CS 4513 Distributed Computing Systems
Craig E. Wills
Given: Tuesday, December 18, 2001

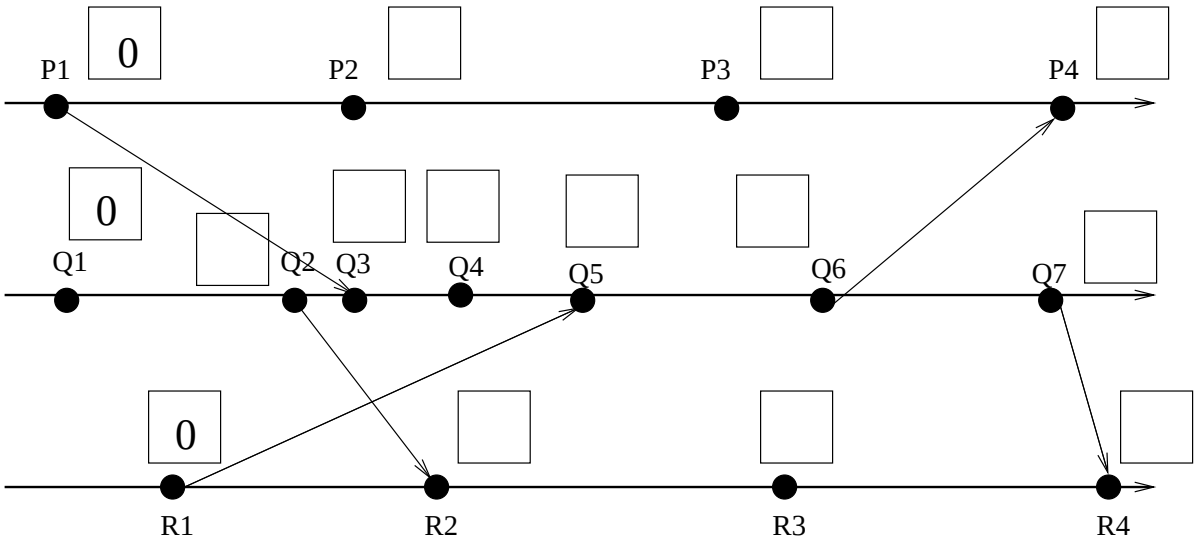
WPI, B Term 2001
Final Exam (100 pts)

NAME:_____

This is a closed book (and notes) examination. Answer all questions on the exam itself. Take the number of points assigned to each problem and the amount of space provided for your answer as a measure of the length and difficulty of the expected solution. The exam totals 100 points.

SCORE:_____

1. (12 points) The following graph shows a series of events within three processes P, Q and R with time moving to the right. Lines between each process are messages transmitted in the direction shown. Using the implementation described by Leslie Lamport for constructing a logical clock, write the logical time in the box next to each event in the graph. As shown the logical clock for the first event in each process is set to zero.



What is the significance of this logical clock in terms of the "happens before" relationship defined by Lamport?

2. (9 points) What is the distributed election problem? Briefly describe an algorithm to solve this problem.

3. (12 points) Assume you have a function/method *charindex()*, which takes as its argument a string and an integer and returns as its result the character indexed by the integer in the string. Using either Sun RPC or Java RMI (your choice, but not both!) show how the interface definition file is created for this function/method. You do not have to write the contents of the function/method.

   Show the sequence of steps to build the client, build the server and start execution of the client. Be sure and indicate how the client locates the server.

4. (10 points) As part of Project 3, you compared the time on your local machine with the time on remote Web servers. Is network delay an issue in making this comparison? If yes, then indicate how it is taken into consideration. If no, then briefly describe why it is not an issue.

5. (8 points) Multicasting is used in the load sharing work of Wills and Finkel as well as in the Multicast Request Protocol in JINI. What are the advantages and disadvantages of using multicasting-based approaches?

6. (13 points) In class we discussed the Andrew File System (AFS) and Network File System (NFS).

   (a) Describe how the AFS callback mechanism for caching works.

   (b) How does this mechanism compare with file *delegation* in version 4 of the Network File System?

7. (14 points) In a distributed environment, distribution of excess computations to idle or lightly loaded machines is desirable.

   (a) What measure can be used to determine if a machine is idle and thus eligible to receive a computation?

   (b) In a sender-initiated approach, machines wishing to distribute a computation need to locate an idle machine. Describe a mechanism for locating an idle machine in a lab like the Fossil Lab as well as any advantages and disadvantages of your approach.

8. (12 points) One of the concepts in distributed systems is the idea of *leasing*.

   (a) Briefly explain how the lease concept is used in JINI.

   (b) How could the lease mechanism be combined with a callback mechanism such as used in AFS? Why would this approach be advantageous?

9. (10 points) A useful feature for a computing environment such as we have on the WPI campus is a notification mechanism that allows one user to be notified when another user logs into one of the WPI machines. Describe how such a notification mechanism could be designed and implemented. Describe the strengths and weaknesses of your approach.