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Compaq, Intel and Microsoft Technology White Paper: Introduction to Device Bay Interface Specification

The Device Bay Interface Specification is an industry specification co-authored by Compaq Corporation, Intel Corporation and Microsoft Corporation. This introduction and overview to Device Bay is based on the Draft Revision 0.9, dated November 6, 1998.

The ownership of the Device Bay specification is currently in transition to the 1394 Trade Association's Device Bay Working Group (DBWG). Please see www.1394ta.com or www.device-bay.org for details on joining the DBWG.

Contents

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Introduction

Device Bay is an industry specification that defines a mechanism for easily adding and upgrading PC peripheral devices without opening the chassis. The Device Bay specification applies to all classes of computers, including desktop, mobile, home and server machines.

Any PC system that supports all specified bus interfaces, form factors, and thermal, mechanical, and electrical characteristics, and that provides the specified operating system behavior can support Device Bay. Device Bay adds value in the following ways:

- Provides a simple path for user upgrade, expansion, and replacement allowing PC peripheral devices to be added as easily as inserting a floppy disk into a drive.
- Enables new form factors by using next-generation I/O interfaces, reducing the requirement to support legacy I/O such as IDE and ISA.
- Provides an architecture that enables device security features.

The broad capabilities that Device Bay can provide for manageability, security, and support for a wide range of peripherals means that the technologies apply to a broad range of PC categories, including business and consumer desktops and portables, small form factor PCs, home-theater technology, and other device categories, including consumer electronics and PC peripherals.

Possible uses of Device Bay include allowing original equipment manufacturers (OEMs), retailers, and end users to easily add the appropriate peripherals to support specific application needs. For example, a CD-R drive could be added to provide a large storage medium for digital imaging or audio authoring, a DVD-ROM drive could be added to enable DVD-Video playback, or a smart card reader could be added for secure online banking or shopping.

Another possible use for Device Bay is to support swapping a hard disk drive—and thus a set of data and an environment—between a desktop system used in the office and a laptop used on the road.

Similarly, in the corporate environment, a hard disk drive could be removed from a failed system and inserted in a working system, minimizing employee downtime and thus lowering total cost of ownership.

The Device Bay specification defines characteristics to enable compatibility and interoperability between any Device Bay peripheral and any Device Bay-enabled system bay. These characteristics include the following:

- Mechanical form factors, including the Device Bay form factors, connectors, and eject mechanisms.
- Power and thermal dissipation requirements, including the broad range of requirements for peripherals such as high-performance media drives.
- Bus interfaces for Universal Serial Bus (USB) and IEEE 1394 buses included in the Device Bay interface. USB is a medium-bandwidth serial bus supporting 1 to 12 megabits per second (Mbps) data transfer speeds. IEEE 1394 is a high-bandwidth serial bus scalable to gigabits per second data-transfer rates.
- Connectors, specifying the connector set on both the device side and the bay side, with high demands for durability and reliability.
- Device Bay controller logic, including DBC registers and DBC interfaces to Advanced Configuration and Power Interface (ACPI) and USB, as a mechanism for both motherboard and remote Device Bay implementations to support security, power management, and insertion and removal notification.
- Operating system behavior for hot insertion and removal of devices, including software interfaces for Plug and Play, power management, and the relationship between boot devices and Device Bay. (Operating

system support will be provided in future versions of the Microsoft® Windows® and Windows NT® operating systems.)

The USB and IEEE 1394 buses provide a broad range of bandwidths and scalable performance to support the future requirements of PC peripherals. Device Bay is complementary to and co-exists with USB and IEEE 1394 external connectors.

Device Bay supports devices for mass storage, security, communications and connectivity, and a variety of other devices. These device categories represent an intersection between end-user upgrade needs and the technical ability to implement device support at a reasonable cost. The Device Bay infrastructure can support additional device categories. Device Bay does not support processors or memory.

Device Bay for Mobile vs. Desktop Systems

The Device Bay specification in its final version will provide form factors suitable for desktop and mobile applications. The primary differences in design needs for mobile platforms are related to the form factor size and the demands for staged power consumption (important for mobile hosts in low-battery situations).

The data transfer buses (USB and IEEE 1394) are the same for all form factors, but there are differences in the power bus. All form factors use the same connector-set definition.

The Device Bay specification assures interoperability between desktop and mobile platforms. Devices designed for a smaller form factor require an adapter in order to be plugged into a Device Bay-enabled bay with a larger form factor. This is because of the size differences between the bays.

The specification provides the flexibility for the system manufacturers to implement the smaller form factor bays onto a desktop PC and conversely a large form factor bay onto a portable if they choose to, as long as they comply with the spec requirements.

Unique Characteristics per Form Factor

To address the unique needs of the various Device Bay form factors, the following differences between DB32, DB20, and DB13 are defined in this specification:

- To accommodate a wide variety of device and system needs, each form factor's size is different.
- The power and thermal thresholds are significantly higher for the DB32 device than for DB20 or DB13.
- The set of power and thermal alternatives is greater for the DB32 device than for DB20 or DB13.

Definition of Terms

The *Device Bay Interface Specification* uses the following terminology:

1394

For the purposes of this document, 1394 refers to IEEE 1394-1995 and 1394b. IEEE 1394-1995 is a hot-pluggable, high-speed serial bus that operates at speeds of 100 Mb/s, 200 Mb/s, and 400Mb/s. 1394b is expected to operate at speeds of 800Mb/s, 1600Mb/s, and 3200Mb/s. Device Bay requires the host system to support a minimum speed of 400Mb/s. 1394 can handle asynchronous and isochronous transfers. Typical devices include hard-disk drives, CD-ROMs, DVD-ROMs, tape drives, and consumer-electronics devices such as camcorders, VCRs, DVD players, and set-top boxes.

1394 PHY

1394 drivers and receivers.

ACPI Specification

Advanced Configuration and Power Interface Specification, Revision 1.0 or later. A specification that defines a new interface to the system board that enables the operating system to implement operating system–directed power management and system configuration. Following the ACPI specification allows system manufacturers to build systems consistent with the OnNow design initiative for instantly available PCs.

Bay

The receiving slot, dock, or cavity in the larger system that provides connectivity for the device. In this specification, all uses of the term *bay* refer to a Device Bay-compliant bay.

DB13

A Device Bay device form factor that encompasses the global Device Bay device characteristics and also meets the unique power, connector, mechanical, and thermal requirements for the DB13 form factor (as defined in sections 3, 4, and 5 of the specification). One of the most obvious differentiating characteristics of a DB13 device is that it is approximately 13 mm high.

DB20

A Device Bay device form factor that encompasses the global Device Bay device characteristics and also meets the unique power, connector, mechanical, and thermal requirements for the DB20 form factor (as defined in sections 3, 4, and 5 of the specification). One of the most obvious differentiating characteristics of a DB20 device is that it is approximately 20 mm high.

DB32

A Device Bay device form factor that encompasses the global Device Bay device characteristics and also meets the unique power, connector, mechanical, and thermal requirements for the DB32 form factor (as defined in sections 3, 4, and 5 of the specification). One of the most obvious differentiating characteristics of a DB32 device is that it is approximately 32 mm high.

DBC

Device Bay Controller. The DBC resides on the host side of the bay and contributes to the following processes: device insertion, device removal request, device enumeration, staged power consumption, and mapping USB and 1394 ports to bays. One of the primary benefits of the DBC is its role in discouraging the user from removing a device without first making a removal request. Removal requests enable the operating system to do whatever is necessary to ensure the integrity of user data, applications, and the operating system. A DBC can be implemented in a variety of ways: as part of a serial bus hub function, as a stand-alone device, or as an integral part of a system-board chip set. A DBC can interface to the system either as a USB device or as an ACPI object. Using ACPI, the DBC can reside on any bus in the system that can be described through ACPI. Examples are PCI, I2C/SMBus, and embedded controllers.

Device

A modular component that is intended to be swapped, upgraded, or replaced on, between, or in a larger system. For Device Bay, this can be a device for mass storage, communications and connectivity, security, or a variety of other uses. For Device Bay, this does not mean a system processor (CPU) or memory. A Device Bay-compliant device meets the power, connector, mechanical, and thermal requirements in the Device Bay specification.

Device Bay

The overall concept of providing devices and bays under a standardized and interchangeable environment. Also, an industry specification that defines a mechanism for both peripheral devices and system bays that allows adding and upgrading PC peripheral devices without opening the chassis.

Device Bay connector set

The Device Bay connector set consists of a plug connector that resides on a removable device and a receptacle connector that resides in a bay. The Device Bay connector set has the following four pin groups: 1394 (interfaces to a 1394 PHY), USB (interfaces to a USB hub), power (interfaces to the power supply), and miscellaneous bay management signals (interfaces to the DBC). The Device Bay connector set specification ensures blind mating, live insertion and removal, and high insertion/removal cycle durability (a minimum of 2,500 cycles).

Device Bay subsystem

An implementation of the Device Bay concept. In a Device Bay subsystem, all bays are controlled by one DBC.

USB

Universal Serial Bus. A bi-directional, isochronous, dynamically attachable serial interface for adding peripheral devices such as game controllers, serial and parallel ports, and input devices on a single bus.

Technical Overview of Device Bay

Figure 1 shows the relationship between a Device Bay device and a Device Bay-enabled bay on the system board. Important features include:

- The interface to devices is USB, IEEE 1394, or a combination of the two; a bridge is needed to interface with legacy devices. The legacy bridge that enables existing devices to work with Device Bay is on the device. In this example, an IDE-to-IEEE–1394 bridge is shown that enables legacy IDE storage devices to work with Device Bay.
- On the host side of the Device Bay connector, the power field-effect transistor (FET) or switch component enables the bay to be instrumented to control device power.

Figure 1. Relationship between Device Bay device and bay

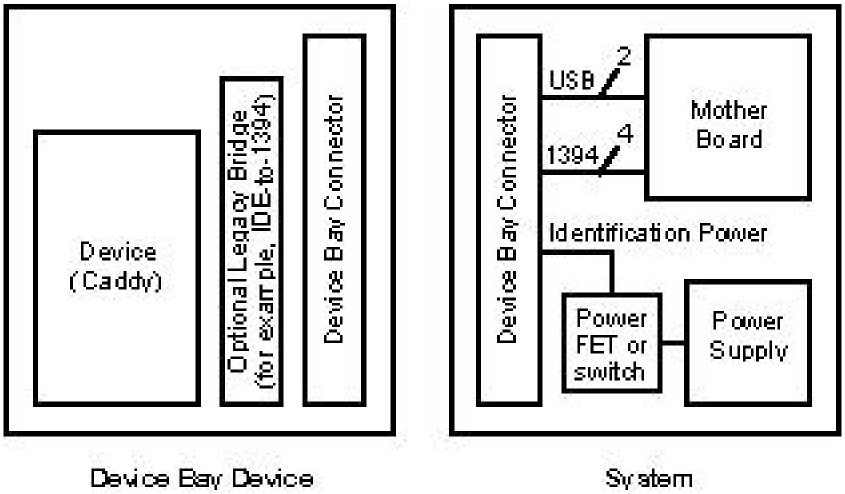
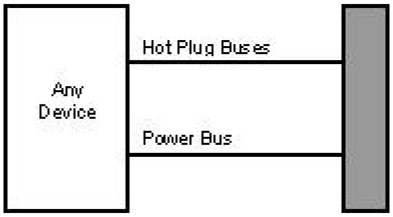


Figure 2 shows the device interface to Device Bay without the legacy bridge shown in Figure 1. This block diagram could show, for example, a native IEEE 1394 bus device interface if the line labeled “Hot Plug Buses” is an IEEE 1394 bus. Note that the Device Bay connector on the device side does not require signal pins for both serial data transfer buses. If the device is exclusively an IEEE 1394 device, for example, USB support need not be provided.

Figure 2. Device interface to Device Bay



Benefits for End Users

PC users will realize benefits from Device Bay features in several ways. The following summarizes some of the benefits described in the Device Bay specification as part of various usage scenarios.

Device Bay bays are accessible. Users can easily upgrade, replace, and add devices without opening the PC case.

Devices inserted into Device Bay bays are automatically configured. The end user can immediately start using a newly inserted device. This is accomplished by a Plug and Play-capable operating system running on a platform that includes a Device Bay.

Devices can be inserted into, removed from, and swapped between Device Bay bays while the PC is powered up. This eliminates the time-consuming power-down and power-up cycles used by many of today's systems. It also contributes to the end user being able to immediately use the new device.

Device Bay peripherals work properly when plugged into any Device Bay bay. This enables the user not only to swap devices in any combination on one PC, but also to easily swap devices between different Device Bay-equipped PCs. Interoperability between platforms that provide bays is assured. Additionally, devices with a smaller form factor can be inserted into a larger Device Bay bay using an adapter.

A broad diversity of peripherals can be Device Bay devices. For example, consumer-electronics devices can be Device Bay devices, thereby expanding the usefulness of a PC.

PCs can be quickly and easily configured/reconfigured to a user's specific application needs at any time. For example, a consumer may insert a DVD-ROM drive in the Device Bay bay in order to play a DVD-Video title. The same system can be reconfigured for consumer imaging by inserting a CD-R/E drive or DVD-RAM. Later, the user can replace the CD-R drive with a smart card reader in order to securely purchase an item over the Internet.

Future high-performance peripherals will work in Device Bay bays. As time goes by, earlier Device Bay-enabled host systems will accept future Device Bay peripheral devices. This ensured compatibility will enhance consumer confidence that Device Bay-enabled hardware investments will not become obsolete.

Security features can be accommodated by Device Bay. Device Bay has a software-controlled physical interlock that can enable security features.

Surprise removal of devices is guarded against. A Device Bay-enabled operating system uses a software-controlled interlock to make sure all applicable open files and applications are closed before the user is able to remove a device (for example, a hard disk drive) from a bay. This protects the current state of the user's data at all times.

Compound devices are supported. An individual device in a bay can concurrently use both USB and 1394 buses.

Device Bay resources, such as bandwidth and power, can be allocated. The Device Bay architecture supports the inclusion of a software agent that can manage the system resources as they are allocated to devices.

Device Bay provides deterministic hardware platforms. A Device Bay system maps devices to specific bays. This provides a deterministic model for the system to manage the insertion, removal, and operation of devices.

Device Bay Benefits for OEMs and IHVs

The PC industry will also realize benefits from Device Bay technologies. The following summarizes some benefits that OEMs and independent hardware vendors (IHVs) can gain from implementing hardware that follows the Device Bay specification.

For PC OEMs, Device Bay provides these benefits for customization and profitability:

Device Bay simplifies the manufacturing process and system configuration. This simplifies an OEM's ability to design and deliver customized systems while optimizing the manufacturing and distribution processes. Just-in-time, configure-to-order manufacturing processes can take advantage of the modular nature of Device Bay and allow for cost-effective delivery of tailored PC configurations.

Device Bay simplifies product design and enables rapid adoption of new technologies into existing product lines, without altering either the PC system design or manufacturing processes. Using the standardized Device Bay form factors and device interfaces can reduce design lead time because the Device Bay specification addresses connectivity and interoperability design issues. The addition of new Device Bay-enabled peripherals can occur much later in the manufacturing pipeline than has previously been possible.

Device Bay reduces obsolescence issues for OEMs. Earlier peripheral devices can be used on evolving platforms and evolving peripherals can be used on platforms that have not changed.

Device Bay lowers support costs. A principal goal of the Device Bay specification is to reduce support calls and related costs due to improper installation of new peripherals. Device Bay design ensures that many current configuration conflicts will be eliminated.

For IHVs, Device Bay provides these benefits:

Device Bay enables development of new product segments and enables faster integration of devices by OEMs into their platforms. Implementing new designs based on Device Bay will also mean more rapid adoption of new technologies once an installed base of Device Bay-enabled systems is present.

Device Bay provides for standardized design of device interfaces, connectors, and form factors. The enhanced interoperability that Device Bay ensures means that independent hardware vendors (IHVs) have a clear indication of what to build and can realize great economies of scale for connectors, casings, and other components.

Device Bay Benefits for Operating Systems Vendors

The following summarizes some benefits that operating system providers can gain from supporting Device Bay platforms and devices.

Device Bay reduces the number of different software interfaces that have to be provided to support a wide variety of devices. Over time, various devices can be supported through just the two Device Bay data transfer buses, USB and 1394.

Surprise removal of devices is guarded against. Software controls the insertion and removal requests of Device Bay devices.

Device Bay provides deterministic hardware platforms. A Device Bay system maps devices to specific bays. This provides a deterministic model for the system to manage the insertion, removal, and operation of devices.

Device Categories

This section describes in more detail the principal device categories supported by Device Bay.

Storage Devices

Rich multimedia content needs larger, faster storage devices, reflecting the fact that storage is currently near the top of the list for hardware upgrades. Multimedia content also results in larger file sizes, rendering some traditional media nearly obsolete as a suitable storage medium. Users want new means of transporting large files, which can mean media such as the LS120 high-capacity floppy.

The need for removable, large-capacity storage devices is supported by Device Bay, where large capacity can range from hundreds of megabytes to several gigabytes of storage. Both removable and fixed-media storage devices are supported. A Device Bay-capable operating system and BIOS allows the user to boot a PC from a Device Bay mass-storage device. The following are examples of the storage devices supported by Device Bay:

- Hard disk drives (HDD)
- Tape backup
- High-density floppy disk drives
- CD-ROM, DVD-ROM, DVD-R, DVD-RAM, magneto-optical, and consumer electronic devices such as camcorders, VCRs, DVD-players, and set-top boxes.

Device Bay support for these devices allows PC users to add extra storage, back up the files, transport large files, and boot their PCs from new mass-storage devices. This support for mass storage also allows users to place their personal data and environment on an easily transportable device, thereby enhancing mobility and system flexibility.

In the corporate environment, this enables a user to exchange a mobile HDD between a desktop and a mobile system for travel. The same device could also be carried to another site and used in a virtual office or shared PC environment (community workstation). Both scenarios lead to increased productivity and decreased employee difficulties related to travel. In addition, a failed system can be serviced by moving the devices to another system and repairing the broken system off-line, while the user retains any personal data on the moved Device Bay mass-storage devices. This approach will minimize employee downtime and thus reduce total cost of ownership.

Device Bay support for mass storage also enables a home PC scenario where different members of the family have their own devices, which can be easily inserted, removed, and even transported to a friend's PC.

Communications and Connectivity Devices

Communications and connectivity devices enable the PC to interface with the outside world as well as to distribute data within the home or business. POTS modems, Integrated Service Digital Network (ISDN) adapters, network cards, cable interfaces, and wireless infrared (IR) and radio frequency (RF) devices all fall into this category. This device class is supported by Device Bay, enabling the PC to be more easily configured as the center of communications to, from, and within the home and business.

The presence of richer media types, such as graphics, video, and audio, on the Internet and Intranets is a driving factor for higher capacity interfaces into the PC. End-user desire for better and faster communications devices is underlined by the fact that modem cards were one of the most popular end-user PC upgrades in 1995. The ability to easily increase the capacity of the communications pipe into the PC in order to keep pace with rapid technological advances will improve the end-user experience and reduce fear of hardware obsolescence.

The PC must be able to communicate with other PCs and devices within the home or business; this enriches the end-user experience. Different applications and usage models drive different connectivity requirements. Due to the number of possible connections and usage models, supporting all user needs with a standard set of connectors is difficult and costly. Connections to printers, scanners, and other traditional PC peripherals may be supported.

As it becomes more cost-effective, this networking capability may move to multi-PC homes. The advent of digital media formats such as MPEG-2 video, Dolby AC-3 multichannel audio, and digital video (camcorders and VCRs) presents the opportunity to bring the computational power of the PC platform to bear on the consumer-electronics world, using digital connections such as 1394. Additionally, as the PC continues growing in the family-room space, the resulting shift in usage model will drive the demand for wireless I/O devices, both IR and RF. Device Bay provides a simple method of allowing OEMs and/or end users to add ports and connectors based on the specific application needs of a PC.

Data Security Devices

Device Bay supports security devices as a means to provide user authentication, useful both in the corporate world and for consumer applications such as home shopping. Simply adding a Device Bay smart card reader to a corporate PC or mobile system provides a high level of data security, even meeting requirements for PCs purchased by the U.S. government. For the consumer, inserting a smart card reader enables secure online credit-card shopping. Such lack of security has been cited by consumers as the primary reason why they have not made online purchases. Even higher levels of security can be achieved with encryption module security devices.

References

The *Device Bay Interface Specification* is available for public review on the World Wide Web at www.device-bay.org. Two email reflectors are in use:

www.device-bay.org: chatlist. This is a general public reflector where anyone can post a message (list and non-list members) and it will be reflected to all the list members. See www.device-bay.org for instructions on how to sign up on the chatlist reflector.

www.1394ta.com: dbwg reflector. This reflector carries the traffic of the 1394 Trade Association's Device Bay Working Group (DBWG) and thus is only open to 1394 members. DBWG activities and proposed DB specification changes are the main traffic. See www.1394ta.com -> members -> DBWG or www.device-bay.org for instructions on how to sign up.

Specifications that must be used in conjunction with the Device Bay specification include:

- *P1394a Draft Standard for a High Performance Serial Bus (Supplement),* which is available at ftp://ftp.symbios.com/pub/standards/io/1394/P1394a/Drafts/.
- *1394-1995 IEEE Standard for a High Performance Serial Bus,* which can be ordered from the IEEE Standards Catalog, available at http://standards.ieee.org/catalog/index.html.
- *1394 Power Management Spec, version 1.04, 6/10/97,* which is available at http://www.p1394pm.org, and currently exists as three separate documents, with the following revision numbers:
    - *i)* *Suspend/Resume Proposal Power Specification*
    - ii) 1394 Trade Association Power Specification, Part 1: Cable Power Distribution Revision 0.91x
    - *iii)* *Power Management Draft Specification Revision 1.05*
- *Universal Serial Bus Specification, Revision 1.0*, which is available at http://www.usb.org/.
- *Advanced Configuration and Power Interface Specification, Revision 1.0*, which is available at http://www.teleport.com/~acpi/.
- Microsoft Windows 2000 Driver Development Kit (DDK) documentation, which is available at

http: //www.microsoft.com/ddk/

- *ASME Y14.5M-1994, Dimensioning and Tolerancing, Engineering Drawings and Related Documentation Practices, which is available from* the American Society of Mechanical Engineers (ASME), New York, NY, 1994.

The Plug and Play specification for legacy hardware platforms is the *Plug and Play BIOS Specification, Version 1.0a*, available at http://www.microsoft.com/hwdev/respec/pnpspecs.htm.

A description of the OnNow power management initiative for future hardware platforms is available at http://www.microsoft.com/hwdev/onnow/, which includes links to the following technical papers:

- *OnNow: The Evolution of the PC Platform*
- *Power Management Architecture for Applications*
- *Device Power Management*
- *OnNow Power Management and the Windows Driver Model*