

UNIVERSITY OF WISCONSIN

Computer Sciences Department

Operating Systems Qualifying Exam

Spring 2015

Instructions: There are *six* questions on this exam; answer *all six* questions.

Question 1. The End-to-End Argument

The end-to-end argument was presented with a detailed example of doing file transfer. Describe how this end-to-end argument applies to the follow scenarios and how a solution would incorporate the end-to-end argument. Be sure to show how the end-to-end argument helps to influence design trade-offs.

- A. Key exchange for secure communication in a network.
 - B. Reliable data transmission over a network.
 - C. Layering software components in the design of a program. In layered software, deciding where to place specific functionality.
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Question 2. Weak Consistency

Both Grapevine and Google GFS use a computation model that weakens the constraints on consistency for data that is stored and accessed in a distributed way.

- A. For each of these two systems, describe the data that is stored and in what way the consistency of that data is weakened.
 - B. For each of these two systems, describe the performance benefit (over a design that required strong consistency) in using their consistency model.
 - C. What disadvantages, if any, do these system have in terms of being understandable and usable to users or programmers as a result of adopting a weakened consistency model?
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Question 3. Policy - Mechanism Separation

Policy dictates how decisions are made, while mechanism is the machinery that can be directed to implement a given policy. For example, round-robin scheduling is a policy, and a mechanism for that is a timer interrupt and a context switch routine.

- A. Pick two systems from the reading list and describe how they separate policy and mechanism differently for virtual memory management.
 - B. Pick two systems from the reading list and describe how they separate policy and mechanism differently for file systems.
 - C. What are important considerations when deciding how to separate policy from mechanism in a system?
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Question 4. Scheduling and Communication

Compared to RPC, LRPC provides fast inter-process communication by doing as much work as possible during binding.

- A. Explain the operations that LRPC does during binding that Needham and Schroeder's RPC did on every call.
 - B. A key piece of LRPC is clever consideration of scheduling. Explain how LRPC scheduling of threads speeds communication.
 - C. On a multiprocessor, is it better with LRPC to serve an incoming call on the same core as the caller, or on a separate core? Why?
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Question 5. Authentication Protocols

Both the Needham and Schroeder symmetric-key authentication protocol and Kerberos rely on an authentication service.

- A. What is the importance and value of having an authentication service that is separate from application services?
 - B. Both of the Needham and Schroeder symmetric-key authentication and Kerberos protocols require the client to contact the authentication service rather than having the server contact the authentication service. What are the benefits of having the client contact the authentication service? What are the drawbacks?
 - C. Suppose you are a customer of two banks and have accounts at each one. You would like to be able to log in to either of the banks and use that credential at both banks, for example to log in to one bank and transfer money into that bank from the other.
Using Kerberos and assuming that the authenticating services are secure and trusted, how can you design a protocol to allow a customer to make such an operation, but prevents the one bank doing operations at the other without the customer's permission? Explain your answer.
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Question 6. Fault Tolerance and Reliability

- A. The failure models for a system describes the set of failures that can be handled. For each system below, explain the failure model, and give one example of a reasonable failure that is not in the failure model (if any).
 - a. Map/Reduce
 - b. The Log-Structured File System
 - c. The Google File System.
 - B. Recovery from a failure that occurs in the middle of an operation generally requires redundancy to roll forward and complete the operation or to roll back. For the same set of three systems, explain the source of redundancy and how it is used for recovery.
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