Computer Sciences Department
University of Wisconsin-Madison
CS/ECE 552 – Introduction to Computer Architecture
In-Class Exercise (04/07)

Answers to all questions should be uploaded on Canvas.

1. [6 points] Given a system with SCSI-2 controllers and disks (that do random reads), and given the following parameters:

- 300 MIPS CPU, 100 MB/s I/O bus
- 50K OS insns + 100K user insns per I/O operation
- SCSI-2 controllers (20 MB/s): each accommodates up to 7 disks
- 5 MB/s disks with $t_{seek} + t_{rotation} = 10$ ms, 64 KB reads

Determine the following:

(a) [3 points] What is the maximum sustainable I/O rate?
   a. What is the I/O rate for the CPU?
   b. What is the I/O rate for the bus?
   c. Given a and b, what is the maximum sustainable I/O rate?

CPU: 300M instr/2 / 150K = 2000IO/s
I/O bus: 100/64k = 1562IO/s
Peak: 1562

(b) [3 points] How many SCSI-2 controllers and disks are needed?
   a. What is the I/O rate for a given disk?
   b. How many disks are needed?
   c. Given a and b, how many SCSI-2 controllers are needed?

1/(10+64/5)=43.9

1562/43.9 = 36 disks

7*5=35<36

Need 6 controllers

2. [1 point] You are setting up a RAID system for your company. According to your CTO, how long it takes to access your disks does not matter. Given this, is there any benefit to using RAID-5 over RAID-4?

Tolerate any disk loss

3. [3 points] As transistor size decreases, transistors continue to become more and more unreliable, necessitating more advanced RAID techniques.

(a) [1 point] How many simultaneous disk failure(s) per row can RAID-5 prevent?

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(b) [2 points] As transistors become more unreliable, more advanced techniques beyond RAID-5 have been introduced. For example, RAID-6 adds a second parity disk to calculate *diagonal parity* on the diagonal across the disks (much like RAID-5 does per row). Thus, RAID-6 has two forms of parity: row parity and diagonal parity. Compared to RAID-5, what failure case does this provide protection against?

Two disks failed at the same time.