

Booting

COMP755
Advanced Operating Systems

Booting



- The computer word **boot** is short for “bootstrap” or “bootstrap load”, sometimes called Initial Program Load (IPL).
- During the boot process a series of firmware and software load progressively larger and more complex programs until the full OS is started.

Starting the Computer

- The boot process involves the
 - Hardware
 - Firmware
 - Software

Initialization Goals

- Test for errors
- Reconfigure to adapt to hardware changes
- Reset the hardware
- Establish environment
- Start the operating system

Integrity Checks

- Processor hardware integrity (**hardware**)
- I/O devices (**firmware**)
 - Anything missing?
 - Anything new?
 - Everything responding?
 - Runaway devices
- File system check (**software**)

Configuration Check

- Hardware modifications are usually done when the computer is turned off.
- BIOS and OS check for configuration changes.
- Plug and Play assigns IRQ and I/O addresses

Turning On the Computer

- When the CPU is powered on (or power is applied to the reset pin), the computer will start executing instructions at a fixed address.
- This first address is usually in the BIOS ROM.
- The BIOS runs configuration checks and eventually loads the initial OS boot loader and starts its execution.

Pseudo-code for Simple Boot Loader

- 0: set the index register to 8
- 1: check paper tape reader ready
- 2: if not ready, jump to 1
- 3: read byte from paper tape reader to accumulator
- 4: if end of tape, jump to 8
- 5: store accumulator to address in index register
- 6: increment the index register
- 7: jump to 1

Master Boot Record

Description	Size in bytes
Code Area	440 (max. 446)
Optional Disk signature	4
Usually Nulls; 0x0000	2
Table of primary partitions (Four 16-byte entries)	64
MBR signature; 0xAA55	2
MBR, total size: $446 + 64 + 2 =$	512

Multiple-Stage Boot Loaders

- The first program loaded during a boot sequence is often very small.
- The size of the program in a master boot record is only 446 bytes.
- Usually the first boot program reads in a second boot program (*that might read in a third boot program*).

Booting in the Stone Age

To boot my communications frontend program on a minicomputer you had to:

1. Enter about a dozen bytes through the control panel
2. Put the paper tape in the teletype reader
3. Press the run button on the computer
4. Press the run button on the paper tape reader
5. After the tape had been read, enter the level 2 loader address on the front and press run.
6. This loader would load the program over a communications line from the mainframe.



GRUB boot loader



- GRUB is a boot loader package from GNU.
- When you turn on your computer, BIOS loads GRUB stage 1 from the MBR. This loads stage 1.5 which loads stage 2.
- GRUB reads a configuration script and interacts with the user.
- GRUB can load a variety of OS including Linux and Windows.

Windows Boot Sequence

- BIOS Power On Self Test
- Firmware checks hardware configuration
- Check media in boot sequence.
- For floppy drives, load the boot sector.
- For hard drives
 - Load the Master Boot Record.
 - Find the active partition.
 - Load boot sector.

Windows Boot Sequence (cont.)

- Run the loaded boot code.
- Load and run NTLDR
- Load and run NTDETECT.COM
- Read BOOT.INI
- Ask which OS to start (*if there is an option*)
- Load and run Windows Kernel
- Load Hardware Adaptation Layer

Windows Boot Sequence (cont.)

- Load system hive
- Load some drivers and services
- Initialize kernel and drivers that were loaded
- Load and initialize the rest of the drivers
- Create hardware list in registry using NTDETECT information
- Load and run Autocheck to check file systems

Windows Boot Sequence (cont.)

- Set up paging
- Load services defined in the registry
- Win32 starts the logon process
- Run applications specified in the registry for this user.
- Run applications in startup directory.

Boot Errors

- If the active partition does not contain the boot components (or if you left a data diskette in the floppy drive), you will see

```
BOOT: Couldn't find NTLDR
Please insert another disk
```

Boot Errors

- If the boot.ini file points to the partition and directory that does not contain a copy of NT, you may see the messages:

```
Windows could not start because the
following file is missing or
corrupt:
\<winnt root>\system32\ntoskrnl.exe
Please re-install a copy of the above
file.
```

Run the Occasional Program

- Many applications need to take some low priority action on an infrequent basis.
- Many choose to do this when you reboot
 - Virus checking
 - Archiving
 - Application updates
- The result is that the boot process take longer.

Levels of Off

Microsoft Windows supports several ways to turn your computer “off”

- Powered Off – The power is disconnected
- Shutdown – The system is turned off but the network is still active
 - Power on LAN can remotely wake a computer
- Stand by – Low power execution
- Hibernate – The RAM is copied to disk and the system is shutdown. When you restart, it reloads RAM and goes from there.

Boot Media

- Hard drives are the usual media.
- CD-ROM can be used for OS installation.
- Knopix is an operating system based on Linux designed to be run directly from a CD
- USB thumb drives can be used to boot the OS and hold all mass storage.
- Some system boot from a network server.