X86架构的部分内容

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# 存储控制器（Memory Controller）

* 存储控制器提供了通过软件来读写内存的方式。同时也负责对RAM芯片做持续的刷新，来确保芯片上的数据不会丢失。
* 存储器控制器通过多路复用器（Multiplexer）和解复用器（Demultiplexer）电路来准确选择要处理的RAM芯片，以及在地址总线上要引用的地址。

# I/O子系统

**I/O子系统（I/O subsystem）表示的就是I/O端口（I/O ports），这个基础的系统，负责在软件和硬件的控制器之间提供一个接口（interface）。**

* 端口（ports）

所谓的端口，就是在两个设备之间提供接口的东西。可以分为硬件端口和软件端口。

### 硬件端口（Hardware Ports）

硬件的端口就是在硬件设备之间提供接口的，一般用来连接不同的设备。比如常见的串行口（serial ports），并行口（Parallel ports），USB接口（USB ports）等

### 软件端口（software ports）

软件的端口是用来与硬件对接的（interface）。一个软件端口就是一个数字，这个数字代表了一个硬件控制器。

然而本质上，我们与硬件的交流，是通过特定的地址实现的。这个数字（即软件端口），代表的就是这个地址值。而这个地址则可能表示了设备上的一个特定的寄存器，比如控制寄存器。

* 存储映射（memory mapping）

在x86架构上，处理器使用特定的内存地址，来代表特定的内容。

例如，地址0xA000:0就表示了显卡上起始的VRAM，在这里写内容，实际上就改变了显存的内容，也就是改变了屏幕上显示的内容。

### x86实模式存储映射（x86 real mode memory map）

* 0x00000000 - 0x000003FF - Real Mode Interrupt Vector Table
* 0x00000400 - 0x000004FF - BIOS Data Area
* 0x00000500 - 0x00007BFF - Unused
* 0x00007C00 - 0x00007DFF - Our Bootloader
* 0x00007E00 - 0x0009FFFF - Unused
* 0x000A0000 - 0x000BFFFF - Video RAM (VRAM) Memory
* 0x000B0000 - 0x000B7777 - Monochrome Video Memory
* 0x000B8000 - 0x000BFFFF - Color Video Memory
* 0x000C0000 - 0x000C7FFF - Video ROM BIOS
* 0x000C8000 - 0x000EFFFF - BIOS Shadow Area
* 0x000F0000 - 0x000FFFFF - System BIOS

实际上这些设备也可以映射到其它的地址上，这个只是BIOS在POST时，做的一个映射。

### 端口映射-存储映射的I/O（Port Mapping-Memory Mapped I/O）

每一个硬件的控制器，都会监视一个端口地址，实际上就是一个特殊的数字。当启动的时候（booting），ROM BIOS会把不同的数字分配给这些控制器，然后启动处理器（processor），并把BIOS的程序放到0xFFFF:0处。

因为每个控制器都被分配了不同的数字，这样它们之间就可以互相区分，这样也就可以使用中断向量表（Interrupt Vector Table）来实现不同的中断了

###### *但这里就有一个问题了，处理器如何区分到底是在通过端口操作硬件，还是确切地在读取我们地址的东西。*

这个实现是通过一根特殊的控制线实现的，即所谓的I/O获取线（I/O access line），如果这个线被设置了，那么I/O控制器就会监视我们的地址总线（Address Bus），如果地址总线里的地址和分配的设备相对应，那么对应的设备就会从数据总线上读取内容，做操作等。

而如果处理器要对内存做读写，就不会设置这根线的内容，这样就是正常的对于内存的读写了。

默认的x86分配的端口的地址如附表所示：

### IN和OUT指令

那么具体来讲，如何通过这些端口来操作硬件呢？x86的处理器提供了两个指令，分别是IN和OUT，这两个指令分别从硬件设备读内容和写内容

内容在之前的笔记上重新提炼，总结

<<附录1\_x86架构.docx>>

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Default x86 Port Address Assignments |  |  |  |  |
| Address Range | First QWORD | Second QWORD | Third QWORD | Fourth QWORD |
| 0x000-0x00F | DMA Controller Channels 0-3 |  |  |  |
| 0x010-0x01F | System Use |  |  |  |
| 0x020-0x02F | Interrupt Controller 1 | System Use |  |  |
| 0x030-0x03F | System Use |  |  |  |
| 0x040-0x04F | System Timers | System Use |  |  |
| 0x050-0x05F | System Use |  |  |  |
| 0x060-0x06F | Keyboard/PS2 Moude (Port 0x60)  Speaker (0x61) | Keyboard/PS2 Mouse (0x64) | System Use |  |
| 0x070-0x07F | RTC/CMOS/NMI (0x70, 0x71) | DMA Controller Channels 0-3 |  |  |
| 0x080-0x08F | DMA Page Register 0-2 (0x81 - 0x83) | DMA Page Register 3 (0x87) | DMA Page Register 4-6 (0x89-0x8B) | DMA Page Register 7 (0x8F) |
| 0x090-0x09F | System Use |  |  |  |
| 0x0A0-0x0AF | Interrupt Controller 2 (0xA0-0xA1) | System Use |  |  |
| 0x0B0-0x0BF | System Use |  |  |  |
| 0x0C0-0x0CF | DMA Controller Channels 4-7 (0x0C0-0x0DF), bytes 1-16 |  |  |  |
| 0x0D0-0x0DF | DMA Controller Channels 4-7 (0x0C0-0x0DF), bytes 16-32 |  |  |  |
| 0x0E0-0x0EF | System Use |  |  |  |
| 0x0F0-0x0FF | Floating Point Unit (FPU/NPU/Mah Copprocessor) |  |  |  |
| 0x100-0x10F | System Use |  |  |  |
| 0x110-0x11F | System Use |  |  |  |
| 0x120-0x12F | System Use |  |  |  |
| 0x130-0x13F | SCSI Host Adapter (0x130-0x14F), bytes 1-16 |  |  |  |
| 0x140-0x14F | SCSI Host Adapter (0x130-0x14F), bytes 17-32 |  | SCSI Host Adapter (0x140-0x15F), bytes 1-16 |  |
| 0x150-0x15F | SCSI Host Adapter (0x140-0x15F), bytes 17-32 |  |  |  |
| 0x160-0x16F | System Use |  | Quaternary IDE Controller, master slave |  |
| 0x170-0x17F | Secondary IDE Controller, Master drive |  | System Use |  |
| 0x180-0x18F | System Use |  |  |  |
| 0x190-0x19F | System Use |  |  |  |
| 0x1A0-0x1AF | System Use |  |  |  |
| 0x1B0-0x1BF | System Use |  |  |  |
| 0x1C0-0x1CF | System Use |  |  |  |
| 0x1D0-0x1DF | System Use |  |  |  |
| 0x1E0-0x1EF | System Use |  | Tertiary IDE Controller, master slave |  |
| 0x1F0-0x1FF | Primary IDE Controller, master slave |  | System Use |  |
| 0x200-0x20F | Joystick Port |  | System Use |  |
| 0x210-0x21F | System Use |  |  |  |
| 0x220-0x22F |  |  |  |  |
|  | Sound Card |  |  |  |
|  | Non-NE2000 Network Card | System Use |  |  |
| 0x230-0x23F | SCSI Host Adapter (0x220-0x23F), bytes 17-32) |  |  |  |
| 0x240-0x24F |  |  |  |  |
|  | Sound Card |  |  |  |
|  | Non-NE2000 Network Card | System Use |  |  |
|  | NE2000 Network Card (0x240-0x25F) Bytes 1-16 |  |  |  |
| 0x250-0x25F | NE2000 Network Card (0x240-0x25F) Bytes 17-32 |  |  |  |
| 0x260-0x26F |  |  |  |  |
|  | Sound Card |  |  |  |
|  | Non-NE2000 Network Card | System Use |  |  |
|  | NE2000 Network Card (0x240-0x27F) Bytes 1-16 |  |  |  |
| 0x270-0x27F |  |  |  |  |
|  | System Use | Plug and Play System Devices | LPT2 - Second Parallel Port |  |
|  | System Use |  | LPT3 - Third Parallel Port (Monochrome Systems) |  |
|  | NE2000 Network Card (0x260-0x27F) Bytes 17-32 |  |  |  |
| 0x280-0x28F |  |  |  |  |
|  | Sound Card |  |  |  |
|  | Non NE2000 Network Card | System Use |  |  |
|  | NE2000 Network Card (0x280-0x29F) Bytes 1-16 |  |  |  |
| 0x290-0x29F | NE2000 Network Card (0x280-0x29F) Bytes 17-32 |  |  |  |
| 0x2A0-0x2AF |  |  |  |  |
|  | Non NE2000 Network Card | System Use |  |  |
|  | NE2000 Network Card (0x280-0x29F) Bytes 1-16 |  |  |  |
| 0x2B0-0x2BF | NE2000 Network Card (0x280-0x29F) Bytes 17-32 |  |  |  |
| 0x2C0-0x2CF | System Use |  |  |  |
| 0x2D0-0x2DF | System Use |  |  |  |
| 0x2E0-0x2EF | System Use |  | COM4 - Fourth Serial Port |  |
| 0x2F0-0x2FF | System Use |  | COM2 - Second Serial Port |  |
| 0x300-0x30F |  |  |  |  |
|  | Sound Card / MIDI Port | System Use |  |  |
|  | Non NE2000 Network Card | System Use |  |  |
|  | NE2000 Network Card (0x300-0x31F) Bytes 1-16 |  |  |  |
| 0x310-0x31F | NE2000 Network Card (0x300-0x32F) Bytes 17-32 |  |  |  |
| 0x320-0x32F |  |  |  |  |
|  | Sound Card / MIDI Port (0x330, 0x331) | System Use |  |  |
|  | NE2000 Network Card (0x300-0x31F) Bytes 17-32 |  |  |  |
|  | SCSI Host Adapter (0x330-0x34F) Bytes 1-16 |  |  |  |
| 0x330-0x33F |  |  |  |  |
|  | Sound Card / MIDI Port | System Use |  |  |
|  | Non NE2000 Network Card | System Use |  |  |
|  | NE2000 Network Card (0x300-0x31F) Bytes 1-16 |  |  |  |
| 0x340-0x34F |  |  |  |  |
|  | SCSI Host Adapter (0x330-0x34F) Bytes 17-32 |  |  |  |
|  | SCSI Host Adapter (0x340-0x35F) Bytes 1-16 |  |  |  |
|  | Non NE2000 Network Card | System Use |  |  |
|  | NE2000 Network Card (0x340-0x35F) Bytes 1-16 |  |  |  |
| 0x350-0x35F |  |  |  |  |
|  | SCSI Host Adapter (0x340-0x35F) Bytes 17-32 |  |  |  |
|  | NE2000 Network Card (0x300-0x31F) Bytes 1-16 |  |  |  |
| 0x360-0x36F |  |  |  |  |
|  | Tape Accelerator Card (0x360) | System Use |  | Quaternary IDE Controller (Slave Drive)(0x36E-0x36F) |
|  | Non NE2000 Network Card | System Use |  |  |
|  | NE2000 Network Card (0x300-0x31F) Bytes 1-16 |  |  |  |
| 0x370-0x37F |  |  |  |  |
|  | Tape Accelerator Card (0x370) | Secondary IDE Controller (Slave Drive) | LPT1 - First Parallel Port (Color systems) |  |
|  | System Use |  | LPT2 - Second Parallel Port (Monochrome Systems) |  |
|  | NE2000 Network Card (0x360-0x37F) Bytes 1-16 |  |  |  |
| 0x380-0x38F | System Use |  | Sound Card (FM Synthesizer) | System Use |
| 0x390-0x39F | System Use |  |  |  |
| 0x3A0-0x3AF | System Use |  |  |  |
| 0x3B0-0x3BF | VGA/Monochrome Video |  |  | LPT1 - First Parallel Port (Monochrome Systems) |
| 0x3C0-0x3CF | VGA/CGA Video |  |  |  |
| 0x3D0-0x3DF | VGA/CGA Video |  |  |  |
| 0x3E0-0x3EF |  |  |  |  |
|  | Tape Accelerator Card (0x370) | System Use | COM3 - Third Serial Port |  |
|  | System Use |  |  | Tertiary IDE Controller (Slave Drive)(0x3EE-0x3EF) |
| 0x3F0-0x3FF |  |  |  |  |
|  | Floppy Disk Controller |  | COM1 - First Serial Port |  |
|  | Tape Accelerator Card (0x3F0) | Primary IDE Controller (Slave Drive)(0x3F6-0x3F7) | System Use |  |

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