

Basic PC 98

This chapter provides a summary of features for the system types defined in the PC 98 requirements. As introduced in Part 1 of this guide, this chapter describes two different forms of the Basic PC 98 system. It is assumed that the OEM designs and builds a baseline platform that meets the Basic PC 98 requirements, with specific models targeted for either of two categories: Office or Consumer.

For definitions of common terms, acronyms, and abbreviations used in this guide, see the Hardware Glossary in the References part of this guide. See also the “Conventions Used in This Guide” section in the Welcome part of this guide.

Important: The system requirements defined in this guide provide guidelines for designing PC systems that will result in an optimal user experience with typical Windows-based applications running under either the Microsoft Windows or Windows NT Workstation operating systems. These design requirements are not the basic system requirements for running the Windows operating system.

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Note: All references in this chapter to requirements for Network PC (Net PC) systems refer to similarly named requirements in the *Network PC System Design Guidelines, Version 1.0b*, co-authored by Compaq Computer Corporation, Dell Computer Corporation, Hewlett-Packard Company, Intel Corporation, and Microsoft Corporation. The Net PC guide is included as Appendix E in the References part of this guide. Information about Net PC is provided as a context for Office PC 98 requirements; Net PC is not a PC 98 system type.

Basic PC 98 General System Requirements

This section presents a summary of the general system requirements and recommendations, including system board, memory, and BIOS requirements.

1. System performance meets PC 98 minimum requirements

<i>Consumer PC 98</i>	<i>Office PC 98</i>	<i>Entertainment PC 98</i>
<i>Required</i>	<i>Required</i>	<i>Required</i>

The performance requirements for PC 98 systems are based on the minimum computational capabilities and performance necessary to support the demands of Windows-based applications. The increased requirements over those defined in *PC 97 Hardware Design Guide* represent the estimated processing demand and processing capability of the lowest-end processor by mid-1998.

For systems based on Intel Architecture processors, the minimum PC 98 performance requirement consists of the following:

- 200-MHz Pentium processor with Intel MMX technology, or equivalent performance.

The minimum microprocessor capability is specified to support the demands of rich media, Internet access, and conferencing. The performance requirement for media enhancement is specified to ensure that the system meets performance targets at minimum platform power.

- Minimum 256K Level 2 (L2) cache, or equivalent performance.
- 32 MB minimum system memory.

Recommended: 64 MB. Memory should be 66-MHz Dynamic Random Access Memory (DRAM) or better.

For a PC 98 system with 32 MB or more of memory, only 4 MB of memory can be locked and unavailable for the system to use at boot time. The remaining memory cannot be locked from use by the operating system. This minimum requirement does not preclude applications that use dynamically allocated memory for audio or video playback or other temporary uses.

For systems based on RISC architecture, the requirement is a Windows NT-compatible RISC processor. Notice that all PC 98 requirements for RISC-based PCs are for the Windows NT operating system only. There are no plans to enable Windows to run on RISC-based PCs.

Note: If multiprocessor support is provided in any system using Intel Architecture, such support must comply with *MultiProcessor Specification, Version 1.4* or higher, and the Advanced Programmable Interrupt Controller (APIC) extension to the ACPI 1.0 specification.

For guidelines and exceptions for other system types, see the “Workstation PC 98” and “Mobile PC 98” chapters in Part 2 of this guide.

2. System design meets ACPI 1.0 specification and PC 98 requirements

<i>Consumer PC 98</i>	<i>Office PC 98</i>	<i>Entertainment PC 98</i>
<i>Required</i>	<i>Required</i>	<i>Required</i>

Recommended: Thermal model and fan control as defined in Section 12 of the ACPI 1.0 specification.

The system board must support the *Advanced Configuration and Power Interface Specification, Revision 1.0* or higher. This requirement ensures that the system correctly supports Plug and Play and power management as described in Part 1 of this guide. ACPI support must include the following:

- Power-management timer.
- Power button in compliance with the ACPI 1.0 specification. This should be implemented as described in the “Hardware design supports OnNow initiative” requirement later in this section. A separate reset switch is an acceptable alternative to the ACPI-specified override mechanism.
- Real-time clock alarm that supports wake up due to a scheduled time and day of the month. Notice that the day-of-month feature is a requirement for PC 98, although it is an optional feature in the ACPI 1.0 specification.
- The S5 (soft-off) state, as required in the ACPI 1.0 specification, plus at least one of the S1, S2, or S3 sleep states. Notice that one of sleep states S1–S3 is required for PC 98, although this is only recommended in the ACPI 1.0 specification. The S4 and S4BIOS sleep states are not sufficient to meet this requirement.

Recommended: For maximum power savings and system response, support of the S3 sleep state is recommended.

- System control interrupt and Status and Enable (STS/EN) bits for the power-management timer, power button, and real-time clock.
- Description table for system-board devices, including host PCI bridges. This table defines the complete hierarchy, including all non-Plug and Play devices to be enumerated and all other devices for which power management or removal capabilities have been added by the system-board design.
- ACPI control methods necessary to configure each bus and device enumerated using ACPI. This is as described in the “Each bus and device meets Plug and Play specifications” requirement in the “Basic PC 98 General Device Requirements” section later in this chapter.
- USB host controller able to wake system from at least one sleeping state (S1, S2, or S3) using ACPI mechanisms. This is a requirement for PC 98, although it is only a recommendation in the ACPI 1.0 specification.
- No capabilities to disable system ACPI support using CMOS or other means.

Implementing the thermal model and fan control as defined in the ACPI 1.0 specification is recommended as a means of running the PC quietly while working, and turning the fan off while the PC is sleeping. Notice that a hardware-based open-loop thermal control is an acceptable implementation for system cooling if it meets the capabilities defined in the “Audible noise meets PC 98 requirements” item later in this chapter. However, the recommended implementation is a closed-loop control using the PC’s processor, an embedded controller, or both. If a closed-loop implementation is used, it must comply with the ACPI 1.0 specification.

Note: Any other system-board power management or Plug and Play features must be implemented in compliance with the ACPI 1.0 specification, even if a particular feature is not a specific PC 98 requirement or recommendation.

3. Hardware design supports OnNow initiative

<i>Consumer PC 98</i>	<i>Office PC 98</i>	<i>Entertainment PC 98</i>
<i>Required</i>	<i>Required</i>	<i>Required</i>

Recommended: If telephone answering machine (TAM) capabilities are built into the system, then a Message Waiting indicator should be included on desktop systems.

Elements of the OnNow design initiative ensure that the operating system and device drivers control the state of individual devices and the system board. The following support is required for PC 98 hardware:

- The user experiences the PC as off when it is in a sleep state.

At a minimum, the hard disks, CD drives, display, sound, input devices, and fans must be perceived as off while the system is in a sleep state (for example, no noise or lights other than the status indicator).
- The user can easily see whether the PC is working or sleeping.

A non-flashing light-emitting diode (LED) sleep indicator that is a different color than the wake indicator is the preferred implementation. A slowly blinking—less than 1 Hz—LED indicator is an acceptable implementation. Notice that the nonvolatile sleep state (S4 or S4BIOS) should appear to the user as the off state; that is, these states should have the same indicator.

At a minimum, the PC 98 system must provide one or more indicators to show whether the system is in the working or sleep state.
- The user can easily control power through switches and software.

The system must provide an easily accessible power switch that can be controlled by software and that supports the functionality required in Section 4.7.2.2.1 of the ACPI 1.0 specification.

To meet this requirement, an OnNow PC can have either a power button or a sleep button. The recommended implementation for both desktop and mobile PCs is to have both. If both buttons are implemented, the sleep button should be the user's primary switch interface and must be easily distinguishable from the power button. The preferred implementation is to hide the power button.

The function of these buttons is determined by the operating system. In single-button configurations, it can be used for either sleep/wake transitions ($G0 \leftrightarrow G1/S1-S4$) or off/on transitions ($G0 \leftrightarrow G2/S5$), depending on user preference and the policy set in the operating system and use of an operating system–provided user interface. The default action for the sleep button is to cause the machine to enter a sleep state. The default action for the power button is to shut down the operating system and power off the machine. In a two-button configuration that includes separate power and sleep buttons, the operating system user interface will allow only the default actions.

For PC 98, in the case of a hardware or software failure that prevents normal operation of the software-controlled buttons, the switch capabilities must include an override mechanism for turning off the PC. Notice that the override mechanism is not an alternative way for the user to turn off the PC in normal operation; it is only a fail-safe function for fault conditions.

The implementation recommended in Section 4.7.2.2.1 of the ACPI 1.0 specification is a 4-second override mechanism. The override can be on either the power button or the sleep button in a two-button configuration.

Note: It is strongly recommended that the override be associated with the sleep button in order to establish an industry-standard implementation.

An acceptable but not recommended alternative is a separate hidden or recessed switch that cannot be mistaken for either the power button or the sleep button. Notice that although the ACPI 1.0 specification suggests the override be associated with the power button, the recommended implementation for an OnNow PC is to have the primary and most accessible button be the sleep button.

Equivalent button functionality can be provided using a keyboard key. If the power switch is provided on the keyboard, the key must be clearly labeled and must consist of a single keystroke for turning on the PC. (Two keystrokes are permissible for turning off the PC.) The single keystroke ensures accessibility for persons with disabilities. For information about the correct scan codes for keyboard power switches, see <http://www.microsoft.com/hwdev/pcfuture/>.

This requirement for an easily accessible power switch does not preclude power-control capabilities such as closing the lid on a mobile PC.

Power management is supported for any of the following buses present on the system: PCI, USB, IEEE 1394, and PC Card. Any of these buses must support power management requirements as defined in the related bus standard in Part 3 of this guide.

- Each device supports the power management specifications for its class.
All devices and drivers must support the D0 and D3 power states consistent with the definitions in the relevant device class power management reference specification or the *Default Device Class Power Management Specification, Version 1.0* or higher.

This means that each device can successfully survive a system sleep/wake transition (D3 to D0) without losing functionality and without requiring user intervention to restore functionality. This applies whether or not system power is removed while the device is in the D3 power state.

Notice that there is no power consumption requirement for devices in the D3 power state. It is strongly recommended, however, that devices implement the D3 power state such that device power consumption is reduced to near zero. This recognizes that there is no requirement to retain any device context because it will be preserved or restored by the driver when returning to the D0 power state.

It is recommended that devices and drivers support the D1, D2, or both low-power states and also support the defined wake-up events as designated in the related device class power management reference specification.

4. BIOS meets PC 98 requirements for OnNow support

<i>Consumer PC 98</i>	<i>Office PC 98</i>	<i>Entertainment PC 98</i>
<i>Required</i>	<i>Required</i>	<i>Required</i>

This requirement does not apply for RISC-based PCs, except for the requirement for fast power-on self test (POST). For PC 98, the following BIOS support is required:

- Fast POST. The system must be available to the user as fast as possible. Although a specific time limit is not established, the basic recommendation is that power on to the bootstrap loader should occur within 5 seconds, plus hard disk ready time. The following are recommended ways to reduce processing overhead to make system boot time as fast as possible:
 - No video memory test, and limited test for DRAM size.
 - No tests for serial or parallel ports.
 - No floppy disk test or media check (boot from hard disk only).
 - No tests for hard disk controller or drive type (if the system does not include swappable drives).
 - Test execution controlled using Windows-based control panel or application that can be scheduled to run periodically at off-hours.
 - Fast POST mode for BIOS that can be disabled by the user for troubleshooting.

- Minimal time for resume from sleep state.
Resume from sleep state (S1–S4) to operating system handoff must occur within 500 ms. This requirement does not apply for the S4BIOS state. For all other sleep states, the time to operating system handoff is measured from when the processor starts running (first instruction) until the BIOS jumps to the Waking Vector in the ACPI firmware control structure table, as described in Section 5.2.6 in the ACPI 1.0 specification.
- Minimal start-up display. System start-up draws the end user’s attention only in case of errors or when there is a need for user action.
The default configuration must allow a beep during the boot process only in case of an error. The only screen display allowed is the OEM splash screen, which can include information such as copyright notices. By default, the system must be configured so the screen display does not display memory counts, device status, and so on, but presents a “clean” BIOS start-up. However, this requirement does not preclude the following:
 - Presenting a blank start-up screen.
 - Providing a hot-key override to display screen messages for troubleshooting or to display user-definable CMOS settings.
 - Presenting text-based end-user action messages—for example, messages to display the setup hot key, system help hot key, password entry, network log on for remote booting, and so on.
 - Presenting manufacturer branding messages.
 - Providing a CMOS option to turn the clean start-up screen off and on.

The intention of this requirement is to ensure that the end user is not presented with confusing information and unnecessary visual display, and to ensure that access to error information remains available using a hot key.

5. BIOS meets PC 98 requirements for boot support

<i>Consumer PC 98</i>	<i>Office PC 98</i>	<i>Entertainment PC 98</i>
<i>Required</i>	<i>Required</i>	<i>Required</i>

This requirement does not apply for RISC-based PCs. ACPI BIOS entries, as defined in Section 1.6 of the ACPI 1.0 specification, should be the same for supporting either Windows 98 or Windows NT 5.0. In general, the run-time services portion of the Plug and Play BIOS is replaced by ACPI and therefore is not required. In fact, the Plug and Play BIOS must be disabled when ACPI is enabled. The Extended System Configuration Data (ESCD) calling interface is not supported by Windows 98 or Windows NT 5.0.

The PC 98 requirements include the following:

- Preboot execution environment supported.
For Office PC 98, the execution environment provided by the PC system must conform to the description given in “Attachment B: Preboot Execution Environment” of *Network PC System Design Guidelines*.
For Consumer PC 98 and Entertainment PC 98, this means providing a PXENV unique system ID structure in the system BIOS or CMOS, as defined in “Attachment B: Preboot Execution Environment” of *Network PC System Design Guidelines*.
- BIOS boot for CD-ROM supported.
For any system that includes a CD-ROM, the system BIOS or option ROM must support the No Emulation mode in *El Torito—Bootable CD-ROM Format Specification, Version 1.0*, by IBM and Phoenix Technologies, Limited, or an equivalent method that supports the Windows NT CD-ROM installation process.
- BIOS boot for network adapter supported.
For any PC 98 system that includes a network adapter, the system BIOS must comply with the requirements defined in Sections 3 and 4 (as they apply to Plug and Play devices) of the *Compaq, Phoenix, Intel BIOS Boot Specification, Version 1.01* or higher, which describes the requirements for Initial Program Load (IPL) devices.
- Dates beyond the year 2000 correctly supported in BIOS and CMOS.

The following features are required for Office PC 98 systems to ensure manageability and security:

- Security such as a pre-boot password provided to protect enable/disable capabilities for hardware components before the operating system boots.
This capability is required for Office PC 98 systems and is recommended for other system types. The purpose of this feature is to prevent end users from accidentally or purposefully circumventing operating system-level security and control as applied by an administrator.

- BIOS updates and revisions supported.

This item is required for Office PC 98 and Net PC systems. BIOS updates must be implemented in order for BIOS ROMs to be upgraded to a new image through OEM-provided programs using either (1) the remote new system setup mechanism that will be downloaded and executed at boot time or (2) normal file access and execution methods when the system is fully booted into the normal operating system environment. For information about requirements related to the remote new system setup mechanism, see the “Network Communications” chapter in Part 4 of this guide.

Recommended: Implement a mechanism to authenticate the requester of the update programming. Implement a mechanism to validate that the program arrived intact after download.

A working group is developing a mechanism to implement this requirement for non-volatile storage update capabilities. When available, this information will be available on the web site at <http://www.teleport.com/~nsispec/>.

If option ROMs are provided, they must also be capable of being upgraded.

- BIOS boot for USB keyboard supported if USB is the only keyboard.

For any Intel Architecture system with a USB keyboard as the only keyboard in the system, the system BIOS must provide boot support as defined in *Universal Serial Bus PC Legacy Compatibility Specification, Version 0.9* or higher.

Basic PC 98 Physical Design Requirements

This section summarizes physical design requirements and recommendations for PC 98 systems. These requirements are in addition to those related to the OnNow initiative for power-state indicators and easily accessible power switches.

6. All expansion slots in the system are accessible for users to insert cards

<i>Consumer PC 98</i>	<i>Office PC 98</i>	<i>Entertainment PC 98</i>
<i>Required</i>	<i>Required</i>	<i>Required</i>

The internal expansion slots cannot be physically blocked by components or devices provided with the system. This requirement does not exclude configurations that allow space only for half-height cards for some slots, for passive back planes for connectors, and so on.

For Net PC systems, user-accessible internal expansion slots are not allowed. For mobile guidelines and exceptions, see the “Mobile PC 98” chapter in Part 2 of this guide.

7. Audible noise meets PC 98 requirements

Consumer PC 98

Office PC 98

Entertainment PC 98

Required

Required

Required

A PC 98 system must be “silent” in the sleep state. That is, it must be perceived as not significantly noisier than the off state to typical users, relevant to an operating position appropriate to the PC’s form factor (such as desktop, minitower, or laptop) and the ambient noise level of its normal usage environment (such as corporate office, home office, family room, and so on). This requirement applies primarily to fan noise, as all other devices will not be active in the sleep state.

It is hoped that this definition will become more objective over time through standardization of acoustic noise measurement and reporting procedures for PCs. Intel and Microsoft are working on proposals for acoustic noise measurement and reporting. The goal is to achieve common PC acoustic noise measurement methods based on established international standards. With such methods in place, end users will be able to receive reliable acoustic noise specifications about PCs similar to those available for other product categories such as automobiles and appliances.

Although this PC 98 requirement does not specify noise limits for PCs in idle and working states, manufacturers are strongly encouraged to design systems that operate as quietly as possible, especially Entertainment PCs designed for use in the home family room. It is expected that future design guidelines will propose operational noise limits for the Entertainment PC category.

8. System and component design practices follow accessibility guidelines

Consumer PC 98

Office PC 98

Entertainment PC 98

Recommended

Recommended

Recommended

Accessibility design guidelines are provided in the “Accessibility” appendix in the References part of this guide. These guidelines were developed in consultation with the Trace Research and Development Center at the University of Wisconsin at Madison. This recommendation will not become a requirement.

9. Internal system modification capabilities are not accessible to end users

Consumer PC 98

Office PC 98

Entertainment PC 98

Recommended

Recommended

Recommended

This recommendation is based on goals to reduce TCO by ensuring that end users are prevented from inadvertently (or purposefully) altering the predefined software and hardware configurations. This recommendation, which is a requirement for Net PC systems, can encompass any of the following system requirements as defined in the *Network PC System Design Guidelines*:

- Lockable or sealed-case design, where internal expansion capabilities are not end-user accessible
- Upgrade capabilities for RAM and CPU are not end-user accessible

10. System design provides physical security

<i>Consumer PC 98</i>	<i>Office PC 98</i>	<i>Entertainment PC 98</i>
<i>Recommended</i>	<i>Recommended</i>	<i>Recommended</i>

To prevent unauthorized hardware access, the following security features are recommended for PC 98 systems and required for Net PC hardware:

- External drive devices have locking capabilities. Each removable media device should be capable of being locked to prevent unauthorized data access. This means that the device is rendered inoperable, either electronically or mechanically, when locked.
- PC case and switches have locking capabilities to prevent unauthorized internal access. An OEM-specific method can be implemented, either electronically or mechanically.

Basic PC 98 General Device Requirements

The requirements in this section apply for every device, whether present on the system board or as an expansion device provided by the OEM in a default system configuration. Most general device requirements are related to Plug and Play capabilities.

11. Each device and driver meets PC 98 device requirements

<i>Consumer PC 98</i>	<i>Office PC 98</i>	<i>Entertainment PC 98</i>
<i>Required</i>	<i>Required</i>	<i>Required</i>

Each device must comply with all PC 98 requirements for the related device class, whether the device is provided in the PC system as an expansion card or as an external device.

Drivers must be provided for both Windows and Windows NT operating systems. The manufacturer does not need to supply a driver for a device if the device passes PC 98 compliance testing using a driver provided with the operating system. Notice that not all drivers provided with Windows or Windows NT comply with the basic and device-specific requirements for drivers as defined in this guide.

In addition to the device requirements in this section, see also the specific requirements for each device class in Part 4 of this guide.

12. Each bus and device meets Plug and Play specifications*Consumer PC 98**Office PC 98**Entertainment PC 98**Required**Required**Required*

Each bus and device provided in a PC 98 system must meet the current Plug and Play specifications related to its class, including requirements defined in Section 6 of the ACPI 1.0 specification and clarifications published for some Plug and Play specifications. This includes requirements for automatic device configuration, resource allocation, and dynamic disable capabilities.

For information about new Plug and Play support under Windows NT 5.0, see the Windows NT 5.0 DDK.

The following shows current version numbers for all Plug and Play specifications:

- *PCI Local Bus Specification, Revision 2.1 (PCI 2.1)*
- *Plug and Play External COM Device Specification, Version 1.0*
- *Plug and Play Industry Standard Architecture (ISA) Specification, Version 1.0a*
- *Clarification to Plug and Play ISA Specification, Version 1.0a*
- *Plug and Play Parallel Port Device Specification, Version 1.0b*
- *Plug and Play Small Computer System Interface Specification, Version 1.0*
- *Universal Serial Bus Specification, Version 1.0*

Plug and Play specifications for IEEE 1394 are defined in this guide. For information, see the “IEEE 1394” chapter in Part 3 of this guide.

Note: Standard system devices are excluded from this requirement. The system can reserve static resources for devices such as programmable interrupt controllers (PICs) 1 and 2, timer (8254-2), keyboard controller (8042), real-time clock, DMA page registers, DMA controllers 1 and 2, and math coprocessor. For systems based on Intel Architecture processors, these fixed resources are located at I/O addresses under 100h and can also include a Nonmaskable Interrupt (NMI). For more information, see the “Legacy Support” appendix in the References part of this guide.

In addition, systems designed to run only on Windows NT are not required to meet PC 98 requirements for legacy Plug and Play support. If the system is designed to run either Windows 98 or Windows NT, it must meet all PC 98 requirements for legacy Plug and Play support.

13. Unique Plug and Play device ID provided for each system device and add-on device

<i>Consumer PC 98</i>	<i>Office PC 98</i>	<i>Entertainment PC 98</i>
<i>Required</i>	<i>Required</i>	<i>Required</i>

Each device connected to an expansion bus must be able to supply its own unique ID, as defined in the current Plug and Play specification for the bus that it uses. The following defines the specific requirements for Plug and Play device IDs:

- Each separate function or device on the system board must be separately enumerated; therefore, each must provide a device ID in the manner required for the bus it uses.
- If a device on an expansion card is enumerated by the BIOS, it must have a unique ID and its own resources according to the PC 98 device ID requirements for the bus to which the card is connected. This includes devices that are separately enumerated on multifunction cards or multifunction chips. CardBus devices must meet the requirements defined in the “PC Card” chapter in Part 3 of this guide.

The following are exceptions to this requirement:

- Legacy devices attached to the ISA bus on the system board do not have unique Plug and Play IDs—for example, serial ports, parallel ports, or PS/2-compatible port devices. The method for device identification is defined in the *Plug and Play ISA Specification, Version 1.0a*, and the ACPI 1.0 specification.
- Some multifunction devices (such as Super I/O) might include devices that do not have unique Plug and Play IDs or unique PCI subsystem IDs, but that are supported by drivers provided with the Windows operating system.
- A device such as a multifunction PCI device that supports a number of functions but uses only a single set of relocatable resources does not have to provide separate IDs for each function included on the device.

In addition, for Office PC 98 and Net PC systems, if an OEM uses a proprietary mechanism to assign asset or serial numbers to hardware, this information must be available to the operating system using Windows hardware instrumentation technology, as defined in the *Network PC System Design Guidelines*.

14. Option ROMs meet Plug and Play requirements

Consumer PC 98

Office PC 98

Entertainment PC 98

Required

Required

Required

This requirement applies only for devices that might use option ROM on systems based on Intel Architecture processors, whether the device is present on the system board or provided through an expansion card.

Option ROMs are usually located on cards used as system boot devices. During the boot process, option ROMs initialize the boot devices, which provide the primary input, primary output, and IPL device to boot the system. However, Plug and Play option ROMs can be used to supply the Plug and Play expansion header to devices other than boot devices, enabling them to initialize both devices when the system boots.

To design an option ROM with Plug and Play capabilities, follow the requirements described in the *Plug and Play BIOS Specification, Version 1.0a*, and *Clarification to Plug and Play BIOS Specification, Version 1.0a*, which describe the Plug and Play expansion header and the interaction between the system BIOS and the option ROM. In particular, note the following points from the specifications:

- The header contains information that identifies the type of boot device connected to the expansion card. This information allows the system BIOS to prioritize the boot devices. Shadowed copies of the option ROM must also contain the Plug and Play expansion headers.
- A Plug and Play option ROM must be able to determine whether the system BIOS complies with Plug and Play. If the system ROM is not Plug and Play-compliant, the option ROM should immediately initialize the card and hook the proper interrupt as though it were a non-Plug and Play option ROM. This allows the expansion card to be used in non-Plug and Play systems.
- An option ROM can use the system BIOS run-time functions, but these functions are not available until after the POST process has completed and Int 19 has been called. In particular, an option ROM must not hook the following interrupts until the system BIOS calls the boot connection vector contained in the Plug and Play expansion header: Int 9h, Int 10h, Int 13h, Int 18h, or Int 19h. Option ROM routines must not try to use these run-time functions until that time, because the results can be unpredictable.

Option ROM requirements for specific devices are defined in the “IDE and ATAPI” and “SCSI” chapters in Part 3 of this guide and in the “Graphics Adapters” and “Storage and Related Peripherals” chapters in Part 4.

Note: Systems designed to run only on Windows NT are not required to meet PC 98 requirements for legacy Plug and Play support.

15. “PNP” vendor code used only to define a legacy device’s CompatibleID

<i>Consumer PC 98</i>	<i>Office PC 98</i>	<i>Entertainment PC 98</i>
<i>Required</i>	<i>Required</i>	<i>Required</i>

All legacy devices not enumerated by the system-board interface must not use “PNP” in their vendor and device codes. The PNP vendor code is reserved for Microsoft and for vendors whose hardware is specifically assigned a particular ID. Other hardware can use a PNP code only when defining a device’s CompatibleID and only after first indicating the device’s HardwareID in the Plug and Play header.

Use of CompatibleIDs is strongly recommended for devices that use device drivers provided with the Windows operating system, such as a Standard PC COM Port (PNP0500) or Sound Blaster 16-compatible Sound Device (PNPB003).

For information about using PNP CompatibleIDs, see the “Device Identifiers” appendix in the References part of this guide. To obtain a unique PNP vendor ID, please send a request by e-mail to npnid@microsoft.com.

16. Device driver and installation meet PC 98 requirements

<i>Consumer PC 98</i>	<i>Office PC 98</i>	<i>Entertainment PC 98</i>
<i>Required</i>	<i>Required</i>	<i>Required</i>

Each device must have drivers for both Windows and Windows NT to ensure correct support under both operating systems. For some device classes, this support can be provided using a WDM driver, as defined in the related device requirements in Part 4 of this guide.

General driver requirements. The manufacturer does not need to supply a driver for a device if the device passes PC 98 compliance testing using a driver provided with the operating system. If the manufacturer supplies a driver, the device drivers and installation requirements include the following:

- All devices and drivers must pass PC 98 compliance testing. Each device included in a PC 98 system must comply with the PC 98 requirements and must have supporting 32-bit device drivers for the CPU platform and operating system.

Notice that for the Windows operating system, the display driver file is a Win16 module.

- All configuration settings are stored in the registry. The driver must not use INI files for configuration settings.

The driver must also include correct provider, version, and copyright entries. This information is displayed in the user interface, such as Device Manager in Windows.

- The correct minidriver, virtual device drivers (VxDs), or any other manufacturer-supplied files specified in the device's INF file must be installed in the correct location.

For manufacturer-provided files, the vendor must *not* be identified as Microsoft and all other copyright and version information must be correct for the manufacturer.

- Driver installation and removal must use Windows-based methods as defined in the Windows and Windows NT DDKs.

The device driver must be able to be removed using Windows-based software, which can be managed using either the Windows Control Panel option for removing devices or its own remove utility. For information, see “Driver Installation” in the Windows NT 5.0 DDK and “Windows 95 Class Installers and Network Driver Installers” in the Windows 95 DDK.

However, any software applications included with the device can be installed using an alternate Windows-based installation method as defined in the Win32 SDK.

Also, any software components and registry entries installed during driver installation must be removed during driver uninstallation.

- Driver files provided by the vendor must not use the same file names as used by files included in Microsoft operating systems and provided as either retail or OEM products, unless specifically agreed upon with Microsoft.
- It must be possible for the device's driver to be installed using a mechanism, such as a script or special software, for supplying required parameters without the user being present.
- In order to ensure that the user can correctly change settings, a Windows Help file must be provided if special driver parameters are used. The device's installation routine must install the Help file as part of the setup program. The user interface for the device's dialog boxes must display the correct Help file, and the Help file must contain relevant information to assist the user. The guidelines for implementing a Help file are defined in the Windows NT DDK.

System-specific requirements. For systems that come pre-installed with either Windows 98 or Windows NT 5.0, the following requirements apply:

- For any device for which WDM-based support is provided in the operating system, the driver supplied by the manufacturer must be a WDM minidriver.
- Every driver (or minidriver) must support Plug and Play and power management I/O request packets (IRPs).

For systems that come with Windows NT pre-installed, only 32-bit protected-mode components are installed. No real-mode or 16-bit protected-mode components can be provided in order to operate under Windows NT.

For systems that come pre-installed with Windows, the following requirements apply for drivers:

- Every VxD must support Plug and Play and power management messages.
- The driver must provide power management support as required by any device class power management reference specification.
- Any real-mode components provided for backward compatibility should use separate installation procedures. Although installation of Windows-based components must not make entries in Autoexec.bat or Config.sys, the separate real-mode installation program can make such entries but must not modify the registry, Win.ini, or System.ini.

17. Minimal user interaction needed to install and configure devices

<i>Consumer PC 98</i>	<i>Office PC 98</i>	<i>Entertainment PC 98</i>
<i>Required</i>	<i>Required</i>	<i>Required</i>

After physically installing the device, the user must not be required to perform any action other than to insert the disks that contain drivers and other files. The user should have to restart the system only for devices that do not support hot plugging.

As specified in the requirement, “Hot-plugging capabilities for buses and devices meet PC 98 requirements,” later in this section, devices that use USB, IEEE 1394, or PC Card must support hot plugging. For devices that use other buses, detection occurs when the system is powered on after the device is inserted.

The following requirements must be met:

- The device is immediately functional without restarting the system.
It is acceptable to require rebooting for primary system devices such as the primary graphics adapter and the primary hard disk controller. In all cases, however, changing configuration settings must not require the end user to make jumper changes.
- Software settings are available for configuring all resources.
All buses and devices on both the system board and all expansion cards must be capable of being configured by the operating system and by software (such as Device Manager in Windows) so that the user does not need to open the PC case to change the configuration. DIP switches on boot devices can be used for an initial power-on default state or for non-Plug and Play system compatibility, but such settings must be capable of being overridden by software configuration after power on occurs under Plug and Play operating systems.
Note: This requirement does not apply for jumper settings used by the OEM to set CPU speed, select a keyboard, or make other basic system-related settings in the factory. This requirement applies only for settings that the end user must make to configure the hardware.

- Dynamic disable capabilities are supported for all devices.

All devices must be capable of being automatically disabled by the system. Also, disabling the device must result in the freeing of all its resources for use by other devices.

The following devices are exempt from this requirement: all legacy devices using the I/O range under 100h, keyboard controller, FDC, hard disk controller, video graphics array (VGA) memory and I/O addresses, and any BIOS memory ranges required for legacy boot support.

18. Connections use icons plus keyed or shrouded connectors

<i>Consumer PC 98</i>	<i>Office PC 98</i>	<i>Entertainment PC 98</i>
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<i>Required</i>	<i>Required</i>	<i>Required</i>
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This requirement helps ensure that the end user can correctly make the physical connections required for adding a device to a system. This requirement includes the following:

- Wherever possible, keyed or shrouded connectors or other configurations should be used to prevent misconnection.

The physical design of the connector must ensure that the user cannot mistakenly insert the connector into the wrong port. For specific requirements related to keyed connectors and cables for I/O controllers and peripherals, see the “IDE and ATAPI” and “SCSI” chapters in Part 3 of this guide.

- Icons are provided for all external connectors.

The icons can be molded, printed, or affixed as permanent stickers (which can include text). Icons can be based on existing vendor designs or on the examples listed in the “Icons” appendix in the References part of this guide.

PC 98 does not specifically require color coding of connectors and other cable markings, but the PC designer is free to implement color coding in order to enhance user accessibility.

Note: It is recognized that the design for legacy ports, such as the PS/2-compatible mouse and keyboard ports, analog audio and video jacks, and the microphone and speaker jacks, will not change and therefore cannot fully meet this requirement. However, icons and labels must be provided wherever possible to help the user make the correct connections.

19. Hot-plugging capabilities for buses and devices meet PC 98 requirements

<i>Consumer PC 98</i>	<i>Office PC 98</i>	<i>Entertainment PC 98</i>
<i>Required</i>	<i>Required</i>	<i>Required</i>

Recommended: A locking mechanism to ensure that devices are removed only under operating system control or during sleep or off states.

To ensure reliable support for hot-plugging capabilities, the following PC 98 requirements must be met:

- Devices and buses must support hot plugging if using USB, IEEE 1394, or PC Card.

When designed under their respective specifications, USB, IEEE 1394, and PC Card all support hot plugging. Any device designed to use any of these connections must support being added or removed while the system is fully powered on.

The exception to this requirement is any device required for booting such as the primary graphics adapter. For information about supporting multiple graphics adapters, see the “Graphics Adapters” chapter in Part 4 of this guide.

- Hot plugging for PCI devices must use ACPI-based methods.

Windows 98 and Windows NT 5.0 support dynamic enumeration, installation, and removal of PCI devices only if there is a supported hardware insert/remove notification mechanism.

The notification mechanism is defined as part of the bus standard for CardBus bus controllers. For other solutions, such as those required for docking stations or other devices, the hardware insert/remove notification mechanism must be implemented as defined in Section 5.6.3 of the ACPI 1.0 specification.

In order to properly function with the native support in the operating system, developing industry standards such as those referred to as PCI Hot Plug and Compact PCI must use ACPI-based methods for supporting hardware insertion and removal as defined in the ACPI 1.0 specification.

- Removable media must support the appropriate media status notification method to ensure that no loss of data or system failure results when such media is removed from the system.

The media status notification requirements for CD-ROM, DVD-ROM, IDE, and ATAPI removable devices are defined in the “Basic PC 98 Storage and Related Peripherals” section later in this chapter. The Device Bay implementation guidelines are defined in the following requirement.

It is strongly recommended that designers ensure that surprise removal of any swappable device should not cause a system failure. A failure related to surprise removal of a swappable device includes any spontaneous reboot, system stall, or blue screen. At a minimum, the device driver should ensure that the PC system does not fail if the user accidentally pulls the device out of its socket. The only absolute way to ensure against system failure is to prevent surprise removals by including a locking mechanism, which is strongly recommended for PC 98 systems.

Another method of protection is to have the driver check whether its device is present when it receives certain interrupts. For example, CardBus cards share the same PCI interrupt as their socket controller, so interrupt handlers for both the card driver and socket driver are chained to the same PCI interrupt request (IRQ). To prevent a system fault after surprise removal of the CardBus card, its driver must check whether its device is still present whenever it reads a value such as 0xFFh in its status register, and then it must be able to recover gracefully when this occurs.

In all cases, for any failure that might occur, the PC system as a whole must be able to recover gracefully and report the condition to the end user.

For information related to implementation details and for additional design guidelines, see the article about hot-plugging support on the web site at <http://www.microsoft.com/hwdev/devdes/>.

20. Device Bay-capable bay and peripherals meet Device Bay specification

<i>Consumer PC 98</i>	<i>Office PC 98</i>	<i>Entertainment PC 98</i>
<i>Required</i>	<i>Required</i>	<i>Required</i>

If implemented in a PC 98 system, Device Bay capabilities must meet the following requirements:

- A Device Bay Controller (DBC) compliant with *Device Bay Interface Specification, Version 1.0* or higher, and implemented as an ACPI device object on the system board, as defined in Section 8 of the Device Bay specification
- One USB controller and one IEEE 1394 controller to support all Device Bay-capable bays in the system
- One USB port and one IEEE 1394 port for each Device Bay-capable bay in the system

Any Device Bay peripherals provided with a PC 98 system must meet the following requirements:

- Compliant with *Device Bay Interface Specification, Version 1.0* or higher
- Interface with either the USB bus, IEEE 1394 bus, or both
- Support relevant USB device class specifications

21. Multifunction add-on devices meet PC 98 device requirements for each device

<i>Consumer PC 98</i>	<i>Office PC 98</i>	<i>Entertainment PC 98</i>
<i>Required</i>	<i>Required</i>	<i>Required</i>

Multifunction add-on devices can contain more than one device. They must meet the requirements defined earlier in this section for automated software-only settings for device configuration, device drivers, and Windows-based installation. In addition, the following requirements must be met:

- Each function or device on the multifunction add-on device that is individually enumerated by the BIOS must provide a device ID for the bus it uses.
- The system must be able to separately access each logical device that is individually enumerated by the BIOS, configure the device resources independently, and disable individual devices in the event of a conflict.
- For each individually enumerated device, resource configuration requirements are the same as for an equivalent device on a separate expansion card. This means that registers cannot be shared among individually enumerated devices on a multifunction add-on device, but does not supersede device requirements among different bus classes.

The exception to this requirement is a device such as a multifunction PCI device, which supports several functions but uses only a single set of relocatable resources. When each device is not individually enumerated, there is no requirement to provide separate IDs and separate resources for each function on the device.

22. All devices support correct 16-bit decoding for I/O port addresses

<i>Consumer PC 98</i>	<i>Office PC 98</i>	<i>Entertainment PC 98</i>
<i>Required</i>	<i>Required</i>	<i>Required</i>

Each device must support a unique I/O port address in the 16-bit address range. This requirement means that, at a minimum, the upper address lines (A10–A15) can be used as the device enable address, so that the device does not respond to addresses outside of the 10-bit address range. CardBus controllers and cards must meet the requirements defined in the “PC Card” chapter in Part 3 of this guide.

Devices that use less than 16-bit I/O decode create conflicts that cannot be resolved by a Plug and Play operating system. Phantom (alias) addressing is not supported by the Windows operating system and cannot be used to meet PC 98 requirements.

Notice, however, that this requirement does not apply for the three ISA auto-configuration registers used during device enumeration and configuration. The ADDRESS, WRITE_DATA, and READ_DATA registers will continue to use 12-bit decoding as described in the *ISA Plug and Play Specification, Version 1.0a*.

23. System-board devices use ISA-compatible addresses*Consumer PC 98**Office PC 98**Entertainment PC 98*

*Required**Required**Required*

This requirement does not apply for RISC-based PCs. This requirement is unchanged under the plan for migration away from ISA.

This requirement includes devices with I/O port addresses within the reserved range 0h–0xFFh. For information about legacy system I/O addresses, see the “Legacy Support” appendix in the References part of this guide.

Basic PC 98 Buses and Devices

This section defines specific requirements for buses and devices provided in a PC 98 system, in addition to the basic requirement for supporting the ACPI 1.0 specification defined earlier in this chapter.

Basic PC 98 System Buses

This section defines the general requirements for system buses. Additional requirements for specific buses are defined in Part 3 of this guide.

24. Each bus meets written specifications and PC 98 requirements*Consumer PC 98**Office PC 98**Entertainment PC 98*

*Required**Required**Required*

In the past, some bus designs did not fully implement all of the bus requirements on every expansion card connector. For PC 98, each bus used in the system must meet all the requirements for that bus as defined in Part 3 of this guide.

Each bus and device provided in a PC 98 system must also meet the current Plug and Play specifications related to its class, including requirements defined in the ACPI 1.0 specification and the clarifications published for some Plug and Play specifications. This includes requirements for automatic device configuration, resource allocation, and dynamic disable capabilities. See also the related Plug and Play requirements in the “Basic PC 98 General Device Requirements” section earlier in this chapter.

25. System includes USB with one USB port, minimum

<i>Consumer PC 98</i>	<i>Office PC 98</i>	<i>Entertainment PC 98</i>
<i>Required</i>	<i>Required</i>	<i>Required, with 2 USB ports</i>

Recommended: 2 ports.

USB provides a bi-directional, isochronous, dynamically attachable serial interface for adding peripheral devices, such as game controllers, communications devices, and input devices, on a single bus.

The USB controller must be capable of waking the system as defined in Section 3.4.4 of the ACPI 1.0 specification. This capability is part of the requirement for ACPI compliance, as defined in the requirement, “System design meets ACPI 1.0 specification and PC 98 requirements,” earlier in this chapter.

The USB implementation in the system must also meet the requirements defined in the USB specifications plus any additional requirements for PC 98 defined in the “USB” chapter in Part 3 of this guide.

26. System includes support for other high-speed expansion capabilities

<i>Consumer PC 98</i>	<i>Office PC 98</i>	<i>Entertainment PC 98</i>
<i>Recommended</i>	<i>Recommended</i>	<i>Required, with 2 IEEE 1394 ports</i>

Recommended: Use either SCSI or IEEE 1394 as the default I/O port for devices such as scanners and external drives that require high-speed data transfer.

For all PC 98 systems, additional support for expansion capabilities can be provided using PCI 2.1, IEEE 1394, CardBus, or other high-speed buses. Any expansion bus implemented in the system must meet the requirements defined in the related chapter in Part 3 of this guide. For information about Device Bay requirements, see the “Device Bay-capable bay and peripherals meet Device Bay specification” requirement earlier in this chapter.

For Net PC systems, external expansion capabilities that are accessible by the end user are not recommended, with the exception of USB and Device Bay. If expansion capabilities are implemented in a Net PC system, additional requirements are defined in the *Network PC System Design Guidelines*.

27. If present, PCI bus meets PCI 2.1 or higher, plus PC 98 requirements*Consumer PC 98**Office PC 98**Entertainment PC 98**Required**Required**Required*

If PCI is used in a PC system, the PCI bus must meet the requirements defined in PCI 2.1 or higher, plus any additional requirements for PC 98 defined in the “PCI” chapter in Part 3 of this guide. Exceptions for particular devices are noted in Parts 3 and 4 of this guide.

Add-on PCI IDE devices must comply with PCI 2.1 requirements and also must provide Subsystem IDs and Subsystem Vendor IDs. However, PCI-to-PCI bridges and core chip sets do not have to provide Subsystem IDs and Subsystem Vendor IDs.

All PCI connectors on the system board must be able to allow any PCI expansion card to have bus master privileges.

28. System does not include ISA expansion devices*Consumer PC 98**Office PC 98**Entertainment PC 98**Required**Required**Required, with no ISA slots*

ISA expansion devices cannot be included in a PC 98 system, although ISA expansion slots are allowed on Consumer PC 98 and Office PC 98 systems. It is acceptable for all PC 98 systems to use ISA protocols and signaling or ISA-like protocols and signaling for an internal implementation. On-board devices such as audio, modems, or network adapters are not acceptable for PC 98, nor can the IDE controller use an ISA bus.

There will be a delayed phase-in period for this requirement, during which only system-board ISA devices will be allowed. Please notice that the ISA requirements that apply during the transition phase are the same as those defined in *PC 97 Hardware Design Guide*, and are also summarized in the “Legacy Support” appendix in the References part of this guide.

For Entertainment PC 98, the system must not contain ISA expansion slots that can be accessed by the end user. This is also a requirement for Net PC systems and is strongly recommended for workstations.

The benefits of designing ISA-free systems include easier and more stable system configuration, lower support cost, and improved performance.

For on-board legacy implementations, interrupts are supported using the legacy 8259 or (for Windows NT 5.0) APIC. Any on-board legacy implementations, such as BIOS ROM, Super I/O, 8042 controllers, math coprocessors, and so on, are allowed and must meet the requirements defined in the “Legacy Support” appendix in the References part of this guide.

Basic PC 98 I/O Devices

This section defines the general requirements for I/O devices. Additional requirements are defined in the “Basic PC 98 Graphics Adapters, Video, and Broadcast Services” and “Basic PC 98 Storage and Related Peripherals” sections later in this chapter.

29. System includes keyboard connection and keyboard

<i>Consumer PC 98</i>	<i>Office PC 98</i>	<i>Entertainment PC 98</i>
<i>Required</i>	<i>Required</i>	<i>Required; USB or wireless</i>

Recommended: USB.

The external keyboard connection requirements on any PC can be met by using either USB, a PS/2-style port, or wireless capabilities in the system. A mobile or all-in-one system that has a built-in keyboard must also provide the capability for an external keyboard connection, which can be implemented using a port replicator or a single PS/2-style port with special cabling for both an external keyboard and an external mouse. For complete requirements for keyboard ports and peripherals, see the “I/O Ports and Devices” chapter in Part 4 of this guide.

30. System includes pointing-device connection and pointing device

<i>Consumer PC 98</i>	<i>Office PC 98</i>	<i>Entertainment PC 98</i>
<i>Required</i>	<i>Required</i>	<i>Required; USB or wireless</i>

Recommended: USB or other external bus.

The external pointing-device connection requirements on any PC can be met by using USB, a PS/2-style port, or wireless capabilities in the system. A mobile or all-in-one system that has a built-in pointing device must also provide the capability for an external pointing-device connection. This can be implemented using a port replicator or a single PS/2-style port with special cabling for both an external keyboard and an external pointing device.

A second serial port is not an acceptable external connection for a pointing device. For complete requirements for pointing-device ports and peripherals, see the “I/O Ports and Devices” chapter in Part 4 of this guide.

31. System includes connection for external parallel devices

<i>Consumer PC 98</i>	<i>Office PC 98</i>	<i>Entertainment PC 98</i>
<i>Required</i>	<i>Required</i>	<i>Required</i>

Recommended: USB or other external bus.

The requirement for an external connection for parallel devices can be met by using USB or another external bus. This capability can also be provided as a parallel port with extended capabilities port (ECP) capabilities, but a legacy parallel port is not the recommended implementation. For complete parallel port requirements, see the “I/O Ports and Devices” chapter in Part 4 of this guide.

32. System includes connection for external serial devices

<i>Consumer PC 98</i>	<i>Office PC 98</i>	<i>Entertainment PC 98</i>
<i>Required</i>	<i>Required</i>	<i>Required</i>

Recommended: USB or CardBus.

The requirement for an external connection for serial devices can be met by using USB or CardBus. An RS-232C serial connection can also be implemented using a 16550A or equivalent serial port, but a legacy serial port is not recommended. For complete serial port requirements, see the “I/O Ports and Devices” chapter in Part 4 of this guide.

33. System includes wireless capabilities

<i>Consumer PC 98</i>	<i>Office PC 98</i>	<i>Entertainment PC 98</i>
<i>Recommended</i>	<i>Recommended</i>	<i>Recommended</i>

Infrared Data Association (IrDA) fast IR is recommended for all PC 98 systems, including mobile PCs, in order to enable synchronization and data exchanges with digital still cameras, printers, and other peripherals.

Standards for wireless PC peripherals are being developed within IrDA and are expected to be completed in 1997. For information about wireless requirements for PC 98, see the “I/O Ports and Devices” chapter in Part 4 of this guide.

34. System includes support for operating system installation

<i>Consumer PC 98</i>	<i>Office PC 98</i>	<i>Entertainment PC 98</i>
<i>Required</i>	<i>Required</i>	<i>Required</i>

A PC 98 system must include I/O device support and system BIOS support for boot devices, as described in the “BIOS meets PC 98 requirements for boot support” requirement earlier in this chapter. This allows the user to install or reinstall the operating system. Legacy and native hard disks, CD-ROM, and so on can be connected using interfaces to IEEE 1394.

The PC 98 support requirement can be included as one of the following types of devices, depending on specific customer requirements:

- CD-ROM drive

If this device is present, the host controller must meet the specific requirements defined in Part 3 of this guide, and the device must meet the requirements defined in the “Storage and Related Peripherals” chapter in Part 4.

- Network adapter

For PC 98, the network adapter driver must support NDIS 5.0 to take advantage of new operating system capabilities. An NDIS 4.0 or MAC implementation is not acceptable. For complete information about PC 98 requirements for network adapters, see the “Network Communications” chapter in Part 4 of this guide.

For a PC 98 system that uses a network adapter as a boot device to support operating system installation, the network adapter must be compatible with remote operating system installation and boot capabilities, as defined in the “Network Communications” chapter in Part 4 of this guide.

For Office PC 98, the BIOS must support using a network adapter as a boot device, and the system must be tested with a network adapter as part of PC 98 compliance testing. For Net PC systems, a network adapter and system BIOS support are also required for using the adapter as a boot device.

- Floppy disk drive: 3.5-inch, 1.44-MB minimum capacity

Support for a floppy disk drive can be provided using PC Card, USB, or a legacy FDC device as defined in the “Basic PC 98 Storage and Related Peripherals” section later in this chapter.

For the Windows NT operating system, either a CD-ROM drive or network adapter must be included in the system, because Windows NT does not support installing the operating system from a floppy disk drive.

Note: It is recognized that OEMs supply PC systems to corporations with specific feature requirements. For example, a customer might want to insert network adapters at the end-user site. However, a system submitted for PC 98 compliance testing must include a device that meets this requirement.

For information about how these requirements can be implemented for mobile PCs, see the “Mobile PC 98” chapter in Part 2 of this guide.

35. System audio support meets PC 98 requirements

<i>Consumer PC 98</i>	<i>Office PC 98</i>	<i>Entertainment PC 98</i>
<i>Recommended</i>	<i>Recommended</i>	<i>Required</i>

Although audio is a standard feature in most PC market segments, it is understood that certain SOHO and Office PC designs that focus on cost will not require audio. For those PCs that contain audio, the PC 98 audio requirements differ greatly from those defined in earlier hardware design guides, and they now include new performance metrics. For implementation details, see the “Audio Components” chapter in Part 4 of this guide.

36. System includes communications device*Consumer PC 98**Office PC 98**Entertainment PC 98**Required; modem**Required; network adapter**Required; modem*

Recommended: NDIS 5.0-supported, high-speed dial-up communications.

The PC 98 minimum modem requirements call for an internal 33.6-Kbps V.34-1996 data/fax/voice modem, using WDM driver support where relevant. The increased PC 98 requirements represent current market trends for modems available in 1998.

For complete information about PC 98 requirements for communications devices, see the “Modems” and “Network Communications” chapters in Part 4 of this guide. For information about implementation of this requirement for mobile PCs, see the “Mobile PC 98” chapter in Part 2.

Note: It is recognized that OEMs supply PC systems to corporations with specific feature requirements. For example, a customer might want to insert network adapters at the end-user site. However, a Consumer PC 98 or Entertainment PC 98 system submitted for PC 98 compliance testing must include a modem that meets PC 98 requirements. An Office PC 98 system submitted for compliance testing must include a network adapter.

37. System includes smart card support*Consumer PC 98**Office PC 98**Entertainment PC 98**Not applicable**Recommended**Not applicable*

If implemented in an Office PC 98 system, smart card readers and cards must be compatible with *Interoperability Specification for ICCs and Personal Computer Systems*, published by Bull Personal Transaction Systems, Hewlett-Packard, Microsoft, Schlumberger, and Siemens Nixdorf at <http://www.smartcardsys.com>.

In addition, smart card readers and device drivers must be Plug and Play-compliant and must adhere to the Win32 smart card specifications published in the Windows NT DDK. Smart card applications and service-provider dynamic link libraries (DLLs) must adhere to the Win32 smart card specifications as published in the Win32 SDK.

The smart card system required for a PC 98 system with digital satellite television support represents a different technology, as defined in the “Video and Broadcast Components” chapter in Part 4 of this guide.

Basic PC 98 Graphics Adapters, Video, and Broadcast Services

This section summarizes the PC 98 requirements for graphics adapters and monitors. For complete details, including recommendations for hardware acceleration, see the “Graphics Adapters” chapter in Part 4 of this guide.

38. Graphics adapter meets PC 98 minimum requirements

<i>Consumer PC 98</i>	<i>Office PC 98</i>	<i>Entertainment PC 98</i>
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<i>Required</i>	<i>Required</i>	<i>Required</i>
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The following list summarizes the key requirements for PC 98 graphics adapters:

- Graphics adapter uses PCI, AGP, or other high-speed bus.
For the primary graphics adapter, the video bus must not use ISA or any other legacy local bus. Possible implementations that meet this requirement can include PCI 2.1 or the AGP 1.0 interface. For Entertainment PC 98, AGP is required.
Whether implemented using PCI or AGP, the video bus must meet the requirements defined in the “Graphics Adapters” chapter in Part 4 of this guide.
- Graphics adapter works normally with default VGA mode driver.
The default VGA driver is required for operating system installation. The adapter must support 4-bit planar VGA mode as described in the Windows DDK.
- Adapter and driver support multiple adapters and multiple monitors.
This support ensures that the end user has guaranteed automatic support in the hardware and driver to allow the operating system to correctly configure use of multiple monitors or multiple graphics adapters.
- The adapter must support screen resolutions as defined by VESA up to the PC 98 required maximum, including $640 \times 480 \times [8, 15, 16, 24]$ bpp, $800 \times 600 \times [8, 15, 16, 24]$ bpp, and $1024 \times 768 \times [8, 15, 16]$ bpp.

For information about requirements for the built-in display adapter on a mobile PC, see the “Mobile PC 98” chapter in Part 2.

39. Adapter supports television output if system does not include a large-screen monitor

<i>Consumer PC 98</i>	<i>Office PC 98</i>	<i>Entertainment PC 98</i>
<i>Recommended</i>	<i>Recommended</i>	<i>Recommended</i>

The ability to connect and use a standard NTSC or PAL television as a large display surface is key to the ability to deliver realistic television, movie, and game experiences. For complete information about the television output requirements, refer to the “Graphics Adapters” chapter in Part 4 of this guide. For information about large-screen monitor requirements for Entertainment PC systems, see the “Monitors” chapter in Part 4 of this guide.

40. Color monitor is DDC-compliant with unique EDID identifier

<i>Consumer PC 98</i>	<i>Office PC 98</i>	<i>Entertainment PC 98</i>
<i>Required</i>	<i>Required</i>	<i>Required</i>

A monitor designed for or included with a PC 98 system must be compliant with *Display Data Channel Standard, Version 2.0*. It also must transmit an Extended Display Identification Data (EDID) structure containing unique Manufacturer Name IDs and Product Code IDs, plus all required fields defined in Section 3 of the *Extended Display Identification Data Standard, Version 2.0* or higher. This requirement does not apply to liquid crystal displays (LCDs).

For complete PC 98 requirements for monitors, including requirements for image color matching (ICM), ergonomic timing standards, and DDC support, see the “Monitors” chapter in Part 4 of this guide.

41. System meets PC 98 DVD-Video and MPEG-2 playback requirements

<i>Consumer PC 98</i>	<i>Office PC 98</i>	<i>Entertainment PC 98</i>
<i>Required</i>	<i>Required with DVD-Video</i>	<i>Required</i>

Under Windows and Windows NT, operating-system playback support for MPEG-1 is provided through Microsoft DirectShow. This requirement refers to built-in system support for DVD-Video playback or any other MPEG-2 playback capabilities, whether provided as a hardware decoder, a software decoder, or a combination of the two. This requirement does not apply for Office PC 98 systems that provide DVD-ROM drives for storage purposes only.

For PC 98, the graphics adapter requirements in support of MPEG-2 and DVD-Video playback are described in the “Graphics Adapters” chapter in Part 4 of this guide. Software requirements and hardware capabilities for MPEG-2 and DVD-Video playback are defined in the “Video and Broadcast Components” chapter in Part 4 of this guide.

These capabilities are recommended for mobile PCs, as described in the “Mobile PC 98” chapter in Part 2 of this guide.

42. System supports PC 98 analog video input and capture capabilities

<i>Consumer PC 98</i>	<i>Office PC 98</i>	<i>Entertainment PC 98</i>
<i>Recommended</i>	<i>Recommended</i>	<i>Required</i>

If video-capture capability is implemented in a PC 98 system, it must meet the requirements defined in the “Video and Broadcast Components” chapter in Part 4 of this guide.

Support for video input and capture is recommended for Consumer PC 98 and Office PC 98 systems, implemented as an add-on device or a direct interface on the system board. Systems with USB or IEEE 1394 support are capable of supporting the new low-cost digital video cameras entering the Office PC 98 market. It is strongly recommended that systems include more than one USB or IEEE 1394 port if the PC comes bundled with a USB or IEEE 1394 video conferencing camera.

For PC 98, all video input sources and capture devices must implement driver support as defined for Still Image architecture in the Windows NT 5.0 DDK.

43. System includes analog television tuner

<i>Consumer PC 98</i>	<i>Office PC 98</i>	<i>Entertainment PC 98</i>
<i>Recommended</i>	<i>Recommended</i>	<i>Required</i>

Recommended: Digital broadcast or satellite television tuner.

If this capability is implemented in a PC 98 system, it must meet the requirements defined in the “Video and Broadcast Components” chapter in Part 4 of this guide.

Basic PC 98 Storage and Related Peripherals

This section summarizes the PC 98 requirements for storage devices. For system requirements related to CD-ROM and floppy disk drives, see the “Basic PC 98 Buses and Devices” section earlier in this chapter.

44. System BIOS and option ROMs support Int 13h Extensions

<i>Consumer PC 98</i>	<i>Office PC 98</i>	<i>Entertainment PC 98</i>
<i>Required</i>	<i>Required</i>	<i>Required</i>

This requirement applies for systems that run either Windows or Windows NT, but does not apply for RISC-based PCs.

The Int 13h Extensions ensure correct support for high-capacity drives. Support for the fixed-disk access subset of Int 13h Extensions must be provided in the system BIOS and in any option ROMs for storage devices that include BIOS support. The Int 13h Extensions are defined in the Windows NT 5.0 DDK and in the “Layered Block Device Drivers” section of the Windows DDK.

45. Host controller for storage device meets PC 98 requirements

<i>Consumer PC 98</i>	<i>Office PC 98</i>	<i>Entertainment PC 98</i>
<i>Required</i>	<i>Required</i>	<i>Required</i>

The host controller in a PC 98 system must meet requirements defined for the bus it uses. For IDE or SCSI controllers, it must also meet the requirements outlined in the “IDE and ATAPI” or “SCSI” chapters in Part 3 of this guide.

46. Host controllers and devices support bus mastering

<i>Consumer PC 98</i>	<i>Office PC 98</i>	<i>Entertainment PC 98</i>
<i>Required</i>	<i>Required</i>	<i>Required</i>

The host controller for storage devices must support bus mastering, whether using IDE, SCSI, or IEEE 1394. Bus mastering support must also be enabled for storage devices, including hard disks, CD-ROM, DVD-ROM, and tape drives. Use of the ISA bus by storage devices is not acceptable for PC 98 systems.

Bus master capabilities must meet the related specification for the particular controller. For example, the programming register set for PCI IDE bus master DMA is defined in Small Form Factor (SFF) 8038i.

Note: This requirement does not apply to legacy FDCs and will not become a requirement for FDCs in the future.

47. Hard drive meets PC 98 requirements

<i>Consumer PC 98</i>	<i>Office PC 98</i>	<i>Entertainment PC 98</i>
<i>Required</i>	<i>Required</i>	<i>Required</i>

The hard disk drive must meet the requirements defined in the “Storage and Related Peripherals” chapter in Part 4 of this guide. Hard drives implemented as IDE or SCSI peripherals must also meet the requirements outlined in the “IDE and ATAPI” or “SCSI” chapters in Part 3 of this guide.

For all PC 98 systems, the hard drive must be SMART-compliant, using the SMART I/O control application programming interface (IOCTL API), as defined in the “Storage and Related Peripherals” chapter in Part 4 of this guide.

48. Removable media support media status notification

<i>Consumer PC 98</i>	<i>Office PC 98</i>	<i>Entertainment PC 98</i>
<i>Required</i>	<i>Required</i>	<i>Required</i>

CD-ROM and DVD-ROM devices must comply with all provisions defined in the “Media Status Event Notification Support” subsection of SFF 8090 (Mt. Fuji specification). Other types of IDE and ATAPI removable devices must follow the *Media Status Notification Support Specification, Version 1.03*.

For SCSI devices other than CD-ROM and DVD, additional media status notification support is not required.

49. Floppy disk capabilities are provided using an expansion card or external bus

<i>Consumer PC 98</i>	<i>Office PC 98</i>	<i>Entertainment PC 98</i>
<i>Recommended</i>	<i>Recommended</i>	<i>Recommended</i>

To support migration away from legacy devices for PC 98, it is recommended that support for floppy disk drives be provided by using a solution based on an external bus, such as USB, PC Card, or a SCSI or IDE expansion card. If a legacy FDC is included on a PC 98 system, it must meet the requirements specified in the “Storage and Related Peripherals” chapter in Part 4 of this guide.

For Net PC systems, any floppy disk drive implemented on the system must be capable of being remotely disabled and locked as defined in the *Network PC System Design Guidelines*. This is also recommended for Office PC 98.

Manageability Component Instrumentation Requirements

This section presents new requirements and recommendations for PC 98 systems related to the Wired for Management (WfM) initiative and the Zero Administration initiative for Windows. The WfM initiative seeks to raise the level of management capabilities for mobile, desktop, and server platforms. The Zero Administration initiative seeks to ensure a controlled, highly manageable enterprise.

The baseline for these requirements is *Windows Hardware Instrumentation Implementation Guidelines, Version 1.0* (WHIG), which also defines the Windows-specific requirements of the *Wired for Management Baseline Specification, Version 2.0*, for hardware instrumentation.

Collectively, the items in this section represent the Manageability Baseline requirements for Office PC 98. Platform management information requirements are defined for two key areas:

- Component instrumentation. Interfaces through which information is supplied by PC 98 platform management components.
- Management information providers. Interfaces used by applications to access PC 98 platform management information.

Tips for implementing management capabilities. For PC 98 systems and components, these are the design steps to pursue:

- Implement the component instrumentation features defined for PC 98 systems in WHIIG.
- For those components that require Windows Management Instrumentation (WMI), ensure that WMI is enabled in device minidrivers as defined in the Windows NT 5.0 DDK.
- Refer to WHIIG for other driver requirements and design tips.
- For all instrumented components, test against the baseline features required in WHIIG.
- For each component, extend the Web-Based Enterprise Management (WBEM) and Common Information Model (CIM) schema to expose the device's custom features in any CIM-ready management browser.

50. System supports WHIIG

<i>Consumer PC 98</i>	<i>Office PC 98</i>	<i>Entertainment PC 98</i>
<i>Not applicable</i>	<i>Required</i>	<i>Not applicable</i>

The PC 98 requirement is defined in *Windows Hardware Instrumentation Implementation Guidelines, Version 1.0*.

51. System includes driver support for WMI

<i>Consumer PC 98</i>	<i>Office PC 98</i>	<i>Entertainment PC 98</i>
<i>Not applicable</i>	<i>Required</i>	<i>Not applicable</i>

Requirements and recommendations related to implementing WMI for Windows NT 5.0 and Windows are defined in WHIIG.

Support for WMI, CIM, and Win32 extension schema objects and data must be implemented as defined in WHIIG.

52. Management information service provider enabled by default

<i>Consumer PC 98</i>	<i>Office PC 98</i>	<i>Entertainment PC 98</i>
<i>Not applicable</i>	<i>Required</i>	<i>Not applicable</i>

The management information service providers must be enabled on Office PC 98 and Net PC systems as defined in WHIIG.

Also, newly developed applications for managing WBEM-capable PC 98 systems should be written to access those systems through industry-standard WBEM protocols and interfaces.

53. Expansion devices can be remotely managed

<i>Consumer PC 98</i>	<i>Office PC 98</i>	<i>Entertainment PC 98</i>
<i>Not applicable</i>	<i>Required</i>	<i>Not applicable</i>

Devices provided as expansion devices must be capable of being remotely managed to ensure that control and TCO policies can be realized. For example, for any implementation of a floppy disk drive on an Office PC 98 system, the drive must be capable of being remotely disabled as a boot selection and provisions must be made for locking.

It is not a requirement that certain devices be capable of being remotely disabled, including the primary hard disk drive, the network adapter, and any standard devices that use legacy connections, such as a keyboard or pointing device that uses a PS/2 connection. However, it must be possible that permissions, policies, or other methods can be used to remotely manage capabilities such as hard disk access or to control end-user ability to change the MAC address or configuration settings for the network adapter.

See also the “BIOS meets PC 98 requirements for boot support” requirement in the “Basic PC 98 General System Requirements” section earlier in this chapter.

Basic PC 98 References

The following represents some of the references, services, and tools available to help build hardware that is optimized to work with Windows operating systems.

Advanced Configuration and Power Interface Specification, Revision 1.0

<http://www.teleport.com/~acpi/>

Device Bay Interface Specification, Version 1.0

<http://www.device-bay.org>

Display Data Channel Standard, Version 2.0

Extended Display Identification Data Standard, Version 2.0

<http://www.vesa.org>

El Torito—Bootable CD-ROM Format Specification, Version 1.0

Compaq, Intel, Phoenix BIOS Boot Specification, Version 1.01

<http://www.ptltd.com/techs/specs.html>

Hot-plugging support under Windows operating systems

<http://www.microsoft.com/hwdev/devdes/>

Intel/Duracell Smart Battery System Specification

<http://www.mediacity.com/~sbs/>

Intel hardware developer site

<http://developer.intel.com>

Interoperability Specification for ICCs and Personal Computer Systems

<http://www.smartcardsys.com>

Media Status Notification Support Specification, Version 1.03

Plug and Play specifications

<http://www.microsoft.com/hwdev/specs/>

Vendor ID registration: pnpid@microsoft.com

MultiProcessor Specification, Version 1.4

Intel part number 242016-002

<http://developer.intel.com>

PCI Local Bus Specification, Revision 2.1 (PCI 2.1)

PCI SIG

Phone: (800) 433-5177

<http://www.pcisig.com>

Power management specifications for device and bus classes

Guidelines for audible noise and other OnNow technologies

<http://www.microsoft.com/hwdev/onnow.htm>

SFF 8070i, SFF 8038i, SFF 8090 (Mt. Fuji specification), and other

SFF specifications

SFF Committee publications

FaxAccess: (408) 741-1600 (fax-back)

Fax: (408) 867-2115

<ftp://ftp.symbios.com/pub/standards/io/>

Universal Serial Bus PC Legacy Compatibility Specification, Version 0.9

http://www.teleport.com/~usb/data/usb_le9.pdf

USB Specification, Version 1.0

USB Device Class Definition for Human Interface Devices, Version 1.0

Other USB device class specifications

Phone: (503) 264-0590

Fax: (503) 693-7975

<http://www.usb.org>

Web-Based Enterprise Management (WBEM) information

<http://wbem.freerange.com>

<http://www.microsoft.com/management/wbem/>

<http://www.dmtf.org/work/cim.html>

Windows and Windows NT DDKs, including NDIS documentation

MSDN Professional membership

Windows Hardware Instrumentation Implementation Guidelines, Version 1.0

(WHIIG), Microsoft Corporation and Intel Corporation

<http://www.microsoft.com/hwdev/specs/>

(This specification is expected in the second half of 1997.)

Wired for Management Baseline Specification, Version 2.0

Intel Corporation.

<http://www.intel.com/managedpc/wired>

(This specification is expected in the second half of 1997.)

Checklist for Basic PC 98

If a recommended feature is implemented, it must meet the PC 98 requirements for that feature as defined in this document.

Consumer PC 98	Office PC 98	Entertainment PC 98
1. System performance meets PC 98 minimum requirements <i>Required</i>	PC 98 minimum requirements <i>Required</i>	<i>Required</i>
2. System design meets ACPI 1.0 specification and PC 98 requirements <i>Required</i>	<i>Required</i>	<i>Required</i>
3. Hardware design supports OnNow initiative <i>Required</i>	<i>Required</i>	<i>Required</i>
4. BIOS meets PC 98 requirements for OnNow support <i>Required</i>	<i>Required</i>	<i>Required</i>
5. BIOS meets PC 98 requirements for boot support <i>Required</i>	<i>Required</i>	<i>Required</i>
6. All expansion slots in the system are accessible for users to insert cards <i>Required</i>	<i>Required</i>	<i>Required</i>
7. Audible noise meets PC 98 requirements <i>Required</i>	<i>Required</i>	<i>Required</i>
8. System and component design practices follow accessibility guidelines <i>Recommended</i>	<i>Recommended</i>	<i>Recommended</i>
9. Internal system modification capabilities are not accessible to end users <i>Recommended</i>	<i>Recommended</i>	<i>Recommended</i>
10. System design provides physical security <i>Recommended</i>	<i>Recommended</i>	<i>Recommended</i>
11. Each device and driver meets PC 98 device requirements <i>Required</i>	<i>Required</i>	<i>Required</i>
12. Each bus and device meets Plug and Play specifications <i>Required</i>	<i>Required</i>	<i>Required</i>
13. Unique Plug and Play device ID provided for each system device and add-on device <i>Required</i>	<i>Required</i>	<i>Required</i>
14. Option ROMs meet Plug and Play requirements <i>Required</i>	<i>Required</i>	<i>Required</i>
15. "PNP" vendor code used only to define a legacy device's <i>Required</i>	<i>Required</i>	CompatibleID <i>Required</i>
16. Device driver and installation meet PC 98 requirements <i>Required</i>	<i>Required</i>	<i>Required</i>
17. Minimal user interaction needed to install and configure devices <i>Required</i>	<i>Required</i>	<i>Required</i>
18. Connections use icons plus keyed or shrouded connectors <i>Required</i>	<i>Required</i>	<i>Required</i>
19. Hot-plugging capabilities for buses and devices meet PC 98 requirements <i>Required</i>	<i>Required</i>	<i>Required</i>

Consumer PC 98	Office PC 98	Entertainment PC 98
20. Device Bay-capable bay and peripherals meet Device Bay specification <i>Required</i>	<i>Required</i>	<i>Required</i>
21. Multifunction add-on devices meet PC 98 device requirements for each device <i>Required</i>	<i>Required</i>	<i>Required</i>
22. All devices support correct 16-bit decoding for I/O port addresses <i>Required</i>	<i>Required</i>	<i>Required</i>
23. System-board devices use ISA-compatible addresses <i>Required</i>	<i>Required</i>	<i>Required</i>
24. Each bus meets written specifications and PC 98 requirements <i>Required</i>	<i>Required</i>	<i>Required</i>
25. System includes USB with one USB port, minimum <i>Required</i>	<i>Required</i>	<i>Required, with 2 USB ports</i>
26. System includes support for other high-speed expansion capabilities <i>Recommended</i>	<i>Recommended</i>	<i>Required, with 2 IEEE 1394 ports</i>
27. If present, PCI bus meets PCI 2.1 or higher, plus PC 98 requirements <i>Required</i>	<i>Required</i>	<i>Required</i>
28. System does not include ISA expansion devices <i>Required</i>	<i>Required</i>	<i>Required, with no ISA slots</i>
29. System includes keyboard connection and keyboard <i>Required</i>	<i>Required</i>	<i>Required; USB or wireless</i>
30. System includes pointing-device connection and pointing device <i>Required</i>	<i>Required</i>	<i>Required; USB or wireless</i>
31. System includes connection for external parallel devices <i>Required</i>	<i>Required</i>	<i>Required</i>
32. System includes connection for external serial devices <i>Required</i>	<i>Required</i>	<i>Required</i>
33. System includes wireless capabilities <i>Recommended</i>	<i>Recommended</i>	<i>Recommended</i>
34. System includes support for operating system installation <i>Required</i>	<i>Required</i>	<i>Required</i>
35. System audio support meets PC 98 requirements <i>Recommended</i>	<i>Recommended</i>	<i>Required</i>
36. System includes communications device <i>Required; modem</i>	<i>Required; network adapter</i>	<i>Required; modem</i>
37. System includes smart card support <i>Not applicable</i>	<i>Recommended</i>	<i>Not applicable</i>
38. Graphics adapter meets PC 98 minimum requirements <i>Required</i>	<i>Required</i>	<i>Required</i>
39. Adapter supports television output if system does not include a large-screen monitor <i>Recommended</i>	<i>Recommended</i>	<i>Recommended</i>
40. Color monitor is DDC-compliant with unique EDID identifier <i>Required</i>	<i>Required</i>	<i>Required</i>

Consumer PC 98	Office PC 98	Entertainment PC 98
41. System meets PC 98 DVD-Video and MPEG-2 playback requirements <i>Required</i>	<i>Required with DVD-Video</i>	<i>Required</i>
42. System supports PC 98 analog video input and capture capabilities <i>Recommended</i>	<i>Recommended</i>	<i>Required</i>
43. System includes analog television tuner <i>Recommended</i>	<i>Recommended</i>	<i>Required</i>
44. System BIOS and option ROMs support Int 13h Extensions <i>Required</i>	<i>Required</i>	<i>Required</i>
45. Host controller for storage device meets PC 98 requirements <i>Required</i>	<i>Required</i>	<i>Required</i>
46. Host controllers and devices support bus mastering <i>Required</i>	<i>Required</i>	<i>Required</i>
47. Hard drive meets PC 98 requirements <i>Required</i>	<i>Required</i>	<i>Required</i>
48. Removable media support media status notification <i>Required</i>	<i>Required</i>	<i>Required</i>
49. Floppy disk capabilities are provided using an expansion card or external bus <i>Recommended</i>	<i>Recommended</i>	<i>Recommended</i>
50. System supports WHIIG <i>Not applicable</i>	<i>Required</i>	<i>Not applicable</i>
51. System includes driver support for WMI <i>Not applicable</i>	<i>Required</i>	<i>Not applicable</i>
52. Management information service provider enabled by default <i>Not applicable</i>	<i>Required</i>	<i>Not applicable</i>
53. Expansion devices can be remotely managed <i>Not applicable</i>	<i>Required</i>	<i>Not applicable</i>

