

Principles of Computer Systems

Final Exam

20-Dec-2016

This exam has 9 questions, totaling 100 points. You have 105 minutes to answer them, which means you earn about 1 point per minute of work – please consider spending on each question no more minutes than the number of points attributed to it. The first five questions are multiple-choice, with zero, one, or more correct choices. The last four questions require short answers in the form of 1-2 paragraphs of prose; exceeding this limit is unlikely to provide any benefit.

If you exit the room during the exam, you will have to turn in your exam, and you will not be permitted to return to the room until the end of the exam. Please plan accordingly.

You are allowed to have any amount of printed material you like (books, papers, notes) but no laptops, tablets, cellphones, etc. are permitted during the exam. You must take the seat assigned by the course staff and present your CAMIPRO card to the staff upon request.

Do not open the exam until instructed to do so.

Your name: _____

SCIPER: _____

Question 1 [2 points]

Consider a web server whose availability A is 99% (two nines). After a hardware upgrade, the MTBF of the server is doubled. Which is the new value of A , assuming nothing else changed?

- ☐ 99.2%
- ☐ 99.5%
- ☐ 99.9%
- ☐ 99.99%

Question 2 [1 point]

Consider a web server whose availability A is 99% (two nines). After a software upgrade, the MTTR of the server is halved. Which is the new value of A , assuming nothing else changed?

- ☐ 99.2%
- ☐ 99.5%
- ☐ 99.9%
- ☐ 99.99%

Question 3 [2 points]

The Trusted Computing Base (TCB) is sometimes defined as "the totality of protection mechanisms within a computer system (including hardware, firmware, and software) that is responsible for enforcing a computer security policy." Say you access an online store or your e-banking service over the Web, and you rely on SSL or TLS to secure your connection, and the corresponding certificates are issued by a certification authority (CA). Indicate below which parts of the system are in the TCB according to this definition.

- ☐ The operating system of both the server and of the client
- ☐ The code of the client's web browser
- ☐ The SSL/TLS libraries used by the client's web browser
- ☐ The network infrastructure
- ☐ The human operators of the CA that issued the bank's certificate
- ☐ The human operators of all CAs whose certificates are accepted by the client's web browser
- ☐ The sysadmins' laptops at all CAs whose certificates are accepted by the client's web browser

Question 4 [2 points]

Which of the following are violations of the end-to-end principle?

- ☐ Trying to provide 100% reliable data delivery at the network layer
- ☐ Implementing ACKs and retransmissions in the link layer of wireless networks
- ☐ Providing TCP as the sole transport-layer protocol
- ☐ Performing packet forwarding based on application-layer data (e.g., for load-balancing)

Question 5 [2 points]

The paper "Memory Resource Management in VMware ESX Server" by C. Waldspurger describes several concepts. Indicate below which one is a policy vs. which one is a mechanism by checking the box in the correct column:

	is a policy	is a mechanism
Ballooning	<input type="checkbox"/>	<input type="checkbox"/>
Idle tax	<input type="checkbox"/>	<input type="checkbox"/>
Content-based page sharing	<input type="checkbox"/>	<input type="checkbox"/>
Memory shares	<input type="checkbox"/>	<input type="checkbox"/>

Question 6 *[25 points]*

Identify one recent hardware trend and describe its implications on OS architecture. Identify a second (different) hardware trend and describe its implications on hypervisor architectures or on cloud computing.

Question 7 [25 points]

Consider a software-defined network, in the style of what is described in "Ethane: taking control of the enterprise design" by M. Casado et al. Suppose you want to make it able to tolerate network partitions. How would you define "tolerate" in this context, i.e., how would you want the network to behave in case of a partition? How would you achieve this kind of tolerance? Would the fault-tolerance techniques mentioned in the Ethane paper help?

Question 8 [22 points]

In his paper on "The design philosophy of the DARPA Internet protocols", D.D. Clark mentions resource accountability as one of the second-level goals. How do you understand this goal? How would you alter the Internet architecture to provide it? Which layer(s) would you add it to? Or would you add an additional accountability layer?

Question 9 [19 points]

State, in your own words, the argument that D. Engler et al. make in "Exokernel: An operating system architecture for application-level resource management" for revisiting the abstractions provided by operating systems. Support your argument with ideas and elements from B. Lampson's "Hints for computer system design".