Complex obfuscation? Meh… (1/2)

decoded.avast.io/janrubin/complex-obfuscation-meh/

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by Jan RubínSeptember 17, 20207 min read

For some time now, we've been monitoring a new strain of malicious programs that we are referring to as "Meh" (we will explain why later on). It all started when we came across large amounts of files with randomly generated strings at their beginning, followed by a compiled AutoIt script… and what a ride it has been since. In this blog series, we will describe how we peeled away at Meh's obfuscation and what we found thereafter.

Analysis

Meh is composed of two main parts. The first part is a crypter, we named MehCrypter, that consists of multiple stages, and is distributed as a compiled AutoIt script prepended with a randomly generated string sequence. This string sequence is skipped by the AutoIt interpreter that scans for the magic bytes that determine the file format and effectively obfuscates the file without influencing its functionality.

The second part is a password stealer, called Meh. The stealer is the core of the malware and holds many functionalities. It is capable of stealing clipboard contents, keylogging, stealing cryptocurrency wallets, downloading additional files via torrents, and much more. Nearly all of its functionalities are performed in subthreads, executed from injected processes. We will focus on the password stealer in our next blog post.

MehCrypter

First and foremost, Meh is a password stealer/keylogger. But to get there, we need to chew through several layers of the MehCrypter. First, let's take a look at a snippet of what the actual crypter looks like from a high level view:

A snippet of the MehCrypter AutoIt script

The string at the beginning of the file is randomly generated and its length varies as well. We have seen samples with several MB of data prepended in this area to samples with almost no data at all.

Upon a closer look, however, the file also contains code which is actually a compiled AutoIt script which can be interpreted by the AutoIt interpreter. The interpreter is designed in such a way that it searches the entire file content until it finds the string `AU3!EA06`. Thus, the whole prepended string is skipped completely and serves only as a confusion technique to avoid detection.

The decompilation yields a very readable script which serves a single purpose: concatenate hard coded hexadecimal strings, decode them, and load the result PE using reflective loading via a custom AutoIt PE loader.

```
Global $hdll = dllfrommemory(BinaryToString($pe_data))
DllClose($hdll)

Func bindll($sfile)
    Local $hfile = FileOpen($sfile, 16)
    Local $bbinary = FileRead($hfile)
    FileClose($hfile)
    Return $bbinary
EndFunc

Func dllfrommemory($bbinaryimage)
    Local $tbinary = DllStructCreate("byte[" & BinaryLen($bbinaryimage) & "]")
    DllStructSetData($tbinary, 1, $bbinaryimage)
    Local $ppointer = DllStructGetPtr($tbinary)
    Local $timage_dos_header = DllStructCreate("char Magic[2];" & "word BytesOnLastPage;" & "word Pages;"
    $ppointer += DllStructGetData($timage_dos_header, "AddressOfNewExeHeader")
    Local $smagic = DllStructGetData($timage_dos_header, "Magic")
    If NOT ($smagic == "MZ") Then
        Return SetError(1, 0, 0)
    EndIf
    Local $timage_nt_signature = DllStructCreate("dword Signature", $ppointer)
    $ppointer += 4
    If DllStructGetData($timage_nt_signature, "Signature") <> 17744 Then
        Return SetError(2, 0, 0)
    EndIf
    Local $timage_file_header = DllStructCreate("word Machine;" & "word NumberOfSections;" & "dword TimeD
    Local $inumberofsections = DllStructGetData($timage_file_header, "NumberOfSections")
    $ppointer += 20
```

A snippet of an AutoIt PE loader

Note that up to this point, the crypter is very generic and we have seen at least five different families using it so far, with the most known being Agent Tesla and XMRig.

MehCrypter dropper

From the script described above, we can manually extract the binary. This binary is a very simple dropper written in Borland Delphi which makes several HTTP POST requests to the C&C server in order to download three additional files:

- http://83[.]171.237.233/s2/pe.bin
- http://83[.]171.237.233/s2/base.au3
- http://83[.]171.237.233/s2/autoit.exe

After these files are downloaded, they are saved into the `C:\testintel2\` directory and the file `base.au3` is executed (i.e. interpreted by `autoit.exe`). `pe.bin` is an encrypted Meh password stealer binary. But we will get to that later.

Furthermore, the dropper also tries to clean up the environment from previous installations of the Meh password stealer, which we'll discuss in depth in the next part of this blog series. Specifically, it attempts to terminate several processes:

- notepad.exe
- werfault.exe

- vbc.exe
- systeminfo.exe
- calc.exe

These processes are used by Meh for later PE injections. At this stage it also removes its installation folder `C:\programdata\intel\wireless`.

We would like to mention one file that is also created by the Meh dropper: `C:\testintel2\a.txt`
This file contains only three bytes: `meh`. This was so hilarious upon the first look that we decided to name the whole family Meh, including its crypter, MehCrypter.

`base.au3` uses the same crypter (MehCrypter) as the original sample. However, it contains a shellcode only instead of a whole PE binary. Thus, it omits the PE loader part and it is executed using the CallWindowProc API function.

base.au3 shellcode

base.au3 shellcode has two parts. In the first part, the shellcode constructs yet another shellcode on the stack. We can see its beginning at the address `0x00000025`. The second shellcode is executed later via an indirect jump.

```
seg000:00000000 55                                      push    ebp
seg000:00000001 8B EC                                   mov     ebp, esp
seg000:00000003 50                                      push    eax
seg000:00000004 B8 E9 00 00 00                          mov     eax, 0E9h
seg000:00000009
seg000:00000009                                 loc_9:                                  ; CODE XREF: sub_0+11↓j
seg000:00000009 81 C4 04 F0 FF FF                       add     esp, 0FFFFF004h
seg000:0000000F 50                                      push    eax
seg000:00000010 48                                      dec     eax
seg000:00000011 75 F6                                   jnz     short loc_9
seg000:00000013 8B 45 FC                                mov     eax, [ebp-4]
seg000:00000016 83 C4 9C                                add     esp, 0FFFFFF9Ch
seg000:00000019 8D 85 09 73 F1 FF                       lea     eax, [ebp+var_pe]
seg000:0000001F 8D 95 9B 6F F1 FF                       lea     edx, [ebp+var_shellcode]
seg000:00000025 C6 02 55                                mov     byte ptr [edx], 55h ; 'U'
seg000:00000028 C6 42 01 8B                             mov     byte ptr [edx+1], 8Bh
seg000:0000002C C6 42 02 EC                             mov     byte ptr [edx+2], 0ECh
seg000:00000030 C6 42 03 83                             mov     byte ptr [edx+3], 83h
seg000:00000034 C6 42 04 C4                             mov     byte ptr [edx+4], 0C4h
seg000:00000038 C6 42 05 A0                             mov     byte ptr [edx+5], 0A0h
seg000:0000003C C6 42 06 53                             mov     byte ptr [edx+6], 53h ; 'S'
seg000:00000040 C6 42 07 56                             mov     byte ptr [edx+7], 56h ; 'V'
seg000:00000044 C6 42 08 57                             mov     byte ptr [edx+8], 57h ; 'W'
seg000:00000048 C6 42 09 89                             mov     byte ptr [edx+9], 89h
seg000:0000004C C6 42 0A 5D                             mov     byte ptr [edx+0Ah], 5Dh ; ']'
seg000:00000050 C6 42 0B FC                             mov     byte ptr [edx+0Bh], 0FCh
seg000:00000054 C6 42 0C 64                             mov     byte ptr [edx+0Ch], 64h ; 'd'
seg000:00000058 C6 42 0D 8B                             mov     byte ptr [edx+0Dh], 8Bh
seg000:0000005C C6 42 0E 05                             mov     byte ptr [edx+0Eh], 5
seg000:00000060 C6 42 0F 30                             mov     byte ptr [edx+0Fh], 30h ; '0'
```

Assembly of the base.au3 shellcode with the beginning of the second shellcode

The second part is an unencrypted binary file. The MZ header starts at the address `0x0000168A`.

```
seg000:0000168A C6 00 4D                                mov     byte ptr [eax], 4Dh ; 'M'
seg000:0000168D C6 40 01 5A                             mov     byte ptr [eax+1], 5Ah ; 'Z'
seg000:00001691 C6 40 02 50                             mov     byte ptr [eax+2], 50h ; 'P'
seg000:00001695 C6 40 03 00                             mov     byte ptr [eax+3], 0
seg000:00001699 C6 40 04 02                             mov     byte ptr [eax+4], 2
seg000:0000169D C6 40 05 00                             mov     byte ptr [eax+5], 0
seg000:000016A1 C6 40 06 00                             mov     byte ptr [eax+6], 0
seg000:000016A5 C6 40 07 00                             mov     byte ptr [eax+7], 0
seg000:000016A9 C6 40 08 04                             mov     byte ptr [eax+8], 4
seg000:000016AD C6 40 09 00                             mov     byte ptr [eax+9], 0
seg000:000016B1 C6 40 0A 0F                             mov     byte ptr [eax+0Ah], 0Fh
seg000:000016B5 C6 40 0B 00                             mov     byte ptr [eax+0Bh], 0
seg000:000016B9 C6 40 0C FF                             mov     byte ptr [eax+0Ch], 0FFh
seg000:000016BD C6 40 0D FF                             mov     byte ptr [eax+0Dh], 0FFh
seg000:000016C1 C6 40 0E 00                             mov     byte ptr [eax+0Eh], 0
seg000:000016C5 C6 40 0F 00                             mov     byte ptr [eax+0Fh], 0
seg000:000016C9 C6 40 10 B8                             mov     byte ptr [eax+10h], 0B8h
seg000:000016CD C6 40 11 00                             mov     byte ptr [eax+11h], 0
seg000:000016D1 C6 40 12 00                             mov     byte ptr [eax+12h], 0
seg000:000016D5 C6 40 13 00                             mov     byte ptr [eax+13h], 0
seg000:000016D9 C6 40 14 00                             mov     byte ptr [eax+14h], 0
seg000:000016DD C6 40 15 00                             mov     byte ptr [eax+15h], 0
seg000:000016E1 C6 40 16 00                             mov     byte ptr [eax+16h], 0
seg000:000016E5 C6 40 17 00                             mov     byte ptr [eax+17h], 0
seg000:000016E9 C6 40 18 40                             mov     byte ptr [eax+18h], 40h ; '@'
seg000:000016ED C6 40 19 00                             mov     byte ptr [eax+19h], 0
seg000:000016F1 C6 40 1A 1A                             mov     byte ptr [eax+1Ah], 1Ah
seg000:000016F5 C6 40 1B 00                             mov     byte ptr [eax+1Bh], 0
```

Assembly of the base.au3 shellcode with the beginning of the binary

As we might guess, the second (constructed) shellcode is in fact another PE loader that just loads and executes the hardcoded binary file. This binary is the last stage of the crypter's *envelope* and is a stager for the Meh password stealer.

Meh stager

After the long journey of peeling away MehCrypter's layers, we finally reach the Meh stager, written in Borland Delphi. This stager is the third (and final) PE loader, which decrypts the aforementioned `pe.bin` file using a very simple XOR cipher.

pe.bin decryption

The decryption function takes two inputs – a base64-encoded ciphertext and a key. Fortunately, both of these are contained in the `pe.bin`.

The contents of the `pe.bin` file can look like this:

ilvDcfsEUgkTsnwVZfgTlwIEYMBeBLpUOIViNlphggZObNMzFGQbRZBuHIykGmozpzVwqJNhMZlFtuuzKCefYEnhGaHPNQmpKMGYFpJFLMTz
rpWshByAdFiHtZqaJyfcwACSPaiasqYwFcBhAjkrhrNmZshepGMaPyShFXVmUFKQabPBXvNtoyVIcjIeosUxchGzfJdlULTzbUgQLSqOeDuiH
mYjzExYGgilFQABJBuxKaKGJgyOdhiZlCJHAoUbAZVFfNoYlFXCOrDsZTIehevTtDvhifzwAIvhigkHiemkEMwAzhpThKrzmSydHPmVJgPptI
iAptFQyhVsTuPHaZRFyflnLlQhLQryFabMkQaQOrsVRykiRJSzFZxgtpPFKHmNfYPwQEejcsxkQozldYZgNuLqVEMBktrnorpYQyFguqCsnwJ
TEoaLdsPbugyWnpMzpJUCUdcjzwaWbMQlhRVHLnTWjZVeVyJEZxdVHsWUmxkmeLCBVyDIKctjfaWiDQsHjQtLHaqHSkCQiYmtmZDKbGldkzvz
wZDfiVMoTYBdyJkXJEIFDFCbzHUpwyATHjBhsiyTYO|UsUzmbiYdQ|3crAkJKQkJCUkJ+Qb2+QkCiQkJCQkJCQ0JCKkJCQkJCQkJCQkJCQkJC
CQkJCQkJCQkJCQkJCQkJCQkJCQkJCQkJCQkJCQkJCQkJCQkJCQkJCQkJCQkJCQkJCQkJCQkJCQkJCQkJCQkJCQkJCQkJCQkJCQkJCQkMDVkJD
CQkJCQkJCQkJCQkJCQkJCQkJCQQJWQuNuQkJCQkJCQkJCQkJCQkJCQkJCQkJCQkJBQlZCIkJCQkJCQkJCQkJCQkJCQkJCQkJCQkJCQkJCQkJC
CQkJCQkJBQvvn08eTxkJCqgpCQkACVkJCEkJCQ+JWQkJCQkJCQkJCQkJCQ0JCQUL7k/OOQkJCQnJCQkJAglZCQkJCQkOyVkJCQkJCQkJCQkJC
CQ0JaQkJCQkJB0lZCQkJCQkJCQkJCQkJDQkJDAkJCQkJCQkJCQkJCQkJCQkJCQkJCQkJCQkJCQkJCQkJCQkJCQkJCQkJCQkJCQkJCQkJCQkJC
P1lMTi5fUd0JC8gNCQkZjD/fH8/Pn+5JKQEG9vb++QkADUgNCQkZfZ/uT19/XilJCQkBBvb2/vG1DMgNCQkZTS6eT1kZCQkJBvkJCQAOCA0JC
Hz9ZCQkJCRkJCQkJCQkJBQkJCQkJCQ1pbD6ePk9f2TkG9vXBPUtJRoec3CkJAT1LSUaHnrwpCQE9S0lGh5FcKQkFxcjYHQkLeB0JChgdCQkZC
+1XAHVkBtQb7VYAdWQG1BvtVQB1ZAbUG+1UAHVkBtQb7UsAdWQG1BvtSgB1ZAbUG+1JAHVkBtQb7UgAdWQG1BvtTwB1ZAbUG+1OAHVkBtQb7U
HVkBtQb7VMAdWQG1BvtfQB1ZAbUG+18AHVkBtQb7XMAdWQG1BvtWQB1ZAbUG+1YAHVkBtQb7V8AdWQG1BvtcgB1ZAbUG+1xAHVkBtQb7XAAdW
gB1ZAbUG+1tAHVkBtQb7WwAdWQG1BvtYwB1ZAbUG+1iAHVkBtQwxNUZCtwFdWQE6uQ5cn41JaQkPqQeDZvb28Z1LSYE+y0mJDll6NQGZS0e8A
vEtJQZ0pwbkxmUtBvUtJQbhLQZgBvUtJQZyJQblLQbxLSUGcCUG9S0lBmTIJHJys7LUxNUaBvAlBmEtBuAGcS0lBuEtBvctJQZmhvEtJQbnLC
9vFFDllKNQGZPJys3PzstTHdCQw8bHxRNUYBmUtBtkG5YZ1LScG5oblhvQmKtYnxIWkJCQG0gbrpPPnBtpk+qUq0/i5qtY5bEb0pQbnpHRmBv

The contents of pe.bin file with the highlighted XOR key

As can be seen in the screenshot above there is a randomly generated string at the beginning of the file, similarly to the initial AutoIt script. After a series of random letters, however, we can see a string delimited by pipes, followed by a base64 string. These are exactly the parameters the decryption function needs. A corresponding decryptor written in Python can be found below.

The key, as shown above, is not used in this exact form. The malware replaces the first character of the key-string with “a” and omits the last letter. Thus, the actual key is `asUzmbiYd`.

After that, the base64 string is decoded and a one-byte key is derived from the XOR key string:

```
key = len(xor_key)
for i in range(0, len(xor_key)):
    key = xor_key[i] ^ key
```

The bit-negated version of this one-byte key is then used to decrypt the content of the file. As mentioned before, the cipher is a simple XOR cipher:

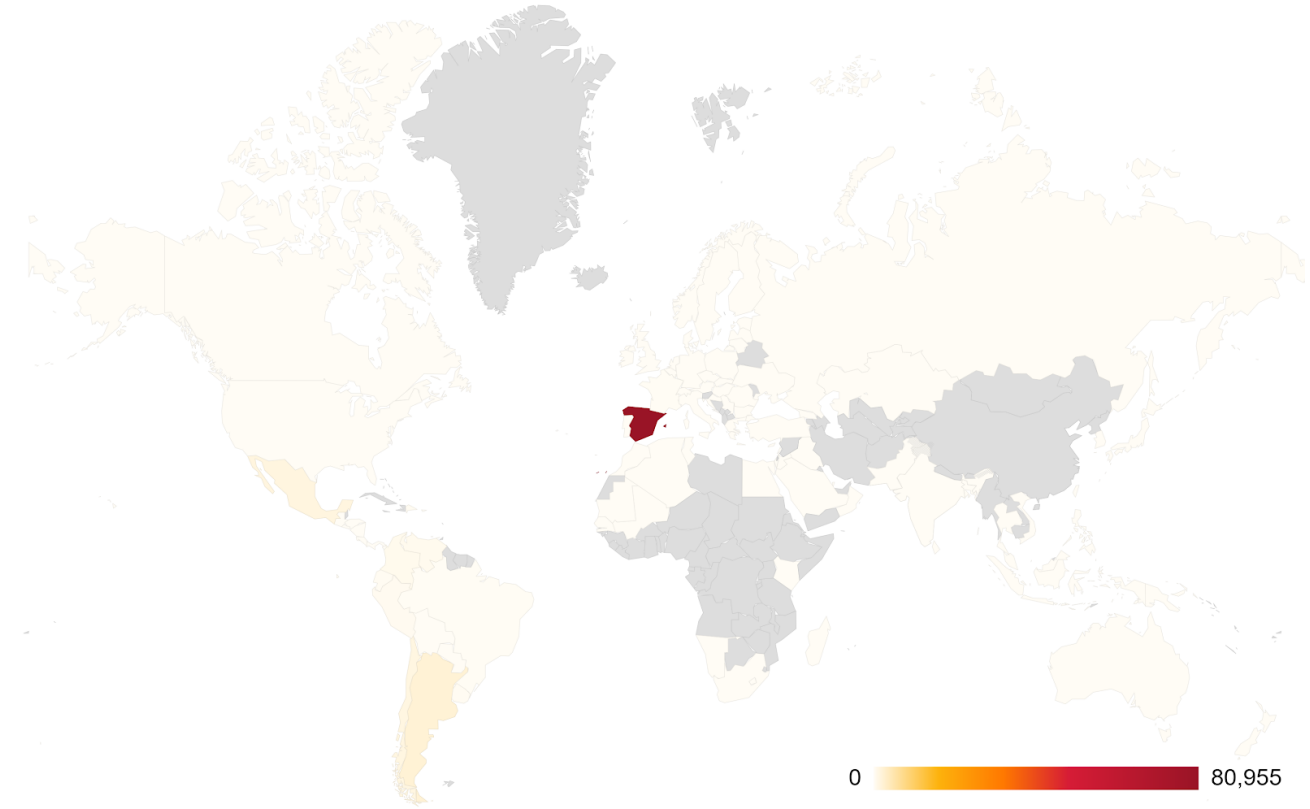
```
for i in range(0, len(file_contents_pe)):
    result += bytes([file_contents_pe[i] ^ key ^ 255])
```

Due to a bad key-derivation procedure, the actual size of the key-space is just 256 keys. Therefore, an analyst can bruteforce the decryption key, e.g. by trying to decrypt the PE file header looking for MZ magic bytes.

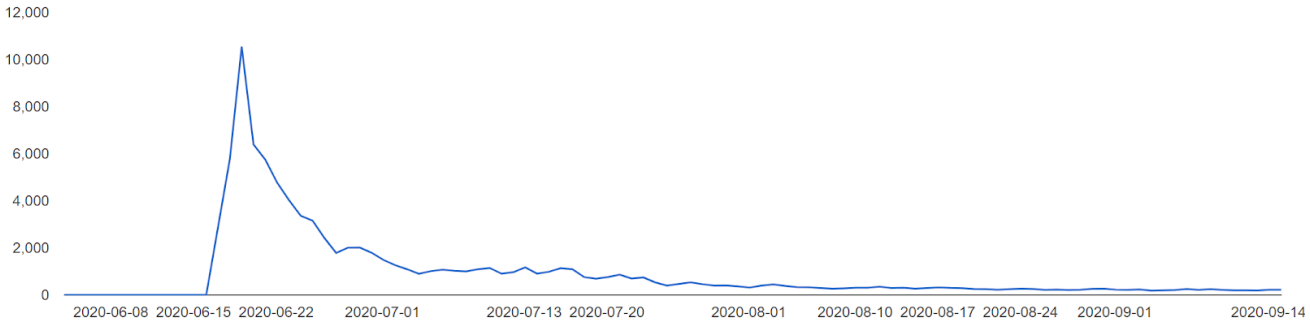
The whole decryptor written in Python can be found here.

Campaign overview

The surge of Meh and MehCrypter infections started mid-June where we were counting several thousands infections per day. The malware is most prevalent in Spain where Avast blocked infection attempts on more than 80,000 of our users. The second most targeted country is Argentina with more than 2,000 attacked users.



Map illustrating the countries Meh has targeted from June to September 2020



Graph illustrating Meh's spread in time (hits)

Summary

In this post, we looked into a MehCrypter family that is used to obfuscate many malware families circulating in the wild. One of these families is the Meh password stealer, which we will describe in detail in the next part of the series, so stay tuned!

IoCs

File name	Hash
Initial AutoIt script	94c2479d0a222ebdce04c02f0b0e58ec433b62299c9a537a31090bb75a33a06e
Stage 1 – Dropper	43bfa7e8b83b54b18b6b48365008b2588a15ccebb3db57b2b9311f257e81f34c
Stage 2 – Shellcode	34684e4c46d237bfd8964d3bb1fae8a7d04faa6562d8a41d0523796f2e80a2a6
Stage 3 – Shellcode 2	2256801ef5bfe8743c548a580fefe6822c87b1d3105ffb593cbaef0f806344c5
Stage 4 – Meh stager	657ea4bf4e591d48ee4aaa2233e870eb99a17435968652e31fc9f33bbb2fe282
pe.bin	66de6f71f268a76358f88dc882fad2d2eaaec273b4d946ed930b8b7571f778a8
base.au3	75949175f00eb365a94266b5da285ec3f6c46dadfd8db48ef0d3c4f079ac6d30
autoit.exe	1da298cab4d537b0b7b5dabf09bff6a212b9e45731e0cc772f99026005fb9e48

URL
http://83[.]171.237.233/s2/pe.bin
http://83[.]171.237.233/s2/base.au3
http://83[.]171.237.233/s2/autoit.exe

Repository: https://github.com/avast/ioc/tree/master/Meh

Tagged ascrypter, obfuscation, reversing, stealer