

Operating Systems Boot Process

Boot Process in a nutshell

- ▶ Execute code from a well-known location.
i.e. ROM-BIOS Chip.
- ▶ Execute first-stage boot loader from MBR.
- ▶ Execute second-stage boot loader.
- ▶ Load the kernel.
- ▶ Load the first user space program.

Stage 1: BIOS

- ▶ BIOS - Basic Input/Output System.
- ▶ Boot firmware designed to run at start up.
- ▶ POST (Power-On Self-Test)
 - Identifies, tests, and initializes system devices
- ▶ Run-time services
 - Initial configuration
 - Selects which device to boot from
- ▶ Loads the MBR (Master Boot Record) to RAM.

POST (Power-On Self-Test)

- ▶ One of the first processes that a computer undergoes when booting.
- ▶ POST tests the computer to ensure that it is working as it is supposed to.
- ▶ POST can detect some errors with the processor, motherboard, RAM and other memory, as well as the video card.
- ▶ Most BIOS chips use a system of beep codes to indicate the POST status to the user and each BIOS chipset uses a different code.
- ▶ The IBM PC BIOS code standard, for example, uses one short beep to indicate a successful POST and two short beeps to indicate a POST error.

Stage 2: MBR (Master Boot Record)

After the POST the BIOS wants to boot up an operating system, which must be found somewhere: hard drives, CD-ROM drives, floppy disks, etc.

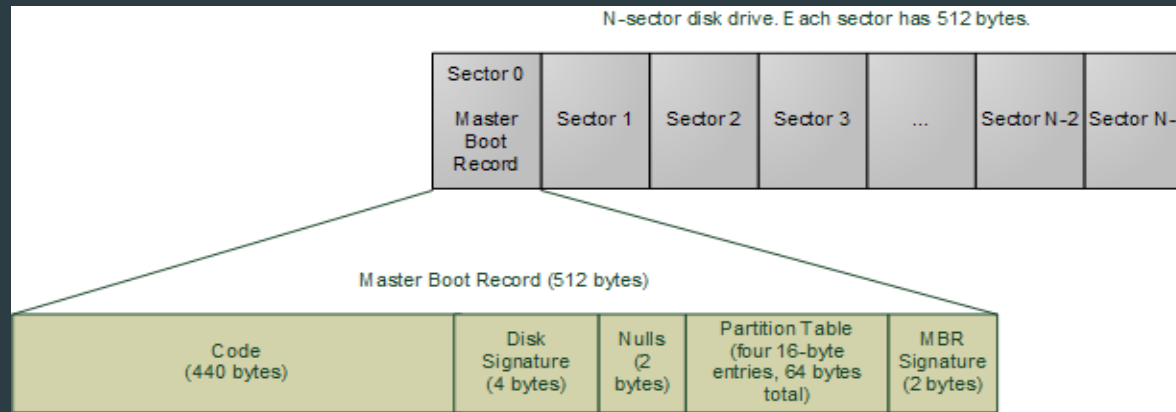
The actual order in which the BIOS seeks a boot device is called Boot-sequence and is user configurable.

If there is no suitable boot device the BIOS halts with a complaint like “Non-System Disk or Disk Error.”

The master boot record is always located at cylinder 0, head 0, and sector 0, the first sector on the disk

The BIOS now reads the first 512-byte sector (sector zero) of the hard disk. This is called the Master Boot Record.

Stage 2: MBR (Master Boot Record)



Boot Code: The specific code in the MBR could be a Windows MBR loader, or a code from Linux loaders such as LILO or GRUB. It is also called primary boot-loader or first-stage boot-loader.

Partition table: Describes how the disk has been divided up (so you can run multiple operating systems or have separate volumes in the same disk). Traditionally Microsoft MBR code takes a look at the partition table, finds the (only) partition marked as active, loads the boot sector for *that* partition, and runs that code.

Stage 3: VBR (Volume Boot Record)

Once the BIOS transfers control to the start of the MBR that was loaded into memory, the MBR code scans through its partition table and loads the **Volume Boot Record** for that partition.

The **Volume Boot Record** is the first sector of a partition, as opposed to the first sector for the whole disk.

The first block of the VBR identifies the partition type and size and contains an **Instruction Program Loader** that contains code to load additional blocks that comprise the second stage boot loader.

On Windows NT-derived systems (e.g., Windows 2008, Windows 2012, Windows 7, Windows 8), the IPL loads a program called **NTLDR**, which then loads the operating system.

Beyond Windows

Under GRUB, the MBR typically contains GRUB Stage 1.

The Stage 1 boot loader loads GRUB Stage 2.

The Stage 2 loader presents the user with a choice of operating systems to boot and allows the user to specify any additional boot parameters for those systems (e.g., force maximum memory, enable debugging). It then reads in the selected operating system kernel and transfers control to it.

The second-stage boot loader comparison

In GRUB this is GRUB Stage 2, and in Windows NT this is NTLDR.

If step 2 fails in Windows you'd get a message like "NTLDR is missing".

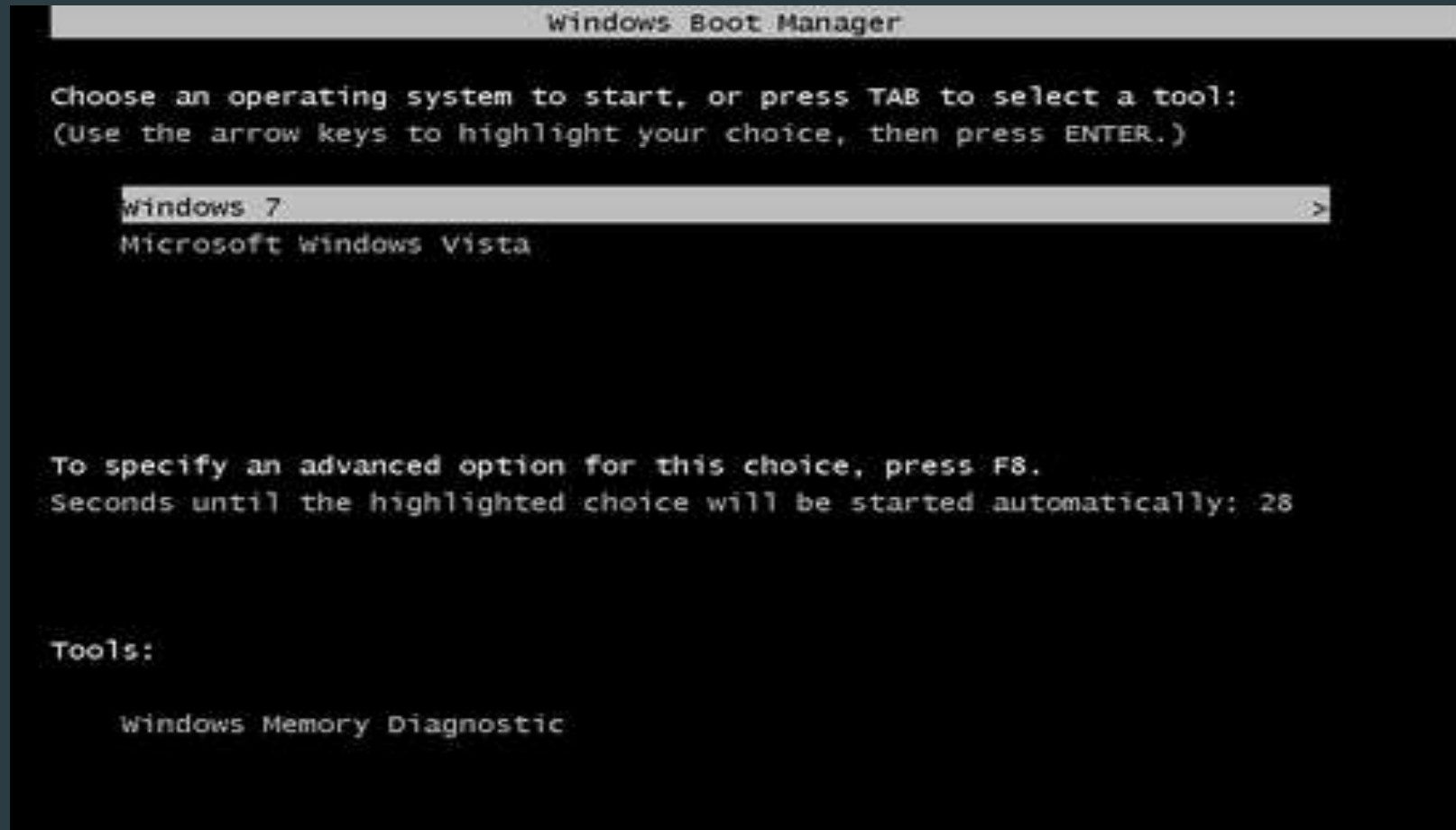
The stage 2 code then reads a boot configuration file (e.g., grub.conf in GRUB, boot.ini in Windows).

It then presents boot choices to the user or simply goes ahead in a single-boot system.

The Linux second-stage boot loader “GRUB”



The Windows second-stage boot loader “Windows Boot Manager”



1. The PC is turned on & the BIOS initializes the hardware.

