ZLAB

The stealth process injection of the new Ursnif malware

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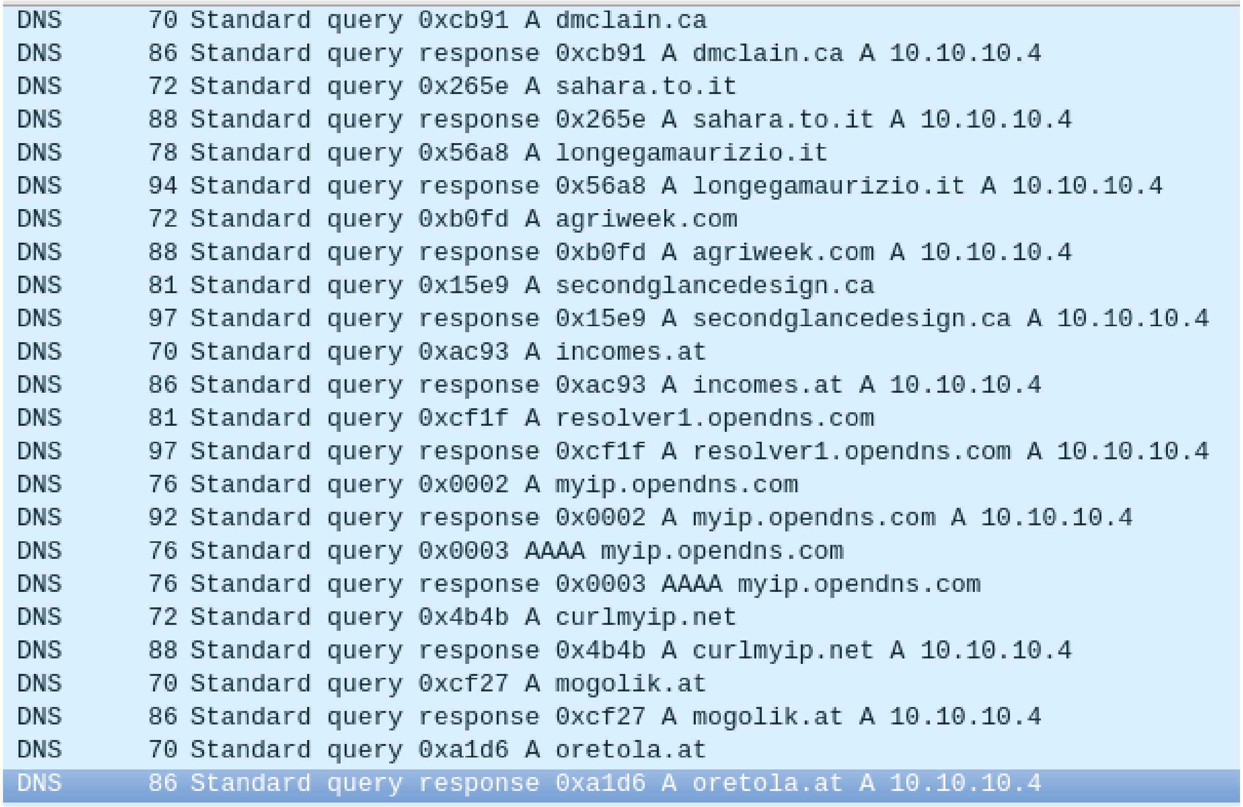
Introduction

Whereas the malware LockPos, famous for its new incredibly advanced and sophisticated evasion technique, spread and affected many Points of Sale, another variant spread in the wild and adopts a similar but not identical advanced evasion trick. It is probably a new variant of “ursnif v3”, another evolution of an old banking trojan and spread in November 2017. Moreover, the command and control of this new malware, oretola[.]at has been sinkholed by authorities, so it is difficult to reconstruct the entire behavior and the real purpose of this malware.

However, it is very interesting make an analysis of its stealth technique, thanks to which it can be invisible to many modern antiviruses. In fact, its final stage is to hide itself as a thread of “explorer.exe” process and this make the analysis too tough. To reach its goal, the malware uses a sort of “double process hollowing” technique based on Windows Native API, using the “svchost.exe” system process as a way to make privilege escalation and to get to inject malicious code in “explorer.exe”.

Only after the concealment in “explorer.exe” it starts to make its malicious operations that consist of to contact a series of compromised sites in which are hosted encrypted additional payloads. The final step of its malicious behavior is to periodically communicate with its C2C, “oretola[.]at”, where it sends information about the victim host.

This malware probably spreads up through spam mails, containing a URL to a compromised site on which the sample is hosted. We discovered the malware sample just on one of these compromised sites, in particular it is an Italian blog dedicated to dolls “marinellafashiondolls[.]com/_private/php3.exe”.



```
DNS      70 Standard query 0xcb91 A dmclain.ca
DNS      86 Standard query response 0xcb91 A dmclain.ca A 10.10.10.4
DNS      72 Standard query 0x265e A sahara.to.it
DNS      88 Standard query response 0x265e A sahara.to.it A 10.10.10.4
DNS      78 Standard query 0x56a8 A longegamaurizio.it
DNS      94 Standard query response 0x56a8 A longegamaurizio.it A 10.10.10.4
DNS      72 Standard query 0xb0fd A agriweek.com
DNS      88 Standard query response 0xb0fd A agriweek.com A 10.10.10.4
DNS      81 Standard query 0x15e9 A secondglancedesign.ca
DNS      97 Standard query response 0x15e9 A secondglancedesign.ca A 10.10.10.4
DNS      70 Standard query 0xac93 A incomes.at
DNS      86 Standard query response 0xac93 A incomes.at A 10.10.10.4
DNS      81 Standard query 0xcf1f A resolver1.opendns.com
DNS      97 Standard query response 0xcf1f A resolver1.opendns.com A 10.10.10.4
DNS      76 Standard query 0x0002 A myip.opendns.com
DNS      92 Standard query response 0x0002 A myip.opendns.com A 10.10.10.4
DNS      76 Standard query 0x0003 AAAA myip.opendns.com
DNS      76 Standard query response 0x0003 AAAA myip.opendns.com
DNS      72 Standard query 0x4b4b A curlmyip.net
DNS      88 Standard query response 0x4b4b A curlmyip.net A 10.10.10.4
DNS      70 Standard query 0xcf27 A mogolik.at
DNS      86 Standard query response 0xcf27 A mogolik.at A 10.10.10.4
DNS      70 Standard query 0xa1d6 A oretola.at
DNS      86 Standard query response 0xa1d6 A oretola.at A 10.10.10.4
```

Figure 1 - List of some domains resolved by the malware

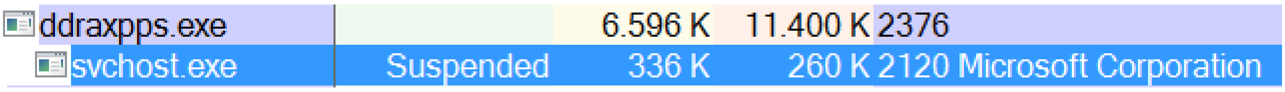
Technique

First of all, this malware uses almost exclusively the Native API of Windows with also its undocumented functions. The use of them causes a more difficult monitoring by antiviruses.

Once the php3.exe file is executed, it deletes itself from the original path and recopy itself in “%APPDATA%\Roaming\Microsoft\Brdgplua\ddraxpps.exe” path.

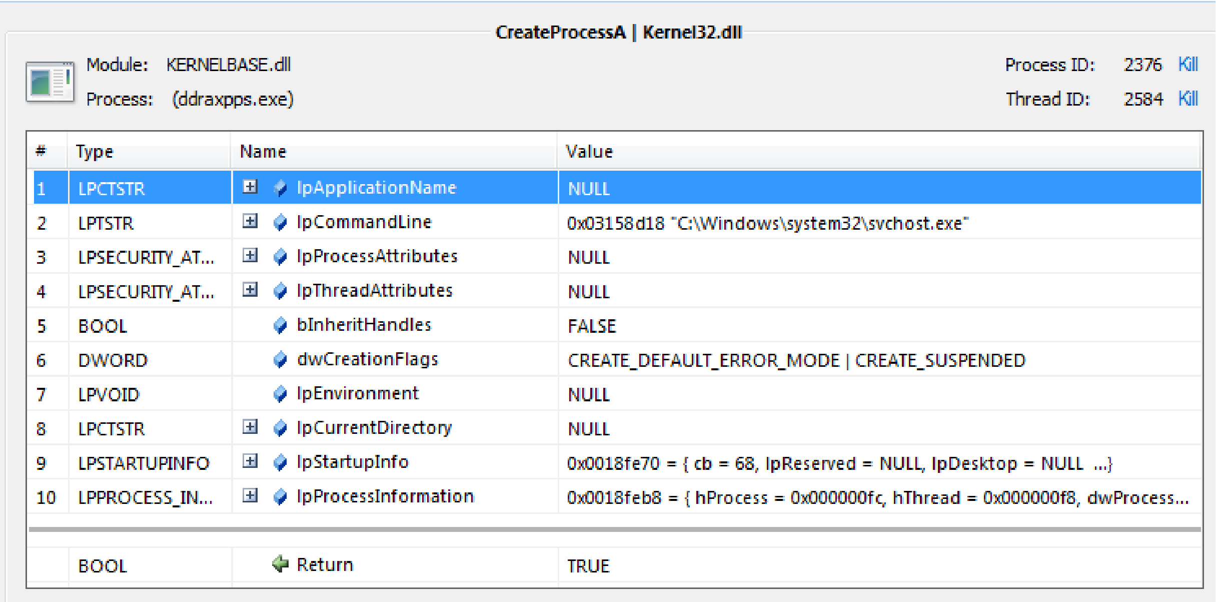
After this operation, the malware starts its malicious behavior, synthesizable in these phases:

1. Create a new “svchost.exe” process in suspended mode, using CreateProcessA.



ddraxpps.exe		6.596 K	11.400 K	2376	
svchost.exe	Suspended	336 K	260 K	2120	Microsoft Corporation

Figure 2 - svchost.exe process creation



CreateProcessA | Kernel32.dll

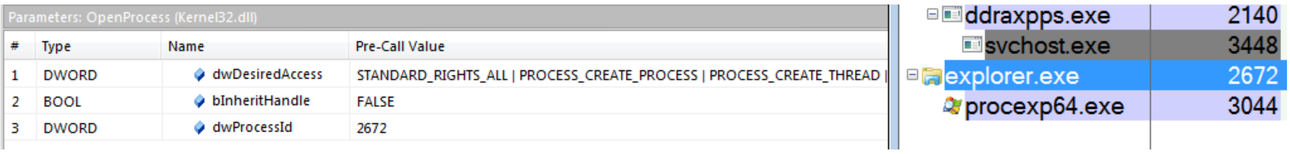
Module: KERNELBASE.dll
Process: (ddraxpps.exe)

Process ID: 2376 Kill
Thread ID: 2584 Kill

#	Type	Name	Value
1	LPCTSTR	lpApplicationName	NULL
2	LPTSTR	lpCommandLine	0x03158d18 "C:\\Windows\system32\svchost.exe"
3	LPSECURITY_AT...	lpProcessAttributes	NULL
4	LPSECURITY_AT...	lpThreadAttributes	NULL
5	BOOL	bInheritHandles	FALSE
6	DWORD	dwCreationFlags	CREATE_DEFAULT_ERROR_MODE | CREATE_SUSPENDED
7	LPVOID	lpEnvironment	NULL
8	LPCTSTR	lpCurrentDirectory	NULL
9	LPSTARTUPINFO	lpStartupInfo	0x0018fe70 = { cb = 68, lpReserved = NULL, lpDesktop = NULL ...}
10	LPPROCESS_IN...	lpProcessInformation	0x0018feb8 = { hProcess = 0x000000fc, hThread = 0x000000f8, dwProcess...
	BOOL	Return	TRUE

Figure 3 - Parameters of CreateProcessA

2. Create a new thread of “explorer.exe” process in suspended mode using OpenProcess with PROCESS_CREATE_THREAD and PROCESS_SUSPEND_RESUME flags enabled.



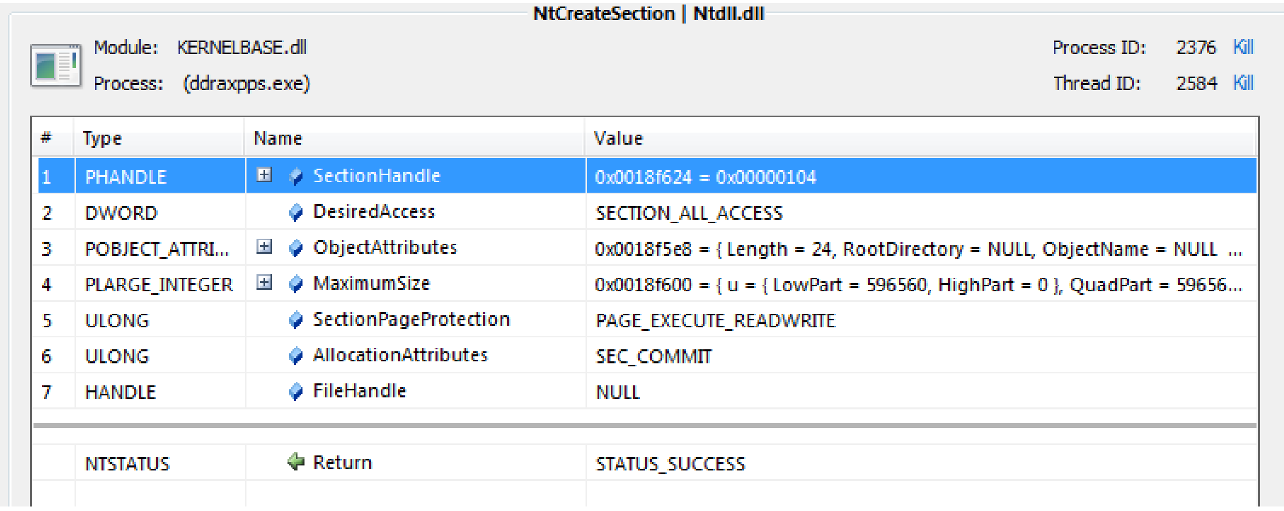
Parameters: OpenProcess (Kernel32.dll)

#	Type	Name	Pre-Call Value
1	DWORD	dwDesiredAccess	STANDARD_RIGHTS_ALL | PROCESS_CREATE_PROCESS | PROCESS_CREATE_THREAD |
2	BOOL	bInheritHandle	FALSE
3	DWORD	dwProcessId	2672

ddraxpps.exe	2140
svchost.exe	3448
explorer.exe	2672
procexp64.exe	3044

Figure 4 - Creation of a new thread of explorer.exe process (PID 2672) in suspended mode

3. Create a new section in memory in which it is loaded the code to map in “svchost.exe” process.



NtCreateSection | Ntdll.dll

Module: KERNELBASE.dll

Process: (ddraxpps.exe)

Process ID: 2376 Kill

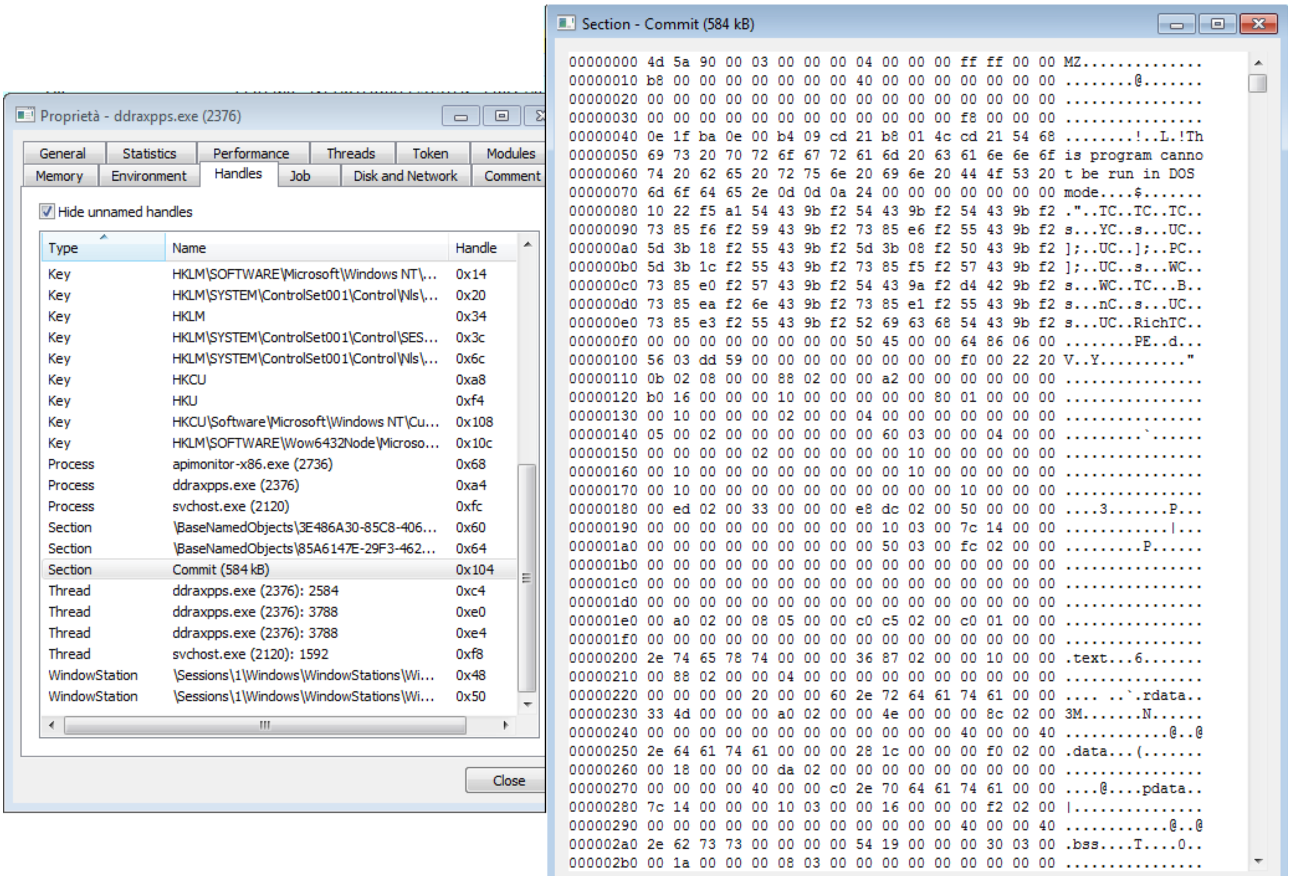
Thread ID: 2584 Kill

#	Type	Name	Value
1	PHANDLE	⊞ SectionHandle	0x0018f624 = 0x00000104
2	DWORD	DesiredAccess	SECTION_ALL_ACCESS
3	POBJECT_ATTRI...	⊞ ObjectAttributes	0x0018f5e8 = { Length = 24, RootDirectory = NULL, ObjectName = NULL ...
4	PLARGE_INTEGER	⊞ MaximumSize	0x0018f600 = { u = { LowPart = 596560, HighPart = 0 }, QuadPart = 59656...
5	ULONG	SectionPageProtection	PAGE_EXECUTE_READWRITE
6	ULONG	AllocationAttributes	SEC_COMMIT
7	HANDLE	FileHandle	NULL
	NTSTATUS	Return	STATUS_SUCCESS

Figure 5 - Section creation

At this moment, the section is empty and it will be filled in the next step

4. Copy the payload into the previous section using "memcpy" function



Proprietà - ddraxpps.exe (2376)

☑ Hide unnamed handles

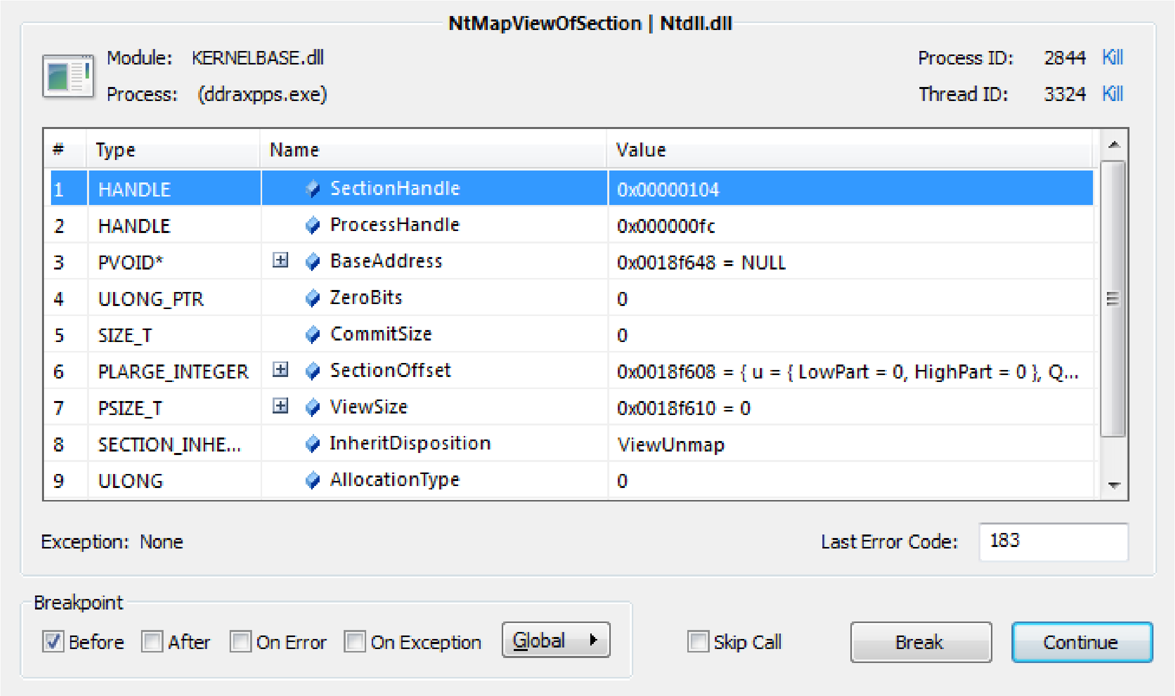
Type	Name	Handle
Key	HKLM\SOFTWARE\Microsoft\Windows NT\...	0x14
Key	HKLM\SYSTEM\ControlSet001\Control\Nls\...	0x20
Key	HKLM	0x34
Key	HKLM\SYSTEM\ControlSet001\Control\SES...	0x3c
Key	HKLM\SYSTEM\ControlSet001\Control\Nls\...	0x6c
Key	HKCU	0xa8
Key	HKU	0xf4
Key	HKCU\Software\Microsoft\Windows NT\Cu...	0x108
Key	HKLM\SOFTWARE\Wow6432Node\Microso...	0x10c
Process	apimonitor-x86.exe (2736)	0x68
Process	ddraxpps.exe (2376)	0xa4
Process	svchost.exe (2120)	0xfc
Section	\BaseNamedObjects\3E486A30-85C8-406...	0x60
Section	\BaseNamedObjects\85A6147E-29F3-462...	0x64
Section	Commit (584 kB)	0x104
Thread	ddraxpps.exe (2376): 2584	0xc4
Thread	ddraxpps.exe (2376): 3788	0xe0
Thread	ddraxpps.exe (2376): 3788	0xe4
Thread	svchost.exe (2120): 1592	0xf8
WindowStation	\Sessions\1\Windows\WindowStations\Wi...	0x48
WindowStation	\Sessions\1\Windows\WindowStations\Wi...	0x50

Section - Commit (584 kB)

```
00000000 4d 5a 90 00 03 00 00 00 04 00 00 00 ff ff 00 00 MZ..............
00000010 b8 00 00 00 00 00 00 00 40 00 00 00 00 00 00 00 ........@.......
00000020 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 ................
00000030 00 00 00 00 00 00 00 00 00 00 00 00 f8 00 00 00 ................
00000040 0e 1f ba 0e 00 b4 09 cd 21 b8 01 4c cd 21 54 68 ........!..L.!Th
00000050 69 73 20 70 72 6f 67 72 61 6d 20 63 61 6e 6e 6f is program canno
00000060 74 20 62 65 20 72 75 6e 20 69 6e 20 44 4f 53 20 t be run in DOS 
00000070 6d 6f 64 65 2e 0d 0d 0a 24 00 00 00 00 00 00 00 mode....$.......
00000080 10 22 f5 a1 54 43 9b f2 54 43 9b f2 54 43 9b f2 ."..TC..TC..TC..
00000090 73 85 f6 f2 59 43 9b f2 73 85 e6 f2 55 43 9b f2 s...YC..s...UC..
000000a0 5d 3b 18 f2 55 43 9b f2 5d 3b 08 f2 50 43 9b f2 ];..UC..];..PC..
000000b0 5d 3b 1c f2 55 43 9b f2 73 85 f5 f2 57 43 9b f2 ];..UC..s...WC..
000000c0 73 85 e0 f2 57 43 9b f2 54 43 9a f2 d4 42 9b f2 s...WC..TC...B..
000000d0 73 85 ea f2 6e 43 9b f2 73 85 e1 f2 55 43 9b f2 s...nC..s...UC..
000000e0 73 85 e3 f2 55 43 9b f2 52 69 63 68 54 43 9b f2 s...UC..RichTC..
000000f0 00 00 00 00 00 00 00 00 50 45 00 00 64 86 06 00 ........PE..d...
00000100 56 03 dd 59 00 00 00 00 00 00 00 00 f0 00 22 20 V..Y.........." 
00000110 0b 02 08 00 00 88 02 00 00 a2 00 00 00 00 00 00 ................
00000120 b0 16 00 00 00 10 00 00 00 00 00 80 01 00 00 00 ................
00000130 00 10 00 00 00 02 00 00 04 00 00 00 00 00 00 00 ................
00000140 05 00 02 00 00 00 00 00 00 60 03 00 00 04 00 00 .........`......
00000150 00 00 00 00 02 00 00 00 00 00 10 00 00 00 00 00 ................
00000160 00 10 00 00 00 00 00 00 00 00 10 00 00 00 00 00 ................
00000170 00 10 00 00 00 00 00 00 00 00 00 00 10 00 00 00 ................
00000180 00 ed 02 00 33 00 00 00 e8 dc 02 00 50 00 00 00 ....3.......P...
00000190 00 00 00 00 00 00 00 00 00 10 03 00 7c 14 00 00 ............|...
000001a0 00 00 00 00 00 00 00 00 00 50 03 00 fc 02 00 00 .........P......
000001b0 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 ................
000001c0 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 ................
000001d0 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 ................
000001e0 00 a0 02 00 08 05 00 00 c0 c5 02 00 c0 01 00 00 ................
000001f0 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 ................
00000200 2e 74 65 78 74 00 00 00 36 87 02 00 00 10 00 00 .text...6.......
00000210 00 88 02 00 00 04 00 00 00 00 00 00 00 00 00 00 ................
00000220 00 00 00 00 20 00 00 60 2e 72 64 61 74 61 00 00 .... ..`.rdata..
00000230 33 4d 00 00 00 a0 02 00 00 4e 00 00 00 8c 02 00 3M.......N......
00000240 00 00 00 00 00 00 00 00 00 00 00 00 40 00 00 40 ............@..@
00000250 2e 64 61 74 61 00 00 00 28 1c 00 00 00 f0 02 00 .data...(.......
00000260 00 18 00 00 00 da 02 00 00 00 00 00 00 00 00 00 ................
00000270 00 00 00 00 40 00 00 c0 2e 70 64 61 74 61 00 00 ....@....pdata..
00000280 7c 14 00 00 00 10 03 00 00 16 00 00 00 f2 02 00 |...............
00000290 00 00 00 00 00 00 00 00 00 00 00 00 40 00 00 40 ............@..@
000002a0 2e 62 73 73 00 00 00 00 54 19 00 00 00 30 03 00 .bss....T....0..
000002b0 00 1a 00 00 00 08 03 00 00 00 00 00 00 00 00 00 ................
```

Figure 6 - Payload's copy in the section previously created through memcpy function

5. Map the filled section to "svchost.exe" process using the Windows Native API function NtMapViewOfSection.



NtMapViewOfSection | Ntdll.dll

Module: KERNELBASE.dll
Process: (ddraxpps.exe)

Process ID: 2844 Kill
Thread ID: 3324 Kill

#	Type	Name	Value
1	HANDLE	SectionHandle	0x00000104
2	HANDLE	ProcessHandle	0x000000fc
3	PVOID*	⊞ BaseAddress	0x0018f648 = NULL
4	ULONG_PTR	ZeroBits	0
5	SIZE_T	CommitSize	0
6	PLARGE_INTEGER	⊞ SectionOffset	0x0018f608 = { u = { LowPart = 0, HighPart = 0 }, Q...
7	PSIZE_T	⊞ ViewSize	0x0018f610 = 0
8	SECTION_INHE...	InheritDisposition	ViewUnmap
9	ULONG	AllocationType	0

Exception: None

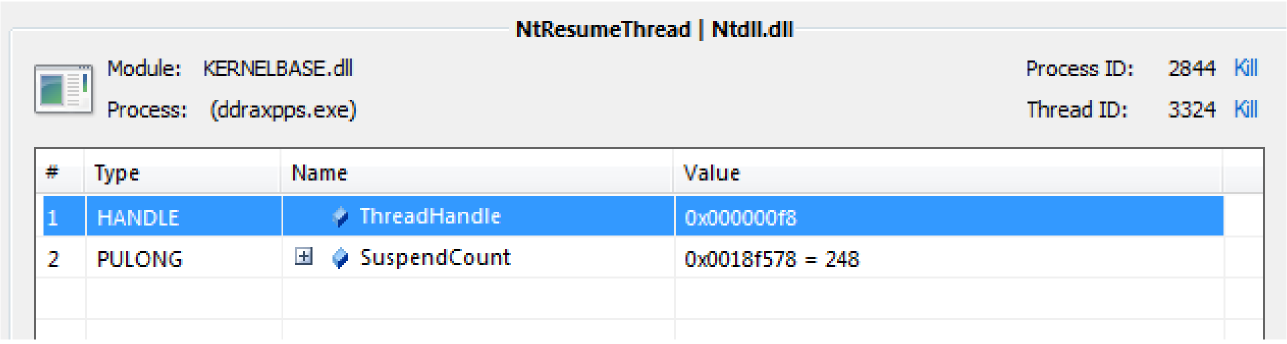
Last Error Code: 183

Breakpoint

☑ Before □ After □ On Error □ On Exception

Figure 7 - Mapping of the previously filled section to svchost.exe process through NtMapViewOfSection

6. Resume “svchost.exe” thread in order to act in the section previously allocated.



NtResumeThread | Ntdll.dll

Module: KERNELBASE.dll
Process: (ddraxpps.exe)

Process ID: 2844 Kill
Thread ID: 3324 Kill

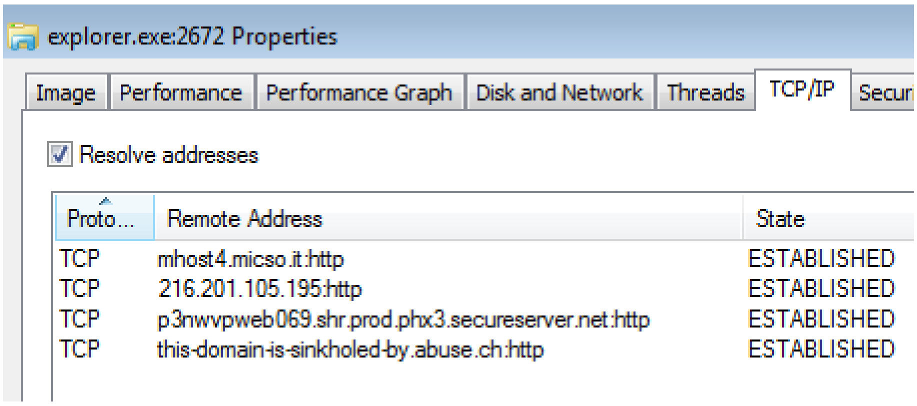
#	Type	Name	Value
1	HANDLE	ThreadHandle	0x000000f8
2	PULONG	⊞ SuspendCount	0x0018f578 = 248

Figure 8 - svchost.exe resuming in order to execute the payload loaded into the section

7. Exit

After this step, we lose the control of the behavior, because “svchost.exe” is a system process and we are not able to monitor the activities performed by it. But we can see that

- Both malicious “svchost.exe” and its father “ddraxpps.exe” terminate
- “explorer.exe” process start to have a malicious behavior, in particular it generates internet traffic to compromised websites.



☑ Resolve addresses

Proto...	Remote Address	State
TCP	mhost4.micso.it:http	ESTABLISHED
TCP	216.201.105.195:http	ESTABLISHED
TCP	p3nwvpweb069.shr.prod.phx3.secureserver.net:http	ESTABLISHED
TCP	this-domain-is-sinkholed-by.abuse.ch:http	ESTABLISHED

Figure 9 - Abnormal traffic performed by explorer.exe process

Thus, we can deduce with a good confidence that the effective payload is injected in “explorer.exe” thread and “svchost.exe” is only a proxy used to transfer the malicious code into the explorer process in order to make stealthier the malware execution. In fact, it is highly probable that “svchost.exe” performs the same actions viewed above to reach its goal. It seems that the first stage of process hollowing is used to perform a privilege escalation, starting from a user-space project to a system one; the second stage is to totally hide the payload to a user.

In conclusion, in this malware analysis the real challenging part was reversing this absolutely unusual and powerful hiding technique. In fact, it’s true that lots of sophisticated malwares adopt process hollowing for conceal themselves, but not this two-step version. The malware adopts the principles of privilege escalation and process hollowing, and make the analysis very hard.

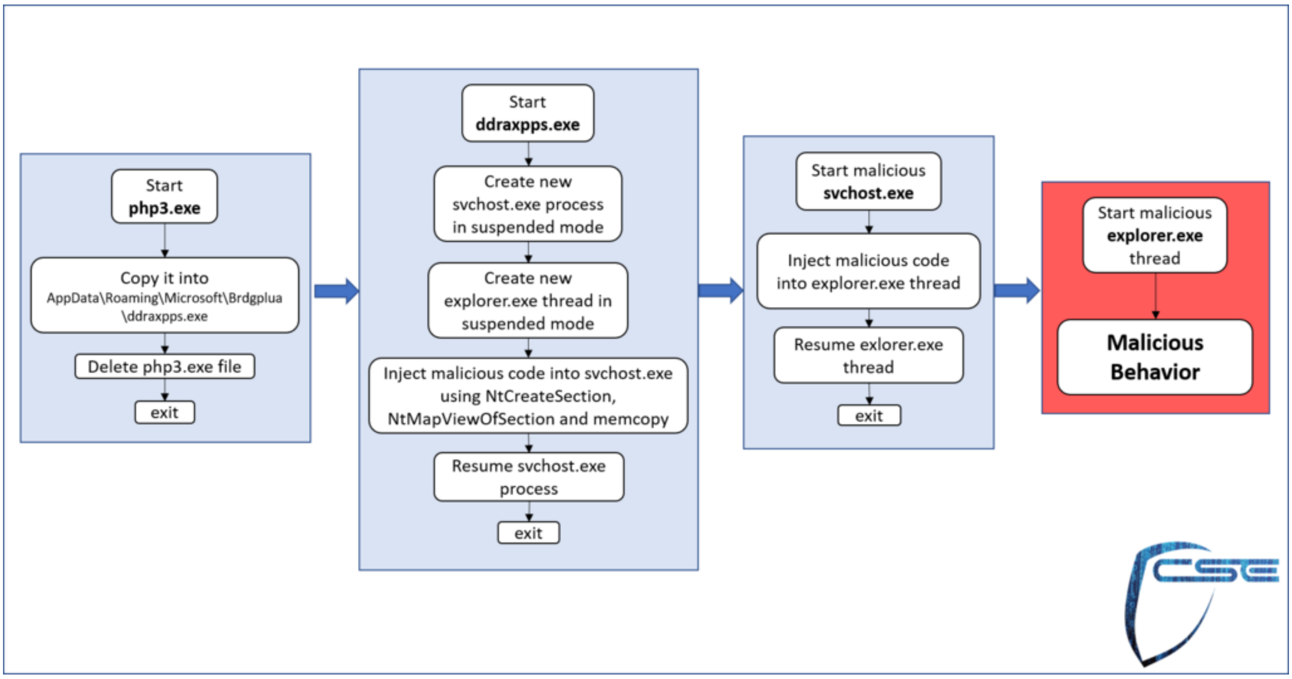

Start php3.exe
Copy it into AppData\Roaming\Microsoft\Brdgplua \ddraxpps.exe
Delete php3.exe file
exit
Start ddraxpps.exe
Create new svchost.exe process in suspended mode
Create new explorer.exe thread in suspended mode
Inject malicious code into svchost.exe using NtCreateSection, NtMapViewOfSection and memcopy
Resume svchost.exe process
exit
Start malicious svchost.exe
Inject malicious code into explorer.exe thread
Resume exlorer.exe thread
exit
Start malicious explorer.exe thread
Malicious Behavior
CSE

Figure 10 - Double Process Hollowing used by the malware.