



**K.F. Ibrahim describes the Windows 2000 PC operating system, its boot-up sequence and some boot-up faults. There are standalone and server (used for workgroups) versions of the system: this article concentrates on the former version, which Microsoft calls Professional**

# Windows 2000

**T**here are a number of computer operating systems, such as DOS, Windows 98 and Netware 4.11. One or more may be loaded into a PC, but only one can be in use at any one time. PC operating systems have a number of characteristics, such as single- or multi-processing and being platform-dependent or -independent. Windows 2000 is a multi-processing, multi-tasking, multi-threading, platform-independent operating system. These terms require explanation.

**Multi-processing:** An operating system that will work with a multi-processor motherboard, i.e. a motherboard that contains more than one microprocessor chip, is known as a multi-processing operating system. DOS, Windows 3.x, 95, 98 and Novell 2.x, 3.x, 4.0 and 4.10 are all single-processing operating systems. Multi-processing systems include Windows NT, ME, 2000 and Novell 4.11 and 5.x.

**Multi-tasking:** A multi-tasking operating system enables more

than one application to run simultaneously, one in the foreground and a second or third or more in the background.

There are two types of multi-tasking: co-operative (Windows 3.11) and pre-emptive (Windows 95, 98, ME, NT and 2000). The first relies on the application in the foreground relinquishing control to another application when requested by the system. This technique is prone to causing computer crashes – when one application refuses to yield to another. With the pre-emptive type the operating system retains control so that it can force applications to relinquish control as required.

**Multi-threading:** A thread is a single basic unit of code scheduled for use. A number of threads form a process and a number of processes constitute an instruction. A sequence of instructions forms a program. Two threads can be used simultaneously when two ALUs (Arithmetic Logic Units) are available. This is known as multi-threading.

Up to the Intel 80486, microprocessor chips had only one ALU and could thus handle only a single thread at a time. From the Pentium onwards processors were manufactured with two ALUs to provide multi-threading. DOS, Windows 3, O/S and Novell 2.x and 3.x can recognise only one ALU and are thus single-thread operating systems. Windows 95, ME, 2000, NT and Novell 4.x and 5.x can use two ALUs and are thus referred to as multi-threading systems.

**Platform dependency:** An operating system is said to be platform-dependent if it can be used with only one type of processor, either an Intel-based CISC (Complex Instruction Set Code) or an Alpha-based RISC (Reduced Instruction Set Code) processor. Operating systems such as Windows NT and 2000 can be used with either CISC or RISC processors and are known as platform-independent systems. To achieve this with a RISC motherboard, a software layer known as the Hardware Abstraction Layer (HAL) is inserted between the computer hardware and the operating system. With HAL present the operating system is not aware of the type of processor in use.

RISC processors are faster: they can perform fast mathematical operations using fewer (a 'reduced' number of) instructions. Examples of CISC processors are the Intel



The Windows 2000 control panel screen.

80XXX and Pentium series. Examples of RISC processors are the Alpha and OAK type.

### Fully plug-n-play cards

Modern PC adaptor cards are of the plug-n-play (PnP) type, with which IRQ (Interrupt Request), port address and any other resource requirements are allocated automatically by a software routine that checks the resources available and allocates the first available ones to the card. Three requirements must be met for successful PnP installation of a device: the device itself must be of the PnP type, the motherboard must have a PnP BIOS (Basic Input Output Services) chip and the operating system must support PnP installation. Such operating systems include Windows 95, 98, ME and 2000.

During the boot-up, the PnP BIOS chip helps to resolve conflicts as devices mounted on the motherboard and peripherals plugged into slots compete for access to limited system resources. This continues after the boot-up, with the BIOS chip providing configuration services. It enables resources to be allocated and relocated even after the operating system has been loaded.

### Device Manager

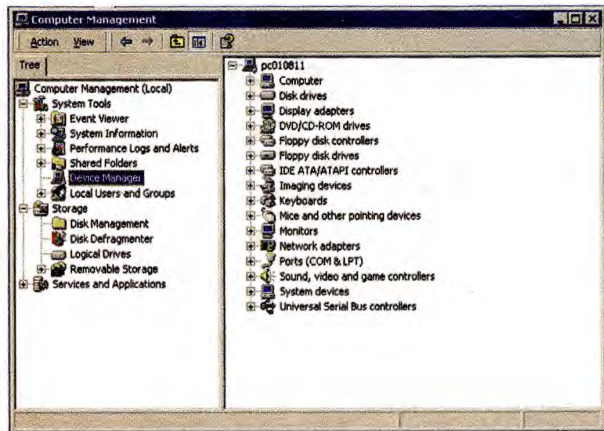
The Device Manager is a utility introduced by Microsoft and used with Windows 95, 98, ME and 2000 but not NT. It provides a graphical representation of all the devices that have been configured and can be accessed by selecting the system icon in the control panel. It lists all the hardware devices, their properties, drivers and the resources allocated to them. Problems are indicated by three red symbols:

- ⚠ This indicates that either a device is not present, that it's not installed or that there's a resource conflict.
- ❔ This indicates that not all drivers have been installed.
- ⊗ This indicates severe resource conflict, with the offending item disabled.

By double-clicking on the offending symbol, the device properties, including its drivers and resource allocation (IRQ and port address), can be examined and in some cases modified.

### File systems

Three file systems are in common use: the 16-bit FAT (File Allocation Table), the 32-bit FAT32 and NTFS (New Technology File System). FAT is a basic standard that can be used by DOS and almost all other operating systems including Windows 95, 98, NT and 2000 as well as Novell systems. FAT-formatted partitions use filenames with a maximum of 11 characters (8.3 format) for DOS and 255 characters for Windows 95, 98, ME and 2000, also NT. It uses 12- or 16-bit binary numbers to identify clusters and



The Windows 2000 computer management screen.

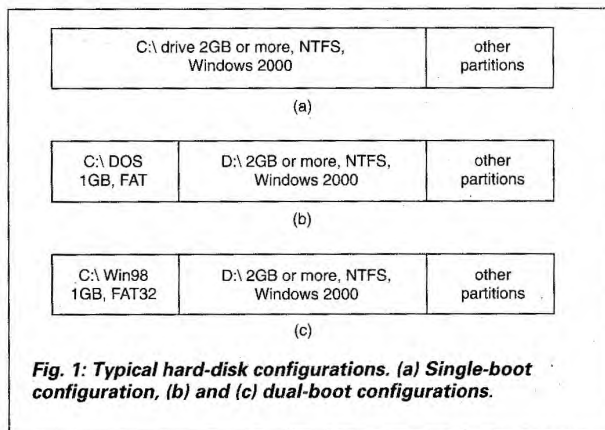


Fig. 1: Typical hard-disk configurations. (a) Single-boot configuration, (b) and (c) dual-boot configurations.

thus provide a maximum hard-disk capacity of 2GB.

Partitioning a hard disk is carried out by the DOS FDISK command, which generates a menu that enables the user to divide the hard disk into one or two partitions, a primary and an extended partition. The extended partition can be further divided into a number of logical drives (up to 25) such as D:, E: and so on. Each partition and logical drive is allocated a proportion of the total disk space.

The partition where the operating system is to be loaded, normally drive C:, must be a primary partition and must be made active. Failure to do this will result in the BIOS being unable to detect and load the operating system at start up.

FAT32 uses 32-bit numbers to identify clusters, thus increasing the maximum supported disk capacity to 2,048GB (2TB). Windows 95 onwards can use FAT32.

NTFS is faster than FAT and FAT32. It can use names up to 255 characters long and very large partitions. The other advantage is that it provides an extended list of attributes and security features compared with FAT's limited attributes. It suffers from the fact that it can be used with only two operating systems, Windows NT and 2000.

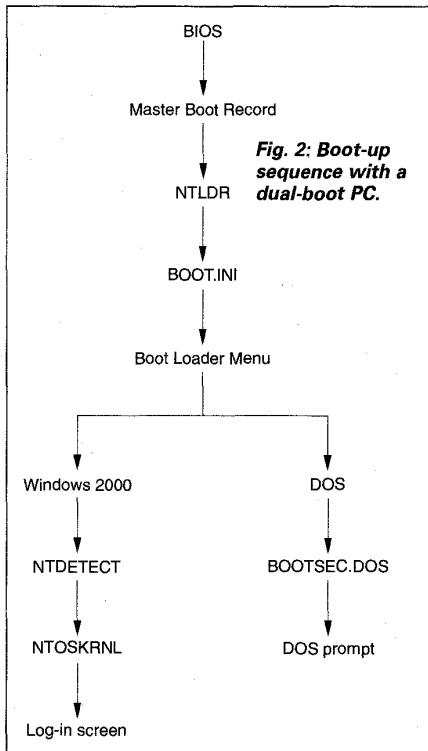
### Installation

The minimum hardware requirements (microprocessor type and speed, system memory and hard-disk space) specified by Microsoft for a machine that's to have Windows 2000 Professional installed are theoretical limits. A PC that has this minimum hardware specification will be very slow – if it ever gets off the ground. In practice the following is considered to be satisfactory: a Pentium 400MHz (preferably 800MHz) microprocessor; 64MB (preferably 128MB) of memory; 1GB (preferably 2GB) of hard-disk space and a CD-ROM drive (preferably x52). Typical hard-disk configurations are shown in Fig. 1.

Microsoft supplies an installation CD-ROM disk from which the operating system can be installed. Windows 2000 is a multi-boot operating system. This means that it can be installed in a PC which already has an operating system such as DOS or a previous version of Windows installed. The two systems can coexist in the same PC. At boot-up a menu will be displayed enabling the user to select one of the two or more operating systems installed. If DOS is to be one of the operating systems it must be installed first – if it is installed last it will remove all previously installed operating systems.

To install Windows 2000 with an Intel-based DOS PC, boot up into DOS, make the CD-ROM drive (normally D:\) the working directory, change the directory to i386 and enter WINNT at the prompt, i.e. >D:\i386\WINNT.

The installation wizard will then be launched and you will be asked to fill in a number of details and settings, including name and organisation (which could be anything), name of administrator (which is Administrator by default) and a password (which is case sensitive) of your choosing. You will also be asked to specify the partition where the system folder is to be located. This is normally



a folder called WINNT. If a separate partition to that used for DOS is selected, you are given the options to format it into FAT or NTFS.

At the end of the installation process you are asked if you want to log on automatically. This option is appropriate only if you have no security requirements, as in the case of a standalone PC in someone's home. Otherwise, a log-on window will appear each time the PC boots up and you will have to enter a user name and a password.

The same procedure is used

to install Windows 2000 with a PC that has Windows 95, 98, ME or NT installed, except that WINNT32 must be entered in the RUN command line.

With a single-boot PC that has no previously installed operating system the Windows 2000 installation CD can be used directly as a boot CD, provided the boot sequence in CMOS is set for CD-ROM to be the first boot. The set-up Wizard will be launched and the installation process begins.

### The Windows 2000 boot-up process

The PC boot-up process consists of two phases. The first is the BIOS phase, which is common to all operating systems. In this phase BIOS routines stored in a BIOS ROM chip are carried out to prepare for loading the operating system itself, be this DOS, Windows or Novell. The second phase loads the operating system and is operating-system specific. Since Windows 2000 is a multiprocessing system, there are two boot-up sequences, one for CISC and the other for RISC processors. The following is the sequence for CISC-processor PCs.

The BIOS phase of the boot-up process is as follows. At switch-on the processor is reset and BIOS is loaded. BIOS then runs the POST (Power On System Test), loads the HD driver and loads the master boot record (MBR) into memory. MBR searches the partition boot record (PBR) of the hard disk for an active partition and loads the boot sector into memory.

Phase two consists of loading five system files: NTLDR (NT loader); BOOT.INI; NTDETECT.COM; and NTOSKRNL.EXE (operating system kernel).

The following is a more detailed account of phase two.

(1) The boot sector loads and initialises the NT loader (NTLDR) which begins the boot sequence. NTLDR changes the processor memory access to a 32-bit flat (linear) memory model and starts a minifile system that depends on whether the FAT or NTFS file system is used.

(2) The NT loader reads file BOOT.INI to construct the Boot Loader Menu (BLM). This menu appears on-screen for user selection with timeout (30 seconds by default) after which the

default operating system is selected. F8 may be pressed at this stage for troubleshooting purposes. In single-boot machines the menu is bypassed.

(3) NTLDR loads the operating system selected from the BLM. (4) If Windows is selected, NTDETECT.COM is carried out. It checks the hardware and builds a hardware list.

(5) Control of the computer is now passed to the operating system kernel NTOSKRNL.EXE. This final stage of the boot-up process consists of three phases: the kernel load phase; the kernel initialisation phase; and the log-on phase. The latter normally consists of a log-on screen which asks the user to enter a user name and a password (the password may be blank). This phase is bypassed if automatic log-on is selected at the installation stage.

Those familiar with Windows NT will realise that the boot-up routine, including system file names, for Windows 2000 is identical to that for NT.

With a dual-boot PC, if the second operating system is DOS, BOOTSECT.DOS is loaded after the Boot Loader Menu, followed by the DOS prompt.

Try booting up Windows 2000 Professional. Observe the boot-up sequence as displayed on the screen. If it's a dual-boot system, the menu will appear with the default operating system highlighted and a countdown.

Fig. 2 illustrates the boot-up sequence with a dual-boot PC.

### The BOOT.INI file

This is the only file, in text form, that can be changed and edited. Unlike Windows NT4, with which BOOT.INI is a read-only file (attribute R), with Windows 2000 it has attributes H (hidden) and S (system). It can, therefore, though hidden be edited without having to change its attributes.

**Table 1: Typical BOOT.INI file.**

```

[boot loader]
timeout=30
default=multi (0) disk (0) rdisk (0) partition (2) \WINNT
[operating systems]
multi (0) disk (0) rdisk (0) partition (2) \WINNT="Microsoft Win
2000 Professional"
C:\="MS-DOS"
  
```

A typical BOOT.INI file is shown in Table 1. It contains two sections: boot loader and operating systems. The boot loader contains two settings, default and timeout. Default specifies the path to the folder (default WINNT) where the operating system resides. The default operating system is selected if no other operating system is present or none is selected during the timeout period. Timeout is the time (default value 30 seconds) allowed for the user to select an operating system from the boot menu. The second section, operating systems, lists the path to each available operating system that's been loaded in the PC.

Two operating systems are listed in Table 1, Windows 2000 and DOS, with Windows 2000 as default. The path for Windows 2000 is contained in the part of the line before the = sign. *Multi (0)* indicates an IDE or EIDE drive (scsi is used for SCSI drives), with (0) giving the number of the hard-disk drive. *Disk (0)* is always (0) for multi – for SCSI drives the number in brackets would be between 0-6 to specify the SCSI ID. *Rdisk (0)* indicates that the drive is master (1 is used for slave) – for SCSI it's always (0). *Partition (2)* points to the second partition of the hard disk. *WINNT* specifies the name of the folder where System32 folder and system files are placed.

The part of the line after the = sign, within the " " marks, is the text that appears in the boot loader menu to describe the operating system.

The BOOT.INI file can be edited using DOS editor or it can be opened up within Windows. Editing can be carried out in three ways:

(1) Boot up and select DOS from the boot-up menu (if DOS is available as a previous operating system). Change the working directory to C:\ and type EDIT BOOT.INI at the prompt. An editable BOOT.INI file will be displayed. Note that although BOOT.INI with attributes H and S will not be shown in directory listing DIR, it may be listed if either the ATTRIB or DIR/A command is used.

(2) Boot up into Windows 2000 and open the command line (Start > Run > enter CMD > OK). Change the working directory to C:. Carry out (1) above.

(3) From the desktop, double click on My Computer > double click on C:\ > Tools form bar menu > Folder options > View > click on Show Hidden Files > click to remove tick on Hide protected operating system files > click Yes to warning > Apply > OK. BOOT.INI will now be displayed. Double click on BOOT.INI to open. Edit as necessary, save and exit.

### Boot-up process with RISC-processor PCs

Phase one is the same as with CISC-processor based PCs. In phase two, instead of the NT loader the resident ROM firmware examines the BIOS Parameter Block (BPB) to verify that it contains the FAT file system. The firmware then proceeds to load OSLOADER.EXE and passes control to it, along with the results of the hardware detection determined by the POST routine.

OSLOADER.EXE then loads NTOSKRNL.EXE followed by HAL.DLL, hardware-specific files (extension .PAL) and system files. NTOSKRNL.EXE then loads the device drivers.

Note that with a RISC processor-based PC (a) the POST routine gathers the hardware information and passes it to the operating system kernel, hence the absence of NTDETECT.COM, and (b) the Boot menu is stored in a non-volatile RAM, thus there's no need for a BOOT.INI file.

### Advanced options menu

Windows 2000 provides an Advanced Options Menu for troubleshooting purposes. Use it in cases of failure to boot up caused by a missing boot file, the introduction of new hardware or a new application. The Advanced Options Menu can be brought up by pressing F8 during the boot-up process. It provides a number of options that can be used in cases where normal booting up is not possible. The options are as follows.

(1) *Safe Mode*. Enables the most basic drivers and services including VGA 4-bit colour, 640 x 480, 60Hz refresh rate; mouse; keyboard; hard disk; CD-ROM drive; PS/2 (not serial) mouse. As far as Microsoft is concerned, serial mouse, sound card and network adaptor card are non-standard devices.

(2) *Safe Mode with command prompt*. Loads standard device drivers as Safe Mode with a command-prompt interface. Note that Windows 95/98/ME Safe Mode includes only keyboard, hard disk and monitor.

(3) *Safe Mode with networking*. Loads Safe Mode devices with the drivers and services necessary for networking.

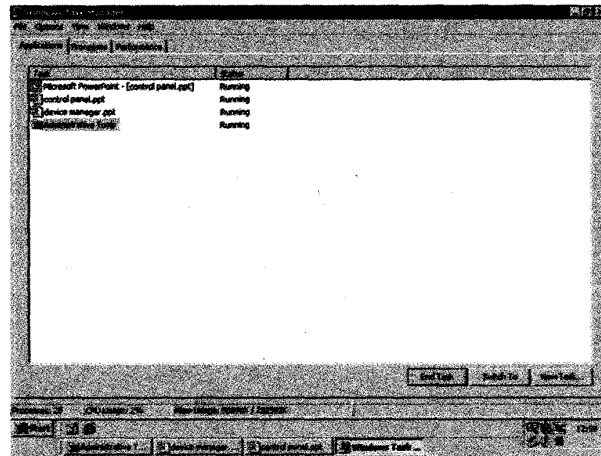
(4) *Enable VGA Mode*. Loads the VGA graphics driver only. This option is enabled with all Safe Mode boot options.

(5) *Last Known Good Configuration*. If the PC fails to boot up as a result of changes in the registry, caused by loading new drivers for example, the previous configuration can be obtained by selecting this option. This may be useful where, for example, new drivers have been loaded causing a boot-up failure.

This option is possible because Windows 2000 maintains several complete copies of the system configuration in the registry.

(6) *Directory Services Restore Mode*. Restores a corrupt directory database. This is only for servers that are Domain Controllers.

(7) *Debugging Mode*. Initiates the debugging process to gather



The Windows 2000 task manager screen.

debugging data for future diagnostics. Available only with Windows 2000 servers.

### Common boot-up faults

Boot-up faults mean that the system will not boot up in Windows and/or DOS or another operating system if the PC is a multi-boot one. A Windows 2000 boot-up or start-up disk may therefore be very helpful. Unlike the DOS start-up disk however, which can be used to boot up the machine independently of the hard disk, the Windows 2000 disk contains what Microsoft calls 'system files', namely NTLDR, NTDETECT and BOOT.INI, but not NTOSKRNL. The latter resides on the hard disk in the WINNT/System32 directory. It follows that a Windows 2000 boot-up disk can boot the PC into Windows 2000 only if it can correctly locate and load up the kernel NTOSKRNL file from the hard disk. As mentioned earlier, the location of the kernel file is specified in BOOT.INI. Since BOOT.INI is machine-specific, it follows that each machine must have its own specific boot-up disk.

Boot-up faults are invariably caused by missing or corrupted boot files. This is another reason for creating and keeping a machine-specific boot-up disk, which will enable missing files to be copied back from the boot-up disk as necessary.

### Creating a Windows 2000 start-up disc

For a CISC-type processor PC, proceed as follows. Boot up a Windows 2000 Professional machine, insert a floppy disc and format it using the Windows 2000 format utility (My Computer > right click on floppy A:\ > select Format > enter a label such as W2K boot > Start > Warning to the effect that data on the disk will be lost > press OK to the warning > exit when finished).

Copy the following files from the hard disk (normally drive C:\) to the floppy disk: BOOT.INI; NTLDR; NTDETECT.COM; BOOTSECT.DOS (for multi-boot into DOS).

Remove the disk and label it W2K Boot or any other appropriate name of your choosing.

You can test the boot-up disk by inserting it in the floppy drive and restarting the PC. The PC should boot up in Windows 2000 Professional. If not, check that the boot-up sequence in the CMOS set-up is set to the floppy drive as the first boot-up option.

With a RISC-type processor PC, format a floppy disk as above and copy the following files: OSLOADER.EXE; HAL.DLL; \*.PAL.

### Recovery console

Use of a boot-up disc is not the only way in which a start up can be attempted in the event of failure to do so normally. An installation disk is a start-up CD, and can be used to boot up a PC. After installing drivers the user is asked to select a Repair option by pressing R or an install option. Selection of the Repair option will set up the Recovery Console. The user is asked to select a

console (one is usually available and 1 is selected). Before you are allowed to enter the Recovery Console, a user name and password must be entered. The user name must be the administrator or any other user name with equivalent rights.

A prompt, very similar to the DOS prompt, will appear with WINNT as the working directory, i.e. D:\WINNT>

Some DOS commands can be used, including DIR and COPY, but the majority of the Recovery Console commands are different. Examples are LIST SVC to list services, and ENABLE and DISABLE to start and terminate services or applications.

The DISABLE command is very useful when a boot-up failure occurs as a result of a new application refusing to terminate, causing a crash.

Recovery Console can be used to copy missing files from say a floppy disk to the hard disk.

A full list of commands can be obtained by typing in HELP.

#### **Boot-up error messages**

The following is a list of typical boot-up error messages, their meanings and solutions.

(1) Message "NTLDR missing". The solution is to copy the NTLDR file from a Windows 2000 boot-up disk or from a known-good Professional system. Copying can be carried out in two ways. One is to boot up using a start-up disk and then copy from the floppy disc to C:\. The other is to open the Recovery Console and copy NTLDR from a floppy disc to C:\.

(2) Message "I/O error accessing bootsector file" is displayed when attempting to boot a multi-boot PC to DOS. It means that the BOOTSECTOR.DOS file is missing. The solution is to copy from

(3) Message "NTDETECT failed". The solution is to copy the NTDETECT file from a floppy disk in the same way as above. If the PC is a multi-boot one with DOS as one operating system available, you can boot up into DOS then copy the NTDETECT file from the floppy disk.

(4) Message "NTOSKRNL missing or corrupt: please install a copy". This does not normally mean that the NTOSKRNL.EXE file is actually missing or corrupted: the most likely cause is a missing BOOT.INI file or an incorrect entry in it.

The solution is first to check that the BOOT.INI file is present and that its contents are correct. This can be done by booting up in DOS if available, or booting from a Windows 2000 start-up disk, or by entering the Recovery Console. If the BOOT.INI file is missing, copy it from a boot-up disk. If the BOOT.INI file is present, check its contents and edit if necessary. It may be easier to copy the file than attempting to edit it. Remember that the BOOT.INI file is machine-specific.

To copy the BOOT.INI file or edit it, use the same procedure as used for copying the NTLDR or other boot files.

If BOOT.INI is not the cause of the problem, copy NTOSKRNL.EXE from the Windows 2000 installation disc.

K.F. Ibrahim is Technical Development Manager of the Digital Village at the College of North West London. He is author of several books, including PC Operation and Repair (second edition) and Digital Television.