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HP One-Button Disaster Recovery

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Introduction

HP One-Button Disaster Recovery (HP OBDR) represents a major improvement in the usability of disaster recovery systems. It should both encourage use of disaster recovery (DR) and reduce operator errors-giving increased dependability in practice.

The remainder of this white paper will look in detail at the technology involved in HP One-Button Disaster Recovery, discuss how to ensure it works in any given system, and consider where the technology may lead in the future.

Audience for This Paper

Technical Specifiers: If you recommend backup solutions for HP NetServers, this paper provides useful information to assist you in specifying the appropriate backup solution for your customers.

Reviewers and Interested End Users: This paper gives an overview of the technologies that permit HP One-Button Disaster Recovery to work and explains how these are applied to give real benefits in practice.

Why HP One-Button Disaster Recovery Is Unique

Booting from a tape drive is not new. In fact, most dedicated UNIX" workstations are able to do this, as can big transaction processing systems. Until now, however, it has been almost impossible for a standard PC to do so. There has never been BIOS support for sequential devices such as tape drives^{*}, and they can only function once drivers have been loaded later in the boot process. Consequently, the necessary, minimal DR operating system cannot be loaded and the restoration process cannot start.

Hardware Features: The *secret* of HP OBDR is simple: by a patented method the tape drive is switched into a special mode, emulating a CD-ROM drive with a bootable disk loaded. In this mode, the system can recognize the drive and can boot using the tape drive alone. Once the restoration is under way, the software automatically switches the drive back into "normal" mode.

Mainstream Software Support: Achieving this breakthrough would be useless without backup software able to take advantage of the drive's new capabilities. Hewlett-Packard has been working with the major backup software vendors to ensure that options for their *standard packages* can make HP OBDR cartridges and fully support HP OBDR tape drives. As a result, customers can take advantage of HP OBDR immediately, since the capability is available for backup packages that they *already use*^{**}.

It is also simple for software houses (if they wish) to release versions of the same software packages that do not support HP OBDR. These versions see HP OBDR cartridges as normal backup cartridges. Full compatibility is maintained, and HP OBDR cartridges can be used to archive or migrate data, just like any other backup.

The Need for HP One-Button Disaster Recovery

Comparing the Alternatives

Nobody who has ever had to recover a server against the clock would question the value of single-button disaster recovery. Simply comparing the necessary tasks illustrates the value of the technique:

Figure 1. Comparing DR Process Steps

Conventional Method	Using Disaster Recovery Floppies	HP One-Button Disaster Recovery
Repair Hardware	Repair Hardware	Repair Hardware
Collect all necessary media together	Collect all necessary media together	Boot in DR mode and automatically restore system

Reload OS from CD-ROM or floppies	REBOOT from DR floppies	REBOOT
REBOOT	Load recovery tape & restore system	
Reload backup software from CD-ROM or floppies	REBOOT	
REBOOT		
Load recovery tape and restore system		
REBOOT		

In the conventional method, any problem at any time can delay the process or even prevent its completion. Booting from special disaster-recovery floppy disks or a CD-ROM (containing the DR record of the system configuration) does work, but the inherent vulnerability of floppy disks and CDs makes it potentially unreliable in practice.

In contrast, HP One-Button Disaster Recovery is almost entirely automatic. It only requires the most recent backup cartridge and the press of a button. The DR record is stored on the cartridge itself: it cannot be separated from the backup set it relates to, and it is far less vulnerable to damage than other media.

How Long Will Recovery Take?

Time required for completion is a significant weakness in conventional DR methods. It is not just the additional rebooting needed (depending on the exact method employed, each reboot can take up to twenty minutes), but the fact that floppy and CD-ROM technologies often have very slow transfer rates for loading vital data. In contrast, HP OBDR requires just a cartridge (and nothing else), and can restore all of the system as fast as the tape drive can stream-at speeds in excess of 7.2 GB/hour for Hewlett-Packard DDS-2 and DDS-3 drives.

The Hidden Overhead of Maintaining a DR System

Servers rarely keep the same configuration throughout their operating life. Even if a system is never upgraded-which is unlikely given the rapid growth of storage requirements-components still fail occasionally. Whenever this happens, items such as SCSI controller cards are often replaced with newer, better performing versions-requiring an updated driver to be installed at the same time. For a disaster recovery policy, this carries a hidden cost because, to work at all, any DR system must always be up-to-date with the latest system configuration. If the SCSI card has been

replaced, but any updates are not reflected in the DR record, the system may be difficult to recover-it certainly will not start cleanly the first time after a failure.

So, for traditional DR, if you make any change to the system you must repeat the laborious procedure of creating the DR record-either on a set of floppy disks or by "burning" a new CD-ROM. This is usually a separate operation from the main backup process, requiring someone to sit by the computer either "feeding" it floppy disks, as needed, or managing the CD-ROM creation process. Since this is often regarded as a maintenance activity, you may also need to take the server offline during this process. Once completed, you must remember to store the new DR disk set with the tapes in the offsite data vault. Otherwise, it will not be available for subsequent recovery of the server.

To summarize: with conventional DR, the requirement to update the DR record can easily double the downtime required to replace a failed component. Additionally, keeping the recovery disks up-to-date requires organization and effort. In a large enterprise, this can mean a significant, additional system management cost.

HP OBDR Is Simple and Fast

HP OBDR offers clear advantages. Updating the DR record takes place automatically as long as a DR backup is scheduled to occur at the same time as the normal backup-for most software, this is the default setting, and in any case only involves selecting a single checkbox. A fresh backup cartridge (or an old one to be overwritten) is the only other item needed. The HP OBDR backup will run completely unattended (just as any other backup). Downtime is minimal because the server can be brought back into normal use immediately, and no valuable engineer time is wasted "babysitting" the DR record creation process.

The Technology of HP One-Button Disaster Recovery

Activities in a Generic Disaster Recovery

To recover a system, the following sequence of operations has to take place:

1. Boot the system in such a way that the DR process has control of it.
2. Recreate the basic structure of the system, including all disk partitions and volumes, raid and mirroring.
3. Reload the kernel of the usual operating system.
4. Restore essential device and service registry entries.
5. Restore all data to its original locations.
6. Finally, reboot (into the usual operating system) to return the system to operational status.

The first stage is crucial. It enables the rest of process to happen automatically and is described in detail below.

The Boot Process

From its earliest days, PC architecture has provided the ability to load and run different operating systems, so that users can tune the system to their requirements. Today, at least a dozen operating systems are in general use, ranging from the simplest, single-tasking DOS (Disk Operating System), to multi-processor, clustered, Network Operating Systems (NOS) from Novell, SCO and Microsoft.

The Importance of the System BIOS

All these operating systems are the same during the initial stages of loading: they rely on the PC's ROM BIOS (Basic Input/Output System) to control the hardware. The BIOS is permanently stored in static Read-Only Memory (ROM) on the motherboard, and nowadays its purpose is to load operating system code from secondary storage (disk) into memory. Once this is achieved, it is usual for the operating system to manage the hardware directly, bypassing the built-in BIOS functions with its own, more efficient routines.

Booting for Disaster Recovery

Disaster recovery systems make use of the same BIOS-controlled, boot process. A minimal "DR" operating system is loaded initially by the BIOS, with just enough functionality to complete stages two and three of the recovery process. It copies the essentials of the normal operating system from the backup cartridge to their correct places on the system hard disks.

At this point the DR operating system has completed its task, and a reboot will usually take place to load the normal operating system. The standard backup application code can then be run to restore all non-essential parts of the operating system from the backup cartridge, along with all user programs and data.

Addressing the Requirements of the PC BIOS

The PC's ROM BIOS is vital to the disaster recovery system because, no matter what storage medium is used for the main recovery, the DR operating system must be available for the BIOS to load at boot time. It is not possible to load a bootable image directly from a normal tape drive because, historically, the only device types directly supported by the BIOS for booting were floppy and hard disks. Recent improvements to BIOS and CD-ROM technology mean that, for most modern systems, CD-ROM is now also an alternative.

The actual boot device is usually decided in advance by the BIOS configuration chosen by the user (using whatever BIOS "setup" utility is provided by the manufacturer). By default, most systems look for bootable media in the floppy and CD-ROM drives first, before attempting to boot from the hard disk. This makes it easy to switch boot configurations and

operating systems, by use of a selection of "boot disks" that may be floppy disk, CD-ROM or similar.

Providing support for bootable tape, therefore, requires that the drive should emulate either a floppy disk or a CD-ROM drive with a bootable disk loaded. This will "fool" the operating system into loading the correct boot image (in reality off the backup cartridge), which can then start the main system restoration. The CD-ROM emulation is the most suitable for a number of reasons:

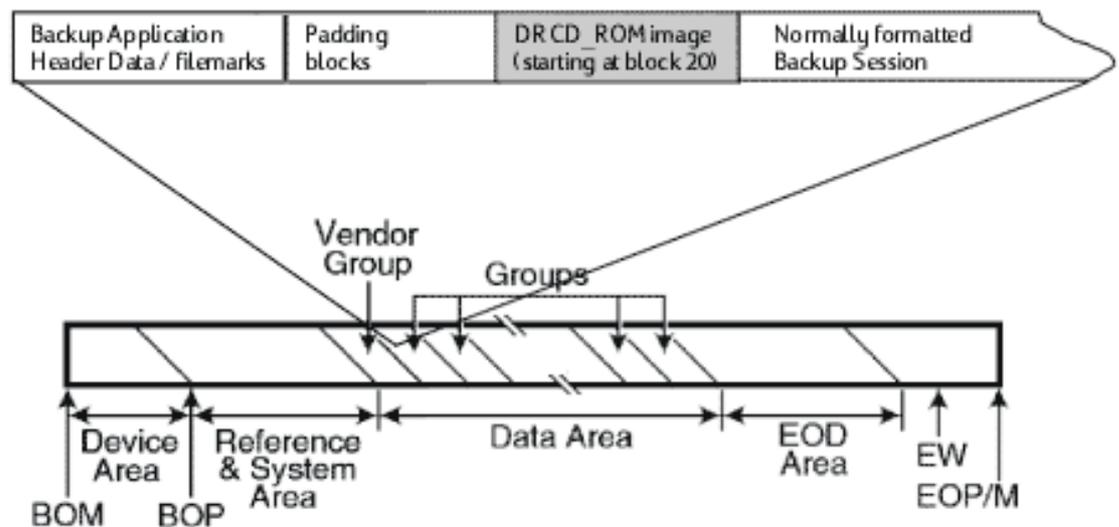
- CD-ROMs are much greater capacity than floppies, so the entire DR operating system can be contained in a single "virtual" disk image, which reduces the complexity of implementation.
- CD-ROMs are available already with SCSI and ATAPI interfaces; floppy disks generally are not. This means that the necessary support for bootable CD-ROMs is already present in the BIOS for most SCSI controllers.

Not surprisingly, the HP OBDR firmware emulates a bootable CD-ROM drive.

How the Tape Drive Behaves

The most significant development in the HP OBDR system is new firmware for the tape drive, enabling it to emulate a bootable CD-ROM drive. This functionality is triggered by switching off the unit and holding in the front panel 'eject' button while restoring the power (if the drive is mounted inside the server it is necessary to power-cycle the computer).

Figure 2. Logical (top) and Physical (bottom) Layout of HP OBDR Recovery Tape



Once switched into HP OBDR mode, the DDS tape drive waits and checks any cartridge it receives for a disaster recovery header. Any non-DR cartridge is ejected, but once it detects a DR cartridge, it proceeds to read the special DR CD-ROM image block, and the computer boots from this code.

To make optimum use of the drive's buffer RAM, Hewlett-Packard has implemented sophisticated caching algorithms in the tape drive's firmware. The specification also requires the software to write the boot image as near sequentially as possible on the cartridge. Taken together, these two features ensure that booting off the backup cartridge is fast, and that access times are well within the typical timeouts built into a system's BIOS.

The format for this CD-ROM image block on cartridge is defined by the industry-standard, El Torito bootable CD-ROM specification, and the exact contents are determined by the backup software that wrote the cartridge. The code loaded into memory is just sufficient to boot the computer and permit loading of the operating system and restore software, so that a full restoration can take place.

At some point in the process the drive is switched out of HP OBDR mode, back to normal operation. The drive switches in response to a SCSI bus RESET, but it will not do this automatically until sufficient blocks have been read sequentially from the cartridge in DR mode. This ensures that the tape drive remains ready in DR mode even if the system is rebooted during the initial stages of the recovery.

Switching from DR mode to normal operation can also occur under software control or it can be forced by power-cycling the drive manually. In effect, the DR CD-ROM image on tape completely obsoletes the set of floppy disks or custom-written CD-ROM required by earlier technologies and eliminates the need for the operating system CD-ROM during the recovery process.

Compatibility

Backwards Compatibility

The DR image is stored in the data area of the backup cartridge, which is laid out under software control. The HP OBDR specification requires that all HP OBDR cartridges must be readable by non-OBDR (basic) tape drives, so that restoration of files from any drive is possible. This also allows HP OBDR technology to be progressively rolled-out across an enterprise, giving improved protection while still maintaining the ability to perform remote restoration of data across the network.

	Software		Drive Hardware	
	HP OBDR	Basic	HP OBDR	Basic
Read HP OBDR cartridges	yes	yes *	yes	yes, but not for DR purposes
Write HP OBDR cartridges	yes	no, but could append to HP OBDR cartridges	yes	no, but could append to HP OBDR cartridges

* Basic software will not be able to read the DR image off the backup cartridge, but will read the normal backup set data.

Cartridges conforming to the HP OBDR specification can be used for normal file-by-file restore with basic drives and software, without prejudicing the HP OBDR capability.

Future Compatibility

The HP OBDR specification has been carefully designed to support both present and future PC technologies, by making use of established standards as much as possible. For example, both the BIOS Boot Specification and support for the El Torito format are required components of the Microsoft PC99 definition. The PC99 standard comes into effect from Fall '99, so that almost all commercially built PC systems after that date will be able to support HP OBDR automatically, without even requiring manual changes to their BIOS settings.

Wider Connectivity and Standardization

HP One-Button Disaster Recovery represents a major step forward in data protection, and, as a consequence, Hewlett-Packard is keen to see it implemented as widely as possible. The full specification for HP OBDR has already been published to software vendors, and the technique of switching the tape drive between CD-ROM emulation and normal behavior has patents pending globally.

The Software Element of HP One-Button Disaster Recovery

The Disaster Recovery CD-ROM Image

Much of Hewlett-Packard's new OBDR specification is devoted to creating a framework that software vendors can then use to implement their own one-button disaster recovery system, adapting their existing code as little as possible. Firmware in the HP DAT drive emulates a bootable CD-ROM drive, but the "virtual CD" (which the system will boot from) is written by the backup software.

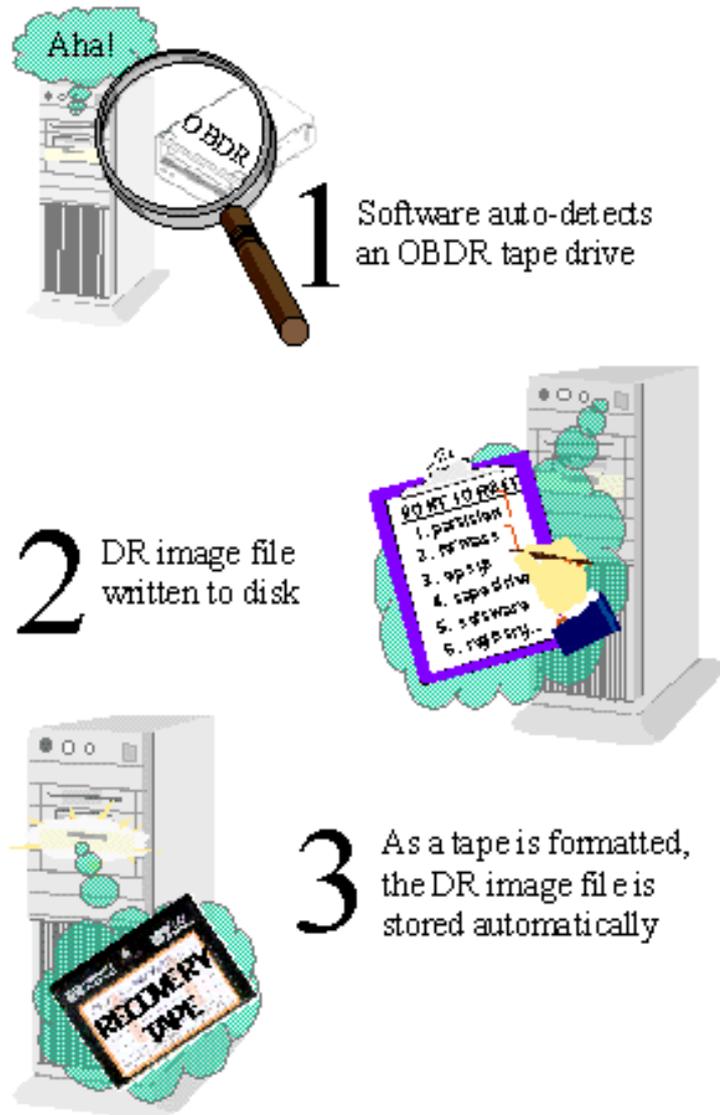
The "virtual CD" varies with backup software implementations (for example, three of the major software vendors each have slightly different approaches), but it always contains one essential component-bootable code to restart the computer and reload the original operating system, including drivers for the main peripherals.

Interacting with the Tape Drive

Automatic detection of an HP OBDR drive (1) takes place either when the software is installed, or when the drive is first connected. The software presents the user with a splash screen, indicating successful detection and explaining details of HP OBDR.

Detection also triggers the software to create the special DR CD-ROM image file on disk (2). It is copied to tape (3) at the first opportunity, either when a new cartridge is formatted, or when an existing cartridge is re-used from the beginning.

Figure 3. Auto-Detection of Tape Drive and Software's Subsequent Tasks



At this point the backup cartridge is theoretically just about usable for disaster recovery (although the full system could not be restored without an earlier backup). The backup cartridge becomes fully DR-capable once the first normal backup completes. Until then, it does not contain all the data files.

As the system configuration changes, the vital disaster recovery information is kept up-to-date on the hard disk and automatically written to tape whenever a new backup cartridge is used (or an old one overwritten). This is required by the HP OBDR specification.

User Interaction with HP OBDR Software

In the middle of a stressful disaster recovery, learning a new piece of software is the last thing a system administrator wants to do. It is obviously helpful if the disaster recovery features of software are consistent between products from different manufacturers. To this end, Hewlett-Packard has produced a Software Developers' Kit for HP One-Button Disaster Recovery that will facilitate the inclusion of this functionality in existing disaster

recovery products. It includes sample dialogs, relevant source code, and methods for interaction between software and hardware. The intention is not just to accelerate the adoption of this technology, but to ensure that a broadly similar HP OBDR user interface is presented by all of the major software vendors.

So how would a typical interaction look? This section uses illustrations from Replica Single Server for HP SureStore Tape, which is supplied with all HP SureStore Tape products. Other software may differ in screens and detail, however, the fundamentals should be quite similar.

Auto-Detection of the Tape Drive

The HP OBDR specification requires that the tape drive is auto-detected, either when the software is installed, or (if the software is already on the system) the first time that the software communicates with a newly added tape drive.

Figure 4. HP OBDR Drive Auto-Detected during Software Installation

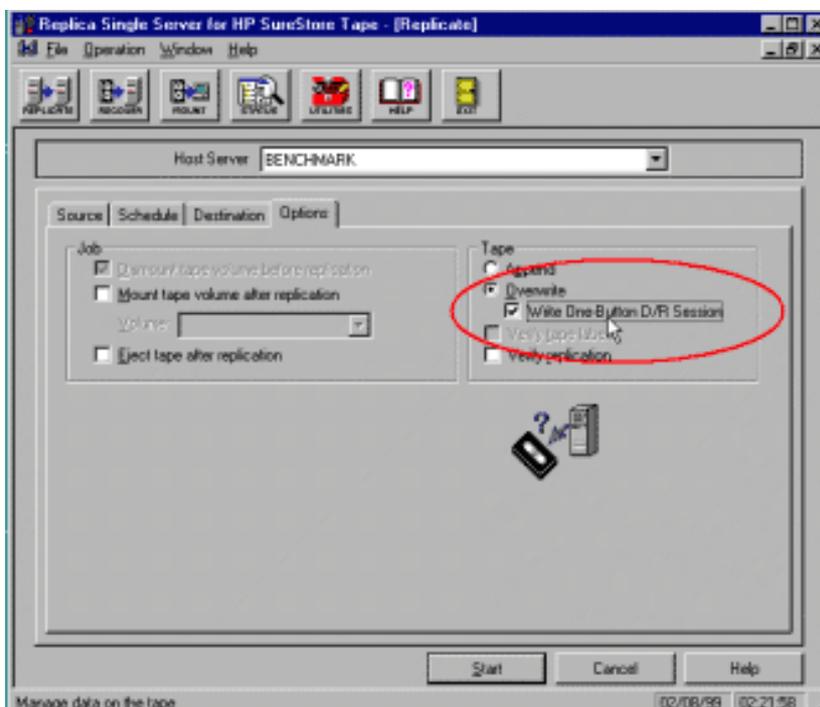


Once the HP OBDR drive has been identified, the installation utility informs the user. This is an opportunity to explain what steps are necessary to test the HP OBDR functionality and make the first, real backup that is protected by HP OBDR.

Selection of the HP OBDR Option for Backup

HP OBDR backups are intended to happen automatically, so there are almost no operational controls for users to alter. In most software implementations, a single checkbox determines whether or not an HP OBDR cartridge is made at the next scheduled backup.

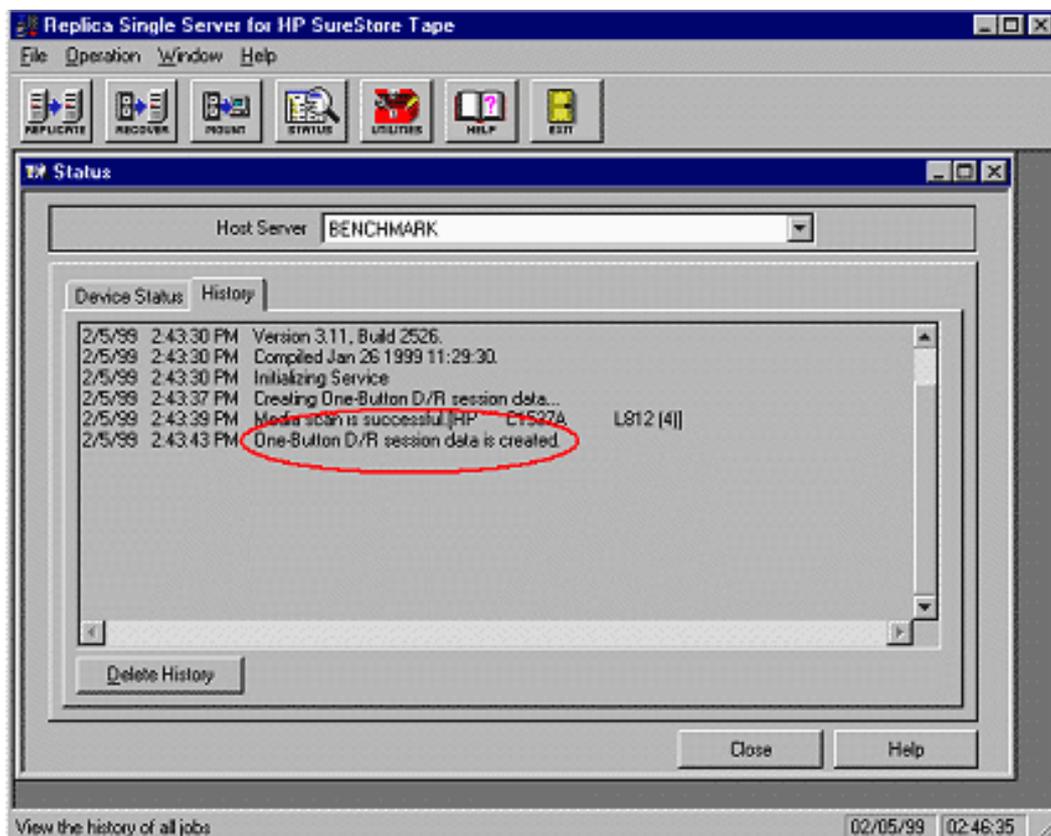
Figure 5. Single Checkbox Turns On HP OBDR Functionality (Replica Software)



Since the system is fully backward compatible, there can be very few circumstances when this option needs to be turned off. Just possibly, the few minutes added to the backup time for DR cartridge creation may be significant when the backup window is extremely short. However, in these cases it may be better to schedule a separate time specifically for DR cartridge creation and not to do it during normal backup operations.

Assuming that HP OBDR is enabled (which it should be, by default), the first full backup of the system will automatically create an HP OBDR backup cartridge and notify the user that it has completed successfully:

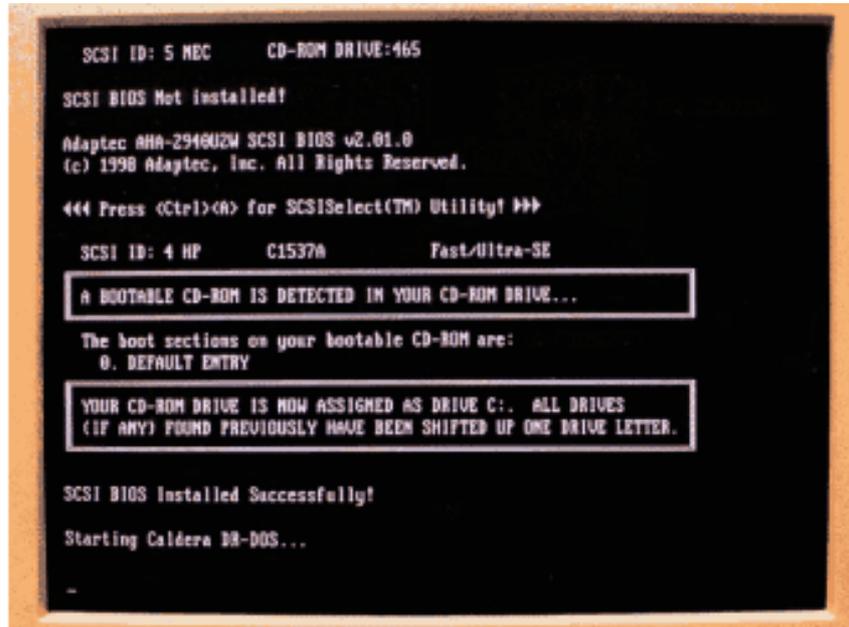
Figure 6. Status Shows Successful Completion of HP OBDR Backup



Using HP OBDR to Restore a System

In this scenario, the system has crashed. The hardware has been repaired, and now a disaster recovery has been started. The user started the tape drive in HP OBDR mode, so that it is now behaving as a CD-ROM drive:

Figure 7. Typical HP OBDR Boot Message



This screen indicates that the tape drive has been detected as a bootable CD-ROM. The line immediately above the "A Bootable CD-ROM&" message shows that the tape drive is attached to the SCSI adapter at ID 4.

(If there is no backup cartridge in the drive, the system will pause once the drive has been detected, waiting for a cartridge to be inserted. If a backup without an HP OBDR header is inserted, the cartridge will be ejected, and the drive will return to normal mode.)

An HP OBDR cartridge was loaded in this scenario, so a bootable, minimal operating system is now loaded into memory. As soon as enough functionality has been returned to the system, it can display a disaster recovery information page:

Figure 8. HP One-Button Disaster Recovery Welcome Screen (for Recoveries)



This screen explains what is going on and helps to prevent users overwriting their system in the unlikely event that they have triggered HP OBDR by mistake.

Next, the minimal operating system and disaster recovery files are copied to the hard disk, which is made bootable. The system will then reboot back into its usual operating system (for example Windows NT). The restoration will continue by determining how many complete backup sessions there are on the cartridge, and letting the user select one for the restore process.

Figure 9. Choosing Session to Restore System (Replica Software, Using Windows NT Installation Engine)



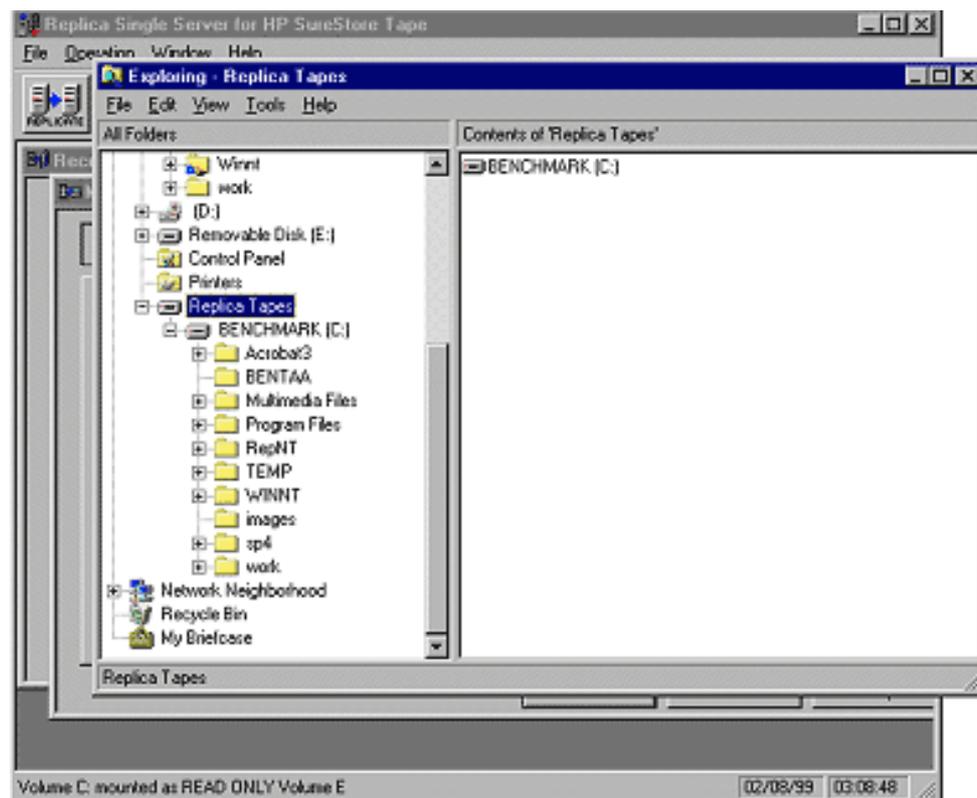
Users can select backups earlier than the most recent if they exist on the cartridge, or they can swap the cartridge for another containing the desired session.

Using HP OBDR Tapes in Normal Operations

There are no special requirements-HP OBDR cartridges are mounted and used just as any other backup cartridge. The screenshot below shows the backup cartridge used for this white paper mounted as a logical, read-only

disk drive by Replica Single Server for HP SureStore Tape (viewed in Windows Explorer). To restore files in this mode, just drag them from the cartridge and drop them onto the desired location on the real hard disks.

Figure 10. HP OBDR Cartridge Mounted As a Virtual Disk



Obviously, this functionality is specific to the backup software package, in this case Replica Single Server for HP SureStore Tape, but it illustrates well the transparency of the HP OBDR system. If a basic tape drive had been used instead of one with HP OBDR capability, the backup cartridge would have been mounted and accessible in exactly the same way.

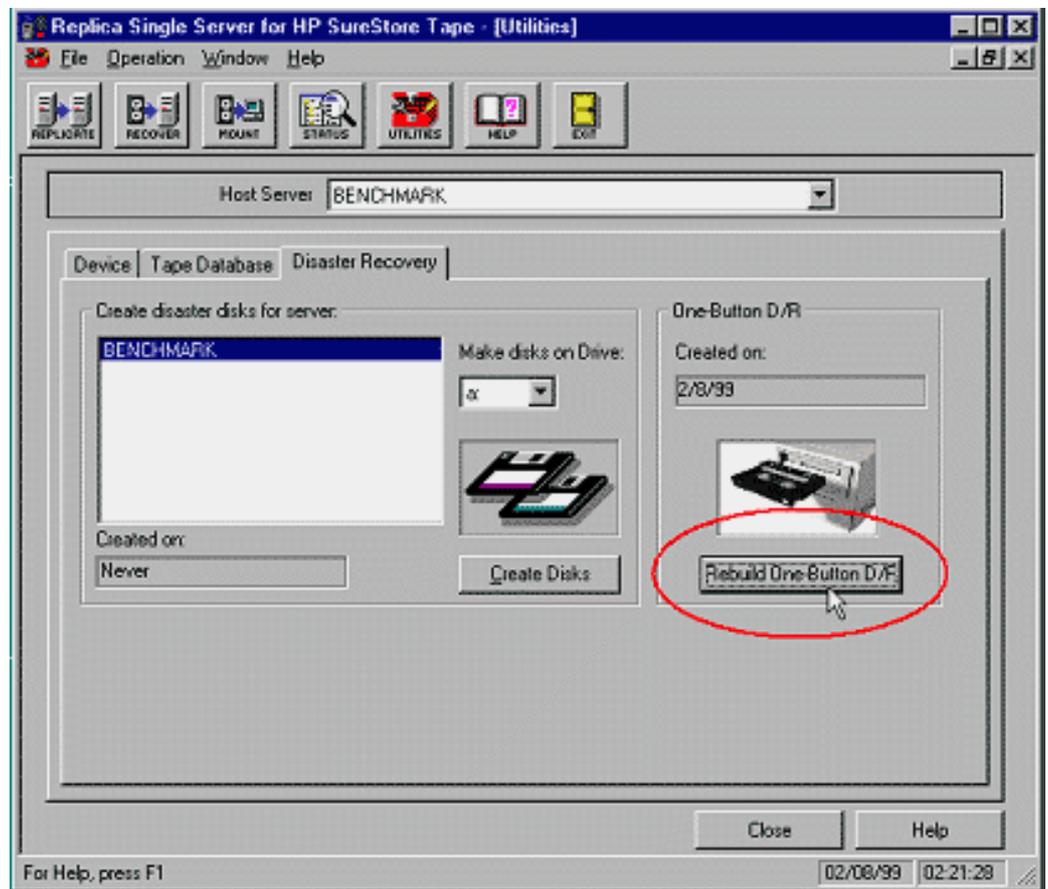
HP OBDR Maintenance

HP One-Button Disaster Recovery backups require either a new backup cartridge or an old cartridge that can be overwritten from the beginning. Creating the backup is easy—as outlined earlier a single control activates creation of an HP OBDR cartridge at the next backup.

For maintenance of the HP OBDR information itself, the HP OBDR specification requires provision in the software for automatic, regular updates. Any change to the system configuration, such as adding an extra disk, must be automatically reflected in the stored HP OBDR image.

Updating or rebuilding of the DR image file can also be forced manually. This is useful in case the DR image file is accidentally deleted or requires unexpected replacement, for example after a virus attack. In this case, the function is accessible from a Utilities menu:

Figure 11. Utility Option to Force Immediate Updating of HP OBDR Data



Appendices

1. About the El Torito Format

The El Torito specification, developed jointly by IBM and Phoenix Technologies defines how a CD should be structured to hold one or more bootable images. It was originally developed for operating system distribution and multimedia applications, permitting developers to put bootable code for different platforms onto one distribution CD. The target computer can then be booted with a tuned, application-specific operating system (for example, a games engine or multimedia kiosk system). It is often used this way today, and one CD may contain code for, say, both PC and Macintosh versions of the same game, or several similar versions of code, each optimized for different CPU types^{***}.

How El Torito Works

Booting from an El Torito CD-ROM relies on the BIOS supporting Int13 extensions (support for bootable hard disks). The standard defines three "modes" or layouts for El Torito CD-ROMs: Floppy Disk, Hard Disk, and No Emulation:

- **Floppy and Hard Disk Emulation** require the host adapter's Int13 handler to translate logical block addressing (LBA) to 'physical' addressing, so that the CD-ROM looks exactly like floppy or hard disk hardware and is treated as such during the boot process. This functionality was defined primarily as an aid to developers. The image structure stored on CD-ROM can be identical to that on the equivalent

floppy or hard disk (using LBA), so an application can be developed and debugged on floppy or hard disk (using standard tools), and ported to CD-ROM at a late stage in the process. The major drawback is the additional BIOS code required—support for the required functions in the SCSI adapter hardware is by no means guaranteed. Furthermore, with the decreasing cost of CD-R and CD-RW technology, creating and testing CD images has become easy to do for developers. These emulations are rarely used today.

- **No Emulation** is the simplest approach. The binary image stored on disk is simply copied sequentially into contiguous main memory and executed, without any attempt by the Int13 handler to emulate a disk structure. The EI Torito specification permits the use of up to FFFFh 800-byte sectors on CD for the binary image, allowing the full 640k low memory area of the PC to be loaded with an image. It is supported by any modern SCSI host adapter with an option ROM (BIOS), and it is required by the *PC 99 System Design Guide*¹, jointly prepared by Microsoft and Intel as the hardware specification for systems running Microsoft Windows 98 and Windows NT version 5.0 operating systems.

EI Torito and HP OBDR

In practice, software that writes HP OBDR images uses all three EI Torito emulation modes. The format is flexible, permitting an image of reasonable size and giving backup software vendors considerable freedom to structure the DR operating system as best suits them.

2. The Bios Boot Specification

This standard was introduced by Phoenix Technologies to present users with a menu of bootable choices when their system starts. It simplifies boot management, and can prevent accidental booting from CD-ROM (for example, when one is left in the drive by mistake).

Hewlett-Packard has developed an extension to this specification, such that the system will automatically boot by default from a tape drive in HP OBDR mode. A special boot record identifier, "\$DR," is used in the tape drive's CD-ROM emulation. This is detected by the SCSI BIOS automatically, and the system boots from the disaster recovery image on tape, ignoring any other boot options. The Hewlett-Packard extension to the standard has now been adopted by major BIOS manufacturers. Adaptec SCSI cards have incorporated the necessary functionality for some while; upgrades for cards using a Symbios Logic BIOS are included with HP SureStore Tape products as a courtesy to customers. Upgrades should be available for other recent SCSI cards from the card manufacturers.

3. Compatibility Information

There are two aspects to compatibility with HP One-Button Disaster Recovery:

- Software support, which is the ability to create suitable HP OBDR backup cartridges, and use them to recover a system and to recognize a tape drive automatically
- The ability of the SCSI BIOS to recognize and communicate with the tape drive correctly when it is operating in HP OBDR mode.

These are addressed below, but for the most up-to-date connectivity and compatibility information on all HP SureStore Tape products, we recommend you visit our [Configuration page](#).

Software Support

Backup software packages from the following companies are expected to support HP OBDR fully:

- Computer Associates
- Seagate Software
- Stac Software

BIOS Support

To ensure correct HP OBDR functionality, the SCSI host adapter must be at a BIOS revision, which correctly supports the El Torito bootable CD-ROM specification. The following BIOS revisions are suitable:

Adaptec: For 29xx / 39xx series of SCSI host adapter cards, BIOS revision 1.25 and later

Symbios Logic: Bios revisions 4.13.03 and later

System Support

The following Hewlett-Packard systems have been tested and proven to support HP OBDR:

HP NetServer PC servers: E-series, LC-series, LD-series, LH-series, LPr, LXr 8000

HP Kayak PC workstations: XU series, XW series, XA series & XA-s series

Note: These HP NetServers require an additional SCSI host adapter to be fitted. See the [Configuration page](#) for up-to-date information. A BIOS update is in preparation to support HP OBDR on the embedded Symbios SCSI chipset.

¹PC veterans going back to 1981 will recall that the original IBM PC BIOS supported program loading from audio Compact Cassettes, so, strictly speaking, tape support in the BIOS did once exist. The author does not recommend using this feature to protect modern servers, because, even if the feature is still there, DOS 1.0 is not usually available for current systems.

**In a few cases (when the customer is using an old version of backup software), it may be necessary to obtain a patch or update from the software vendor. Additionally, some software vendors supply disaster

recovery modules separately from their main backup packages.

***Microsoft's Windows NT Workstation retail distribution disk is an example of this, containing bootable code for both Intel and Alpha architectures.

PC 99 System Design Guide Chapter 11, Section 11.2, Intel Corporation and Microsoft Corporation, with Compaq Computer Corporation, Dell Computer Corporation, Gateway 2000 Inc. and Hewlett-Packard Company: Microsoft Press, Redmond, 1998, ISBN: 0-7356-0518-1.

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