Process Enumeration - NtQuerySystemInformation

Introduction

This module discusses a more unique way of performing process enumeration using `NtQuerySystemInformation`, which is a **syscall** (more on syscalls later). `NtQuerySystemInformation` is exported from the `ntdll.dll` module and therefore it will require the use of `GetModuleHandle` and `GetProcAddress`.

Microsoft's documentation on `NtQuerySystemInformation` shows that it is capable of returning a lot of information about the system. The focus of this module will be on using it to perform process enumeration.

Retrieve NtQuerySystemInformation's Address

As previously mentioned, `GetProcAddress` and `GetModuleHandle` are needed to retrieve `NtQuerySystemInformation`'s address from `ntdll.dll`.

```
// Function pointer
typedef NTSTATUS (NTAPI* fnNtQuerySystemInformation)(
        SYSTEM_INFORMATION_CLASS SystemInformationClass,
        PVOID                    SystemInformation,
        ULONG                    SystemInformationLength,
        PULONG                   ReturnLength
);

fnNtQuerySystemInformation pNtQuerySystemInformation = NULL;

// Getting NtQuerySystemInformation's address
pNtQuerySystemInformation =
(fnNtQuerySystemInformation)GetProcAddress(GetModuleHandle(L"NTDLL.DLL"),
"NtQuerySystemInformation");
if (pNtQuerySystemInformation == NULL) {
        printf("[!] GetProcAddress Failed With Error : %d\n",
GetLastError());
        return FALSE;
}
```

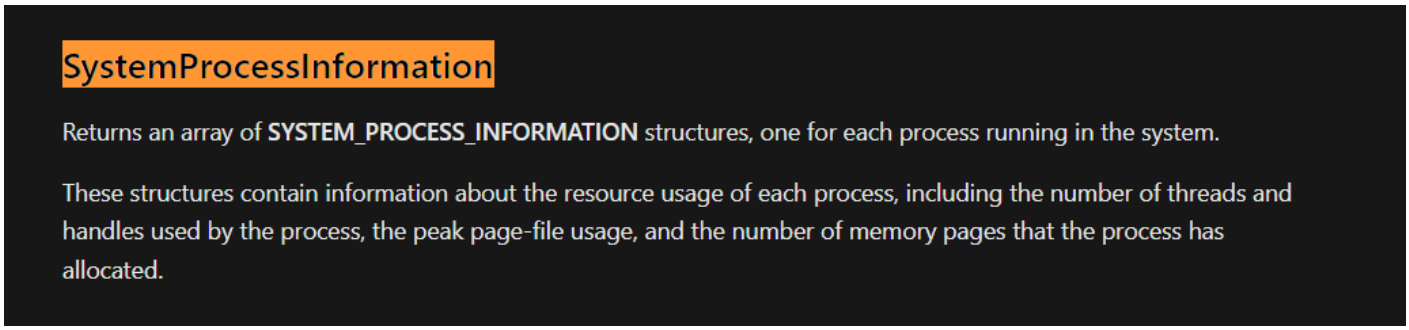
NtQuerySystemInformation Parameters

`NtQuerySystemInformation`'s parameters are shown below.

```
__kernel_entry NTSTATUS NtQuerySystemInformation(
  [in]            SYSTEM_INFORMATION_CLASS SystemInformationClass,
  [in, out]       PVOID                    SystemInformation,
  [in]            ULONG                    SystemInformationLength,
  [out, optional] PULONG                   ReturnLength
);
```

- `SystemInformationClass` - Decides what type of system information the function returns.
- `SystemInformation` - A pointer to a buffer that will receive the requested information. The returned information will be in a form of a structure of type specified according to the `SystemInformationClass` parameter.
- `SystemInformationLength` - The size of the buffer pointed to by the `SystemInformation` parameter, in bytes.
- `ReturnLength` - A pointer to a ULONG variable that will receive the actual size of the information written to `SystemInformation`.

Since the objective is process enumeration, the SystemProcessInformation flag will be used. Using this flag will make the function return an array of `SYSTEM_PROCESS_INFORMATION` structures (via the `SystemInformation` parameter), one for each process running in the system.



SYSTEM_PROCESS_INFORMATION Structure

The next step is to review Microsoft's documentation to understand what the `SYSTEM_PROCESS_INFORMATION` structure looks like.

```
typedef struct _SYSTEM_PROCESS_INFORMATION {
    ULONG NextEntryOffset;
    ULONG NumberOfThreads;
    BYTE Reserved1[48];
    UNICODE_STRING ImageName;
    KPRIORITY BasePriority;
    HANDLE UniqueProcessId;
    PVOID Reserved2;
    ULONG HandleCount;
    ULONG SessionId;
    PVOID Reserved3;
    SIZE_T PeakVirtualSize;
```

```
    SIZE_T VirtualSize;
    ULONG Reserved4;
    SIZE_T PeakWorkingSetSize;
    SIZE_T WorkingSetSize;
    PVOID Reserved5;
    SIZE_T QuotaPagedPoolUsage;
    PVOID Reserved6;
    SIZE_T QuotaNonPagedPoolUsage;
    SIZE_T PagefileUsage;
    SIZE_T PeakPagefileUsage;
    SIZE_T PrivatePageCount;
    LARGE_INTEGER Reserved7[6];
} SYSTEM_PROCESS_INFORMATION;
```

The focus will be on `UNICODE_STRING ImageName` which contains the process name and `UniqueProcessId` which is the process ID. Additionally, `NextEntryOffset` will be used to move into the next element in the returned array.

Since calling `NtQuerySystemInformation` with the `SystemProcessInformation` flag will return an array of `SYSTEM_PROCESS_INFORMATION` of unknown size, `NtQuerySystemInformation` will need to be called twice. The first call will retrieve the array size, which is used to allocate a buffer, and then the second call will use the allocated buffer.

It's expected that the first `NtQuerySystemInformation` call will fail with a `STATUS_INFO_LENGTH_MISMATCH` (0xC0000004) error since invalid parameters are being passed simply to retrieve the array size.

```
ULONG                       uReturnLen1    = NULL,
                            uReturnLen2    = NULL;
PSYSTEM_PROCESS_INFORMATION SystemProcInfo = NULL;
NTSTATUS                    STATUS         = NULL;

// First NtQuerySystemInformation call
// This will fail with STATUS_INFO_LENGTH_MISMATCH
// But it will provide information about how much memory to allocate
(uReturnLen1)
pNtQuerySystemInformation(SystemProcessInformation, NULL, NULL,
&uReturnLen1);

// Allocating enough buffer for the returned array of
`SYSTEM_PROCESS_INFORMATION` struct
SystemProcInfo = (PSYSTEM_PROCESS_INFORMATION) HeapAlloc(GetProcessHeap(),
HEAP_ZERO_MEMORY, (SIZE_T)uReturnLen1);
if (SystemProcInfo == NULL) {
        printf("[!] HeapAlloc Failed With Error : %d\n", GetLastError());
```

```
        return FALSE;
}

// Second NtQuerySystemInformation call
// Calling NtQuerySystemInformation with the correct arguments, the output
will be saved to 'SystemProcInfo'
STATUS = pNtQuerySystemInformation(SystemProcessInformation,
SystemProcInfo, uReturnLen1, &uReturnLen2);
if (STATUS != 0x0) {
        printf("[!] NtQuerySystemInformation Failed With Error : 0x%0.8X
\n", STATUS);
        return FALSE;
}
```

Iterating Through Processes

Now that the array has been successfully retrieved, the next step is to loop through it and access `ImageName.Buffer`, which holds the process name. Every iteration will compare the process name to the target process name.

To access each element of type `SYSTEM_PROCESS_INFORMATION` in the array, the `NextEntryOffset` member must be used. To find the address of the next element, add the address of the previous element to `NextEntryOffset`. This is demonstrated in the snippet below.

```
// 'SystemProcInfo' will now represent a new element in the array
SystemProcInfo = (PSYSTEM_PROCESS_INFORMATION)((ULONG_PTR)SystemProcInfo +
SystemProcInfo->NextEntryOffset);
```

Freeing allocated Memory

Before moving `SystemProcInfo` to the new element in the array, the initial address of the allocated memory needs to be saved in order to be freed later. Therefore, right before the loop begins, the address needs to be saved to a temporary variable.

```
// Since we will modify 'SystemProcInfo', we will save its initial value
before the while loop to free it later
pValueToFree = SystemProcInfo;
```

NtQuerySystemInformation Process Enumeration

The complete code to perform process enumeration using `NtQuerySystemInformation` is shown below.

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

```
        fnNtQuerySystemInformation   pNtQuerySystemInformation = NULL;
        ULONG                        uReturnLen1                = NULL,
                                     uReturnLen2                = NULL;
    PSYSTEM_PROCESS_INFORMATION  SystemProcInfo             = NULL;
    NTSTATUS                     STATUS                     = NULL;
        PVOID                        pValueToFree               = NULL;

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

        pNtQuerySystemInformation(SystemProcessInformation, NULL, NULL,
&uReturnLen1);

        SystemProcInfo =
(PSYSTEM_PROCESS_INFORMATION)HeapAlloc(GetProcessHeap(), HEAP_ZERO_MEMORY,
(SIZE_T)uReturnLen1);
        if (SystemProcInfo == NULL) {
                printf("[!] HeapAlloc Failed With Error : %d\n",
GetLastError());
                return FALSE;
        }

        // Since we will modify 'SystemProcInfo', we will save its initial
value before the while loop to free it later
        pValueToFree = SystemProcInfo;

        STATUS = pNtQuerySystemInformation(SystemProcessInformation,
SystemProcInfo, uReturnLen1, &uReturnLen2);
        if (STATUS != 0x0) {
                printf("[!] NtQuerySystemInformation Failed With Error :
0x%0.8X \n", STATUS);
                return FALSE;
        }

        while (TRUE) {

                // Check the process's name size
```

```
                // Comparing the enumerated process name to the intended
target process
                if (SystemProcInfo->ImageName.Length &&
wcscmp(SystemProcInfo->ImageName.Buffer, szProcName) == 0) {

                        // Opening a handle to the target process, saving
it, and then breaking
                        *pdwPid         = (DWORD)SystemProcInfo-
>UniqueProcessId;
                        *phProcess      = OpenProcess(PROCESS_ALL_ACCESS,
FALSE, (DWORD)SystemProcInfo->UniqueProcessId);
                        break;
                }

                // If NextEntryOffset is 0, we reached the end of the array
                if (!SystemProcInfo->NextEntryOffset)
                        break;

                // Move to the next element in the array
                SystemProcInfo = (PSYSTEM_PROCESS_INFORMATION)
((ULONG_PTR)SystemProcInfo + SystemProcInfo->NextEntryOffset);
        }

        // Free using the initial address
        HeapFree(GetProcessHeap(), 0, pValueToFree);

        // Check if we successfully got the target process handle
        if (*pdwPid == NULL || *phProcess == NULL)
                return FALSE;
        else
                return TRUE;
}
```

Undocumented Part of NtQuerySystemInformation

`NtQuerySystemInformation` remains largely undocumented and a large portion of it is still unknown. For example, notice the `Reserved` members in `SYSTEM_PROCESS_INFORMATION`.

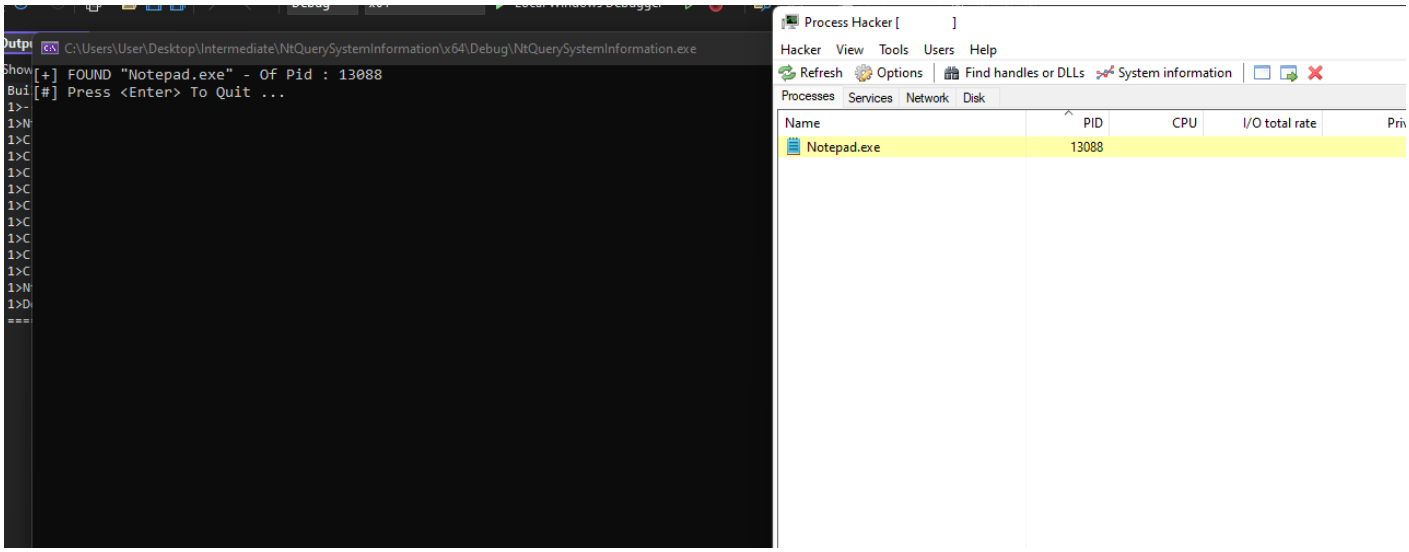
```
typedef struct _SYSTEM_PROCESS_INFORMATION {
    ULONG NextEntryOffset;
    ULONG NumberOfThreads;
    BYTE Reserved1[48];
    UNICODE_STRING ImageName;
    KPRIORITY BasePriority;
    HANDLE UniqueProcessId;
    PVOID Reserved2;
    ULONG HandleCount;
    ULONG SessionId;
    PVOID Reserved3;
    SIZE_T PeakVirtualSize;
    SIZE_T VirtualSize;
    ULONG Reserved4;
    SIZE_T PeakWorkingSetSize;
    SIZE_T WorkingSetSize;
    PVOID Reserved5;
    SIZE_T QuotaPagedPoolUsage;
    PVOID Reserved6;
    SIZE_T QuotaNonPagedPoolUsage;
    SIZE_T PagefileUsage;
    SIZE_T PeakPagefileUsage;
    SIZE_T PrivatePageCount;
    LARGE_INTEGER Reserved7[6];
} SYSTEM_PROCESS_INFORMATION;
```

The code provided in this module uses a different version of the `SYSTEM_PROCESS_INFORMATION` structure. Regardless, both Microsoft's version and the version used in the module's code lead to the same output. The main difference is the structure that's used in this module contains more information rather than Microsoft's limited version which contains several `Reserved` members. Furthermore, another version of the `SYSTEM_INFORMATION_CLASS` structure was used which is also more documented than Microsoft's version. Both structures can be viewed via the links below.

- `SYSTEM_PROCESS_INFORMATION` from ReactOS Documentation
- `SYSTEM_INFORMATION_CLASS` from System Informer Documentation

Demo

The image below shows the output after compiling and running the code presented in this module. The target process is `notepad.exe` (on Windows 10) and `Notepad.exe` (on Windows 11).


C:\Users\User\Desktop\Intermediate\NtQuerySystemInformation\x64\Debug\NtQuerySystemInformation.exe
[+] FOUND "Notepad.exe" - Of Pid : 13088
[#] 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
Notepad.exe 13088