

Operating Systems and Architecture Comprehensive Exam

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The test monitor will answer some parts of these questions for you if you are unsure of what some of these terms mean. The only penalty is that you will not get any points for the part that was answered for you. You can still answer the other parts of the question. This can get you started on a question even if you are not sure of the definitions.

Do any five questions. Be **sure** that it is absolutely clear which questions you are answering.

1. **Device drivers** (20 points) Suppose a computer system has a SCSI controller and the SCSI bus has three devices on it: a disk drive, a DAT drive, and a laser printer. What device drivers will the system need to control all this (the SCSI bus and the devices on it)? Describe the interfaces these drivers will have. What other drivers, other parts of the operating system, device controllers, and devices will they call (or communicate with)? Who will call each of these drivers?
2. **Context switching** (20 points)
 - (a) (8 points) Explain what context switching in an operating system is. Go into some details and describe what happens in both the hardware and the software during a context switch. Explain what a half-context switch is. Talk about the registers and what happens to them.
 - (b) (6 points) Context switching is not possible without some help from the hardware, that is, an instruction specially designed to do the critical part of context switching. Explain why such instructions are necessary. Be sure to describe the problem and why it cannot be handled with ordinary instructions.
 - (c) (6 points) Context switching slows down the processor by quite a bit. We are not talking about the time to execute the context switch itself but side effects from the context switch. Explain why this is so, that is, describe why the process is slowed down after a context switch.
3. **Address spaces** (20 points) Consider a system with 40-bit physical addresses and 48-bit logical addresses which are translated with a three-level page table. The system also has an address cache (usually called a TLB).
 - (a) (6 points) Decide on a good size for each page and the number of address bits assigned to each level. Draw a diagram of the logical address and how each part is used.
 - (b) (9 points) Draw a diagram that explains how the address is translated from a logical address coming in from the processor to a physical address to the bus. Include the TLB in your diagram and show where it fits it. Use text annotations so that the diagram stands by itself and can be understood easily.
 - (c) (5 points) Suppose a memory read cycle for a physical address put on the bus takes 50 ns. The processor will not see this speed because of the overhead for address translation. Suppose we wanted the processor to see an average 60 ns memory read time for reads from logical addresses. What would the hit rate on the TLB have to be to achieve this goal.
4. **Authentication and Protection** (20 points) Define authentication and protection in an operating system and tell how they relate to each other. Describe one method of protection that can be used in an operating system. Describe one method for users to be authenticated and one method that operating systems can authenticate themselves to user. Give three examples of security attacks, one which exploits a protection failure, one of which exploits a user authentication failure and one of which exploits a system authentication failure.
5. **Networks** (20 points) Computer networks are frequently described by the ISO/OSI 7-layer

model. However, in practice, most TCP/IP/Ethernet LANs do not conform exactly to this model. Compare the ISO/OSI to TCP/IP/Ethernet layer by layer. For each layer in the TCP/IP/Ethernet, tell where you would expect to find it in an OS like UNIX or Linux.

6. **Hardware** (20 points) Ten years ago, prognosticators predicted the “end of the millennium” PC machine would have the three G’s (a gigahertz processor, a gigabyte of memory, and a gigabit network connection). Now that the new millennium is here, assess whether or not they were right (i.e., what is typical (for a new PC) for each of the three resources). What is your prediction for the 2010 machine and for each of the three resources. Justify in some detail your prediction.
7. **Consistency and coherence** (20 points) In the context for a shared memory multiprocessor systems, explain the difference between the terms consistency and coherence as these terms relate to the manipulation of data structures.