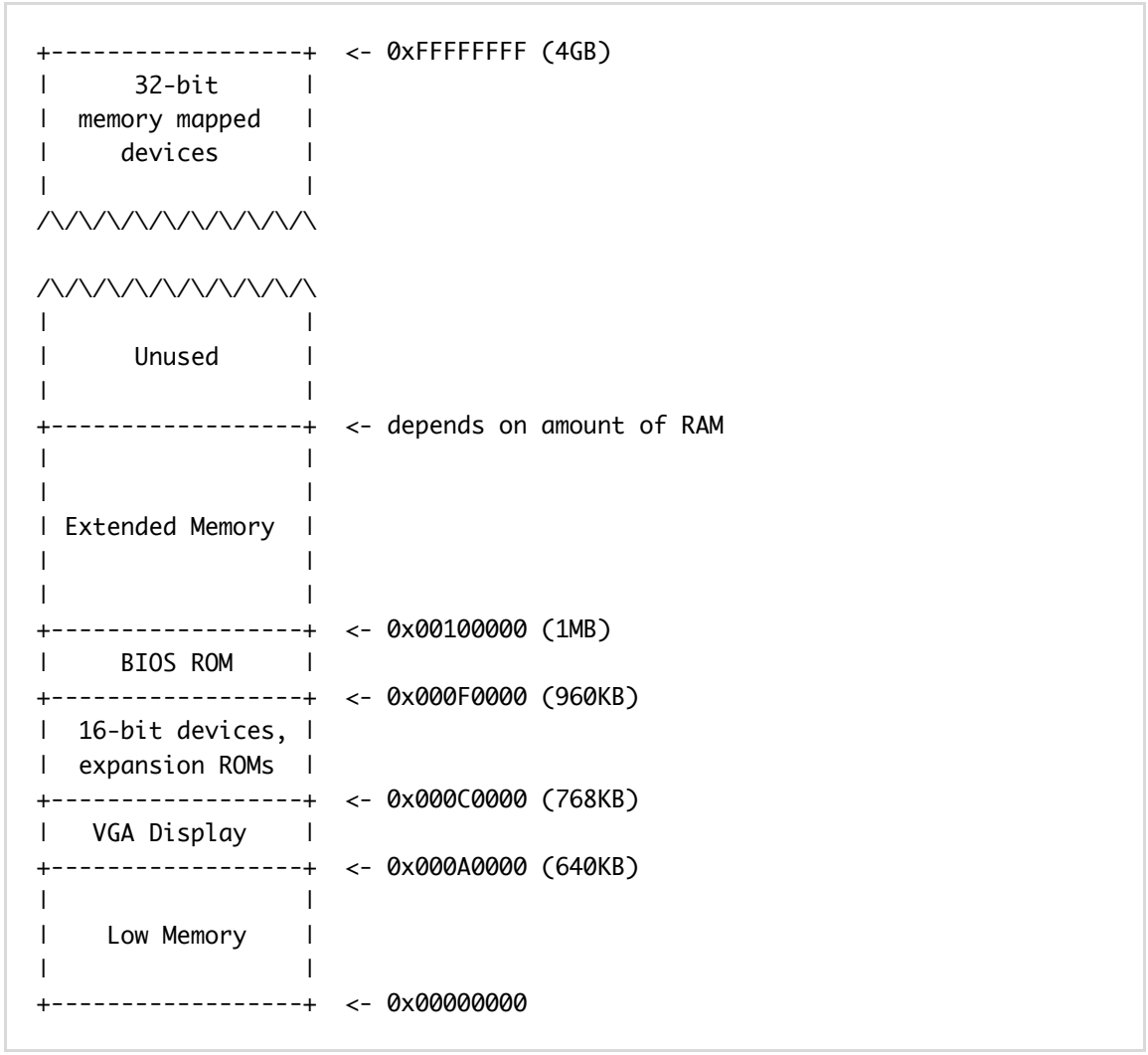
The PC's Physical Address Space

We will now dive into a bit more detail about how a PC starts up. A PC's physical address space is hard-wired to have the following general layout:



Low Memory

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> *The first PCs, which were based on the 16-bit Intel 8088 processor, were only capable of addressing 1MB of physical memory. The physical address space of an early PC would therefore start at 0x00000000 but end at 0x000FFFFF instead of 0xFFFFFFFF. The 640KB area marked "Low Memory" was the only random-access memory (RAM) that an early PC could use; in fact the very earliest PCs only could be configured with 16KB, 32KB, or 64KB of RAM!*

最初的个人计算机用的 16 位 Intel 8088 处理器，具备 1 MB 寻址能力。物理地址从 `0x00000000` 起，终与 `0x000FFFFF` (1MB) 而不是 `0xFFFFFFFF` (4GB). 前 640 KB 叫 Low Moemory，用来随机寻址。

Rest

> *The 384KB area from 0x000A0000 through 0x000FFFFF was reserved by the hardware for special uses such as video display buffers and firmware held in non-volatile memory. The most important part of this reserved area is the Basic Input/Output System (BIOS), which occupies the 64KB region from 0x000F0000 through 0x000FFFFF. In early PCs the BIOS was held in true read-only memory (ROM), but current PCs store the BIOS in updateable flash memory. The BIOS is responsible for performing basic system initialization such as activating the video card and checking the amount of memory installed. After performing this initialization, the BIOS loads the operating system from some appropriate location such as floppy disk, hard disk, CD-ROM, or the network, and passes control of the machine to the operating system.*

剩下的 `0X000A000` 到 `0x000FFFFF` （640KB ~ 1024KB)，384 KB 用来给硬件相关的东西用。比如 视频缓存，固件 静态存储。

最重要的是 `0X00F0000` 到 `0x000FFFFF` 这最后 64KB 区域，用来存 BIOS。早期这一块是不可复写的，现在是能升级的。

BIOS 是负责初始化硬件，如启动显卡，检查内存容量。初始化后它会把操作系统从某个存储介质中载入并把操作权交给操作系统。

Modern

> *When Intel finally "broke the one megabyte barrier" with the 80286 and 80386 processors, which supported 16MB and 4GB physical address spaces respectively, the PC architects nevertheless preserved the original layout for the low 1MB of physical address space in order to ensure backward compatibility with existing software. Modern PCs therefore have a "hole" in physical memory from 0x000A0000 to 0x00100000, dividing RAM into "low" or "conventional memory" (the first 640KB) and "extended memory" (everything else). In addition, some space at the very top of the PC's 32-bit physical address space, above all physical RAM, is now commonly reserved by the BIOS for use by 32-bit PCI devices.*

Intel 80286 80386 终于突破了 1MB 寻址能力的局限。支持了 16MB 和 4GB 物理地址寻址。为了兼容性，他们还是按照原来的 1MB 的框架来分配内存。

现代计算机在内存的 `0x000A0000` to `0x00100000` 有一个“洞”，把内存氛围 low\conventional memory （前 640KB）和 extended memory 两部分。另外，现在某些 32位地址的高位上，现在 BIOS 用来给 32位 PCI 设备用了。

> *Recent x86 processors can support more than 4GB of physical RAM, so RAM can extend further above oxFFFFFFFF. In this case the BIOS must arrange to leave a second hole in the system's RAM at the top of the 32-bit addressable region, to leave room for these 32-bit devices to be mapped. Because of design limitations JOS will use only the first 256MB of a PC's physical memory anyway, so for now we will pretend that all PCs have "only" a 32-bit physical address space. But dealing with complicated physical address spaces and other aspects of hardware organization that evolved over many years is one of the important practical challenges of OS development.*

近年来的 x86 处理器支持超过 4GB 的物理寻址，所以内存可以会被扩展到高于 `0xFFFFFFFF`。 这时候 BIOS 必须在内存 32位寻址能力极限外的地方也放一个“洞”让 32位 的设备能被寻址。 因为 JOS 设计的局限性，它将只能用前 256 MB 的内存。所以这里我们假设所有计算机都“只有”32位的寻址空间。 同时，我们要知道管理复杂的寻址控件和其他硬件管理层面是操作系统开发的重要问题之一。