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Semester Bs(cs) 4th

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Subject Computer Architecture

Assignment 3rd (Chap 3)

Answer the Questions.

Q. Discuss the two approaches for dealing with multiple interrupts?

Ans. The first is to disable interrupts while an interrupt ~~is~~ is being processed. A disabled interrupt simply means that the processor can & will ignore the interrupt request signal.

* The drawback to the preceding approach is that it doesn't take into account relative priority or time critical needs.

Q. A second approach is to define priorities for interrupts & to allow an interrupt of higher priority to cause a lower priority interrupt handler to be itself interrupted.

b. Discuss the types of exchanges that are needed by indicating the major forms of input & output for processor, memory & I/O modules?

Ans. Following are the types.

* Memory to processor:-

The processor read that instruction or a unit of data from memory.

* Processor to memory:-

The processor write a unit of data to memory.

* I/O to processor:-

The processor read data from I/O device via an I/O module.

* Processor to I/O:-

The processor send data to the I/O data.

* I/O to or from memory:-

From these two cases an I/O modules is allow to exchange data directly with memory, without going through the processor, using direct memory access.

C) Discuss the Quickpath Interconnect (QPI) Protocol layers?

Ans QPI Protocol layer:-

In this layer the packet is defined as the unit of transfer, one key function performed at this level is cache Coherency protocol, which deals with making sure that main memory values held in multiple cache are consistent. A typical data packet payload is a block of data being sent to or from a cache.

Q) Discuss the physical & logical architecture of PCIe in detail?

Ans

* Physical & logical architecture of PCIe:-

* A root complex device, also referred to as a chipset or a host bridge connects the processor & memory subsystem to the PCI express switch fabric comprising one or more PCIe & PCIe Switch devices.

* PCIe links from the chipset may attach to the following kind of devices that implement PCIe.

* Switch:-

The switch manages multiple PCIe streams.

* PCIe endpoint:-

An I/O device or controller that implement PCIe such as a Gigabit ethernet switch, a graphics or videos controller, disk interface or a communication controller.

* Legacy endpoint:-

Legacy endpoint category is intended for existing design that have been migrated to PCI & it's allow legacy behaviour such as use I/O space & locked transaction.

* PCIe/PCI bridge:-

Allows order PCI device to be connected to PCIe-based system.

Write short note on each of the following:

A. Instruction cycle:-

The processing required for a single instruction is called an instruction cycle. Using the simplified two step description given previously the instruction cycle is depicted. The two steps are referred to as the fetch cycle & the execute cycle. Program execution halts only if the machine is turned off, some sort of unrecoverable error occurs, or a program instruction that halts the computer is encountered.

B. Instruction cycle state diagram:-

* Instruction address calculation (IAC)

Determine the address of the next instruction to be executed.

* Instruction fetch (IF):-

Read instruction from its memory location into the processor.

* Instruction operation decoding:-

Analyze instruction to determine the type of operation to be performed & operand(s) to be used.

* Operand address calculation (OAC):-

If the operation involve reference to an operand in memory or available via I/O then determine the address of the operand.

* Operand fetch (Op):-

fetch the operand from memory or read it in form I/O.

* Data operation:-

Perform the operation indicated in the instruction.

* Operand stor (Os):-

Write the result into memory or out to I/O.

C) Causes of interrupts:-

Ans) Its generated by some condition that occur as a result of an instruction execution such as arithmetic overflow, division by zero, attempt to execute an illegal machine instruction, or reference outside a user's allowed memory space.

* Timer:-

Its generated by a timer within a processor. This allows the operating system to perform certain function on a regular basis.

* I/O:-

Its generated by an I/O controller to signal normal completion of an operation request service from the processor, or to signal a variety of error condition.

D) Bus interconnection Scheme:-

The most common computer interconnection structure are based on the use of one or more system buses.

* Data lines:-

The data lines provide a path for moving data among system module. These lines collectively are called the data bus.

* Address lines:-

The address lines are used to designate the source of destination of the data on the data bus.

* Control lines:-

Control lines are used to control the access to & the used of the data & address lines. Because the address & the data lines are shared by all components.

Differentiate each of the following.

A- Programming in hardware & programming in software.

* Programming in hardware:-

The program is in the form of hardware & term a hardware program. Suppose we construct a general purpose configuration of arithmetic & logic function. This set of hardware will perform various function on data depending on control signals applied to the hardware. In original case of customized hardware the system accept data & produce result.

* Programming in software:-

The new method of programming which is a sequence of codes or instruction is called software. In this method programming is much easier, instead of rewiring the hardware for each new sequence of code each code is in effect an instruction & part of the hardware interprets each instruction & generates control signals.

B) Program flow of control without interrupt & with interrupt.

Ans) In the interrupt cycle, the processor check to see if any interrupts have occurred, indicated by the presence of interrupt signal.

* If no interrupt are pending, the processor proceed to the fetch cycle & fetches the next instruction of the current program.

c) Disabled interrupt & nested interrupt

processing: *

As A disabled interrupt simply means that processor can & will ignore that interrupt request signal. If an interrupt occur during this time it generally remain pending & will be checked by the processor after the processor has enabled interrupts.

* A nested interrupt is to allow an interrupt of higher priority to cause a lower priority interrupt handler to be itself interrupted. A user program begins at $t=0$. At $t=10$ a printer interrupt user information is placed on the system stack & execution continue at the printer interrupt service routine (ISR) while this routine is still executing at $t=15$ a communication interrupt occurs.

Q4) Solve each of the following.

The hypothetical machine of has two I/O instruction (see fig 01)

011 = load AC from I/O

011 = store AC to I/O

In these cases the 12-bit address identify a particular I/O device. Show the program execution (using the format of fig 3.5) for the following program.

Load AC from device 5
Add. Contents of memory location 940
Store AC to device 6.

Add that the next value retrieved from device 5 is 3 & that location 940 contains a value of 2.

Ans) Memory (contents in hex): 300: 3005, 301: 5940, 302: 7006
step 1: 3005 \rightarrow IR;
Step 2: 3
 \rightarrow AC step 3: 5940 \rightarrow IR; step 4: $3+2=5 \rightarrow$
AC step 5: 7006 \rightarrow IR; step 6: AC \rightarrow Device 6

B) The program execution of fig 02 is described in the text using six steps. Expand this description to show the use of the MAR & MBR?

Ans) The PC contain 300, the address of the first instruction. This value is loaded into the MAR. b. The value in location 300 (which is the instruction with the value 1940 in hexadecimal) is loaded into the MBR & the PC is incremented. The two steps can be done in parallel. The value in the MBR is loaded into the IR.

2. The address portion of the IR (940) is loaded into the MAR. b. The value in location 940 is loaded into the MBR. c. The value in the MBR is loaded into the ac.

3. The value in the pc(301) is loaded into the MAR-b. The value in location (301) is loaded into the MBR & Pc is incremented c. The value in the MBR & the Pc is incremented c. The value in the MBR is loaded into the IR (941).

4) The address portion of IR (941) is loaded into the MAR(B). The value of the ac & the value of location MBR are added & the result is stored in the Ac.

5) The value in the Pc(302) is loaded into the MAR-b. The value in location 302 is loaded into the MBR & the Pc is incremented c. The value in the MBR is loaded into the IR.

6) The address portion of the IR (941) is loaded into MAR-b. The value in the AC is loaded into MBR C. The value in the MBR is stored in location 941.

C. Consider a hypothetical 32-bit microprocessor having 32-bit instruction composed of two fields. the first byte contain the opcode & the remainder the immediate operand or an operand address.

a. What is maximum directly addressable memory capacity (in bytes)?

b. Discuss the impact on the system speed if the microprocessor bus has.

- 1) 32 bit local address bus & 16 bit local data bus or.
- 2) 16 bit local address bus & a 16 bit local data bus.
- c. How many bits are needed for the Program Counter & the instruction register.

Ans $2^4 = 16 \text{ MBytes}$.

b (1) If the address bus is 32 bits the whole addressed can be transferred at once and decoded in the memory. However, because the data bus is only 16 bits, it will require 2 cycle to fetch a 32-bit instruction or operand.

(2) The 16 Bit of the address placed on the address bus can't access the whole memory thus a more complex memory interface control is needed to latch the first part of the address & then the second part.

c: The program counter must be at least 24 bits. Typically a 32-bit microprocessor will have a 32 bit external address bus & a 32 bit program counter. Unless on chip segment register are used that may work with a smaller program counter. If the instruction register is to contain the whole instruction it will have to be 32-bits long. If it will contain only the op code (called the op code registers) then it will have to be 8 bits long.

D) Consider a 32-bit microprocessor with a 16 bit external data bus, drive by an 8-MHz input clock. Assume that this microprocessor has a bus cycle whose minimum duration equals four input clock cycles. what is the maximum data transfer rate across the bus that this microprocessor can sustain? To increase its performance, would it be better to make its external data bus 32 bits or double the external clock frequency supplied to the microprocessor? State any other assumption you make & explain.

Ans) Clock Cycle

$t = 125\text{ns}$ 8 MHz Bus Cycle = $4 \times 125\text{ns} = 500\text{ns}$
 2 bytes transferred every 500ns, thus transfer rate.

* 4MByte/sec:-

Doubling the frequency may mean adopting a new manufacturing technology doubling the external data bus means wider (maybe newer) on chip data bus drivers latches & modification to the bus control logic in first case, the speed of the memory chips will also need to double not to slow down the microprocessor. in the second case the "wordlength" of the memory will have to double to be able to send/receive 32-bit quantities.

e) Consider two microprocessor having 8 & 16 bit wide external data buses respectively. The two processor are identical otherwise & their bus cycle take just as long.

A. Suppose all instructions & operands are two bytes long. By what factor do the maximum data transfer rate differ?

b. Repeat if half of the operands & instructions are one byte long.

Ans. During a single bus cycle, the 8 bit microprocessor transfer one byte while the 16 bit microprocessor transfer two bytes. The 16 bit microprocessor transfer two bytes. The 16 bit microprocessor has twice the data transfer rate.

b. Suppose we do 100 transfers of operands & instructions of which 50 are one byte long & 50 are two bytes long. The 8 bit microprocessor takes $50 + (2 \times 50) = 150$ bus cycle for the transfer. The 16-bit microprocessor requires $50 + 50 = 100$ bus cycle. Thus the data transfer rate differ by a factor 1.5.

f) The intel 8086 is a 16-bit processor similar in many ways to the 8-bit 8088. The 8088 uses a 16-bit bus that can transfer 2-bytes at a time.

Provided that then lower order byte has an even address, However. the 8086 allow both even & odd aligned word is referenced, two memory cycle each consisting of four bus cycle are required to transfer the word. Consider an instruction on the 8086 that involves two 16-bit operands. How long does it take to fetch the operand. Give the range of possible answer. Assume a clocking rate of 4MHz & no wait states

Ans) A bus cycle take $0.25 \mu s$ so a memory cycle take $1 \mu s$. If both operand are even aligned, it take $2 \mu s$ to fetch the two operands, if one is odd-aligned, the time required is $3 \mu s$. If both are odd-aligned the time required is $4 \mu s$.

Q) Consider a 32-bit microprocessor whose bus cycle is the same duration as that of a 16-bit microprocessor. Assume that an average 20% the operands & instruction are 32 bits long 40% are 16 bit long. Calculate the improvement achieved when fetching instruction & operands with the 32-bit microprocessor.

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Consider a mix of 100 instructions & operands on average they consist of 20% 32-bit items, 40% 16-bit items, & 40% 8-bit items. The number of bus cycles required for the 16-bit microprocessor is $(2 \times 20) + 40 + 40 = 120$.

For the 32-bit microprocessor, the number required is 100. This amounts to an improvement of $20/120$ or about 17%.