CS 240
Laboratory 10
Introduction to Buffer Overflow

Create 4 exploit strings to use as input to a vulnerable executable called `laptop.bin`

Each exploit is a **buffer overrun** attack (intentionally overfilling the stack with specific values, causing the program to execute differently than it normally does)

The exploits increase in sophistication from exploit 1 to exploit 4

Repository

laptop.c: you are given important parts of the C code that you can read to help you understand how the compiled version works.

This is similar to how you were given the **main.c** code for the x86 assignment to help you understand how **adventure** worked.

laptop.bin: compiled/executable version of laptop.c You will run **laptop** using a file containing input to the program.

This is similar to how you ran **adventure.bin** using **inputs.txt** in the x86 assignment.

You will design the input to the program to take advantage of how the stack is used to get the program to do something different than what was originally intended (this is called an *exploit).*

exploit1.hex, exploit2.hex, exploit3.hex, **exploit4.hex**: input files you will create for each of the 4 exploits you will design.

These correspond to **inputs.txt** for the x86 assignment, except that you use a separate file for each exploit.

Each exploit file must contain the correct number of bytes with the correct hexadecimal value for each byte to represent your exploit.

hex2raw.bin: tool/executable file you are given which helps you prepare to run your exploits

This executable file will take the input you design for an exploit (for example, **exploit1.hex)** and turn it into the proper raw byte form (**exploit1.bytes**) needed to run the program.

questions.txt: file for English descriptions of your exploits

This is similar to **descriptions.txt** in the x86 assignment.

Designing Stack Exploits

`laptop` uses a function `Gets()` that is poorly designed

`Gets()` is called from function **getbuf()**

```
unsigned long long getbuf() {
  char buf[36];

  // other statements

  unsigned long long val = (unsigned long long)Gets(buf);

// other statements

}
```

buf , an array of 36 bytes, is a local variable, so will by stored *on the stack*

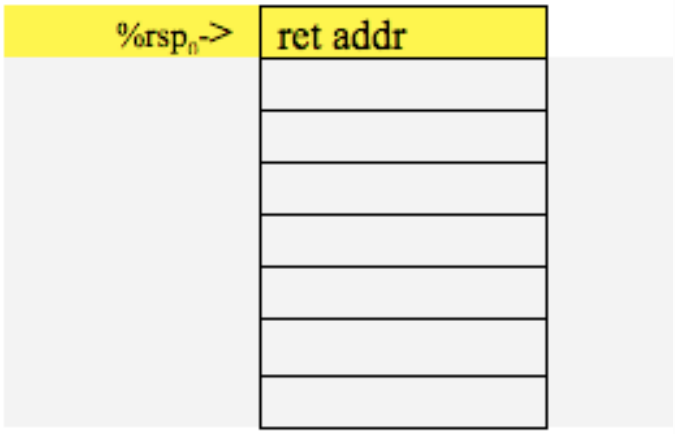
Gets() takes **buf** as a parameter

```
Gets(char* buf)
```

- **Gets()** accepts a string from standard input and stores the bytes from the string in **buf** (on the stack)
- **Gets()** does NOT check to see if the string accepted is longer than the size of the array!
- If the string is too long, it may overwrite important values on the stack (such as return addresses).

Stack diagram for the execution of the x86 code for **getbuf**

```
<getbuf>
<+0> push   %rbp
<+1> mov    %rsp,%rbp
<+4> sub    $0x30,%rsp
<+8> lea -0x30(%rbp),%rdi
<+12> callq  Gets
```



Formatting Exploit Strings

Use a string to represent the values of the bytes in the exploit

Given the string

> `"01 02 03 04"`

The string is represented by the ASCII values for each character:

> `0x30 0x31 0x20 0x30 0x32 0x20 0x30 0x33 0x20 0x30 0x34`

If the raw bytes we want are actually:

> `0x01 0x02 0x03 0x04`

We use a tool called `hex2raw.bin` to convert `"01 02 03 04"` to `0x01 0x02 0x03 0x04`

- In the string, each byte is written as pair of hexadecimal digits
- Successive bytes may be separated by spaces.
- The output of `hex2raw.bin` is a raw byte sequence, where each byte has the hexadecimal value described by the corresponding pair of characters in the input.

NOTE: do not use `0A` in your exploit strings!

> Your exploit string must not contain 0A, since this is the ASCII code for newline (`'\n'`).
>
> When `Gets()` encounters this byte, it will assume you intended to terminate the string input, and will ignore the rest of your values.
>
> `hex2raw.bin` will warn you if it encounters this byte value.

Running and Testing Exploits

1. Write the exploit string in a file, for example `exploit1.hex`
2. Translate it to raw bytes with `hex2raw`

```
$ ./hex2raw.bin < exploit1.hex > exploit1.bytes
```

3. Run it directly (possible for Exploits 1 and 2):

```
$ ./laptop.bin -u your_cs_username < exploit1.bytes
```

   or run it under `gdb` (required for Exploits 3 and 4):

```
$ gdb ./laptop.bin
```

```
(gdb) run -u your_cs_username < exploit1.bytes
```

4. If you change your exploit string in `exploit1.hex`, you must always run `hex2raw` to create a new version of `exploit1.bytes` before running again.

Why do exploit 3 and 4 need to be run from gdb?

Exploits 3 and 4 require putting code on the stack, and executing it from there.

Running program stored on the stack is not normally allowed (for security reasons).

However, from within the debugger, it is safe to do so (so, we must test those exploits using **gdb**).