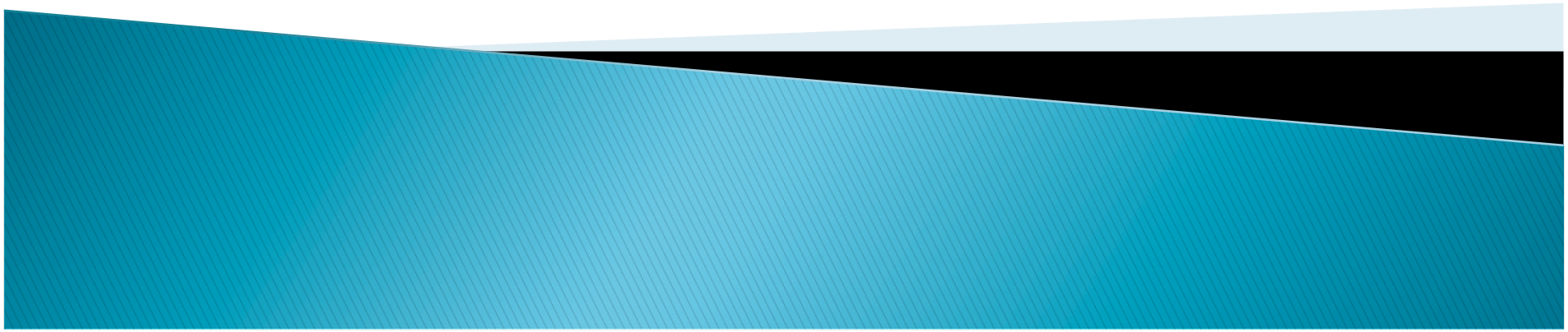
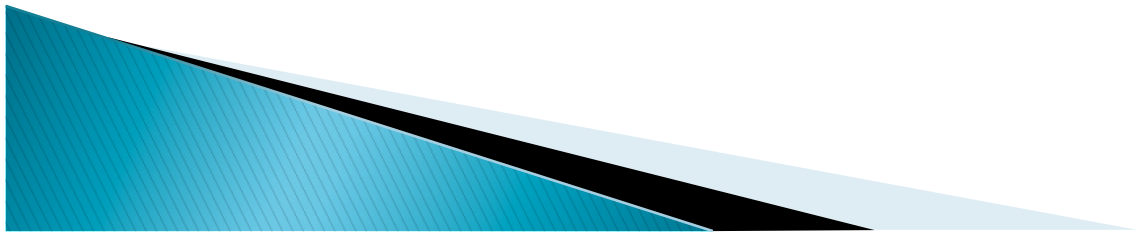
Smashing the Stack for Fun and Profit



General Overview

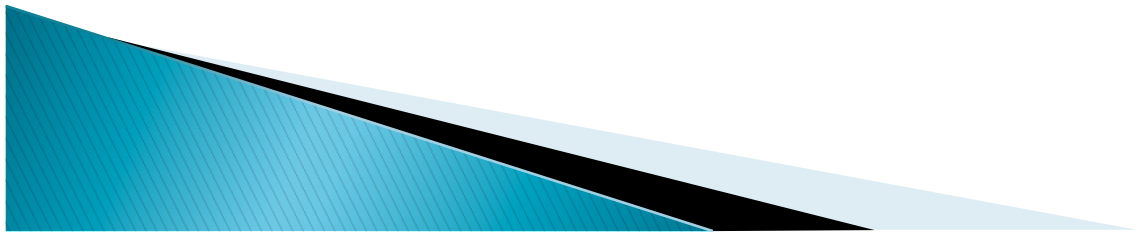
- “Smashing the Stack” is a type of buffer overflow attack – overwriting the return address to redirect control to attack code

- Most common buffer overflow error since it is the easiest to make and take advantage of



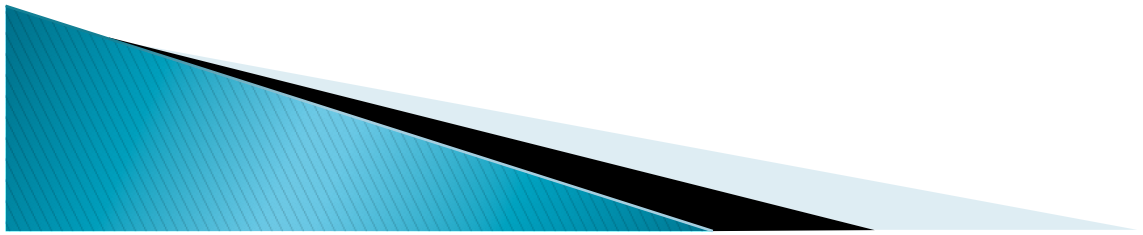
Buffer Overflows

- No one would do something like this, right?



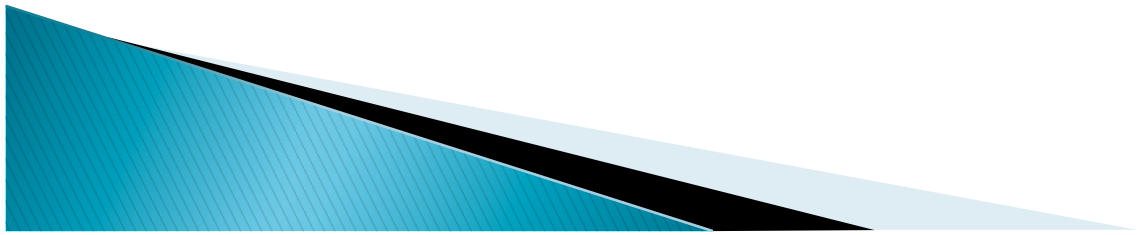
Slammer Worm Info

- First example of a high speed worm (previously only existed in theory)
- Infected a total of 75,000 hosts in about 30 minutes
- Infected 90% of vulnerable hosts in 10 min
- Exploited a vulnerability in MS SQL Server Resolution Service, for which a patch had been available for 6 months

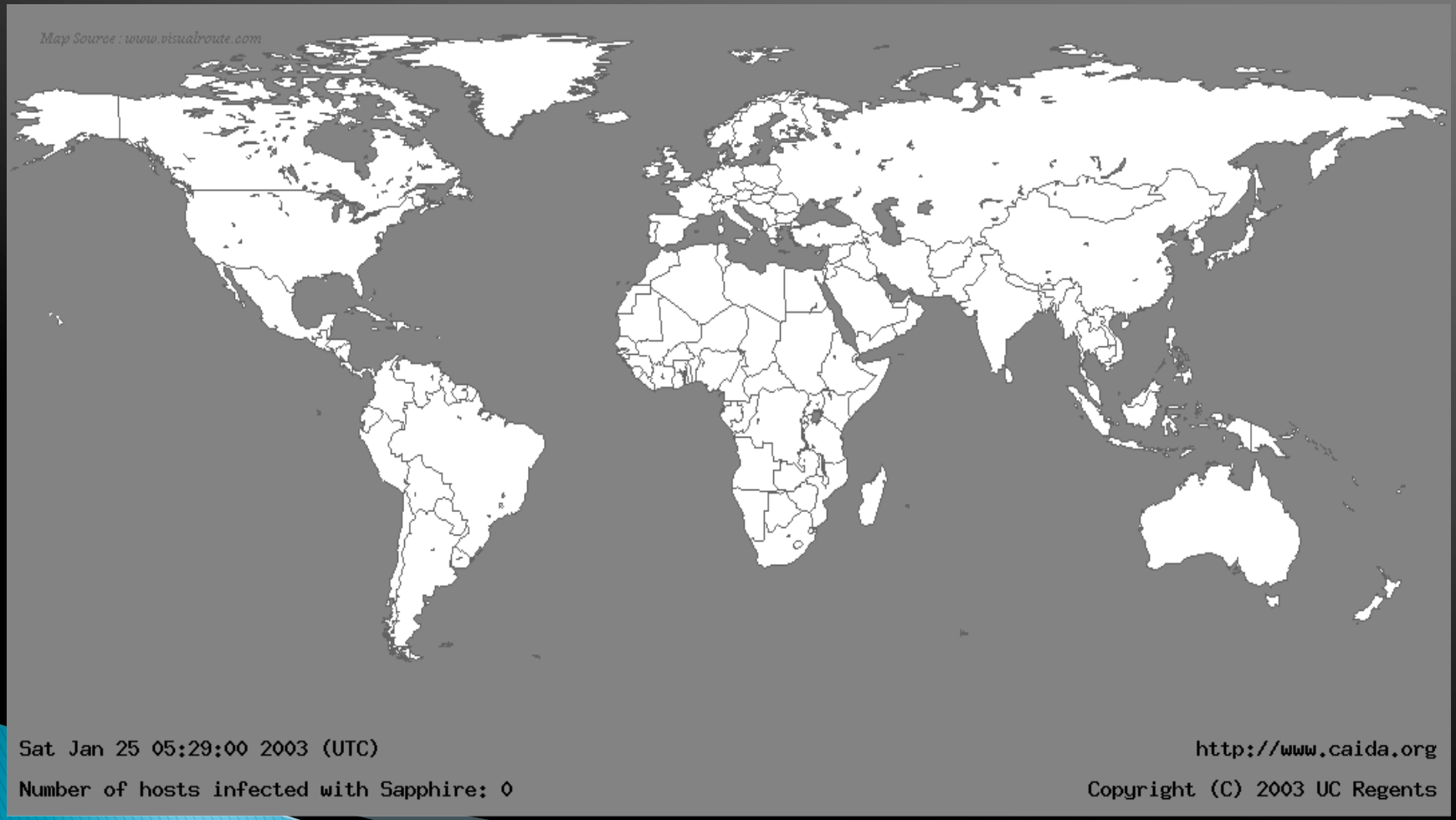


Slammer Worm Info

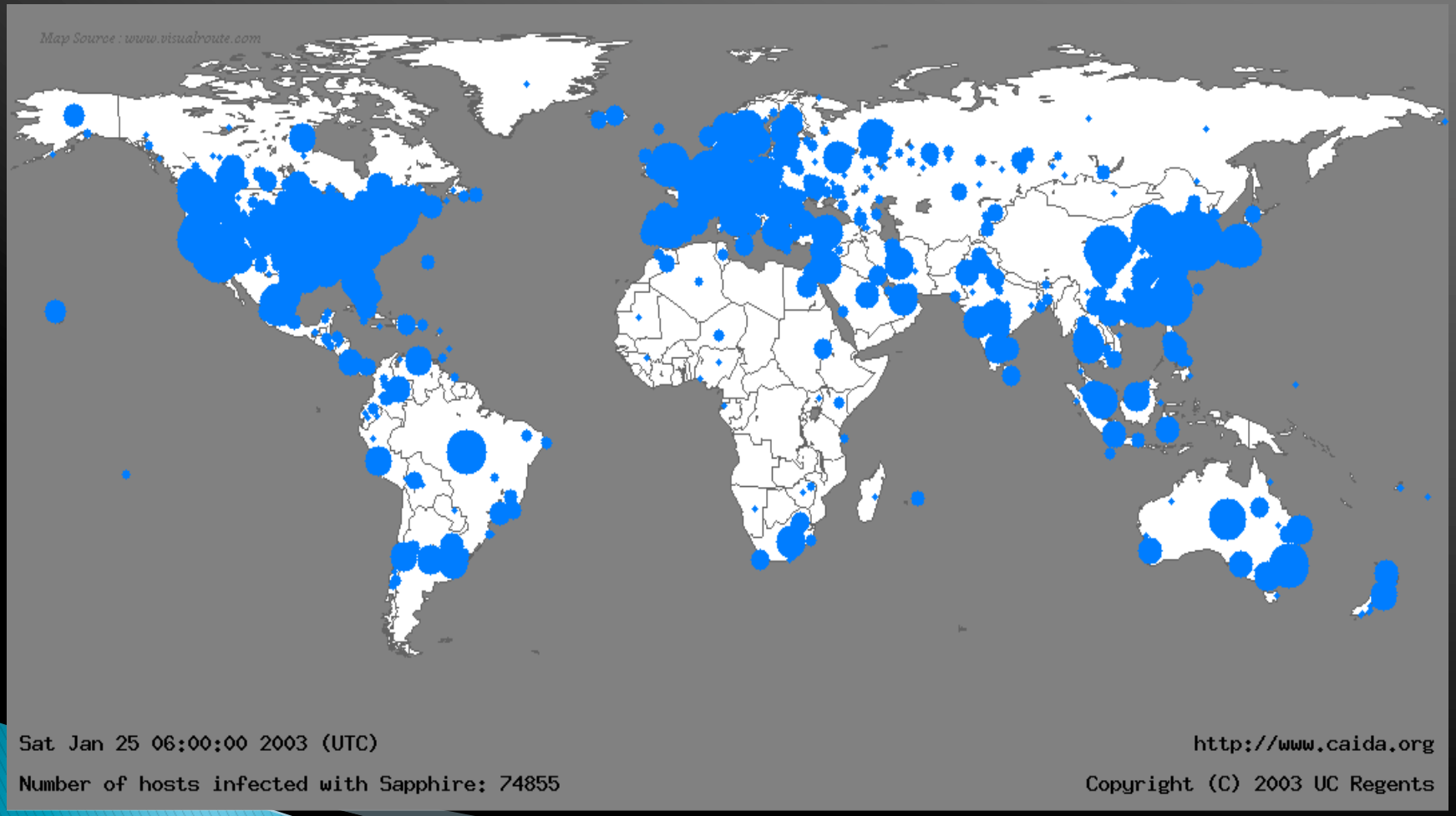
- Code randomly generated an IP address and sent out a copy of itself
- Used UDP – limited by bandwidth, not network latency (TCP handshake).
- Packet was just 376 bytes long…
- Spread doubled every 8.5 seconds
- Max scanning rate (55 million scans/second) reached in 3 minutes



Slammer Worm – Eye Candy



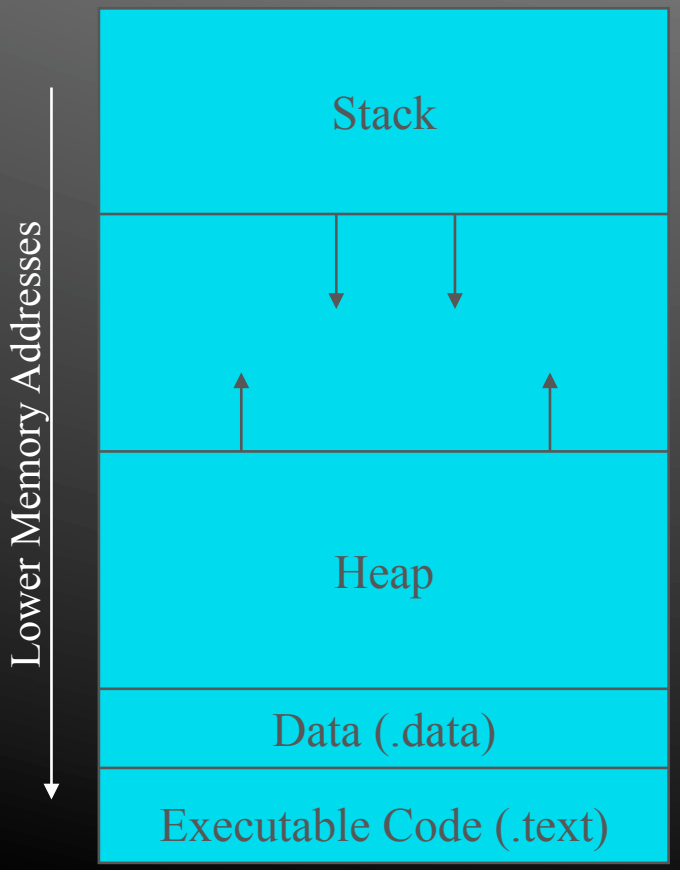
Slammer Worm – Eye Candy



Anatomy of Memory

Assumptions

- Stack grows down
- Stack pointer points to the last address on the stack



Example Program

Let us consider how the stack of this program would look:

```
void function(int a, int b, int c){
     char buf[16];
}

int main(){
     function(1,2,3);
}
```

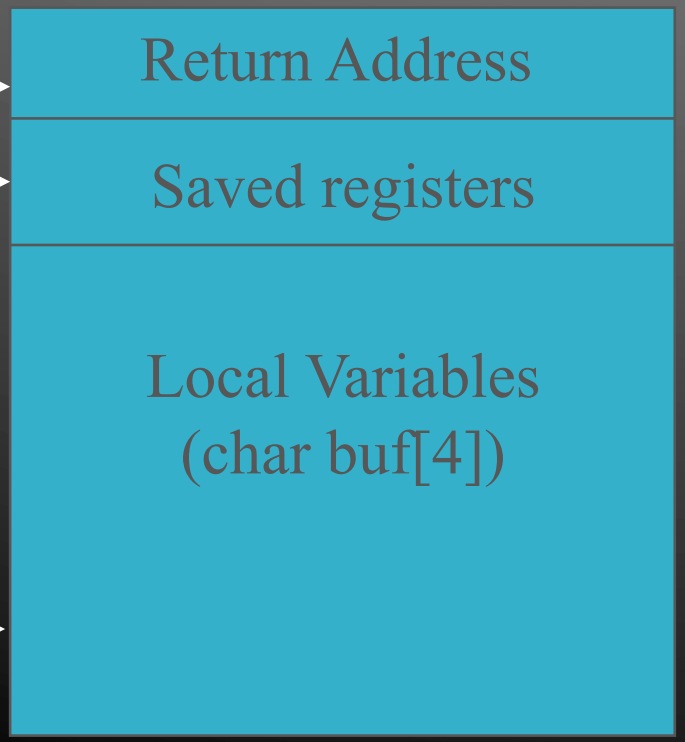
Stack Frame

function prolog

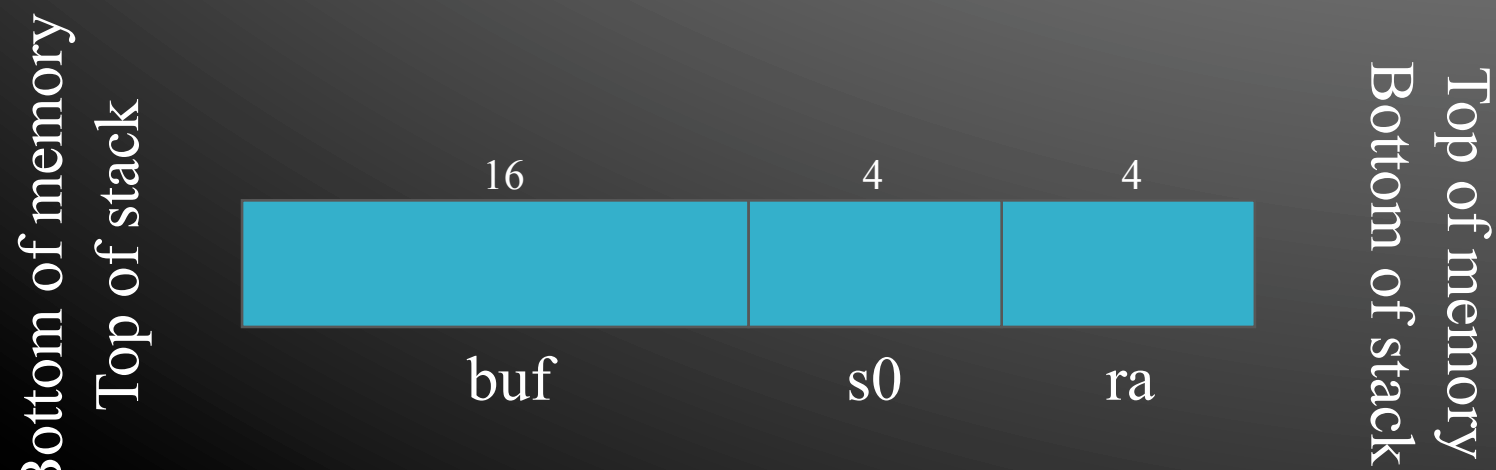
```
sw $ra, -4(sp)
sw $s0, -8(sp)
```

```
addi $sp, $sp, -24
```

Allocates space for stack frame



Linear View Of Frame/Stack



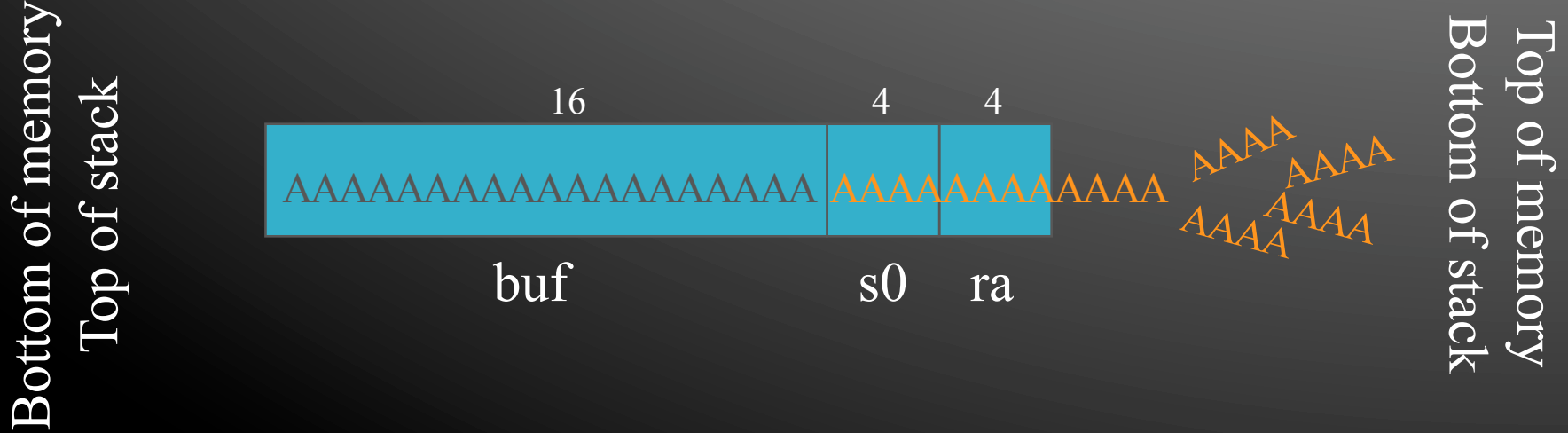
Example Program 2

```
void function(char *str){
        char buf [16];
        strcpy(buf, str);
}

int main(){
        char large_string[32];
        int i;
        for (i = 0; i < 31; i++){
            large_string[i] = 'A';
        }
        function(large_string);
}
```

Example Program 2

When this program is run, it results in an exception



The return address is overwritten with ‘AAAA’ (0x41414141)

Function exits and goes to execute instruction at 0x41414141…..

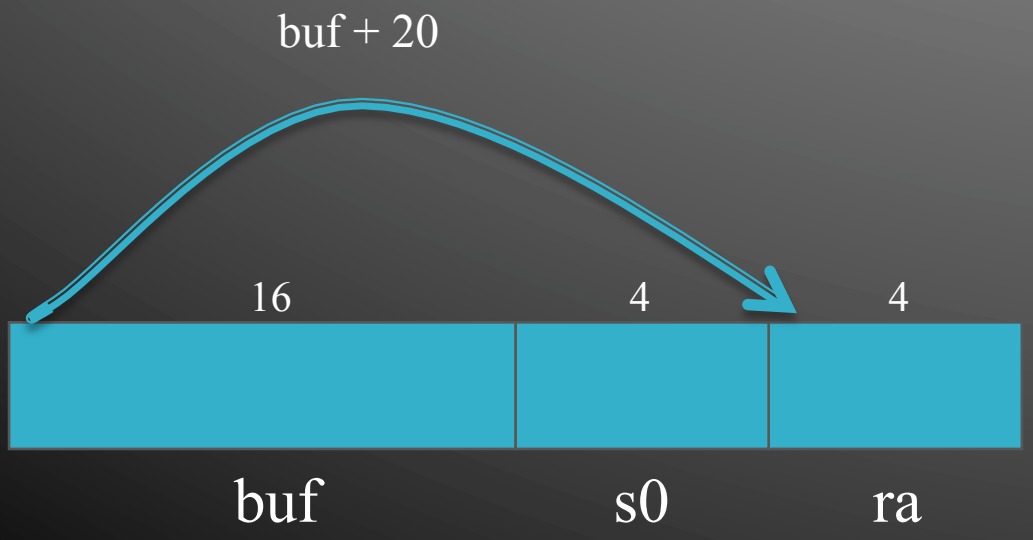
Example Program 3

Can we take advantage of this to execute code, instead of crashing?

```
void function(int a, int b, int c){
        char buf[4];
        int *r;
        r = buf + 20;
        (*r) += 8;
}

int main(){
        int x = 0;
        function(1,2,3);
        x = 1;
        printf("%d\n", x);
}
```

Example Program 3



Bottom of memory
Top of stack

Top of memory
Bottom of stack

This causes it to skip the assignment of 1 to x, and prints out 0 for the value of x

So What?

- We have seen how we can overwrite the return address of our own program to crash it or skip a few instructions – basically just writing a buggy program
- How can these principles be used by an attacker to hijack the execution of a program?
- Attacker can use some kind of user/network input to inject attack code into such a buffer