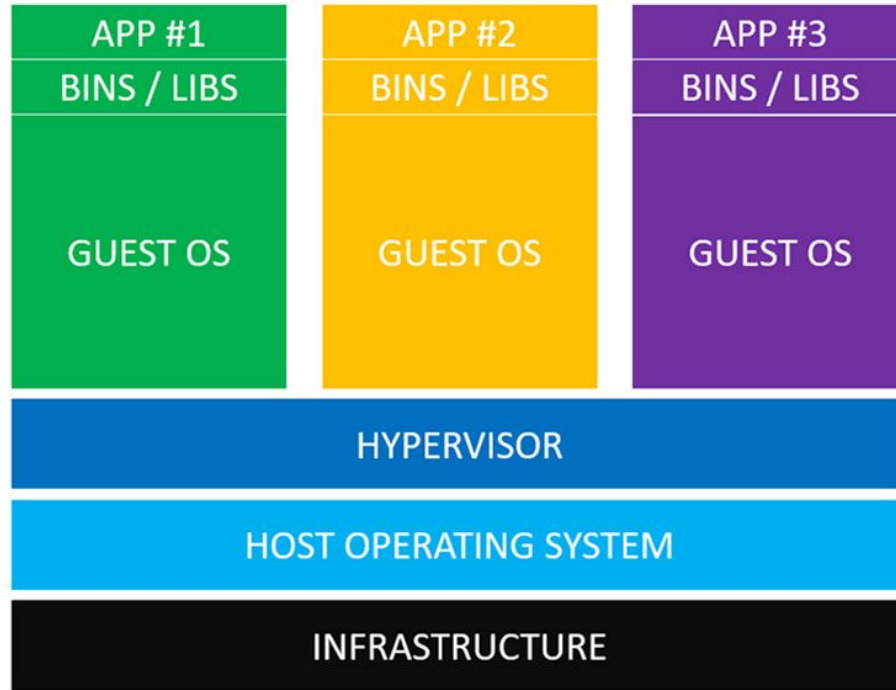


Discussion 1/25/19

# Today

- Topic review
- Project questions

# Virtual Machines



# Process vs Threads

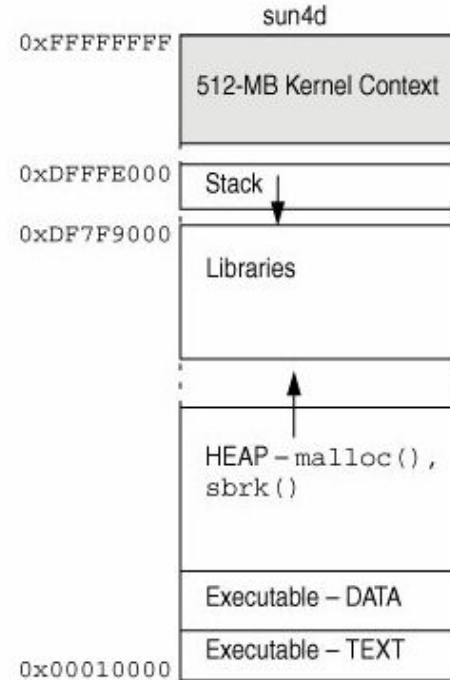
- Both processes and threads are independent sequences of execution. The typical difference is that threads (of the same process) run in a shared memory space, while processes run in separate memory spaces.
- A thread represents the sequence of instructions that the CPU has (and will) execute. To remember how to return from function calls, and to store the values of automatic variables and parameters a thread uses a stack.
  - To create a process in C: `fork()`
  - To create a thread: `clone()`

# Processes

To keep track of all these processes, your operating system gives each process a number and that process is called the PID, process ID.

Processes could also contain

- Mappings
- State
- File Descriptors
- Permissions



# Processes

We are able to create our own processes in a C program using `fork()`. Man page:

## NAME

`fork` - create a child process

## SYNOPSIS

```
#include <unistd.h>
```

```
pid_t fork(void);
```

## DESCRIPTION

`fork()` creates a new process by duplicating the calling process. The new process, referred to as the child, is an exact duplicate of the calling process, referred to as the parent, except for the following points:

# Using Processes in C

- Example!

# Threads

You can have more than one thread running inside a process. You get the first thread for free! It runs the code you write inside 'main'. If you need more threads you can call `pthread_create` to create a new thread using the pthread library.

## NAME

`pthread_create` - create a new thread

## SYNOPSIS

```
#include <pthread.h>
```

```
int pthread_create(pthread_t *thread, const pthread_attr_t *attr,  
                  void *(*start_routine) (void *), void *arg);
```

Compile and link with `-pthread`.

## DESCRIPTION

The `pthread_create()` function starts a new thread in the calling process. The new thread starts execution by invoking `start_routine()`; `arg` is passed as the sole argument of `start_routine()`.

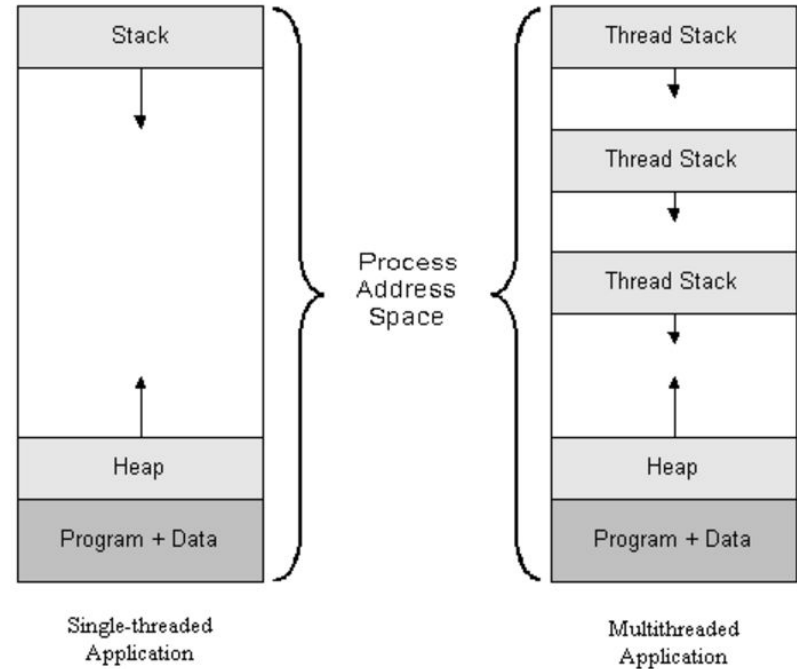


# Threads

In a multithreaded program, there are multiple stack but only one address space.

The pthread library allocates some stack space (either in the heap or using a part of the main program's stack) and uses the clone function call to start the thread at that stack address.

The total address space may look something like this.



# Using Threads in C

- Example

Questions on the project?