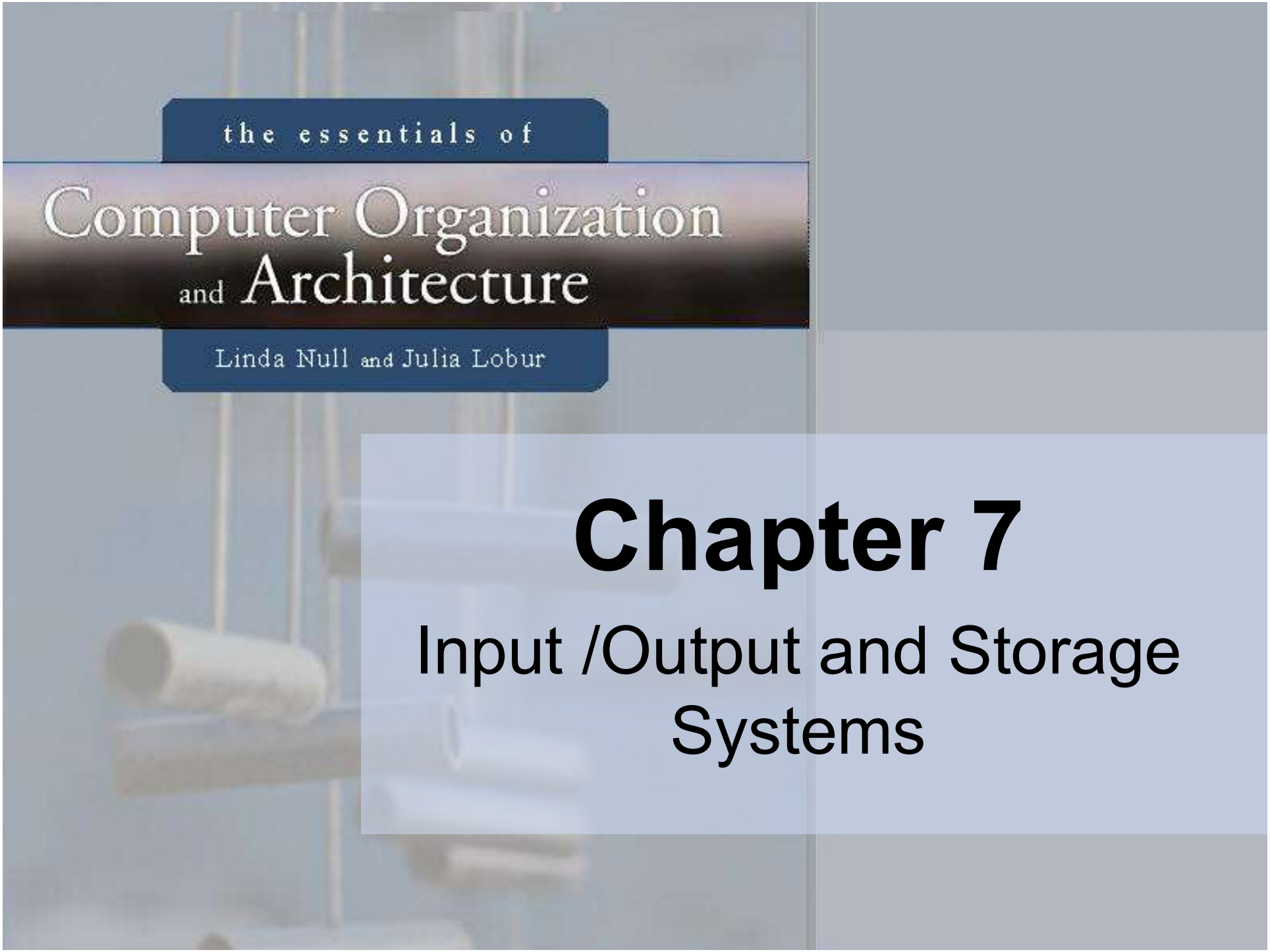

Chapter 7

Input /Output and Storage Systems

Chapter 7
REVIEW OF ESSENTIAL TERMS AND CONCEPTS

1. State Amdahl's Law in words.

2. What is speedup?

5. Explain how programmed I/O is different from interrupt-driven I/O.

8. How does direct memory access (DMA) work?

12. How is channel I/O different from interrupt-driven I/O?

13. How is channel I/O similar to DMA?

21. What is seek time?

22. What is the sum of rotational delay and seek time called?

Chapter 7
EXERCISES

1. Calculate the overall speedup of a system that spends 65% of its time on I/O with a disk upgrade that provides for 50% greater throughput.

3. Suppose your company has decided that it needs to make certain busy servers 50% faster. Processes in the workload spend 60% of their time using the CPU and 40% on I/O. In order to achieve an overall system speedup of 25%:

a) How much faster does the CPU need to be?

b) How much faster does the disk need to be?

Chapter 7
EXERCISES

4. Suppose that you are designing a game system that responds to players' pressing buttons and toggling joysticks. The prototype system is failing to react in time to these input events, causing noticeable annoyance to the gamers. You have calculated that you need to improve overall system performance by 50%. This is to say that the entire system needs to be 50% faster than it is now. You know that these I/O events account for 75% of the system workload. You figure that a new I/O interface card should do the trick. If the system's existing I/O card runs at 10 kHz (pulses per second), what is the speed of the I/O card that you need to order from the supplier?

Chapter 7
EXERCISES

8. Suppose the daytime processing load consists of 60% CPU activity and 40% disk activity. Your customers are complaining that the system is slow. After doing some research, you learn that you can upgrade your disks for $8,000 to make them 2.5 times as fast as they are currently. You have also learned that you can upgrade your CPU to make it 1.4 times as fast for $5,000.

a) Which would you choose to yield the best performance improvement for the least amount of money?

b) Which option would you choose if you don't care about the money, but want a faster system?

c) What is the break-even point for the upgrades? That is, what price would be charged for both upgrades to make their cost and performance improvement equal?

Chapter 7
EXERCISES

11. Name the four types of I/O architectures. Where are each of these typically used and why are they used there?

15. Why are I/O buses provided with clock signals?

16. If an address bus needs to be able to address eight devices, how many conductors will be required? What if each of those devices also needs to be able to talk back to the I/O control device?

Chapter 7
EXERCISES

21. Define the terms seek time, rotational delay, and transfer time. Explain their relationship.

26. The disk specification in Figure 7.15 gives a data transfer rate of 60MB per second when reading from the disk, and 320MB per second when writing to the disk. Why are these numbers different? (Hint: Think about buffering.)

Chapter 7
EXERCISES

28. Suppose a disk drive has the following characteristics:

- **4 surfaces**
- **1024 tracks per surface**
- **128 sectors per track**
- **512 bytes/sector**
- **Track-to-track seek time of 5 milliseconds**
- **Rotational speed of 5000 RPM.**

◆ **a) What is the capacity of the drive?**

◆ **b) What is the access time?**

Chapter 7
EXERCISES

32. Transfer rate of a disk drive can be no faster than the bit density (bits / track) times the rotational speed of the disk. Figure 7.15 gives a data transfer rate of 112 GB/sec. Assume that the average track length of the disk is 5.5 inches. What is the average bit density of the disk?

37. Explain wear leveling and why it is needed for SSDs. We said that wear-leveling is important for the continual updating of virtual memory pagefiles. What problem does wear-leveling aggravate for pagefiles?