BinaryNewbie Small Keygenme

https://crackmes.one/crackme/5e83f7f433c5d4439bb2e059

Crackme writeup by @H0l3Bl4ck https://twitter.com/H0l3Bl4ck

crackmes.one user b1h0 https://crackmes.one/user/b1h0

Date: 22/abr/2020

You can download **Small Keygenme** from this link.

The author informs us of this within a **README**:

```
Hello buddy !!!!
An easy keygenme challenge.
Read the [SPECS]
Have fun.
Binary Newbie.

[SPECS]
- Assembled with nasm;
- Stripped;
- 64-bits elf file, tested in ubuntu 18.04 LTS;
- Any kind of patch is forbidden;
- Obfuscation: 0;
- anti-debug/anti-disassembly tricks: 0;
- Goals - Understand how it works, write a keygen, and finally, write a solution;
- Target - Beginners.

PS: If you have any doubt or any question about the challenge, feel free to call me in Dis
```

Ghidra's static analysis

We have here an executable in **ELF** format compiled for **64 bits**.

About little-crackme

Project File Name:	little-crackme
Last Modified:	Mon Apr 20 14:32:46 CEST 2020
Readonly:	false
Program Name:	little-crackme
Language ID:	x86:LE:64:default (2.9)
Compiler ID:	gcc
Processor:	x86
Endian:	Little
Address Size:	64
Minimum Address:	00400000
Maximum Address:	_elfSectionHeaders::0000013f
# of Bytes:	1096
# of Memory Blocks:	6
# of Instructions:	143
# of Defined Data:	12
# of Functions:	7
# of Symbols:	7
# of Data Types:	16
# of Data Type Categories:	2
Analyzed:	true
Created With Ghidra Version:	9.1.1
Date Created:	Mon Apr 20 14:32:20 CEST 2020
ELF File Type:	executable
ELF Original Image Base:	0x400000
ELF Prelinked:	false
Executable Format:	Executable and Linking Format (ELF)

We see that it uses the **SYSCALL** and to identify the functions we can start from this website: **https://filippo.io/linux-syscall-table/** that offers us the reference for **64 bits**.

%rax	Name	Entry point	Implementation
0	read	sys_read	fs/read_write.c

%rdi	%rsi	%rdx
unsigned int fd	**char __user *** buf	**size_t** count

%rax	Name	Entry point	Implementation
1	write	sys_write	fs/read_write.c

%rdi	%rsi	%rdx
unsigned int fd	**const char __user *** buf	**size_t** count

Analyzing the entry point, we identify the first function that prints the texts on the screen and rename it to clarify the code.

```
                     *************************************************************
                     *                          FUNCTION                         *
                     *************************************************************
                     undefined[16] __stdcall FUN_PRINT_STRING(void)
     undefined[16]     RDX:8,RAX:8    <RETURN>
                     FUN_PRINT_STRING                        XREF[5]:   entry:004001d0(c), entry:004001dc(c),
                                                                        entry:0040023c(c), entry:0040024f(c)
004000c3 48 83 c4 08        ADD     RSP,0x8
004000c7 b8 01 00 00 00     MOV     EAX,0x1                             syscall sys_write
004000cc 48 89 c7           MOV     RDI,RAX
004000cf 5e                 POP     RSI                                 pointer to char string
004000d0 5a                 POP     RDX                                 count of chars to print
004000d1 0f 05              SYSCALL
004000d3 48 83 ec 18        SUB     RSP,0x18
004000d7 c3                 RET
```

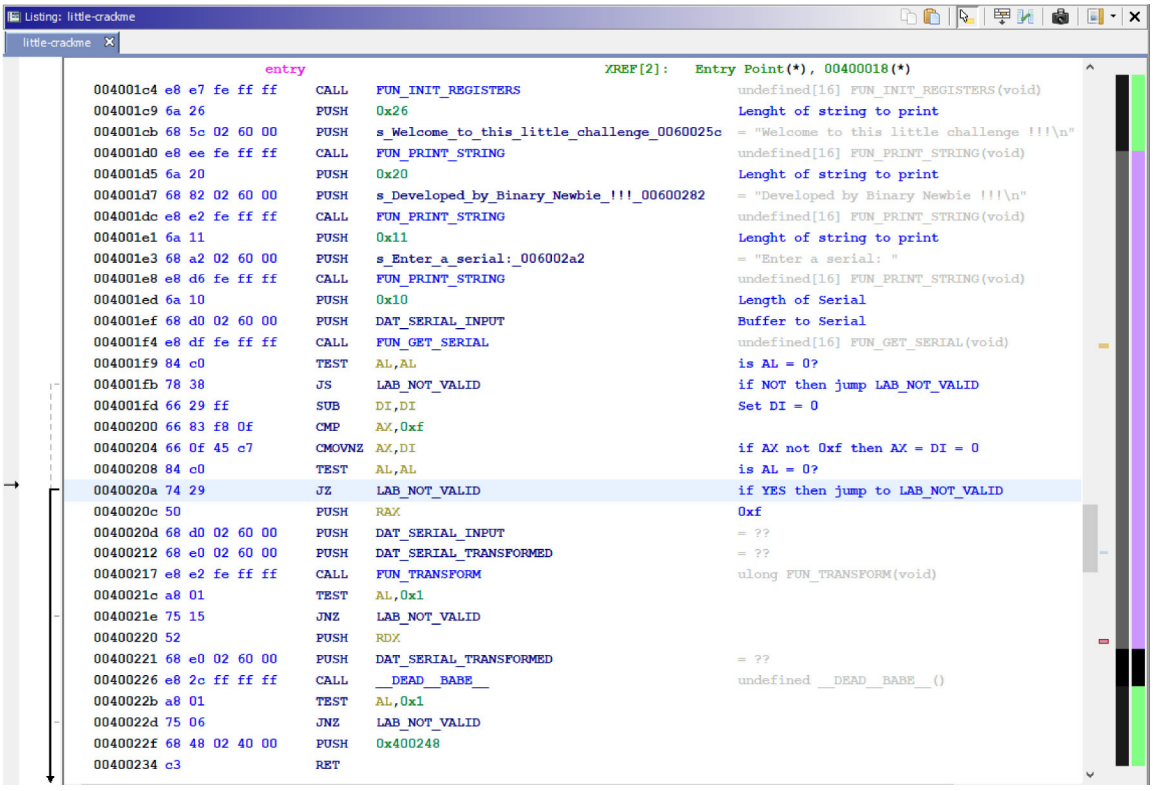
Next, we identify the function expected to enter the serial number.

```
                     *************************************************************
                     *                          FUNCTION                         *
                     *************************************************************
                     undefined[16] __stdcall FUN_GET_SERIAL(void)
        undefined[16]    RDX:8,RAX:8    <RETURN>
                     FUN_GET_SERIAL                                  XREF[1]:     entry:004001f4(c)
004000d8 48 83 c4 08         ADD     RSP,0x8
004000dc 48 29 c0            SUB     RAX,RAX                                     syscall sys_read
004000df 48 89 c7            MOV     RDI,RAX                                     file descriptor
004000e2 5e                  POP     RSI                                         pointer to char buffer
004000e3 5a                  POP     RDX                                         count of chars to read
004000e4 0f 05               SYSCALL
004000e6 48 83 e8 01         SUB     RAX,0x1
004000ea 80 3c 06 0a         CMP     byte ptr [RSI + RAX*0x1],0xa                checks for line feed and remove it
004000ee 74 02               JZ      LAB_004000f2
004000f0 eb 07               JMP     LAB_004000f9

                     LAB_004000f2                                    XREF[1]:     004000ee(j)
004000f2 48 c7 c0 ff ff ff ff    MOV     RAX,-0x1

                     LAB_004000f9                                    XREF[1]:     004000f0(j)
004000f9 48 83 ec 18         SUB     RSP,0x18
004000fd c3                  RET
```

We continue to identify small pieces of code and functions and give them names. In this case, the exit to the system.

```
                     *************************************************************
                     *                          FUNCTION                         *
                     *************************************************************
                     undefined __stdcall FUN_SYS_EXIT(void)
          undefined         AL:1           <RETURN>
                     FUN_SYS_EXIT                                    XREF[2]:     entry:00400243(c), entry:00400256(c)
004001b8 48 83 c4 08         ADD     RSP,0x8
004001bc b8 3c 00 00 00      MOV     EAX,0x3c                                    syscall sys_exit (60 dec)
004001c1 5f                  POP     RDI
004001c2 0f 05               SYSCALL
```

So, after having renamed some functions and commenting on some operations, we have the **entry point** (which is the **main function** of the program) as follows, in the absence of finishing analyzing some functions.



I will now focus on 2 functions that are what have to give us the solution.

The first one I will call **FUN_TRANSFORM**, which without knowing exactly what it does yet, seems to carry out some kind of calculation or transformation of the string.

I will call the second function **DEAD__BABE** for a specific operation it does.

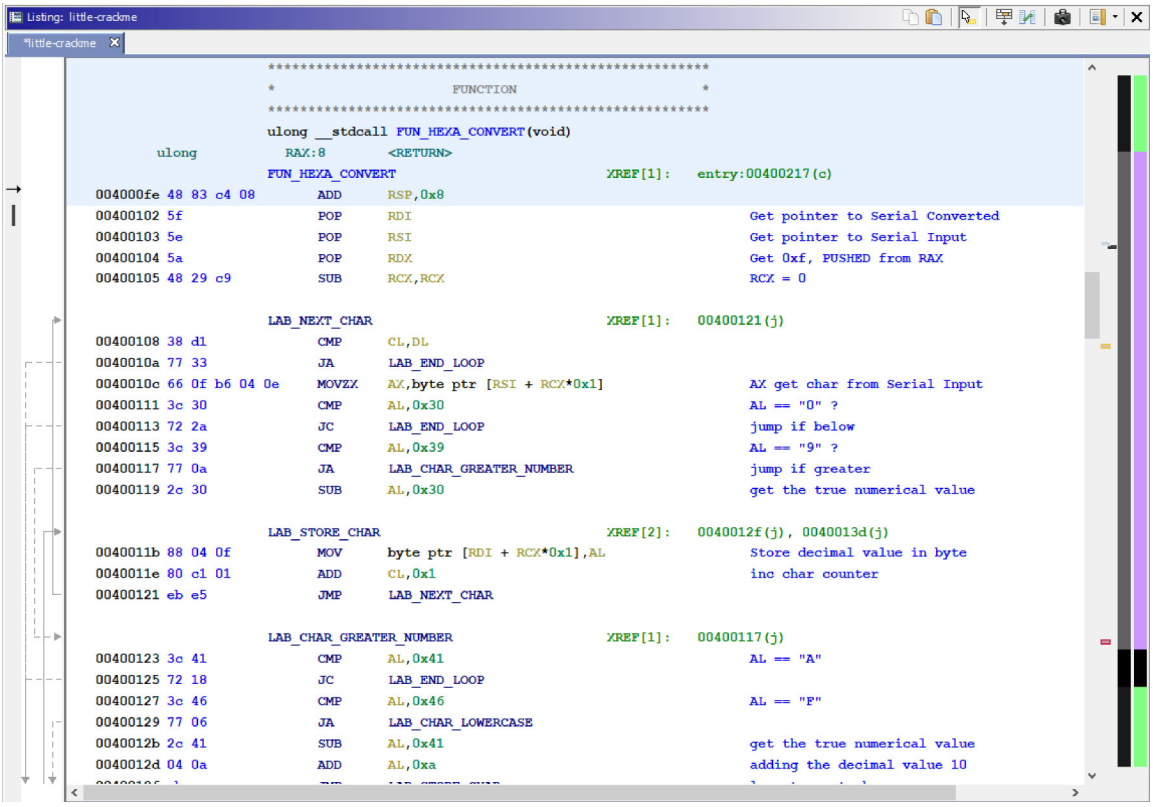
And finally, note a curious thing, and that is that the code has a jump to the **LAB_NOT_VALID** tag that shows us the message that the serial is not valid, but there is **no jump** to the message that indicates that the serial is correct .

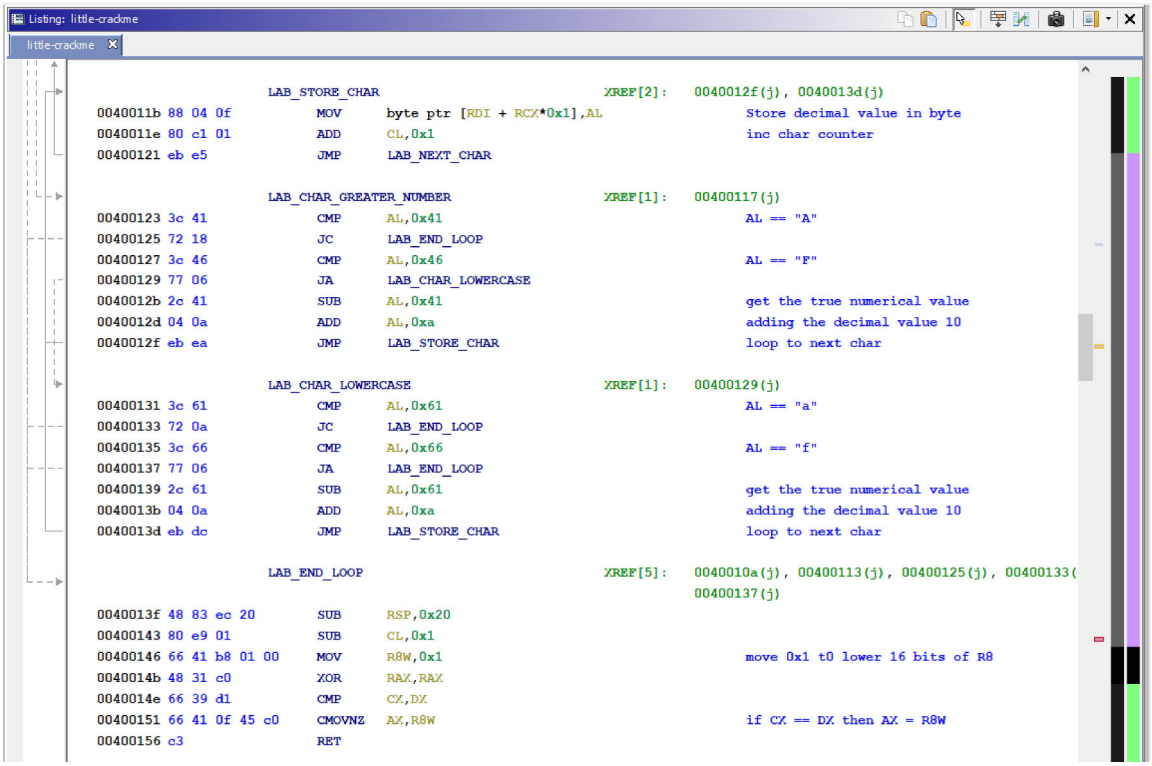
To hide the jump to the **"Valid !!!"** message, note that after the conditional jump there is a **PUSH** in the stack of the value **0x400248**. This is the address where the code to display this message starts and when it finds the **RET** afterwards it forces a salo to this address.

After analyzing the **FUN_TRANSFORM** function, we see that what it actually does is check that all the digits entered in the serial are valid values for a hexadecimal number, and it stores its value in decimal (one per byte) in a new array.

So we will change the name of the function and call it **FUN_HEXA_CONVERT**.

I leave here the complete function in two screenshots, and with your comments, which I think are more than enough to understand what it does.

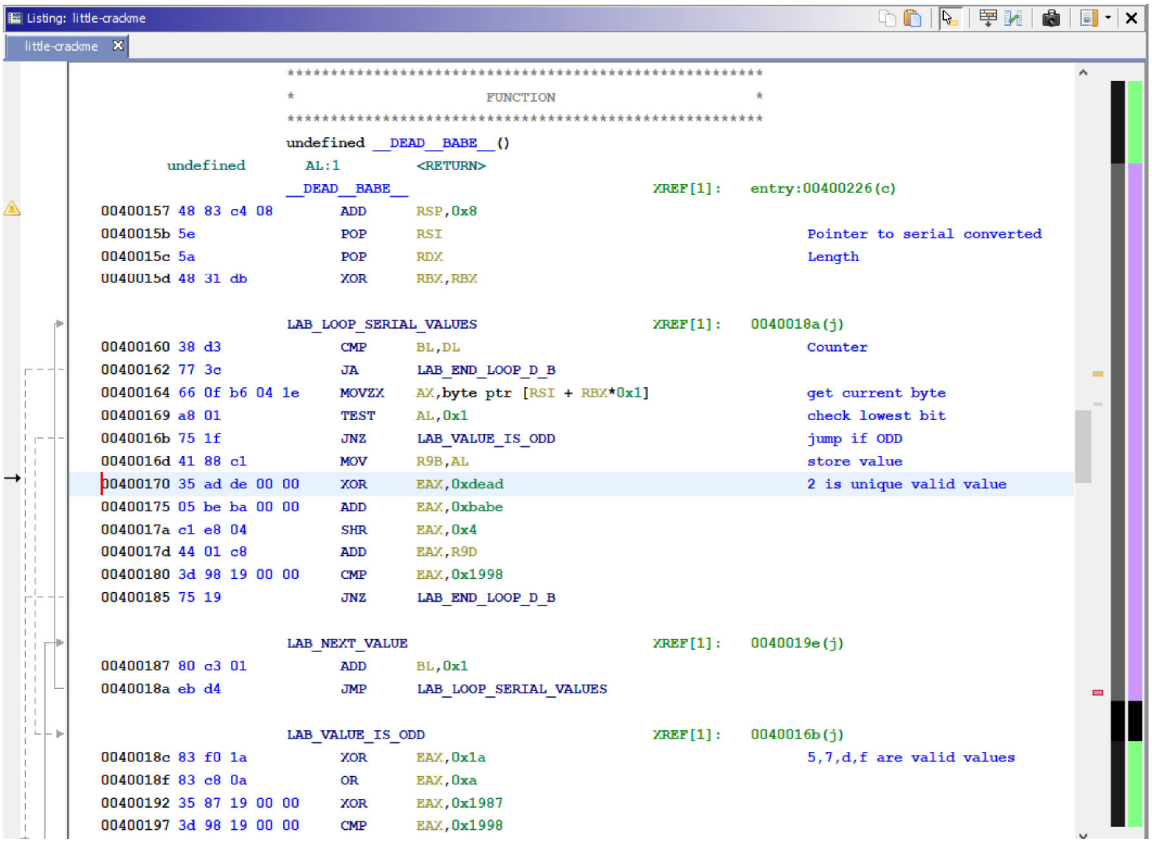




We will now analyze the function that we have named as **DEAD__BABE** which will give us the solution to crackme.

We have here a function that goes through all the values and performs some operations to check certain values. Depending on whether the value is **odd** or **even**, it will do different operations. If all the values pass the validation, the serial number will be good.

Knowing that the valid digits are hexadecimal values we have that we can only test the values **0,1,2,3,4,5,6,7,8,9, A, B, C, D, E, F**.



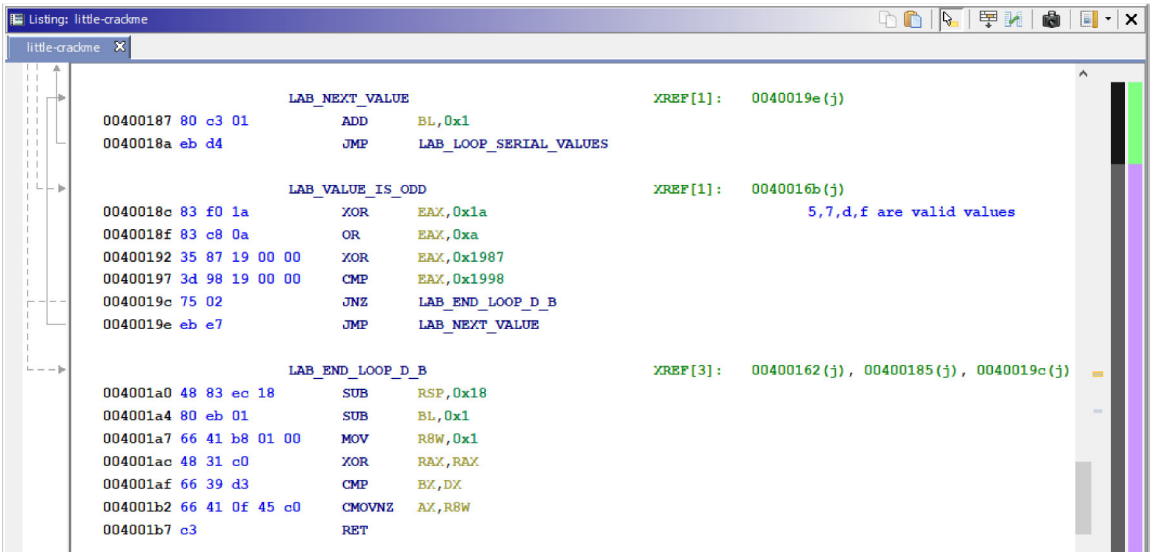
As the calculation is different for odd and even we separate them and do the manual test with the operations. Let's see an example with the number 2 that is even:

We see that the original value is saved in the **R9B** register, subsequently an **XOR** is made with the value **0xdead**, the result is added the value **0xbabe**, they are moved 4 bits to the right and the previously stored value is added. If the result of the operation is **0x1998** then the value is valid.

```
0040016d 41 88 c1           MOV     R9B,AL                  ; R9B = 2
00400170 35 ad de 00 00     XOR     EAX,0xdead              ; 2 XOR 0xdead = 0xdeaf
00400175 05 be ba 00 00     ADD     EAX,0xbabe              ; EAX = EAX + 0xbabe = 0x1
0040017a c1 e8 04           SHR     EAX,0x4                 ; 0x1996D shr 4 = 0x1996
0040017d 44 01 c8           ADD     EAX,R9D                 ; EAX = 0x1996 + 2 = 0x199
00400180 3d 98 19 00 00     CMP     EAX,0x1998
00400185 75 19              JNZ     LAB_END_LOOP_D_B
```

As we can see **2 meets the condition**. If we do the same operations with the rest of the even numbers, none of them comply, therefore, in this section we can determine that the only valid number is 2.

We are going to do the same with the odd numbers.



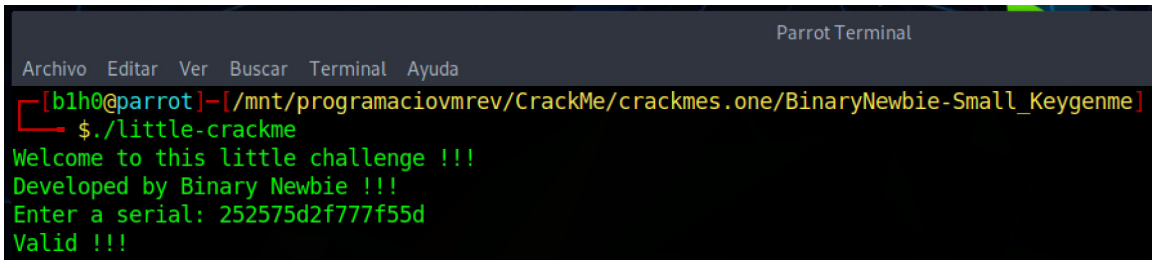

```
                    LAB_VALUE_IS_ODD
0040018c 83 f0 1a           XOR     EAX,0x1a                ; EAX = 5 XOR 0x1a = 0x1f
0040018f 83 c8 0a           OR      EAX,0xa                 ; 0x1f OR 0xa = 0x1f
00400192 35 87 19 00 00     XOR     EAX,0x1987              ; 0x1f XOR 0x1987 = 0x1998
00400197 3d 98 19 00 00     CMP     EAX,0x1998
0040019c 75 02              JNZ     LAB_END_LOOP_D_B
0040019e eb e7              JMP     LAB_NEXT_VALUE
```

Here the operations are different. An **XOR** of the value is made with **0x1a**, followed by an **OR** with **0xa** and again an **XOR** with **0x1997**. If the result is **0x1998** then that value (digit) is valid. As there are not many, you just have to do the operations with this and we obtain that the valid values are: **5,7,d**, and **f**.

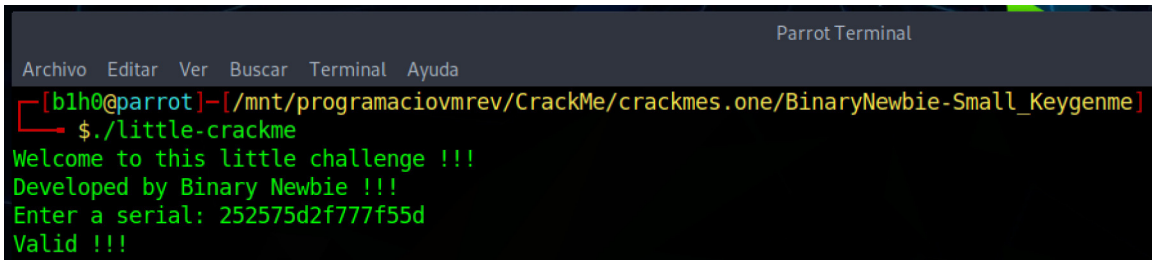
Thus we can conclude that any **16 digit** serial number containing the characters **2, 5, 7, d or f** will be valid.

Let's check it with 3 different random combinations to see what happens ...

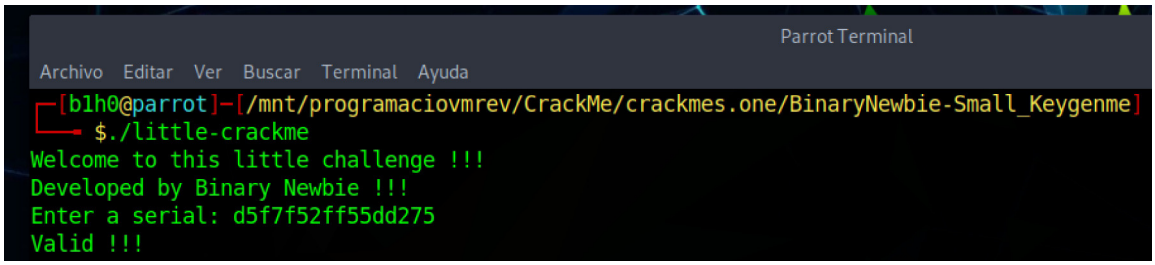
- **252575d2f777f55d**



- **7df522ff575dd2df**



- **d5f7f52ff55dd275**



Serial generator

We are going to create a simple serial number generator. Each time we invoke it it will give us a random number that matches the specifications.

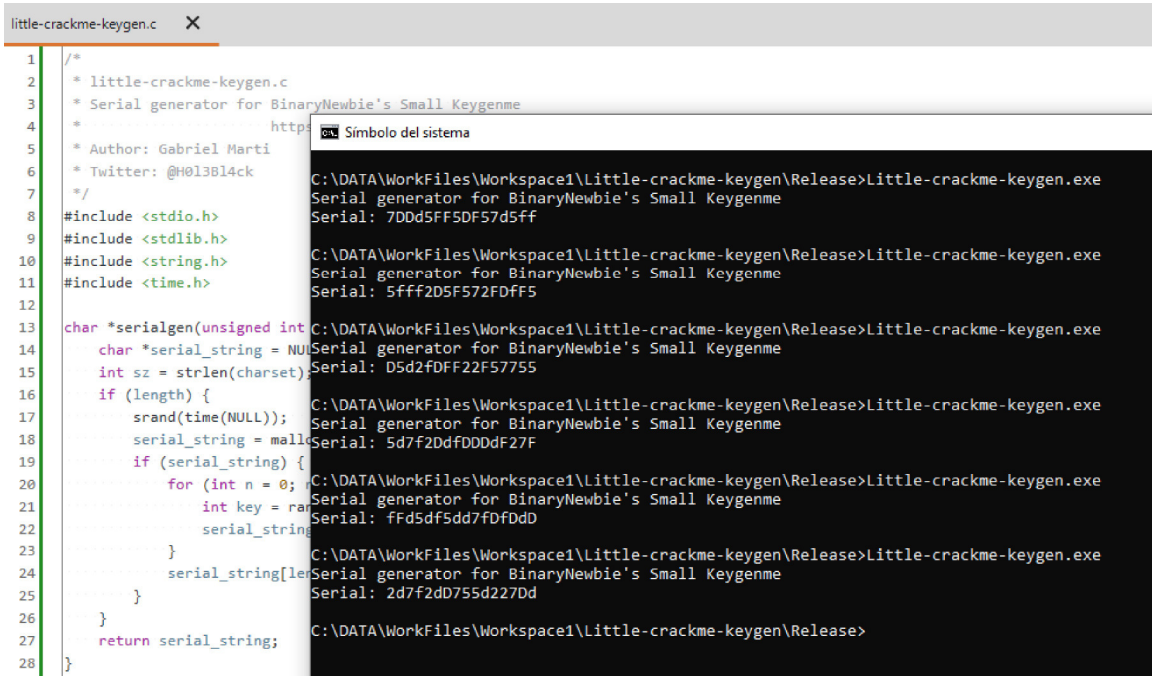
Keep in mind that the letters can be uppercase or lowercase, and have the same value, but we can mix them to make it appear that the serial number is different, although in reality it is the same.

Download source code

```
/*
 * little-crackme-keygen.c
 * Serial generator for BinaryNewbie's Small Keygenme
 *                      https://crackmes.one/crackme/5e83f7f433c5d4439bb2e059
 * Author: Gabriel Marti
 * Twitter: @H0l3Bl4ck
 */
#include <stdio.h>
#include <stdlib.h>
#include <string.h>
#include <time.h>

char *serialgen(unsigned int length, char *charset) {
        char *serial_string = NULL;
        int sz = strlen(charset);
        if (length) {
                srand(time(NULL));
                serial_string = malloc(sizeof(char) * (length+1));
                if (serial_string) {
                        for (int n = 0; n < length; n++) {
                                int key = rand() % sz;
                                serial_string[n] = charset[key];
                        }
                        serial_string[length] = '\0';
                }
        }
        return serial_string;
}

int main(int argc, char **argv) {
        char *valid_digits = "257dfDF";
```

```
        printf("Serial generator for BinaryNewbie's Small Keygenme\n");
        printf("Serial: %s\n", serialgen(16, valid_digits));
        return 0;
}
```

We're going to try it



You can **download** the keygen Windows binary from here

That's all folks!