Chapter 7 review

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Chapter 7 review questions

1. List three broad classifications of external, or peripheral, devices.
Human readable, machine readable, and communication.

2. What is the International Reference Alphabet?
It is 7-bit text code used to represent characters (numbers, letters, special characters).

3. What are the major functions of an I/O module?
Control and timing, processor communication, device communication, data buffering, error detection.

4. List and briefly define three techniques for performing I/O.
Programmed I/O - data exchanged between the processor and the I/O module. The processor executes a program that gives it direct control of the I/O operation, including sensing device status, sending a read or write command, and transferring the data.

Interrupt-driven I/O - processor issues I/O command, then goes off to do other things until the I/O module interrupts the processor to request service when it is ready to exchange data with the processor.

Direct Memory Access - involves an additional module on the system bus. The DMA module is capable of mimicking the processor, and, indeed, of taking over control of the system from the processor.

5. What is the difference between memory-mapped I/O and isolated I/O?
With memory mapped I/O, there is a single address space for memory locations and I/O drives. With isolated I/Ok, the address space for I/O is isolated from that from memory, since the bus may be equipped with memory read and right plus input and output command lines.

6. When a device interrupt occurs, how does the processor determine which device issued the interrupt?
It can use software polling, polling each I/O module to see which one caused the interrupt, daisy chaining, with a message sent from the processor when it receives an interrupt, and the message going through each module until it reaches the module, which then sends an response to the processor, or using vectored interrupts for bus arbitration. The module takes over the bus line, and only one module can do so at a time.

7. When a DMA module takes control of a bus, and while it retains control of the bus, what does the processor do?
The processor either doesn't need to use the bus at the time, or it is forced to suspend operation temporarily. The processor deals with other things, while the bus operation is left to DMA.

Problems

6. For programmed I/O, figure 7.5 indicates that the processor is stuck in a wait loop doing status checking of an I/O device. To increase efficiency, the I/O software could be written so that the processor periodically checks the status of the device. If the device is not ready, the processor can jump to other tasks. After some timed interval, the processor comes back to check status again.

a. Consider the above scheme for outputting data one character at a time to a printer that operates at 10 characters per second (cps). What would happen if its status is scanned every 200ms?
The printers rate would be effectively halved, since the printer itself would be ready every 100ms (10 characters per second would mean 1 character every 100ms), but the processor is checking every 200ms.

b. Next consider a keyboard with a single character buffer. On average, characters are entered at a rate of 10 cps.

However, the time interval between two consecutive key depressions can be as short as 60ms. At what frequency should the keyboard be scanned by the I/O program?
60ms. Example. Rate is at 10 cps. With 200ms no letters would be lost due to the buffer. If one press were to be 60ms, there is the possibility of loss of the character that was just in the buffer, since the status check would not have happened yet.

8. In section 7.3, one advantage and one disadvantage of memory-mapped I/O compared with isolated I/O, were listed. List two more advantages and two more disadvantages.
With memory mapped I/O, the programmer can have direct access to the hardware, to manipulate it just by dealing with the memory locations to which the registers of, say, the video card is mapped. Another advantage is that the same machine instructions used to deal with memory can be used to deal with the hardware. One disadvantage is that affecting the hardware can become more difficult in a memory mapped I/O system, especially in higher level programming. Another disadvantage would be having to directly deal with the hardware with machine instructions, instead of having a more abstracted (requiring special instructions) way to deal with the hardware.

10. Consider a system employing interrupt-driven I/O for a particular device that transfers data at an average of 8 KB/s on a continuous basis.

a. Assume that interrupt processing takes about 100 microseconds (i.e., the time to jump to the interrupt service routine (ISR), execute it, and return to the main program). Determine what fraction of processor time is consumed by this I/O device if it interrupts for every byte.
8000 bytes per second. 1/8000 = .000125 = 125µs
100/125 = 4/5 = .80

b. Now assume that the device has two 16-byte buffers and interrupts the processor when one of the buffers is full. Naturally, interrupt processing takes longer because the ISR must transfer 16 bytes. While executing the IRS, the processor takes about 8 microseconds for the transfer of each byte. Determine what fraction of processor time is consumed by this I/O device in this case.
8µs * 16b/s = 128µs
128/125 = 1 1/125. = 1.024

12. A DMA module is transferring characters to memory using cycle stealing, from a device tramsitting at 9600 bps. The processor is fetching instructions at the rate of 1 million instructions per second (1 MIPS). By how much will the processor be slowed down due to the DMA activity?

1/9600 = 104.1667μs

1 cycle lost every 104μs

1/1000000 = .000006 = 6μs

6/104 = .05769231

20. The following problem is based on a suggested illustration of I/O mechanisms in [ECKE90](figure 7.24):

Two women are on either side of a high fence. One of the women, named Apple-server, has a beatiful apple tree loaded with delicious apples growing on her. The other woman, named apple-eater, loves to eat apples but has none. In fact, she must eat her apples at a fixed rate (an apple a day keeps the doctor away). If she eats them faster than that rate, she will get sick. If she eats them slower, she will suffer malnutrition. Neither woman can talk, and so the problem is to get apples from Apple-server to Apple-eater at the correct rate.

a. Asume that there is an alarm clock sitting on top of the fence and that the clock can have multiple alarm settings. How can the clock be used to solve the problem? Draw a timing diagram to illustrate the solution.

b. Now assume that there is no alarm clock. Instead, Apple-eater has a flag that she can wave whenever she needs an apple. Suggest a new solution. Would it be helpful for apple-server also to have a flag? If so, incorporate this into the solution. Discuss the drawbacks of this approach.

c. Now take away the flag and assume the existence of a long piece of string. Suggest a solution that is superior to that of (b) using the string.

a. the alarm clock can be set to ring according to the eating rate of apple-eater. When the alarm goes off, apple-server could drop everything and serve up an apple to apple-eater, and then go back to what she was doing. (use the alarm as an interrupt).

b. Apple-eater could wave the flag when she needs an apple. Have apple server keep an eye out for a flag. When there is no flag, apple-server can deal with other things. When apple-eater waves the flag, apple-server can send an apple to apple-eater. It would be helpful for apple-server to have a flag, since apple-server could wave her flag to let apple-eater know she has seen the flag, and will send an apple.

c. With a string, apple-eater can tug on the string to alert apple-server of the need for an apple. Apple-server could then tug on the string to signal that an apple is on the way. Apple-server and apple-eater do not have to try to look for a waving flag over the fence (which could be missed), instead, just by tugging on a string, a signal can be sent.

Comments