RATs and stealers rush through “Heaven’s Gate” with new loader

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Executive summary

Malware is constantly finding new ways to avoid detection. This doesn't mean that some will never be detected, but it does allow adversaries to increase the period of time between initial release and detection. Flying under the radar for just a few days is enough to infect sufficient machines to earn a decent amount of revenue for an attack. Cisco Talos recently discovered a new campaign delivering the HawkEye Reborn keylogger and other malware that proves attackers are constantly creating new ways to avoid antivirus detection. In this campaign, the attackers built a complex loader to ensure antivirus systems to not detect the payload malware. Among these features is the infamous "Heaven's Gate" technique — a trick that allows 32-bit malware running on 64-bit systems to hide API calls by switching to a 64-bit environment. In this blog, we will show how to analyze this loader quickly, and provide an overview of how these attackers deliver the well-known HawkEye Reborn malware. During our analysis, we also discovered several notable malware families, including Remcos and various cryptocurrency mining trojans, leveraging the same loader in an attempt to evade detection and impede analysis.

Technical overview

First, let's go through a high-level overview of the loader that's used to hide and execute HawkEye Reborn. The "technical details" section will describe these stages in detail. Even if the final malware is packed and coming with

its own obfuscation, it is never written to the disk. It's always hidden inside the loader, so it's difficult for antivirus systems to detect it.

1. Find and resolve some basic API calls by CRC32.
2. Decode encoded code from the .data section.
3. Jump to this code.
4. Perform some anti-debug/anti-analysis checks.
5. Load two resources (in this case, UDXCUSCK and SCCJZ) from the loader's PE file.
6. Decode the configuration stored in the UDXCUSCK resource.
7. Copy loader to %APPDATA% folder and make it persistent via StartUp link.
8. Decode the malware payload (in this case HawkEye) stored in SCCJZ resource.
9. Start the legitimate RegAsm.exe process.
10. Inject and execute malware payload (HawkEye) into this process via process-hollowing.
11. Protect injected malware code.
12. Exit loader process.

The majority of API calls are executed by a function we called "Exec_Function":

- This function takes a custom hash value for the wanted API call as one of its arguments.
- It finds the kernel.dll address via its CRC32 checksum.
- Then, it resolves the addresses of basic API calls by name by iterating over the InMemoryOrderModuleList in the PEB_LDR_DATA structure.
- Next, it resolves the address of the wanted API call by using a custom hash function.
- Finally, it uses CallWindowProcW to execute the resolved API call.

Besides the aforementioned obfuscation techniques, some API calls are additionally obfuscated by using direct syscalls via the sysenter instruction on 32-bit systems and the Heaven's Gate technique on x64 systems. The latter means the code switches between 32- and 64-bit systems. Some antivirus applications and debuggers are missing these calls as far as they are not expecting a 32-bit application running under the Microsoft WOW64 technology on a 64-bit system to use 64-bit calls directly.

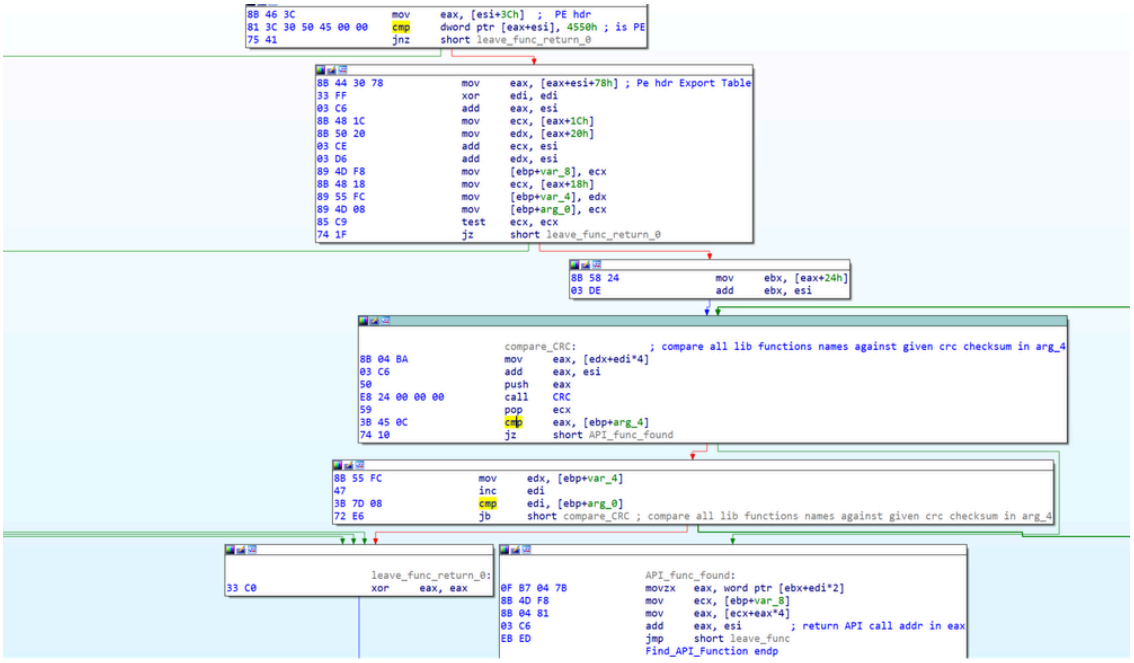
Technical details

The sample starts with some interesting calls to sub_401000.

```
.text:00401114 argv            = dword ptr  0Ch
.text:00401114 envp            = dword ptr  10h
.text:00401114
.text:00401114                 push    ebp
.text:00401115                 mov     ebp, esp
.text:00401117                 sub     esp, 78h
.text:0040111A                 push    ebx
.text:0040111B                 push    esi
.text:0040111C                 mov     esi, ds:LoadLibraryW
.text:00401122                 push    edi
.text:00401123                 push    1881CADEh       ; GetConsoleWindow
.text:00401128                 push    offset LibFileName ; "Kernel32.dll"
.text:0040112D                 mov     [ebp+var_C], 1
.text:00401134                 call    esi ; LoadLibraryW
.text:00401136                 push    eax
.text:00401137                 call    sub_401000
.text:0040113C                 pop     ecx
.text:0040113D                 pop     ecx
.text:0040113E                 push    0D535BD37h      ; SetWindowPos
.text:00401143                 push    offset aUser32Dll ; "User32.dll"
.text:00401148                 mov     edi, eax
.text:0040114A                 call    esi ; LoadLibraryW
.text:0040114C                 push    eax
.text:0040114D                 call    sub_401000
.text:00401152                 pop     ecx
.text:00401153                 pop     ecx
```

_main - Function

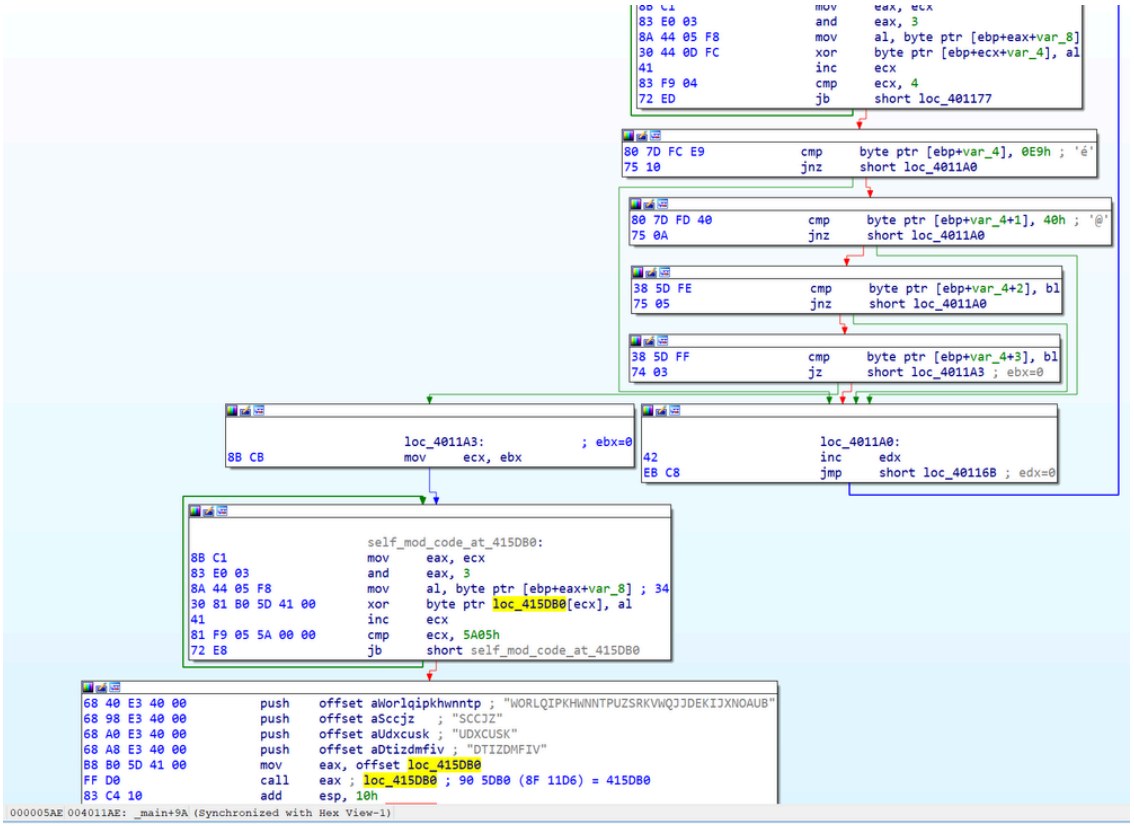
This function is iterating through the function list names in the export table of the PE header in memory. Then, it generates the CRC32 checksum for the function name string and compares it with the given argument arg_4 (see 1881CADEh above). Finally, it returns the address for the exported API function. We renamed this function "Find_API_Function_by_CRC32."



Sub_401000 (Find_API_Function_by_CRC32) function.

The returned API function address is then stored in a register or local variable, which is called when the sample needs the API function. The sample is using this and similar API call obfuscations for most of its API calls. This makes it more difficult to understand what the sample is actually doing during static analysis. The bad news is, this is the simplest one of the obfuscation techniques the sample is using.

After some initialization and decoding of the data at 415DB0 (upper right part of the picture below), the next notable call is 'call eax,' which calls the formerly decoded code at 415DB0 (see below).



Beginning of the second stage.

The function arguments aUdtizdmfiv and aSccjz are pointing to the names of two resource sections in the PE header of the sample file and DTIZDMFIV is their resource type. This makes it even more interesting. So let's look into this function. Unfortunately, we can't in our static analysis, because the data is encoded and then decoded at runtime.

```
.data:00415DB0 byte_415DB0     db 0DDh                 ; CODE XREF: _main+C2↑p
.data:00415DB0                                         ; DATA XREF: _main+9A↑w ...
.data:00415DB1                 db  79h ; y
.data:00415DB2                 db  38h ; 8
.data:00415DB3                 db  37h ; 7
.data:00415DB4                 db  34h ; 4
.data:00415DB5                 db  6Ch ; l
.data:00415DB6                 db 0B3h ; ³
.data:00415DB7                 db 0DBh ; Û
.data:00415DB8                 db  65h ; e
.data:00415DB9                 db 0B2h ; ²
.data:00415DBA                 db  7Dh ; }
.data:00415DBB                 db  3Fh ; ?
.data:00415DBC                 db 0BDh ; ½
.data:00415DBD                 db  7Ch ; |
```

Encoded next stage of the dropper.

We wrote an IDA Python script which decodes this data for us.

```
addr = 0x415db0
end = 0x5A05

magicval = [ 0x34, 0x39, 0x38, 0x37 ]

for j in range(0, end):
  a = idc.GetManyBytes(addr+j, 1)
  b = int(a.encode("hex"),16)
  b ^= magicval[j % 4]
  patch_byte(addr+j, b)
```

The script decodes the bytes and allows us to convert it into code.

```
.data:00415DB0                jmp     loc_415DF5
.data:00415DB5
.data:00415DB5 ; =============== S U B R O U T I N E =======================================
.data:00415DB5
.data:00415DB5 ; Attributes: bp-based frame
.data:00415DB5
.data:00415DB5 sub_415DB5     proc near               ; CODE XREF: .data:00416CA0↓p
.data:00415DB5
.data:00415DB5 var_4          = dword ptr -4
.data:00415DB5 arg_0          = dword ptr  8
.data:00415DB5 arg_4          = dword ptr  0Ch
.data:00415DB5
.data:00415DB5                push    ebp
.data:00415DB6                mov     ebp, esp
.data:00415DB8                push    ecx
.data:00415DB9                mov     eax, [ebp+arg_0]
```

Jump to main malware function.

The code at 415DB0 is actually a jump to the start of the main malware function at 415DF5.

```
.data:00415DF5                push    ebp
.data:00415DF6                mov     ebp, esp
.data:00415DF8                sub     esp, 8B0h
.data:00415DFE                push    ebx
.data:00415DFF                push    esi
.data:00415E00                push    edi
.data:00415E01                mov     eax, 6Bh ; 'k'
.data:00415E06                mov     [ebp-24h], ax
.data:00415E0A                mov     ecx, 65h ; 'e'
.data:00415E0F                mov     [ebp-22h], cx
.data:00415E13                mov     edx, 72h ; 'r'
.data:00415E18                mov     [ebp-20h], dx
.data:00415E1C                mov     eax, 6Eh ; 'n'
.data:00415E21                mov     [ebp-1Eh], ax
.data:00415E25                mov     ecx, 65h ; 'e'
.data:00415E2A                mov     [ebp-1Ch], cx
.data:00415E2E                mov     edx, 6Ch ; 'l'
.data:00415E33                mov     [ebp-1Ah], dx
.data:00415E37                mov     eax, 33h ; '3'
.data:00415E3C                mov     [ebp-18h], ax
.data:00415E40                mov     ecx, 32h ; '2'
.data:00415E45                mov     [ebp-16h], cx
.data:00415E49                mov     edx, 2Eh ; '.'
.data:00415E4E                mov     [ebp-14h], dx
.data:00415E52                mov     eax, 64h ; 'd'
.data:00415E57                mov     [ebp-12h], ax
.data:00415E5B                mov     ecx, 6Ch ; 'l'
.data:00415E60                mov     [ebp-10h], cx
.data:00415E64                mov     edx, 6Ch ; 'l'
.data:00415E69                mov     [ebp-0Eh], dx
.data:00415E6D                xor     eax, eax
.data:00415E6F                mov     [ebp-0Ch], ax
.data:00415E73                mov     dword ptr [ebp-30h], 0
.data:00415E7A                mov     dword ptr [ebp-2A4h], 0
.data:00415E84                mov     dword ptr [ebp-38h], 0
.data:00415E8B                mov     ecx, 43h ; 'C'
.data:00415E90                mov     [ebp-144h], cx
.data:00415E97                mov     edx, 3Ah ; ':'
.data:00415E9C                mov     [ebp-142h], dx
.data:00415EA3                mov     eax, 5Ch ; '\'
.data:00415EA8                mov     [ebp-140h], ax
.data:00415EAF                mov     ecx, 57h ; 'W'
.data:00415EB4                mov     [ebp-13Eh], cx
.data:00415EBB                mov     edx, 69h ; 'i'
.data:00415EC0                mov     [ebp-13Ch], dx
.data:00415EC7                mov     eax, 6Eh ; 'n'
```

String obfuscation.

The sample stores all characters of its strings, such as "kernel32.dll" in local variables (see above). It does this in many other locations, too. The next call at 416C74 is also worth breaking down.

```
.data:00416C46                  mov     [ebp+var_40], ax
.data:00416C4A                  mov     ecx, 6Ch ; 'l'
.data:00416C4F                  mov     [ebp+var_3E], cx
.data:00416C53                  xor     edx, edx
.data:00416C55                  mov     [ebp+var_3C], dx
.data:00416C59                  push    4
.data:00416C5B                  push    3000h
.data:00416C60                  push    17D78400h
.data:00416C65                  push    0
.data:00416C67                  push    4
.data:00416C69                  push    7554284Ch
.data:00416C6E                  lea     eax, [ebp+var_24]
.data:00416C71                  push    eax
.data:00416C72                  push    1
.data:00416C74                  call    sub_41B285
.data:00416C79                  add     esp, 20h
.data:00416C7C                  mov     [ebp+var_28], eax
.data:00416C7F                  push    eax
.data:00416C80                  cmp     eax, 11h
.data:00416C83                  jz      short loc_416C8A
.data:00416C85                  mov     eax, eax
.data:00416C87                  cld
.data:00416C88                  test    ecx, ecx
```

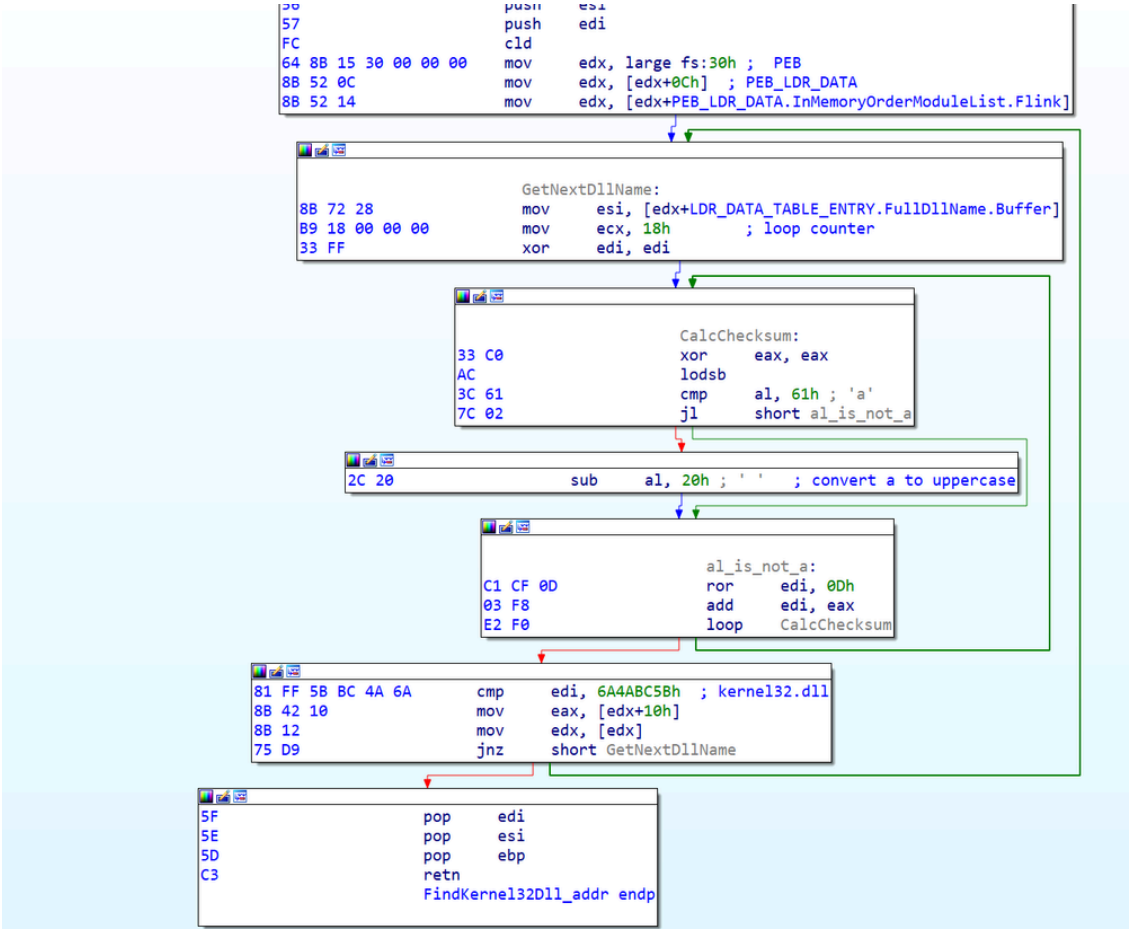
Call to sub_41B285 (Exec_Function).

Following the call into the function, we see another call at the beginning (41B28B).

```
.data:0041B286                  mov     ebp, esp
.data:0041B288                  sub     esp, 78h
.data:0041B28B                  call    sub_41AF15
.data:0041B290                  mov     [ebp+var_10], eax
.data:0041B293                  mov     [ebp+var_40], 4Ch ; 'L'
.data:0041B297                  mov     [ebp+var_3F], 6Fh ; 'o'
.data:0041B29B                  mov     [ebp+var_3E], 61h ; 'a'
.data:0041B29F                  mov     [ebp+var_3D], 64h ; 'd'
.data:0041B2A3                  mov     [ebp+var_3C], 4Ch ; 'L'
```

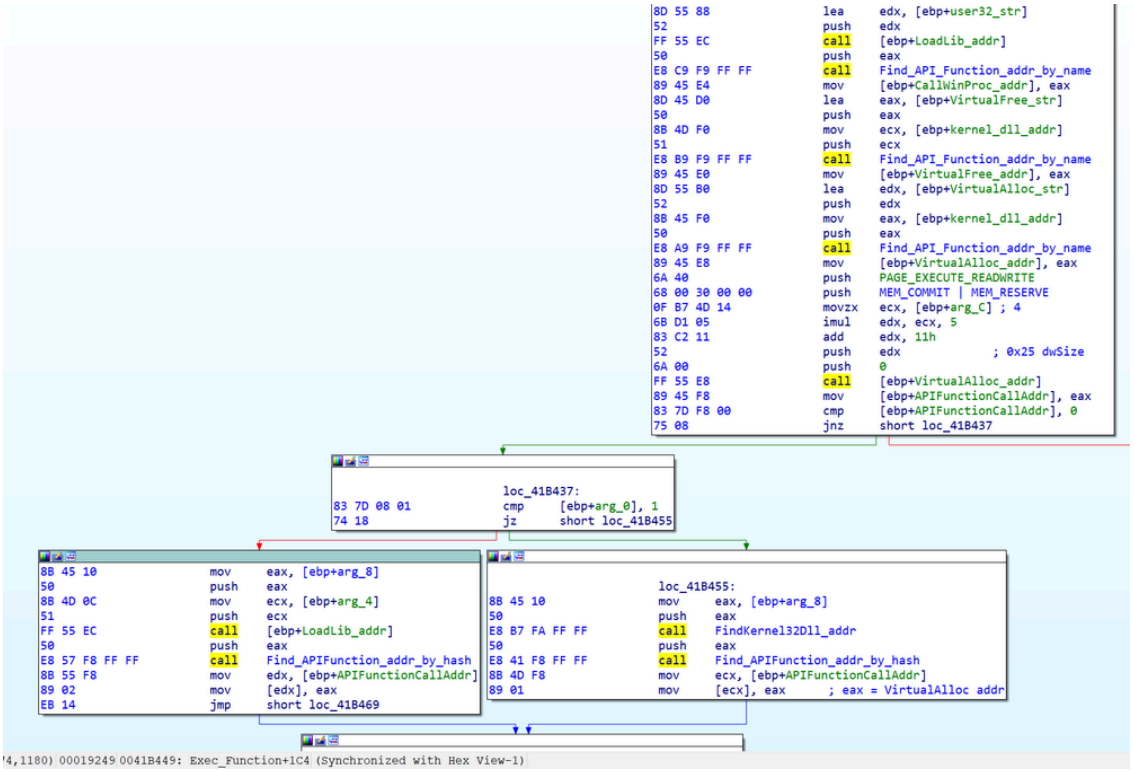
Call to sub_41AF15 (FindKernel32DLL).

After analysing it, we see it resolves the address of the loaded kernel32.dll. It uses a typical shellcode technique by parsing the PEB and some underlying structures. By finding the InMemoryOrderModuleList in PEB_LDR_DATA, it can iterate through all loaded module names and find kernel32.dll by comparing the generated checksum (6A4ABC5B).



FindKernel32DLL function.

Now, let's go back to the upper function, the one which has called "FindKernel32DLL_addr." After storing the kernel32.dll address and initializing more local variables with some strings (not shown in the picture), the code resolves a bunch of API function addresses (ex. LoadLibrary, CallWindowsProcedure, etc.) by using the function Find_API_function_addr_by_name (see below).

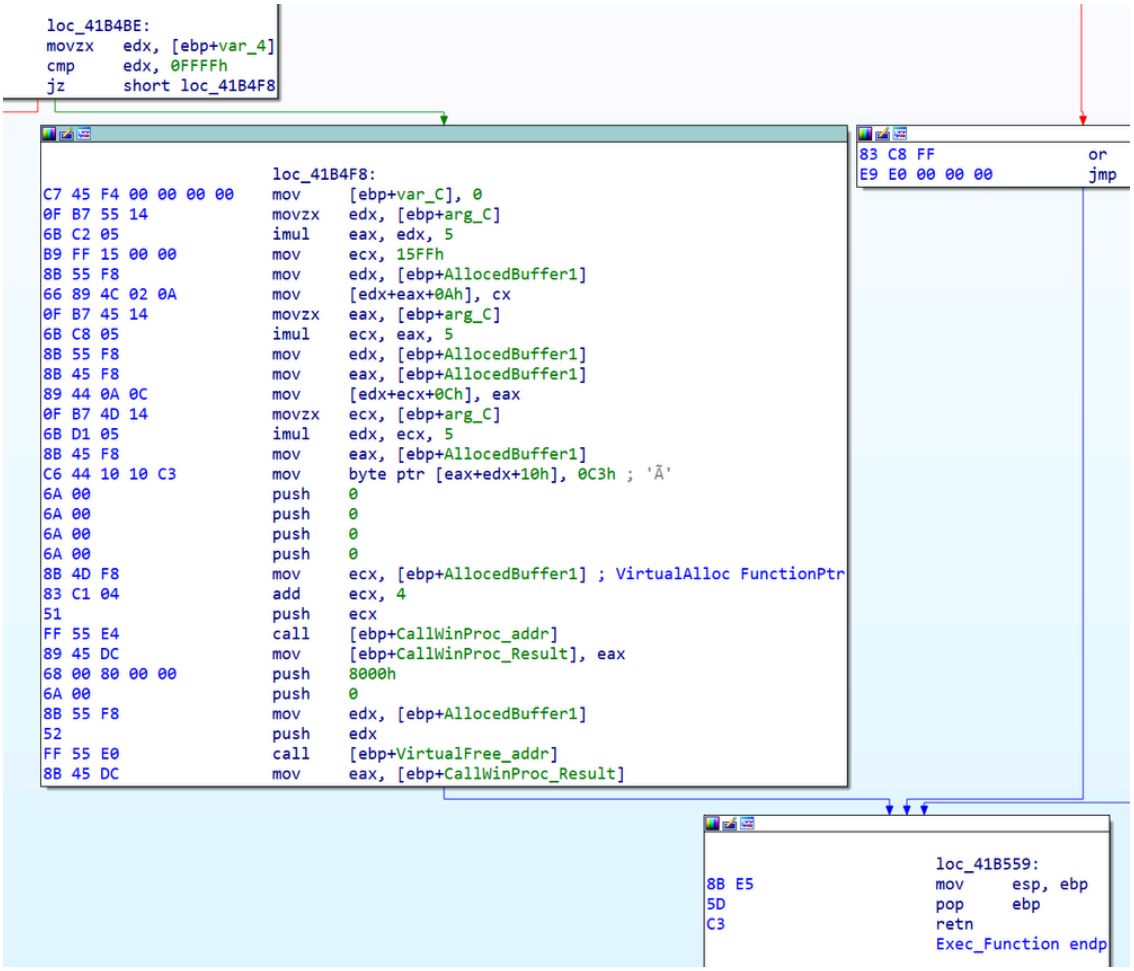


Exec_Function find API call address.

Then, it uses the given third argument (arg_8 - 7554284Ch, the custom hash of the API function) to find the corresponding API function address. The used custom hashing function is based on the following pseudocode algorithm:

```
i = 112186;
while ( *a1 )
  i = (char)*a1++ + 33 * i;
return i;
```

Finally, it uses CallWindowProcW to execute the resolved API function (see below). The latter is also an old shellcode trick used by many exploits to execute position independent code stored in some buffer. It misuses the CallWindowProcW function and leverages the fact that CallWindowProcW is simply executing the function pointer in the first argument, assuming it is either the address of a window or dialog box procedure. From an obfuscation point, this makes the static analysis more difficult and might also confuse weak antivirus products.



Exec_Function (sub_41B285).

We can rename the sub_41B285 function "Exec_Function." The picture below shows how it works. It can be used to execute most of the important Windows API calls. It is no surprise that the sample is leveraging it for most of its API calls.

```
.data:00416C46 66 89 45 C0          mov     [ebp+var_40], ax
.data:00416C4A B9 6C 00 00 00       mov     ecx, 6Ch ; 'l'
.data:00416C4F 66 89 4D C2          mov     [ebp+var_3E], cx
.data:00416C53 33 D2                xor     edx, edx
.data:00416C55 66 89 55 C4          mov     [ebp+var_3C], dx
.data:00416C59 6A 04                push    4               ; arg4 - e.g. flProtect
.data:00416C5B 68 00 30 00 00       push    3000h           ; arg3 - e.g. flAllocationType
.data:00416C60 68 00 84 D7 17       push    17D78400h       ; arg2 - e.g. dwSize
.data:00416C65 6A 00                push    0               ; arg1 - e.g. lpAddress
.data:00416C67 6A 04                push    4               ; Num arguments
.data:00416C69 68 4C 28 54 75       push    7554284Ch       ; API Call hash e.g. VirtualAlloc
.data:00416C6E 8D 45 DC             lea     eax, [ebp+var_24]
.data:00416C71 50                   push    eax
.data:00416C72 6A 01                push    1
.data:00416C74 E8 0C 46 00 00       call    Exec_Function   ; VirtualAlloc
.data:00416C79 83 C4 20             add     esp, 20h
.data:00416C7C 89 45 D8             mov     [ebp+var_28], eax
.data:00416C7F 50                   push    eax
.data:00416C80 83 F8 11             cmp     eax, 11h
.data:00416C83 74 05                jz      short loc_416C8A
.data:00416C85 8B C0                mov     eax, eax
.data:00416C87 FC                   cld
.data:00416C88 85 C9                test    ecx, ecx
```

Exec_Function parameters.

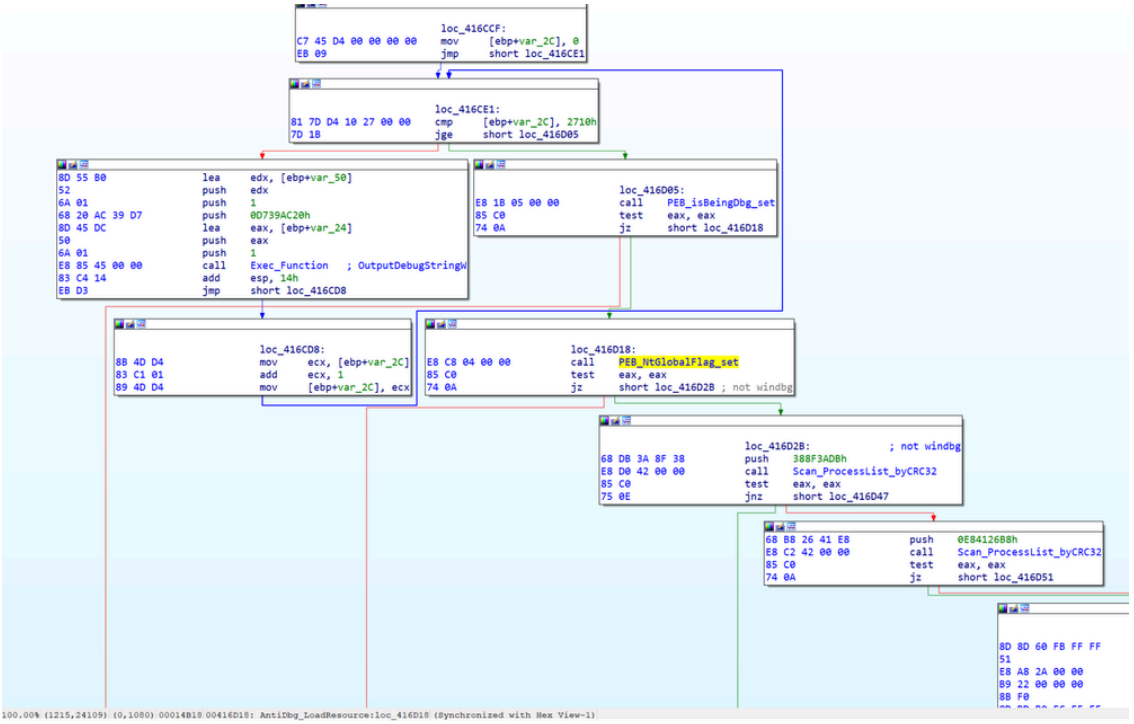
As far as "call Exec_Function" doesn't tell us which API function is called, we wrote another small IDA Python script, which parses all XREFs to this function, checks arg_8 (e.g. 7554284Ch) and resolves the given hash to an

API function call name (e.g. VirtualAlloc). Then it writes a comment to the call Exec_Function, which names the API function name that is going to be executed.

Next, the sample executes some anti-analysis checks. This includes a function, which is checking for certain processes by parsing the processlist and comparing the names against a CRC32 checksum. We called it "Scan_ProcessList_byCRC32." These checks are not only done at this location, they are distributed all over the sample and looking for the following names:

- 0x388f3adb = mple.exe
- 0xe84126b8 = sample.exe
- 0x6b68c4c6 = avastui.exe
- 0x923d5594 = avgui.exe
- 0x6b68c4c6 = avastui.exe
- 0x923d5594 = avgui.exe
- 0x6b68c4c6 = avastui.exe
- 0x923d5594 = avgui.exe
- 0x958e9b43 = extsszf.exe

We haven't checked every location, but where we did, the sample kills itself if those processes are found.



Debug checks.

After the debug checks, the sample is extracting the two resources UDXCUSK and SCCJZ from the PE resource section and stores them in two buffers for later use (see below). Then, it decodes the configuration stored in the UDXCUSK buffer. The function DecodeConfigFromResourceUDXCUSK stores pointers to the decoded data blobs on the stack. It finds them later via dword ptr ss:[ebp+eax-2C8], where eax is the offset to the different data

blobs/config parameters. Later on, these parameters help to decrypt the actual final malware embedded in the SCCJZ resource.

```
E8 A8 2A 00 00          call    Build_IAT
B9 22 00 00 00          mov     ecx, 22h ; '"'
8B F0                   mov     esi, eax
8D BD B0 FC FF FF       lea     edi, [ebp+IAT_buffer]
F3 A5                   rep movsd
C7 45 CC 00 00 00 00    mov     [ebp+res_UDXCUSK_buffer], 0
8D 95 5C FD FF FF       lea     edx, [ebp+var_size_res_UDXCUSK]
52                      push    edx
8B 45 0C                mov     eax, [ebp+arg_4_UDXCUSK] ; sub resource 1
50                      push    eax
8B 4D 08                mov     ecx, [ebp+arg_0_resource_type] ; DTIZDMFIV
51                      push    ecx
E8 DE 04 00 00          call    LoadResourceToBuffer
89 45 CC                mov     [ebp+res_UDXCUSK_buffer], eax
8D 55 C8                lea     edx, [ebp+var_size_res_SCCJZ]
52                      push    edx
8B 45 10                mov     eax, [ebp+arg_8_SCCJZ] ;  sub resource 2
50                      push    eax
8B 4D 08                mov     ecx, [ebp+arg_0_resource_type] ; DTIZDMFIV
51                      push    ecx
E8 CA 04 00 00          call    LoadResourceToBuffer
89 45 D0                mov     [ebp+res_SCCJZ_buffer], eax
8B 55 14                mov     edx, [ebp+arg_C_WORLQIPK] ; "WORLQIPKHWNNTPUZSRKVWQJJDEKIJXNOAUB"
52                      push    edx
8D 85 38 FD FF FF       lea     eax, [ebp+var_2C8_config_base] ; "0123456789:;<=>?"
50                      push    eax
8B 4D CC                mov     ecx, [ebp+res_UDXCUSK_buffer] ; "WORLQIPKHWNNTPUZS...KVWQJJDEKIJXNOAUB1"
51                      push    ecx
E8 B3 47 00 00          call    DecodeConfigFromResourceUDXCUSK
6A 32                   push    32h ; '2'
8D 95 E8 FB FF FF       lea     edx, [ebp+var_418_kgehorzlnr]
```

Load resources and decode configuration.

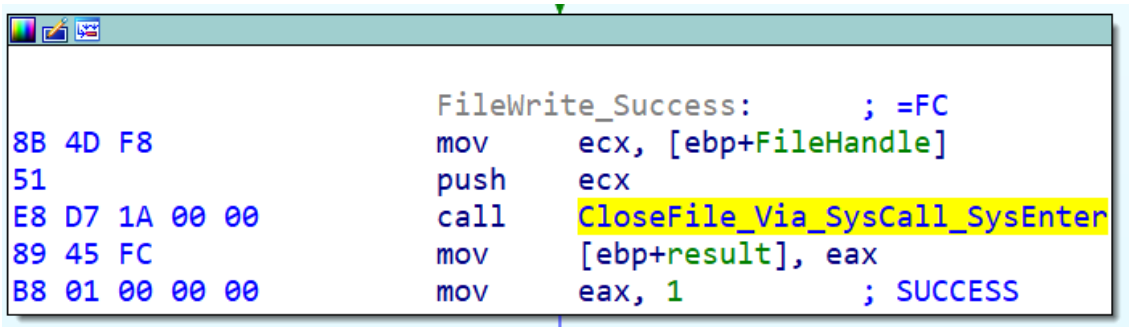
Then, makes itself persistent by copying over to <%APPDATA%>/kgehorzlnr/zqwlnpeijybtmkv.exe and placing a link to the file into the Windows startup folder.

```
6A 00                   push    0               ; if not, try again
6A 00                   push    0
8D 8D 4C FC FF FF       lea     ecx, [ebp+var_3B4] ; L"zqwlnpeijybtmkv"
51                      push    ecx
8D 95 E8 FB FF FF       lea     edx, [ebp+var_418] ; L"kgehorzlnr"
52                      push    edx
E8 20 0B 00 00          call    CopyFilesAndCreateStartupLink
89 85 58 FD FF FF       mov     [ebp+result], eax ; SUCCESS = 1
83 BD 58 FD FF FF 00    cmp     [ebp+result], 0
75 36                   jnz     short GetModFilename ; jmp if file created successfully

68 C6 C4 68 6B          push    6B68C4C6h       ; avastui.exe
E8 37 41 00 00          call    Scan_ProcessList_byCRC32
```

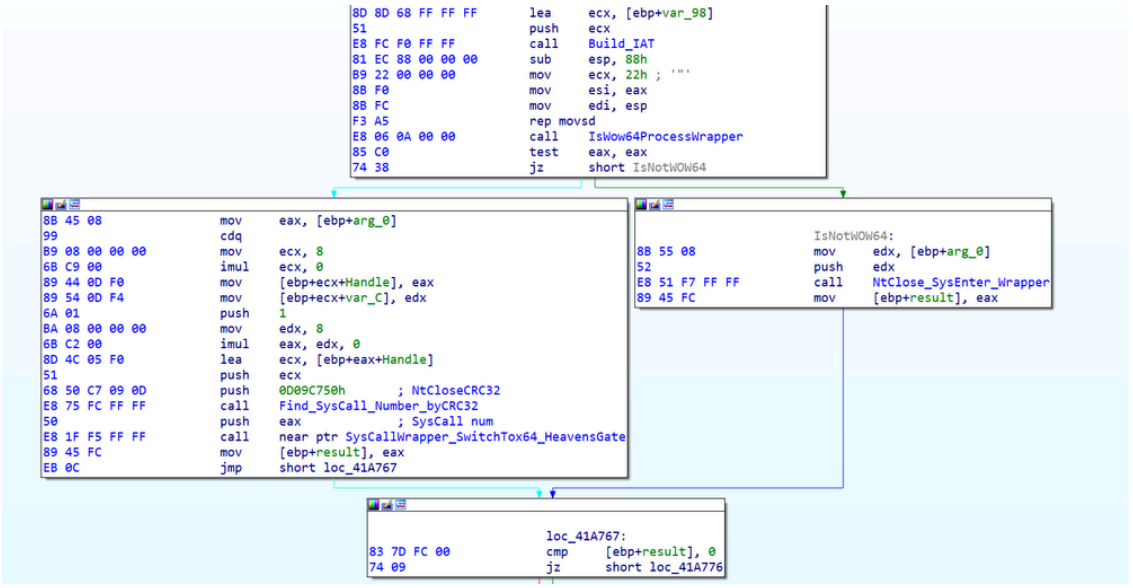
Copy loader and make it persistent.

CopyFilesAndCreateStartupLink is a complex function with a few sub functions. It is mostly using the obfuscation techniques that we've already seen, but it is also uses Heaven's Gate for some of the API calls, such as CloseFile.



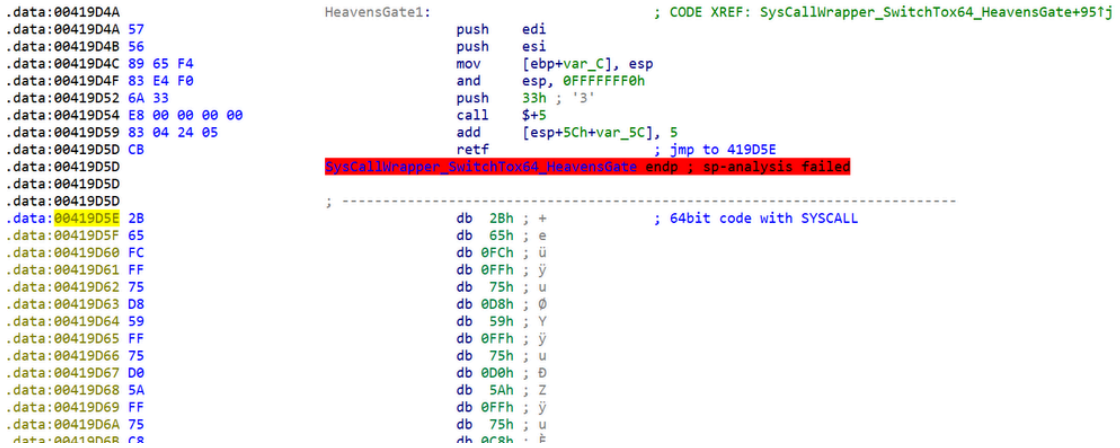
Leveraging syscalls for obfuscation.

If we dig into the CloseFile_Via_syscall_SysEnter function, we see that it is checking if it is running as a 32-bit process on a 64-bit system under the SysWOW64 technology. Depending on this check, it either uses the 32-bit sysenter instruction or the Heaven's Gate trick to execute the API call directly via the 64-bit syscall instruction. If it is using the 64-bit world, it is getting the syscall number in a similar way to what we've seen before with the API calls. It is parsing ntdll.dll for the hash of the function — such as NtCloseFile = 0D09C750h — and then it finds the corresponding syscall number.



WOW64 check and syscall resolution.

We can see the switch from 32-bit to 64-bit code inside of the SysCallwrapper_SwitchTox64_HeavensGate function. First, it pushes 33h onto the stack. Then, it performs the call $+5 trick, which means it just calls the next instruction at 419D59, but the call instruction is also pushing the instruction pointer address to the stack (419D54). The 'add' instruction adds five to this value. In other words, we have the values 419D5E and 33h on the stack. If the CPU executes 'retf,' it is jumping to 419D5E and changing the CS register to 33h (far jump). The latter means switching to 64-bit mode. You can read the details here.



Heaven's Gate

Unfortunately, this means we need to switch to the 64-bit version of IDA for the code starting at 41D55E. In 64-bit, we can see that it is simply preparing the function arguments and then calling the syscall instruction. The sample uses this for calls listed in the disassembler comments in the picture below.

```
HeavensGate proc far

var_8= dword ptr -8
var_4= dword ptr -4
arg_10= qword ptr  20h

sub     esp, [rbp-4]
push    qword ptr [rbp-28h]
pop     rcx
push    qword ptr [rbp-30h]
pop     rdx
push    qword ptr [rbp-38h]
pop     r8
push    qword ptr [rbp-40h]
pop     r9
push    qword ptr [rbp-20h]
pop     rdi
push    qword ptr [rbp-18h]
pop     rsi
test    esi, esi
jz      short loc_31
```

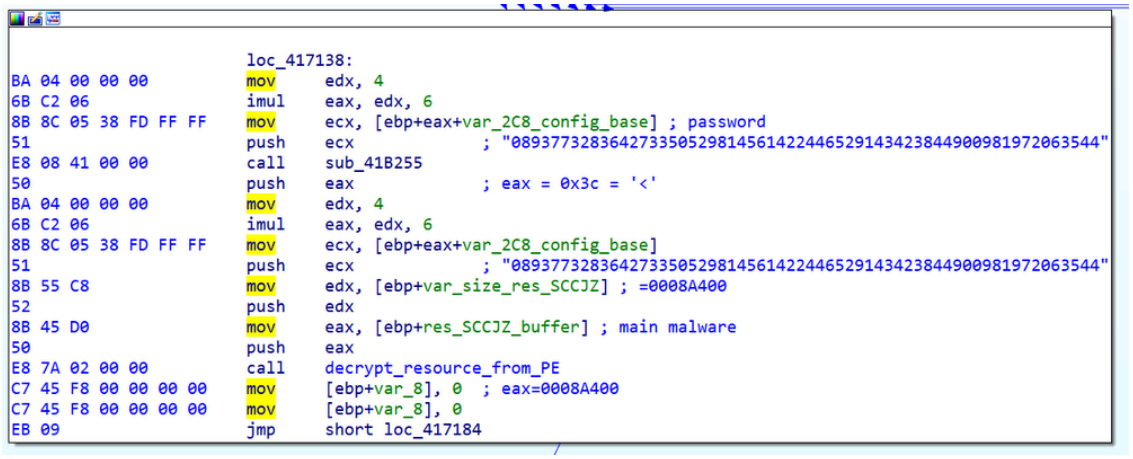
```
loc_21:
mov     rcx, [edi+esi*8]
mov     [esp+esi*8+arg_10], rcx
sub     esi, 1
jnz     short loc_21
```

```
loc_31:
push    qword ptr [rbp-28h]
pop     r10
mov     eax, [rbp+8]    ; rax = SysCallNr:
                        ; 0x47=NtCreateSection
                        ; 0x25=NtMapViewOfSection
                        ; 0x37=NtWriteVirtualMemory
                        ; 0x4f=NtResumeThread
                        ; 0x27=NtUnmapViewOfSection
                        ; 0x29=NtTerminateProcess
syscall                 ; Low latency system call
mov     [rbp-10h], eax
add     esp, [rbp-4]
call    $+5
mov     [rsp+8+var_4], 23h ; '#'
add     [rsp+8+var_8], 0Dh
retf
```

64-bit code — syscall execution.

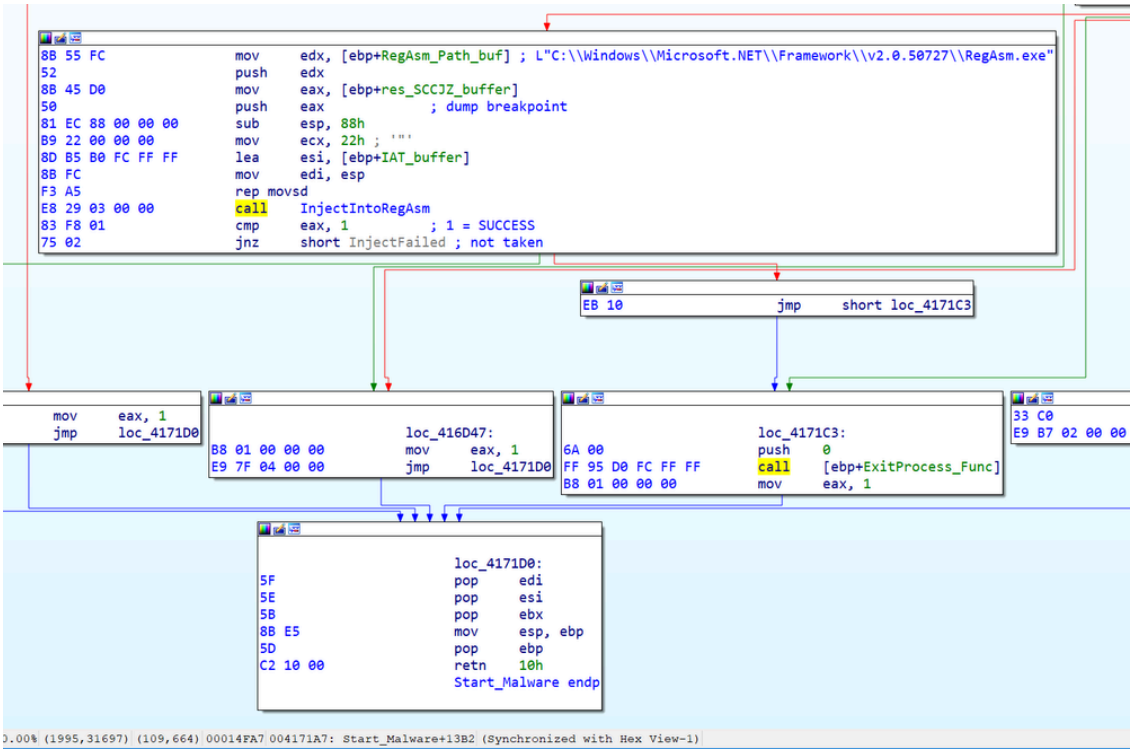
Executing 64-bit calls in a 32-bit application can also cause certain antivirus products to miss these calls, thus missing the real behavior of the application.

Now we are going back to the main malware routine. Remember that the malware has already extracted the *SCCJZ* resource into the *res_SCCJZ_buffer*. It has also already decoded the configuration that includes the "*089377328364273...981972063544*" string to decode the *SCCJZ* resource. It is stored in *ebp+eax+var_2c8*_config_base, where eax is *0x18* (-> "*089377328364273...981972063544*").



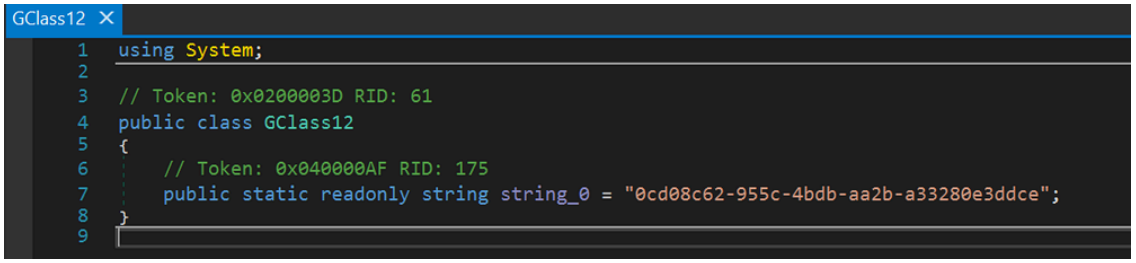
Decoding the dropped malware.

The next step is starting the legitimate RegAsm.exe process and injecting the decoded data from the resource section via the typical process-hollowing technique. Using the same obfuscation tricks previously described, we called this function "InjectIntoRegAsm" below.



InjectIntoRegAsm

In this case, the final malware injected into RegAsm.exe is our old information-stealer friend HawkEye Reborn v9, Version=9.0.1.6. As usual, it is obfuscated with ConfuserEx described in our previous research. The stolen data is exfiltrated via the email account *sartaj@jaguarline.com* to the mail server *mail.jaguarline.com*. The HawkEye Reborn configuration decryption password is: *0cd08c62-955c-4bdb-aa2b-a33280e3ddce*.



Hawkeye password

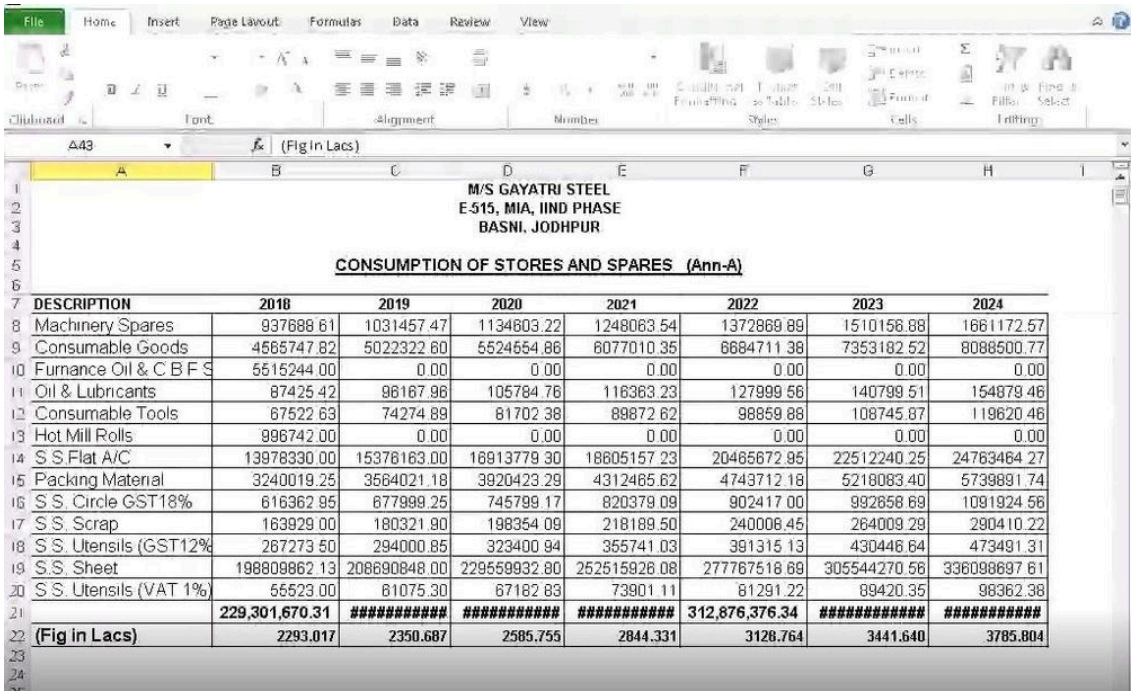
Distribution activity

After analyzing the previously described loader, we began to analyze what malware families may be leveraging it to infect victims. The most widely observed malware family at this time is HawkEye Reborn, version 9.0.1.6. Talos already broke down this malware in a previous post. We also observed several other commodity malware distribution campaigns leveraging the same loader to infect victims with Remcos, as well as cryptocurrency mining malware. This activity demonstrates how advanced techniques such as Heaven's Gate can be quickly integrated across large portions of the threat landscape. In many cases, the cybercriminals leveraging these kits lack the expertise to implement this type of functionality natively, but can instead leverage available loaders to achieve the same goal.

Email distribution

In all of the malware distribution campaigns we observed, the infection process starts very consistent with what we previously observed from threats like HawkEye Reborn, Remcos, Agent Tesla, and other commodity malware. The attackers send emails to victims disguised as invoices, banking statements and other financial-related topics.

These emails typically contain Microsoft Excel spreadsheets or Microsoft Word documents that leverage CVE-2017-11882, a vulnerability affecting Microsoft Equation Editor. When opened by victims, these malicious documents function as malware downloaders, reaching out to web servers on which the attacker is hosting their malware payload. The contents of the documents varies, but one example is below:



M/S GAYATRI STEEL
E-515, MIA, IIND PHASE
BASNI, JODHPUR

CONSUMPTION OF STORES AND SPARES (Ann-A)

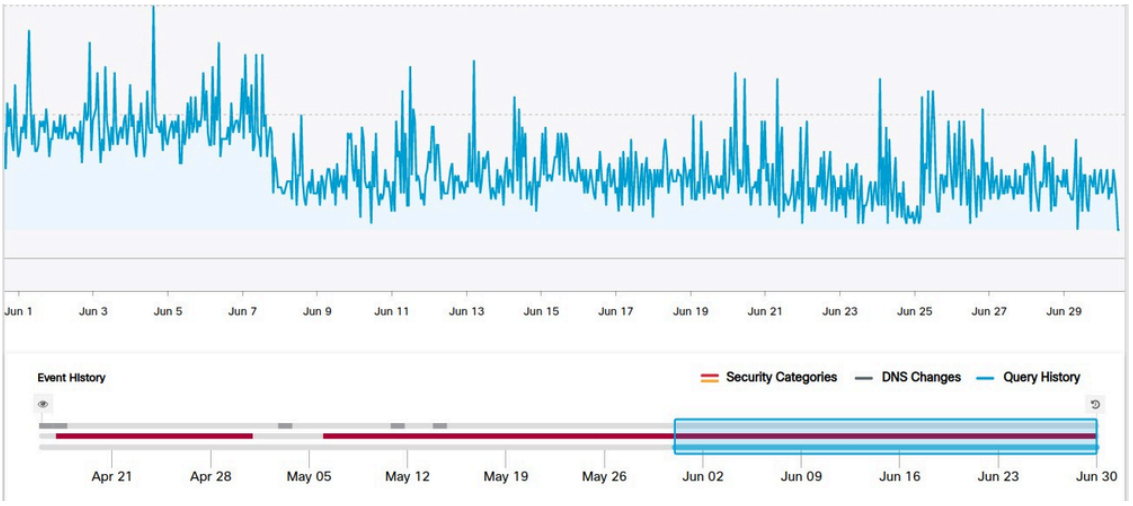
DESCRIPTION	2018	2019	2020	2021	2022	2023	2024
Machinery Spares	937688.61	1031457.47	1134603.22	1248063.54	1372869.89	1510156.88	1661172.57
Consumable Goods	4565747.82	5022322.60	5524554.86	6077010.35	6684711.38	7353182.52	8088500.77
Furnance Oil & C B F S	5515244.00	0.00	0.00	0.00	0.00	0.00	0.00
Oil & Lubricants	87425.42	96167.96	105784.76	116363.23	127999.56	140799.51	154879.46
Consumable Tools	67522.63	74274.89	81702.38	89872.62	98859.88	108745.87	119620.46
Hot Mill Rolls	996742.00	0.00	0.00	0.00	0.00	0.00	0.00
S.S.Flat A/C	13978330.00	15376163.00	16913779.30	18605157.23	20465672.95	22512240.25	24763464.27
Packing Material	3240019.25	3564021.18	3920423.29	4312465.62	4743712.18	5218083.40	5739891.74
S.S. Circle GST18%	616362.95	677999.25	745799.17	820379.09	902417.00	992658.69	1091924.56
S.S. Scrap	163929.00	180321.90	198354.09	218189.50	240008.45	264009.29	290410.22
S.S. Utensils (GST12%	267273.50	294000.85	323400.94	355741.03	391315.13	430446.64	473491.31
S.S. Sheet	198809862.13	208690848.00	229559932.80	252515926.08	277767518.69	305544270.56	336098697.61
S.S. Utensils (VAT 1%)	55523.00	61075.30	67182.83	73901.11	81291.22	89420.35	98362.38
	229,301,670.31	**##########**	**##########**	**##########**	**312,876,376.34**	**##########**	**##########**
(Fig in Lacs)	**2293.017**	**2350.687**	**2585.755**	**2844.331**	**3128.764**	**3441.640**	**3785.804**

These campaigns are ongoing, with new binaries being hosted and new emails being sent on a regular basis.

URLs ⓘ

Scanned	Detections	URL
2019-06-30	10 / 70	http://terryhill.top/proforma/
2019-06-30	10 / 70	http://terryhill.top/invoice/
2019-06-29	12 / 70	http://terryhill.top/proforma/ME.exe
2019-06-28	12 / 71	http://terryhill.top/proforma/tkraw_Protected.exe
2019-06-28	10 / 70	http://terryhill.top/proforma
2019-06-28	12 / 71	http://terryhill.top/invoice/benucrypt.exe
2019-06-27	13 / 70	http://terryhill.top/proforma/bobnewcr.exe
2019-06-27	15 / 71	http://terryhill.top/proforma/crpholi.exe
2019-06-27	13 / 71	http://terryhill.top/proforma/Joko.bat.exe
2019-06-25	15 / 71	http://terryhill.top/proforma/ttkoooo.exe
2019-06-25	10 / 70	http://terryhill.top/proforma/benuc.exe
2019-06-25	10 / 70	http://terryhill.top/proforma/playerc4.exe
2019-06-25	14 / 71	http://terryhill.top/proforma/50knewc.exe
2019-06-25	12 / 70	http://terryhill.top/proforma/benu7.exe
2019-06-25	13 / 72	http://terryhill.top/invoice/tkcrypt.exe

Below is a graph showing DNS resolution activity associated with one of the domains that is being used to host the malicious PE32 executables, and is reflective of the consistent, ongoing nature of these campaigns.



Conclusion

This campaign is the latest example of what modern malware uses to fly under the radar. With the described process, the actors are able to hide the original malware inside the loader. The Malware is only decrypted at runtime and injected into memory — it's never unencrypted on the hard drive. This means, if any antivirus tools scans the malware, it has no chance to identify the malware on the disk.

The adversaries in this case used sophisticated loaders that leverage several different low-level operating system techniques to make it as hard as possible for antivirus programs to detect the malware. By using these loaders, they can quickly and easily change the final malware or in other words the payload of the loader.

Coverage

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

Product	Protection
AMP	✓
Cloudlock	N/A
CWS	✓
Email Security	✓
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.

AMP 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.

Indicators of Compromise (IOCs)

The following indicators of compromise can be used to identify malicious activity associated with these malware distribution campaigns.

Domains:
www[.]kemostarlogistics[.]co[.]ke
www[.]terryhill[.]top
mail[.]jaguarline[.]com

IP Addresses:
173.254.126[.]115
164.160.128[.]110

Email:
Email: sartaj@jaguarline.com
Mailserver: mail.jaguarline.com

Link in Windows Startup folder:
L"[InternetShortcut]\nURL=file:///C:\\Users\\Dex Dexter\\AppData\\Roaming\\kgehorzlnr\\zqwlnpeijybtmkv.exe"

Malicious Document Hashes (SHA256):

```
cf0a3dadba03f32d90e84401451c9acc1a1d2378d5bdae8e87fc2ab9c6ff0f12
e23d16a5b770a04664dd42f8d2153ad62ce5fbf65af2a6dfd791ad70deef61b0
```

PE32 Hashes (SHA256) analyzed:

```
 01349f0b7a30d36f21711455486024516 43d670870f8863f8baeec4f76cf83a0
10149bf87feb3276a7d6bfb864864c655b4e11aa2ed6d677c177353dbffdfc25
c2e98978063f02f9769d8372d10abc3fe734cd7e686c6ab5dedb08dd57076b17
fc31b4107bec4352fac3e1a13d91031b6b49969e21abff2301609219c43cd472
```

SHA256 of related samples using very likely the same loader:

```
 b97d550a3d4e5bc0f5f01fb3989f30e0047a8cac56b9e6be4e46ad527c9835df
53b2eead3c1b8e4652c3ec079dbf0f9cb2e1bbf51a9883b7c5c2c5414e43b54b
3c1f585dd6df5cc0e0391f2924768da9fb2c9ac2f46af9a1f50325cb362728a6
5839edf29a8841b66e6da0a821ea1e2be60a4c9c0765c1ab27df03c2d8b3d22a
c6544c438662421fda4ebb8212526f64588081bf54e233da78a8720b9e0f5532
d8977770d90fcda7b502db771ca6398ae90601ac8f2eddf1484285c2a7b4a098
f067364aa4d565aba90d38afca9c21d67253b16fec8a5c36c6cfb84d6295c108
2b139cdc6423fed45dfb5adfb18e3a141eeb7df9248bf2ac9be1696778851484
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4c03059b3a796b093a754a767b18f7945357bb410779d8cd3d447ff02e1ea88b
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b51afa3b4cca3020daff7a93ca38060794d5f02e7e1925db17d01e5aa8031492
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780b1e40fc5b8a2f3d0cbd5c02455064606281fb2a24ee88633340178e021bae
254af6d5f33bd179b07dff10836e86574567c5f2bdee0e8e26a90af601d16d0a
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e8cc0d6364caf0231c6b48d7eb44a10645b739bb5659d81e31dd5924eed29110
a3b39af055b7432c7098a01736877b036fd88ffadb54502ef88d517dd5715f33
d0ab8fa84459da9cfcbe85fc5bfe2ac3e1613aba4272698847d49efaad110587
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79a91c943baca8578abaddc8e4d5c96d91deb60281e71118e4b1931ff58f8107
87b0e89cb6cf9d14c36004996558ab6da6e0f8ca4e357674417a4296fd247bc2
8090fbedfcdfc8e646ff20d1f1405b9e5b9e1223c5a6260cbccf298fdd1e2ff9
cbfb44b652ca595d4125f81910e29095c679fd9ea031b31068ab85b9b5e268b1
```

```
5eb0c3a8b143b7c96fa61435d8753b6ae6650054d35ad1d0ebc357424e27e472
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2b4f00ad30839c2a2c37801bb86dab1ab5df209d58788f840e4dbdd00ad06d4a
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```

```
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b19e62bf6617aec9cdc3d7f96fcfc23a63c1587099e632fff025ef51278d7dd4
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Source: https://blog.talosintelligence.com/rats-and-stealers-rush-through-heavens/