Unpacking Emotet Trojan

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Emotet, in general, is a **banking trojan.** Identified in-the-wild for the first time in 2014 as a stealth info stealer (mainly targeting banking informations), emotet has evolved to a sofisticated trojan over the years; Now having funcionalities that goes from simply keylogging to self-spreading (as worms do).

The main campaign of the malware is through **malspam**. Using the "**urgency**" pretext, emotet make his victims by malicous documents with a macro embedded, malicious scripts or malicious links. Then, the pretext comes with subjects like: "**Your Invoice**", "**Payment Details**" or an upcoming shipment from **well-known companies**.

Emotet uses some tricks to evade and prevent his detection and analysis. The malware will **check for common malware analysis tools** (like IDA or Wireshark), check if it is running on a **virtual environment** and remain sleep, and every sample comes **packed** or **encrypted**.

Today we will be covering the **unpacking** of a sample from emotet family.

Reconnaissance

```
sha256: 3a9494f66babc7deb43f65f9f28c44bd9bd4b3237031d80314ae7eb3526a4d8f
md5: ca06acd3e1cab1691a7670a5f23baef4
```

First, we need to know if the sample is definitely packed. Lets open it on **DiE**.

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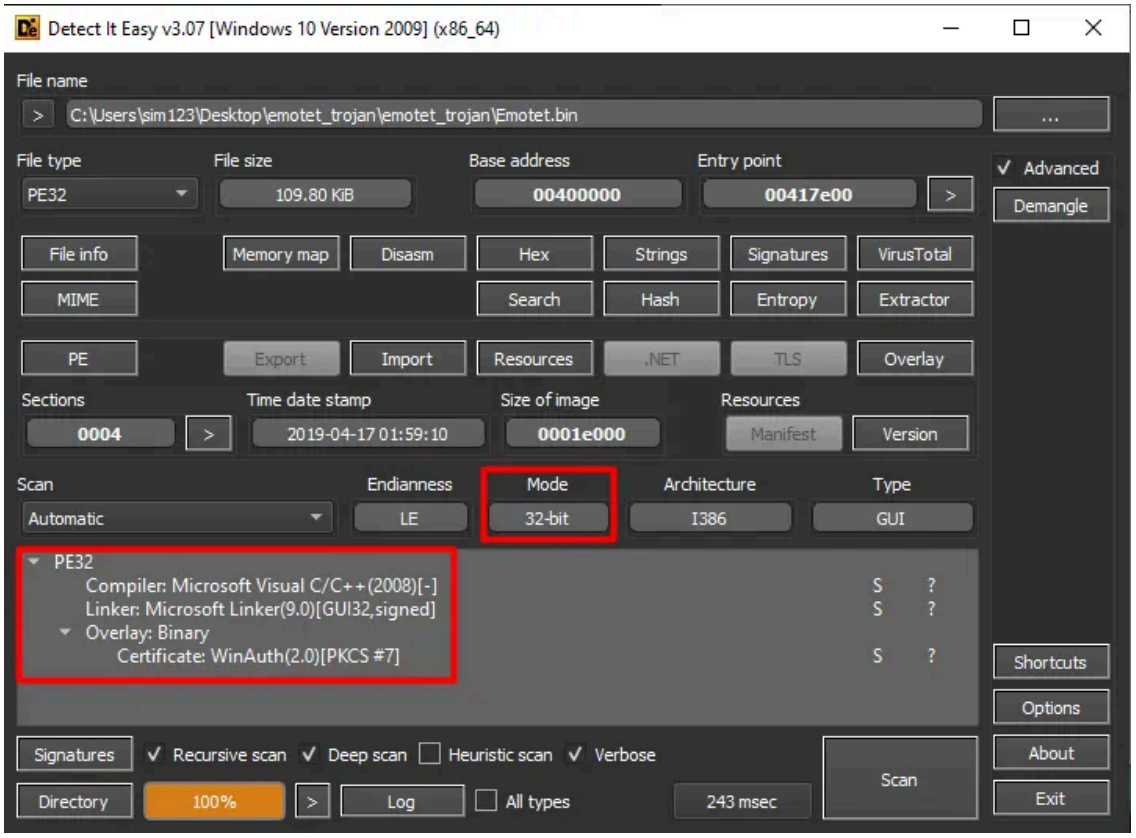

We can see that it is a **32-bit binary**, made in C/C++ and having a certificate stored in the overlay section (*WinAuth(2.0)*)

By looking at the **entropy**, we see that the binary has ***89%*** chance of being packed.

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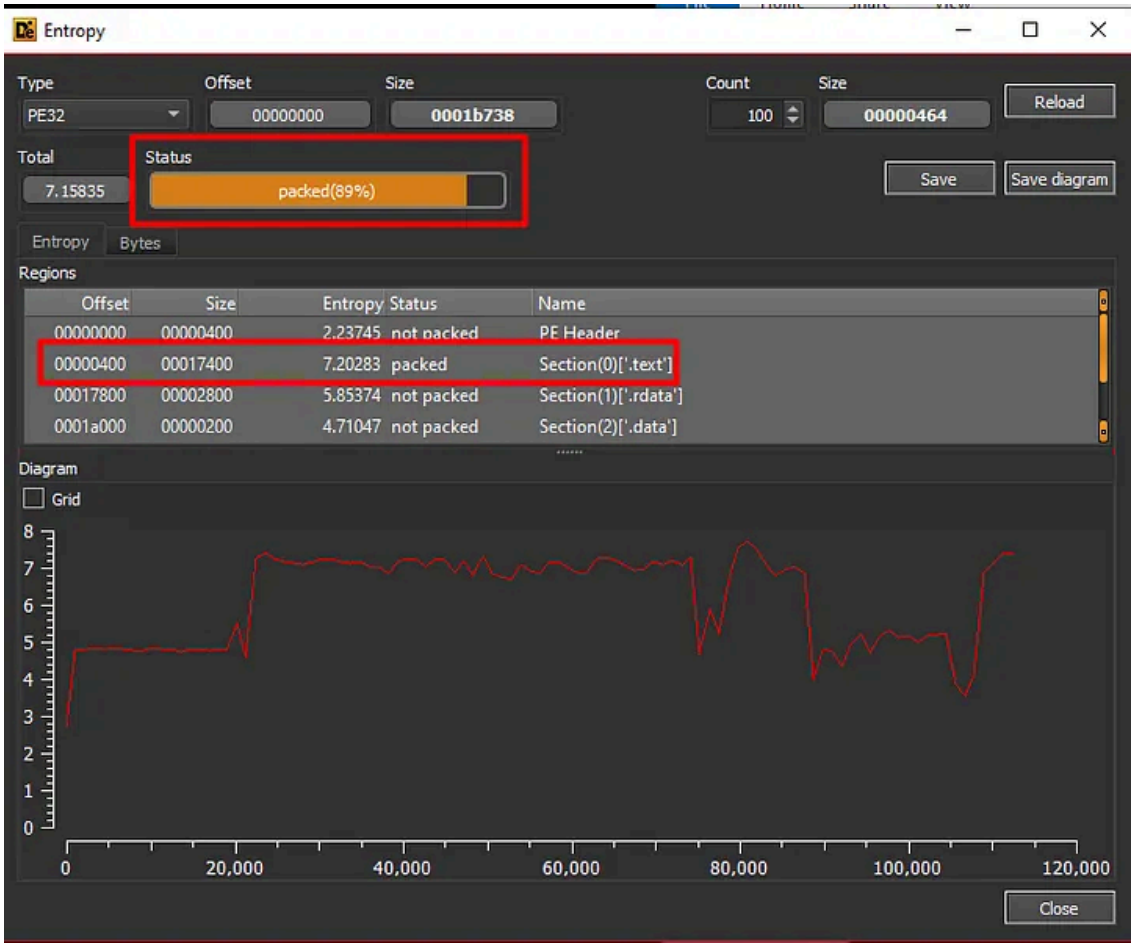
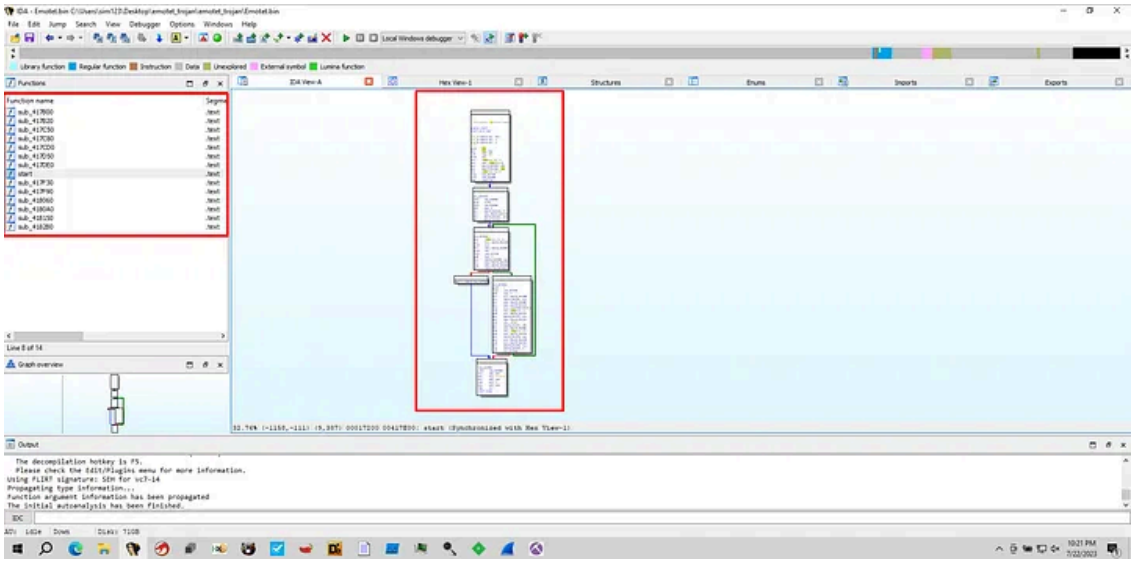


We can confirm it by looking at the sample on **IDA**.

Press enter or click to view image in full size



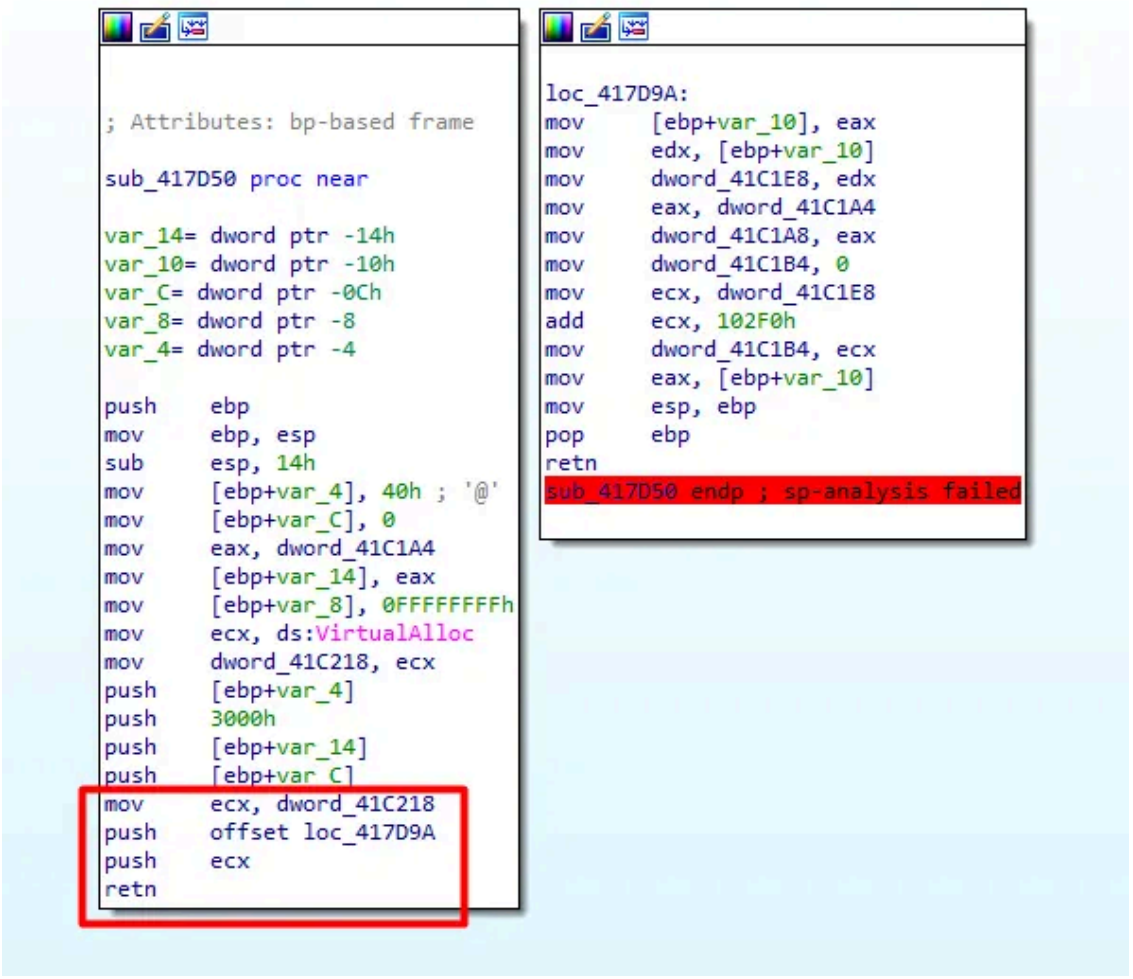
IDA shows some **indicators of packing**, like:

- Lack of functions on a malware this sofisticated.
- Main (start) function seems small and doesn't have any WindowsAPI call.

But, we can have the proof of it by looking into **common packing APIs**:

- **CreateProcessInternalW()**
- **VirtualAlloc()**
- **VirtualAllocEx()**
- **VirtualProtect() | ZwProtectVirtualMemory()**
- **WriteProcessMemory() | NtWriteProcessMemory()**
- **ResumeThread() | NtResumeThread()**
- **CryptDecrypt() | RtlDecompressBuffer()**
- **NtCreateSection() + MapViewOfSection() | ZwMapViewOfSection()**
- **UnmapViewOfSection() | ZwUnmapViewOfSection()**
- **NtWriteVirtualMemory()**
- **NtReadVirtualMemory()**

Searching for **VirtualAlloc()**, we will soon find the subroutine that probably is the responsible for unpacking the malware.



Now it gets a little bit more complicated. The red box marks an "**abnormal epilogue**". An "abnormal epilogue" occurs when we have some **pushes into the stack and not a single pop before it returns**.

> You can notice that **ds:VirtualAlloc** is being moved into ecx, then ecx is pushed onto the stack and the return is called, meaning the call of VirtualAlloc().

After calling ecx (*VirtualAlloc*), the return will execute the second push from the stack (*osffset loc_417d9a*), executing whatever is present on the second block, and then the **real return** will come.

```
.text:00417E3A                call    sub_417D50
.text:00417E3F                add     esp, 4
```

So, the return of the subroutine will be on ***0x00417E3F***.

Normally, after the code finishes the unpack, **we will have a jmp to it**.

```
.text:00417F0C loc_417F0C:                            ; CODE XREF: start+8F↑j
.text:00417F0C                call    sub_417DE0
.text:00417F11                mov     edi, edi
.text:00417F13                mov     ecx, 417BC4h
.text:00417F18                mov     edi, edi
.text:00417F1A                sub     ecx, 4
.text:00417F1D                mov     edi, edi
.text:00417F1F                jmp     ecx
.text:00417F1F start          endp
```

We can confirm it by looking at the **end** of the **main** function, which has an "*jmp ecx*".

Again, take notes of the address. ***0x00417F1F***.

Unpacking

So we got two addresses to set breakpoints in:

```
0x00417E3F
0x00417F1F
```

We can open it on **x64dbg**, search for those addresses (**Ctrl+G**), and then set the breakpoints.

Press enter or click to view image in full size

Type	Address	Module/Label/Exception	State	Disassembly	Hits	Summary
Software						
	00417E3F	emotet.bin	Enabled	add esp,4	0	
	00417F1F	emotet.bin	Enabled	jmp ecx	0	

By going to the "***jmp***" breakpoint and scrolling down, we will encounter another abnormal set of instructions. This time, a **subroutine** is being pushed into the stack and not popped, the the ret makes the call to that subroutine.

```
00417C34    8B15 B4C14100    mov edx,dword ptr ds:[41C1B4]
00417C3A    52               push edx
00417C3B    C3               ret
```

Following it on the dump, we can see that it is the **newly allocated memory**.

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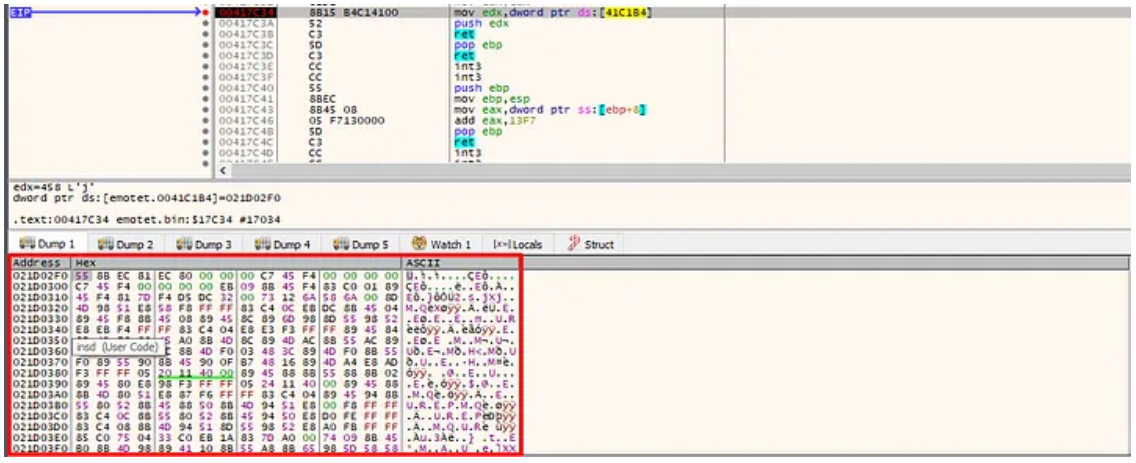

Having the knowledge of the abnormal epilogue, we will stepover until the ret is called and take us to another stage of the unpack.

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Now, we will have to **stepover** that code and analyze all those calls(e. g. call 21CF710).

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After some analysis, we eventually will find the call to ***3AF830***, which has some interesting code:

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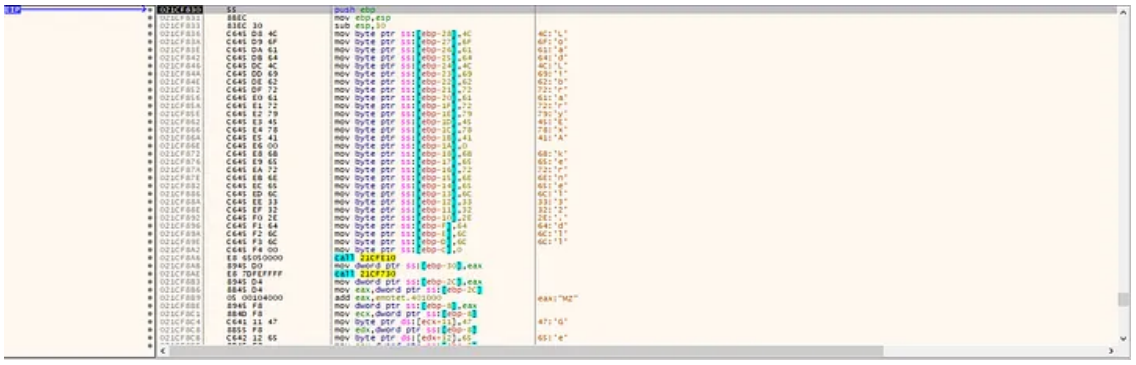

We can see that this subroutine is using "***stack string***s" as a form of evasion/obfuscation. This piece of code tries to obfuscate the passing of arguments "*LoadLibraryExA*" and "*kernel32.dll*" to the call ***21CFE10***. And many others.

As we know what is happening here, lets go straight to the **return of that subroutine.**

After returning to the **main unpacking subroutine**, we notice that the upcoming calls has the same mechanism as ***3AF830***.

But, the last one is important. Since the code inside of it is different, is worth a analysis.

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We can assume that edx is a call to **VirtualAlloc**, because some of the parameters passed to it are common parameters passed to **VirtualAlloc** itself.

> **push 40 as: PAGE_EXECUTE_READWRITE (flProtect)**
> **push 3000 as: MEM_COMMIT | MEM_RESERVE**

To confirm it, we stepover to that call.

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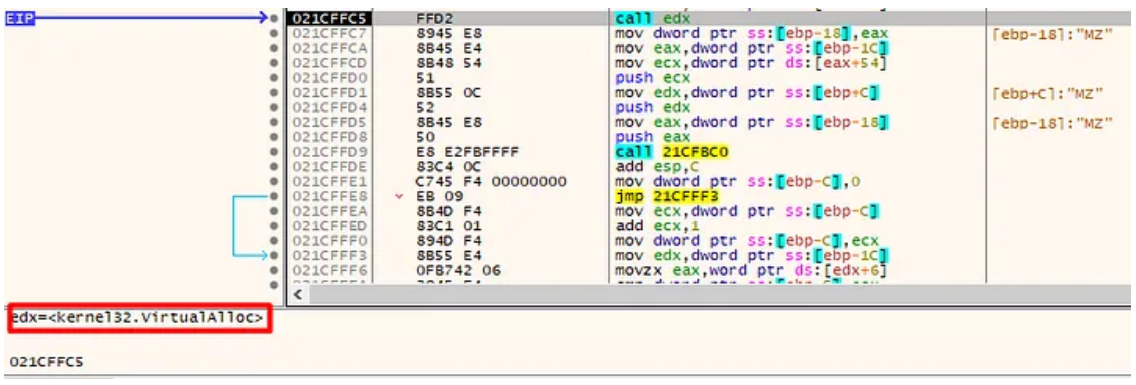

:)

Knowing the return of that API is the **base address of the recent allocated memory**, we can follow the address in ***EAX*** (return).

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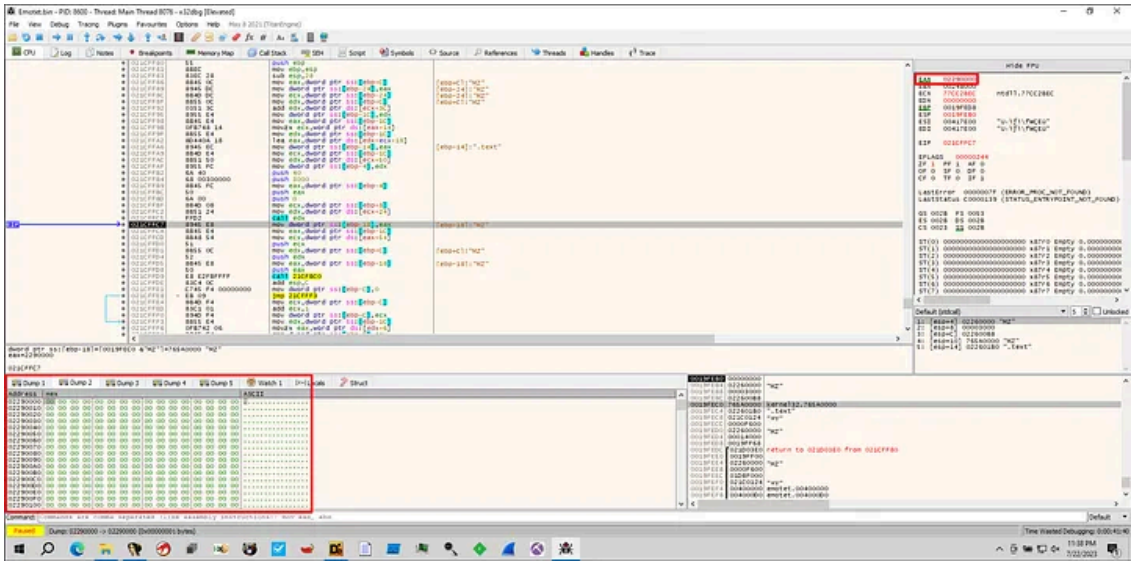

After stepping over a little bit more, we will notice that memory being populated, more specifically after the call to ***21CFBC0***.

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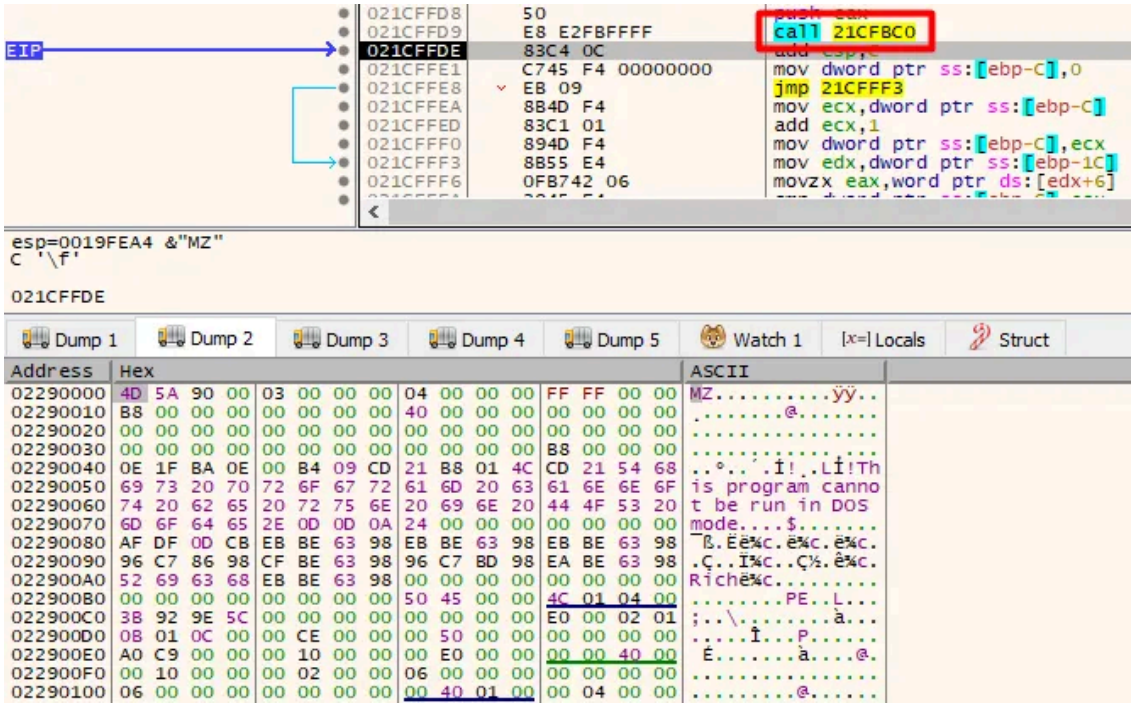

Then, we have to continue to stepover **until the subroutine finishes populating that memory**.

> We will know it finished when we encounter a **return**.

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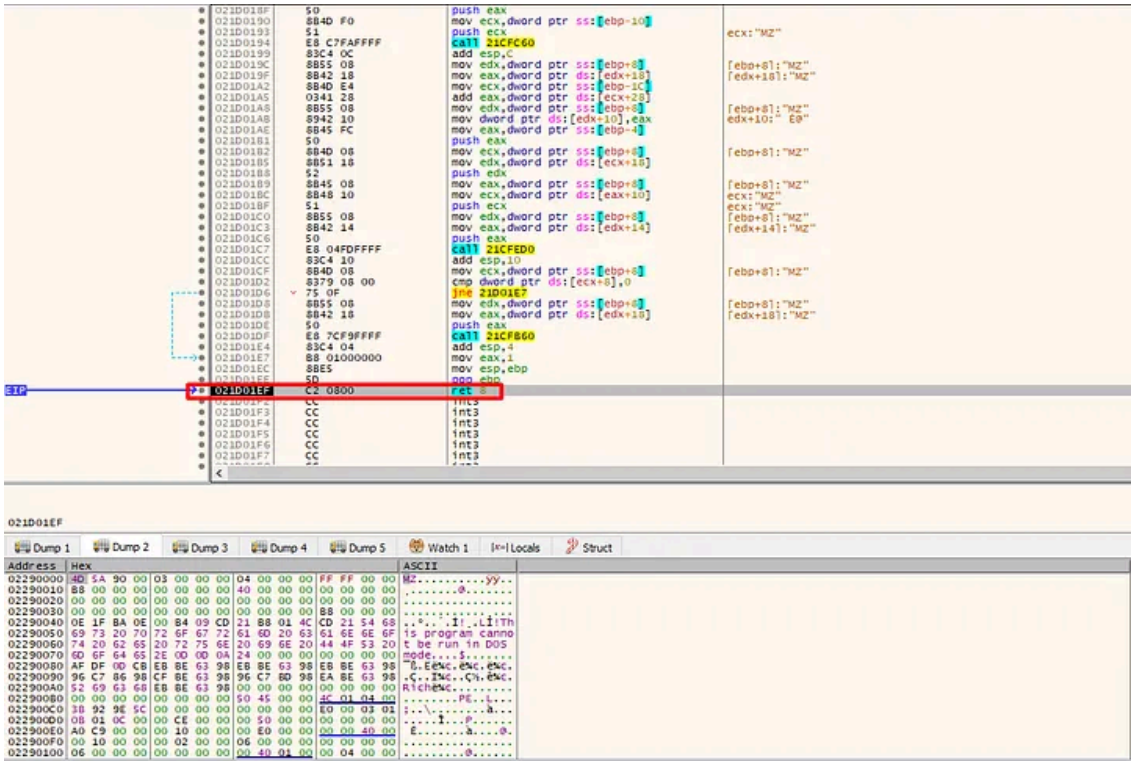
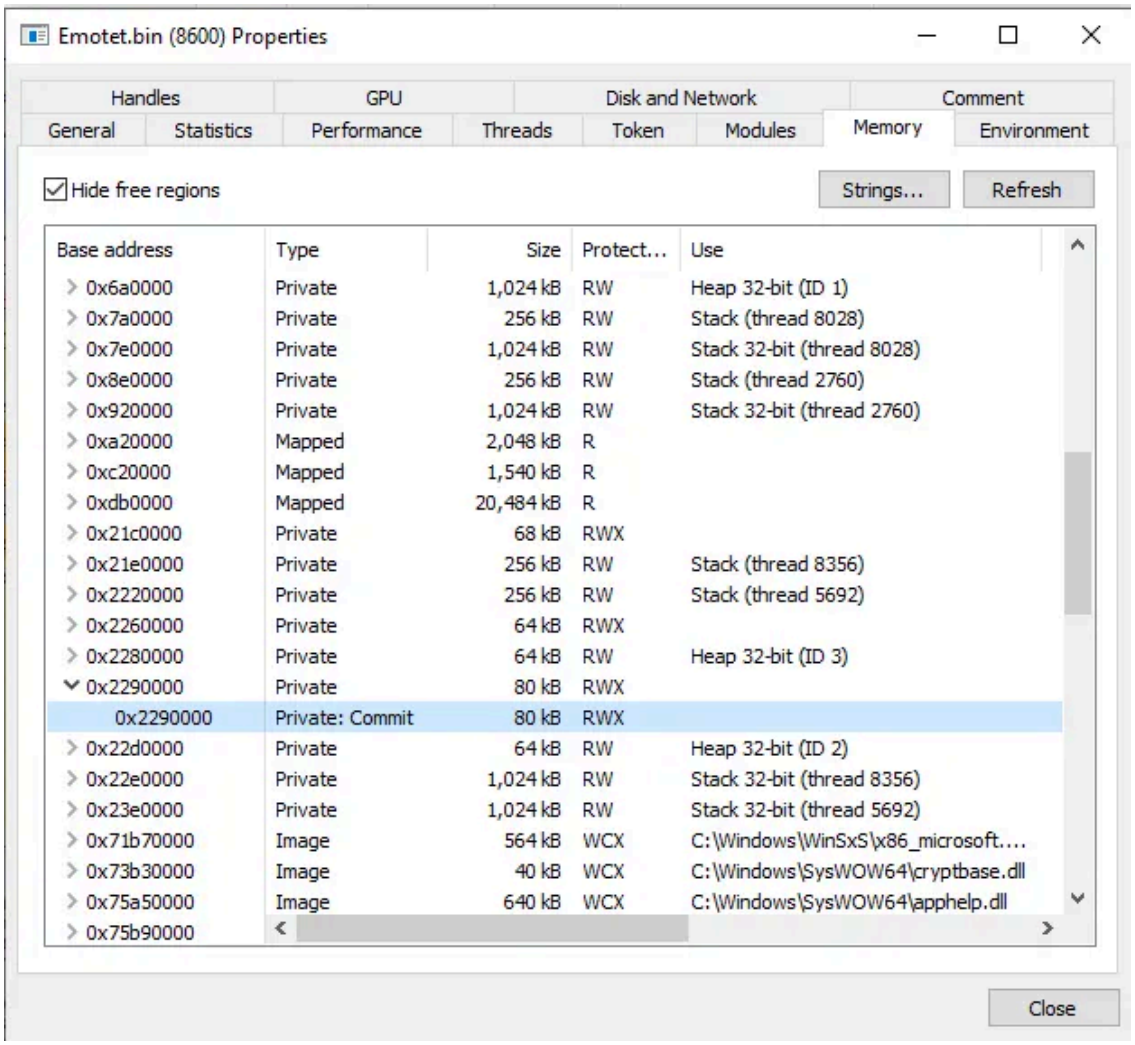


After all of this, we can finally **dump that memory**.

The dump is made by:

```
right-clicking the first byte -> following it on memory map -> right-click > dump memory to file
```

> Another way of doing it is: Opening the process in **process hacker** (administrator), searching for the address marked in dump, then dumping to a file.



Unmapping

If we open the recently dumped file on IDA for example, it will be **completely scrambled**. The reason for this is because the binary may be **unaligned or mapped**, so we need to align and unmap it.

To align and unmap it, we will open the dumped binary on **PE Bear**.

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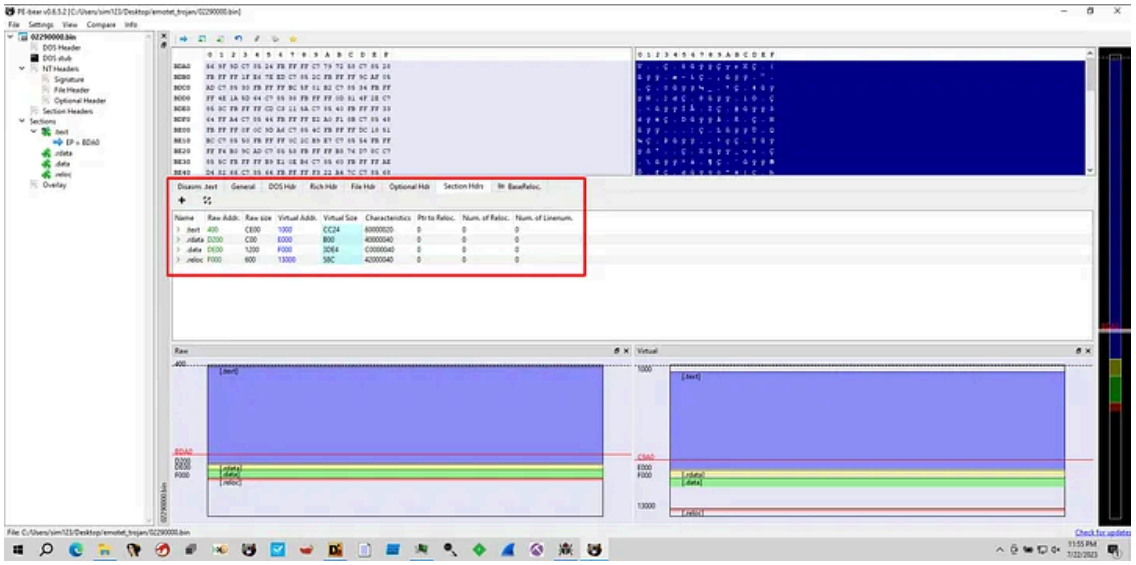

As you can see, we don’t have the **import tab**, meaning we need to unmap the binary.

The unmap process is simples. It will take 4 steps:

1. Change the Raw Address to the **same** as Virtual Address.
2. Ajust the Raw Size by **subtracting** the first sectin by the second, and so on.
3. **Copy** the adjusted Raw Size to the Virtual Size
4. Fix the Base Address in the Optional Header (The **same** as the **dump address**).

> You can subtract those values with the windows calculator and the “**programmer**” option.

After that, we have the Unmapped Binary:

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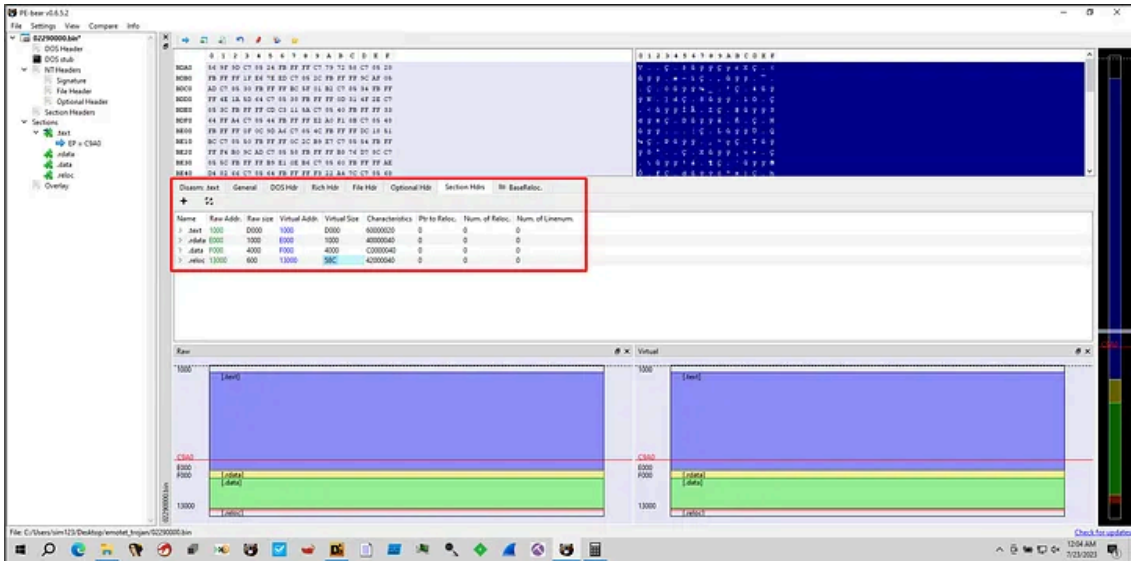

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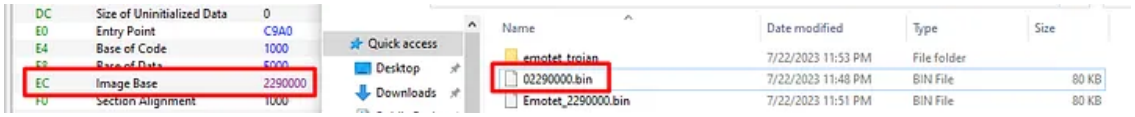

Now, all we have to do is save the new binary.

```
Binary name -> right-click -> Save the executable as...
```

Confirming

To confirm all we've done , let's open it on **IDA**.

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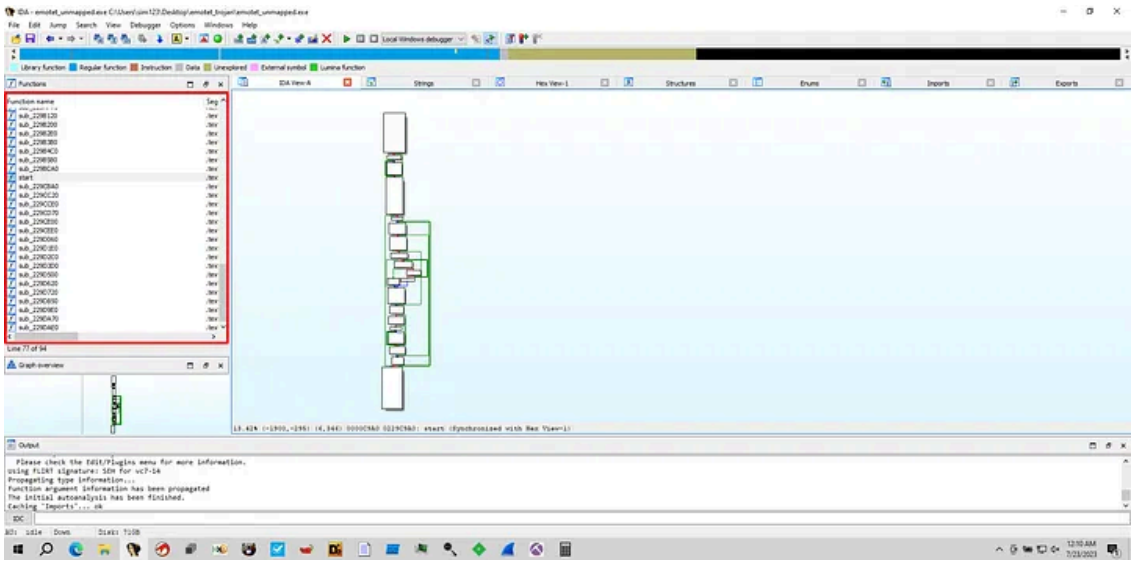
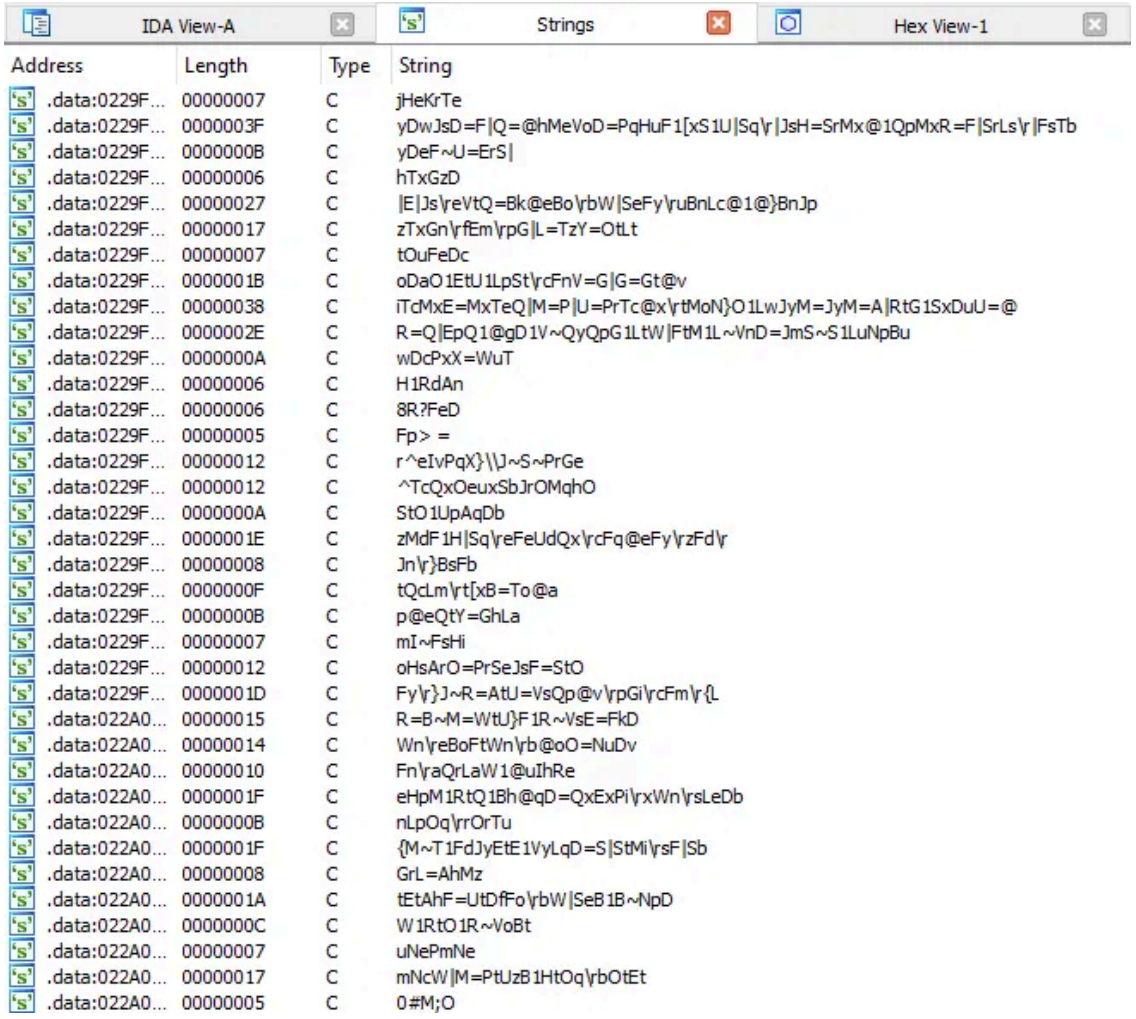


As you notice, now we have plenty of functions to analyze, and assuming by it's strings and imports, the malware is unpacked but has a severe method of **encryption** and **dynamic linking**.



IDA View-A | Strings | Hex View-1

Address	Length	Type	String
.data:0229F...	00000007	C	jHeKrTe
.data:0229F...	0000003F	C	yDwJsD=F|Q=@hMeVoD=PqHuF1[xS1U|Sq\r|JsH=SrMx@1QpMxR=F|SrLs\r|FsTb
.data:0229F...	0000000B	C	yDeF~U=ErS|
.data:0229F...	00000006	C	hTxGzD
.data:0229F...	00000027	C	|E|Js\reVtQ=Bk@eBo\rbW|SeFy\ruBnLc@1@}BnJp
.data:0229F...	00000017	C	zTxGn\rfEm\rpG|L=TzY=OtLt
.data:0229F...	00000007	C	tOuFeDc
.data:0229F...	0000001B	C	oDaO1EtU1LpSt\rcFnV=G|G=Gt@v
.data:0229F...	00000038	C	iTcMxE=MxTeQ|M=P|U=PrTc@x\rtMoN}O1LwJyM=JyM=A|RtG1SxDuU=@
.data:0229F...	0000002E	C	R=Q|EpQ1@gD1V~QyQpG1LtW|FtM1L~VnD=JmS~S1LuNpBu
.data:0229F...	0000000A	C	wDcPxX=WuT
.data:0229F...	00000006	C	H1RdAn
.data:0229F...	00000006	C	8R?FeD
.data:0229F...	00000005	C	Fp> =
.data:0229F...	00000012	C	r^eIvPqX}\\J~S~PrGe
.data:0229F...	00000012	C	^TcQxOeuxSbJrOMqhO
.data:0229F...	0000000A	C	StO1UpAqDb
.data:0229F...	0000001E	C	zMdF1H|Sq\reFeUdQx\rcFq@eFy\rzFd\r
.data:0229F...	00000008	C	Jn\r}BsFb
.data:0229F...	0000000F	C	tQcLm\rt[xB=To@a
.data:0229F...	0000000B	C	p@eQtY=GhLa
.data:0229F...	00000007	C	mI~FsHi
.data:0229F...	00000012	C	oHsArO=PrSeJsF=StO
.data:0229F...	0000001D	C	Fy\r}J~R=AtU=VsQp@v\rpGi\rcFm\r{L
.data:022A0...	00000015	C	R=B~M=WtU}F1R~VsE=FkD
.data:022A0...	00000014	C	Wn\reBoFtWn\rb@oO=NuDv
.data:022A0...	00000010	C	Fn\raQrLaW1@uIhRe
.data:022A0...	0000001F	C	eHpM1RtQ1Bh@qD=QxExPi\rxWn\rsLeDb
.data:022A0...	0000000B	C	nLpOq\rrOrTu
.data:022A0...	0000001F	C	{M~T1FdJyEtE1VyLqD=S|StMi\rsF|Sb
.data:022A0...	00000008	C	GrL=AhMz
.data:022A0...	0000001A	C	tEtAhF=UtDfFo\rbW|SeB1B~NpD
.data:022A0...	0000000C	C	W1RtO1R~VoBt
.data:022A0...	00000007	C	uNePmNe
.data:022A0...	00000017	C	mNcW|M=PtUzB1HtOq\rbOtEt
.data:022A0...	00000005	C	0#M;O

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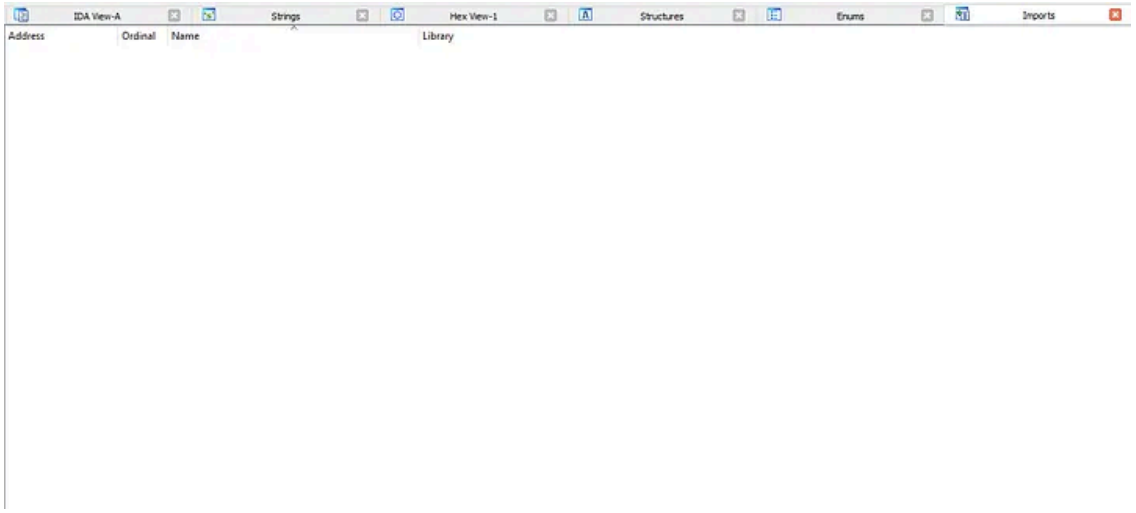

And that’s it for today, hope you liked and learned something from this article. Thank you!!

Source: https://infosecwriteups.com/unpacking-emotet-trojan-dac7e6119a0a