Malware Analysis —Manual Unpacking of Redaman

jonahacks.medium.com/malware-analysis-manual-unpacking-of-redaman-ec1782352cfb

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6 min read

In this post, we are looking to manually unpack the sample called Redaman, which is a banking trojan. Some of its capabilities include:

- Monitor browser activity,
- Downloading files to the infected host
- Keylogging activity
- Capture screen shots and record video of the Windows desktop
- Collecting and exfiltrating financial data, specifically targeting Russian banks
- Smart card monitoring
- Shutting down the infected host
- Altering DNS configuration through the Windows host file
- Retrieving clipboard data
- Terminating running processes
- Adding certificates to the Windows store

> Info from Unit42 Analysis.

What makes this sample unique and an excellent training sample to practice manual unpacking is because this sample performs a fairly simple packing process: PE overwrite and a secondary DLL Injection.

Self-Injection, or in this example the PE Overwrite occurs when the malware allocates a “stub” in itself, transfers to that stub address, allocates that stub area and write whatever malicious content it needs to in there, and then changes the permissions, and then run from that overwritten area.

> A Better Explanation.

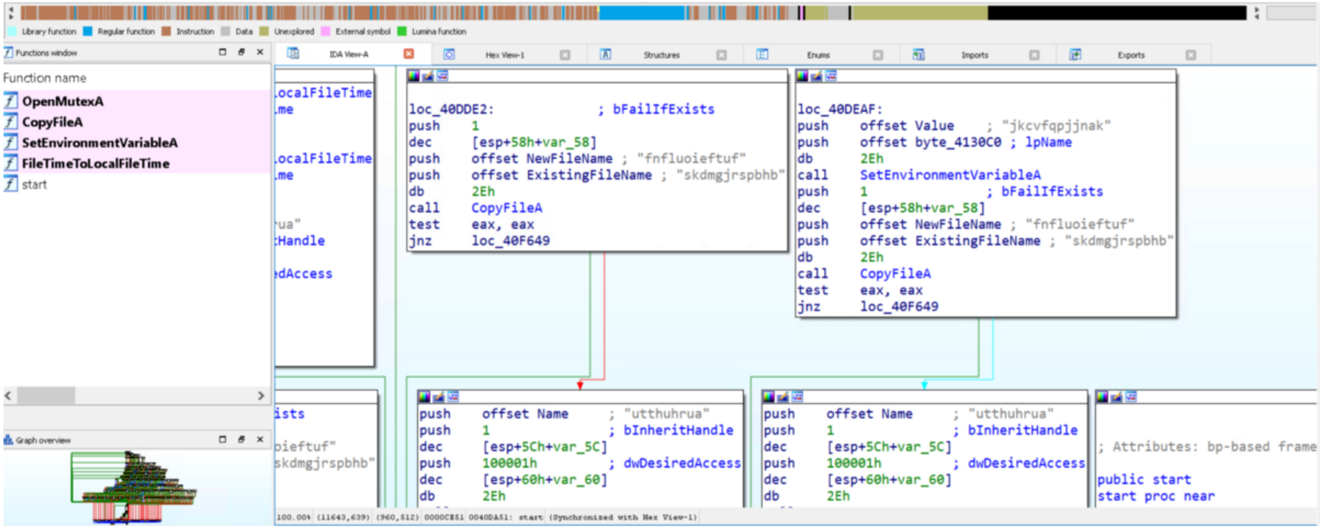
Packed Sample

We can identify this file as packed based on a number of info:

High level entropy on the main file with PEStudio:

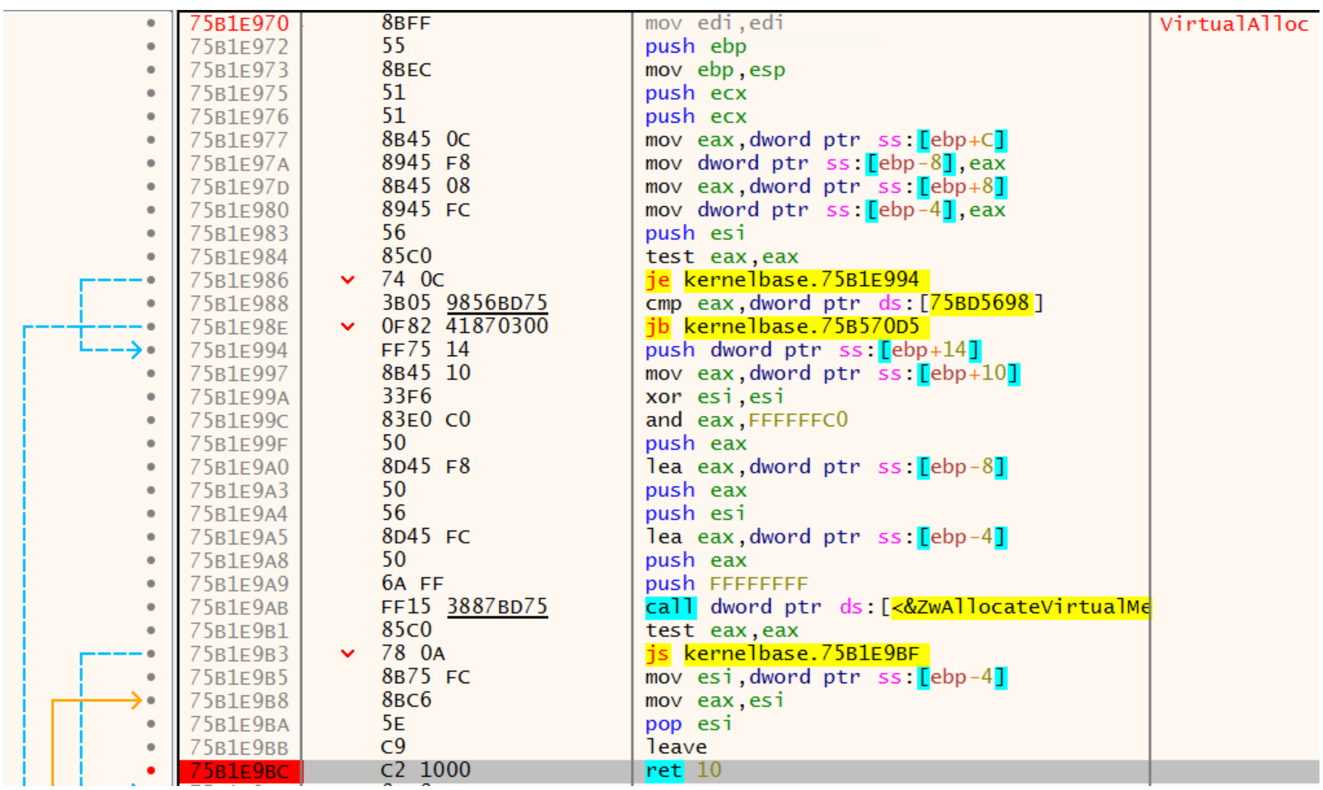
property	value
md5	DF725667733410F1A023A76D36FCBD31
sha1	F7DEC59AEF9CC9E5C13827CF7786D05819170F1B
sha256	CEB8EFB3A3EB1085C61BBA4B0A77D1ACA1F7B10511497E1521135F18
md5-without-overlay	n/a
sha1-without-overlay	n/a
sha256-without-overlay	n/a
first-bytes-hex	4D 5A 90 00 03 00 00 00 04 00 00 00 FF FF 00 00 B8 00 00 00 00 00 00 00
first-bytes-text	M Z .. .. @ .. ..
file-size	326656 (bytes)
size-without-overlay	n/a
entropy	7.164
imphash	80D3242711EC48AC212E70C55619D01D
signature	n/a
entry-point	50 8D 15 BD 56 44 00 42 89 E2 89 2C 24 89 E5 6A 05 83 C4 B0 66 81 EA
file-version	n/a
description	n/a
file-type	**executable**
cpu	**32-bit**
subsystem	GUI
compiler-stamp	0x514C152D (Fri Mar 22 08:24:13 2013)
debugger-stamp	n/a
resources-stamp	empty
exports-stamp	n/a
version-stamp	n/a

Checking in IDA, we see that first there is some obfuscation, barely any functions, and only a small amount of analyzed code (blue bar at the top of screenshot)



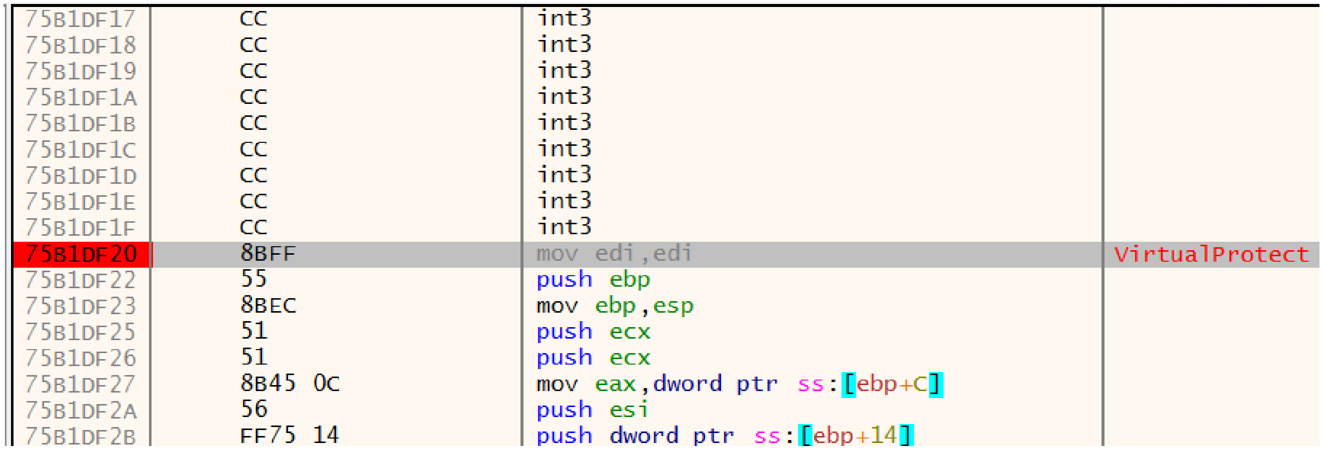
PE Overwrite

To start we look for where virtual allocation of memory takes place which in this case it is the function VirtualAlloc. The return value for VirtualAlloc is the base address of the allocated region. Which we can find in the EAX register. We put a breakpoint at the return of the function:

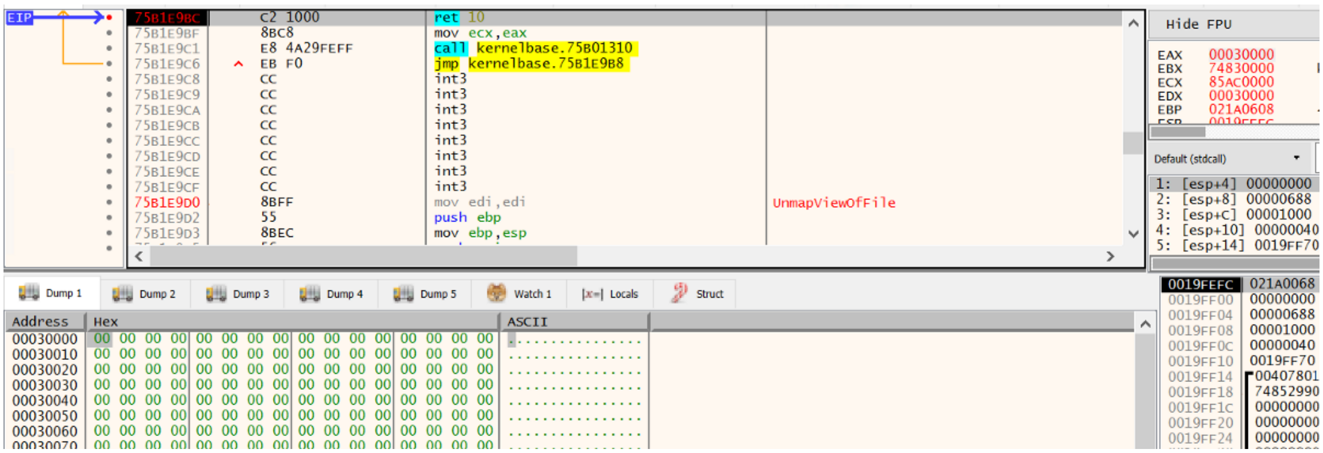


This will help us to see how many times and where memory is being virtually allocated.

We also want to add a breakpoint at the entry of VirtualProtect, this is where the protections and access is changed. The first argument to VirtualProtect will be the address to the memory section which protections will be changed. It needs to change the protections to get the permission to write

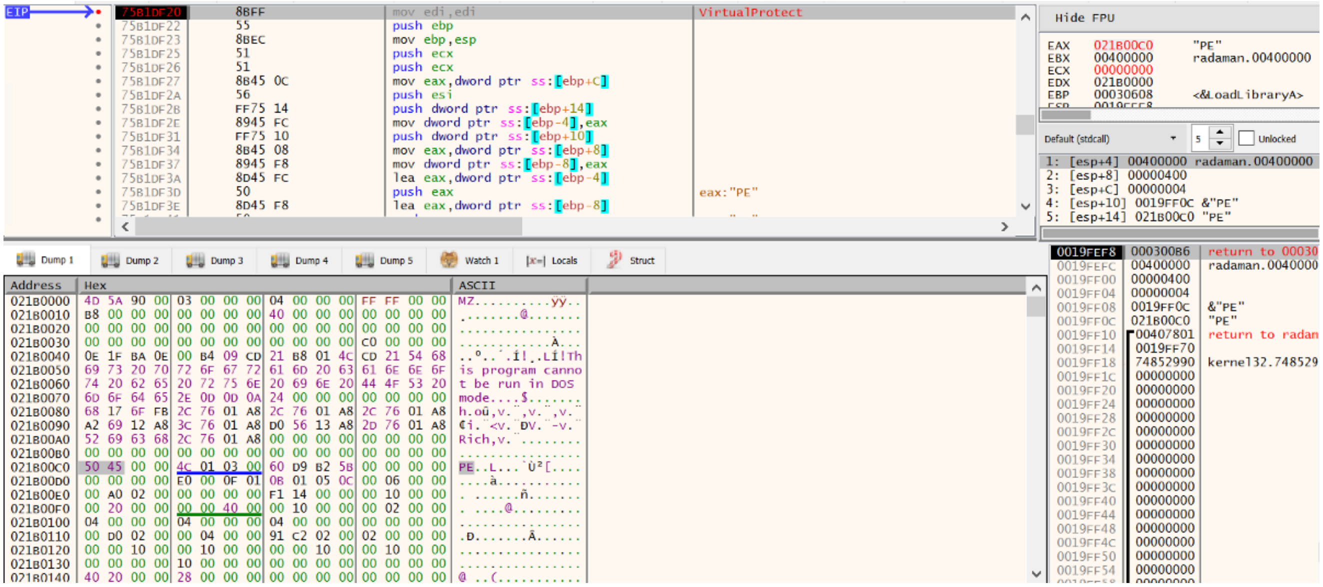


Now we run the debugger until we hit our second breakpoint (First one is always on the entry point of the file).



From the screenshot we hit the breakpoint, we right click on the address in EAX and follow in dump. We can see that at address 0003000 there is a large amount of zeros where VirtualAlloc has allocated space.

Continuing on we hit the return of VirtualAlloc again at address 021B0000. So we know that VirtualAlloc is used at address 0003000 and 021B0000. Our next hit is the entry of VirtualProtect:



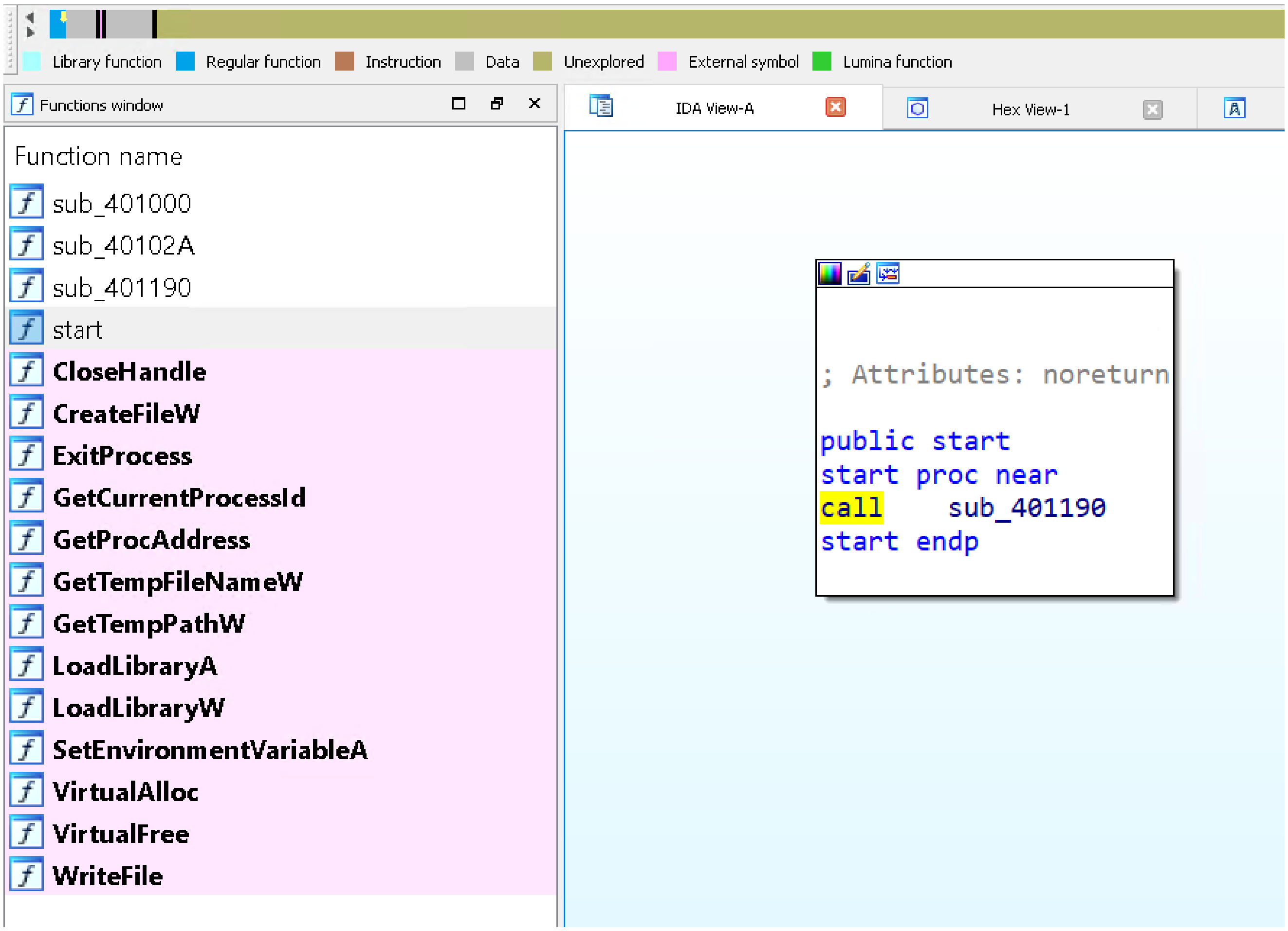
Checking the first argument passed to VirtualProtect in the EAX register we can automatically see that instead of zeros we now have what looks to be an exe (the MZ or hex 4D 5A gives it away). At this point we now have gotten to the point in the malware where not only has the main payload been unpacked but now it is ready to have its permissions and access changed, we now right click on the dump and choose the “Follow in Memory Map”

Address	Size	Info	Content	Type	Protection	Initial
003DA000	00026000	Reserved (00200000)		PRV		-RW--
00400000	00001000	radaman.exe		IMG	-R---	ERWC-
00401000	00011000	".text"	Executable code	IMG	ERWC-	ERWC-
00412000	00001000	".rdata"	Read-only initialized data	IMG	-R---	ERWC-
00413000	00003000	".data"	Initialized data	IMG	-RW--	ERWC-
00416000	0003C000	".rsrc"	Resources	IMG	-RWC-	ERWC-
00460000	000C7000	\Device\HarddiskVolume2\Windows\Sy		MAP	-R---	-R---
00530000	00006000			PRV	-RW--	-RW--
00536000	0000A000	Reserved (00530000)		PRV		-RW--
00540000	000FC000	Reserved		PRV		-RW--
0063C000	00004000	Thread 714 Stack		PRV	-RW-G	-RW--
00660000	00010000			PRV	-RW--	-RW--
00670000	000F0000	Reserved (00660000)		PRV		-RW--
00760000	00035000	Reserved		PRV		-RW--
00795000	0000B000			PRV	-RW-G	-RW--
007A0000	000FC000	Reserved		PRV		-RW--
0089C000	00004000	Thread 6A4 Stack		PRV	-RW-G	-RW--
008A0000	00035000	Reserved		PRV		-RW--
008D5000	0000B000			PRV	-RW-G	-RW--
008E0000	000FD000	Reserved		PRV		-RW--
009DD000	00003000	Thread CEC Stack		PRV	-RW-G	-RW--
009E0000	0000A000			MAP	-R---	-R---
009EA000	001F6000	Reserved (009E0000)		MAP		-R---
00BE0000	00181000			MAP	-R---	-R---
00D70000	00053000			MAP	-R---	-R---
00DC3000	013AE000	Reserved (00D70000)		MAP		-R---
021A0000	00001000			PRV	ERW--	ERW--
021B0000	0002B000			PRV	-RW--	-RW--
022A0000	00003000			PRV	-RW--	-RW--
022A3000	0000D000	Reserved (022A0000)		PRV		-RW--

In memory map we can see that at the address where the exe is loaded, (021B0000) that location has read and write protections. We now dump out that location and examine it.

Unpacked File

Immediately after opening the “unpacked” file we notice that is indeed packed again based on IDA.

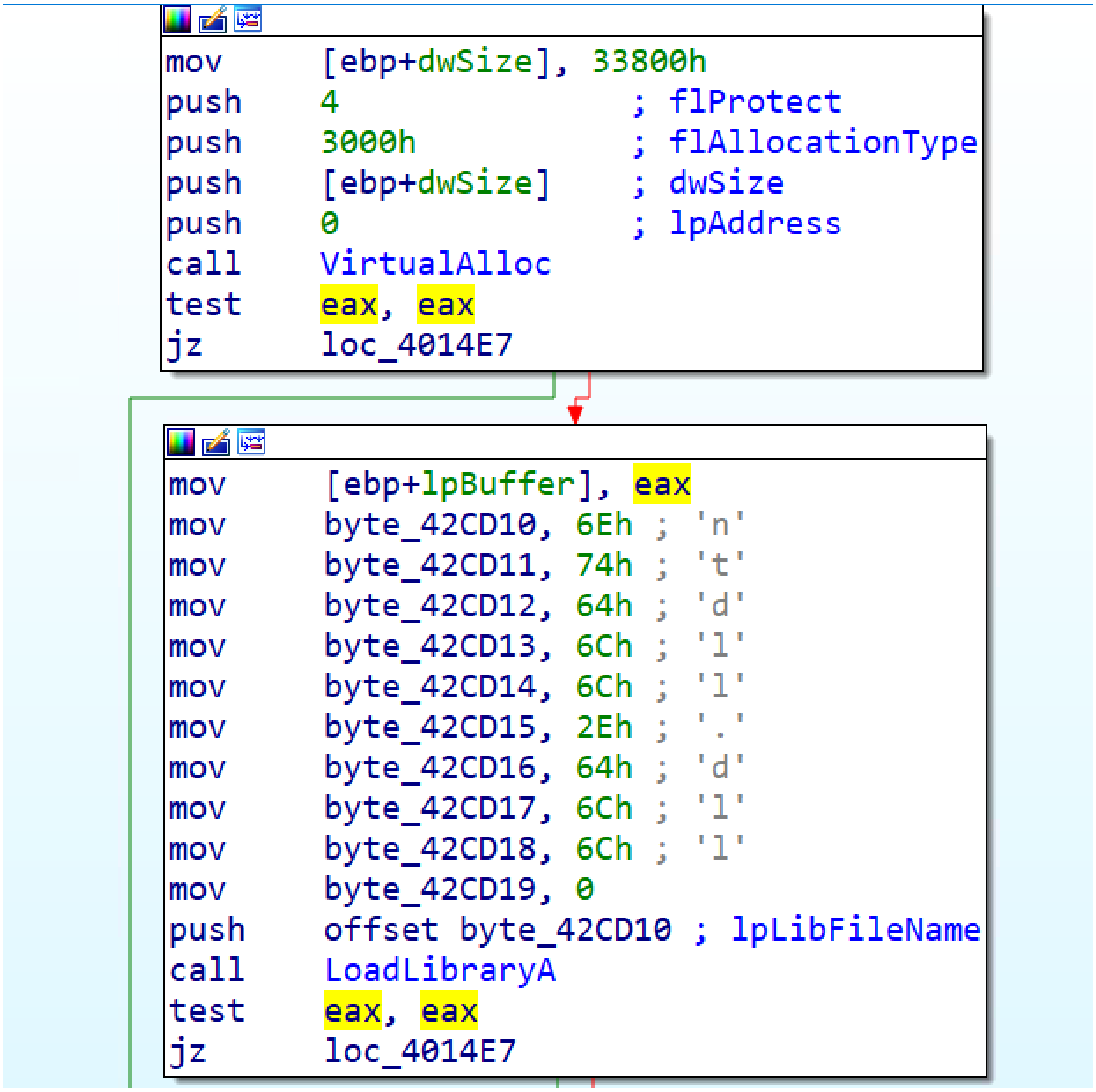


There are not enough functions and small amount of analyzed code by IDA. Looking at the few functions that are available we can start to see some interesting actions taking place.

```
lpBuffer= dword ptr -4

push    ebp
mov     ebp, esp
add     esp, 0FFFFFBE4h
push    ebx
mov     edx, 1B8C88EEh  ; A key? because its being used in the loop below
lea     eax, unk_403000 ; Strange function
mov     ecx, 29CD6h     ; Counter or length?

loc_4011AA:
xor     [eax], dl
rol     edx, 7
inc     eax
dec     ecx
jnz     short loc_4011AA

mov     [ebp+dwSize], 33800h
push    4               ; flProtect
push    3000h           ; flAllocationType
push    [ebp+dwSize]    ; dwSize
push    0               ; lpAddress
call    VirtualAlloc
```

loc_4011AA looks to be a loop. The key is moved to EDX and XORed with a byte from unk_403000 then rotated left. Then theres some decreasing and increasing happening and then there is a conditional jnz which moves the code along only if not being equal to zero.

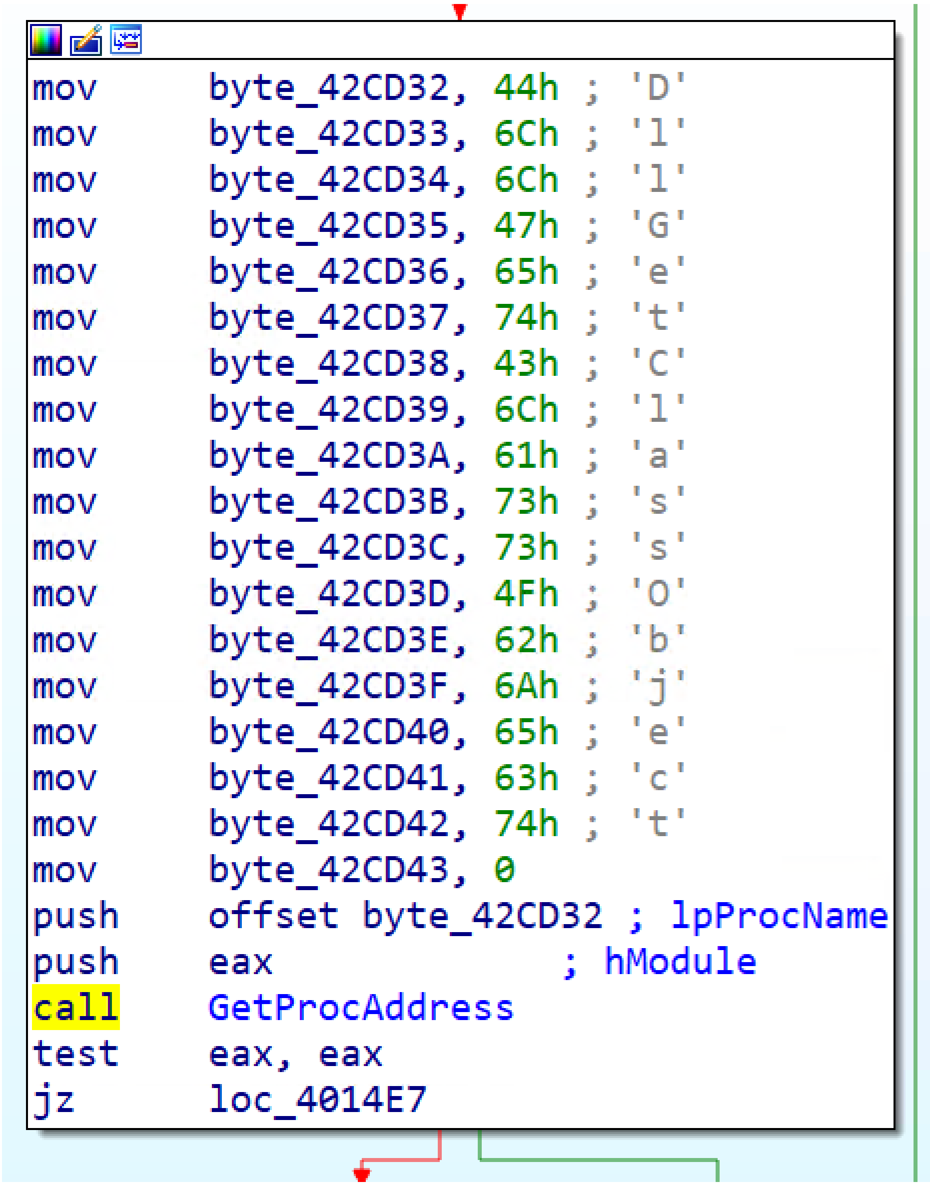
This is most likely the encryption or encoding algorithm used.



Following along we can see that it is loading DLLs into a buffer. LoadLibraryA is called which provides a return to a handle that can be used in GetProcAddress below:

```
mov     byte_42CD1C, 52h ; 'R'
mov     byte_42CD1D, 74h ; 't'
mov     byte_42CD1E, 6Ch ; 'l'
mov     byte_42CD1F, 44h ; 'D'
mov     byte_42CD20, 65h ; 'e'
mov     byte_42CD21, 63h ; 'c'
mov     byte_42CD22, 6Fh ; 'o'
mov     byte_42CD23, 6Dh ; 'm'
mov     byte_42CD24, 70h ; 'p'
mov     byte_42CD25, 72h ; 'r'
mov     byte_42CD26, 65h ; 'e'
mov     byte_42CD27, 73h ; 's'
mov     byte_42CD28, 73h ; 's'
mov     byte_42CD29, 42h ; 'B'
mov     byte_42CD2A, 75h ; 'u'
mov     byte_42CD2B, 66h ; 'f'
mov     byte_42CD2C, 66h ; 'f'
mov     byte_42CD2D, 65h ; 'e'
mov     byte_42CD2E, 72h ; 'r'
mov     byte_42CD2F, 0
push    offset byte_42CD1C ; lpProcName
push    eax             ; hModule
call    GetProcAddress
test    eax, eax
jz      loc_4014E7
```

Next it pushes into a buffer RTLDecompressBuffer which decompresses the buffer which is in this case: NTDLL.DLL



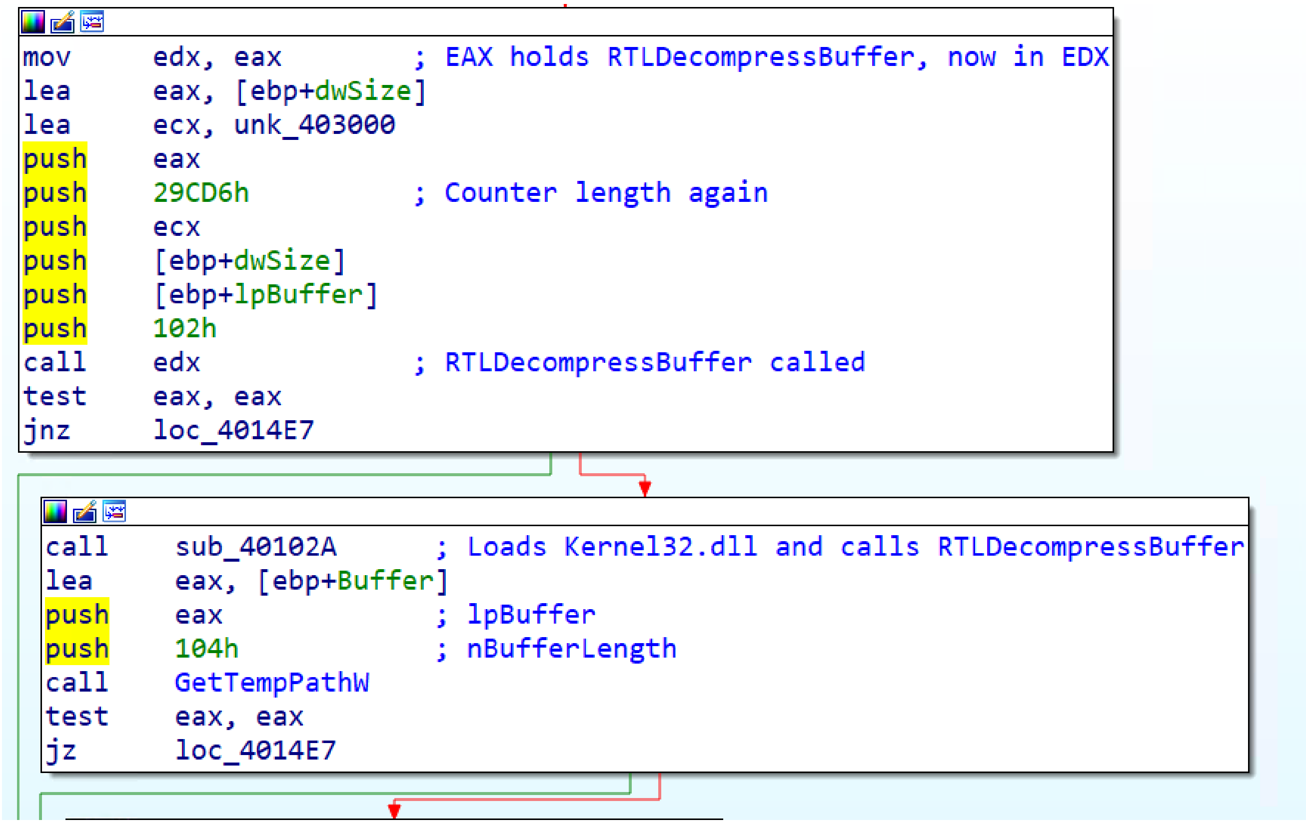
```
mov     byte_42CD32, 44h ; 'D'
mov     byte_42CD33, 6Ch ; 'l'
mov     byte_42CD34, 6Ch ; 'l'
mov     byte_42CD35, 47h ; 'G'
mov     byte_42CD36, 65h ; 'e'
mov     byte_42CD37, 74h ; 't'
mov     byte_42CD38, 43h ; 'C'
mov     byte_42CD39, 6Ch ; 'l'
mov     byte_42CD3A, 61h ; 'a'
mov     byte_42CD3B, 73h ; 's'
mov     byte_42CD3C, 73h ; 's'
mov     byte_42CD3D, 4Fh ; 'O'
mov     byte_42CD3E, 62h ; 'b'
mov     byte_42CD3F, 6Ah ; 'j'
mov     byte_42CD40, 65h ; 'e'
mov     byte_42CD41, 63h ; 'c'
mov     byte_42CD42, 74h ; 't'
mov     byte_42CD43, 0
push    offset byte_42CD32 ; lpProcName
push    eax             ; hModule
call    GetProcAddress
test    eax, eax
jz      loc_4014E7
```

Next called up is DLLGetGlassObject of NTDLL.DLL and then a call to GetProcAddress.

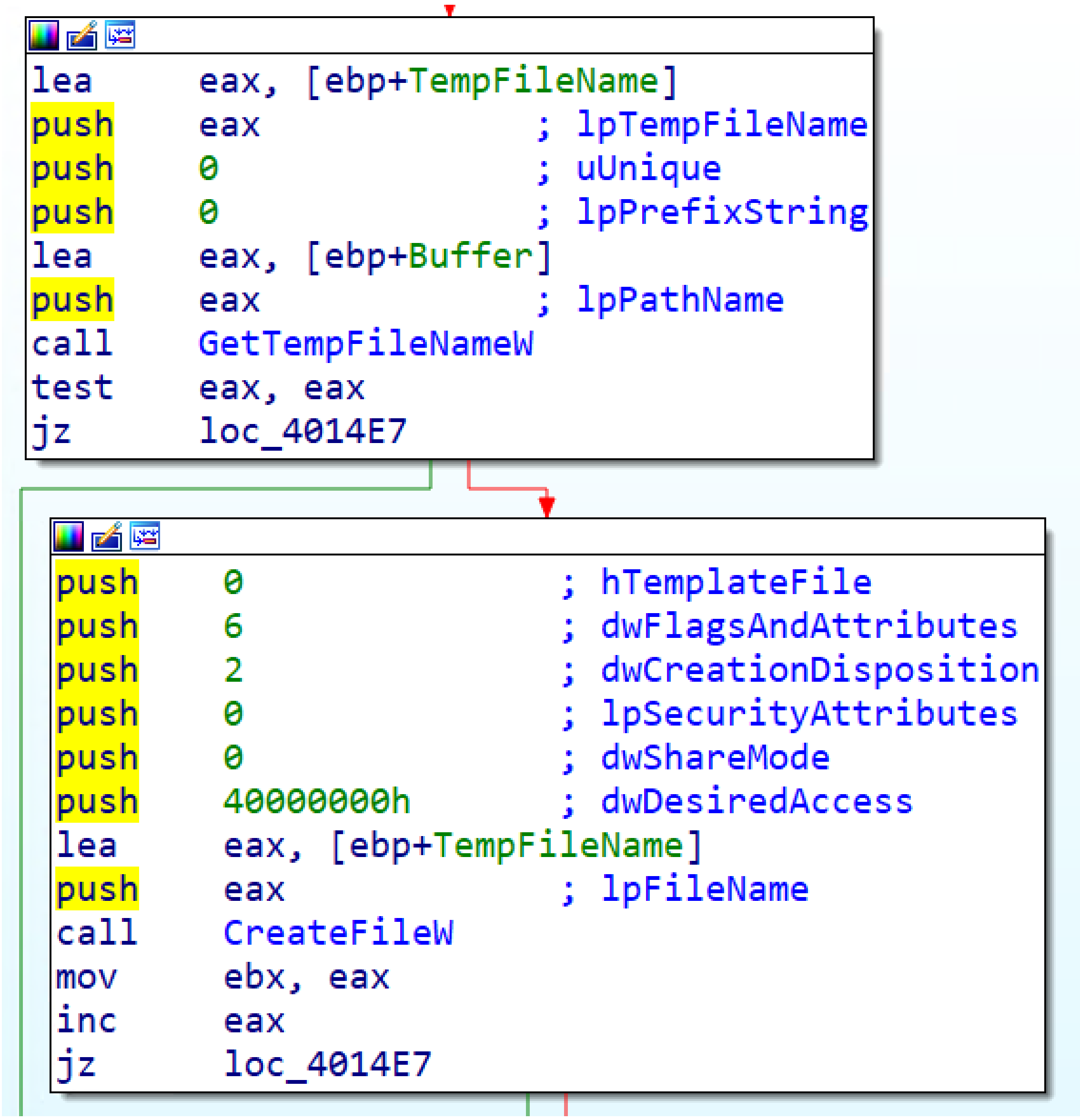
We then see that EAX which holds RTLDecompressBuffer is moved to EDX and then called again. Looking at the documentation for RTLDecompressBuffer, the parameters are:

- [in] which is 102h
- [Out] Buffer which is [ebp+lpBuffer]
- [in] which is [ebp+dwSize]
- [in] buffer that contains the data in ECX which holds unk_403000 (encryption method)
- [in] which is the length 29CD6h
- [out] which is the return stored at EAX

This result is then cmp with itself and if it meets the conditional it continues on.



sub_40102A loads KERNEL32.DLL and calls RTLDecompressBuffer in the same way NTDLL.DLL is loaded in. Then we start to see the formation of a temp file



The malware uses GetTempFileNameW, creates the file with CreateFileW, writes to the file using WriteFile and then loads the file as a DLL using LoadLibraryA. (Partially Pictured)

An finally a buffer with the string “host 00000000000” before the code ends. The zeros are probably changed to some unique ID that the malware uses to send back to a C&C server.

```
mov     byte_42CD46, 68h ; 'h'
mov     byte_42CD47, 6Fh ; 'o'
mov     byte_42CD48, 73h ; 's'
mov     byte_42CD49, 74h ; 't'
mov     byte_42CD4A, 20h ; ' '
mov     byte_42CD4B, 30h ; '0'
mov     byte_42CD4C, 30h ; '0'
mov     byte_42CD4D, 30h ; '0'
mov     byte_42CD4E, 30h ; '0'
mov     byte_42CD4F, 30h ; '0'
mov     byte_42CD50, 30h ; '0'
mov     byte_42CD51, 30h ; '0'
mov     byte_42CD52, 30h ; '0'
mov     byte_42CD53, 30h ; '0'
mov     byte_42CD54, 30h ; '0'
mov     byte_42CD55, 30h ; '0'
mov     byte_42CD56, 30h ; '0'
mov     byte_42CD57, 0
push    0
push    offset byte_42CD46
push    0
push    0
call    eax
```

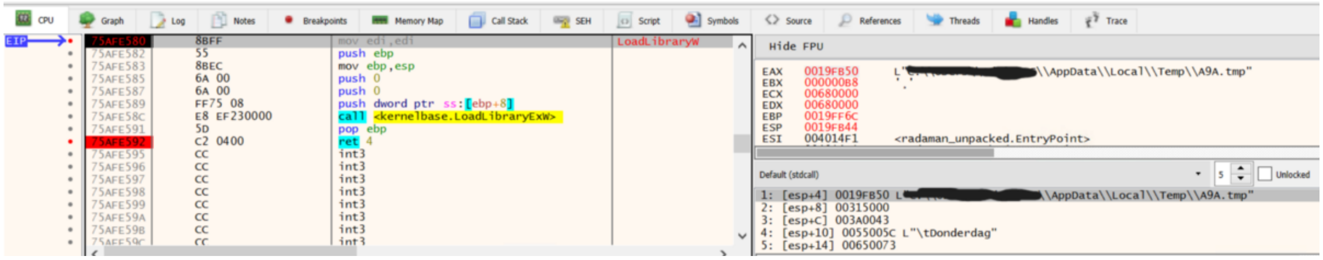
That's all we can get out of IDA so now we move to the debugger and use the same methods to find the payload DLL

Unpacking the "Unpacked" File

Since we know the next step of this malware is to perform a DLL injection, we can put a breakpoint at LoadLibraryW (not LoadLibraryA)…

> `'A'` stands for ASCII and `'W'` stands for byte string and the `'A'` calls are just the wrappers around the `'W'` ones so placing the breakpoint at the `LoadLibraryW` will hit all the load DLL calls.
>
> Source

and from there we can see the path where the DLL will be dropped.



Checking that location we can find the file and checking in PEStudio we can see that it is a DLL (file maybe hidden).

property	value
md5	BA09C5888E93D7F81B6E65F260962DE4
sha1	D4CF1157B3AF4207803CDA74FD8300E920E3CCF3
sha256	D5CCC140D73A5E76154AA15B2015FCD0F022298825430F02B408C38CDC48F79B
md5-without-overlay	n/a
sha1-without-overlay	n/a
sha256-without-overlay	n/a
first-bytes-hex	4D 5A 90 00 03 00 00 00 04 00 00 00 FF FF 00 00 B8 00 00 00 00 00 00 00 40 00 00 00 00 00 C
first-bytes-text	M Z .. .. @ .. ..
file-size	200704 (bytes)
size-without-overlay	n/a
entropy	7.450
imphash	D3B0A68EC2185264A5C5A26F84A23AC5
signature	n/a
entry-point	60 31 D2 55 54 5D 83 C4 A4 B9 B3 98 08 00 BA E2 BB 08 00 E8 2A 00 00 00 00 00 00 00 00 0
file-version	n/a
description	n/a
file-type	**dynamic-link-library**
cpu	**32-bit**
subsystem	GUI
compiler-stamp	0x58246200 (Thu Nov 10 12:03:12 2016)
debugger-stamp	empty
resources-stamp	empty
exports-stamp	empty

Conclusion

So to wrap things up, we successfully unpacked the inital Redaman file using VirtalAlloc and VirtualProtect, we then discovered the encryption algorithm it uses, and finally unpacked once again with LoadLibraryW to find the payload DLL.

Thanks for reading.

Resources:

[Russian Language Malspam Pushing Redaman Banking Malware]

Unpacking Redaman Malware & Basics of Self-Injection Packers — ft. OALabs

Unpacking Redaman Malware & Basics of Self-Injection Packers — ft. OALabs (Video)