

Analyzing Malware with Hooks, Stomps and Return-addresses

By Arash Parsa

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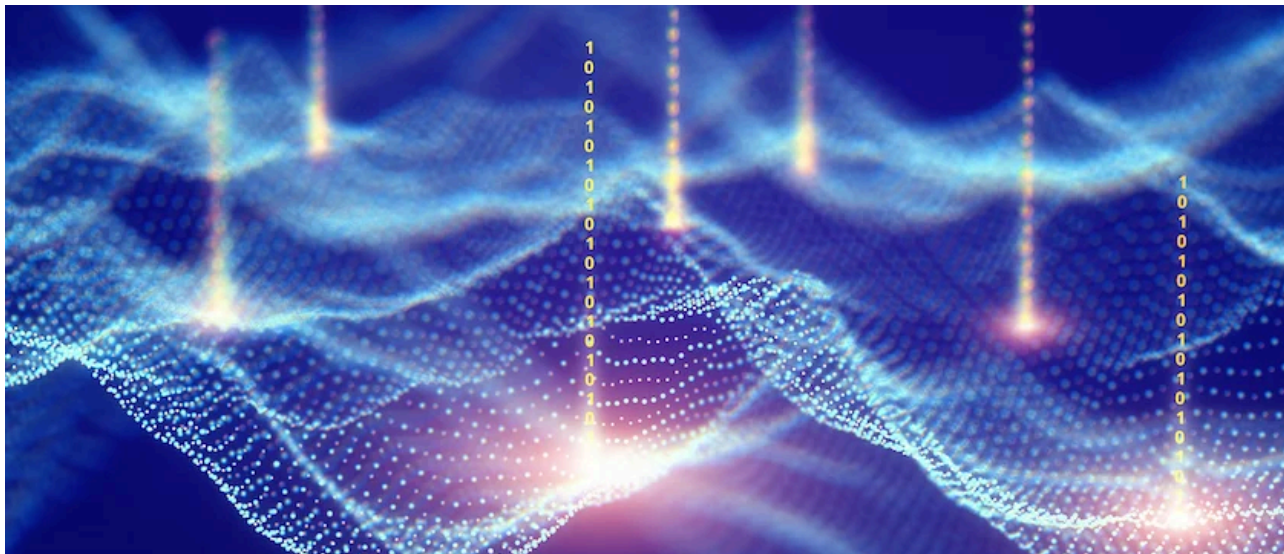


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Introduction

This is the second post in my series and with this post we will focus on malware and some of their relevant detections. This post will focus on an interesting observation I made when creating my heap encryption and how this could be leveraged to detect arbitrary shellcode as well as tools like cobalt strike, how those detections could be bypassed and even newer detections can be made.

Sample code of a POC can be found here: <https://github.com/waldo-irc/MalMemDetect>

The First Detection

If you recall [in the first post](#), our method at targeting Cobalt Strikes heap allocations was to hook the process space and manage all allocations made by essentially what was a module with no name. Here is the code we had used as a refresher:

```
#include
#pragma intrinsic(_ReturnAddress)

GlobalThreadId = GetCurrentThreadId(); We get the thread Id of our dropper!

HookedHeapAlloc (Arg1, Arg2, Arg3) {
    LPVOID pointerToEncrypt = OldHeapAlloc(Arg1, Arg2, Arg3);
    if (GlobalThreadId == GetCurrentThreadId()) { // If the calling ThreadId matches our initial thread

        HMODULE hModule;
        char lpBaseName[256];

        if (::GetModuleHandleExA(GET_MODULE_HANDLE_EX_FLAG_FROM_ADDRESS, (LPCSTR)_ReturnAddress,
                                &hModule, sizeof(hModule))) {
            ::GetModuleBaseNameA(GetCurrentProcess(), hModule, lpBaseName, sizeof(lpBaseName));
        }

        std::string modName = lpBaseName;
        std::transform(modName.begin(), modName.end(), modName.begin(),
            [](unsigned char c) { return std::tolower(c); });
        if (modName.find("dll") == std::string::npos && modName.find("exe") == std::string::npos) {
            // Insert pointerToEncrypt variable into a list
        }
    }
}
```

The magic lines lie here:

```
if (::GetModuleHandleExA(GET_MODULE_HANDLE_EX_FLAG_FROM_ADDRESS, (LPCSTR)_ReturnAddress(), &hModule)
    && ::GetModuleBaseNameA(GetCurrentProcess(), hModule, lpBaseName, sizeof(lpBaseName))) {
}
```

What we are trying to do here is take the current address our function will be returning to and attempting to resolve it to a module name using the function `GetModuleHandleExA` with the argument `GET_MODULE_HANDLE_EX_FLAG_FROM_ADDRESS`. With this flag the implication is the address we are passing is: “an address in the module” (<https://docs.microsoft.com/en-us/windows/win32/api/libloaderapi/nf-libloaderapi-getmodulehandleexa>). The module name will get returned and stored in the `lpBaseName` variable.

With the case of our thread – targeted heap encryption – this function actually returns nothing, as it cannot resolve the return address to a module! This also means `lpBaseName` ends up containing nothing.

As always, let’s see what this looks like in our debugger. First, we’ll start with a legitimate call. I’ve gone ahead and hooked `HeapAlloc` using `MinHook` (<https://github.com/TsudaKageyu/minhook>) and am tracing the return address of all callers. Let’s see who the first function to call our hooked `malloc` is:

Name	Value
data	0x00007ffffb9018363 "H:ØH...Àt)D:Ç%ø8IÁà\x3HH\x103Òè°\x5"
IpBaseName	0x000000e068ffeff0 "ntdll.dll"
<i>Add item to watch</i>	

fig 4. Return address module resolved

This works because the function maps to a DLL we appear to have loaded from disk. Because of this, Windows knows how to identify what module the function comes from. What about our shellcode though? Let's see what that looks like.

Name	Value
data	0x00000015bec3e3d51 "H...Åu-f=\x1bñ\x1"
IpBaseName	0x000000050fcff020 ""
<i>Add item to watch</i>	

fig 5. Shellcode return address and failed resolution

So our base name is empty because the function fails to resolve the address to a module. Let's see what that address looks like in the disassembler:

```
Address: 0x0000015bec3e3d51
Viewing Options
0000015BEC3E3D17  E8 20 01 77 77  call 0000015BEC3E3D07
0000015BEC3E3D1C  C7 00 0C 00 00 00  mov  dword ptr [rax],0Ch
0000015BEC3E3D22  33 C0          xor  eax,eax
0000015BEC3E3D24  EB 5D          jmp  0000015BEC3E3D83
0000015BEC3E3D26  48 0F AF D9   imul rbx,rcx
0000015BEC3E3D2A  B8 01 00 00 00  mov  eax,1
0000015BEC3E3D2F  48 85 DB      test  rbx,rbx
0000015BEC3E3D32  48 0F 44 D8   cmov  rbx,rax
0000015BEC3E3D36  33 C0          xor  eax,eax
0000015BEC3E3D38  48 83 FB E0   cmp  rbx,0FFFFFFFFFFFFFFE0h
0000015BEC3E3D3C  77 18          ja   0000015BEC3E3D56
0000015BEC3E3D3E  48 8B 0D EB EA 01 00  mov  rcx,qword ptr [15BEC402830h]
0000015BEC3E3D45  8D 50 08      lea  edx,[rax+8]
0000015BEC3E3D48  4C 8B C3      mov  r8,rbx
0000015BEC3E3D4B  FF 15 B7 86 00 00  call qword ptr [15BEC3EC408h]
0000015BEC3E3D51  48 85 C0      test  rax,rax
0000015BEC3E3D54  75 2D          jne  0000015BEC3E3D83
0000015BEC3E3D56  83 3D 1B F1 01 00 00  cmp  dword ptr [15BEC402E78h],0
0000015BEC3E3D5D  74 19          je   0000015BEC3E3D78
0000015BEC3E3D5F  48 8B CB      mov  rcx,rbx
0000015BEC3E3D62  E8 39 82 FF FF  call 0000015BEC3DBFA0
0000015BEC3E3D67  85 C0          test  eax,eax
0000015BEC3E3D69  75 CB          jne  0000015BEC3E3D36
0000015BEC3E3D6B  48 85 FF      test  rdi,rdi
0000015BEC3E3D6E  74 B2          je   0000015BEC3E3D22
0000015BEC3E3D70  C7 07 0C 00 00 00  mov  dword ptr [rdi],0Ch
0000015BEC3E3D76  EB AA          jmp  0000015BEC3E3D22
0000015BEC3E3D78  48 85 FF      test  rdi,rdi
0000015BEC3E3D7A  74 05          jz   0000015BEC3E3D83
```

fig 6. Shellcode return address location

There’s our address at “test rax,rax”. We actually know this is our shellcode based on the address:

Base address	Type	Size	Protect...	Use
0x7fff8d38000	Image: Commit	216 kB	R	C:\Windows\System32\advapi32.dll
0x7fff8d6e000	Image: Commit	4 kB	RW	C:\Windows\System32\advapi32.dll
0x7fff8d6f000	Image: Commit	4 kB	WC	C:\Windows\System32\advapi32.dll
0x7fff8d70000	Image: Commit	8 kB	RW	C:\Windows\System32\advapi32.dll
0x7fff8d72000	Image: Commit	4 kB	WC	C:\Windows\System32\advapi32.dll
0x7fff8d73000	Image: Commit	36 kB	R	C:\Windows\System32\advapi32.dll
0x7fff8ed0000	Image: Commit	4 kB	R	C:\Windows\System32\kernel32.dll
0x7fff8ed1000	Image: Commit	508 kB	RX	C:\Windows\System32\kernel32.dll
0x7fff8f50000	Image: Commit	204 kB	R	C:\Windows\System32\kernel32.dll
0x7fff8f83000	Image: Commit	8 kB	RW	C:\Windows\System32\kernel32.dll
0x7fff8f85000	Image: Commit	36 kB	R	C:\Windows\System32\kernel32.dll
0x7fff8fd0000	Image: Commit	4 kB	R	C:\Windows\System32\ntdll.dll
0x7fff8fd1000	Image: Commit	1,132 kB	RX	C:\Windows\System32\ntdll.dll
0x7fff90ec000	Image: Commit	288 kB	R	C:\Windows\System32\ntdll.dll
0x7fff9134000	Image: Commit	4 kB	RW	C:\Windows\System32\ntdll.dll
0x7fff9135000	Image: Commit	8 kB	WC	C:\Windows\System32\ntdll.dll
0x7fff9137000	Image: Commit	36 kB	RW	C:\Windows\System32\ntdll.dll
0x7fff9140000	Image: Commit	532 kB	R	C:\Windows\System32\ntdll.dll

fig 10. Use section for DLLs is filled

This is because our arbitrarily allocated memory does not map to anything on disk. Because of this, when we attempt to resolve the return address to a module we get nothing returned as a result.

That being said, we can see instances of RWX memory that don't map to disk in processes that use JIT compilers such as C# and browser processes as well. You can see in stage 3 of the Managed Execution Process (<https://docs.microsoft.com/en-us/dotnet/standard/managed-execution-process>) that an additional compiler takes the C# code a user creates and turns it into native code (which means our C# IL now becomes native assembly). For this process to take place a RWX region needs to be allocated for it to be able to write the new code and also be able to execute it. We can see these RWX regions in C# processes with ProcessHacker.

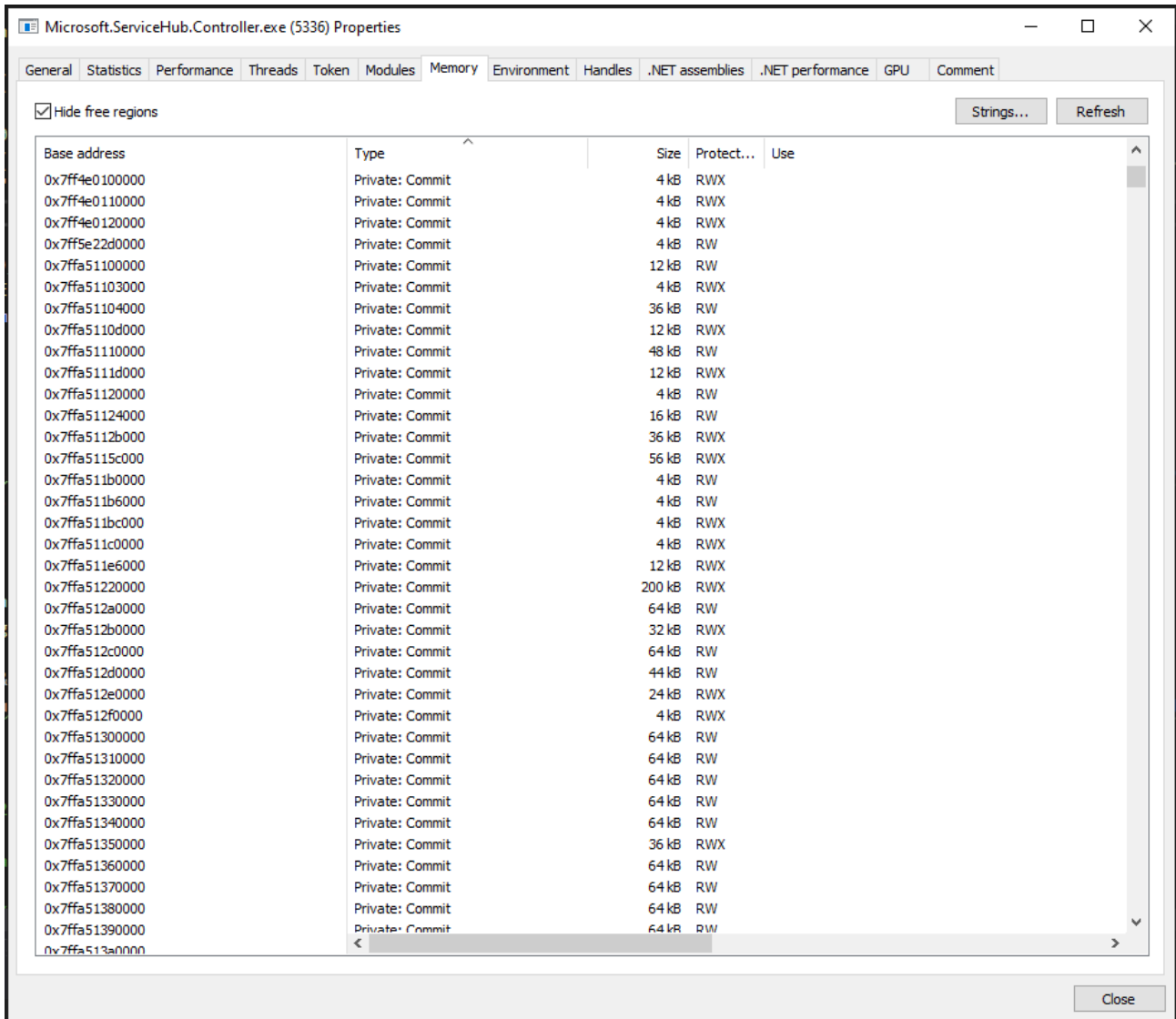


fig 11. JIT Compiler RWX sections

Above you can see a small sample of these RWX sections within my Microsoft.ServiceHub.Controller.exe process. This means that in theory we could see false positives from JIT compiler-based languages that run any of our hooked functions from these memory regions. Additionally, this means these sorts of processes can also be great spaces to hide your RWX malware, as Private Commit RWX regions are otherwise considered suspicious (as we have executable memory that doesn't map to anything on disk).

Outside of blending in with JIT processes though, let's discuss another simple bypass to this, one that exists within Cobalt Strikes own C2 profile even.

The Module Stomp Bypass

If we think back to the original detection, we were able to observe executablememory calling our hooked functions that couldn't resolve to any module name. A first thought may be "what is a mechanism to bypass this" as one must exist. Several exist in fact, but we can start with a simple one, a mechanism called "Module Stomping" (<https://www.forrest-orr.net/post/malicious-memory-artifacts-part-i-dll-hollowing> as well as

<https://www.ired.team/offensive-security/code-injection-process-injection/modulestomping-dll-hollowing-shellcode-injection>).

What this technique effectively does is load a DLL that our process doesn't currently have loaded and hollow out its memory regions to contain the data for a malicious DLL of ours instead. This would make it so all our calls now appear to be coming from this legitimate module!

The section in your malleable C2 profile (for Cobalt Strike) that you would have to edit is the following:

```
set allocator "VirtualAlloc"; # HeapAlloc,MapViewOfFile, and VirtualAlloc.  
  
# Ask the x86 ReflectiveLoader to load the specified library and overwrite  
# its space instead of allocating memory with VirtualAlloc.  
# Only works with VirtualAlloc  
set module_x86 "xpsservices.dll";  
set module_x64 "xpsservices.dll";
```

These settings can be observed in the old reference profile here: <https://github.com/rsmudge/Malleable-C2-Profiles/blob/master/normal/reference.profile>. By changing your allocator to "VirtualAlloc" and enabling the set module_x86 and x64 settings you can now allocate your Cobalt Strike payload to arbitrary modules you load instead of arbitrarily allocated executable memory space.

Let's change the setting and see what this looks like. We will simply run an unstaged Cobalt Strike EXE and observe for this experiment.

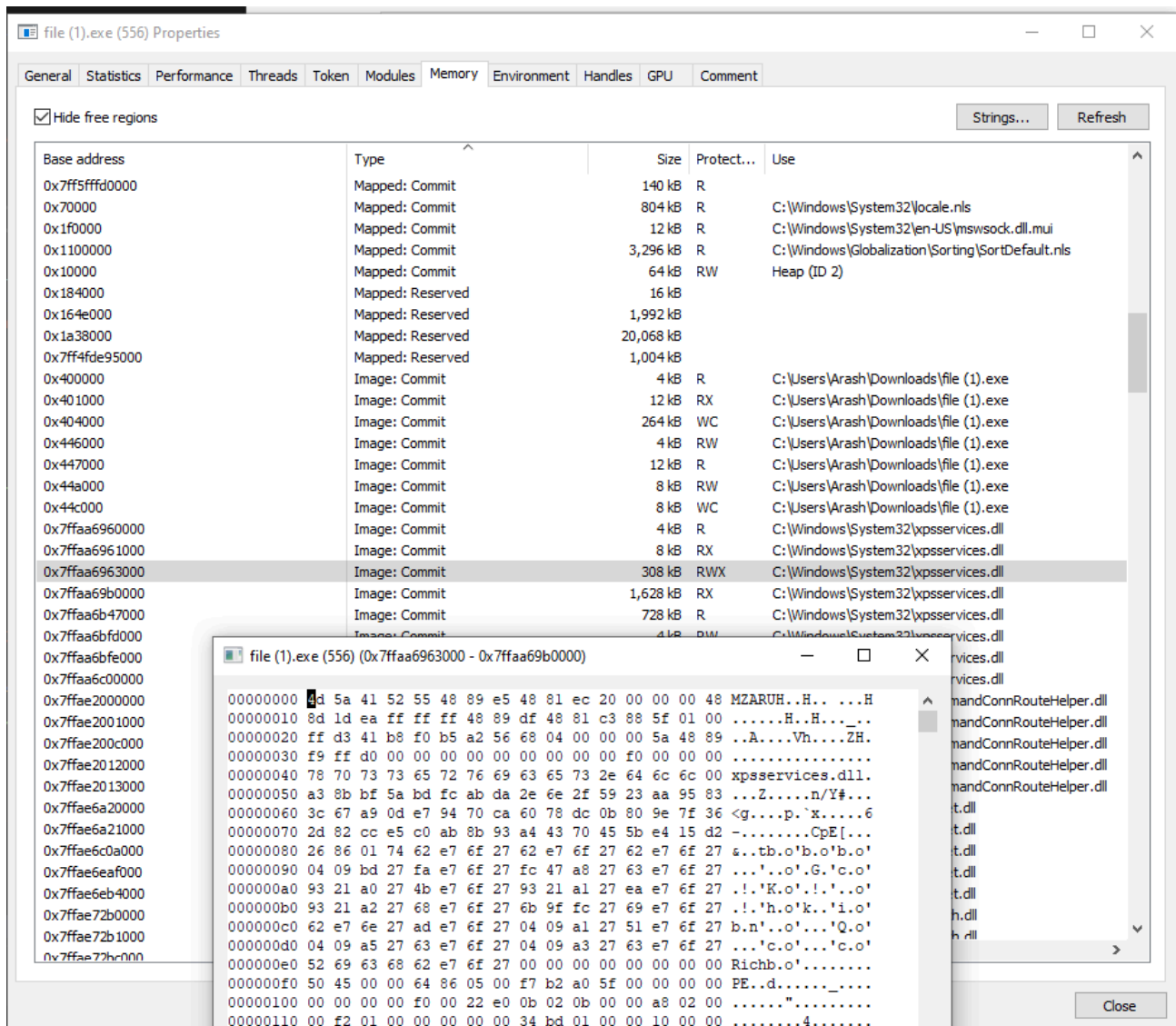


fig 12. Cobalt Strike module stomp

Let's go ahead and run this with our module name resolver and see what it looks like. Since the name should always resolve, now we will change the logic a bit to monitor only xpservices.dll.

```

LPCSTR data = (LPCSTR)_ReturnAddress();
if (::GetModuleHandleExA(GET_MODULE_HANDLE_EX_FLAG_FROM_ADDRESS, data, &hModule) == 1) {
    ::GetModuleBaseNameA(GetCurrentProcess(), hModule, lpBaseName, sizeof(lpBaseName));
}
else {
    if (threadMonitor == NULL) {
        threadMonitor = callerId;
    }
    sprintf(log, 255, "Suspicious Malloc() from thread with id:%d LPVOID:%p Heap Handle:%p S
LogDetected(&log);
printf("Found NON Module Caller!\n");
}
std::string modName = lpBaseName;
std::transform(modName.begin(), modName.end(), modName.begin(),
    [](unsigned char c) { return tolower(c); });
if (modName.find("xpsservices.dll") != std::string::npos) {
    printf("Found CS Caller Module!\n");
}
}

```

fig 13. New code to monitor xpsservices

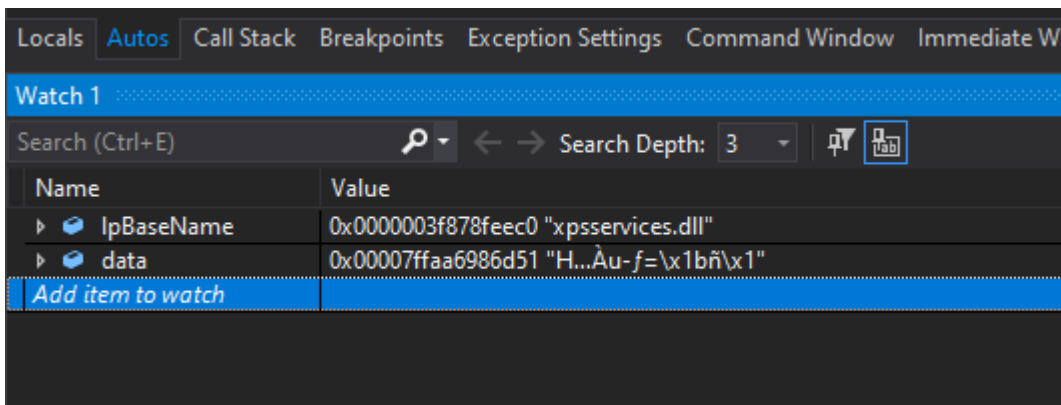


fig 14. Name resolved properly

Here we can see the new stomped DLL calling our hooked malloc, and that our code can successfully resolve calls to this module. If we look at the print statements, we would also see all the calls – from anything that doesn't map to modules that have disappeared.

The other detection is a much more basic one. Within any executable file, the section where executable code lives is the .TEXT section. If we walk the .TEXT section of a DLL on disk and compare it to the .TEXT section of its equivalent offload in memory the sections in theory should always match, as the code should not change unless the file is polymorphic. The code for this is fairly basic.

```
HMODULE lphModule[1024];
DWORD lpcbNeeded;
// Get a handle to the process.
HANDLE = hProcess = OpenProcess(PROCESS_QUERY_INFORMATION |
    PROCESS_VM_READ,
    FALSE, processID);

// Get a list of all the modules in this process.
if (EnumProcessModules(hProcess, lphModule, sizeof(lphModule), &lpcbNeeded))
{
    for (i = 0; i < (lpcbNeeded / sizeof(HMODULE)); i++)
    {
        char szModName[MAX_PATH];

        // Get the full path to the module's file.

        if (K32GetModuleFileNameExA(hProcess, lphModule[i], szModName,
            sizeof(szModName) / sizeof(char)))
        {
            // Do stuff
        }
    }
}
```

Here we simply start by iterating every module in the process.

```
// Get file Bytes
FILE* pFile;
long lSize;
//SIZE_T lSize;
BYTE* buffer;
size_t result;
pFile = fopen(szModName, "rb");
// obtain file size:
fseek(pFile, 0, SEEK_END);
lSize = ftell(pFile);
rewind(pFile);
// allocate memory to contain the whole file:
buffer = (BYTE*)malloc(sizeof(BYTE) * lSize);
// copy the file into the buffer:
result = fread(buffer, 1, lSize, pFile);
```

```
fclose(pFile);

BYTE* buff;
buff = (BYTE*)malloc(sizeof(BYTE) * lSize);
_ReadProcessMemory(hProcess, lphModule[i], buff, lSize, NULL);

PIMAGE_NT_HEADERS64 NtHeader = ImageNtHeader(buff);
PIMAGE_SECTION_HEADER Section = IMAGE_FIRST_SECTION(NtHeader);
WORD NumSections = NtHeader->FileHeader.NumberOfSections;
for (WORD i = 0; i < NumSections; i++) { std::string secName(reinterpret_cast(Section->Name), 5);
    if (secName.find(".text") != std::string::npos) {
        break;
    }
    Section++;
}
```

We then load the relevant module file on disk and store the bytes for comparing memory in the var buffer. We then also read from the base address of the module located in “lphModule[i]” and store all the bytes within the var buff. We then enumerate all the sections in the loaded module until we find the .TEXT section and break the loop. At this point the “Section” variable will contain all our relevant section data.

To be able to match the on-disk file to the one in memory we need to use the Section offsets to find the .TEXT section location on disk and in memory. This actually will not match (usually). The offset to the .TEXT section in memory generally gets relocated down a page, 4096 bytes. The offset to the section on disk is usually 1024 bytes in comparison. But we say usually so we of course will simply use “Section->PointerToRawData” to get the offset on disk and “Section->VirtualAddress” to get its offloaded address in memory to be 100% sure.

```
LPBYTE txtSectionFile = buffer + Section->PointerToRawData;
LPBYTE txtSectionMem = buff + Section->VirtualAddress;
```

At this point all you’d have to do is compare each memory region byte for byte and make sure they match.

```
int inconsistencies = 0;
for (int i = 0; i < Section->SizeOfRawData; i++) {
    if ((char*)txtSectionFile[i] != (char*)txtSectionMem[i]) {
        inconsistencies++;
    }
}
```

Now of course we need to account for things like hooks and such, as we know many AV and EDR will perform hooks, we know these will provide false positives. As a result we take the amount of the differences and if it’s greater than a certain number only then do we get concerned.

```

if (inconsistencies > 10000) {
    printf("FOUND DLL HOLLOW.\nNOW MONITORING: %s with %f changes found. %f%% Overall\n\n", szModName,
    CHAR* log = (CHAR*)malloc(256);
    sprintf(log, 255, "FOUND DLL HOLLOW.\nNOW MONITORING: %s with %f changes found. %f%% Overall\n\n",
    LogDetected(&log);
    free(log);
    std::string moduleName(szModName, sizeof(szModName) / sizeof(char));
    std::transform(moduleName.begin(), moduleName.end(), moduleName.begin(),
        [](unsigned char c) { return tolower(c); });
    dllMonitor = moduleName;
    break;
}

```

We arbitrarily pick 10,000 as our amount, simply because we know it'll certainly be a larger number than any number of hooks any utility would alter for the hooks, as well as being small enough as we know most raw malware payloads at least are much bigger. This should reduce false positives substantially while finding any altered DLLs in memory. The only caveat to this would be additional false positives from polymorphic DLLs who alter themselves in memory.

Let's run our new detector against our Cobalt Strike payload and the hollowed DLL and observe the results.

```

C:\Users\Arash\source\repos\LockdExeCSScannerStable\x64\Debug\LockdExe.exe (00007FF6B7490000)
C:\Windows\SYSTEM32\ntdll.dll (00007FFAFD7B0000)
C:\Windows\System32\KERNEL32.DLL (00007FFAFC170000)
C:\Windows\System32\KERNELBASE.dll (00007FFAFB210000)
C:\Windows\SYSTEM32\dbghelp.dll (00007FFAED1E0000)
C:\Windows\System32\ucrtbase.dll (00007FFAFB090000)
C:\Users\Arash\source\repos\LockdExeCSScannerStable\x64\Debug\LockdExe.exe (00007FF6B7490000)
C:\Windows\SYSTEM32\ntdll.dll (00007FFAFD7B0000)
Found more than 5 bytes altered, there's potentially hooks here: C:\Windows\SYSTEM32\ntdll.dll Bytes Altered: 10.000000
C:\Windows\System32\KERNEL32.DLL (00007FFAFC170000)
C:\Windows\System32\KERNELBASE.dll (00007FFAFB210000)
C:\Windows\SYSTEM32\dbghelp.dll (00007FFAED1E0000)
C:\Windows\System32\ucrtbase.dll (00007FFAFB090000)
C:\Windows\SYSTEM32\wininet.dll (00007FFAE6A20000)
Found more than 5 bytes altered, there's potentially hooks here: C:\Windows\SYSTEM32\wininet.dll Bytes Altered: 10.000000
C:\Windows\System32\msvcrt.dll (00007FFAFCAD0000)
C:\Windows\SYSTEM32\iertutil.dll (00007FFAF1860000)
C:\Windows\System32\combase.dll (00007FFAFB800000)
C:\Windows\System32\RPCRT4.dll (00007FFAFCB70000)
C:\Windows\System32\sechost.dll (00007FFAFCB80000)
C:\Windows\System32\advapi32.dll (00007FFAFBBD0000)
C:\Windows\System32\shcore.dll (00007FFAFC020000)
C:\Windows\SYSTEM32\SspiCli.dll (00007FFAFAD90000)
C:\Windows\System32\user32.dll (00007FFAFCEE0000)
C:\Windows\System32\win32u.dll (00007FFAFB190000)
C:\Windows\System32\GDI32.dll (00007FFAFD170000)
C:\Windows\System32\gdi32full.dll (00007FFAFB6F0000)
C:\Windows\System32\msvc_p_win.dll (00007FFAFB4E0000)
C:\Windows\System32\IMM32.DLL (00007FFAFBE40000)
C:\Windows\SYSTEM32\windows.storage.dll (00007FFAF8FF0000)
C:\Windows\SYSTEM32\Wldp.dll (00007FFAF850000)
C:\Windows\System32\shlwapi.dll (00007FFAFD1A0000)
C:\Windows\SYSTEM32\profapi.dll (00007FFAFAE10000)
C:\Windows\System32\WS2_32.dll (00007FFAFBB60000)
C:\Windows\SYSTEM32\ondemandconroutehelper.dll (00007FFAE2000000)
C:\Windows\SYSTEM32\winhttp.dll (00007FFAF0C50000)
C:\Windows\SYSTEM32\kernel.appcore.dll (00007FFAF8DF0000)
C:\Windows\system32\mswsock.dll (00007FFAFA5B0000)
C:\Windows\SYSTEM32\IPHLPAPI.DLL (00007FFAFA2A0000)
C:\Windows\SYSTEM32\WINNSI.DLL (00007FFAF2BE0000)
C:\Windows\System32\NSI.dll (00007FFAFC160000)
C:\Windows\SYSTEM32\urlmon.dll (00007FFAF1410000)
C:\Windows\SYSTEM32\srvccli.dll (00007FFAF13E0000)
C:\Windows\SYSTEM32\netutils.dll (00007FFAFA3B0000)
C:\Windows\System32\OLEAUT32.dll (00007FFAFD0A0000)
C:\Windows\SYSTEM32\xpservices.dll (00007FFAA6960000)
Found more than 5 bytes altered, there's potentially hooks here: C:\Windows\SYSTEM32\xpservices.dll Bytes Altered: 303562.000000
FOUND DLL HOLLOW.
NOW MONITORING: C:\Windows\SYSTEM32\xpservices.dll with 303562.000000 changes found. 15.265049% Overall

```

fig 16. DLL Hollow Detection

Here we can see a few false positives from our own hooks actually, where we alter five bytes to the prologue of each function, two functions being altered in each DLL. Finally at the end we can see our hollowed xpsservices.dll and the detection is observed with over 300k bytes altered.

Let's go ahead and turn our tool into a DLL and inject it into everything to observe false positives:

By injecting into everything and logging all data to files we can observe our detection:

```

Found more than 5 bytes altered, there's potentially hooks here: C:\Windows\SYSTEM32\xpsservices.dll Bytes Altered: 303562.000000
FOUND DLL HOLLOW.
NOW MONITORING: C:\Windows\SYSTEM32\xpsservices.dll with 303562.000000 changes found. 15.265049% Overall

Suspicious Malloc() from module with name:c:\windows\system32\xpsservices.dll LPVOID:000000000842960 Heap Handle:000000000760000 Size: 41
Suspicious InternetConnectA() from module with name: c:\windows\system32\xpsservices.dll, Name: 192.168.1.182 Creds: (null)[(null)]
Suspicious Malloc() from module with name:c:\windows\system32\xpsservices.dll LPVOID:0000000007C3300 Heap Handle:000000000760000 Size: 24
Suspicious Malloc() from module with name:c:\windows\system32\xpsservices.dll LPVOID:0000000002FE0080 Heap Handle:000000000760000 Size: 27648
Suspicious Malloc() from module with name:c:\windows\system32\xpsservices.dll LPVOID:000000000786760 Heap Handle:000000000760000 Size: 8
Suspicious Malloc() from module with name:c:\windows\system32\xpsservices.dll LPVOID:000000000842960 Heap Handle:000000000760000 Size: 41
Suspicious InternetConnectA() from module with name: c:\windows\system32\xpsservices.dll, Name: 192.168.1.182 Creds: (null)[(null)]
Suspicious Malloc() from module with name:c:\windows\system32\xpsservices.dll LPVOID:0000000007C2F20 Heap Handle:000000000760000 Size: 24
Suspicious Malloc() from module with name:c:\windows\system32\xpsservices.dll LPVOID:0000000002FE0080 Heap Handle:000000000760000 Size: 27648
Suspicious Malloc() from module with name:c:\windows\system32\xpsservices.dll LPVOID:0000000007866E0 Heap Handle:000000000760000 Size: 8
Suspicious Malloc() from module with name:c:\windows\system32\xpsservices.dll LPVOID:000000000842660 Heap Handle:000000000760000 Size: 41
Suspicious InternetConnectA() from module with name: c:\windows\system32\xpsservices.dll, Name: 192.168.1.182 Creds: (null)[(null)]
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Suspicious Malloc() from module with name:c:\windows\system32\xpsservices.dll LPVOID:000000000786820 Heap Handle:000000000760000 Size: 8
Suspicious Malloc() from module with name:c:\windows\system32\xpsservices.dll LPVOID:000000000842020 Heap Handle:000000000760000 Size: 41
Suspicious InternetConnectA() from module with name: c:\windows\system32\xpsservices.dll, Name: 192.168.1.182 Creds: (null)[(null)]
Suspicious Malloc() from module with name:c:\windows\system32\xpsservices.dll LPVOID:0000000007C31A0 Heap Handle:000000000760000 Size: 24
Suspicious Malloc() from module with name:c:\windows\system32\xpsservices.dll LPVOID:0000000002FE0080 Heap Handle:000000000760000 Size: 27648
Suspicious Malloc() from module with name:c:\windows\system32\xpsservices.dll LPVOID:0000000007866E0 Heap Handle:000000000760000 Size: 8
Suspicious Malloc() from module with name:c:\windows\system32\xpsservices.dll LPVOID:0000000008420A0 Heap Handle:000000000760000 Size: 41
Suspicious InternetConnectA() from module with name: c:\windows\system32\xpsservices.dll, Name: 192.168.1.182 Creds: (null)[(null)]
Suspicious Malloc() from module with name:c:\windows\system32\xpsservices.dll LPVOID:0000000007C33A0 Heap Handle:000000000760000 Size: 24
Suspicious Malloc() from module with name:c:\windows\system32\xpsservices.dll LPVOID:0000000002FE0080 Heap Handle:000000000760000 Size: 27648
Suspicious Malloc() from module with name:c:\windows\system32\xpsservices.dll LPVOID:0000000007866E0 Heap Handle:000000000760000 Size: 8
Suspicious Malloc() from module with name:c:\windows\system32\xpsservices.dll LPVOID:000000000842020 Heap Handle:000000000760000 Size: 41
Suspicious InternetConnectA() from module with name: c:\windows\system32\xpsservices.dll, Name: 192.168.1.182 Creds: (null)[(null)]
Suspicious Malloc() from module with name:c:\windows\system32\xpsservices.dll LPVOID:0000000007C3140 Heap Handle:000000000760000 Size: 24
Suspicious Malloc() from module with name:c:\windows\system32\xpsservices.dll LPVOID:0000000002FE0080 Heap Handle:000000000760000 Size: 27648
Suspicious Malloc() from module with name:c:\windows\system32\xpsservices.dll LPVOID:000000000786810 Heap Handle:000000000760000 Size: 8
Suspicious Malloc() from module with name:c:\windows\system32\xpsservices.dll LPVOID:000000000842660 Heap Handle:000000000760000 Size: 41
Suspicious InternetConnectA() from module with name: c:\windows\system32\xpsservices.dll, Name: 192.168.1.182 Creds: (null)[(null)]
Suspicious Malloc() from module with name:c:\windows\system32\xpsservices.dll LPVOID:0000000007C35C0 Heap Handle:000000000760000 Size: 24
Suspicious Malloc() from module with name:c:\windows\system32\xpsservices.dll LPVOID:0000000002FE0080 Heap Handle:000000000760000 Size: 27648

```

fig 17. Detection

BUT! Interestingly enough we do observe one false positive on what appears to be a polymorphic DLL after all...

```

Found more than 5 bytes altered, there's potentially hooks here: C:\Program Files\VMware\VMware Tools\intl.dll Bytes Altered: 7064.000000

```

fig 18. False positive

Unfortunately not enough bytes are altered to be useful for a hollow target though!

How do you bypass this detection? Now the simple obvious solution is to restore the DLL bytes (per <https://twitter.com/solomonsklash>'s idea) on sleep to prevent this sort of detection and next steps would be hooking those calls and detecting the restores, if possible, or the constant file reads etc. As we all know, cybersecurity is a never-ending cat and mouse.

Final Thoughts

As red teamers work on malware, often we make discoveries that can lead to new detections too. These observations can be tremendously useful to the community while also pushing researchers to the cutting edge and

forcing them to think outside of the box if they'd like this game to continue longer.

As we've seen above, we find detections, make bypasses, find more detections — and the game will never end. Hopefully some interesting new insights could be made to make our defensive industry far more robust overall, as we work together towards a goal of secure internet usage.

Source: <https://www.cyberark.com/resources/threat-research/analyzing-malware-with-hooks-stomps-and-return-addresses-2>