Homework Assignment 6, Part b (the last one!)

Due: Thursday, December 6, 2001, in class.

Reading:

The following papers:

1. "Unreliable failure detectors for reliable distributed systems" by Chandra and Toueg;
2. "The part-time parliament" by L. Lamport.
3. "Practical Byzantine fault tolerance" by Miguel Castro and Barbara Liskov.

Basic Problems:

1. A "reliable broadcast service (RBCast)" is defined to have the same interface as the one that was described in class for an atomic broadcast service (ABCast). The guarantees are:
   Integrity: Only correct messages are delivered, at most once at any location.
   Self-delivery: In a fair execution, any message broadcast at a non-failing location is eventually delivered at that location.
   Agreement: In a fair execution, any message delivered at some location is eventually delivered at all non-failing locations.
   Prove that the addition of a reliable broadcast service is not sufficient to make consensus solvable with 1-failure termination, in the standard send/receive distributed network model. You may assume a reliable fifo network.

2. Prove that the view-change protocol of Castro and Liskov achieves its safety condition. (i.e., show that it guarantees that all non-faulty replicas agree on the sequence numbers of requests that they commit locally).

Regular Problems:

3. Design an algorithm that solves the problem of k-agreement, $k \geq 1$ and tolerates f failures, $f < k$, Your algorithm should be asynchronous but should use a perfect failure detector (P, in the notation of Chandra and Toueg).
   (Hint: See Exercise 21.13 in the textbook.) Give precondition/effect code and argue correctness.

4. Describe a modification of the Paxos protocol that uses a "quorum system" consisting of "read-quorums" and "write-quorums" instead of simple majorities.

(A "quorum system" consists of two collections of sets of processes: a set of "read-quorums" and a set of "write-quorums". The only condition is that every read quorum has to have a nonempty intersection with every write-quorum.)

In this modified protocol, the leader should seek information and approval from a read-quorum of processes in the first phase, and approval from a write-quorum in the second phase.

(a) Describe the protocol carefully in words.
(b) Sketch a proof that it works.