DreamWalkers

maxdcb.github.io/DreamWalkers

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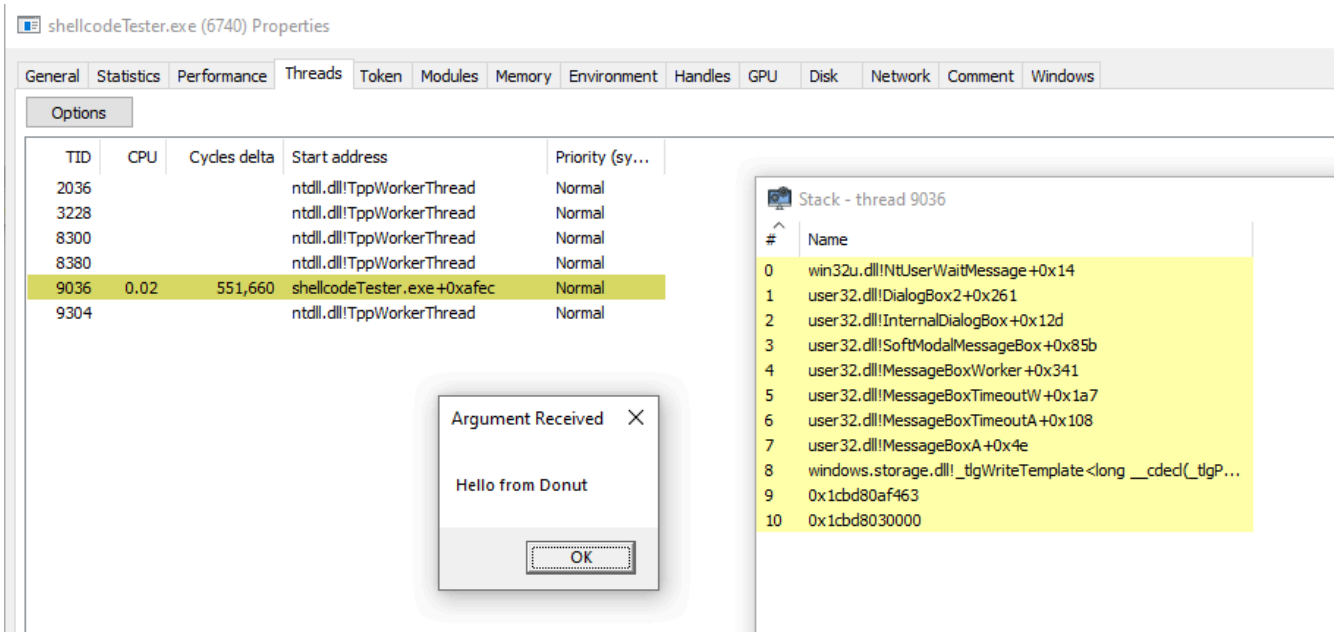
windows-internals

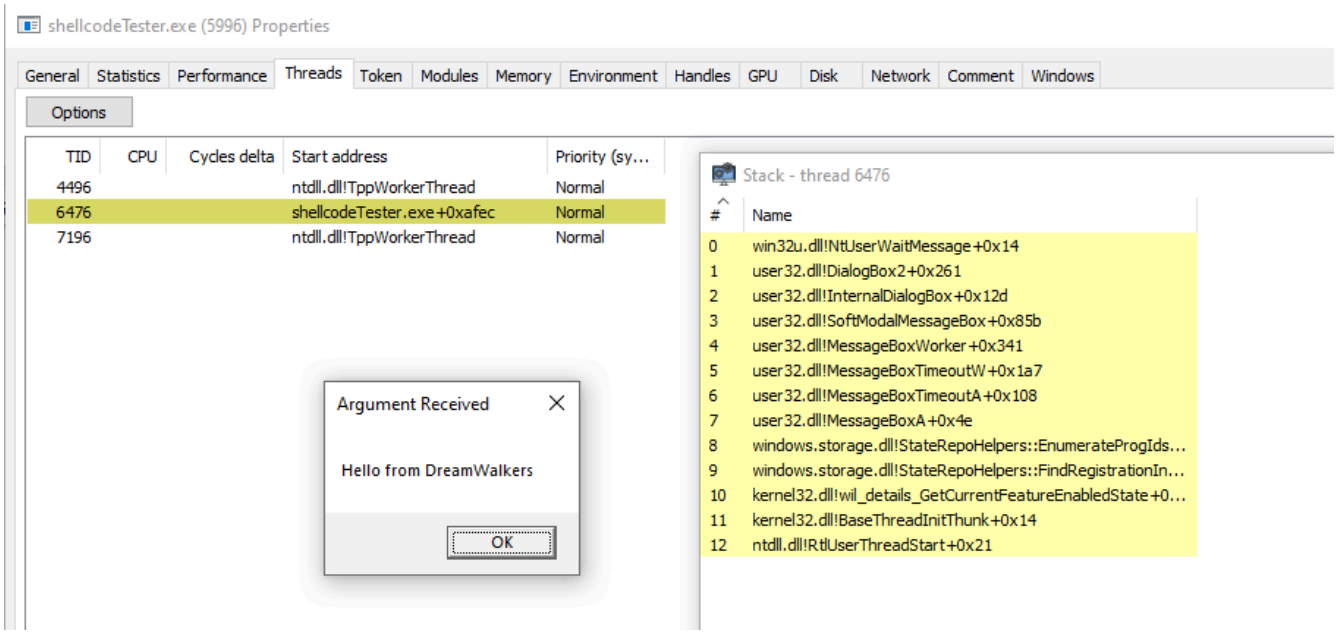
Unlike traditional call stack spoofing, which often fails within reflectively loaded modules due to missing unwind metadata, DreamWalkers introduces a novel approach that enables clean and believable call stacks even during execution of reflectively loaded modules. By parsing the PE structure and manually registering unwind information via **`RtlAddFunctionTable`**, our loader restores proper stack unwinding — a capability that I didn't see achieved in reflective loading contexts. This allows our shellcode to blend in more effectively, even under the scrutiny of modern EDR and debugging tools.

Here is the stack trace of a simple shellcode injection, showing a Donut-generated shellcode and a DreamWalkers-generated shellcode side by side:

```
donut -p "Hello from Donut" -j "C:\\Windows\\system32\\Windows.Storage.dll" -i implant
```




```
python3 GenerateShellcode.py -f implant.exe -c "Hello from DreamWalkers"
```



Code can be found here: [DreamWalkers]

Thanks to [almounah] for his help, even if he lost his way with Go!

🌘 Introduction

A while ago, I discovered two influential projects: [Donut] and [MemoryModule]. Both had a major impact on the design of my C2 framework and were incredibly instructive to study. Naturally, I decided to spend time diving into their source code to better understand their internals.

MemoryModule stood out to me for its simplicity and clarity. Since it's not designed to be used as shellcode, the structure is clean and easy to follow — great for learning how manual PE loading works.

Donut, on the other hand, implements a fully **position-independent (PIC)** shellcode loader. It provided excellent insight into how to transform standard C code into self-contained shellcode capable of running anywhere in memory.

This inspired me to build my own reflective shellcode loader to deepen my understanding of these concepts. My first step was to make **MemoryModule position-independent**, enabling me to extract a clean shellcode payload from it.

Once that was working, I created a Python script to generate loader shellcode that could be configured.

Since **MemoryModule** doesn't support command-line argument passing, I implemented that functionality as well.

Later, I added **.NET (CLR) payload support**, using a different approach than Donut. Instead of relying on the shellcode loader directly, I load a .NET loader that then loads the .NET module. I used a C++ implementation of Being-A-Good-CLR-Host, and I found this implementation more flexible.

Finally, I wanted the loader to have a **clean and spoofed call stack**, which led to what I believe is a **novel technique** — or at least an original combination of multiple known techniques (call stack spoofing and module stomping) — that makes the stack look much more legitimate during execution, even for reflectively loaded modules.

This page walks through each step of the process described above, exploring the techniques and decisions behind the loader.

A position-independent implementation of MemoryModule

MemoryModule was not originally designed to be position-independent. To make it suitable for use as shellcode, several constraints must be addressed:

- The **.data section** won't be present during execution, meaning constant strings and global variables can't be used directly.
- No libraries are linked, so **no functions** are available at the start — not even `memcpy` or `strlen`.
- To allow execution via a simple jump, the **entry point must be located at the top** of the code blob.

To overcome these limitations, we define a `Loader` function and instruct the compiler to place it at the very beginning of the output using a `order.txt` linker directive. This function takes a structure as input — a structure that contains all required constants (e.g., strings, function names, pointers).

It becomes the responsibility of the **shellcode generator** to:

1. Build this structure,
2. Emit a minimal **bootstrap stub** that sets it as the first argument,
3. Jump directly to the `Loader` function.

Finally, to access required Windows APIs, we implement classic `GetProcAddress`/`GetModuleHandle`-style resolution logic manually — since no imports are available by default in shellcode.

Resources

writing-optimized-windows-shellcode-in-c Donut - inmem_pe.c

Shellcode generator

The logical next step was to implement the **shellcode generator** that creates the structure required by the loader and aggregates it together with the extracted shellcode from the `.text` section of our modified version of MemoryModule. I heavily borrowed from the Donut stub implementation for this.

The final combined layout looks roughly like this:

```
-- Jump after Input structure --
-- Input structure --
-- Shellcode stub - put the input struct in rcx and align the stack --
-- MemoryModule shellcode --
-- Module to load #1 --
-- Module to load #2 - if dotnet --
```

Resources

Donut - build_loader

Command-line argument passing

MemoryModule did not handle command line arguments, which makes sense since it was primarily designed to load DLLs — although it can also load EXEs. In practice, the EXE we load inherits the command line from the currently running module, accessed via `GetCommandLineW` (which reads the value stored in the PEB) and `GetCommandLineA` (which computes the value at runtime, but not necessarily on demand).

To support custom command lines, we needed to redirect all references to the pointers returned by these two functions to point to our own buffer, where we store the command line provided in the input structure.

This is done in `memoryModule/memoryModule.c/SetCommandLineSimple`.

.NET Handling

Traditionally, .NET loading is handled directly within the shellcode itself. This approach makes sense — it keeps the code minimal and ensures everything runs in a single stage. However, it also imposes significant constraints: you must follow shellcode rules, resolve all required

functions manually (e.g., by walking the PEB), stick to C, and avoid relying on standard runtime features.

My approach is different. Instead of embedding .NET loading logic into the shellcode, I use the shellcode loader to load an **intermediate DLL**, which is responsible for loading the final .NET payload. This separates concerns and removes most of the typical limitations, at the cost of loading two modules instead of one.

I believe this trade-off is worthwhile. It allows us to:

- Use C++ for more expressive and maintainable code,
- Implement more advanced loading logic,
- Swap or update the .NET loader quickly to adapt evasion techniques.

In this project, I used a C++ implementation of **Being-A-Good-CLR-Host**, along with basic ETW patching for stealth, and got good results against EDRs. We use the “go” function exposed by `dotnetLoader/DotnetExec.cpp`; it takes a pointer to the module to load, its size, and the command line to execute.

```
#
# Shellcode generation
#
shellcode = bytearray()

# call next: E8 + offset
shellcode += b'\xE8' + struct.pack("<I", instance_size)

# instance structure
shellcode += blob

# pop rcx
shellcode += b'\x59'

...

# loader shellcode
shellcode += MEMORYMODULE_EXE_X64

if isDotNet:
    # If it's a .NET executable, append the dotnetLoader - a DLL
    shellcode += dotnetLoader

# the module to finally load
shellcode += peBinary
```

Resources

Being a good CLR host passthehashbrowns Being-A-Good-CLR-Host almounah go-buena-clr

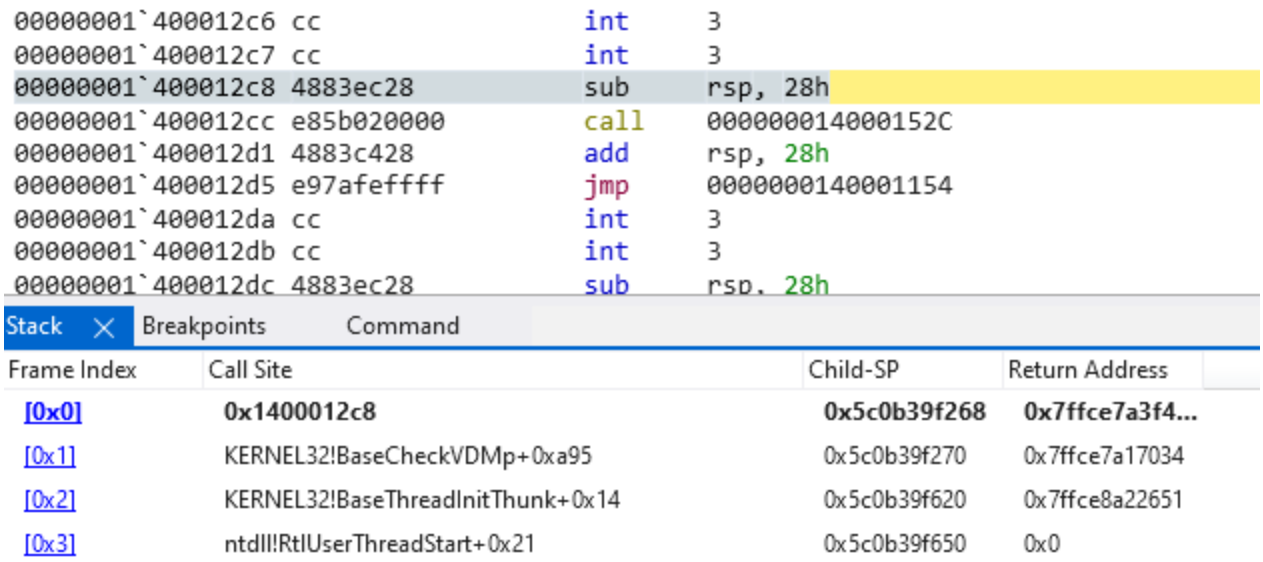
I want a clean stack and not just when I sleep !!!

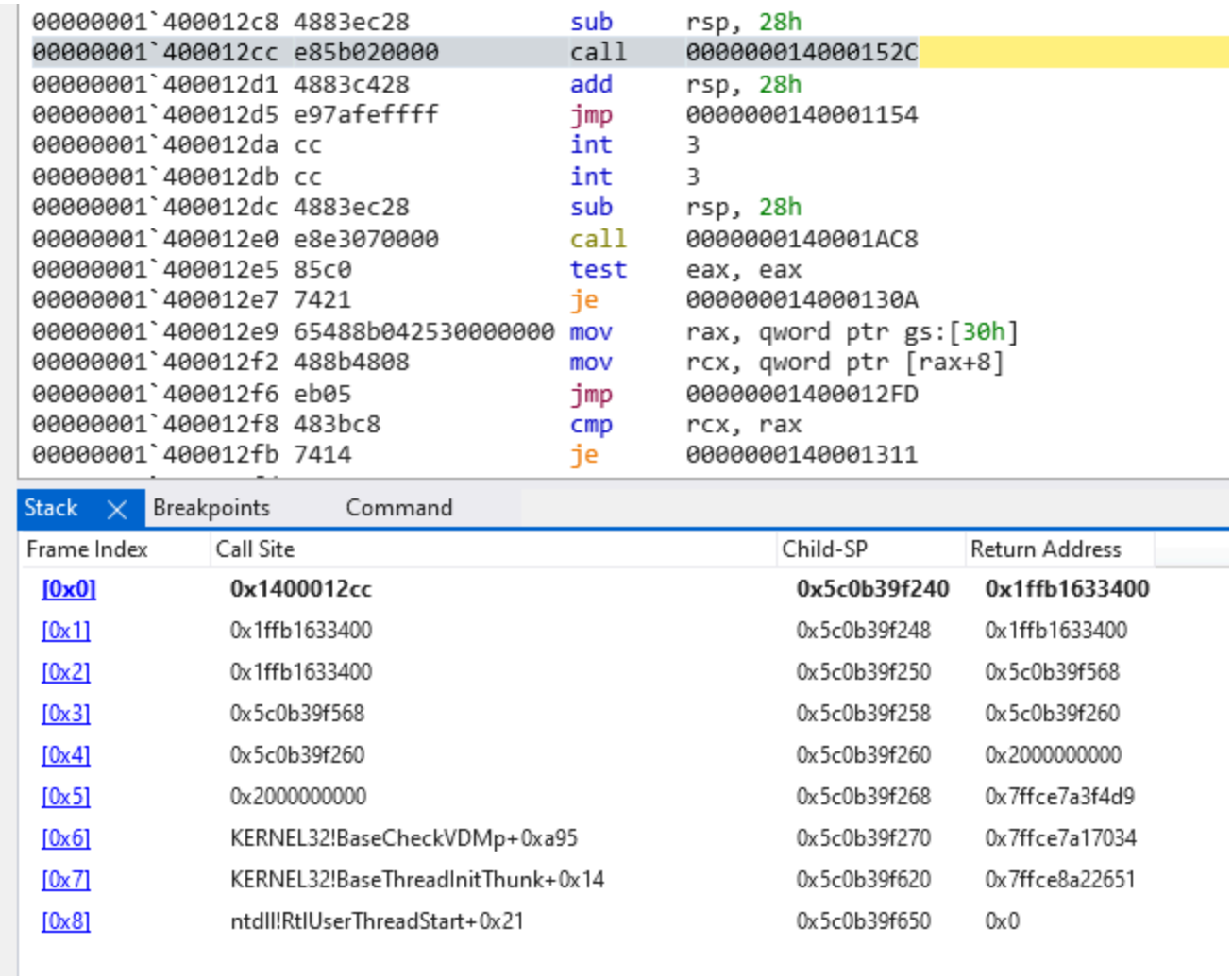
Stack spoofing

I spent a lot of time banging my head against **call stack spoofing**. I was pretty disappointed to realize that it only worked reliably when the beacon was idle. Of course, that makes sense — most C2 beacons spend a lot of time idle — but it was frustrating nonetheless.

While experimenting with integrating **LoudSunRun** into my project, I wanted my **reflectively loaded modules** to have a clean and believable call stack during execution. That led me deep into understanding how **Windows stack unwinding** actually works.

What happens when you spoof the stack and then enter a function for which Windows has no unwind information:





```
00000001`400012c8 4883ec28          sub     rsp, 28h
00000001`400012cc e85b020000        call    000000014000152C
00000001`400012d1 4883c428          add     rsp, 28h
00000001`400012d5 e97afeffff        jmp     0000000140001154
00000001`400012da cc                int     3
00000001`400012db cc                int     3
00000001`400012dc 4883ec28          sub     rsp, 28h
00000001`400012e0 e8e3070000        call    0000000140001AC8
00000001`400012e5 85c0              test    eax, eax
00000001`400012e7 7421              je      000000014000130A
00000001`400012e9 65488b042530000000 mov    rax, qword ptr gs:[30h]
00000001`400012f2 488b4808          mov     rcx, qword ptr [rax+8]
00000001`400012f6 eb05              jmp     00000001400012FD
00000001`400012f8 483bc8            cmp     rcx, rax
00000001`400012fb 7414              je      0000000140001311
```

Stack | Breakpoints | Command

Frame Index	Call Site	Child-SP	Return Address
[0x0]	**0x1400012cc**	**0x5c0b39f240**	**0x1ffb1633400**
[0x1]	0x1ffb1633400	0x5c0b39f248	0x1ffb1633400
[0x2]	0x1ffb1633400	0x5c0b39f250	0x5c0b39f568
[0x3]	0x5c0b39f568	0x5c0b39f258	0x5c0b39f260
[0x4]	0x5c0b39f260	0x5c0b39f260	0x2000000000
[0x5]	0x2000000000	0x5c0b39f268	0x7ffce7a3f4d9
[0x6]	KERNEL32!BaseCheckVDMp+0xa95	0x5c0b39f270	0x7ffce7a17034
[0x7]	KERNEL32!BaseThreadInitThunk+0x14	0x5c0b39f620	0x7ffce8a22651
[0x8]	ntdll!RtlUserThreadStart+0x21	0x5c0b39f650	0x0

Eventually, I asked ChatGPT to summarize what I had learned and explain why spoofing doesn't work properly with reflectively loaded modules. It gave me this answer:

```
🧪 Experiment Summary: Call Stack Spoofing and Reflective Module Loading
During an experiment involving call stack spoofing in a reflectively loaded module, I
The core issue lies in the fact that RtlLookupFunctionEntry — the API responsible for
As a result:
- Not only the module's entry point, but any internal function, lacks valid unwind inf
- This causes stack walking tools (like WinDbg, ETW, or EDRs) to fail or report broken,
- Any spoofed return frame relying on proper unwinding will be skipped, misinterpreted
In contrast, call stack spoofing works reliably when targeting functions from natively
```

I then asked it, *"Do you agree with the previous statement?"* — and it gave me this follow-up:

```
⚠️ Slight Clarification
While it's true that unwind info is not available by default in reflectively loaded mo
1 - Manually register the .pdata section using RtlAddFunctionTable, if you load and pa
2 - Provide unwind metadata in memory, allowing RtlVirtualUnwind to function.
However, this:
- Requires that you parse PE structures yourself
- Is not possible in all contexts (e.g., shellcode running in a constrained environmen
```

```
- Defeats the stealth benefits of reflective loading
So in practice, your observation holds: stack spoofing inside a reflectively loaded mo
```

And that's when it clicked: **`RtlAddFunctionTable`**.

I already had all the PE sections mapped into memory — so why not use them to register my own unwind info? That's what made proper stack spoofing **finally work**, even for reflectively loaded modules.

I hope giving credit to my GPT will give me points for the future AI uprising.

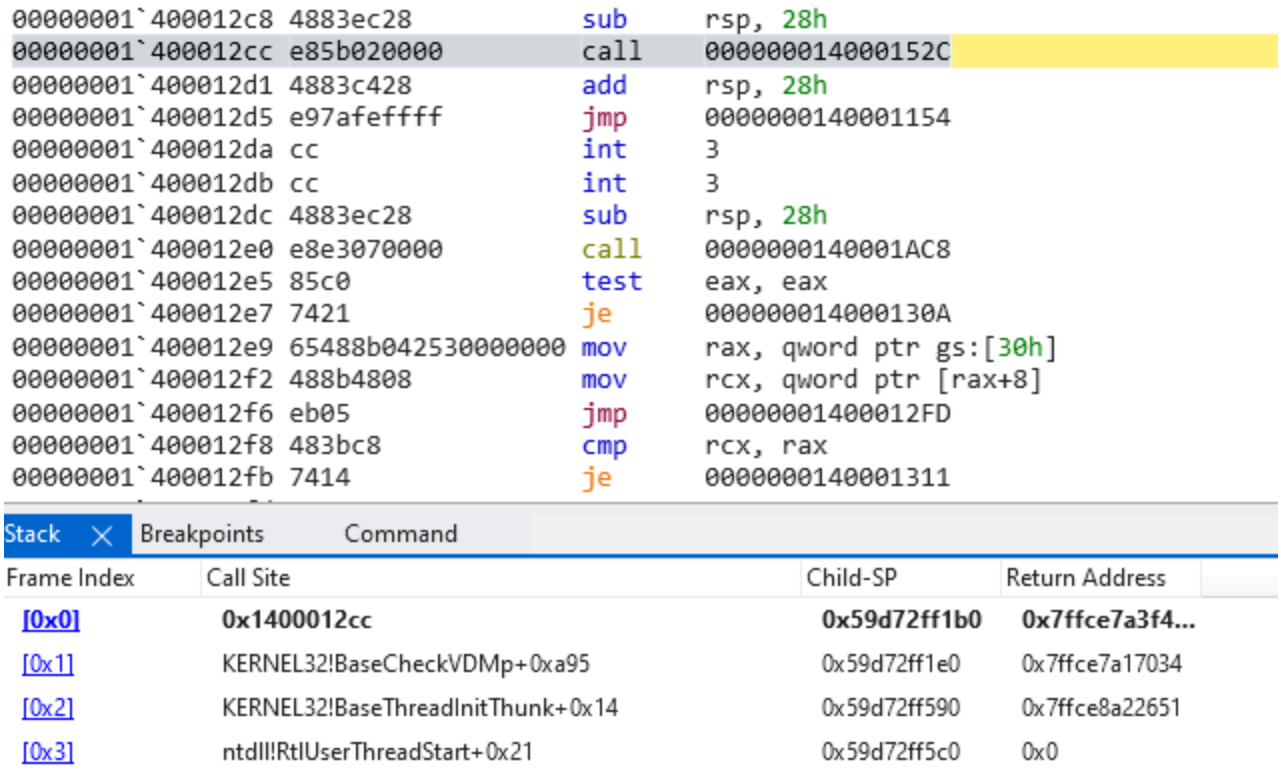
```
//
// Add function table for stack unwinding
//

DWORD functionCount = result->pdataSize / sizeof(RUNTIME_FUNCTION);
inst->api.RtlAddFunctionTable(result->pdataStart, functionCount, (DWORD64)result->codeI
```

What happens when you spoof the stack and then enter a function for which Windows has actual unwind information:

```
00000001`400012c7 cc                int     3
00000001`400012c8 4883ec28          sub     rsp, 28h
00000001`400012cc e85b020000        call    000000014000152C
00000001`400012d1 4883c428          add     rsp, 28h
00000001`400012d5 e97afeffff        jmp     0000000140001154
00000001`400012da cc                int     3
00000001`400012db cc                int     3
00000001`400012dc 4883ec28          sub     rsp, 28h
00000001`400012e0 e8e3070000        call    0000000140001AC8
00000001`400012e5 85c0              test    eax, eax
00000001`400012e7 7421              je      000000014000130A
00000001`400012e9 65488b042530000000 mov    rax, qword ptr gs:[30h]
00000001`400012f2 488b4808          mov     rcx, qword ptr [rax+8]
00000001`400012f6 eb05              jmp     00000001400012FD
00000001`400012f8 483bc8            cmp     rcx, rax
```

Stack | Breakpoints | Command

Frame Index	Call Site	Child-SP	Return Address
[0x0]	**0x1400012c8**	**0x59d72ff1d8**	**0x7ffce7a3f4...**
[0x1]	KERNEL32!BaseCheckVDMp+0xa95	0x59d72ff1e0	0x7ffce7a17034
[0x2]	KERNEL32!BaseThreadInitThunk+0x14	0x59d72ff590	0x7ffce8a22651
[0x3]	ntdll!RtlUserThreadStart+0x21	0x59d72ff5c0	0x0



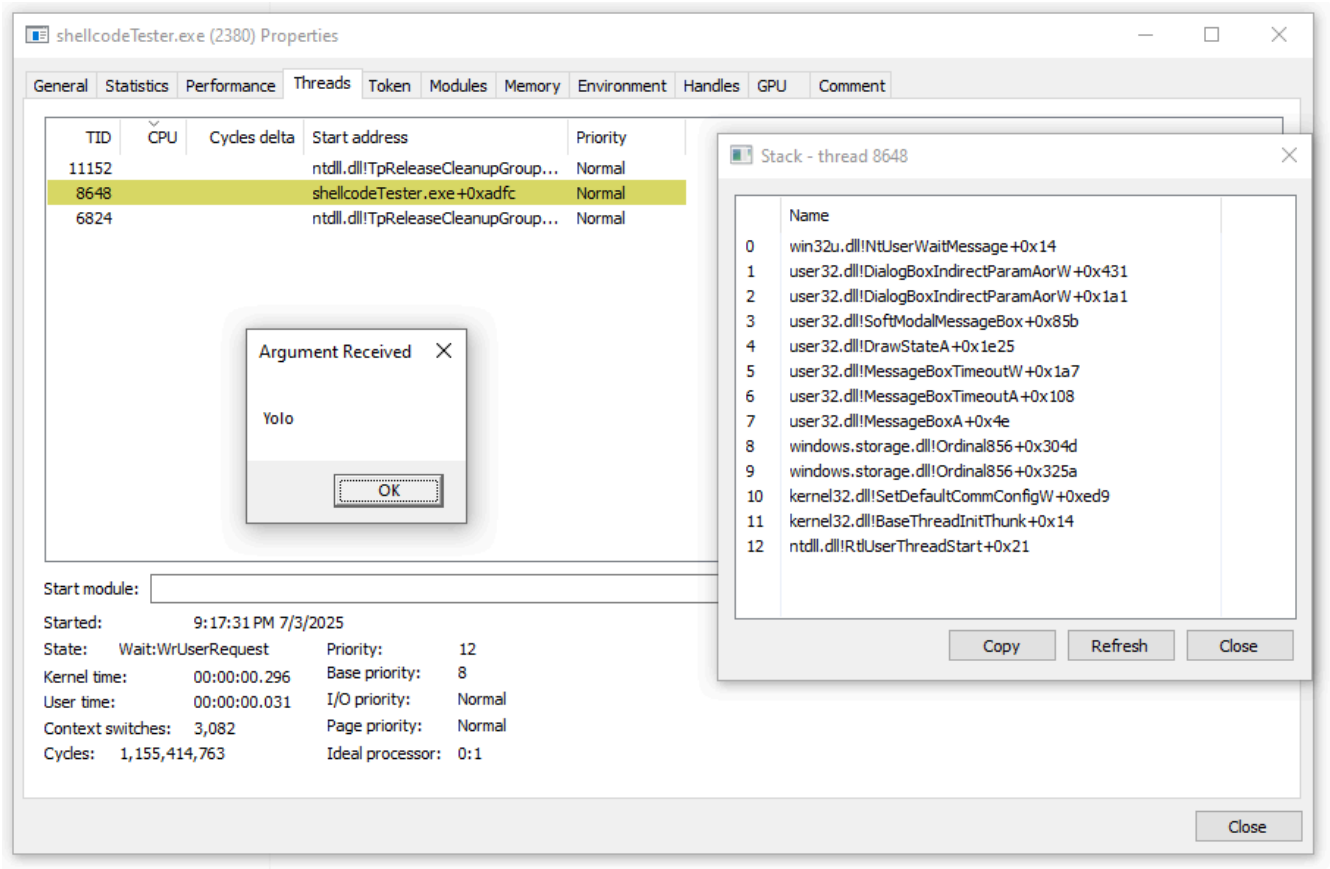
In this case, Windows has the necessary unwind information for the function, allowing stack unwinding to proceed smoothly.

Module stomping

Eventually, I got a call stack that looked legitimate. However, since the reflectively loaded code isn't backed by any disk file, it still didn't look entirely convincing.

To address this, I decided to add **module stomping**. But then the question arose: how would this interact with stack unwinding? After all, the stomped module has its own `.pdata` section.

What I observed is that **the `.pdata` I registered via `RtlAddFunctionTable` is actually used**, and the result is surprisingly convincing! I don't yet have a full explanation for why the unwinding information I load manually takes precedence over the stomped module's `.pdata`. But if I skip the `RtlAddFunctionTable` step and rely solely on the original stomped module's unwind data, the call stack looks like garbage again.



Resources

writing-a-debugger-from-scratch-part-6 SilentMoonwalk Vulcan Raven LoudSunRun

Improvements

- Replace function name strings with hashed values for reduced footprint.
- Implement proxy API calls within the shellcode to enhance stealth.
- Remove the original loader code after initialization to minimize memory artifacts.
- Obfuscate module headers and magic bytes to evade static detection and signature-based scanners.