

CS 5204
Fall, 1999

Final Examination

1. (30 points) Use a tuple space to solve the following synchronization problem. In “ n -way barrier” synchronization an arriving process is forced to wait until all n processes have arrived at which time all n processes may continue. Show the tuple space operations used by one of the n process. All n process should have the same tuple space code.

2. (20 points) Compare and contrast the characteristics of communication as found in CSP, tuple spaces, and remote procedure call (or remote invocation). You will be graded both on the quality of the criteria chosen as well as on the evaluation and comparison according to these criteria.
 - (a) Identify two criteria that you will use in your comparison. Briefly explain each criterion.
 - (b) Describe each method according to each of your criteria.
 - (c) Show a table that summarizes your comparison.

3. (30 points) A distributed system uses lock-and-key for access control. An access control manager on a node creates the locks and keys for objects on that node. The keys are distributed to other nodes where the subjects execute. One danger in this system is forgery. Forgery might occur because a malicious node could generate a fake key and send it to the node holding the lock. Show how to use public key encryption in a distributed system to prevent forgery. Structure your answer as follows:
 - (a) Show how the locks and keys are generated by the access control manager.
 - (b) Show how the access control manager makes an access control decision given a key.
 - (c) Explain how forgery is prevented using your scheme.

4. (15 points) In a public key system show how a user A can securely send a message M to user C via an intermediate user B. In this system, A sends an encrypted form of the message to B. B delivers the message to C when C requests the delivery of a message from B. Your solution must guarantee:
 - C knows the message came from A,
 - B is unable to read the message,
 - C can detect an attempted replay attack
 - only messages intended for C are delivered to it by B
 - messages intended for C are only sent to C

Structure your answer as follows:

- (a) Show what is sent from A to B
- (b) Show the request sent from C to B
- (c) Show the reply sent from B to C

5. (15 points) Consider a system with two nodes, P and Q, implementing a checkpointing scheme. P_c and Q_c are a pair of events that capture a consistent checkpoint on P and Q, respectively. P_s is the first message send event on P after P_c . Q_r is the event of receiving this message on Q. Using vector-timestamp concepts, identify all of the true statements among the following:
- (a) P_c and Q_c are concurrent.
 - (b) P_s comes before Q_c
 - (c) P_s comes after Q_c
 - (d) Q_r comes after P_c
6. (15 points) Illustrate the necessity for the two-phase structure of two-phase locking. Show a log for a pair of transactions which could result from using locking, but not two-phase locking, and explain how the resulting database might lose its consistency.
7. (15 points) Show a log for a pair of transactions that is serializable but which cannot occur under two phase locking.
8. (15 points) A simple system is shown below in CCS notation.

$$\begin{aligned}
 A &= a.A' & B &= c.B' \\
 A' &= \bar{b}.A'' & B' &= b.B \\
 A'' &= d.A \\
 \text{SYSTEM} &= (A \mid B) \setminus \{b\}
 \end{aligned}$$

(a) Draw a graph that shows the structure of this system. Show each agent, its ports and the connections between ports.

(b) Draw a graph that shows the behavior of the system. The nodes (vertices) of the graph represent the state of the system and the arcs are labelled by the action that moves the system from one state to another. The initial node of this graph is:

