Section 4: Lab 2 (contd.)

Section 4: 4/25/19

Exec

- Replaces the current process, does not create a new process
  - Commonly used with fork. Fork first creates a new process and then exec loads a program and has the newly created process run it.
- Many uses for exec, for example the shell uses fork and exec to run commands.

Note: Example code is from Hal Perkin's 333 course. Thanks to Hal and his team for the shell code.

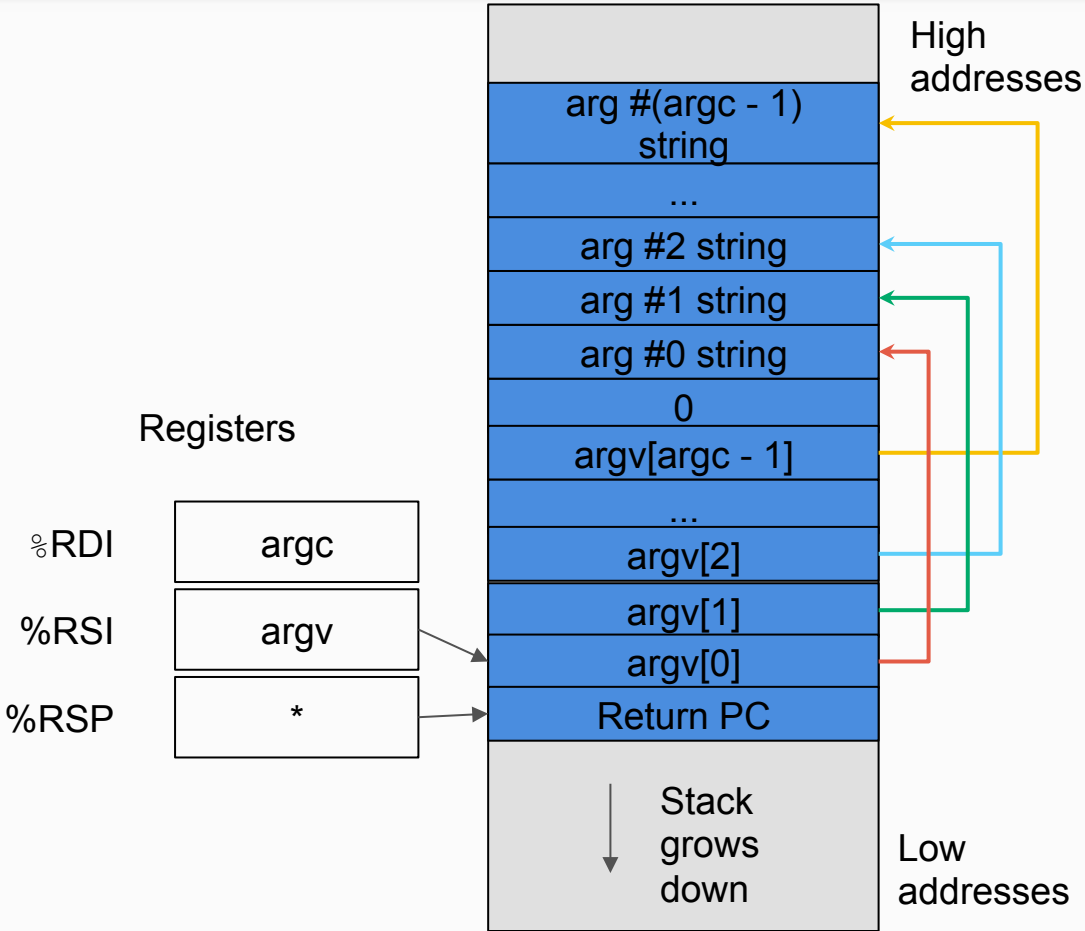
x86-64 Calling Conventions

- %rdi
  - Holds the first argument
- %rsi
  - Holds the second argument
- %rsp
  - Points to the top of the stack/lowest address (stack grows down)
- Local variables are stored on the stack (If arguments are arrays, store them on the stack and store a pointer in the register)

```
int
main(int argc,
     char *argv)
```

- First argument will always be **argc** (number of arguments)
- Second argument will always be **argv**, an array of strings (first string is always the name of the program)

Exec Stack Layout



- argv is an array of pointers, therefore %RSI points to an array on the stack
- Since each element of the argv array is a char *, each element points to a string stored elsewhere on the stack.
- You can think of all variables stored above the return PC on the stack as local variables of the caller.

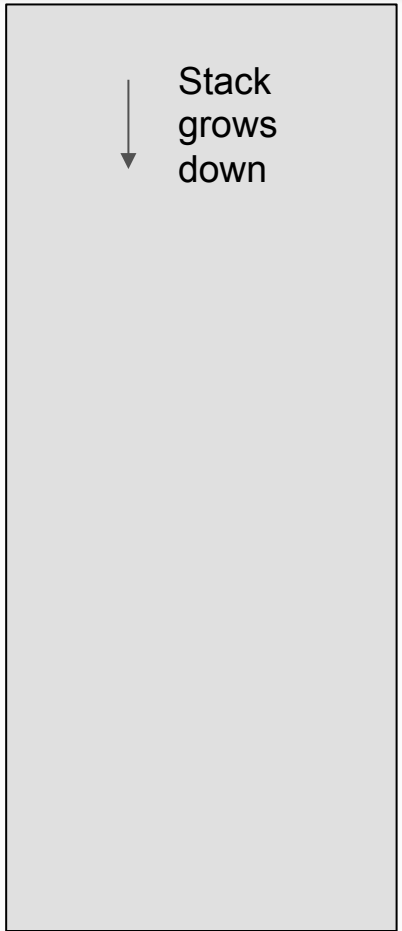
Let’s Practice!

(Get out some paper and pens!)

Practice Exercise 1 - “cat cat.txt”

Registers

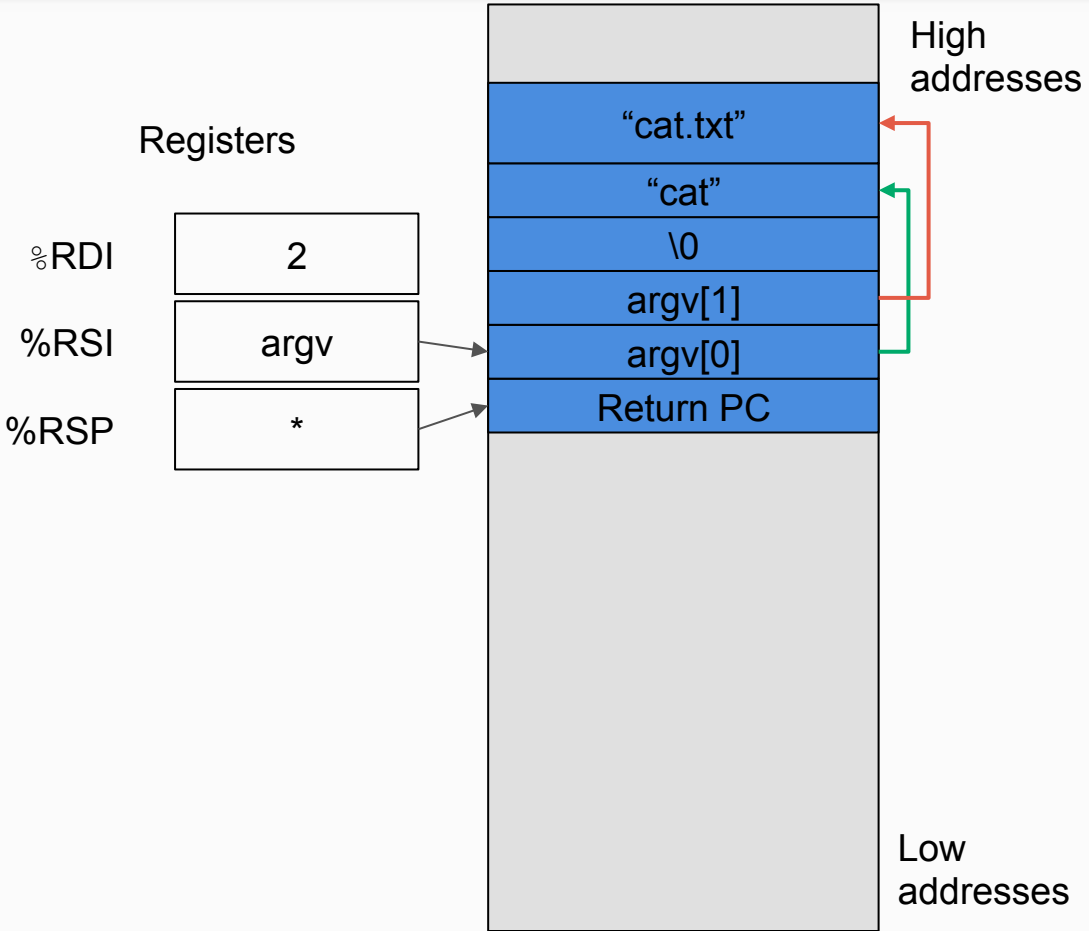
%RDI	?
%RSI	?
%RSP	?



TODO:

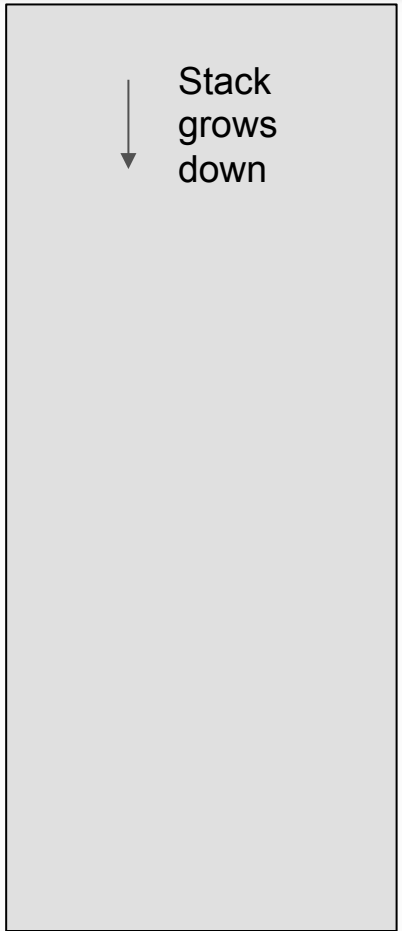
Draw out the stack layout and determine the register values for exec called with “cat cat.txt”.

Practice Exercise 1 - “cat cat.txt” Solution



- %RDI, the first argument, holds argc, which is 2.
- %RSI, the second argument, holds argv, which is a pointer to the beginning of the argv array.
- %RSP, the stack pointer, has been properly adjusted to point to the bottom of the stack. The value of the return PC does not matter.

Practice Exercise 2 - “kill -9 500”



High addresses

Low addresses

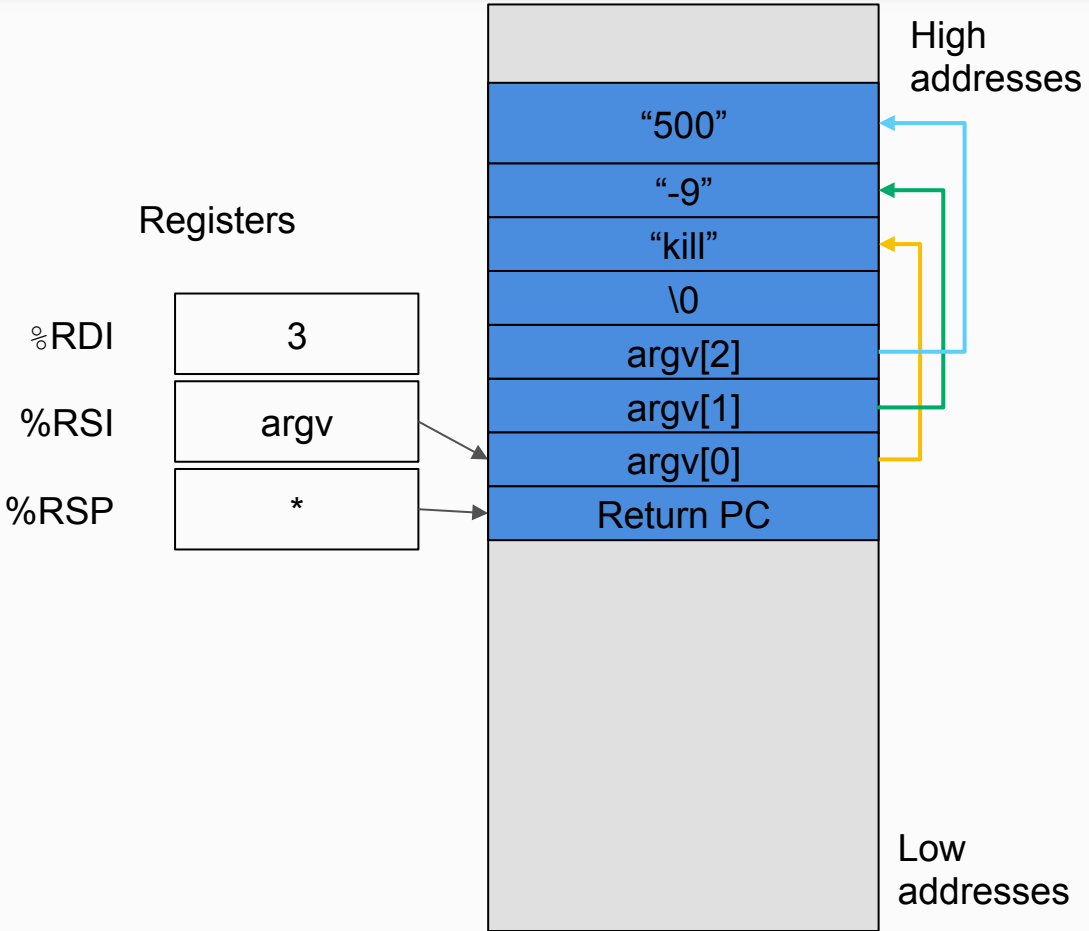
Registers

%RDI	?
%RSI	?
%RSP	?

TODO:

Draw out the stack layout and determine the register values for exec called with “kill -9 500”.

Practice Exercise 2 - “kill -9 500” Solution



- %RDI, the first argument, holds argc, which is 3.
- %RSI, the second argument, holds argv, which is a pointer to the beginning of the argv array.
- %RSP, the stack pointer, has been properly adjusted to point to the bottom of the stack. The value of the return PC does not matter.

Pipes

- Pipes are a mechanism used for inter-process communication (IPC)
- With the sys_pipe, a process sets up a writing and reading end to a “holding area” where data can be passed from process to process
- What should happen if the write end or the read end is closed (by potentially multiple writers/readers)? When can you free the buffer of the pipe?

Pipe allocation

- Pipes should be allocated at runtime, when the pipe is requested by a process
  - What mechanism does xk provide to allocate memory dynamically?
- Each pipe should behave like a file so that the file-oriented system calls can work as normal with the pipe
  - How can you determine whether a struct file is an inode or a pipe?

Design Document Review

- How did it feel to write a design document?
- Was it beneficial to construct your overall code structure before the code was written?
- How often did you go back and modify the design document as you iterated on your code?
- Share your design docs with a group near you for some peer review!