

## CHAPTER 7

# Plug and Play

Personal computers have revolutionized the way people work. Today, PCs are being used extensively both at work and home for various tasks — for personal productivity, information exchange, and education and entertainment (“edutainment”). Furthermore, as hardware technology has advanced in the areas of graphics, audio, networking, storage, imaging and communication, PCs have become more powerful and less expensive, accelerating their adoption on a worldwide basis. The widespread adoption of the Microsoft Windows operating system has gone hand in hand with the advances in hardware technology.

With these innovations, however, have come new industry challenges. Specifically, configuring PC hardware and operating systems to work with different networks and peripheral devices can pose a significant problem. Changing the hardware configuration of a machine is a task that few end users attempt and even trained technicians can find difficult, time-consuming and frustrating. This problem is compounded by the growing use of mobile computers, because users of mobile computers typically need to change their PC configurations more frequently. Mobile devices are often unplugged from corporate networks and peripheral devices in the office and reconfigured to allow computing and remote communication from home or while on the road.

Whether related to changing the configuration of a notebook computer from an office to a mobile setting or simply adding a CD-ROM or other device to an existing desktop computer, today’s PC configuration difficulties can result in low customer satisfaction and high support costs. With the Microsoft Windows 95 operating system, together with the Plug and Play framework architecture, Microsoft is attempting to reduce the cost of owning PCs while increasing their ease of use and value.

## Plug and Play

### What Is Plug and Play?

Plug and Play is both a design philosophy and a set of PC architecture specifications. Microsoft’s goal for Plug and Play is to make the PC, add-in hardware devices, drivers and operating system work together automatically without user intervention. In order to achieve this goal, all the components need to be Plug and Play-compatible. The components of a fully Plug and Play system consist of the following:

- A Plug and Play operating system
- A Plug and Play Basic Input Output System (BIOS)

- Plug and Play hardware devices with drivers

## Levels of Plug and Play Support

The system's ease of use and dynamic operation depends on how many of the three main components — the operating system, system BIOS and hardware devices with drivers — support Plug and Play. At the lowest level, when none of the components supports Plug and Play, the user needs to set card jumpers and switches manually, and load drivers from floppies.

At the next level, when the operating system supports Plug and Play but is used with legacy or non-Plug and Play hardware, user intervention is reduced but not completely eliminated. To aid the user in hardware setup, the Plug and Play operating system provides tools like the Device Wizard, the Device Manager, and the Registry (see the section Plug and Play Architecture in Windows 95 for a description of these features). In addition, drivers are installed, loaded and unloaded automatically.

At the highest level, when all three components support Plug and Play, installing new devices is as easy as plugging them in and turning on the system. Hardware identification and configuration is completely automated and transparent to users. And because of the Plug and Play BIOS, the system supports full dynamic operation, including hot docking, APM 1.1 power management, automatic configuration of boot devices, and programming of motherboard devices.

## Benefits of Plug and Play

A complete Plug and Play system provides substantial benefits to both users and computer-industry vendors. The PC is easier to use, since users do not have to worry about switches, jumpers, hardware conflicts or loading drivers manually. For example, to turn a desktop-computer system into a great multimedia system, all the user has to do is plug in a Plug and Play audio card, CD-ROM drive and SCSI adapter, turn on the system, and play a video clip.

Users will also have great mobility. For example, hot-docking stations that support Plug and Play enable the user to remove a portable system while it is running and bring the system to a meeting without having to close or reboot the computer. The system automatically senses its removal from the station, reconfigures itself to work with a new display, and adjusts for the absence of a network card and large disk drive.

For PC vendors, Plug and Play can provide cost reductions. As many as 50 percent of support calls to PC vendors result from installation and configuration problems. By making operations easier and automatic, manufacturers can achieve lower support costs and pass these savings to the user. Easier installation and configuration during setup also benefit original equipment manufacturers (OEMs) who offer systems with Windows preinstalled; they, too, can pass cost savings to the user. Similarly, Plug and Play's Universal Driver simplifies device-driver development, which enables a developer to create a single driver that works across multiple bus types and eliminates the need to include bus-specific code in several drivers.

Finally, Plug and Play provides a common platform that enables PC vendors to develop innovative features and differentiate their products from others. This effort can have the effect of expanding the overall PC market.

## Market Momentum

The Plug and Play effort was formally introduced in March 1993 at the Windows Hardware Engineering Conference to more than 1,300 attendees by Microsoft Corp., Intel Corp. and Compaq Computer Corp. At COMDEX/Fall 93, 18 Plug and Play devices were demonstrated. Today, acceptance of Plug and Play is widespread throughout the PC industry. More than 100 Plug and Play products from over 60 vendors have been demonstrated to work, most of which are already available (see the Plug and Play Catalog for a comprehensive list of these products).

In addition, Plug and Play hardware specifications for BIOS, APM, ISA, SCSI, LPT, COM, ESCD, PCI, PCMCIA, VL and VESA DDC have been completed and are publicly available to PC vendors. These specifications were generated using an open-design process via CompuServe<sup>®</sup>. The PLUGPLAY forum on CompuServe was used to distribute the specifications and solicit feedback from more than 3,000 participants.

Finally, Plug and Play is an integral part of PC vendors' product plans for 1995. Vendors are using the specifications, in addition to the "Hardware Design Guide for Microsoft Windows 95," to build all three components of Plug and Play systems. These components were tested during Plug and Play interoperability workshops (or "PlugFests") held during 1994.

## Configuration Process in a Plug and Play System

A certain amount of configuration must first be performed by the system BIOS during the power-up phase. In order for the system to boot, the BIOS must, at a minimum, configure a display device, an input device and a device for initial program loading. Then, it must pass the information about each of these devices to the operating system for additional system configuration.

When devices are added and removed, the three components of a Plug and Play system coordinate and perform the following basic tasks:

- Identify installed devices
- Determine device-resource requirements
- Create a nonconflicting system configuration
- Program devices
- Load device drivers
- Notify the operating system of configuration changes

The operating system first identifies every installed device in the system and determines the resource requirements for each device. Each nonbooting device is inactive upon power-up, so that the operating system can identify any conflicts between the resource requirements of different devices before configuring them. The operating system then identifies and creates a nonconflicting system configuration. Once any resource conflicts have been resolved, the operating system programs each hardware device automatically with its working configuration, then stores all configuration information in the central database. Finally, the operating system loads the device drivers for each device and

notifies these drivers of the resource assignments. This process, which is centrally managed by the Plug and Play operating system, is repeated as devices are added or removed.

If a change occurs to the system configuration during operation, the hardware must be able to notify the operating system of the event so that the operating system can configure the new device. Additionally, applications must be able to respond to configuration changes to take advantage of new devices and to cease calling devices that have been removed. Such dynamic configuration events might include the insertion of a PCMCIA card, the addition or removal of a peripheral such as a mouse, CD-ROM drive or printer, or a docking event for a notebook computer.

## Plug and Play Support in Windows 95

The Plug and Play specifications are designed to be implementation-independent and are not tied to a specific operating system. It is up to the operating system developer to define the level of support the system provides. Windows 95 was designed and built with Plug and Play support in mind and therefore every component provides a very rich implementation of Plug and Play functionality. With Windows 95, configuration of hardware resources is greatly simplified over legacy configuration techniques: *It just works.*

Plug and Play in Windows 95 makes PCs even easier to use and supports both existing market requirements and future PC growth to deliver the following:

- **Compatibility with legacy hardware.** With over 140 million MS-DOS-based and Windows-based PCs used throughout the world, providing compatibility with legacy hardware was a requirement. Compatibility with existing hardware ensures that neither Windows 95 nor the new Plug and Play peripherals require the purchase of completely new hardware.
- **Automatic installation and configuration of Plug and Play devices.** With Plug and Play, initial PC configuration is automatic. Users no longer need to configure their systems and make system-resource assignments, such as those for IRQs, I/O ports, and DMA addresses. These assignments are handled by the BIOS and operating system, thus avoiding configuration conflicts. Installation and configuration of add-on devices and peripherals is also automatic.
- **A dynamic operating environment that supports mobile computing environments.** This functionality brings out the real power of the Plug and Play architecture and sets Windows 95 apart from other operating system implementations of Plug and Play. Dynamic Plug and Play properties in Windows 95 include support for the following:
  - Hot-docking and undocking of mobile computers to change the state of the system dynamically
  - Hot-plugging and unplugging of Plug and Play devices on the fly
  - “Dynaload drivers,” which are loaded by the operating system for devices that are present and removed from memory when the device is no longer available
  - Unified messaging mechanism for dynamically notifying other operating system components and applications about changes to the state of the system

Users of Windows 95 can reconfigure their PCs on the fly and have the changes take effect immediately, without rebooting.

- **A universal driver model that simplifies device driver development.** To simplify the development of device drivers for independent hardware vendor (IHV) hardware devices, Windows 95 incorporates the use of a universal driver model in various components of the system. Whereas Windows 3.1 supported a universal driver model only for printer drivers, Windows 95 provides this support for several other areas, including communications drivers, display adapter drivers, mouse drivers, and disk device drivers. The universal driver model ensures that IHVs can easily write peripheral drivers, thus increasing the number of Plug and Play devices available on the market.
- **An open and extensible architecture that supports new technologies.** The Plug and Play implementation in Windows 95 is flexible and extensible enough to support future technologies as they emerge on the market. The Plug and Play Initiative will spur the creation of new and innovative technologies, and Windows 95 will support them.
- **The availability of configuration information for simplified systems management.** The sharing of configuration information not only helps users solve configuration problems, but also helps MIS organizations support and manage PCs within corporate environments, which may have hundreds or thousands of PCs. Through the use of the Registry, configuration information is easily available to the system and to applications, both locally and remotely.

## Plug and Play Architecture in Windows 95

To provide complete Plug and Play functionality in Windows 95, Microsoft has included the following new components:

- Configuration Manager
- Hardware Tree and Registry
- Bus and Port Enumerators
- Resource Arbitrators
- Setup and Device Installer

### Configuration Manager

The Configuration Manager is the central software component that handles all phases of the configuration process. It orchestrates the entire flow of operations performed by all the components involved in the configuration process, and it accepts and responds to communications from the BIOS and hardware devices during the configuration process. It also responds to dynamic events during operation, including the insertion or removal of devices and the docking or undocking of mobile computers. As these events occur, the Configuration Manager communicates the information to the applications.

## Hardware Tree and Registry

The hardware tree is a record of the current system configuration. The tree information is drawn from a central database of configuration information for all devices, called the Registry. The Registry is stored locally for each computer and holds information about all device types, whether they are currently installed or not. The hardware tree is created by the Configuration Manager each time the system boots or a run-time change occurs to the system configuration. The existence of the Registry eliminates the need for most of the device-specific initialization files used today. The hardware tree is displayed to the user on the Device Manager property sheet page as shown in Figure 44.

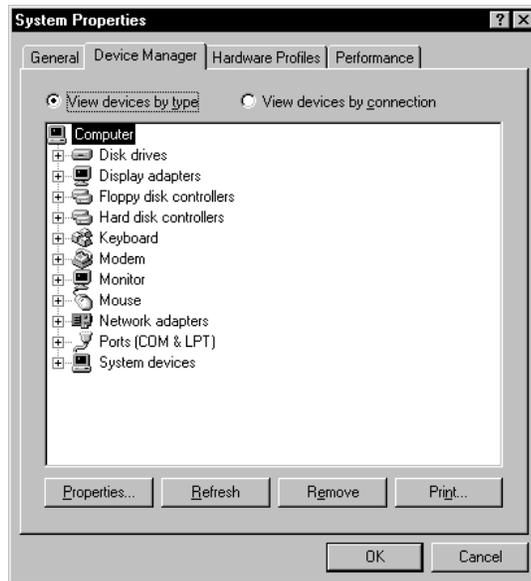


Figure 44. The Device Manager property sheet

## Bus and Port Enumerators

Bus enumerators are responsible for building (enumerating) the hardware tree on a Plug and Play system. The bus enumerators are a new type of driver. Enumerators are based on specific bus architectures and understand the implementation details of their bus types. Therefore, an ISA enumerator can identify the devices on an ISA bus, read their resource requirements, and configure them as instructed by the Configuration Manager. Other enumerators include those for VLB, PCI, SCSI, PCMCIA, serial ports and parallel ports. During installation, Windows will determine automatically which bus enumerators are applicable to a given computer.

## Resource Arbitrators

Resource Arbitrators allocate specific types of resources to devices and resolve conflicts between devices that request identical resource assignments. The functional separation of the Resource Arbitrator and the Configuration Manager provides for future extension of the Windows operating system to address new types of resources.

## Setup and Device Installer

A new operating-system setup program will create the central configuration database during initial system setup. Although under normal circumstances the system will not require user intervention to perform any initial-setup configuration operations, there are some exceptions. For example, if the system fails to detect a non-Plug and Play device, the user can force an installation by using the Add New Hardware Wizard in the Control Panel (shown in Figure 45.) At times, the system may be unable to generate a nonconflicting configuration for a non-Plug and Play device. In this case, a new Windows user-interface component will communicate the event to the user and present the user with several options to resolve the problem.



Figure 45. Add New Hardware Wizard

## Plug and Play Hardware Design

### PC 95 Hardware

PC 95 hardware is optimized for Windows 95 and takes full advantage of Plug and Play. PC 95 hardware meets certain requirements that are listed in the Hardware Design Guide for Microsoft Windows 95 and the Plug and Play specifications.

### The Windows 95 Logo Program

To help users easily identify PC 95 hardware and software that is optimized for Windows 95, a “Designed for Microsoft Windows 95” logo is available. This new logo replaces the old “Windows Ready-to-Run” and “Windows Compatible” logos. To encourage users to look for the logo when purchasing PCs, peripherals and software, Microsoft will actively promote the benefits of logo-authorized products.

### Building PC 95 Hardware

Building PC 95 hardware is the first of three essential steps PC hardware vendors must follow to qualify for the Windows 95 logo. The other two steps are passing the Windows 95 Hardware Compatibility Tests (HCTs) and returning a signed logo-license agreement to Microsoft (see the Windows 95 Logo Program for PC Hardware Vendors Backgrounder for more information).

PC 95 hardware covers all the major buses (ISA, PCI and VLB); connectors (PCMCIA and SCSI); ports (LPT, COM, keyboard and mouse); systems (desktops and mobiles); motherboard devices; and add-on devices (such as monitors, display adapters and network adapters, as well as SCSI, IDE and floppy storage devices, printers and other LPT devices, fax/modems, and other COM devices).

## Summary

Plug and Play technology will benefit the entire personal-computer industry. The technology will increase customer satisfaction by making PCs easier to use and maintain and will help lower support and maintenance costs for both vendors and users. Plug and Play will provide a flexible, robust platform for increased functionality and industrywide innovation.

Systems incorporating the three components of the Plug and Play architecture — a Plug and Play operating system, a Plug and Play BIOS, and Plug and Play hardware devices — will achieve the full benefits of Plug and Play. These systems will be able to configure hardware devices automatically without any user intervention and respond to dynamic configuration events. Excellent docking-system solutions will be feasible, because the system will be able to load and unload device drivers automatically to reflect the devices attached to the system when it is docked or undocked. Also, applications will be able to adjust their configurations automatically to reflect the insertion or removal of devices such as network cards and fax/modem cards.

To achieve this full Plug and Play functionality, vendors of the operating system, the BIOS, and hardware need to deliver Plug and Play products. Microsoft is delivering the Plug and Play operating system with Windows 95. Similarly, hardware vendors need to build and use PC 95 hardware, implement 32-bit drivers for Windows 95, and test the hardware with Windows 95 HCTs. They are also encouraged to help users identify great Plug and Play hardware by applying for and using the “Designed for Microsoft Windows 95” logo and engaging in joint-marketing activities with Microsoft, such as demonstrating PC 95 hardware at trade shows, engaging in joint advertising, and selling systems preinstalled with Windows 95.

## For More Information

The following documents can be obtained via CompuServe from the libraries in the PLUGPLAY forum, or from the <ftp://ftp.microsoft.com/developr/drg/Plug-and-Play> subdirectory:

- Plug and Play specifications
  - BIOS 1.0a
  - APM 1.1
  - ISA 1.0a
  - SCSI 1.0
  - LPT Device 1.0a
  - COM Device 0.99
  - ESCD 1.02a
- Plug and Play Catalog, Oct. 18, 1994
- Plug and Play in Window 95 Fact Sheet, October 1994

- Windows 95 Questions and Answers, November 1994
- Windows 95 Logo Fact Sheet, October 1994
- Windows 95 Logo Program for PC Hardware Vendors Backgrounder, scheduled to be available in the first quarter of 1995

In addition, the Hardware Design Guide for Windows 95 (1994, ISBN 1-55615-642-1) is available in bookstores, or call (800) MSPRESS 677-7377 to order.



