

## 第七章作业

1. A DMA module is transferring characters to memory using cycle stealing, from a device transmitting 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? (默认字长为 1B)

解:

设备传输率转换:

$$\text{传输速率} = \frac{9600\text{bps}}{8\text{bps/byte}} = 1200\text{byte/s}$$

在周期窃取模式下, DMA 每次传输 1 字节数据时, 占用一个总线周期。因此, 每秒需要进行的总线周期数为:

$$\text{总线周期数} = 1200\text{bytes/s}$$

处理器以 1 MIPS 的速度工作由于窃取, 速度会减慢 1200 IPS, 计算性能下降比例:

$$\text{性能下降比例} = \frac{1200\text{IPS}}{1,000,000\text{IPS}} = 0.0012 = 0.12\%$$

2. A 32-bit computer has two selector channels and one multiplexor channel. Each selector channel supports two magnetic disk and two magnetic tape units. The multiplexor channel has two line printers, two card readers, and 10 VDT terminals connected to it. Assume the following transfer rates:

Disk drive            800KB/s

Magnetic tape drive 200KB/s

Line printer         6.6KB/s

Card reader         1.2KB/s

VDT                  1KB/s

Estimate the maximum aggregate I/O transfer rate in this system.

解:

由于选择通道在同一时刻只能连接到一台设备, 因此在选择通道同时连接到磁盘的情况下选择通道速率为:

$$\text{选择通道速率} = 2 \times 800\text{KB/s} = 1600\text{KB/s}$$

多路复用通道的最大速率计算:

$$\text{行打印机速率} = 2 \times 6.6\text{KB/s} = 13.2\text{KB/s}$$

$$\text{读卡器速率} = 2 \times 1.2\text{KB/s} = 2.4\text{KB/s}$$

$$\text{VDT 终端速率} = 10 \times 1\text{KB/s} = 10\text{KB/s}$$

$$\text{多路复用的总速率} = 13.2\text{KB/s} + 2.4\text{KB/s} + 10\text{KB/s} = 25.6\text{KB/s}$$

综上，最大总 I/O 传输速率为：

$$\text{最大总 I/O 传输速率} = 1600\text{KB/s} + 25.6\text{KB/s} = 1625.6\text{KB/s}$$

3. Assume some I/O device send information to CPU with the maximum frequency of 4000 times per second, while the executing time of the corresponding interrupt handler routine is  $40\mu\text{s}$ . Can this I/O device adopt Interrupt driven mode to work? And why?

解：

I/O 设备的最大频率是 4000 次/秒，因此最小的平均数据发送间隔为：

$$\text{最小间隔} = \frac{1\text{s}}{4000} = 0.25\text{ms} = 250\mu\text{s}$$

而中断处理时间是  $40\mu\text{s}$ ：

$$40\mu\text{s} < 250\mu\text{s}$$

故可以采用中断驱动方式工作。

4. Assume that a disk uses 32-bit word as the data transmission unit with transferring rate of  $1\text{MB/s}$ , and CPU clock cycles is  $50\text{MHz}$ . Please answer the following questions:

- In programmed mode, suppose that it takes 100 clock cycles to finish required operation. Please calculate the ratio of time that CPU uses for I/O inquiring (assume that there is enough inquiring operation to avoid data loss).
- In Interrupt driven mode, the time consumption (including handling interrupt) for each transferring process is 80 clock cycles. Please calculate the ratio of time that CPU takes for data transferring of disk.
- In DMA mode, assume that it takes 1000 clock cycles to start DMA, and 500 clock cycles to post-process when the DMA

finished. If the length of the average transmission data is 4 KB, how much is the ratio of time that CPU use to finish I/O operation when disk working? Ignore the bus-request time of DMA.

解:

a. 字传输速率为:

$$\text{传输速率} = \frac{1\text{MB/s}}{32\text{bits}} = 250,000\text{words/s}$$

CPU 的时钟频率是 50 MHz, 每次询问操作需要 100 个时钟周期, 因此每次询问的时间为:

$$100 \times \frac{1}{50 \times 10^6} = 2\mu\text{s}/\text{inquiry}$$

计算 CPU 总共花在 I/O 询问上的时间:

$$250,000 \times 2\mu\text{s} = 500,000\mu\text{s} = 0.5$$

因此, 在程序控制模式下, CPU 花费的时间比例为 50%。

b. 计算每次中断处理的时间:

$$80 \times 0.02\mu\text{s} = 1.6\mu\text{s}/\text{interrupt}$$

计算 CPU 花在中断处理上的总时间:

$$250,000 \times 1.6\mu\text{s} = 400,000\mu\text{s} = 0.4$$

因此, 在中断驱动模式下, CPU 花费的时间比例为 40%。

c. 块传输速率为:

$$\frac{1\text{MB/s}}{4\text{KB}} = 256\text{blocks/s}$$

CPU 等待 DMA 的时钟周期为:

$$1000 + 500 = 1500$$

该周期传输的块为:

$$\frac{256\text{blocks/s} \times 1500}{50\text{MHz}} = 0.0075\text{words}$$

因此, I/O 时间比例为 0.75%