LAB3pre Work: Processes in an OS Kernel

DUE: 9-23-2021

Answer questions below. Submit a (text-edit) file to TA

1. READ List: Chapter 3: 3.1-3.5

What's a process? (Page 102)  
It is a sequence of executions regarded by the OS kernel as a single entity for using system resources.

Each process is represented by a PROC structure.

Read the PROC structure in 3.4.1 on Page 111 and answer the following questions:

What's the meaning of:

pid, ppid? pid - process ID, ppid – parent process ID.

status ? PROC status=FREE|READY, etc.

priority ? Scheduling priority.

event ? Event value to sleep on.

exitCode ? Exit value.

READ 3.5.2 on Process Family Tree. What are the

PROC pointers child, sibling, parent used for?

Child points to the first child of a process and sibling points to a list of other children of the same parent. Each PROC also uses a parent pointer to point at its parent.

2. Download samples/LAB3pre/mtx. Run it under Linux.

MTX is a multitasking system. It simulates process operations in a

Unix/Linux kernel, which include

fork, exit, wait, sleep, wakeup, process switching

/\*\*\*\*\*\*\*\*\*\*\* A Multitasking System \*\*\*\*\*\*\*\*\*\*\*\*/

#include <stdio.h>

#include <stdlib.h>

#include <string.h>

#include "type.h" // PROC struct and system constants

// global variables:

PROC proc[NPROC], \*running, \*freeList, \*readyQueue, \*sleepList;

running = pointer to the current running PROC

freeList = a list of all FREE PROCs

readyQueue = a priority queue of procs that are READY to run

sleepList = a list of SLEEP procs, if any.

Run mtx. It first initialize the system, creates an initial process P0.

P0 has the lowest priotiry 0, all other processes have priority 1

Ater initialization,

P0 forks a child prcoess P1, switch process to run P1.

The display looks like the following

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Welcome to KCW's Multitasking System

1. init system

freeList = [0 0]->[1 0]->[2 0]->[3 0]->[4 0]->[5 0]->[6 0]->[7 0]->[8 0]->NULL

2. create initial process P0

init complete: P0 running

3. P0 fork P1 : enter P1 into readyQueue

4. P0 switch process to run P1

P0: switch task

proc 0 in scheduler()

readyQueue = [1 1]->[0 0]->NULL

next running = 1

proc 1 resume to body()

proc 1 running: Parent=0 childList = NULL

freeList = [2 0]->[3 0]->[4 0]->[5 0]->[6 0]->[7 0]->[8 0]->NULL

readQueue = [0 0]->NULL

sleepList = NULL

input a command: [ps|fork|switch|exit|sleep|wakeup|wait] :

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5. COMMANDS:

ps : display procs with pid, ppid, status; same as ps in Unix/Linux

fork : READ kfork() on Page 109: What does it do?

Creates a child task and enters it into the readyQueue.

switch : READ tswitch() on Page 108: What does it do?

It acts as a process switch box, where one process goes in and, in general, another process emerges.

exit : READ kexit() on Page 112: What does it do?

1. Erase process user-mode context, e.g. close file descriptors,

release resources, deallocate user-mode image memory, etc.

2. Dispose of children processes, if any

3. Record exitValue in PROC.exitCode for parent to get

4. Become a ZOMBIE (but do not free the PROC)

5. Wakeup parent and, if needed, also the INIT process P1

sleep : READ ksleep() on Page 111: What does it do?

lets a process go to sleep.

wakeup : READ kwakeup() on Page 112: What does it do?

Wakes a sleeping process up and ready.

wait : READ kwait() on Page 114: What does it do?

wait for a ZOMBIE child process.

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------------------------ TEST REQUIREMENTS ---------------------------------

6. Step 1: test fork

While P1 running, enter fork: What happens?

A child process 2 was created and was added to the readyQueue

Enter fork many times;

How many times can P1 fork? 7. WHY? Because there are only 7 free PROCs available in the freeList.

Enter Control-c to end the program run.

7. Step 2: Test sleep/wakeup

Run mtx again.

While P1 running, fork a child P2;

Switch to run P2. Where did P1 go? P1 is in readQueue.

WHY? Scheduler puts P1 into readyQueue for running where P1 is read to the readQueue.

P2 running : Enter sleep, with a value, e.g.123 to let P2 SLEEP.

What happens? P2 is added to sleepList. WHY? Calling sleep will let P2 sleep and switch to run P1.

Now, P1 should be running. Enter wakeup with a value, e.g. 234

Did any proc wake up? no WHY? Because the value for wakeup does not match the value when putting P2 to sleep.

P1: Enter wakeup with 123

What happens? P2 wakes up. WHY? Wakeup with the correct value removes P2 from the sleepList and reads it.

8. Step 3: test child exit/parent wait

When a proc dies (exit) with a value, it becomes a ZOMBIE, wakeup its parent.

Parent may issue wait to wait for a ZOMBIE child, and frees the ZOMBIE

Run mtx;

P1: enter wait; What happens? Nothing happens. WHY? Because P1 is waiting for a zombie child.

CASE 1: child exit first, parent wait later

P1: fork a child P2, switch to P2.

P2: enter exit, with a value, e.g. 123 ==> P2 will die with exitCode=123.

Which process runs now? P1. WHY? Because P2 becomes a zombie.

enter ps to see the proc status: P2 status = ? ZOMBIE

(P1 still running) enter wait; What happens? P2 is added to the end of freeList.

enter ps; What happened to P2? P2 is now free.

CASE 2: parent wait first, child exit later

P1: enter fork to fork a child P3

P1: enter wait; What happens to P1? P1 is waiting for a zombie child. WHY? P1 is waiting for P3 finishes running to obtain the exit code of P3.

P3: Enter exit with a value; What happens? P3 is now added to the end of freeList.

P1: enter ps; What's the status of P3? P3 is now free. WHY?

Because wait() releases zombie child back to freeList for reuse purpose.

9. Step 4: test Orphans

When a process with children dies first, all its children become orphans.

In Unix/Linux, every process (except P0) MUST have a unique parent.

So, all orphans become P1's children. Hence P1 never dies.

Run mtx again.

P1: fork child P2, Switch to P2.

P2: fork several children of its own, e.g. P3, P4, P5 (all in its childList).

P2: exit with a value.

P1 should be running WHY? Because P2 becomes a zombie, so switch to running P1.

P1: enter ps to see proc status: which proc is ZOMBIE? P2

What happened to P2's children? Became orphans and eventually becomes P1’s childs.

P1: enter wait; What happens? P2 is released to freeList.

P1: enter wait again; What happens? P1 goes to sleep WHY? P1 goes to sleep, waiting for its next child P3 to finish running and exit.

How to let P1 READY to run again? Let P3 exits so P1 is woken up and added to the end of readList. Keep switching until P1 runs again.