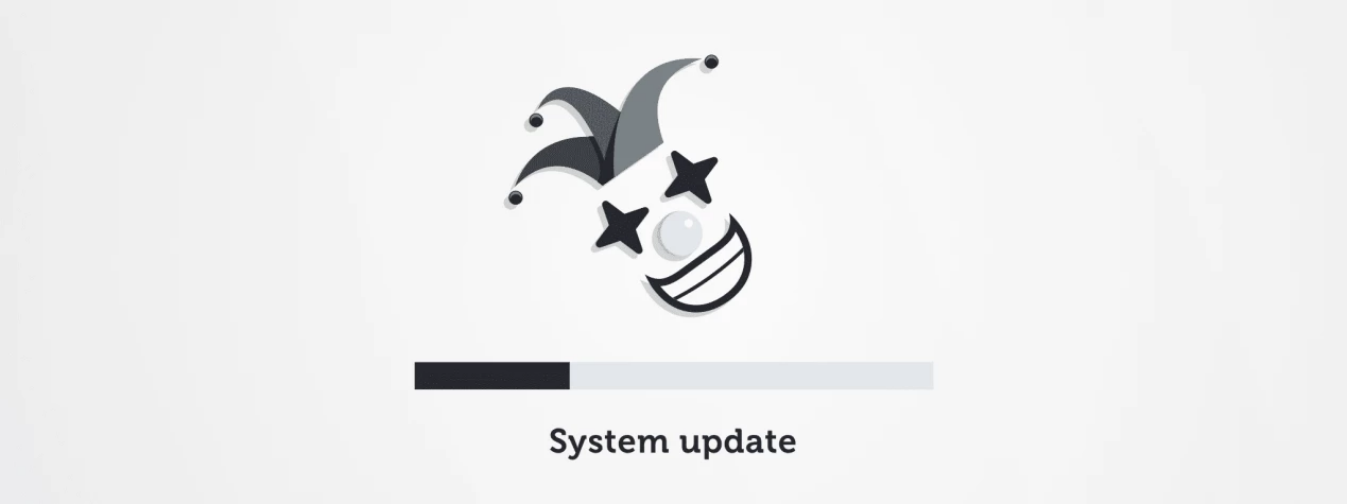
New SysJoker Backdoor Targets Windows, Linux, and macOS

Avigayil Mechtinger



Malware targeting multiple operating systems has become no exception in the malware threat landscape. Vermilion Strike, which was documented just last September, is among the latest examples until now.

In December 2021, we discovered a new multi-platform backdoor that targets Windows, Mac, and Linux. The Linux and Mac versions are fully undetected in VirusTotal. We named this backdoor **SysJoker**.

SysJoker was first discovered during an active attack on a Linux-based web server of a leading educational institution. After further investigation, we found that SysJoker also has Mach-O and Windows PE versions. Based on Command and Control (C2) domain registration and samples found in VirusTotal, we estimate that the SysJoker attack was initiated during the second half of 2021.

SysJoker masquerades as a system update and generates its C2 by decoding a string retrieved from a text file hosted on Google Drive. During our analysis the C2 changed three times, indicating the attacker is active

and monitoring for infected machines. Based on victimology and malware's behavior, we assess that SysJoker is after specific targets.

SysJoker was uploaded to VirusTotal with the suffix *.ts* which is used for TypeScript files. A possible attack vector for this malware is via an infected npm package.

Below we provide a technical analysis of this malware together with IoCs and detection and response mitigations.

Technical Analysis of SysJoker

The malware is written in C++ and each sample is tailored for the specific operating system it targets. Both the macOS and Linux samples are fully undetected in VirusTotal.

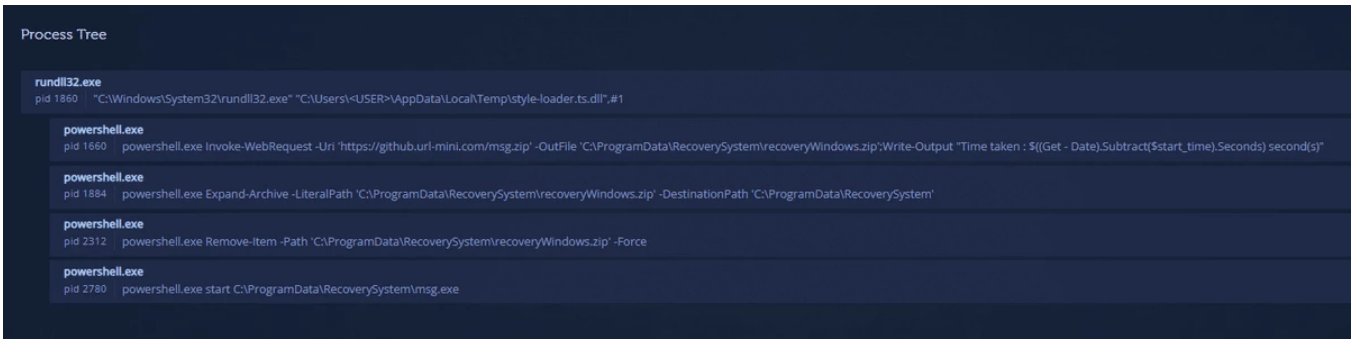
e06e06752509f9cd8bc85aa1aa24dba2 in VirusTotal targeting Mac M1 processor

Behavioral Analysis

SysJoker's behavior is similar for all three operating systems. We will analyze SysJoker's behavior on Windows.

Unlike Mac and Linux samples, the Windows version contains a first-stage dropper. The dropper (**d71e1a6ee83221f1ac7ed870bc272f01**) is a DLL that was uploaded to VirusTotal as *style-loader.ts* and has only 6 detections at the time of this writing.

The Dropper drops a zipped SysJoker (**53f1bb23f670d331c9041748e7e8e396**) from C2 *https[://]github[.]url-mini[.]com/msg.zip*, copies it to *C:|ProgramData|RecoverySystem|recoveryWindows.zip*, unzips it and executes it. All of these actions are executed via PowerShell commands.



Process tree showing PowerShell commands.

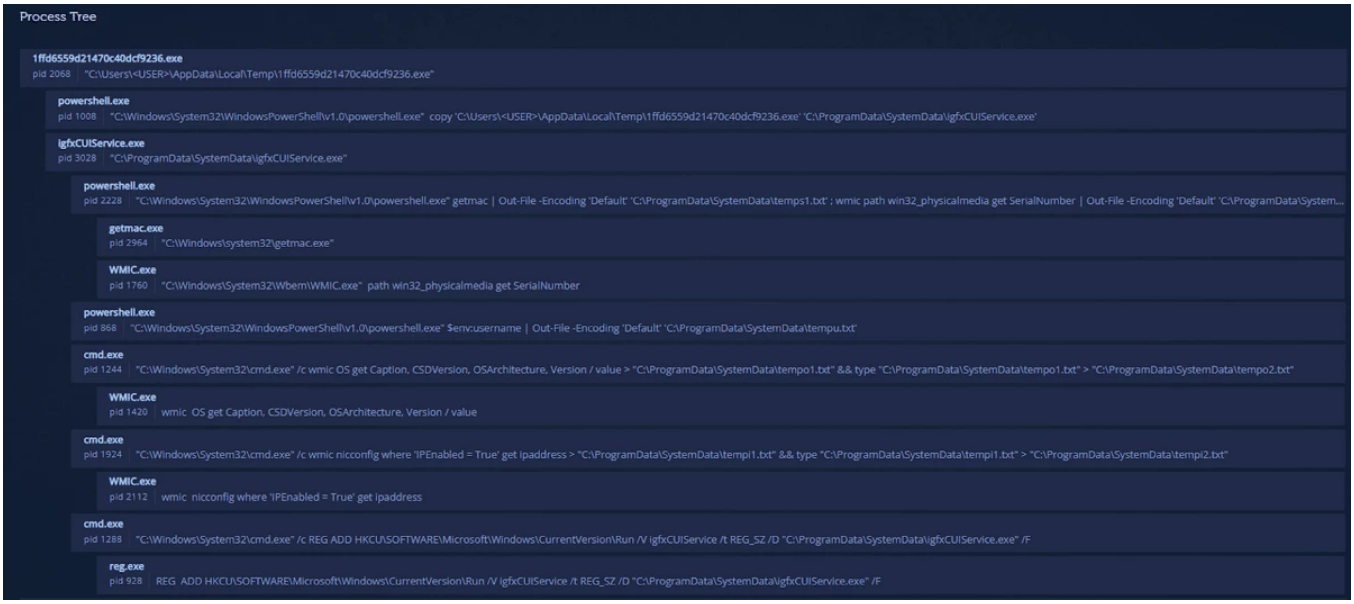
Once SysJoker (**d90d0f4d6dad402b5d025987030cc87c**) is executed it sleeps for a random duration between 90 to 120 seconds. Then, it will create the C:\ProgramData\SystemData\ directory and copy itself under this directory, masquerading as *igfxCUIService.exe* (igfxCUIService stands for Intel Graphics Common User Interface Service). Next, it will gather information about the machine using Living off the Land (LOtL) commands. SysJoker uses different temporary text files to log the results of the commands. These text files are deleted immediately, stored in a JSON object, and then encoded and written to a file named *microsoft_windows.dll*. The figure below shows the JSON object built in memory by SysJoker.

```
0022E140  66 33 65 39 2D 34 65 38 65 63 36 36 37 22 2C 22  [redacted]","
0022E150  75 73 22 3A 22 49 45 55 73 65 72 22 2C 22 6F 73  us":"IEUser","os
0022E160  22 3A 22 20 4D 69 63 72 6F 73 6F 66 74 20 57 69  ":" Microsoft Wi
0022E170  6E 64 6F 77 73 20 37 20 45 6E 74 65 72 70 72 69  ndows 7 Enterpri
0022E180  73 65 20 53 65 72 76 69 63 65 20 50 61 63 6B 20  se Service Pack
0022E190  31 20 33 32 2D 62 69 74 20 36 2E 31 2E 37 36 30  1 32-bit 6.1.760
0022E1A0  31 22 2C 22 61 76 22 3A 22 22 2C 22 69 70 22 3A  1","av":"","ip":
0022E1B0  22 31 30 2E 30 2E 32 2E 31 35 00 BA 0D F0 AD BA  "10.0.2.15.°.ð.°
```

JSON object built in memory by SysJoker.

It will gather the MAC address, user name, physical media serial number, and IP address (see IoCs section for the full commands list). SysJoker will create persistence by adding an entry to the registry run key *HKEY_CURRENT_USER|Software|Microsoft|Windows|CurrentVersion|Run*. Between each of the steps above, the malware sleeps for a random duration.

The following screenshot shows the processes tree and commands.



Processes tree and commands.

Next, SysJoker will begin its C2 communication.

Decoding/Encoding Scheme

SysJoker holds within the binary a hardcoded XOR key which is used for decoding and encoding strings from within the binary and data sent and

received from the C2. The XOR key is an RSA public key that is not used in the decoding scheme. The same XOR key exists in all versions of SysJoker:

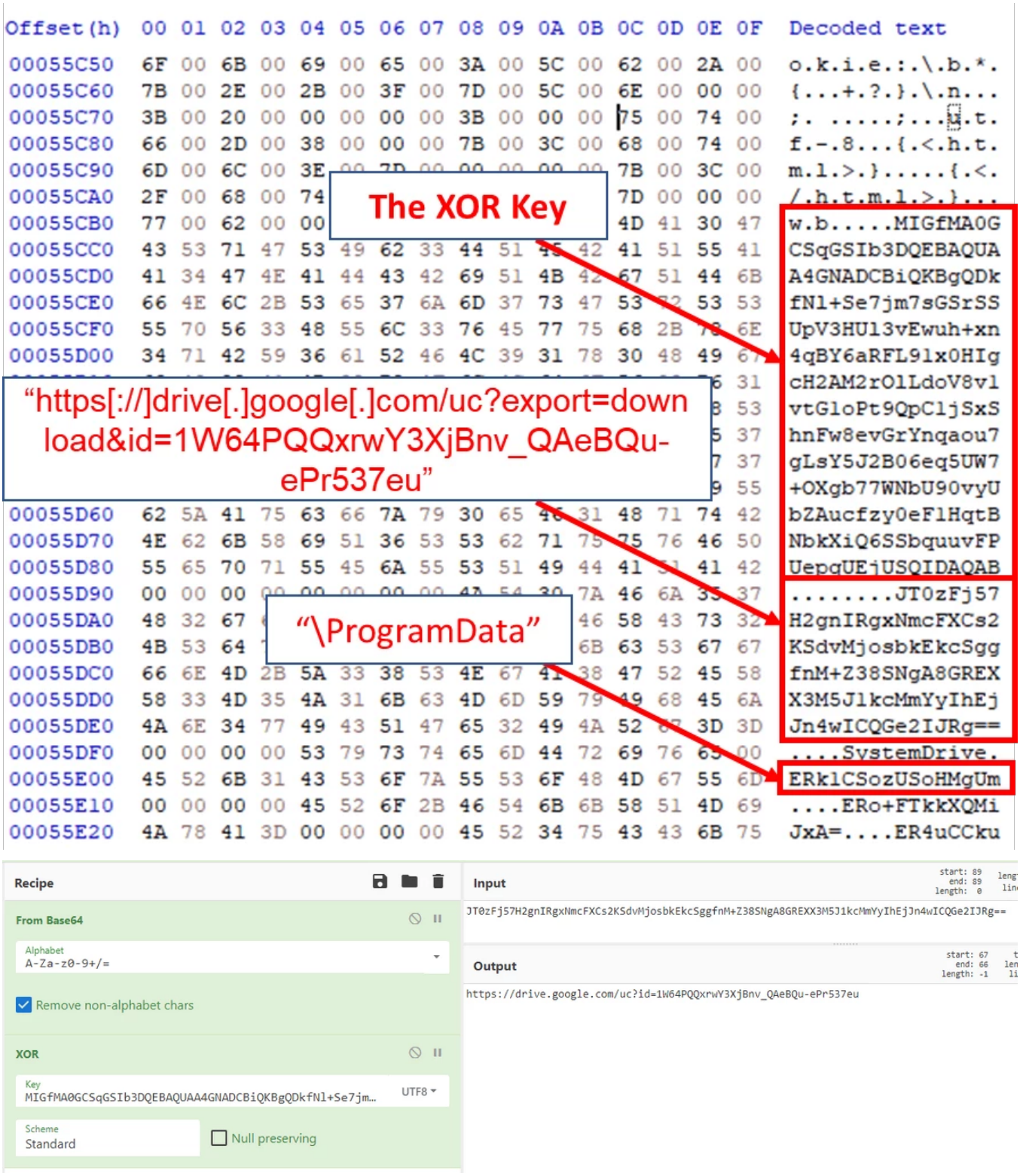
MIGfMA0GCSqGSIb3DQEBAQUAA4GNADCBiQKBgQDkfNl+Se7jm7sGSrSSUpV3HUl3vEwuh+xn4q|

BY6aRFL91x0HlgcH2AM2rOlLdoV8v1vtG1oPt9QpC1jSxShnFw8evGrYnqaou7gLsY5J2B06eq5UW7|

+OXgb77WNbU90vyUbZAucfzy0eF1HqtBNbkXiQ6SSbquuvFPUepqUEjUSQIDAQAB

Resolving C2

To get an available C2 and start communication, SysJoker first decodes a hardcoded Google Drive link.



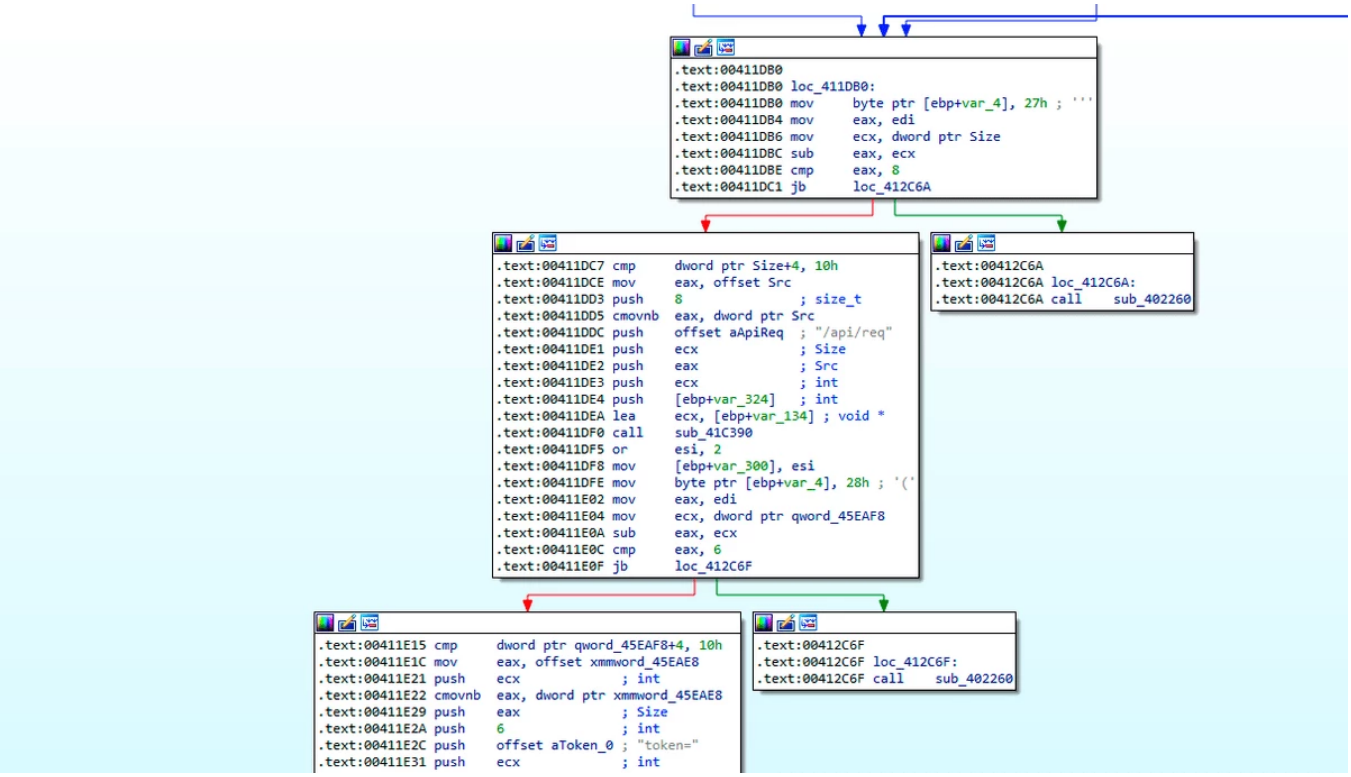
Decoding with CyberChef.

The Google Drive link hosts a text file named *domain.txt* that holds an encoded C2. The text file's content changes over time, depending on the current available C2. SysJoker will decode the C2 and send the collected user's information to the C2's ***/api/attach*** directory as an initial

handshake. The C2 replies with a unique token which will be used as an identifier from now on when the malware communicates with the C2.

C2 Instructions

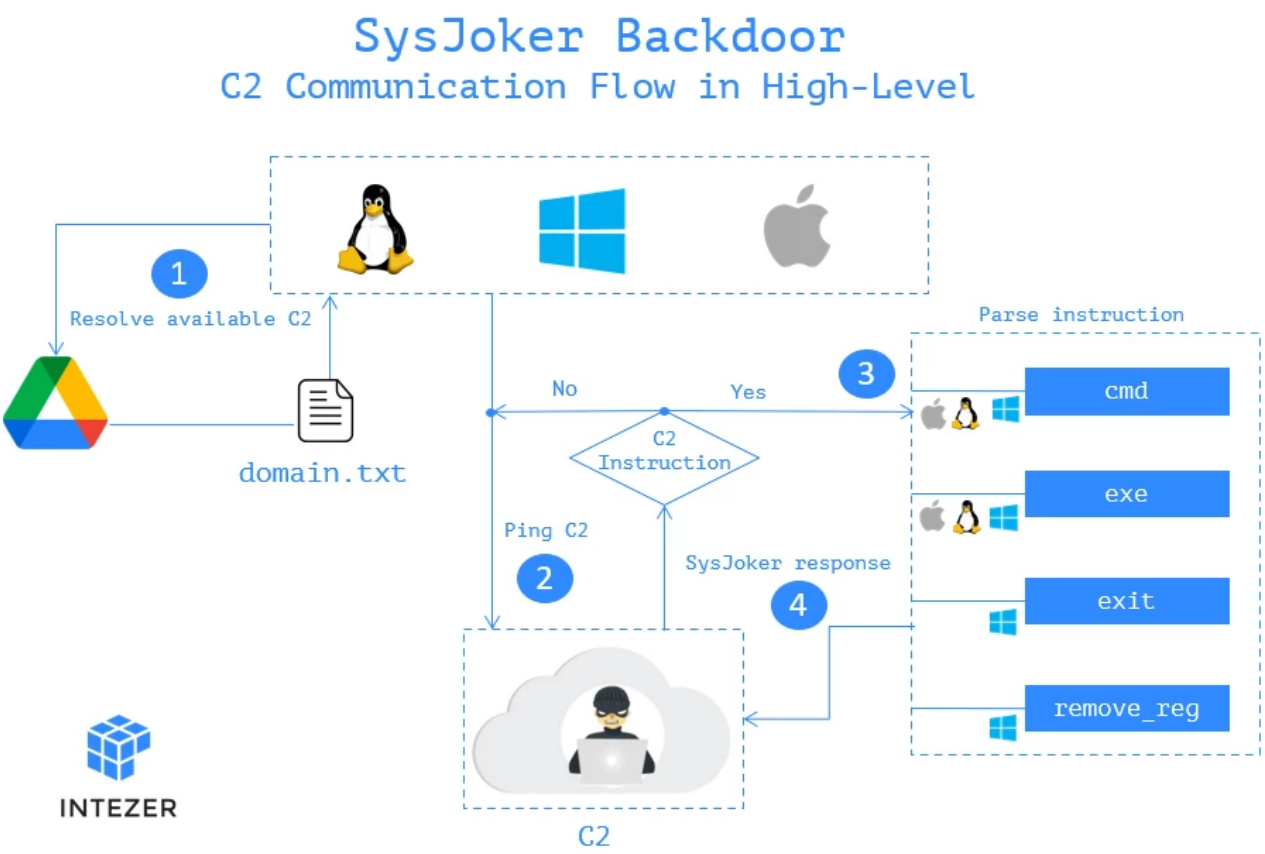
SysJoker runs a while(1) loop that sends a request to the C2's **/api/req** directory with the unique token and will process the C2's response which is built as JSON using functions from this library. This is how SysJoker pings the C2 for instructions (see step 2 in the image below):



Steps.

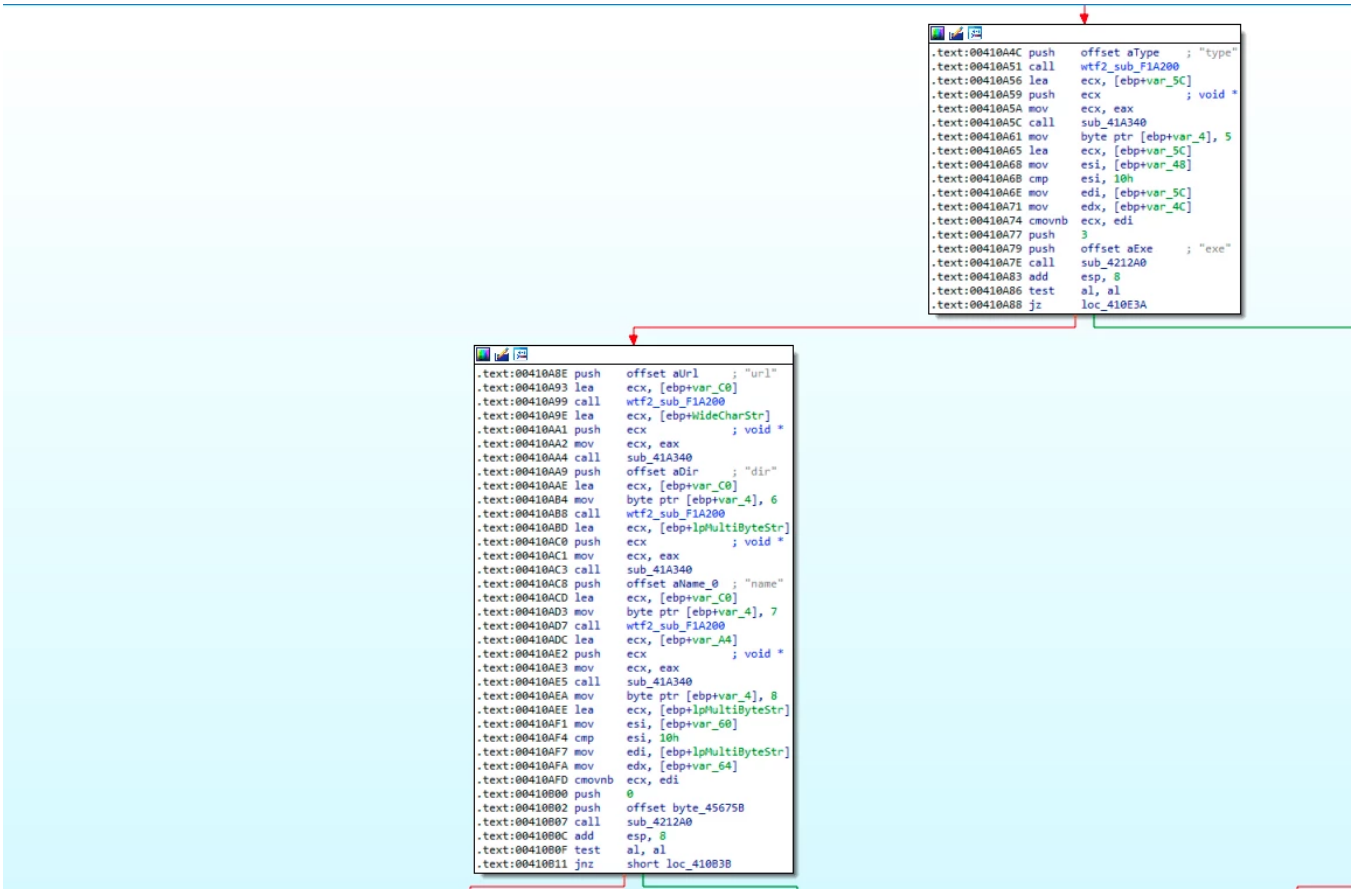
If the server responds with data, SysJoker will parse the received payload (see step 3 in the image below). SysJoker can receive the following instruction from the C2: *exe*, *cmd*, *remove_reg*, and *exit*.

The following image shows the flow of SysJoker's communication with the C2.



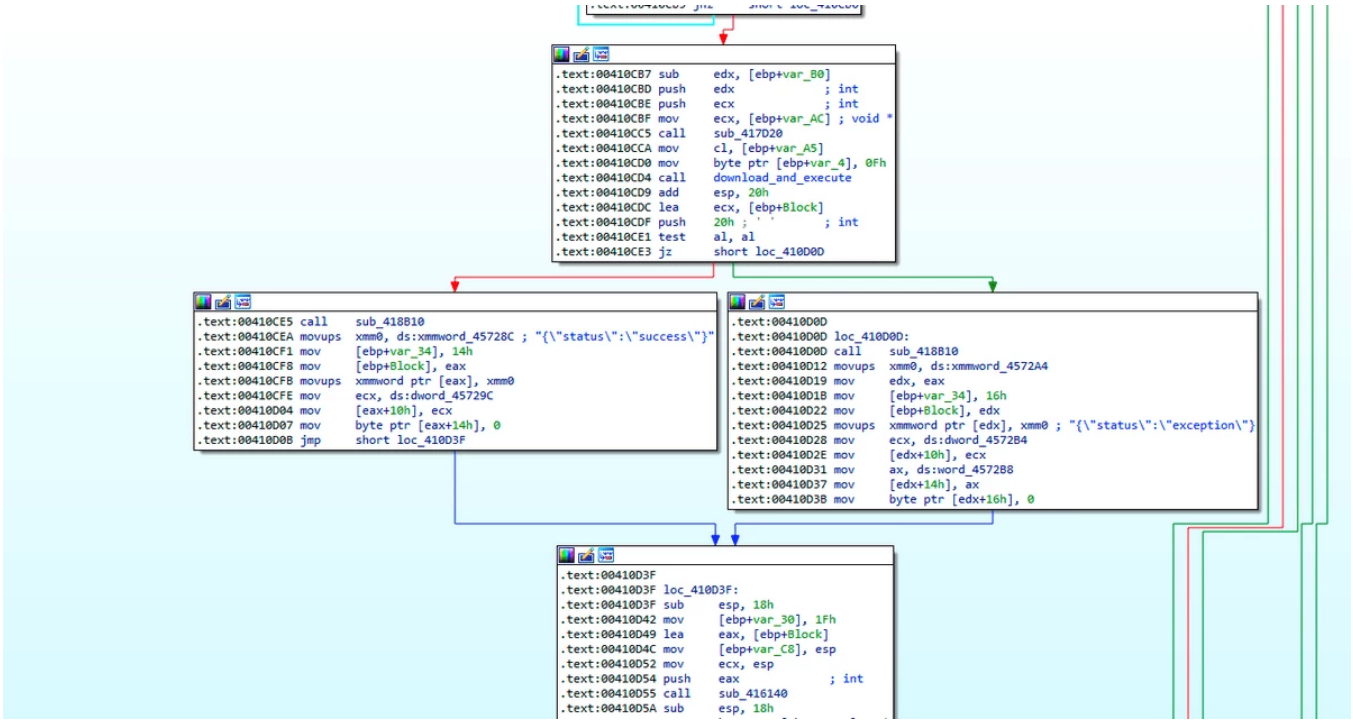
remove_reg and *exit* are not implemented in this current version. Based on the instruction names, we can assume that they are in charge of self-deletion of the malware. Let's look into *exe* and *cmd* instructions:

exe – This command is in charge of dropping and running an executable. SysJoker will receive a URL to a zip file, a directory for the path the file should be dropped to, and a filename that the malware should use on the extracted executable. It will download this file, unzip it and execute it.



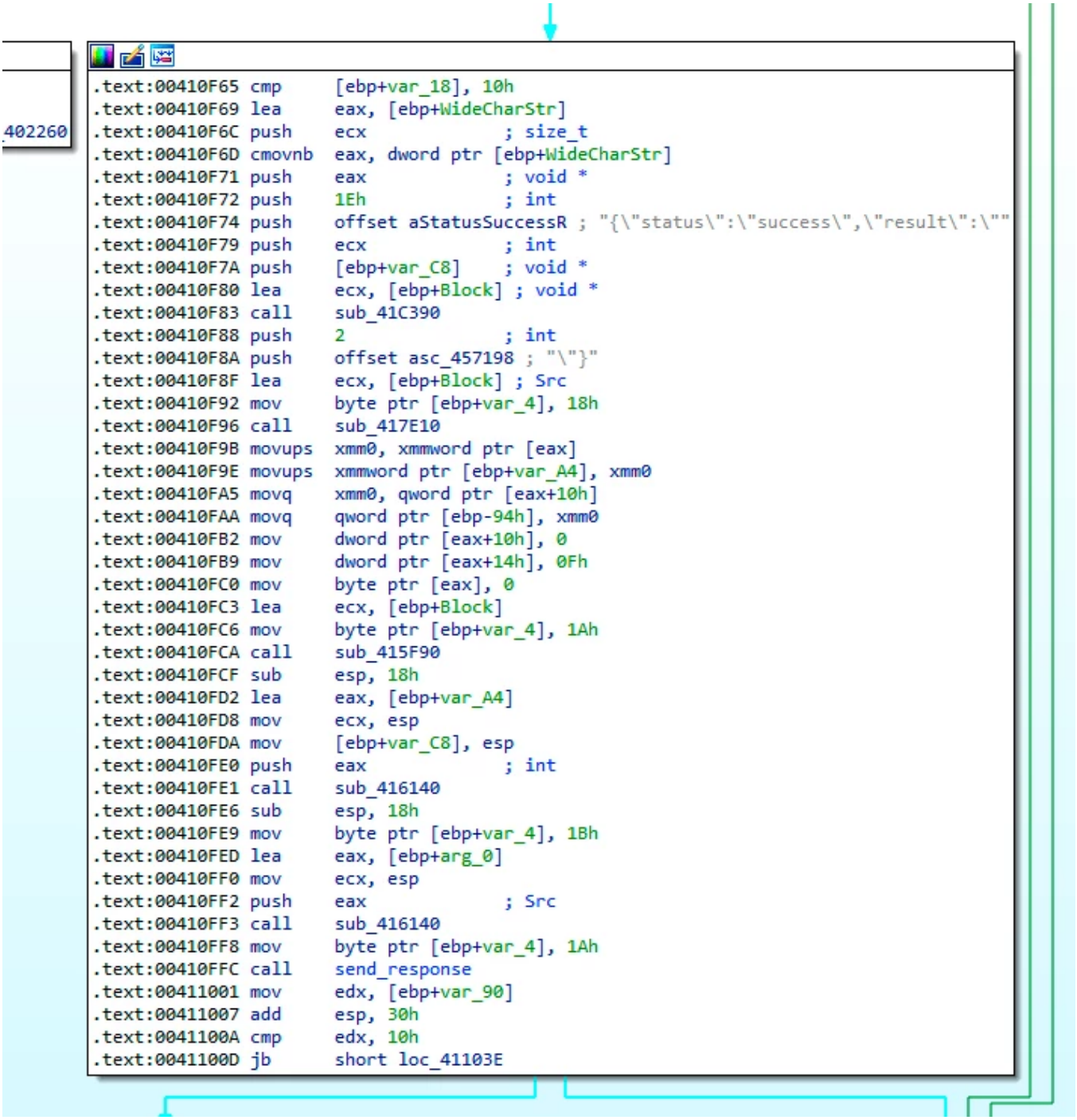
IDA code snippet of the parsing function, if *exe* part.

After execution, the malware will reply to the C2's **/api/req/res** API with either "success" if the process went successful or "exception" if not (step 4 in the image above).



IDA code snippet of the parsing function, building response status.

cmd – This instruction is in charge of running a command and uploading its response to the C2. SysJoker will decode the command, execute it and upload the command's response to the C2 via **/api/req/res** API (step 4 in the image above).



```
402260
.text:00410F65 cmp     [ebp+var_18], 10h
.text:00410F69 lea     eax, [ebp+WideCharStr]
.text:00410F6C push    ecx             ; size_t
.text:00410F6D cmovnb  eax, dword ptr [ebp+WideCharStr]
.text:00410F71 push    eax             ; void *
.text:00410F72 push    1Eh             ; int
.text:00410F74 push    offset aStatusSuccessR ; "{\"status\":\"success\",\"result\":\""
.text:00410F79 push    ecx             ; int
.text:00410F7A push    [ebp+var_C8]    ; void *
.text:00410F80 lea     ecx, [ebp+Block] ; void *
.text:00410F83 call    sub_41C390
.text:00410F88 push    2               ; int
.text:00410F8A push    offset asc_457198 ; "\"}"
.text:00410F8F lea     ecx, [ebp+Block] ; Src
.text:00410F92 mov     byte ptr [ebp+var_4], 18h
.text:00410F96 call    sub_417E10
.text:00410F9B movups  xmm0, xmmword ptr [eax]
.text:00410F9E movups  xmmword ptr [ebp+var_A4], xmm0
.text:00410FA5 movq    xmm0, qword ptr [eax+10h]
.text:00410FAA movq    qword ptr [ebp-94h], xmm0
.text:00410FB2 mov     dword ptr [eax+10h], 0
.text:00410FB9 mov     dword ptr [eax+14h], 0Fh
.text:00410FC0 mov     byte ptr [eax], 0
.text:00410FC3 lea     ecx, [ebp+Block]
.text:00410FC6 mov     byte ptr [ebp+var_4], 1Ah
.text:00410FCA call    sub_415F90
.text:00410FCF sub     esp, 18h
.text:00410FD2 lea     eax, [ebp+var_A4]
.text:00410FD8 mov     ecx, esp
.text:00410FDA mov     [ebp+var_C8], esp
.text:00410FE0 push    eax             ; int
.text:00410FE1 call    sub_416140
.text:00410FE6 sub     esp, 18h
.text:00410FE9 mov     byte ptr [ebp+var_4], 1Bh
.text:00410FED lea     eax, [ebp+arg_0]
.text:00410FF0 mov     ecx, esp
.text:00410FF2 push    eax             ; Src
.text:00410FF3 call    sub_416140
.text:00410FF8 mov     byte ptr [ebp+var_4], 1Ah
.text:00410FFC call    send_response
.text:00411001 mov     edx, [ebp+var_90]
.text:00411007 add     esp, 30h
.text:0041100A cmp     edx, 10h
.text:0041100D jb      short loc_41103E
```

IDA code snippet of the parsing function, building *cmd* command response.

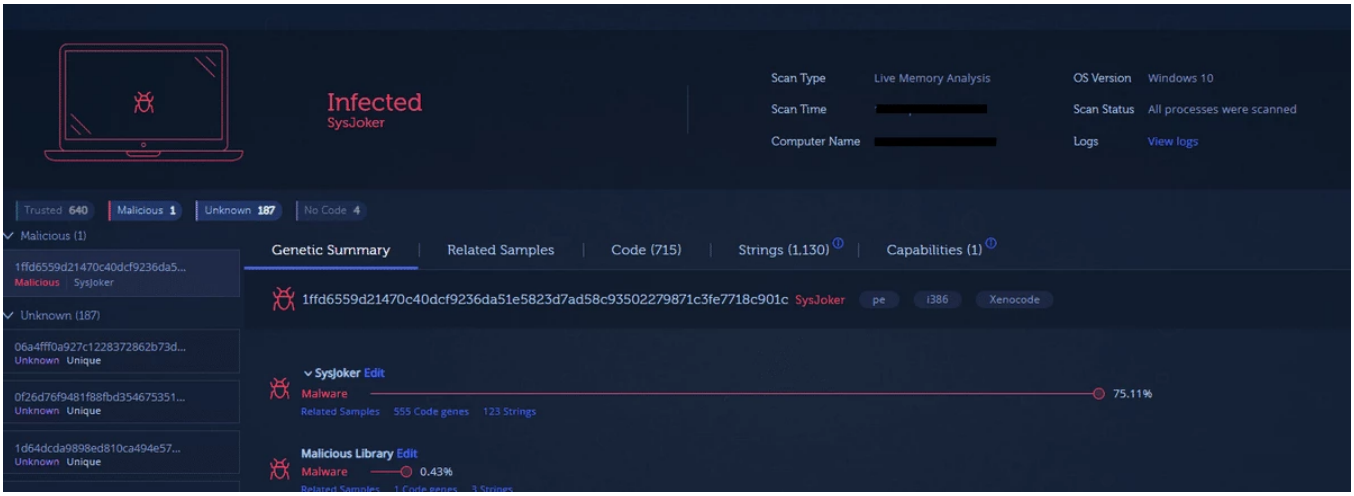
During our analysis, the C2 hasn't responded with a next stage instruction.

Detection & Response

To detect if a machine in your organization has been compromised, we recommend taking the following steps:

1. Use memory scanners to detect SysJoker payload in memory

-
    - For Linux machines, use Intezer Protect to gain full runtime visibility over the code in your Linux-based systems and get alerted on any malicious or unauthorized code. We have a free community edition.
    - For Windows machines, use Intezer's Endpoint Scanner. The Endpoint Scanner will provide you with visibility into the type and origin of all binary code that resides in your machine's memory. The figure below shows an example of an endpoint infected with SysJoker:

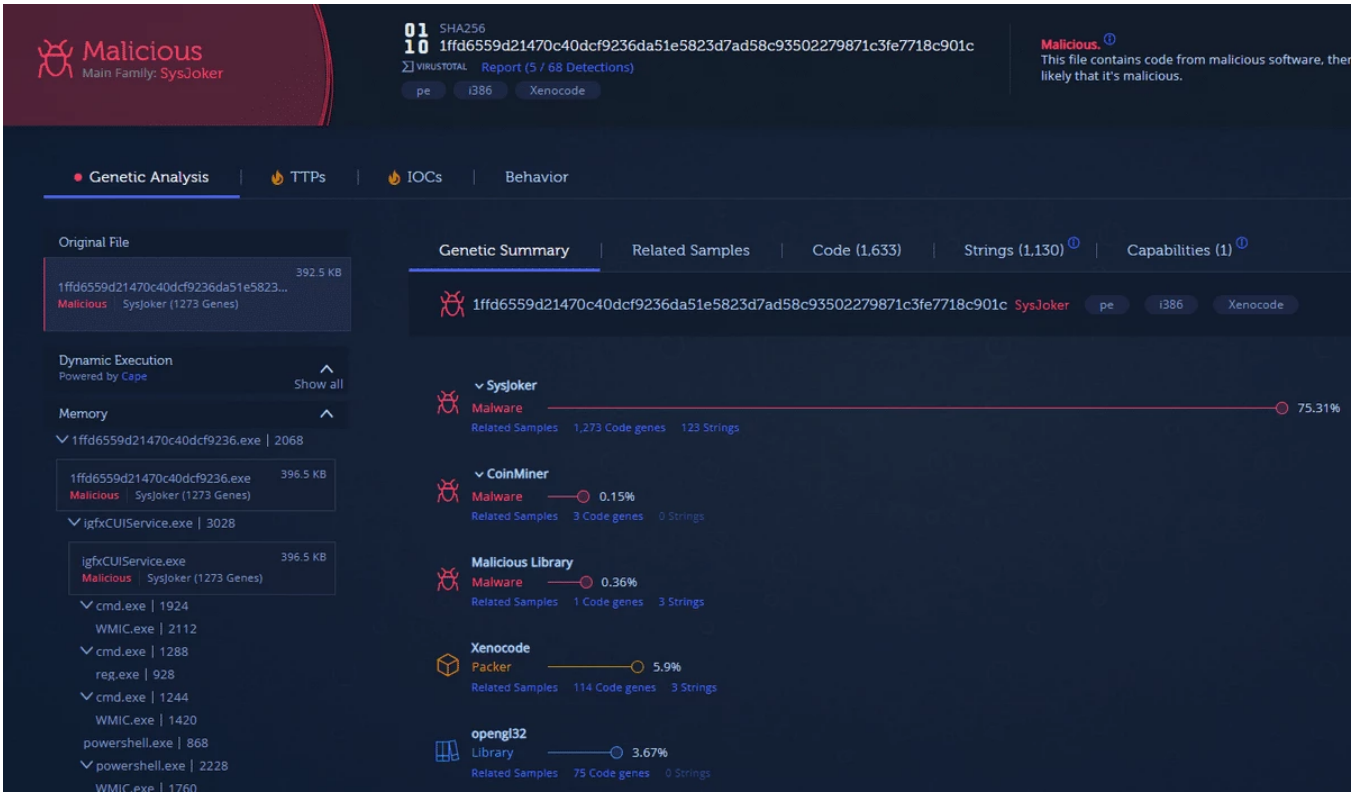


2. Use detection content to search in your EDR or SIEM. We provided you with IoCs and a rich list of detection content for each operating system below. Use these with your EDR to hunt for infected machines. **We will publish a dedicated blog soon discussing how to use detection content for detecting SysJoker.**

If you have been compromised, take the following steps:

1. Kill the processes related to SysJoker, delete the relevant persistence mechanism, and all files related to SysJoker (see detection content section below)
2. Make sure that the infected machine is clean by running a memory scanner
3. Investigate the initial entry point of the malware. If a server was infected with SysJoker, in the course of this investigation, check:
    - Configuration status and password complexity for publicly facing services
    - Used software versions and possible known exploits

SysJoker's Linux and Windows versions are now indexed in [Intezer Analyze.](#)



Final Points

There are indications that SysJoker attack is performed by an advanced

threat actor:

1. The fact that the code was written from scratch and hasn't been seen before in other attacks. On top of that, it is rare to find previously unseen Linux malware in a live attack.
2. The attacker registered at least 4 different domains and wrote from scratch the malware for three different operating systems.
3. During our analysis, we haven't witnessed a second stage or command sent from the attacker. This suggests that the attack is specific which usually fits for an advanced actor.

Based on the malware's capabilities we assess that the goal of the attack is espionage together with lateral movement which might also lead to a ransomware attack as one of the next stages.

IoCs

ELF

bd0141e88a0d56b508bc52db4dab68a49b6027a486e4d9514ec0db006fe71eed

d028e64bf4ec97dfd655ccd1157a5b96515d461a710231ac8a529d7bdb936ff3

Mac

1a9a5c797777f37463b44de2b49a7f95abca786db3977dcdac0f79da739c08ac

fe99db3268e058e1204aff679e0726dc77fd45d06757a5fda9eafc6a28cfb8df

d0febda3a3d2d68b0374c26784198dc4309dbe4a8978e44bb7584fd832c325f0

Windows

61df74731fbe1eafb2eb987f20e5226962eeceef010164e41ea6c4494a4010fc

1ffd6559d21470c40dcf9236da51e5823d7ad58c93502279871c3fe7718c901c

d476ca89674c987ca399a97f2d635fe30a6ba81c95f93e8320a5f979a0563517

36fed8ab1bf473714d6886b8dcfbcaa200a72997d50ea0225a90c28306b7670e

C2

https[://]bookitlab[.]tech

https[://]winaudio-tools[.]com

https[://]graphic-updater[.]com

https[://]github[.]url-mini[.]com

https[://]office360-update[.]com

https[://]drive[.]google[.]com/uc?export=download&id=1-NVty4YX0dPHdxkgMrbdCldQCpCaE-Hn

https[://]drive[.]google[.]com/uc?export=download&id=1W64PQQxrwY3XjBnv_QAeBQu-ePr537eu

Detection Content

Windows

Files and directories created on the machine:

C:|ProgramData|RecoverySystem

C:|ProgramData|RecoverySystem|recoveryWindows.zip

C:|ProgramData|RecoverySystem|msg.exe

C:|ProgramData|SystemData

C:|ProgramData|SystemData|igfxCUIService.exe

C:|ProgramData|SystemData|tempo1.txt

C:|ProgramData|SystemData|tempo2.txt

C:|ProgramData|SystemData|tempi1.txt

C:|ProgramData|SystemData|tempi2.txt

C:|ProgramData|SystemData|temps1.txt

C:|ProgramData|SystemData|temps2.txt

C:|ProgramData|SystemData|tempu.txt

C:|ProgramData|SystemData|microsoft_windows.dll

C:|ProgramData|xAE Operating System|ServiceHub.exe

Persistence:

HKEY_CURRENT_USERSoftwareMicrosoftWindowsCurrentVersionRun

Name: *igfxCUIService* ***Type:*** *REG_SZ*
Data: *"C:|ProgramData|SystemData|igfxCUIService.exe"*

Commands:

“C:|Windows|System32|WindowsPowerShell|v1.0|powershell.exe” getmac | Out-File -Encoding ‘Default’ ‘C:|ProgramData|SystemData|temps1.txt’ ; wmic path win32_physicalmedia get SerialNumber | Out-File -Encoding ‘Default’ ‘C:|ProgramData|SystemData|temps2.txt’

“C:|Windows|System32|Wbem|WMIC.exe” path win32_physicalmedia get SerialNumber

“C:|Windows|system32|getmac.exe”

“C:|Windows|System32|WindowsPowerShell|v1.0|powershell.exe” $env:username | Out-File -Encoding ‘Default’ ‘C:|ProgramData|SystemData|tempu.txt’

“C:|Windows|System32|cmd.exe” /c wmic OS get Caption, CSDVersion, OSArchitecture, Version / value > “C:|ProgramData|SystemData|tempo1.txt” && type “C:|ProgramData|SystemData|tempo1.txt” > “C:|ProgramData|SystemData|tempo2.txt”

wmic OS get Caption, CSDVersion, OSArchitecture, Version / value

“C:|Windows|System32|cmd.exe” /c wmic nicconfig where ‘IPEnabled = True’ get ipaddress > “C:|ProgramData|SystemData|tempi1.txt” && type “C:|ProgramData|SystemData|tempi1.txt” > “C:|ProgramData|SystemData|tempi2.txt”

wmic nicconfig where ‘IPEnabled = True’ get ipaddress

“C:|Windows|System32|cmd.exe” /c REG ADD HKCU|SOFTWARE|Microsoft|Windows|CurrentVersion|Run /V igfxCUIService /t REG_SZ /D

“C:|ProgramData|SystemData|igfxCUIService.exe” /F

REG ADD HKCU|SOFTWARE|Microsoft|Windows|CurrentVersion|Run /V igfxCUIService /t REG_SZ /D “C:|ProgramData|SystemData|igfxCUIService.exe” /F

Linux

Files and directories created on the machine:

/.Library/

/.Library/SystemServices/updateSystem

/.Library/SystemNetwork

/.Library/log.txt

Persistence:

Creates the cron job:

@reboot (/.Library/SystemServices/updateSystem)

Commands:

crontab -l | egrep -v “^(#|$)” | grep -e “@reboot (/.Library/SystemServices/updateSystem)”

cp -rf <sample name> /.Library/SystemServices/updateSystem

nohup ‘/.Library/SystemServices/updateSystem’ >/dev/null 2>&1 &

ifconfig | grep -v 127.0.0.1 | grep -E “inet ([0-9]{1,3}.[0-9]{1,3}.[0-9]{1,3}.[0-9]{1,3})” | awk ‘{print $2}’

ip address | awk ‘/ether/{print $2}’

id -u

uname -mrs

Mac

Files and directories created on the machine:

/Library/MacOsServices

/Library/MacOsServices/updateMacOs

/Library/SystemNetwork

/Library/LaunchAgents/com.apple.update.plist

Persistence:

Creates persistence via LaunchAgent under the path */Library/LaunchAgents/com.apple.update.plist*.

Content:

```
<?xml version="1.0" encoding="UTF-8"?>

<!DOCTYPE plist PUBLIC "-//Apple//DTD PLIST 1.0//EN"
"http://www.apple.com/DTDs/PropertyList-1.0.dtd">

<plist version="1.0">

<dict>

        <key>Label</key>

        <string>com.apple.update</string>

    <key>LimitLoadToSessionType</key>
```

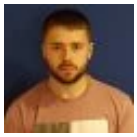
```
    <string>Aqua</string>
      <key>ProgramArguments</key>
      <array>
            <string>/Library/MacOsServices/updateMacOs</string>
      </array>
      <key>KeepAlive</key>
    <dict>
      <key>SuccessfulExit</key>
      <true/>
    </dict>
      <key>RunAtLoad</key>
      <true/>
</dict>
</plist>
```

You can find more information about SysJoker in Intezer Analyze, which now has the Linux and Windows versions indexed.

Avigayil Mechtinger

Avigayil is a product manager at Intezer, leading Intezer Analyze product lifecycle. Prior to this role, Avigayil was part of Intezer's research team and

specialized in malware analysis and threat hunting. During her time at Intezer, she has uncovered and documented different malware targeting both Linux and Windows platforms.



Ryan Robinson

Ryan is a security researcher analyzing malware and scripts. Formerly, he was a researcher on Anomali's Threat Research Team.

Nicole Fishbein

Nicole is a malware analyst and reverse engineer. Prior to Intezer she was an embedded researcher in the Israel Defense Forces (IDF) Intelligence Corps.

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