Practical Malware Analysis & Triage

Malware Analysis Report

WannaCry Ransomware

Feb 2024

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Executive Summary

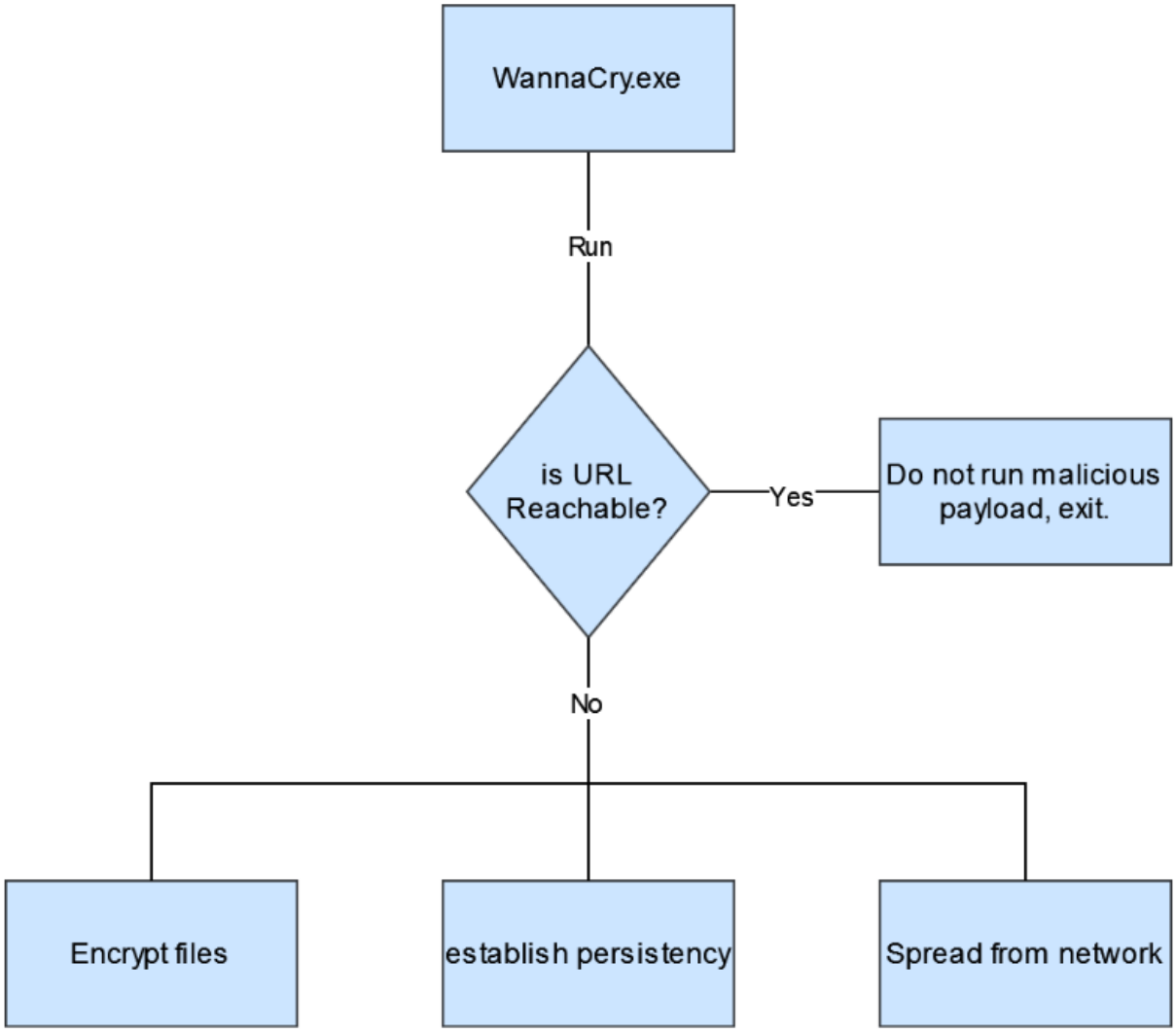
SHA256 hash	24D004A104D4D54034DBCFFC2A4B19A11F39008A575AA614EA04703480B1022C

WannaCry is a crypto ransomware used to extort money that became a global pandemic in May 2017. This ransomware spread through computers with Microsoft Windows OS. The user's files were held hostage, and a Bitcoin Ransom was demanded for their return.

This file encrypts all files on the victim and uses it as pivot to spread itself on other computers on the network. Additionally, it presents persistence capabilities, keeping the files encrypted and the malware active after reboot.

High-Level Technical Summary

WannaCry presents itself with a killswitch mechanism that won't trigger the encryption if a certain URL is available and returns a 200OK response.
When not available, it proceeds to create persistence via a Registry Key and encrypting all the files, starting from the local directory of the file.
Also, the file has worm capabilities, spreading through the network with specific Source and Destination Ports.



Static Analysis

Information extracted without executing the sample. Tools used:
CFF Explorer, FLOSS, PEStudio,

Original name	Ransomware.wannacry.exe
Written Language	C++
Architecture	32 Bits

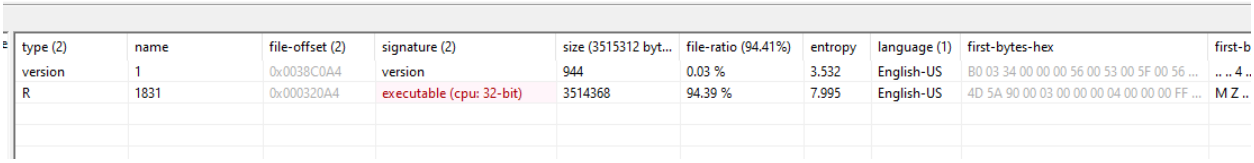
Extracted Strings

String	Information
hxxp://www.iuqerfsodp9ifjaposdfjhgosurijfaewrwergwea.com	URL
cmd.exe /c "%s"	Executes command on variable %s
diskpart.exe	Command interpreter helps manage the computer's drives
CreateServiceA	Create a service object and add it to the service control manager database. This function is commonly used by malware for persistence.
StartServiceA	
CreateServiceA	
InternetOpenA	
InternetOpenUrlA	
icacls . /grant Everyone:F /T /C /Q	
GetStartupInfoA	
mssecsvc.exe	

tasksche.exe	
Ihdfrgui.exe	
CryptEncrypt	
CryptDestroyKey	
C:\%s\qeriuwjhrf	
WanaCrypt0r	

The string "**!This program cannot be run in DOS mode.**" Appears 4 times, which suggests more than 1 executable in the file. Confirmed resources with PEStudio

```
C:\Users\husky\Desktop
λ grep "!This program cannot be run in DOS mode." strings.txt
!This program cannot be run in DOS mode.
!This program cannot be run in DOS mode.
!This program cannot be run in DOS mode.
!This program cannot be run in DOS mode.
```



type (2)	name	file-offset (2)	signature (2)	size (3515312 byt...	file-ratio (94.41%)	entropy	language (1)	first-bytes-hex	first-b
version	1	0x0038C0A4	version	944	0.03 %	3.532	English-US	B0 03 34 00 00 00 56 00 53 00 5F 00 56 ...	.. .. 4 ..
R	1831	0x000320A4	executable (cpu: 32-bit)	3514368	94.39 %	7.995	English-US	4D 5A 90 00 03 00 00 00 04 00 00 00 FF ...	M Z ..

Capabilities

```
+-------------------------+-----------------------------------------------------------------------------------+
| ATT&CK Tactic           | ATT&CK Technique                                                                  |
|-------------------------+-----------------------------------------------------------------------------------|
| DEFENSE EVASION         | Obfuscated Files or Information::Indicator Removal from Tools [T1027.005]         |
| DISCOVERY               | File and Directory Discovery [T1083]                                              |
|                         | System Information Discovery [T1082]                                             |
|                         | System Network Configuration Discovery [T1016]                                    |
| EXECUTION               | Shared Modules [T1129]                                                            |
|                         | System Services::Service Execution [T1569.002]                                    |
| PERSISTENCE             | Create or Modify System Process::Windows Service [T1543.003]                      |
+-------------------------+-----------------------------------------------------------------------------------+
```

MBC Objective	MBC Behavior
ANTI-BEHAVIORAL ANALYSIS	Debugger Detection::Timing/Delay Check GetTickCount [B0001.032]
	Debugger Detection::Timing/Delay Check QueryPerformanceCounter [B0001.033]
	Execution Guardrails::Runs as Service [E1480.m07]
ANTI-STATIC ANALYSIS	Disassembler Evasion::Argument Obfuscation [B0012.001]
COMMAND AND CONTROL	C2 Communication::Receive Data [B0030.002]
	C2 Communication::Send Data [B0030.001]
COMMUNICATION	HTTP Communication::Create Request [C0002.012]
	HTTP Communication::Open URL [C0002.004]
	Socket Communication::Connect Socket [C0001.004]
	Socket Communication::Create TCP Socket [C0001.011]
	Socket Communication::Create UDP Socket [C0001.010]
	Socket Communication::Get Socket Status [C0001.012]
	Socket Communication::Initialize Winsock Library [C0001.009]
	Socket Communication::Receive Data [C0001.006]
	Socket Communication::Send Data [C0001.007]
	Socket Communication::Set Socket Config [C0001.001]
	Socket Communication::TCP Client [C0001.008]
CRYPTOGRAPHY	Generate Pseudo-random Sequence::Use API [C0021.003]
DATA	Compression Library [C0060]
EXECUTION	Install Additional Program [B0023]
FILE SYSTEM	Read File [C0051]
PROCESS	Create Thread [C0038]
	Terminate Process [C0018]
	Terminate Thread [C0039]

CAPABILITY	NAMESPACE
check for time delay via GetTickCount	anti-analysis/anti-debugging/debugger-detection
check for time delay via QueryPerformanceCounter	anti-analysis/anti-debugging/debugger-detection
contain obfuscated stackstrings	anti-analysis/obfuscation/string/stackstring
receive data (5 matches)	communication
send data (5 matches)	communication
connect to URL	communication/http/client
get socket status	communication/socket
initialize Winsock library	communication/socket
set socket configuration	communication/socket
create UDP socket (4 matches)	communication/socket/udp/send
act as TCP client	communication/tcp/client
generate random numbers via WinAPI	data-manipulation/prng
contain a resource (.rsrc) section	executable/pe/section/rsrc
extract resource via kernel32 functions	executable/resource
contain an embedded PE file	executable/subfile/pe
get file size	host-interaction/file-system/meta
move file	host-interaction/file-system/move
read file	host-interaction/file-system/read
get number of processors	host-interaction/hardware/cpu
get networking interfaces	host-interaction/network/interface
terminate process	host-interaction/process/terminate
run as service	host-interaction/service
create service	host-interaction/service/create
modify service	host-interaction/service/modify
start service	host-interaction/service/start
create thread (4 matches)	host-interaction/thread/create
terminate thread	host-interaction/thread/terminate
link function at runtime	linking/runtime-linking
linked against ZLIB	linking/static/zlib
inspect section memory permissions	load-code/pe
parse PE exports	load-code/pe
parse PE header	load-code/pe
persist via Windows service	persistence/service

Without executing the file, we use cutter to access an attempted decompiled version of the source code.

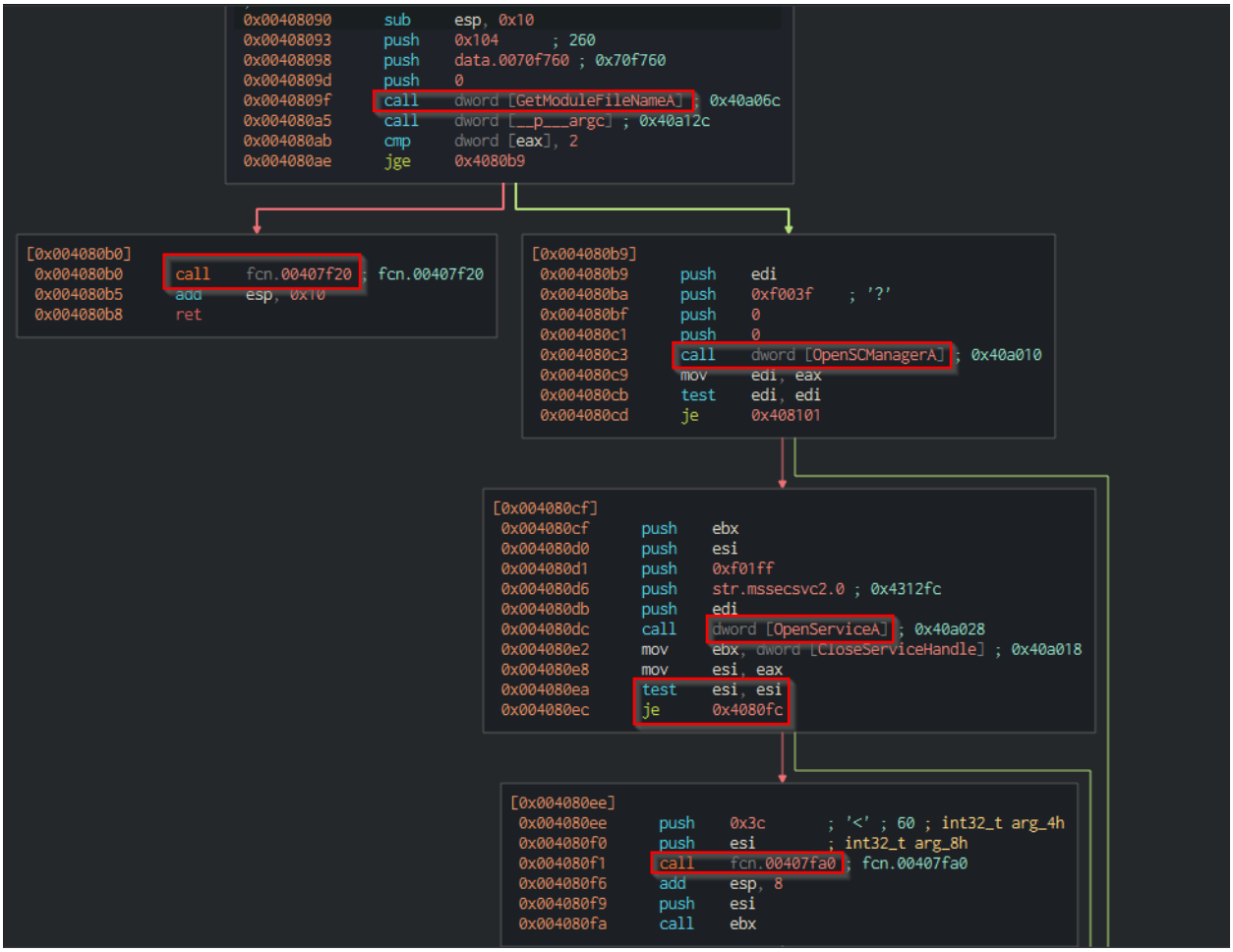
Main function

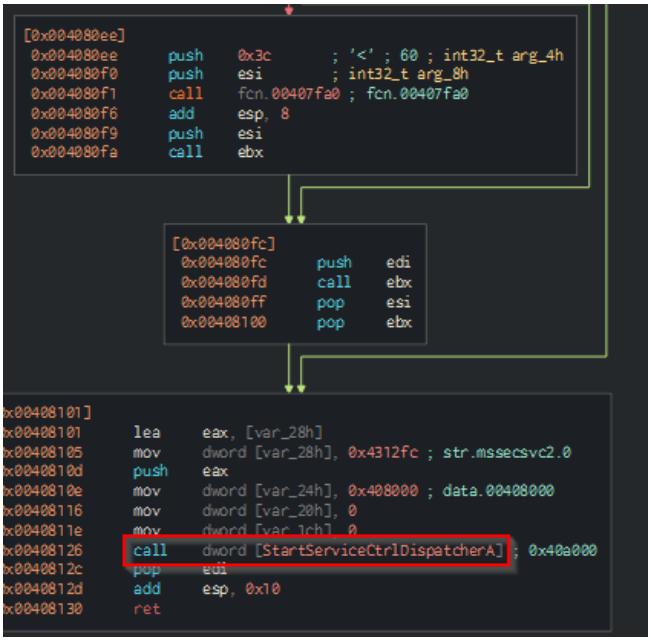
```
; var int32_t var_bh @ stack - 0xb
; var int32_t var_7h @ stack - 0x7
; var int32_t var_3h @ stack - 0x3
; var int32_t var_1h @ stack - 0x1
0x00408140      sub     esp, 0x50
0x00408143      push    esi
0x00408144      push    edi
0x00408145      mov     ecx, 0xe    ; 14
0x0040814a      mov     esi, str.http:__www.iuqerfsodp9ifjaposdfjhgosurijfaewrwergwea.com ; 0x4313d0
0x0040814f      lea     edi, [var_50h]
0x00408153      xor     eax, eax
0x00408155      rep     movsd dword es:[edi], dword ptr [esi]
0x00408157      movsb   byte es:[edi], byte ptr [esi]
0x00408158      mov     dword [var_17h], eax
0x0040815c      mov     dword [var_13h], eax
0x00408160      mov     dword [var_fh], eax
0x00408164      mov     dword [var_bh], eax
0x00408168      mov     dword [var_7h], eax
0x0040816c      mov     word [var_3h], ax
0x00408171      push    eax
0x00408172      push    eax
0x00408173      push    eax
0x00408174      push    1           ; 1
0x00408176      push    eax
0x00408177      mov     byte [var_1h], al
0x0040817b      call    dword [InternetOpenA] ; 0x40a134
0x00408181      push    0
0x00408183      push    0x84000000
0x00408188      push    0
0x0040818a      lea     ecx, [var_64h]
0x0040818e      mov     esi, eax
0x00408190      push    0
0x00408192      push    ecx
0x00408193      push    esi
0x00408194      call    dword [InternetOpenUrlA] ; 0x40a138
0x0040819a      mov     edi, eax
0x0040819c      push    esi
0x0040819d      mov     esi, dword [InternetCloseHandle] ; 0x40a13c
0x004081a3      test    edi, edi
0x004081a5      jne     0x4081bc
```

Program stores the URL and attempts an internet connection through Windows API calls. Depending on the result it jumps to different sections of the code.

The left side shows the execution of the payload, calling on function allocated on 00408090. Otherwise, it will exit the program.

“Execute payload” (00408090)



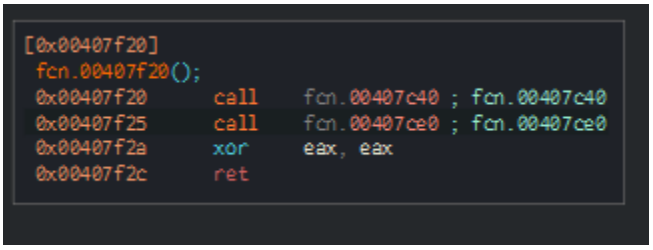


Calling the GetModuleFileNameA with an empty argument returns the path of the directory of the executable file. Then calls on the __p__argc function, which we currently don't know its purpose.

One flow of the program calls on the Service Control Manager and opens a service, then calls on function 00407fa0, finishing on a StartService.

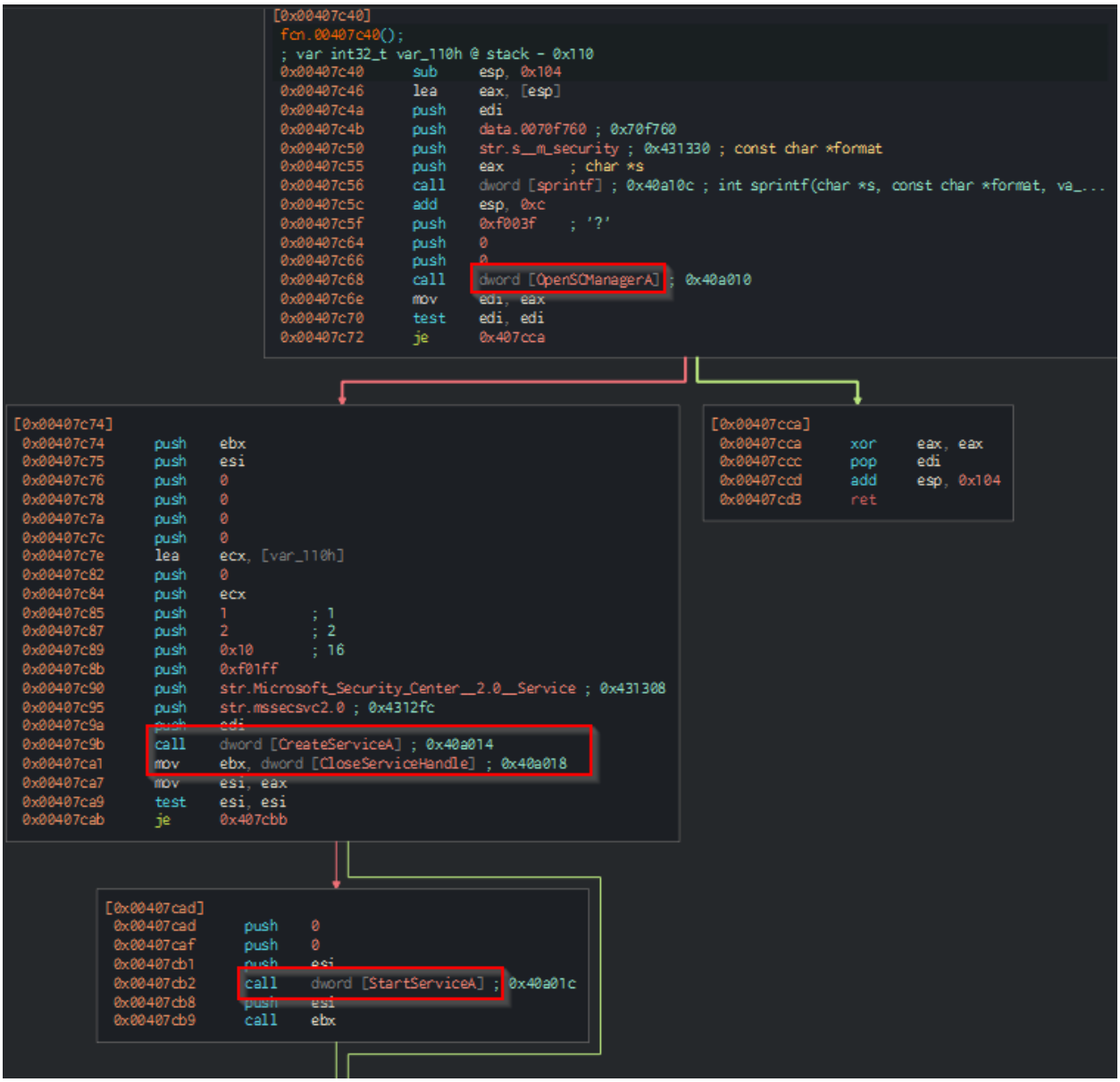
The other flow calls on function 00407f20.

00407f20



Simply calls 2 functions

00407c40

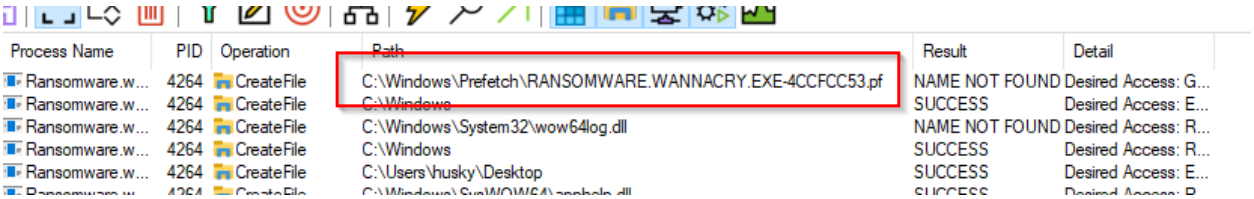


First function Opens a service manager, creates, and starts a service

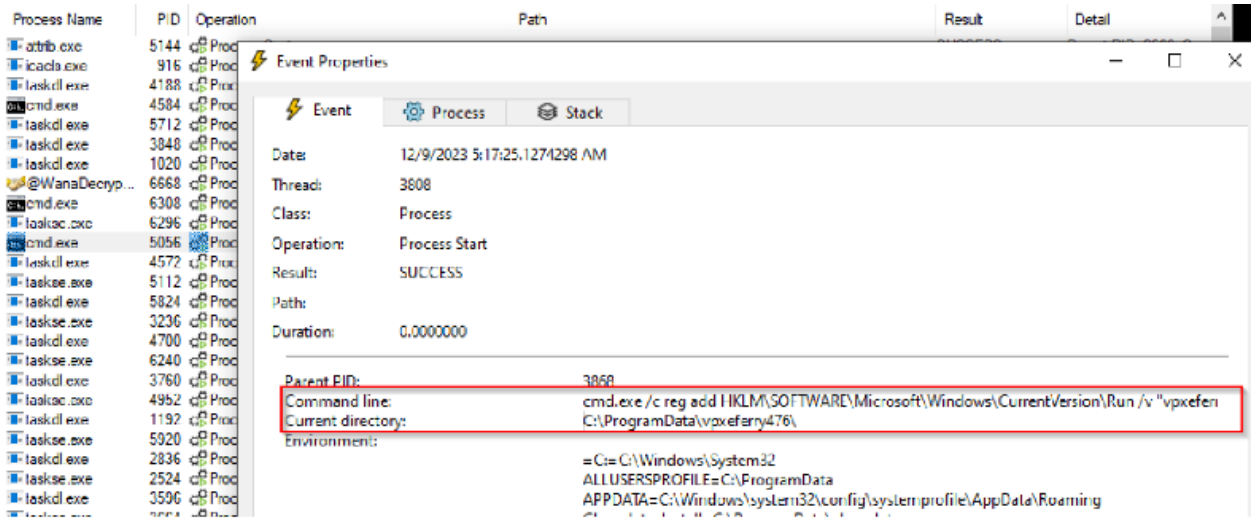
Dynamic Analysis

First, we execute the file with INetSim running on a REMnux machine with Wireshark analyzing the traffic. Nothing seems to happen, which means the part of the code seen whether or not to execute the payload depends on if the URL is reachable. If it is, it won't execute.

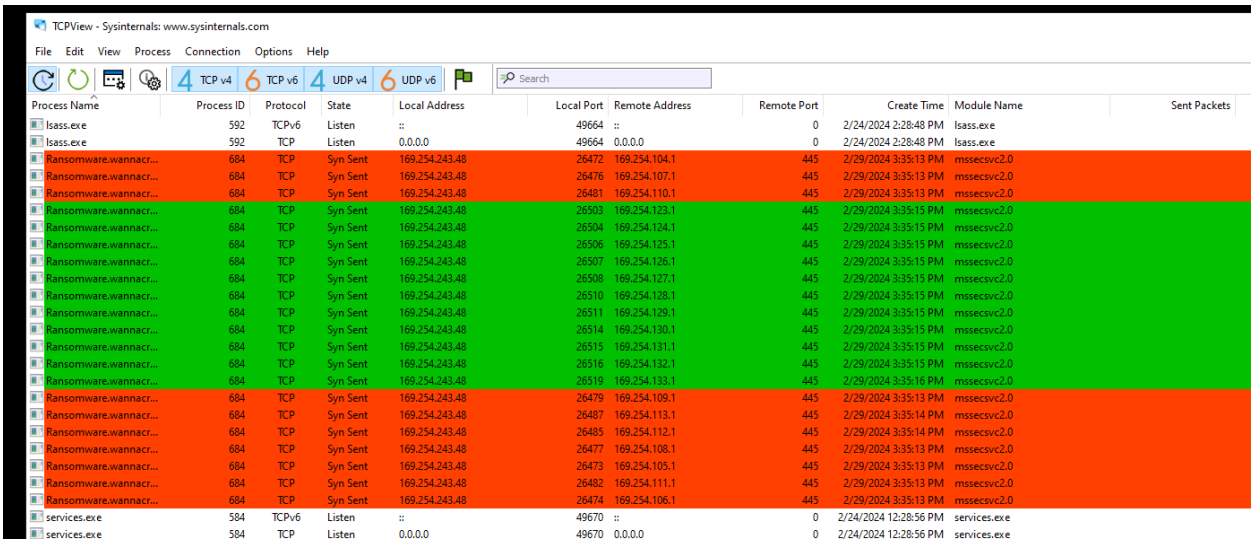
We see the HTP request for the URL seen on the Static Analysis.



We see a PF file was created on path *C:\Windows\Prefetch\RANSOMWARE.WANNACRY.EXE-4CCFCC53.pf*
Files with the file extension .pf can only be launched by certain applications. The file extension refers to encrypted files.



When shutting down InetSIM and re-detonating the malware, we see that it encrypts all available files, changes the Desktop Background and pops a GUI of the WannaCry de-cryptor, requesting a ransomware payment. Also, the malware makes multiple connection attempts throughout the network from port 684 to port 445.



Process Name	Process ID	Protocol	State	Local Address	Local Port	Remote Address	Remote Port	Create Time	Module Name	Sent Packets
lsass.exe	592	TCPv6	Listen	::	49664	::	0	2/24/2024 2:28:48 PM	lsass.exe	
lsass.exe	592	TCP	Listen	0.0.0.0	49664	0.0.0.0	0	2/24/2024 2:28:48 PM	lsass.exe	
Ransomware.wannacr...	684	TCP	Syn Sent	169.254.243.48	26472	169.254.104.1	445	2/29/2024 3:35:13 PM	mssecsvc2.0	
Ransomware.wannacr...	684	TCP	Syn Sent	169.254.243.48	26476	169.254.107.1	445	2/29/2024 3:35:13 PM	mssecsvc2.0	
Ransomware.wannacr...	684	TCP	Syn Sent	169.254.243.48	26481	169.254.110.1	445	2/29/2024 3:35:13 PM	mssecsvc2.0	
Ransomware.wannacr...	684	TCP	Syn Sent	169.254.243.48	26503	169.254.123.1	445	2/29/2024 3:35:15 PM	mssecsvc2.0	
Ransomware.wannacr...	684	TCP	Syn Sent	169.254.243.48	26504	169.254.124.1	445	2/29/2024 3:35:15 PM	mssecsvc2.0	
Ransomware.wannacr...	684	TCP	Syn Sent	169.254.243.48	26506	169.254.125.1	445	2/29/2024 3:35:15 PM	mssecsvc2.0	
Ransomware.wannacr...	684	TCP	Syn Sent	169.254.243.48	26507	169.254.126.1	445	2/29/2024 3:35:15 PM	mssecsvc2.0	
Ransomware.wannacr...	684	TCP	Syn Sent	169.254.243.48	26508	169.254.127.1	445	2/29/2024 3:35:15 PM	mssecsvc2.0	
Ransomware.wannacr...	684	TCP	Syn Sent	169.254.243.48	26510	169.254.128.1	445	2/29/2024 3:35:15 PM	mssecsvc2.0	
Ransomware.wannacr...	684	TCP	Syn Sent	169.254.243.48	26511	169.254.129.1	445	2/29/2024 3:35:15 PM	mssecsvc2.0	
Ransomware.wannacr...	684	TCP	Syn Sent	169.254.243.48	26514	169.254.130.1	445	2/29/2024 3:35:15 PM	mssecsvc2.0	
Ransomware.wannacr...	684	TCP	Syn Sent	169.254.243.48	26515	169.254.131.1	445	2/29/2024 3:35:15 PM	mssecsvc2.0	
Ransomware.wannacr...	684	TCP	Syn Sent	169.254.243.48	26516	169.254.132.1	445	2/29/2024 3:35:15 PM	mssecsvc2.0	
Ransomware.wannacr...	684	TCP	Syn Sent	169.254.243.48	26519	169.254.133.1	445	2/29/2024 3:35:16 PM	mssecsvc2.0	
Ransomware.wannacr...	684	TCP	Syn Sent	169.254.243.48	26479	169.254.109.1	445	2/29/2024 3:35:13 PM	mssecsvc2.0	
Ransomware.wannacr...	684	TCP	Syn Sent	169.254.243.48	26487	169.254.113.1	445	2/29/2024 3:35:14 PM	mssecsvc2.0	
Ransomware.wannacr...	684	TCP	Syn Sent	169.254.243.48	26485	169.254.112.1	445	2/29/2024 3:35:14 PM	mssecsvc2.0	
Ransomware.wannacr...	684	TCP	Syn Sent	169.254.243.48	26477	169.254.108.1	445	2/29/2024 3:35:13 PM	mssecsvc2.0	
Ransomware.wannacr...	684	TCP	Syn Sent	169.254.243.48	26473	169.254.105.1	445	2/29/2024 3:35:13 PM	mssecsvc2.0	
Ransomware.wannacr...	684	TCP	Syn Sent	169.254.243.48	26482	169.254.111.1	445	2/29/2024 3:35:13 PM	mssecsvc2.0	
Ransomware.wannacr...	684	TCP	Syn Sent	169.254.243.48	26474	169.254.106.1	445	2/29/2024 3:35:13 PM	mssecsvc2.0	
services.exe	584	TCPv6	Listen	::	49670	::	0	2/24/2024 12:28:56 PM	services.exe	
services.exe	584	TCP	Listen	0.0.0.0	49670	0.0.0.0	0	2/24/2024 12:28:56 PM	services.exe	

Indicators of Compromise

Network Indicators

- URL hxxp://www.iuqerfsodp9ifjaposdfjhgosurijfaewrwergwea.com
- Connections from port 684 to port 445

Host-based Indicators

- File *RANSOMWARE.WANNACRY.EXE-4CCFCC53.pf*
- Registry Key changed to autorun taskshe.exe
- Sha256 24D004A104D4D54034DBCFFC2A4B19A11F39008A575AA614EA04703480B1022C