Plug and Play

C H A P T E R   6

Configuring PC hardware and operating systems has become a significant problem in the PC industry, resulting in customer dissatisfaction and increased support costs—all of which impacts the industry affecting PC market growth. A broad-based group of PC industry members is tackling this industry-wide problem with the development of an open and extensible framework architecture called Plug and Play. Microsoft, Compaq Computer Corporation, and Intel Corporation, cooperatively launched the effort to create the Plug and Play architecture, and have been key contributors and leaders in developing and implementing the Plug and Play specifications. The Plug and Play specifications describe hardware and software changes to the PC and its peripherals that free the PC user from manually configuring hardware resources. Furthermore, Plug and Play is an industry-wide effort, with the specifications governed by the Plug and Play Association, an independent organization of leading PC and peripheral manufacturers.

Windows 95 is the operating system that ties Plug and Play components together. Operating system services are implemented in Windows 95 to make PCs even easier to use by providing:

- Help in device detection for installing and configuring devices
- Event notification for informing other system components and applications of dynamic changes to the system state
- Tight integration among device drivers, system components, and the user interface to make the operating system easier to use, configure, and manage.

Plug and Play in Windows 95 not only offers functionality to make it even easier to use a Plug and Play PC, but provides benefits to configuring and managing legacy PC hardware.

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The Problem With PCs Today

For a user who is not a trained technician, installing or configuring a device on a PC can be a daunting task. Most users have neither the time nor the inclination to learn about such arcane subjects as interrupt request (IRQ) lines, direct memory access (DMA) channels, small computer system interface (SCSI) termination, or monitor timings. However, if users want to add devices to their PCs or take advantage of the features of a new device, they often must address these subjects, because most existing PC systems offer no alternative. Potential PC users hear about problems that current users encounter in these areas, which reinforce their viewpoint that PCs are complex, intimidating, and difficult to use.

Although the availability of add-on devices is an advantage of the PC, the fact that the typical PC contains devices made by numerous vendors tends to compound the hardware and software configuration problem. The hardware, operating system, and applications don't know about other PC components, and the hardware can't tell when conflicts exist between different devices trying to share the same system resource.

The main problems associated with today's PC hardware and operating systems can be summarized by the following three points:

- Adding devices to a PC can be a painful process.

  A lack of coordination between hardware and software components leads to device conflicts when vying for valuable system resources such as IRQs, DMA addresses, and I/O addresses.

  There is also no easy access to information about the configuration of a PC, leading to confusion and an increased burden on the end-user and technical support resources to solve conflicts and other device errors.

- Software has no idea what's in the system.

  Today's operating systems only support rudimentary mechanisms for allowing applications to query the configuration of a PC. This information usually covers just basic properties of the PC including the type of CPU it has, the amount of memory configured, and possibly information about base devices such as communication ports. However, beyond basic properties, there are no consistent mechanisms to query detailed information about connected peripherals, or support for receiving system notification that may be associated with dynamic configuration of system resources (such as the

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addition or removal of a device on-the-fly).

 Evolution of the PC platform is stalled due to compatibility problems.

Many different bus standards exist that are used in PCs today. These include ISA, EISA, Micro Channel, PCMCIA, serial ports, parallel ports, and ECP. Creating a new bus standard or device architecture, while maintaining compatibility with the existing architectures is a difficult task. Plug and Play provides a framework on which to design and implement new PC architectures, providing a common and consistent way for devices to interact and coexist, using a bus-independent design.

Mobile Computers Demand Much Higher Flexibility

The bigger problem that the current PC architecture encounters is trying to support the higher flexibility requirements for mobile computers. Mobile computers are used in a number of environments by on-the-road users, and the technology aimed at mobile computing professionals is growing by leaps and bounds. The configuration scenario shared by mobile computer users is different from that of desktop computer users. The mobile environment is much more dynamic and demands higher flexibility from the computing platform:

 Mobile users need flexible configuration support whether in the office and on the road.

Users plug their mobile PCs into a docking station while used within the office, and run them in an undocked state while on the road. While connected to a docking station, a mobile PC may have network connectivity for accessing shared corporate resources, however once it is undocked, it's necessary to reconfigure the PC, perhaps support network connectivity through a dial-up process rather than a local, physical connection.

 Support for hot-docking or hot-plugging of devices needs special operating system support and applications aware of changing environment.

The advent and popularity of PCMCIA also poses some dilemmas for the operating system and application programs. A main issue is how best to provide support for dynamic configuration when a device is added or removed from the system. For example, what should the operating system or application do in response to the addition of a PCMCIA card that provides access to SCSI devices, provides additional hard disk storage, or adds modem connectivity to the PC? Any of these hardware changes may affect the way software behaves on the system. Therefore, it is necessary for the operating

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system to support a mechanism for notification to inform the applications that their system configuration state may change and that they will need to take appropriate action. For example, suppose someone uses a word processing

application to open a document on a PCMCIA hard disk drive, then decides he or she want to remove that hard disk. To gracefully handle this situation, the word processing application (which, of course, is Plug-and-Play aware) saves and closes the document before the hard disk is removed.

The Plug and Play Solution

Through automatic installation of drivers and seamless configuration, the Plug and Play architecture will turn the PC into more of an "appliance" rather than a complex, difficult to configure piece of hardware as it is today. A key benefit of Plug and Play is that it will help to create and support a platform that recognizes and enables the transformation of the PC platform to a more mobile and dynamic environment.

The Plug and Play architecture is an open, flexible, and cost-effective framework for designing Plug and Play products. Plug and Play was jointly developed by a group of leading vendors who obtained reviews for their design proposals from hundreds of companies in the industry. Plug and Play provides a framework that works on many types of bus architectures — ISA, EISA, PCMCIA, VESA local bus (VL-bus), Peripheral Component Interconnect local bus (PCI), and so on — and I/O port connections, and can be extended to future designs.

Here are three major benefits of the Plug and Play architecture:

- **Support costs are reduced for end-users, MIS support organizations, and industry hardware and software vendors.**

 Reducing the complexities of installing and configuring devices and peripherals will have a material benefit for both users, and MIS organizations.

 As many as half of all support calls currently received by operating system and device manufacturers are related to installation and configuration of devices. For businesses, reducing the high cost of supporting PCs increases the use of PCs in the workplace and focuses information systems personnel on using computer technology to solve business problems. Both Plug and Play PCs *and* legacy PCs store hardware and software configuration in the Registry for centralized access, so support benefits can be achieved on existing hardware.

- **Plug and Play makes it easy to install and configure add-on devices with little or no user intervention.**

 Windows 95 stores all information about the hardware and resource configuration of peripheral devices (such as IRQs, I/O addresses, DMA channels, and memory addresses) in the Registry. On Plug and Play PCs,

resource allocation is automatically arbitrated by the system and free resources are used to configure the hardware device. On legacy PCs, the information stored in the centralized Registry is used to notify the user of a potential resource conflict when configuring the peripheral. It is used also to perform device detection using the known resource information.

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With a Plug and Play PC, a user can easily install or connect Plug and Play devices to the system, letting the system automatically allocate hardware resources with no user intervention. For example, by simply plugging in a CD-ROM and sound card, a desktop PC can be easily turned into a multimedia playback system. The user simply plugs in the components, turns on the PC, and "plays" a video clip.

Suppose the user wanted to install a new device on a legacy PC system. Further, suppose the new device requires an IRQ setting, and a legacy network card is already installed on the PC. Since the network card already uses IRQ 5, for example, the system tells the user that a device is already using IRQ 5 and that a different IRQ setting should be chosen. Device conflicts are a thing of the past.

❑ **PC systems can be designed with new features.**

With warm-docking capabilities, for example, a businessperson could remove a portable PC from the docking station while the PC was still running, and go to a meeting. The portable PC would automatically reconfigure to accommodate the absence of the network card and large disk drive. Another example of this is an infrared (IR)-enabled subnotebook that would automatically recognize, install, and configure an IR-enabled printer when the user walked into the printer room.

Plug and Play Support in Windows 95

As set forth by the industry initiative, 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 vendor to define the level of support the system will provide for making the PC easier to use.

Windows 95 was designed and built from the ground up with Plug and Play support in mind, and therefore provides a very rich implementation of Plug and Play functionality throughout every component of its design. 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 or Windows–based PCs used throughout the world, providing compatibility with existing (or "legacy") hardware was a given requirement. The benefit of compatibility with existing hardware

ensures support for Windows 95 and support for new Plug and Play peripherals does not require the purchase of completely new hardware.

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☐ **Automatic installation and configuration of Plug and Play devices**

This means that initial PC configuration is automatic. With Plug and Play, users no longer need to configure their system and make system-resource assignments. These assignments (including those for IRQs, I/O ports, and DMA addresses, and memory 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.

☐ **Dynamic operating environment to support 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 functionality. Dynamic Plug and Play properties in Windows 95 include support for:

☐ 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" where the operating system loads drivers for devices that are present and removes drivers from memory when the device is no longer available

☐ Unified messaging for mechanism for notifying other operating system components and applications about changes to the state of the system dynamically

Users of Windows 95 will be able to reconfigure their computer on the fly and have the changes take affect immediately, without rebooting the PC.

☐ **Simplified device driver development by using a universal driver model**

To simplify device driver development support for an IHV's hardware device, Windows 95 incorporates the use of a universal driver model throughout various components in the system. Windows 3.1 supported a universal driver model for printer drivers, but Windows 95 provides this support for more areas including communications drivers, display adapter drivers, mouse drivers, and disk device drivers. The universal driver model ensures that it's easy for IHVs to write peripheral drivers, thus providing for more Plug and Play devices available on the market.

☐ **An open and extensible architecture to support new technologies**

The Plug and Play implementation in Windows 95 must be 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 deliver this support.

◻ **Availability of configuration information for simplified systems management**

This level of information sharing helps not only the solving of configuration problems for an end-user, but also the supportability and manageability of PCs within a corporate environment which may have hundreds or thousands of PCs. Through the use of the Registry, configuration information is easily available to the system and applications, and access to the information is made available to both locally and remotely.

Additional information about the Plug and Play capabilities in Windows 95 is discussed in the following sections.

Benefits of Plug and Play with Windows 95

Plug and Play will be of enormous benefit to the user. No longer will the user be required to manually set jumpers and switches to redirect IRQs, DMA channels, or I/O port addresses. This will save the user's time and will also save OEMs and IHVs the expense of supporting large numbers of user service calls related to these configurations.

Plug and Play is designed so that adding a device, either permanently or dynamically, requires nothing more than taking it out of the box and plugging it in. The PC seamlessly adjusts to the new configuration.

◻ **Users need not concern themselves with the inner workings of Plug and Play—it just works.**

The Plug and Play specifications define how the various hardware devices, software drivers, and operating system components interact. At the level where the user interacts with the PC, the PC simply works. Plug and Play reduces the time users spend on technical problems and increases their productivity and satisfaction with PCs.

◻ **Plug and Play also benefits users who install Plug and Play devices into older, legacy PC systems.**

Components using the Plug and Play architecture are able to accommodate the

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lack of device-reporting mechanisms in non - Plug and Play devices. Information about these devices is stored centrally in the Registry, and devices

that cannot be reconfigured by the software receive first priority when resources are allocated.

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◻ **Plug and Play makes it easier to manage and support PC configurations.**

This is because many procedures that were once done manually—such as setting IRQ lines, figuring out what the right jumper settings are, and installing the correct device drivers—are now performed by the Plug and Play PC system. Problems that users used to encounter with non - Plug and Play PC systems generated a tremendous support burden. Customer frustration with the configuration process reduced demand for add-on and upgrade products. For businesses, the high cost of supporting PCs inhibited increased use of PCs in the workplace and diverted information systems personnel from focusing on using computer technology to solve business problems.

Hardware Design Guide for Microsoft Windows 95

Intended for PC manufacturers, peripheral vendors, and readers interested in learning the technical details of Plug and Play, the *Hardware Design Guide for Microsoft Windows* 95 from Microsoft Press contains the official Microsoft guidelines and recommendations for developing—and developing for—a *PC 95* computer. This comprehensive discussion of the Plug and Play specification explores the *PC 95* concept in detail; examines the rationale for improving on the present standards; and outlines the design criteria for Plug and Play systems, devices, buses, and peripherals. It is also covers the full technical details of the *PC 95,* including including internal and external peripherals, the BIOS used in the *PC 95,* and the new services performed by the BIOS as the go-between for the Plug and Play operating system and the system hardware.

You can find or order the Hardware Design Guide for Microsoft Windows 95 wherever better computer books are sold or you may order it direcly from Microsoft Press at 1-800-MSPRESS (in Canada call 1-800-667-1115). Outside of the U.S. and Canada, contact your local computer book retailer or the Microsoft subsidiary in your area.

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Device Manager

In order to properly manage resources on the PC (e.g., IRQs, I/O addresses, DMA addresses, etc.), Windows 95 tracks devices and resources allocated to devices in the registry. This information is maintained for both Plug and Play devices *and* legacy devices. The Device Manager, accessible from the System icon in Control Panel, provides a graphical representation of devices configured in Windows 95, and allows properties used by these devices to be viewed and, as appropriate, changed. While users would normally have no need to modify entries from within Device Manager, the information is useful for identifying devices that Windows 95 knows about for a particular PC configuration. Figure 1 shows a sample Device Manager property sheet identifying different devices configured in Windows 95. The "View devices by connection" option in the Device Manager property sheet allows the devices configured in the system to be listed in a hierarchy with the associated adapter or controller card. For example, the CD-ROM device would be listed under the SCSI controller adapter heading, identifying the connection and associated device.
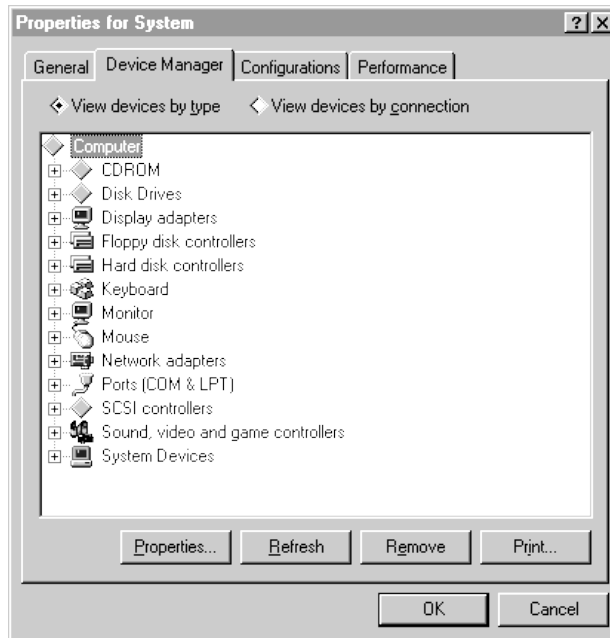
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Figure 1. Device Manager Property Sheet

In addition to showing devices configured in Windows 95, Device Manager also shows resource allocated for the configured devices. Resources such as memory ranges, I/O addresses. DMA addresses. and IRQs required by used by devices can be viewed from the "Properties" dialog for the computer configuration. Figure 2 shows sample properties for a given computer configuration.
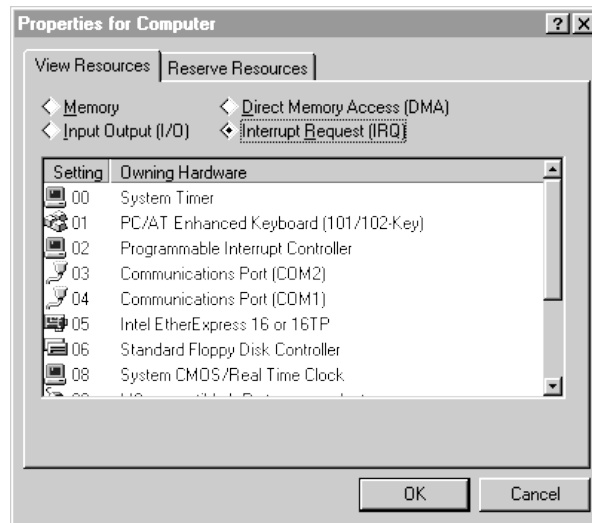

Figure 2. Properties for Computer Dialog Box in Device Manager

The power of Plug and Play comes from Windows 95 being aware of the resources available on the computer, resources allocated by the computer, and required resources being reported by a Plug and Play device. Through the resource configuration information maintained in the registry, Windows 95 is able to automatically identify and resolve device resource conflicts for Plug and Play devices. For legacy devices, the tracking of resources in Windows 95 will help users and support organizations quickly and easily identify conflicting resources and devices that are configured in the system—these items are then highlighted in the Device Manager.

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