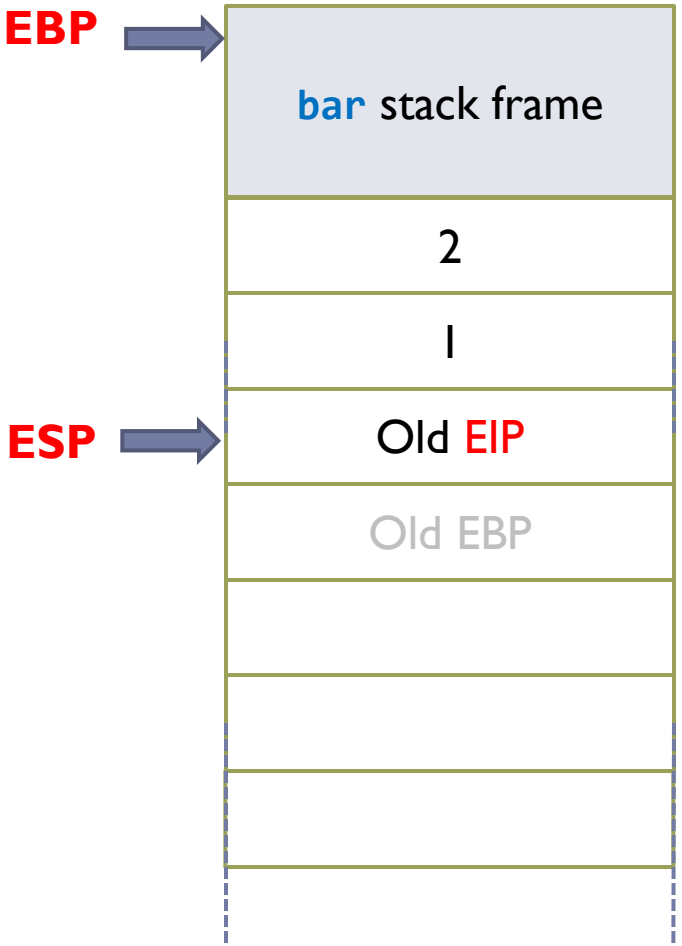
Function Call Convention

Step 8: Restore EBP.

- Pop a value from the stack (old EBP), and assign it to EBP.
- ESP is also updated (old EIP) due to the pop operation.
- (old EBP) is deleted from the stack.

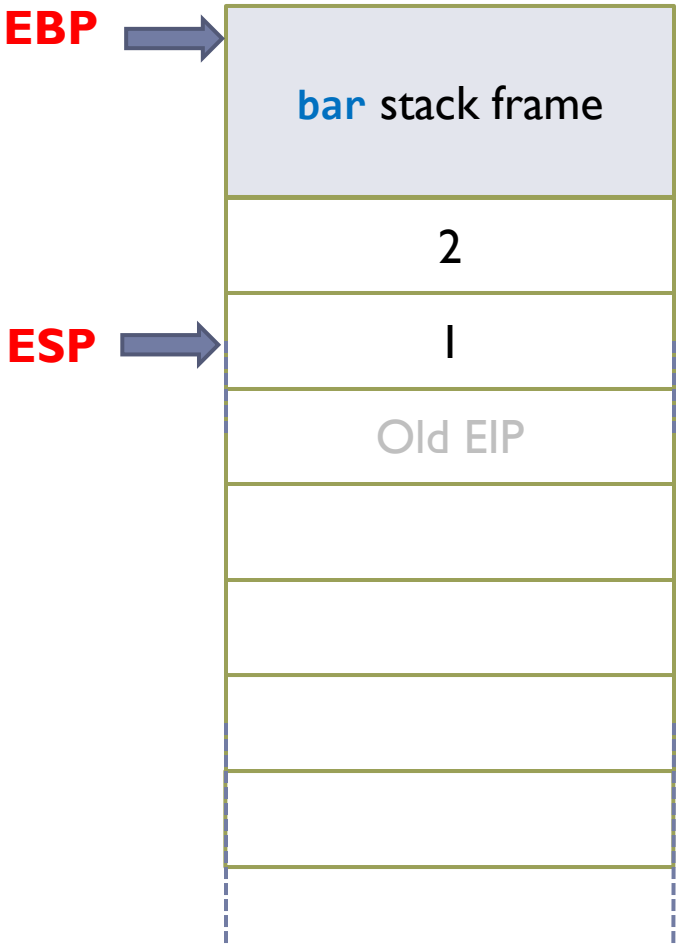



```
void bar( ) {
  foo(1, 2);
}
int foo(int x, int y){
  int z = x + y;
  return z;
}
```

Function Call Convention

Step 9: Restore EIP.

- Pop a value from the stack (old EIP), and assign it to EIP.
- ESP is also updated (1) due to the pop operation.
- (old EIP) is deleted from the stack.

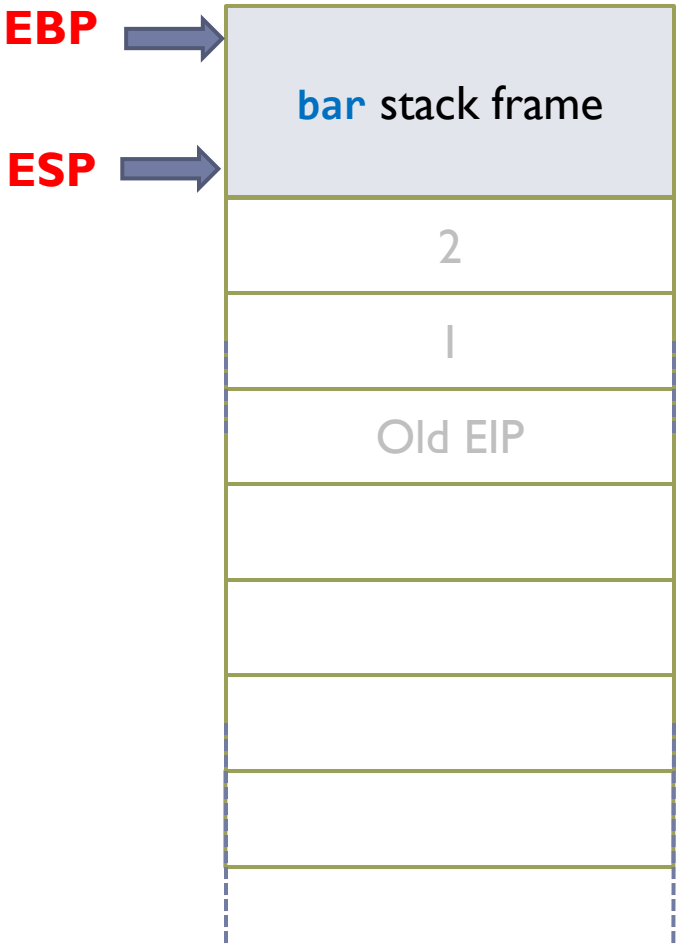



```
void bar( ) {
  foo(1, 2);
}
int foo(int x, int y){
  int z = x + y;
  return z;
}
```

Function Call Convention

Step 10: Delete function parameters.

- Pop values from the stack (1, 2).
- ESP is also updated (old ESP) due to the pop operation.
- Function parameters (1, 2) are deleted from the stack.
- Continue the execution in function `bar`.




```
void bar( ) {
  foo(1, 2);
}
int foo(int x, int y){
  int z = x + y;
  return z;
}
```

Outline

- Review: Memory Layout and Function Call Convention

- **Buffer Overflow Vulnerability**

A Common Vulnerability in C Language

String

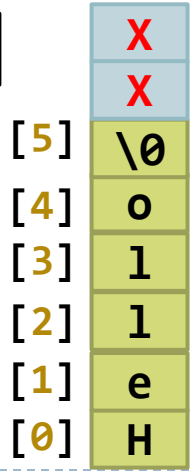
- An array of characters (1 Byte).
- Must end with NULL (or `\0'). A string of length n can hold only $n-1$ characters, while the last character is reserved for NULL.

`char* strcpy (char* dest, char* src)`

- Copy string *src* to *dest*
- No checks on the length of the destination string.

What if the source string is larger than destination string?

```
char str[6] = "Hello";
```



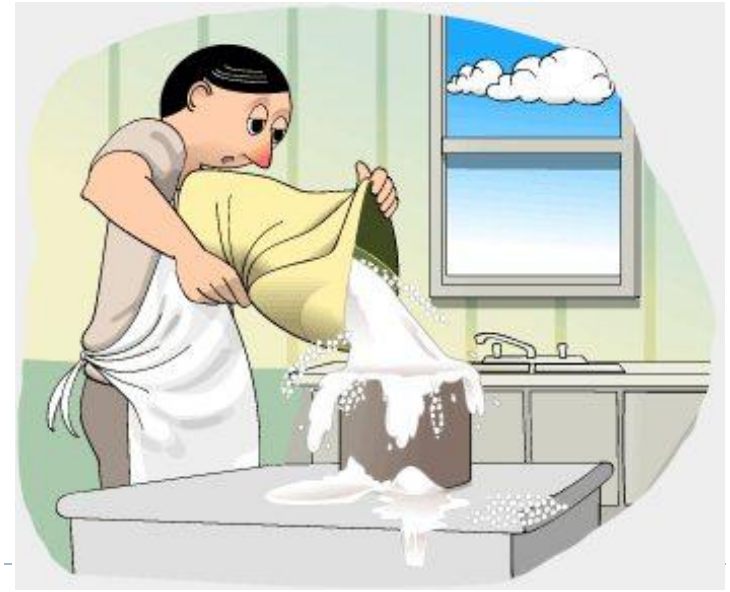

```
char* strcpy (char* dest, const char* src) {
  unsigned i;
  for (i=0; src[i] != '\0'; ++i)
    dest[i] = src[i];
  dest[i] = '\0';
  return dest;
}
```

General Idea

More data into a memory buffer than the capacity allocated.

Overwriting other information adjacent to that memory buffer.

Key reason: C does not check boundaries when copying data to the memory.



High coverage

Any system implemented using C or C++ can be vulnerable.

- Program receiving input data from untrusted network

  sendmail, web browser, wireless network driver, ...

- Program receiving input data from untrusted users or multi-user systems

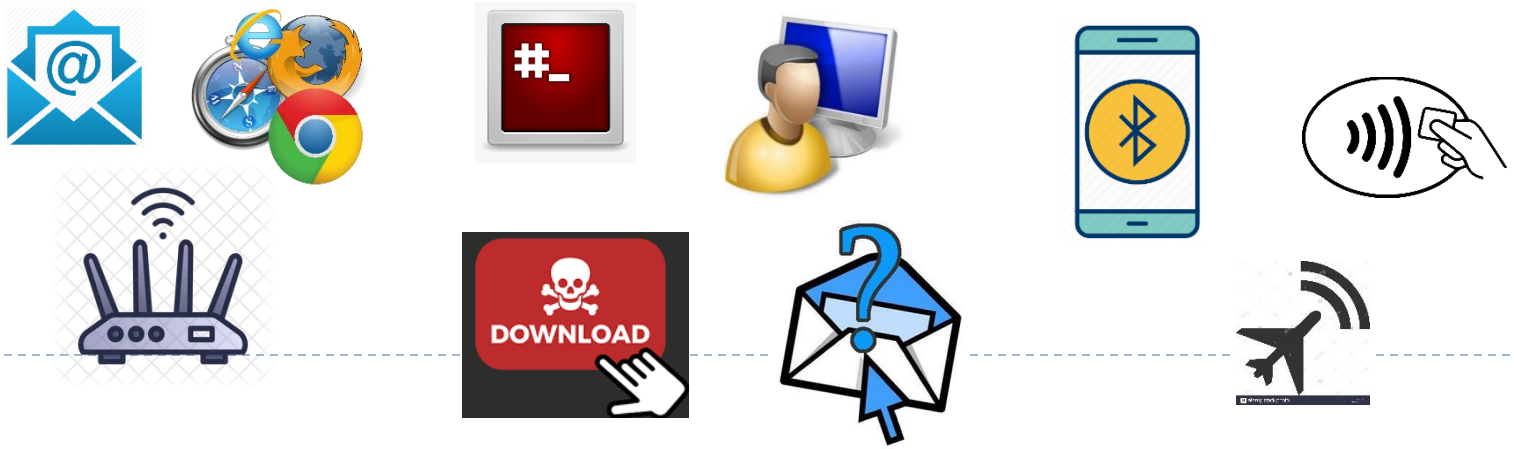
  services running with high privileges (root in Unix/Linux, SYSTEM in Windows)

- Program processing untrusted files

  downloaded files or email attachment.

- Embedded software

  mobile phones with Bluetooth, wireless smartcards, airplane navigation systems, …



Example of Buffer Overflow

Corruption of program data

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

int main(int argc, char* argv[]) {
    char str[4] = “abc”;
    char buf[12];
    strcpy(buf, “Buffer-Overflow”);
    printf(“str is %s\n",str);
    return 0;
}
```