Salfram: Robbing the place without removing your name tag

blog.talosintelligence.com/2020/09/salfram-robbing-place-without-removing.html

By Holger Unterbrink and Edmund Brumaghin.

Threat summary

- Cisco Talos recently uncovered a series of email campaigns utilizing links to malicious documents hosted on legitimate file-sharing platforms to spread malware.
- The campaigns distributed various malware payloads including Gozi ISFB, ZLoader, SmokeLoader and AveMaria, among others.
- Ongoing campaigns are distributing various malware families using the same crypter. While effective, this crypting mechanism contains an easy-to-detect flaw: The presence of a specific string value "Salfram" makes it easy to track over time.
- Obfuscated binaries are completely different, from both a binary and execution flow graph perspective.
- The techniques used by this crypter can confuse weak API behavior-based systems and static analysis tools.
- This crypter appears to be undergoing active development and improvement over time.

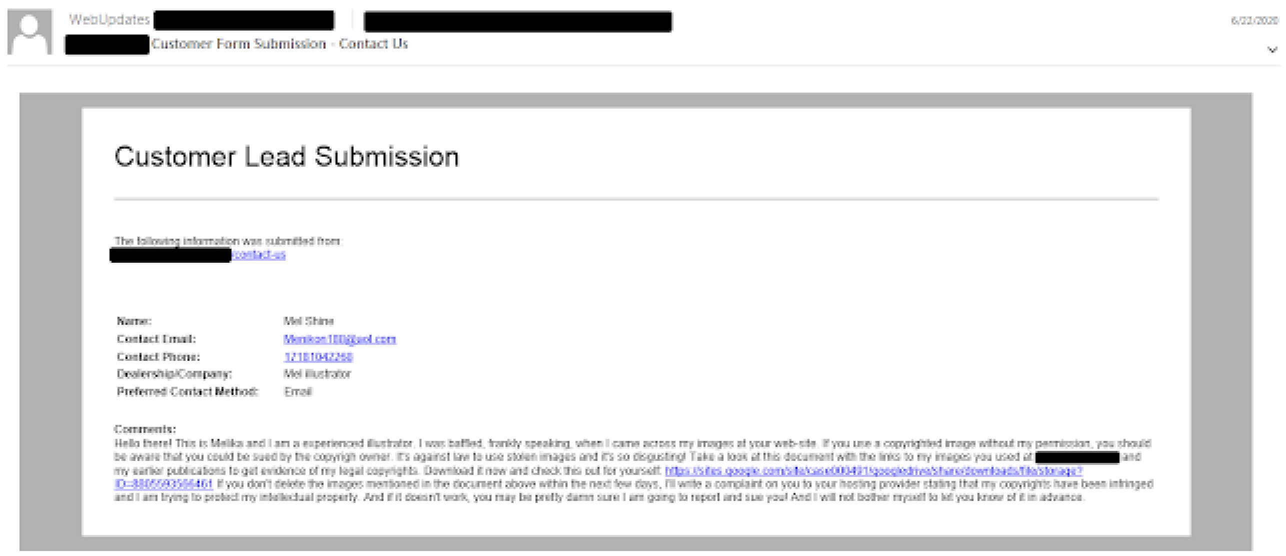
Executive summary

Over the past several months, Cisco Talos has seen attackers carrying out ongoing email-based malware distribution campaigns to distribute various malware payloads. These email campaigns feature several notable characteristics that appear designed to evade detection and maximize the effectiveness of these campaigns. The use of web-based contact forms, legitimate hosting platforms, and a specific crypter make analysis and detection more difficult. All of the malware samples associated with these campaigns feature a modified DOS header containing the string "Salfram," making them extremely easy to track over time. The crypter used in these campaigns is undergoing active development and improvements to obfuscate the contents of malware payloads. Additionally, the crypter uses several effective techniques to make the detection and analysis of the final malware payload more difficult. It obfuscates the original payload binaries in a way that results in payloads that appear completely different from each other after being packed using the same crypter. It even takes a great amount of effort to compare the packed binaries in a disassembler and determine if the same packer was used.

Distribution campaigns

The email distribution campaigns associated with these malware payloads feature characteristics designed to evade detection and make analysis and tracking more difficult. In most cases, the threat actor was initiating email-based communications with potential victims using the contact forms present on the victim organization's website. This results in email communications that appear to originate from legitimate sources which may allow the adversaries to evade some email security mechanisms.

In the messages, the attacker purports to be the copyright owner of images that the attacker claims they found hosted on the target organization's website without their permission. The email contents are somewhat customized, listing the target organization's domain as the website containing the infringing content and prompting them to access a hyperlink present in the email. Figure 1 is an example of one of the emails associated with one of these campaigns.


WebUpdates [redacted] [redacted] 6/22/2020

[redacted] Customer Form Submission - Contact Us

Customer Lead Submission

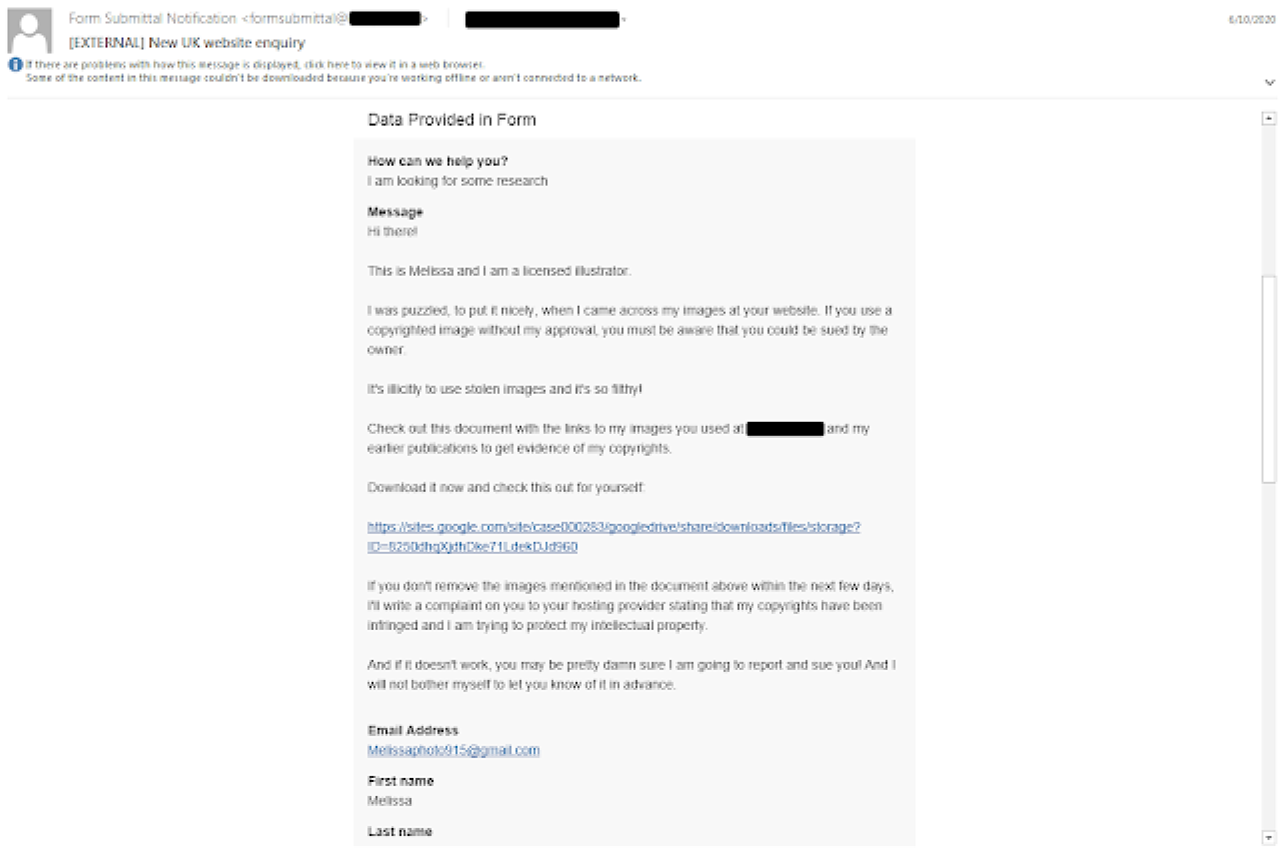
The following information was submitted from:
[redacted]/contact-us

Name:	Mel Shine
Contact Email:	Menikon180@aol.com
Contact Phone:	17181042258
Dealership/Company:	Mel illustrator
Preferred Contact Method:	Email

Comments:
Hello there! This is Melika and I am a experienced illustrator. I was baffled, frankly speaking, when I came across my images at your web-site. If you use a copyrighted image without my permission, you should be aware that you could be sued by the copyrigh owner. It's against law to use stolen images and it's so disgusting! Take a look at this document with the links to my images you used at [redacted] and my earlier publications to get evidence of my legal copyrights. Download it now and check this out for yourself: https://sites.google.com/site/case000491googledrive/Share/downloads/file/storage?ID=8805693566461 If you don't delete the images mentioned in the document above within the next few days, I'll write a complaint on you to your hosting provider stating that my copyrights have been infringed and I am trying to protect my intellectual property. And if it doesn't work, you may be pretty damn sure I am going to report and sue you! And I will not bother myself to let you know of it in advance.

Figure 1

Figure 2 is another example of these emails, demonstrating how the contents of individual messages may change based on the contact form and website configuration for the organization being targeted.



Form Submittal Notification <formsubmittal@[redacted]> [redacted]

6/10/2020

[EXTERNAL] New UK website enquiry

If there are problems with how this message is displayed, click here to view it in a web browser.
Some of the content in this message couldn't be downloaded because you're working offline or aren't connected to a network.

Data Provided in Form

How can we help you?
I am looking for some research

Message
Hi there!

This is Melissa and I am a licensed illustrator.

I was puzzled, to put it nicely, when I came across my images at your website. If you use a copyrighted image without my approval, you must be aware that you could be sued by the owner.

It's illicitly to use stolen images and it's so filthy!

Check out this document with the links to my images you used at [redacted] and my earlier publications to get evidence of my copyrights.

Download it now and check this out for yourself:

https://sites.google.com/site/case000283/googledrive/share/downloads/files/storage?ID=8250dhgXjdhDke71LdekDJd960

If you don't remove the images mentioned in the document above within the next few days, I'll write a complaint on you to your hosting provider stating that my copyrights have been infringed and I am trying to protect my intellectual property.

And if it doesn't work, you may be pretty damn sure I am going to report and sue you! And I will not bother myself to let you know of it in advance.

Email Address
Melissaphoto915@gmail.com

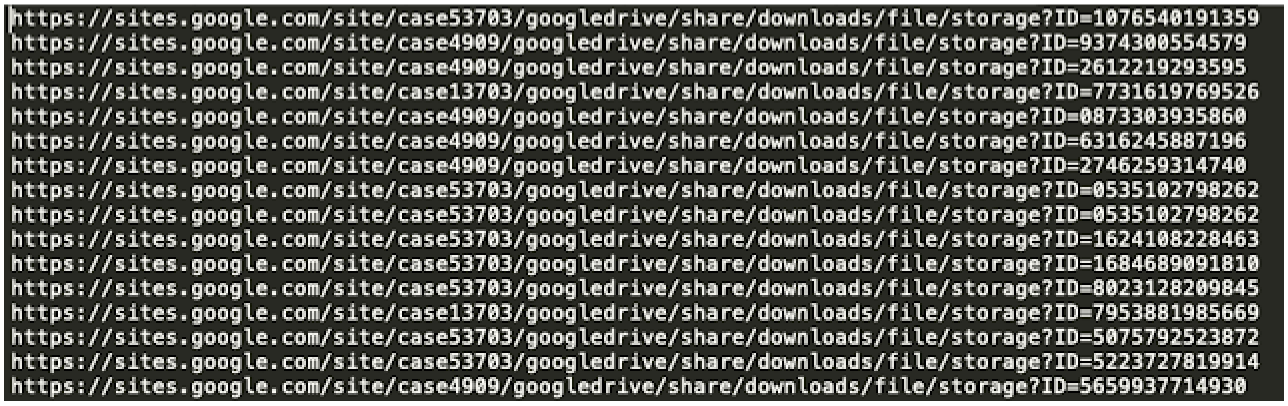
First name
Melissa

Last name

Figure 2

In analyzing malicious contact form submissions associated with these campaigns, we obtained information about the system used to submit the form contents. The contact form submissions were performed via proxy servers using an automated mechanism, such as scripting, to generate and submit the data.

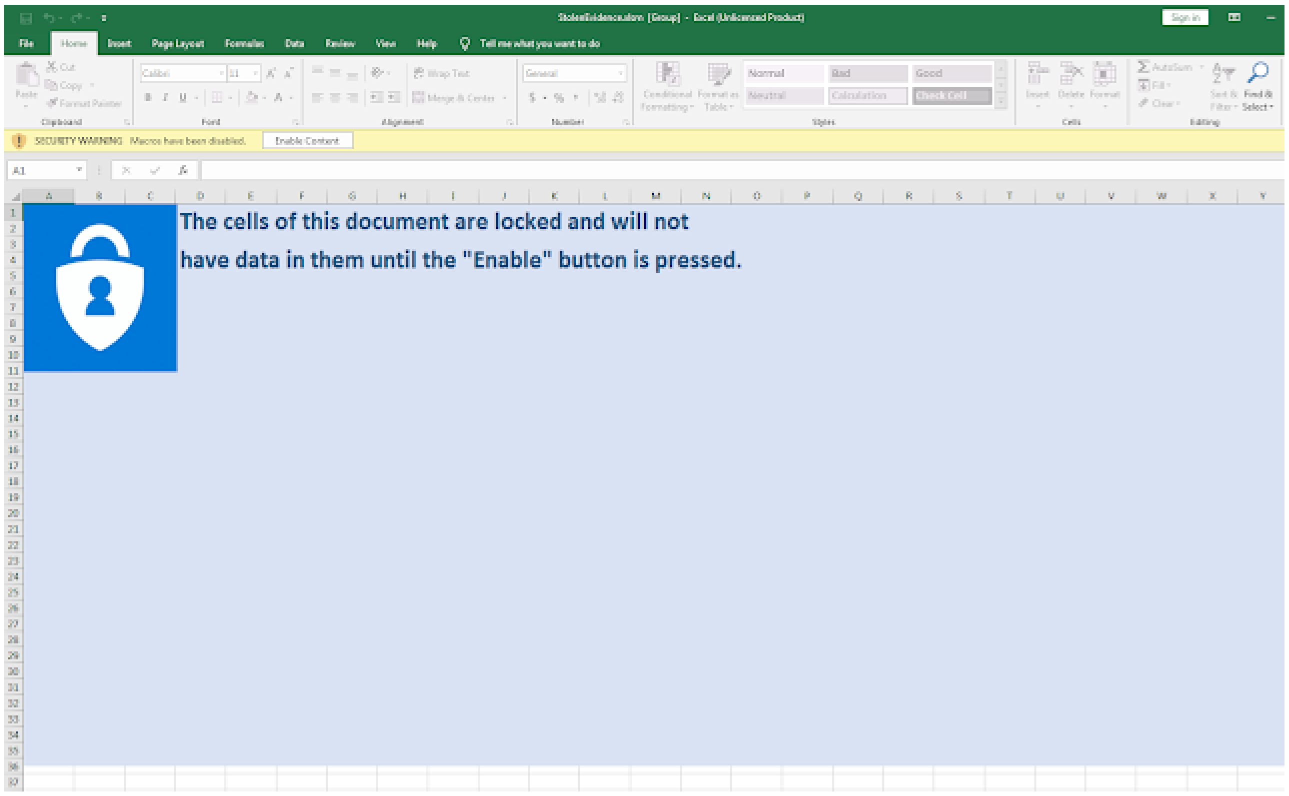
The majority of the emails contained links to a malicious file hosted on Google Drive. The directory structure and parameter values rotate frequently across various emails. Figure 3 lists some examples of these URLs.



```
https://sites.google.com/site/case53703/googledrive/share/downloads/file/storage?ID=1076540191359
https://sites.google.com/site/case4909/googledrive/share/downloads/file/storage?ID=9374300554579
https://sites.google.com/site/case4909/googledrive/share/downloads/file/storage?ID=2612219293595
https://sites.google.com/site/case13703/googledrive/share/downloads/file/storage?ID=7731619769526
https://sites.google.com/site/case4909/googledrive/share/downloads/file/storage?ID=0873303935860
https://sites.google.com/site/case4909/googledrive/share/downloads/file/storage?ID=6316245887196
https://sites.google.com/site/case4909/googledrive/share/downloads/file/storage?ID=2746259314740
https://sites.google.com/site/case53703/googledrive/share/downloads/file/storage?ID=0535102798262
https://sites.google.com/site/case53703/googledrive/share/downloads/file/storage?ID=0535102798262
https://sites.google.com/site/case53703/googledrive/share/downloads/file/storage?ID=1624108228463
https://sites.google.com/site/case53703/googledrive/share/downloads/file/storage?ID=1684689091810
https://sites.google.com/site/case53703/googledrive/share/downloads/file/storage?ID=8023128209845
https://sites.google.com/site/case13703/googledrive/share/downloads/file/storage?ID=7953881985669
https://sites.google.com/site/case53703/googledrive/share/downloads/file/storage?ID=5075792523872
https://sites.google.com/site/case53703/googledrive/share/downloads/file/storage?ID=5223727819914
https://sites.google.com/site/case4909/googledrive/share/downloads/file/storage?ID=5659937714930
```

Figure 3

Again, the use of a legitimate web platform for hosting the malicious content may provide another way for the attacker to evade various protections that may be deployed in environments that they are targeting. When the URL is accessed, the victim is delivered a malicious file, often a Microsoft Office document similar to the one in Figure 4.

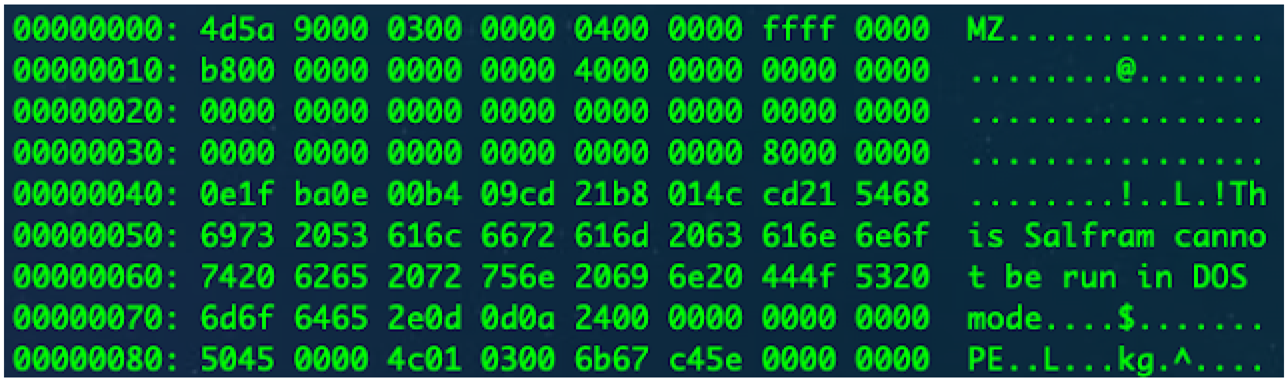


The cells of this document are locked and will not have data in them until the "Enable" button is pressed.

Figure 4

These documents contain malicious macros that initiate the infection process and are responsible for retrieving a malicious payload and executing it to infect the system. The payloads delivered have varied over time. Over the past several months, we have observed campaigns being used to deliver various information stealers, banking trojans and other malware loaders including but not limited to Gozi ISFB, ZLoader, SmokeLoader, Oski, AveMaria and Cobalt Strike payloads, among others.

We also discovered infection chains that deliver multiple payloads to a single victim as part of a multi-stage infection process. While the payload delivery features several distinct malware families, in all of the campaigns observed, the initial malware payloads used the same crypter, which obfuscates the malicious contents present in the binary executable and make analysis more difficult. As shown in Figure 5 these samples can be quickly observed as the packed samples feature a specific modification to the DOS stub:



```
00000000: 4d5a 9000 0300 0000 0400 0000 ffff 0000  MZ..............
00000010: b800 0000 0000 0000 4000 0000 0000 0000  ........@.......
00000020: 0000 0000 0000 0000 0000 0000 0000 0000  ................
00000030: 0000 0000 0000 0000 0000 0000 8000 0000  ................
00000040: 0e1f ba0e 00b4 09cd 21b8 014c cd21 5468  ........!..L.!Th
00000050: 6973 2053 616c 6672 616d 2063 616e 6e6f  is Salfram canno
00000060: 7420 6265 2072 756e 2069 6e20 444f 5320  t be run in DOS
00000070: 6d6f 6465 2e0d 0d0a 2400 0000 0000 0000  mode....$.......
00000080: 5045 0000 4c01 0300 6b67 c45e 0000 0000  PE..L...kg.^....
```

Figure 5

The next section describes how these techniques have been implemented and how to analyze samples that may have been obfuscated using this crypter.

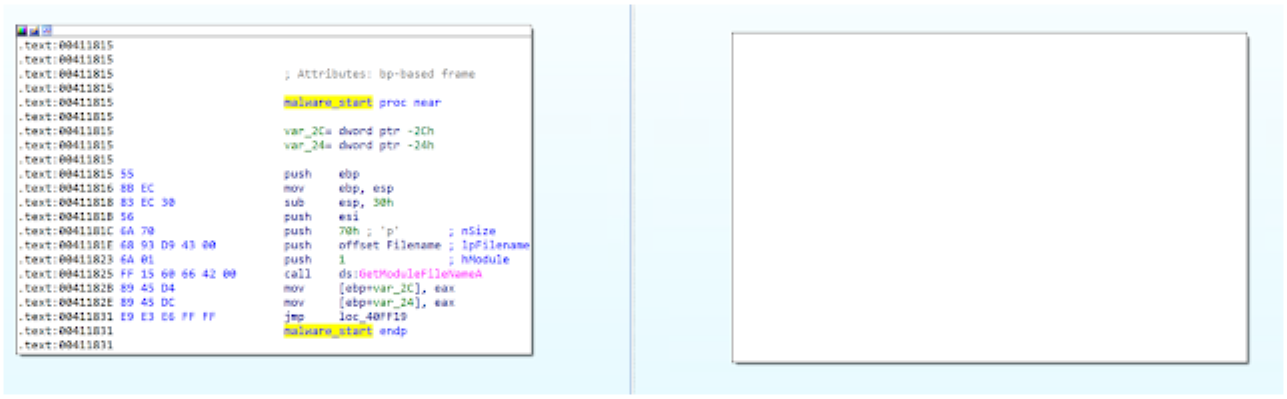
Technical overview

The obfuscation techniques used by this packer are not trivial, so it is surprising that all of the binaries observed contained the easily-trackable string "Salfram" inside the DOS stub. Further investigation is required to determine if the packer is automatically modifying contents of the DOS stub or if this is being done by the actor behind the campaigns.

The samples we analyzed have compiler or debug timestamps ranging from April 2019 to August 2020, but the majority of samples are from January 2020 onward. The campaigns before are either quite small or just tests. The binary structure of many of the samples is different, with differences ranging from minor changes all the way to code execution flows that are completely different. Nevertheless, they share the same or at least a very similar logic. It is hard to say if these changes are due to the use of different obfuscation features available within the crypter, or the use of different versions of the crypter. Comparing the samples we analyzed, we believe it is a bit of both — the crypter is frequently updated and actively maintained by the software author.

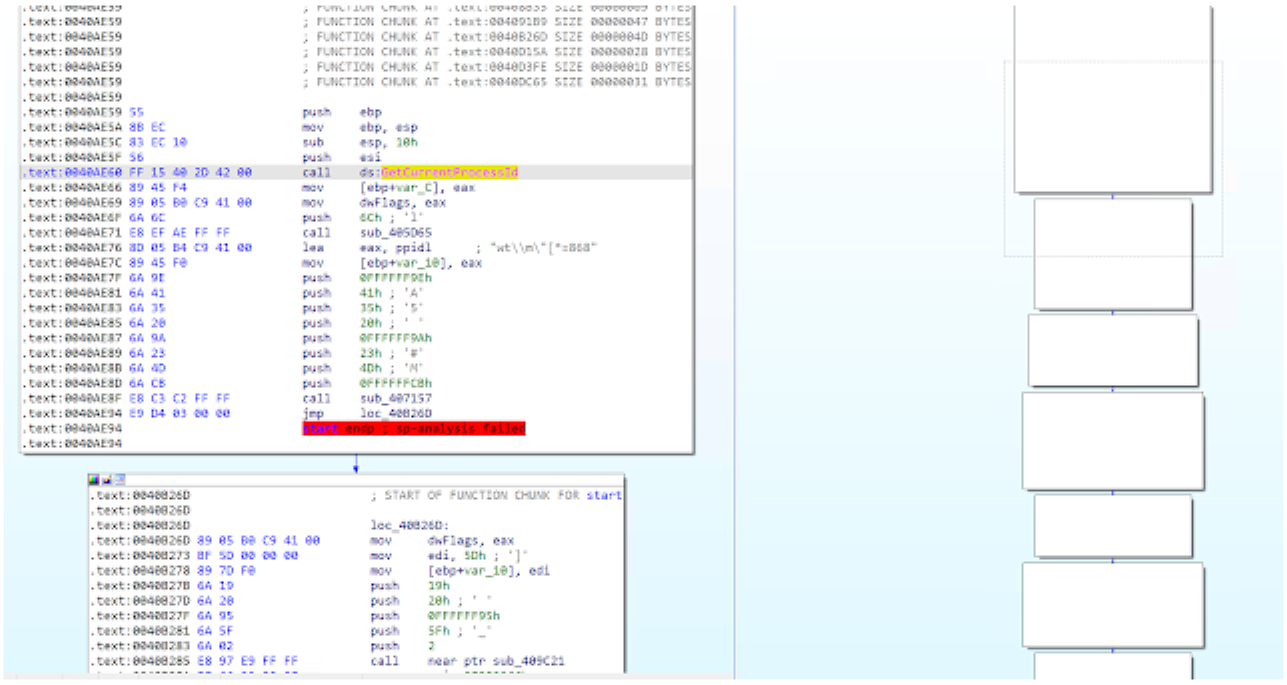
The following section describes a subset of the typical differences and similarities which we have observed when analyzing samples leveraging this obfuscator.

The majority of the samples begin with a common initialization routine (security_init_cookie) and then jump to the main unpacking function. This function may vary in different samples and even the start up looks different in the newer samples. Figures 6 - 8 show the startup and unpacking functions in three different samples.



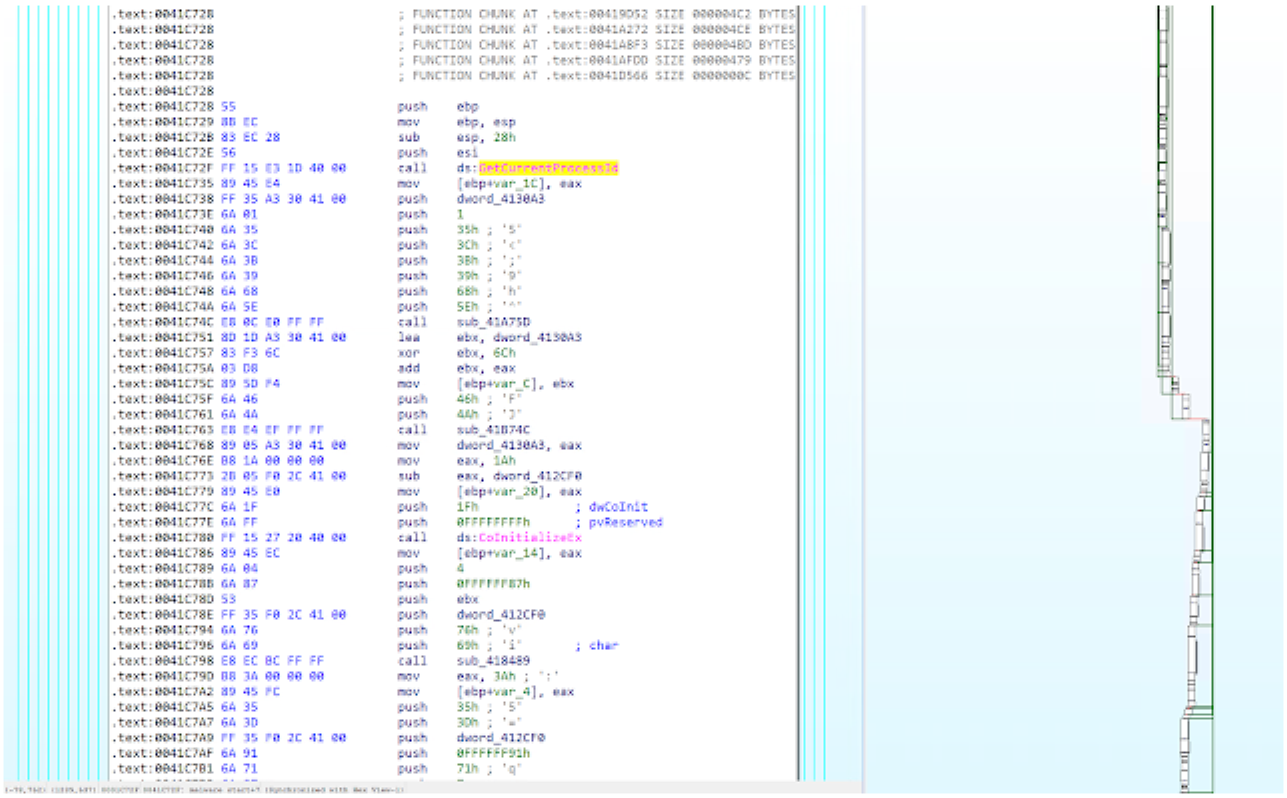
```
.text:00411815
.text:00411815
.text:00411815                          ; Attributes: bp-based frame
.text:00411815
.text:00411815                          malware_start proc near
.text:00411815
.text:00411815                          var_2C= dword ptr -2Ch
.text:00411815                          var_24= dword ptr -24h
.text:00411815
.text:00411815 55                       push    ebp
.text:00411816 8B EC                    mov     ebp, esp
.text:00411818 83 EC 30                 sub     esp, 30h
.text:0041181B 56                       push    esi
.text:0041181C 6A 70                    push    70h ; 'p'        ; nSize
.text:0041181E 68 93 D9 43 00           push    offset Filename ; lpFilename
.text:00411823 6A 01                    push    1                ; hModule
.text:00411825 FF 15 60 66 42 00        call    ds:GetModuleFileNameA
.text:0041182B 89 45 D4                 mov     [ebp+var_2C], eax
.text:0041182E 89 45 DC                 mov     [ebp+var_24], eax
.text:00411831 E9 E3 E6 FF FF           jmp     loc_40FF19
.text:00411831                          malware_start endp
.text:00411831
```

Figure 6: Sample 4bfd547775ba5892e66d2ff6a0c1de4365ab11b3_exe.bin (946d4d332a06b9af10da38beb3e8195054840b59a870a2f9027e6471f4869dc6)



```
.text:0040AE59                  ; FUNCTION CHUNK AT .text:004091B9 SIZE 00000047 BYTES
.text:0040AE59                  ; FUNCTION CHUNK AT .text:0040B26D SIZE 0000004D BYTES
.text:0040AE59                  ; FUNCTION CHUNK AT .text:0040D15A SIZE 00000028 BYTES
.text:0040AE59                  ; FUNCTION CHUNK AT .text:0040D3FE SIZE 0000001D BYTES
.text:0040AE59                  ; FUNCTION CHUNK AT .text:0040DC65 SIZE 00000031 BYTES
.text:0040AE59
.text:0040AE59 55                       push    ebp
.text:0040AE5A 8B EC                    mov     ebp, esp
.text:0040AE5C 83 EC 10                 sub     esp, 10h
.text:0040AE5F 56                       push    esi
.text:0040AE60 FF 15 40 2D 42 00        call    ds:GetCurrentProcessId
.text:0040AE66 89 45 F4                 mov     [ebp+var_C], eax
.text:0040AE69 89 05 B0 C9 41 00        mov     dwFlags, eax
.text:0040AE6F 6A 6C                    push    6Ch ; 'l'
.text:0040AE71 E8 EF AE FF FF           call    sub_405D65
.text:0040AE76 8D 05 B4 C9 41 00        lea     eax, ppidl      ; "wt\\m\"[*=868"
.text:0040AE7C 89 45 F0                 mov     [ebp+var_10], eax
.text:0040AE7F 6A 9E                    push    0FFFFFF9Eh
.text:0040AE81 6A 41                    push    41h ; 'A'
.text:0040AE83 6A 35                    push    35h ; '5'
.text:0040AE85 6A 20                    push    20h ; ' '
.text:0040AE87 6A 9A                    push    0FFFFFF9Ah
.text:0040AE89 6A 23                    push    23h ; '#'
.text:0040AE8B 6A 4D                    push    4Dh ; 'M'
.text:0040AE8D 6A CB                    push    0FFFFFFCBh
.text:0040AE8F E8 C3 C2 FF FF           call    sub_407157
.text:0040AE94 E9 D4 03 00 00           jmp     loc_40B26D
.text:0040AE94                          start endp ; sp-analysis failed
.text:0040AE94

.text:0040B26D                          ; START OF FUNCTION CHUNK FOR start
.text:0040B26D
.text:0040B26D                          loc_40B26D:
.text:0040B26D 89 05 B0 C9 41 00        mov     dwFlags, eax
.text:0040B273 BF 5D 00 00 00           mov     edi, 5Dh ; ']'
.text:0040B278 89 7D F0                 mov     [ebp+var_10], edi
.text:0040B27B 6A 19                    push    19h
.text:0040B27D 6A 20                    push    20h ; ' '
.text:0040B27F 6A 95                    push    0FFFFFF95h
.text:0040B281 6A 5F                    push    5Fh ; '_'
.text:0040B283 6A 02                    push    2
.text:0040B285 E8 97 E9 FF FF           call    near ptr sub_409C21
```

Figure 7: Sample 9679f2690d31cee38e57f080656b8618ca474c65_exe.bin (9b28aa737bbfec90341c6a42e2d44f3308659e4fb9dd42d98a0b46cde7aaed63)



```
.text:0041C728                         ; FUNCTION CHUNK AT .text:00419D52 SIZE 000004C2 BYTES
.text:0041C728                         ; FUNCTION CHUNK AT .text:0041A272 SIZE 000004CE BYTES
.text:0041C728                         ; FUNCTION CHUNK AT .text:0041ABF3 SIZE 000004BD BYTES
.text:0041C728                         ; FUNCTION CHUNK AT .text:0041AFDD SIZE 00000479 BYTES
.text:0041C728                         ; FUNCTION CHUNK AT .text:0041D566 SIZE 0000000C BYTES
.text:0041C728
.text:0041C728 55                      push    ebp
.text:0041C729 8B EC                   mov     ebp, esp
.text:0041C72B 83 EC 28                sub     esp, 28h
.text:0041C72E 56                      push    esi
.text:0041C72F FF 15 E3 1D 40 00       call    ds:GetCurrentProcessId
.text:0041C735 89 45 E4                mov     [ebp+var_1C], eax
.text:0041C738 FF 35 A3 30 41 00       push    dword_4130A3
.text:0041C73E 6A 01                   push    1
.text:0041C740 6A 35                   push    35h ; '5'
.text:0041C742 6A 3C                   push    3Ch ; '<'
.text:0041C744 6A 3B                   push    3Bh ; ';'
.text:0041C746 6A 39                   push    39h ; '9'
.text:0041C748 6A 68                   push    68h ; 'h'
.text:0041C74A 6A 5E                   push    5Eh ; '^'
.text:0041C74C E8 0C E0 FF FF          call    sub_41A75D
.text:0041C751 8D 1D A3 30 41 00       lea     ebx, dword_4130A3
.text:0041C757 83 F3 6C                xor     ebx, 6Ch
.text:0041C75A 03 D8                   add     ebx, eax
.text:0041C75C 89 5D F4                mov     [ebp+var_C], ebx
.text:0041C75F 6A 46                   push    46h ; 'F'
.text:0041C761 6A 4A                   push    4Ah ; 'J'
.text:0041C763 E8 E4 EF FF FF          call    sub_41B74C
.text:0041C768 89 05 A3 30 41 00       mov     dword_4130A3, eax
.text:0041C76E B8 1A 00 00 00          mov     eax, 1Ah
.text:0041C773 2B 05 F0 2C 41 00       sub     eax, dword_412CF0
.text:0041C779 89 45 E0                mov     [ebp+var_20], eax
.text:0041C77C 6A 1F                   push    1Fh             ; dwCoInit
.text:0041C77E 6A FF                   push    0FFFFFFFFh      ; pvReserved
.text:0041C780 FF 15 27 20 40 00       call    ds:CoInitializeEx
.text:0041C786 89 45 EC                mov     [ebp+var_14], eax
.text:0041C789 6A 04                   push    4
.text:0041C78B 6A 87                   push    0FFFFFF87h
.text:0041C78D 53                      push    ebx
.text:0041C78E FF 35 F0 2C 41 00       push    dword_412CF0
.text:0041C794 6A 76                   push    76h ; 'v'
.text:0041C796 6A 69                   push    69h ; 'i'       ; char
.text:0041C798 E8 EC 8C FF FF          call    sub_418489
.text:0041C79D B8 3A 00 00 00          mov     eax, 3Ah ; ':'
.text:0041C7A2 89 45 FC                mov     [ebp+var_4], eax
.text:0041C7A5 6A 35                   push    35h ; '5'
.text:0041C7A7 6A 3D                   push    3Dh ; '='
.text:0041C7A9 FF 35 F0 2C 41 00       push    dword_412CF0
.text:0041C7AF 6A 91                   push    0FFFFFF91h
.text:0041C7B1 6A 71                   push    71h ; 'q'
```

Figure 8: Sample 64800a2f85e12090eea5109e05d969a08ae9850a_exe.bin (0c09ea2d5722a2484804bf8c4f051d66d8a95d23c19e5d1277a55cafd80b67be)

What they all have in common is that they push many unpacking-related values to the stack and insert a large number of fake API calls in between. Figure 6 shows the nonsense arguments handed over to GetModuleFilenameA. Figure 9 shows another example of this:

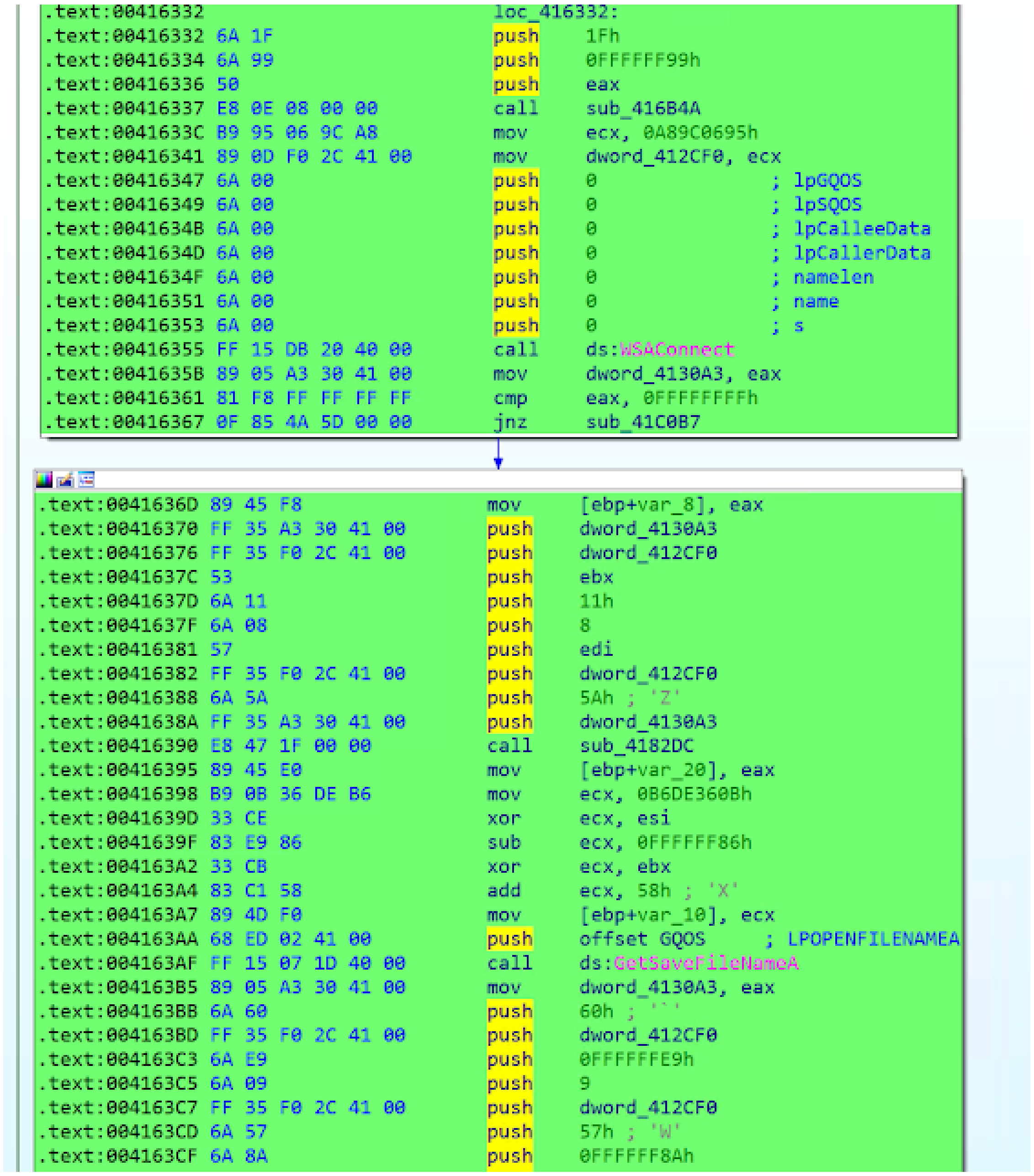
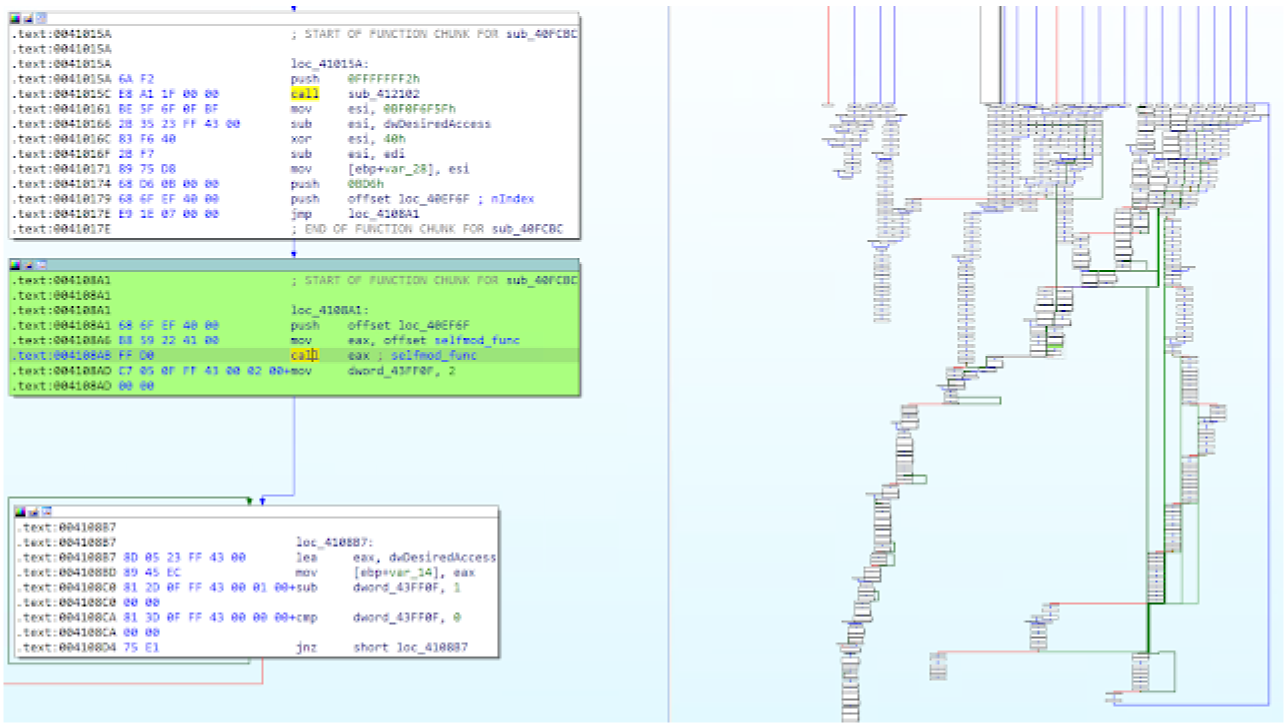

```
.text:00416332                   loc_416332:
.text:00416332 6A 1F             push    1Fh
.text:00416334 6A 99             push    0FFFFFF99h
.text:00416336 50                push    eax
.text:00416337 E8 0E 08 00 00    call    sub_416B4A
.text:0041633C B9 95 06 9C A8    mov     ecx, 0A89C0695h
.text:00416341 89 0D F0 2C 41 00 mov     dword_412CF0, ecx
.text:00416347 6A 00             push    0               ; lpGQOS
.text:00416349 6A 00             push    0               ; lpSQOS
.text:0041634B 6A 00             push    0               ; lpCalleeData
.text:0041634D 6A 00             push    0               ; lpCallerData
.text:0041634F 6A 00             push    0               ; namelen
.text:00416351 6A 00             push    0               ; name
.text:00416353 6A 00             push    0               ; s
.text:00416355 FF 15 DB 20 40 00 call    ds:WSAConnect
.text:0041635B 89 05 A3 30 41 00 mov     dword_4130A3, eax
.text:00416361 81 F8 FF FF FF FF cmp     eax, 0FFFFFFFFh
.text:00416367 0F 85 4A 5D 00 00 jnz     sub_41C0B7

.text:0041636D 89 45 F8          mov     [ebp+var_8], eax
.text:00416370 FF 35 A3 30 41 00 push    dword_4130A3
.text:00416376 FF 35 F0 2C 41 00 push    dword_412CF0
.text:0041637C 53                push    ebx
.text:0041637D 6A 11             push    11h
.text:0041637F 6A 08             push    8
.text:00416381 57                push    edi
.text:00416382 FF 35 F0 2C 41 00 push    dword_412CF0
.text:00416388 6A 5A             push    5Ah ; 'Z'
.text:0041638A FF 35 A3 30 41 00 push    dword_4130A3
.text:00416390 E8 47 1F 00 00    call    sub_4182DC
.text:00416395 89 45 E0          mov     [ebp+var_20], eax
.text:00416398 B9 0B 36 DE B6    mov     ecx, 0B6DE360Bh
.text:0041639D 33 CE             xor     ecx, esi
.text:0041639F 83 E9 86          sub     ecx, 0FFFFFF86h
.text:004163A2 33 CB             xor     ecx, ebx
.text:004163A4 83 C1 58          add     ecx, 58h ; 'X'
.text:004163A7 89 4D F0          mov     [ebp+var_10], ecx
.text:004163AA 68 ED 02 41 00    push    offset GQOS     ; LPOPENFILENAMEA
.text:004163AF FF 15 07 1D 40 00 call    ds:GetSaveFileNameA
.text:004163B5 89 05 A3 30 41 00 mov     dword_4130A3, eax
.text:004163BB 6A 60             push    60h ; '`'
.text:004163BD FF 35 F0 2C 41 00 push    dword_412CF0
.text:004163C3 6A E9             push    0FFFFFFE9h
.text:004163C5 6A 09             push    9
.text:004163C7 FF 35 F0 2C 41 00 push    dword_412CF0
.text:004163CD 6A 57             push    57h ; 'W'
.text:004163CF 6A 8A             push    0FFFFFF8Ah
```

Figure 9

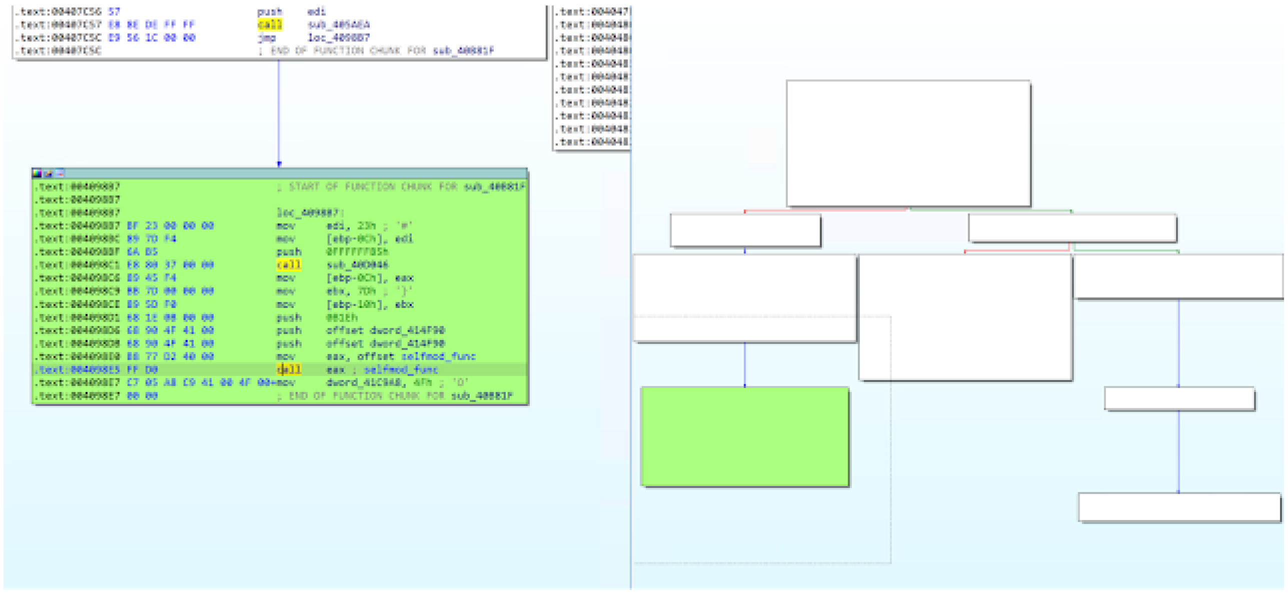
The other common feature is that the crypter breaks up the code into many basic blocks that are connected via jumps and return instructions. Most are unconditional jumps, but there are also ones using conditions which are always true or false — in other words, the code flow is always predefined. Further, especially at locations like non-fake API calls, the code pushes the address of the next code block or API call to the stack and uses the return instruction to jump to it. This results in spaghetti code that is difficult to decipher. Besides obfuscated disassembly code, the fake API calls can also confuse weak behaviour-based detection systems and/or may be used to detect certain emulation-based systems. Due to the amount of API calls, we haven't analyzed the latter in detail.

The next layer of protection comes with a bunch of self-modification routines. After it sets the stage hidden inside the spaghetti code, the vast majority of samples execute a self-modification routine via "call eax" (Figures 10 and 11).



```
.text:0041015A                          ; START OF FUNCTION CHUNK FOR sub_40FCBC
.text:0041015A
.text:0041015A                          loc_41015A:
.text:0041015A 6A F2                    push    0FFFFFFF2h
.text:0041015C E8 A1 1F 00 00           call    sub_412102
.text:00410161 BE 5F 6F 0F BF           mov     esi, 0BF0F6F5Fh
.text:00410166 2B 35 23 FF 43 00        sub     esi, dwDesiredAccess
.text:0041016C 83 F6 40                 xor     esi, 40h
.text:0041016F 2B F7                    sub     esi, edi
.text:00410171 89 75 D8                 mov     [ebp+var_28], esi
.text:00410174 68 D6 0B 00 00           push    0BD6h
.text:00410179 68 6F EF 40 00           push    offset loc_40EF6F ; nIndex
.text:0041017E E9 1E 07 00 00           jmp     loc_4108A1
.text:0041017E                          ; END OF FUNCTION CHUNK FOR sub_40FCBC

.text:004108A1                          ; START OF FUNCTION CHUNK FOR sub_40FCBC
.text:004108A1
.text:004108A1                          loc_4108A1:
.text:004108A1 68 6F EF 40 00           push    offset loc_40EF6F
.text:004108A6 B8 59 22 41 00           mov     eax, offset selfmod_func
.text:004108AB FF D0                    call    eax ; selfmod_func
.text:004108AD C7 05 0F FF 43 00 02 00+mov     dword_43FF0F, 2
.text:004108AD 00 00

.text:004108B7
.text:004108B7                          loc_4108B7:
.text:004108B7 8D 05 23 FF 43 00        lea     eax, dwDesiredAccess
.text:004108BD 89 45 EC                 mov     [ebp+var_14], eax
.text:004108C0 81 2D 0F FF 43 00 01 00+sub     dword_43FF0F, 1
.text:004108C0 00 00
.text:004108CA 81 3D 0F FF 43 00 00 00+cmp     dword_43FF0F, 0
.text:004108CA 00 00
.text:004108D4 75 E1                    jnz     short loc_4108B7
```

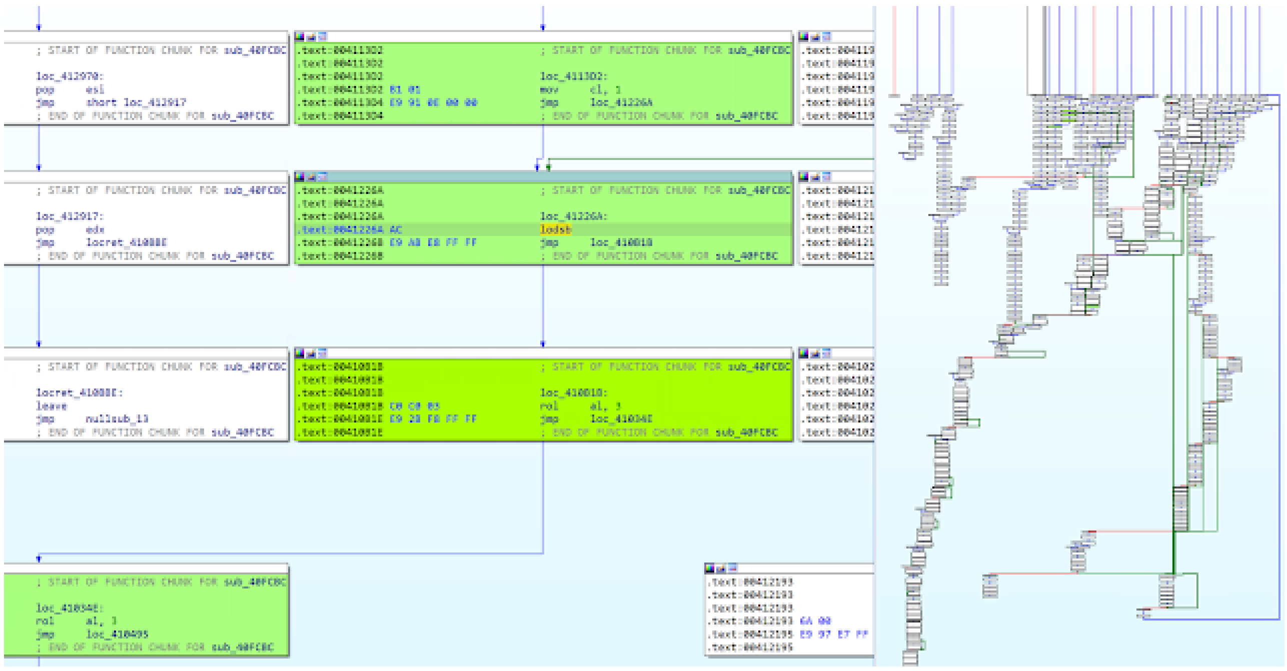
Figure 10: Sample 4bfd547775ba5892e66d2ff6a0c1de4365ab11b3_exe.bin (946d4d332a06b9af10da38beb3e8195054840b59a870a2f9027e6471f4869dc6)



```
.text:00407C56 57                       push    edi
.text:00407C57 E8 8E DE FF FF           call    sub_405AEA
.text:00407C5C E9 56 1C 00 00           jmp     loc_4098B7
.text:00407C5C                          ; END OF FUNCTION CHUNK FOR sub_40881F

.text:004098B7                          ; START OF FUNCTION CHUNK FOR sub_40881F
.text:004098B7
.text:004098B7                          loc_4098B7:
.text:004098B7 BF 23 00 00 00           mov     edi, 23h ; '#'
.text:004098BC 89 7D F4                 mov     [ebp-0Ch], edi
.text:004098BF 6A B5                    push    0FFFFFFB5h
.text:004098C1 E8 80 37 00 00           call    sub_40D046
.text:004098C6 89 45 F4                 mov     [ebp-0Ch], eax
.text:004098C9 BB 7D 00 00 00           mov     ebx, 7Dh ; '}'
.text:004098CE 89 5D F0                 mov     [ebp-10h], ebx
.text:004098D1 68 1E 08 00 00           push    081Eh
.text:004098D6 68 90 4F 41 00           push    offset dword_414F90
.text:004098DB 68 90 4F 41 00           push    offset dword_414F90
.text:004098E0 B8 77 D2 40 00           mov     eax, offset selfmod_func
.text:004098E5 FF D0                    call    eax ; selfmod_func
.text:004098E7 C7 05 A8 C9 41 00 4F 00+mov     dword_41C9A8, 4Fh ; 'O'
.text:004098E7 00 00                    ; END OF FUNCTION CHUNK FOR sub_40881F
```

Figure 11: Sample 9679f2690d31cee38e57f080656b8618ca474c65_exe.bin (9b28aa737bbfec90341c6a42e2d44f3308659e4fb9dd42d98a0b46cde7aaed63)

Again, as shown in Figures 12 and 13, the code around this call looks different across different samples and even the instructions used to decode the bytes which are to be modified are different across different samples.



```
; START OF FUNCTION CHUNK FOR sub_40FCBC

loc_412970:
pop     esi
jmp     short loc_412917
; END OF FUNCTION CHUNK FOR sub_40FCBC
```

```
.text:004113D2                          ; START OF FUNCTION CHUNK FOR sub_40FCBC
.text:004113D2
.text:004113D2                          loc_4113D2:
.text:004113D2 B1 01                    mov     cl, 1
.text:004113D4 E9 91 0E 00 00           jmp     loc_41226A
.text:004113D4                          ; END OF FUNCTION CHUNK FOR sub_40FCBC
```

```
; START OF FUNCTION CHUNK FOR sub_40FCBC

loc_412917:
pop     edx
jmp     locret_41088E
; END OF FUNCTION CHUNK FOR sub_40FCBC
```

```
.text:0041226A                          ; START OF FUNCTION CHUNK FOR sub_40FCBC
.text:0041226A
.text:0041226A                          loc_41226A:
.text:0041226A AC                       lodsb
.text:0041226B E9 A8 E8 FF FF           jmp     loc_410B18
.text:0041226B                          ; END OF FUNCTION CHUNK FOR sub_40FCBC
```

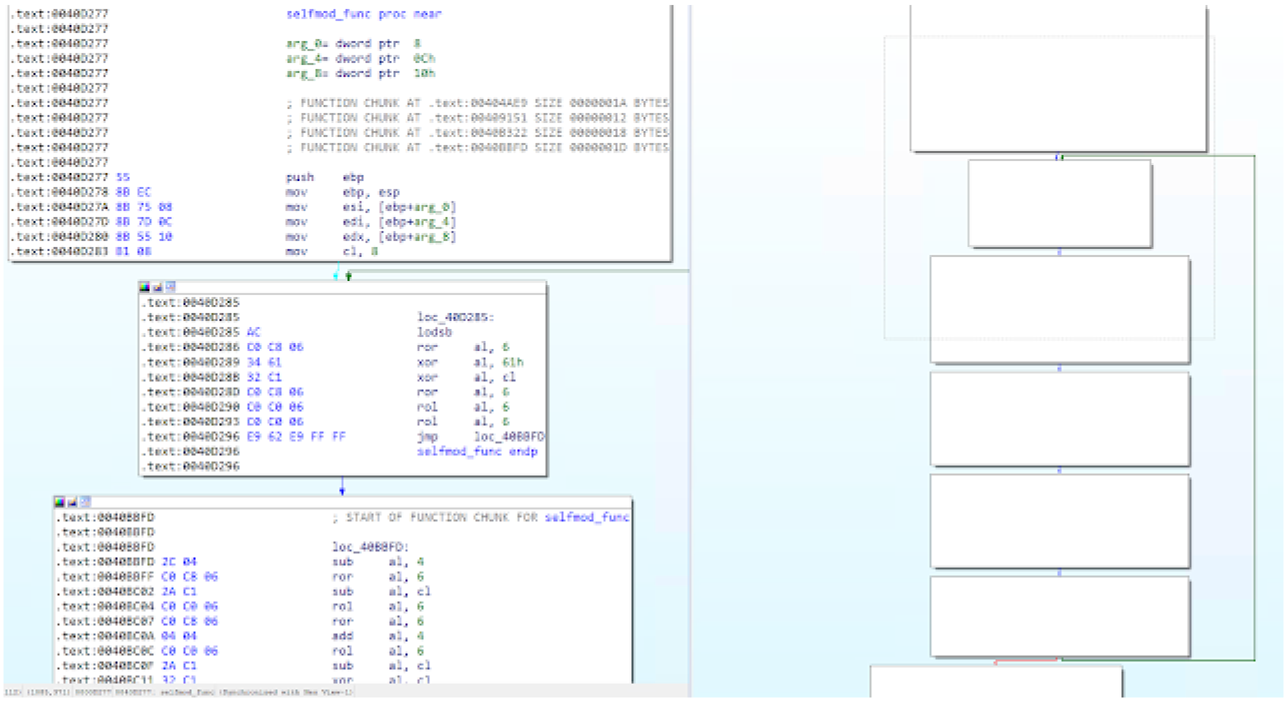
```
; START OF FUNCTION CHUNK FOR sub_40FCBC

locret_41088E:
leave
jmp     nullsub_13
; END OF FUNCTION CHUNK FOR sub_40FCBC
```

```
.text:00410B18                          ; START OF FUNCTION CHUNK FOR sub_40FCBC
.text:00410B18
.text:00410B18                          loc_410B18:
.text:00410B18 C0 C0 03                 rol     al, 3
.text:00410B1E E9 2B F8 FF FF           jmp     loc_41034E
.text:00410B1E                          ; END OF FUNCTION CHUNK FOR sub_40FCBC
```

```
; START OF FUNCTION CHUNK FOR sub_40FCBC

loc_41034E:
rol     al, 3
jmp     loc_410495
; END OF FUNCTION CHUNK FOR sub_40FCBC
```

```
.text:00412193
.text:00412193
.text:00412193
.text:00412193 6A 00
.text:00412195 E9 97 E7 FF
.text:00412195
```

Figure 12: Sample 4bfd547775ba5892e66d2ff6a0c1de4365ab11b3_exe.bin (946d4d332a06b9af10da38beb3e8195054840b59a870a2f9027e6471f4869dc6) decoding instructions



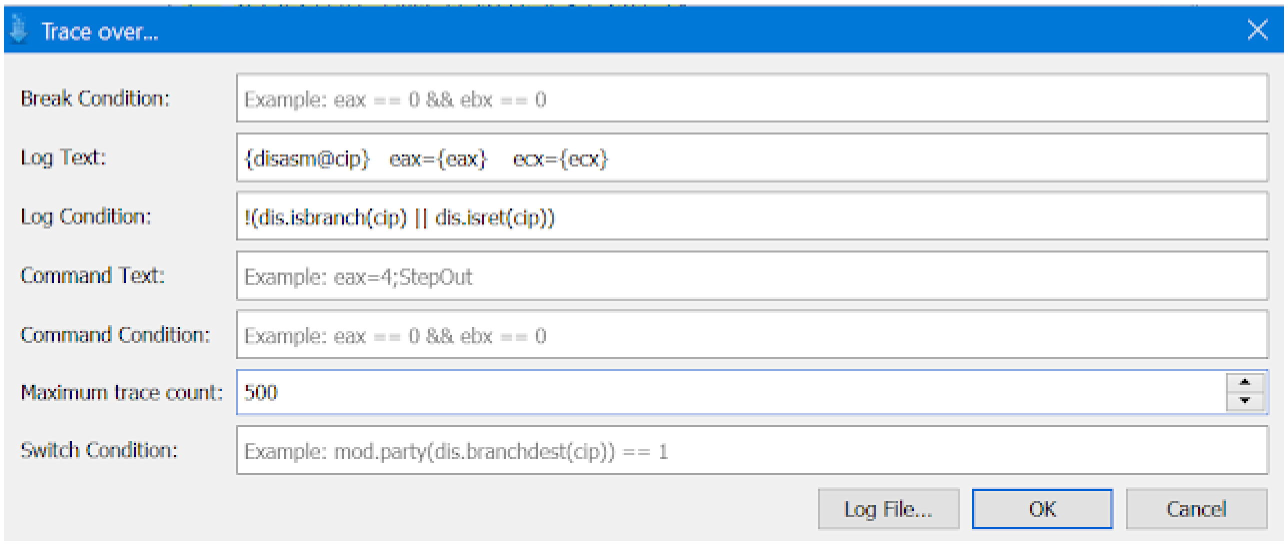
```
.text:0040D277                          selfmod_func proc near
.text:0040D277
.text:0040D277                          arg_0= dword ptr  8
.text:0040D277                          arg_4= dword ptr  0Ch
.text:0040D277                          arg_8= dword ptr  10h
.text:0040D277
.text:0040D277                          ; FUNCTION CHUNK AT .text:00404AE9 SIZE 0000001A BYTES
.text:0040D277                          ; FUNCTION CHUNK AT .text:00409151 SIZE 00000012 BYTES
.text:0040D277                          ; FUNCTION CHUNK AT .text:0040B322 SIZE 00000018 BYTES
.text:0040D277                          ; FUNCTION CHUNK AT .text:0040BBFD SIZE 0000001D BYTES
.text:0040D277
.text:0040D277 55                       push    ebp
.text:0040D278 8B EC                    mov     ebp, esp
.text:0040D27A 8B 75 08                 mov     esi, [ebp+arg_0]
.text:0040D27D 8B 7D 0C                 mov     edi, [ebp+arg_4]
.text:0040D280 8B 55 10                 mov     edx, [ebp+arg_8]
.text:0040D283 B1 08                    mov     cl, 8
```

```
.text:0040D285
.text:0040D285                          loc_40D285:
.text:0040D285 AC                       lodsb
.text:0040D286 C0 C8 06                 ror     al, 6
.text:0040D289 34 61                    xor     al, 61h
.text:0040D28B 32 C1                    xor     al, cl
.text:0040D28D C0 C8 06                 ror     al, 6
.text:0040D290 C0 C0 06                 rol     al, 6
.text:0040D293 C0 C0 06                 rol     al, 6
.text:0040D296 E9 62 E9 FF FF           jmp     loc_40BBFD
.text:0040D296                          selfmod_func endp
.text:0040D296
```

```
.text:0040BBFD                          ; START OF FUNCTION CHUNK FOR selfmod_func
.text:0040BBFD
.text:0040BBFD                          loc_40BBFD:
.text:0040BBFD 2C 04                    sub     al, 4
.text:0040BBFF C0 C8 06                 ror     al, 6
.text:0040BC02 2A C1                    sub     al, cl
.text:0040BC04 C0 C0 06                 rol     al, 6
.text:0040BC07 C0 C8 06                 ror     al, 6
.text:0040BC0A 04 04                    add     al, 4
.text:0040BC0C C0 C0 06                 rol     al, 6
.text:0040BC0F 2A C1                    sub     al, cl
.text:0040BC11 32 C1                    xor     al, cl
```

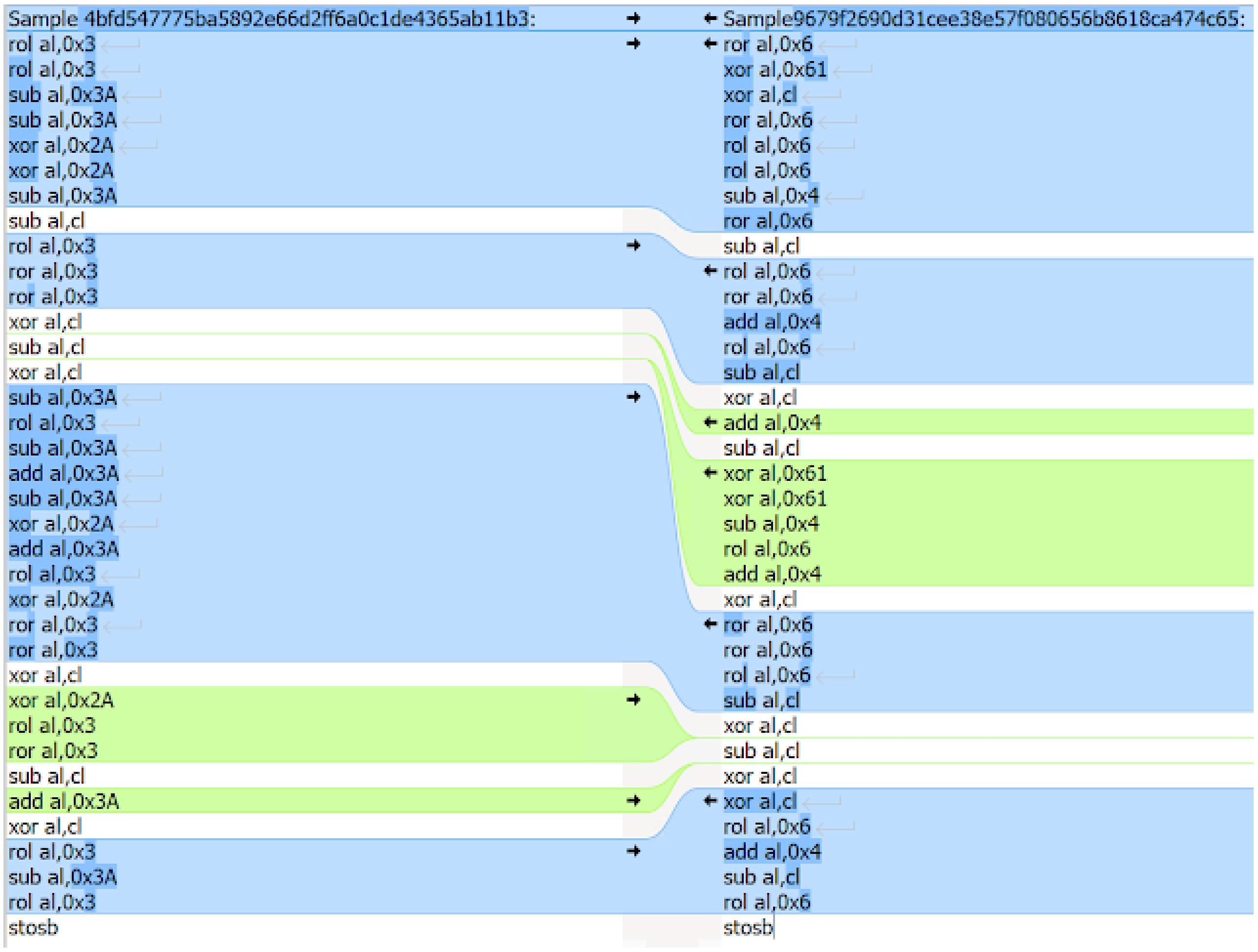
Figure 13: Sample 9679f2690d31cee38e57f080656b8618ca474c65_exe.bin (9b28aa737bbfec90341c6a42e2d44f3308659e4fb9dd42d98a0b46cde7aaed63) decoding instructions

Tracing over the instructions in x64dbg (Figure 14) shows the differences (Figure 15) in the decoding algorithm per sample.



Break Condition:	Example: eax == 0 && ebx == 0
Log Text:	{disasm@cip} eax={eax} ecx={ecx}
Log Condition:	!(dis.isbranch(cip) || dis.isret(cip))
Command Text:	Example: eax=4;StepOut
Command Condition:	Example: eax == 0 && ebx == 0
Maximum trace count:	500
Switch Condition:	Example: mod.party(dis.branchdest(cip)) == 1

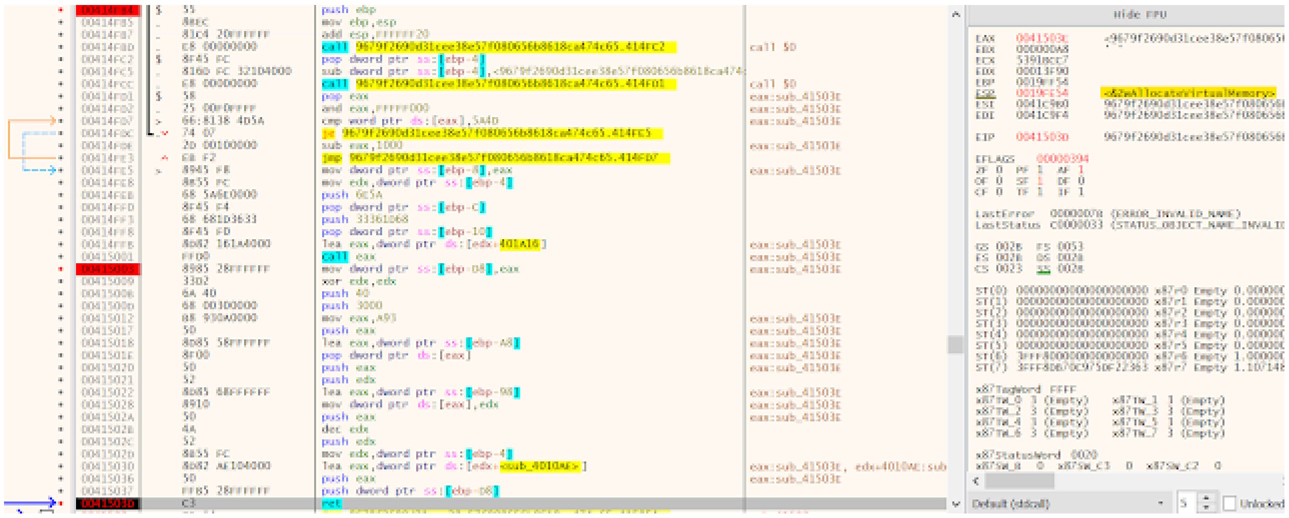
Figure 14 - X64dbg trace over settings



```
Sample 4bfd547775ba5892e66d2ff6a0c1de4365ab11b3:     Sample9679f2690d31cee38e57f080656b8618ca474c65:
rol al,0x3                                           ror al,0x6
rol al,0x3                                           xor al,0x61
sub al,0x3A                                          xor al,cl
sub al,0x3A                                          ror al,0x6
xor al,0x2A                                          rol al,0x6
xor al,0x2A                                          rol al,0x6
sub al,0x3A                                          sub al,0x4
sub al,cl                                            ror al,0x6
rol al,0x3                                           sub al,cl
ror al,0x3                                           rol al,0x6
ror al,0x3                                           ror al,0x6
xor al,cl                                            add al,0x4
sub al,cl                                            rol al,0x6
xor al,cl                                            sub al,cl
sub al,0x3A                                          xor al,cl
rol al,0x3                                           add al,0x4
sub al,0x3A                                          sub al,cl
add al,0x3A                                          xor al,0x61
sub al,0x3A                                          xor al,0x61
xor al,0x2A                                          sub al,0x4
add al,0x3A                                          rol al,0x6
rol al,0x3                                           add al,0x4
xor al,0x2A                                          xor al,cl
ror al,0x3                                           ror al,0x6
ror al,0x3                                           ror al,0x6
xor al,cl                                            rol al,0x6
xor al,0x2A                                          sub al,cl
rol al,0x3                                           xor al,cl
ror al,0x3                                           sub al,cl
sub al,cl                                            xor al,cl
add al,0x3A                                          xor al,cl
xor al,cl                                            rol al,0x6
rol al,0x3                                           add al,0x4
sub al,0x3A                                          sub al,cl
rol al,0x3                                           rol al,0x6
stosb                                                stosb
```

Figure 15

Looking into the decoded bytes, the first 24 bytes are just rubbish to hide the real start of the function. The function later called starts at offset 24 and looks like Figure 16.



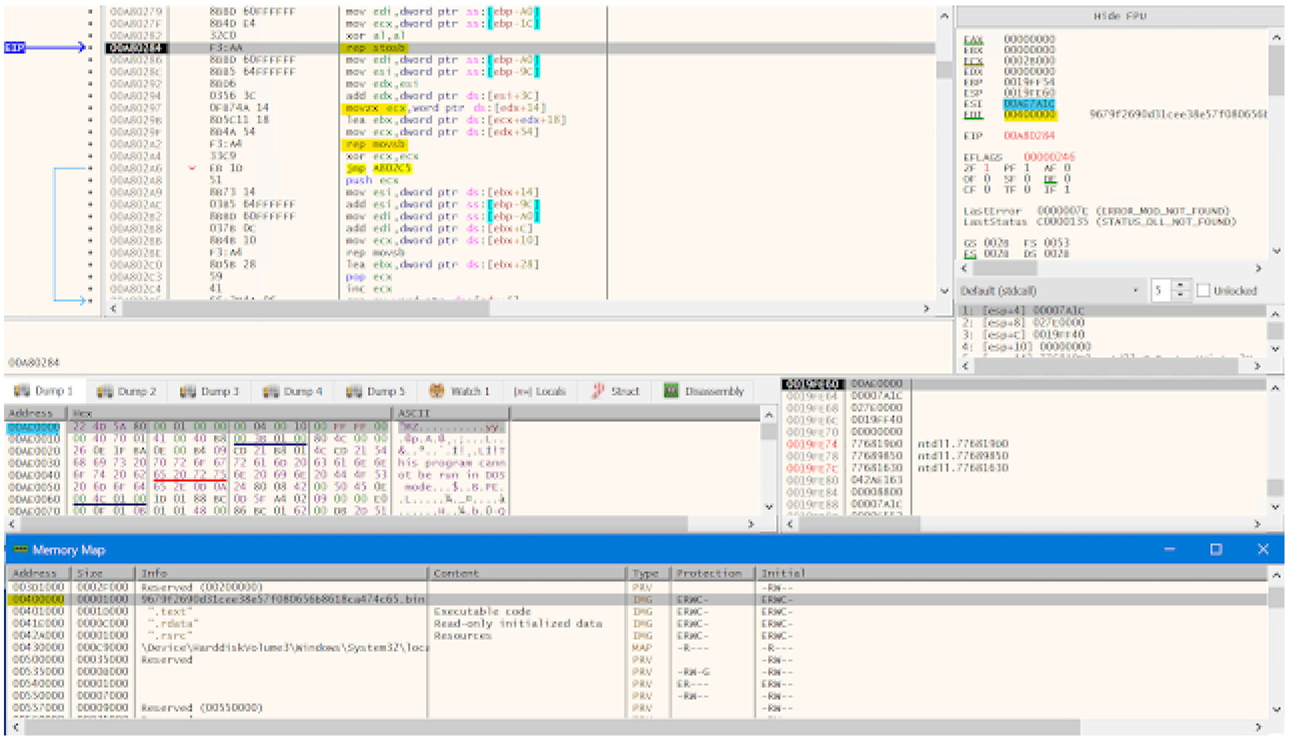
```
00414FB4  55              push ebp
00414FB5  8BEC            mov ebp,esp
00414FB7  81C4 20FFFFFF   add esp,FFFFFF20
00414FBD  E8 00000000     call 9679f2690d31cee38e57f080656b8618ca474c65.414FC2     call $0
00414FC2  8F45 FC         pop dword ptr ss:[ebp-4]
00414FC5  8160 FC 32104000 sub dword ptr ss:[ebp-4],<9679f2690d31cee38e57f080656b8618ca474c
00414FCC  E8 00000000     call 9679f2690d31cee38e57f080656b8618ca474c65.414FD1     call $0
00414FD1  58              pop eax                                                   eax:sub_41503E
00414FD2  25 00F0FFFF     and eax,FFFFF000                                          eax:sub_41503E
00414FD7  66:8138 4D5A    cmp word ptr ds:[eax],5A4D                                eax:sub_41503E
00414FDC  74 07           je 9679f2690d31cee38e57f080656b8618ca474c65.414FE5
00414FDE  2D 00100000     sub eax,1000                                              eax:sub_41503E
00414FE3  EB F2           jmp 9679f2690d31cee38e57f080656b8618ca474c65.414FD7
00414FE5  8945 F8         mov dword ptr ss:[ebp-8],eax                              eax:sub_41503E
00414FE8  8B55 FC         mov edx,dword ptr ss:[ebp-4]
00414FEB  68 5A6E0000     push 6E5A
00414FF0  8F45 F4         pop dword ptr ss:[ebp-C]
00414FF3  68 681D3633     push 33361D68
00414FF8  8F45 FD         pop dword ptr ss:[ebp-10]
00414FFB  8D82 161A4000   lea eax,dword ptr ds:[edx+401A16]                         eax:sub_41503E
00415001  FFD0            call eax                                                  eax:sub_41503E
00415003  8985 28FFFFFF   mov dword ptr ss:[ebp-D8],eax                             eax:sub_41503E
00415009  33D2            xor edx,edx
0041500B  6A 40           push 40
0041500D  68 00100000     push 3000
00415012  B8 930A0000     mov eax,A93                                               eax:sub_41503E
00415017  50              push eax                                                  eax:sub_41503E
00415018  8D85 58FFFFFF   lea eax,dword ptr ss:[ebp-A8]                             eax:sub_41503E
0041501E  8F00            pop dword ptr ds:[eax]                                    eax:sub_41503E
00415020  50              push eax                                                  eax:sub_41503E
00415021  52              push edx
00415022  8D85 68FFFFFF   lea eax,dword ptr ss:[ebp-98]                             eax:sub_41503E
00415028  8910            mov dword ptr ds:[eax],edx                                eax:sub_41503E
0041502A  50              push eax                                                  eax:sub_41503E
0041502B  4A              dec edx
0041502C  52              push edx
0041502D  8B55 FC         mov edx,dword ptr ss:[ebp-4]
00415030  8D82 AE104000   lea eax,dword ptr ds:[edx+<sub_4010AE>]                   eax:sub_41503E, edx+4010AE:sub
00415036  50              push eax                                                  eax:sub_41503E
00415037  FFB5 28FFFFFF   push dword ptr ss:[ebp-D8]
0041503D  C3              ret
```

```
Hide FPU

EAX     0041503E     <9679f2690d31cee38e57f080656
EBX     000000A8
ECX     5391BCC7
EDX     00013F90
EBP     0019FF54
ESP     0019FE54     <&ZwAllocateVirtualMemory>
ESI     0041C9E0     9679f2690d31cee38e57f080656
EDI     0041C9F4     9679f2690d31cee38e57f080656

EIP     0041503D     9679f2690d31cee38e57f080656

EFLAGS     00000394
ZF 0  PF 1  AF 1
OF 0  SF 1  DF 0
CF 0  TF 1  IF 1

LastError   0000007B (ERROR_INVALID_NAME)
LastStatus  C0000033 (STATUS_OBJECT_NAME_INVALID

GS 002B  FS 0053
ES 002B  DS 002B
CS 0023  SS 002B

ST(0) 00000000000000000000 x87r0 Empty 0.00000
ST(1) 00000000000000000000 x87r1 Empty 0.00000
ST(2) 00000000000000000000 x87r2 Empty 0.00000
ST(3) 00000000000000000000 x87r3 Empty 0.00000
ST(4) 00000000000000000000 x87r4 Empty 0.00000
ST(5) 00000000000000000000 x87r5 Empty 0.00000
ST(6) 3FFF8000000000000000 x87r6 Empty 1.00000
ST(7) 3FFF8D670C9750F22363 x87r7 Empty 1.10714

x87TagWord  FFFF
x87TW_0 3 (Empty)     x87TW_1 3 (Empty)
x87TW_2 3 (Empty)     x87TW_3 3 (Empty)
x87TW_4 3 (Empty)     x87TW_5 3 (Empty)
x87TW_6 3 (Empty)     x87TW_7 3 (Empty)

x87StatusWord  0020
x87SW_B   0   x87SW_C3   0   x87SW_C2   0

Default (stdcall)   5   Unlocked
```

Figure 16: ZWAllocateVirtualMemory

It resolves the address of the native API call ZWAllocateVirtualMemory at address 00415003 in Figure 11 and executes it via the return instruction at 0041503D. It calls this and similar functions several times while unpacking the final payload. The number of times varies based on the sample being analyzed. It fills these allocated buffers with helper functions which are used for further self modifications or unpacking procedures of the payload. The last allocated buffer is then finally filled with the unpacked malware payload. The code used for these steps varies across samples.

Sample 9679f2690d31cee38e57f080656b8618ca474c65_exe.bin (9b28aa737bbfec90341c6a42e2d44f3308659e4fb9dd42d98a0b46cde7aaed63) is adapting and then injecting the payload into its own PE image in memory at the end (Figure 17).



```
00A80279   8B8D 60FFFFFF   mov edi,dword ptr ss:[ebp-A0]
00A8027F   8B4D E4         mov ecx,dword ptr ss:[ebp-1C]
00A80282   32C0            xor al,al
00A80284   F3:AA           rep stosb
00A80286   8B8D 60FFFFFF   mov edi,dword ptr ss:[ebp-A0]
00A8028C   8B85 64FFFFFF   mov esi,dword ptr ss:[ebp-9C]
00A80292   8BD6            mov edx,esi
00A80294   0356 3C         add edx,dword ptr ds:[esi+3C]
00A80297   0FB74A 14       movzx ecx,word ptr ds:[edx+14]
00A8029B   8D5C11 18       lea ebx,dword ptr ds:[ecx+edx+18]
00A8029F   8B4A 54         mov ecx,dword ptr ds:[edx+54]
00A802A2   F3:A4           rep movsb
00A802A4   33C9            xor ecx,ecx
00A802A6   EB 1D           jmp A802C5
00A802A8   51              push ecx
00A802A9   8B73 14         mov esi,dword ptr ds:[ebx+14]
00A802AC   03B5 64FFFFFF   add esi,dword ptr ss:[ebp-9C]
00A802B2   8BBD 60FFFFFF   mov edi,dword ptr ss:[ebp-A0]
00A802B8   037B 0C         add edi,dword ptr ds:[ebx+C]
00A802BB   8B4B 10         mov ecx,dword ptr ds:[ebx+10]
00A802BE   F3:A4           rep movsb
00A802C0   8D5B 28         lea ebx,dword ptr ds:[ebx+28]
00A802C3   59              pop ecx
00A802C4   41              inc ecx

00A80284
```

```
EAX     00000000
EBX     00000000
ECX     0002B000
EDX     00000000
EBP     0019FF54
ESP     0019FE60
ESI     00A67A1C
EDI     00400000     9679f2690d31cee38e57f080656b

EIP     00A80284

EFLAGS    00000246
ZF 1  PF 1  AF 0
OF 0  SF 0  DF 0
CF 0  TF 0  IF 1

LastError   0000007E (ERROR_MOD_NOT_FOUND)
LastStatus  C0000135 (STATUS_DLL_NOT_FOUND)

GS 002B   FS 0053
ES 002B   DS 002B

Default (stdcall)   5   Unlocked
1: [esp+4]  00007A1C
2: [esp+8]  027E0000
3: [esp+C]  0019FF40
4: [esp+10] 00000000
```

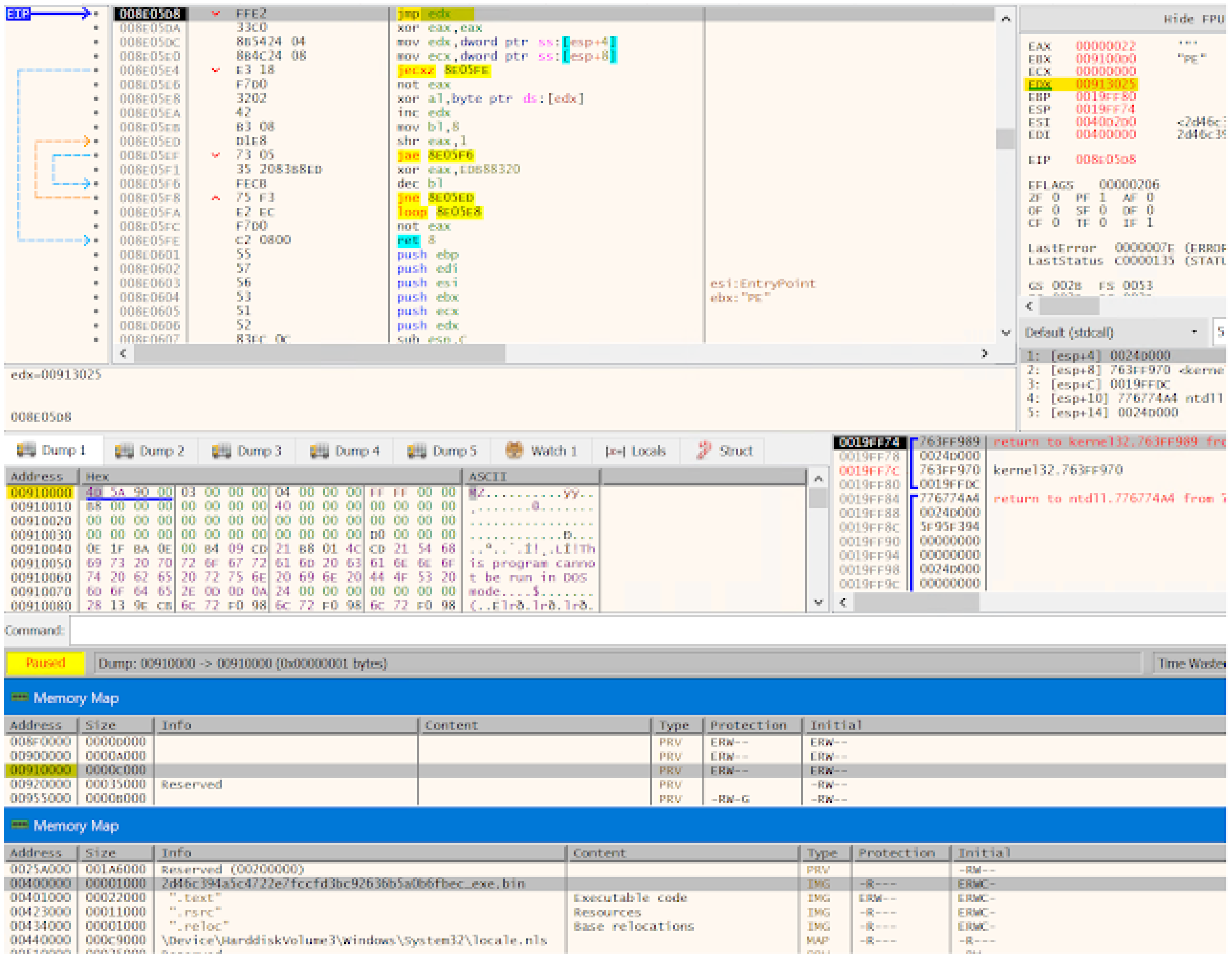
```
Address   Hex                                               ASCII
00AC0000  22 4D 5A 80 00 01 00 00 00 04 00 10 00 FF FF 00  "MZ..........ÿÿ.
00AC0010  00 40 70 01 41 00 40 B8 00 38 01 00 80 4C 00 00  .@p.A.@¸.8...L..
00AC0020  26 0E 1F BA 0E 00 B4 09 CD 21 B8 01 4C CD 21 54  &..º..´.Í!¸.LÍ!T
00AC0030  68 69 73 20 70 72 6F 67 72 61 6D 20 63 61 6E 6E  his program cann
00AC0040  6F 74 20 62 65 20 72 75 6E 20 69 6E 20 44 4F 53  ot be run in DOS
00AC0050  20 6D 6F 64 65 2E 0D 0A 24 80 08 42 00 50 45 0E   mode...$..B.PE.
00AC0060  00 4C 01 00 1D 01 88 BC 0D 5F A4 02 09 00 00 E0  .L......_.....à
00AC0070  00 0F 01 0B 01 01 48 00 86 BC 01 62 00 08 20 51  ......H...b.. Q

0019FE60  00AC0000
0019FE64  00007A1C
0019FE68  027E0000
0019FE6C  0019FF40
0019FE70  00000000
0019FE74  776B19D0  ntdll.776B19D0
0019FE78  77689850  ntdll.77689850
0019FE7C  776B1630  ntdll.776B1630
0019FE80  042A6163
0019FE84  00008800
0019FE88  00007A1C
```

Memory Map

```
Address   Size      Info                                              Content                     Type  Protection  Initial
00301000  0002F000  Reserved (00200000)                                                           PRV               -RW--
00400000  00001000  9679f2690d31cee38e57f080656b8618ca474c65.bin                                  IMG   ERWC-       ERWC-
00401000  00010000   ".text"                                          Executable code             IMG   ERWC-       ERWC-
0041C000  0000C000   ".rdata"                                         Read-only initialized data  IMG   ERWC-       ERWC-
0042A000  00001000   ".rsrc"                                          Resources                   IMG   ERWC-       ERWC-
00430000  000C9000  \Device\HarddiskVolume3\Windows\System32\loc                                  MAP   -R---       -R---
00500000  00035000  Reserved                                                                      PRV               -RW--
00535000  0000B000                                                                                PRV   -RW-G       -RW--
00540000  00001000                                                                                PRV   ER---       ERW--
00550000  00007000                                                                                PRV   -RW--       -RW--
00557000  00009000  Reserved (00550000)                                                           PRV               -RW--
```

Figure 17: Overwriting own PE image in memory with payload

Other samples simply unpack the payload to the aforementioned buffer and jump into it (Figure 18) e.g. sample b95fe75736d19887ae4e3516c5cd9c7fa7caf763a138794f9aaecdee8d37f0b0. At the end, no matter the sample version, they all use a "jmp edx" to hand over execution control to the payload (Figure 18 - first line).



```
EIP → 008E05D8   FFE2          jmp edx
      008E05DA   33C0          xor eax,eax
      008E05DC   8B5424 04     mov edx,dword ptr ss:[esp+4]
      008E05E0   8B4C24 08     mov ecx,dword ptr ss:[esp+8]
      008E05E4   E3 18         jecxz 8E05FE
      008E05E6   F7D0          not eax
      008E05E8   3202          xor al,byte ptr ds:[edx]
      008E05EA   42            inc edx
      008E05EB   B3 08         mov bl,8
      008E05ED   D1E8          shr eax,1
      008E05EF   73 05         jae 8E05F6
      008E05F1   35 2083B8ED   xor eax,EDB88320
      008E05F6   FECB          dec bl
      008E05F8   75 F3         jne 8E05ED
      008E05FA   E2 EC         loop 8E05E8
      008E05FC   F7D0          not eax
      008E05FE   C2 0800       ret 8
      008E0601   55            push ebp
      008E0602   57            push edi
      008E0603   56            push esi                 esi:EntryPoint
      008E0604   53            push ebx                 ebx:"PE"
      008E0605   51            push ecx
      008E0606   52            push edx
      008E0607   83EC 0C       sub esp,C

edx=00913025

008E05D8
```

```
Hide FPU

EAX     00000022     """
EBX     009100D0     "PE"
ECX     00000000
EDX     00913025
EBP     0019FF80
ESP     0019FF74
ESI     0040D2D0     <2d46c3
EDI     00400000     2d46c39

EIP     008E05D8

EFLAGS     00000206
ZF 0   PF 1   AF 0
OF 0   SF 0   DF 0
CF 0   TF 0   IF 1

LastError    0000007E (ERROR
LastStatus   C0000135 (STATU

GS 002B   FS 0053

Default (stdcall)
1: [esp+4] 0024D000
2: [esp+8] 763FF970 <kerne
3: [esp+C] 0019FFDC
4: [esp+10] 776774A4 ntdll
5: [esp+14] 0024D000
```

Dump 1 | Dump 2 | Dump 3 | Dump 4 | Dump 5 | Watch 1 | [x=] Locals | Struct

```
Address   Hex                                              ASCII
00910000  4D 5A 90 00 03 00 00 00 04 00 00 00 FF FF 00 00  MZ..........ÿÿ..
00910010  B8 00 00 00 00 00 00 00 40 00 00 00 00 00 00 00  ,.......@.......
00910020  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00  ................
00910030  00 00 00 00 00 00 00 00 00 00 00 00 D0 00 00 00  ............Ð...
00910040  0E 1F BA 0E 00 B4 09 CD 21 B8 01 4C CD 21 54 68  ..º..´.Í!¸.LÍ!Th
00910050  69 73 20 70 72 6F 67 72 61 6D 20 63 61 6E 6E 6F  is program canno
00910060  74 20 62 65 20 72 75 6E 20 69 6E 20 44 4F 53 20  t be run in DOS 
00910070  6D 6F 64 65 2E 0D 0D 0A 24 00 00 00 00 00 00 00  mode....$.......
00910080  28 13 9E CB 6C 72 F0 98 6C 72 F0 98 6C 72 F0 98  (..Ëlrð.lrð.lrð.
```

```
0019FF74  763FF989  return to kernel32.763FF989 fro
0019FF78  0024D000
0019FF7C  763FF970  kernel32.763FF970
0019FF80  0019FFDC
0019FF84  776774A4  return to ntdll.776774A4 from 
0019FF88  0024D000
0019FF8C  5F95F394
0019FF90  00000000
0019FF94  00000000
0019FF98  0024D000
0019FF9C  00000000
```

Command:

Paused   Dump: 00910000 -> 00910000 (0x00000001 bytes)   Time Waste

Memory Map

Address	Size	Info	Content	Type	Protection	Initial
008F0000	0000D000			PRV	ERW--	ERW--
00900000	0000A000			PRV	ERW--	ERW--
00910000	0000C000			PRV	ERW--	ERW--
00920000	00035000	Reserved		PRV		-RW--
00955000	0000B000			PRV	-RW-G	-RW--

Memory Map

Address	Size	Info	Content	Type	Protection	Initial
0025A000	001A6000	Reserved (00200000)		PRV		-RW--
00400000	00001000	2d46c394a5c4722e7fccfd3bc92636b5a0b6fbec_exe.bin		IMG	-R---	ERWC-
00401000	00022000	".text"	Executable code	IMG	ERW--	ERWC-
00423000	00011000	".rsrc"	Resources	IMG	-R---	ERWC-
00434000	00001000	".reloc"	Base relocations	IMG	-R---	ERWC-
00440000	000C9000	\Device\HarddiskVolume3\Windows\System32\locale.nls		MAP	-R---	-R---

Figure 18

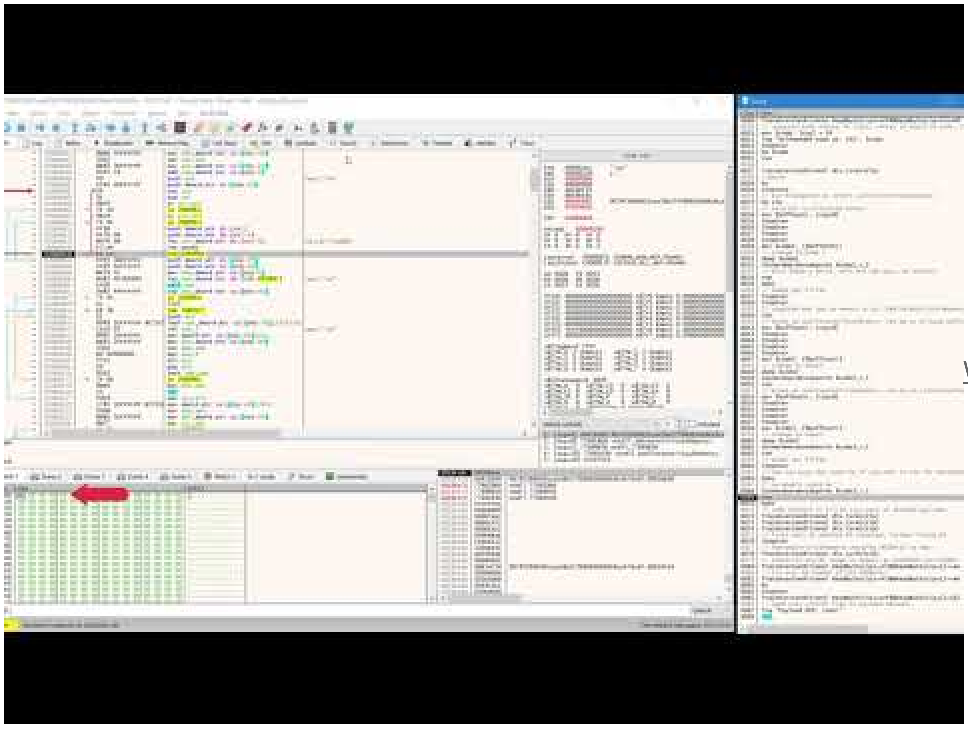
The last technique to mention is primarily observed in older samples, but it is hard to say if this is an evolution of the packer or just an additional feature enabled while building the packed binary.

Having a closer look to the PE image in Figures 17 and 18 also shows that the samples even have different segments. In other words, as previously mentioned, the diversity of samples packed with this crypter is quite high.

If you want to get an idea of all the different layers and self modifications we are providing two unpacking scripts for the samples 9679f2690d31cee38e57f080656b8618ca474c65_exe.bin (9b28aa737bbfec90341c6a42e2d44f3308659e4fb9dd42d98a0b46cde7aaed63) and 2d46c394a5c4722e7fccfd3bc92636b5a0b6fbec_exe.bin (b95fe75736d19887ae4e3516c5cd9c7fa7caf763a138794f9aaecdee8d37f0b0) in the Appendix of this post.

Only use these scripts for the samples mentioned in the header of the script. Be careful using them for other samples released before this blog post. Anyone looking to dissect this more should be extremely careful with new samples released after this blog post — it is very likely the adversaries will modify the packer. Keep in mind that these scripts do not work for every sample. It is recommended to single-step through the scripts (TAB) to verify that the different steps are working for the sample being analyzed.

The video below shows the unpacking process for sample 9679f2690d31cee38e57f080656b8618ca474c65_exe.bin (9b28aa737bbfec90341c6a42e2d44f3308659e4fb9dd42d98a0b46cde7aaed63) which is the latest sample we looked at. The file's timestamp suggests that it was built on Monday, Aug. 24, 2020.



Watch Video At:

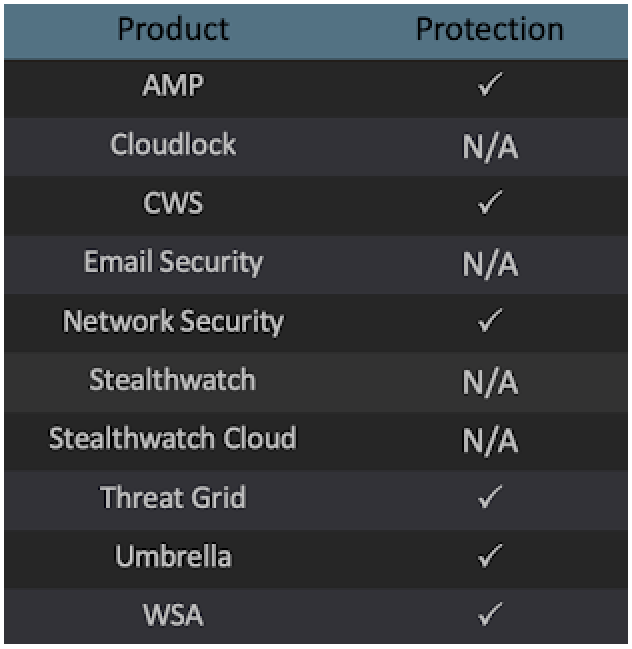
https://youtu.be/2j-3UI522pU

Conclusion

The email distribution campaigns associated with samples built using this crypter feature several notable characteristics designed to evade detection and make tracking and analysis more difficult. The use of web-based contact forms demonstrates how adversaries can take advantage of any communications pathway to internal employees to attempt to infect organizational systems with malware. And the inclusion of legitimate hosting platforms makes it more difficult to respond to these campaigns — some organizations may require access to the same platform for legitimate business purposes. The crypter used to obfuscate various malware families features several interesting techniques which are used to make analysis more difficult. The diverse list of malware families being distributed by adversaries creates a variety of risks to organizations which should be considered by defenders who are responsible for security corporate environments. These campaigns and the refinement of the TTPs being used will likely continue for the foreseeable future.

Coverage

Ways our customers can detect and block this threat are listed below.



Product	Protection
AMP	✓
Cloudlock	N/A
CWS	✓
Email Security	N/A
Network Security	✓
Stealthwatch	N/A
Stealthwatch Cloud	N/A
Threat Grid	✓
Umbrella	✓
WSA	✓

Advanced Malware Protection (AMP) is ideally suited to prevent the execution of the malware detailed in this post. Below is a screenshot showing how AMP can protect customers from this threat. Try AMP for free here.

Cisco Cloud Web Security (CWS) or Web Security Appliance (WSA) web scanning prevents access to malicious websites and detects malware used in these attacks.

Network Security appliances such as Next-Generation Firewall (NGFW), Next-Generation Intrusion Prevention System (NGIPS), and Meraki MX can detect malicious activity associated with this threat.

Threat Grid helps identify malicious binaries and build protection into all Cisco Security products.

Umbrella, our secure internet gateway (SIG), blocks users from connecting to malicious domains, IPs, and URLs, whether users are on or off the corporate network.

Additional protections with context to your specific environment and threat data are available from the Firepower Management Center.

Open Source Snort Subscriber Rule Set customers can stay up to date by downloading the latest rule pack available for purchase on Snort.org.The following SIDs have been released to detect this threat: 54920, 54921.

Indicators of Compromise (IOCs)

The following indicators of compromise (IOCs) have been observed as being associated with attacks leveraging this malware loader.

File Hashes (SHA256)

The following hashes are malicious binaries observed as associated with malware attacks leveraging this malware loader.

00272dd639402fa76db43207d074fe52d4849e5d46008f786b944a789b09afc2
00a27bcfb0940ff100f8ae4dce0eb122014926bd0541799989303a48c9327934
010c432222ef81d02edb03bfea7e866c740d4ec2f181d6ccdaa8426cf8b390c4
01453cb1e75f9a3cc2fd490c028adfcdaf63fbb63216a79379a507697dbf325e
049c5f625953b02a7aba1c904a14851cdd998ea21ee1e604016f8ba37c952ed1
051c33755b7bb0beec230c1f2af5d7880203ad2d75804719429e8054e7fb2edb
06aa2c01416bce49d24834eedd47c2dd9dc75ae39053c72168c7cc1efdd76fcd
0a6df8d51b26c7bd3a7376f6118049f1c37a91ee0b2f1ada2b86c561d1170e1b
0b61ae1202d964bea67cea9d663c8530b11c1268bcea9439b949e669b3b3be7c
0c09ea2d5722a2484804bf8c4f051d66d8a95d23c19e5d1277a55cafd80b67be
0c8569e4304f46352b041dcb692f85c9e195130db2013d4f2216130603478035
0c8fb7da34371d8c87ac3d892ceee0ba6353f00ff72d87eeebb0066d32aede56
0d261d63162d4087a82d1f67012c781cc0aaa05fbe801566f9bffa8d23981736
0d6aad4b3fe886c7d24286d333094bed9eb2c6d5ee3f7afb7fabbd1538f440e2
0dd44c11dd1b2599b8afe1121a08be81eb4230c5f1bff335b521a74bf6baadcd
12eb2aebb455cda2819b9a1e3d18d4adcebe76ec0ee94e7676d6633965ea190f
13b155af2f1503def5c0cba197902e0669faf324ec039c80a332f66f8fa4578c
1478aec44d67217a18fb2b88e9db45b9c15c468f2498f56f09a5d1fef4eafb66
161dabd778b2d24a7cae425bc2349e3db840acf49222c6067359ec7a01d3e05e
16464a294fc276ea38e4f8aedd7fa6d1f426036d42b342bde27bdc63b5c6658c
1670b07e9f5ff620a7eb773f4119023c67911655fb43bd2872021d11d05c1b0f
1be04e51510b2aafb51598838b97124a73952c46b17d3d1c38254dd6d94e82a7
1d7680d04b5d5403b34205336ad9b9c993e6e091708da775c766e2ad5e8d8547
9b28aa737bbfec90341c6a42e2d44f3308659e4fb9dd42d98a0b46cde7aaed63
1df55177a6326406d491cd9b6d4951392e565dd13e597836684468de6fec52f1
1f5e08770d900bd0eb4f3377b05083d645e1ac9bb92f08146cd2a625363bc0c7
20013032b298d4632abacefea5b8a6b376746c21642a8f8a38e039fd237d3c47

201493f9e767eac36acc868f6903b574d5c9fcb78b30c5be4c1e3358e0f0026d
2026e97bd58d8848dbd55664417790d5ee804bc2fe86ad054cb6a304d2d39a6b
219594d5b634d5f95904376a1cbd8ecde93b8cdd6cfb785069e51e7eccc78baa
243b7b37f5544bbbbaf533f819d90b6702131fd09139d2d9d86a5a305f9ae63e
25b24d6e39aecc3bd23e8ad26b66f6aeb29777a6038e611263dac2c586726fe7
2b448e88df42c70da86e6df1a1c1cfe587fe9b8d5f075d3f6ae2572a7936af8f
30ed17e5c4c4891e495af85476f5928e4d4249ee1ce305de6735e56604af2922
32ff75054df9b2b9cefec2dcc9e4cb6cfb231bc7ad9be5a41e2d3fc37f15563b
34f383ad792bd93bc10079ee7f2a620402f35c25655eb7f2621f4b4a0a7c74b7
3685ce874b1abef3448d4c50ea0371e31a78afbae09287d3ff5d25953091659c
3733c5093677fb3d4d73c7850fe399cfbf5e327ef3e151e5e279c4a9622928c5
3f70f5fc0ef938508398fbdcda54f45cada78165fdd40d6ab95d7c2a59cadc6c
431a34f1ab6dec2c646b408b9b5ce091882244fde39498484fc0c73390d8f7f0
431d9d2618fb3fa040f17f106617a943a43933bd19bf5cc5e4a964aabaee5674
45763478ad7f43aa83ebaaea28bafaac6835bec45bf8c6948cf5dd454b6e30c7
468b1785ef8bb53970a37e5399ccda3d12854587a95967081281ba857f8d2c54
468eb27c31a7c90e3c6fc3a708dc5f78cfc5c0f8f3d76213919ca6d4e21950c1
471325daa2bc75f50856e93e9de088386556fc3ead653894d5c2a67f2a8b4975
47b6fae16a8c59bf1be620cb167e2673af2e0ffa92503fadf101b4bd47132ed5
4b3ff2b99ed45563241abdf5079986e2e895ff7a011a2530e6ab9da20fa14954
4eb476010c782e251800a7850be86b5b206ffbabe5f30bca76d20e68b13fafaa
526abd604aacfa30338c708974493d272d8ab09df53cd1db657c3666113fbca1
532e67f58bdc181f0df5428f72356c58a0bcfbd85b721564242983ac6e1e39bc
549eb886be64ac9d6d2817575f5d0d0f46c0c5602fedd29aa561ab3f05e3349e
5557fd15d615f360af1aefa6a7e2bed3382e26bdabb08d7e5a8f0f9387449f3a
56f9b54e1e16887d66b8b9b7ea71d610951c18662a132cf7c9900d67b9745e81
5757ebcb5b2227615a6d3a795beeff4745037313939426f9c7f8061568bbd55d
57c7f0bc7a487df329eb3e8b19debde9ce1821e250123227cdc2dfbdd8b1b766
5942b57d50e389ec7be01bd5b4007249e3755064fe156941dfbe310f7fa53a73
59fc347dac3dd1c78d62393589818b5417ca041d697d155040988b14562bc797
5b819852f844200d4d0b6ecc66451734c7421a98086d552e354709180d86d2d3
5b831fb067dfb53992bb8a346e4fc038de6441a94ad5a3932dc8bd64f80e56fc
5bc775300f1d06d0f92f53ec9bd8d6a919fb07101d91af05c5308063e832c34e
5eaf5d22f937189275b6fae1257fc682194ca768a91d7b5e897770ad008f7112
5f287d8b207645d9cfb47ff2aacb7ed2a6769fa14b1fe78c45a73efc73f0a84c
614dc6fb2ee570cc9d1782534a64a3ea2c0be9d213e806141bb28d23542f6c47
6297c5e9a01f95d14ab4928e69bbc0f7cc4113b08f782e5ea9f04b1d1814b74b
630c098ef8211c05e0e68008bcbed6e4402e580e9538817b56084dc301954426
64965473405235f37a721d9fecafb4ccb0ca038a3014538eba80cd9943beb1d7
6627f0ea1f8ac35ea8567a1677ed4c67e7429344a56a80a094706fcd6d063221
6b2e0ce03329ccb773cbc31f68ea9a74991cd0445f9e69df3c8e01ab6498d2d5
6ce892674ac5a9607abafaf1011210cf9cb8bec2dc683b8dbf3c71c5e75a47fd

6d3ff9a1f4745625b44f5361e4d8d78b38898d24eddaf328c2448a2bb377c99a
6f21364272988368a75692e2e30970ce18e625bd7b2bcb154353415b31816d4e
6fee95a3e283d9ad09a399e99b086ef70c3679eb8ad548161bdfababe3da68fb
725e1b82b882d693028f13e3a082a8a9f278b79ad5ade994ccc9414b4e46d32c
72a744dcfd609870d53a513083d89a75c41c87d178025821963a1353216d0090
72f7451a21dcf26ebba525994d312a06483ef3fda0ffcd6500e36b94dcf78681
7556a3160ba28ac50418bb9989de2f83a5dfc54376a43500d16db7c3c76c04d4
76776877cf663f9b3d5647b0efdf3e062cf41d7d4757371ed9ad4fc0d85d7179
77dd0d459a930c4e2692f935d775f9aa6560e26b19715ee61c20ce6bdbcc8200
7da2c8166c73f7f5cf4f8f07b3ad161fe7cac6aa87c6a2701cb7fdc74242dfa6
827fb4f521e8f22fb91ee61d921d3287bab18c9f01d333139e4124c989d34c76
8281d87c1343eed7d48c8d98043864ace2f0dade93628cbda7ebc2eb07c77dd7
87c04cc74ea6e8958bcbc6319f7c1f8293d63ce4a2e34a3c99ba296e55fd0ff4
88c23ddbc21c130588f88500c753138e1b03a55f4658ff199c247fd8ceee5bd3
890eacb1a49d606586eb585ee0738f55ac76fb3a175016ad627532425ee19dc8
8a237182974d55a414f91a6d657403fafc8b79685ff1a73562758b333aeea590
8be791cfaf6dbe2f1022406cbab97c3f53a084abd5b7e2ede043bd10de268352
915f41dbb8a500f22f5aa346a0b6eff9db5fb6149b936968476ad585694688c5
91f7787447cdaaec0f0feb10440bc2cb2c48ec8f3ce96a49719cbb9a20b3667d
91f9f150e8a010ac25cdfd1a5489dd87f5e4af1d1daf8d12710748fb49396f67
932b193e475a885c612b6610ad40177e65fc18eba76485e7da690cd4c9c5894a
942331c18f6435087cc15c1012f4b4c9c7265d6ffaef0650aadb6ce4064c5c3c
9444adaa9f6597a02f2e7f889b65db228c489658e0a81c28a3ac2d51f88b5e3c
946d4d332a06b9af10da38beb3e8195054840b59a870a2f9027e6471f4869dc6
98c59ba70665df6ff4bbabbad56b11ea24e1bb478fd0547a02dbfbacd6bbfdf4
99fe4effb3bd5d31a6c9b740f693460042e9b327b6e6d78aaa04d40762784c8f
9a6b7c1ebfe3ba98cbfc7d3cdd67fdb34dcf86b411eb7502c3e6d865084742b6
9c2eb5790e7874950db0e51764ba68bb4a0fa5be68b659717c73363883da0db7
9ff5246727eb8baf06d825830b061df21a7e7b8ecf0f4f584da3b886643f84ed
a2387ef5d3af113c8c902f478df1c2d7f7a7acf729873b13508c1f1915bf5000
a27f8297924f2318e1e4d2da534be65806198a6e9d53c905a79ed3f93f5c52a9
a2e7f64c3d584a25a35bdedec0d394033a2ebb54d3457e09ceea3a623c208491
a654dbed7f65e6e6b8830e42b137fd85ddce872dc29ca006e8f7653f0aadcac7
a66f6d5fe714527cc94af30695cbabc44dd2fc355bc8e917e77350f35b0c6852
a770fcb1791d4a1c1037921403f936fb699b4e86df500abc41cb7fa1d762e302
a7b83a87772511641557b1ace41c478ecf6f1be0e1585cf6ce170cbaab16d6bb
a8231bdd44d469fd1a30464e238d0efa7c257566f301dae2fd80bdc43893b5d2
aa33731aa48e2ea6d1eaab7c425f9001182c0e73e0226eb01145d6b78d7cb9eb
aaa7efb4c15a71baff014071a71aa08f17e71c433016b2a0f05caac5f35adbe5
ab24760ec387919fc8d177510f39f36ac0ee011f8349faf63456e83aa0e50944
ad2b0478c0c3c717f6dabb96a6e957ea000462a8f8792f1c73868f9e894e037a
adce8f29cb6cbbc44f5566031370753da43ea431ad3aeb11a6fc2186d571c957

b1c6c7afedd5fdf67d7e9bbec952945e31c136785de3bc33313aede44f1696cf
b240ff47de5859d0428c980a30a36a787e141761e8d7c8b2db8ab2364d226a94
b29c4a567b439ef6072e41c38091c0f8d4d2bc0955d60062169f35e4a1cf9de4
b3cb381f114ec9c163335509a217bbe1c6baa8d2cf5655b5ff84fd8d0a28dc9a
b6a02bdf54b97688fda5137215e5237bd9df650bb052094dbc37947b59a93122
b71a38ed297eff72a77fbbefa8f326a0c752f0f4fb5d80d1bf8e393824e99223
b8e75cbb6e4c360fec71e12b85f3c5e4933e66a64928ff4d337ebe6a6cc9150f
b95349e88b1c800c3cb84bd3875aa556c7107900567b9cffb54047bafa364dc1
b95fe75736d19887ae4e3516c5cd9c7fa7caf763a138794f9aaecdee8d37f0b0
ba5fa7cc1a918b866354f4a5d9d92ceb3965ff81eb96e1608f190bccf12d38e6
bb33e0b91b1b38802b2bfd5654d3888dee17959c6f07d3ce67dbac278712a402
bc275cd76478e4d3387740dd955d9b9b5b36f064656ecb1e1cea9b8649eec57d
bc2c5e2692df4493a1bbc9364689f1b7c532964497512065d3693cae50214860
bcf19173facde547cd07eb8495bd48e8eea67c4f2441d4239e883f264744de7e
c12c749cbb465484968bf99c46a51ce717620ddee2a5cd9b0168b104b604ba42
c1665f6717238ba405059e44533e1fb7ad35798bb3d8b6ebb29cf0428241d721
c50b34da0b0d1cc4728e4af9ae2c921df26ef71869bba0d5f9a24caa229529c9
c679503d8fe5e6b127af12142f8a3ae32e94ef0751337de67c9dcb4dea180987
c772f069931f2c0429bea0919fd7238de92618e6bea9e6581129656f6d86170c
ca4214e15181e52923f713771455f5709e4baa13626cad85b735734cf66d36db
ca9d4a7488644ce5fa20248e388291d60ca4a3bfe783acae4f02821618d1563f
ccb8e17d3df37549a3dbdb31f3b5e03b8fbb3ddf9462cf962518c8e0312cdb56
cda685d0e85b2f28c00d145da358edc3748357786455965af86a3b0b292051fd
ce30c658a17cdced008ca04ea67f5ddb4c3c8d9042fe700ea89731c3d631628b
d175b76aae5c16a5870df88cadc1d147c78a4977cc8dd4b213224e031cbcb7fb
d3255ed380e290f4992701d1c10a3f65580b5e0aff384ab4308a8202d71f38a8
d3639a02c300ab5f1063c7000fc8fa9eda8b69ac98840e5e49e26ea578274c4d
d4d3cb3f7ffed9e1847a3b47a41d1da3c649374cd1d4772baaa95e62735ac3ca
d7bcc39c42e66f4d7ce42d49aadbd63ac541e39889dc72ee41d140c919a92d85
da5d88c3090b95ab3bca96669880af7a39b7d8ce9a206ec1bb558086ccacff41
de5947af1ec1e205ed4c953359a8ca9b6a72dc4ffc81ce1048969553d440c265
deb8e521c4509a83b61d96291efe3cdaf2379c953f0590433d98a0bbd6bc82ab
df638bde1ffafcfb7a25fe30b631d549299f9502f23efc47fc5efaa118e96b97
e0b15c5b68a21db7a86f92689c5df63d343a52e3e7b09d19f3ffbf941b32c4d1
e0f5471baf3e0e4b3eb3711f89479a910fe68b75ad53070c58302821ddb84220
e38c9a5d62aec8a807336ef40668f82a9bf764a8102fe464ee7f82041e007bee
e5a6108aa4f8be08c8192590ab2b3231e9a33277ead76a0420557258220383be
e655f1afb49be062cded5683df9292ff4cd602ad5d6f648dddd8778af13c44e2
e6b30d246362081d7cb76a4d21584f6dbcff535812aed8e9675c17ca518c0242
eafbd21a0f9f082fa2e94e010569d7fa8512d978087c2633d652b865b922465a
ec1efcb050ec701c4a5895215e8a5ff9a89faf5b56976975de4e3846577841f0
ee42a34b83f4c27c57ebfa79f78d4702cdf5c845443b929b9e9d3246409aacca

f1d43050a57365d41f2ec6ac3f73f1ddf9fa454c8b96aa5aa30749490b5a5fd4
f29484e8e60d1104bb60a504279909f7d4c5a68d77d794dcaed4758d95989a99
f38a38d97bd96a42e8c3f985f1e65daca97dce229b36c8c80c9229666826f325
f431b5b6dc04208fe9ffc89eafd94c92d1383857d17702240f14aa19f538b3aa
f6c96250359377ca85340b8c2c7253dd4f8fb5b1b8bf87d9fbce45ae40fe5417
f6ebd6f0fe20fe561d1cf5d6aea5201712a0eabf4624c863a5ab6d44b1f57755
fc856c48ddb5be64f343a482faaece641542c06e9a52556c16a8a80f973347ad
fd03a9145d89c102799e5719608a28da681c1289352eb1d40b557cc667ba2ad0
fd95fc2bc6b3362454dc6a0f0aa03f8c481ece2442e544b4ea0d9b0f81cd8b8c
fe0d4a9ac1d0e3a626b44357e4469f402b9dad3f020776ecf771da693a782d61
ff5fc5c5318fa051992c7c3408d203f306c13b5fcd9400f860f734ce47a3b676

Domains

The following domains have been observed during various portions of the malware infection process.

123pcloud[.]com
92g938uextmgvb7rllv8wcad[.]biz
98iudjsandsas[.]info
df1[.]kamalak[.]at
aes[.]one
amfibiyapolyakova[.]com
api3[.]lamanak[.]at
askyourspace[.]com
banisdor[.]top
banudarog[.]com
banusle[.]top
basa[.]nutarborg[.]com
bnxhbc25hwcv8b8afawhevzw[.]biz
calmstill[.]xyz
cheneer[.]org
choksaiiwkokskkall[.]info
cmck4vve6e24wdktsc9n8l1izi7eb9[.]biz
crocopexpire[.]ug
cromecho[.]com
cupersip[.]com
dailystepstowardsuccess[.]com
dasifosafjasfhasf[.]com
deliverynice[.]club
dksadjsahnfaskmsa[.]com
dksdjasi92iejdnfsa[.]info
dksjdsajdiei28uj2[.]info

dodontrami[.]com
drysetfirst[.]com
dsdjfhd9ddksaas[.]pro
dsdjfhdsufudhjas[.]com
dsdjfhdsufudhjas[.]pro
dsjdjsjdsadhasdas[.]com
dskdsajdsadasda[.]info
dskdsajdsahda[.]info
dskjdsadhsahjsas[.]info
dwajfjaiakdnsandks[.]com
dweandro[.]com
esplody[.]org
fastandstrongwolf[.]com
fdsjfjdsfjdsdsjajjs[.]com
fdsjfjdsfjdsjfdjsfh[.]com
fedex-tracking[.]press
findulz[.]com
fredoam[.]com
fslakdasjdnsasjsj[.]com
giridly[.]com
gstat[.]rayzacastillo[.]com
haponebitold[.]com
heclinggotof[.]com
idisaudhasdhasdj[.]com
idsakjfsanfaskj[.]com
iloveyoubaby1[.]pro
infinitydeveloperspes[.]info
informatioshopname[.]ru
ipnfbqg2raz3asn4j631ha453bbr4h[.]biz
islacangrejo[.]fun
j2888hennene[.]site
jdafiasfjsafahhfs[.]com
kasfajfsafhasfhaf[.]com
kdsidsiadsakfsas[.]com
line[.]largefamiliesonpurpose[.]com
line[.]lawnteam[.]org
line[.]monalisapizzeriasi[.]com
line[.]rllconsulting[.]com
line[.]zepcnc[.]com
link[.]paichecafe[.]com
link[.]philippeschellekens[.]com
manutobis[.]top

menosita[.]top
mesoplano[.]com
morenodorf[.]com
mifastubiv[.]ru
morentok[.]top
oajdasnndkdahm[.]com
odoncrol[.]com
oi2jidsdjsdd[.]info
opetileon[.]ru
orderrys[.]com
paiancil[.]com
petronasconn[.]ru
phanleb[.]com
pics[.]crystalridgedesigns[.]com
pleclep[.]com
procinul[.]com
redsobabtert[.]com
retordownty[.]com
rolhorabdidn[.]ru
rygotunren[.]ru
service[.]pandtelectric[.]com
shoolman[.]ca
siciliyaopartion[.]ru
sl9xa73g7u3eo07wt42n7f4vin5fzh[.]biz
smarteyecare[.]in
soletrobuse[.]ru
staycalm[.]club
stoutorder[.]xyz
sweleger[.]com
syndicationtwimg[.]site
telete[.]in
teoresp[.]com
toptopcoorp[.]info
toptopcop[.]info
twiitter[.]website
ukronet[.]ru
unverifiedintigoosjai[.]info
weksrubaz[.]ru
wp[.]quercus[.]palustris[.]dk
wunchilm[.]com
yamaha[.]ug
zonculet[.]com

IP Addresses

The following IP addresses have been observed as being infrastructure used for delivery and post-compromise network communications as part of these malware campaigns.

109[.]248[.]11[.]134
109[.]94[.]209[.]7
139[.]60[.]161[.]58
141[.]255[.]166[.]149
142[.]93[.]110[.]250
166[.]62[.]30[.]148
179[.]43[.]147[.]73
185[.]153[.]196[.]209
185[.]158[.]249[.]63
185[.]252[.]144[.]191
188[.]127[.]230[.]211
192[.]155[.]111[.]215
193[.]38[.]55[.]23
193[.]38[.]55[.]92
194[.]67[.]78[.]65
195[.]123[.]209[.]4
195[.]123[.]214[.]163
195[.]140[.]164[.]58
195[.]201[.]225[.]248
31[.]148[.]99[.]73
31[.]184[.]253[.]171
31[.]184[.]253[.]248
31[.]44[.]184[.]125
31[.]44[.]184[.]50
34[.]240[.]96[.]52
40[.]81[.]188[.]85
45[.]84[.]227[.]231
46[.]20[.]33[.]219
47[.]241[.]8[.]147
47[.]57[.]89[.]207
5[.]101[.]51[.]172
5[.]188[.]62[.]165
5[.]63[.]159[.]168
62[.]108[.]35[.]53
78[.]46[.]233[.]14
80[.]249[.]144[.]38
80[.]78[.]254[.]167

84[.]38[.]181[.]209
84[.]38[.]183[.]147
84[.]38[.]183[.]162
84[.]38[.]183[.]181
85[.]143[.]222[.]85
88[.]80[.]186[.]83

Appendix

X64dbg Unpacking scripts:

Script 1:

```
// Unpacker script for sample 2d46c394a5c4722e7fccfd3bc92636b5a0b6fbec_exe.bin
// (b95fe75736d19887ae4e3516c5cd9c7fa7caf763a138794f9aaecdee8d37f0b0)
//
// Author: Holger Unterbrink (twitter: hunterbr72)
//
// This script should show the logic of the packer, it is not an optimized unpacking script
//
// Load sample and go to entry point, then execute script:
// (there are some race conditions, single step (TAB) through the script)
//
//
// find first call eax
TraceOverConditional ReadByte(cip)==FF&&ReadByte(cip+1)==D0
// unpacked code stored in [csp], offset 24 begin of code, first 24 bytes are only used for
obfuscation
mov $code, [csp] + 24
log "Selfmodded code at: {0}", $code
StepOver
bp $code
run
// run until return
TraceOverConditional dis.isret(cip)
//pause
bc
StepInto
mov $codeptr, [csp+8]
bp cip
run
// from here some samples are different, some allocate more buffers, some less
run
run
```

```
run
mov $codeptr, [csp+8]
StepOver
StepOver
StepOver
StepInto
mov $code, [$codeptr]
bc
SetHardwareBreakpoint $code,r,1
log "Final payload at: {0}", $code
run
bphc
// run until jmp edx - OEP unpacked payload
TraceOverConditional ReadByte(cip)==FF&&ReadByte(cip+1)==E2
log "Dump payload malware at: {0}", $code
ret
```

Script 2:

```
// Unpacking script for sample 9679f2690d31cee38e57f080656b8618ca474c65_exe.bin
// (9b28aa737bbfec90341c6a42e2d44f3308659e4fb9dd42d98a0b46cde7aaed63)
//
// Author: Holger Unterbrink (twitter: hunterbr72)
//
// This script should show the logic of the packer, it is not an optimized unpacking script
//
// Load sample and go to entry point, then execute script:
// (there are some race conditions, single step (TAB) through the script)
//
//
// find first call eax
TraceOverConditional ReadByte(cip)==FF&&ReadByte(cip+1)==D0
// unpacked code stored in [csp], offset 24 begin of code, first 24 bytes are only used for
obfuscation
mov $code, [csp] + 24
log "Selfmodded code at: {0}", $code
StepOver
bp $code
run
TraceOverConditional dis.isret(cip)
//pause
bc
StepInto
// set breakpoint at <ntdll.ZwAllocateVirtualMemory>
```

```
bp cip
// save ptr to allocated memory
mov $bufferptr, [csp+8]
StepOver
StepOver
StepOver
StepOver
mov $code1, [$bufferptr]
// change to Dump 1
dump $code1
SetHardwareBreakpoint $code1,r,1
// this takes a while, only hit tab once, be patient
run
bphc
// Dump1 get filled
StepOver
StepOver
// unpacked and jmp to memory alloc (ZwAllocateVirtualMemory) function
run
// break at ZwAllocateVirtualMemory, set bp to allocate buffer
mov $bufferptr, [csp+8]
StepOver
StepOver
StepOver
StepOver
mov $code2, [$bufferptr]
// change to dump2
dump $code2
SetHardwareBreakpoint $code2,r,1
run
// break at ZwAllocateVirtualMemory, set bp to allocated buffer
mov $bufferptr, [csp+8]
StepOver
StepOver
StepOver
StepOver
mov $code3, [$bufferptr]
// change to dump3
dump $code3
SetHardwareBreakpoint $code3,r,1
run
// Dump2 get filled
```

```
StepOver
// you can keep the code2 bp if you want to see the decoding of the buffer
bphc
// re-enable code3 bp
SetHardwareBreakpoint $code3,r,1
run
bphc
// code buffer3 is filled (1st part of decoded payload)
TraceOverConditional dis.isret(cip)
TraceOverConditional dis.isret(cip)
TraceOverConditional dis.isret(cip)
// first part of payload PE unpacked, further fixing PE
StepOver
// ZwProtectVirtualMemory changing 0019FF3C to ERW
TraceOverConditional dis.isret(cip)
// overwrite org PE image in memory at 0x400000 Len 0x2B00
TraceOverConditional ReadByte(cip)==F3&&ReadByte(cip+1)==AA
// fix org. PE header (first 200Byte)
TraceOverConditional ReadByte(cip)==F3&&ReadByte(cip+1)==A4
bc
StepOver
TraceOverConditional ReadByte(cip)==FF&&ReadByte(cip+1)==E2
// hand over control flow to payload malware
log "Payload OEP: {edx}"
```