Precept 4: IPC & Process Mngmt.

COS 318: Fall 2019
Project 4 Schedule

- **Precept:** Monday 11/04 & Tuesday 11/05, 7:30pm - 8:20pm
- **Design Review:** Monday 11/11 & Tuesday 11/12, 3:00pm - 7:00pm
- **Due:** Sunday 11/17, 11:55pm
Project 4 Overview

- **Goal:** Add process management and inter-process communication to the kernel
- Read the project spec for details
- Starter code can be found on the lab machines (/u/318/code/project4)
- Start early
Project 4 Overview

1. Implement a spawn system call
2. Implement inter-process communication using message boxes
3. Implement a handler for the keyboard interrupt
4. Implement a kill system call
5. Implement a wait system call
1. **do_spawn**: creates a new process
2. **do_mbox_***: mbox functions to enable IPC
   - open, close, send, recv, is_full
3. **Handle keyboard input**: putchar, do_getchar
4. **do_kill**: kills a process
5. **do_wait**: waits on a process
System Calls
Spawn

- Kernel has a fixed array of PCBs

- What information do you need to initialize a process?
  - PID
  - New stacks (user/stack)
  - Entry point (ramdisk_find)
  - total_ready_priority (lottery scheduling)

- Scheduler uses lottery scheduling

- Make sure you keep the sum of the priorities updated
Kill

- A process should be killed immediately
- Which queue it’s in (ready, blocked, sleeping, etc.) doesn’t matter – kill it!
- Do not reclaim locks (this is extra credit)
- Reclaim memory:
  - PCB
  - Stacks
  - Look at robinhood test case to determine what else needs to be reclaimed
- Update total_ready_priority
Wait

- Waits for a process to terminate:
  - Blocks until the process is killed or exits normally
- What do you need to add to the PCB to implement this behavior?
- Return -1 on failure, 0 on success
Message Passing + Keyboard
Message Box - Overview

● Used for inter-process communication
  ○ Processes can both put and consume data from the message box

● It’s a bounded buffer problem!
  ○ `send` blocks if the message box is full
  ○ `recv` blocks if there are no messages
Message Box - Implementation

● Implemented as a circular buffer
  ○ Array, with head and tail pointers

● Receive messages in FIFO order

● Messages can have variable length
  ○ But, there is a fixed max length. See constants at bottom of common.h
Message Box - Suggestions

- Use locks and CVs as shown in class
  - Probably need two CVs: `fullBuffer` and `emptyBuffer`
- Multiple producers + consumers: protect against race conditions
- Review [Lecture 10](#) and MOS 2.3.7-8
Keyboard - How does it work?

- **IRQ1 interrupt generated on key press or release**
- **Interrupt handler gets key scan code from hardware**
- **Specific key handler called, based on key type:**
  - Modifier Key: change internal state
  - Other Keys: convert scan code to ASCII char+ post to keyboard buffer
Keyboard - Software Design

- `kernel.c: init_idt` sets keyboard handler to `entry.S: irq1_entry`
- `irq1_entry` saves context + calls `keyboard.c: keyboard_interrupt`
- `keyboard_interrupt` gets scan code from hardware + calls specific key handler...
● Modifier keys get their own handlers

● `normal_handler` catches everything else:
  ○ Converts scan code to ASCII character
  ○ Calls `putchar` to add it to keyboard buffer

● Processes read from buffer with `get_char`
Keyboard - What you need to do

- Implement `putchar` and `do_getchar`
  - Use your message box API!
- Producer should not be blocked
  - If keyboard message box is full, discard the character
  - Use `do_mbox_is_full` to check beforehand
- What if IRQ1 occurs while a process is calling `get_char`?
• Synchronization is tricky: think carefully about when/how to use locks, CVs, and critical sections

• Look at util.h + other .h files for helpful functions

• May need to change other pieces of code - this is fine
  ○ Make sure you submit them!

• Only two test cases provided: write your own unit tests
Design Review

- **Process Management:**
  - How will your spawn, wait, and kill work?
  - How will you satisfy the requirement that *if a process is killed while blocked on a lock, semaphore, condition variable or barrier, the other processes which interact with that synchronization primitive will be unaffected*?

- **Mailboxes:**
  - What fields will the structs need?
  - Which synchronization primitives will you use?
Questions?