

- 1a How does distribution as a scaling technique help in improving the performance of a worldwide distributed system? 5pt
It helps to solve numerical scalability problems by offloading servers
- 1b Which new performance problem may distribution as a scaling technique possibly introduce for a worldwide distributed system? 5pt
Because servers are spread worldwide, we may suddenly have a geographical scalability problem.
- 2a Explain what is meant by *at-most-once* semantics in the case of remote procedure calls. 5pt
This means that the system ensures that when a client issues an RPC, the referenced procedure is called at most once at the server side, even in the presence of failures.
- 2b What is the role of a message broker in message-oriented communication? 5pt
It acts as a central point where incoming messages can be converted and redirected to their destination such that the latter can process them. A message broker is generally used to integrate existing, but different systems.
- 3a What's the difference between strong and weak mobility? 5pt
With weak mobility, only the code and data associated with an object is moved. With strong mobility, also the execution state (processor, process, and thread context) is migrated to the destination.
- 3b Standard Java can support only weak mobility. How would you mimic strong mobility without changing the Java virtual machine? 5pt
The best you can do is record (inside an object) its current state, and let that state determine which code should be executed next when invoking the object again after having migrated it to another host.
- 4 Iterative name resolution may introduce higher communication costs in comparison to recursive name resolution. Explain how this can happen. 5pt
See figure 4-11.
- 5a Explain precisely what is meant by causally-ordered message delivery. 5pt
This means that the communication subsystem guarantees that it will deliver message m to process P only if there are no other messages m^ that should be delivered to P as well, but on which the sending of m depended. In other words, as long as there are messages m^* that causally precede m , the delivery of m will be postponed.*

5a Opponents of letting the middleware guarantee causally-ordered message delivery state that the middleware is not good at detecting causality. Explain what they mean by this statement. 5pt

There are two issues. First, the best that middleware can do is register potential causality between messages. Because it does not (and cannot) take the semantics of messages into account, it may register two messages as causally related, while in fact they are completely independent. Second, to detect causality, we must assume that all communication takes place with the middleware. This is often not the case. If two applications exchange information outside the scope of the middleware, for example, through a database or another external communication channel, then the middleware will not be able to detect causality, and can thus not guarantee causally-ordered message delivery.

Grading: The final grade is calculated by accumulating the scores per question (maximum: 45 points), and adding 5 bonus points. The maximum total is therefore 50 points.