Malware sandbox evasion in x64 assembly by checking ram size - Part 2

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Karlo is a programmer for 10+ years who switched to cyber security. He is currently working as a L2 SOC Analyst and is focusing on malware reverse engineering and development.

In the previous post, I explored a sandbox evasion technique that uses `GetPhysicallyInstalledSystemMemory` to check the size of the RAM of the machine. The idea behind this technique (MBC Technique ID: B0009.014) is that any value that is lower than 4GB *may* probably be a sandbox (to reduce costs). This information can then be used with other sandbox evasion techniques to confirm.

For part 2 of this series, I'll be talking about an alternative Windows API function called `GlobalMemoryStatusEx`. This function is as straightforward as the first one, but requires the passing of a pointer to a C struct. This is significant because I'll be converting a working C code to x64 assembly so we can fully understand how it works under the hood.

Using GlobalMemoryStatusEx

Here is an example of an implementation of `GlobalMemoryStatusEx` in C that we'll later be converting to x64 assembly.

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

int main(void)
{
    MEMORYSTATUSEX statex;
    statex.dwLength = sizeof (statex);
    GlobalMemoryStatusEx (&statex);
    printf ("Memory size: %*I64d", 7, statex.ullTotalPhys/1024);
}
```

You will see that the first parameter for `GlobalMemoryStatusEx` is expecting a pointer to a `MEMORYSTATUSEX` object. We need to declare the memory location `statex` by putting it onto the stack. Before we can do that, however, we first need to know beforehand how much we would need to reserve.

Getting the size of the struct

Finding out the size of a structure in C is easy with the `sizeof` function. However, we can't really use this in assembly, so we have to determine it manually by adding up the sizes of each member of the struct.

Consider the example struct definition below:

```
struct TestStruct {
    char member1;
    int member2;
    float member3;
};
```

If we would look at this table containing the fundamental types and their sizes, we could determine the sizes of each member:

- `member1` is of type `char` which has a size of *1 byte*
- `member2` is of type `int` which is *4 bytes*
- `member3` is of type `float` which also is *4 bytes*

Adding all of these sizes results in `TestStruct` having a total size of *9 bytes*.

Now to apply the same computation to our `MEMORYSTATUSEX` struct. Here is the definition of the struct according to MSDN:

```
typedef struct _MEMORYSTATUSEX {
  DWORD     dwLength;
  DWORD     dwMemoryLoad;
  DWORDLONG ullTotalPhys;
  DWORDLONG ullAvailPhys;
  DWORDLONG ullTotalPageFile;
  DWORDLONG ullAvailPageFile;
  DWORDLONG ullTotalVirtual;
  DWORDLONG ullAvailVirtual;
  DWORDLONG ullAvailExtendedVirtual;
} MEMORYSTATUSEX, *LPMEMORYSTATUSEX;
```

The types that we have are `DWORD` and `DWORDLONG` (which is just Window's own version of `unsigned long` and `unsigned int64`):

- `DWORD` or `unsigned long` has a size of *4 bytes*
- `DWORDLONG` or `unsigned int64` has a size of *8 bytes*

So adding the two `DWORD` s and seven `DWORDLONG` s results in `MEMORYSTATUSEX` having a total size of *64 bytes*.

Initializing statex

Now that we know the total size, we can now reserve this amount of space on the stack.

```
sub rsp, 0x40   ; Reserve space for struct on stack
                ; MEMORYSTATUSEX's is 64 bytes (0x40) in size
```

Before we can call `GlobalMemoryStatusEx`, however, MSDN states that the `dwLength` member should be first set. And this can be done by assigning *64 bytes* to the corresponding memory location on the stack.

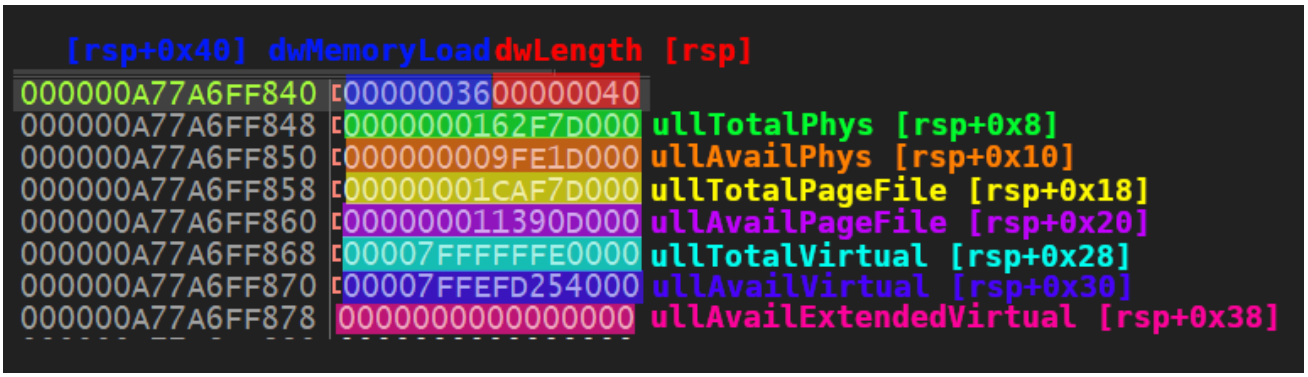
```
mov rax, 0x40
mov [rsp], rax  ; Assign 0x40 to dwLength
lea rcx, [rsp]  ; Load the memory location of struct
```

With this we can finally call our function:

```
sub rsp, 32     ; Reserve shadow space
call    GlobalMemoryStatusEx
add rsp, 32     ; Release shadow space
```

Using the result

If successful, the function `GlobalMemoryStatusEx` populates the memory location we passed to it, as shown below:



The struct member `ullTotalPhys` now has the memory size that we need. And because our stack pointer still points to the beginning of the struct, we can get this value by adding an offset to `rsp`.

```
mov rax, [rsp+0x8]  ; Retrive value of ullTotalPhys from stack
```

We offset by `0x8` because the first 8 bytes is assigned to `dwLength` and `dwMemoryLoad` (both at 4 bytes each).

Displaying the result

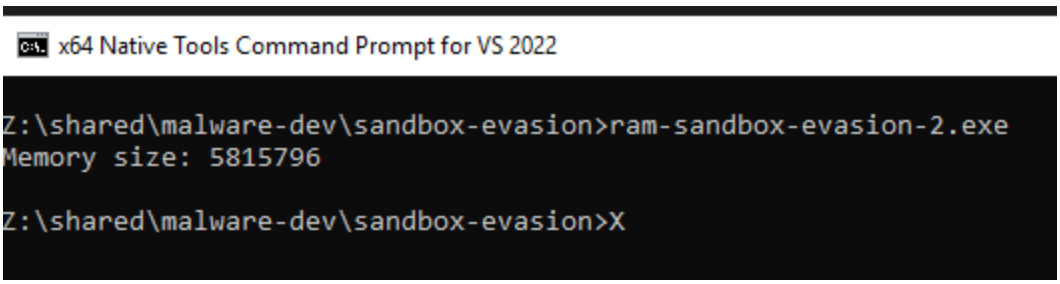
As seen above, the value returned by `GlobalMemoryStatusEx` is in bytes. To be consistent with our example from the previous post, we need to convert this value to kilobytes by dividing it by `1024`.

```
mov rcx, 1024
xor rdx, rdx    ; Clear rdx; This is required before calling div
div rcx         ; Divide by 1024 to convert to KB
```

The result of the above operation is saved to `rax` which we can then move to `rdx` so we can pass it as the second argument to `printf`.

```
mov rdx, rax    ; Argument 2; Result of ullTotalPhys / 1024
lea rcx, [msg_memory_size]  ; Argument 1; Format string
sub rsp, 32     ; Reserve shadow space
call    printf
add rsp, 32     ; Release shadow space
```

With this, we can now finally display the result on the console:



Here is the full source code for reference:

```
    bits 64
    default rel

segment .data
    msg_memory_size db  "Memory size: %lld", 0xd, 0xa, 0

segment .text
    global main
    extern ExitProcess
    extern GlobalMemoryStatusEx
    extern printf

main:
    push    rbp
    mov     rbp, rsp

    sub rsp, 0x40   ; Reserve space for struct on stack
                    ; MEMORYSTATUSEX's is 64 bytes (0x40) in size

    mov rax, 0x40
    mov [rsp], rax  ; Assign 0x40 to dwLength
    lea rcx, [rsp]  ; Load the memory location of struct

    sub rsp, 32     ; Reserve shadow space
    call    GlobalMemoryStatusEx
    add rsp, 32     ; Release shadow space

    mov rax, [rsp+0x8]  ; Retrive value of ullTotalPhys from stack
    mov rcx, 1024
    xor     rdx, rdx    ; Clear rdx; This is required before calling div
    div rcx     ; Divide by 1024 to convert to KB

    mov rdx, rax    ; Argument 2; Result of ullTotalPhys / 1024
    lea rcx, [msg_memory_size]  ; Argument 1; Format string
    sub rsp, 32     ; Reserve shadow space
    call    printf
    add rsp, 32     ; Release shadow space

    add rsp, 0x40   ; Release space of struct from stack

    xor     rax, rax
    call    ExitProcess
```

Conclusion

Over the past two blog posts, we've learned how to use `GlobalMemoryStatusEx` and `GetPhysicallyInstalledSystemMemory` to determine the size of the RAM of a machine. We've also learned about using the stack to pass arguments to functions using x64 assembly.

In future posts I plan to continue exploring malware behavior and techniques and at the same time teach x64 assembly so that we can both improve when writing and reverse engineering malware.

Until then, you can view the C and Assembly code along with the build scripts for this evasion technique on this repository here.

Feel free to reach out to me on Twitter or LinkedIn for any questions or comments.

Comments