Computer Systems - Architecture

Main Memory Tutorial - Questions

1 How many address bits are required for a 4G x 32-bit main memory if

(a) main memory is word-addressable?
(b) main memory is byte-addressable?

2 The first two bytes of a 1G x 16-bit main memory have the following **hex** values:

Byte 0 = FF
Byte 1 = 01

If these bytes hold a 16-bit two's complement integer what is its **decimal** value if

(a) main memory is big-endian?
(b) main memory is little-endian?

3 Suppose that a 1G x 32-bit main memory is built using 256M x 4-bit RAM chips and that this memory is **word-addressable**.

For this memory organisation evaluate:

a) the number of RAM chips per memory module?
b) the number of memory modules?
c) the number of RAM chips for the full memory?
d) the number of address bits needed for a memory module?
e) the number of address bits needed for the full memory?

In which memory module would memory word 14 (ie. word address 14) be found when the memory system uses:

f) high-order interleave?
g) low-order interleave?

Assume memory modules are numbered from 0.

4 Suppose that the main memory given in question 3 is **byte-addressable**.

For this byte-addressable memory organisation evaluate:

a) the number of address bits needed for the full memory?

In which memory module would byte 14 (i.e. byte address 14) be found when the memory system uses:

b) high-order interleave?
c) low-order interleave?

Assume memory modules are numbered from 0.

5 The answers for questions 2(a) and 2(b) are different. Comment on the implications if we wished to transfer data between a little-endian memory (e.g. on an Intel computer) and a big-endian memory (e.g. on an PowerPC computer)?

Remember to show your working and carry out all the conversions without a calculator.