Delft University of Technology
Faculty of Electrical Engineering, Mathematics and Computer Science
Computer Engineering Lab
2022-2023

Computer Architecture and Organization (CAO) EE3D11

Assignment 5

Deadline Mar 31, 2023 before 08:00!

Note:
Upload a single file having the name "YourFirstName-LastName-HW-5" to the corresponding assignment in Brightspace.
When needed, the answer should be justified. Show clearly which theory is used to find your final answer.

Exercise 1 [12pts: 1/ 2/ 2/ 2/ 3/2]

Assume we will run a program (instructions) on a processor with the following parameters:

- L1 cache size: 4KB
- L1 hit rate: 94%
- L1 hit time: 0.9ns
- Main memory access time: 70ns
- Load and stores rate: 36% of the instructions

1. If we assume that the hit time of L1 determine the cycle time of the processor, what is then the clock rate of the processor?
2. What is the average memory access time AMAT?
3. If we assume that CPI of the processor is 1 without any memory stalls, what is the total CPI for the processor?
4. Assume we add now a second level cache to the processor; the following parameters apply:
   - L2 size= 1MB, L2 hit time = 6 ns
   - Miss rate to the main memory (i.e., global miss rate) = 10%

   What is the AMAT for the processor when L2 cache is added?
5. If we assume that CPI of the processor is 1 without any memory stalls, what is the total CPI for the processor with the addition of L2?
6. By adding L2 cache did the processor become faster or slower? Justify your answer and give the reason behind the obtained result/conclusion.

Exercise 2 [8pts: 2/2/2/2]

Assume the following memory architecture of a machine that uses virtual memory:

- Virtual address: 48 bits
- Page size: 8Kbytes
- Page Table Entry PTE size: 4 bytes
- 12 bits are reserved for other operating system and status bits (such as placement, valid, dirty bit, etc.) and not used hardware address translation.

1. How many pages are in the **virtual** address space?
2. What is the maximum size of **physical** addressable space for this machine, assuming the above PTE format?
3. How much memory is needed for storing the page table?
4. Assume **one application** exists in the system and the maximum physical memory is devoted to it. How much physical space is there for this application's code and data.