CS 194   S. Shenker
Spring 2005   I. Stoica

Homework Assignment #2— Due: March 9, 2005 @ 11:59:59pm
Total: 10 points
1. (**4 points**) Problems from Tanenbaum & Steen book. (1 point for each problem)
   a. Chapter 5 – Problem 2 (page 289)
   b. Chapter 5 – Problem 4 (page 289)
   c. Chapter 6 – Problem 6 (page 358)
   d. Chapter 6 – Problem 17 (page 359)

2. (**3 points**) Consider nodes A, B, C that all use Lamport (or logical) Clocks. The notation A4$\rightarrow$C2 will mean that A sent a message to C and that when the message was sent A's logical clock read 4 and when the message was received C's logical clock read 2.

   a. (**1 point**) Which of the following are legal sets of events? The events in each set are NOT necessarily listed in time order! Each set is merely a collection of message send and receive times.
   i) A5$\rightarrow$C11, C12$\rightarrow$A6
   ii) C12$\rightarrow$A5, A6$\rightarrow$C11
   iii) C4$\rightarrow$A10, B9$\rightarrow$C3,B3$\rightarrow$A15

   b. (**2 points**) Consider the following set of events: A13$\rightarrow$B10, A11$\rightarrow$C11, C10$\rightarrow$A3, B9$\rightarrow$C3. A chimed when its logical clock read 3. B chimed when its logical clock reads 8.

   i) Can you prove who chimed first just by using logical clocks? If so, which one chimed first?

   ii) Now, let's use timestamp vectors. Assume that all three nodes begin with timestamp vectors [0,0,0] (i.e., at time zero they all know each other's state). Can you prove who chimed first by using vector timestamps? If so, which one chimed first?

3. (**2 points**) Consider the following locking policies for transactions.

P1: Lock all items at beginning of transaction, release when transaction is completed.
P2: Lock items only when first needed, release when transaction is completed.
P3: Lock all items at beginning of transaction, release each item when no longer needed
P4: Lock items when first needed, release items when no longer needed
P5: Two-phase locking

Consider the following three transactions (T1, T2, T3), acting on three data items A, B, and C. O1(A) refers to an operation from T1 acting on the item A, etc.

T1=O1(A)O1(A,B)O1(B)
T2=O2(B)O2(C)
T3=O3(C)O3(A)

Consider the following sequences of operations:

S1=O1(A)O2(B)O3(C)O2(C)O1(A,B)O1(B)O3(A)
S2=O1(A)O2(C)O2(B)O3(C)O1(A,B)O3(A)O1(B)
S3=O1(A)O2(B)O2(C)O1(A,B)O3(C)O1(B)O3(A)

For each of these sequences, answer the following two questions:

   a. Which (if any) of the *five* policies does this order obey?
   b. Is this a serializable order?

4. (**3 points**) This question concerns how updates are handled in Bayou.

Assume that process alpha begins a session and connects to server P and does a read R with read set is [P4,A1,A4,B17], where P4 refers to the update with timestamp 4 from server P, etc.. The process then writes, and that write has timestamp P14.

Process alpha then detaches server P and attaches to server A, which has version vector [x, y, z]. While continuing the session, process alpha reads, with read set [P2, A3, B1, B3, B21], and writes, which is timestamped A7.

   a. For process alpha to have the properties of Reading Your Writes and Monotonic Reads, and for the above scenario to be possible, what are the minimal values that x, y, and z can have?
   b. Now assume a new process beta starts a session and attaches to server B, which has version vector [r, s, t]. If s=9, what is the minimal value of r such that the property Monotonic Writes will hold? Does it matter what the value of t is for Monotonic Writes to hold?
   c. Assuming the scenario at point (b), if s=7, what are the minimal values of r and t such that the properties of Monotonic Writes and Writes follow Reads will hold?

5. (**3 points**) Consider a quorum-based consistency scheme for three nodes (A, B, C). Each node has a probability of failure p, with $pA=.1$, $pB=.1$, and $pC=.2$. Consider the following vote assignment schemes and read/write quorums, with VA denoting the number of votes for A, etc., and VW and VR denoting the write and read quorums.

S1: VA=1, VB=0, VC=0: VW=1, VR=1
S2: VA=5, VB=3, VC=2: VW=5, VR=6
S3: VA=3, VB=2, VC=1: VW=4, VR=3

    a. Which of these are valid quorum schemes?
    b. Of the valid ones, what is the probability that they will allow a write?
    c. Of the valid ones, what is the probability that they will allow a read?

Submissions instructions:
1) Create a directory hw2 in your cs194 class account.
2) Create a text file hw2.txt in that directory.
3) Edit the file hw2.txt with your answers.
4) Once ready to submit, run "submit hw2" from the hw2 directory