CS & IT ENGINEERING

COMPUTER ORGANIZATION AND ARCHITECTURE

IO Organization

Lecture No.- 03

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Recap of Previous Lecture

- **Topic** Modes of Transfer
- **Topic** Programmed IO
- **Topic** Interrupt IO

Topics to be Covered

- **Topic** Direct Memory Access (DMA)
- **Topic** Cycle Stealing
- **Topic** Burst Mode

[NAT]

#Q. A device with data transfer rate 20 KB/sec is connected to a CPU. Data is transferred byte-wise. Let the interrupt overhead be 10 microsecond.

(550 us) 1. Total time required in programmed IO for 10 bytes data transfer?

2. Total time required in interrupt IO for 10 bytes data transfer?

3. What is the minimum performance gain of operating the device under interrupt mode over operating it under program controlled mode?

1. Time needed in programmed I/O = time to check status + Data transfer time

= 1 Byte status Reg. + 10 Bytes transfer time

transfer time

= 50 usec + (10 * 50) = 550 usec

for 20kB, device takes = 1sec

for 1 Byte —11— = $\frac{1\,sec}{20\,kB} * 1B$

$= \frac{1}{20}\,msec$

$= \frac{1000}{20}\,\mu sec$

$= 50\,\mu sec$

2. Total time in interrupt I/O = Interrupt overhead + Service time

$= 10\ \mu sec + (10 * 50)\ \mu s$

$= 510\ \mu sec$

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3. performance gain or speed up of faster technique $= \frac{\text{older technique time}}{\text{faster technique time}} = \frac{550\ \mu sec}{510\ \mu sec}$

$= 1.078$

[NAT]

Ans = 25

GATE - PYQ 2005

#Q. A device with data transfer rate 10KB/sec is connected to a CPU. Data is transferred byte-wise. Let the interrupt overhead be 4 microsec. The byte transfer time between the device interface register and CPU or memory is negligible. What is the minimum performance gain of operating the device under interrupt mode over operating it under program-controlled mode?

for 10kB, time = 1sec

for 1B, time = $\frac{1\ sec}{10\ kB} * 1B$

$= \frac{1}{10}\ msec$

$= 100\ \mu sec$

Programmed I/O time = 100 + 0 = 100 μs

Interrupt I/O time = 4 + 0 = 4 μs

Performance gain = $\frac{100\ \mu s}{4\ \mu s} = 25$

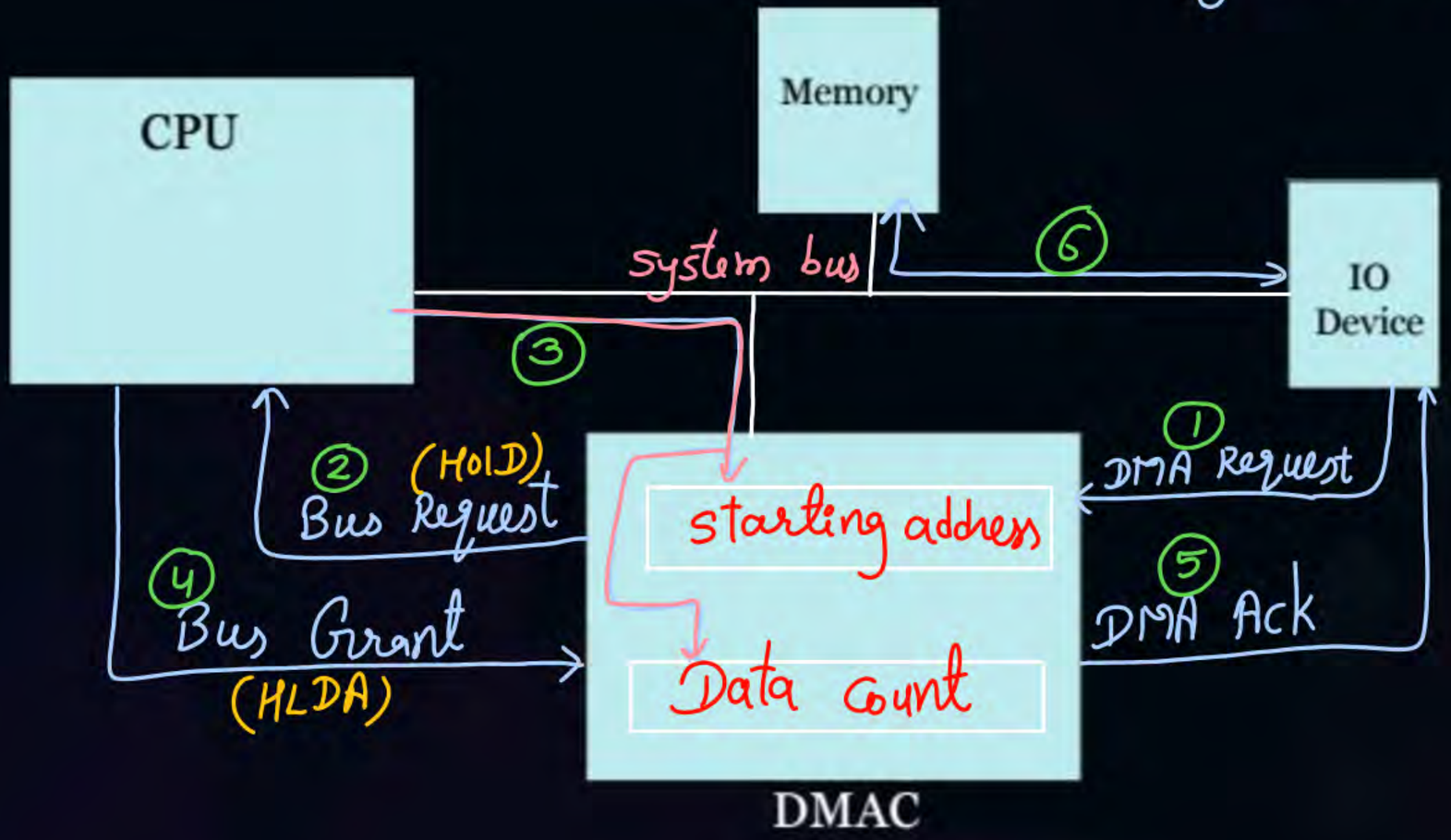
Topic : DMA (Direct Memory Access)

- Enables data transfer between I/O and memory without CPU intervention
- Need a hardware: DMAC (DMA Controller)

Topic : DMA

$t_x = 100$ ms

$t_y = 5$ ms



Topic : DMA

1. Starting Address :- add. of mem., starting from where data transfer starts in memory

2. Data Count :- No. of bytes / words to be transferred.

example

	Initially	After 1B transferred	After 1B		
starting add.	200	201	202	.....	Transfer stops when data count becomes zero.
Data count	50	49	48	.....	

During DMA transfer CPU can not use system buses.

So CPU can perform only those operations which do not require system bus; which means CPU remains idle or blocked during that time.

Topic : Modes of DMA Transfer

After how much time (when) CPU takes back control of the bus from DMAC.

Topic : Modes of DMA Transfer

1. Burst Mode
2. Cycle Stealing
3. Interleaving DMA

Topic : Modes of DMA Transfer

Burst Mode :

when control of the buses is given to DMAC, then a burst (block) of data is transferred before CPU takes back the bus control.

Topic : Modes of DMA Transfer

Cycle Stealing :

slow I/O device takes time to prepare data internally. During that time CPU keeps the control of the buses.

when the data (1 byte or 1 word) is prepared, DMAC steals buses for 1 cycle from CPU and transfers the prepared data to memory; and again bus control is returned to CPU after that.

Data preparation time in I/O ⇒ Calculated based on speed of I/O

Data transfer time to memory ⇒ —— 11 —————— 11 —— of memory

Assume,

Data preparation time in I/O = t_x

Data transfer time to memory = t_y

Percentage of time CPU is blocked due to DMA = $\frac{t_y}{t_x + t_y} * 100\%$ (Burst Mode)

" " " " = $\frac{t_y}{t_x} * 100\%$ (cycle stealing)

[MCQ]

Ans = 12.5 %

#Q. Consider a device operating on 1MBPS speed and transferring the data to memory using cycle stealing mode of DMA. If it takes 2 microseconds to transfer 16 bytes data to memory when it is ready/prepared. Then percentage of time CPU is blocked due to DMA is?

$t_y = 2$ μsec

$t_x = 16$ μsec

for 1 MB preparat^n, time = 1sec

for 16 B —11— , time = $\frac{1\text{sec}}{1\text{MB}} * 16\text{B}$

$t_x = 16$ μsec

% of time CPU blocked due to DMA = $\frac{2\ \mu s}{16\ \mu s} * 100\%$

= 12.5 %

2 mins Summary

Topic Modes of Transfer

Topic Programmed IO

Topic Interrupt IO

Happy Learning

THANK - YOU