CENG 331 Rectitation 1 Defusing a Binary Bomb

Middle East Technical University
Department of Computer Engineering

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INTRODUCTION

- **Oh no!!! Dr. Evil placed an evil program in our INEK machines, we have to stop him!!! But how I wonder..?**

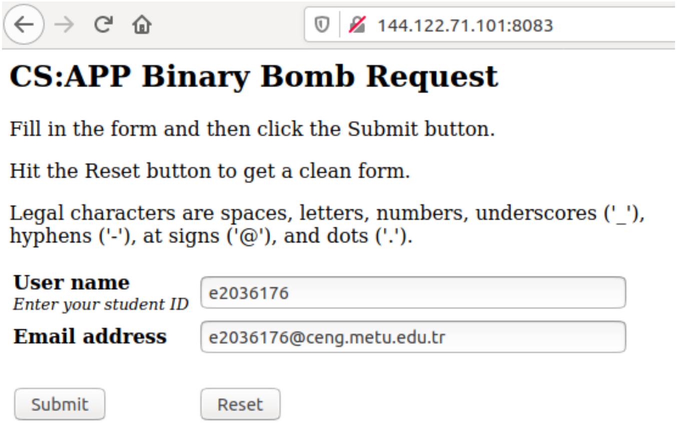
PURPOSE

- **Make you familiar with assembly by hacking into some real programs.**
- **Understanding machine level operations.**
- **Improving debugging skills with the use of debuggers.**

BOMBLAB

- You are handed a partial source code, in which Dr. Evil mocks you and your abilities as a hacker, and an executable file.
- You can't read the code but you need to figure out what it does. How!?
- From the binary executable itself!!!

Get Your Own Bomb



CS:APP Binary Bomb Request

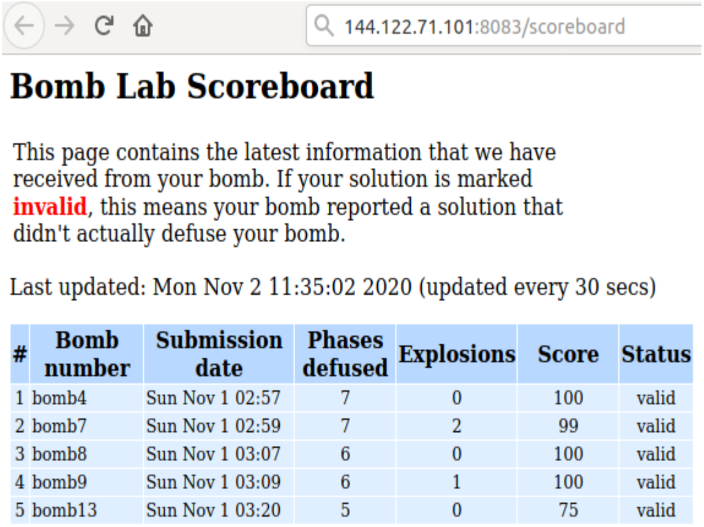
Fill in the form and then click the Submit button.

Hit the Reset button to get a clean form.

Legal characters are spaces, letters, numbers, underscores ('_'), hyphens ('-'), at signs ('@'), and dots ('.').

User name *Enter your student ID*	e2036176
Email address	e2036176@ceng.metu.edu.tr

SCOREBOARD



144.122.71.101:8083/scoreboard

Bomb Lab Scoreboard

This page contains the latest information that we have received from your bomb. If your solution is marked **invalid**, this means your bomb reported a solution that didn't actually defuse your bomb.

Last updated: Mon Nov 2 11:35:02 2020 (updated every 30 secs)

#	Bomb number	Submission date	Phases defused	Explosions	Score	Status
1	bomb4	Sun Nov 1 02:57	7	0	100	valid
2	bomb7	Sun Nov 1 02:59	7	2	99	valid
3	bomb8	Sun Nov 1 03:07	6	0	100	valid
4	bomb9	Sun Nov 1 03:09	6	1	100	valid
5	bomb13	Sun Nov 1 03:20	5	0	75	valid

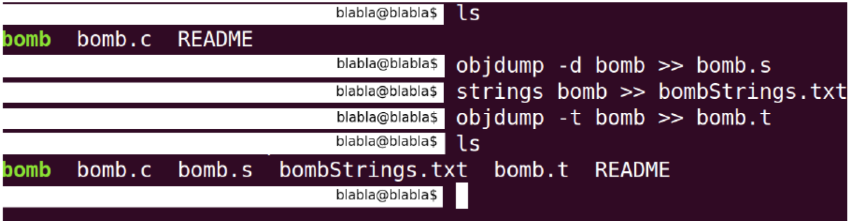
WHAT DOES IT DO

- Each students receives an executable with the name "bomb" and a C source code named "bomb.c".
- Executable expects strings from you. If you enter a wrong string it will explode, meaning that it will print a BOOM!!! message and send a signal to the server to decrement your points by 0.5.
- Every time you enter a correct string, you solve a phase and a new phase starts. After you solve 6 of them the bomb is defused.
- You can only work from inek machines. You can connect to the machines with SSH.

HOW TO START

- **With objdump−d you can get the, relatively more readable, assembly code of the executable.**
- **objdump−d bomb>>bomb.s will write assembly code in bomb.s.**
- **You can search function names that are in bomb.c in the assembly file and trace what they do.**
- **With strings command you can print all strings in the executable into a file. Some of the strings may or may not lead you to some answers.**

EXAMPLE



```
blabla@blabla$ ls
bomb  bomb.c  README
blabla@blabla$ objdump -d bomb >> bomb.s
blabla@blabla$ strings bomb >> bombStrings.txt
blabla@blabla$ objdump -t bomb >> bomb.t
blabla@blabla$ ls
bomb  bomb.c  bomb.s  bombStrings.txt  bomb.t  README
blabla@blabla$ 
```

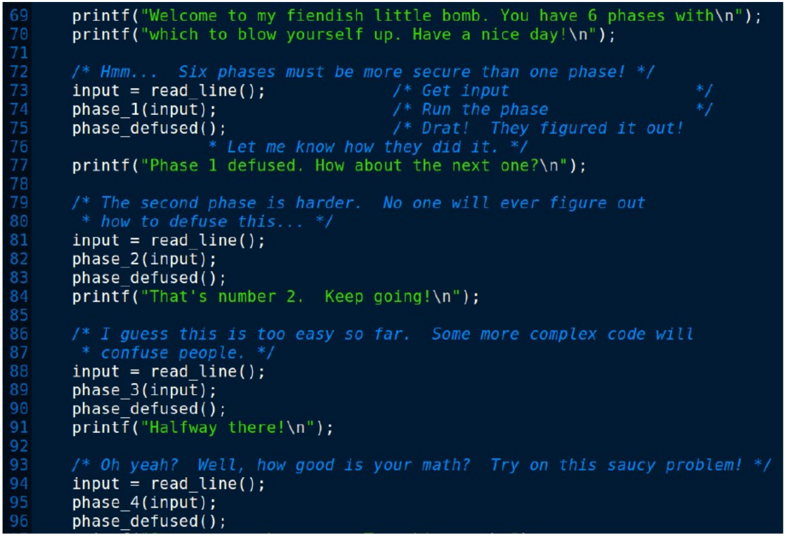
HINTS

- Make sure to run the bomb with GDB, this way you can put breakpoints to certain parts of the code to obstruct it from exploding.
- If you don't run the bomb in GDB you should enter all correct answers in one shot fashion to stop the bomb from exploding (Or you can really stop a bomb with Ctrl-C who knows?).
- You don't have to reenter all the strings you found to get to your current phase, you can feed them with "run solutions . txt" in GDB. "solutions.txt" is the file you saved your solutions up to that point.

GDB CRASH COURSE

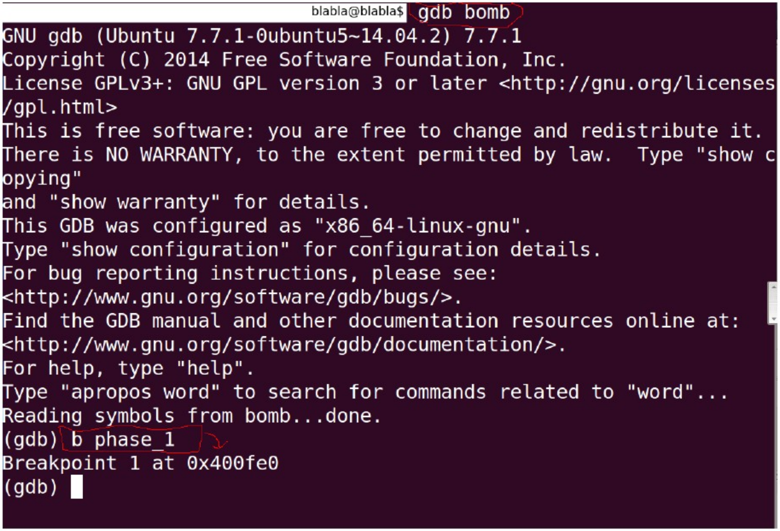
- **GDB−>The GNU Project Debugger.**
- **Helps debugging the executable by running it line by line, putting breakpoints to instructions, examining memory content etc.**
- **Use it with an executable. Ex: ”gdb bomb”.**

BOMB.C FILE



```
    printf("Welcome to my fiendish little bomb. You have 6 phases with\n");
    printf("which to blow yourself up. Have a nice day!\n");

    /* Hmm...  Six phases must be more secure than one phase! */
    input = read_line();             /* Get input                   */
    phase_1(input);                  /* Run the phase               */
    phase_defused();                 /* Drat!  They figured it out!
                  * Let me know how they did it. */
    printf("Phase 1 defused. How about the next one?\n");

    /* The second phase is harder.  No one will ever figure out
     * how to defuse this... */
    input = read_line();
    phase_2(input);
    phase_defused();
    printf("That's number 2.  Keep going!\n");

    /* I guess this is too easy so far.  Some more complex code will
     * confuse people. */
    input = read_line();
    phase_3(input);
    phase_defused();
    printf("Halfway there!\n");

    /* Oh yeah?  Well, how good is your math?  Try on this saucy problem! */
    input = read_line();
    phase_4(input);
    phase_defused();
```

EXAMPLE

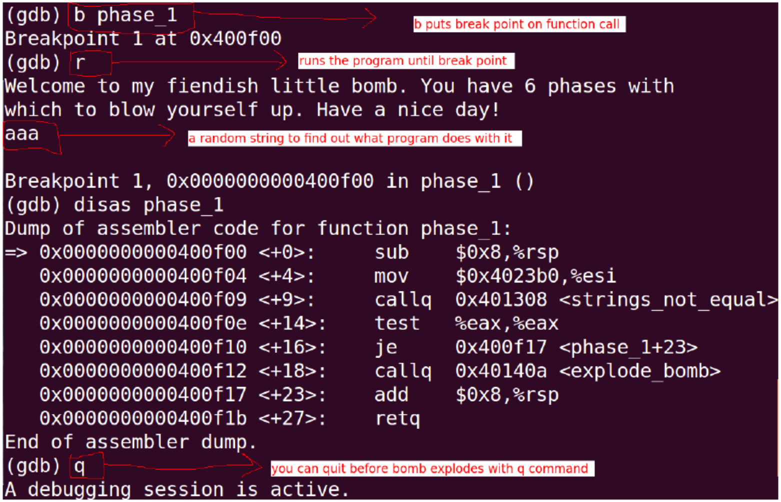


```
blabla@blabla$ gdb bomb
GNU gdb (Ubuntu 7.7.1-0ubuntu5~14.04.2) 7.7.1
Copyright (C) 2014 Free Software Foundation, Inc.
License GPLv3+: GNU GPL version 3 or later <http://gnu.org/licenses
/gpl.html>
This is free software: you are free to change and redistribute it.
There is NO WARRANTY, to the extent permitted by law.  Type "show c
opying"
and "show warranty" for details.
This GDB was configured as "x86_64-linux-gnu".
Type "show configuration" for configuration details.
For bug reporting instructions, please see:
<http://www.gnu.org/software/gdb/bugs/>.
Find the GDB manual and other documentation resources online at:
<http://www.gnu.org/software/gdb/documentation/>.
For help, type "help".
Type "apropos word" to search for commands related to "word"...
Reading symbols from bomb...done.
(gdb) b phase_1
Breakpoint 1 at 0x400fe0
(gdb) 
```

GDB CRASH COURSE CONT'D

- **b puts a break point.**
- **r runs the program until it hits a break point.**
- **disas prints the assembly code of a specific phase. You can also use the output of objdump to see the assembly code.**

Example



```
(gdb) b phase_1
Breakpoint 1 at 0x400f00
(gdb) r
Welcome to my fiendish little bomb. You have 6 phases with
which to blow yourself up. Have a nice day!
aaa

Breakpoint 1, 0x0000000000400f00 in phase_1 ()
(gdb) disas phase_1
Dump of assembler code for function phase_1:
=> 0x0000000000400f00 <+0>:     sub    $0x8,%rsp
   0x0000000000400f04 <+4>:     mov    $0x4023b0,%esi
   0x0000000000400f09 <+9>:     callq  0x401308 <strings_not_equal>
   0x0000000000400f0e <+14>:    test   %eax,%eax
   0x0000000000400f10 <+16>:    je     0x400f17 <phase_1+23>
   0x0000000000400f12 <+18>:    callq  0x40140a <explode_bomb>
   0x0000000000400f17 <+23>:    add    $0x8,%rsp
   0x0000000000400f1b <+27>:    retq
End of assembler dump.
(gdb) q
A debugging session is active.
```

b puts break point on function call
runs the program until break point
a random string to find out what program does with it
you can quit before bomb explodes with q command

ONE LAST HINT

- **The bomb frequently calls sscanf to itemize your input strings.**
- **Ex: *"%s %x %s"* represents an input of a string, a hex number and a string.**
- **You can use this knowledge to figure out what kinds of arguments a phase is expecting.**
- **man sscanf !.**

RESOURCES

- **A cheat sheet about GDB: http://csapp.cs.cmu.edu/3e/docs/gdbnotes-x86-64.pdf**
- **Chapter 3 from your book.**
- **Homework text. Read it carefully you can find many details there.**
- **You can use the discussion forum in ODTUClass for discussions.**
- **You can send an email to mtapli@ceng.metu.edu.tr or sayin@ceng.metu.edu.tr.**