University of Rochester **Mobile Computing (CSC290e)**

Final Exam

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Read before beginning: Please write clearly. Illegible answers cannot be graded. Be sure to identify all of your answers in your blue book. All questions are worth 10 points. Answer all questions.

While I have tried to make the questions as unambiguous as possible, if you need to make any assumptions in order to continue, state these as clearly as possible as part of your answer. In the name of fairness, I would like to avoid answering questions during the exam.

Please turn in both your bluebook and this exam sheet. Exams can be picked up after Tuesday of next week.

1. **Bluetooth and 802.11.**: Briefly explain why Bluetooth and 802.11 can conflict with one another when they are running in the same physical space. Describe one option which would solve this problem (your solution need not be complicated).

2. **Mobile IP.**: One of the advantages of IP tunneling is to allow the incremental deployment of of new protocols in the existing Internet.

   (a) What is IP tunneling?

   (b) How is IP tunneling used in Mobile IP?

   (c) If a mobile host uses a foreign agent to receive and forward its messages, in most cases the mobile host need not even care about the tunneling and IP-in-IP encapsulation. Why is this *not* true in the case of multicast messages being forwarded from the home to the foreign agent and then to the mobile host?

3. **Mobile Agents.**: Briefly define strong and weak mobility. It might be helpful in your definitions to give an example of the behavior of a strongly mobile agent vs. a weakly mobile agent. Which is possible in Java?

4. **Mobile Code Analysis.**: The figure on the last page shows the analysis of the traffic overhead for a single invocation of a network management application over one to twenty nodes using mobile agents, client server, and remote evaluation. At each host, 20kb of data are collected. Briefly explain why the mobile agent curve is shaped the way it is, and name/describe the technique which helps to flatten out this curve.

5. **Disconnected Transitive Communication.**: The core DTC model shows how a single message propagates through the hosts of the mobile ad hoc network. One alternative is to replicate the message when it goes to the next hop, effectively producing several copies of the same message which traverse independently through the network. Discuss one advantage and one disadvantage of this alternative.

6. **Lime.**: When two processes execute on two different host computers, you cannot make any assumptions about the order in which the operations are executed. The same is also true for operations which execute in different processes on the same machine. In LIME, both issues arise.

   Consider the scenario with two hosts, `host1` and `host2`, which are within communication range of one another. Assume each host is running LIME, the LIME servers are engaged, Agent 0 is on `host1`, Agent 1 is on `host2`, and each agent has a shared, default tuple space.

The pseudocode below shows a few operations for each agent (line numbers are given in parenthesis on the left of each statement). Because of the unpredictable order of execution of operations, you cannot predict with complete accuracy the final values of `t1` and `t2`.

To answer this problem, list all the possible values for t1 and t2, and for each set of values, give one interleaving (e.g., a sequence of line numbers) that produces those values. Hint, there are more than 2 and less than 5 possible output value combinations. Assume that initially the tuple spaces are empty.

Agent 0

```
(1) p=<string?>
(2) t1 = rdp(host1, UNSPECIFIED, p)
(3) out(<hello>)
(4) t2 = rd(p)
```

Agent 1

```
(11) t=<hi>
(12) out(t)
(13) migrate(host1)
```

7. **Distributed and Mobile Computing.**: (Note: this question is long to read, but NOT difficult to answer. Read carefully.) In the first week of class class, we talked about the fact that distributed consensus is impossible. Basically, this means that it is impossible to know (in a faulty environment) that both participants in a communication agree on a particular outcome. In terms of the "coordinated attack" problem, this means that the two generals cannot agree on whether or not to *attack at dawn*.

   In a mobile setting, the link between any pair of hosts is unpredictable (i.e., faulty). Think about LIME, a middleware which works in the mobile environment, and in particular, think about the `out(otherAgent, t)` operation, where the `otherAgent` is on a connected host when the first agent issues the `out` operation.

   When this tuple, `t`, is being transmitted to the other host, if the link between the two hosts disappears, distributed consensus tells us that we cannot know the actual status of the tuple (i.e., if it actually arrived at the other host or not). Another way to think of this is that the sender and receiver can each perceive that the transmission was successful or was a failure. If transmission is using a standard TCP the following three cases are possible:

Sender Perceives	Receiver Perceives
success	success
failure	success
failure	failure

   As you know, the current version of LIME does not handle this kind of sudden disconnection, but suppose we were to extend it to do so. Think about an extension to your Maze application where the players were finding gold as they visit the rooms of the maze, and put that gold into their tuple space. At some point, one of the players decides to give 10 pieces of its gold to another player (on a different host, in the same room) using the `out(otherAgent,t)` operation. Suppose a disconnection occurred while the tuple containing the gold, `t`, was being transferred, and the sender perceived failure.

   (a) Let our modified version of LIME choose to insert the tuple as a misplaced tuple into the sender's tuple space. What is the result to the total amount of gold in the game in the case where the receiver perceived success?

   (b) Let our modified version of LIME choose to ignore the failure and do nothing. What is the result to the total amount of gold in the game in the case where the receiver perceived failure?

   (c) Suppose that we were not willing to accept either of these consequences. Briefly describe one option. Remember, in the maze we are guaranteed that at the end of the game, the players will meet back in the first room of the maze.