HP StorageWorks DDS/DAT USB tape drive white paper

Executive summary

HP StorageWorks DDS/DAT tape drives have traditionally been based on the parallel SCSI (pSCSI) interface. This interface has always been widely used and popular for its high reliability and performance. However, dramatic changes in the interface market, including numerous new interface introductions, have caused a number of server manufacturers to phase out native pSCSI support. As pSCSI becomes less common as a native interface, customers of HP DDS/DAT SCSI drives will be required to pay more for their solution, either by paying for a pSCSI interface option as part of their new server, or if they do not have a SCSI connector available, by buying a host bus adapter (HBA) and SCSI cable.

As a consequence, HP is implementing the USB 2.0 interface on its DDS/DAT tape drives as an alternative to traditional SCSI because HP sees USB as a reliable, low-cost interface that will proliferate in almost every computer system.

The following additional benefits are realized by implementing USB 2.0 on DDS/DAT tape drives:

- Wide connectivity—USB is everywhere. USB ports are increasing in number and they are available on virtually every low-end, midrange, and high-end platform.
- Connector abundance—USB port availability for tape connect is nearly guaranteed. Other interfaces, like Serial ATA (SATA) and Serial Attached SCSI (SAS), are more likely to be consumed by hard disk and optical drives.
- Ease of implementation—External drive connect is easily achieved with a standard Type A USB connector. For internal connection, an inexpensive header may be installed on the system motherboard.
- Full functionality—By implementing the USB 2.0 with a SCSI command set, the full functionality and feature set (that is, ISV support, One-Button Disaster Recovery [OBDR]) of the DDS/DAT product are realized.

Figure 1. HP StorageWorks DAT 72 USB tape drive

Background to change

The current interface trend indicates that pSCSI is slowly being replaced by less expensive serial alternatives. To protect customers of HP StorageWorks DDS/DAT drives and align with industry trends, HP decided that an interface alternative should be developed that would protect customers from having to pay extra to keep the interface connect as well as enhance the customer experience. HP is therefore implementing the USB 2.0 interface on its DDS/DAT tape drives as an alternative to traditional pSCSI. USB was conceived out of a need to simplify computer peripheral device connection cost, configuration, and attachment. It is a reliable, low-cost interface solution that is easy to use and will proliferate in almost every computer system. HP StorageWorks DDS/DAT USB solutions will co-exist with pSCSI solutions from 2005.

Interface choices

New interfaces are emerging as viable alternatives to pSCSI. SATA and SAS maintain the popular ATAPI and SCSI protocol command sets on a serial physical layer. However, neither interface promises to be available for peripheral attachment across the system base. While SATA is a popular disk drive interface on low-end servers and workstations, SAS is expected to penetrate the high-end server market. USB 2.0 is the only interface that is widely available today across the entire computing landscape. USB 2.0 has proliferated on the lowest end PCs and laptops as well as high-end supercomputers. This proliferation is one reason why HP has decided to bring USB to DDS/DAT as an alternative interface to pSCSI.

Figure 2. The USB icon, widely recognized as representative of ease of use and wide connectivity

Table 1.

	USB	SATA	SAS	IDE-ATAPI	pSCSI	FireWire
Market sector	All platforms	Desktop PC low/mid range	Enterprise Storage	Desktop PC	Enterprise Storage	Consumer products
Cost of solution	Lowest	Medium	High	Low	High	High
Motherboard support	Extensive native support, 6–8 ports	2–4 ports native, usually tied to disks and DVD	Only starting to ship	Intel® phasing out native support	Still widely available but native support declining	None available today in servers
Availability of drives	USB tape drives available	No SATA tape drives	None	IDE tape drives available	SCSI tape drives available	No FireWire tape drives
Usability	Easy to use. Very inexpensive HBAs if required	Internal connect only	New to market, needs HBA	Bulky cables	Without native support requires HBA and cable	Easy to use with consumer products
Performance	Sufficient for DDS/DAT 480 Mb/s	SATA II is 300 MB/s	Will be 300 MB/s	100 MB/s	320 MB/s	400 Mb/s

Solution description

USB was conceived out of a need to simplify computer peripheral device connection cost, configuration, and attachment. It solved direct mapping IRQ into the system processor, I/O addressing, cable management, configuration, and provided hot plugability.

USB design goals include:

- Hot plug support
- Low-cost solution for system and peripheral implementations
- Single connector type for any peripheral device
- Support of multiple peripheral attachment to single port
- Easing the computer system resource requirements and conflicts
- Automatic detection and configuration of devices
- Enhanced performance capability
- Low power consumption

USB provides an easy way to connect a device to your computer. The cables follow an industry standard and are easy to install. Devices are easily connected, automatically configured, and do not require setting up hardware or system shutdowns. Virtually every computer has at least one expandable USB port. The USB Implementers Forum (IF) standards ensure a reliable and compliant solution from silicon to cable.

Adopting USB 2.0 as a tape drive interface is the perfect union. USB simplifies tape drive attachment and reduces configuration complexity and time. USB 2.0, with enhanced performance at 480 Mb/s, can easily sustain a streaming DDS/DAT tape drive. USB ensures availability drive interface support going forward; as parallel interfaces are phased out, USB will continue. In addition, the total storage solution is simplified, eliminating the need and therefore cost of expensive SCSI cables and terminators.

Consider the ease of installation of a USB external DDS/DAT drive as compared with an external pSCSI variant.
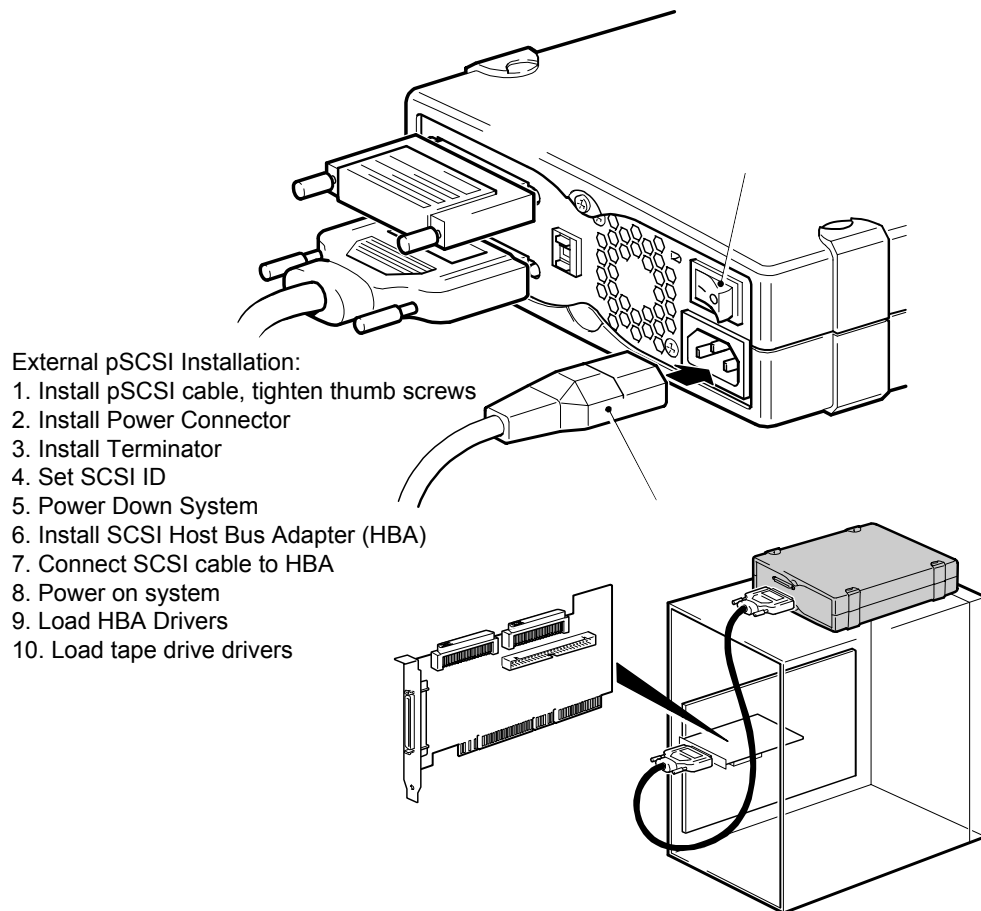
Figure 3. External pSCSI installation

External pSCSI Installation:
1. Install pSCSI cable, tighten thumb screws
2. Install Power Connector
3. Install Terminator
4. Set SCSI ID
5. Power Down System
6. Install SCSI Host Bus Adapter (HBA)
7. Connect SCSI cable to HBA
8. Power on system
9. Load HBA Drivers
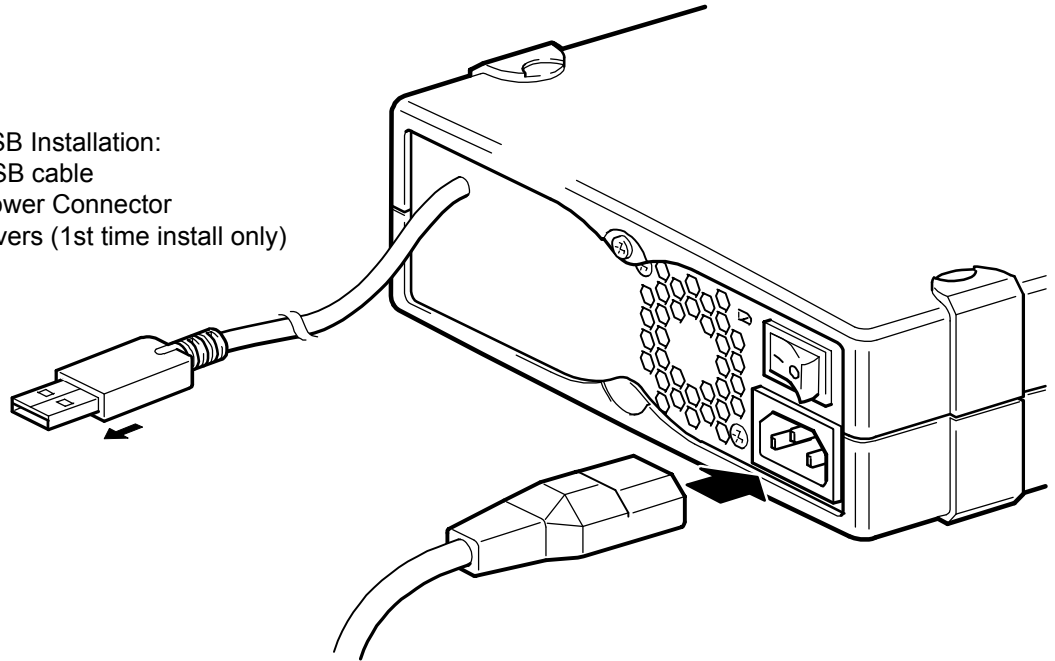10. Load tape drive drivers

Figure 4. External DAT USB drive installation

External USB Installation:
1. Install USB cable
2. Install Power Connector
3. Load Drivers (1st time install only)

pSCSI installation takes approximately six times as long as a USB installation.

Physical

USB cables consist of five wires: a power pair, a differential signal pair, and a drain wire. The cables are easily routable as they are thinner than most interface cables, come in a variety of lengths, and have no extraneous parts. The connectors are keyed to allow connection to either a peripheral or a host. Aside from being either USB 1.x or 2.x compliant, you can use any cable with Series A or B connectors, reducing confusion over cable setup.

Figure 5. Series A and B connectors

Series A   Series B

USB cables are easy to attach. Cables with Series A or Series B connectors plug into receptacles designed to have a minimum retention force of 10 Newtons. Extracting and inserting USB connectors can be easily accomplished by hand, yet retention forces are such that connectors will not unintentionally become disconnected from the receptacle. Meaning, moving your device, or your computer for that matter, is trivial to do with USB. There are no thumb screws to deal with, no need to label cable ends—the entire process is completed by hand. HP recommends the Belkin USB Cable a-b, 6' (2 m), HP part number P5309C#ABA and the 4-port USB 2.0 hub, HP part number DM866A#ABA. In the box an 8121-092 Header USB cable (a special cable allowing an internal DDS/DAT USB drive to connect to certain HP ProLiant server motherboards) will be provided.

Figure 6. Internal USB cable for connection to HP ProLiant server

USB is everywhere; virtually every computer has USB. The connection is essentially free, no need to add in an HBA to your machine. If you do not have enough ports, expansion is easy. USB hubs can be installed to add additional ports supporting up to 127 devices.
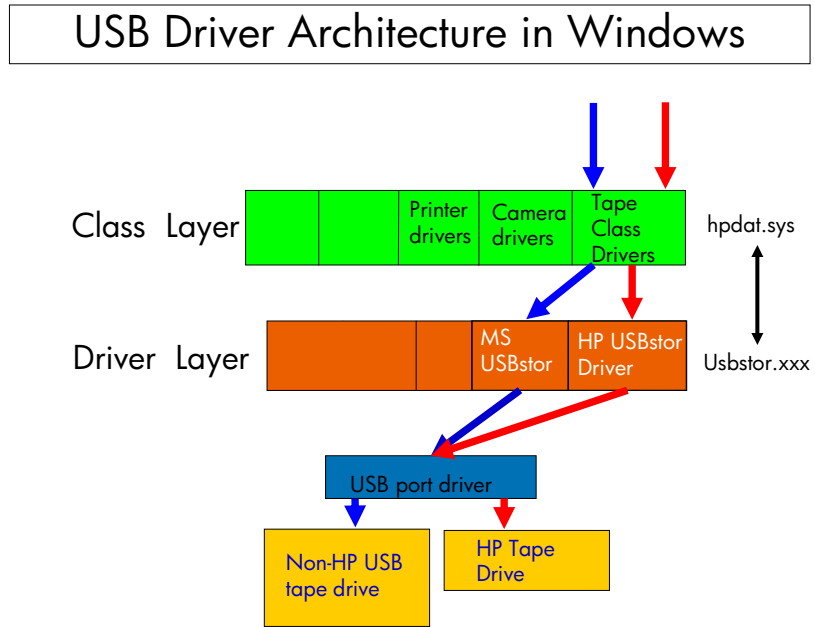
Usability

Plug-and-Play connectivity for the user means the device is automatically sensed by the system. USB detects the attachment of a device and automatically installs the required software to support the device (device drivers, and so on). Device functionality is exposed by way of the driver. There are no switches or jumpers to set. Device hot-plug capability and automatic software installation are particularly beneficial in minimizing system downtime.

As a result of the proliferation of USB Plug-and-Play and hot-plug capability, the DDS/DAT drive with USB 2.0 is also intrinsically portable. Much like an MP3 player or USB flask drive, you can connect to any computer and share your files without encountering configuration or setup issues.

Microsoft® fully supports USB devices natively in their operating systems. Drivers are certified and digitally signed by way of the WHCL process. More recently Microsoft implemented a Global Unique Identifier (GUID) for enumerating and establishing connection to USB devices. The GUID implementation provides a greater measure of security with regards to accessing your device. In addition, the GUID implementation provides a standard for device interface naming and access that device vendors can utilize. It is language neutral, easily extensible, usable in an environment with many hardware and software vendors, and easily documented. It reflects a commitment from Microsoft to continue to enhance USB capability and ease efforts from an implementer's point of view.

The tape class driver, hpdat.sys, has been enhanced for operation with the DDS/DAT USB drives. HP strongly recommends the use of the driver installer supplied on the "in box" CD or downloadable from the HP support website: http://www.hp.com/support
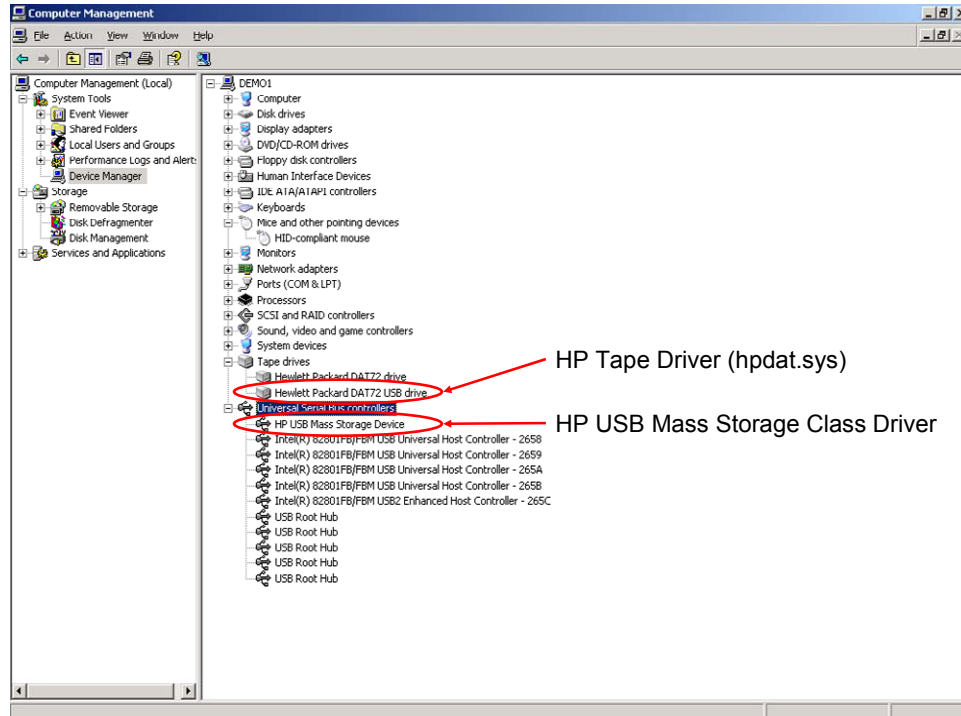
Figure 7. Windows® driver stack

USB Driver Architecture in Windows

In addition to USB IF and WHCL for operating system drivers, HP devices and device-specific drivers must pass the rigors of the HP device qualification.

Figure 8. DAT USB tape driver and HP USB mass storage driver

HP Tape Driver (hpdat.sys)

HP USB Mass Storage Class Driver

Reliability

USB 2.0 has multiple levels of physical error detection and recovery. These exist primarily at the packet level, with additional protections during handshake operations.

- Cyclic Redundancy Checks (CRC)—Each packet contains five or 16 CRC bits (depending on the amount of data) validating any information after the PID field. This is on par with the highly reliable Fibre Channel CRC protection and is superior to the parity bit implementation in pSCSI.

- Packet ID (PID) checks—Each packet within a transaction contains a PID as well as a PID check field. All target devices perform the PID check and ignore packets if an error is detected.

- Bit stuffing—Bit stuffing is used to ensure that Non Return to Zero, Inverted (NRZI) data maintains.

- Synchronization—By utilizing packet acknowledgments and a transaction toggle bit, USB provides additional error handling during handshake operations. USB also provides time stamp information embedded within the transmission, allowing for error detection and recovery against babbling devices and loss of activity. When errors are detected, the result is typically a retransmission of the entire packet.

Figure 9. USB packet breakdown
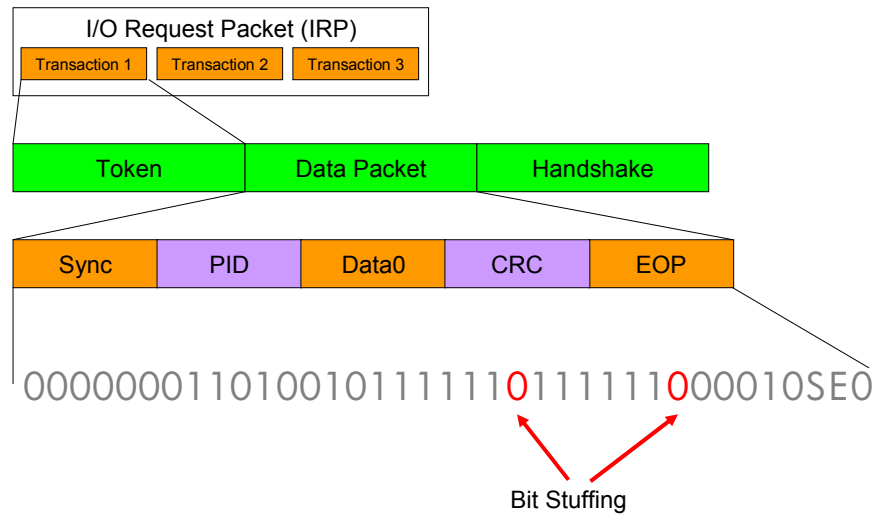
Connector abundance

Where other available native interfaces are almost completely consumed with "in box" peripherals, USB ports remain plentiful. Of the native interfaces, USB ports will be in greatest abundance and so ensure that there will always be a port available to connect to the HP DDS/DAT drive. The Southbridge chip implementation provides eight USB ports, while AMD implementations provide a minimum of six USB ports. Other interfaces designed for high-performance applications are likely to be restricted in number and consumed by hard disk and optical drives.

Best practices

- Install the Windows drivers before plugging in the drive. HP recommends using the driver installer found on the CD included in the box or downloadable from the web at www.hp.com/go/tape.
- To maximize performance:
  - Use only a USB 2.0 Hi-Speed host port.
    - o Use an USB 2.0 HBA if the server has no USB 2.0 ports.
    - o USB 1.1 may limit the transfer rate.
  - Plug the drive directly into connectors on the server.
    - o Avoid the use of hubs if possible.
    - o If a hub is used, it **must** be Hi-Speed USB 2.0 certified.
  - Use only Hi-Speed USB 2.0 certified cables.
    - o Certified cables are guaranteed to be of proper overall length.
- For Linux installation details, refer to the documentation on the DDS StorageWorks CD.

Full features and functionality

USB is used as a mechanism to transport SCSI packets to and from the drive by way of a priority-based transfer, which guarantees100 percent accurate data delivery. The product therefore benefits from the built-in reliability and failure recovery inherent in the underlying SCSI protocol.

The SCSI command set has been the standard command set for tape and disk for over a decade. It is rich in its functionality, management ability, and reliability. HP ISV partners have built their applications on top of and around this command set.

HP is the first company to develop a native USB tape drive. Most implementations today rely on a converter from USB to the native drive interface, typically ATAPI. HP developed a native USB drive that uses the SCSI command set within the USB payload. This affords the drive the full functionality exposed in SCSI with the flexibility of USB and without the reliance on an expensive converter.

Benchmarking

USB 2.0 has a transfer rate of 480 mbit/s (60 mb/s). DDS/DAT format's data transfer rate is approximately 6 MB per second, or one-tenth of the maximum USB data rate. In HP tests, USB 2.0 was able to sustain the DDS tape drive at 29 MB/sec. That bandwidth can support DDS/DAT products operating at high compression ratios (approximately 5:1 with a DAT 72 drive) and with room to spare for the future generations illustrated on the DDS/DAT manufacturer's roadmap.

Certifications

All USB logo devices must meet the requirements of the USB IF testing. The IF has strict test requirements for the host, hub, cable, device, and silicon. Each of these items must be tested in accordance with their standards to achieve USB logo certification.

Compatibility/interoperability

For complete compatibility details, see the product Quick Specs and Go Connect compatibility matrix at www.hp.com/go/connect. At this time the DAT USB drive will be compatible with all HP ProLiant servers with a USB 2.0 port. VERITAS Backup Exec and Tapeware with OBDR will also be supported at launch.

The following HP ProLiant servers possess a specific USB tape connector on the system motherboard:

- HP ProLiant ML110 G2 server
- HP ProLiant ML150 G2 server
- HP ProLiant ML310 G2, G3 servers
- HP ProLiant ML350 G4 server
- HP ProLiant ML370 G4 server
- HP ProLiant ML570 G3 server

Table 2. OS and ISV Compatibility

	Windows XP (Home Edition & Pro)	Windows Server 2003 (32- and 64-bit x86)	Windows Server 2003 (64-bit IPF)	Windows 2000 (Server & Pro)	Linux 2.6+ Kernel*
Windows NT® Backup	✔	✔	-	✔	✔
VERITAS Backup Exec v10	✔	✔	-	✔	✔
Yosemite Tapeware v8.1	✔	✔	-	✔	✔
Linux built-in backup apps	✔	✔	-	✔	✔
✔ USB tape supported					
- Not supported					
* Using standard tape drivers					

Configuration

To configure the DAT USB drive, connect power and insert the USB cable into an available USB 2.0 port. For a first-time install, the USB Mass Storage driver must be loaded from the "in box" CD (see Figure 10.) The DAT USB drives ship with the following items in the box:

- HP StorageWorks DAT USB tape drive
- Cables
- OBDR—A free, patented HP exclusive allowing easy and quick "bare-metal" server restores
- Yosemite Tapeware backup software and license
- Library and Tape Tools Diagnostics
- Drivers and documentation
- Easy setup poster
- HP DAT tape media—The most reliable and extensively tested tape media
- HP DAT cleaning cartridge
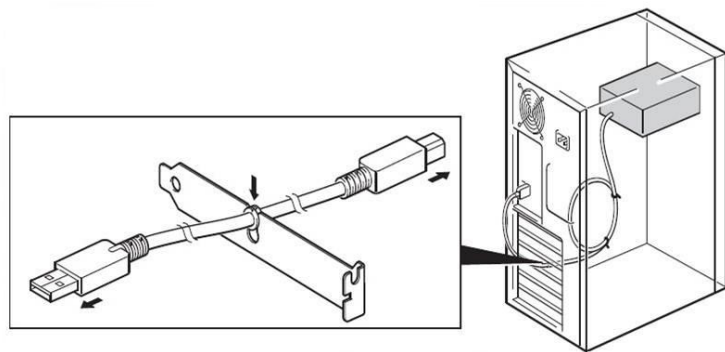- Three-year warranty

Figure 10. Connecting DAT USB internal drives
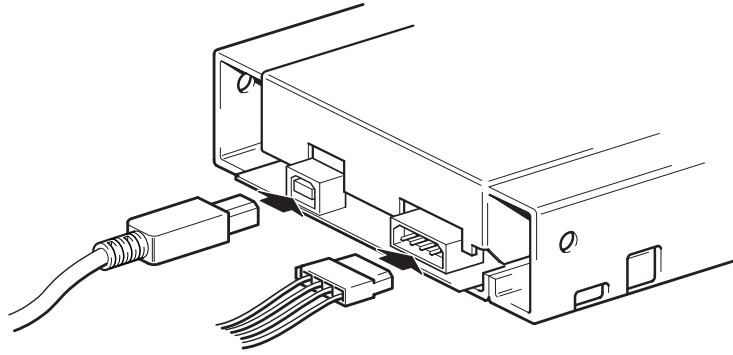
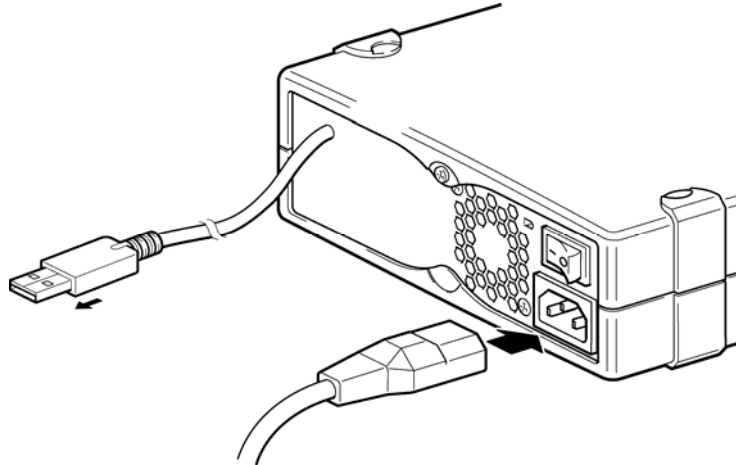USB cable (Type B receptacle) and standard power connector
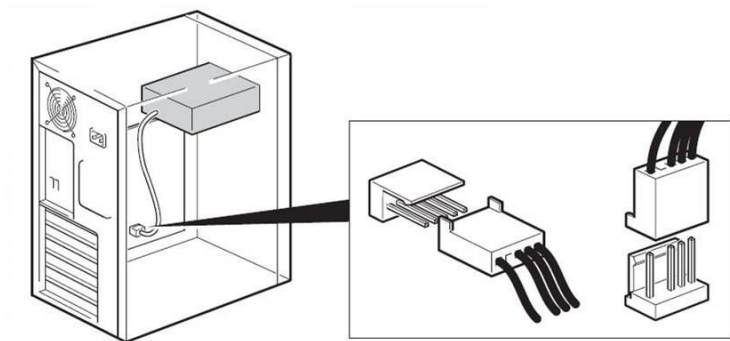
HP ProLiant motherboard connection available

Server connection by way of external port

Figure 11. Connecting DAT USB external drives
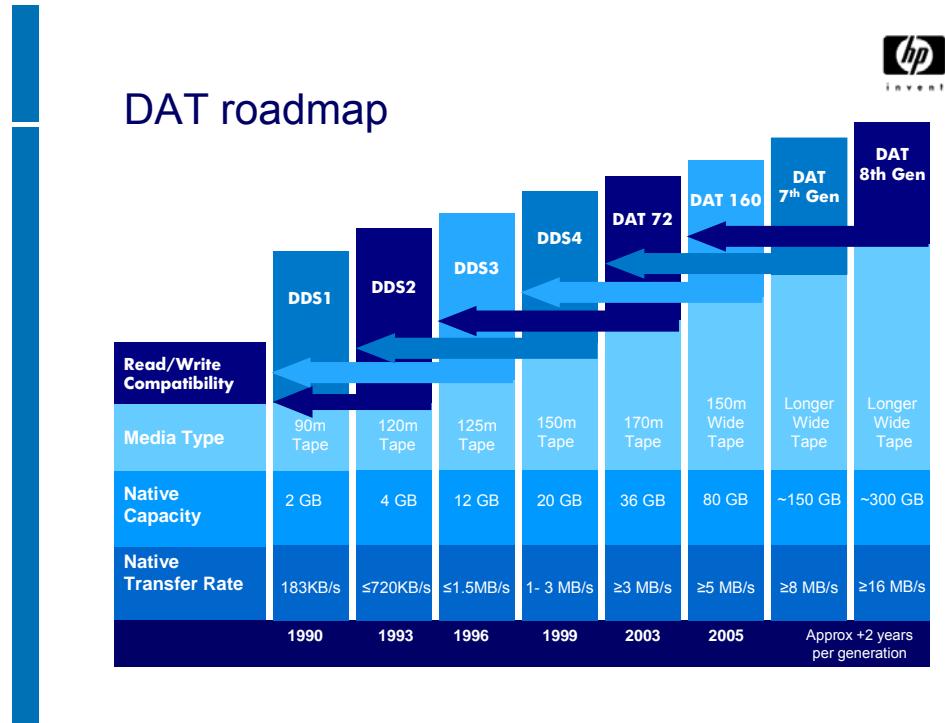

Summary

There are four primary reasons for selecting USB 2.0 as an alternative interface for DDS/DAT:

- USB is everywhere—USB ports are increasing in number and they are available on every low-end, midrange, and high-end platform.
- Connector abundance—USB port availability for tape connect is nearly guaranteed. Other interfaces, like SATA and SAS, are more likely to be consumed by hard disk and optical drives.
- Ease of implementation—External drive connect is easily achieved with a standard Type A USB connector. For internal connection, an inexpensive header may be installed on the system motherboard.
- Full functionality—By implementing the USB 2.0 with a SCSI command set, the full functionality and feature set (that is, ISV support, OBDR) of the DDS/DAT product are realized.

Appendix A

Figure 12. The DAT roadmap

DAT roadmap

	DDS1	DDS2	DDS3	DDS4	DAT 72	DAT 160	DAT 7th Gen	DAT 8th Gen
Media Type	90m Tape	120m Tape	125m Tape	150m Tape	170m Tape	150m Wide Tape	Longer Wide Tape	Longer Wide Tape
Native Capacity	2 GB	4 GB	12 GB	20 GB	36 GB	80 GB	~150 GB	~300 GB
Native Transfer Rate	183KB/s	≤720KB/s	≤1.5MB/s	1- 3 MB/s	≥3 MB/s	≥5 MB/s	≥8 MB/s	≥16 MB/s
	1990	1993	1996	1999	2003	2005	Approx +2 years per generation	

Read/Write Compatibility

hp invent

For more information

For more information on HP StorageWorks DDS/DAT USB drives, visit:

- www.hp.com/go/connect
- www.hp.com/go/tape
- www.hp.com/go/OBDR
- http://www.datmgm.com/datroadmap.htm