

New SysJoker Backdoor Targets Windows, Linux, and macOS

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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.

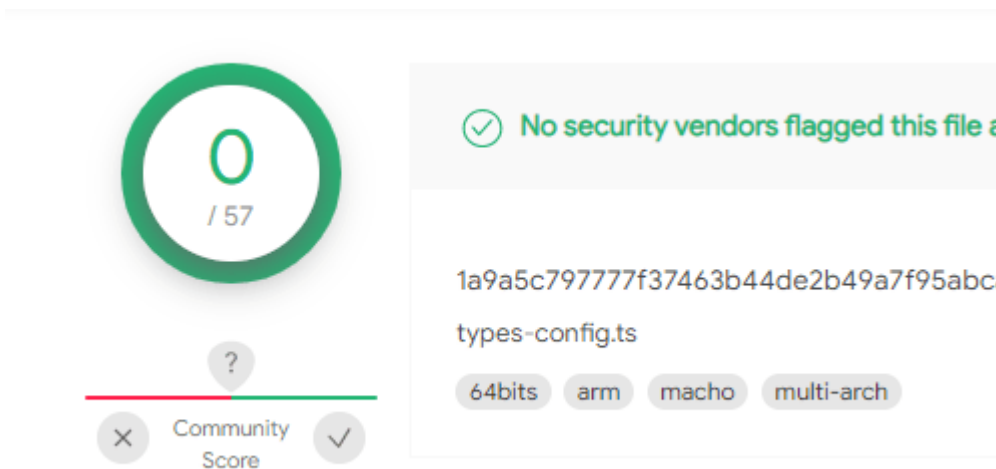
SysJoker masquerades as a system update and generates its C2 by decoding a string retrieved from a text file hosted on Google Drive. During our analysis the C2 changed three times, indicating the attacker is active and monitoring for infected machines. Based on victimology and malware's behavior, we 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.



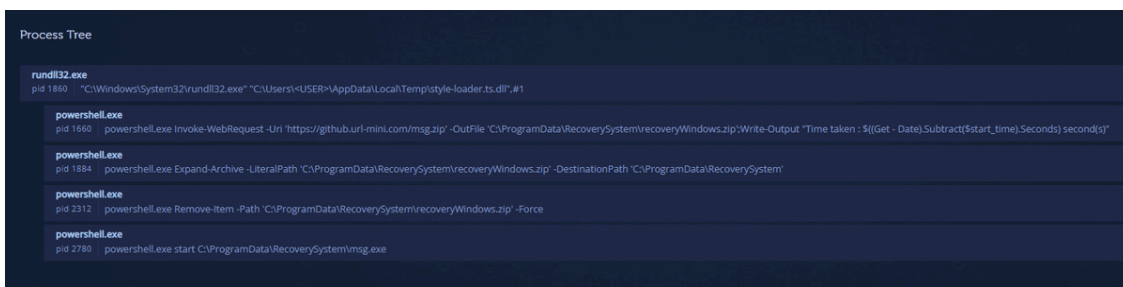
e06e06752509f9cd8bc85aa1aa24dba2 in VirusTotal targeting Mac M1 processor

Behavioral Analysis

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

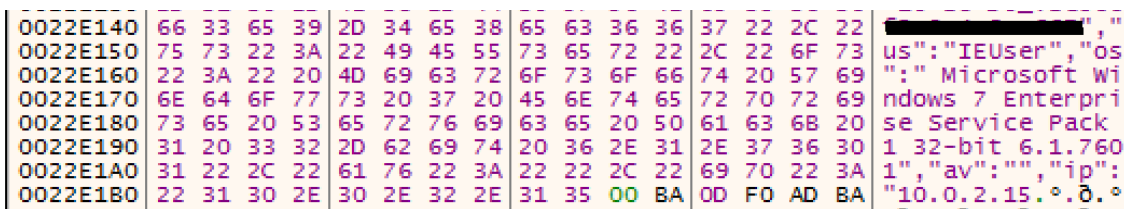
Unlike Mac and Linux samples, the Windows version contains a first-stage dropper. The dropper (**d71e1a6ee83221f1ac7ed870bc272f01**) is a DLL that was uploaded to VirusTotal as *style-loader.ts* and has only 6 detections at the time of this writing.

The Dropper drops a zipped SysJoker (**53f1bb23f670d331c9041748e7e8e396**) from C2 *https[://]github[.]url-mini[.]com/msg.zip*, copies it to *C:ProgramDataRecoverySystemrecoveryWindows.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:ProgramDataSystemData* 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.



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_USERSoftwareMicrosoftWindowsCurrentVersionRun*. 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

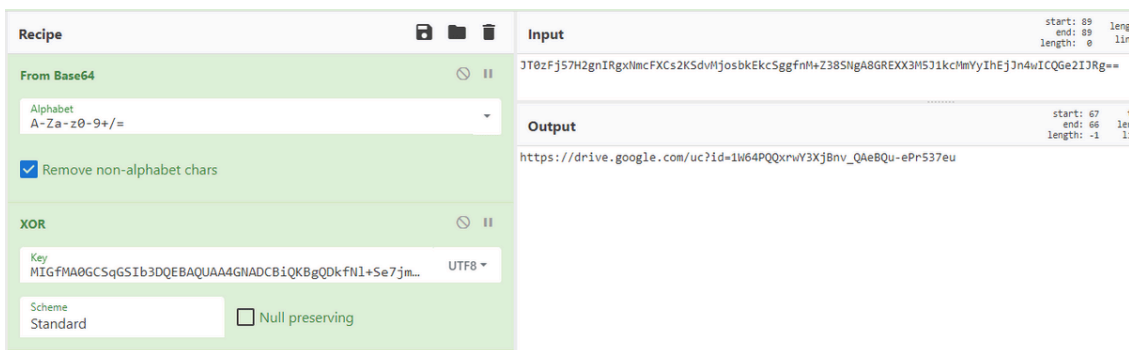
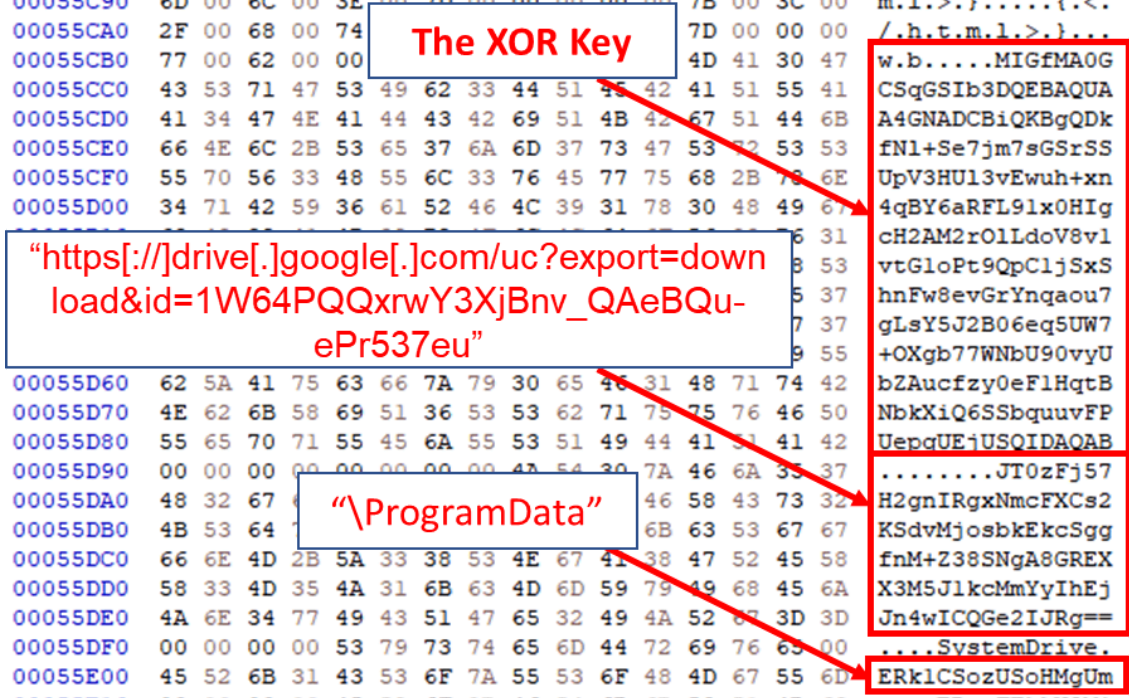
SysJoker holds within the binary a hardcoded XOR key which is used for decoding and encoding strings from within the binary and data sent and received from the C2. The XOR key is an RSA public key that is not used in the decoding scheme. The same XOR key exists in all versions of SysJoker:

*MIGfMA0GCSqSIB3DQEBAQUAA4GNADCBiQKBgQDkfnI+Se7jm7sGSrSSUpV3HUI3vEwuh+xn4q
BY6aRFL91x0HIgcH2AM2rOILdoV8v1vtG1oPt9QpC1jSxShnFw8evGrYnqaou7gLSY5J2B06eq5UW7
+OXgb77WNbU90vyUbZAuczfy0eF1HqtBNbkXiQ6SSbquuvFPUepqUEjUSQIDAQAB*

Resolving C2

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

Offset (h)	00	01	02	03	04	05	06	07	08	09	0A	0B	0C	0D	0E	0F	Decoded text
00055C50	6F	00	6B	00	69	00	65	00	3A	00	5C	00	62	00	2A	00	o.k.i.e...\.b.*.
00055C60	7B	00	2E	00	2B	00	3F	00	7D	00	5C	00	6E	00	00	00	{...+?.}.\.n...
00055C70	3B	00	20	00	00	00	00	00	3B	00	00	00	75	00	74	00	;.;...t.
00055C80	66	00	2D	00	38	00	00	00	7B	00	3C	00	68	00	74	00	f.-.8...{.<.h.t.
00055C90	6D	00	6C	00	3E	00	7D	00	00	00	00	00	7B	00	3C	00	m.l.>.)....{.<.
00055CA0	2F	00	68	00	74				7D	00	00	00	7D	00	00	00	/.h.t.m.l.>.)...
00055CB0	77	00	62	00	00				4D	41	30	47					w.b....MIGFMA0G
00055CC0	43	53	71	47	53	49	62	33	44	51	45	42	41	51	55	41	CSqGSIB3DQEBAQUA
00055CD0	41	34	47	4E	41	44	43	42	69	51	4B	42	67	51	44	6B	A4GNADCBiQKBgQDk
00055CE0	66	4E	6C	2B	53	65	37	6A	6D	37	73	47	53	52	53	53	fn1+Se7jm7sGSrSS
00055CF0	55	70	56	33	48	55	6C	33	76	45	77	75	68	2B	78	6E	UpV3HU13vEwuh+xn
00055D00	34	71	42	59	36	61	52	46	4C	39	31	78	30	48	49	67	4qBY6aRFL91x0HIg
																	cH2AM2rOlLdoV8vl
																	vtGloPt9QpCljSxS
																	hnFw8evGrYnqaou7
																	gLsY5J2B06eqSUW7
																	+OXgb77WNbU90vyU
00055D60	62	5A	41	75	63	66	7A	79	30	65	46	31	48	71	74	42	bZAucfzy0eFlHqtB
00055D70	4E	62	6B	58	69	51	36	53	53	62	71	75	75	76	46	50	NbkXiQ6SSbquuvFP
00055D80	55	65	70	71	55	45	6A	55	53	51	49	44	41	51	41	42	UepqUEiUSQIDAQAB
00055D90	00	00	00	00	00	00	00	00	43	54	30	7A	46	6A	35	37JT0zFj57
00055DA0	48	32	67						46	58	43	73	32				H2gnIRgxNmcFXCs2
00055DB0	4B	53	64						6B	63	53	67	67				KSdvMjosbkEkcSgg
00055DC0	66	6E	4D	2B	5A	33	38	53	4E	67	41	38	47	52	45	58	fnM+Z38SNgA8GREX
00055DD0	58	33	4D	35	4A	31	6B	63	4D	6D	59	79	49	68	45	6A	X3M5J1kcMmYyIhEj
00055DE0	4A	6E	34	77	49	43	51	47	65	32	49	4A	52	67	3D	3D	Jn4wICQGe2IURg==
00055DF0	00	00	00	00	53	79	73	74	65	6D	44	72	69	76	65	00SystemDrive.
00055E00	45	52	6B	31	43	53	6F	7A	55	53	6F	48	4D	67	55	6D	ERklCSozUSoHMgUm
00055E10	00	00	00	00	45	52	6F	2B	46	54	6B	6B	58	51	4D	69ERo+FTkkXQMi
00055E20	4A	78	41	3D	00	00	00	00	45	52	34	75	43	43	6B	75	JxA=....ER4uCCku

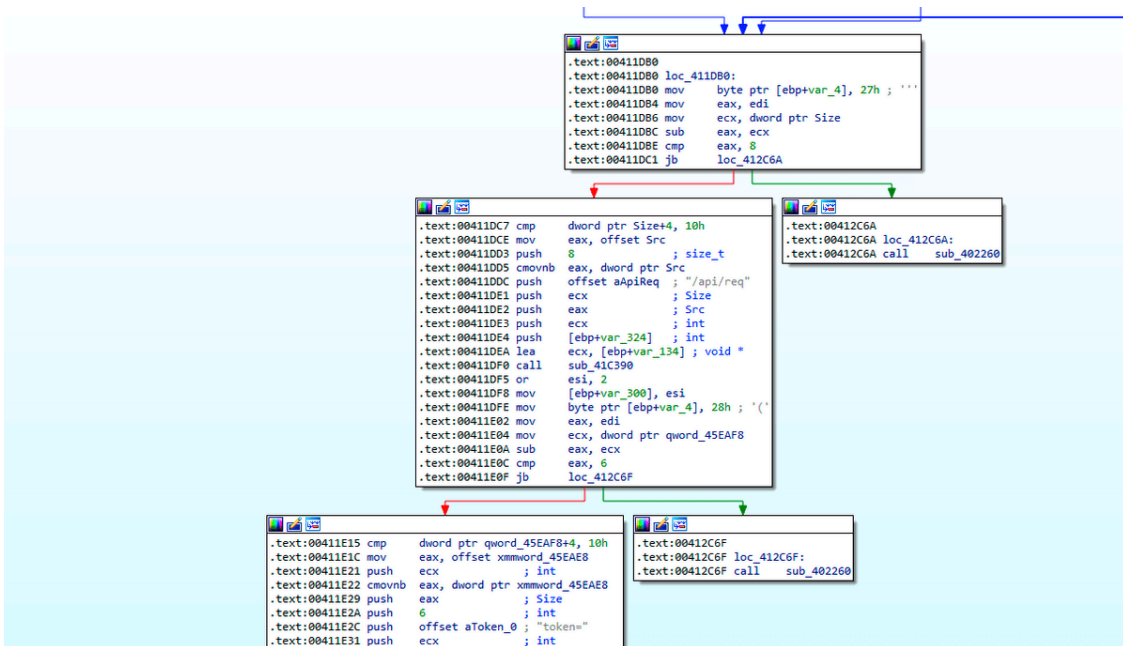


Decoding with [CyberChef](https://gchq.github.io/CyberChef/).

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

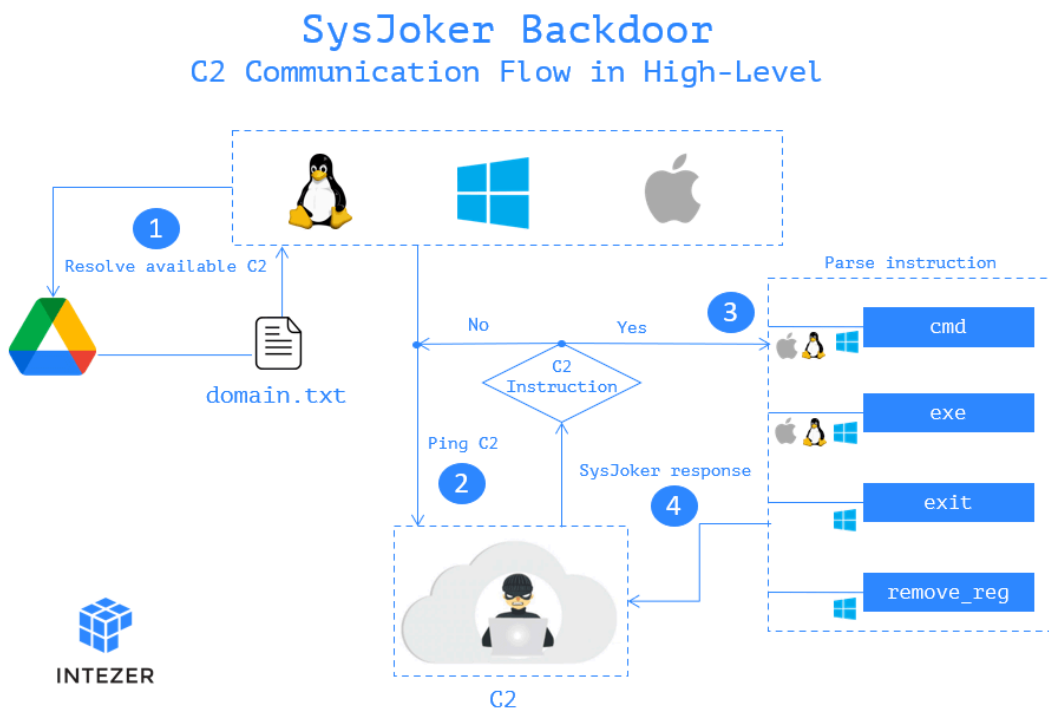
SysJoker runs a while(1) loop that sends a request to the C2's */api/req* directory with the unique token and will process the C2's response which is built as JSON using functions from [this library](#). This is how SysJoker pings the C2 for instructions (see step 2 in the image below):



Steps.

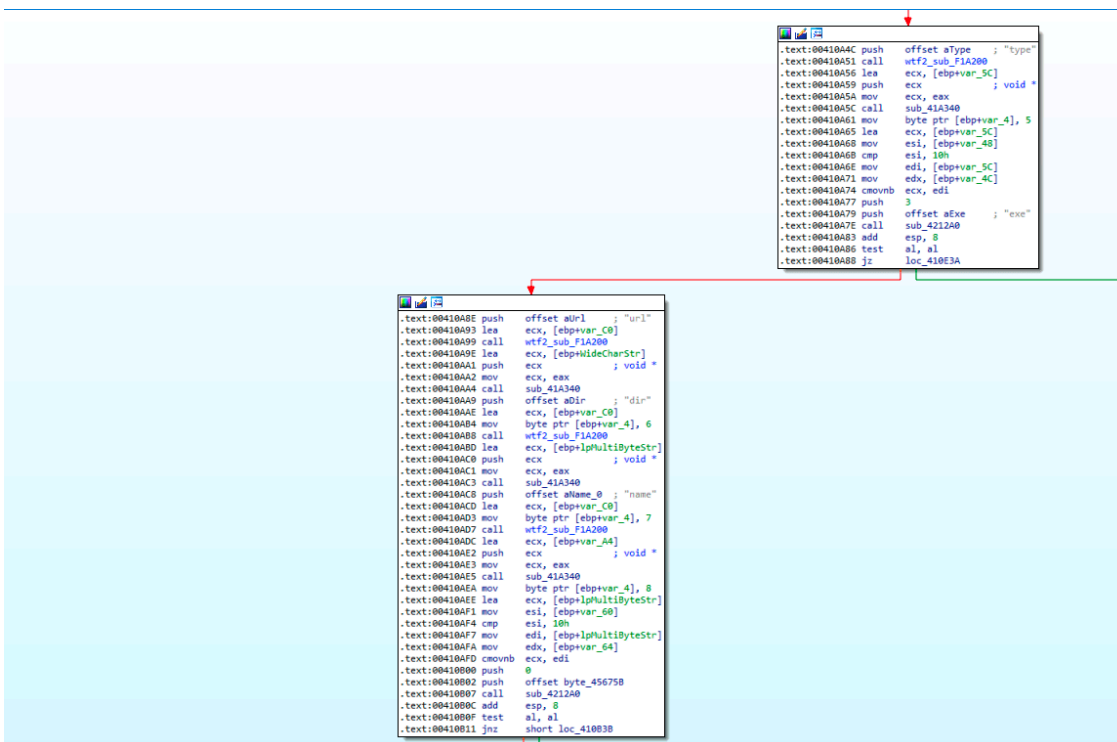
If the server responds with data, SysJoker will parse the received payload (see step 3 in the image below). SysJoker can receive the following instruction from the C2: *exe*, *cmd*, *remove_reg*, and *exit*.

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



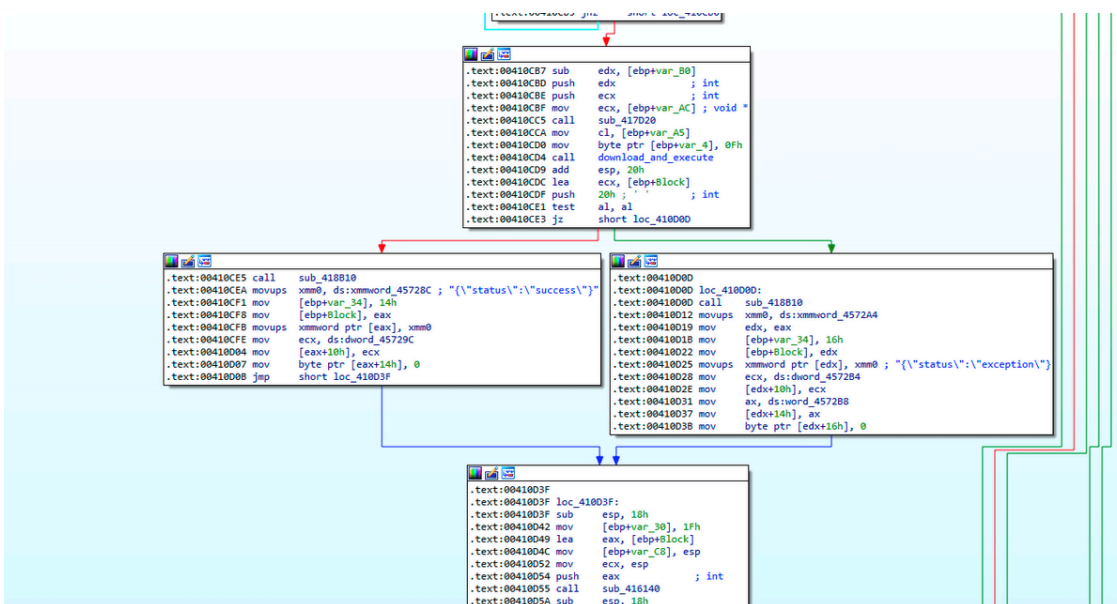
remove_reg and *exit* are not implemented in this current version. Based on the instruction names, we can assume that they are in charge of self-deletion of the malware. Let’s look into *exe* and *cmd* instructions:

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.



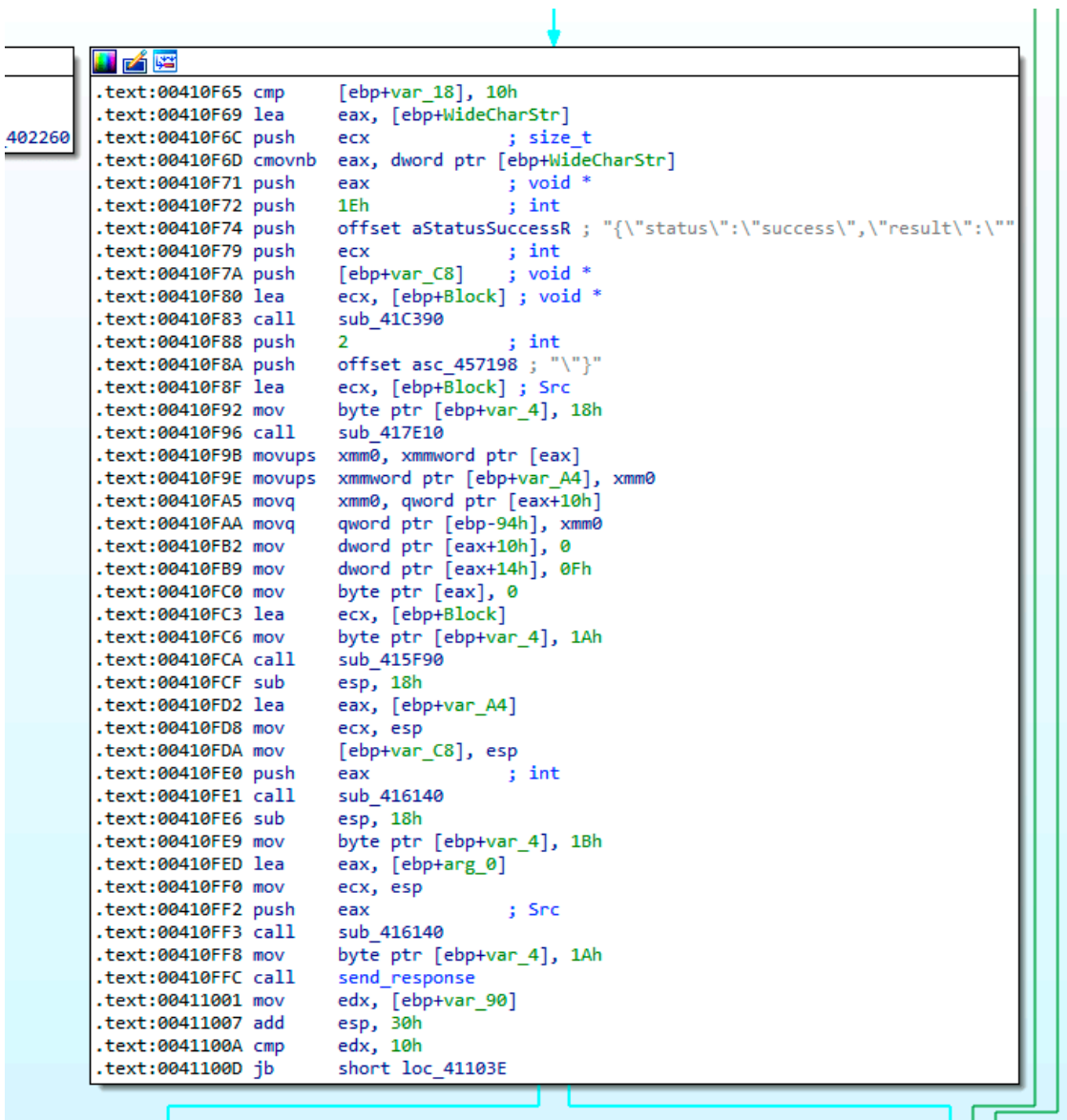
IDA code snippet of the parsing function, if **exe** part.

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).



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

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

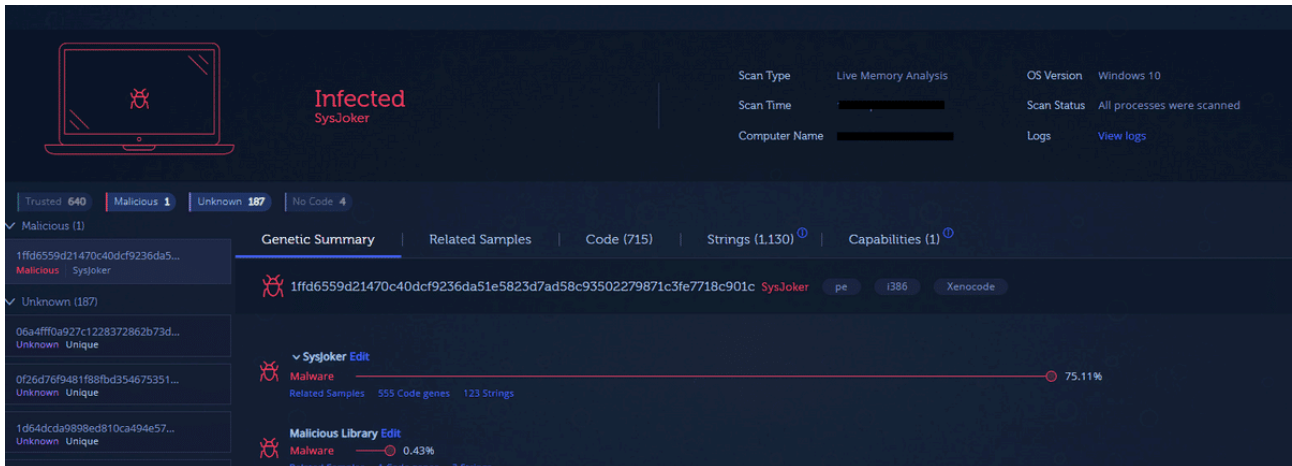
Detection & Response

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:

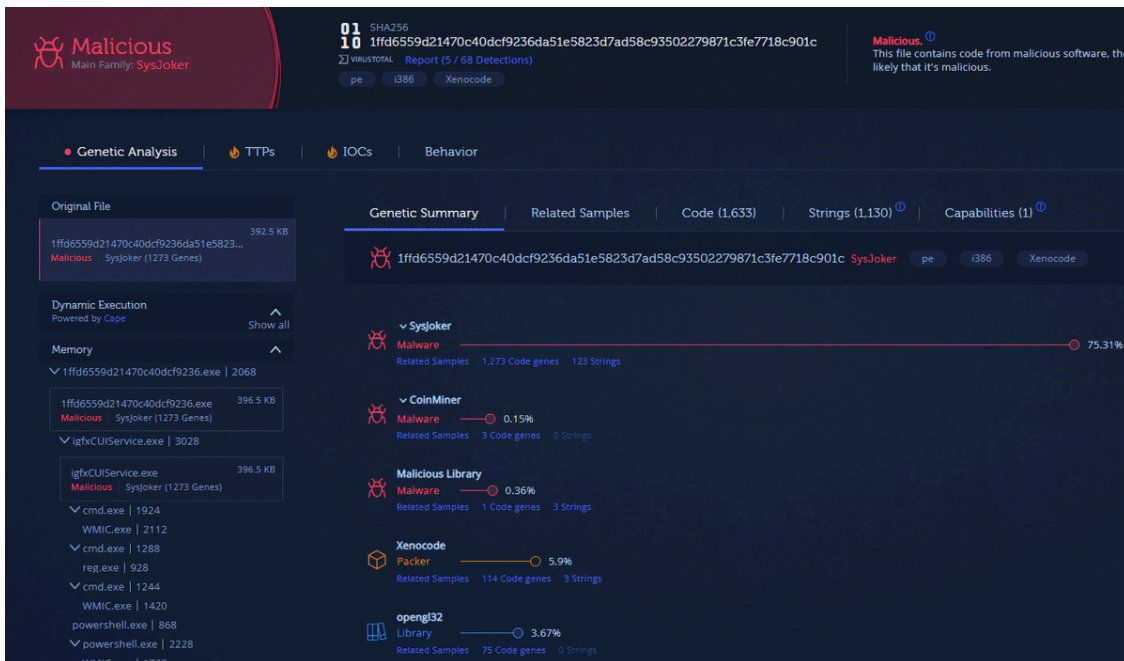


2. Use detection content to search in your EDR or SIEM. We provided you with IoCs and a rich list of detection content for each operating system below. Use these with your EDR to hunt for infected machines. **We will publish a dedicated blog soon discussing how to use detection content for detecting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

[https://winaudio-tools\[.\]com](https://winaudio-tools[.]com)

[https://graphic-updater\[.\]com](https://graphic-updater[.]com)

[https://github\[.\]url-mini\[.\]com](https://github[.]url-mini[.]com)

[https://office360-update\[.\]com](https://office360-update[.]com)

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

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

Detection Content

Windows

Files and directories created on the machine:

C:\ProgramDataRecoverySystem

C:\ProgramDataRecoverySystemrecoveryWindows.zip

C:\ProgramDataRecoverySystemmsg.exe

C:\ProgramDataSystemData

C:\ProgramDataSystemDataigfxCUIService.exe

C:\ProgramDataSystemDatatempo1.txt

C:\ProgramDataSystemDatatempo2.txt

C:\ProgramDataSystemDatatempi1.txt

C:\ProgramDataSystemDatatempi2.txt

C:ProgramDataSystemDatatemp1.txt

C:ProgramDataSystemDatatemp2.txt

C:ProgramDataSystemDatatempu.txt

C:ProgramDataSystemDatamicrosoft_windows.dll

C:ProgramData\AE Operating System\ServiceHub.exe

Persistence:

HKEY_CURRENT_USER\Software\Microsoft\Windows\CurrentVersion\Run

Name: igfxCUIService **Type:** REG_SZ **Data:** "C:ProgramDataSystemData\igfxCUIService.exe"

Commands:

"C:Windows\System32\WindowsPowerShell\v1.0\powershell.exe" getmac | Out-File -Encoding 'Default' 'C:ProgramDataSystemDatatemp1.txt'; wmic path win32_physicalmedia get SerialNumber | Out-File -Encoding 'Default' 'C:ProgramDataSystemDatatemp2.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:ProgramDataSystemDatatempu.txt'

"C:Windows\System32\cmd.exe" /c wmic OS get Caption, CSDVersion, OSArchitecture, Version / value > "C:ProgramDataSystemDatatemp1.txt" && type "C:ProgramDataSystemDatatemp1.txt" > "C:ProgramDataSystemDatatemp2.txt"

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

"C:Windows\System32\cmd.exe" /c wmic nicconfig where 'IPEnabled = True' get ipaddress > "C:ProgramDataSystemDatatemp1.txt" && type "C:ProgramDataSystemDatatemp1.txt" > "C:ProgramDataSystemDatatemp2.txt"

wmic nicconfig where 'IPEnabled = True' get ipaddress

"C:Windows\System32\cmd.exe" /c REG ADD HKCUSOFTWARE\Microsoft\Windows\CurrentVersion\Run /V igfxCUIService /t REG_SZ /D "C:ProgramDataSystemData\igfxCUIService.exe" /F

REG ADD HKCUSOFTWARE\Microsoft\Windows\CurrentVersion\Run /V igfxCUIService /t REG_SZ /D "C:ProgramDataSystemData\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.

Source: <https://www.intezer.com/blog/malware-analysis/new-backdoor-sysjoker/>