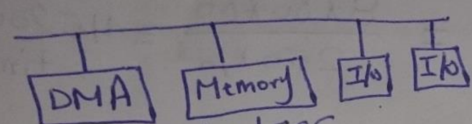
Tutorial #05

[5 points] A DMA controller collects characters from a device and transfers them to memory using cycle stealing. The device produces characters at a rate of 2400 characters per second. The processor is fetching instructions at the rate of 1 million instructions per second (1 MIPS). The system bus can transfer no more than one instruction or character every cycle. By how much will the processor be slowed down due to the DMA activity for each of the following two DMA configurations:

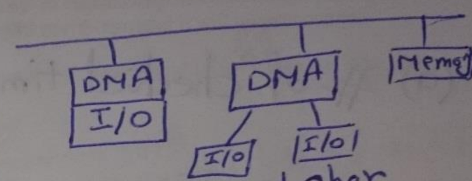
(a) Single-bus, detached DMA
(b) Single-bus, integrated DMA

(a)



2 bus cycle / sec

slow down : $(2 * 2400) / 10^6$



1 bus cycle / char

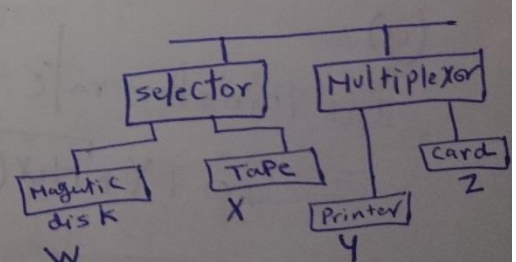
slow down : $(2400) / 10^6$

[5 points] A computer has one selector channel and one multiplexor channel. The selector channel is connected to a magnetic disk drive and a magnetic tape drive. The multiplexor channel is connected to a laser printer and a card reader. Assume the following transfer rates: disk drive = w bps, tape drive = x bps, laser printer = y bps, card reader = z bps, where w, x, y, and z are positive numbers.

(a) What the maximum aggregate I/O transfer rate in this system.
(b) How many more disk drives can be connected to the selector channel without changing the maximum aggregate I/O transfer rate.
(c) How many more laser printers can be connected to the multiplexor channel without changing the maximum aggregate I/O transfer rate.
(d) If another laser printer is to be connected to the selector channel. Which condition needs to be satisfied in order to maintain the same maximum aggregate I/O transfer rate.

(a) Max I/O aggregate:

$\equiv y + z + \max(w, x)$



(b) any number as long as it's rate is (less or Equal) than $\max(w, x)$

(c) Zero

(d) $y \le \max(w, x)$

[4 points] A particular system is controlled remotely by an operator through commands sent over a communication line. The average number of commands entered in an 8-hour interval is 100. Suppose the processor scans the communication line once every 250 ms.

(a) How many times will the communication line be checked in an 8-hour period?

(b) What would be the percentage of reduction in the number of processor visits to the communication line if interrupt-driven I/O were used?

(a) # of checked times $= \dfrac{8*60*60}{250*10^{-3}} = 115200$ time

(b) # of Processor visits with Interrupt driven $= 100$

% of reduction $= \dfrac{115200-100}{115200} \times 100$

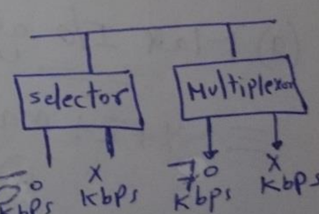
[6 points] A computer has one selector channel and one multiplexor channel. The selector channel connects two devices whose transfer rates are 50 Kbps and x Kbps, respectively. The multiplexor channel connects two other devices whose transfer rates are 70 Kbps and x Kbps, respectively.

(a) Represent the maximum aggregate I/O transfer rate of this system as an expression in terms of x.

(b) Calculate a value for x such that the maximum aggregate I/O transfer rate is 130 Kbps.

(c) Would it be possible to connect a fifth device to this system without changing the maximum aggregate I/O transfer rate? Justify your answer.

(a) I/O transfer rate $= 70 + X + \overbrace{\text{Max}(50, X)}^{\text{selector}}$



(b) * if $\boxed{X=50}$

I/O $= 70 + 50 + 50 = 170$ "rejected"

* $\boxed{X>50}$: I/O $= 70 + 2X = 130$, $\boxed{X=30}$ X

due to if "50Kbps" device is selected The I/O will be > 130 Kbps

* $\boxed{X<50}$: I/O $= 70 + X + 50 = 130$, $\boxed{X = 10 \text{ Kbps}}$

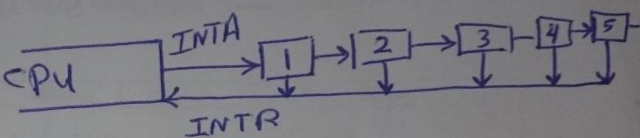
(c) Yes, connect to selector in condition of it's rate less or Equal than Max(50, X)

[9 points] Five input devices are connected to a CPU in a daisy-chain. Suppose each device produces no more than c characters/s. When a device has a character, it issues an interrupt request to the CPU. The CPU responds immediately by sending an interrupt acknowledge down the chain. Once a device receives an acknowledge, it takes 200 μs to either put its vector (*i.e.*, ID) on the bus or else pass the acknowledge along to the next device. Once the device puts its vector on the bus, the CPU takes 100 μs to execute the ISR of that device (*i.e.*, collect the character, and be ready to serve the next device).

(a) Calculate the time taken by the CPU to collect the characters in the following cases:
   i. There are only two characters available; one in the first device and one in the fifth device.
   ii. There is one character available in each device.

(b) What is the maximum value of c?

(c) If the total number of devices in the daisy-chain was n, what would be the maximum value of c (expressed as function in n)?



(a)

- First device: $200+100$

Fifth device: $200*5+100$

total time $= 300+1100 = 1400$ μsec

- one character at each device:

total time $= 300+200*2+100+200*3+100$
$+200*4+100+200*5+100$
$= 3500$ μsec

(b) worst case there is a character at each device. so no device Produce anew character until cpu receives all characters:

$$c = \frac{1}{3500\ \mu sec} = 285\ \frac{char}{sec}$$

(c) time $= 200+100+200*2+100+ ----- +200*n+100$
$= 100*n + 200(1+2+---+n)$
$= 100n + 200*\frac{(n+1)}{2}*n \equiv 100n(n+2)$

$$\boxed{c = 1/(100n(n+2))}$$