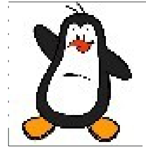
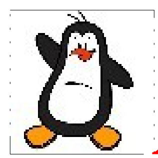


# Lecture # 1.5
# Process Stack
# Behind the Curtain

**Course: Advanced Operating System**

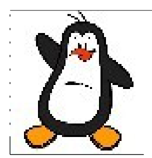
**Instructor: Arif Butt**

**Punjab University College of Information Technology (PUCIT)**
**University of the Punjab**



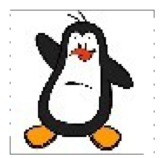
# Agenda

- Review of a Process Logical Address Space
- Command Line Arguments
- Environment Variables
- Layout of a Process User Stack
- Growing and Shrinking of Stack
- Stack Buffer Overflow
- Non-Local goto using `longjmp()`



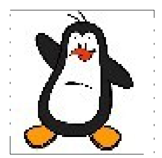


# Process Logical Address Space



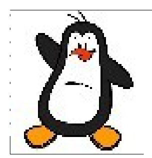


# Example
# `logicaladdresses.c`





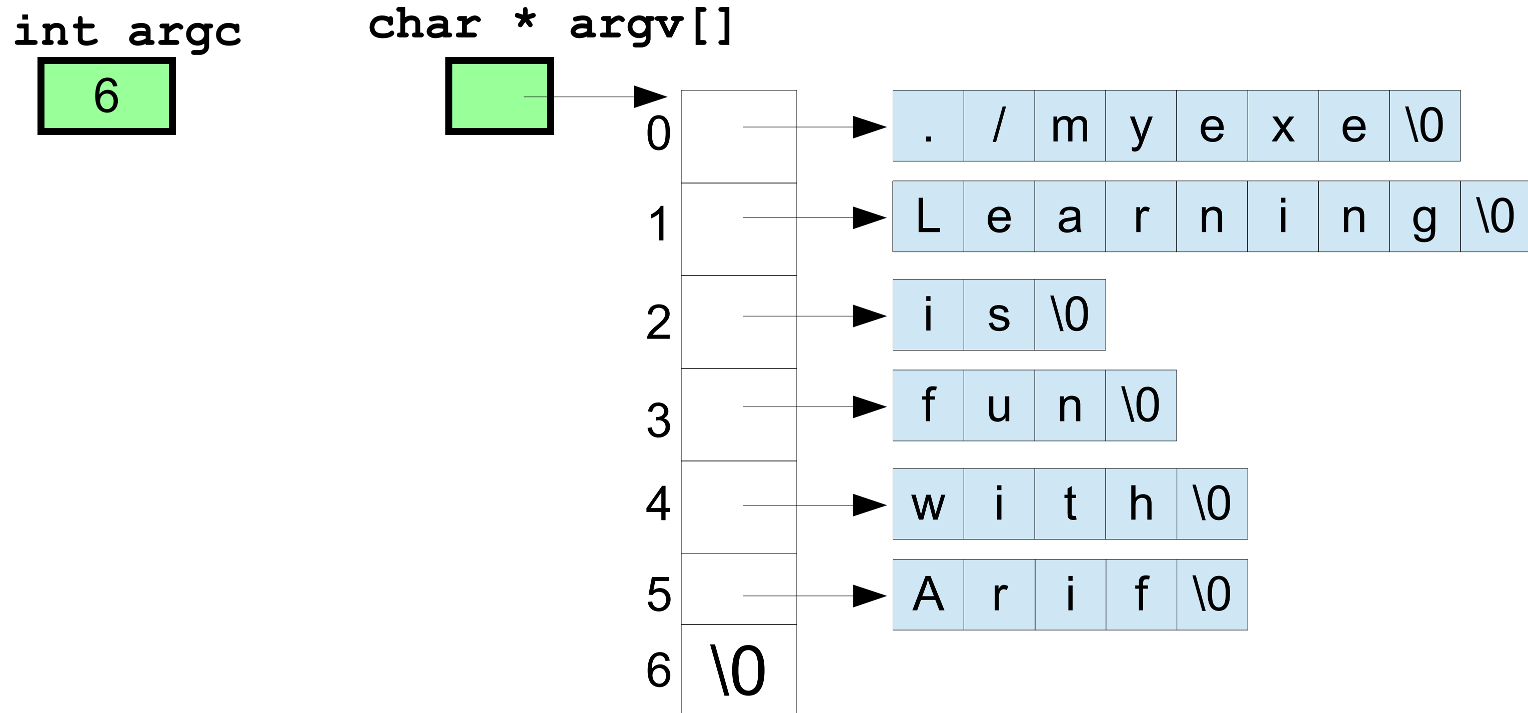
# Command Line Arguments & Environment Variables

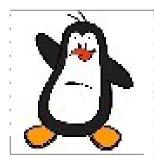


# Command Line Arguments

```
int main(int argc, char *argv[]){
   printf("No of arguments passed are: %d\n",argc);
   printf("Parameters are:\n");
   for(int i = 0; argv[i] != NULL ; i++)
      printf("argv[%d]:%s \n", i, argv[i]);
   return 0;
}
```

```
$ ./myexe Learning is fun with Arif
```



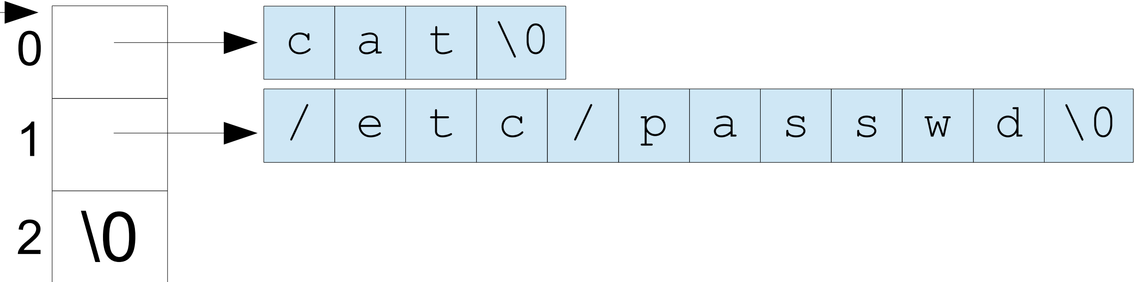


# Use of Command Line Arguments

**$ cat /etc/passwd**

int argc    char * argv[]

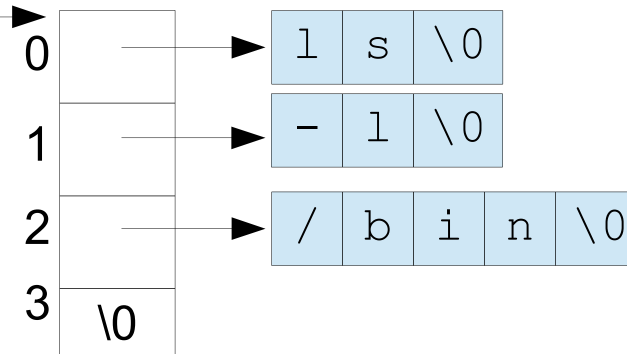
2

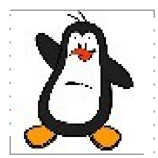



**$ ls -l /bin**

int argc    char * argv[]

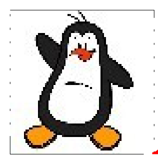
3







# Example
# cmdarg_ex2.c

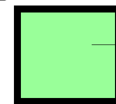


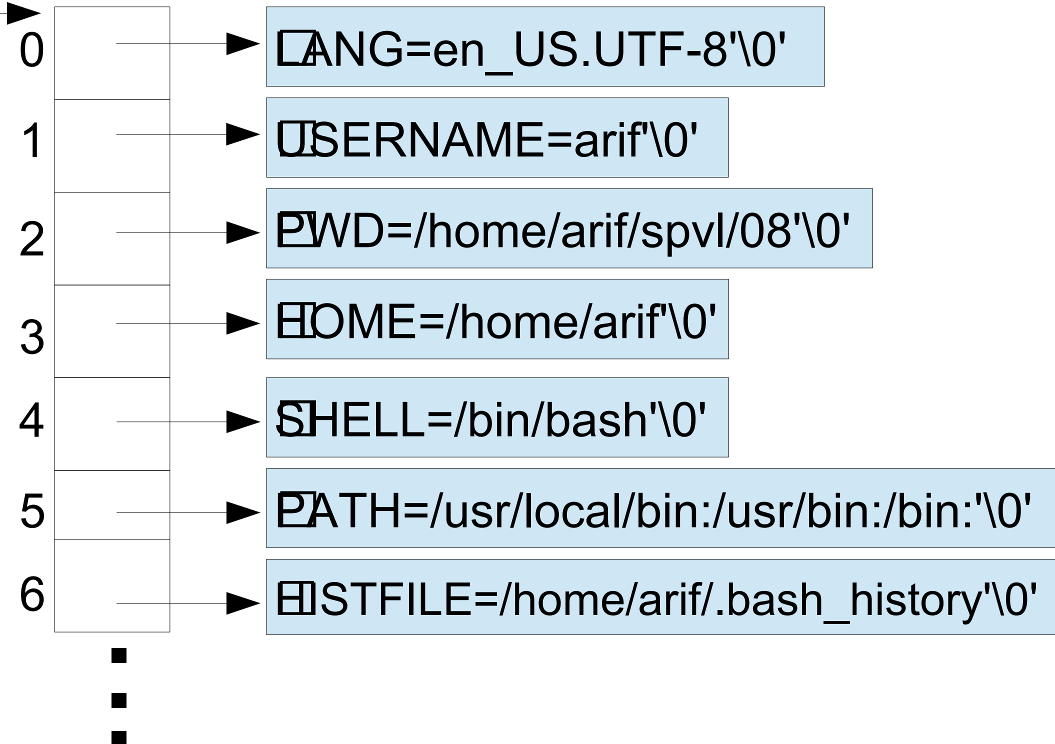
# Accessing Environment Variables

```
int extern char **environ;
int main(){
   printf("\n Environment variable passed are:\n");
   for (int i = 0; environ[i] != NULL ; i++)
      printf("environ[%d]:%s\n", i, environ[i]);
   return 0;
}
```

$ ./myexe

char ** environ





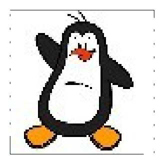
# Modifying Environment Variables

The way we can change environment variables on the shell, we can also change them form within a C program, as well as can create a new environment variable using library functions like:

```
char *getenv(const  char *name)
int putenv(char *string)
int setenv(const char *name,const char *val,int overwrite)
int unsetenv(const char *name)
int clearenv()
```

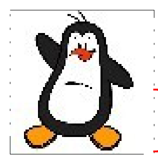
**Reasons to modify the environment variables:**

- To build a suitable environment for a process to run
- A form of IPC, since a child gets a copy of its parent's environment variables at the time it is created



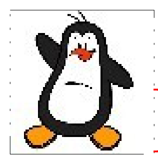


# Layout of a Process Stack



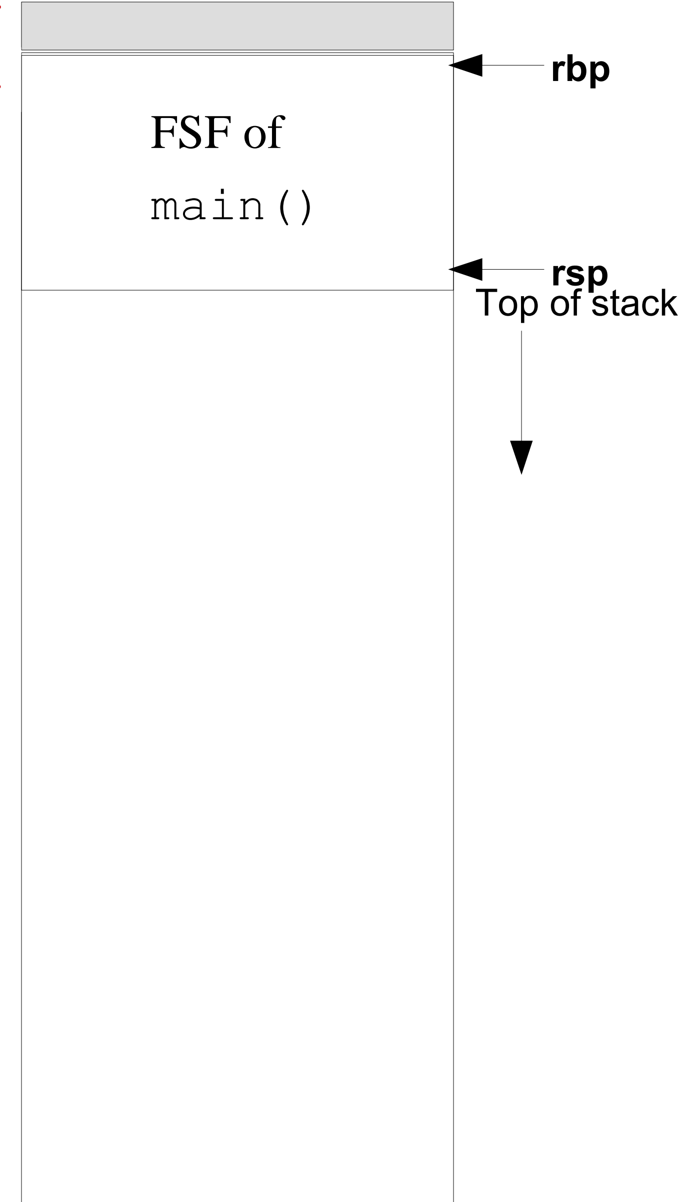
# Layout of Process Stack

Stack grows from high to low addresses in Intel, MIPS, Motorola, & SPARC architectures.



# Layout of Process Stack (cont...)

- Function Stack Frames
- Used to store **local variables**
- For passing **arguments** to the functions
- For storing the **return address**
- For storing the **base pointer**
- Stack grows downward
- Frame pointer (rbp)
- Stack top (rsp)
- Reclaiming stack memory

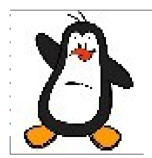


# Function Calling Convention

**Function calling convention means:**

- How the function arguments are passed?
  - Via Stack
  - Via Registers
  - Mix of above two
- Order in which function arguments are passed?
  - Right to left
  - Left to right
- Who is responsible for creating the FSF?
  - Callee
  - Caller
- Who is responsible for unwinding the stack?
  - Callee
  - Caller

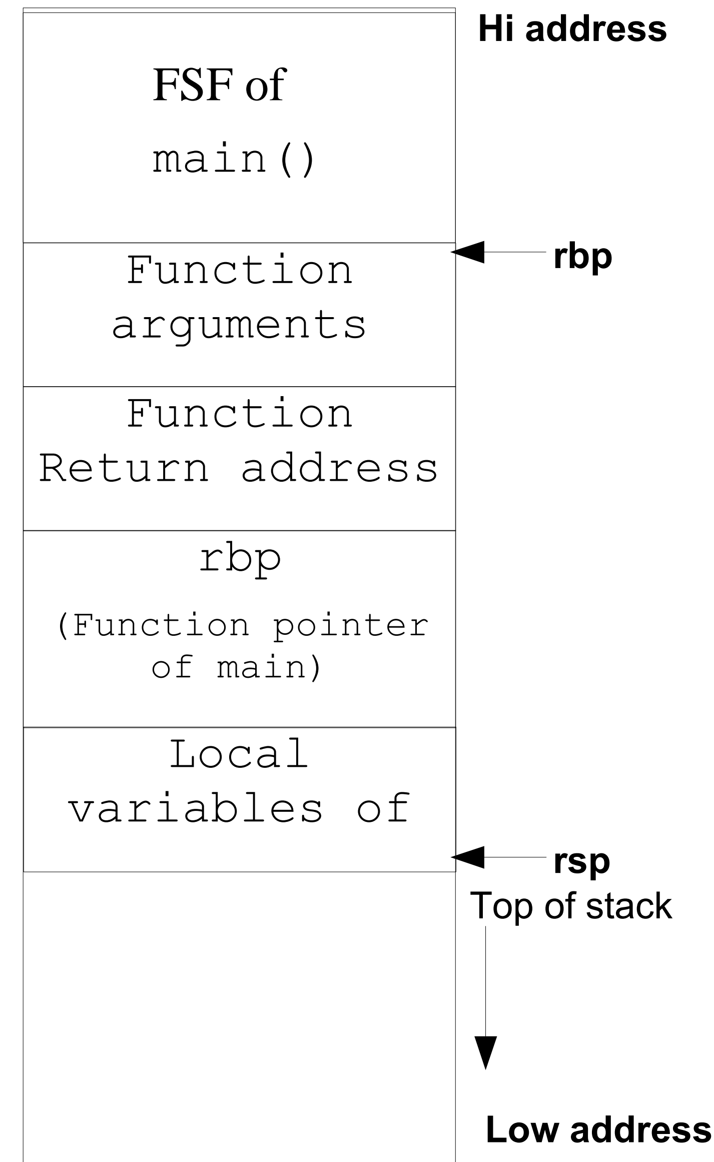
**Different calling conventions used by C language are Cdecl, stdcall, and fastcall**

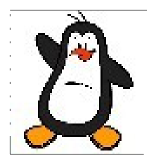


# Stack Growing and Shrinking

Suppose the `main()` calls another function `foo()` , the sequence of steps for creation of FSF of `foo()`:

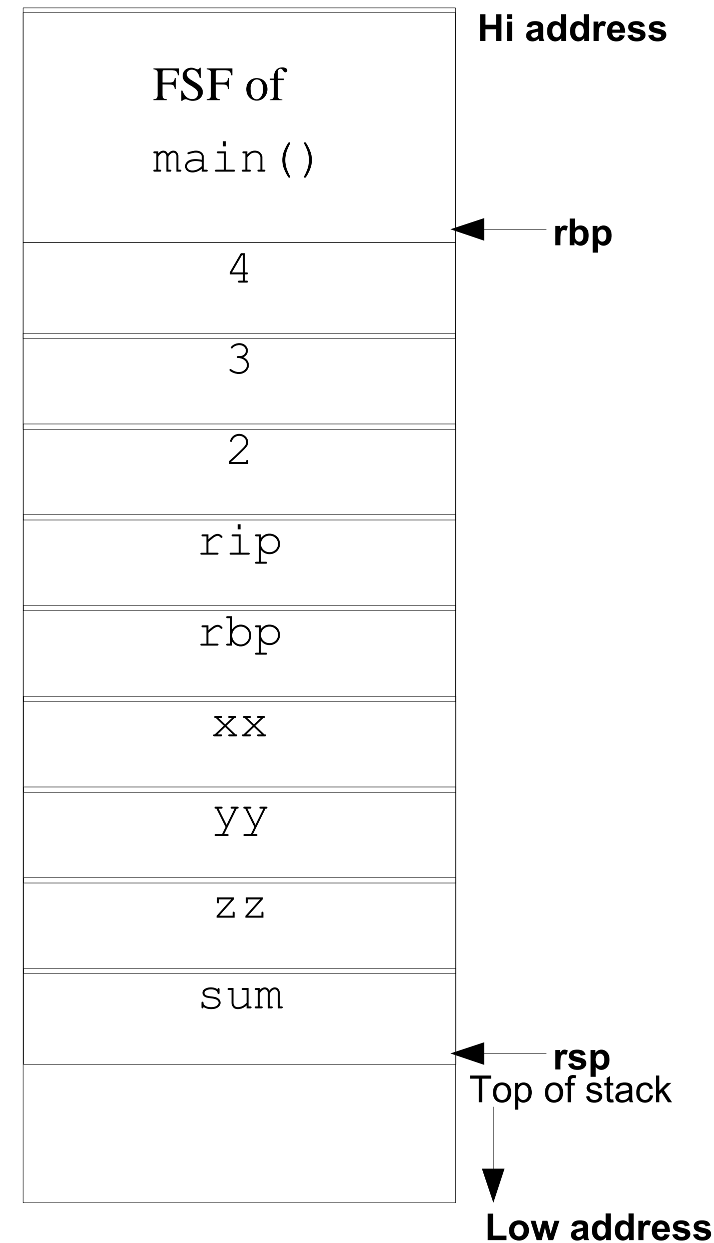
- Arguments are pushed on the stack, in reverse order
- Contents of `rip` (return address) is also pushed on the stack
- The contents of `rbp` containing starting address of `main` stack frame is saved on stack for later use, and `rbp` is moved to where `rsp` is pointing to create new stack frame pointer of function `foo()`
- Space created for local variables by moving `rsp` down or to lower address

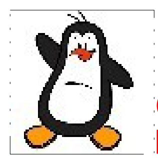




# Stack Growing and Shrinking (cont...)

```
int main(...){
   ...
   return foo(2,3,4);
}
void foo(int a,int b, int c){
   int xx = a+2;
   int yy = b+2;
   int zz = c+2;
   int sum = xx + yy + zz;
   return sum; }
```

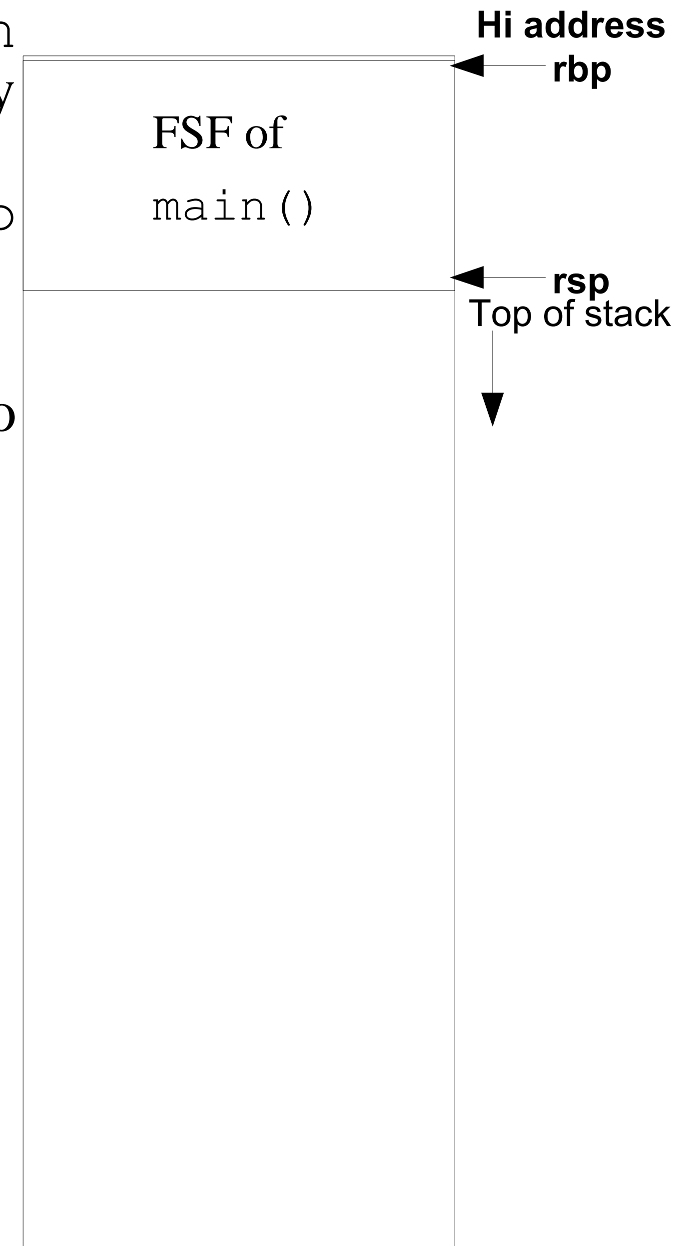




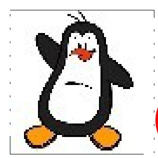
# Stack Growing and Shrinking (cont...)

Finally when the `foo()` function executes `return` statement, memory on the stack is automatically, and very efficiently reclaimed:

- The saved base pointer is popped and placed in `rbp` which moves to the starting address of `main` FSF
- The saved return address is popped and placed in `rip`
- The stack is shrinked by moving the `rsp` further up to where `rbp` is pointing

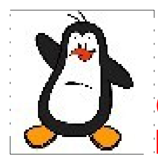



```
int main(...){
   ...
   return foo(2,3,4);
}
void foo(int a,int b, int c){
   int xx = a+2;
   int yy = b+2;
   int zz = c+2;
   int sum = xx + yy + zz;
   return sum; }
```



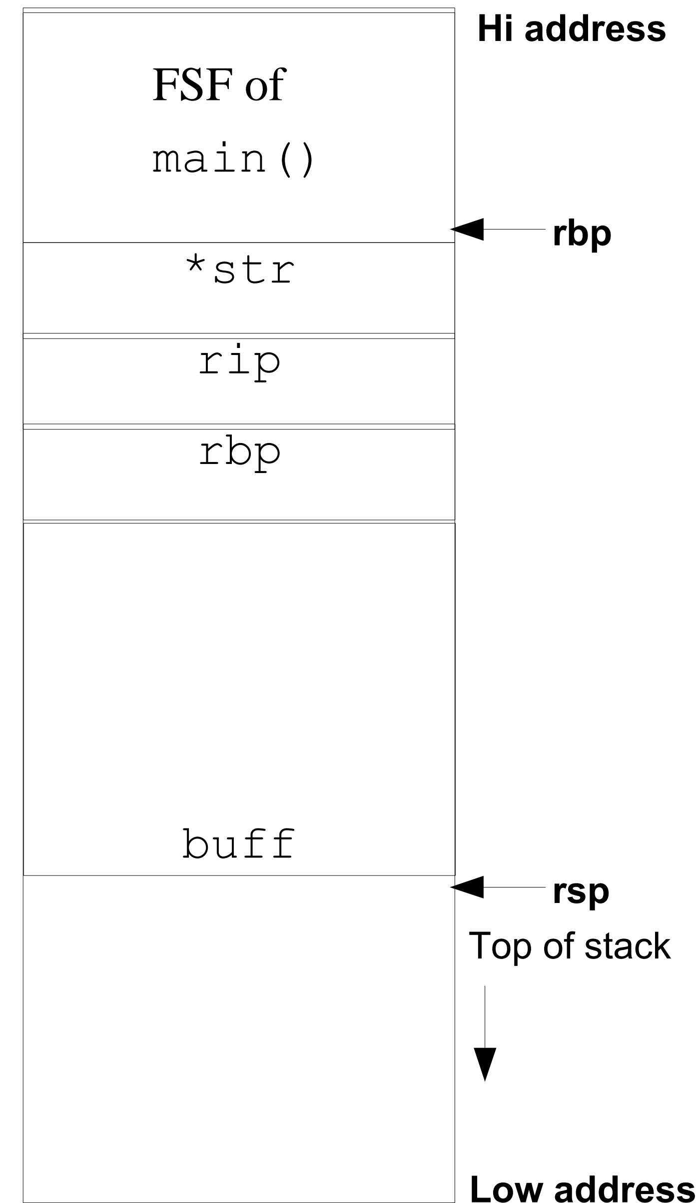
# Overview of Buffer Overflow

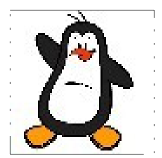
A buffer overflow is a bug in a program, which occurs when more data is written to a block of memory than it can handle



# Stack Growing and Shrinking (cont...)

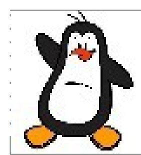
```
int main(...){
    ...
    display(argv[1]);
    ...
}
void display(char* str){
    char buff[10];
    strcpy(buff, str);
    printf("Data is:%s\n", buff);
}
```



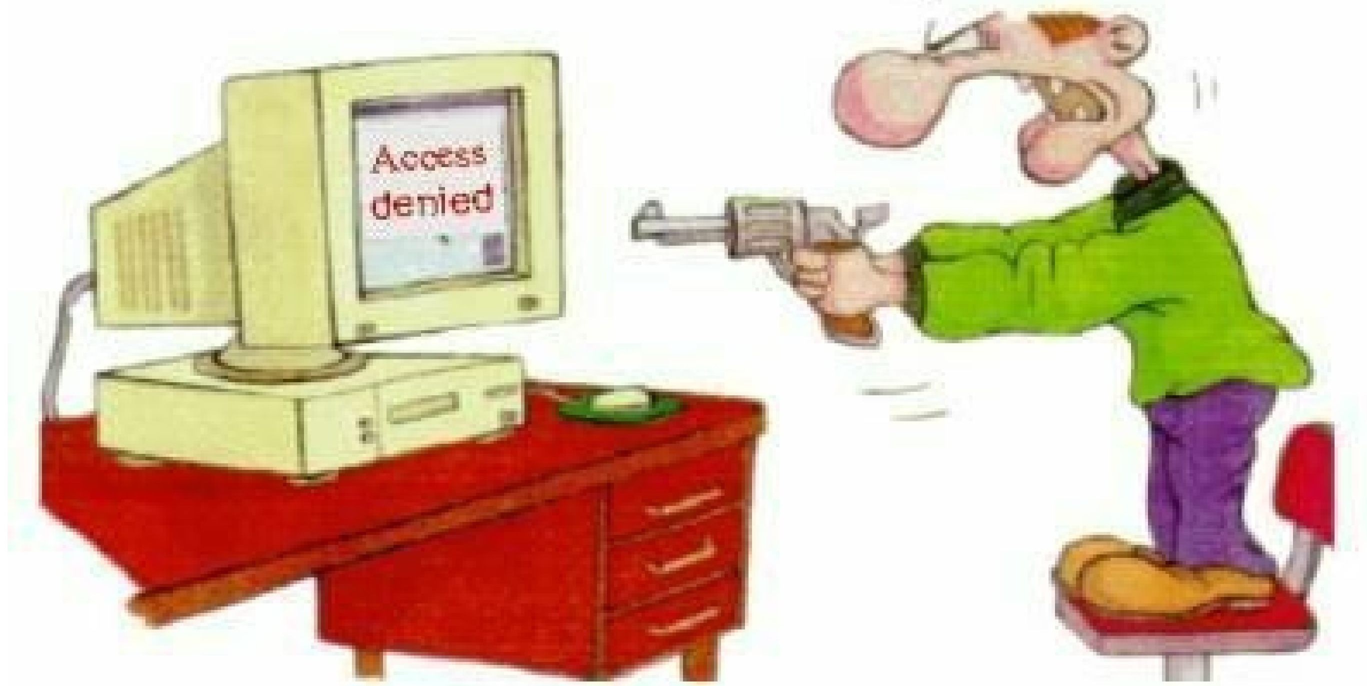




# Non-Local goto



# Things To Do

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