Process Enumeration - EnumProcesses

Introduction

One way to perform process enumeration was previously demonstrated in the process injection module that used `CreateToolHelp32Snapshot`. This module will demonstrate another way to perform process enumeration using `EnumProcesses`.

It's important for malware authors to be able to implement a technique within their malware in several ways to remain unpredictable in their actions.

EnumProcesses

Start by reviewing Microsoft's documentation on EnumProcesses. Notice that the function returns the Process IDs (PIDs) as an array, without the associated process names. The problem is that only having PIDs without the associated process names makes it difficult to identify the process from a human perspective.

The solution is to use the OpenProcess, GetModuleBaseName and EnumProcessModules WinAPIs.

1. `OpenProcess` will be used to open a handle to a PID with `PROCESS_QUERY_INFORMATION` and `PROCESS_VM_READ` access rights.
2. `EnumProcessModules` will be used to enumerate all the modules within the opened process. This is required for step 3.
3. `GetModuleBaseName` will determine the name of the process, given the enumerated process modules from step 2.

EnumProcesses Advantage

Using the `CreateToolhelp32Snapshot` process enumeration method, a snapshot is created and a string comparison is performed to determine whether the process name matches the intended target process. The issue with that method is when there are multiple instances of a process running at different privilege levels, there's no way to differentiate them during the string comparison. For example, some `svchost.exe` processes run with normal user privileges whereas others run with elevated privileges. There is no way to determine the privilege level of `svchost.exe` during the string comparison. Therefore the only indicator as to whether it's privileged is if the `OpenProcess` call fails (assuming that the implementation is running with normal user privileges).

On the other hand, using the `EnumProcesses` process enumeration method provides the PID and handle to the process, and the objective is to obtain the process name. This method is guaranteed to be successful since a handle to the process already exists.

Code Walkthrough

This section will explain code snippets that are based on Microsoft's example of process enumeration.

PrintProcesses Function

`PrintProcesses` is a custom function that prints the process name and PID of the enumerated processes. Only processes running with the same privileges as the implementation can have their information retrieved. Information about elevated processes cannot be retrieved, again, assuming the implementation is running with normal user privileges. Attempts to open a handle to high-privileged processes using `OpenProcess` will result in `ERROR_ACCESS_DENIED` error.

It's possible to use `OpenProcess`'s response as an indicator to determine if the process can be targeted. Processes that cannot have a handle open to them cannot be targeted whereas the ones with a handle successfully opened can be targeted.

```
BOOL PrintProcesses() {

        DWORD           adwProcesses    [1024 * 2],
                            dwReturnLen1                = NULL,
                            dwReturnLen2                = NULL,
                            dwNmbrOfPids                = NULL;

        HANDLE          hProcess                = NULL;
        HMODULE         hModule                 = NULL;

        WCHAR           szProc                  [MAX_PATH];

        // Get the array of PIDs
        if (!EnumProcesses(adwProcesses, sizeof(adwProcesses),
&dwReturnLen1)) {
                printf("[!] EnumProcesses Failed With Error : %d \n",
GetLastError());
                return FALSE;
        }

        // Calculating the number of elements in the array
        dwNmbrOfPids = dwReturnLen1 / sizeof(DWORD);

        printf("[i] Number Of Processes Detected : %d \n", dwNmbrOfPids);

        for (int i = 0; i < dwNmbrOfPids; i++) {

                // If process is not NULL
                if (adwProcesses[i] != NULL) {
```

```
                        // Open a process handle
                        if ((hProcess =
OpenProcess(PROCESS_QUERY_INFORMATION | PROCESS_VM_READ, FALSE,
adwProcesses[i])) != NULL) {

                                // If handle is valid
                                // Get a handle of a module in the process
'hProcess'
                                // The module handle is needed for
'GetModuleBaseName'
                                if (!EnumProcessModules(hProcess, &hModule,
sizeof(HMODULE), &dwReturnLen2)) {
                                        printf("[!] EnumProcessModules
Failed [ At Pid: %d ] With Error : %d \n", adwProcesses[i],
GetLastError());
                                }
                                else {
                                        // If EnumProcessModules succeeded
                                        // Get the name of 'hProcess' and
save it in the 'szProc' variable
                                        if (!GetModuleBaseName(hProcess,
hModule, szProc, sizeof(szProc) / sizeof(WCHAR))) {
                                                printf("[!]
GetModuleBaseName Failed [ At Pid: %d ] With Error : %d \n",
adwProcesses[i], GetLastError());
                                        }
                                        else {
                                                // Printing the process
name & its PID
                                                wprintf(L"[%0.3d] Process
\"%s\" - Of Pid : %d \n", i, szProc, adwProcesses[i]);
                                        }
                                }

                                // Close process handle
                                CloseHandle(hProcess);
                        }
                }

                // Iterate through the PIDs array
        }
```

```
        return TRUE;
}
```

GetRemoteProcessHandle Function

The code snippet below is an update to the previous `PrintProcesses` function. `GetRemoteProcessHandle` will perform the same tasks as `PrintProcesses` except it will return a handle to the specified process.

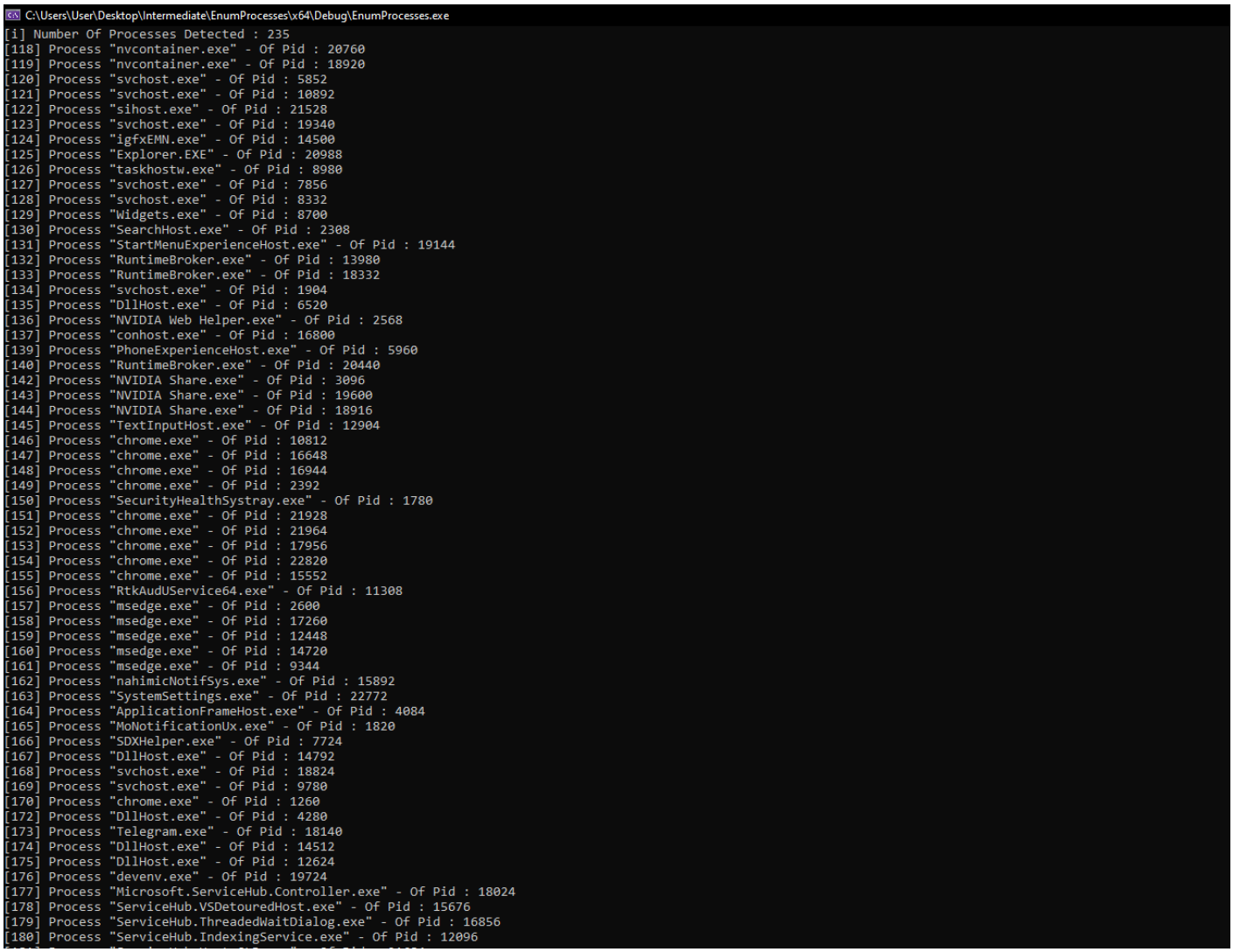
The updated function uses `wcscmp` to verify the target process. Furthermore, `OpenProcess`'s access control is changed from `PROCESS_QUERY_INFORMATION | PROCESS_VM_READ` to `PROCESS_ALL_ACCESS` to provide more access to the returned process object.

```
BOOL GetRemoteProcessHandle(LPCWSTR szProcName, DWORD* pdwPid, HANDLE*
phProcess) {

        DWORD           adwProcesses    [1024 * 2],
                            dwReturnLen1                = NULL,
                            dwReturnLen2                = NULL,
                            dwNmbrOfPids                = NULL;

        HANDLE          hProcess                = NULL;
        HMODULE         hModule                 = NULL;

        WCHAR           szProc                  [MAX_PATH];

        // Get the array of PIDs
        if (!EnumProcesses(adwProcesses, sizeof(adwProcesses),
&dwReturnLen1)) {
                printf("[!] EnumProcesses Failed With Error : %d \n",
GetLastError());
                return FALSE;
        }

        // Calculating the number of elements in the array
        dwNmbrOfPids = dwReturnLen1 / sizeof(DWORD);

        printf("[i] Number Of Processes Detected : %d \n", dwNmbrOfPids);

        for (int i = 0; i < dwNmbrOfPids; i++) {

                // If process is not NULL
                if (adwProcesses[i] != NULL) {

                        // Open a process handle
```

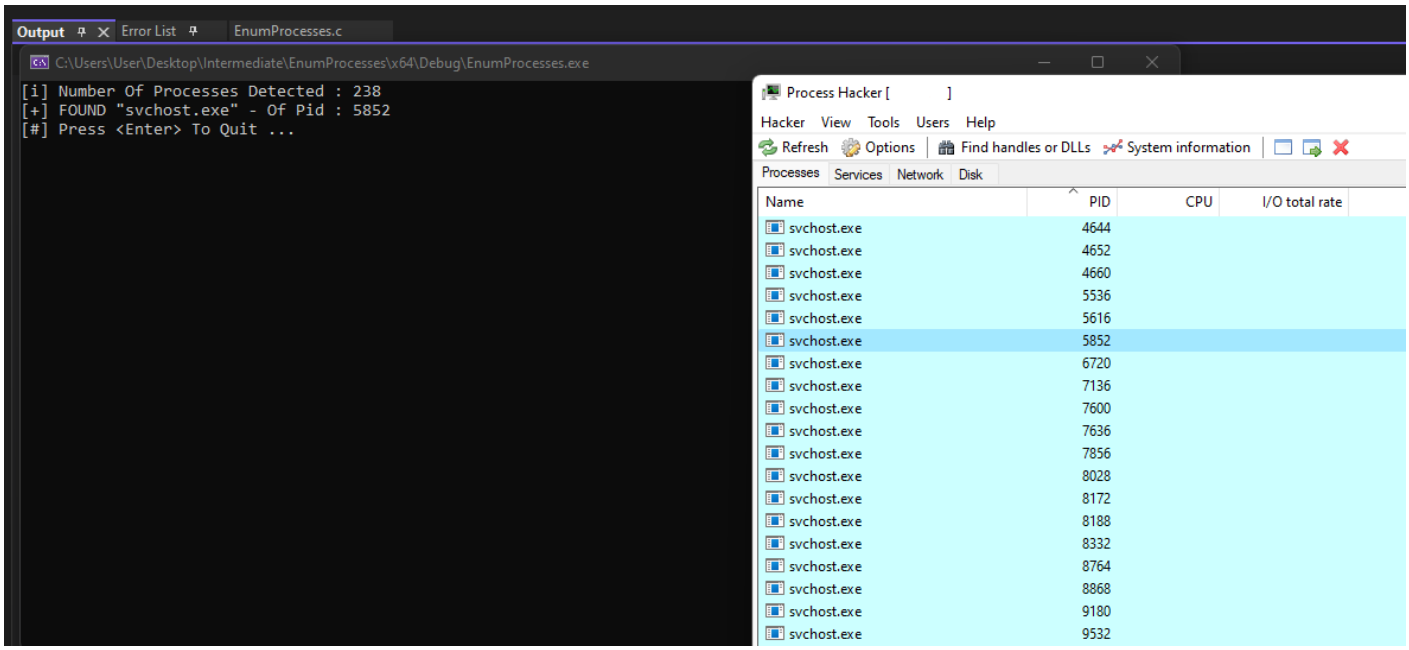
```
                        if ((hProcess = OpenProcess(PROCESS_ALL_ACCESS,
FALSE, adwProcesses[i])) != NULL) {

                                // If handle is valid
                                // Get a handle of a module in the process
'hProcess'.
                                // The module handle is needed for
'GetModuleBaseName'
                                if (!EnumProcessModules(hProcess, &hModule,
sizeof(HMODULE), &dwReturnLen2)) {
                                        printf("[!] EnumProcessModules
Failed [ At Pid: %d ] With Error : %d \n", adwProcesses[i],
GetLastError());
                                }
                                else {
                                        // If EnumProcessModules succeeded
                                        // Get the name of 'hProcess' and
save it in the 'szProc' variable
                                        if (!GetModuleBaseName(hProcess,
hModule, szProc, sizeof(szProc) / sizeof(WCHAR))) {
                                                printf("[!]
GetModuleBaseName Failed [ At Pid: %d ] With Error : %d \n",
adwProcesses[i], GetLastError());
                                        }
                                        else {
                                                // Perform the comparison
logic
                                                if (wcscmp(szProcName,
szProc) == 0) {
                                                        wprintf(L"[+] FOUND
\"%s\" - Of Pid : %d \n", szProc, adwProcesses[i]);
                                                        // Return by
reference
                                                        *pdwPid         =
adwProcesses[i];
                                                        *phProcess      =
hProcess;
                                                        break;
                                                }
                                        }
                                }

                                CloseHandle(hProcess);
                        }
```

```
                }
        }

        // Check if pdwPid or phProcess are NULL
        if (*pdwPid == NULL || *phProcess == NULL)
                return FALSE;
        else
                return TRUE;
}
```

PrintProcesses - Example



GetRemoteProcessHandle - Example


Output
Error List
EnumProcesses.c
C:\Users\User\Desktop\Intermediate\EnumProcesses\x64\Debug\EnumProcesses.exe
[i] Number Of Processes Detected : 238
[+] FOUND "svchost.exe" - Of Pid : 5852
[#] Press <Enter> To Quit ...
Process Hacker [ ]
Hacker View Tools Users Help
Refresh Options Find handles or DLLs System information
Processes Services Network Disk
Name PID CPU I/O total rate
svchost.exe 4644
svchost.exe 4652
svchost.exe 4660
svchost.exe 5536
svchost.exe 5616
svchost.exe 5852
svchost.exe 6720
svchost.exe 7136
svchost.exe 7600
svchost.exe 7636
svchost.exe 7856
svchost.exe 8028
svchost.exe 8172
svchost.exe 8188
svchost.exe 8332
svchost.exe 8764
svchost.exe 8868
svchost.exe 9180
svchost.exe 9532