Sliver vs Havoc | Culbert Report

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January 13, 2023

Sliver vs Havoc - Two Adversary Emulation Frameworks

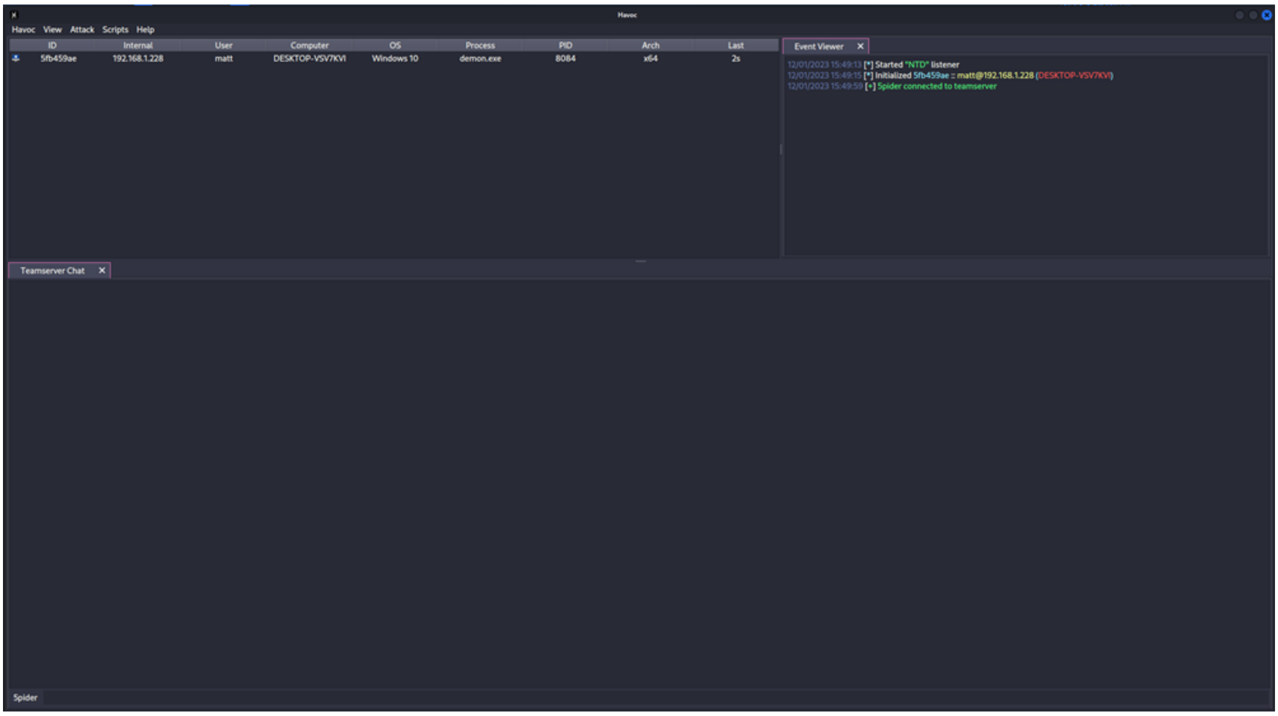
I wanted to objectively measure two well known frameworks against one another and see which fits certain needs best. To this end, each platform has been measured by if you can expand on them, how easy they are to get using, and why you might want one over the other. Before going further, for those unfamiliar, both Sliver and Havoc are command and control frameworks that are free to use on GitHub. Sliver is developed by BishopFox and is a reasonably old project that first started in 2019. It’s seen some major upgrades since then, with the most recent being in October 2022. Havoc is a much newer tool developed by three independent contributors that was first started in September 2022. Both teams are responsive to questions and issues and, since they’re open source, you are free to expand on them as you need. With that said, the first question that should be answered is how easy is it to spin one of these up?

How easy is it to spin one up and get going vs the other?

Havoc

- Havoc utilizes team profiles at launch to dictate implant functionality
- The documentation is fairly well laid out, but online only.
- You should have prior knowledge with C++ and implementing bypass techniques because out of the box the implants are detected quickly.

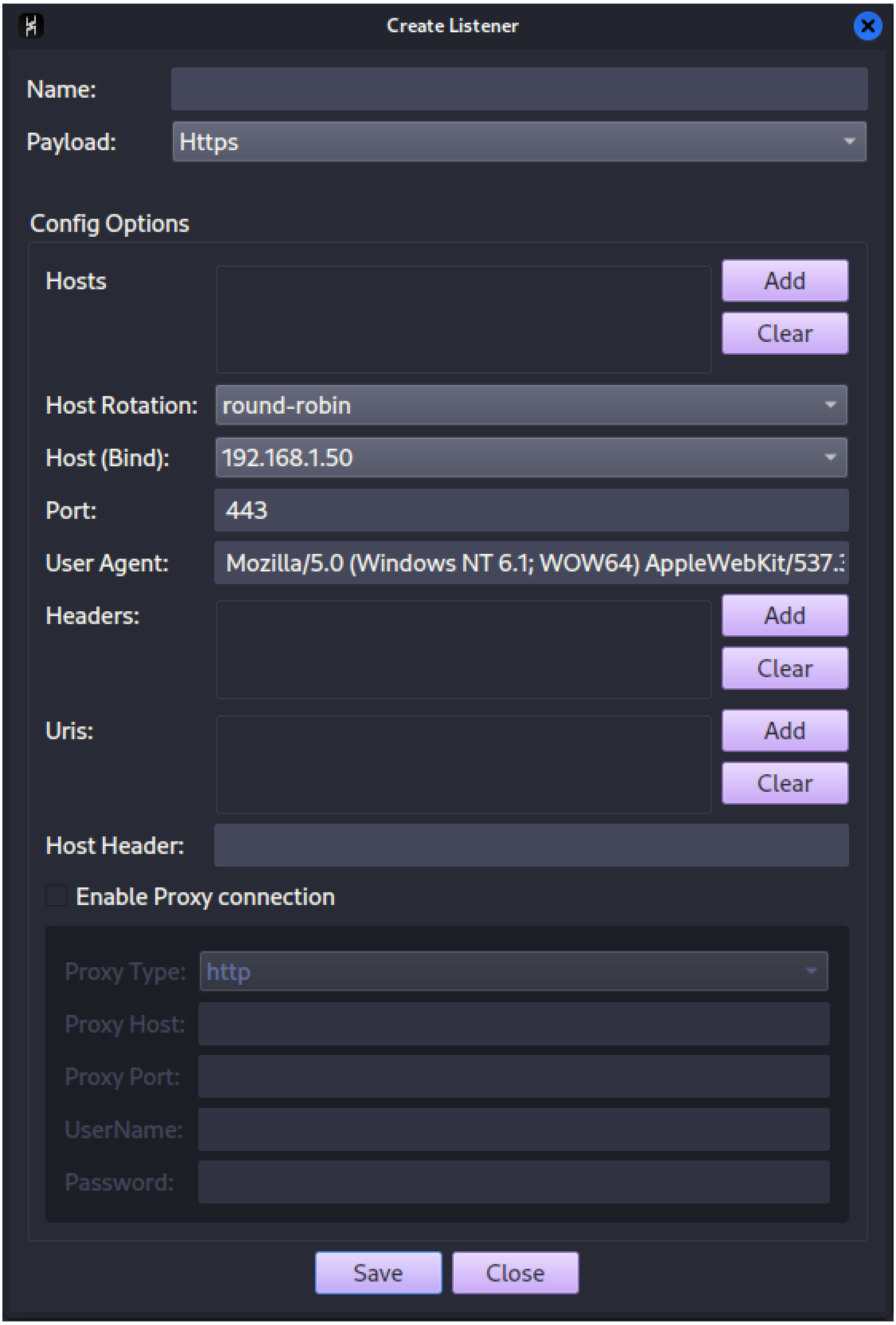
Havoc is very neat. Much like Cobaltstrike, you can start the teamserver by passing it a json profile of users and their passwords as well as some general functionality things like sleep time and jitter of your implants. An opsec concern right off the bat for teams may be that the passwords in this file not encrypted, so setting proper read permissions of it and the directory is very important. Once the server is started, the dashboard is very intuitively laid out if you’ve ever used Cobaltstrike.



	ID	Internal	User	Computer	OS	Process	PID	Arch	Last
	5fb459ae	192.168.1.228	matt	DESKTOP-VSV7KVI	Windows 10	demon.exe	8084	x64	2s

```
12/01/2023 15:49:13 [*] Started "NTD" listener
12/01/2023 15:49:15 [*] Initialized 5fb459ae :: matt@192.168.1.228 (DESKTOP-VSV7KVI)
12/01/2023 15:49:59 [+] Spider connected to teamserver
```

Starting a listener is easy as well. Hitting `view -> listeners` allows us to add a new one. From here, you just step through the simple option menu and configure a few things like the port, if we'll be using hostnames, and the header to use, and you're set.



Create Listener

Name:

Payload: Https

Config Options

Hosts

Host Rotation: round-robin

Host (Bind): 192.168.1.50

Port: 443

User Agent: Mozilla/5.0 (Windows NT 6.1; WOW64) AppleWebKit/537.3

Headers:

Uris:

Host Header:

☐ Enable Proxy connection

Proxy Type: http

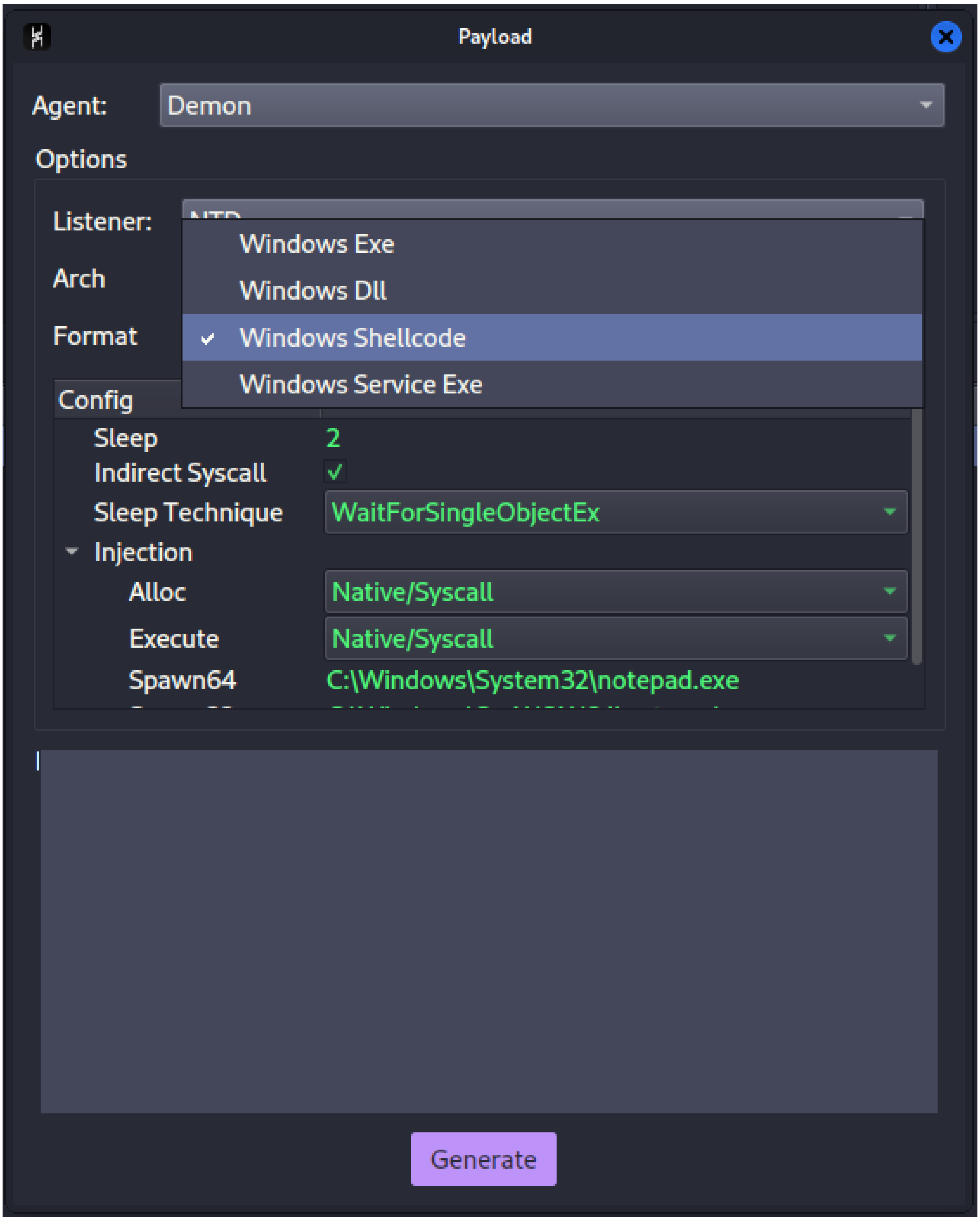
Proxy Host:

Proxy Port:

UserName:

Password:

And the payload options, while slim, have enough to them that we can make the necessary modifications to let them slip by the EDR we anticipate meeting. We can output in four file formats. These are exe, dll, shellcode, or service exe.



Payload

Agent: Demon

Options

Listener:

Arch

Format

Config

Sleep 2

Indirect Syscall ✓

Sleep Technique WaitForSingleObjectEx

Injection

Alloc Native/Syscall

Execute Native/Syscall

Spawn64 C:\Windows\System32\notepad.exe

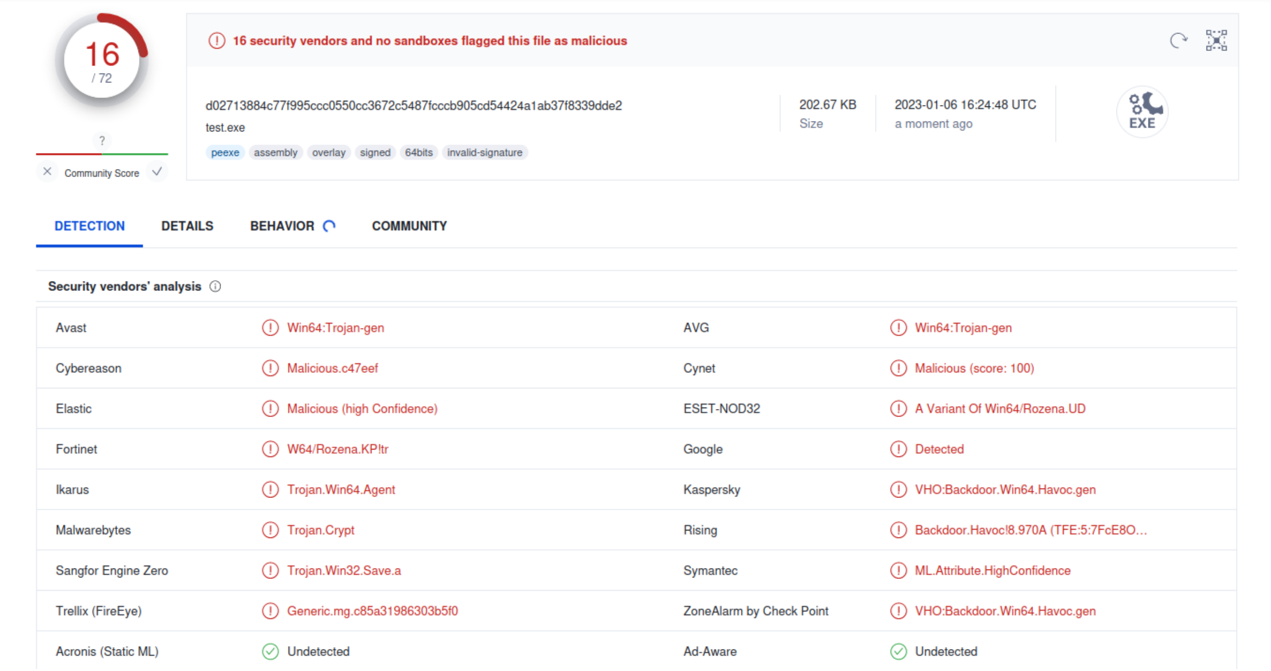
The default implant of an EXE gets detected very quickly, so we'll be testing the shellcode option here and implant it through the resource section of another EXE we develop ourselves.

Next, we have to select the memory allocation and execution methods. For those, our options are syscalls or Win32. My understanding is that this means either performing a VirtualAlloc or NtAllocateVirtualMemory in the case of allocation, and for execution it would be NtCreateThreadEx or CreateRemoteThread.

NtAllocateVirtualMemory is typically called through VirtualAlloc since it is an undocumented function. As we briefly touched on in the NTDLL article in September 2022, these undocumented functions can change on a dime but are very useful for bypassing detection methods that focus solely on break points in NTDLL when called.

Their downside is that seeing syscalls like this is quite unusual and alarming, so EDR watching for this could alert very quickly. VirtualAlloc on the other hand is the lowest level call from user space that we can perform and hooks into Ring0 using syscalls to allocate memory within the bounds of what's known as the system granularity boundary. For most Windows systems, this will be 64kb. Allocations also must be a multiple of this boundary, so for example a 3 byte allocation would cause errors. Moving to the execution methods, NtCreateThreadEx is the undocumented, lower level, version of CreateRemoteThread. Like NtAllocateVirtualMemory, it is contingent on syscalls being up to date and suffers from the same pitfalls. CreateRemoteThread is much safer *but* also easier to detect. Finding a balance between the two options is important when generating your implant. Different EDR might be tuned to detect one method more over the other.

After taking all this into account and developing our executable for the shellcode, we can see that the detection levels has dropped from 26 to 16. That's not ideal, but if your target platform is Microsoft, you've made it past stage 1 with only a few changes.



16 security vendors and no sandboxes flagged this file as malicious

d02713884c77f995ccc0550cc3672c5487fcccb905cd54424a1ab37f8339dde2
test.exe
peexe assembly overlay signed 64bits invalid-signature

202.67 KB
Size

2023-01-06 16:24:48 UTC
a moment ago

Security vendors' analysis

Avast	Win64:Trojan-gen	AVG	Win64:Trojan-gen
Cybereason	Malicious.c47eef	Cynet	Malicious (score: 100)
Elastic	Malicious (high Confidence)	ESET-NOD32	A Variant Of Win64/Rozena.UD
Fortinet	W64/Rozena.KP!tr	Google	Detected
Ikarus	Trojan.Win64.Agent	Kaspersky	VHO:Backdoor.Win64.Havoc.gen
Malwarebytes	Trojan.Crypt	Rising	Backdoor.Havoc!8.970A (TFE:5:7FcE8O…
Sangfor Engine Zero	Trojan.Win32.Save.a	Symantec	ML.Attribute.HighConfidence
Trellix (FireEye)	Generic.mg.c85a31986303b5f0	ZoneAlarm by Check Point	VHO:Backdoor.Win64.Havoc.gen
Acronis (Static ML)	✓ Undetected	Ad-Aware	✓ Undetected

While using Havoc, it felt like their target audience was professionals who are experienced with other C2 platforms and want something that they can build off of on their own. It's hard to get leadership buy in on a project that is only maintaned by three people and doesn't have a company backing it like BishopFox, so it's hard to say how likely you are to encounter it in an enterprise. For those who really enjoy working in a GUI though, this will definitely scratch that itch.

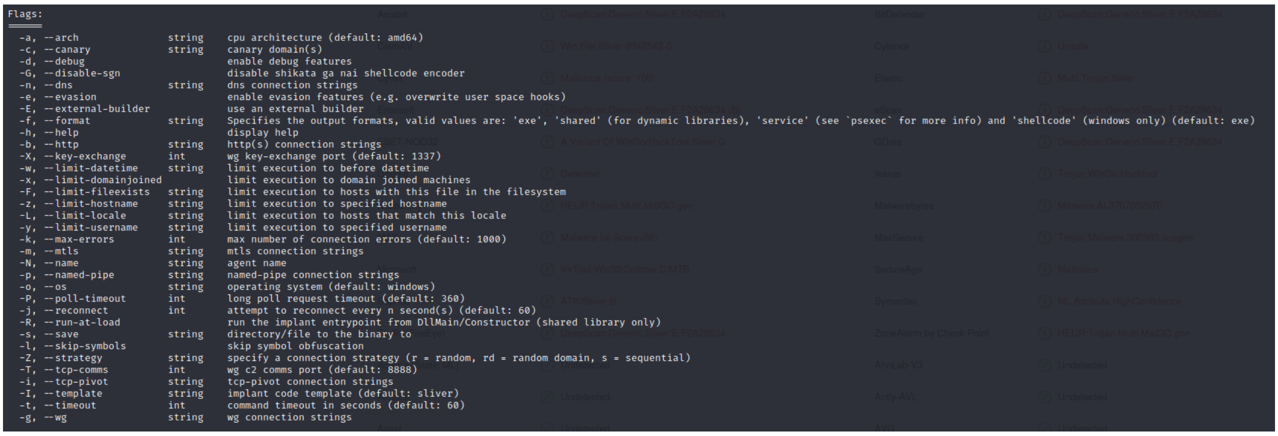
Sliver

Let's now shift a little and check out Sliver.

- Sliver is completely terminal based meaning if you need a GUI to be able to visualize things, this won't work for you.

- The documentation is expansive and intimidating, which is great, and you can type help for any function.
- Sliver also lets you set expiration dates for beacons, so they stop working after a set time.

Sliver gives you everything and expects you know what to do with it. If you don’t know what to do with it, there’s a help dialogue for each option, but aside from that you are left to figure it out. Just check out the options for compiling an implant.



```
Flags:
======
  -a, --arch               string    cpu architecture (default: amd64)
  -c, --canary             string    canary domain(s)
  -d, --debug                        enable debug features
  -G, --disable-sgn                  disable shikata ga nai shellcode encoder
  -n, --dns                string    dns connection strings
  -e, --evasion                      enable evasion features (e.g. overwrite user space hooks)
  -E, --external-builder             use an external builder
  -f, --format             string    Specifies the output formats, valid values are: 'exe', 'shared' (for dynamic libraries), 'service' (see `psexec` for more info) and 'shellcode' (windows only) (default: exe)
  -h, --help                         display help
  -b, --http               string    http(s) connection strings
  -X, --key-exchange       int       wg key-exchange port (default: 1337)
  -w, --limit-datetime     string    limit execution to before datetime
  -x, --limit-domainjoined           limit execution to domain joined machines
  -F, --limit-fileexists   string    limit execution to hosts with this file in the filesystem
  -z, --limit-hostname     string    limit execution to specified hostname
  -L, --limit-locale       string    limit execution to hosts that match this locale
  -y, --limit-username     string    limit execution to specified username
  -k, --max-errors         int       max number of connection errors (default: 1000)
  -m, --mtls               string    mtls connection strings
  -N, --name               string    agent name
  -p, --named-pipe         string    named-pipe connection strings
  -o, --os                 string    operating system (default: windows)
  -P, --poll-timeout       int       long poll request timeout (default: 360)
  -j, --reconnect          int       attempt to reconnect every n second(s) (default: 60)
  -R, --run-at-load                  run the implant entrypoint from DllMain/Constructor (shared library only)
  -s, --save               string    directory/file to the binary to
  -l, --skip-symbols                 skip symbol obfuscation
  -Z, --strategy           string    specify a connection strategy (r = random, rd = random domain, s = sequential)
  -T, --tcp-comms          int       wg c2 comms port (default: 8888)
  -i, --tcp-pivot          string    tcp-pivot connection strings
  -I, --template           string    implant code template (default: sliver)
  -t, --timeout            int       command timeout in seconds (default: 60)
  -g, --wg                 string    wg connection strings
```

If you don’t know why you might want to disable the Shikata-Ga-Nai shellcode encoder, you’re offered no explanation. There are numerous guides available online for Sliver, which lowers the learning curve significantly and if you would like to get started, these are almost mandatory readings. Some can be found here. The linked reading does a deep dive into Slivers code and finds some interesting shortcuts taken by the developers. For example, generating stagers under the hood is handled through MSFVenom and, while you can specify a DNS name, only hardcoded IPs are passed. This is not publicly documented and a potential drawback when trying to fly under the radar.

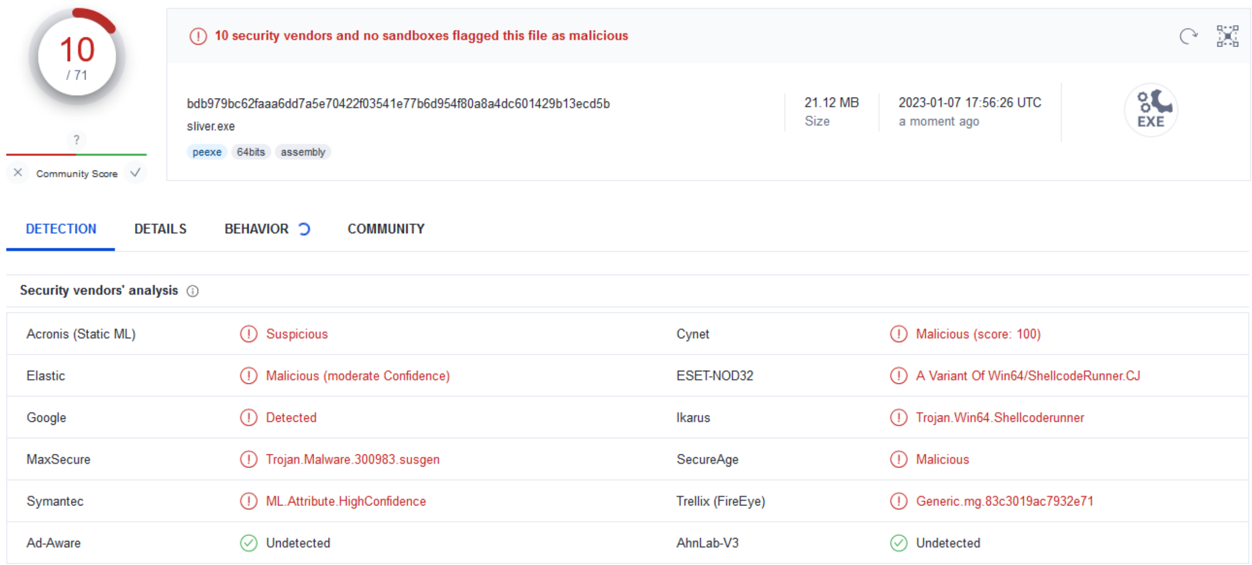
Again, we will be compiling and outputting shellcode for us to further obfuscate and hide. This can be done with the `-f` flag.

Because Sliver does not make it obvious what their execution and injection methods are like Havoc does, we’ll have to do some digging. Looking at the `task_windows.go` file, `VirtualAlloc` and `CreateRemoteThread` are both used to allocate and execute the in memory objects. Really interestingly, BishopFox has gone out of their way to implement their own syscalls package, which only has the commands that they will need to use. It’s a smart way of limiting bloat and reducing imports. For comparison, 7zip has 69 imports from Kernel32 alone. This is definitely a key piece as well in reducing their detection rate combined with EDR sometimes not being equipped to analyze Go binaries.

Sliver also has its own methods for evasion, though this is not something the authors have focused heavily on. They provide two functions that work in tandem in order to accomplish this. The first is `RefreshPE` which reloads the .text section of a file from disk. The second is what they call `writeGoodBytes`. This function takes a process name and a few other variables and proceeds to reload the clean version of a dll into the current processes memory through the first function mentioned. This is called through `err :=`

`evasion.RefreshPE('c:\windows\system32\ntdll.dll')`. Do note, to do this they allocated RWX memory sections, which will set off EDR. Havoc also allocates memory in the same way, so it’s a knock against both.

Now that we have an idea of how things are executed, we can go back to loading our shellcode into the resource section of our executable. Without even encrypting it, we see a strikingly lower detection rate than Havocs shellcode loaded the same way.



10 / 71

? Community Score

10 security vendors and no sandboxes flagged this file as malicious

bdb979bc62faaa6dd7a5e70422f03541e77b6d954f80a8a4dc601429b13ecd5b
sliver.exe
peexe 64bits assembly

21.12 MB
Size

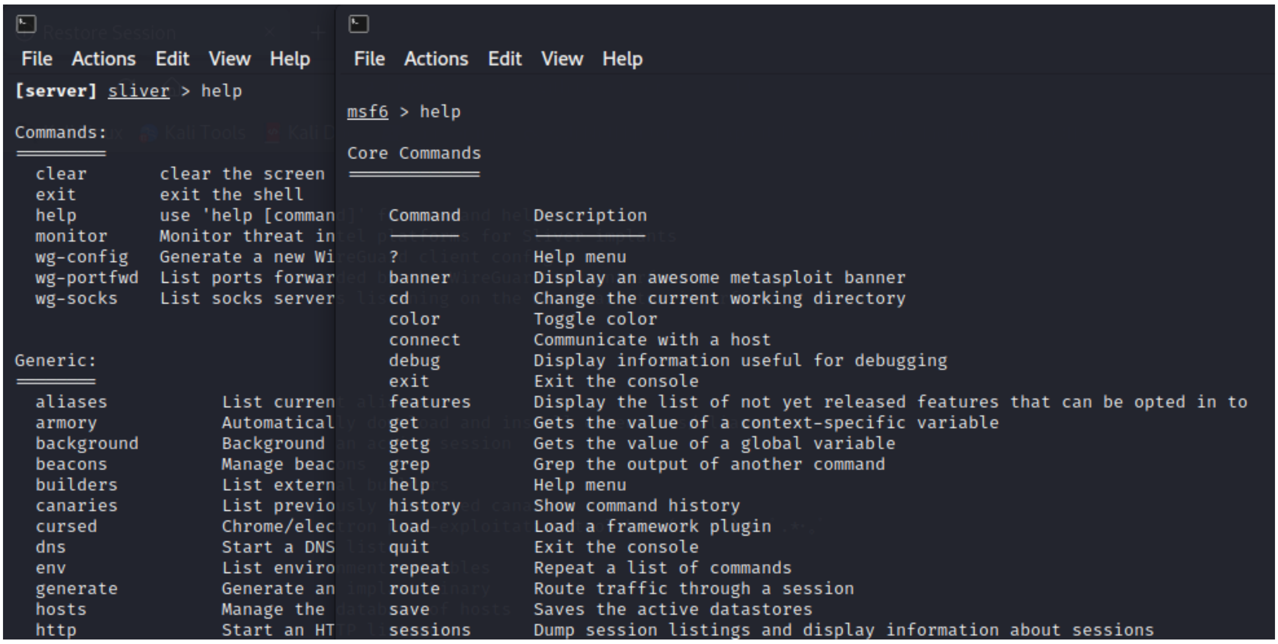
2023-01-07 17:56:26 UTC
a moment ago

EXE

Security vendors' analysis

Acronis (Static ML)	Suspicious	Cynet	Malicious (score: 100)
Elastic	Malicious (moderate Confidence)	ESET-NOD32	A Variant Of Win64/ShellcodeRunner.CJ
Google	Detected	Ikarus	Trojan.Win64.Shellcoderunner
MaxSecure	Trojan.Malware.300983.susgen	SecureAge	Malicious
Symantec	ML.Attribute.HighConfidence	Trellix (FireEye)	Generic.mg.83c3019ac7932e71
Ad-Aware	Undetected	AhnLab-V3	Undetected

A final piece to touch on, BOFs. Sliver allows operators to port over custom beacon object files that were written for Cobaltstrike, as well as downloading prebuilt ones. Let’s see how easy they are to drop. Sliver uses something called Armory to manage these in a sort of extension manner. You can list extensions available through `armory` and install them through `armory install`. Then, once you’ve gotten the BOFs installed, you hop into a session for a beacon and can run any of them just by typing their name and the flags that they require. This is very reminiscent of Metasploit modules and is intuitive to use and figure out. In fact, the whole program is reminiscent of Metasploit down to the help dialogue and how information is presented. This is not surprising, Sliver utilizes MSF internally and has built in functionality that allows operators to do things like inject MSF payloads.



```
[server] sliver > help

Commands:
=========
  clear      clear the screen
  exit       exit the shell
  help       use 'help [comman
  monitor    Monitor threat in
  wg-config  Generate a new Wi
  wg-portfwd List ports forwar
  wg-socks   List socks server


Generic:
========
  aliases          List curren
  armory           Automatical
  background       Background
  beacons          Manage beac
  builders         List extern
  canaries         List previo
  cursed           Chrome/elec
  dns              Start a DNS
  env              List enviro
  generate         Generate an
  hosts            Manage the
  http             Start an HT
```

```
msf6 > help

Core Commands
=============

    Command       Description
    -------       -----------
    ?             Help menu
    banner        Display an awesome metasploit banner
    cd            Change the current working directory
    color         Toggle color
    connect       Communicate with a host
    debug         Display information useful for debugging
    exit          Exit the console
    features      Display the list of not yet released features that can be opted in to
    get           Gets the value of a context-specific variable
    getg          Gets the value of a global variable
    grep          Grep the output of another command
    help          Help menu
    history       Show command history
    load          Load a framework plugin
    quit          Exit the console
    repeat        Repeat a list of commands
    route         Route traffic through a session
    save          Saves the active datastores
    sessions      Dump session listings and display information about sessions
```

Sliver had a lot of touches to it that really gave it the feel of an enterprise ready software. There's a reputable company backing it, it has touches like beacon kill dates built in, and there's a wide range of support for expanding the software while staying within their ecosystem such as with BOFs. It's no surprise that threat actors have caught onto this framework and are integrating it with more and more campaigns. Microsoft has even noted that it is being used in tandem with Cobaltstrike in some attacks.

How can you expand on them?

Havoc

Custom agents are a little tricky to figure out but there are examples provided. It will take some trial and error on your end to determine the exact way to call arguments and add functionality, but CodeXTF2 was kind enough to include their own demo agent written in Python as a demonstration for ease of understanding. Aside from custom agents, if you wish to add your own functionality to the teamserver, the codebase is vast and somewhat poorly commented which makes customization not the easiest.

Sliver

Sliver allows you to use beacon object files from Cobaltstrike to extend the post exploitation capabilities of the framework. While this isn't necessarily a custom agent, this allows customization of agents to add further capabilities. To the unfamiliar, BOF are compiled C programs that are position independent code. Meaning that like Donut, no matter where it is placed in memory, it can execute. BOFs are injected directly into the beacon process typically, avoiding IoC's associated with alternative approaches like execute-assembly which spawns a new empty process to run these assemblies in. Cobaltstrike never intended for BOFs to be executing long-running commands, that's what execute-assembly, is for. Instead, these are for quick functions that return data shortly after launch. Sliver including these as a method for expanding functionality is a very neat approach. Read more about BOFs in the sources section. Regarding their codebase it’s only marginally better commented with comments above primary functions describing what they do, but very little otherwise. This is disappointing to see, I wish commenting code was a more common practice as it helps new people get up to speed with each functions purpose much quicker.

Why might you want one over the other?

Havoc

- The GUI is very intuitive and well thought out.
- Visualizing compromised machines and SSH tunnels was intelligently setup.
- Less can be more. Giving people less to work with means they go deeper on working with what they have. Breeds innovation.

Havoc has the more user-friendly GUI of the two and makes it easy to start and deploy listeners and implants. If you’re wanting to get an introduction to C2s and customization, their GUI makes it much easier for newer operators to get accustomed to the environment. The profiles also work more intuitively than Slivers method of saving configurations for listeners and implants by having you edit a JSON file. The roundrobin technique of hosts and URIs is also very clever, allowing much more randomness to be added, which it makes the defenders job that much harder.

Sliver

- Multi platform framework.
- Deeper resources to put into development.
- BOFs implementation is very smooth.
- More listener options like wireguard and mTLS.

If you want the end game experience of free C2’s, this hands down goes to Sliver with their implementation of BOFs. Sliver also has agents that can be deployed to not only Windows machines, but also Mac and Linux. On top of this, their default detection rate with shellcode was also much lower. These can all be attributed to the number of resources that BishopFox has to throw at things compared to Havocs development team.

> Sources
>
> (BOF) https://www.trustedsec.com/blog/a-developers-introduction-to-beacon-object-files/
>
> (BOF) https://www.cobaltstrike.com/blog/writing-beacon-object-files-flexible-stealthy-and-compatible/
>
> https://0x00sec.org/t/process-injection-remote-thread-injection-or-createremotethread/24399
>
> https://github.com/BishopFox/sliver
>
> https://github.com/HavocFramework/Havoc
>
> https://mez0.cc/posts/detecting-syscalls-with-fennec/