METRO STATE UNIVERSITY

ICS 232 Computer Organization & Architecture
Homework 11 - Chapter 7 - 10 points
Due Date: 11/8/2023

Name: Key

Note: Please post your homework to ICS232 D2L on or before the due date.

Chapter 7 – Input / Output Systems

Essential Terms and Concepts

23. Explain the differences between an SSD and a magnetic disk.

Magnetic disks have platters of magnetic material that rotate. A disk arm positions over the data to read. To access data the disk arm must move to the desired track and the disk must rotate so that the desired sector passes under the read head.

SSD disks are basically random-access memory which is logically divided into cylinders, tracks and sectors. There is no delay in accessing the data.

40. Which RAID levels offer the best performance?

RAID-0, but poor reliability

41. Which RAID levels offer the best economy while providing adequate redundancy?

RAID-3 – single parity disk
RAID-5 – distributed parity disk

Exercises

2. Calculate the overall speedup of a system that spends 40% of its time in calculations with a processor upgrade that provides for 100% greater throughput.

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$$S = \frac{1}{(1 - f) + f/k}$$

where

S is the speedup;
f is the fraction of work performed by the faster component; and
k is the speedup of a new component.

1.25 or 25% (S = 1.25; f = 0.4; k = 2)

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?

S = 1 / ((1 – f) + (f / k))

a) The CPU needs to be 50% faster: S = 1.25; f = 0.6; k=1.25/((1/1.25)-(1-0.6)) = 1.5
b) The disk needs to be 100% faster: S = 1.25; f = 0.4; k=1.25/((1/1.25)-(1-0.4)) = 2

14. Of programmed I/O, interrupt-driven I/O, DMA, or channel I/O, which is most suitable for processing the I/O of a:
a) Mouse
b) Game controller
c) CD
d) Thumb drive or memory stick
Explain your answers.

Mice and game controllers are character-based, sequential devices. Either programmed I/O or interrupt-driven I/O is best. CDs and thumb drives are block-oriented devices that

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lend themselves to DMA. Channel I/O is suitable, but excessive for the small amount of data involved.

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

Seek time is the time it takes for a disk arm to position itself over a requested track. Rotational delay is the time that it takes for the required sector to position itself under a read/write head. The sum of the rotational delay and seek time is known as the access time. If we add to the access time the time that it takes to actually read the data from the disk, we get transfer time.

29. Suppose a disk drive has the following characteristics:
    - 5 surfaces
    - 1024 tracks per surface
    - 256 sectors per track
    - 512 bytes/sector
    - Track-to-track seek time of 8 milliseconds
    - Rotational speed of 7500 RPM.

a) What is the capacity of the drive?
5 surfaces x 1,024 tracks per surface × 256 sectors per track × 512 bytes/sector = 5×1024×256×512/(2^20 bytes/MB) = 640MB.

b) What is the access time?

Rotational delay:

$$\frac{\frac{60 \text{ seconds}}{\text{disk rotation speed}} \times \frac{100 \text{ ms}}{\text{second}}}{2}$$

(60 seconds/7500 rpm) × (1000ms/second)]/2 = 4ms + 8ms seek time = 12ms.

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33. What are the advantages and disadvantages of having a small number of sectors per disk cluster? (Hint: You may want to think about retrieval time and the required lifetime of the archives.)

The advantage with a smaller number of sectors per cluster, is that you get more efficient usage (less wasted space) on the disk. The disadvantage is that the disk directory (or FAT) gets very large and may slow things down.

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 page files. What problem does wear-leveling aggravate for page files?

Wear leveling is a technique that ensures an even distribution of erase-update cycles on an SSD system. Using wear-leveling an updated data block almost never occupies the same block as the original. Because page files require a great deal of storage (usually twice the size of main memory), page file fragmentation can become a problem on an SSD.

41. A company that has engaged in a business that requires fast response time has just received a bid for a new system that includes much more storage than was specified in the requirements document. When the company questioned the vendor about the increased storage, the vendor said that he was bidding a set of the smallest capacity disk drives that the company makes. Why didn't the vendor just bid fewer disks?

The key idea is performance. The vendor calculated throughput based on the number of disk arms. The greater number of disk arms, the better the I/O response time. Having fewer disks would cause I/O delays because transactions would have to compete for fewer disk arms.

48. a) Which of the RAID systems described in this chapter cannot tolerate a single disk failure?

RAID-0.

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b) Which can tolerate more than one simultaneous disk failure?

RAID-1, RAID-2 and RAID-6. RAID-1 can tolerate multiple disk failures only if the failure does not involve a disk and its mirror image.

Prepare for next class by reading Chapter 8 – System Software

Continue working on Project 2

Continue working on Your Group Project