Analyzing KSL0T (Turla's Keylogger), Part 2 – Reupload

0ffset.net/reverse-engineering/malware-analysis/analyzing-turlas-keylogger-2

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(This post is a reupload from my old site which is no longer available – you may have seen it before)

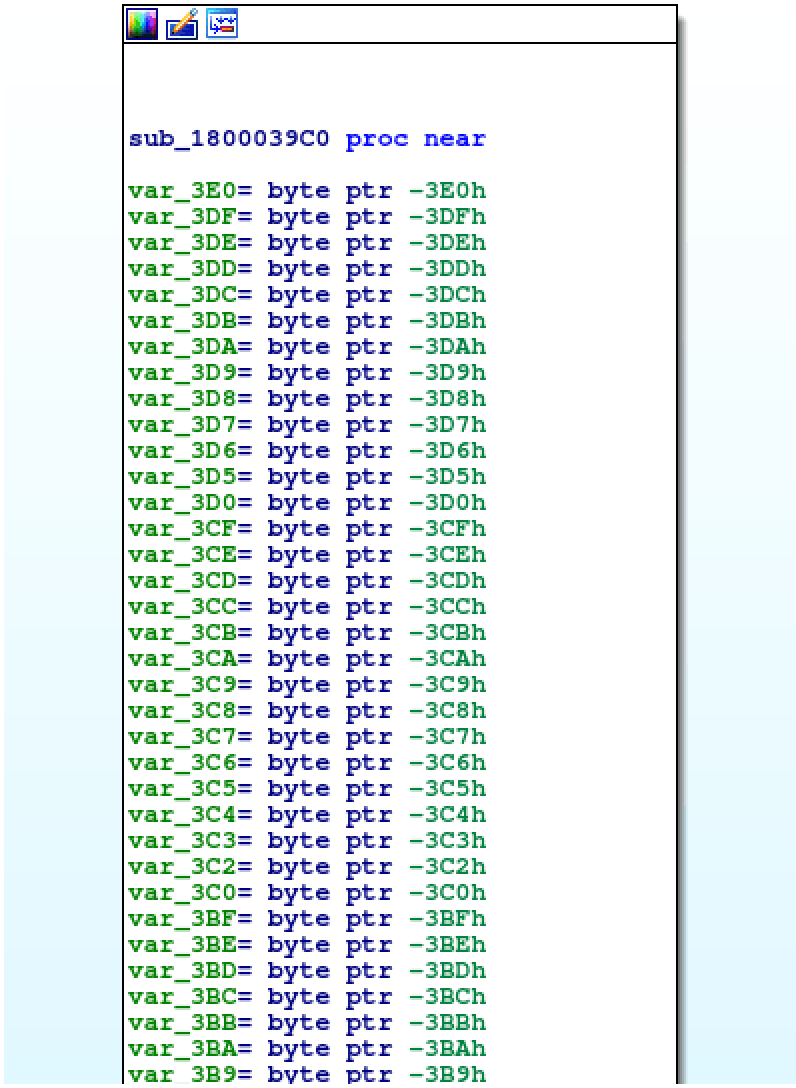
If you haven't read the first post, go check it out **here**. You can download this keylogger off of **VirusBay**. So far we have decrypted a whole lot of text using a simple XOR method, which revealed information on how different keys could be logged, file names in which the data could be logged to, and a possible name for the keylogger: **KSL0T**. If you've got no clue what I'm talking about, you should most definitely check out the last post. Anyway, let's go further down the rabbit hole.

MD5: 59b57bdabee2ce1fb566de51dd92ec94

If you're following along with this analysis, make sure you rename the decryption function, so it confuses things less. After the return of the decryption function, **GetModuleHandleW** and **GetProcAddress** are called, using the recently decrypted values, which are the last two strings to be decrypted. These values are **kernel32.dll** and **GetProcAddress**.

```
call    Decryption
lea     rcx, ModuleName ; lpModuleName
call    cs:GetModuleHandleW
mov     [rsp+48h+hModule], rax
lea     rdx, ProcName    ; ":"
mov     rcx, [rsp+48h+hModule] ; hModule
call    cs:GetProcAddress
mov     [rsp+48h+GetProcessAddress], rax
lea     r8, unk_1800105A0
mov     rdx, [rsp+48h+GetProcessAddress]
mov     rcx, [rsp+48h+hModule]
call    sub_1800039C0
mov     r11, [rsp+48h+arg_0]
mov     cs:qword_180010720, r11
mov     rax, [rsp+48h+arg_0]
mov     cs:qword_180010730, rax
lea     r8, dword_180011188
xor     edx, edx
mov     ecx, 2
call    cs:qword_1800106B8
lea     r8, dword_180011188
lea     rdx, word_180011190
mov     ecx, 2
call    cs:qword_1800106B8
movzx   eax, al
test    eax, eax
jz      loc_180001AD5
```

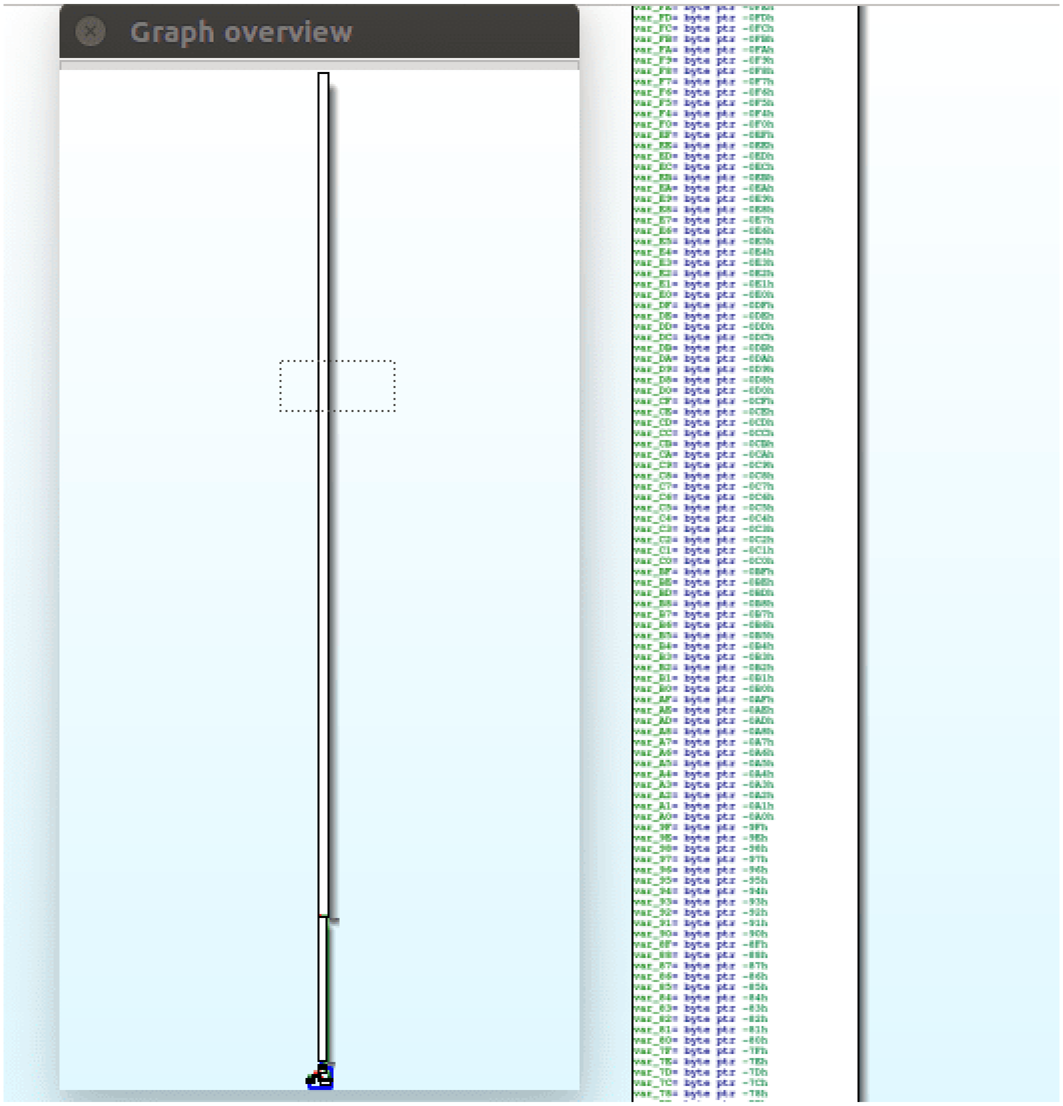
The return value of GetProcAddress will be stored in the **rax** register, which is then moved into the location **[rsp+48h+var_28]**, so to simplify matters, we can rename **var_28** to **GetProcessAddress**, so whenever it is moved into another register (as long as it hasn't been changed), we can identify what is happening if that register is called by the program. Sure enough, it is moved into the **rdx** register, just before a handle to **kernel32.dll** gets moved into the **rcx** register – and then a function at **0x1800039C0** is called.



We can easily identify the arguments passed to this function, as it is using the **mov** operation again. We already know **rcx** contains a handle to **kernel32.dll**, and **rdx** contains the **GetProcAddress** function, and it seems **r8** contains an address to an empty region of memory: **0x1800105A0**, which is filled with zeroes.

```
var_24= byte ptr -24h
var_23= byte ptr -23h
var_22= byte ptr -22h
var_21= byte ptr -21h
var_20= byte ptr -20h
var_18= qword ptr -18h
kernel32= qword ptr  8
getprocaddr= qword ptr  10h
freemem= qword ptr  18h

mov     [rsp+freemem], r8
mov     [rsp+getprocaddr], rdx
mov     [rsp+kernel32], rcx
sub     rsp, 408h
mov     rax, cs:qword_18000F580
xor     rax, rsp
mov     [rsp+408h+var_18], rax
mov     [rsp+408h+var_328], 0
mov     [rsp+408h+var_48], 0
mov     [rsp+408h+var_228], 0
mov     [rsp+408h+var_2D8], 0
mov     [rsp+408h+var_1B8], 0
mov     [rsp+408h+var_1C0], 0
mov     [rsp+408h+loadlibrary], 0
mov     [rsp+408h+var_250], 12h
mov     [rsp+408h+var_24F], 30h
mov     [rsp+408h+var_24E], 21h
mov     [rsp+408h+var_24D], 5
mov     [rsp+408h+var_24C], 27h
```

If you are viewing the function in graph mode, you'll be able to see that the flow is simply one long "line", with no **if's** or **for** statements until the end. You can also see that there are a lot of variables that are declared before the arguments are filled – as we are analyzing this binary using static analysis, this function alone will require a lot of work to understand (because it is a possible anti-static analysis method used by Turla to prevent easy analysis). Hint: It's more data decryption, except this time, the encrypted data is loaded during runtime – hence why there are so many **mov** operations in a row. Due to this, we will have to manually extract those bytes, figure out how they are decrypted, and find a way to decrypt them, through automation or writing a script. Let's get stuck into it!



There is most definitely a better way to decrypt the data, although I am unaware of it, so I took the long route. Highlight the **mov** instructions and copy it to a file. We will be stripping this down so it only contains the second argument to the instruction – the encrypted data.

```
.text:0000000180003A5C                 mov     [rsp+408h+var_24C], 27h
.text:0000000180003A64                 mov     [rsp+408h+var_24B], 3Ah
.text:0000000180003A6C                 mov     [rsp+408h+var_24A], 36h
.text:0000000180003A74                 mov     [rsp+408h+var_249], 30h
.text:0000000180003A7C                 mov     [rsp+408h+var_248], 26h
.text:0000000180003A84                 mov     [rsp+408h+var_247], 26h
.text:0000000180003A8C                 mov     [rsp+408h+var_246], 1Ch
.text:0000000180003A94                 mov     [rsp+408h+var_245], 38h
.text:0000000180003A9C                 mov     [rsp+408h+var_244], 34h
.text:0000000180003AA4                 mov     [rsp+408h+var_243], 32h
.text:0000000180003AAC                 mov     [rsp+408h+var_242], 30h
.text:0000000180003AB4                 mov     [rsp+408h+var_241], 13h
.text:0000000180003ABC                 mov     [rsp+408h+var_240], 3Ch
.text:0000000180003AC4                 mov     [rsp+408h+var_23F], 39h
.text:0000000180003ACC                 mov     [rsp+408h+var_23E], 30h
.text:0000000180003AD4                 mov     [rsp+408h+var_23D], 1Bh
.text:0000000180003ADC                 mov     [rsp+408h+var_23C], 34h
.text:0000000180003AE4                 mov     [rsp+408h+var_23B], 38h
.text:0000000180003AEC                 mov     [rsp+408h+var_23A], 30h
.text:0000000180003AF4                 mov     [rsp+408h+var_239], 2
.text:0000000180003AFC                 mov     [rsp+408h+var_238], 55h
.text:0000000180003B04                 mov     [rsp+408h+var_D0], 12h
```

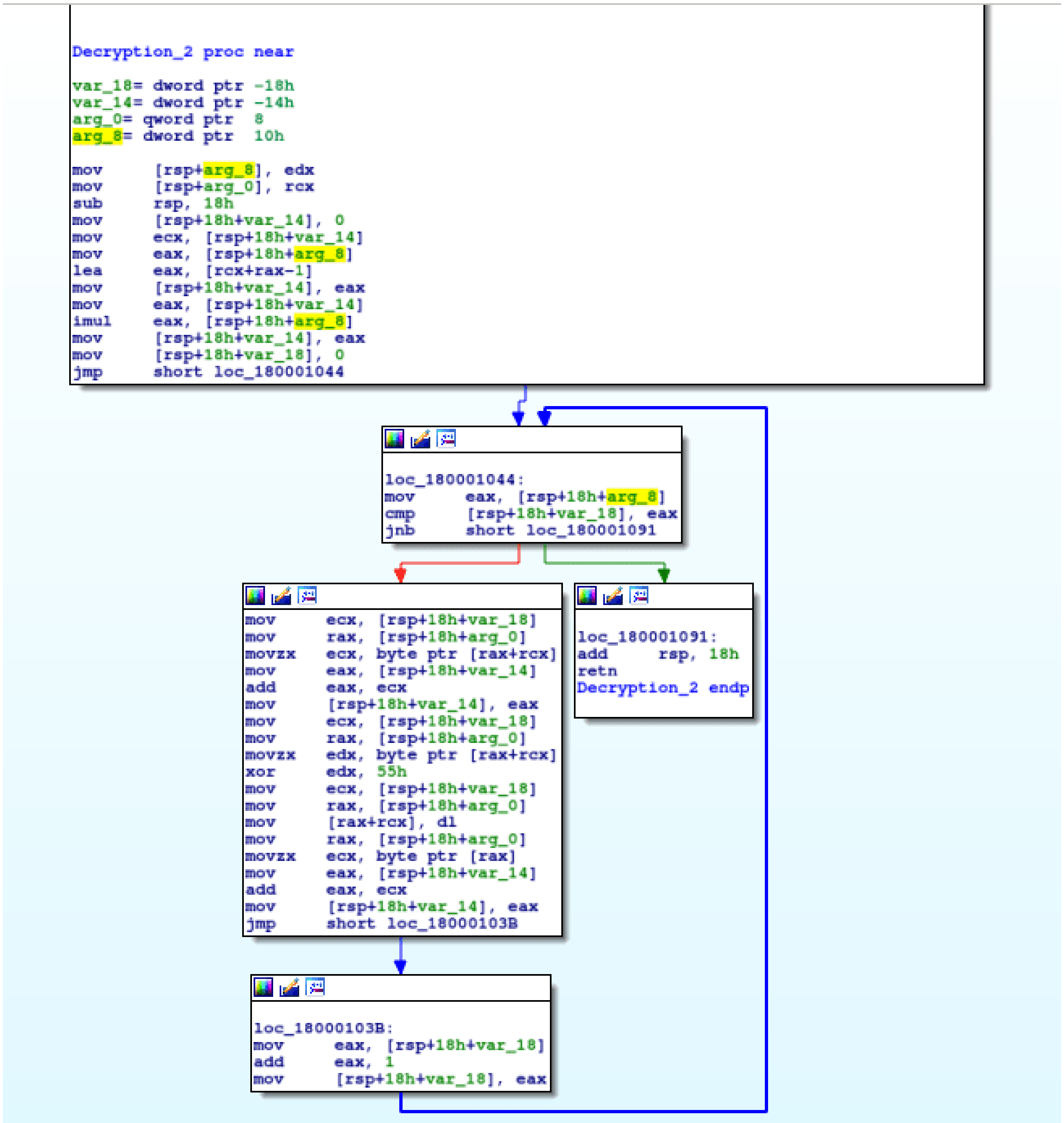
Now we need to parse the data and format it correctly, so that we only have the value being moved into the destination. Below is a script that removes everything but the digit, including the **h** specifying the hexadecimal format. For singular digits, a zero is prepended onto the value, to make an understandable hex value.

```
def main():
f = open("data.txt", "r")
data = f.readlines()
f.close()

f = open("data_2.txt", "w")

for lines in data:
    lines = lines.split("], ")[1]

    if "h" in lines:
        lines = lines.split("h")[0]
        lines = lines + " "
    else:
        lines = "0" + lines
        lines = lines.split("\n")[0]
        lines = lines + " "

    f.write(lines)

f.close()

if name == “main”:

main()
```

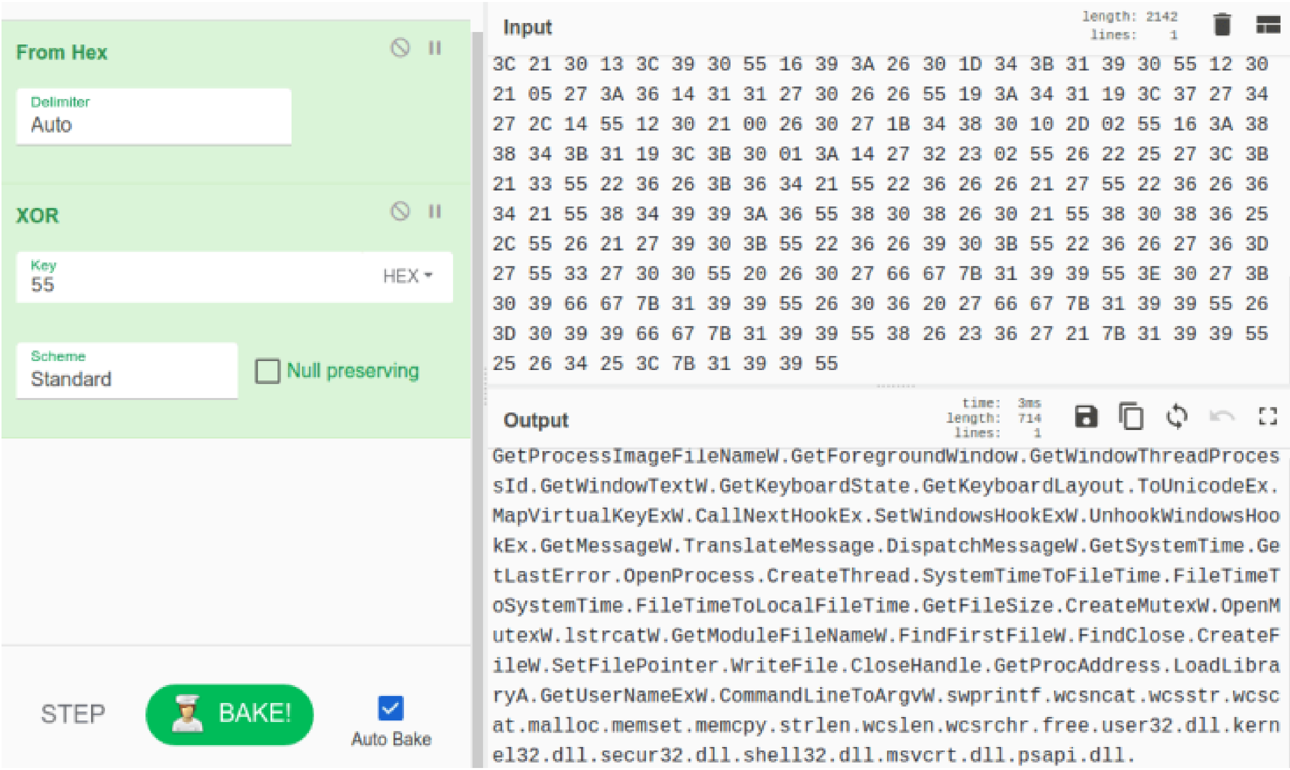
After executing the script, we get this output in **data_2.txt**. This is the extracted encrypted data, so we need to identify the decryption method used, to understand what it is encrypted with.

```
12 30 21 05 27 3A 36 30 26 26 1C 38 34 32 30 13 3C 39 30 1B 34 38 30 02 55 12 30 21 13 3A 27 30 32 27 3A 20 3B 31 02 3C 3B 31 3A 22 55 12 30 21
02 3C 3B 31 3A 22 01 3D 27 30 34 31 05 27 3A 36 30 26 26 1C 31 55 12 30 21 02 3C 3B 31 3A 22 01 30 2D 21 02 55 12 30 21 1E 30 2C 37 3A 34 27 31
06 21 34 21 30 55 12 30 21 1E 30 2C 37 3A 34 27 31 19 34 2C 3A 20 21 55 01 3A 00 3B 3C 36 3A 31 30 10 2D 55 18 34 25 03 3C 27 21 20 34 39 1E 30
2C 10 2D 02 55 16 34 39 39 1B 30 2D 21 1D 3A 3A 3E 10 2D 55 06 30 21 02 3C 3B 31 3A 22 26 1D 3A 3A 3E 10 2D 02 55 00 3B 3D 3A 3A 3E 02 3C 3B 31
3A 22 26 1D 3A 3A 3E 10 2D 55 12 30 21 18 30 26 26 34 32 30 02 55 01 27 34 3B 26 39 34 21 30 18 30 26 26 34 32 30 55 11 3C 26 25 34 21 36 3D 18
30 26 26 34 32 30 02 55 12 30 21 06 2C 26 21 30 38 01 3C 38 30 55 12 30 21 19 34 26 21 10 27 27 3A 27 55 1A 25 30 3B 05 27 3A 36 30 26 26 55 16
27 30 34 21 30 01 3D 27 30 34 31 55 06 2C 26 21 30 38 01 3C 38 30 01 3A 13 3C 39 30 01 3C 38 30 55 13 3C 39 30 01 3C 38 30 01 3A 06 2C 26 21 30
38 01 3C 38 30 55 13 3C 39 30 01 3C 38 30 01 3A 19 3A 36 34 39 13 3C 39 30 01 3C 38 30 55 12 30 21 13 3C 39 30 06 3C 2F 30 55 16 27 30 34 21 30
18 20 21 30 2D 02 55 1A 25 30 3B 18 20 21 30 2D 02 55 39 26 21 27 36 34 21 02 55 12 30 21 18 3A 31 20 39 30 13 3C 39 30 1B 34 38 30 02 55 13 3C
3B 31 13 3C 27 26 21 13 3C 39 30 02 55 13 3C 3B 31 16 39 3A 26 30 55 16 27 30 34 21 30 13 3C 39 30 02 55 06 30 21 13 3C 39 30 05 3A 3C 3B 21 30
27 55 02 27 3C 21 30 13 3C 39 30 55 16 39 3A 26 30 1D 34 3B 31 39 30 55 12 30 21 05 27 3A 36 14 31 31 27 30 26 26 55 19 3A 34 31 19 3C 37 27 34
27 2C 14 55 12 30 21 00 26 30 27 1B 34 38 30 10 2D 02 55 16 3A 38 38 34 3B 31 19 3C 3B 30 01 3A 14 27 32 23 02 55 26 22 25 27 3C 3B 21 33 55 22
36 26 3B 36 34 21 55 22 36 26 26 21 27 55 22 36 26 36 34 21 55 38 34 39 39 3A 36 55 38 30 38 26 30 21 55 38 30 38 36 25 2C 55 26 21 27 39 30 3B
55 22 36 26 39 30 3B 55 22 36 26 27 36 3D 27 55 33 27 30 30 55 20 26 30 27 66 67 7B 31 39 39 55 3E 30 27 3B 30 39 66 67 7B 31 39 39 55 26 30 36
20 27 66 67 7B 31 39 39 55 26 3D 30 39 39 66 67 7B 31 39 39 55 38 26 23 36 27 21 7B 31 39 39 55 25 26 34 25 3C 7B 31 39 39 55
```

Back to the assembly, after the individual bytes have been moved into the correct locations, a function at **0x180001000** is called repeatedly in a similar fashion to the first decryption function, except this time with 2 arguments.



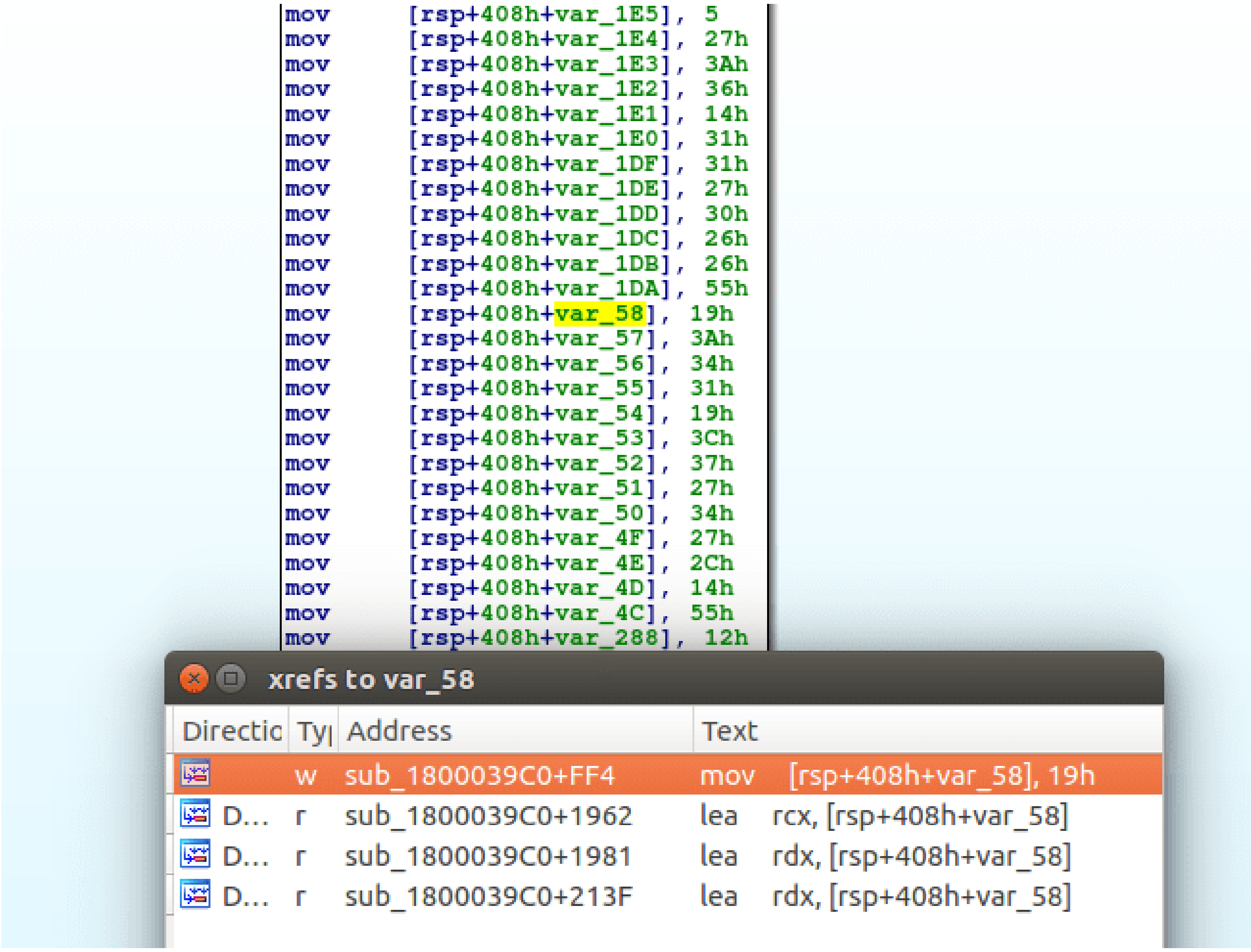
As you've probably guessed, this is another algorithm, although it is a lot less complex than the last one – this is due to the fact that each section of data is XORed using **0x55**, meaning we don't need to write some sort of decryption script, and we can simply put it into **CyberChef** and perform a basic XOR decryption, and then convert it from hexadecimal format. If you haven't used **CyberChef** before, you should check it out, as it is extremely useful in situations like these.



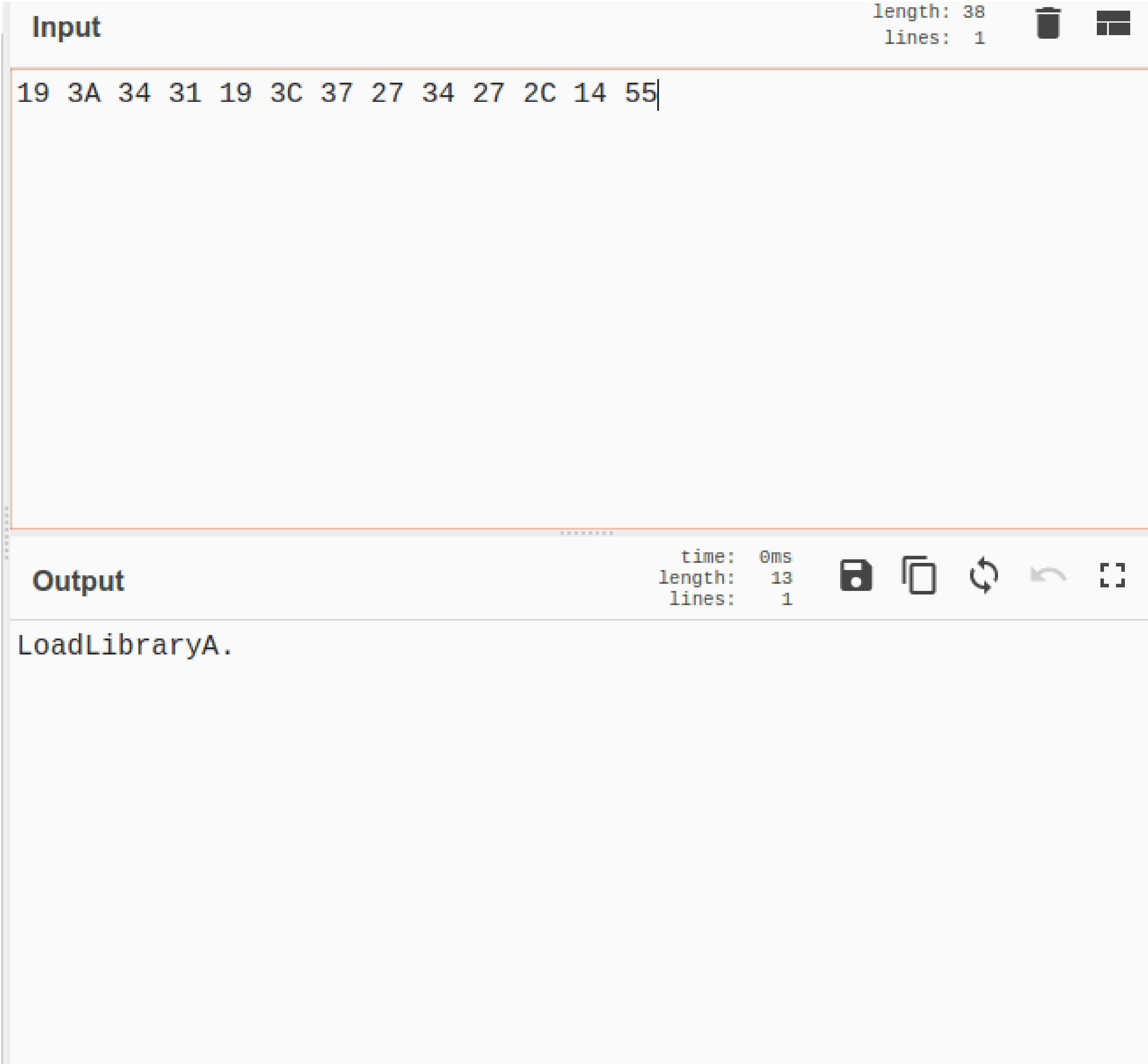
As you can see, the data contains multiple API calls and DLL's that are loaded during runtime – in this function. As we scroll down the graph, there are several calls to GetProcAddress, as well as calls to variables, such as **var_290**. There are two ways we can approach this to figure out what is being stored in variable 290 – using a debugger, or in this case through static analysis (the more complex method). To do so, we need to trace backwards. We can see that the value in **rax** is stored in **var_290**, just after a **GetProcAddress** call, and as one of the arguments is **kernel32.dll**, the other must be the function that is called – this is stored in **var_58**.

```
call    Decryption_2
lea     rdx, [rsp+408h+var_58]
mov     rcx, [rsp+408h+kernel32]
call    [rsp+408h+getprocaddr]
mov     [rsp+408h+var_290], rax
mov     rcx, [rsp+408h+freemem]
mov     rax, [rsp+408h+kernel32]
mov     [rcx], rax
lea     rcx, [rsp+408h+var_A8]
call    [rsp+408h+var_290]
mov     [rsp+408h+var_228], rax
lea     rcx, [rsp+408h+var_148]
call    [rsp+408h+var_290]
mov     [rsp+408h+var_48], rax
lea     rcx, [rsp+408h+var_B8]
call    [rsp+408h+var_290]
mov     [rsp+408h+var_2D8], rax
lea     rcx, [rsp+408h+var_2D0]
call    [rsp+408h+var_290]
mov     [rsp+408h+var_1B8], rax
lea     rcx, [rsp+408h+var_128]
call    [rsp+408h+var_290]
mov     [rsp+408h+var_328], rax
lea     rcx, [rsp+408h+var_1A0]
call    [rsp+408h+var_290]
mov     [rsp+408h+var_1C0], rax
cmp     [rsp+408h+freemem], 0
jz      loc_180005B51
```

Just above the **GetProcAddress**, the decryption function is used to decrypt 13 bytes of data at **var_58**, so lets go to the **x-ref** of **var_58** in this function, and count out 13 bytes of data: **var_58 -> var_4C**.



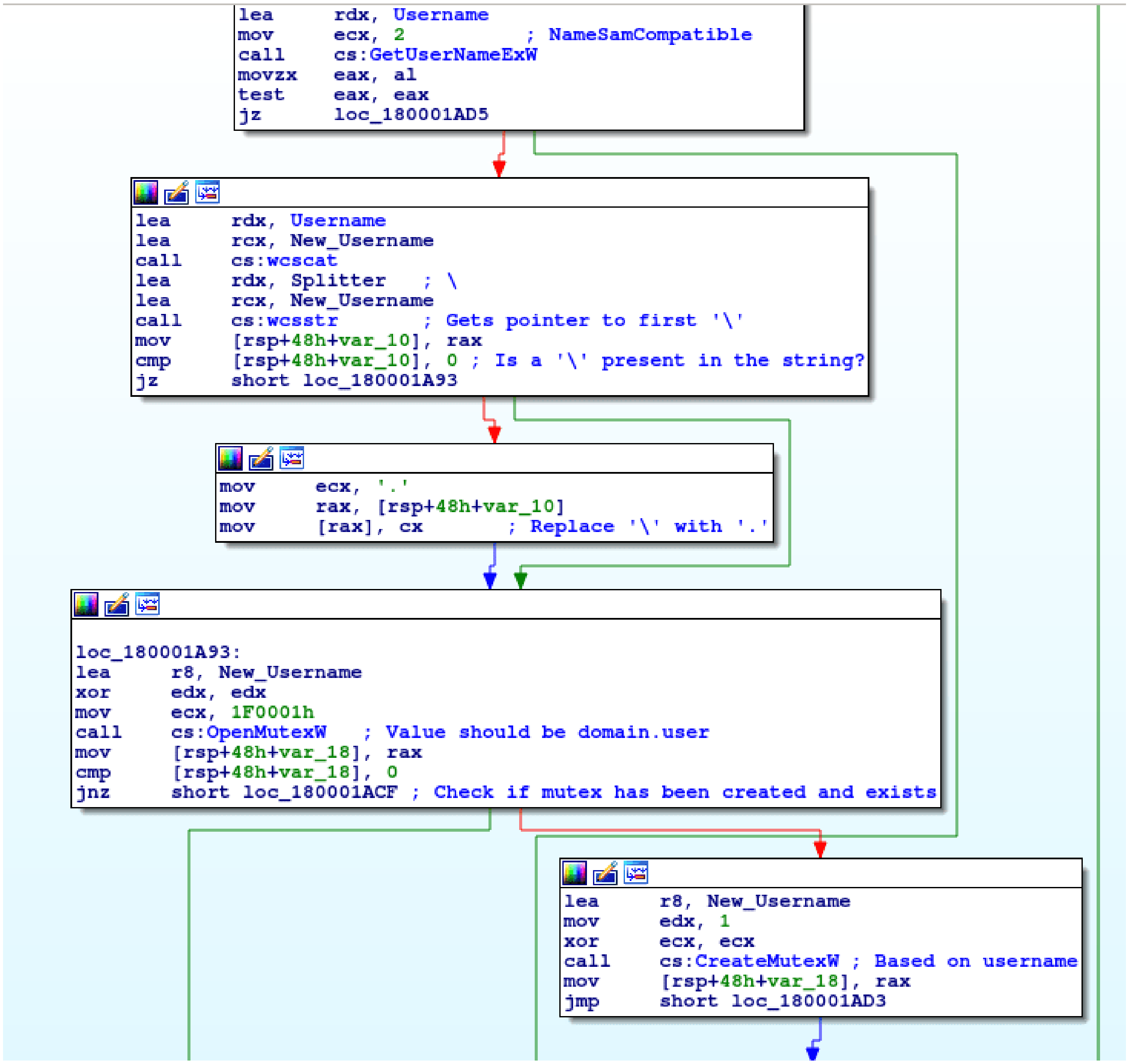
Copy those bytes and put them into CyberChef, and XOR with **0x55**. You should get **LoadLibraryA.**



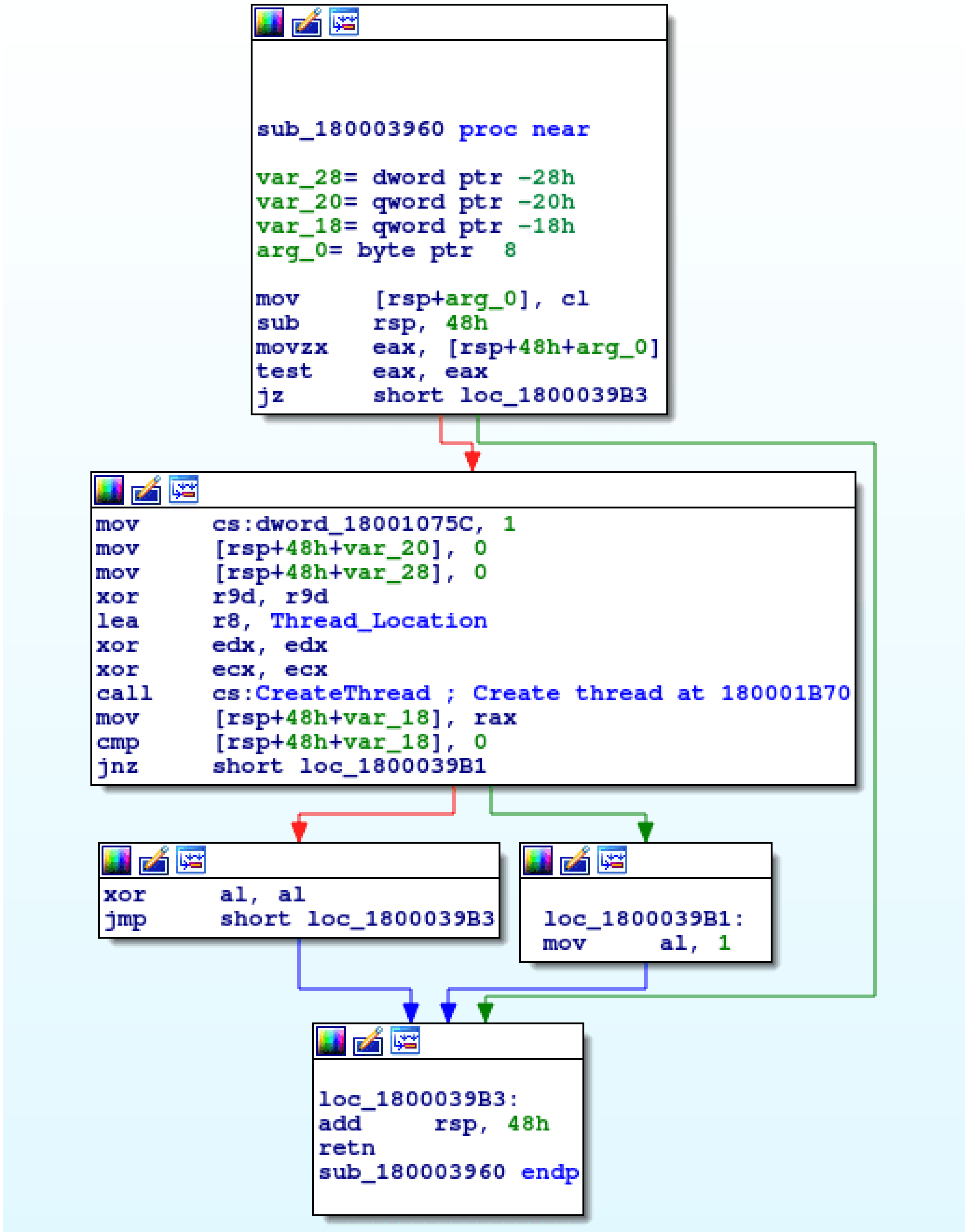
From then on, only **GetProcAddress** and **LoadLibraryA** are called by this function – and we can assume that each of the API functions in the decrypted text are imported. Obviously we could do that all manually, but if you have access to a debugger it would be much quicker.

```
mov     rax, [rsp+408h+arg_10]
mov     [rax+30h], r11
lea     rdx, [rsp+408h+var_378]
mov     rcx, [rsp+408h+var_228] ; ToUnicodeEx
call    [rsp+408h+GetProcAddress]
mov     r11, rax
mov     rax, [rsp+408h+arg_10]
mov     [rax+38h], r11
lea     rdx, [rsp+408h+var_160]
mov     rcx, [rsp+408h+var_228] ; MapVirtualKeyExW
call    [rsp+408h+GetProcAddress]
mov     r11, rax
mov     rax, [rsp+408h+arg_10]
mov     [rax+40h], r11
lea     rdx, [rsp+408h+var_2A0]
mov     rcx, [rsp+408h+var_228] ; CallNextHookEx
call    [rsp+408h+GetProcAddress]
mov     r11, rax
mov     rax, [rsp+408h+arg_10]
mov     [rax+48h], r11
lea     rdx, [rsp+408h+var_390]
mov     rcx, [rsp+408h+var_228] ; SetWindowsHookEx
call    [rsp+408h+GetProcAddress]
mov     r11, rax
mov     rax, [rsp+408h+arg_10]
mov     [rax+50h], r11
lea     rdx, [rsp+408h+var_2F0]
mov     rcx, [rsp+408h+var_228] ; UnhookWindowsHookEx
call    [rsp+408h+GetProcAddress]
mov     r11, rax
mov     rax, [rsp+408h+arg_10]
mov     [rax+58h], r11
lea     rdx, [rsp+408h+var_2B0]
mov     rcx, [rsp+408h+var_228] ; GetMessageW
call    [rsp+408h+GetProcAddress]
mov     r11, rax
mov     rax, [rsp+408h+arg_10]
mov     [rax+60h], r11
lea     rdx, [rsp+408h+var_308]
mov     rcx, [rsp+408h+var_228] ; TranslateMessage
call    [rsp+408h+GetProcAddress]
mov     r11, rax
mov     rax, [rsp+408h+arg_10]
mov     [rax+68h], r11
lea     rdx, [rsp+408h+var_1D8]
mov     rcx, [rsp+408h+var_228] ; DispatchMessageW
call    [rsp+408h+GetProcAddress]
mov     r11, rax
mov     rax, [rsp+408h+arg_10]
mov     [rax+70h], r11
lea     rdx, [rsp+408h+var_178]
mov     rcx, [rsp+408h+var_1B8] ; CommandLineToArgvW
call    [rsp+408h+GetProcAddress]
```

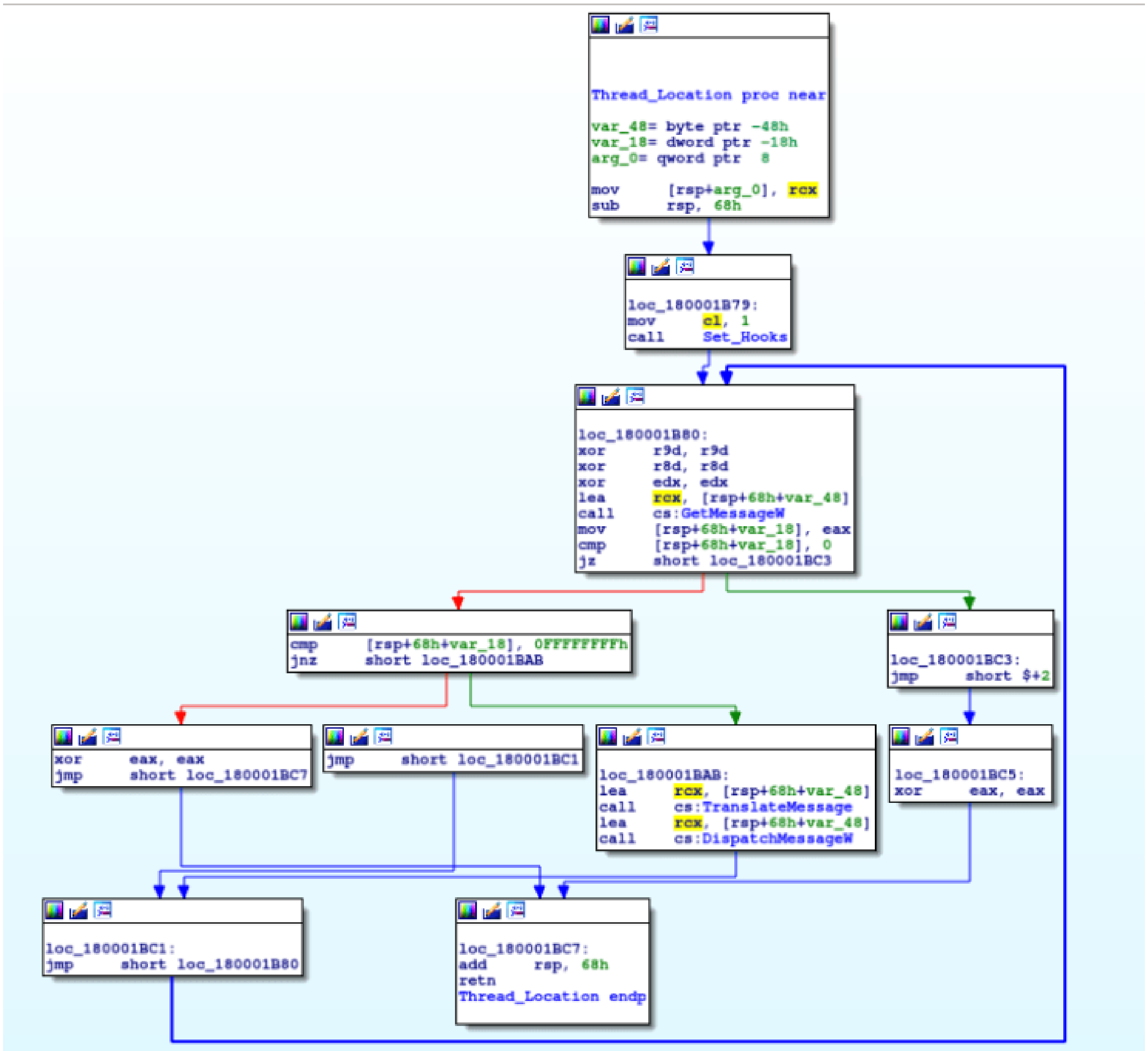
As all of the imports have been resolved, we can move on, out of the function, where the program calls **GetUserNameExW** twice. In my case, the call will return **Reversing\RE** – the domain name and username. The malware then moves it to a different location using **wcscat**, and checks to see if there is a backslash in the returned value, using **wcsstr**. If there is, a pointer to it will be returned. The backslash is then replaced with a full stop, leaving us with **Reversing.RE**. The formatted string is used to create a mutex. The program first checks to see if a mutex has been created under that value by calling **OpenMutexW**, and if it hasn't been created, **CreateMutexW** is called. We are able to double check that this mutex is created by using a tool called **SysAnalyzer**, which is useful for analyzing malicious programs whilst performing dynamic analysis.



Once a mutex has been created, a function at **0x180003960** is called, which creates a new thread pointing to **0x180001B70**. When the created thread exits, the malware exits as well.



So, let's take a look at the newly created thread. It seems that immediately after the thread executes, a function located at **0x180001B00** is called, containing the 'meat' of the keylogger. I have labelled this as **Set_Hooks**, based off of the method used by the keylogger.



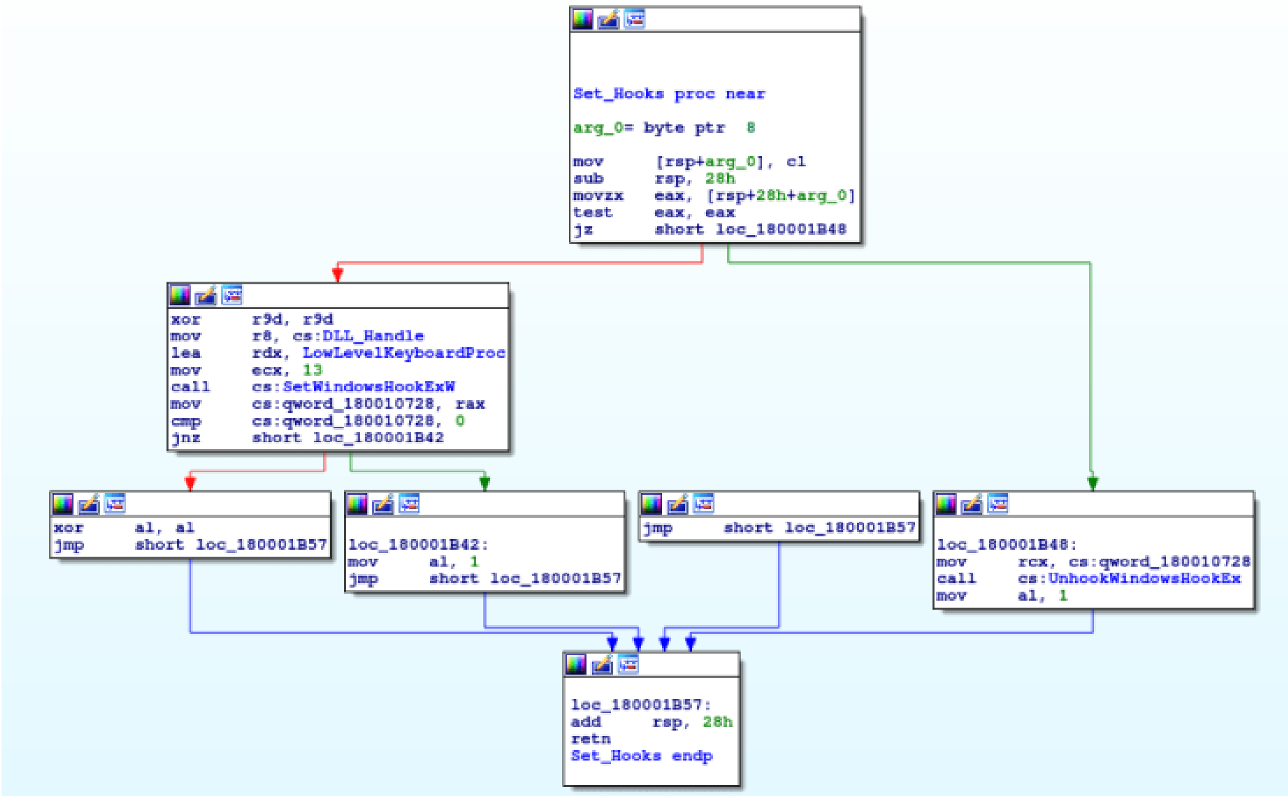
The two most common Windows API calls used in malware and 'legitimate' software to perform keylogging is **GetAsyncKeyState** or **SetWindowsHookEx**. Due to the number of issues with using **GetAsyncKeyState**, most keyloggers utilize **SetWindowsHookEx** nowadays. In this case, **SetWindowsHookEx** is used to capture keystrokes. Whilst we are unable to use the pseudo code function in IDA, we can use MSDN to understand what is being called and how.

```
HHOOK SetWindowsHookExA(int idHook, HOOKPROC lpfn, HINSTANCE hmod, DWORD
dwThreadId);
```

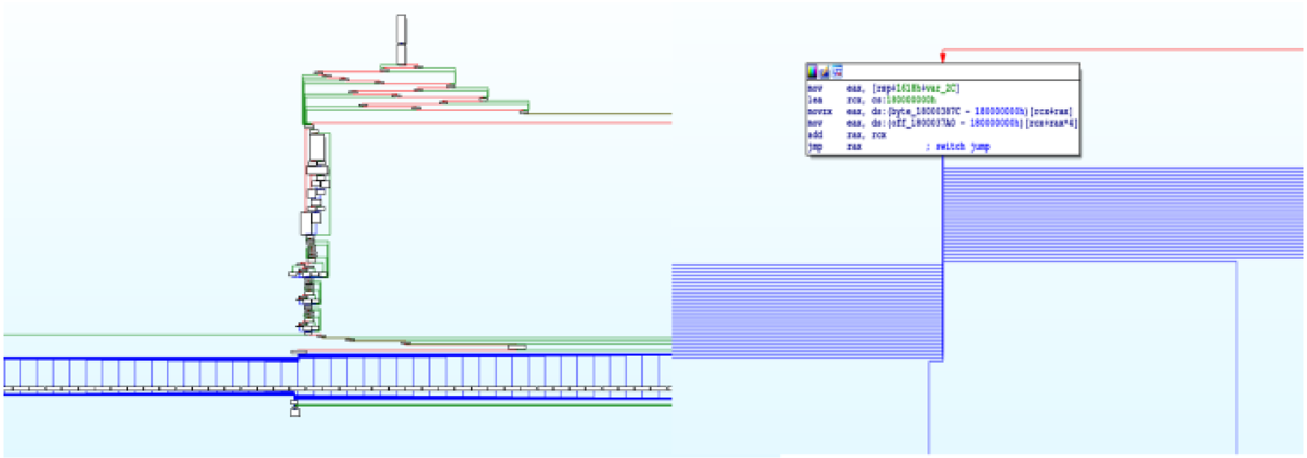
When we input all of the arguments into the function, we get:

```
HHOOK SetWindowsHookExA(13, 0x1800022C0 , 0x180010720, 0);
HHOOK SetWindowsHookExA(WH_KEYBOARD_LL, LowLevelKeyboardProc, DLL_Handle, NULL);
```

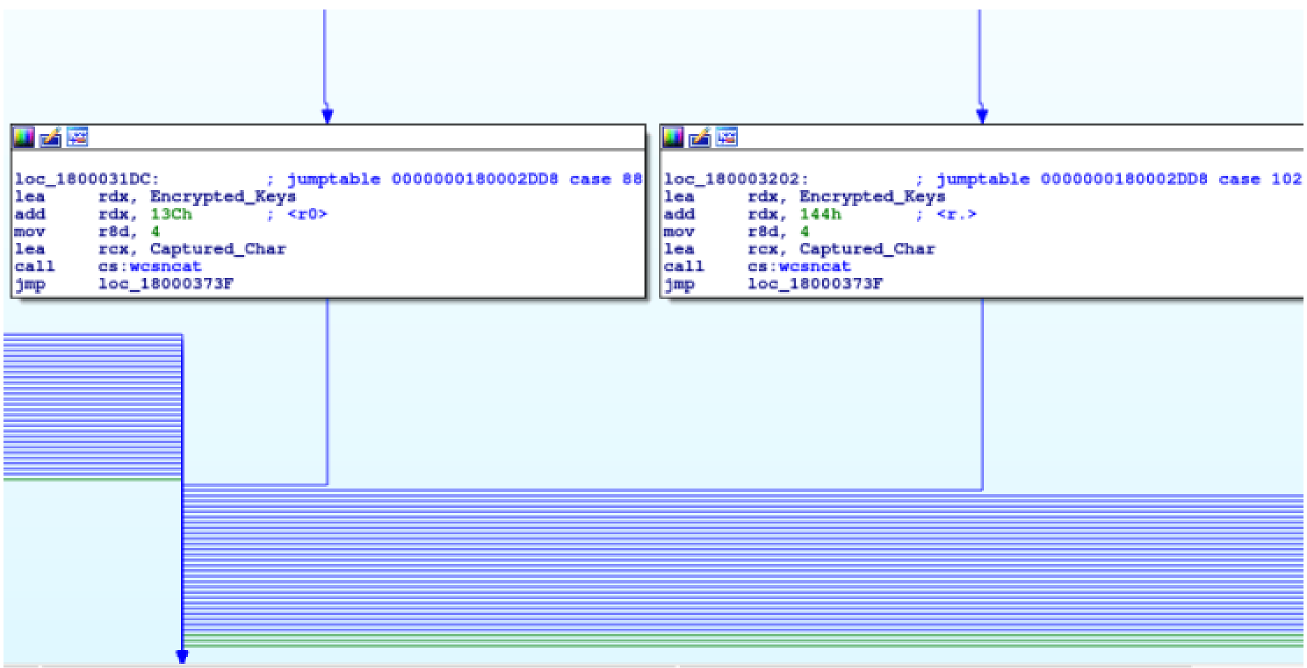
So a hook is installed that ‘*monitors low level keyboard input events*‘, allowing the malware to gather each keystroke. After, the function returns back to the previous function, where a **Get**, **Translate**and **DispatchMessage** loop is created. While the program is keylogging, **GetMessage** will gather each key press and pass it to **TranslateMessage**, which translates virtual key messages into character messages. This is then passed to **DispatchMessage**, and this redirects it to another window procedure. If you want to learn more about the inner workings of keylogging, check out this site **here**, it goes into the very low levels of keystroke logging.



Now lets take a look at the function called by **SetWindowsHookExA**, located at **0x1800022C0**. As you can see from the graph overview, this function is a huge mess. The section at the bottom of the graph is in fact a **switch** statement – we can see there are multiple **case** values, and a **default** value as well. Furthermore, IDA also tells us this is a switch statement. **Here** is an overview of switch statements in C. To sum it up, it is another method of comparing one variable to several different variables, instead of using multiple **if** statements.



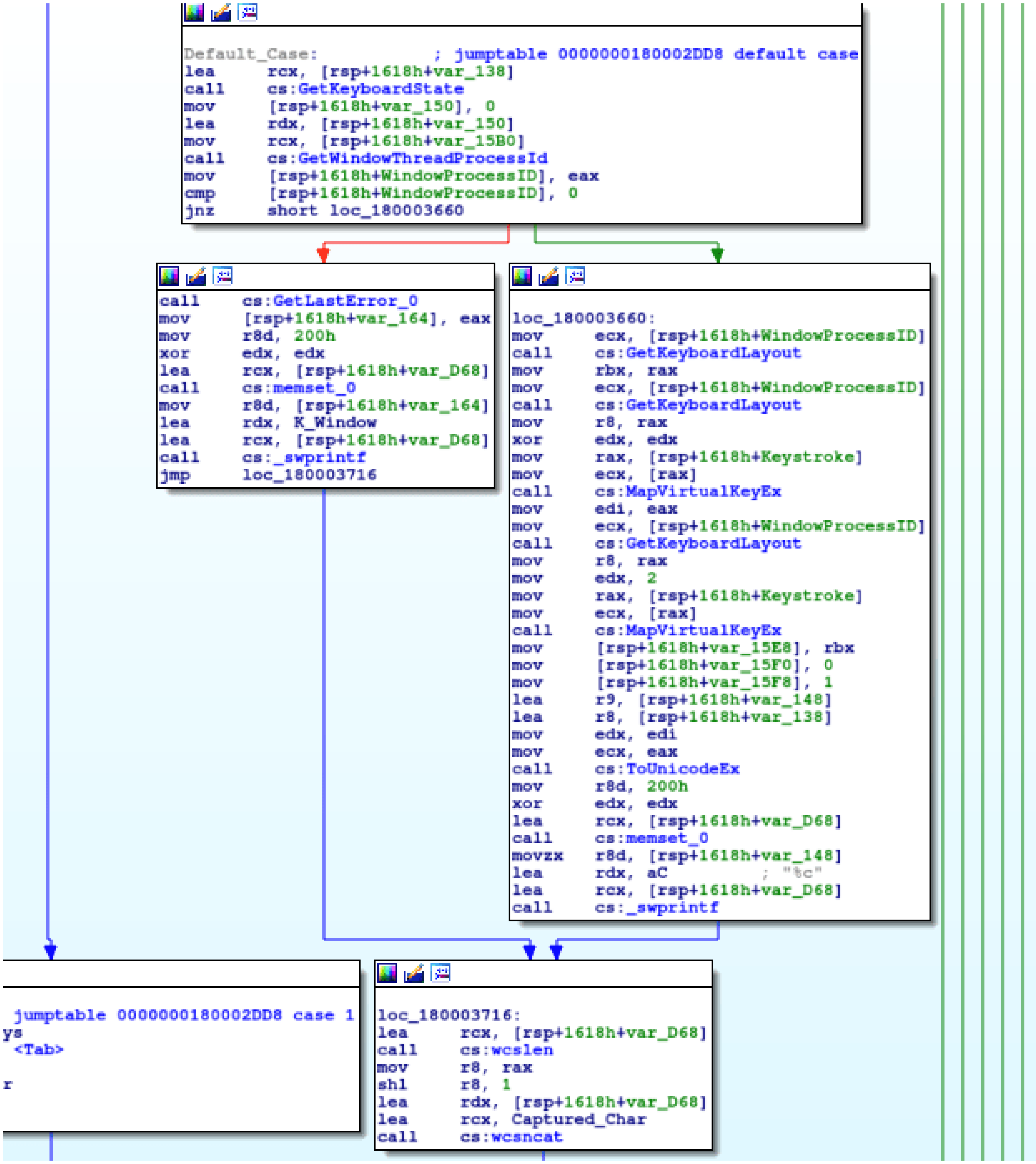
In order to find the values of the case variables, we need to perform some simple addition. Looking at each box, there is a **lea rdx, Encrypted_Keys** and then **add rdx, ...h**, where the **...** indicates a certain hexadecimal value. In one particular case, the value **13C** is being added to the memory address of the Encrypted Keys, which is **0x18000F2F0**. After adding them together, we get **0x18000F42C**, which points to ‘<‘. The next instruction after the **add**, a value is moved into **r8d**. This indicates the size of the string, which is **4**. Therefore, the 3 bytes after **0x18000F42C** are also included, meaning the full value is **<r0>**.



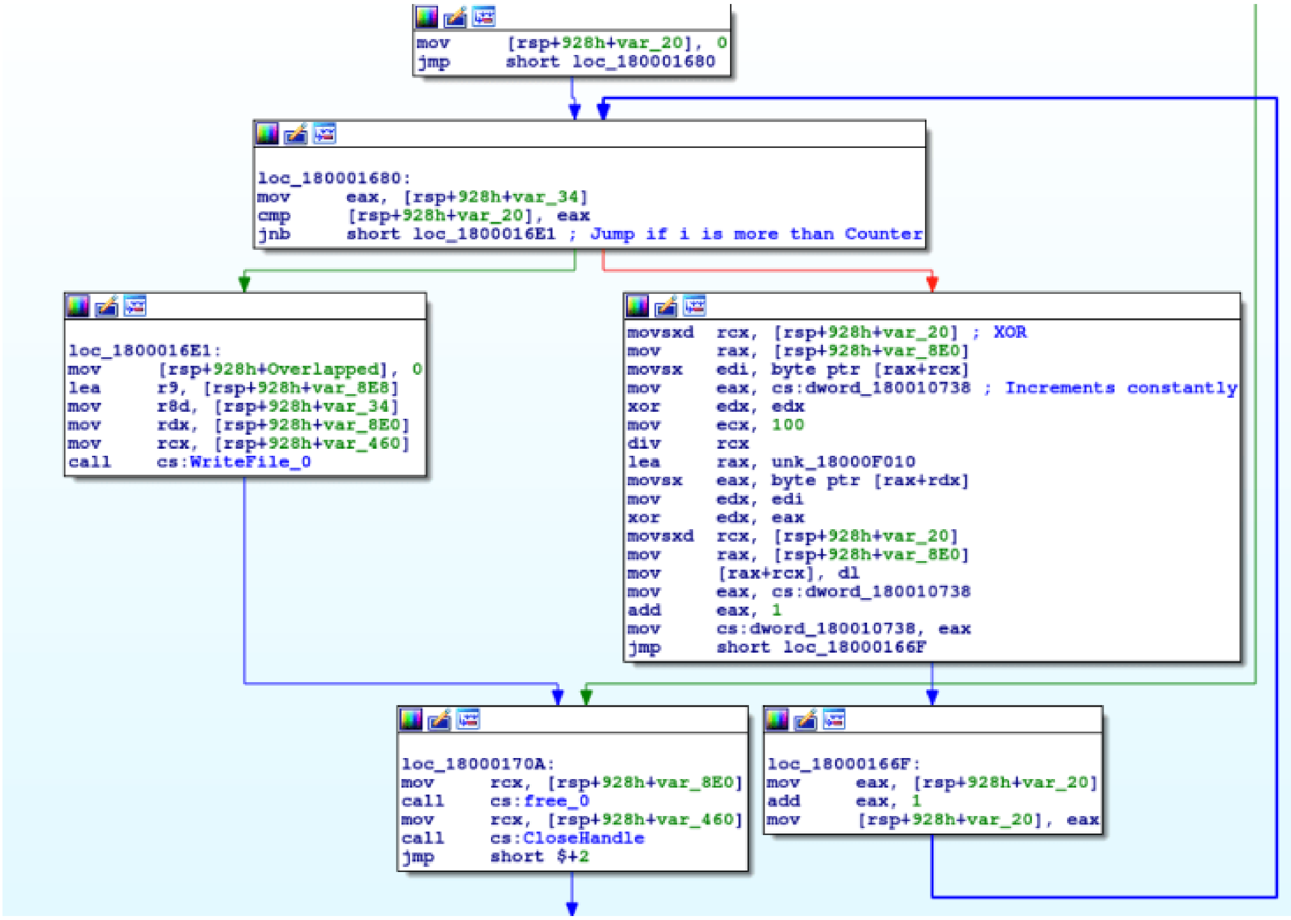
To speed up the process, I wrote a simple script to *automate* the process, so all you have to do is input the addition value and the string length, and the corresponding key is output to the terminal. I have uploaded it to pastebin and you can view it **here**.

```python
def main():

        keys = """<#RShift> <#LShift> <#RCtrl> <#LCtrl> <!RShift> <!LShift> <!RCtrl> <!LCtrl> - + [] \ ; / ` ' , . <PageUp> <PageDown> <NumLock>
<r/> <r*> <r-> <r+> <r1> <r2> <r3> <r4> <r5> <r6> <r7> <r8> <r9> <r0> <r.> <F1> <F2> <F3> <F4> <F5> <F6> <F7> <F8> <F9> <F10> <F11> <F12> <Down>
<Up> <Right> <Left> <Del> <Print> <End> <Insert> <CapsLock> <Enter> <Backspace> <Esc> <Tab> """

        keys = keys.replace(" ", "")
        keys = ".".join(keys)

        addition = raw_input("Hex Value: ")
        size = input("String Size: ")
        val = int(addition, 16)
        size = val + size * 2 - 1

        output = keys[val:size]
        if len(output) > 1:
                output = output.replace(".", "")
        print "Value: " + output

if __name__ == "__main__":
        main()
```

This value is concatenated, using **wcsncat**, into the address **0x1800115B0**. We can rename this to **Captured_Char**, as that is what it is. If the captured keystroke does not equal any of the hardcoded values, the **default** case is used, however they all lead to the same logging function. Before examining the rest of this function, lets take a look at how the data is logged.



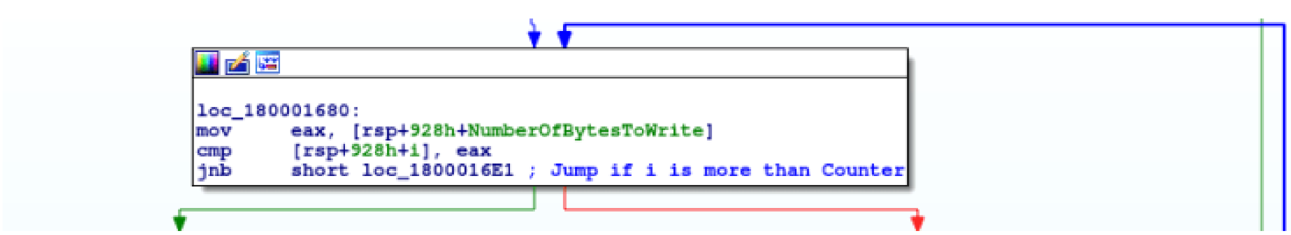
So this function is quite long, although we just need to see the **WriteFile** part, to see if the data is encrypted or not when being stored – which is right at the bottom of the function.



As assumed, the data is encrypted before being written to the file. As you can see, there is a **for** loop, where on one side data is being written using **WriteFile**, and on the other side data is being XORed using the original XOR keys. First, it seems that the value in **var_34** is being compared to the value in **var_20**. We can deduce that **var_34** is the length of the data to be XORed, due to it being the third argument in the **WriteFile** call:

```
WriteFile(hFile, lpBuffer, nNumberOfBytesToWrite, lpNumberOfBytesWritten,
lpOverlapped)
```

Therefore, we can rename that to **NumberOfBytesToWrite**. While doing so, we can also rename the other variables used in the call, so it is easier to understand the function. You might also have noticed that **var_20** is being incremented each loop as well, so we can simply rename that as **i**. So, lets take a look at the actual XOR part.

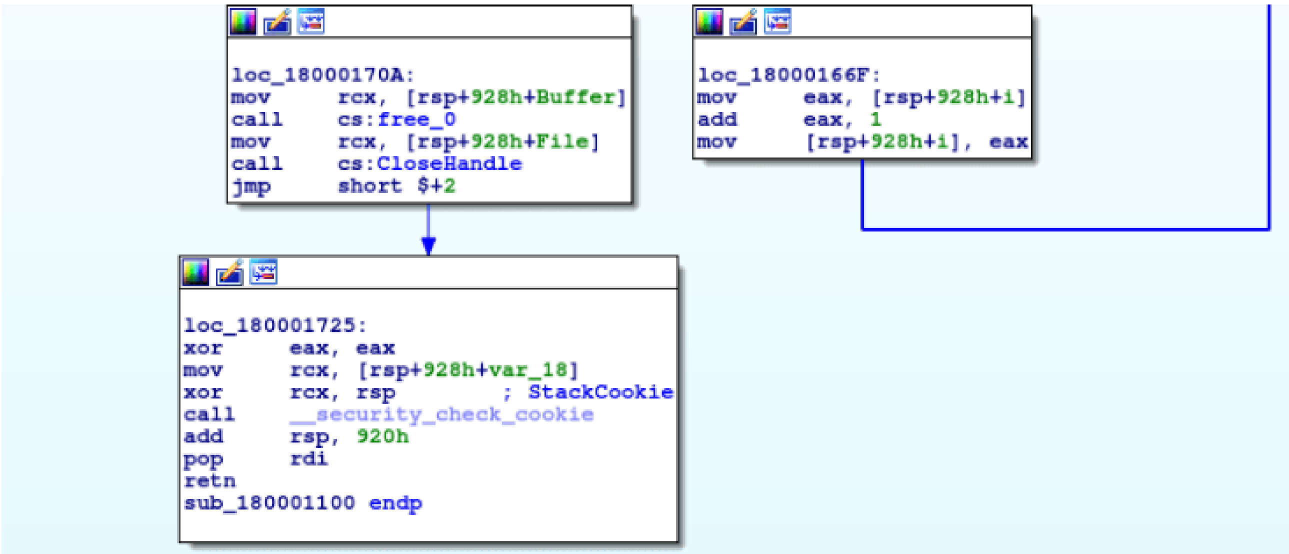


So the value in **i** is moved into **rcx**, and the value in the **Buffer** (highly likely the captured keystrokes plus any additional data) is moved into **rax**. Once again – similar to both decryption routines – the first character that will be encrypted is found by adding the value in **i** to the address of the **Buffer**. This is moved into **edi**, and then **div** is called. If you remember the first post on the keylogger, **div** divides the value in **rax** with the passed operand, which is **rcx**. The value in **rcx** is **100** (**0x64**), and therefore **rax** will be divided by 100. The question is, what is the value in **rax**? We can see **dword_180010738** is being moved into the register – but it is empty. We have to locate the section where a value is moved into the **dword**.

Searching for **xrefs**, there is only one mention of this variable before the encryption routine, which is at **0x1800013F1**. It seems that the malware gets the file size of the file which the keystrokes will be logged to, and then performs another **div** operation, with the remainder being stored in the **dword**. Let's imagine that the file size is **0**, as the logger has just started up. **0** is then divided by **100**, which is obviously **0**. This means that the value in **edx** is **0**, and therefore the value in the **dword** is, you guessed it, also **0**. So we can jump back to the encryption routine and work through the rest.

In order to get a byte from the key to XOR the data with, **rdx** and **rax** are used. The value in **rdx** on the first loop is zero – this is the result of the **div** using the value in **dword_180010738**. The address of the original XOR key is moved into **rax**, and a byte is stored in **eax** using the same **byte ptr [rax+rdx]** used throughout. **edi** (the keystroke data) is moved into **edx**, which is XORedby **eax** (the key). The encrypted character is used to overwrite the character in the keystroke data, based off of the value in **i**. Next, the value of **dword_180010738** is incremented by 1, meaning the key used to XOR the first character of the buffer is different to the key used to XOR the second character of the buffer. Finally, **i** is also incremented by 1, and the loop continues until the buffer is completely overwritten.

The data is then written to the file, the buffer is freed, the file handle is closed, and the function returns.



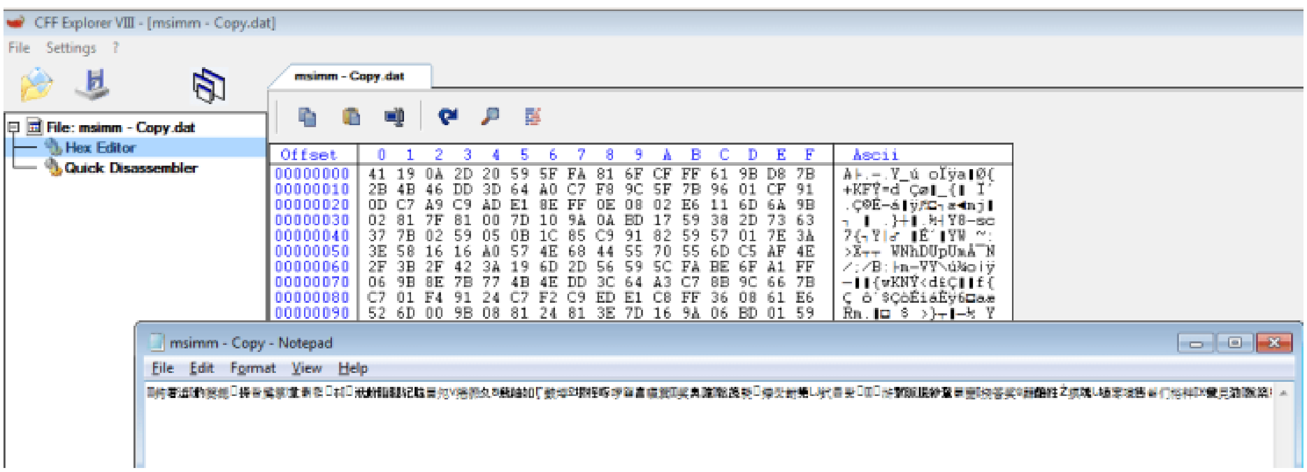
Now we have cracked the algorithm, we need to find where the data is being logged. We already know which variable contains the handle to the file, so lets find the first instance of it being used. Sure enough, there is a **mov [rsp+928h+File], rax** just after a call to **CreateFileW**. When looking at the arguments **CreateFile** takes, we can see that the very first argument is the file name:

```
HANDLE CreateFileA(lpFileName, dwDesiredAccess, dwShareMode, lpSecurityAttributes,
dwCreationDisposition, dwFlagsAndAttributes, hTemplateFile);
```

In this case, the first argument is a variable containing **msimm.dat** – one of the original strings we decrypted. As there is no file path connected to it, it seems that this file is written in the current directory, so wherever the keylogger is run.

We know almost everything about how the file is logged and how the data is stored, so let's see if we can get a sample of the encrypted data in order to analyze it. Open up a VM and run the DLL. In order to run it, I am using x64Dbg, as I couldn't seem to get **rundll32.exe** to run it – maybe due to the lack of exports. Eventually, the file I wanted was created on the Desktop, **msimm.dat**. Upon opening it, there is a lot of what seems to be text in a different language, although this is just the encrypted text being displayed by Notepad. Open the file in something like **CFF Explorer** in order to view the hex data of the file, so that we can XOR it back to plain text. Copy this into a text file on your host machine, and get your favourite text formatting tool up.

```
loc_180001325:
mov     [rsp+928h+NumberOfBytesToWrite], 0
mov     ecx, cs:dword_18001074C
mov     eax, [rsp+928h+Size_LShifted]
lea     rcx, [rcx+rax+1Ch]
mov     eax, cs:Size
lea     rax, [rcx+rax*2+1Ch]
mov     [rsp+928h+var_38], eax
movsxd  rcx, [rsp+928h+var_38]
call    cs:malloc_0
mov     [rsp+928h+Buffer], rax
movsxd  r8, [rsp+928h+var_38]
xor     edx, edx
mov     rcx, [rsp+928h+Buffer]
call    cs:memset_0
mov     [rsp+928h+var_8F8], 0
mov     [rsp+928h+var_900], 80h
mov     dword ptr [rsp+928h+Overlapped], 4
xor     r9d, r9d
mov     r8d, 1
mov     edx, 0C0000000h
lea     rcx, [rsp+928h+msimm] ; msimm.dat
call    cs:CreateFileW
mov     [rsp+928h+File], rax
```



The reason for this is because the script I have written is quite ‘hacky’. I tried several different things in order for python to read hex bytes as **hex bytes** into an array – all failed. If you guys have any ideas on how to improve it, let me know! Anyway, the text needs to be formatted in this way:

```
0x..., 0x..., 0x...
```

And as CFF explorer copies the hex in one long string, we need to split it every second character and convert spaces to **, 0x**. I personally used **this** to do so. Now my script doesn’t work 100% of the time – I’m mainly using it as an example here to show you how to replicate the algorithm in Python. It only seems to work on one section of the text, but I’m sure those of you with a higher level of Pythonic knowledge and malware analysis knowledge will be able to re purpose it so it works flawlessly. Anyway, **here** it is. When we run the script, it will decrypt the section of hex data using the keys and output the plaintext.

There is also a legend that shows you which part means what. As I mentioned, there are so many better ways to do this so that it works for different logs, however I didn't have much time to work on it and make it pristine.

```
loop = len(data_array)
location = 0
i = 0
xor_array = []

print "XORing Data...\n"
                                                    # Get value from div % 100
for item in data_array:
        if location == len(key_array):
                location = 0
        if i == loop:
                break
        data = item ^ key_array[location] # Get XOR key using value from div / 10
        xor_array.append(chr(data))
        i = i + 1;
        location = location + 1

xor_array = ' '.join(xor_array).replace('\x00','')
xor_array = xor_array.replace(' ','')
xor_array = xor_array.replace(' ',' ')
print xor_array
print "\n"
print "Finished Decrypting Data!\n"
```

That pretty much wraps up this analysis, as there isn't much else to analyze. There is no method of extracting the log files in the keylogger, so I believe **Turla** only use it when they have remote access to the machine, and extract the logs through a remote access tool or a backdoor. So I hope you enjoyed the two part analysis, and I should hopefully have the **Hancitor** part two write up soon. Thanks!

IOCs:

Keylogger: 59b57bdabee2ce1fb566de51dd92ec94