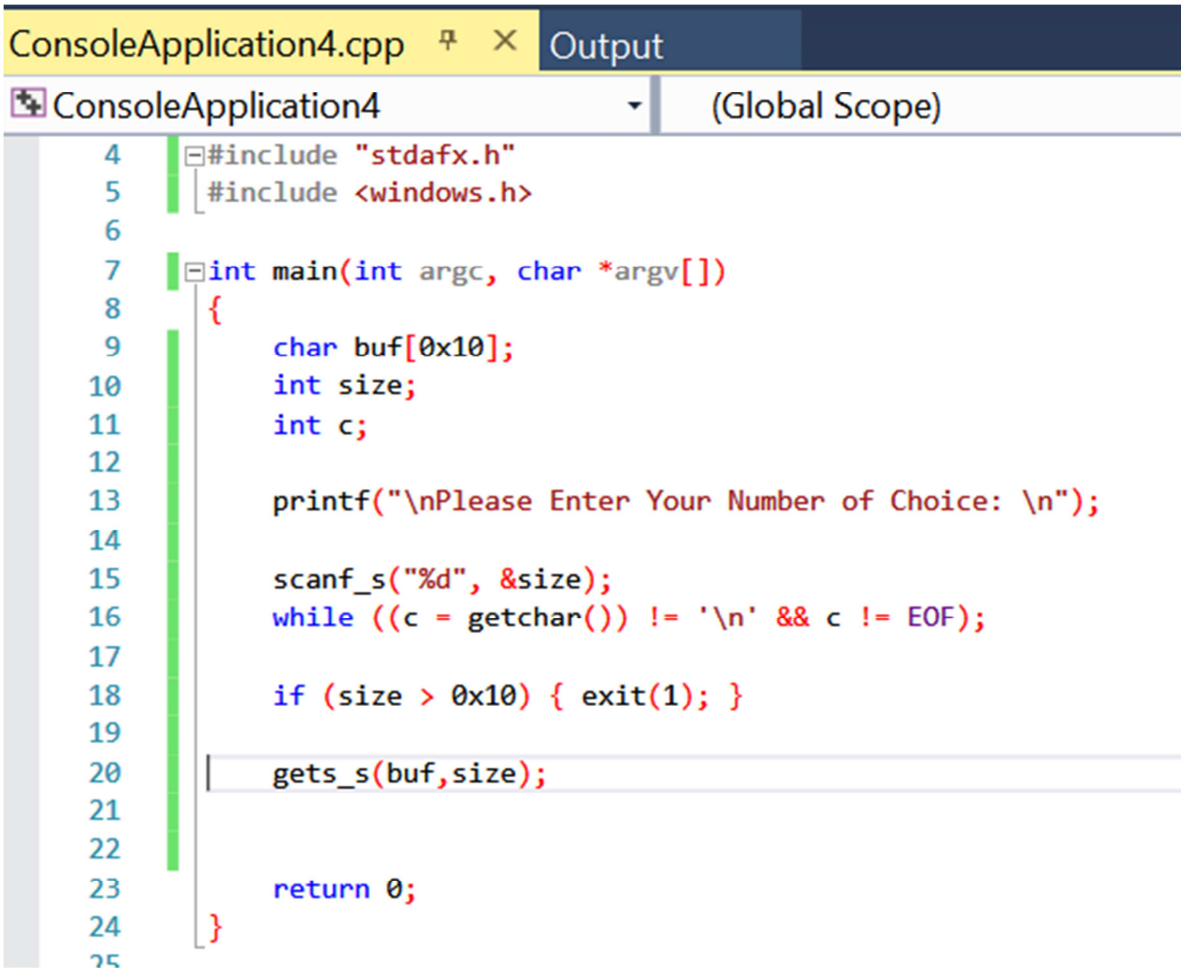
REVERSING WITH IDA PRO FROM SCRATCH
PART 21

In part 20, we left an exercise to analyze if it was vulnerable or not and in the list of CracksLatinos, there were many opinions, I did not answer and let them discuss the subject leaving the solution of the exercise and analysis to be answered in this part.

We had the source code that could help us, the **idb** and the executable to be able to reverse in IDA and debug if necessary.

The source code is this.

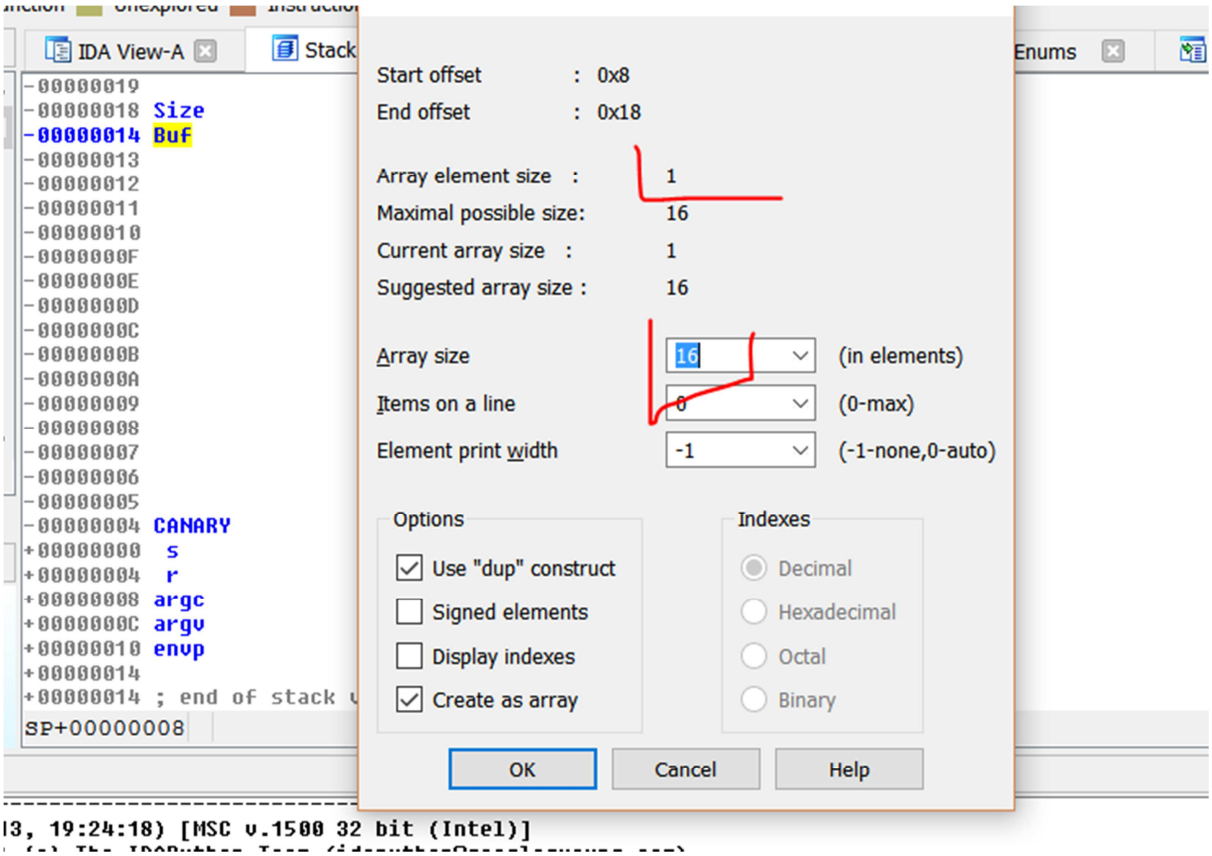


We will analyze it statically in IDA first.

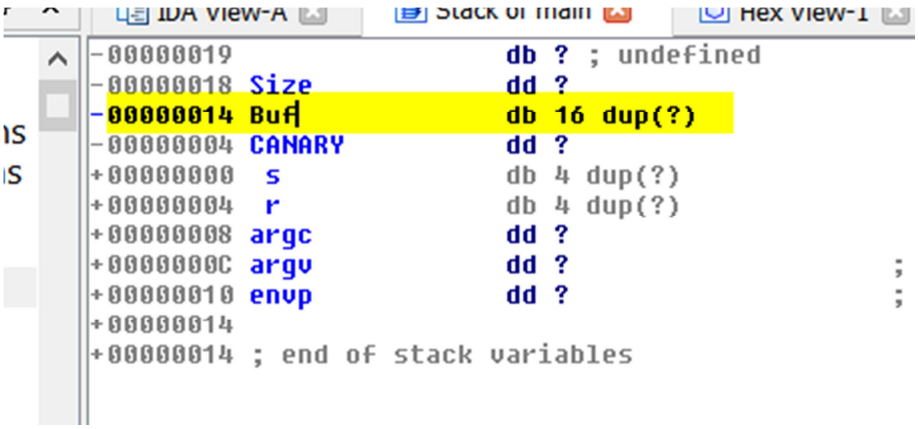
```
00401090 ; int __cdecl main(int argc, const char **argv, const char **envp)
00401090 main proc near
00401090
00401090 Size= dword ptr -18h
00401090 Buf= byte ptr -14h
00401090 CANARY= dword ptr -4
00401090 argc= dword ptr  8
00401090 argv= dword ptr  0Ch
00401090 envp= dword ptr  10h
00401090
00401090 push    ebp
00401091 mov     ebp, esp
00401093 sub     esp, 18h
00401096 mov     eax, __security_cookie
0040109B xor     eax, ebp
0040109D mov     [ebp+CANARY], eax
004010A0 push    esi
004010A1 push    offset aPleaseEnterYou ; "\nPlease Enter Your Number of Choice: \"...
004010A6 call    printf
004010AB lea     eax, [ebp+Size]
004010AE push    eax
004010AF push    offset aD       ; "%d"
004010B4 call    scanf_s
004010B9 mov     esi, ds:__imp__getchar
004010BF add     esp, 0Ch
```

There, we have the CANARY that we rename it as always.

We will see the Buf length in the static representation of the stack.



The length is 16 by 1 which is the length of each element or 16 decimal bytes.



So if we could write more than 16 bytes in the BUFFER, it would be vulnerable.

DO NOT confuse common bugs or crashes with vulnerabilities, not everything that crashes a program is a vulnerability if I do.

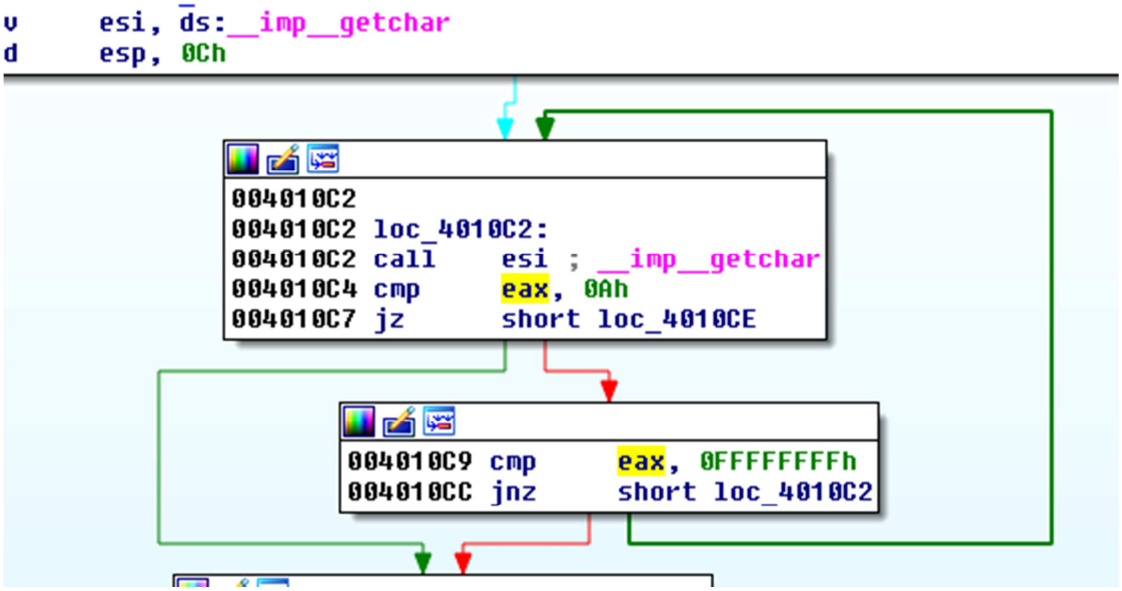
XOR ECX, ECX
DIV ECX

It is a bug that will zero to ECX and divide by zero and will cause an exception that if not handled will be a crash.

That is a simple crash, there are several types of vulnerabilities for now we are only seeing the simpler BUFFER OVERFLOW.

If there is an overflow of a BUFFER being able to write outside of where the space reserved for the same the program will be VULNERABLE because a BUFFER OVERFLOW could occur, later we will see if besides being VULNERABLE it is EXPLOITABLE or not, it can be VULNERABLE and for example NO EXPLOITABLE by some program or system mitigation such as CANARY for example that would prevent its exploitation, but that is a subject for following parts.

So the idea is to analyze if that BUFFER of 16 bytes decimal can be overflowed, as in this case, just below the Buf is the CANARY if we get to overwrite it when copying in the buffer, it is obvious that there is a BUFFER OVERFLOW.



That code corresponds to this line of the source code.

While ((c = getchar ())! = '\ N' && c! = EOF);

It is a line that is used after the scan to read the 0xA of the standard input that is the line break, so it does not bother in a subsequent reading of it, because if it remains and does not filter, in the next call to read characters of the keyboard, it will not work.

We see that it loops until it finds the 0xA corresponding to the LINE JUMP or LF.

Non-printable ASCII control characters:

Ascii code 00 = NULL (null character)
Ascii code 01 = SOH (Header start)
Ascii code 02 = STX (Start of text)
Code ascii 03 = ETX (End of text, heart stick English poker cards)
Code ascii 04 = EOT (End of transmission, stick diamonds decks of poker)
Code ascii 05 = ENQ (Consult, stick clubs English poker cards)
Ascii code 06 = ACK (Recognition, stick cards poker cards)
Ascii code 07 = BEL (Ring)
Ascii code 08 = BS (Backspace)
Ascii code 09 = HT (horizontal Tab)
Ascii code 10 = LF (New line - line break)
Ascii code 11 = VT (Vertical Tab)

Ascii code 12 = FF (New page - page break)
Ascii code 13 = CR (ENTER - carriage return)

I think that happens if I am not mistaken because in WINDOWS when pressing ENTER which is 13 decimal or 0x0d, you cut the input of characters, but always that 0xa in the standard input that annoys in the following input by keyboard, since the Line break also cancels the entry.

Here we see a python script that would be functional to test this exercise.

```
from subprocess import *
import time
p = Popen([r'VULNERABLE_o_NO.exe','f'],stdout=PIPE,stdin=PIPE,
stderr=STDOUT)

print "ATACHEA EL DEBUGGER Y APRETA ENTER\n"
raw_input()

primera="10\n"
p.stdin.write(primera)

time.sleep(0.5)

segunda="AAAA\n"
p.stdin.write(segunda)

testresult = p.communicate()[0]
time.sleep(0.5)
print(testresult)
print primera
print segunda
```

We see that it is a script that uses subprocess to start the process and then…

```
p = Popen([r'VULNERABLE_o_NO.exe','f'],stdout=PIPE,stdin=PIPE,
stderr=STDOUT)
```

It redirects the standard input and output so that we can send you characters as if we had typed.

```
primera="10\n"
p.stdin.write(primera)

time.sleep(0.5)

segunda="AAAA\n"
p.stdin.write(segunda)
```

We see that there are two inputs. First, the size that asks me, I enter 10 to try and then the data I enter with gets_s with the size that we passed before, I can type less than 10.

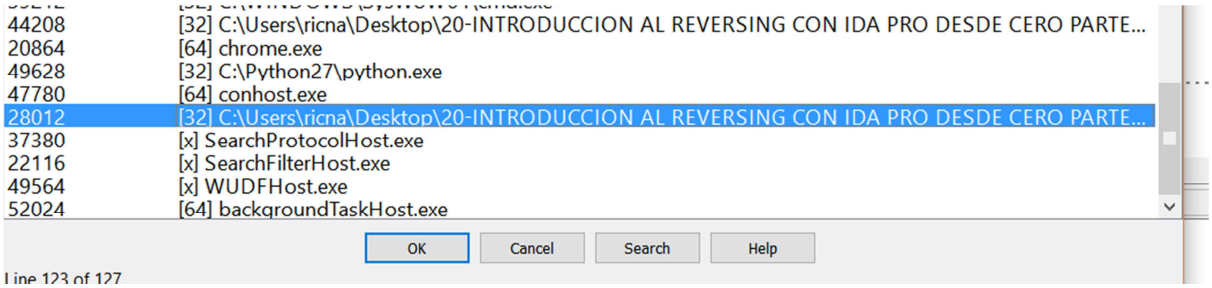
In addition, I added a raw_input () so that once the process is started the python script will stop until ENTER is pressed, which allows me to attach the IDA to the process that will start and wait for input by stdin.

Let's test if the script works as we think.

Let’s run it.

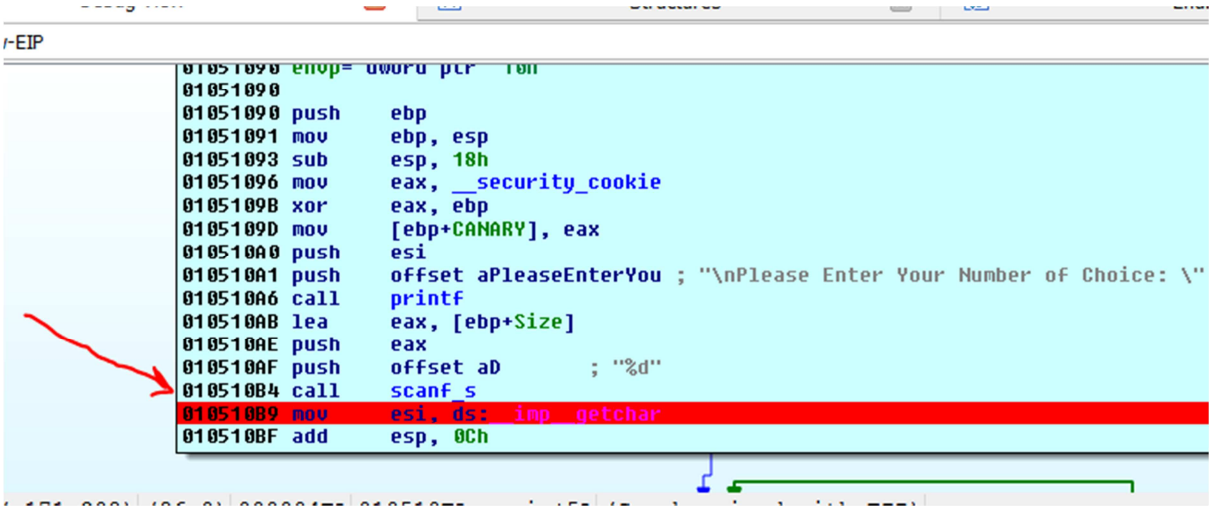
It is stopped there waiting for us to press ENTER giving us the possibility of attaching it in IDA.

In it, I open the VULNERABLE_o_NO.exe to analyze it in the LOADER without running it in the debugger and then, I choose LOCAL WINDOWS DEBUGGER and go to DEBUGGER-ATTACH TO PROCESS.



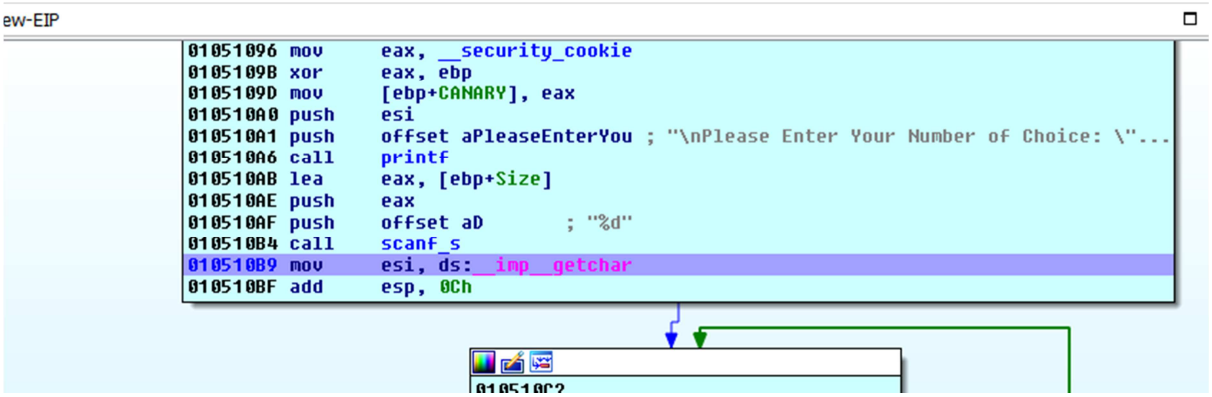
There, you cannot see the name of the executable because the name of the folder is very long, but that's it, I press OK and when it stops, I press F9, so that it is RUNNING.

Then before pressing ENTER in python, I'll set a BREAKPOINT after the first keyboard input since I was waiting there for the process, and I'll only be able to stop after it comes back from that input.

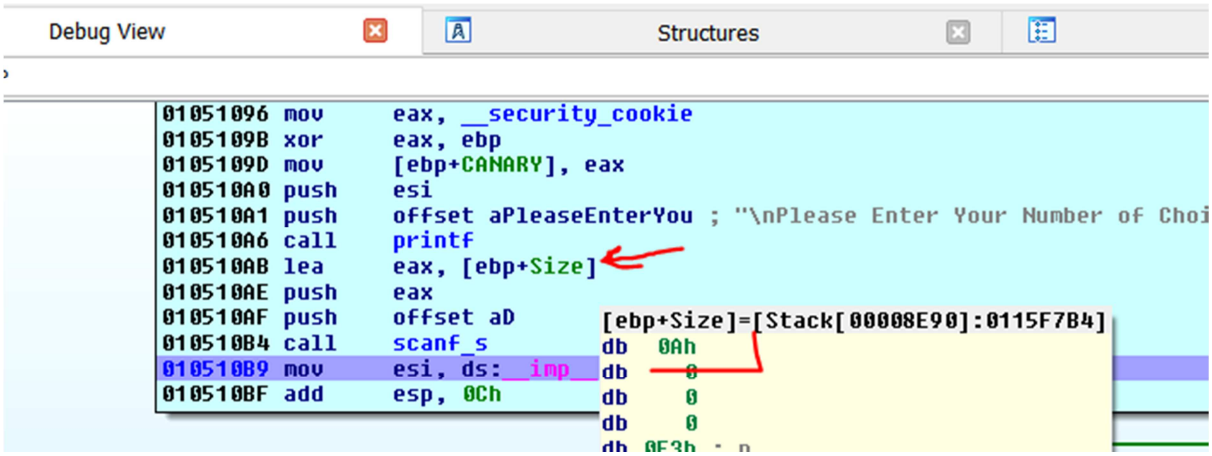


There, I set the BREAKPOINT and then in Python I press ENTER.

We see it stops at the breakpoint.

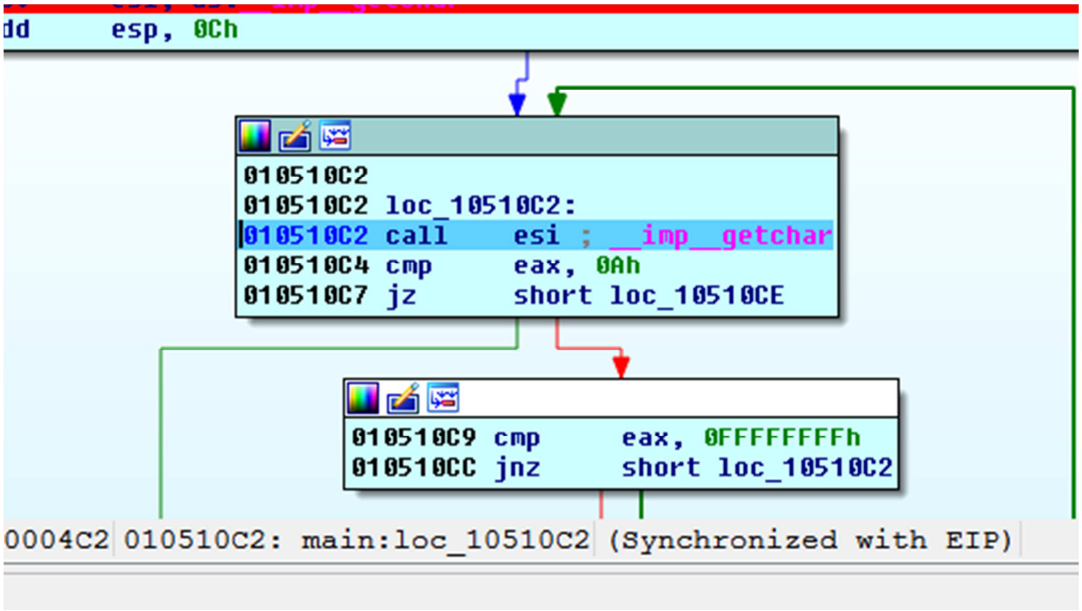


If you pass the mouse over the variable size that is the one that we enter the value in the scanf_s.



.

There, we see that in the variable Size input the value 10 decimal (0xA) that I entered through the script.



If I get to getchar, the reality is that I did not pass any 0xA characters in the script.

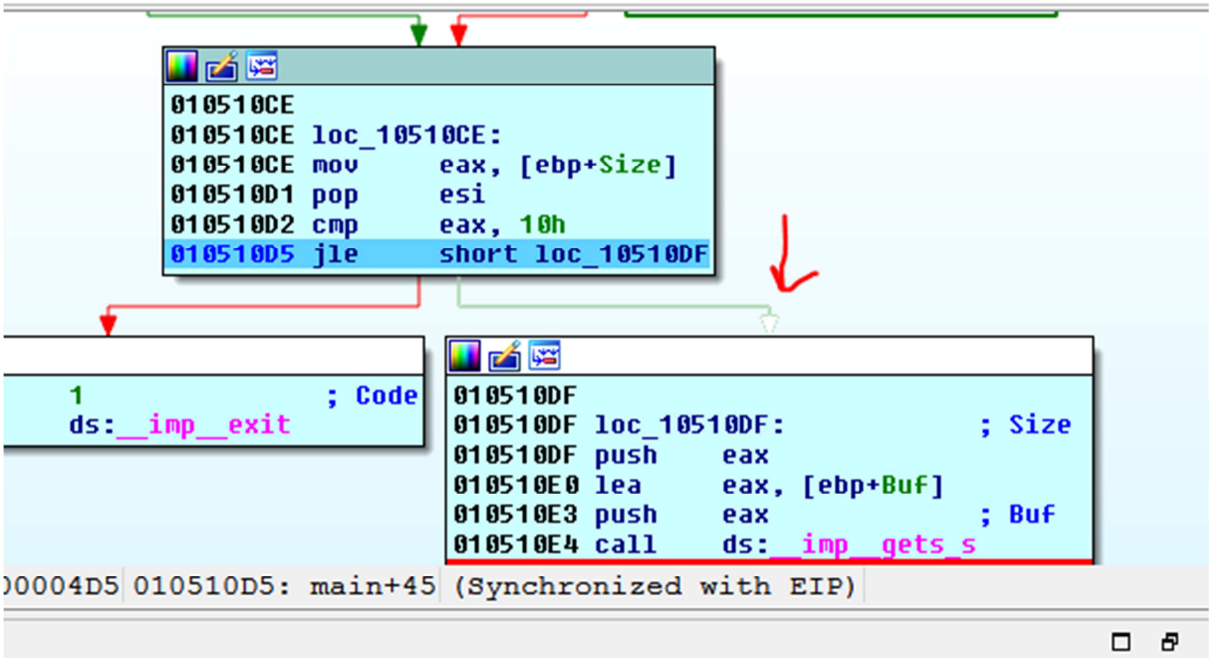
```
primera="10\n"
p.stdin.write(primera)
time.sleep(0.5)

segunda="AAAA\n"
p.stdin.write(segunda)
```

The “ \n” is the ENTER 0x0d

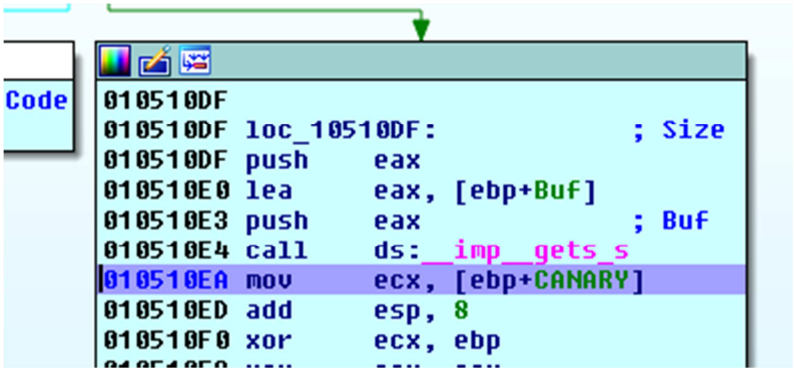
But if I trace the getchar with F8 to skip the CALL and not enter it.

We see that there was a character 0xA that I did not pass, which when read it removed it from the stdin and cleared it for the next input by keyboard.

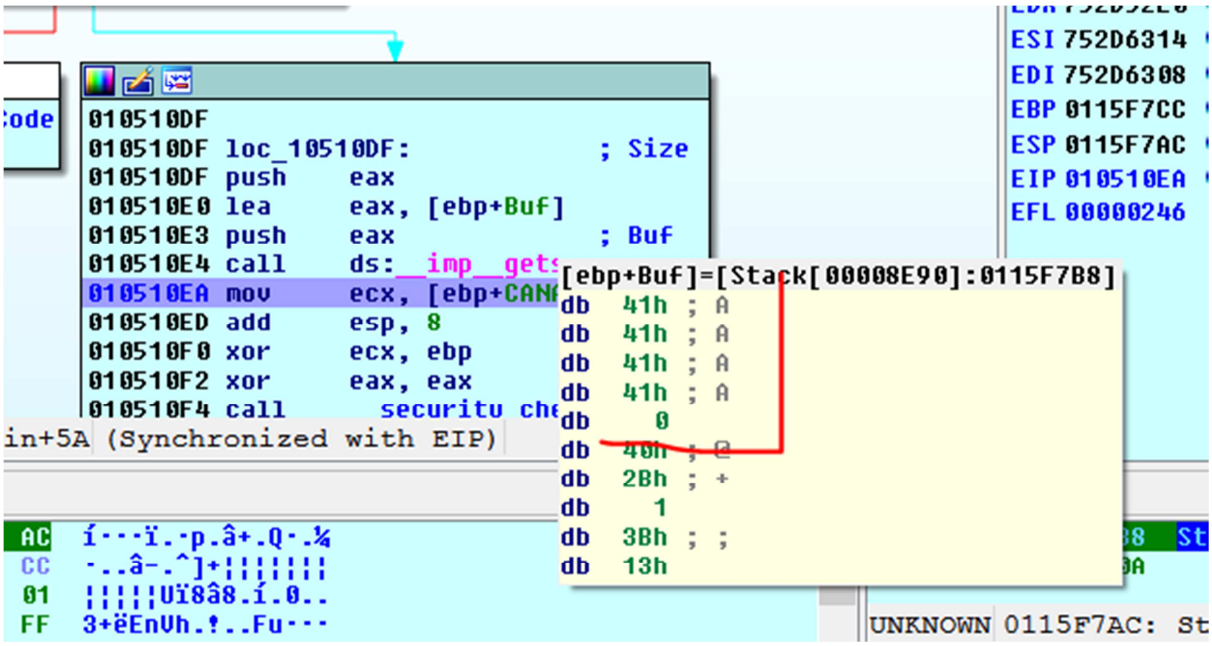
We see that it compares my size 0xA with the maximum 0x10 and as it is smaller, it continues.



When I trace the gets_s with F8.

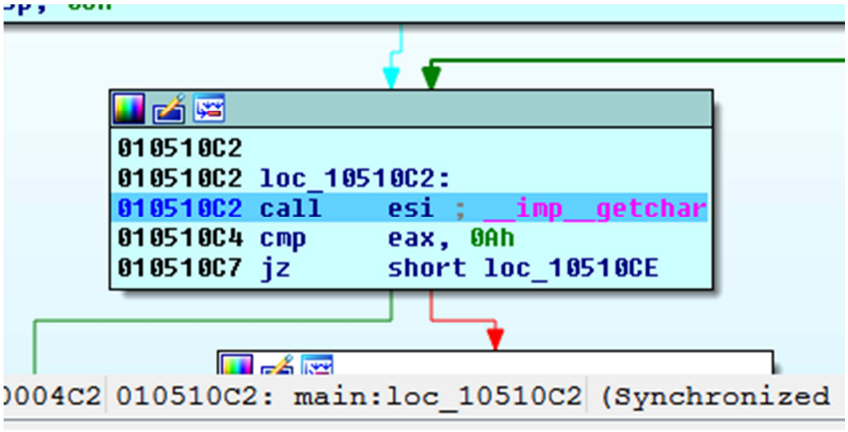


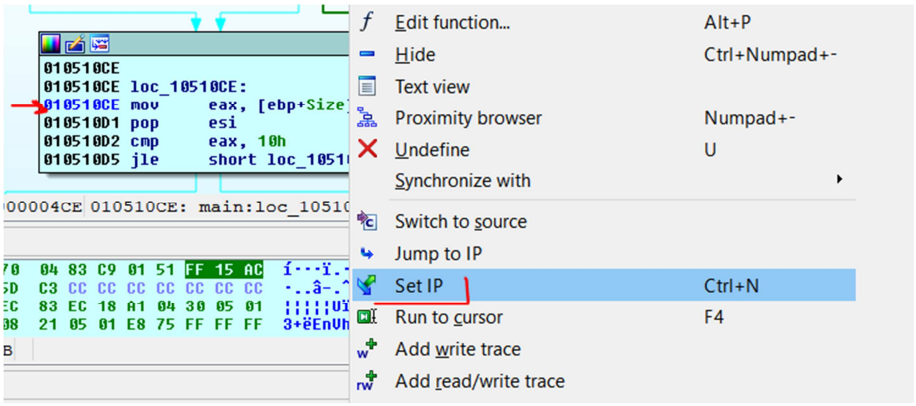
If I pass the mouse over the Buf.



I see that the following A's that I passed in the script entered so that it works and allows me to test and debug what is going on.

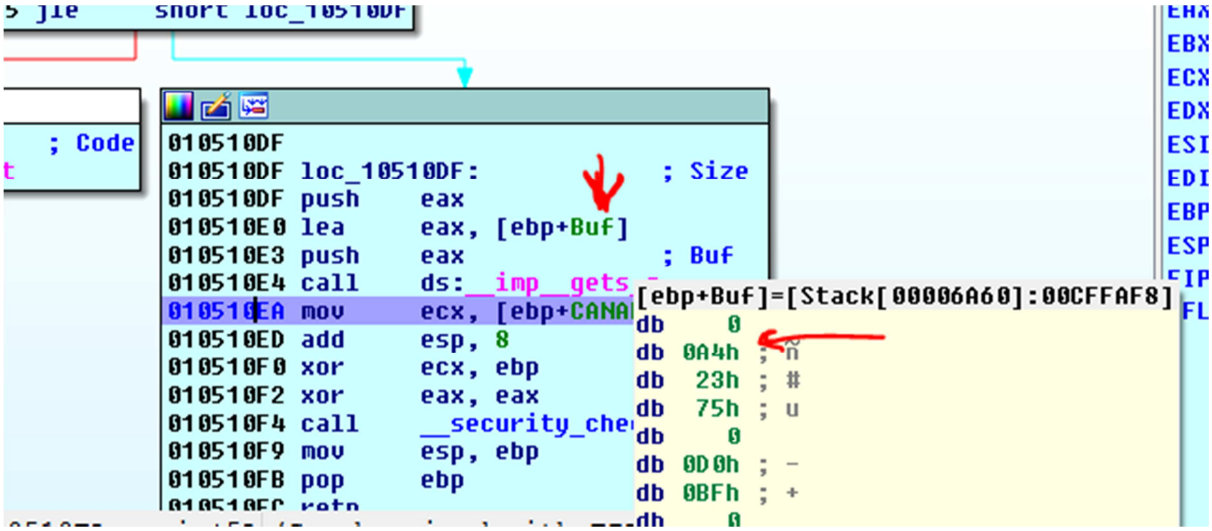
If I run the script again and when I get to getchar I skip it by changing the EIP so it does not read the 0xA.





We change EIP there so it does not filter the 0xa to see what happens.

When I trace the gets_s I see that now I do not enter anything.



That means that the 0xA character that is left in the stdin must be filtered after certain entries so that it does not affect if there are subsequent entries, which is why the line of code is justified.

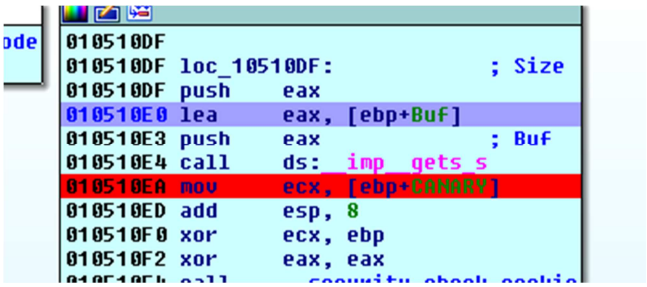
While ((c = getchar ())! = '\ N' && c! = EOF);

Also now that we have the script we can analyze the crash that occurs in gets_s when you type the maximum size to see if something else happens or it is just a crash.

```
primera="16\n"
p.stdin.write(primera)
time.sleep(0.5)

segunda="A" *16 + "\n"
p.stdin.write(segunda)
```

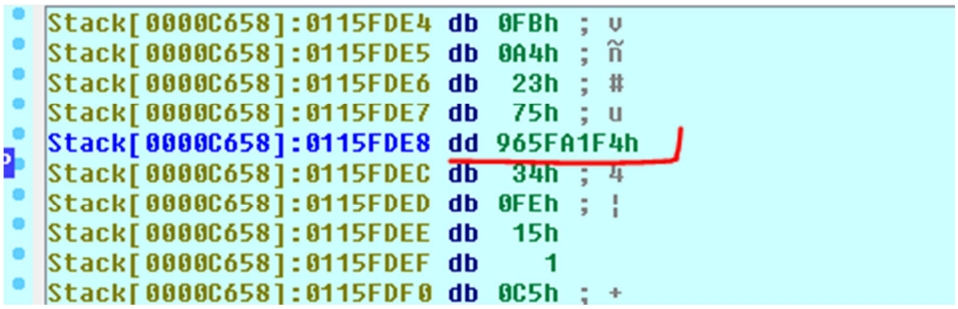
I'll see what happens in this case.

With that information, I get there.

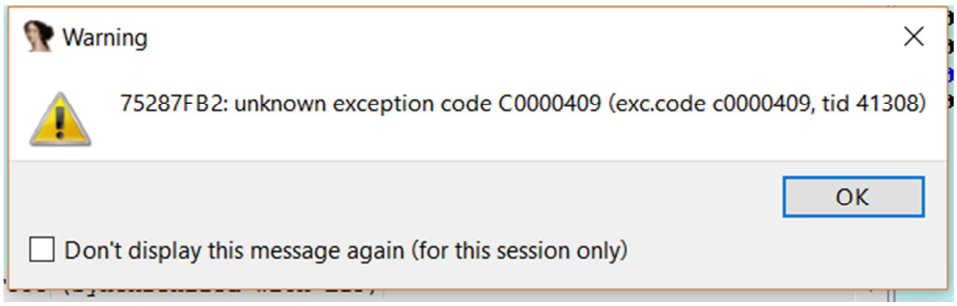


When I pass the LEA, I write the address where the buffer starts, in my case, 0x0115FDD8.

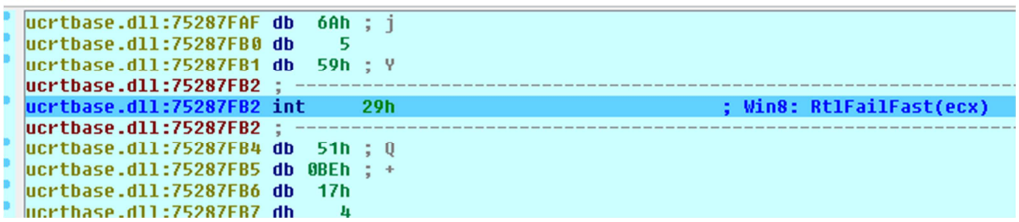
If I double-click on CANARY and press D several times until it is a dword (dd), I can also note the address, in my case, 0x115FDE8 and the CANARY value, in this case, will be 965FA1F4.



I press F9.

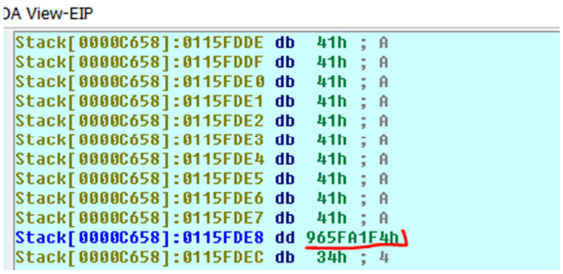


There, it is the exception that the API produces, I accept OK.



There it is. Let's go with G and put the address of the buffer and then the canary to see what happened.

We see that the canary is intact.

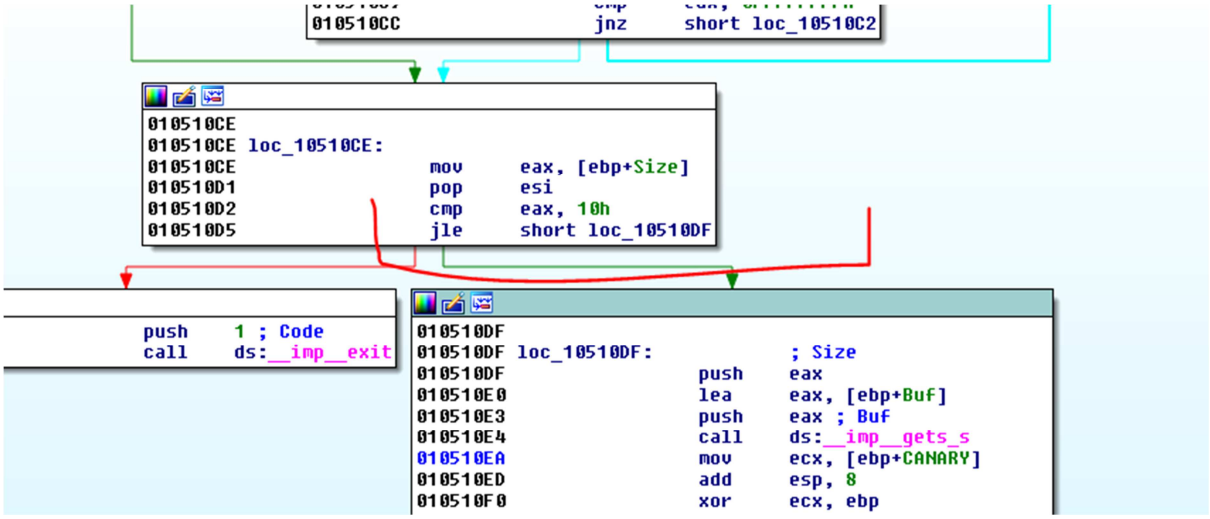


And the buffer was filled. So, typing the maximum does not produce overflow, what is true is that the buffer was full and there was no final zero of the string, which could cause problems if the program continues, but in this case the exception is not managed and the program is closed. So, here it's just a crash. (I also think it puts a zero at the beginning of the buffer to override the string)

If the program handles the exception and continues, it should discard the data from the buffer because if it took it and used it as a string, having no end zero, it could append data after the stack and cause problems, but when it put the zero at the beginning also cancels it.

Well, knowing that there is no overflow here, let's go back to static analysis.

Let's focus on this part.



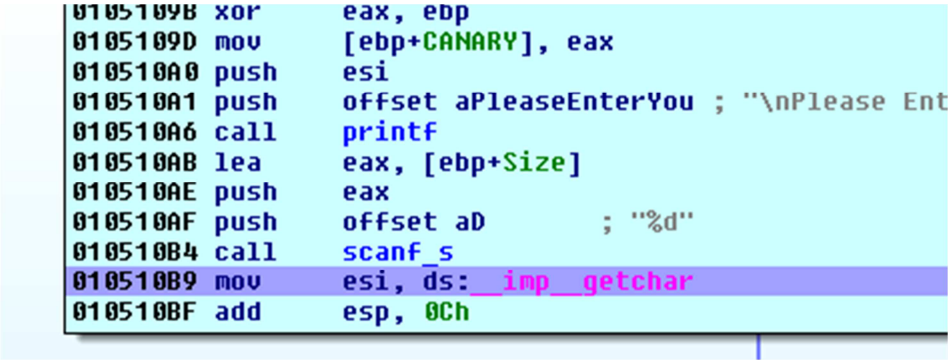
We had said that the JL or JLE jump considers the sign or that EAX could be negative, if for example it was 0xFFFFFFFF would be -1 and would be less than 0x10.

It means that if it passed as size -1, it would be possible for the comparison to pass. Let's see.

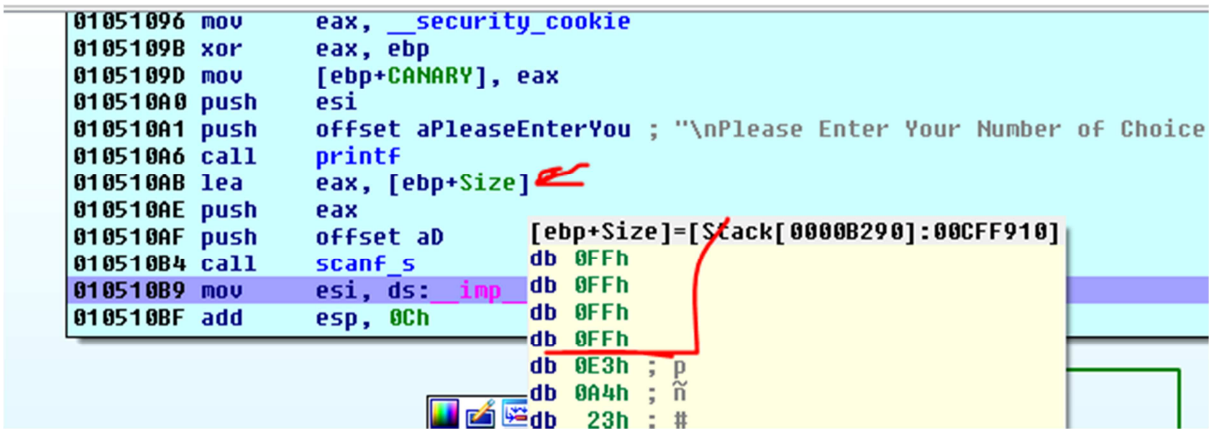
```
primera="-1\n"
p.stdin.write(primera)
time.sleep(0.5)

segunda="A" *0x2000 + "\n"
p.stdin.write(segunda)
```

Let's try the script with these values (size -1)

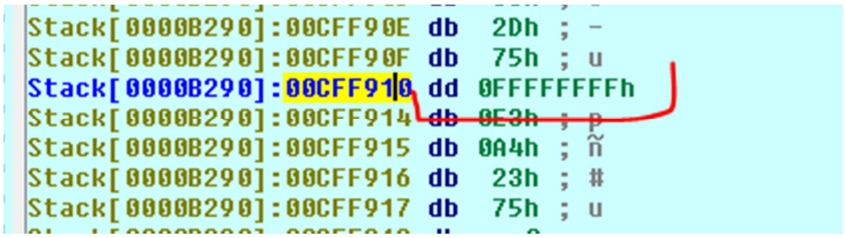
When you stop at the breakpoint.



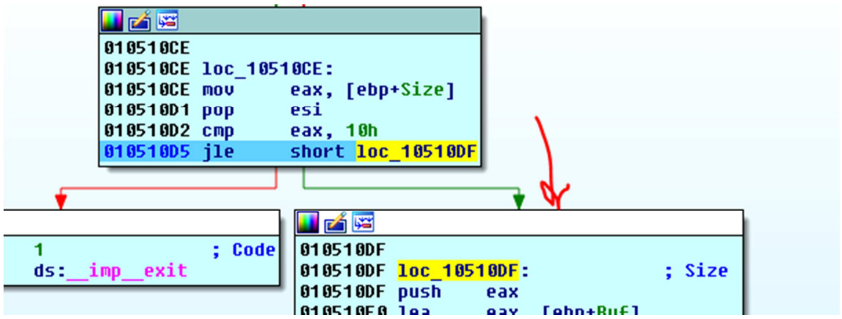
Let's see the value of the size.



We see that it is worth 0xFFFFFFFF if I double click on size and press D to group it until it is a dword.

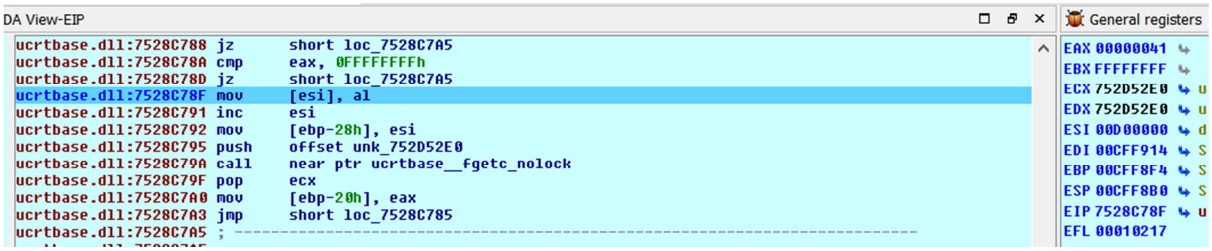


Let's continue tracing until the comparison.

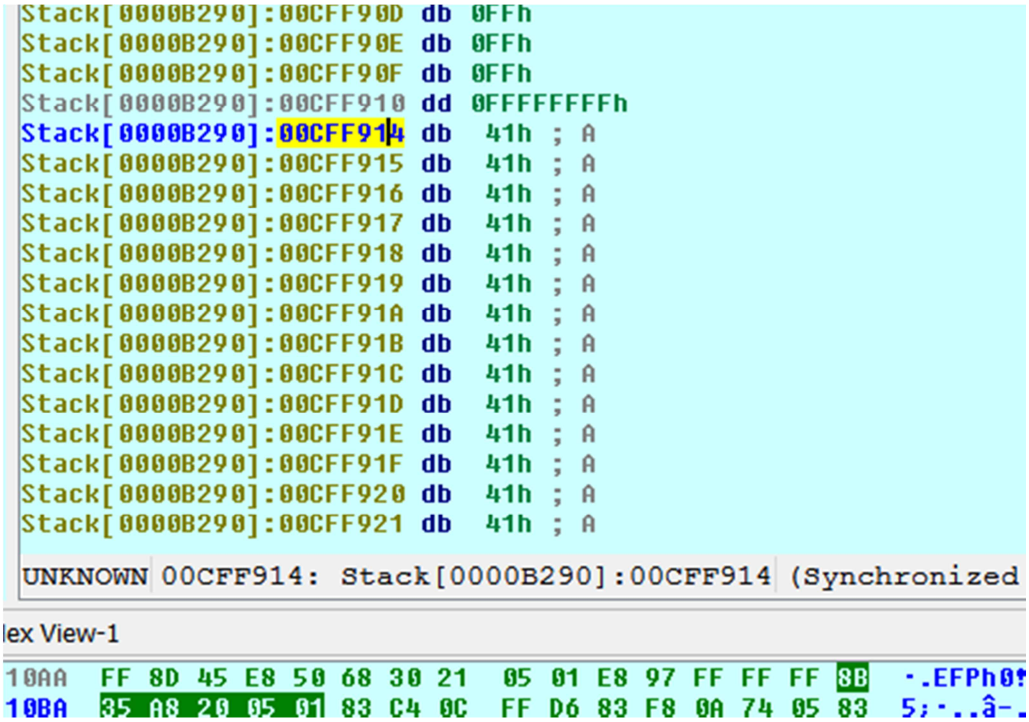


We see that as 0xFFFFFFFF is -1, when considering the sign it does not filter and will continue to read that size. The reality is that in gets_s as well as a memcpy and any API that copies or enters bytes the sizes are interpreted as unsigned, because there are no negative sizes, as they cannot be entered or copied -1 bytes, that is impossible, it Interprets it as positive 0xFFFFFFFF which we see will produce an overflow.

I go back to see where the buffer is this time at 0x00CFF914.



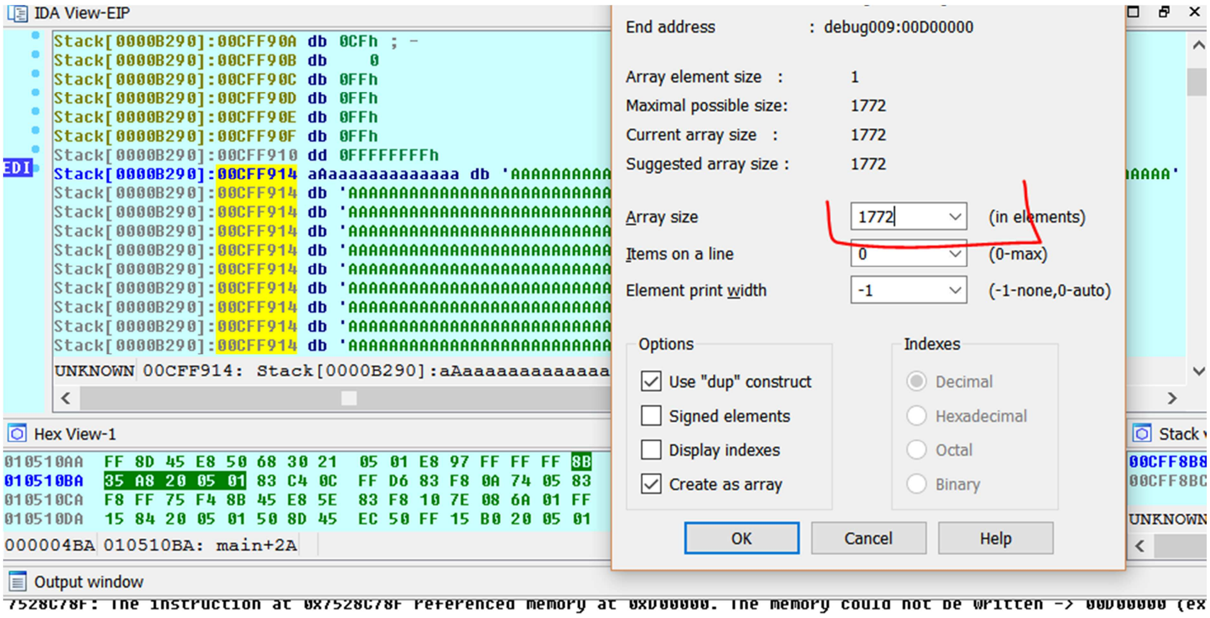
If I go where the buffer starts.



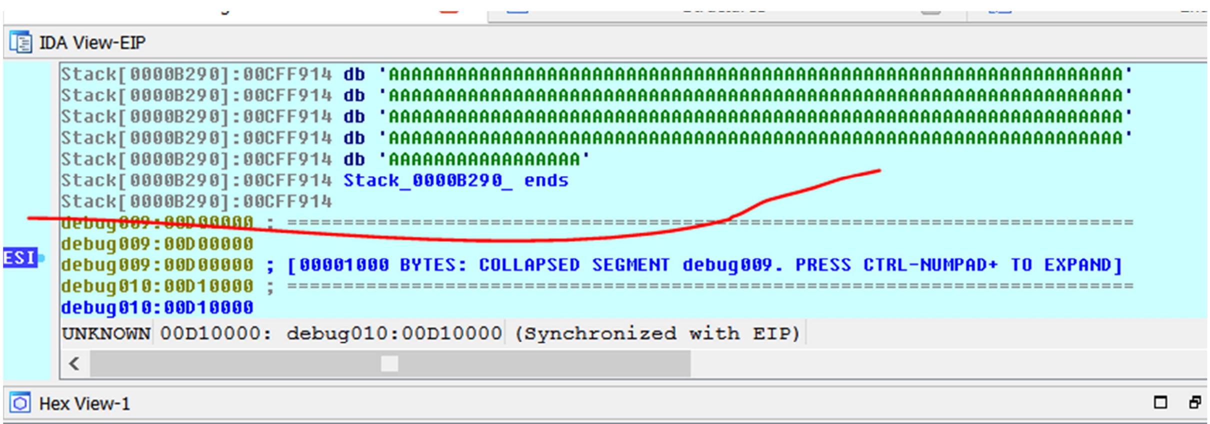
We can see better how much it copied if I transform it in string, at the beginning of the string, press A.

I see the thing is great. ☺

And if I transform it into ARRAY.



I also see that it reaches the end of the stack, overwriting the CANARY and all.



He filled it with Aes until the end of it. Just below, I see that it already changes to another section to debug009.

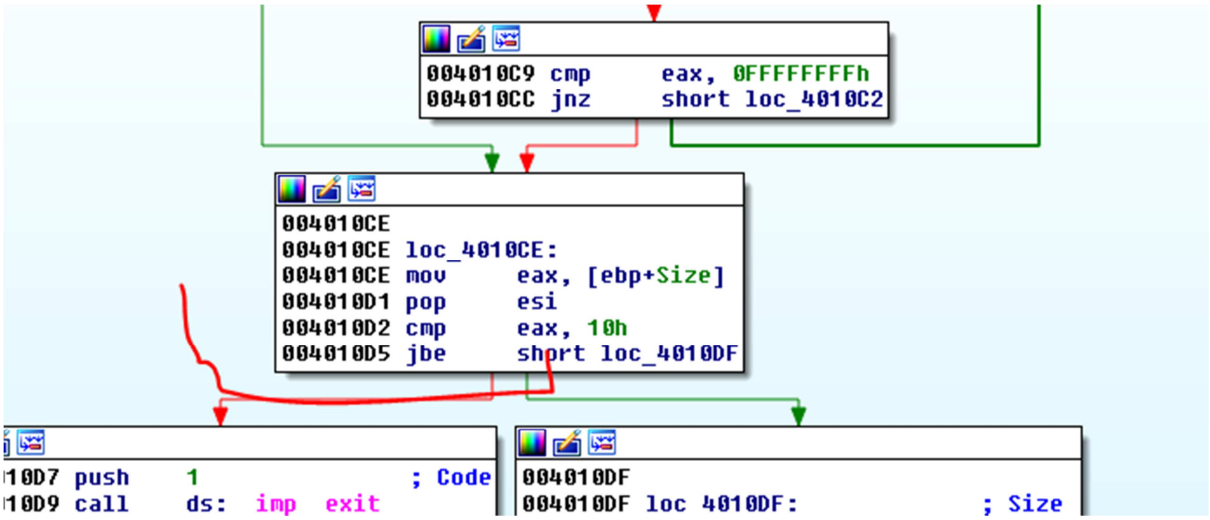
With this we verify that it is vulnerable. Now, how could it be fixed? Obviously, if instead of using a JL or JLE jump that considers the sign we use JB or JBE that does not consider it if we pass -1 will be 0xFFFFFFFF but in the comparison it will take it as positive and it will be bigger than 0x10 and it will go out.

In the source code it would be so.

```
ısoleApplication4                          (Global Scope)
4   #include "stdafx.h"
5   #include <windows.h>
6
7   int main(int argc, char *argv[])
8   {
9       char buf[0x10];
0       unsigned int size;
1       int c;
2
3       printf("\nPlease Enter Your Number of Choice: \n");
4
5       scanf_s("%d", &size);
6       while ((c = getchar()) != '\n' && c != EOF);
7
8       if (size > 0x10) { exit(1); }
9
0       gets_s(buf,size);
1
2
3       return 0;
4   }
```

A single word transforms it from VULNERABLE to NOT VULNERABLE. We compiled it.

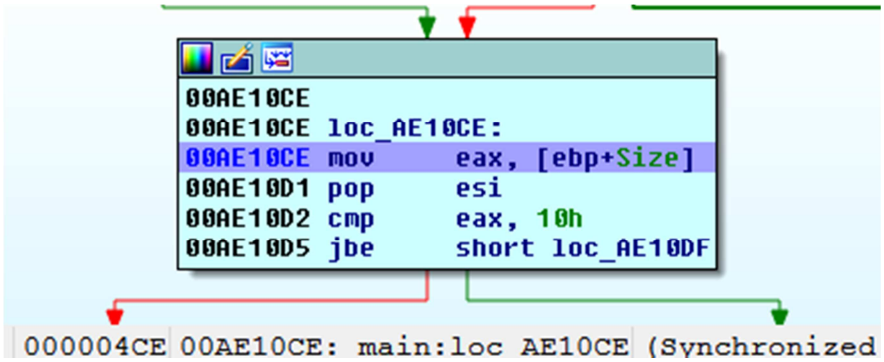
NO_VULNERABLE.exe is the name of the repaired program.



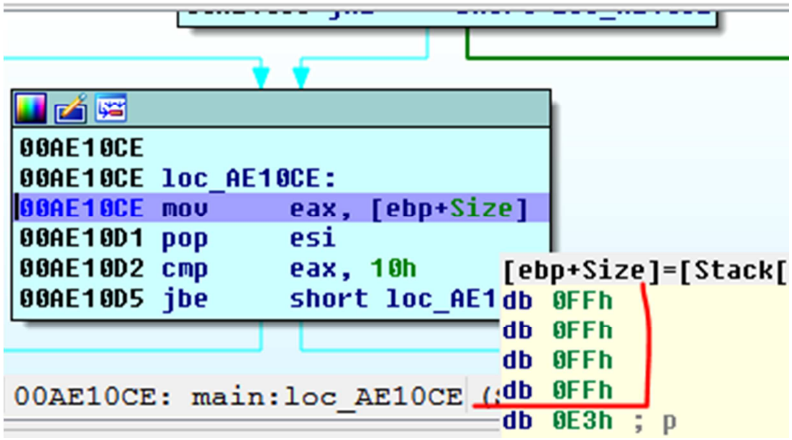
We see that just changing the type of variable to UNSIGNED, it changed when compiling the type of jump that does not consider the sign.

I fix the script by renaming it to load this new executable. I leave the rest the same.

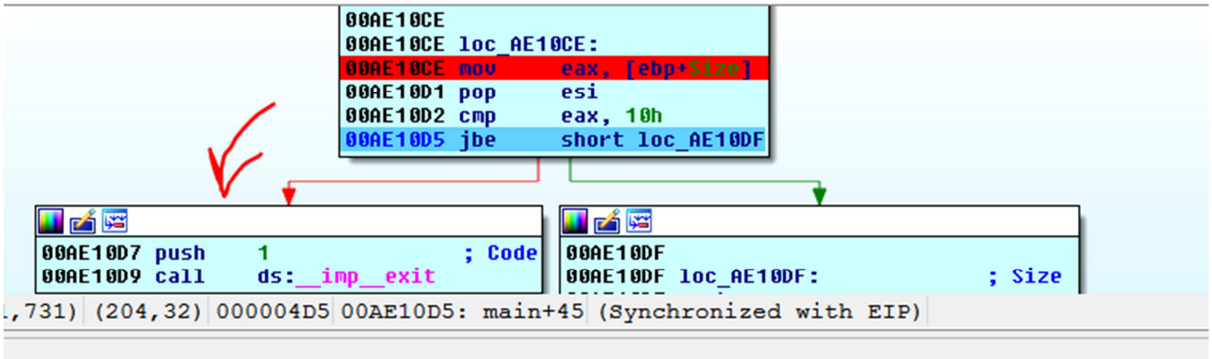
I analyze the new executable in IDA in the LOADER and then started the script and before pressing ENTER, I attach the LOCAL DEBUGGER and I set a BREAKPOINT in the comparison of the size so that it stops there to see what happens.



If I see, in size, the value is still 0xFFFFFFFF.



But If I keep tracing.



Now, it goes to EXIT and it avoids overflow since JBE considers that 0xFFFFFFFF as it does not care the sign, like a big positive number and greater than 0x10, with which the program is repaired.

Therefore the answer to the exercise is that it was VULNERABLE and that it is repaired by changing the size of INT that is SIGNED to UNSIGNED INTEGER, thereby changing the JLE jump by JBE of a jump that considers the sign to one that does not.

Ricardo Narvaja

Translated by: @IvinsonCLS