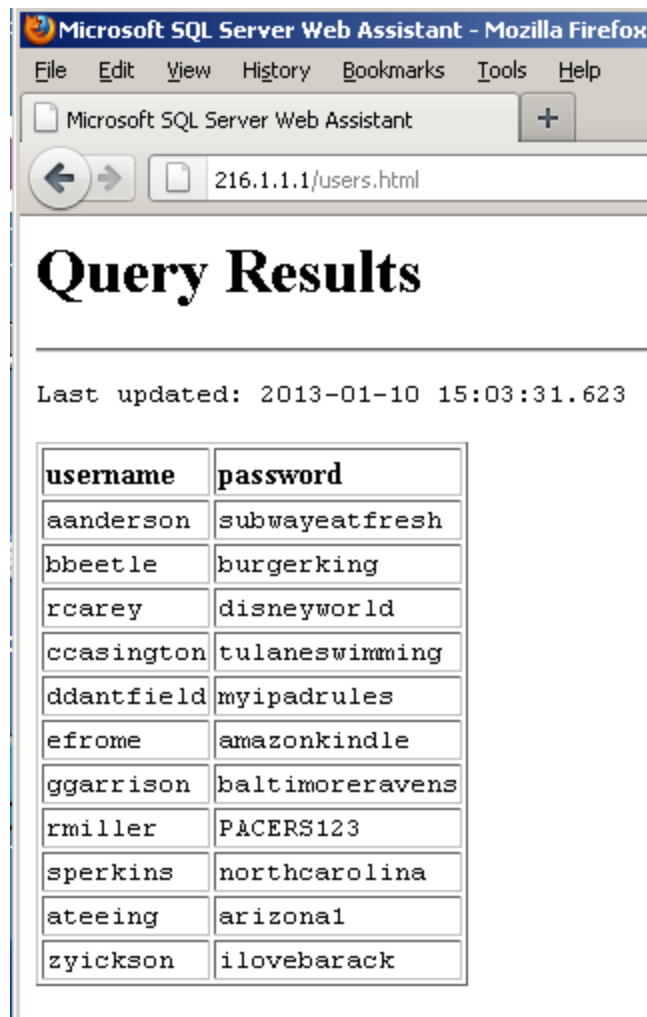
Although you received the following responses from the 216.1.1.1 Web Server:

- Failed Login
- Unknown Username or Bad Password
- Access Is Denied

This does not necessarily mean that your SQL statement did not execute.
Instead, what this means, is that the input you put in the username box of the server was not a username that is recognized in one of the columns of the database.

12. To see if the injection worked, type the following URL in Firefox:
http://216.1.1.1/users.html

Figure 21: The Database of Users and Passwords

So, the entire database containing all of the usernames and passwords is displayed. This could also have been a database of credit cards or social security numbers. Next, we will inject a username and password into the existing database. By doing this, we can then log into the database and possibly gain access to resources. Or, we could create an account in a database that will grant us physical or network access.

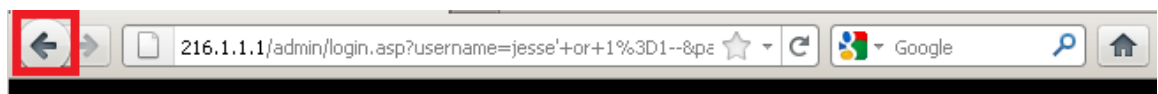13. Click the Back button to return to the 216.1.1.1 home page

Figure 22: Returning to the Home Page

14. Clear any input that was in the username box by hitting the **Clear** button:

XYZ Company Login

Username [ ]

Password [ ]
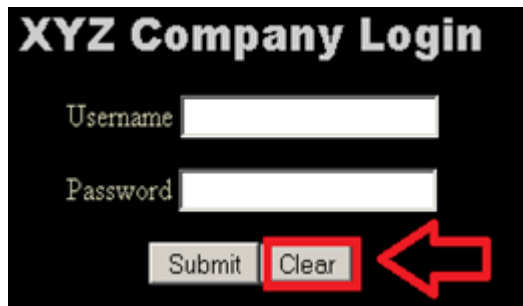
[Submit] [Clear]

Figure 23: Clearing the Input in the Web Form

15. Highlight the third line in the sql.txt file. Select **edit**, then **Copy** from the menu.

sql.txt - Notepad

File Edit Format View Help

```
jesse' or 1=1--
';exec master..sp_makewebtask "c:\inetpub\wwwroo
';insert into Users values('jesse','james123')--
```

Undo

Cut
Copy
Paste
Delete

Select All

Right to left Reading order
Show Unicode control characters
Insert Unicode control character ▶

Open IME
Reconversion

Figure 24: Copying a Line of Text

16. Right-click in the username field and select **Paste**. Click the submit button.

XYZ Company Login

Username ues('jesse','james123')--|

Undo

Password

Cut
Copy
S   Paste

Figure 25: Inputting the Information into the Username Field

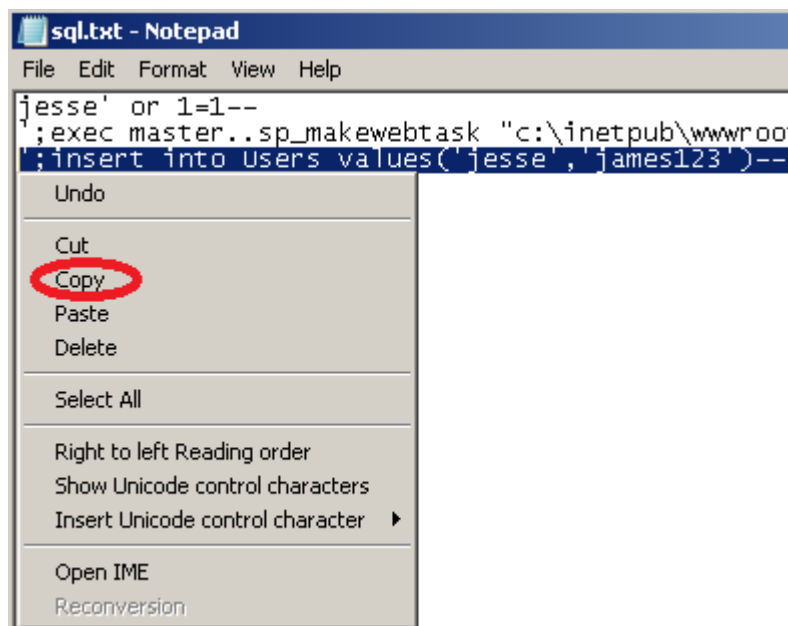You should see a web page with the response displayed in the figure below:
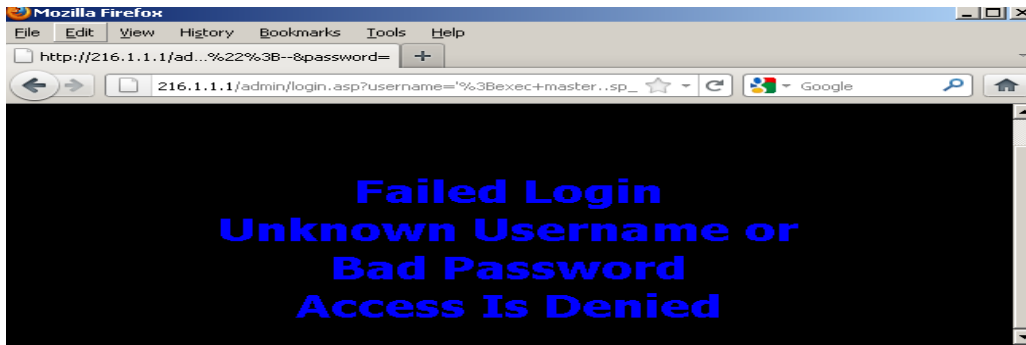

Figure 26: Inputting the Information into the Username Field

17. Log on to the Microsoft Windows 2003 Server. Use the PC menu in the NETLAB+ Remote PC Viewer to send a **Ctrl-Alt-Del** (version 2 viewer), or click the **Send Ctrl-Alt-Del** link in the bottom right corner of the viewer window (version 1 viewer. Log on to the 2003 server with the username of **Administrator** and the password of **P@ssw0rd**.
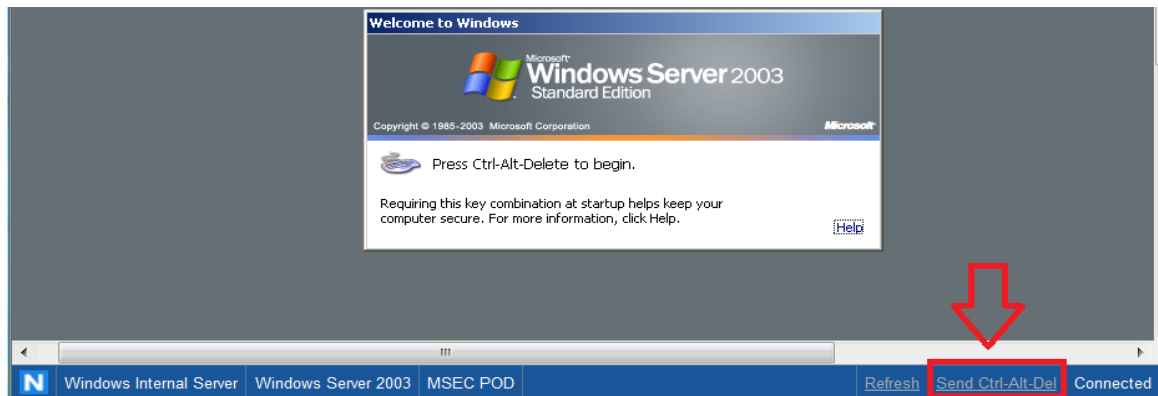

Figure 27: Send Ctrl-Alt-Del to the Windows 2003 Server

18. Click on the shortcut to **SQL Server Management Studio Express** on the desktop.

Figure 28: Opening SQL Server Management

Next, we will log on to the SQL server with the sa, or system administrator, account.

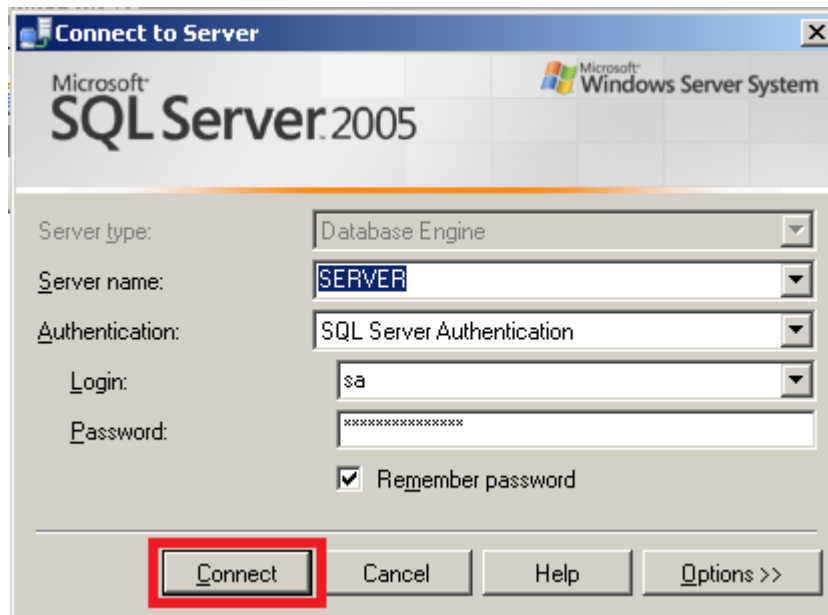19. Click the **connect** button to log on to the Server as the **sa** account

Figure 29: Connecting to the Microsoft SQL Server

20. Expand **Server**, expand **Databases**, expand **System Databases**, expand **master**, and expand **tables**. Right-click on **dbo.users** and select **Open Table**.
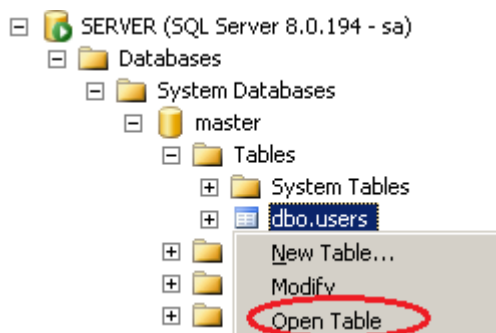

Figure 30: Opening a Table

21. View the second to last entries that were injected into the table.

Figure 31: The User's Table

We also could have gone to http://216.1.1.1 and tried to log on with the username jesse and the password of james123. That would have been successful. We also could have used sp_makewebtask again to determine if jesse was in the list.

1.2   Conclusion

An attacker can use SQL injection to manipulate tables within a database or to reveal information within that database. A database server is less secure if it relies on client side validation as opposed to server side validation. When only client side validation is required, an attacker can disable JavaScript on their browser and insert SQL statements.

1.3   Discussion Questions

1. What does the stored procedure sp_makewebtask do?
2. How do disable JavaScript within Firefox?
3. What is client side validation?
4. What could be done to make an SQL secure more secure?

2   Poison Ivy Payload

At this point, we will use the stored procedure xp_cmd shell to attempt to run operating system commands. If we can run operating system commands, we can use the ftp command to download a malicious Poison Ivy payload. We can also execute the payload using the xp_cmd shell and get a connection from the victim machine to the attacker.

Before creating the malicious Poison Ivy payload, let's verify that this particular MSSQL server is vulnerable and will allow us to use the stored procedure xp_cmd shell.

2.1   Making the Poison Ivy Payload

1. Highlight the fourth line in the sql.txt file. Select **edit**, then **copy** from the menu.
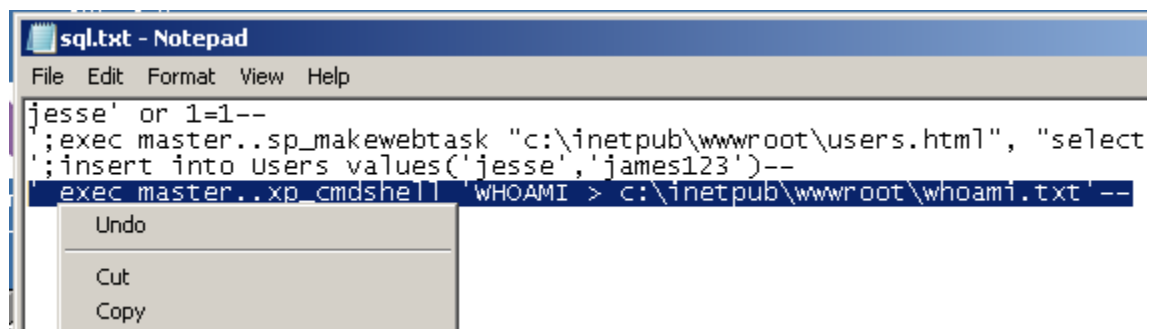

Figure 32: Copying a Line of Text

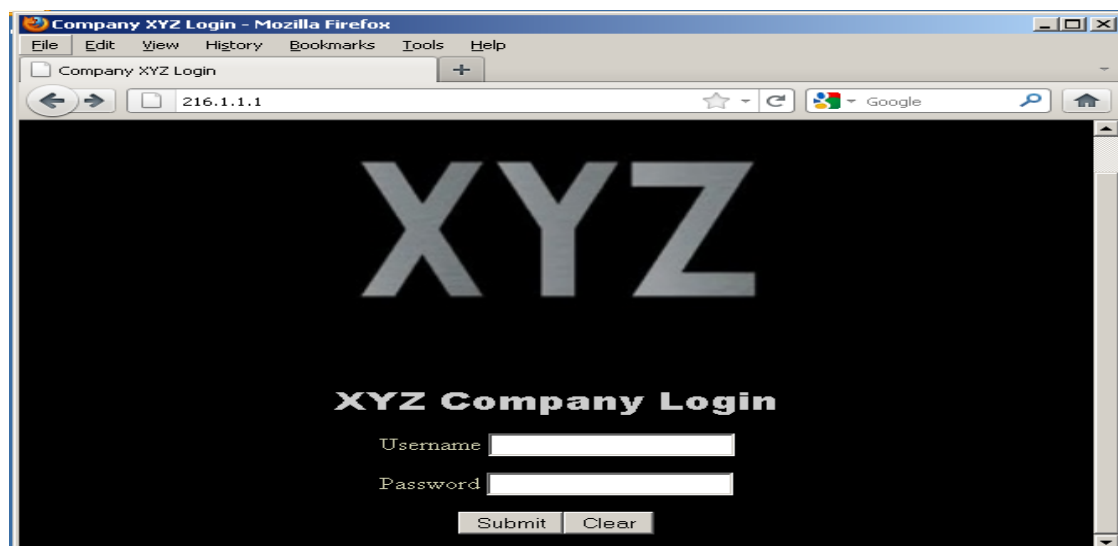2. Go to the Public IP address of XYZ Company by typing this URL in your browser: http://216.1.1.1

Figure 33: Public Facing Website

3. Paste this line into the Username field:

' exec master..xp_cmdshell 'WHOAMI > c:\inetpub\wwwroot\whoami.txt'--

By pasting the line above into the username field, we are trying to determine:

- Will we have access to the stored procedure xp_cmd shell?
- What level of privilege will we have when we run commands?

The output of the command whoami is redirected to a file called whoami.txt, which resides in the C:\Inetpub\wwwroot directory. This is the default directory location for the webroot on a Windows system and it is the only location the hacker can now access.

4. Right-click in the username field and select **Paste**. Click the submit button.

Figure 34: Inputting the Information into the Username Field

You should see a web page with the response displayed in the figure below:

Figure 35: Inputting the Information into the Username Field

5. Click the Back button to return to the 216.1.1.1 home page.
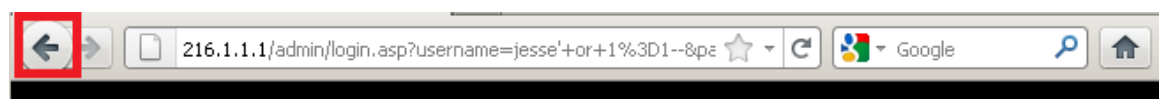

Figure 36: Returning to the Home Page

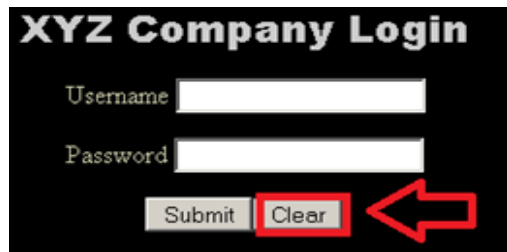6. Clear any input that was in the username box by hitting the **Clear** button:

Figure 37: Clearing the Input in the Web Form

7. Go to the Public IP address of XYZ Company by typing this URL in your browser:
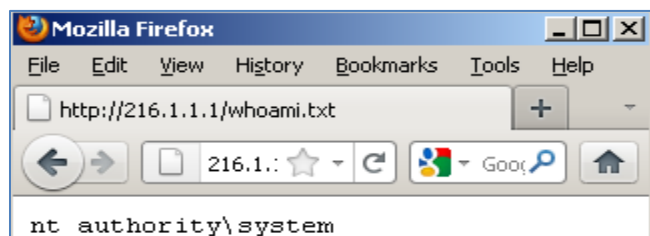   http://216.1.1.1/whoami.txt

Figure 38: Public Facing Website

We can use the stored procedure xp_cmd shell when we perform injection on this SQL server. It also tells us we will run these commands with SYSTEM privileges. Now that we know we can run commands, we will create a payload to be uploaded to the server.

8. Open the **Malware** folder on the **Windows 7** Desktop. Right-click on the **PI2.3.2.rar** file, select **7-zip** and select the 4th choice down **Extract to "PI2.3.2**.
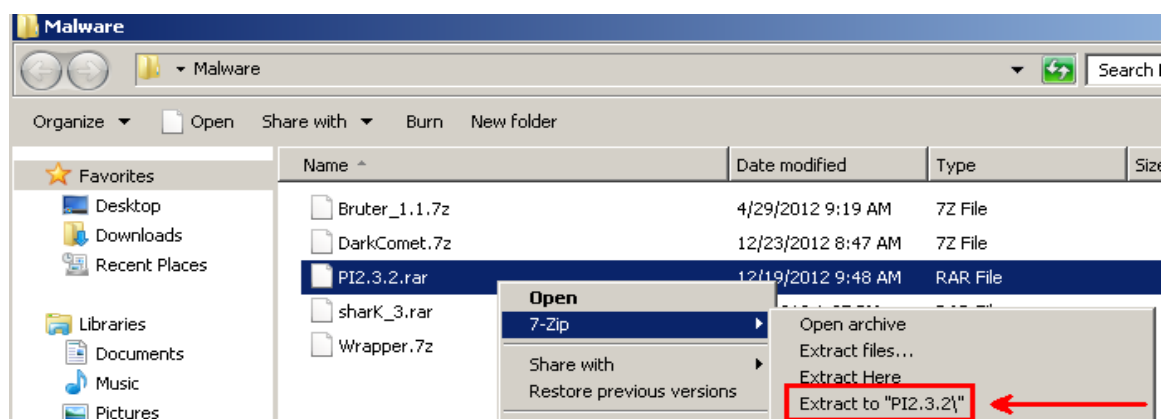

Figure 39: Extracting the file with 7-zip

9. Double-click on the **PI2.3.2** folder and double-click on **Poison Ivy 2.3.2.exe**. Wait 10 seconds, click **Don't show this message in the future** and click **I Agree**.
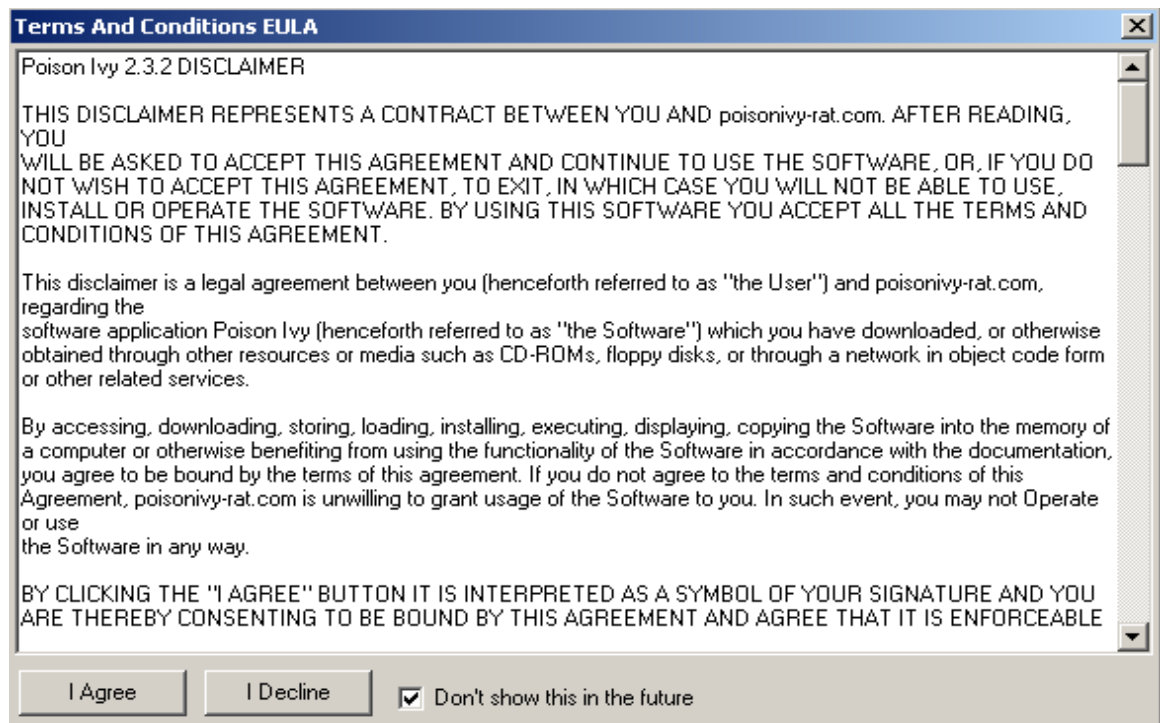

Figure 40: The Poison Ivy License Agreement

Although it may seem counterintuitive, the Poison Ivy client is configured on the machine that will act as the server and accept client connections. We will be configuring the Windows 7 VM to be the Poison Ivy Client (or Server, as it might be referred to).

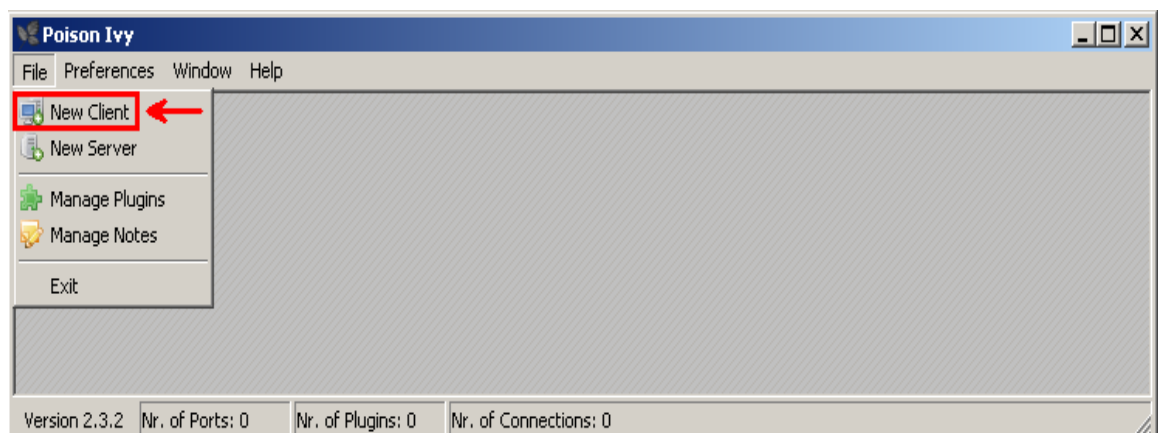10. From the Poison Ivy Menu bar, click **File** and select **New Client** from the list.

Figure 41: Select New Client

11. In the listen on Port box, type **443**. Click **Start** to begin listening on that port.
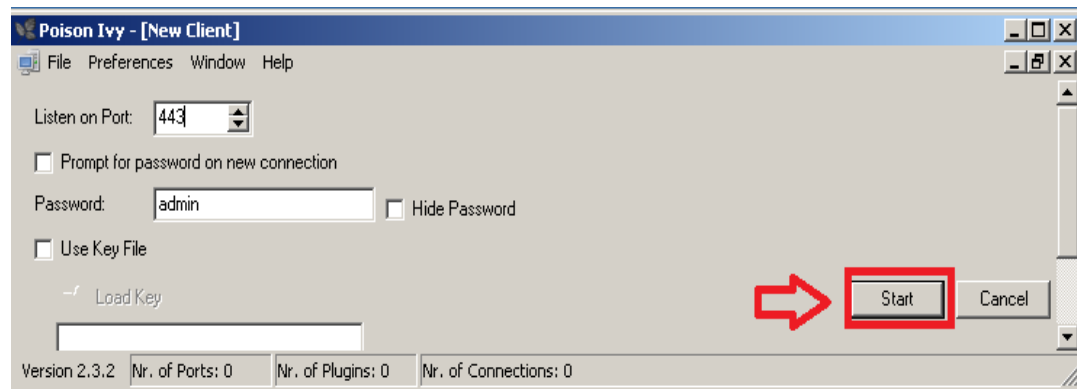

Figure 42: Start the Listener on Port 443

12. From the Poison Ivy Menu bar, click **File** and select **New Server** from the list.
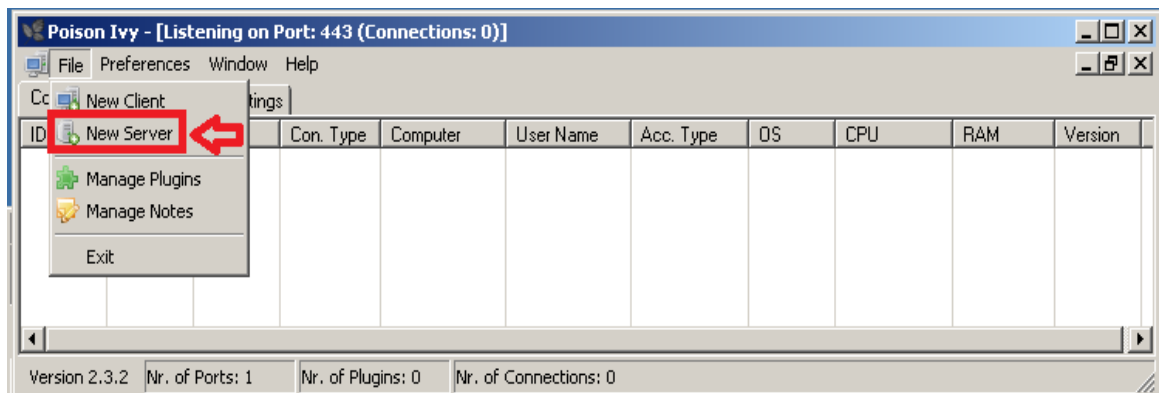
Figure 43: Creating the Poison Ivy "Server"

13. From the Profiles screen, click **Create Profile**. Name the Profile **CEH** and click **OK.**

Figure 44: Creating a Profile within Poison Ivy

14. In the DNS/Port box, carefully type **216.5.1.200:443:0,** and click **Next**.

Figure 45: The Connection Screen in Poison Ivy

15. Check the box that states **Start on system startup**. Name the HKLM/Run Name **Norton** to disguise its presence. Then, click the next arrow to advance.
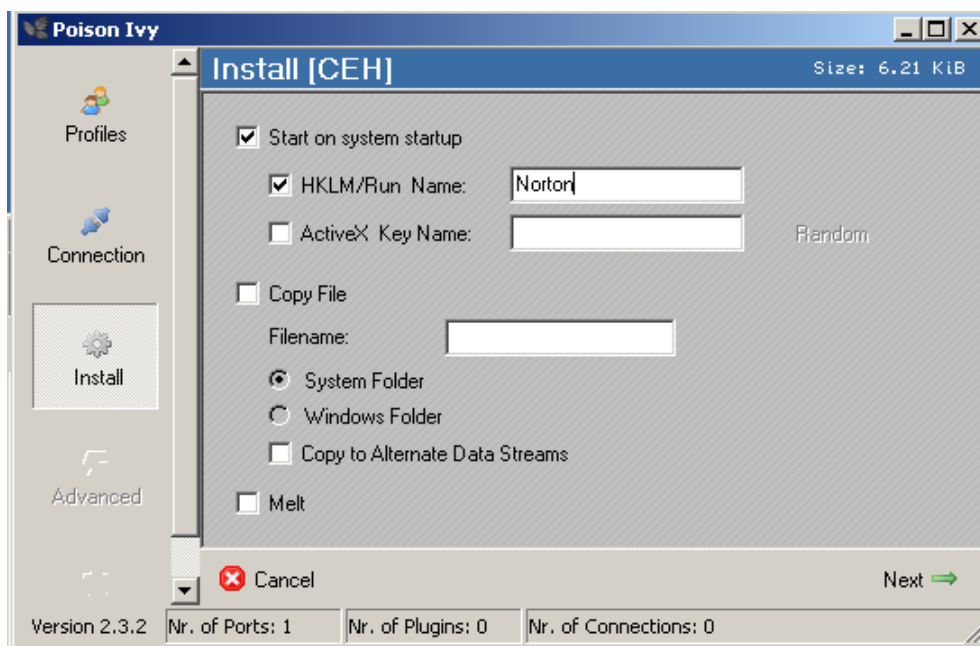
Figure 46: The Install Screen in Poison Ivy

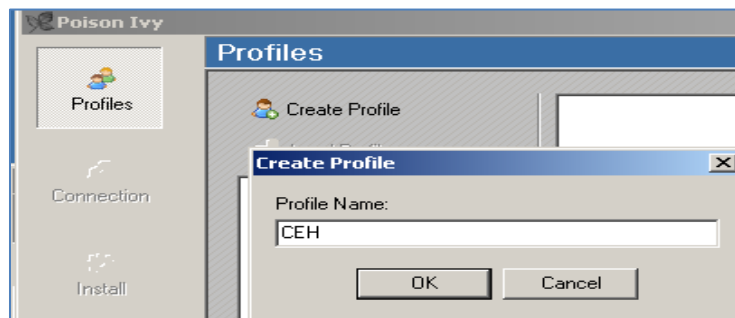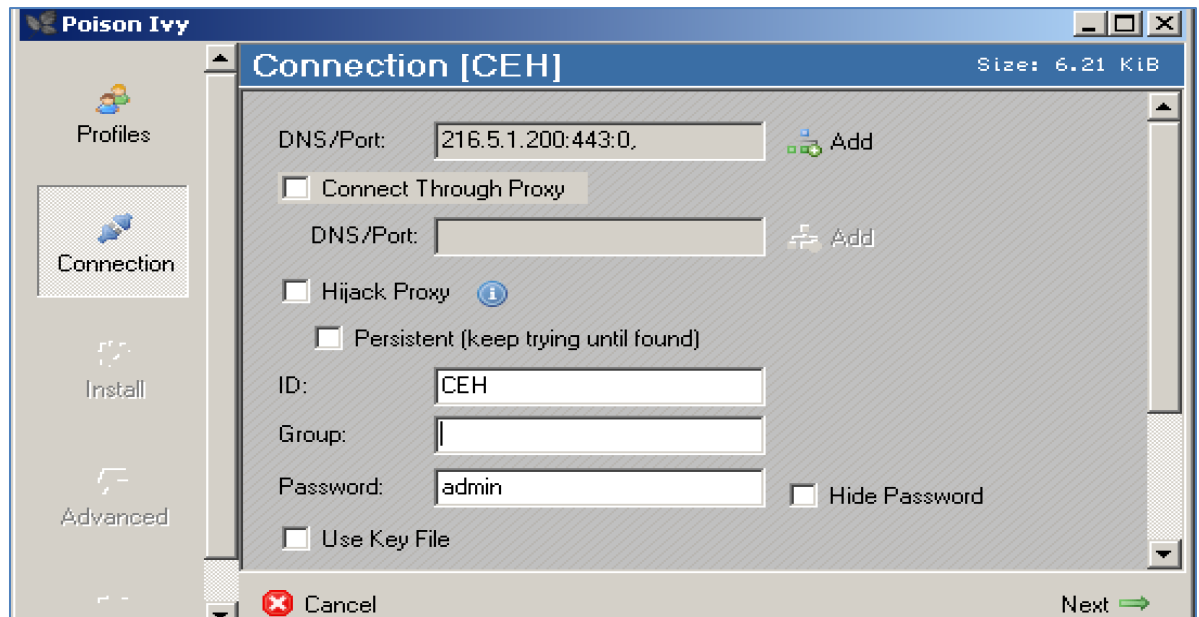16. At the Advanced Screen, leave all of the default options. Click **Next** to advance.
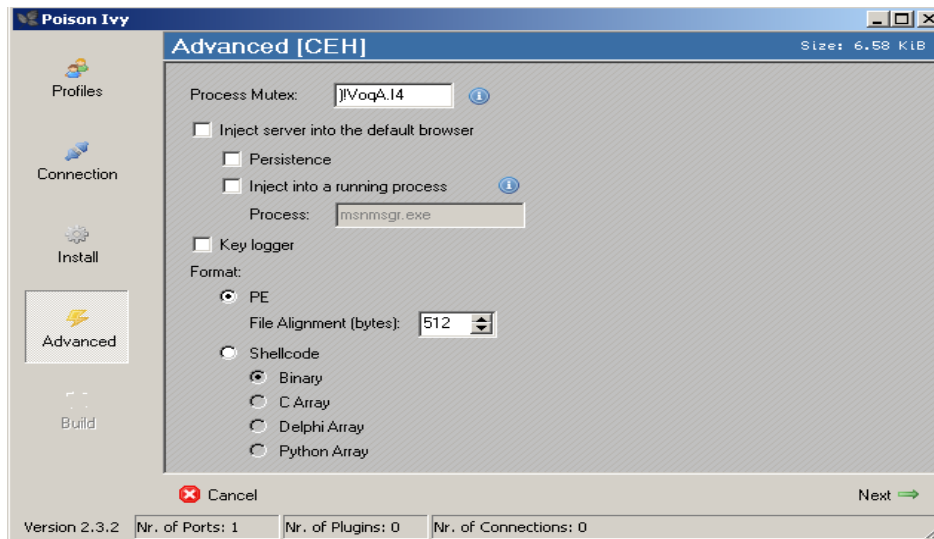
Figure 47: The Advanced Screen of Poison Ivy

17. First click **generate**. Then click on **Computer** on the left in the Save as box.
Click on **Local Disk (C:)**, then the **inetpub** directory, then the **ftproot** directory.
Name the file **iexplore** and click **Save** to save the generated payload.

Figure 48: Generating the Payload

First, we tested the Microsoft SQL server to see if we were able to use the stored procedure xp_cmd shell. It worked and gave us SYSTEM level access when we used it. The name of the malicious Poison Ivy payload is iexplore.exe. This is the name of a real executable 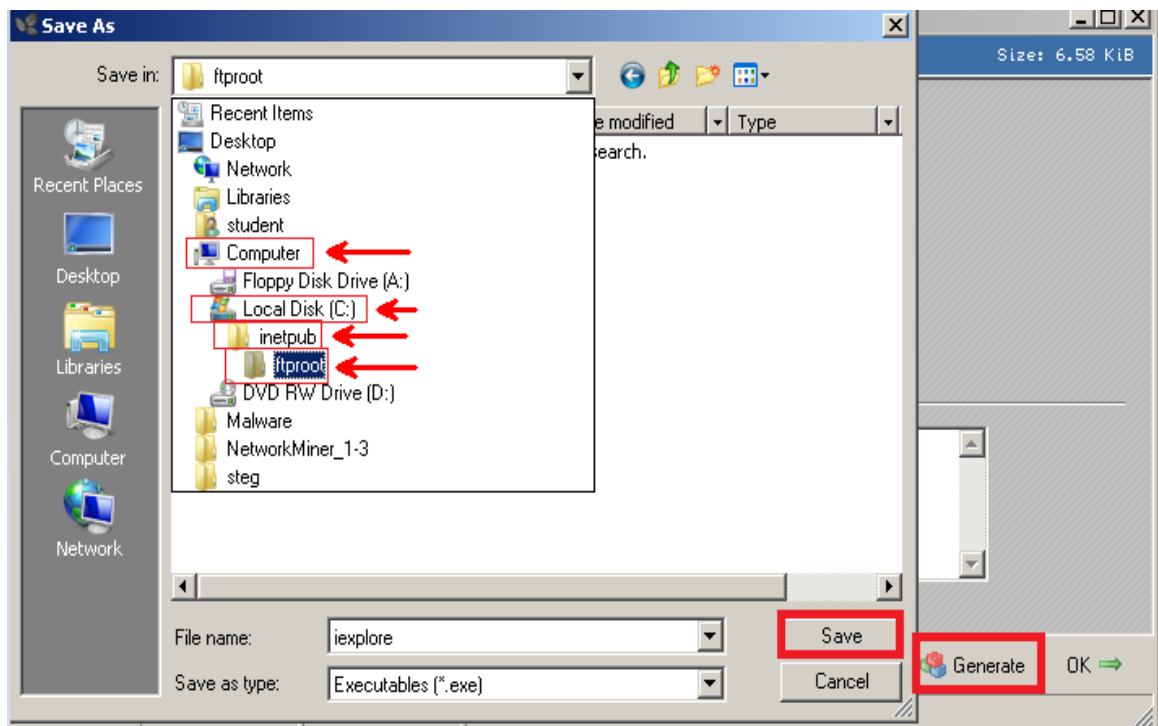for Windows. However, that executable resides in the C:\Program Files Internet Explorer directory. We will drop our iexplore.exe file in C:\Windows\system32 After you click OK, Poison Ivy will return to the screen that says it is listening on port 443.

2.2   Conclusion

Poison Ivy is malware that has a server and a client component. The attacker first sets up the client, which will listen on a port and wait for connections. Attackers on the Internet cannot directly attack internal machines on an internal network. Rather, they need them to get users on an internal network with Private IP addresses to launch a program so they will be able to connect to an External IP address on the Internet.

2.3   Discussion Questions

1. What is xp_cmd shell?
2. What needs to be done after the Poison Ivy software is initially launched?
3. What is a good name for a Poison Ivy payload?
4. What does the command whoami tell you?

3   Launch a Malicious Payload

In this exercise, we will upload the malicious payload to the victim machine using the stored procedure xp_cmd shell. We will upload the iexplore.exe file, which is actually a Poison Ivy payload, by creating an ftp answer file and executing the ftp command. After uploading the file, we will launch it to get the victim to connect to the attacker.

3.1   Using the xp_cmd shell to upload and launch a Malicious Payload k

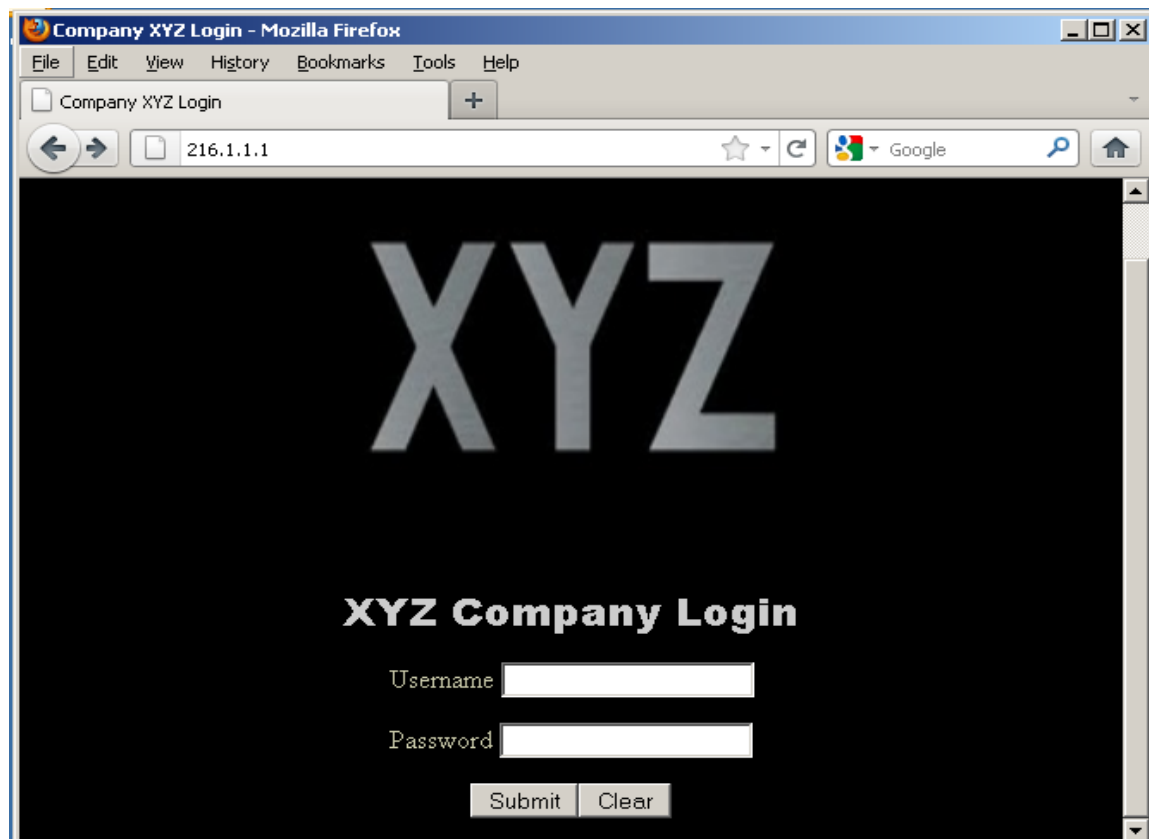1. Go to the public IP address of XYZ Company by typing this URL in your browser: http://216.1.1.1

Figure 49: Public Facing Website

2. Highlight the fifth line in the sql.txt file. Select edit, then copy from the menu.

Figure 50: Copying a Line of Text

3. Right-click in the username field and select paste. Click the submit button.

Figure 51: Inputting the Information into the Username Field

You should see a web page with the response displayed in the figure below:

Figure 52: Inputting the Information into the Username Field

4. Click the down arrow to the right of the URL bar and drop down to 216.1.1.1.

Figure 53: Returning to the Home Page

5. Highlight the sixth line of the sql.txt file. Select edit, then copy from the menu.

Figure 54: Copying a Line of Text

6. Right-click in the username field and select **Paste**. Click the Submit button.

Figure 55: Inputting the Information into the Username Field

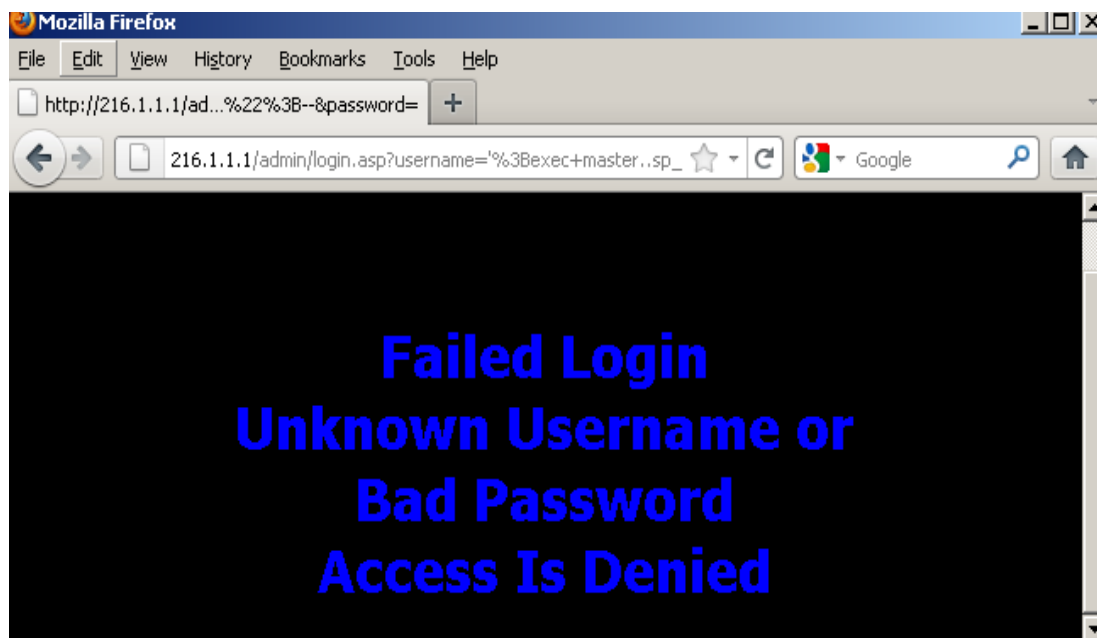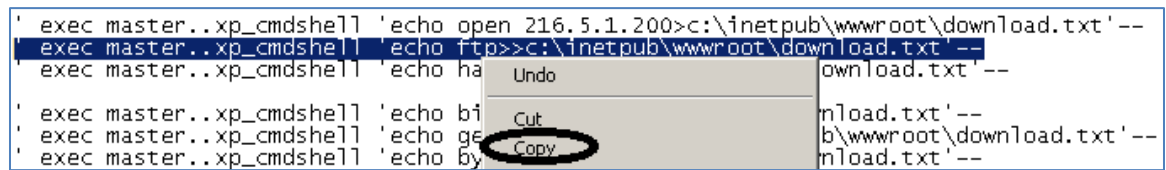You should see a web page with the response displayed in the figure below:

Figure 56: Inputting the Information into the Username Field

7. Click the down arrow to the right of the URL bar and drop down to 216.1.1.1.

Figure 57: Returning to the Home Page

8. Highlight the seventh line in sql.txt. Select edit, then **Copy** from the menu.
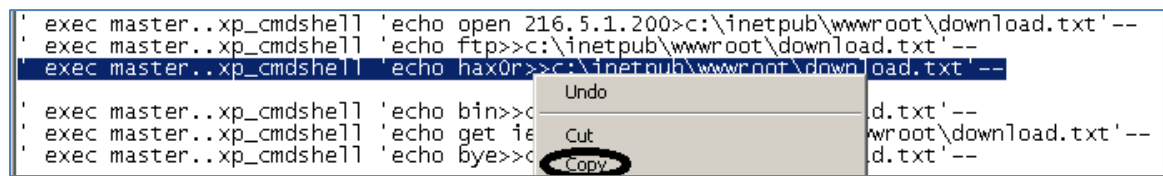

Figure 58: Copying a Line of Text

9. Right-click in the username field and select **Paste**. Click the Submit button.

Figure 59: Inputting the Information into the Username Field

You should see a web page with the response displayed in the figure below:

Figure 60: Inputting the Information into the Username Field

10. Click the down arrow to the right of the URL bar and drop down to 216.1.1.1.

Figure 61: Returning to the Home Page

11. Highlight the eighth line in the sql.txt file. Select edit, then **Copy** from the menu.

Figure 62: Copying a Line of Text

12. Right-click in the username field and select Paste. Click the Submit button.

Figure 63: Inputting the Information into the Username Field

You should see a web page with the response displayed in the figure below:

Figure 64: Inputting the Information into the Username Field

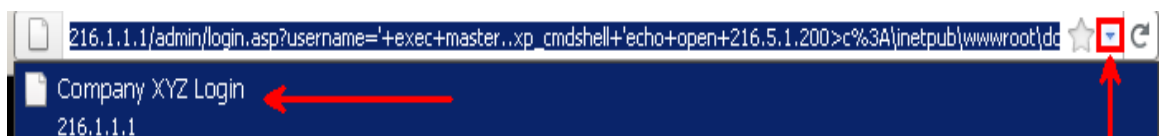13. Click the down arrow to the right of the URL bar and drop down to 216.1.1.1.

Figure 65: Returning to the Home Page

14. Highlight the ninth line in the sql.txt file. Select edit, then **Copy** from the menu.
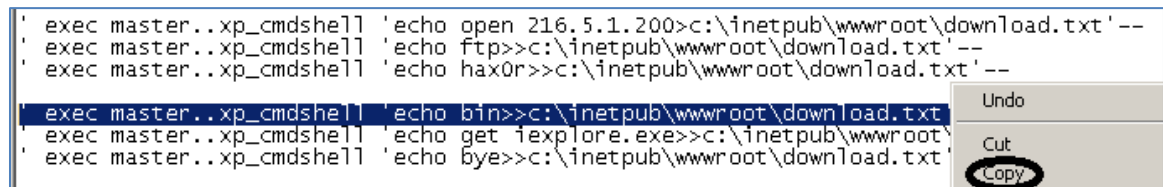

Figure 66: Copying a Line of Text

15. Right-click in the username field and select **Paste**. Click the Submit button.

Figure 67: Inputting the Information into the Username Field

You should see a web page with the response displayed in the figure below:

Figure 68: Inputting the Information into the Username Field

16. Click the down arrow to the right of the URL bar and drop down to 216.1.1.1.

Figure 69: Returning to the Home Page

17. Highlight the tenth line in the sql.txt file. Select edit, then **Copy** from the menu.
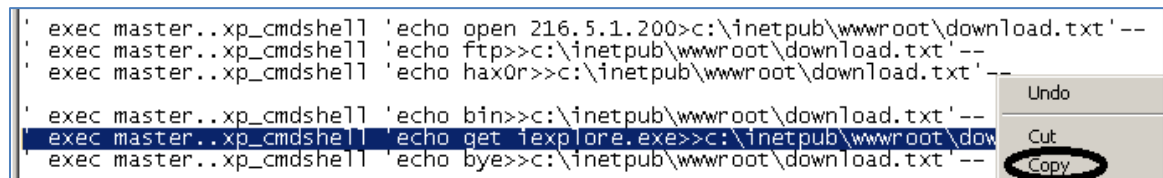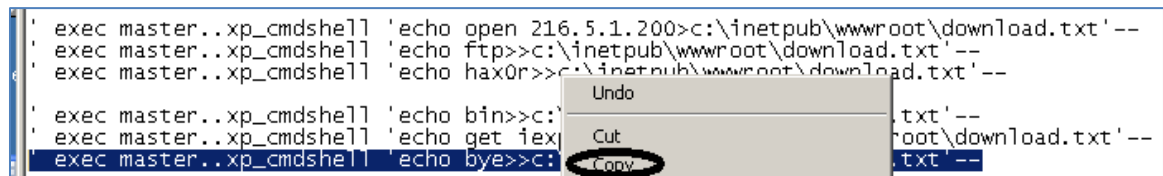

Figure 70: Copying a Line of Text

18. Right-click in the username field and select **Paste**. Click the submit button.

Figure 71: Inputting the Information into the Username Field

You should see a web page with the response displayed in the figure below:

Figure 72: Inputting the Information into the Username Field

19. Click the down arrow to the right of the URL bar and drop down to 216.1.1.1.

Figure 73: Returning to the Home Page

20. Go to the Public IP address of XYZ Company by typing this URL in your browser:
http://216.1.1.1/download.txt

You should have the same 6 lines in the figure below. If not, go back to 3.1.
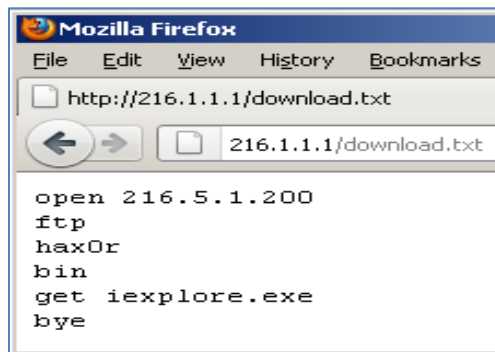

Figure 74: The Created FTP file

21. Click the down arrow to the right of the URL bar and drop down to 216.1.1.1.

Figure 75: Returning to the Home Page

22. Highlight the eleventh line in sql.txt. Select edit, then copy from the menu.

Figure 76: Copying a Line of Text

23. Right-click in the username field and select paste. Click the Submit button.

Figure 77: Inputting the Information into the Username Field

You should see a web page with the response displayed in the figure below:

Figure 78: Inputting the Information into the Username Field

24. Click the down arrow to the right of the URL bar and drop down to 216.1.1.1

Figure 79: Returning to the Home Page

25. Highlight the eleventh line in sql.txt. Select edit, then copy from the menu.
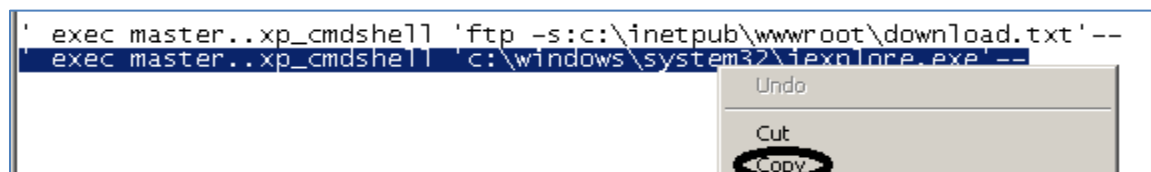

Figure 80: Copying a Line of Text

26. Right-click in the username field and select paste. Click the submit button.

Figure 81: Inputting the Information into the Username Field

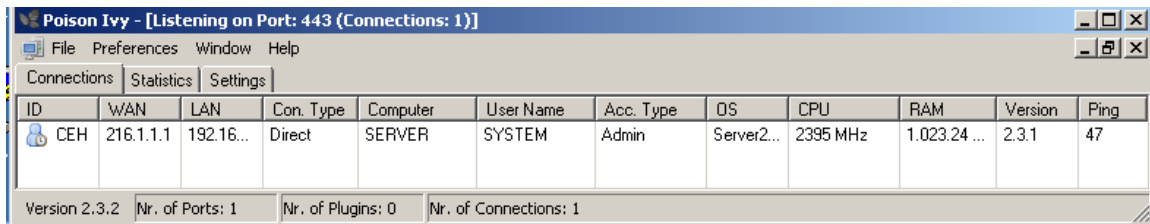You should now have a Poison Ivy connection to the victim SQL server machine.

Figure 82: A Poison Ivy Connection to the Victim (Thanks to SQL Injection)

3.2   Conclusion

An attacker can use the stored procedure xp_cmd shell to run operating system commands on a victim machine. This can include downloading and then executing malware. Once the malware is launched through the SQL injection process, the attacker can then shift to using a tool like Poison Ivy Remote Administration Tool.

3.3   Discussion Questions

1. What does RAT stand for?
2. What protocol can be used to download files with the xp_cmd shell?
3. What is included in the FTP answer file called download.txt?
4. What mechanism could be used on SQL servers to help lock them down?

References

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