

Homework Assignment 5 Solutions

ECE 151 / CMPSC 171 - Spring 2013

MARKING SCHEME:

Problems 1,6 - 20 points

Problems 2,3,4,5 - 15 points

1. (a) Given the replicas in Lecture 8, Slide 7. What needs to be done to finalize the values in the conit so that A and B see the same result?

In this case it is relatively simple; if A and B exchange their list of tentative operations and subsequently order the according to the time, then both would see the same result.

(b) Given the interleavings in Lecture 8, Slide 13. Is 001110 a valid result for a sequentially consistent data store? Explain why or why not.

No. 001110 cannot be the result for a sequentially consistent data store. However we interleave the execution statements as per the sequentially consistency model the last of all the six statement will be a print statement which would print the values of two variables. By the time the last statement is executed all the three variables would have been initialized to '1'. Hence the last two values printed will always be '11'.

2. Given four processes P1, P2, P3, P4 with the read and write operations shown in the examples below.

(a) Does the following example satisfy sequential consistency? Explain why or why not

P1		R(y)b	R(x)c	R(x)a
P2	W(x)a		W(x)c	
P3			R(y)b	R(x)c
P4		W(y)b		

This example does not satisfy sequential consistency, because there is no sequence in which x=c before x=a, because P2 performs W(x)a before W(x)c but P1 performs R(x)c before R(x)a.

(b) Does the following example satisfy causal consistency? Explain why or why not.

P1	W(x)a		
P2		R(x)a	R(x)b
P3	R(x)a	W(x)b	
P4		R(x)b	R(x)a

This example does not satisfy causal consistency, because P3 performs W(x)b after R(x)a, so b depends on a, but P4 performs R(x)a after R(x)b, i.e., after x=a was overwritten by x=b. Note that P2 performs R(x)a before R(x)b and P4 performs R(x)b before R(x)a is the wrong reason, because causal consistency allows it.

3. (a) Given three processes P1, P2, P3, with the read, write, acquire and release operations shown in the examples below.

(a) Does the following example satisfy release consistency? Explain why or why not.

P1		Acq(L)	W(x)b	Rel(L)	
P2	Acq(L)	W(x)a	Rel(L)		
P3			R(x)a		Acq(L) R(x)a Rel(L)

This example does not satisfy release consistency. In P3, the second R(x)a should be R(x)b, because b was the value of x when the lock was last released by P1.

(b) Does the following example satisfy entry consistency? Explain why or why not.

P1	Acq(L)	W(x)a	W(y)b	Rel(L)	
P2			Acq(L)	R(x)a	W(x)c Rel(L)
P3					Acq(L) R(x)a Rel(L) R(y)b

This example does not satisfy entry consistency. In P3, R(x)a should be R(x)c, because c was the value of x when P3 acquired the lock.

4. In the examples below, the operations are performed by a process on two different local copies (L1 and L2) of the same distributed data store. (See Lecture 9, Slides 5-13 for notation and examples.)

(a) Does the following example satisfy read-your-writes consistency? Explain why or why not.

L1	WS(x ₁)		WS(x ₃)
L2		WS(x ₂)	R(x ₂)

The example does not satisfy read-your-writes consistency. One reason is that the read should be $R(x_3)$, because x_3 was the last value written to x . Another reason is that the read of x_2 in L_2 does not see the writes of x_1 and x_3 in L_1 .

(b) Does the following example satisfy writes-follow-reads consistency? Explain why or why not.

L1	WS(x_1, x_2)	R(x_2)
L2	R(x_1)	WS(x_1, x_3)

This example does not satisfy writes-follow-reads consistency. The last write should be $WS(x_2, x_3)$, because x_2 was the last value read from x .

5. A file is replicated on 12 servers using a quorum system. List all of the possible pairs of write quorum and corresponding minimal possible read quorum. For example, one possible (write quorum, read quorum) pair is (7,6).

There are six possible write-quorum, minimum read-quorum pairs. They are: (7,6), (8,5), (9,4), (10,3), (11,2), (12,1).

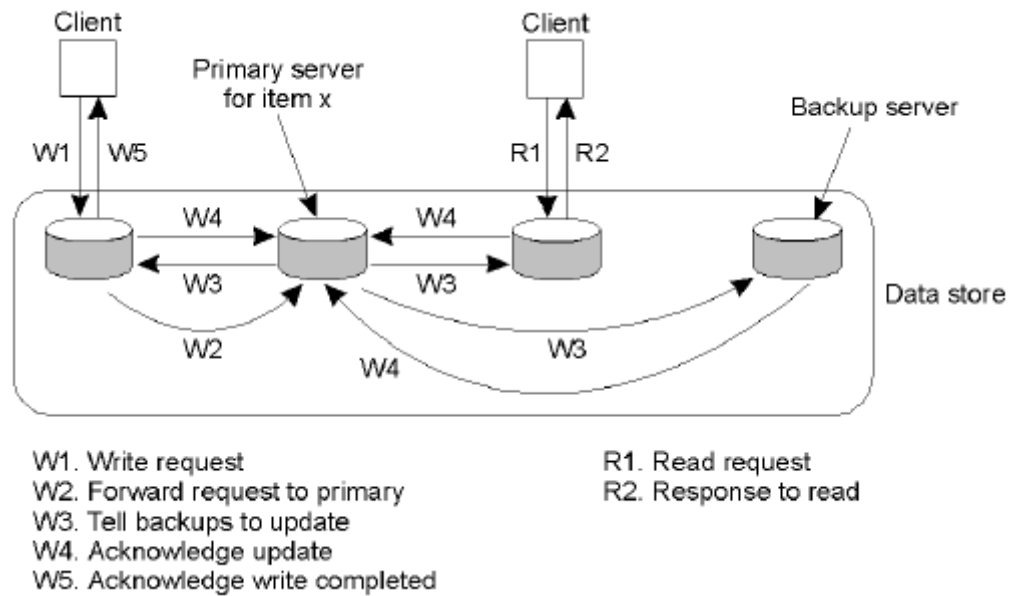
6. (a) Explain the difference between a primary-based remote-write protocol and a primary-based local-write protocol, in terms of whether the data or the operations are sent from one server to another.

(b) In each case, explain when the data or the operations are sent from one server to another.

(a) In primary based remote write protocol, the write operation is sent to the primary. In primary based local write, the copy of data is sent from the old primary to new primary (server connected to client).

(b) Primary based remote write:

All write operations on a data item are forwarded to a single fixed server, called the primary. Read operations can be performed locally at the backups.



Primary based local write:

When a process wants to update a data item, it locates the primary copy and migrates the data item to its own location. The process then updates the data item locally. It may perform several successive writes locally. Other processes may read the data item but may not update it.

