Babble Babble Babble Babble Babble Babble BabbleLoader

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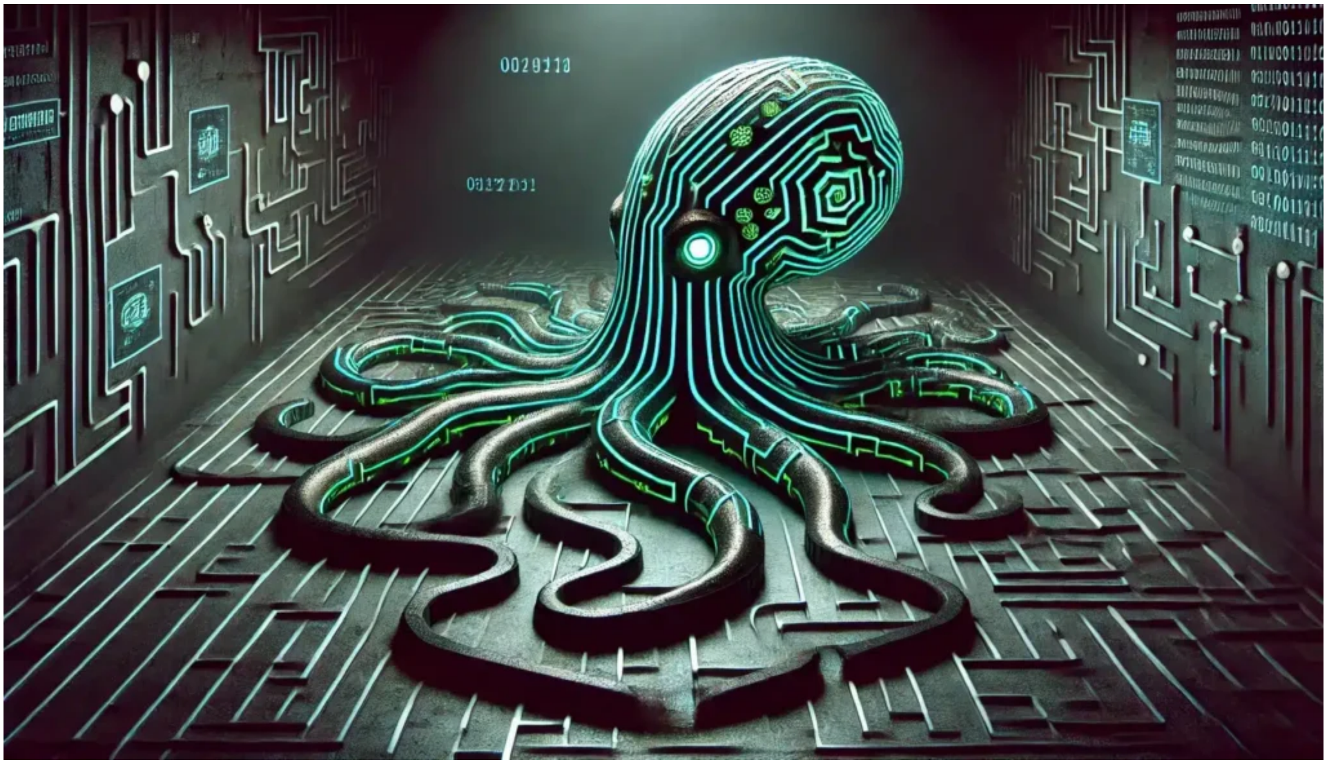
November 17, 2024



Loaders, an Ever Evolving Market

The pace of innovation and development in the malware detection market is relentless, the same goes for the development of malware itself. Constantly charging and adapting to create ever more evasive and capable payloads.

One such sector of this market is the loader (also called crypter or packer) market. In today's threat landscape, loaders have become a critical tool in cybercrime operations, serving as the backbone for delivering a range of malicious payloads. Loaders are often the first stage in an attack chain, designed to stealthily execute or inject malware, such as info-stealers or ransomware, into a target system. Their prevalence reflects an evolution in tactics, allowing threat actors to evade traditional antivirus defenses through techniques like in-memory execution and anti-analysis features. Widely available for purchase or lease on underground markets, loaders are now a commodity in malware distribution, making sophisticated attack methods accessible to a broader range of actors and adaptable across diverse campaigns and targets.

In this blog, we will introduce “BabbleLoader”, an extremely evasive loader, packed with defensive mechanisms, that is designed to bypass antivirus and sandbox environments to deliver stealers into memory.

BabbleLoader’s Techniques to Evade Traditional and AI Systems

BabbleLoader stands out for its array of sophisticated evasion techniques that challenge both traditional and AI-based detection systems. Key features include junk code insertion and metamorphic transformations, which alter the loader’s structure and flow, effectively evading signature-based, Artificial Intelligence, and behavioral detections. Through dynamic API resolution, the loader sidesteps common API monitoring by resolving necessary functions only at runtime, preventing static analysis from identifying telltale Windows APIs. Also bypassing sandbox injected DLLs that hook API calls. Shellcode loading and decryption further obfuscate the payload by embedding and decrypting malicious code in memory, bypassing file-based scanning. Additionally, anti-sandboxing and anti-analysis measures detect virtual environments, impeding sandbox analysis and automated AI defenses. Together, these techniques make this loader a versatile tool, capable of subverting both static and dynamic security layers.

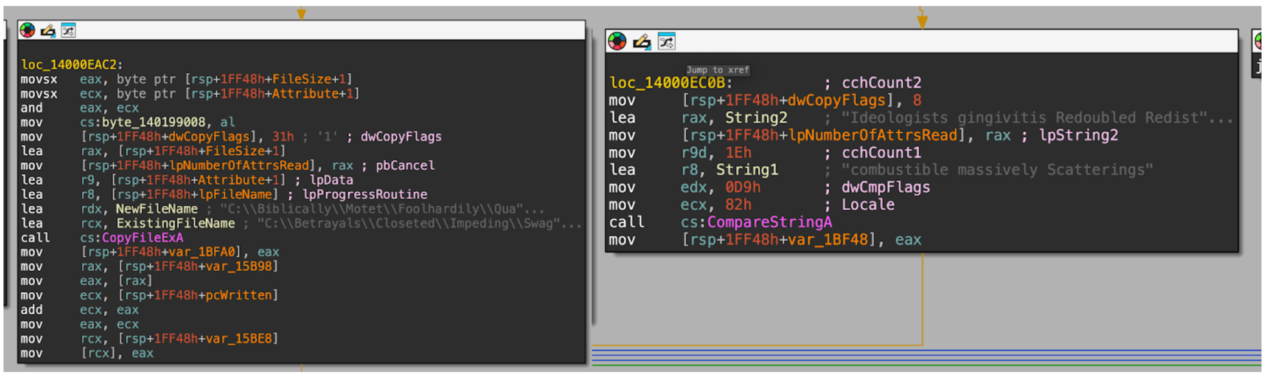
When investigating this loader, we have seen it used across multiple campaigns, targeting both English and Russian speaking individuals. Lure themes suggest it is targeting a vast range of users, from users looking to download generic cracked software, such as video editing, gaming, VPN, browsers, and utilities. We have also noticed campaigns that target with a particular focus on business professionals in finance and administration, masquerading as accounting software, and forms for filling out eligibility checks often used by HR or payroll professionals.

Technical Analysis

The sample used in this analysis is:
a08db4c7b7bacc2bacd1e9a0ac7fbb91306bf83c279582f5ac3570a90e8b0f87

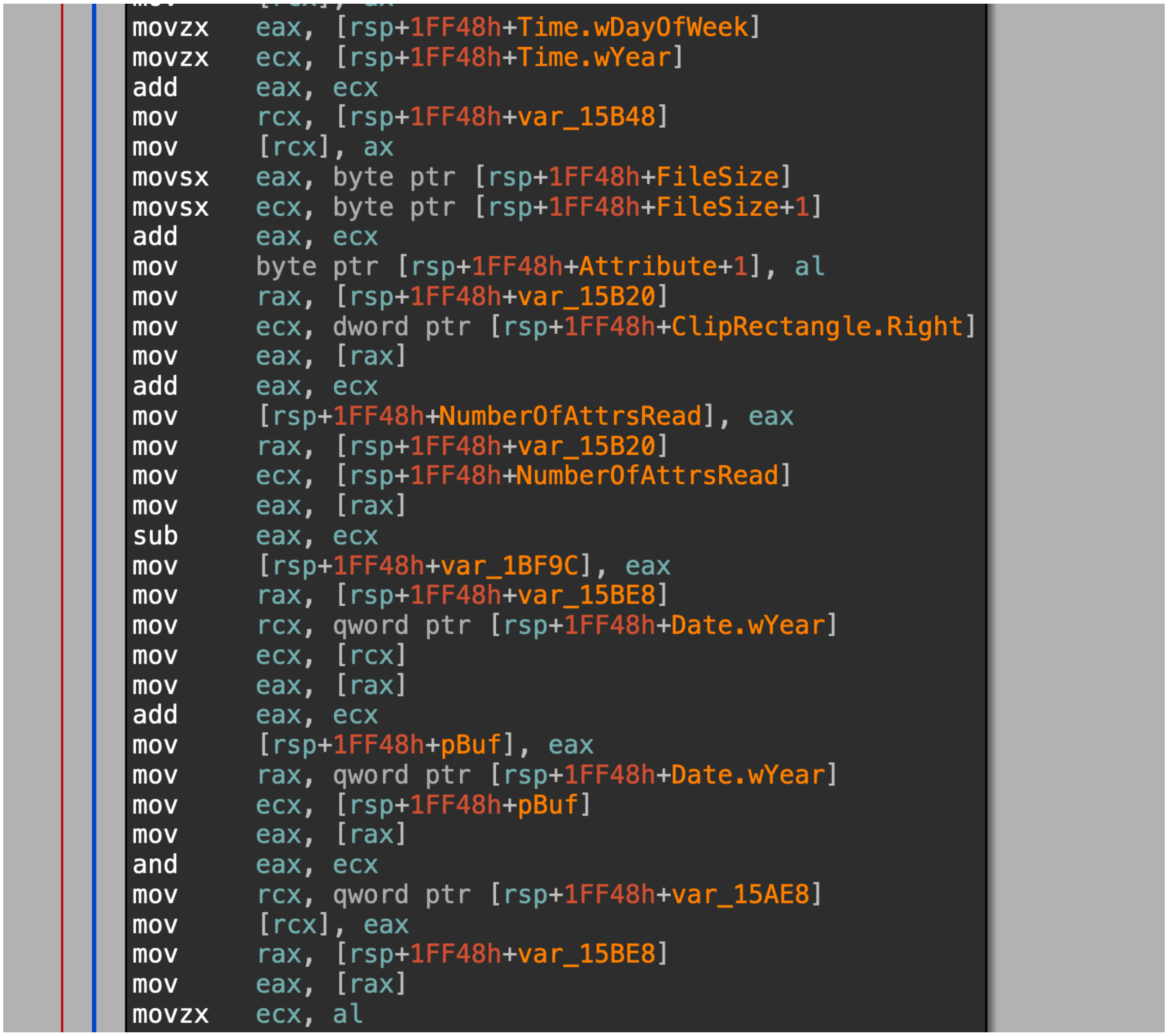
Junk Code/Metamorphism

BabbleLoader makes diabolical use of junk code. This is done in an effort to hamper analysis by confusing the analyst. This is achieved through multiple means. There are many paths of code that are never actually accessed, but use random imports with randomly generated hardcoded strings.



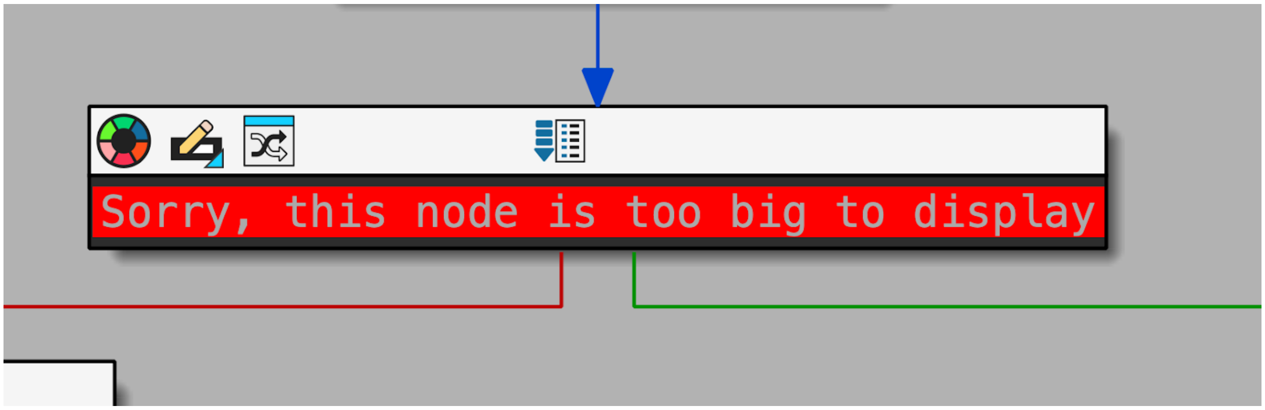
Junk Code making rubbish calls

The loader also makes excessive use of random instructions, adding values to local variables and moving data around registers for no particular functionality.



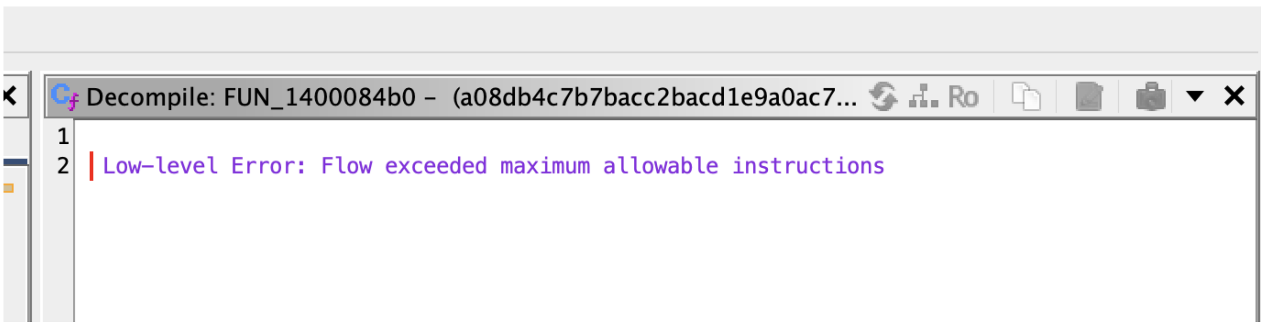
Junk Code

The amount of junk code added into the sample greatly increases the amount of code to the point where it starts to crash disassembly or decompilation tools through its sheer mass alone. In the case of IDA needs to collapse nodes due to them being so large.



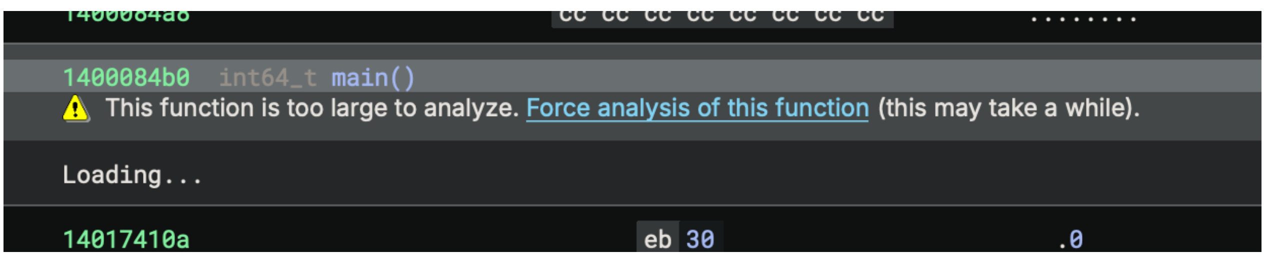
Collapsed Node in IDA

In Ghidra the function graph view will freeze and there are too many instructions for the decompiler to show.



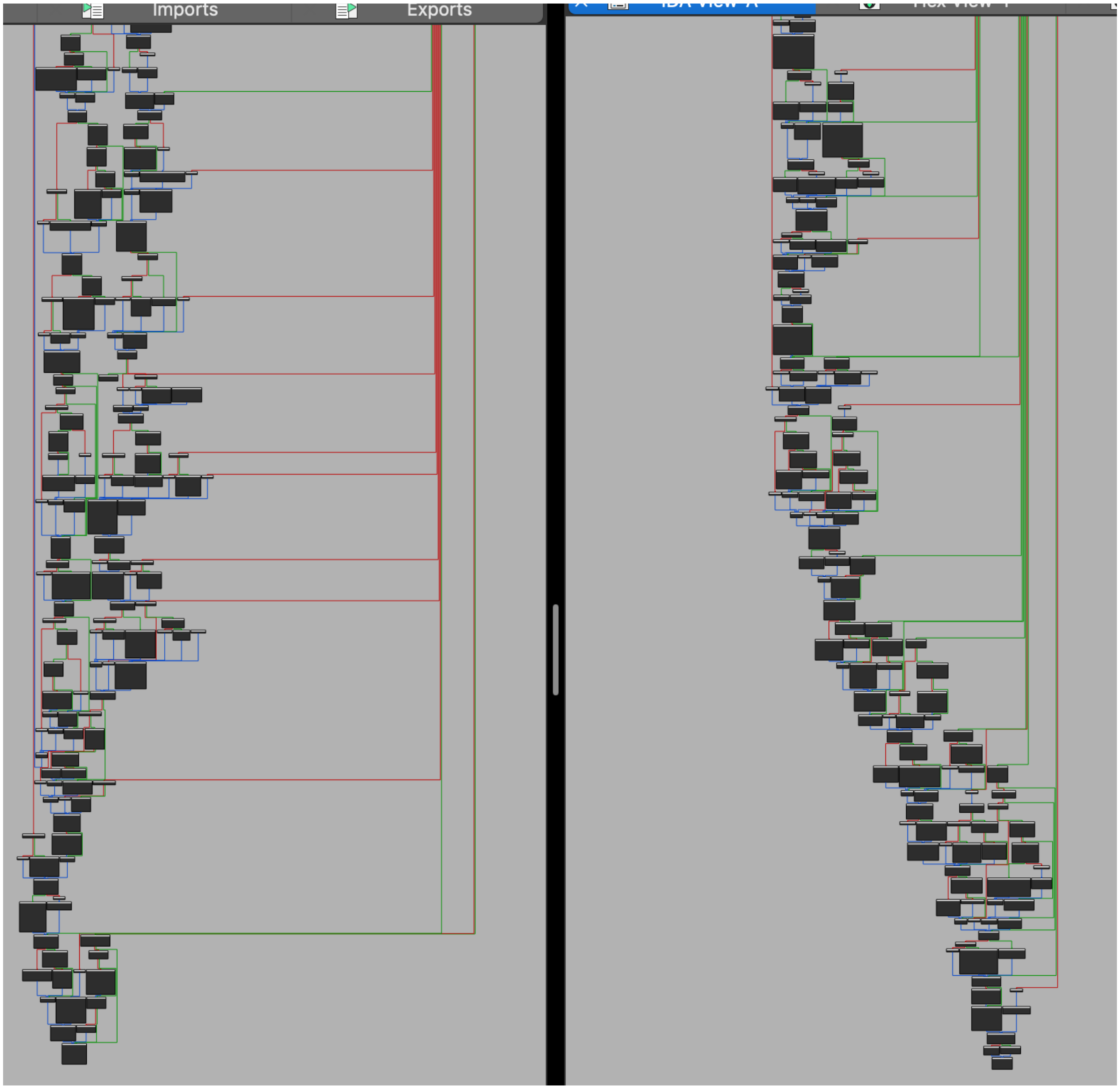
Decompilation output in Ghidra

We have even checked in Binary Ninja to see the effects of the junk code. The user is required to manually force analysis of the function due to the size.



Binary Ninja showing large function

Each of these techniques also serve the purpose of making the loader metamorphic. Each build of the loader will have unique strings, unique metadata, unique code, unique hashes, unique encryption, and a unique control flow. Each sample is structurally unique with only a few snippets of shared code. Below is a very small snippet of the main method of two different samples, showing very different control flow.



Comparison of structure of two BabbleLoader samples

Even the metadata of the file is randomized for each sample.

Property	Value
Comments	Ferry forbidden aniline tangle discoloured milkman
CompanyName	Outsourcing
FileDescription	Tormented cudgel sheer households drownings festivals
FileVersion	4.29.221.0
InternalName	Uprated disclaimer
LegalCopyright	Copyright © Saddle misunderstands respectable
LegalTrademarks	Babbling landmarks loveless metronomic

Junk Metadata

What This Means for AI-Based Analysis Techniques

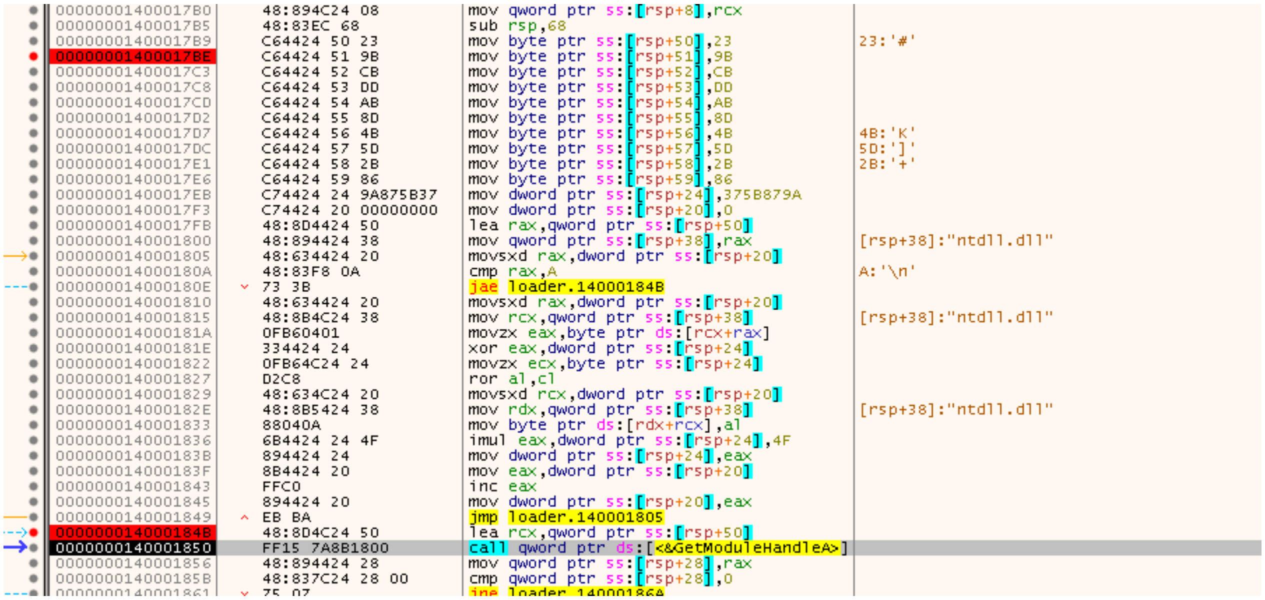
These techniques also have large implications for AI based analysis techniques. This constant variation in code structure forces AI models to continuously re-learn what to look for—a process that often leads to missed detections or false positives. By filling the code with junk instructions, the loader can trick AI into interpreting irrelevant actions as meaningful ones, leading it to predict that the malware will perform operations that it never actually executes. Junk code also generates a large volume of "noise" in the program flow, overwhelming the AI's pattern-recognition capabilities and forcing it to sift through thousands of extraneous actions that mask the true behavior of the malware.

Additionally, the inclusion of countless junk variables adds another layer of complexity. AI models analyzing variable behavior to understand data flow must now track thousands of decoy variables, each potentially obfuscated or dynamically transformed to further confuse the analysis. This variable noise, combined with the ever-shifting structure from metamorphism, makes it extremely difficult for AI to reliably determine which variables are integral to the malware's function and which are simply junk.

The sheer volume of junk code and variables also makes analyzing this loader exceptionally costly. The sheer number of tokens AI must process to parse and interpret the junk alone leads to high computational and financial costs, effectively weaponizing the malware's complexity against AI-driven defenses. This combination of overwhelming data volume, misleading patterns, and high processing requirements creates significant challenges in detecting and analyzing the malware accurately.

Dynamic API Resolution

One of the first operations of the loader is to start the process of dynamically resolving API calls. It will achieve this through API hashing. It will first get a module handle for `ntdll.dll`. The string for the DLL is decrypted using a rolling XOR cipher.

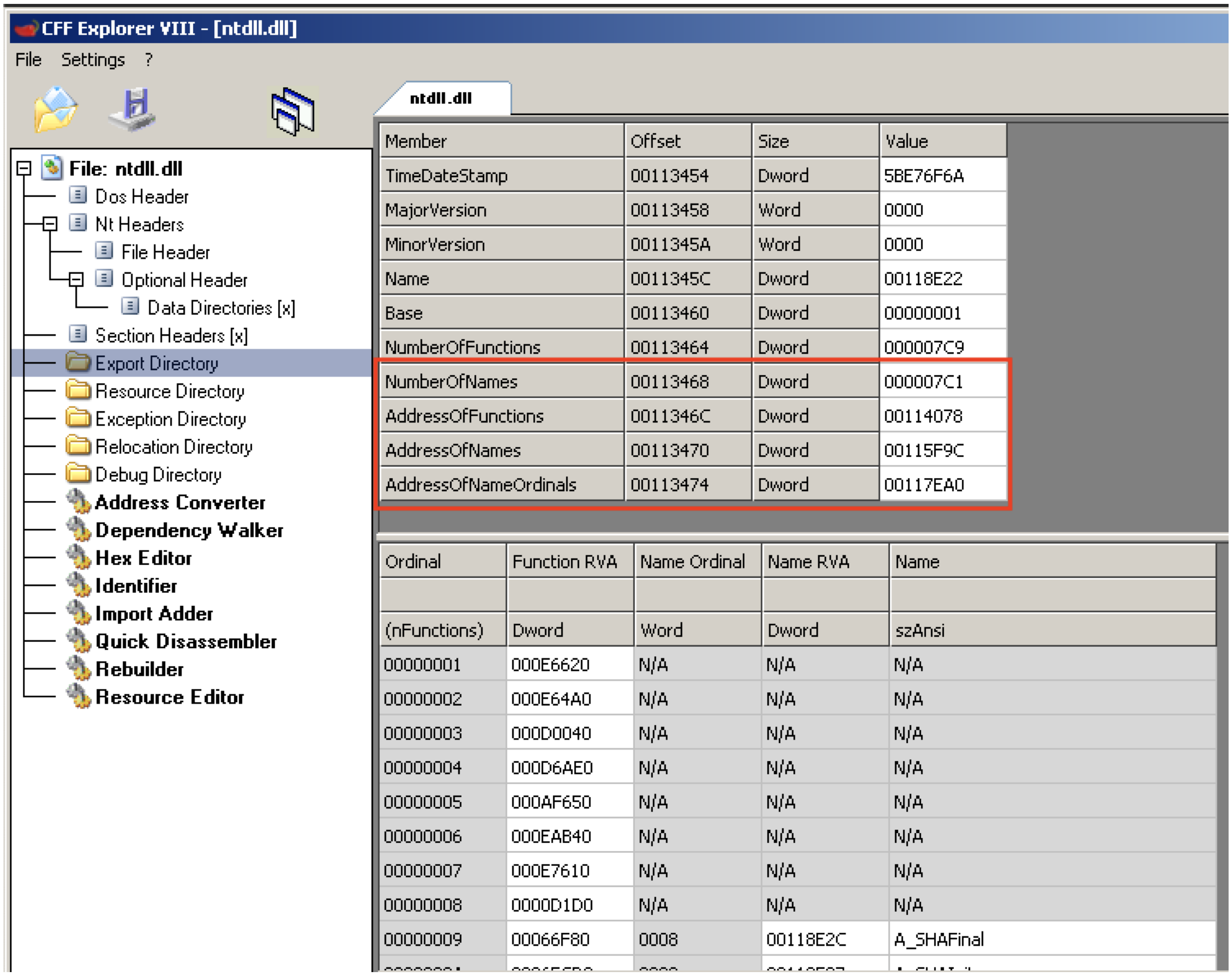


Decoding of NTDLL string

Using the returned handle, the loader will start to read the PE header of ntdll.dll and it will locate the export directory and start parsing out values that it will need to dynamically resolve the functions by hash. The loader builds up the following struct.

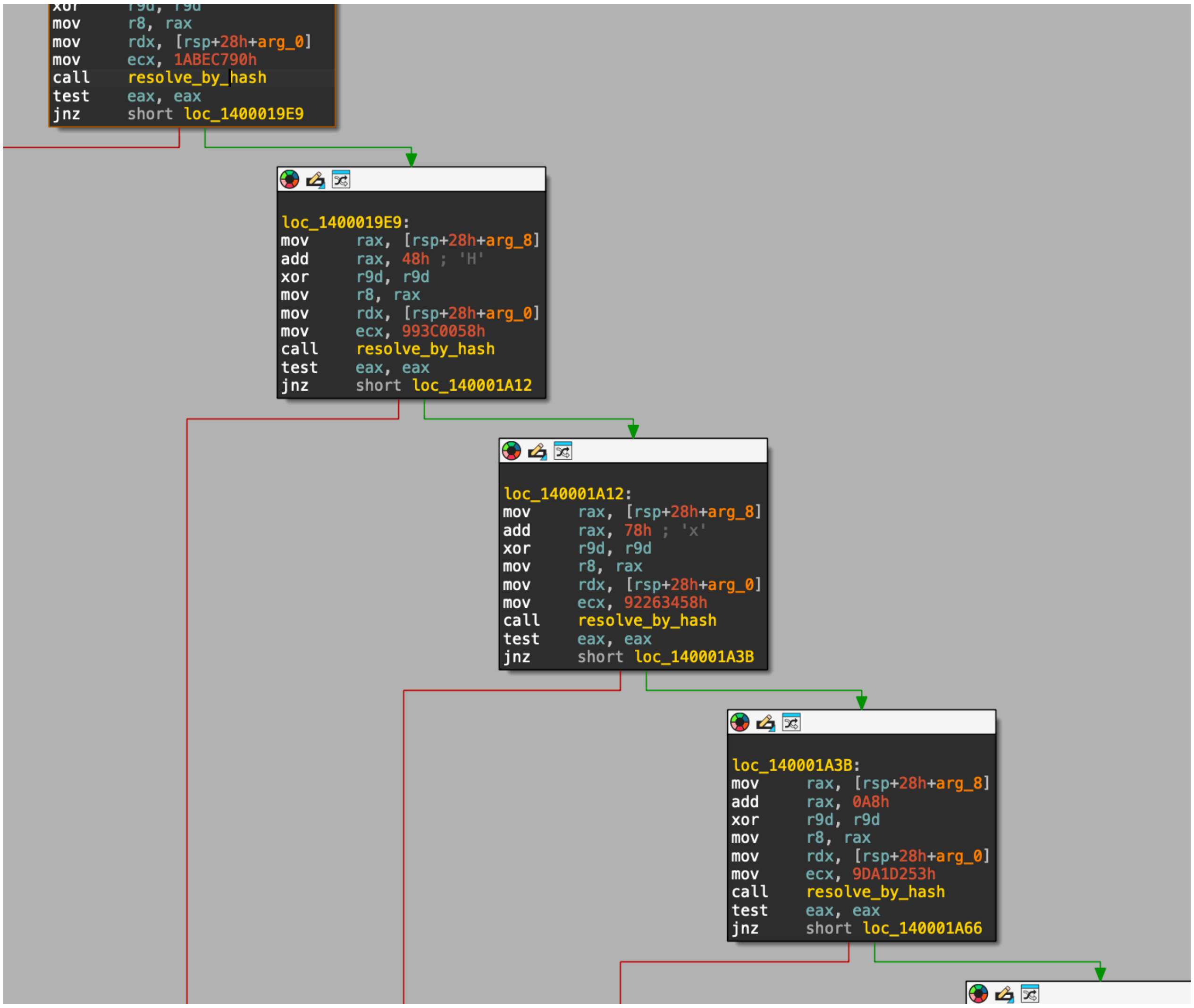
```
struct _NtDllExportInfo {
    DWORD* AddressOfFunctions;
    DWORD* AddressOfNames;
    DWORD* AddressOfNameOrdinals;
    DWORD NumberOfNames;
    HMODULE NtdllModuleHandle;
}
```

The parsed values can be seen easily from viewing the export directory in CFF explorer.



Parsed fields shown in CFF Explorer

Once the struct has been built up, it can then proceed to iterate through the export names, hashing the names to compare to hardcoded values in the binary.



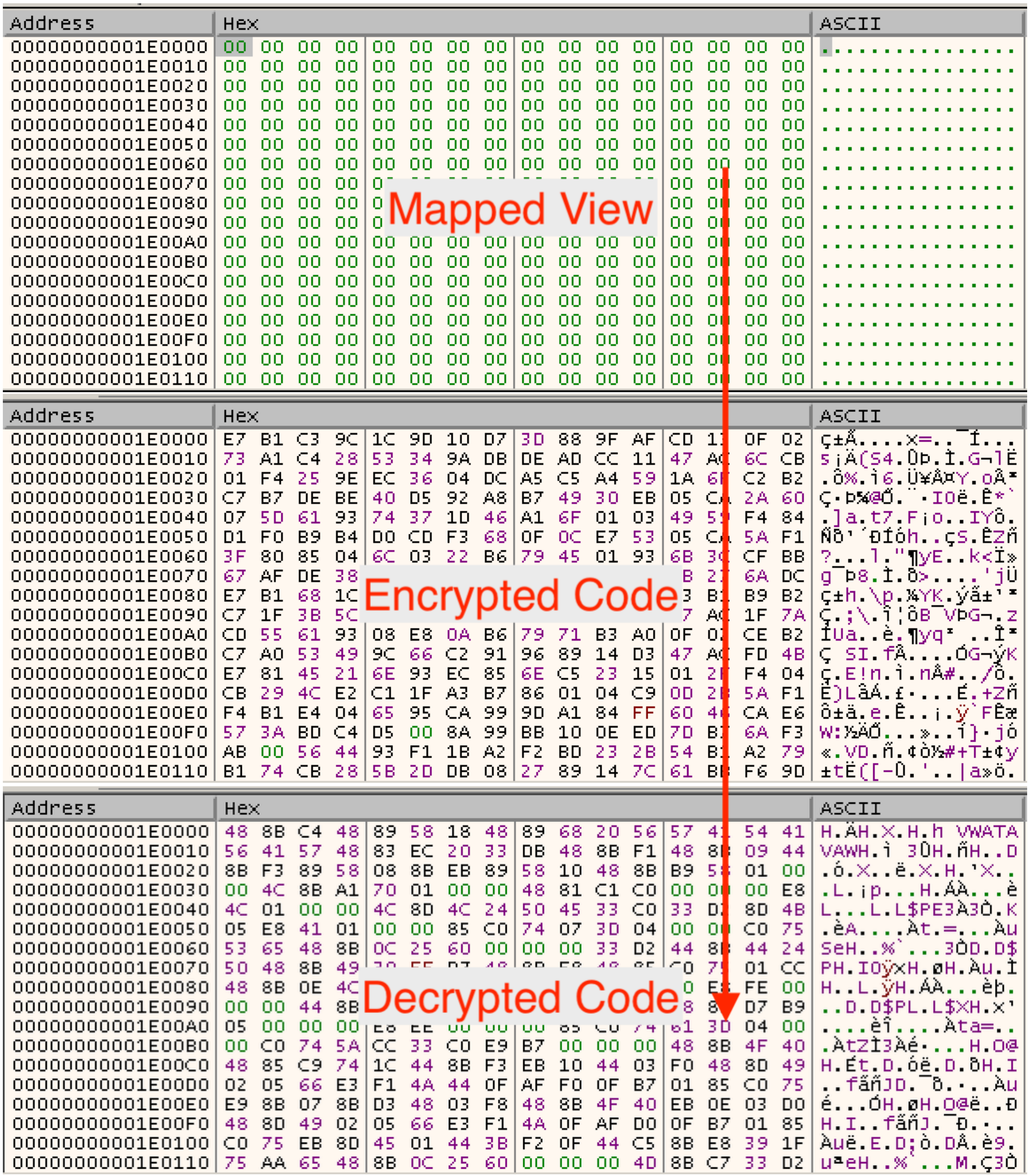
Resolution of functions by hash

The following calls are resolved, getting pointers for imports. Whilst the exports will remain the same for each build of the malware, the hashing will be unique per each build.

Hash	Call
1ABEC790	NtCreateSection
993C0058	NtMapViewOfSection
92263458	NtUnmapViewOfSection
9DA1D253	NtClose
6AF3F390	NTQuerySystemInformation
0A96AB0E4	RtlAllocateHeap
8A21A480	RtlFreeHeap

Shellcode Loading and Payload Decryption

Once the loader resolves pointers for the imports, it first calls `NtCreateSection`, followed by `NtMapViewOfSection`. This approach allows the malware to allocate and manage memory outside the standard process space. The decryption process begins with the loader rearranging the randomly stored encrypted chunks of the payload into their correct order within the mapped memory, before proceeding to decrypt each block.



Decryption stages

Before calling the decrypted code, the loader will perform one of a number of anti sandboxing checks.

AntiSandboxing/Analysis

DirectX DLL

One of the anti-sandboxing checks involves checking the installed graphics adapters to see if it is running in a sandboxed environment or not. This is achieved by importing the DLL `dxgi.dll`. The DLL is the DirectX Graphics Infrastructure library and is a core Windows DLL that provides functionality for interfacing with graphics hardware.

The exported function CreateDXGIFactory is called giving the loader a IDXGIFactory object. This allows the loader to enumerate information from the installed graphics adapters by calling `EnumAdapters`, followed by `GetDesc` from the `IDXGIAdapter` object to give a `DXGI_ADAPTER_DESC` struct.

```
typedef struct DXGI_ADAPTER_DESC
    {
    WCHAR Description[ 128 ];
    UINT VendorId;
    UINT DeviceId;
    UINT SubSysId;
    UINT Revision;
    SIZE_T DedicatedVideoMemory;
    SIZE_T DedicatedSystemMemory;
    SIZE_T SharedSystemMemory;
    LUID AdapterLuid;
    } DXGI_ADAPTER_DESC;
```

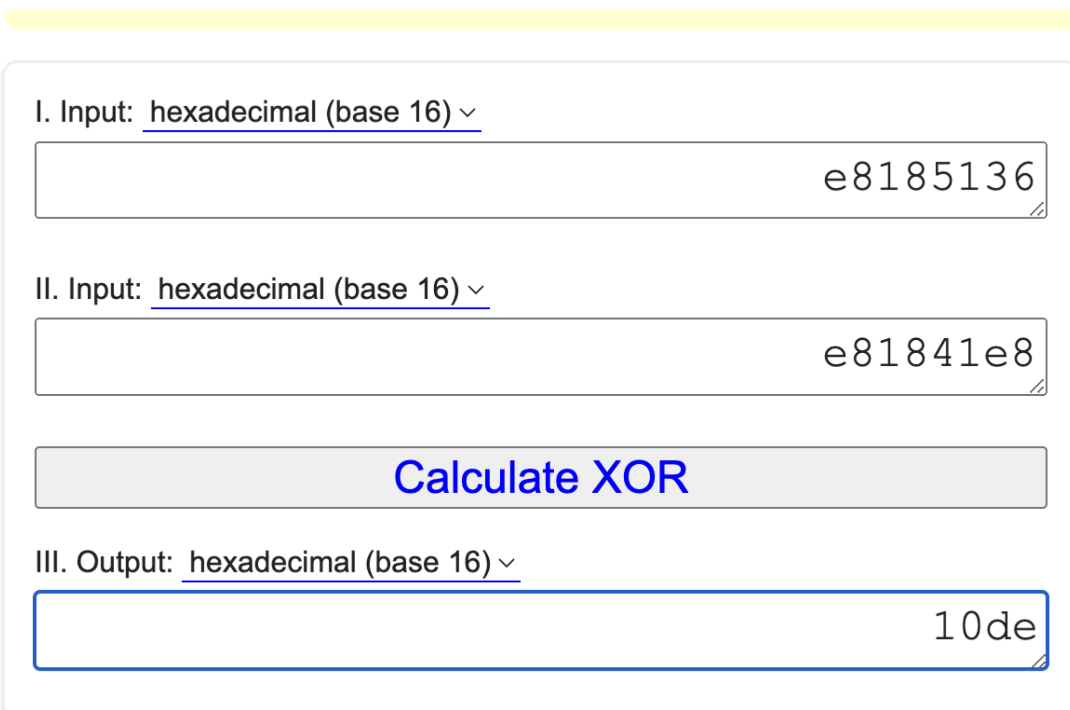
From these structs is parsed the `VendorId`, and it is compared against three values that form a vendor whitelist.

ID	Vendor
8086	Intel
10DE	Nvidia
1002	AMD

This anti-sandboxing technique has been observed in previous malwares, namely Furtim in 2016 and Invalid Printer Loader in 2023. BabbleLoader takes additional measures to hide the vendor ID numbers through using a simple XOR key and a few assembly instructions. The instructions are separated by a large amount of junk code so as to hide the values when statically analyzing the sample in a disassembler.

```
mov     [rsp+1FF48h+nvidiaId], 0E8185136h
...
//Junk
...
mmov     eax, [rsp+1FF48h+nvidiaId]
xor     eax, 0E81841E8h
mov     [rsp+1FF48h+nvidiaId], eax
...
//Junk
...
mov     eax, [rsp+1FF48h+nvidiaId]
cmp     [rsp+1FF48h+vendorId], eax
```

The decoded value (Nvidia Vendor ID) is shown below:



XOR to derive VendorID

VDLL Function

Another form of anti-sandboxing comes in the form of a VDLL check to combat Windows Defender’s Antivirus Emulator. To start this check, BabbleLoader, in a similar manner to how it deobfuscates strings to dynamically resolve functions, will decode two DLLs with exports.

The first check is to get `kernel32.dll` and look for the proc address for `MpSwitchToNextThread_WithCheck`. The second check is `ntdll.dll` with the export of `MpDispatchException`.

Call of emulated function

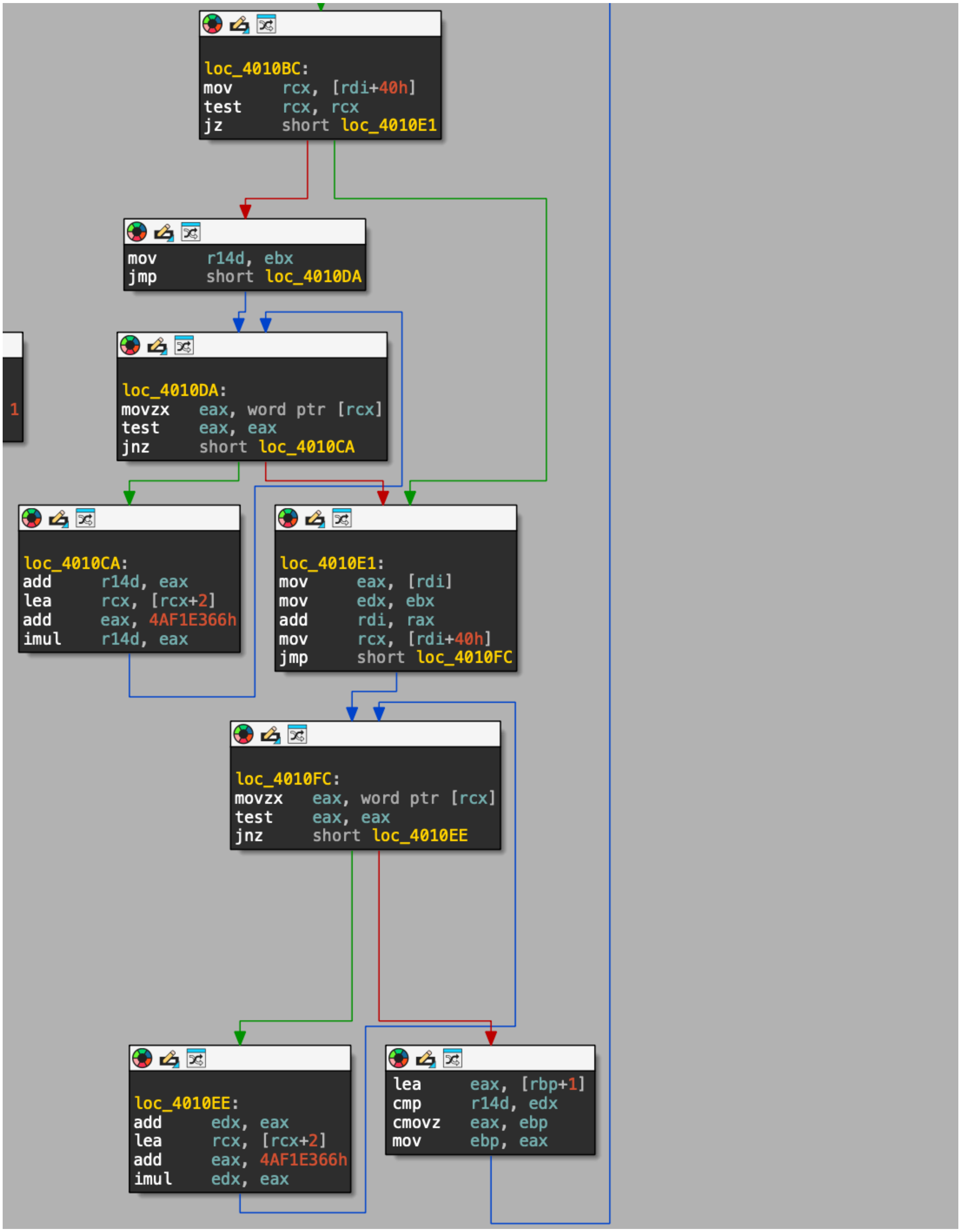
If any of the `GetProcAddress` calls are successful, it will set a variable for the loader to exit later. A successful import of any of these calls will indicate that the loader is being emulated by Windows Defender. This is because these exports only exist in VDLLs, which are modified Windows system DLLs available only in the emulator for Defender. This technique has been used by Raspberry Robin previously, and suggests that the loader developer is able to incorporate new technical research around antivirus and sandboxing internals.

Unique process count

When the shellcode payload that is stored in the mapped memory of the newly created section is executed, it performs another anti sandboxing check, this time based on the running processes in the machine.

This is achieved first by calling `NtQuerySystemInformation`, previously dynamically resolved from `ntdll.dll`. Getting the `SystemProcessInformation` class. This returns an array of `SYSTEM_PROCESS_INFORMATION` structures, one for each process running in the system.

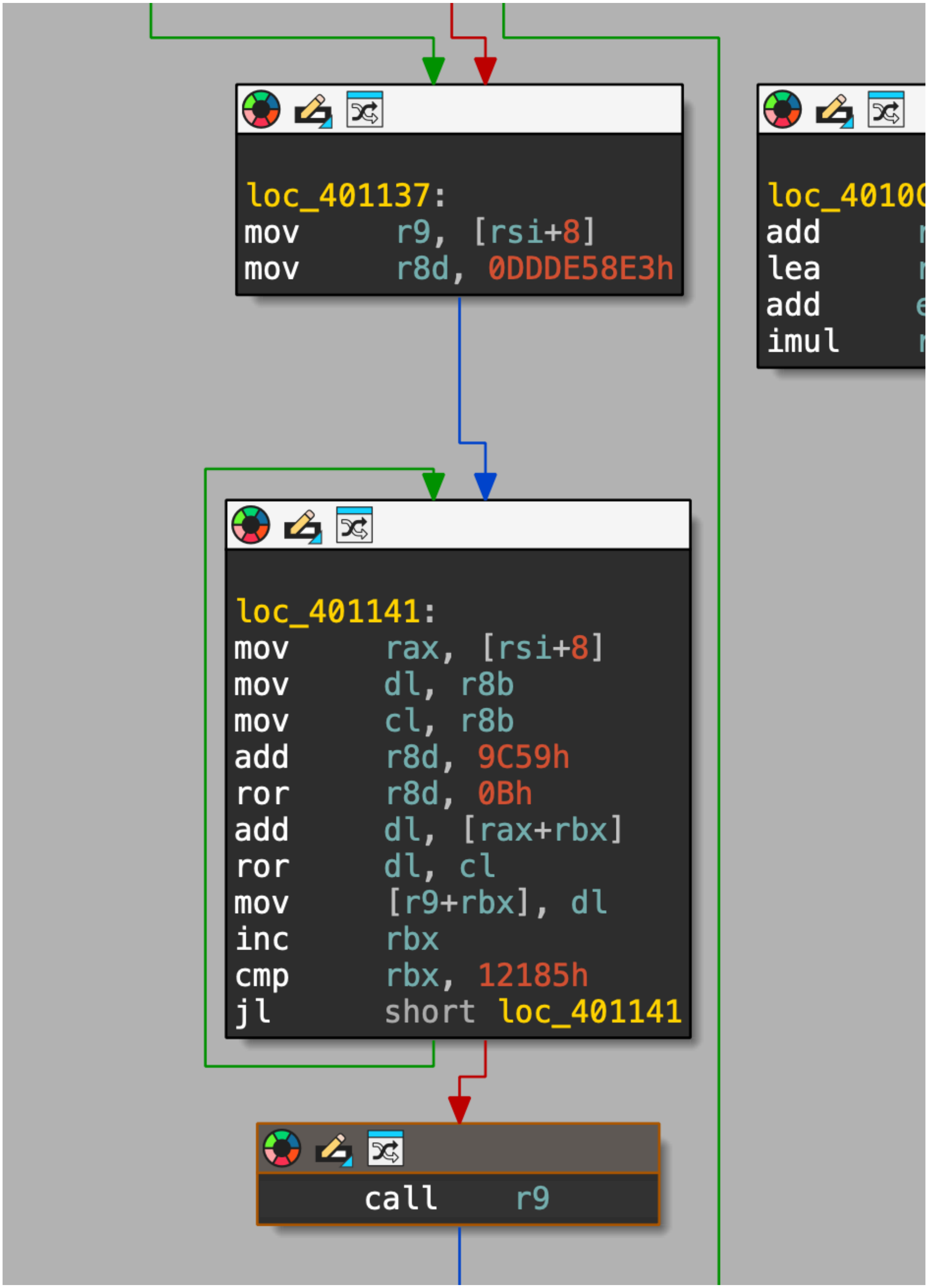
The process name for each process in the array is gathered and hashed as a checksum, and compared with the hash of the name of the process next in the array. A counter is incremented with each iteration, but if the checksums match, the counter is reduced by one. Giving the number of processes with unique names running.



Checksum counter

The counter is compared to check if there are at least 85 unique processes running on the machine. With the assumption that a true infected computer would have more running processes rather than a sandbox or emulator that is trying to be as lightweight as possible to reduce noise and costs. This technique has been employed by other malware also, such as Latrodectus.

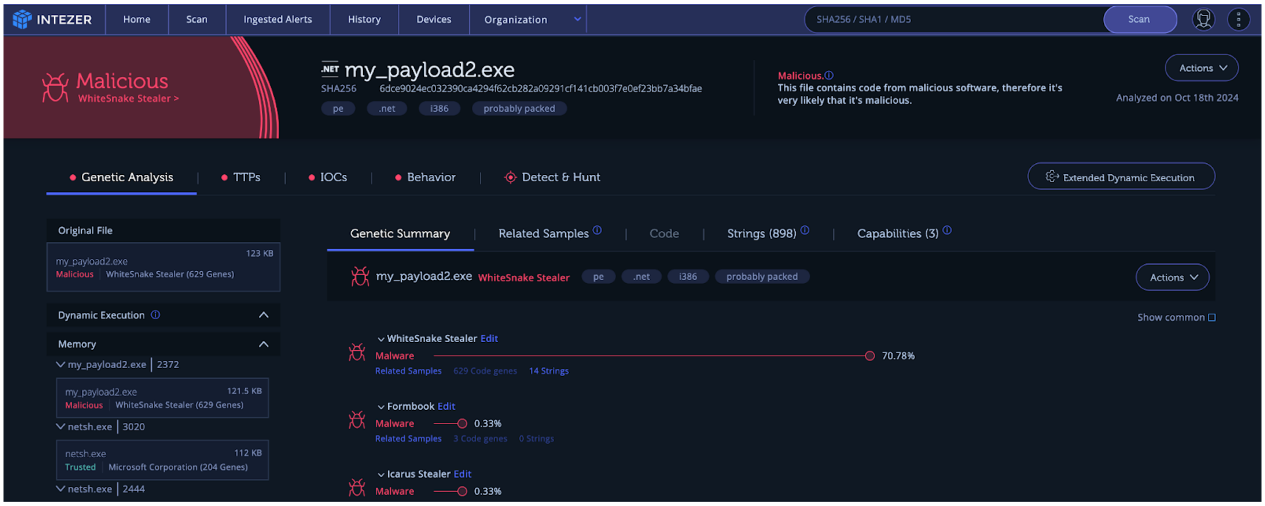
When the check has passed, the next stage of the payload will be decoded and executed.



Second stage of decryption

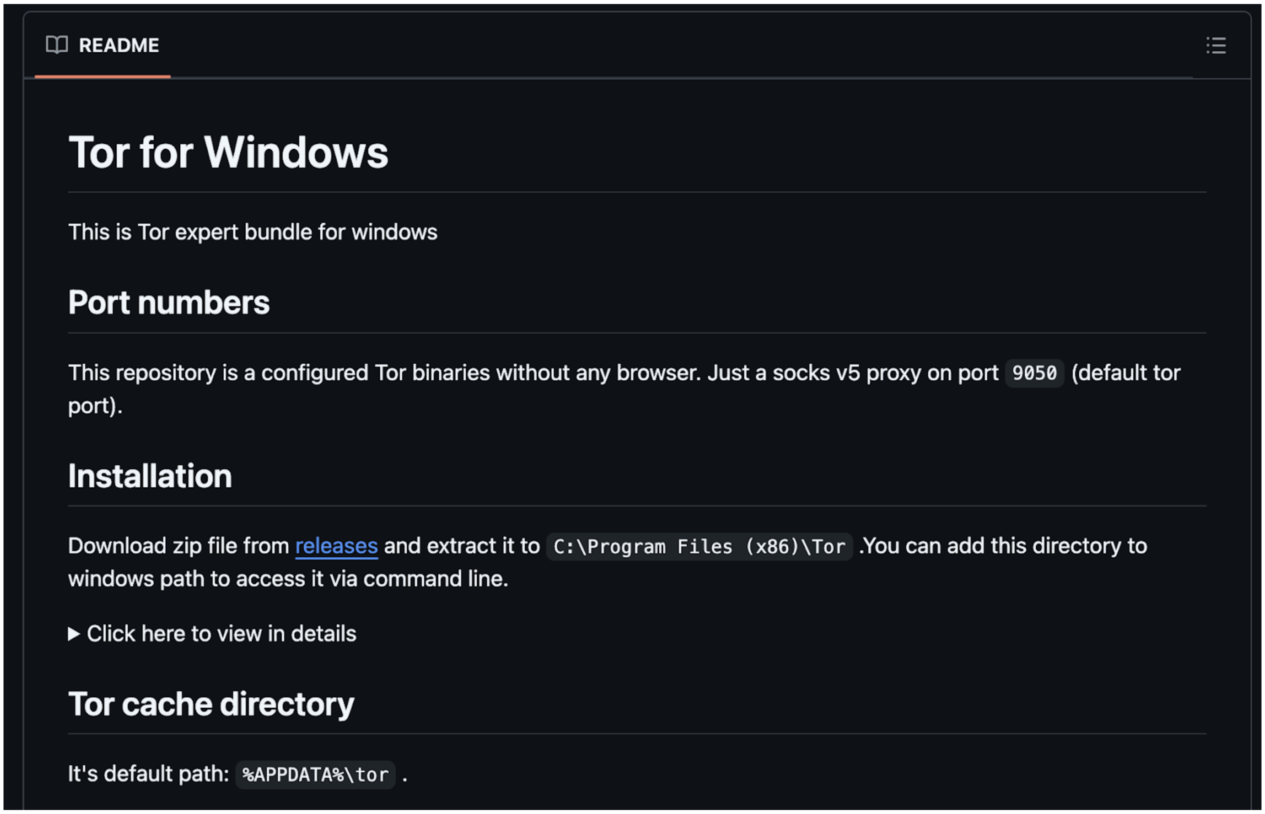
Donut Loader and Payload

The next stage in this chain is a Donut loader. This is used to unpack and execute the final payload in memory. Donut loaders have been used by many different malware and threat groups in their operations. The payload in this sample is a WhiteSnake stealer.



WhiteSnake Payload

This payload has a very interesting method of communication with its Command and Control (C2) server over TOR. The C2 communication is described in further detail in a blog from JFrog in 2023, but instead of downloading from the official TOR Project website. The payload is downloaded from this github repository.



README

Tor for Windows

This is Tor expert bundle for windows

Port numbers

This repository is a configured Tor binaries without any browser. Just a socks v5 proxy on port `9050` (default tor port).

Installation

Download zip file from releases and extract it to `C:\Program Files (x86)\Tor` .You can add this directory to windows path to access it via command line.

▶ Click here to view in details

Tor cache directory

It's default path: `%APPDATA%\tor` .

Open source project downloaded by WhiteSnake

In other samples, Meduza stealer has also been observed. There may be other stealer payloads delivered that have not been observed yet.

Considerations for Defense

The use of loaders is a long-standing technique incorporated by threat actors. In order for modern day threat actors to have any success against the many layers of detection employed by security vendors, they too must incorporate multiple layers of defense within their own builds. It is a never ending arms race between attacker and defender. Each side imposing increasing costs on the other in a frantic effort to come out on top, no matter how short that time period may be.

The better that the loaders can protect the ultimate payloads, the less resources threat actors will need to expend in order to rotate burned infrastructure. BabbleLoader takes measures to protect against as many forms of detection that it can, in order to compete in a crowded loader/crypter market. The types of protection utilized protect the loader against hash, rule, genetic, static, dynamic, and AI forms of detection, imposing costs upon security vendors in the hope that the cost of detection will be so high that it will cause security vendors to overlook analyzing these files.

The developer behind this loader demonstrates an active engagement with current security research, rapidly integrating new techniques to enhance evasion capabilities. For instance, recent anti-sandboxing features reflect insights from research on Windows Defender presented by white-hat experts at Black Hat, allowing the loader to better evade detection by Microsoft's defenses. This adaptability shows a strategic commitment to keeping the loader ahead of evolving security tools by adopting the latest innovations in bypass techniques, making it more resilient and harder to detect with each new build.

Many security vendors will look at using AI to help in future cases with combating these loaders. The loaders of the future are already well equipped in this fight. The loader's layered obfuscation tactics pose a formidable challenge for AI-based defenses. These techniques flood the AI with irrelevant tokens and misleading patterns, making it difficult to distinguish meaningful actions from noise. Each layer of complexity forces the AI to process massive amounts of data, drastically increasing computational and financial costs. By weaponizing this volume and variability, the loader effectively undermines AI's pattern recognition and analysis capabilities, pushing the limits of automated detection systems.

There is no signs of slowing down in the pace in the thriving loader market.

IOCs

BabbleLoader:

052c776fdc9700dfb37f964a73d461a57efad30a01bcf54505d7abcd601e6ff3

0ad8513b62a778d7e426627be3ed2dbaf00d99b9802a1f566dc9203e3d311fc3

0f6847d33cb38b0ed6dc1d8cfe3dc5d2e293d91c4880e3b4f5ddb77fd9d4cd1f

114b868f319162c5d6ff92796e41910f54de0e89f895a066fd4980c6dba2e323

1367fb270f35512b17fe5e73cc0233ace272daafe15cf94e45f696431f52332f

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c2a95f22cfee1f4df67a424e30425b59c23db265bff611f2ee653d71b30a70d8 ca67f61b5f8d20ec3f45dbbfc355045a8ceee15396f1cad032850a3ee23a42b3

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d7967661947ca835deddec30ae6e62d580718cbdeafb42cd6d0f038a407edcf0

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fc589aa3529a057fee52a1c9bd9bb19fa42bbfd291b7dbb3791e77eced376640

ffcae0093d509563b47b1d0cef3aa455a4358de3a1d2c2b84c298a927aa238e8

WhiteSnake Stealer:

6dce9024ec032390ca4294f62cb282a09291cf141cb003f7e0ef23bb7a34bfae

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