CS 6210 Fall 2011 Midterm Solution

Name:___Kishore_____GT Number:

Monday October 10, 2011 (11:05 to 11:55 AM)

Note:

1. **Write your name and GT number on each page.**
2. The test is **CLOSED BOOK** and **NOTES**.
3. Please provide the answers in the space provided. You can use scratch paper (provided by us) to figure things out (if needed) but you get credit **only** for what you put down in the space provided for each answer.
4. For conceptual questions, **concise bullets** (**not wordy sentences**) are preferred.
5. Where appropriate use figures to convey your points (a figure is worth a thousand words!)
6. **Illegible answers are wrong answers.**
7. Please look through the whole test before starting so that you can manage your time better.

Good luck!

Question number	Points earned	Running total
1 (0 min) (Max: 1 pts)		
2 (10 min) (Max: 20 pts)		
3 (10 min) (Max: 20 pts)		
4 (10 min) (Max: 20 pts)		
5 (10 min) (Max: 20 pts)		
6 (10 min) (Max: 19 pts)		
Total (50 min) (Max: 100 pts)		

1. (0 min, 1 point)
CS 6210 guest lecture, Friday Oct 7th
(Don't worry you get a point irrespective of your answer!)

   a. Justin Rattner
   b. Dave Patterson
   c. George Cox
   d. Are you kidding, no guest lecture…TAs held a townhall meeting
   e. There was class on Friday?

CS 6210 Fall 2011 Midterm Solution

Name:___Kishore_____GT Number:

OS Structures (conceptual)

2. (**10 min**, 20 points)

(a) (10 points) Explain the role of the "processor environments" in the Aegis Exokernel. How is it used to achieve the functionalities provided by a library OS?

PE is for library OS in the Exokernel for passing events to the library

+2 * Exception context for program generated exceptions (e.g. div by 0)

+2 * Interrupt context for external events (e.g. timer interrupt)

+2 * Protected entry context for cross domain calls (e.g. to storage manager inside a library OS)

+2 * Addressing context for keeping guaranteed mappings

term for implemented by software TLBs

These contexts are library specific information maintained by

+2 Exokernel. For example, a process page fault will be communicated via the exception context to the page fault handler in the library OS (partial credit commensurate with answers)

(b) (10 points) Explain how the page table for a newly created process is set up by a library operating system executing on top of Xen.

+2 – allocates and initializes a physical page frame and registers it with Xen to serve as the PT for process

+2 – creates VPN to PPN mapping for the process

+2 – communicates these mappings via hypervisor calls to Xen

+2 – Xen populates the PT above with these mappings

+2 – allocates page frames for the process to back these VPN to PPN mappings

(partial credit commensurate with answer)

CS 6210 Fall 2011 Midterm Solution

Name:___Kishore_____GT Number:

3. (**10 min**, 20 points)

(a) (6 points) Distinguish between VPN, PPN, and MPN as discussed in VMWare.

+2 VPN – virtual page number for user level process inside a VM

+2 PPN – VM's idea of the physical page backing the VPN of the user process (physical page number)

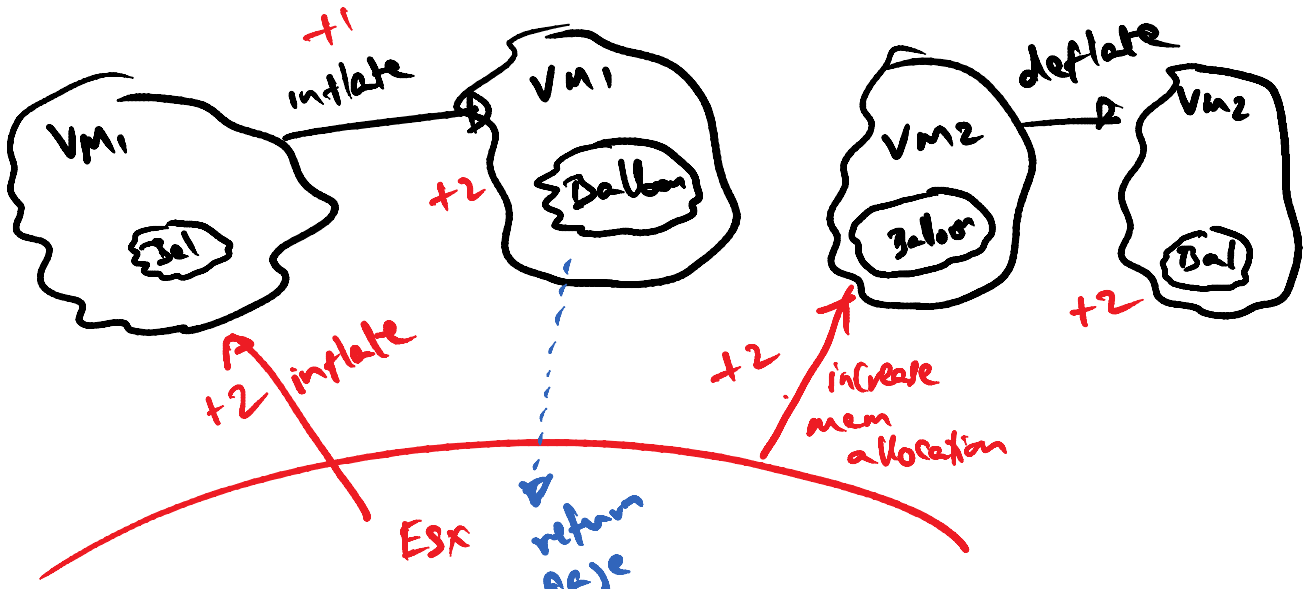
+2 MPN – Machine page number, the actual machine page frame on the processor for backing a given VPN

(b) (4 points) What does the shadow page table of ESX server hold and why?

+2 VPN to MPN mappings for a VM; there is one shadow page table for each VM on top of the ESX server. Shadow page table removes the one level of indirection

+2 VPN → PPN → MPN ← shadow page table

(c) (10 points) VM1 is not using its allocated memory; VM2 needs more memory; ESX server would like to get some memory from VM1 and give it to VM2. How is this accomplished with ballooning? Explain with pictures.



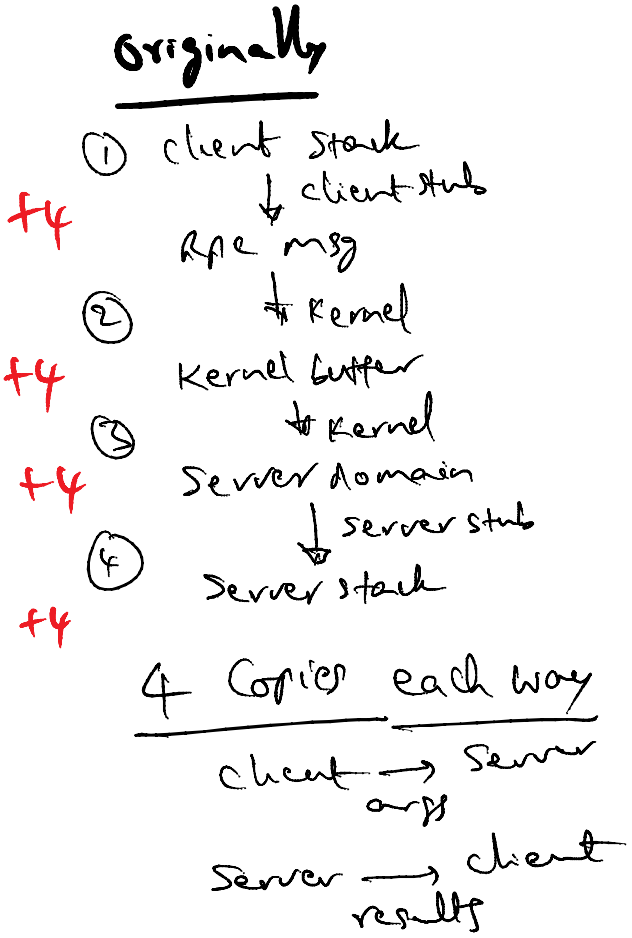
(partial credit commensurate with answer)

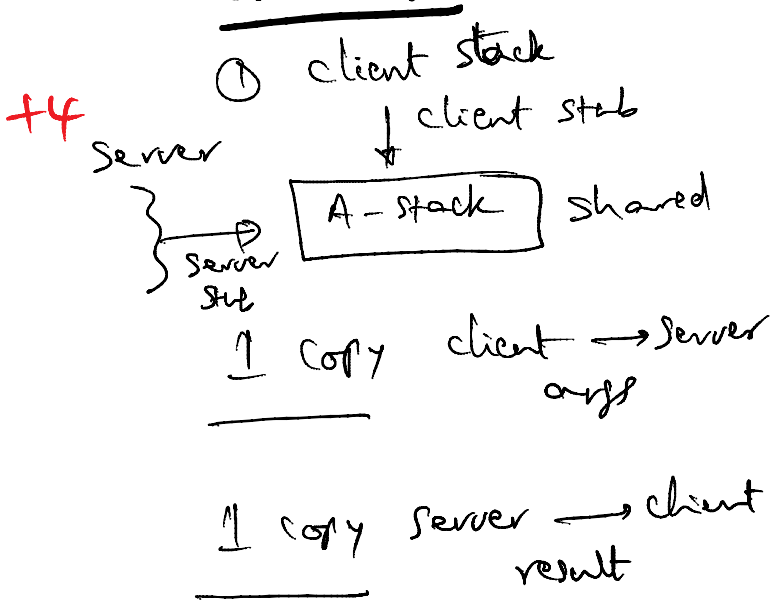
CS 6210 Fall 2011 Midterm Solution

Name:___Kishore_____GT Number:

Synchronization and Communication in Parallel Systems

4. (**10 mins**, 20 points) Prior to the optimization done by LRPC, list the number of and the need for copying involved in a client-server RPC call when the client and server are on the same machine. How does LRPC reduce the number of copies and what are the copies after the optimization?





CS 6210 Fall 2011 Midterm Solution

Name:___Kishore_____GT Number:

5. (**10 mins**, 20 points) Using a series of pictures, explain how barrier synchronization is achieved using the "Tournament barrier" for 8 processors. Just to jog your memory here is the code for tournament barrier.

```
procedure tournament_barrier
    round : integer := 1
    loop                    // arrival
        case rounds[vpid][round].role of
            loser:
                rounds[vpid][round].opponent^ := sense
                repeat until rounds[vpid][round].flag = sense
                exit loop
            winner:
                repeat until rounds[vpid][round].flag = sense
            bye:            // do nothing
            champion:
                repeat until rounds[vpid][round].flag = sense
                rounds[vpid][round].opponent^ := sense
                exit loop
            dropout:    // impossible
        round := round + 1
    loop                    // wakeup
        round := round - 1
        case rounds[vpid][round].role of
            loser:          // impossible
            winner:
                rounds[vpid][round].opponent^ := sense
            bye:            // do nothing
            champion:       // impossible
            dropout:
                exit loop
    sense := not sense
```

Use the next blank page for your answer.

CS 6210 Fall 2011 Midterm Solution

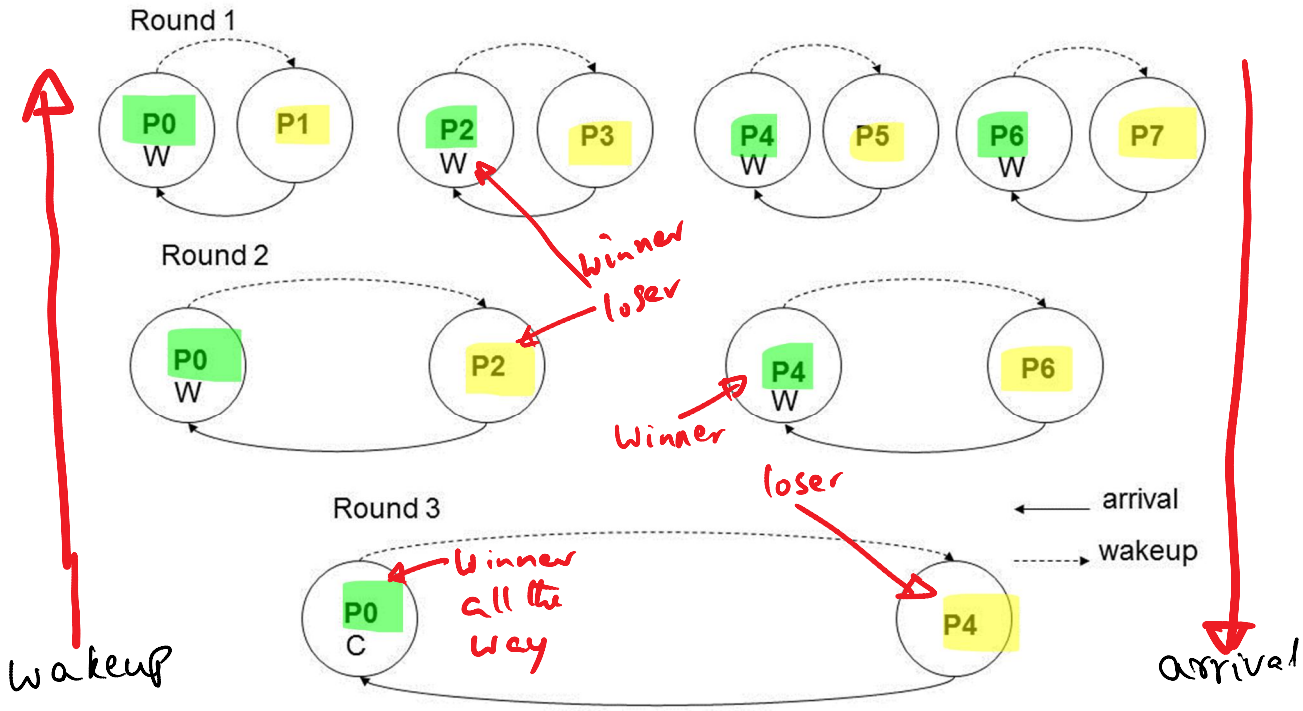
Name:___Kishore_____GT Number:

Space for answer to Q5

Role set statically depending on round

loser in a given round

winner in a given round



-1 for each wrong arrow

-1 for each wrong winner/loser

-1 only showed 4 processors (but otherwise correct answer)

-1 did not say winner statically determined

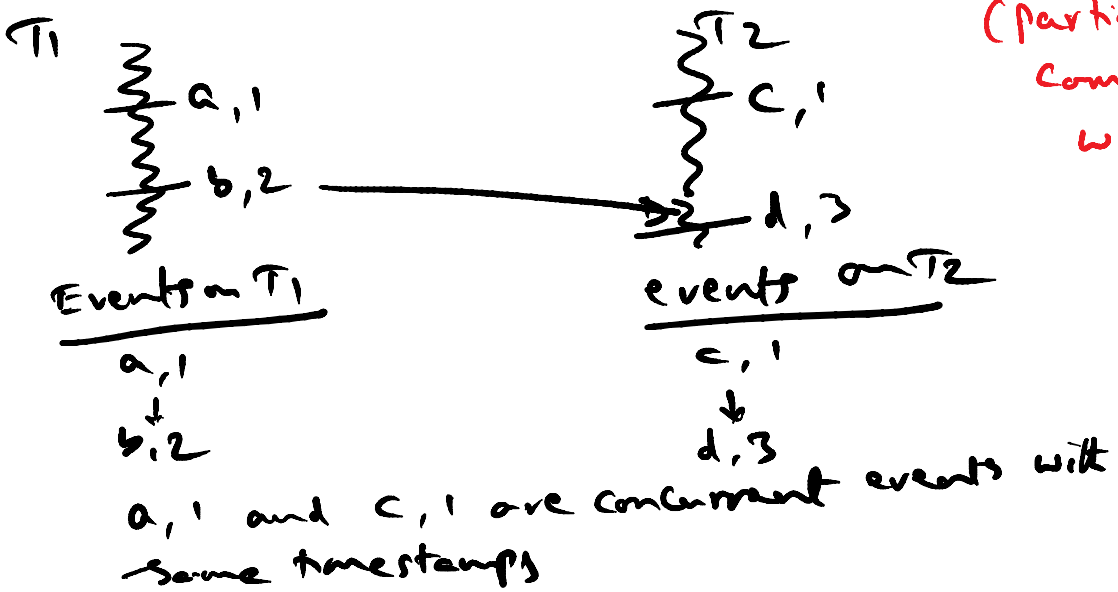
CS 6210 Fall 2011 Midterm Solution

Name:___Kishore_____GT Number:

Communication in Distributed Systems

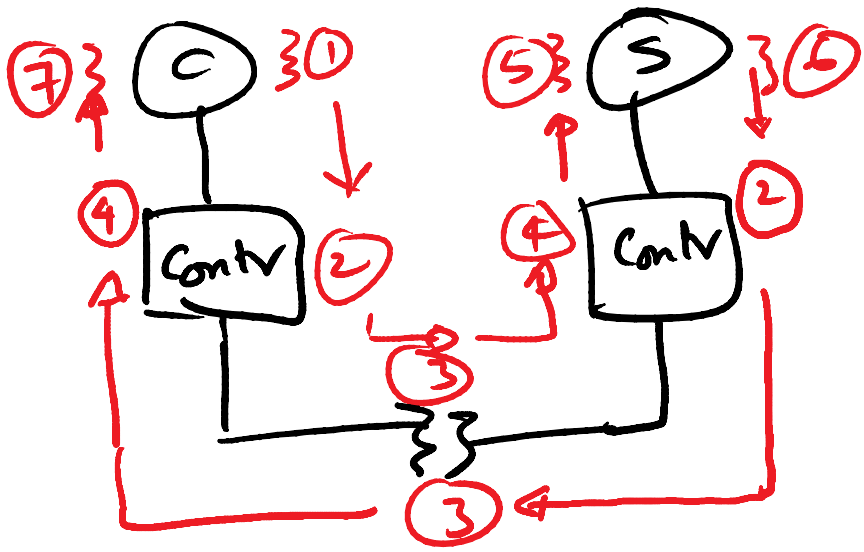
6. (**10 mins**, 19 points)

(a) (5 points) Explain (with a simple example) why Lamport's "happened before" relationship by itself is insufficient to derive a total order of events in a distributed system.



(Partial credit commensurate with answer)

(b) (14 points)For the RPC call shown between client (C) and server (S) in the picture below, give a short sentence description for each of the component times:



+2 for each correct answer

Use next page for writing your answer

CS 6210 Fall 2011 Midterm Solution

Name:___Kishore_____GT Number:

1. Client call:
   Args set up ; Kernel call ; validation ; marshalling ; (-1)
   Controller set up

2. Controller latency:
   At each of client + server
   Time taken by hardware to move bits from host memory to controller buffer (if necessary) ; followed by placing the bits from buffer onto the wire
   (-1) Copy into contr. buffer

3. Time on the wire:
   Actual time taken by the bits to travel from client machine to server machine
   + Vice versa

4. Interrupt handling:
   Time taken by the kernel to dispatch the interrupt handler after saving context currently running process and the time taken by the controller to receive the bits from the wire into its buffer
   (-1) context switch

5. Server call receipt:
   Time for kernel to locate server procedure ; dispatch server procedure ; unmarshall args (-1)

6. Server reply:
   Exec of server procedure ; Setup reply similar to client call (-1) marshall

7. Client reply receipt:
   (-1) dispatch client currently waiting for RPC to complete ; unmarshall result (-1)
   (partial credit commensurate with answer)