Veletrix Loader Infection: A Look from a Digital Forensic Perspective - 0x0d4y Malware Research

By 0x0d4y

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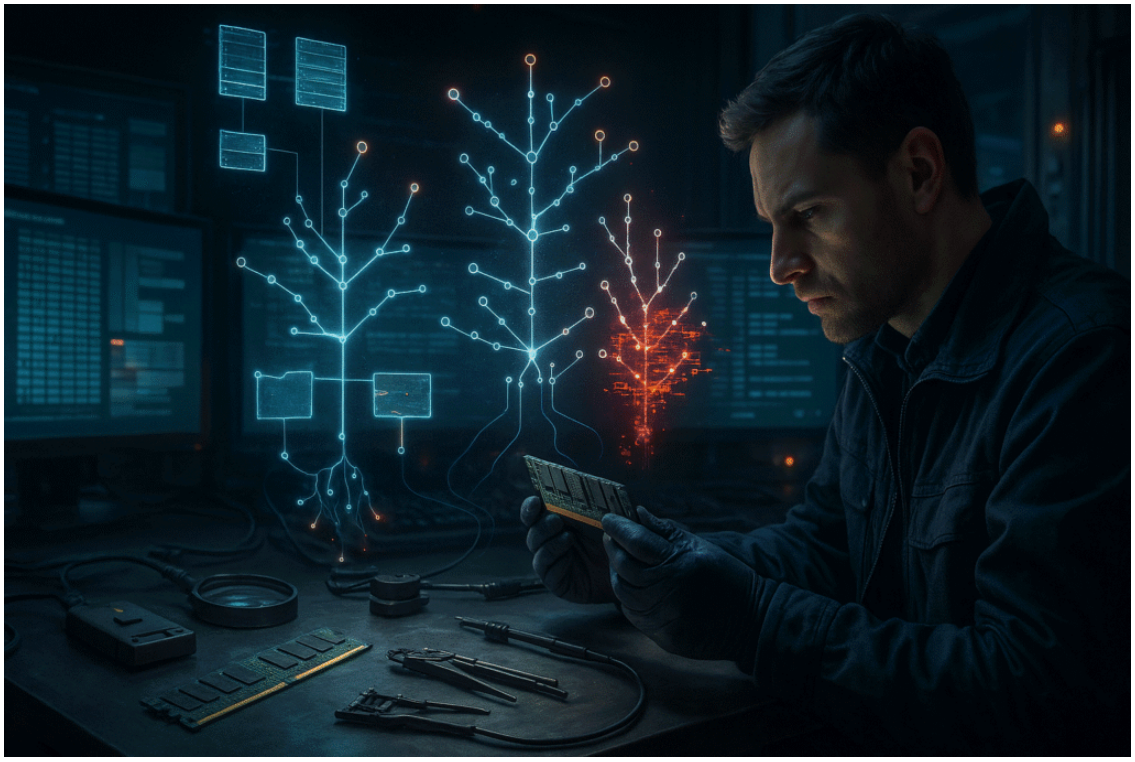


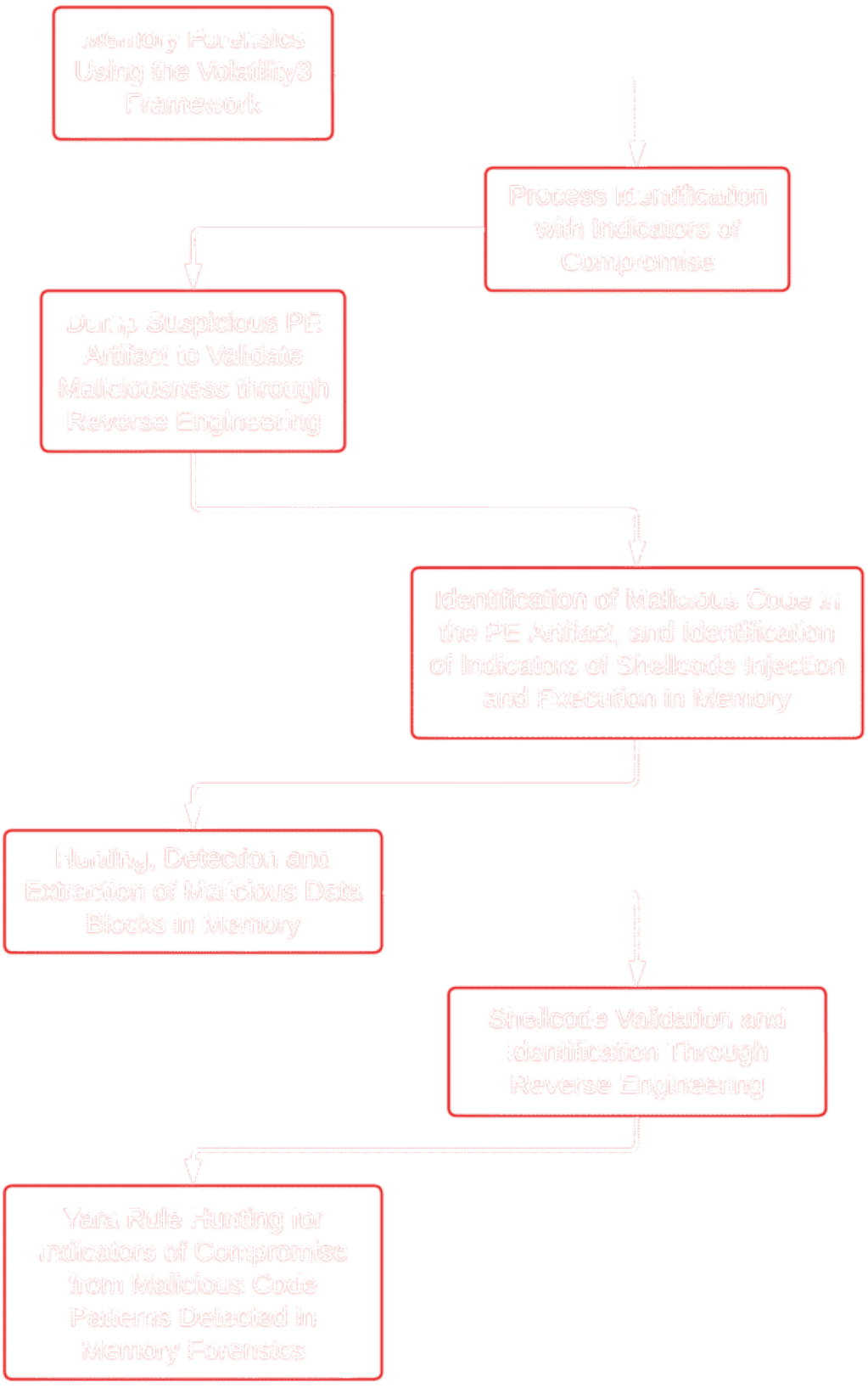
This analysis serves as a complementary study to my previous research on the reverse engineering of *Veletrix Loader* and the infrastructure analysis of the China-nexus threat actor operating this campaign. In this post, I'll examine the Veletrix Loader infection from a digital forensics perspective, analyzing volatile memory captured from an infected system.

The rationale behind this approach lies in the additional detection capabilities that memory forensics can provide, particularly when malware employs sophisticated evasion techniques such as shellcode injection and execution through DLL Side-Loading of legitimate software – in this case, Wondershare software.

Our reverse engineering findings establish a foundation for what digital forensics analysts should investigate when examining systems exhibiting similar infection patterns. This cross-disciplinary approach ensures that our threat research delivers actionable intelligence for DFIR practitioners, ultimately strengthening the defensive capabilities across both malware analysis and incident response domains.

By bridging the gap between malware reverse engineering and digital forensics, we aim to provide comprehensive detection methodologies that enhance the overall security posture against advanced persistent threats employing such sophisticated techniques.

Below you can see the flow of my analysis.



Methodology and Evidence Collection

Our forensic evidence (Memory Dump) consists of a memory dump obtained from a *Windows 10 Professional* virtual machine environment. The infection scenario was replicated by executing the *Wondershare DLL Side-Loading* attack vector, followed by immediate capture of the system's volatile memory to preserve the malware's runtime artifacts.

The memory acquisition process was performed using VirtualBox management tools with the following sequence of commands:

```
 # Pause the virtual machine to preserve memory state
& "C:\Program Files\Oracle\VirtualBox\VBoxManage.exe" controlvm "Windows10" pause

# Extract the complete memory dump
& "C:\Program Files\Oracle\VirtualBox\VBoxManage.exe" debugvm "Windows10" dumpvmcore --filename "C:\Users\0x0d4y
```

Below you can see the integrity of the evidence, through the SHA256 hash. This dump it will be in my Github, so you can validate the checksum.

```
 # Generate cryptographic hash for evidence integrity
Get-FileHash "C:\Users\0x0d4y\Desktop\Research\Malware-Research\China-Nexus\Veletrix\infection_veletrix.mem" -A

Algorithm: SHA256
Hash: FAA50B87AEDB603CB2A3F8EE0D88DAB9ADF317E8D5A3A4534E108AADB993FA45
Path: C:\Users\0x0d4y\Desktop\Research\Malware-Research\China-Nexus\Veletrix\infection_veletrix.mem
```

With our forensic evidence properly collected and verified, we proceed to analyze the memory dump using the Volatility Framework to identify malicious artifacts and behavioral indicators consistent with our reverse engineering findings.

Below we can see the output of the verification of the memory dump collected.

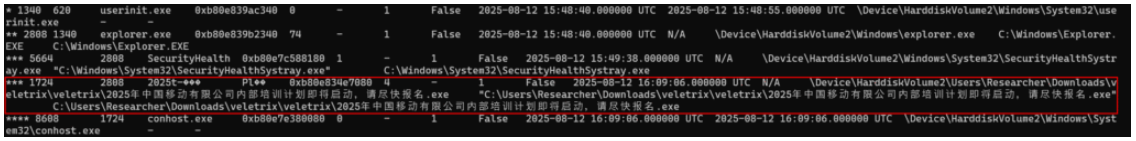
```
 Volatility 3 Framework 2.26.0
Progress:  100.00               PDB scanning finished
Variable        Value

Kernel Base     0xf80547e00000
DTB     0x1aa000
Symbols file:///C:/Users/0x0d4y/AppData/Local/Programs/Python/Python313/Lib/site-packages/volatility3/symbols/wi
Is64Bit True
IsPAE   False
layer_name      0 WindowsIntel32e
memory_layer    1 Elf64Layer
base_layer      2 FileLayer
KdVersionBlock  0xf80548a0f398
Major/Minor     15.19041
MachineType     34404
```

```
KeNumberProcessors      4
SystemTime      2025-08-12 16:09:22+00:00
NtSystemRoot    C:\Windows
NtProductType   NtProductWinNt
NtMajorVersion  10
NtMinorVersion  0
PE MajorOperatingSystemVersion  10
PE MinorOperatingSystemVersion  0
PE Machine      34404
```

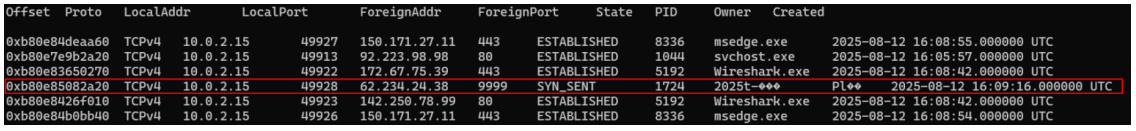
With this, let's start our analysis.

Identification of Malicious Process

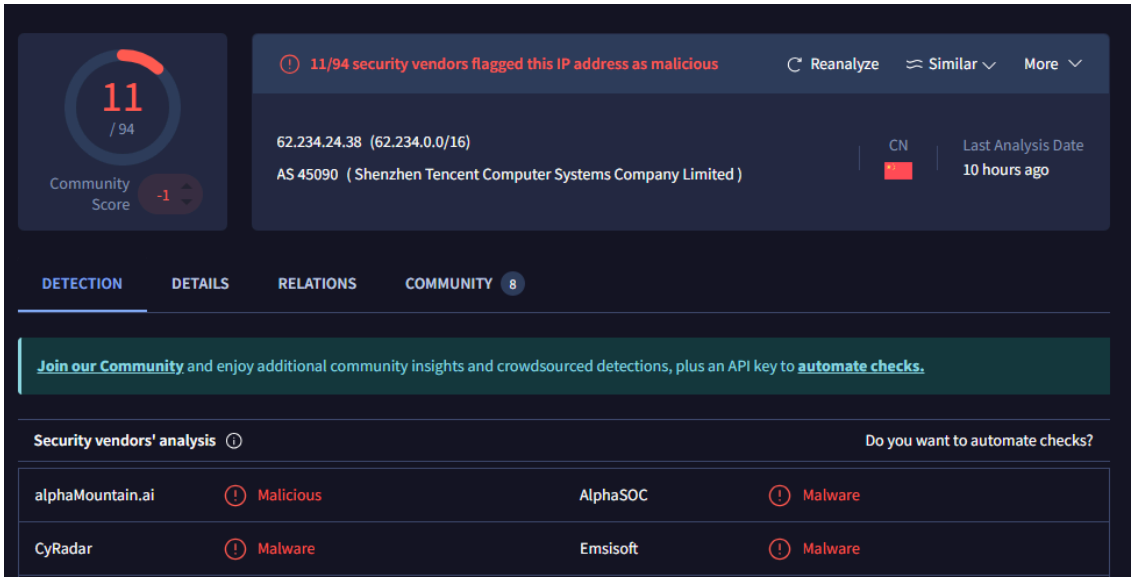
The first step to begin a more in-depth analysis is to identify a target process for our analysis. Below, we can easily see this target, simply by the binary name, which completely deviates from the standards of the others with **PID 1724**.



But of course, we can look for other indicators that this process is suspicious, to ensure we've chosen the correct process for our analysis. Fortunately, when we identified processes that were making connections, we observed the same process with *PID 1724* making a connection to IPv4 address **62.234.24.38**, on **TCP port 9999**.



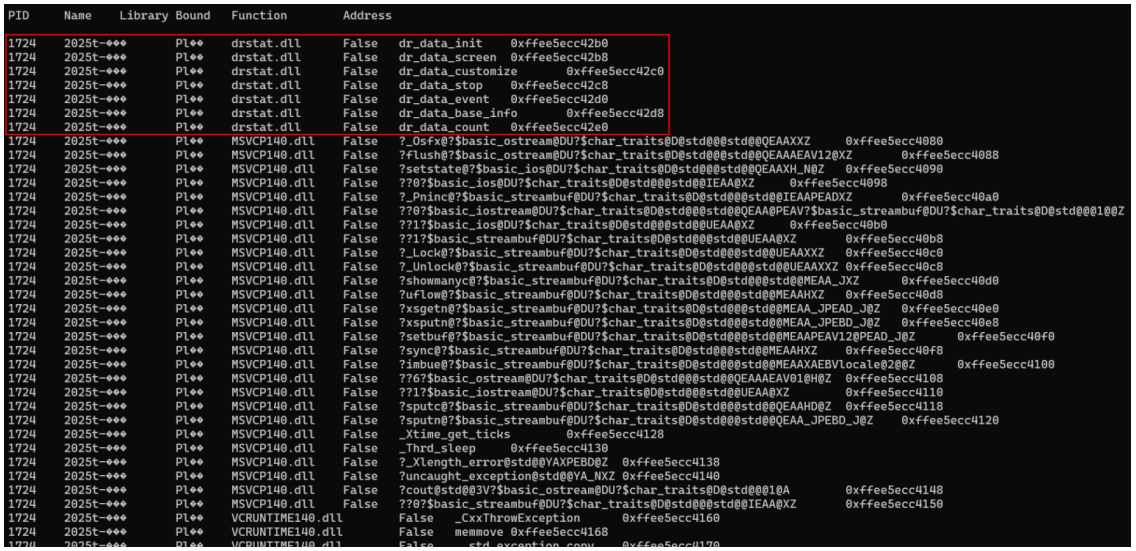
Well, the high TCP port itself is suspicious, but if we go back to the research we did previously, or if we just throw this IPv4 address into VirusTotal, we will validate the indicator of compromise being the process with *PID 1724*.



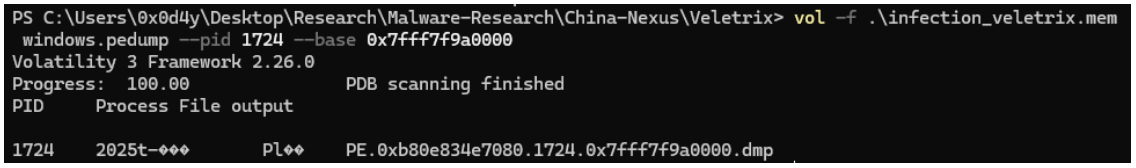
Diving Deeper into Windows Memory

Now we'll delve deeper into the Windows memory dump to identify the details of this infection, such as the detection, extraction, and analysis of malicious code directly from memory. Therefore, let's start with the DLLs imported and used by the binary of the malicious process with *PID 1724*. Below, we can see that the process imports several standard libraries, but four are noteworthy because they are located within the same directory as the main binary (delivered via Phishing).

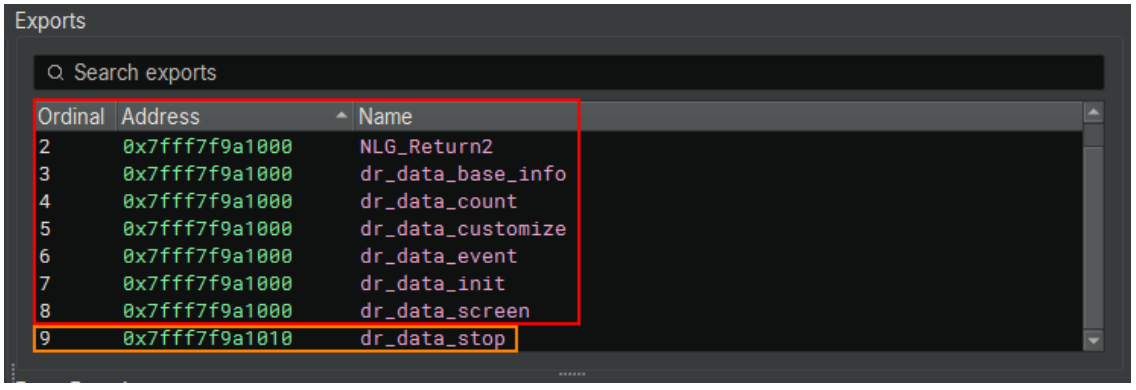
They're noteworthy simply because they contain DLLs within the main binary directory, but the **drstat.dll** DLL is the prime suspect, as the others are known to be standard libraries for the *Visual Studio C++ Runtime*. To validate this information, we simply need to look at the APIs that process *PID 1724* imported when it ran. All functions related to the **MSVCP140** and **VCRUNTIME140** DLLs are standard, but those in drstat.dll are noteworthy because they're unusual.



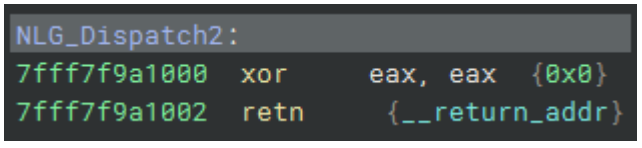
To validate our suspicion, we simply need to extract the *drstat.dll* DLL artifact to conduct reverse engineering to validate the artifact's maliciousness.



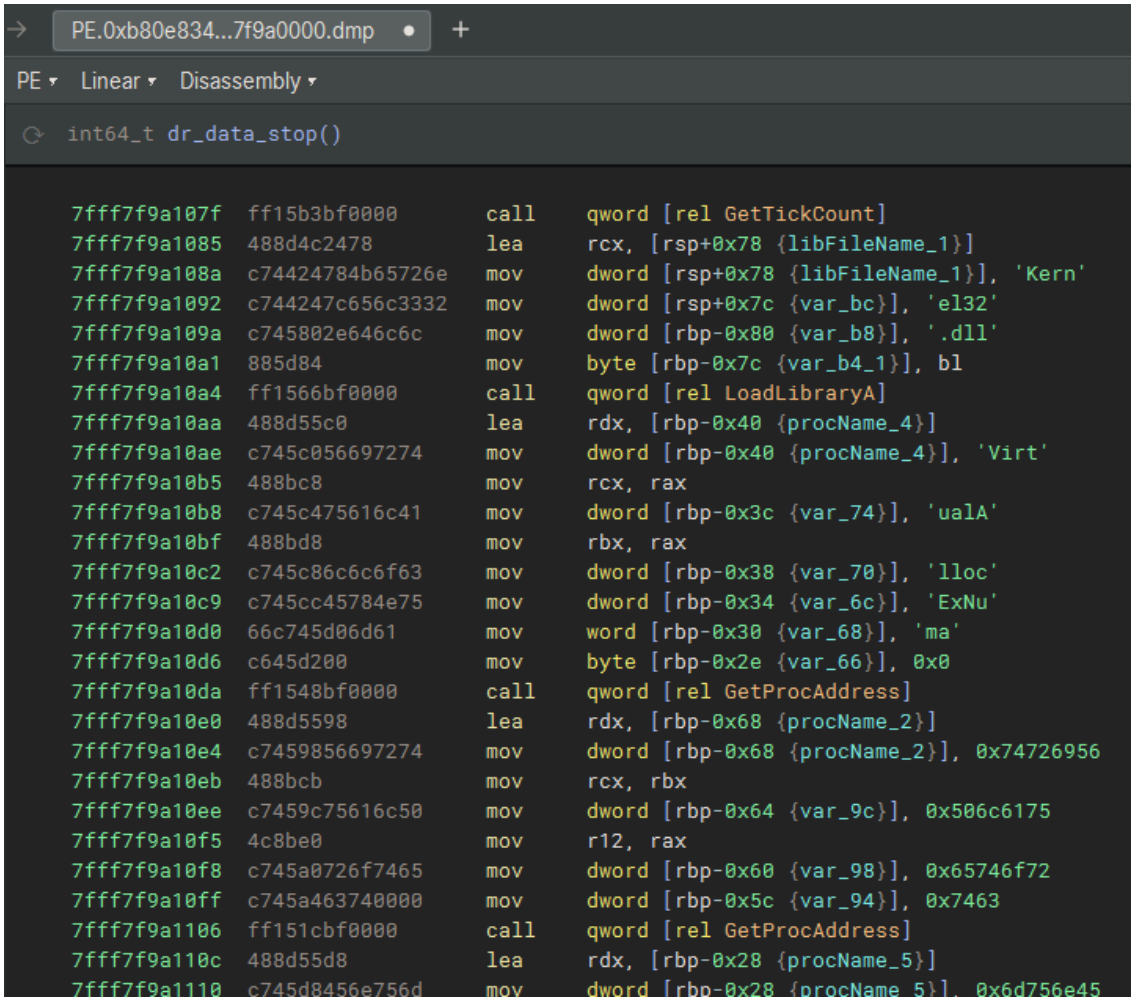
When opening the PE extracted from the memory dump using Volatility, when checking the Exports (since it was a DLL) it is possible to observe that all Exports had the same address, except for the **dr_data_stop** Export.



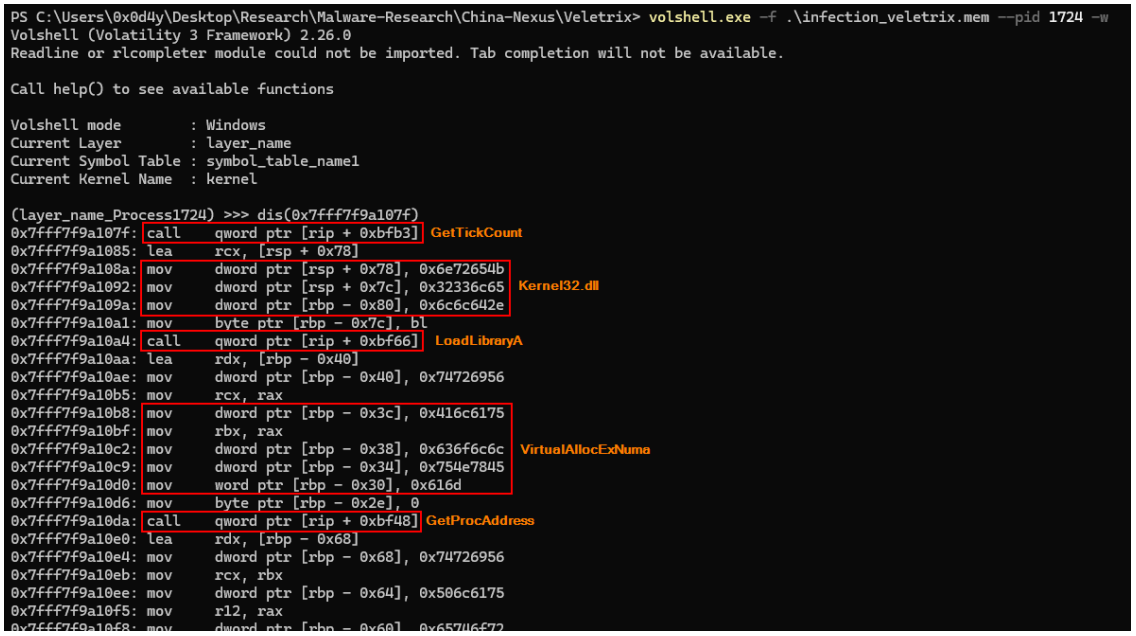
If we access every Export that points to the same address, we will find a dead function, which just **returns 0**.



Below, you can see that the **dr_data_stop** function, specifically, contains malicious code identified in my latest research. In this example, we're viewing the snippet of malicious code responsible for dynamically loading *kernel32.dll* and certain APIs required for shellcode decryption, allocation, and execution in memory.



To validate the existence of this code in the infected system's memory, we can use **volshell.exe** to print the Disassembly code from the previously identified address, and thus, we can observe the exact code described in the previous image using Binary Ninja.



Well, we already know that the **drstat.dll** DLL loaded via DLL-Sideloading is malicious, and that through the **dr_data_stop** function, the malware loads **kernel32.dll** and certain APIs to decrypt shellcode and execute it in memory. Therefore, now we need to detect the shellcode in memory, which is responsible for connecting to the previously identified C&C server.

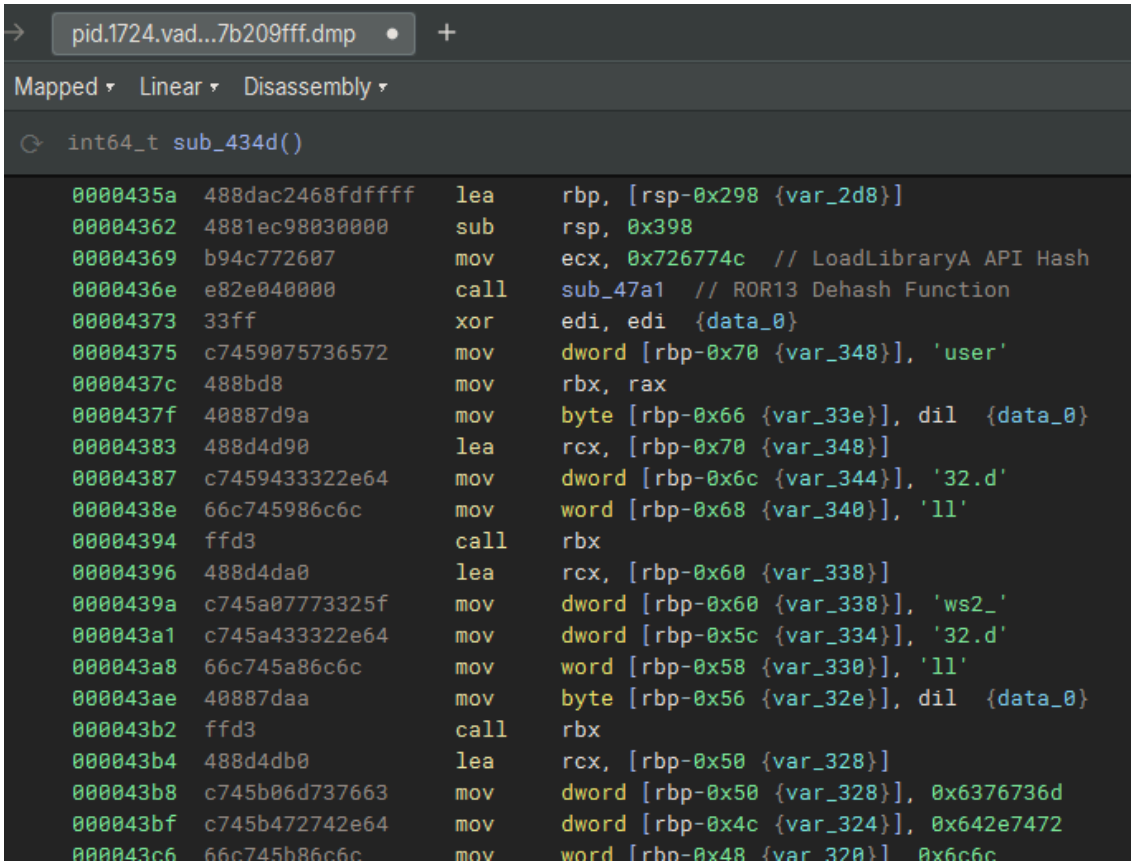
To do this, we need to take a deeper look at *VADs*. *VADs* (*Virtual Address Descriptors*) are Windows data structures that describe regions of virtual memory allocated to each process, including permissions, protection type, and commit status. Therefore, if we only look for regions with *Execute* permission, we won't get anywhere, as only the regions containing DLLs have such permissions. However, by looking at the number of pages reserved for use, that is, the number of *Committed* regions in a *VAD*, we can observe that a specific region contains a significant number with this characteristic, different from the remaining *VADs* for that process, serving as an anomaly indicator.

```
PID    Process Offset  Start VPN       End VPN Tag     Protection      CommitCharge    PrivateMemory   Parent  File    File output

1724    2025t-  0xffffb80e849c00e0      0x7ff5f8db0000  0x7ff5fadb0fff  VadS    PAGE_READWRITE  1       1       0x0     N/A     Disabled
1724    2025t-  0xffffb80e849c0040      0x2027ac60000   0x2027ac61fff   VadS    PAGE_READWRITE  2       1       0xffffb80e849c00e0      N/A     Disabled
1724    2025t-  0xffffb80e84cb87e0      0x2027ac80000   0x2027ac80fff   Vad     PAGE_READONLY   0       0       0xffffb80e849c0040      N/A     Disabled
1724    2025t-  0xffffb80e849bec40      0x83a7000000    0x83a71fffff    VadS    PAGE_READWRITE  9       1       0xffffb80e84cb87e0      N/A     Disabled
1724    2025t-  0xffffb80e849bed30      0x7ffe7000      0x7ffe7fff      VadS    PAGE_READONLY   1       1       0xffffb80e849bec40      N/A     Disabled
1724    2025t-  0xffffb80e849be150      0x7ffe0000      0x7ffe0fff      VadS    PAGE_READONLY   1       1       0xffffb80e849bed30      N/A     Disabled
1724    2025t-  0xffffb80e849bfd20      0x83a6e30000    0x83a6f2ffff    VadS    PAGE_READWRITE  8       1       0xffffb80e849bed30      N/A     Disabled
1724    2025t-  0xffffb80e849c9fa0      0x83a7300000    0x83a73fffff    VadS    PAGE_READWRITE  5       1       0xffffb80e849bec40      N/A     Disabled
1724    2025t-  0xffffb80e849c9f00      0x83a7200000    0x83a72fffff    VadS    PAGE_READWRITE  5       1       0xffffb80e849c9fa0      N/A     Disabled
1724    2025t-  0xffffb80e849ca4f0      0x83a7400000    0x83a74fffff    VadS    PAGE_READWRITE  4       1       0xffffb80e849c9fa0      N/A     Disabled
1724    2025t-  0xffffb80e84cb0ea0      0x2027ac20000   0x2027ac3cfff   Vad     PAGE_READONLY   0       0       0xffffb80e84cb87e0      N/A     Disabled
1724    2025t-  0xffffb80e84cb8060      0x2027ac10000   0x2027ac10fff   Vad     PAGE_READONLY   0       0       0xffffb80e84cb0ea0      N/A     Disabled
1724    2025t-  0xffffb80e84cb0540      0x2027ac40000   0x2027ac43fff   Vad     PAGE_READONLY   0       0       0xffffb80e84cb0ea0      N/A     Disabled
1724    2025t-  0xffffb80e84cb3ce0      0x2027ac50000   0x2027ac50fff   Vad     PAGE_READONLY   0       0       0xffffb80e84cb0540      N/A     Disabled
1724    2025t-  0xffffb80e849c08b0      0x2027ae50000   0x2027af4fffff  VadS    PAGE_READWRITE  64      1       0xffffb80e849c0040      N/A     Disabled
1724    2025t-  0xffffb80e849b7260      0x2027ad60000   0x2027ad79fff   VadS    PAGE_READWRITE  2       1       0xffffb80e849c08b0      N/A     Disabled
1724    2025t-  0xffffb80e84cb7840      0x2027ac80000   0x2027ac8fff    Vad     PAGE_READWRITE  0       0       0xffffb80e849b7260      N/A     Disabled
1724    2025t-  0xffffb80e84cb8100      0x2027ac70000   0x2027ac70fff   Vad     PAGE_READONLY   0       0       0xffffb80e84cb7840      N/A     Disabled
1724    2025t-  0xffffb80e84cb8f60      0x2027ac90000   0x2027ad58fff   Vad     PAGE_READONLY   0       0       0xffffb80e84cb7840      \Windows\System32\locale.nls    Disabled
1724    2025t-  0xffffb80e84a7f8a0      0x2027ada0000   0x2027ada7fff   Vad     PAGE_READONLY   0       0       0xffffb80e849b7260      N/A     Disabled
1724    2025t-  0xffffb80e849b7080      0x2027ad80000   0x2027ad99fff   VadS    PAGE_READWRITE  1       1       0xffffb80e84a7f8a0      N/A     Disabled
1724    2025t-  0xffffb80e849b6770      0x2027ae00000   0x2027ae0ffff   VadS    PAGE_READWRITE  7       1       0xffffb80e84a7f8a0      N/A     Disabled
1724    2025t-  0xffffb80e84a7f940      0x2027b410000   0x2027b590fff   Vad     PAGE_READONLY   0       0       0xffffb80e849c08b0      N/A     Disabled
1724    2025t-  0xffffb80e84a7f6c0      0x2027b210000   0x2027b40ffff   Vad     PAGE_READONLY   0       0       0xffffb80e84a7f940      N/A     Disabled
1724    2025t-  0xffffb80e849b7f30      0x2027af50000   0x2027b209fff   VadS    PAGE_READWRITE  698     1       0xffffb80e84a7f6c0      N/A     Disabled
1724    2025t-  0xffffb80e84cb8600      0x7fff4f8c90000 0x7fff4f8d8ffff Vad     PAGE_READONLY   0       0       0xffffb80e84a7f940      N/A     Disabled
1724    2025t-  0xffffb80e82dbf3b0      0x2027b5a0000   0x2027c9a0fff   Vad     PAGE_READONLY   0       0       0xffffb80e84cb8600      N/A     Disabled
1724    2025t-  0xffffb80e849c0860      0x7fff4f8d90000 0x7fff5f8daffff VadS    PAGE_READWRITE  0       1       0xffffb80e84cb8600      N/A     Disabled
1724    2025t-  0xffffb80e84a67f20      0x7fff88880000  0x7fff8897ffff  Vad     PAGE_EXECUTE_WRITECOPY  4       0       0xffffb80e849c00e0      \Windows\System32\ucrtbase.dll  Disabled
1724    2025t-  0xffffb80e84a6b1c0      0x7fff7f9a0000  0x7fff7f9bcfff  Vad     PAGE_EXECUTE_WRITECOPY  3       0       0xffffb80e84a67f20      \Users\Researcher\Downloads\veletrix\veletrix\drstat.dll Disabled
1724    2025t-  0xffffb80e84a69e60      0x7fff69a40000  0x7fff69ac8fff  Vad     PAGE_EXECUTE_WRITECOPY  5       0       0xffffb80e84a6b1c0      \Users\Researcher\Downloads\veletrix\veletrix\msvcp140.dll       Disabled
1724    2025t-  0xffffb80e84c986c0      0x7ff72f660000  0x7ff72f66afff  Vad     PAGE_EXECUTE_WRITECOPY  2       0       0xffffb80e84a69e60      \Users\Researcher\Downloads\veletrix\veletrix\2025年中国移动有限公司内部培训计划即将启动，请尽快报名.exe       Disabled
1724    2025t-  0xffffb80e84ca4f60      0x7ff5fadd0000  0x7ff5fadf2fff  Vad     PAGE_READONLY   0       0       0xffffb80e84c986c0      N/A     Disabled
1724    2025t-  0xffffb80e84cac620      0x7ff5fadc0000  0x7ff5fadc0fff  Vad     PAGE_READONLY   0       0       0xffffb80e84ca4f60      N/A     Disabled
1724    2025t-  0xffffb80e82dc1930      0x7fff69a00000  0x7fff69a1afff  Vad     PAGE_EXECUTE_WRITECOPY  4       0       0xffffb80e84c986c0      \Windows\System32\pnrpnsp.dll   Disabled
1724    2025t-  0xffffb80e82dc2d30      0x7fff508f0000  0x7fff50101fff  Vad     PAGE_EXECUTE_WRITECOPY  3       0       0xffffb80e82dc1930      \Windows\System32\winrnr.dll    Disabled
1724    2025t-  0xffffb80e82dc0990      0x7fff69a20000  0x7fff69a36fff  Vad     PAGE_EXECUTE_WRITECOPY  3       0       0xffffb80e82dc1930      \Windows\System32\NapiNSP.dll   Disabled
1724    2025t-  0xffffb80e82dc2f10      0x7fff7bed0000  0x7fff7bf4ffff  Vad     PAGE_EXECUTE_WRITECOPY  3       0       0xffffb80e84a69e60      \Windows\System32\FWPUCLNT.DLL  Disabled
1724    2025t-  0xffffb80e82dc1d90      0x7fff75260000  0x7fff7527ffff  Vad     PAGE_EXECUTE_WRITECOPY  4       0       0xffffb80e82dc2f10      \Windows\System32\wshbth.dll    Disabled
1724    2025t-  0xffffb80e82dc23d0      0x7fff7b420000  0x7fff7b429fff  Vad     PAGE_EXECUTE_WRITECOPY  3       0       0xffffb80e82dc1d90      \Windows\System32\rasadhlp.dll  Disabled
1724    2025t-  0xffffb80e84a69f00      0x7fff7f980000  0x7fff7f99dfff  Vad     PAGE_EXECUTE_WRITECOPY  2       0       0xffffb80e82dc2f10      \Users\Researcher\Downloads\veletrix\veletrix\vcruntime140.dll  Disabled
```

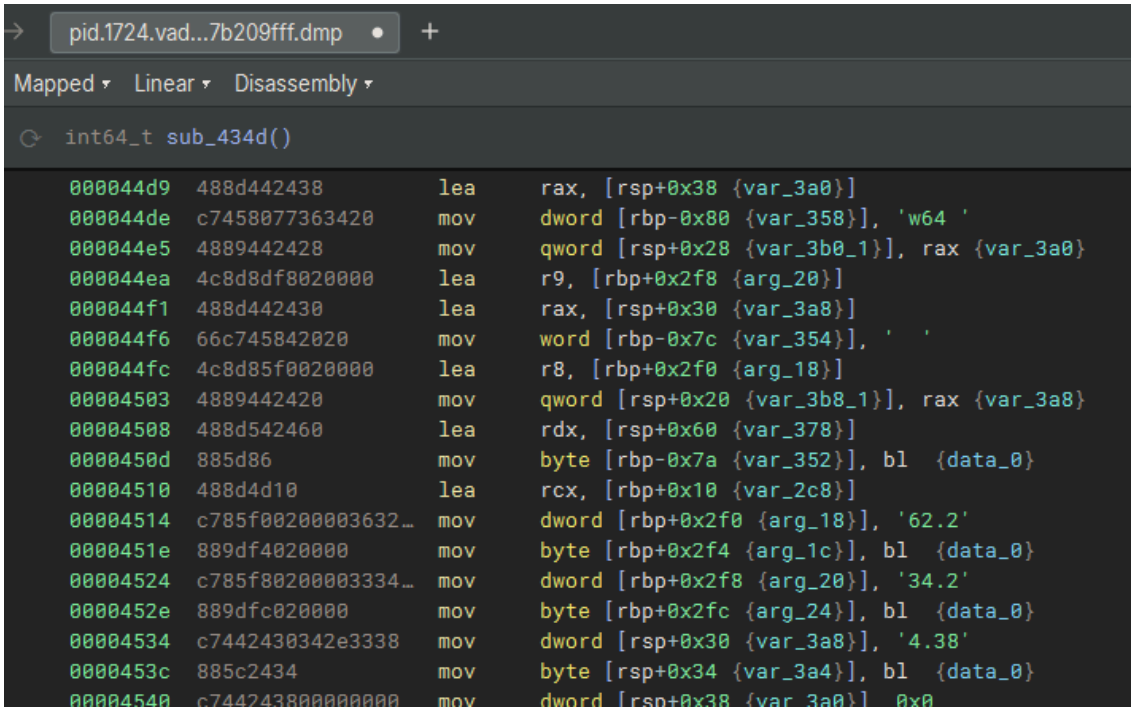
So let's extract this VAD to statically analyze it through reverse engineering.

```
PS C:\Users\0x0d4y\Desktop\Research\Malware-Research\China-Nexus\Veletrix> vol -f .\infection_veletrix.mem windows.vadinfo --pid 1724
 --address 0x2027af50000 --dump
Volatility 3 Framework 2.26.0
Progress:  100.00               PDB scanning finished
PID     Process Offset  Start VPN       End VPN Tag     Protection      CommitCharge    PrivateMemory   Parent  File    File output

1724    2025t-  0xffffb80e849b7f30      0x2027af50000   0x2027b209fff   VadS    PAGE_READWRITE  698     1       0xffffb80e84a7f6c0      N/A     pid.1724.vad.0x2027af50000-0x2027b209fff.dmp
```

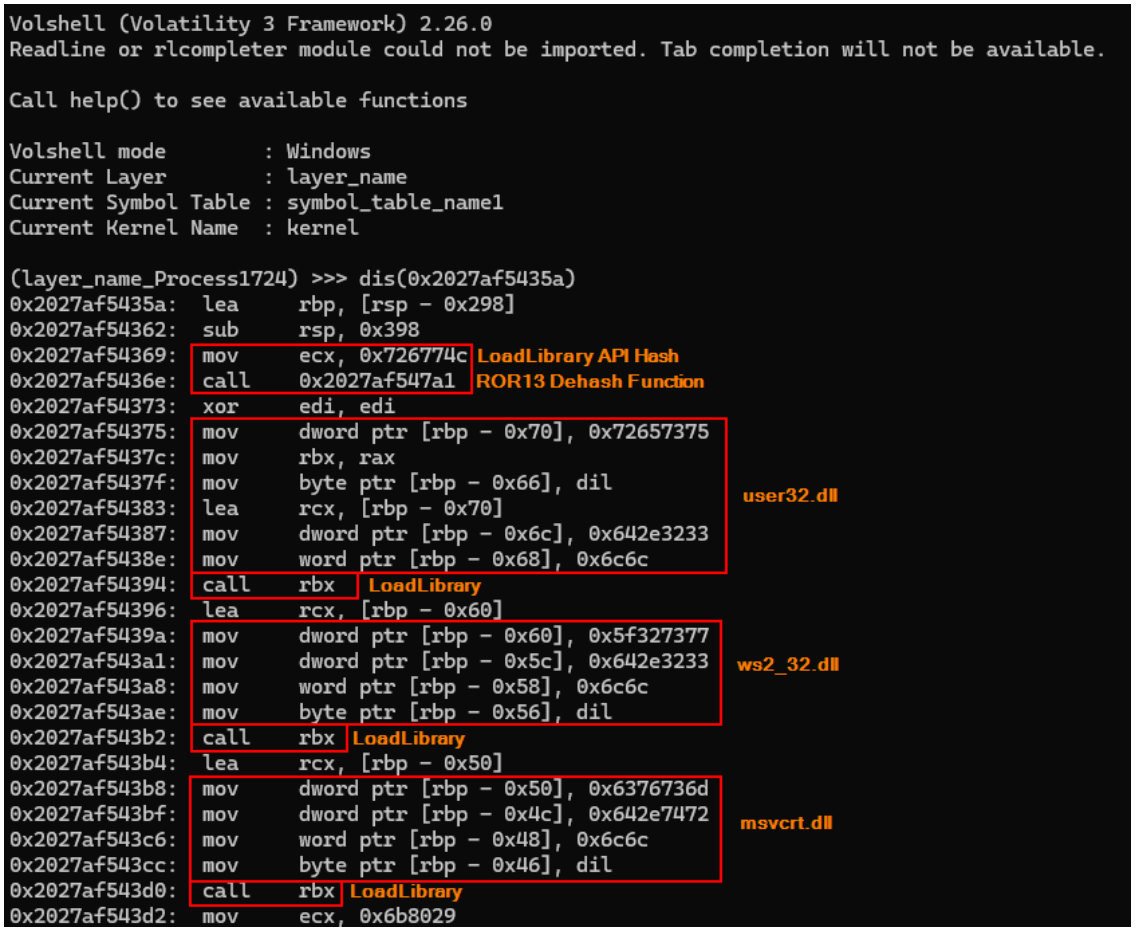
By opening the suspicious data block extracted from the memory dump, we can quickly identify the *shellcode*. Below, we can see a snippet of code that implements the *LoadLibrary* API's hashing technique to dynamically load the DLLs *user32.dll*, *ws2_32.dll*, and others.

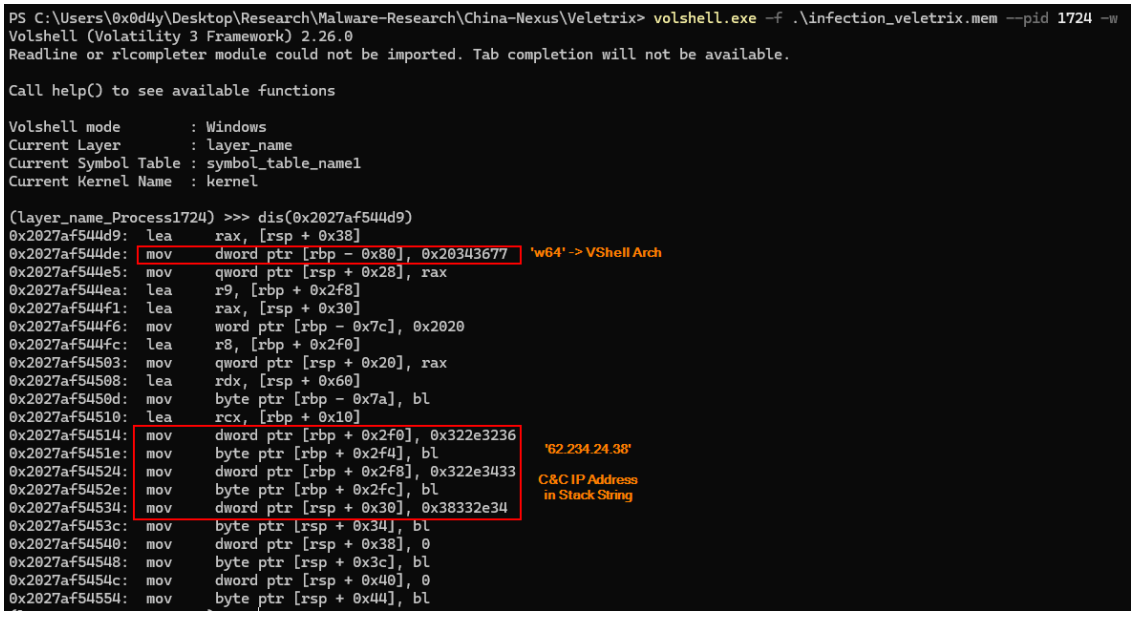


Also in this same code snippet, we can observe the *IPv4* address identified previously, which is the address of the *C&C* server that will be contacted.



Also using Volshell, we can detect exactly the code snippets described in the images above, with the aim of validating their presence in the memory dump, as we can see in the sequence of images below.



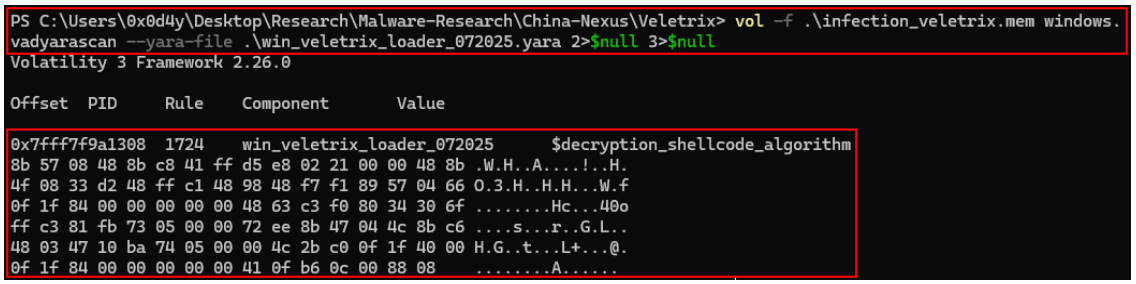


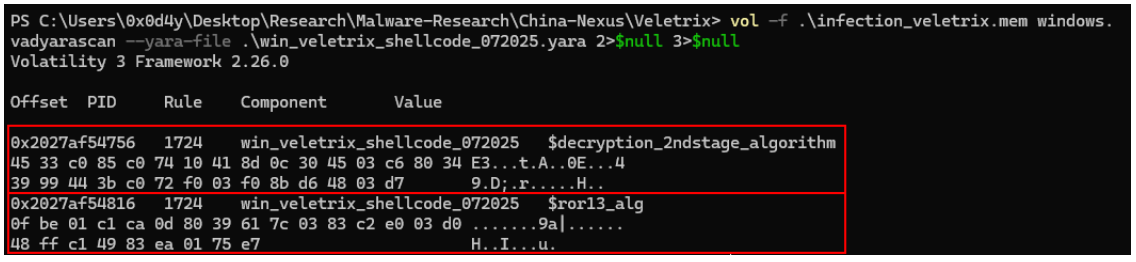
Therefore, we can observe that through forensic analysis of a memory dump from an infected system (in this case, by *Veletrix Loader*), combined with reverse engineering of artifacts extracted directly from the memory dump, we can arrive at the same analysis result, however, through the perspective of a *DFIR Analyst*.

The Importance of Threat Intelligence

And this is a good case where quality threat intelligence takes on significant importance. In this analysis, I pretended not to have the Yara rules at my disposal, trying to reach the same conclusion I reached when I had the malware itself on hand to reverse engineer it.

Below, we can see how much the use of Yara rules would automate our time, but a DFIR Analyst does not always have this at their disposal, and therefore, the analyst is required to have expertise in identifying, analyzing and extracting malicious code, and from this analysis, extracting intelligence.





Final Conclusion

This deepening of the memory forensic analysis perspective allows us to understand the same threat, but from a different perspective that enriches the overall context surrounding this threat. I believe I will incorporate these analyses whenever possible in future researches.

With this perspective, in addition to identifying the patterns identified during reverse engineering, we are also able to extract unique patterns from this analysis, which can help in categorizing the Tactics, Techniques, and Procedures identified during the analysis, and thus enrich the intelligence produced about this campaign.

Tactics	Technique	Details Observed in the Analysis
Initial Access	Spearphishing Attachment [T1566.001]	The Threat Actor delivers, through Spear Phishing, a ZIP file targeted at the Telecom company context, containing benign software from Wondershare, which, when executed by the user, executes the malicious DLL that was placed by the adversary, executing the DLL Side-Loading technique.

Tactics	Technique	Details Observed in the Analysis
Execution	User Execution: Malicious File [T1204.002]	Upon receiving Spear Phishing, the victim is tricked into executing the payload delivered to them.
Defense Evasion	Embedded Payloads [T1027.009]	Inside the Malicious DLL, it contains an encrypted payload, which is the Veletrix Loader Shellcode.
Defense Evasion	Dynamic API Resolution [T1027.007]	Both the malicious DLL and Shellcode implement this technique to evade static detection of their capabilities.
Defense Evasion	Process Injection [T1055]	To be executed by the benign PE, the malicious DLL injects a Shellcode that will initiate communication with the C&C server.
Defense Evasion	Encrypted/Encoded File [T1027.013]	The Shellcode present in the malicious DLL is encrypted and obfuscated using the IPV4Fuscated technique.
Command and Control	Non-Standard Port [T1571]	Shellcode Communicates with the C&C Server via TCP Protocol on port TCP/9999.
Command and Control	Ingress Tool Transfer [T1105]	Shellcode connects to the C&C Server to download and execute in VShell memory

I hope you, the reader, enjoyed this new perspective on Veletrix Loader research. Until next time!
