
Finders Keepers (KPot Stealers)

whois lilly.chalupowski

Table: *who.is results*

Name	Lilly Chalupowski
Status	Employed
Creation Date	1986
Expiry	A Long Time from Now (Hopefully)
Registrant Name	GoSecure
Administrative Contact	Travis Barlow
Job	TITAN Malware Research Lead

Agenda

What will we cover?

- Disclaimer
- Reverse Engineering
- Tools of the Trade
- Injection Techniques
- Workshop

disclaimer_0.log

The tools and techniques covered in this presentation can be dangerous and are being shown for educational purposes.

It is a violation of Federal laws to attempt gaining unauthorized access to information, assets or systems belonging to others, or to exceed authorization on systems for which you have not been granted.

Only use these tools with/on systems you own or have written permission from the owner. I (the speaker) do not assume any responsibility and shall not be held liable for any illegal use of these tools.

GoSecure

disclaimer_1.log

I (the speaker) do not assume any responsibility and shall not be held liable for anyone who infects their machine with the malware supplied for this workshop.

If you need help on preventing the infection of your host machine please raise your hand during the workshop for assistance before you run anything.

The malware used in this workshop can steal your data, shutdown nuclear power plants, encrypt your files and more.

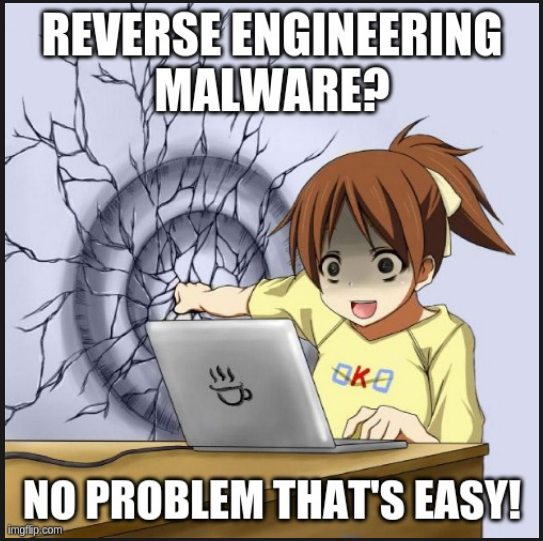
Inspiration

John F. Kennedy

GoSecure

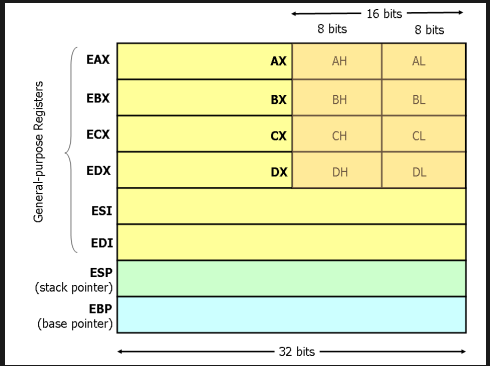
john_f_kennedy.log

We choose to reverse engineer! We choose to reverse engineer... We choose to reverse engineer and do the other things, not because they are easy, but because they are hard; because that goal will serve to organize and measure the best of our energies and skills, because that challenge is one that we are willing to accept, one we are unwilling to postpone, and one we intend to win, and the others, too. - John F. Kennedy


REVERSE ENGINEERING MALWARE?
NO PROBLEM THAT'S EASY!
imgflip.com

Registers

- EAX - Return Value of Functions
- EBX - Base Index (for use with arrays)
- ECX - Counter in Loops
- EDI - Destination Memory Operations
- ESI - Source Memory Operations
- ESP - Stack Pointer
- EBP - Base Frame Pointer

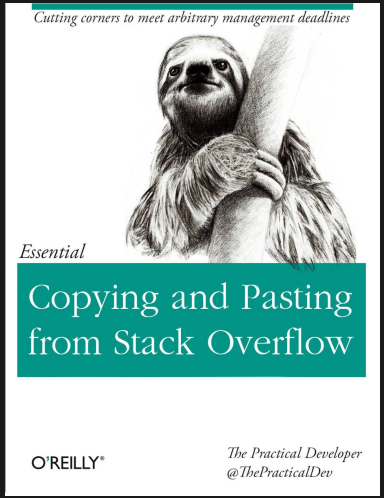


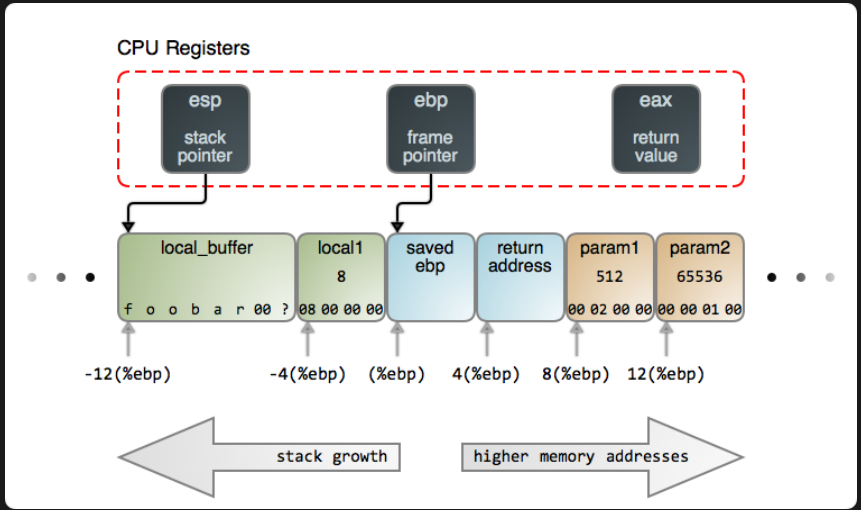
Did You Know: In computer architecture, a processor register is a quickly accessible location available to a computer's central processing unit (CPU).

Registers


We Rent Tools
Professional Tools For Professional Results
Tool Rental
WE RENT
Windows XP

- Last-In First-Out
- Downward Growth
- Function Local Variables
- ESP
- Increment / Decrement = 4
  - Double-Word Aligned



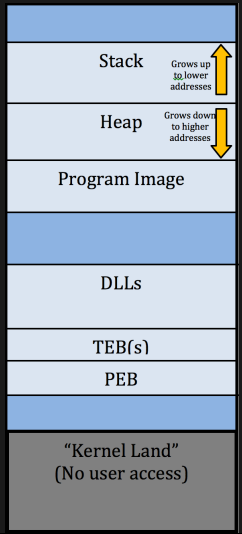

CPU Registers
esp
stack pointer
ebp
frame pointer
eax
return value
local_buffer
f o o b a r 00 ?
local1
8
08 00 00 00
saved ebp
return address
param1
512
00 02 00 00
param2
65536
00 00 01 00
-12(%ebp)
-4(%ebp)
(%ebp)
4(%ebp)
8(%ebp)
12(%ebp)
stack growth
higher memory addresses

- Conditionals
  - CMP
  - TEST
  - JMP
  - JNE
  - JNZ
- EFLAGS
  - ZF / Zero Flag
  - SF / Sign Flag
  - CF / Carry Flag
  - OF/Overflow Flag

- CDECL
  - Arguments Right-to-Left
  - Return Values in EAX
  - Caller Function Cleans the Stack
- STDCALL
  - Used in Windows Win32API
  - Arguments Right-to-Left
  - Return Values in EAX
  - The Callee function cleans the stack, unlike CDECL
  - Does not support variable arguments
- FASTCALL
  - Uses registers as arguments
  - Useful for shellcode

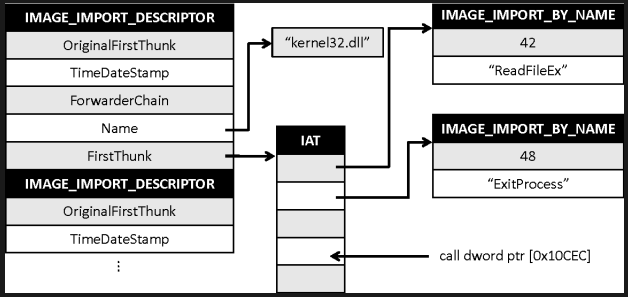
Windows Memory Structure

- Stack - Grows up to lower addresses
- Heap - Grows down to higher addresses
- Program Image
- TEB - Thread Environment Block
  - GetLastError()
  - GetVersion()
  - Pointer to the PEB
- PEB - Process Environment Block
  - Image Name
  - Global Context
  - Startup Parameters
  - Image Base Address
  - IAT (Import Address Table)



IAT and IDT

- Identical to the IDT (Import Directory Table)
- Binding - The process of where functions are mapped to their virtual addresses overwriting the IAT
- Often the IDT and IAT must be rebuilt when packing and unpacking malware



- Common Instructions
  - MOV
  - LEA
  - XOR
  - PUSH
  - POP

Assembly CDECL (Linux)

reverse_engineering: 0x09

GoSecure

cdecl.c

```
__cdecl int add_cdecl(int a, int b){
  return a + b;
}
int x = add_cdecl(2, 3);
```

cdecl.asm

```
_add_cdecl:
  push ebp
  mov ebp, esp
  mov eax, [ebp + 8]   ; get 3 from the stack
  mov edx, [ebp + 12]  ; get 2 from the stack
  add eax, edx         ; add values to eax
  pop ebp
  ret
_start:
  push 3               ; second argument
  push 2               ; first argument
  call _add_cdecl
  add esp, 8
```

Assembly STDCALL (Windows)

reverse_engineering: 0x0b

GoSecure

stdcall.c

```
__stdcall int add_stdcall(int a, int b){
  return a + b;
}
int x = add_stdcall(2, 3);
```

stdcall.asm

```
_add_stdcall:
  push ebp
  mov ebp, esp
  mov eax, [ebp + 8]  ; set eax to 3
  mov edx, [ebp + 12] ; set edx to 2
  add eax, edx
  pop ebp
  ret 8               ; how many bytes to pop
_start:               ; main function
  push 3              ; second argument
  push 2              ; first argument
  call _add_stdcall
```

cdecl.c

```
__fastcall int add_fastcall(int a, int b){
  return a + b;
}
int x = add_fastcall(2, 3);
```

Assembly FASTCALL

reverse_engineering: 0x0e

GoSecure

fastcall.asm

```
_add_fastcall:
  push ebp
  mov ebp, esp
  add eax, edx          ; add and save result in eax
  pop ebp
  ret
_start:
  mov eax, 2            ; first argument
  mov edx, 3            ; second argument
  call _add_fastcall
```

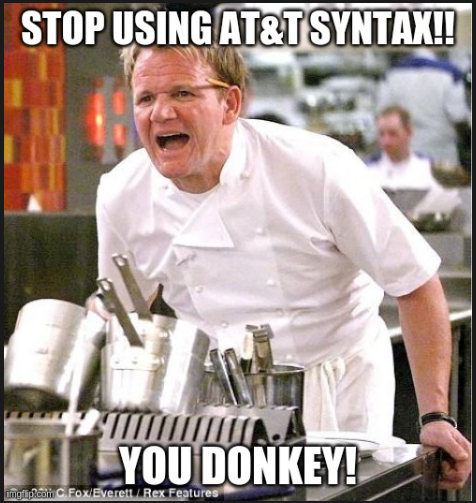
Guess the Calling Convention

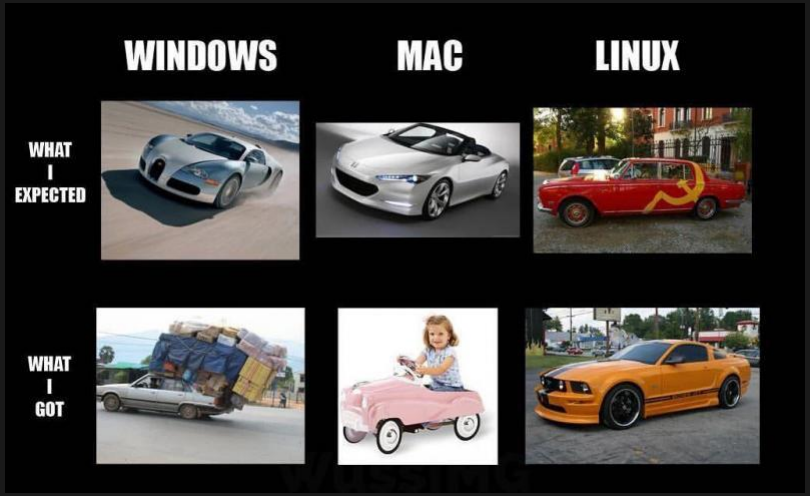
hello.asm

```
section     .text                   ; the code section
global      _start                  ; tell linker entrypoint
_start:
  mov     edx,len                   ; message length
  mov     ecx,msg                   ; message to write
  mov     ebx,1                     ; file descriptor stdout
  mov     eax,4                     ; syscall number for write
  int     0x80                      ; linux x86 interrupt
  mov     eax,1                     ; syscall number for exit
  int     0x80                      ; linux x86 interrupt
section     .data                   ; the data section
  msg     db  'Hello, world!',0x0   ; null terminated string
  len     equ \$ - msg              ; message length
```

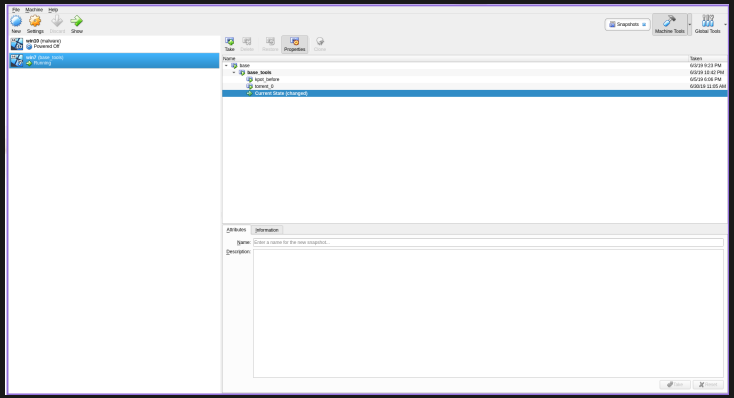
terminal

```
malware@work ~$ nasm -f elf32 -o hello.o hello.asm
malware@work ~$ ld -m elf_i386 -o hello hello.o
malware@work ~$ ./hello
Hello, World!
malware@work ~$
```

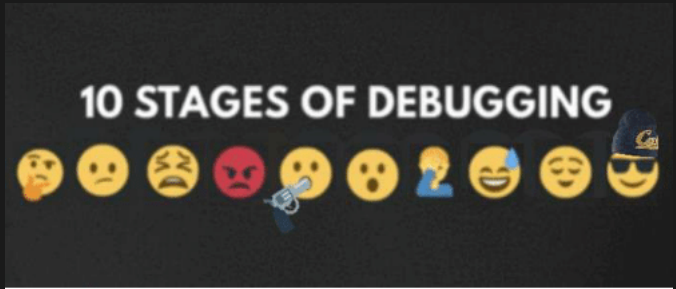

STOP USING AT&T SYNTAX!!
YOU DONKEY!
© Fox/Everett / Rex Features


WINDOWS
MAC
LINUX
WHAT I EXPECTED
WHAT I GOT

- Snapshots
- Security Layer
- Multiple Systems

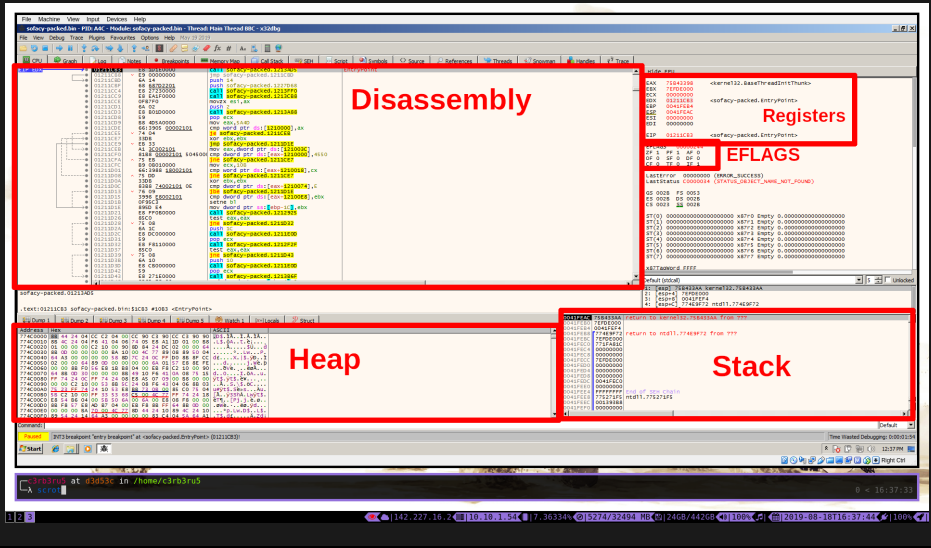


- Resolving APIs
- Dumping Memory
- Modify Control Flow
- Identify Key Behaviors



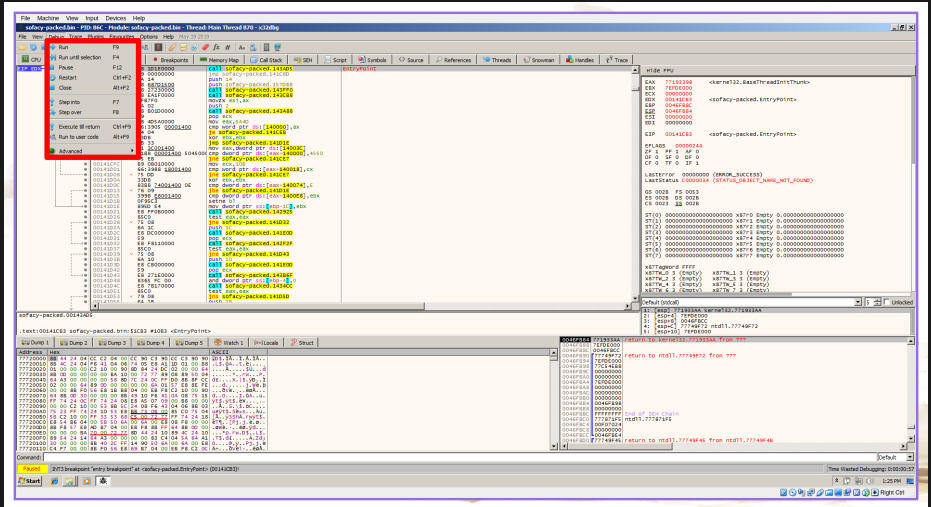
x64dbg

tools_of_the_trade: 0x02



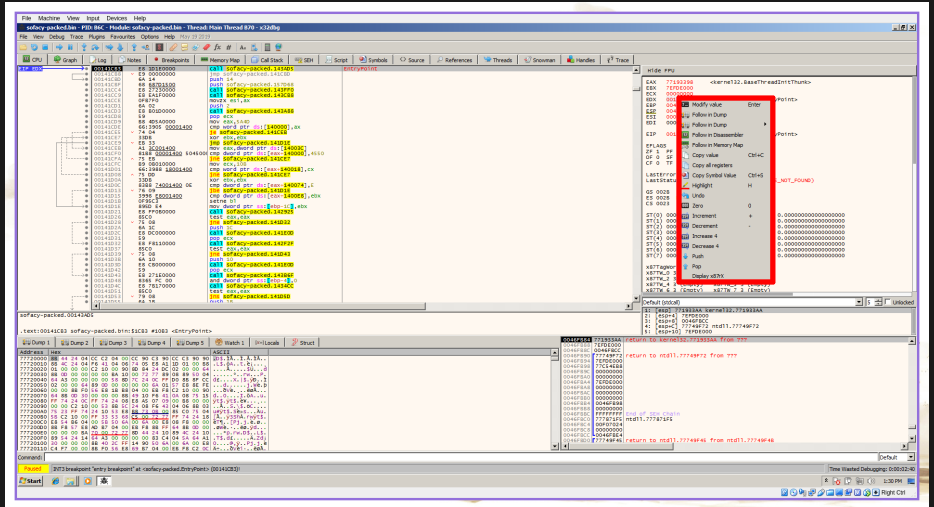
x64dbg

tools_of_the_trade: 0x03

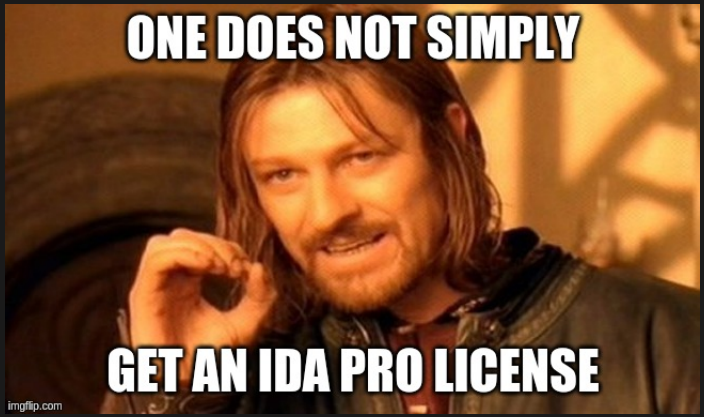


x64dbg

tools_of_the_trade: 0x04

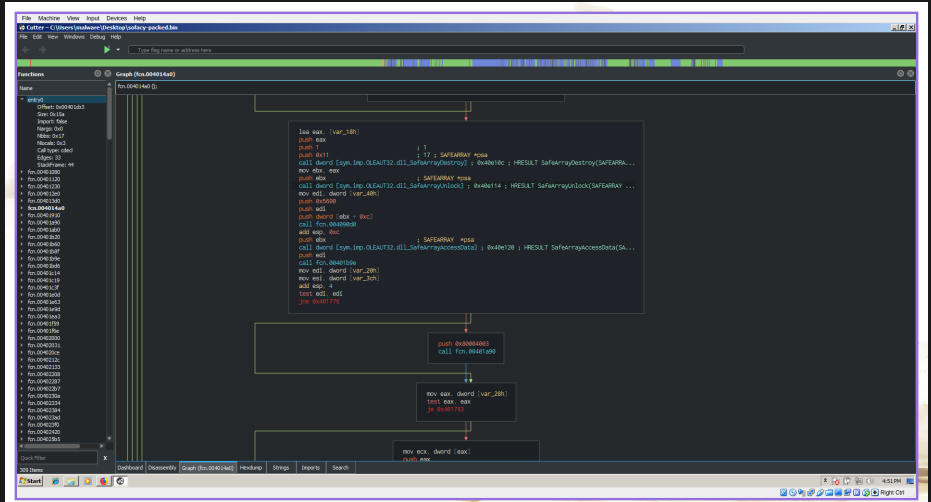


- Markup Reverse Engineered Code
- Control Flow Navigation
- Pseudo Code



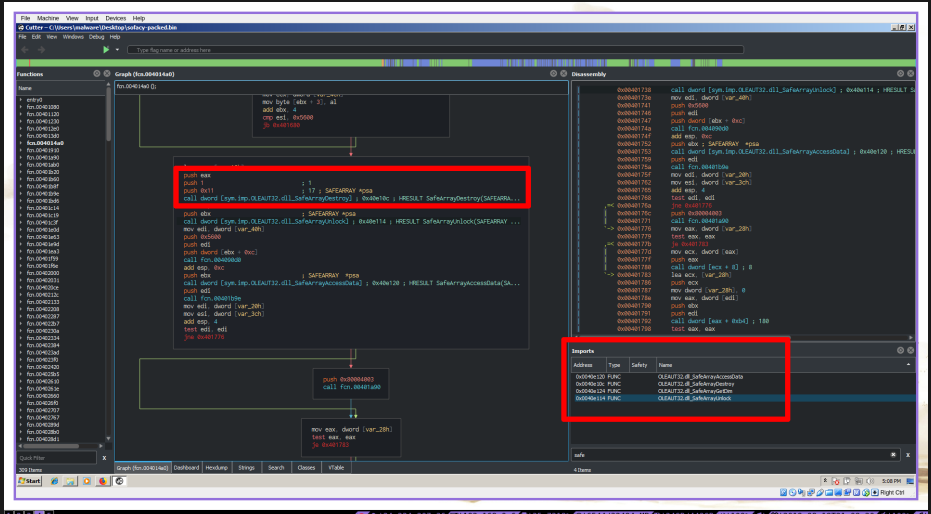
Cutter

tools_of_the_trade: 0x06



Cutter

tools_of_the_trade: 0x07



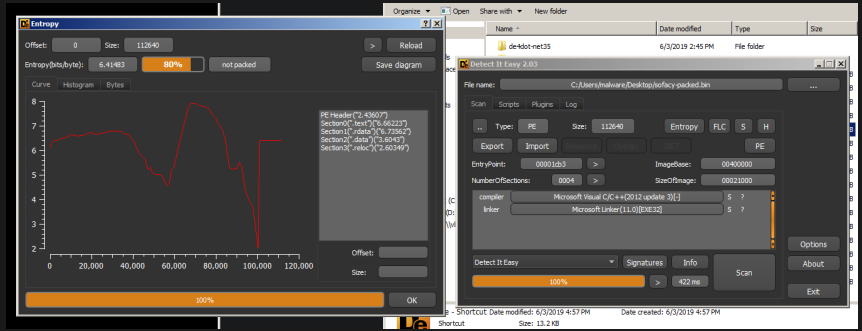
Radare2

tools_of_the_trade: 0x08

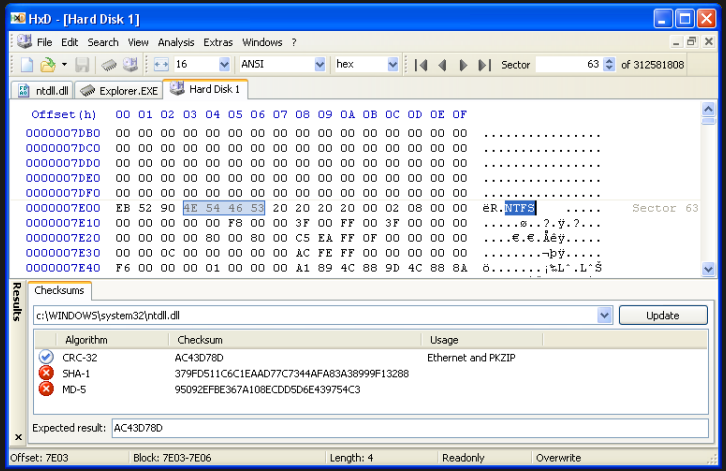
Detect it Easy

tools_of_the_trade: 0x09

- Type
- Packer
- Linker
- Entropy



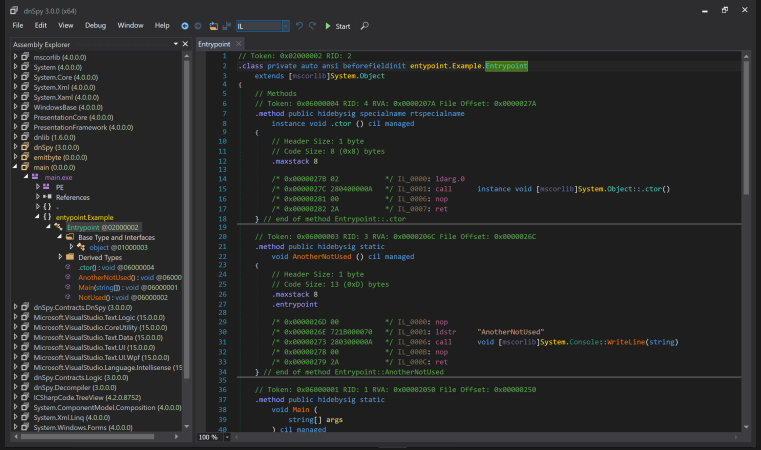
- Modify Dumps
- Read Memory
- Determine File Type



DnSpy

tools_of_the_trade: 0x0b

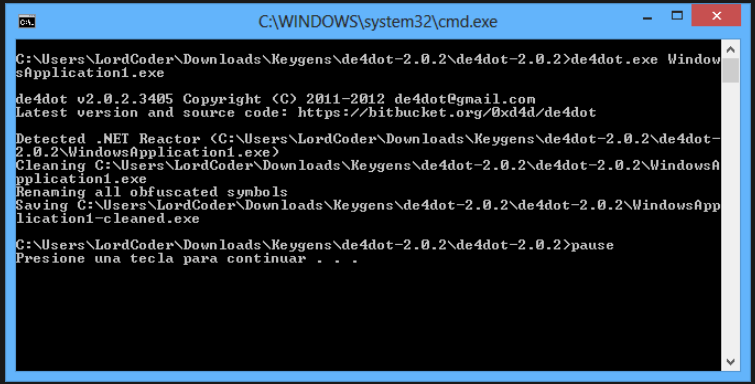
- Code View
- Debugging
- Unpacking



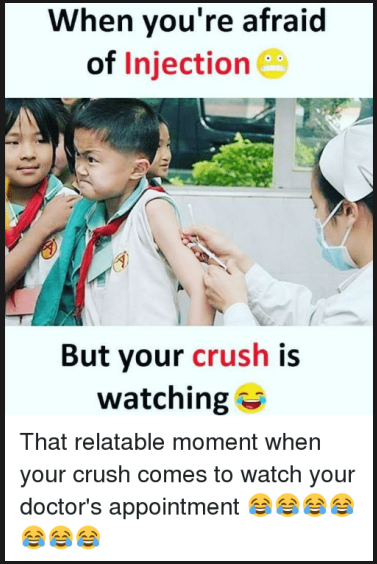
terminal

```
malware@work ~$ file sample.bin
sample.bin: PE32 executable (GUI) Intel 80386, for MS Windows
malware@work ~$ exiftool sample.bin > metadata.log
malware@work ~$ hexdump -C -n 128 sample.bin | less
malware@work ~$ VBoxManage list vms
"win10" {53014b4f-4c94-49b0-9036-818b84a192c9}
"win7" {942cde2e-6a84-4edc-b98a-d7326b4662ee}
malware@work ~$ VBoxManage startvm win7
malware@work ~$
```

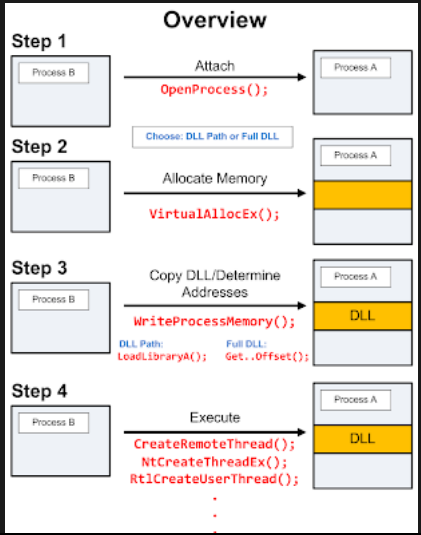
- Automated
- Deobfuscation
- Unpacking



- Unpacking
- Process Hollowing Extraction
- Dump Processes


When you're afraid of Injection 😬
But your crush is watching 😂
That relatable moment when your crush comes to watch your doctor's appointment 😂😂😂😂😂😂😂

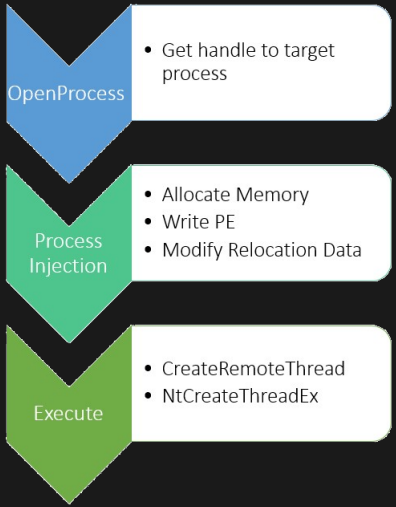
- Get Handle to Target Process
- Allocate Memory
- Write Memory
- Execute by use of Remote Thread



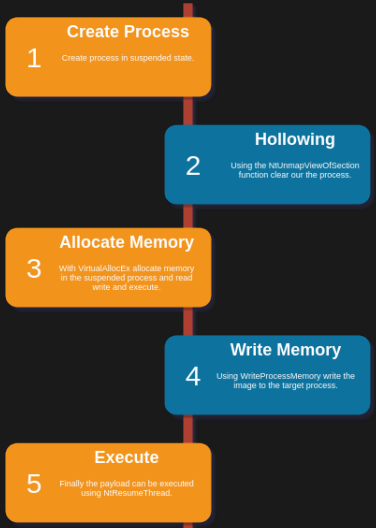
PE (Portable Executable) Injection

injection_techniques: 0x01

- Obtain Handle to Target Process
- Inject Image to Target Process
- Modify Base Address
- Modify Relocation Data
- Execute your Payload

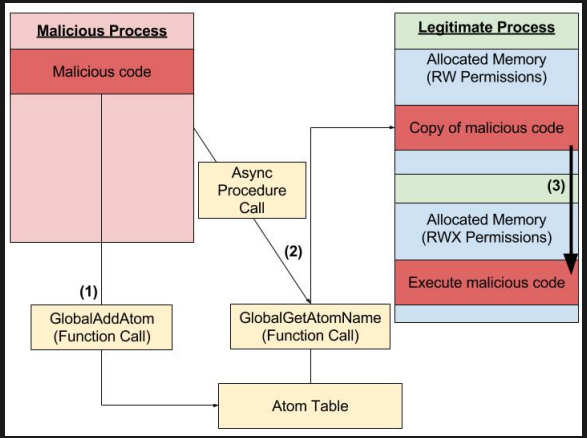


- Create Suspended Process
- Hollow Process with NtUnmapViewOfSection
- Allocate Memory in Process
- Write Memory to Process
- Resume Thread / Process



Atomic bomb test in Italy, 1957, colorized

- Open Target Process
- Get Handle to Alertable Thread
- Find Code Cave
- Shellcode to Call ZwAllocateVirtualMemory and memcpy
- Call GlobalAddAtom
- Suspend Target Thread
- NtQueueApcThread
- Resume Target Thread



- 5466c52191ddd1564b4680060dc329cb

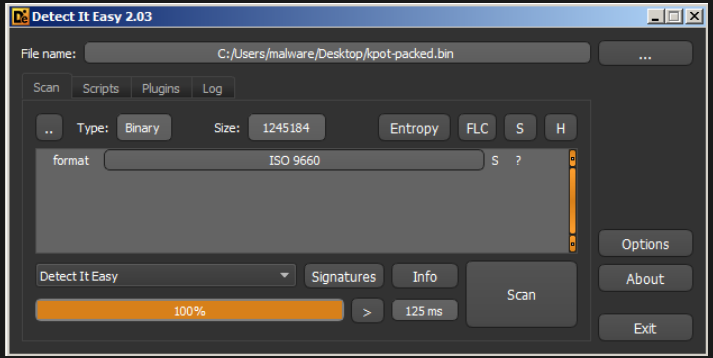
MalSpam Email	
From:	<sidney.m[at]carmellaw[.]com>
Subject:	Wire confirmation
Attached:	img-000310519000.img
Body:	Hello, Kindly find attached the confirmation for your reference please revert back ASAP Regards Sidney morris

- Inbox Detection and Response (IDR) Team
- Lawyers
- Real Estate Agents
- Accountants
- Tax Firms

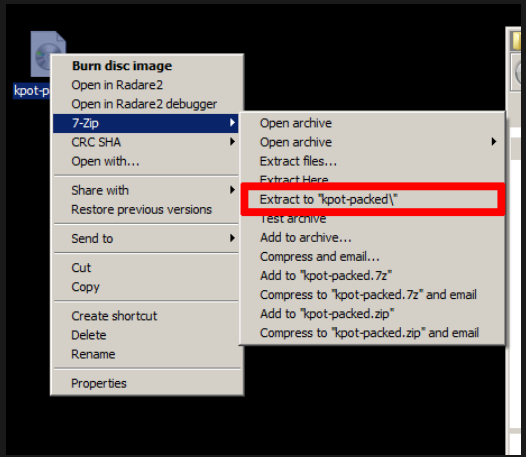
terminal

```
malware@localhost ~$ file img-000310519000.img
UDF filesystem data (version 1.5) NEW_FOLDER_2_
malware@localhost ~$ 7z e img-000310519000.img
malware@localhost ~$ file img-00031051900.exe
PE32 executable (GUI) Intel 80386 Mono/.Net assembly, for MS
Windows
malware@localhost ~$
```

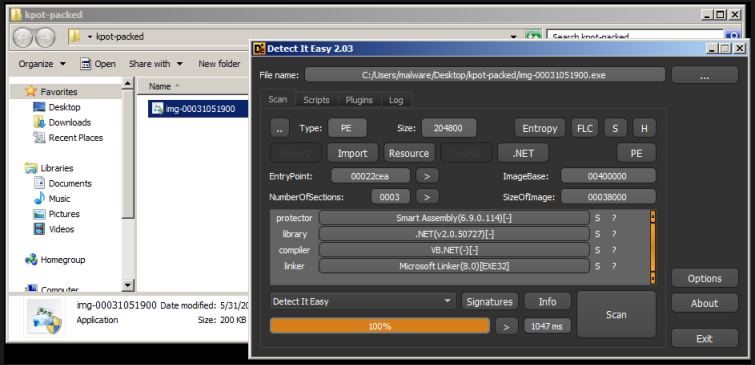
- Looks like this is an ISO
- Let's extract it!



- Extract the ISO Image



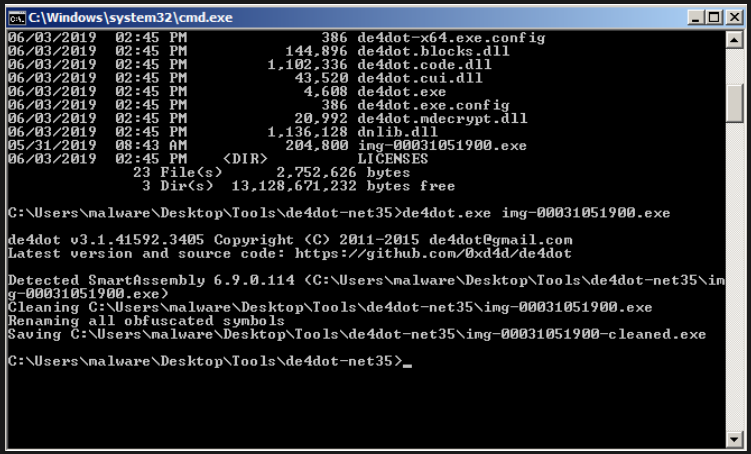
- Packed with Smart Assembly
- Let's now try de4dot



Unpacking KPot

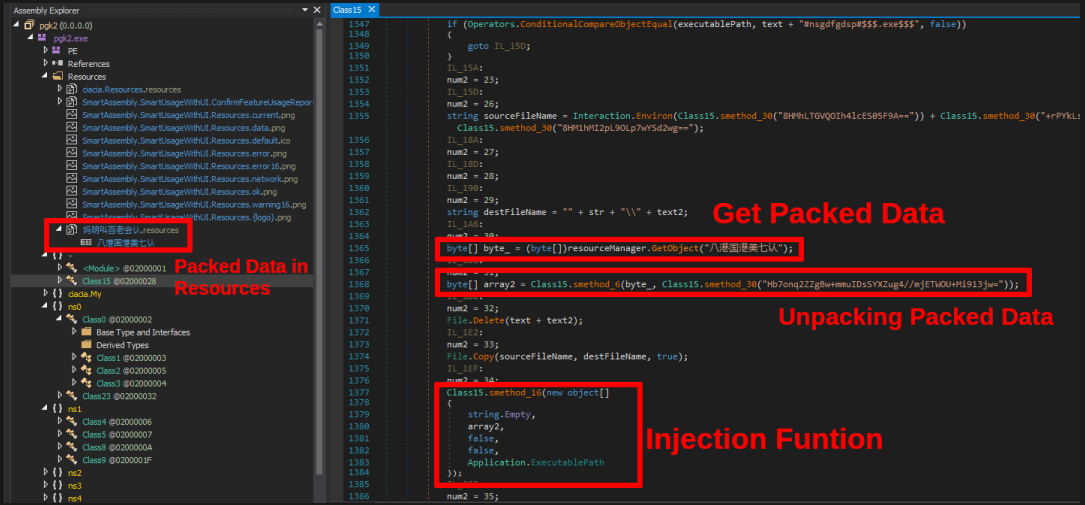
unpacking: 0x03

- de4dot detected smart assembly
- Let's have a look in DnSpy!



Unpacking KPot

unpacking: 0x04



- Uses Rijndael for string obfuscation
- We can use C# in Visual Studio!

```
static string smethod_30(string string_0)
{
    string s = "美明八零会家美";
    RijndaelManaged rijndaelManaged = new RijndaelManaged();
    MD5CryptoServiceProvider md5CryptoServiceProvider = new MD5CryptoServiceProvider();
    string result;
    try
    {
        byte[] array = new byte[32];
        byte[] sourceArray = md5CryptoServiceProvider.ComputeHash(Encoding.ASCII.GetBytes(s));
        Array.Copy(sourceArray, 0, array, 0, 10);
        Array.Copy(sourceArray, 0, array, 15, 10);
        rijndaelManaged.Key = array;
        rijndaelManaged.Mode = CipherMode.ECB;
        ICryptoTransform cryptoTransform = rijndaelManaged.CreateDecryptor();
        byte[] array2 = Convert.FromBase64String(string_0);
        string @string = Encoding.ASCII.GetString(cryptoTransform.TransformFinalBlock(array2, 0, array2.Length));
        result = @string;
    }
    catch (Exception ex)
    {
    }
    return result;
}
```

```
class Program
{
    1 reference
    static string decode(string string_0)
    {
        string s = "美明八零会家美";
        RijndaelManaged rijndaelManaged = new RijndaelManaged();
        MD5CryptoServiceProvider md5CryptoServiceProvider = new MD5CryptoServiceProvider();
        string result;
        byte[] array = new byte[32];
            byte[] sourceArray = md5CryptoServiceProvider.ComputeHash(Encoding.ASCII.GetBytes(s));
            Array.Copy(sourceArray, 0, array, 0, 10);
            Array.Copy(sourceArray, 0, array, 15, 10);
            rijndaelManaged.Key = array;
            rijndaelManaged.Mode = CipherMode.ECB;
            ICryptoTransform cryptoTransform = rijndaelManaged.CreateDecryptor();
            byte[] array2 = Convert.FromBase64String(string_0);
            string @string = Encoding.ASCII.GetString(cryptoTransform.TransformFinalBlock(array2, 0, array2.Length));
            result = @string;
            return result;
    }
    0 references
    static void Main(string[] args)
    {
        Console.WriteLine(decode(args[0]));
    }
}
```

NOTE: Just use copy and paste and now let's try it in PowerShell!

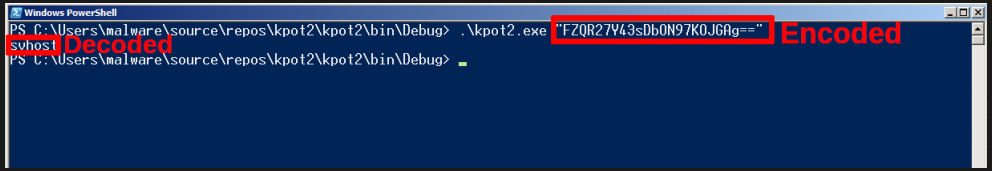


Figure: Unpacking KPot - String Deobfuscation

NOTE: Now let's look at the injection function!

```
static bool smethod_27(object[] object_0)
{
    Class5.Class6 @class = new Class5.Class6();
    Class8.Delegate1 @delegate = Class5.smethod_0<Class8.Delegate1>(Class15.smethod_36("uzbZJOXM1ti/o9VzPqHexQ==", Class15.smethod_36("kVdWt2m955ig9LvIKqBJ7Q==", ));
    Class8.Delegate2 delegate2 = Class5.smethod_0<Class8.Delegate2>(Class15.smethod_36("uzbZJOXM1ti/o9VzPqHexQ==", Class15.smethod_36("M+Cx1wPRkCQPwhR5g7XQekaqAMuhh60oEKoaAbNvuIk=", ));
    Class8.Delegate3 delegate3 = Class5.smethod_0<Class8.Delegate3>(Class15.smethod_36("uzbZJOXM1ti/o9VzPqHexQ==", Class15.smethod_36("OCVBvD5Kb4dymngcmPozmijexOC14Oik/RQZbeXPCDo=", ));
    Class8.Delegate4 delegate4 = Class5.smethod_0<Class8.Delegate4>(Class15.smethod_36("uzbZJOXM1ti/o9VzPqHexQ==", Class15.smethod_36("FjiFXnN7CBcQa33vgPA3B55YktkkXqZt0GLjZJiitb8=", ));
    Class8.Delegate5 delegate5 = Class5.smethod_0<Class8.Delegate5>(Class15.smethod_36("eDAECoHuT4guqKSvOGp4yg==", Class15.smethod_36("e4WJnVJ/R9vGiA+MBU/59/rUjihz+FgywIBB0+3YkVw=", ));
    Class8.Delegate6 delegate6 = Class5.smethod_0<Class8.Delegate6>(Class15.smethod_36("eDAECoHuT4guqKSvOGp4yg==", Class15.smethod_36("oKL4yaE9EBm/y9S+kqvCkaq4w3M21Bt7/g7gAFxXVD4=", ));
    Class8.Delegate7 delegate7 = Class5.smethod_0<Class8.Delegate7>(Class15.smethod_36("uzbZJOXM1ti/o9VzPqHexQ==", Class15.smethod_36("BGwD0JvCcYuc0GAsN3P9tw==", ));
    Class8.Delegate8 delegate8 = Class5.smethod_0<Class8.Delegate8>(Class15.smethod_36("eDAECoHuT4guqKSvOGp4yg==", Class15.smethod_36("iy1ljydF6nv9OhRn+++0LQ==", ));
    string text = (string)object_0[0];
    byte[] array = (byte[])object_0[1];
    bool flag = (bool)object_0[2];
    bool flag2 = (bool)object_0[3];
    string text2 = (string)object_0[4];
    int num = 0;
    string text3 = string.Format("\"{0}\"", text2);
    Class8.Struct1 @struct = default(Class8.Struct1);
    @class.struct0_0 = default(Class8.Struct0);
    @struct.uint_0 = Convert.ToUInt32(Marshal.SizeOf(typeof(Class8.Struct1)));
    bool result;
    try
    {
        Class5.Class6.Class7 class2 = new Class5.Class6.Class7();
        class2.class6_0 = @class;
        if (!string.IsNullOrEmpty(text))
```

Figure: Unpacking KPot - New String Obfuscation Function

NOTE: Let's look at the deobfuscation function!

```
static string $method_36(string string_0)
{
    string password = "fdfdfrtertert";
    string s = "fdfdfrtertert";
    string s2 = "@1B2c3D4sfg5F6g7H8";
    byte[] bytes = Encoding.ASCII.GetBytes(s2);
    byte[] bytes2 = Encoding.ASCII.GetBytes(s);
    byte[] array = Convert.FromBase64String(string_0);
    Rfc2898DeriveBytes rfc2898DeriveBytes = new Rfc2898DeriveBytes(password, bytes2, 2);
    byte[] bytes3 = rfc2898DeriveBytes.GetBytes(32);
    ICryptoTransform transform = new RijndaelManaged
    {
        Mode = CipherMode.CBC
    }.CreateDecryptor(bytes3, bytes);
    MemoryStream memoryStream = new MemoryStream(array);
    CryptoStream cryptoStream = new CryptoStream(memoryStream, transform, CryptoStreamMode.Read);
    byte[] array2 = new byte[checked(array.Length - 1 + 1)];
    int count = cryptoStream.Read(array2, 0, array2.Length);
    memoryStream.Close();
    cryptoStream.Close();
    return Encoding.UTF8.GetString(array2, 0, count);
}
```

Figure: Unpacking KPot - Different Deobfuscation Function

NOTE: Should be able to do copy and paste again with Visual Studio!

deobfuscation.cs

```
using System;
using System.Collections.Generic;
using System.IO;
using System.Linq;
using System.Security.Cryptography;
using System.Text;
using System.Threading.Tasks;
static string decode_0(string string_0){
  string s = "[input unicode characters here]";
  RijndaelManaged rijndaelManaged = new RijndaelManaged();
  MD5CryptoServiceProvider md5CryptoServiceProvider = new MD5CryptoServiceProvider();
  string result;
  byte[] array = new byte[32];
  byte[] sourceArray = md5CryptoServiceProvider.ComputeHash(Encoding.ASCII.GetBytes(s));
  Array.Copy(sourceArray, 0, array, 0, 10);
  Array.Copy(sourceArray, 0, array, 15, 10);
  rijndaelManaged.Key = array;
  rijndaelManaged.Mode = CipherMode.ECB;
  ICryptoTransform cryptoTransform = rijndaelManaged.CreateDecryptor();
  byte[] array2 = Convert.FromBase64String(string_0);
  string @string = Encoding.ASCII.GetString(cryptoTransform.TransformFinalBlock(array2, 0, array2.Length));
  result = @string;
  return result;
}
```

deobfuscation.cs

```
static string decode_1(string string_0){
  string password = "fdfdfrtertert";
  string s = "fdfdfrtertert";
  string s2 = "@1B2c3D4sfg5F6g7H8";
  byte[] bytes = Encoding.ASCII.GetBytes(s2);
  byte[] bytes2 = Encoding.ASCII.GetBytes(s);
  byte[] array = Convert.FromBase64String(string_0);
  Rfc2898DeriveBytes rfc2898DeriveBytes = new Rfc2898DeriveBytes(password, bytes2, 2);
  byte[] bytes3 = rfc2898DeriveBytes.GetBytes(32);
  ICryptoTransform transform = new RijndaelManaged
  {
      Mode = CipherMode.CBC
  }.CreateDecryptor(bytes3, bytes);
  MemoryStream memoryStream = new MemoryStream(array);
  CryptoStream cryptoStream = new CryptoStream(memoryStream, transform, CryptoStreamMode.Read);
  byte[] array2 = new byte[checked(array.Length - 1 + 1)];
  int count = cryptoStream.Read(array2, 0, array2.Length);
  memoryStream.Close();
  cryptoStream.Close();
  return Encoding.UTF8.GetString(array2, 0, count);
}
```

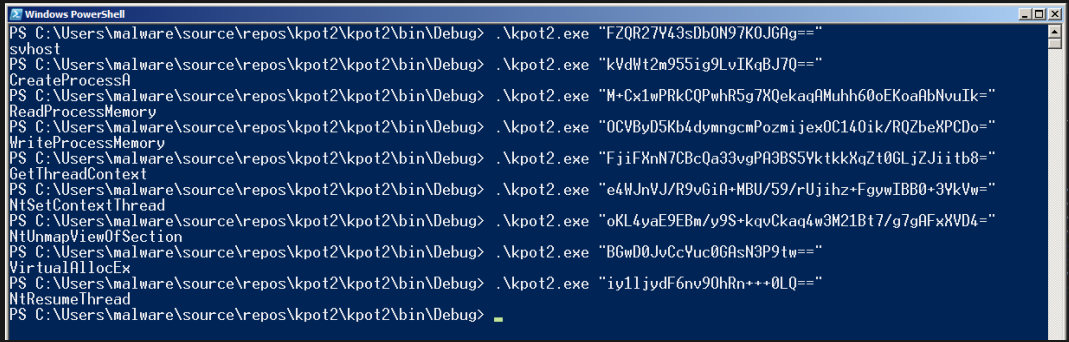


Figure: Unpacking KPot - Process Hollowing Functions

NOTE: Looks like process hollowing, let's breakpoint right before the call to NtResumeThread or delegate8!

Unpacking KPot

unpacking: 0x0E

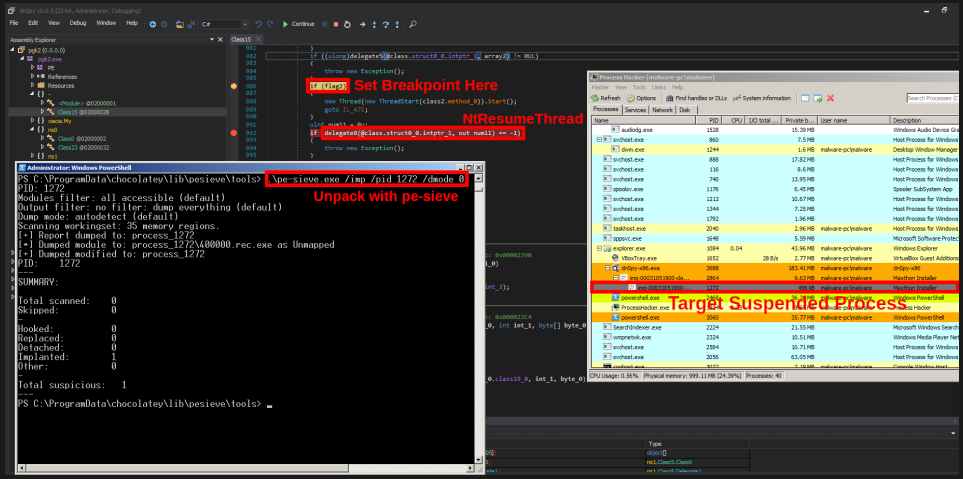


Figure: Unpacking KPot - Now we need to extract it with pe-seive!

Unpacking KPot

unpacking: 0x0F

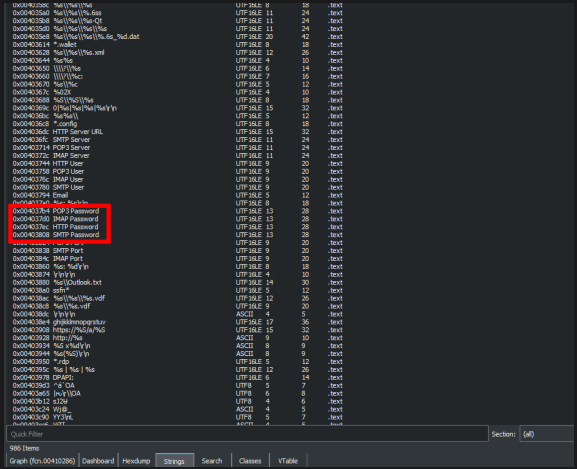
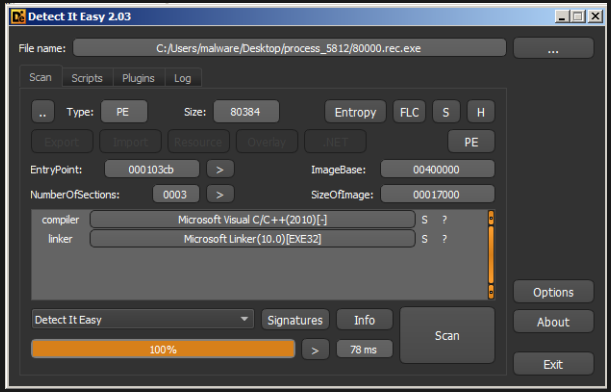


Figure: Open with Cutter and now we can see strings!

- It's not .NET anymore?
- Interesting Let's Look!



References

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