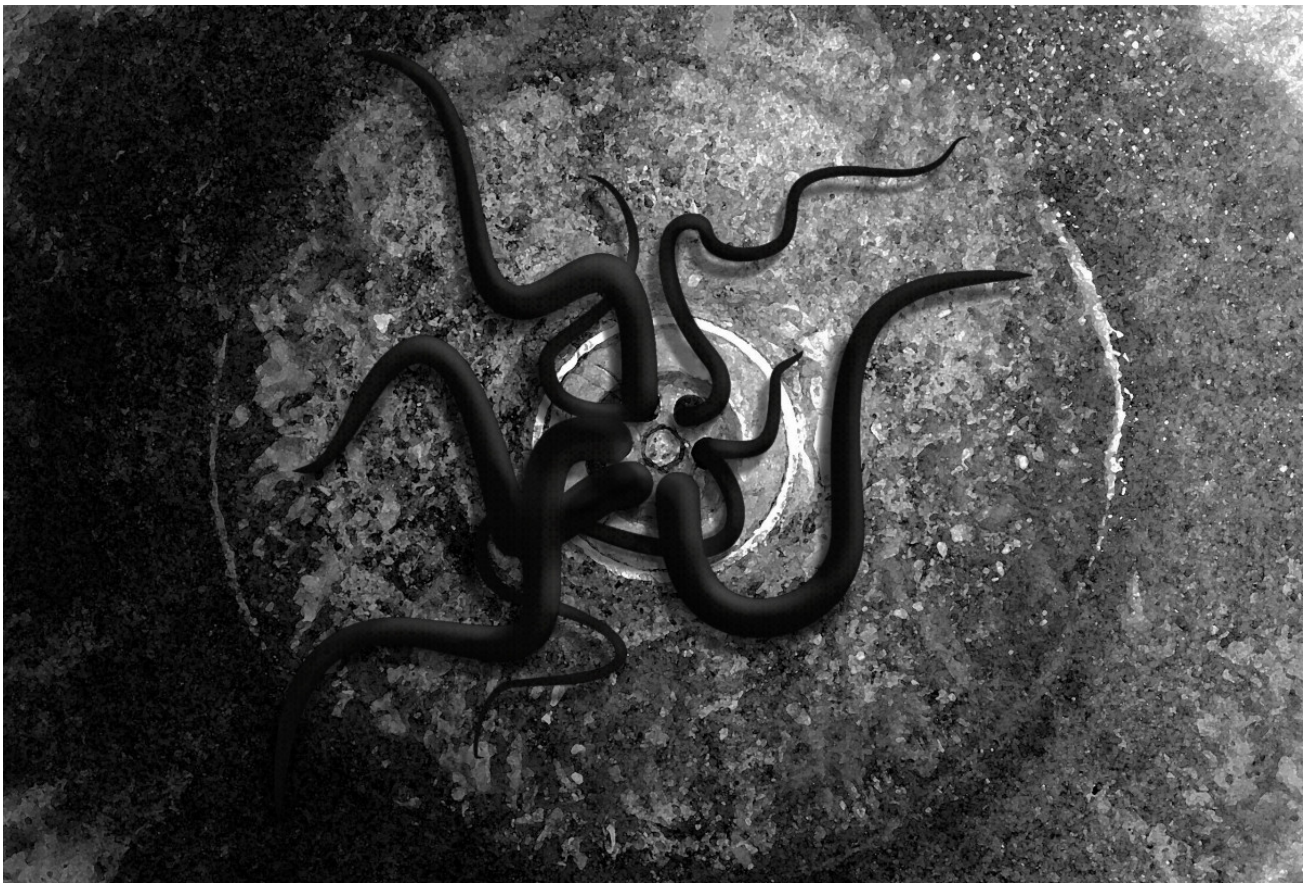
Malware analysis with IDA/Radare2 - Multiple unpacking (Ramnit worm)

artik.blue/malware4



Introduction

Today we are following our previous post on these series unpacking a sample (Ramnit) that looks a bit more complex as it performs multiple unpacking, combining own methods with an open source packer. As this piece of malware is relatively old, I'll be using a Windows 7 box with radare2, processhacker, pebear, pestudio and upx to go with it. The endgame here will be to go on unpacking the malware as many times as necessary until we reach to the final one, then get a general idea of what it does.

About Ramnit

Ramnit is a Computer worm affecting Windows users. It was estimated that it infected 800 000 Windows PCs between September and December 2011. The Ramnit botnet was dismantled by Europol and Symantec in 2015. At its peak in 2015, Ramnit was estimated to have infected 3,200,000 PCs. Ramnit infects removable media such as USB drives and also

hides itself within the master boot record. As soon as it infects a computer, it copies itself to all attached and removable drives. It also searches and infects files with the extensions .exe, .dll, .htm and .html.

The sample we'll be working with can be downloaded here and a similar one can be downloaded from anyrun

First stage

So considering that we are malware analysts who just received a fresh sample of a potential malware, let's go step by step. Usually the first goal of the analysis will be to determine wether the malware is packed/encrypted or not, then to try to extract some configuration, go for the C2 mechanisms and basic capabilities/actions and finally we may try to perform more advanced reversing to determine its full capabilities and detailed workflow. Having donde that the next actions(s) to carry would include to extract signatures for yara, automate the unpacking/scan process maybe and to start with threat intelligence.

Today we are focusing mainly on the unpacking part.

So to start with the sample we'll want to get some basic info on the binary. As we already know, knowing about the entropy may help in detecting packing, a high entropy may be a clear indicator. We can easily check that with rahash:

```
PS C:\Users\labo\Desktop> rahash2.exe -a entropy '.\Zeichnungen Muster.bin'
.\Zeichnungen Muster.bin: 0x00000000-0x001f91f6 entropy: 7.63339648
PS C:\Users\labo\Desktop>
```

We can also check for the strings, a large number of nonesense strings along with strings related to api-calls may indicate suspicious behavior as well.

```
PS C:\Users\lab\Desktop > rafind2.exe -Z '.\Zeichnungen Muster.bin' | more
0x0000004d !This program cannot be run in DOS mode.\r\r\n$
0x000000f8 RichR
0x00000208 .text
0x0000022f `.rdata
0x00000257 @.data
0x00000280 .rsrc
0x000002a7 @.reloc
0x000002cf B.text
0x0040129d u\bWV
0x004012b5 u/;u\f
0x004012d3 u\fj V
0x00401306 9=thL
0x00401330 =thL
0x00401336 5xhL
0x00401363 =lhL
0x004013b4 =lhL
0x004013f5 5dhL
0x004013fb %hhL
0x00401408 %dhL
0x0040140f \rthL
0x00401491 \bt\\HH
0x004014c5 M\b;S\f|
0x004014f7 t\aWV
0x0040156f 9^\f~4
0x0040158b 8\bsS
0x0040159c IU\f;F\f
0x004015ec t +╥ì
0x004016a4 u\fj\a
0x00401759 u\fh8
0x0040176d \\SVW
0x0040178a D$(P
0x004017c8 %hhL
```

We can also check for the overall api calls/imports on the program. Calls related to network, file management, the register, virtual memory or process management may also indicate that the program has a suspiciously unusual interest in manipulating our operating system. LoadLibrary and GetprocessHandle may work in combination with hardcoded api-call strings! That is, to dynamically resolve them in memory (not usual on legitimate programs)

```
PS C:\Users\labo\Desktop > rabin2.exe -I -l -s '.\Zeichnungen Muster.bin'
[Symbols]

nth paddr      vaddr      bind type size lib          name
-------------------------------------------------------------
116 0x0008ebc8 0x0048f7c8 NONE FUNC 0    WSOCK32.dll  imp.WSACleanup
23  0x0008ebcc 0x0048f7cc NONE FUNC 0    WSOCK32.dll  imp.socket
12  0x0008ebd0 0x0048f7d0 NONE FUNC 0    WSOCK32.dll  imp.ioctlsocket
21  0x0008ebd4 0x0048f7d4 NONE FUNC 0    WSOCK32.dll  imp.setsockopt
15  0x0008ebd8 0x0048f7d8 NONE FUNC 0    WSOCK32.dll  imp.ntohs
17  0x0008ebdc 0x0048f7dc NONE FUNC 0    WSOCK32.dll  imp.recvfrom
10  0x0008ebe0 0x0048f7e0 NONE FUNC 0    WSOCK32.dll  imp.inet_addr
9   0x0008ebe4 0x0048f7e4 NONE FUNC 0    WSOCK32.dll  imp.htons
115 0x0008ebe8 0x0048f7e8 NONE FUNC 0    WSOCK32.dll  imp.WSAStartup
151 0x0008ebec 0x0048f7ec NONE FUNC 0    WSOCK32.dll  imp.__WSAFDIsSet
18  0x0008ebf0 0x0048f7f0 NONE FUNC 0    WSOCK32.dll  imp.select
1   0x0008ebf4 0x0048f7f4 NONE FUNC 0    WSOCK32.dll  imp.accept
13  0x0008ebf8 0x0048f7f8 NONE FUNC 0    WSOCK32.dll  imp.listen
2   0x0008ebfc 0x0048f7fc NONE FUNC 0    WSOCK32.dll  imp.bind
3   0x0008ec00 0x0048f800 NONE FUNC 0    WSOCK32.dll  imp.closesocket
111 0x0008ec04 0x0048f804 NONE FUNC 0    WSOCK32.dll  imp.WSAGetLastError
16  0x0008ec08 0x0048f808 NONE FUNC 0    WSOCK32.dll  imp.recv
20  0x0008ec0c 0x0048f80c NONE FUNC 0    WSOCK32.dll  imp.sendto
19  0x0008ec10 0x0048f810 NONE FUNC 0    WSOCK32.dll  imp.send
11  0x0008ec14 0x0048f814 NONE FUNC 0    WSOCK32.dll  imp.inet_ntoa
52  0x0008ec18 0x0048f818 NONE FUNC 0    WSOCK32.dll  imp.gethostbyname
57  0x0008ec1c 0x0048f81c NONE FUNC 0    WSOCK32.dll  imp.gethostname
4   0x0008ec20 0x0048f820 NONE FUNC 0    WSOCK32.dll  imp.connect
108 0x0008e710 0x0048f310 NONE FUNC 0    KERNEL32.dll imp.GetWindowsDirectoryW
109 0x0008e714 0x0048f314 NONE FUNC 0    KERNEL32.dll imp.GetCurrentProcessId
110 0x0008e718 0x0048f318 NONE FUNC 0    KERNEL32.dll imp.GetProcessIoCounters
111 0x0008e71c 0x0048f31c NONE FUNC 0    KERNEL32.dll imp.CreateProcessW
112 0x0008e720 0x0048f320 NONE FUNC 0    KERNEL32.dll imp.GetProcessId
113 0x0008e724 0x0048f324 NONE FUNC 0    KERNEL32.dll imp.SetPriorityClass
114 0x0008e728 0x0048f328 NONE FUNC 0    KERNEL32.dll imp.LoadLibraryW
115 0x0008e72c 0x0048f32c NONE FUNC 0    KERNEL32.dll imp.VirtualAlloc
116 0x0008e730 0x0048f330 NONE FUNC 0    KERNEL32.dll imp.IsDebuggerPresent
117 0x0008e734 0x0048f334 NONE FUNC 0    KERNEL32.dll imp.GetCurrentDirectoryW
118 0x0008e738 0x0048f338 NONE FUNC 0    KERNEL32.dll imp.lstrcmpiW
119 0x0008e73c 0x0048f33c NONE FUNC 0    KERNEL32.dll imp.DecodePointer
120 0x0008e740 0x0048f340 NONE FUNC 0    KERNEL32.dll imp.GetLastError
121 0x0008e744 0x0048f344 NONE FUNC 0    KERNEL32.dll imp.RaiseException
122 0x0008e748 0x0048f348 NONE FUNC 0    KERNEL32.dll
imp.InitializeCriticalSectionAndSpinCount
3   0x0008ebc0 0x0048f7c0 NONE FUNC 0    WINMM.dll    imp.mciSendStringW
1  [...]
120 0x0008eaa8 0x0048f6a8 NONE FUNC 0    USER32.dll   imp.SetProcessWindowStation
121 0x0008eaac 0x0048f6ac NONE FUNC 0    USER32.dll   imp.GetProcessWindowStation
122 0x0008eab0 0x0048f6b0 NONE FUNC 0    USER32.dll   imp.OpenWindowStationW
123 0x0008eab4 0x0048f6b4 NONE FUNC 0    USER32.dll   imp.GetUserObjectSecurity
124 0x0008eab8 0x0048f6b8 NONE FUNC 0    USER32.dll   imp.MessageBoxW
125 0x0008eabc 0x0048f6bc NONE FUNC 0    USER32.dll   imp.DefWindowProcW
```

```
126 0x0008eac0 0x0048f6c0 NONE FUNC 0    USER32.dll   imp.SetClipboardData
127 0x0008eac4 0x0048f6c4 NONE FUNC 0    USER32.dll   imp.EmptyClipboard
128 0x0008eac8 0x0048f6c8 NONE FUNC 0    USER32.dll   imp.CountClipboardFormats
129 0x0008eacc 0x0048f6cc NONE FUNC 0    USER32.dll   imp.CloseClipboard
130 0x0008ead0 0x0048f6d0 NONE FUNC 0    USER32.dll   imp.GetClipboardData
131 0x0008ead4 0x0048f6d4 NONE FUNC 0    USER32.dll   imp.IsClipboardFormatAvailable
132 0x0008ead8 0x0048f6d8 NONE FUNC 0    USER32.dll   imp.OpenClipboard
133 0x0008eadc 0x0048f6dc NONE FUNC 0    USER32.dll   imp.BlockInput
3   0x0008e814 0x0048f414 NONE FUNC 0    OLEAUT32.dll imp.SysAllocStringLen
6   0x0008e818 0x0048f418 NONE FUNC 0    OLEAUT32.dll imp.SysStringLen
38  0x0008e81c 0x0048f41c NONE FUNC 0    OLEAUT32.dll imp.SafeArrayDestroyData
39  0x0008e820 0x0048f420 NONE FUNC 0    OLEAUT32.dll imp.SafeArrayRedim
24  0x0008e824 0x0048f424 NONE FUNC 0    OLEAUT32.dll imp.SafeArrayGetElement
23  0x0008e828 0x0048f428 NONE FUNC 0    OLEAUT32.dll imp.SafeArrayUnaccessData
37  0x0008e82c 0x0048f42c NONE FUNC 0    OLEAUT32.dll imp.SafeArrayDestroyDescriptor
41  0x0008e830 0x0048f430 NONE FUNC 0    OLEAUT32.dll imp.SafeArrayCreateEx
411 0x0008e834 0x0048f434 NONE FUNC 0    OLEAUT32.dll imp.SafeArrayCopyData
163 0x0008e838 0x0048f438 NONE FUNC 0    OLEAUT32.dll imp.QueryPathOfRegTypeLib
32  0x0008e83c 0x0048f43c NONE FUNC 0    OLEAUT32.dll imp.RegisterActiveObject
146 0x0008e840 0x0048f440 NONE FUNC 0    OLEAUT32.dll imp.VariantChangeTypeEx
12  0x0008e844 0x0048f444 NONE FUNC 0    OLEAUT32.dll imp.VariantTimeToDosDateTime
7   0x0008e848 0x0048f448 NONE FUNC 0    OLEAUT32.dll imp.VariantInit
185 0x0008e84c 0x0048f44c NONE FUNC 0    OLEAUT32.dll imp.UnRegisterTypeLib
220 0x0008e850 0x0048f450 NONE FUNC 0    OLEAUT32.dll imp.VarDateFromI1
77  0x0008e854 0x0048f454 NONE FUNC 0    OLEAUT32.dll imp.VarR8FromUI1
10  0x0008e858 0x0048f458 NONE FUNC 0    OLEAUT32.dll imp.VariantCopyInd
9   0x0008e85c 0x0048f45c NONE FUNC 0    OLEAUT32.dll imp.VariantCopy
418 0x0008e860 0x0048f460 NONE FUNC 0    OLEAUT32.dll imp.OleCreatePictureIndirect
164 0x0008e864 0x0048f464 NONE FUNC 0    OLEAUT32.dll imp.LHashValOfNameSys
442 0x0008e868 0x0048f468 NONE FUNC 0    OLEAUT32.dll imp.UnRegisterTypeLibForUser
443 0x0008e86c 0x0048f46c NONE FUNC 0    OLEAUT32.dll
imp.OaEnablePerUserTLibRegistration
186 0x0008e870 0x0048f470 NONE FUNC 0    OLEAUT32.dll imp.VarDecFix
31  0x0008e874 0x0048f474 NONE FUNC 0    OLEAUT32.dll imp.CreateStdDispatch
2   0x0008e878 0x0048f478 NONE FUNC 0    OLEAUT32.dll imp.SysReAllocString
8   0x0008e87c 0x0048f47c NONE FUNC 0    OLEAUT32.dll imp.VariantClear
arch     x86
baddr    0x400000
binsz    2068983
bintype  pe
canary   true
retguard false
class    PE32
cmp.csum 0x002047e2
compiled Sun Apr 19 18:03:00 2020
crypto   false
endian   little
havecode true
hdr.csum 0x002047e2
laddr    0x0
lang     c
linenum  false
```

```
lsyms    false
machine  i386
nx       false
os       windows
overlay  true
cc       cdecl
pic      true
relocs   false
signed   false
sanitize false
static   false
stripped false
subsys   Windows GUI
va       true
[Linked libraries]
wsock32.dll
version.dll
winmm.dll
comctl32.dll
mpr.dll
wininet.dll
psapi.dll
iphlpapi.dll
userenv.dll
uxtheme.dll
kernel32.dll
user32.dll
gdi32.dll
comdlg32.dll
advapi32.dll
shell32.dll
ole32.dll
oleaut32.dll

18 libraries
PS C:\Users\labo\Desktop >
```

We can also check for the program sections:

```
[0x005e4000]> iS
[Sections]

nth paddr           size vaddr          vsize perm name
----------------------------------------------------------
0   0x00000400   0x8e000 0x00401000   0x8e000 -r-x .text
1   0x0008e400   0x2fe00 0x0048f000   0x30000 -r-- .rdata
2   0x000be200    0x5200 0x004bf000    0x9000 -rw- .data
3   0x000c3400  0x113a00 0x004c8000  0x114000 -r-- .rsrc
4   0x001d6e00    0x7200 0x005dc000    0x8000 -r-- .reloc
5   0x001de000   0x1b000 0x005e4000   0x1b000 -rwx .text_1

[0x005e4000]>
```

In this case it's a bit suspicious to have a .text and a .text_1 both with X permissions, one of them RWX… Also it looks like the program won't start from a typical mem addr…

We can go check for the content of the sections, to see if any of them actually holds a bufer (other binary for example, compressed stuff etc):

```
pxw 800 @ 0x005d4000
0x005d4000  0x0000e860 0x8b5d0000 0xa8ed81c5 0x2b2001a6  `.....]....... +
0x005d4010  0x01ae0f85 0x0b858920 0xb02001ae 0x40858600  .... ..... ....@
0x005d4020  0x3c2001b0 0xbc850f01 0x83000001 0x01af3bbd  .. <.........;..
0x005d4030  0x33740020 0xaf3fbd83 0x74002001 0x0b858b2a   .t3..?.. .t*...
0x005d4040  0x2b2001ae 0x01af3b85 0x89008b20 0x01af7885  .. +.;.. ....x..
0x005d4050  0x0b858b20 0x2b2001ae 0x01af3f85 0x89008b20   ..... +.?.. ...
0x005d4060  0x01af7c85 0x8361eb20 0x01af43bd 0x58740020  .|.. .a..C.. .tX
0x005d4070  0xae0b858b 0x852b2001 0x2001af43 0x858d30ff  ..... +.C.. .0..
0x005d4080  0x2001aa94 0xc00bd0ff 0x85893e74 0x2001af47  ... ....t>..G..
0x005d4090  0xaf4b858d 0xff502001 0x01af47b5 0x858d5520  ..K.. P..G.. U..
0x005d40a0  0x2001aad3 0x8589d0ff 0x2001af78 0xaf58858d  ... ....x.. ..X.
0x005d40b0  0xff502001 0x01af47b5 0x858d5520 0x2001aad3  . P..G.. U.....
0x005d40c0  0x8589d0ff 0x2001af7c 0xaf7cbd83 0x0f002001  ....|.. ..|.. ..

[0x005e4000]> pxw @ 0x00401000
0x00401000  0x4c5144b9 0xa507e800 0xa9680003 0xe80043b7  .DQL......h..C..
0x00401010  0x00021f6c 0xb7e8c359 0x6800003a 0x0043b7b3  l...Y...:..h..C.
0x00401020  0x021f5be8 0xe8c35900 0x000039e4 0x43b7b968  .[...Y...9..h..C
0x00401030  0x1f4ae800 0xc3590002 0x43b7be68 0x1f3ee800  ..J...Y.h..C..>.
0x00401040  0xc3590002 0x002c5fe8 0xb7c36800 0x2de80043  ..Y.._,..h..C..-
0x00401050  0x5900021f 0x15efe8c3 0xc8680000 0xe80043b7  ...Y......h..C..
0x00401060  0x00021f1c 0xe851c359 0x0000e863 0x43b7cd68  ....Y.Q.c...h..C
0x00401070  0x1f0ae800 0xc3590002 0x4c6310a1 0x408b5100  ......Y...cL.Q.@
0x00401080  0x63100504 0xe850004c 0x0000615f 0x43b7e268  ...cL.P._a..h..C
0x00401090  0x1eeae800 0xc3590002 0x003196e8 0xb7e76800  ......Y...1..h..
0x004010a0  0xd9e80043 0x5900021e 0x7546e8c3 0xec680000  C......Y..Fu..h.
0x004010b0  0xe80043b7 0x00021ec8 0xc7e8c359 0x6800014d  .C......Y...M..h
0x004010c0  0x0043b7f1 0x021eb7e8 0xb9c35900 0x004c7404  ..C......Y...tL.
0x004010d0  0x0066f2e8 0xb8006800 0xa1e80043 0x5900021e  ..f..h..C......Y
0x004010e0  0xcccccccc 0xcccccccc 0xcccccccc 0xcccccccc  ................
0x004010f0  0x8b575653 0x5b0d6af1 0x016cbe8d 0xef830000  SVW..j.[..l.....
```

But don't expect to find a lot by just pxw'ing whats in there…

And we can also go check the entropy for each sections, so in here we are already getting some hints:

```
[0x005e4000]> iS entropy
[Sections]

nth paddr           size vaddr          vsize perm entropy    name
----------------------------------------------------------------
0   0x00000400   0x8e000 0x00401000   0x8e000 -r-x 6.67524835 .text
1   0x0008e400   0x2fe00 0x0048f000   0x30000 -r-- 5.76322253 .rdata
2   0x000be200    0x5200 0x004bf000    0x9000 -rw- 1.19638192 .data
3   0x000c3400  0x113a00 0x004c8000  0x114000 -r-- 7.98164843 .rsrc
4   0x001d6e00    0x7200 0x005dc000    0x8000 -r-- 6.78395556 .reloc
5   0x001de000   0x1b000 0x005e4000   0x1b000 -rwx 7.87108038 .text_1
```

And we can be even more precise…

```
PS C:\Users\labo\Desktop> radare2.exe -qfnc 'p=e 30'
"C:\Users\labo\Desktop\Zeichnungen Muster.bin.exe"
0x00000000 000 00d1 |##########################################
0x00010d66 001 00c3 |####
0x00021acc 002 00d5 |#
0x00032832 003 00d7 |############################################
0x00043598 004 00d1 |#
0x000542fe 005 00d3 |##########################################
0x00065064 006 00cf |#
0x00075dca 007 00d0 |########################################
0x00086b30 008 00c6 |#####################################
0x00097896 009 00bd |###################################
0x000a85fc 00a 009f |##############################
0x000b9362 00b 0086 |########################
0x000ca0c8 00c 00fa |#
0x000dae2e 00d 00fe |#
0x000ebb94 00e 00fe |#
0x000fc8fa 00f 00fe |#
0x0010d660 010 00fe |#
0x0011e3c6 011 00fe |#
0x0012f12c 012 00fe |#
0x0013fe92 013 00fe |#
0x00150bf8 014 00fe |#
0x0016195e 015 00fe |#
0x001726c4 016 00fe |#
0x0018342a 017 00fe |#
0x00194190 018 00fe |#
0x001a4ef6 019 00fe |#
0x001b5c5c 01a 00fe |#
0x001c69c2 01b 00fe |#####################################################
0x001d7728 01c 00f6 |#
0x001e848e 01d 00f6 |###################################################
PS C:\Users\labo\Desktop>
```

Having done this basic analysis I would be confident that the binary holds something packed into it. So the next step would involve opening it in radare2 to do the debugging:

```
radare2 -AAA
[0x005e4000]> ood
Spawned new process with pid 2904, tid = 2104
= attach 2904 2104
File dbg://C:\\Users\\labo\\Desktop\\Zeichnungen\ Muster.bin.exe  reopened in read-
write mode
2904
[0x777b3820]> pd 10
            ;-- rip:
            0x777b3820      48             dec eax
            0x777b3821      83ec48         sub esp, 0x48
            0x777b3824      4c             dec esp
            0x777b3825      8bc9           mov ecx, ecx
            0x777b3827      48             dec eax
            0x777b3828      8b055af40d00   mov eax, dword [0xdf45a]    ;
[0xdf45a:4]=-1
            0x777b382e      48             dec eax
            0x777b382f      85c0           test eax, eax
        ,=< 0x777b3831      740c           je 0x777b383f
        |   0x777b3833      4c             dec esp
[0x777b3820]> dcu entry0
Continue until 0x00ad4000 using 1 bpsize
(2904) loading library at 0x0000000077760000 (C:\Windows\System32\ntdll.dll)
ntdll.dll
(2904) loading library at 0x0000000077920000 (C:\Windows\SysWOW64\ntdll.dll)
ntdll.dll
(2904) loading library at 0x0000000074410000 (C:\Windows\System32\wow64.dll)
wow64.dll
(2904) loading library at 0x00000000743B0000 (C:\Windows\System32\wow64win.dll)
wow64win.dll
(2904) loading library at 0x00000000743A0000 (C:\Windows\System32\wow64cpu.dll)
wow64cpu.dll
[0x77806fb1]> dcu entry0
Continue until 0x00ad4000 using 1 bpsize
(2904) loading library at 0x0000000077540000 (C:\Windows\System32\kernel32.dll)
kernel32.dll
(2904) unloading library at 0x0000000077540000 (C:\Windows\System32\kernel32.dll)
kernel32.dll
(2904) loading library at 0x00000000765F0000 (C:\Windows\SysWOW64\kernel32.dll)
kernel32.dll
(2904) unloading library at 0x00000000765F0000 (C:\Windows\SysWOW64\kernel32.dll)
kernel32.dll
(2904) loading library at 0x0000000077540000 (C:\Windows\System32\kernel32.dll)
kernel32.dll
(2904) unloading library at 0x0000000077540000 (C:\Windows\System32\kernel32.dll)
kernel32.dll
(2904) loading library at 0x0000000077660000 (C:\Windows\System32\user32.dll)
user32.dll
(2904) unloading library at 0x0000000077660000 (C:\Windows\System32\user32.dll)
user32.dll
(2904) loading library at 0x00000000765F0000 (C:\Windows\SysWOW64\kernel32.dll)
kernel32.dll
```

```
(2904) loading library at 0x0000000076800000 (C:\Windows\SysWOW64\KernelBase.dll)
KernelBase.dll
(2904) loading library at 0x0000000074390000 (C:\Windows\SysWOW64\wsock32.dll)
wsock32.dll
(2904) loading library at 0x0000000076880000 (C:\Windows\SysWOW64\ws2_32.dll)
ws2_32.dll
(2904) loading library at 0x0000000077480000 (C:\Windows\SysWOW64\msvcrt.dll)
msvcrt.dll
(2904) loading library at 0x0000000075E60000 (C:\Windows\SysWOW64\rpcrt4.dll)
rpcrt4.dll
(2904) loading library at 0x0000000075090000 (C:\Windows\SysWOW64\sspicli.dll)
sspicli.dll
(2904) loading library at 0x0000000075080000 (C:\Windows\SysWOW64\cryptbase.dll)
cryptbase.dll
(2904) loading library at 0x00000000761C0000 (C:\Windows\SysWOW64\sechost.dll)
sechost.dll
(2904) loading library at 0x0000000077530000 (C:\Windows\SysWOW64\nsi.dll) nsi.dll
(2904) loading library at 0x0000000074380000 (C:\Windows\SysWOW64\version.dll)
version.dll
(2904) loading library at 0x0000000074340000 (C:\Windows\SysWOW64\winmm.dll)
winmm.dll
(2904) loading library at 0x0000000077370000 (C:\Windows\SysWOW64\user32.dll)
user32.dll
(2904) loading library at 0x00000000761F0000 (C:\Windows\SysWOW64\gdi32.dll)
gdi32.dll
(2904) loading library at 0x0000000076410000 (C:\Windows\SysWOW64\lpk.dll) lpk.dll
(2904) loading library at 0x0000000075F60000 (C:\Windows\SysWOW64\usp10.dll)
usp10.dll
(2904) loading library at 0x0000000076700000 (C:\Windows\SysWOW64\advapi32.dll)
advapi32.dll
(2904) loading library at 0x000000006E780000
(C:\Windows\winsxs\x86_microsoft.windows.common-controlll32.dll) comctl32.d
(2904) loading library at 0x00000000750F0000 (C:\Windows\SysWOW64\shlwapi.dll)
shlwapi.dll
(2904) loading library at 0x0000000074320000 (C:\Windows\SysWOW64\mpr.dll) mpr.dll
(2904) loading library at 0x0000000076A70000 (C:\Windows\SysWOW64\wininet.dll)
wininet.dll
(2904) loading library at 0x00000000768C0000 (C:\Windows\SysWOW64\api-ms-win-
downlevel-user32-l1-1-0.dllel-user32-l1-1-0
(2904) loading library at 0x00000000764B0000 (C:\Windows\SysWOW64\api-ms-win-
downlevel-shlwapi-l1-1--0.dlll-shlwapi-l1-1
(2904) loading library at 0x0000000075E50000 (C:\Windows\SysWOW64\api-ms-win-
downlevel-version-l1-1--0.dlll-version-l1-1
(2904) loading library at 0x0000000077360000 (C:\Windows\SysWOW64\api-ms-win-
downlevel-normaliz-l1-1-1-0.dll-normaliz-l1
(2904) loading library at 0x00000000761B0000 (C:\Windows\SysWOW64\normaliz.dll)
normaliz.dll
(2904) loading library at 0x0000000076F30000 (C:\Windows\SysWOW64\iertutil.dll)
iertutil.dll
(2904) loading library at 0x0000000075F50000 (C:\Windows\SysWOW64\api-ms-win-
downlevel-advapi32-l1-1-1-0.dll-advapi32-l1
(2904) loading library at 0x0000000075150000 (C:\Windows\SysWOW64\userenv.dll)
```

```
userenv.dll
(2904) loading library at 0x0000000077470000 (C:\Windows\SysWOW64\profapi.dll)
profapi.dll
(2904) loading library at 0x00000000761E0000 (C:\Windows\SysWOW64\psapi.dll)
psapi.dll
(2904) loading library at 0x0000000074300000 (C:\Windows\SysWOW64\IPHLPAPI.DLL)
IPHLPAPI.DLL
(2904) loading library at 0x00000000742F0000 (C:\Windows\SysWOW64\winnsi.dll)
winnsi.dll
(2904) loading library at 0x0000000074210000 (C:\Windows\SysWOW64\uxtheme.dll)
uxtheme.dll
(2904) loading library at 0x0000000076280000 (C:\Windows\SysWOW64\comdlg32.dll)
comdlg32.dll
(2904) loading library at 0x0000000075200000 (C:\Windows\SysWOW64\shell32.dll)
shell32.dll
(2904) loading library at 0x0000000076020000 (C:\Windows\SysWOW64\ole32.dll)
ole32.dll
(2904) loading library at 0x0000000076310000 (C:\Windows\SysWOW64\oleaut32.dll)
oleaut32.dll
[0x779c0fc5]> dcu entry0
Continue until 0x00ad4000 using 1 bpsize
(2904) loading library at 0x0000000077300000 (C:\Windows\SysWOW64\imm32.dll)
imm32.dll
(2904) loading library at 0x0000000076E60000 (C:\Windows\SysWOW64\msctf.dll)
msctf.dll
hit breakpoint at: 0xad4000
[0x00ad4000]>
```

So we run the program until we reach the entry point (entry0) to allow it to load the requiered libraries.

After that, we can try to pd/pdf and see if we can easily grasp something. But in many cases such as that its either we have a lot of time and/or a huge interesting in knowing everything or we'd just set breakpoints on relevant api calls and try to detect some behaviour.

So the program starts with what looks like some decoding process:

```
[0x00ad4000]> pd 20
            ;-- section..text_1:
            ;-- map.IMAGE____.__x:
            ;-- rdx:
            ;-- rip:
/ 506: entry0 (int32_t arg_1ch);
|           ; var int32_t var_1ch_2 @ rsp+0x1c
|           ; var int32_t var_1ch @ rsp+0x60
|           ; arg int32_t arg_1ch @ rsp+0x70
|           0x00ad4000      60             pushal                      ; [05] -rwx
section size 110592 named .text_1
|           0x00ad4001      e800000000     call 0xad4006
|           ; CALL XREF from entry0 @ 0xad4001
|           0x00ad4006      5d             pop ebp
|           0x00ad4007      8bc5           mov eax, ebp
|           0x00ad4009      81eda8a60120   sub ebp, 0x2001a6a8
|           0x00ad400f      2b850fae0120   sub eax, dword [ebp + 0x2001ae0f]
|           0x00ad4015      89850bae0120   mov dword [ebp + 0x2001ae0b], eax
|           0x00ad401b      b000           mov al, 0
|           0x00ad401d      868540b00120   xchg byte [ebp + 0x2001b040], al
|           0x00ad4023      3c01           cmp al, 1                   ; 1
|       ,=< 0x00ad4025      0f85bc010000   jne 0xad41e7
|       |   0x00ad402b      83bd3baf0120.  cmp dword [ebp + 0x2001af3b], 0
|      ,==< 0x00ad4032      7433           je 0xad4067
|      ||   0x00ad4034      83bd3faf0120.  cmp dword [ebp + 0x2001af3f], 0
|     ,===< 0x00ad403b      742a           je 0xad4067
|     |||   0x00ad403d      8b850bae0120   mov eax, dword [ebp + 0x2001ae0b]
|     |||   0x00ad4043      2b853baf0120   sub eax, dword [ebp + 0x2001af3b]
|     |||   0x00ad4049      8b00           mov eax, dword [eax]
|     |||   0x00ad404b      898578af0120   mov dword [ebp + 0x2001af78], eax
|     |||   0x00ad4051      8b850bae0120   mov eax, dword [ebp + 0x2001ae0b]
[0x00ad4000]>
```

Ok so the packed hypothesis gains traction. The next thing from this point on is to go for the breakpoint in api calls strategy. In order to do that, let’s go check the libraries we have:

```
[0x005d4000]> dmi
[0x00ad4000]> dmi
0x008f0000 0x00aef000  C:\Users\labo\Desktop\Zeichnungen Muster.bin.exe
0x77760000 0x778ff000  C:\Windows\SYSTEM32\ntdll.dll
0x74410000 0x7444f000  C:\Windows\SYSTEM32\wow64.dll
0x743b0000 0x7440c000  C:\Windows\SYSTEM32\wow64win.dll
0x743a0000 0x743a8000  C:\Windows\SYSTEM32\wow64cpu.dll
0x008f0000 0x00aef000  C:\Users\labo\Desktop\Zeichnungen Muster.bin.exe
0x77920000 0x77aa0000  C:\Windows\SysWOW64\ntdll.dll
0x765f0000 0x76700000  C:\Windows\syswow64\kernel32.dll
0x76800000 0x76847000  C:\Windows\syswow64\KERNELBASE.dll
0x74390000 0x74397000  C:\Windows\SysWOW64\WSOCK32.dll
0x76880000 0x768b5000  C:\Windows\syswow64\WS2_32.dll
0x77480000 0x7752c000  C:\Windows\syswow64\msvcrt.dll
0x75e60000 0x75f50000  C:\Windows\syswow64\RPCRT4.dll
0x75090000 0x750f0000  C:\Windows\syswow64\SspiCli.dll
0x75080000 0x7508c000  C:\Windows\syswow64\CRYPTBASE.dll
0x761c0000 0x761d9000  C:\Windows\SysWOW64\sechost.dll
0x77530000 0x77536000  C:\Windows\syswow64\NSI.dll
0x74380000 0x74389000  C:\Windows\SysWOW64\VERSION.dll
0x74340000 0x74372000  C:\Windows\SysWOW64\WINMM.dll
0x77370000 0x77470000  C:\Windows\syswow64\USER32.dll
0x761f0000 0x76280000  C:\Windows\syswow64\GDI32.dll
0x76410000 0x7641a000  C:\Windows\syswow64\LPK.dll
0x75f60000 0x75ffd000  C:\Windows\syswow64\USP10.dll
0x76700000 0x767a1000  C:\Windows\syswow64\ADVAPI32.dll
0x6e780000 0x6e91e000  C:\Windows\WinSxS\x86_microsoft.windows.common-
controls_6595b64144ccf1df_6.0.2.dllbd5705d\COMCTL
0x750f0000 0x75147000  C:\Windows\syswow64\SHLWAPI.dll
0x74320000 0x74332000  C:\Windows\SysWOW64\MPR.dll
0x76a70000 0x76e51000  C:\Windows\syswow64\WININET.dll
0x768c0000 0x768c4000  C:\Windows\syswow64\api-ms-win-downlevel-user32-l1-1-0.dll
0x764b0000 0x764b4000  C:\Windows\syswow64\api-ms-win-downlevel-shlwapi-l1-1-0.dll
0x75e50000 0x75e54000  C:\Windows\syswow64\api-ms-win-downlevel-version-l1-1-0.dll
0x77360000 0x77363000  C:\Windows\syswow64\api-ms-win-downlevel-normaliz-l1-1-0.dll
0x761b0000 0x761b3000  C:\Windows\syswow64\normaliz.DLL
0x76f30000 0x77166000  C:\Windows\syswow64\iertutil.dll
0x75f50000 0x75f55000  C:\Windows\syswow64\api-ms-win-downlevel-advapi32-l1-1-0.dll
0x75150000 0x75167000  C:\Windows\syswow64\USERENV.dll
0x77470000 0x7747b000  C:\Windows\syswow64\profapi.dll
0x761e0000 0x761e5000  C:\Windows\syswow64\PSAPI.DLL
0x74300000 0x7431c000  C:\Windows\SysWOW64\IPHLPAPI.DLL
0x742f0000 0x742f7000  C:\Windows\SysWOW64\WINNSI.DLL
0x74210000 0x74290000  C:\Windows\SysWOW64\UxTheme.dll
0x76280000 0x762fb000  C:\Windows\syswow64\COMDLG32.dll
0x75200000 0x75e4c000  C:\Windows\syswow64\SHELL32.dll
0x76020000 0x7617d000  C:\Windows\syswow64\ole32.dll
0x76310000 0x763a1000  C:\Windows\syswow64\OLEAUT32.dll
0x77300000 0x77360000  C:\Windows\SysWOW64\IMM32.DLL
0x76e60000 0x76f2d000  C:\Windows\syswow64\MSCTF.dll
[0x00ad4000]>
```

And then identify some interesting file / memory management / process injection related api calls in kernel32 and set those breakpoints there:

```
[0x00ad4000]> dmi kernel32 VirtualAlloc
[Symbols]

nth  paddr      vaddr      bind   type size lib                              name
------------------------------------------------------------------------------
1264 0x00011826 0x76601826 GLOBAL FUNC 0    KERNEL32.dll
VirtualAlloc
4    0x00010908 0x76600908 NONE   FUNC 0    API-MS-Win-Core-Memory-L1-1-0.dll
imp.VirtualAlloc
[0x00ad4000]> dmi kernel32 VirtualProtect
[Symbols]

nth  paddr      vaddr      bind   type size lib                              name
------------------------------------------------------------------------------
1270 0x000143be 0x766043be GLOBAL FUNC 0    KERNEL32.dll
VirtualProtect
8    0x00010918 0x76600918 NONE   FUNC 0    API-MS-Win-Core-Memory-L1-1-0.dll
imp.VirtualProtect
[0x00ad4000]> dmi kernel32 WriteFile
[Symbols]

nth  paddr      vaddr      bind   type size lib                            name
------------------------------------------------------------------------------
1324 0x00011282 0x76601282 GLOBAL FUNC 0    KERNEL32.dll                    WriteFile
9    0x000109e4 0x766009e4 NONE   FUNC 0    API-MS-Win-Core-File-L1-1-0.dll
imp.WriteFile
[0x00ad4000]> dmi kernel32 CreateProcessInternalW
[Symbols]

nth paddr      vaddr      bind   type size lib          name
------------------------------------------------------------
170 0x00023c23 0x76613c23 GLOBAL FUNC 0    KERNEL32.dll CreateProcessInternalW
[0x00ad4000]> dmi kernel32 CreateProcessInternalA
[Symbols]

nth paddr      vaddr      bind   type size lib          name
------------------------------------------------------------
169 0x0002a507 0x7661a507 GLOBAL FUNC 0    KERNEL32.dll CreateProcessInternalA
[
[0x00ad4000]>
[0x00ad4000]> dmi kernel32 IsDebuggerPresent
[Symbols]

nth paddr      vaddr      bind   type size lib                              name
------------------------------------------------------------------------------
770 0x0001494d 0x7660494d GLOBAL FUNC 0    KERNEL32.dll
IsDebuggerPresent
4   0x00010d94 0x76600d94 NONE   FUNC 0    API-MS-Win-Core-Debug-L1-1-0.dll
imp.IsDebuggerPresent
```

Basically we'll want to see if the program writes any content on disk and/or on memory and if it does we'll also want to know if the malware tries to run that in some way.

NtResumeThread/NtResumeProcess are useful for that same reason as well:

```
0x00ad4000]> dmi ntdll NtResumeThread
[Symbols]

nth paddr      vaddr      bind   type size lib       name
-----------------------------------------------------------
480 0x000691c0 0x777c9dc0 GLOBAL FUNC 0    ntdll.dll NtResumeThread
```

Here's a list of some breakpoints that I would set, based on the functions listed:

```
[0x00ad4000]> db 0x7660494d
[0x00ad4000]> db
0x76601826 - 0x76601827 1 --x sw break enabled valid cmd="" cond="" name="0x76601826"
module=""
0x766043be - 0x766043bf 1 --x sw break enabled valid cmd="" cond="" name="0x766043be"
module=""
0x76601282 - 0x76601283 1 --x sw break enabled valid cmd="" cond="" name="0x76601282"
module=""
0x76613c23 - 0x76613c24 1 --x sw break enabled valid cmd="" cond="" name="0x76613c23"
module=""
0x7661a507 - 0x7661a508 1 --x sw break enabled valid cmd="" cond="" name="0x7661a507"
module=""
0x777c9dc0 - 0x777c9dc1 1 --x sw break enabled valid cmd="" cond="" name="0x777c9dc0"
module=""
0x7660494d - 0x7660494e 1 --x sw break enabled valid cmd="" cond="" name="0x7660494d"
module=""
[0x00ad4000]>
```

Having set those, let's do dc and see if we hit any:

We hit the first breakpoint, and it corresponds to WriteFile. Let's inspect the stack:

```
[0x762c35b0]> pxr @rsp
0x015ff9bc 0x005d46ed  .F]. @ rsp IMAGE  .text_1 R W X 'mov ebx, dword [ebp + 8]'
'IMAGE '
0x015ff9c0 0x00000210  .... 528 rdx
0x015ff9c4 0x005d499f  .I]. IMAGE  .text_1 R W X 'dec ebp' 'IMAGE '
0x015ff9c8 0x0001a600  ....
0x015ff9cc 0x015ff9d8  ..._. PRIVATE  rax R W 0xca373ff5
0x015ff9d0 ..[ null bytes ]..   00000000
0x015ff9d4 0x00000210  .... 528 rdx
0x015ff9d8 0xca373ff5  .?7. @ rax
0x015ff9dc 0xe05b995e  ^.[. @ rbp rbx
0x015ff9e0 0x005d41c6  .A]. IMAGE  .text_1 entry0 R W X 'cmp eax, 1' 'IMAGE '
0x015ff9e4 0xe05b995e  ^.[. rbx
0x015ff9ec 0x005d499f  .I]. IMAGE  .text_1 R W X 'dec ebp' 'IMAGE '
```

Ok si it’s defefinetely writing something into the stack, what it is?

```
[0x76601282]> pxw 400 @ 0x00ad499f
0x00ad499f  0x00905a4d 0x00000003 0x00000004 0x0000ffff  MZ..............
0x00ad49af  0x000000b8 0x00000000 0x00000040 0x00000000  ........@.......
0x00ad49bf  0x00000000 0x00000000 0x00000000 0x00000000  ................
0x00ad49cf  0x00000000 0x00000000 0x00000000 0x00000088  ................
0x00ad49df  0xc5f5da09 0x25ea24c8 0x7e5c05f0 0xfa1056b5  .....$.%..\~.V..
0x00ad49ef  0x8427934a 0x1bc0eb0a 0xcb8422dc 0xb1054f0c  J.'......"...O..
0x00ad49ff  0x04feeb0e 0x2b7bbfa2 0x7338965b 0xbe932367  ......{+[.8sg#..
0x00ad4a0f  0x6a7d9a28 0x17c1b915 0x10bcf4d0 0x0ce64e2f  (.}j......../N..
0x00ad4a1f  0x00000000 0x00000000 0x00004550 0x0003014c  ........PE..L...
0x00ad4a2f  0x356b0f6b 0x00000000 0x00000000 0x010f00e0  k.k5............
0x00ad4a3f  0x0407010b 0x00013000 0x00008000 0x0003a000  .....0..........
0x00ad4a4f  0x0004d240 0x0003b000 0x0004e000 0x00400000  @.............@.
0x00ad4a5f  0x00001000 0x00000200 0x00000005 0x00020007  ................
0x00ad4a6f  0x00000004 0x00000000 0x0005d000 0x00001000  ................
0x00ad4a7f  0x00000000 0x00000002 0x00100000 0x00001000  ................
0x00ad4a8f  0x00100000 0x00001000 0x00000000 0x00000010  ................
0x00ad4a9f  0x00000000 0x00000000 0x00055874 0x000000e4  ........tX......
0x00ad4aaf  0x0004e000 0x0000f000 0x00000000 0x00000000  ................
0x00ad4abf  0x00000000 0x00000000 0x00000000 0x00000000  ................
0x00ad4acf  0x00000000 0x00000000 0x00000000 0x00000000  ................
0x00ad4adf  0x00000000 0x00000000 0x00000000 0x00000000  ................
0x00ad4aef  0x00000000 0x00000000 0x00000000 0x00000000  ................
0x00ad4aff  0x00000000 0x00000000 0x00000000 0x00000000  ................
0x00ad4b0f  0x00000000 0x00000000 0x00000000 0x00000000  ................
0x00ad4b1f  0x30585055 0x00000000 0x0003a000 0x00001000  UPX0............
```

Nice it is writting something that looks like a UPX packed binary(so vintage)! Let’s move on, let’s see if it loads it/runs it at some point:

And we hit dc and… we get to a CreateProcess* call!

```
hit breakpoint at: 0x76613c23
[0x76613c23]> pxr @ rsp
0x0064f68c 0x7661a62a  *.av @ rsp IMAGE    kernel32.dll | .text R X | .text'rd [ebp -
0x1c], eax' 'IMAGE    kernel32.dll
0x0064f690 ..[ null bytes ]..   00000000
0x0064f698 0x006e77d8  .wn. PRIVATE   R W 0x3a0043
0x0064f69c ..[ null bytes ]..   00000000
0x0064f6b4 0x0064f6d0  ..d. PRIVATE   rax,rcx R W 0x48
0x0064f6b8 0x0064f7d0  ..d. PRIVATE   R W 0x0
0x0064f6bc ..[ null bytes ]..   00000000
0x0064f6c0 0x55a1e22d  -..U
0x0064f6c4 0x0064f7e0  ..d. PRIVATE   R W 0x0
0x0064f6c8 0x014d4795  .GM. IMAGE    Zeichnungen Muster.bin.exe | .text .text_1 R W
Xster.bin.exe | .text' r.binmgr.exee

[0x76613c23]> pxw @ 0x006e77d8
0x006e77d8  0x003a0043 0x0055005c 0x00650073 0x00730072  C.:.\.U.s.e.r.s.
0x006e77e8  0x006c005c 0x00620061 0x005c006f 0x00650044  \.l.a.b.o.\.D.e.
0x006e77f8  0x006b0073 0x006f0074 0x005c0070 0x0065005a  s.k.t.o.p.\.Z.e.
0x006e7808  0x00630069 0x006e0068 0x006e0075 0x00650067  i.c.h.n.u.n.g.e.
0x006e7818  0x0020006e 0x0075004d 0x00740073 0x00720065  n. .M.u.s.t.e.r.
0x006e7828  0x0062002e 0x006e0069 0x0067006d 0x002e0072  ..b.i.n.m.g.r...
0x006e7838  0x00780065 0x00000065 0xabababab 0xabababab  e.x.e...........
0x006e7848  0x00000000 0x00000000 0x71fd6008 0x0000de77  ........`.qw...
0x006e7858  0x006e9820 0x006e00c4 0x77fe600d 0x1800de65   .n...n..`.we...
0x006e7868  0x00000000 0x00c70138 0x006e7ee0 0x006e35c8  ....8....~n..5n.
0x006e7878  0x00000000 0x00000000 0x00000000 0xbaad0000  ................
0x006e7888  0xabababab 0xabababab 0x00000000 0x00000000  ................
0x006e7898  0x34fe604e 0x1800de60 0xfffde210 0xfffde210  N`.4`...........
0x006e78a8  0x00000000 0x00c707e0 0x00000000 0x00000000  ................
```

And its creating a process on our newly created executable 8)

So at this point, if we proceed hitting dc we'll see a call to NtResumeProcess (as the created process will spawn in a suspended state), so the newly created binary will start its executing while the original one will go one, getting inside a loop checking for processes starting the second program if it stops somehow (more or less).

As we are interested in the unpacking part, at this point we can either attach to the newly created process with (radare2 -d process id) or just open the generated binary for analysis/debug. I'll go for the second option.

Unpacking the second binary

So as we detected, the second binary is UPX packed. We can either unpack it manually by checking for VirtualAlloc and stuff like that or we can just simply do upx -d (upx is included in the FLARE-VM or can be downloaded from the site)

```
PS C:\Users\labo\Desktop> upx -d '.\Zeichnungen Muster.binmgr.exe'
                       Ultimate Packer for eXecutables
                          Copyright (C) 1996 - 2020
UPX 3.96w       Markus Oberhumer, Laszlo Molnar & John Reiser   Jan 23rd 2020

        File size         Ratio      Format      Name
   --------------------   ------   -----------   -----------
    159232 <-    108032   67.85%    win32/pe     Zeichnungen Muster.binmgr.exe

Unpacked 1 file.
PS C:\Users\labo\Desktop>
```

After we unpack the program, its entropy descends to something that looks more normal:

```
PS C:\Users\labo\Desktop> rahash2.exe -a entropy '.\Zeichnungen Muster.binmgr.exe'
.\Zeichnungen Muster.binmgr.exe: 0x00000000-0x00026dff entropy: 4.46272451
PS C:\Users\labo\Desktop>
```

Also, we are not seeing weird stuff on its sections:

```
[0x0040101a]> iS
[Sections]

nth paddr          size vaddr         vsize perm name
-----------------------------------------------------
0   0x00000400   0x1200 0x00401000   0x2000 -r-x .text
1   0x00001600  0x1cc00 0x00403000  0x3f000 -rw- .data
2   0x0001e200    0x200 0x00442000   0x1000 -r-- .rdata
3   0x0001e400   0x8a00 0x00443000   0x9000 -r-- .rsrc
```

But still, let’s go on and debug:

```
[0x0040101a]> ood
Spawned new process with pid 2316, tid = 1172
= attach 2316 1172
File dbg://C:\\Users\\labo\\Desktop\\Zeichnungen\ Muster.binmgr.exe  reopened in
read-write mode
2316
[0x777b3820]> dcu entry0
Continue until 0x0040101a using 1 bpsize
(2316) loading library at 0x0000000077760000 (C:\Windows\System32\ntdll.dll)
ntdll.dll
(2316) loading library at 0x0000000077920000 (C:\Windows\SysWOW64\ntdll.dll)
ntdll.dll
(2316) loading library at 0x00000000743E0000 (C:\Windows\System32\wow64.dll)
wow64.dll
(2316) loading library at 0x0000000074380000 (C:\Windows\System32\wow64win.dll)
wow64win.dll
(2316) loading library at 0x0000000074450000 (C:\Windows\System32\wow64cpu.dll)
wow64cpu.dll
[0x77806fb1]> dcu entry0
Continue until 0x0040101a using 1 bpsize
(2316) loading library at 0x0000000077540000 (C:\Windows\System32\kernel32.dll)
kernel32.dll
(2316) unloading library at 0x0000000077540000 (C:\Windows\System32\kernel32.dll)
kernel32.dll
(2316) loading library at 0x00000000765F0000 (C:\Windows\SysWOW64\kernel32.dll)
kernel32.dll
(2316) unloading library at 0x00000000765F0000 (C:\Windows\SysWOW64\kernel32.dll)
kernel32.dll
(2316) loading library at 0x0000000077540000 (C:\Windows\System32\kernel32.dll)
kernel32.dll
(2316) unloading library at 0x0000000077540000 (C:\Windows\System32\kernel32.dll)
kernel32.dll
(2316) loading library at 0x0000000077660000 (C:\Windows\System32\user32.dll)
user32.dll
(2316) unloading library at 0x0000000077660000 (C:\Windows\System32\user32.dll)
user32.dll
(2316) loading library at 0x00000000765F0000 (C:\Windows\SysWOW64\kernel32.dll)
kernel32.dll
(2316) loading library at 0x0000000076800000 (C:\Windows\SysWOW64\KernelBase.dll)
KernelBase.dll
(2316) loading library at 0x0000000077370000 (C:\Windows\SysWOW64\user32.dll)
user32.dll
(2316) loading library at 0x00000000761F0000 (C:\Windows\SysWOW64\gdi32.dll)
gdi32.dll
(2316) loading library at 0x0000000076410000 (C:\Windows\SysWOW64\lpk.dll) lpk.dll
(2316) loading library at 0x0000000075F60000 (C:\Windows\SysWOW64\usp10.dll)
usp10.dll
(2316) loading library at 0x0000000077480000 (C:\Windows\SysWOW64\msvcrt.dll)
msvcrt.dll
(2316) loading library at 0x0000000076700000 (C:\Windows\SysWOW64\advapi32.dll)
advapi32.dll
(2316) loading library at 0x00000000761C0000 (C:\Windows\SysWOW64\sechost.dll)
```

```
sechost.dll
(2316) loading library at 0x0000000075E60000 (C:\Windows\SysWOW64\rpcrt4.dll)
rpcrt4.dll
(2316) loading library at 0x0000000075090000 (C:\Windows\SysWOW64\sspicli.dll)
sspicli.dll
(2316) loading library at 0x0000000075080000 (C:\Windows\SysWOW64\cryptbase.dll)
cryptbase.dll
[0x779c0fc5]> dcu entry0
Continue until 0x0040101a using 1 bpsize
(2316) loading library at 0x0000000077300000 (C:\Windows\SysWOW64\imm32.dll)
imm32.dll
(2316) loading library at 0x0000000076E60000 (C:\Windows\SysWOW64\msctf.dll)
msctf.dll
hit breakpoint at: 0x40101a
[0x0040101a]>
```

In here we follow the same process, I'll look for memory management and potential process injection / infection techniques:

```
hit breakpoint at: 0x40101a
[0x0040101a]> dmi kernel32 VirtualAlloc
[Symbols]

nth  paddr      vaddr      bind   type size lib                              name
-------------------------------------------------------------------------------
1264 0x00011826 0x76601826 GLOBAL FUNC 0    KERNEL32.dll
VirtualAlloc
4    0x00010908 0x76600908 NONE   FUNC 0    API-MS-Win-Core-Memory-L1-1-0.dll
imp.VirtualAlloc
[0x0040101a]> dmi kernel32 VirtualProtect
[Symbols]

nth  paddr      vaddr      bind   type size lib                              name
-------------------------------------------------------------------------------
1270 0x000143be 0x766043be GLOBAL FUNC 0    KERNEL32.dll
VirtualProtect
8    0x00010918 0x76600918 NONE   FUNC 0    API-MS-Win-Core-Memory-L1-1-0.dll
imp.VirtualProtect
[0x0040101a]> dmi kernel32 WriteFile
[Symbols]

nth  paddr      vaddr      bind   type size lib                            name
-----------------------------------------------------------------------------
1324 0x00011282 0x76601282 GLOBAL FUNC 0    KERNEL32.dll                    WriteFile
9    0x000109e4 0x766009e4 NONE   FUNC 0    API-MS-Win-Core-File-L1-1-0.dll
imp.WriteFile

nth  paddr      vaddr      bind   type size lib                              name
-------------------------------------------------------------------------------
1333 0x0002da28 0x7661da28 GLOBAL FUNC 0    KERNEL32.dll
WriteProcessMemory
9    0x0001091c 0x7660091c NONE   FUNC 0    API-MS-Win-Core-Memory-L1-1-0.dll
imp.WriteProcessMemory
[0x0040101a]> dmi kernel32 IsDebuggerPresent
[Symbols]

nth paddr      vaddr      bind   type size lib                              name
-------------------------------------------------------------------------------
770 0x0001494d 0x7660494d GLOBAL FUNC 0    KERNEL32.dll
IsDebuggerPresent
4   0x00010d94 0x76600d94 NONE   FUNC 0    API-MS-Win-Core-Debug-L1-1-0.dll
imp.IsDebuggerPresent

[0x0040101a]> dmi kernel32 CreateProcessInternalA
[Symbols]

nth paddr      vaddr      bind   type size lib          name
-------------------------------------------------------------
169 0x0002a507 0x7661a507 GLOBAL FUNC 0    KERNEL32.dll CreateProcessInternalA
[0x0040101a]> dmi kernel32 CreateProcessInternalW
[Symbols]
```

```
nth paddr      vaddr      bind   type size lib          name
-------------------------------------------------------------
170 0x00023c23 0x76613c23 GLOBAL FUNC 0    KERNEL32.dll CreateProcessInternalW
```

And we hit dc, the program calls VirtualAlloc. When the program calls VirtualAlloc and the call returns RAX/EAX will contain a pointer to the newly allocated space. We will keep track of those spaces to see if something gets written into them as the execution goes on:

```
[0x0040101a]> dc
hit breakpoint at: 0x76601826
[0x76601826]> dcr
hit breakpoint at: 0x7680f13d
[0x7680f13e]> dr eax
0x00220000
[0x7680f13e]>
```

After the first call, some content gets written into the first buffer, mm not very clear:

```
[0x7680f13e]> dc
hit breakpoint at: 0x76601826
[0x76601826]> pxw @ 0x00220000
0x00220000  0x81ec8b55 0xfff448c4 0xe3e853ff 0x8b000006  U....H...S......
0x00220010  0x4589fc45 0x18a164c8 0x8b000000 0x408b3040  E..E.d......@0.@
0x00220020  0x4c858954 0x6affffff 0x04408d04 0x48858d50  T..L...j..@.P..H
0x00220030  0x50fffff4 0xbec1c368 0x080de836 0xa1680000  ...Ph...6.....h.
0x00220040  0x50753cf4 0x00085fe8 0x8bd0ff00 0xfff44885  .<uP._.......H..
0x00220050  0x75c00bff 0x4c858b0b 0x8bffffff 0x03eb3840  ...u...L....@8..
0x00220060  0x8b04408b 0x200d0440 0x3d002000 0x0077007c  .@..@.. . .=|.w.
0x00220070  0xc95b0374 0xa485c6c3 0x41fffffd 0xfda585c6  t.[........A....
0x00220080  0xc644ffff 0xfffda685 0x85c656ff 0xfffffda7  ..D......V......
0x00220090  0xa885c641 0x50fffffd 0xfda985c6 0xc649ffff  A......P......I.
0x002200a0  0xfffdaa85 0x85c633ff 0xfffffdab 0xac85c632  .....3......2...
0x002200b0  0x2effffd 0xfdad85c6 0xc644ffff 0xfffdae85  ..........D.....
0x002200c0  0x85c64cff 0xfffffdaf 0xb085c64c 0x00fffffd  .L......L.......
0x002200d0  0xfda4858d 0xe850ffff 0x0000083c 0xf65485c6  ......P.<.....T.
0x002200e0  0xc653ffff 0xfff65585 0x85c64fff 0xfffff656  ..S..U...O..V...
0x002200f0  0x5785c646 0x54fffff6 0xf65885c6 0xc657ffff  F..W...T..X...W.
```

We run the second call till return, then check again:

```
[0x76601826]> dcr
hit breakpoint at: 0x7680f13d
[0x7680f13e]> dr eax
0x00230000
```

And we do it another time:

```
[0x7680f13e]> dc
hit breakpoint at: 0x76601826
[0x76601826]> dcr
hit breakpoint at: 0x7680f13d
[0x7680f13e]> dr eax
0x00240000
```

Then look at this!

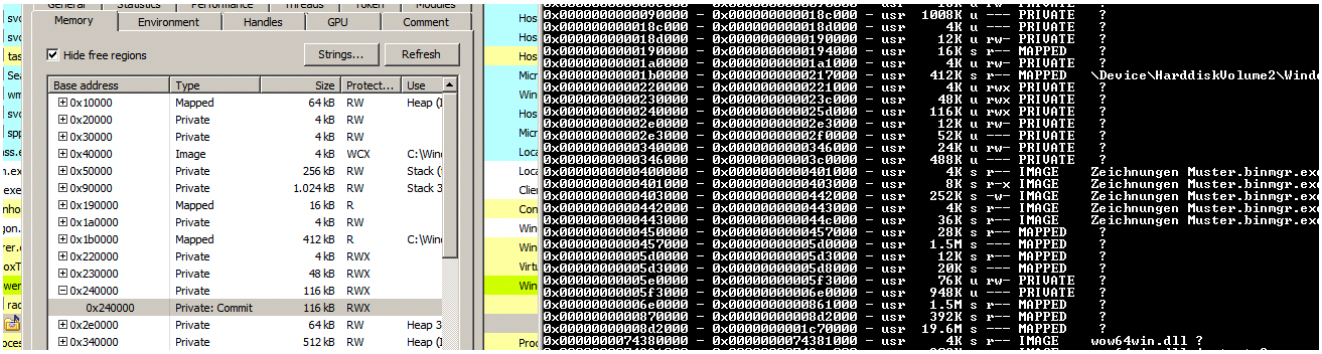
```
[0x7680f13e]> dr eax
0x00240000
[0x7680f13e]> dc
hit breakpoint at: 0x766043be
[0x766043be]> pxw 600 @ 0x00240000
0x00240000  0x00905a4d 0x00000003 0x00000004 0x0000ffff  MZ..............
0x00240010  0x000000b8 0x00000000 0x00000040 0x00000000  ........@.......
0x00240020  0x00000000 0x00000000 0x00000000 0x00000000  ................
0x00240030  0x00000000 0x00000000 0x00000000 0x000000c8  ................
0x00240040  0x0eba1f0e 0xcd09b400 0x4c01b821 0x685421cd  ........!..L.!Th
0x00240050  0x70207369 0x72676f72 0x63206d61 0x6f6e6e61  is program canno
0x00240060  0x65622074 0x6e757220 0x206e6920 0x20534f44  t be run in DOS
0x00240070  0x65646f6d 0x0a0d0d2e 0x00000024 0x00000000  mode....$.......
0x00240080  0x55d9e2b7 0x06b783f3 0x06b783f3 0x06b783f3  ...U............
0x00240090  0x06a49c7d 0x06b783c1 0x06a5a30f 0x06b783f2  }...............
0x002400a0  0x06b18534 0x06b783f2 0x68636952 0x06b783f3  4.......Rich....
0x002400b0  0x00000000 0x00000000 0x00000000 0x00000000  ................
0x002400c0  0x00000000 0x00000000 0x00004550 0x0003014c  ........PE..L...
0x002400d0  0x4cdbdf6c 0x00000000 0x00000000 0x010f00e0  l..L............
0x002400e0  0x0c05010b 0x0000b000 0x00001000 0x00015000  ............P...
0x002400f0  0x000209e0 0x00016000 0x00021000 0x00400000  .....`........@.
0x00240100  0x00001000 0x00000200 0x00000004 0x00000000  ................
0x00240110  0x00000004 0x00000000 0x00022000 0x00001000  ........ .......
0x00240120  0x00000000 0x00000002 0x00100000 0x00001000  ................
0x00240130  0x00100000 0x00001000 0x00000000 0x00000010  ................
0x00240140  0x00000000 0x00000000 0x000216b8 0x00000114  ................
0x00240150  0x00021000 0x000006b8 0x00000000 0x00000000  ................
0x00240160  0x00000000 0x00000000 0x00000000 0x00000000  ................
0x00240170  0x00000000 0x00000000 0x00000000 0x00000000  ................
0x00240180  0x00000000 0x00000000 0x00000000 0x00000000  ................
0x00240190  0x00000000 0x00000000 0x00000000 0x00000000  ................
0x002401a0  0x00000000 0x00000000 0x00000000 0x00000000  ................
0x002401b0  0x00000000 0x00000000 0x00000000 0x00000000  ................
0x002401c0  0x30585055 0x00000000 0x00015000 0x00001000  UPX0.....P......
0x002401d0  0x00000000 0x00000400 0x00000000 0x00000000  ................
0x002401e0  0x00000000 0xe0000080 0x31585055 0x00000000  ........UPX1....
0x002401f0  0x0000b000 0x00016000 0x0000ac00 0x00000400  .....`..........
0x00240200  0x00000000 0x00000000 0x00000000 0xe0000040  ............@...
0x00240210  0x7273722e 0x00000063 0x00001000 0x00021000  .rsrc...........
0x00240220  0x00000800 0x0000b000 0x00000000 0x00000000  ................
0x00240230  0x00000000 0xc0000040 0x00000000 0x00000000  ....@...........
0x00240240  0x00000000 0x00000000 0x00000000 0x00000000  ................
```

Another UPX packed binary!!

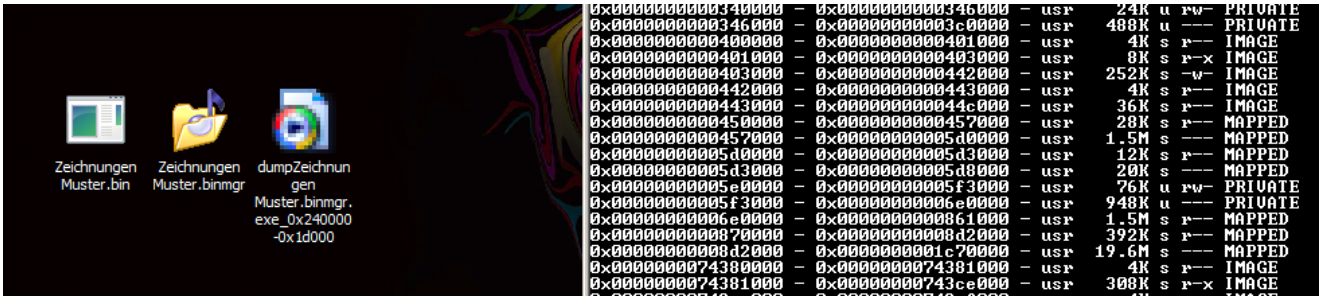
At this point, if we follow the execution of the program we'll see calls on VirtualProtect, related to changing RWX/RW permissions on the program itself, some content being written/decoded and a call to the binary via some decoded shellcode

```
[0x766043be]> pxr @ rsp
0x0018f3a0 0x002209db  ..". @ rsp PRIVATE   R W X 'leave' 'PRIVATE  '
0x0018f3a4 0x00400000  ..@. IMAGE    Zeichnungen Muster.binmgr.exe ascii ('
0x0018f3a8 0x0004c000  ....
0x0018f3ac 0x00000040  @... 64 ascii ('@')
0x0018f3b0 0x0018f3b4  .... PRIVATE   R W 0x1e1f5b
0x0018f3b4 0x001e1f5b  [... MAPPED
\Device\HarddiskVolume2\Windows\System32\locale.nls rsi R 0x6e006500
```

So if we want to move forward, we can just go dump the memory space of the UPX binary we detected. We can do it with process hacker or with radare itself + cat as we did on the previous post.



Unpacking the final binary



So we repeat the unpacking process with the final binary:

```
PS C:\Users\labo\Desktop> upx -d '.\dumpZeichnungen Muster.binmgr.exe_0x240000-
0x1d000.exe'
                       Ultimate Packer for eXecutables
                          Copyright (C) 1996 - 2020
UPX 3.96w       Markus Oberhumer, Laszlo Molnar & John Reiser   Jan 23rd 2020

        File size         Ratio      Format      Name
   --------------------   ------   -----------   -----------
    189952 <-    118784   62.53%    win32/pe     dumpZeichnungen
Muster.binmgr.exe_0x240000-0x1d000.exe

Unpacked 1 file.
PS C:\Users\labo\Desktop>
```

And we will see that this time everything looks clearer, we can even get a general idea of what the malware does:

```
PS C:\Users\labo\Desktop> radare2.exe '.\dumpZeichnungen Muster.binmgr.exe_0x240000-
0x1d000.exe'
 -- Mess with the best, Die like the rest
[0x00402c23]> aaa
[Warning: set your favourite calling convention in `e anal.cc=?`
[x] Analyze all flags starting with sym. and entry0 (aa)
[x] Analyze function calls (aac)
[x] Analyze len bytes of instructions for references (aar)
[x] Finding and parsing C++ vtables (avrr)
[x] Type matching analysis for all functions (aaft)
[x] Propagate noreturn information (aanr)
[x] Use -AA or aaaa to perform additional experimental analysis.
[0x00402c23]> afl
0x00402c23    6 245          entry0
0x0040181b   17 396          fcn.0040181b
0x00402d60    1 6            sub.KERNEL32.DLL_GetModuleHandleA
0x00402d66    1 6            sub.KERNEL32.DLL_GetProcAddress
0x00401000    1 24           fcn.00401000
0x004016d6   12 325          fcn.004016d6
0x00401611    6 106          fcn.00401611
0x00402d48    1 6            sub.KERNEL32.DLL_GetCurrentProcess
0x00402e02    1 6            sub.advapi32.dll_OpenProcessToken
0x00402dfc    1 6            sub.advapi32.dll_LookupPrivilegeValueA
0x00402df6    1 6            sub.advapi32.dll_AdjustTokenPrivileges
0x00402d18    1 6            fcn.00402d18
0x00402a32    1 92           fcn.00402a32
0x00402786    1 14           fcn.00402786
0x00402d4e    1 6            sub.KERNEL32.DLL_GetCurrentProcessId
0x004026d8   13 174          fcn.004026d8
0x0040289a    4 61           fcn.0040289a
0x004027c2    5 216          fcn.004027c2
0x00402dd2    1 6            sub.KERNEL32.DLL_VirtualProtect
0x004027a2    3 32           fcn.004027a2
0x00401dbf    1 25           fcn.00401dbf
0x00401c61   62 350          fcn.00401c61
0x00402dc0    1 6            sub.KERNEL32.DLL_VirtualAlloc
0x00401018    3 37           fcn.00401018
0x00402794    1 14           fcn.00402794
0x00401223    1 93           fcn.00401223
0x00402d24    1 6            sub.KERNEL32.DLL_CreateProcessA
0x00402a8e    3 55           fcn.00402a8e
0x004028d7    5 122          fcn.004028d7
0x00402dcc    1 6            sub.KERNEL32.DLL_VirtualFree
0x004014cc    4 290          fcn.004014cc
0x00402d72    1 6            sub.KERNEL32.DLL_GetWindowsDirectoryA
0x00401052    5 57           fcn.00401052
0x00402d6c    1 6            sub.KERNEL32.DLL_GetVolumeInformationA
0x004013e0    1 58           fcn.004013e0
0x00402df0    1 6            sub.user32.dll_wsprintfA
0x004015ee    3 35           fcn.004015ee
0x00402d8a    1 6            sub.KERNEL32.DLL_OpenMutexA
0x00402ac5    5 169          fcn.00402ac5
```

```
0x00402da2    1 6           sub.KERNEL32.DLL_Sleep
0x00402bd6    6 77          fcn.00402bd6
0x00402d30    1 6           sub.KERNEL32.DLL_ExitProcess
0x0040108b    5 55          fcn.0040108b
0x00402d78    1 6           sub.KERNEL32.DLL_GlobalAlloc
0x00402d42    1 6           sub.KERNEL32.DLL_FindFirstFileA
0x00402d3c    1 6           sub.KERNEL32.DLL_FindClose
0x00401280    4 20          fcn.00401280
0x00401294   19 167         fcn.00401294
0x0040133b    6 95          fcn.0040133b
0x004013be    1 34          fcn.004013be
0x0040139a    1 36          fcn.0040139a
0x00402e0e    1 6           sub.advapi32.dll_RegOpenKeyA
0x00402e14    1 6           sub.advapi32.dll_RegQueryValueExA
0x0040103d    1 21          fcn.0040103d
0x00402e08    1 6           sub.advapi32.dll_RegCloseKey
0x00402dea    1 6           sub.KERNEL32.DLL_lstrlenA
0x00402de4    1 6           sub.KERNEL32.DLL_lstrcpyA
0x0040167b    8 91          fcn.0040167b
0x004011df    4 68          fcn.004011df
0x00402d36    1 6           sub.KERNEL32.DLL_ExpandEnvironmentStringsA
0x004019d5    1 28          fcn.004019d5
0x00401a3e    4 43          fcn.00401a3e
0x00401a1e    4 32          fcn.00401a1e
0x00401a69    4 63          fcn.00401a69
0x00401aa8    4 72          fcn.00401aa8
0x00401af0    4 66          fcn.00401af0
0x00402dc6    1 6           sub.KERNEL32.DLL_VirtualAllocEx
0x00402dde    1 6           sub.KERNEL32.DLL_WriteProcessMemory
0x0040255c   15 380         fcn.0040255c
0x00401dd8   12 84          fcn.00401dd8
0x00401e2c    3 61          fcn.00401e2c
0x00402d5a    1 6           sub.KERNEL32.DLL_GetModuleFileNameA
0x004019a7    1 28          fcn.004019a7
0x00402d96    1 6           sub.KERNEL32.DLL_ReadProcessMemory
0x00402168    4 98          fcn.00402168
0x00401b32    4 72          fcn.00401b32
0x00401b7a   21 231  -> 229  fcn.00401b7a
0x00402d54    1 6           sub.KERNEL32.DLL_GetCurrentThreadId
0x00402d2a    1 6           sub.KERNEL32.DLL_CreateToolhelp32Snapshot
0x00402dae    1 6           sub.KERNEL32.DLL_Thread32First
0x00402d90    1 6           sub.KERNEL32.DLL_OpenThread
0x00402da8    1 6           sub.KERNEL32.DLL_SuspendThread
0x00402d9c    1 6           sub.KERNEL32.DLL_ResumeThread
0x00402db4    1 6           sub.KERNEL32.DLL_Thread32Next
0x004021ca    7 128         fcn.004021ca
0x00401f0e   21 602         fcn.00401f0e
0x00402dd8    1 6           sub.KERNEL32.DLL_VirtualProtectEx
0x00402d1e    1 6           sub.KERNEL32.DLL_CreateFileMappingA
0x00402d7e    1 6           sub.KERNEL32.DLL_MapViewOfFile
0x00402d84    1 6           sub.KERNEL32.DLL_OpenFileMappingA
```

```
0x00402dba    1 6            sub.KERNEL32.DLL_UnmapViewOfFile
[0x00402c23]>
```

For what I see here, it looks like it performs some kind of process injection. It may also try to gain some persistance or information on the machine by the register and maybe resolve some more calls related to its actual behavior by GetModuleHandle, LoadLibrary etc.

```
[0x00402c23]> pdf
            ;-- eip:
/ 245: entry0 ();
|           0x00402c23      e8f3ebffff     call fcn.0040181b
|           0x00402c28      83f801         cmp eax, 1                  ; 1
|       ,=< 0x00402c2b      0f85e0000000   jne 0x402d11
|       |   0x00402c31      6800040000     push 0x400                  ; 1024
|       |   0x00402c36      6870da4100     push 0x41da70
|       |   0x00402c3b      e8c0e3ffff     call fcn.00401000
|       |   0x00402c40      6800040000     push 0x400                  ; 1024
|       |   0x00402c45      6870da4100     push 0x41da70
|       |   0x00402c4a      e887eaffff     call fcn.004016d6
|       |   0x00402c4f      83f801         cmp eax, 1                  ; 1
|      ,==< 0x00402c52      0f85b9000000   jne 0x402d11
|      ||   0x00402c58      6821404000     push 0x404021               ; '!@@' ;
"SeDebugPrivilege"
|      ||   0x00402c5d      e8afe9ffff     call fcn.00401611
|      ||   0x00402c62      6800100100     push 0x11000
|      ||   0x00402c67      6870424000     push 0x404270               ; 'pB@' ;
"MZ\x90"
|      ||   0x00402c6c      e8c1fdffff     call fcn.00402a32
|      ||   0x00402c71      6a01           push 1                      ; 1
|      ||   0x00402c73      6870da4100     push 0x41da70
|      ||   0x00402c78      e8a6e5ffff     call fcn.00401223
|      ||   0x00402c7d      e80cfeffff     call fcn.00402a8e
|      ||   0x00402c82      b800880000     mov eax, 0x8800
|      ||   0x00402c87      83f801         cmp eax, 1                  ; 1
|     ,===< 0x00402c8a      0f8681000000   jbe 0x402d11
|     |||   0x00402c90      6871de4100     push 0x41de71
|     |||   0x00402c95      6a00           push 0
|     |||   0x00402c97      68ea0d0000     push 0xdea                  ; 3562
|     |||   0x00402c9c      e82be8ffff     call fcn.004014cc
|     |||   0x00402ca1      68b1de4100     push 0x41deb1
|     |||   0x00402ca6      6a00           push 0
|     |||   0x00402ca8      686b050000     push 0x56b                  ; 1387
|     |||   0x00402cad      e81ae8ffff     call fcn.004014cc
|     |||   0x00402cb2      6871de4100     push 0x41de71
|     |||   0x00402cb7      e832e9ffff     call fcn.004015ee
|     |||   0x00402cbc      0bc0           or eax, eax
|    ,====< 0x00402cbe      7551           jne 0x402d11
|    ||||   0x00402cc0      6860424000     push 0x404260               ; '`B@'
|    ||||   0x00402cc5      6a00           push 0
|    ||||   0x00402cc7      6800880000     push 0x8800
|    ||||   0x00402ccc      6870524100     push 0x415270               ; 'pRA' ;
"MZ\x90"
|    ||||   0x00402cd1      68b1de4100     push 0x41deb1
|    ||||   0x00402cd6      e8eafdffff     call fcn.00402ac5
|    ||||   0x00402cdb      6800880000     push 0x8800
|    ||||   0x00402ce0      6870524100     push 0x415270               ; 'pRA' ;
"MZ\x90"
|    ||||   0x00402ce5      e848fdffff     call fcn.00402a32
|    ||||   0x00402cea      6a01           push 1                      ; 1
```

```
|    ||||   0x00402cec      6870da4100     push 0x41da70
|    ||||   0x00402cf1      e82de5ffff     call fcn.00401223
|    ||||   0x00402cf6      e893fdffff     call fcn.00402a8e
|    ||||   0x00402cfb      6888130000     push 0x1388
|    ||||   0x00402d00      e89d000000     call sub.KERNEL32.DLL_Sleep
|    ||||   0x00402d05      6a01           push 1                      ; 1
|    ||||   0x00402d07      6860424000     push 0x404260               ; '`B@'
|    ||||   0x00402d0c      e8c5feffff     call fcn.00402bd6
|    ||||   ; CODE XREFS from entry0 @ 0x402c2b, 0x402c52, 0x402c8a, 0x402cbe
|    ````-> 0x00402d11      6a00           push 0
\           0x00402d13      e818000000     call sub.KERNEL32.DLL_ExitProcess
[0x00402c23]>
```

If we look at the imports, we see that same thing, we can also guess an infection / replication on the machine or network.

```
[0x00402c23]> ii
[Imports]
nth vaddr      bind type lib          name
----------------------------------------
1   0x0040301c NONE FUNC KERNEL32.DLL FindFirstFileA
2   0x00403020 NONE FUNC KERNEL32.DLL GetCurrentProcess
3   0x00403024 NONE FUNC KERNEL32.DLL GetCurrentProcessId
4   0x00403028 NONE FUNC KERNEL32.DLL GetCurrentThreadId
5   0x0040302c NONE FUNC KERNEL32.DLL GetModuleFileNameA
6   0x00403030 NONE FUNC KERNEL32.DLL GetModuleHandleA
7   0x00403034 NONE FUNC KERNEL32.DLL GetProcAddress
8   0x00403038 NONE FUNC KERNEL32.DLL GetVolumeInformationA
9   0x0040303c NONE FUNC KERNEL32.DLL GetWindowsDirectoryA
10  0x00403040 NONE FUNC KERNEL32.DLL GlobalAlloc
11  0x00403044 NONE FUNC KERNEL32.DLL MapViewOfFile
12  0x00403048 NONE FUNC KERNEL32.DLL OpenFileMappingA
13  0x0040304c NONE FUNC KERNEL32.DLL OpenMutexA
14  0x00403050 NONE FUNC KERNEL32.DLL OpenThread
15  0x00403054 NONE FUNC KERNEL32.DLL FindClose
16  0x00403058 NONE FUNC KERNEL32.DLL ResumeThread
17  0x0040305c NONE FUNC KERNEL32.DLL Sleep
18  0x00403060 NONE FUNC KERNEL32.DLL SuspendThread
19  0x00403064 NONE FUNC KERNEL32.DLL Thread32First
20  0x00403068 NONE FUNC KERNEL32.DLL Thread32Next
21  0x0040306c NONE FUNC KERNEL32.DLL UnmapViewOfFile
22  0x00403070 NONE FUNC KERNEL32.DLL VirtualAlloc
23  0x00403074 NONE FUNC KERNEL32.DLL VirtualAllocEx
24  0x00403078 NONE FUNC KERNEL32.DLL VirtualFree
25  0x0040307c NONE FUNC KERNEL32.DLL VirtualProtect
26  0x00403080 NONE FUNC KERNEL32.DLL VirtualProtectEx
27  0x00403084 NONE FUNC KERNEL32.DLL WriteProcessMemory
28  0x00403088 NONE FUNC KERNEL32.DLL lstrcpyA
29  0x0040308c NONE FUNC KERNEL32.DLL lstrlenA
30  0x00403090 NONE FUNC KERNEL32.DLL ExpandEnvironmentStringsA
31  0x00403094 NONE FUNC KERNEL32.DLL ExitProcess
32  0x00403098 NONE FUNC KERNEL32.DLL CreateToolhelp32Snapshot
33  0x0040309c NONE FUNC KERNEL32.DLL CreateProcessA
34  0x004030a0 NONE FUNC KERNEL32.DLL CreateFileMappingA
35  0x004030a4 NONE FUNC KERNEL32.DLL ReadProcessMemory
36  0x004030a8 NONE FUNC KERNEL32.DLL CloseHandle
1   0x00403000 NONE FUNC advapi32.dll OpenProcessToken
2   0x00403004 NONE FUNC advapi32.dll LookupPrivilegeValueA
3   0x00403008 NONE FUNC advapi32.dll AdjustTokenPrivileges
4   0x0040300c NONE FUNC advapi32.dll RegOpenKeyA
5   0x00403010 NONE FUNC advapi32.dll RegQueryValueExA
6   0x00403014 NONE FUNC advapi32.dll RegCloseKey
1   0x004030b0 NONE FUNC user32.dll   wsprintfA


[0x00402c23]>

izz
```

```
204  0x00002a21 0x00404021 16  17   .data   ascii   SeDebugPrivilege
205  0x00002a32 0x00404032 45  46   .data   ascii   %ProgramFiles%\Internet
Explorer\iexplore.exe
206  0x00002a60 0x00404060 64  65   .data   ascii
SOFTWARE\Microsoft\Windows\CurrentVersion\App Paths\IEXPLORE.EXE
207  0x00002aa1 0x004040a1 23  24   .data   ascii   http\shell\open\command
```

And the strings located inside point to interesting places.

Conclusions

So at this time I think we can confidentely say that we unpacked the malware, now we have three let's say "modules" we can independently analyse, to see if they unpack anything else, to check their functionalities and see if they interact and how.

The report on anyrun related to this malware, offers an intersting process diagram, that correctly corresponds to our findings!

Tackling the problem on Windows 10

If you tried to replicate this analysis but decided to use Windows 10 instad of Windows 7 you'll probably come up with some errors leading to not being able to unpack the last stage or actually execute the program.

So, to summ it up. This malware is not modern (it uses upx!!) it was developed and spread in a time where Win7 was the latest, so it is prepared for it. An important detail related to this, we see at least in the second binary is that at some point it allocates space, and write some random data that looks like shellcode into it. Well it is actually shellcode, and the execution flow of the program gets transfered there at some point…

And if we dump it and manually reverse it, we'll se plenty of references to "hardcoded" stuff, some calls that are not even present in Windows10, so thats the problem.

```
[0x00000000]> pd 120
            0x00000000      55              push rbp
            0x00000001      8bec            mov ebp, esp
            0x00000003      81c448f4ffff    add esp, 0xfffff448
            0x00000009      53              push rbx
            0x0000000a      e8e3060000      call 0x6f2
            0x0000000f      8b45fc          mov eax, dword [rbp - 4]
            0x00000012      8945c8          mov dword [rbp - 0x38], eax
            0x00000015      64a118000000.   movabs eax, dword fs:[0x8b30408b00000018]
            0x0000001f      4054            push rsp
            0x00000021      89854cf6ffff    mov dword [rbp - 0x9b4], eax
            0x00000027      6a04            push 4
            0x00000029      8d4004          lea eax, [rax + 4]
            0x0000002c      50              push rax
            0x0000002d      8d8548f4ffff    lea eax, [rbp - 0xbb8]
            0x00000033      50              push rax
            0x00000034      68c3c1be36      push 0x36bec1c3
            0x00000039      e80d080000      call 0x84b
            0x0000003e      68a1f43c75      push 0x753cf4a1
            0x00000043      50              push rax
            0x00000044      e85f080000      call 0x8a8
            0x00000049      ffd0            call rax
            0x0000004b      8b8548f4ffff    mov eax, dword [rbp - 0xbb8]
            0x00000051      0bc0            or eax, eax
         ,=< 0x00000053      750b            jne 0x60
         |   0x00000055      8b854cf6ffff    mov eax, dword [rbp - 0x9b4]
         |   0x0000005b      8b4038          mov eax, dword [rax + 0x38]
        ,==< 0x0000005e      eb03            jmp 0x63
        |`-> 0x00000060      8b4004          mov eax, dword [rax + 4]
        `--> 0x00000063      8b4004          mov eax, dword [rax + 4]
            0x00000066      0d20002000      or eax, 0x200020
            0x0000006b      3d7c007700      cmp eax, 0x77007c
         ,=< 0x00000070      7403            je 0x75
         |   0x00000072      5b              pop rbx
         |   0x00000073      c9              leave
         |   0x00000074      c3              ret
         `-> 0x00000075      c685a4fdffff.   mov byte [rbp - 0x25c], 0x41 ; 'A'
            0x0000007c      c685a5fdffff.   mov byte [rbp - 0x25b], 0x44 ; 'D'
            0x00000083      c685a6fdffff.   mov byte [rbp - 0x25a], 0x56 ; 'V'
            0x0000008a      c685a7fdffff.   mov byte [rbp - 0x259], 0x41 ; 'A'
            0x00000091      c685a8fdffff.   mov byte [rbp - 0x258], 0x50 ; 'P'
            0x00000098      c685a9fdffff.   mov byte [rbp - 0x257], 0x49 ; 'I'
            0x0000009f      c685aafdffff.   mov byte [rbp - 0x256], 0x33 ; '3'
            0x000000a6      c685abfdffff.   mov byte [rbp - 0x255], 0x32 ; '2'
            0x000000ad      c685acfdffff.   mov byte [rbp - 0x254], 0x2e ; '.'
            0x000000b4      c685adfdffff.   mov byte [rbp - 0x253], 0x44 ; 'D'
            0x000000bb      c685aefdffff.   mov byte [rbp - 0x252], 0x4c ; 'L'
            0x000000c2      c685affdffff.   mov byte [rbp - 0x251], 0x4c ; 'L'
            0x000000c9      c685b0fdffff.   mov byte [rbp - 0x250], 0
            0x000000d0      8d85a4fdffff    lea eax, [rbp - 0x25c]
            0x000000d6      50              push rax
            0x000000d7      e83c080000      call 0x918
```

```
            0x000000dc      c68554f6ffff.  mov byte [rbp - 0x9ac], 0x53 ; 'S'
            0x000000e3      c68555f6ffff.  mov byte [rbp - 0x9ab], 0x4f ; 'O'
            0x000000ea      c68556f6ffff.  mov byte [rbp - 0x9aa], 0x46 ; 'F'
            0x000000f1      c68557f6ffff.  mov byte [rbp - 0x9a9], 0x54 ; 'T'
            0x000000f8      c68558f6ffff.  mov byte [rbp - 0x9a8], 0x57 ; 'W'
            0x000000ff      c68559f6ffff.  mov byte [rbp - 0x9a7], 0x41 ; 'A'
            0x00000106      c6855af6ffff.  mov byte [rbp - 0x9a6], 0x52 ; 'R'
            0x0000010d      c6855bf6ffff.  mov byte [rbp - 0x9a5], 0x45 ; 'E'
            0x00000114      c6855cf6ffff.  mov byte [rbp - 0x9a4], 0x5c ; '\\'
            0x0000011b      c6855df6ffff.  mov byte [rbp - 0x9a3], 0x4d ; 'M'
            0x00000122      c6855ef6ffff.  mov byte [rbp - 0x9a2], 0x69 ; 'i'
            0x00000129      c6855ff6ffff.  mov byte [rbp - 0x9a1], 0x63 ; 'c'
            0x00000130      c68560f6ffff.  mov byte [rbp - 0x9a0], 0x72 ; 'r'
            0x00000137      c68561f6ffff.  mov byte [rbp - 0x99f], 0x6f ; 'o'
            0x0000013e      c68562f6ffff.  mov byte [rbp - 0x99e], 0x73 ; 's'
            0x00000145      c68563f6ffff.  mov byte [rbp - 0x99d], 0x6f ; 'o'
            0x0000014c      c68564f6ffff.  mov byte [rbp - 0x99c], 0x66 ; 'f'
            0x00000153      c68565f6ffff.  mov byte [rbp - 0x99b], 0x74 ; 't'
            0x0000015a      c68566f6ffff.  mov byte [rbp - 0x99a], 0x5c ; '\\'
            0x00000161      c68567f6ffff.  mov byte [rbp - 0x999], 0x57 ; 'W'
            0x00000168      c68568f6ffff.  mov byte [rbp - 0x998], 0x69 ; 'i'
            0x0000016f      c68569f6ffff.  mov byte [rbp - 0x997], 0x6e ; 'n'
            0x00000176      c6856af6ffff.  mov byte [rbp - 0x996], 0x64 ; 'd'
            0x0000017d      c6856bf6ffff.  mov byte [rbp - 0x995], 0x6f ; 'o'
            0x00000184      c6856cf6ffff.  mov byte [rbp - 0x994], 0x77 ; 'w'
            0x0000018b      c6856df6ffff.  mov byte [rbp - 0x993], 0x73 ; 's'
            0x00000192      c6856ef6ffff.  mov byte [rbp - 0x992], 0x20 ;
"T\x89\x85L\xf6\xff\xffj\x04\x8d@\x04P\x8d\x85H\xf4\xff\xffPh\xc3\u007e6\xe8\r\b"
            0x00000199      c6856ff6ffff.  mov byte [rbp - 0x991], 0x4e ; 'N'
            0x000001a0      c68570f6ffff.  mov byte [rbp - 0x990], 0x54 ; 'T'
            0x000001a7      c68571f6ffff.  mov byte [rbp - 0x98f], 0x5c ; '\\'
            0x000001ae      c68572f6ffff.  mov byte [rbp - 0x98e], 0x43 ; 'C'
            0x000001b5      c68573f6ffff.  mov byte [rbp - 0x98d], 0x75 ; 'u'
            0x000001bc      c68574f6ffff.  mov byte [rbp - 0x98c], 0x72 ; 'r'
            0x000001c3      c68575f6ffff.  mov byte [rbp - 0x98b], 0x72 ; 'r'
            0x000001ca      c68576f6ffff.  mov byte [rbp - 0x98a], 0x65 ; 'e'
            0x000001d1      c68577f6ffff.  mov byte [rbp - 0x989], 0x6e ; 'n'
            0x000001d8      c68578f6ffff.  mov byte [rbp - 0x988], 0x74 ; 't'
            0x000001df      c68579f6ffff.  mov byte [rbp - 0x987], 0x56 ; 'V'
            0x000001e6      c6857af6ffff.  mov byte [rbp - 0x986], 0x65 ; 'e'
            0x000001ed      c6857bf6ffff.  mov byte [rbp - 0x985], 0x72 ; 'r'
            0x000001f4      c6857cf6ffff.  mov byte [rbp - 0x984], 0x73 ; 's'
            0x000001fb      c6857df6ffff.  mov byte [rbp - 0x983], 0x69 ; 'i'
            0x00000202      c6857ef6ffff.  mov byte [rbp - 0x982], 0x6f ; 'o'
            0x00000209      c6857ff6ffff.  mov byte [rbp - 0x981], 0x6e ; 'n'
            0x00000210      c68580f6ffff.  mov byte [rbp - 0x980], 0x5c ; '\\'
            0x00000217      c68581f6ffff.  mov byte [rbp - 0x97f], 0x57 ; 'W'
            0x0000021e      c68582f6ffff.  mov byte [rbp - 0x97e], 0x69 ; 'i'
            0x00000225      c68583f6ffff.  mov byte [rbp - 0x97d], 0x6e ; 'n'
            0x0000022c      c68584f6ffff.  mov byte [rbp - 0x97c], 0x6c ; 'l'
            0x00000233      c68585f6ffff.  mov byte [rbp - 0x97b], 0x6f ; 'o'
            0x0000023a      c68586f6ffff.  mov byte [rbp - 0x97a], 0x67 ; 'g'
```

```
0x00000241      c68587f6ffff.  mov byte [rbp - 0x979], 0x6f ; 'o'
0x00000248      c68588f6ffff.  mov byte [rbp - 0x978], 0x6e ; 'n'
0x0000024f      c68589f6ffff.  mov byte [rbp - 0x977], 0x5c ; '\\'
0x00000256      c6858af6ffff.  mov byte [rbp - 0x976], 0
0x0000025d      8d8550f6ffff   lea eax, [rbp - 0x9b0]
0x00000263      50             push rax
0x00000264      8d8554f6ffff   lea eax, [rbp - 0x9ac]
0x0000026a      50             push rax
```

So my advice in here would be to try to adjust the OS version to the Malware as much as possible, to avoid losing precious time in the analysis.