Operating Systems Design
08a. Exam 1 Review – Spring 2014

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 5/5/2014 1

Question 1

How many times does this code print "hello"?

```
main(int argc, char **argv) {
        int i;
        for (i=0; i < 3; i++) {
                fork();
                printf("hello\n", getpid());
        }
}
```

A process creates a child.

Both it and the child print "hello".

Repeat.

 5/5/2014 2

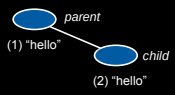
Question 1

```
main(int argc, char **argv) {
        int i;
        for (i=0; i < 3; i++) {
                fork();
                printf("hello\n");
        }
}
```

i = 0

Process forks child

Parent & child print "hello"



 5/5/2014 3

Question 1

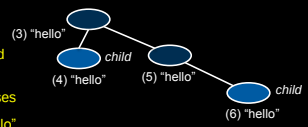
```
main(int argc, char **argv) {
        int i;
        for (i=0; i < 3; i++) {
                fork();
                printf("hello\n");
        }
}
```

i = 1

Original parent and child each fork a process

Now we have 4 processes

Each of them prints "hello"



 5/5/2014 4

Question 1

```
main(int argc, char **argv) {
        int i;
        for (i=0; i < 3; i++) {
                fork();
                printf("hello\n");
        }
}
```

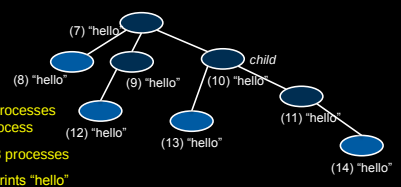
i = 2

Each of the 4 processes forks a child process

Now we have 8 processes

Each of them prints "hello"

Total "hello" messages = 2 + 4 + 8 = **14**



 5/5/2014 5

Question 2

How many times does this code print "hello"?

```
main(int argc, char **argv) {
        int i;
        for (i=0; i < 3; i++) {
                execl("/bin/echo", "echo", "hello", 0);
        }
}
```

execl overwrites the current process by loading the program /bin/echo.

The *for* loop is gone!

Answer: 1

 5/5/2014 6

Question 3

Your system supports messages but does not offer semaphores.

Implement semaphore operations using messages.

Assume that messages use a mailbox. You may assume a unique mailbox per semaphore (i.e., semaphore *s* corresponds to mailbox *s*). Sending a message is a non-blocking operation. Receiving a message is non-blocking only if there is a message ready to be read.

Hint: you may send and receive empty messages (Ø).

a	b	c
Create a new semaphore s and initialize its value to N `init_semaphore(s, N)`	`up(s)`	`down(s)`

Question 3a

Create a new semaphore s and initialize its value to N
`init_semaphore(s, N)`

Semaphore = message

Create new semaphore = create new message

Semaphore: counts # of *down*s before a sleep

Message: Sleep when receiving a message that is not there

To receive N messages before sleeping, fill mailbox with N messages

```
new(s);
for (i=0; i < N; i++)
    send(s, Ø);
```


Question 3b

`up(s)`

Wake one process up if ≥1 processes are sleeping on s – or increment s

Add a message to the mailbox:

- If a process is waiting, it will receive a message & wake up
- If no process is waiting on s, then s gets one extra message

```
send(s, Ø);
```


Question 3c

`down(s)`

If s == 0, then go to sleep. Otherwise, decrement s

With messages:

- If no message in the mailbox, sleep while waiting for one
- Otherwise, take a message (and there will be one fewer message). The contents of the message don't matter and are discarded.

```
recv(s, Ø);
```


Part II

4. Multiprogramming is:

(a) An executable program that is composed of modules built using different programming languages.

(b) Having multiple processors execute different programs at the same time.

(c) Keeping several programs in memory at once and switching between them.

(d) When a program has multiple threads that run concurrently.

Part II

5. With a legacy PC BIOS, the Master Boot Record:

(a) Identifies type of file system on the disk and loads the operating system.

(b) Contains the first code that is run by the computer when it boots up.

(c) Contains a list of operating systems available for booting.

(d) Contains a boot loader to load another boot loader located in the volume boot record.

Part II

6. Which of the following is a policy, not a mechanism?

(a) Create a thread.

(b) Prioritize processes that are using the graphics card.

(c) Send a message from one process to another.

(d) Delete a file.

Part II

7. Which of the following does NOT cause a trap?

(a) A user program divides a number by zero.

(b) The operating system kernel executes a privileged instruction.

(c) A programmable interval timer reaches its specified time.

(d) A user program executes an interrupt instruction.

The kernel is already running in privileged mode, so executing a privileged instruction will not cause a violation.

Part II

8. A context switch always takes place when:

(a) The operating system saves the state of one process and loads another.

(b) A process makes a system call.

(c) A hardware interrupt takes place.

(d) A process makes a function call.

Part II

9. A dedicated system call instruction, such as SYSCALL, is:

(a) Faster than a software interrupt.

(b) More secure than a software interrupt.

(c) More flexible than a software interrupt.

(d) All of the above.

Part II

10. Which of the following is *not* a system call?

(a) Duplicate an open file descriptor.

(b) Get the current directory.

(c) Decrement a semaphore.

(d) Create a new linked list.

Part II

11. A process control block is:

(a) A structure that stores information about a single process.

(b) The kernel's structure for keeping track of all the processes in the system.

(c) A linked list of blocked processes (those waiting on some event).

(d) A kernel interface for controlling processes (creating, deleting, suspending).

Part II

12. A process exists in the zombie (also known as defunct) state because:

(a) It is running but making no progress.

(b) The user may need to restart it without reloading the program.

(c) The parent may need to read its exit status.

(d) The process may still have children that have not exited.

 5/5/2014 19

Part II

13. Which state transition is *not* valid?

(a) Ready → Blocked

(b) Running → Ready

(c) Ready → Running

(d) Running → Blocked

 5/5/2014 20

Part II

14. Threads within the same process *do not* share the same:

(a) Text segment (instructions).

(b) Data segment.

(c) Stack.

(d) Open files.

 5/5/2014 21

Part II

15. A race condition occurs when:

(a) Two or more threads compete to be the first to access a critical section.

(b) The outcome of a program depends on the specific order in which threads are scheduled.

(c) A thread grabs a lock for a critical section, thus preventing another thread from accessing it.

(d) Two threads run in lockstep synchronization with each other.

 5/5/2014 22

Part II

16. Which of the following techniques avoids the need for spinlocks?

(a) Event counters

(b) Test-and-set

(c) Compare-and-swap

(d) All of the above.

 5/5/2014 23

Part II

17. Priority inversion occurs when:

(a) A low priority thread has not been given a chance to run so its priority is temporarily increased.

(b) The scheduler allows a low priority process to run more frequently than a high priority process.

(c) Two or more threads are deadlocked and unable to make progress.

(d) A low priority thread is in a critical section that a high priority thread needs.

 5/5/2014 24

Part II

18. What's the biggest problem with spinlocks?

(a) They are vulnerable to race conditions.

(b) They are fundamentally buggy.

(c) They waste CPU resources.

(d) They rely on kernel support and cannot be implemented at user level.

Part II

19. A condition variable enables a thread to go to sleep and wake up when:

(a) The value of the variable is greater than or equal to some number N.

(b) Another thread sends a signal to that variable.

(c) Another thread increments the variable.

(d) Another thread reads the variable.

Part II

20. Preemption is when an operating system moves a process between these states:

(a) Running → Ready

(b) Running → Blocked

(c) Ready → Blocked

(d) Blocked → Running

Part II

21. The disadvantage of round-robin process scheduling is:

(a) It gives every process an equal share of the CPU.

(b) It can lead to starvation where some processes never get to run.

(c) It puts a high priority on interactive processes.

(d) It never preempts a process, so a long-running process holds everyone else up.

Part II

22. The downside to using a small quantum is:

(a) A process might not get time to complete.

(b) The interactive performance of applications decreases.

(c) Some processes will not get a chance to run.

(d) Context switch overhead becomes significant.

Part II

23. A time-decayed exponential average of previous CPU bursts allows a scheduler to:

(a) Estimate when each process will complete execution and exit.

(b) Compute the optimum number of processes to have in the run queue.

(c) Pick the process that will be most likely block on I/O the soonest.

(d) Determine the overall load on the processor.

Part II

24. Process aging is when:

(a) A long-running process gets pushed to a lower priority level.

(b) A process that did not get to run for a long time gets a higher priority level.

(c) A long-running process gets pushed to a higher priority level.

(d) Memory and other resources are taken away from a process that has run for a long time.

Part II

25. The goal of a multilevel feedback queue is to:

(a) Keep the priority of interactive processes high.

(b) Gradually raise the priority of CPU-intensive processes.

(c) Ensure that each process gets the same share of the CPU regardless of how long it runs.

(d) Allow the scheduler to provide feedback to the process on how often it is being run.

Part II

26. With soft affinity on a multiprocessor system, the scheduler will:

(a) Try to use the same processor for the same process but move it if another processor has no work.

(b) Associate a process with a specific processor and ensure it always runs on that processor.

(c) Use a single run queue so that there is no ongoing association between processors and processes.

(d) Periodically reset the association between all processes and processors.

Part II

27. Process A has a deadline of 100 ms and requires 80 ms of compute time.

Process B has a deadline of 80 ms and requires 50 ms of compute time.

Process C a deadline of 50 ms and requires 10 ms of compute time.

In what order will a *least slack scheduler* schedule these processes?:

(a) A, B, C

(b) C, B, A

(c) B, A, C

(d) C, A, B

Slack = =deadline – compute time
A: slack = 100 – 80 = 20 ms
B: slack = 80 – 50 = 30 ms
C: slack = 50 – 10 = 40 ms

The End