

## Computer Organization and Structure

Homework #1  
Due: 2014/9/30

1. Find the word or phrase from the list below that best matches the description in the following questions. Use the numbers to the left of the words in the answer. Each answer should be used only once.

1. virtual worlds	2. desktop computers	3. servers
4. low-end servers	5. supercomputers	6. terabyte
7. petabyte	8. datacenters	9. embedded computers
10. multicore processors	11. VHDL	12. RAM
13. CPU	14. operating system	15. compiler
16. bit	17. instruction	18. assembly language
19. machine language	20. C	21. Assembler
22. high-level language	23. system software	24. application software
25. cobol	26. fortran	

- a. Computer used to run large problems and usually accessed via a network
- b.  $10^{15}$  or  $2^{50}$  bytes
- c. Computer composed of hundreds to thousands of processors and terabytes of memory
- d. Today's science fiction application that probably will be available in near future
- e. A kind of memory called random access memory
- f. Part of a computer called central processor unit
- g. Thousands of processors forming a large cluster
- h. A microprocessor containing several processors in the same chip
- i. Desktop computer without screen or keyboard usually accessed via a network
- j. Currently the largest class of computer that runs one application or one set of related applications
- k. Special language used to describe hardware components
- l. Personal computer delivering good performance to single users at low cost
- m. Program that translates statements in high-level language to assembly language
- n. Program that translate symbolic instructions to binary instructions
- o. High-level language for business data processing
- p. Binary language that the processor can understand
- q. Commands that the processors understand
- r. High-level language for scientific computation
- s. Symbolic representation of machine instructions
- t. Interface between user's program and hardware providing a variety of services and supervision functions
- u. Software/programs developed by the users
- v. Binary digit (value 0 or 1)
- w. Software layer between the application software and the hardware that includes the operating system and the compilers
- x. High-level language used to write application and system software
- y. Portable language composed of words and algebraic expressions that must be

translated into assembly language before run in a computer

- z.  $10^{12}$  or  $2^{40}$  bytes
2. For a color display using 8 bits for each of the primary colors (red, green, blue) per pixel and with a resolution of 1280 x 800 pixels, what should be the size (in bytes) of the frame buffer to store a frame? If a computer has a main memory of 2 GB, how many frames could it store, assuming the memory contains no other information? If a computer connected to a 1 gigabit Ethernet network needs to send a 256 Kbytes file, how long it would take? Assuming that a cache memory is ten times faster than a DRAM memory, that DRAM is 100,000 times faster than magnetic disk, and that flash memory is 1000 times faster than disk, find how long it takes to read a file from a DRAM, a disk, and a flash memory if it takes 2 microseconds from the cache memory?
3. Consider three different processors P1, P2, and P3 executing the same instruction set with the clock rates and CPIs given in the following table.

<b>Processor</b>	<b>Clock rate</b>	<b>CPI</b>
P1	2 GHz	1.5
P2	1.5 GHz	1.0
P3	3 GHz	2.5

- a. Which processor has the highest performance?
- b. If the processors each execute a program in 10 seconds, find the number of cycles and the number of instructions.
- c. We are trying to reduce the time by 30% but this leads to an increase of 20% in the CPI. What clock rate should we have to get this time reduction?

For problems below, use the information in the following table.

<b>Processor</b>	<b>Clock rate</b>	<b>No. instructions</b>	<b>Time</b>
P1	2 GHz	$20 \times 10^9$	7 s
P2	1.5 GHz	$30 \times 10^9$	10 s
P3	3 GHz	$90 \times 10^9$	9 s

- d. Find the IPC (instructions per cycle) for each processor.
- e. Find the clock rate for P2 that reduces its execution time to that of P1.
- f. Find the number of instructions for P2 that reduces its execution time to that of P3.
4. You are going to enhance a machine, and there are two possible improvements: either make multiply instructions run four times faster than before, or make memory access instructions run two times faster than before. You repeatedly run a program that takes 100 seconds to execute. Of this time, 20% is used for multiplication, 50% for memory access instructions, and 30% for other tasks.
- a. What will the speedup be if you improve only multiplication?
- b. What will the speedup be if you improve only memory access?
- c. What will the speedup be if both improvements are made?

5. The following problems explore number conversions from signed and unsigned binary number to decimal numbers

1.	1010 1101 0001 0000 0000 0000 0000 0010 <sub>two</sub>
2.	1111 1111 1111 1111 1011 0011 0101 0011 <sub>two</sub>

- a. For the patterns above, what base 10 number does it represent, assuming that it is a two's complement integer?
- b. For the patterns above, what hexadecimal number does it represent?

The following problems explore number conversions from decimal to signed and unsigned binary numbers.

3.	2147483647 <sub>ten</sub>
4.	1000 <sub>ten</sub>

- c. For the base ten numbers above, convert to two's complement binary.