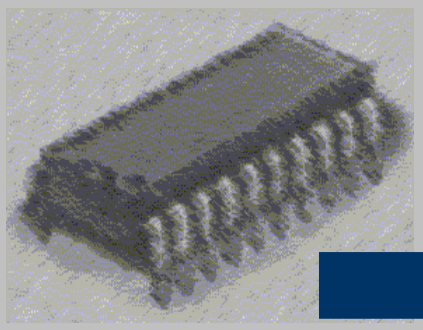
Exercises

Lesson 5: The Input-Output System



Computer Structure and Organization

Graduated in Computer Sciences
Graduated in Computer Engineering

1. We have a computer that is able of executing 10 MIPS (10^7 instruction per second) We wish to attach to such computer one device only. Device characteristics are: transfer speed 20.000 bytes/s. Block reading size 1.024 bytes.

   Different I/O techniques will be tested (programmed, interrupt driven and DMA)

   We also know:

   - I/O program has 10 instructions.
   - I/O service interrupt has 20 instructions.
   - I/O DMA initialization hast 8 instructions. Buses are busy 500 ns. when a reading / writing operation is taken place.

   Please, calculate the number of available instructions to other programs for each type of I/O synchronization.

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2. Solve previous exercises by supposing that transfer speed is 25.000 bytes/s. and blocks size is 512 bytes.

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3. Please, calculate average reading / writing time of 512 bytes sector in a 5.400 r.p.m. hard disk:

   - Positioning time 18 ms.
   - Transfer speed 5 MB/s.
   - Controller overload 3 ms.
   - There isn't waiting time because controller is idle.

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4. Please, calculate promethium reading / writing time of 1024 bytes sector in a 7.200 r.p.m. hard disk:
    - Positioning time 12 ms.
    - Transfer speed 15 MB/s.
    - Controller overload 2 ms.
    - There isn't waiting time because controller is idle.

5. Please, calculate promethium reading / writing time of 1024 bytes sector in a 3.600 r.p.m. hard disk:
    - Positioning time 12 ms.
    - Transfer speed 10 MB/s.
    - Controller overload 2 ms.
    - There isn't waiting time because controller is idle.

6. We have a computer that is able of executing 1000.000 instructions while a 2.048 bytes block is read, please, calculate how many instructions will be available to other processes if we use a DMA I/O synchronization technique. Initialization routine: 8 instructions. Buses will be busy 750 ns. per reading / writing operation.

7. We have a computer that is able of executing 1000.000 instructions while a 2.048 bytes block is read, please, calculate how many instructions will be available to other processes if we use an interrupt driven I/O synchronization mechanism. Service interrupt program is composed of 20 instructions.

8. We wish to compare maximum bandwidth of two buses (asynchronous and synchronous). Clock cycle of synchronous bus is 40 ns. and one clock cycle is required in each transaction. Asynchronous bus needs 40 ns. per Handshaking protocol slots. Both buses have a data width of 16 bits.

   Please, calculate both buses bandwidth for memory readings of one word and an access time of 200 ns.

9. We wish to compare maximum bandwidth of two buses (asynchronous and synchronous). Clock cycle of synchronous bus is 50 ns. and one clock cycle is required in each transaction. Asynchronous bus needs 20 ns. per Handshaking protocol slots. Both buses have a data width of 32 bits.

   Please, calculate both buses bandwidth for memory readings of one word and an access time of 100 ns.

10. We wish to compare maximum bandwidth of two buses (asynchronous and synchronous). Clock cycle of synchronous bus is 20 ns. and one clock cycle is required in each transaction. Asynchronous bus needs 20 ns. per Handshaking protocol slots. Both buses have a data width of 16 bits.

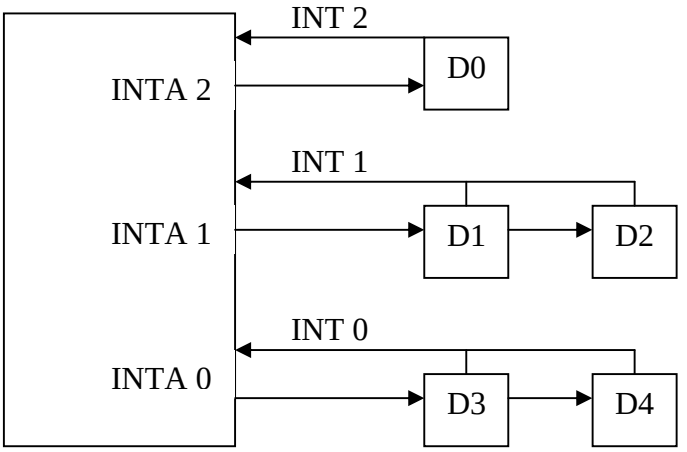
    Please, calculate both buses bandwidth for memory readings of one word and an access time of 30 ns.

11. We wish to compare maximum bandwidth of two buses (asynchronous and synchronous). Clock cycle of synchronous bus is 30 ns. and one clock cycle is required in each transaction. Asynchronous bus needs 25 ns. per Handshaking protocol slots. Both buses have a data width of 32 bits.

Please, calculate both buses bandwidth for memory readings of one word and an access time of 60 ns.

12. Let's be a computer with three priority levels, level 2 is maximum priority and 0 the lowest one. When serving a level *n* interrupt same and lower level interrupts are disabled and jump to first RUT *n* instruction

    Five devices are attached to this computer as shown:



D1 and D2 and D3 and D4 are respectively daisy chain attached.

Service interrupt routines are shown as following:

Number	Pseudo code	Routine
1	A ← counter	Rut 2
2	Counter2 ← A	
3	Enable interrupts level 2	
4	Interrupt return	
11	A ← keyboard	Rut 1
12	Enable interrupts levels 1 and 2	
13	Increment A	
14	Interrupt return	
21	A ← keyboard	Rut 0
22	Index ← A	
23	Enable all levels interrupt	
24	Interrupt return	
100	Enable interrupts level 2	Main Program
101	Counter ← 0	
102	Index ← 0	
103	Enable all levels interrupt	
104	A ← A + D	
105	Display A	
106	TMP ← 0	
107	End program	

Devices request interrupts as following:

Device	First request	Time among requests
D_0	2	Each 49
D_1	22’2	50
D_2	6’5	Each 40
D_3	3’25	Each 42
D_4	0’8	Each 20

Please, trace program between 0 and 29 instants of time.

13. Please, solve previous program but with schema bellow: