

# Hard Drive Update

The new Serial ATA technology is poised to improve the performance and reliability of your system. **By Stephen J. Bigelow**

Virtually every PC today relies on the venerable ATA (Advanced Technology Attachment) interface to connect hard drives, CD drives, and other types of drives. Spurred by the relentless demands for faster drive performance and greater reliability, the ATA standard (also known as IDE), which has a rated connection speed of 3.3 MBps, has undergone many advances. The Ultra ATA (dubbed Ultra ATA/133) interface can pass 16 bits of parallel data between a drive and PC at speeds of up to 133 MBps.

Such parallel-signal schemes, however, are reaching the practical limits of current cable, drive, and controller electronics. To achieve even faster data transfer rates, drive manufacturers are turning to a serial scheme called Serial ATA (SATA). Though it may seem counterintuitive that a serial technology (which transfers data one bit at a time rather than transferring multiple data bits simultaneously, as a parallel scheme does) could outpace a parallel one, that's exactly what SATA does; it transfers data at a much faster rate and more efficiently. Now that SATA drives, add-in controller cards, and most importantly, PC chipsets are finally available, you'll want to understand the benefits of this technology.

SATA typically handles data transfers of up to 150 MBps and in the future can be scaled up to 300 MBps and beyond. Some manufacturers predict speeds as high as 600 MBps. SATA offers a speedier boot process and faster loading of programs and data. But perhaps the best part of the new technology is SATA's simpler cabling.

If you've ever looked inside a PC, you've seen the wide, gray, 40-pin ribbon cable that daisy-chains master/slave drives to the ATA controller port. Not only were those 40 wires laying close together a potential source of interference, but routing the bulky cable made the placement of drives difficult. Moreover, the traditional cables are notorious for disturbing air flow within PCs. SATA uses thin cables that route easily and don't

block a PC's cooling system, thus preventing hot spots and improving overall system reliability.

Connecting SATA drives is easier, too. Each drive connects to the host PC via an individual cable; the host PC treats all drives as master devices, eliminating the jumper settings, which have frustrated users for years. This greatly eases installation and configuration. Finally, the cables can be longer. Current parallel ATA cables max out at 18 inches, while SATA cables can be as long as 39.4 inches (1 meter). That's good for high-end boxes that use full-tower cases.

You will also find adding or replacing drives easier with SATA. You won't have to power down your PC before connecting a new drive, because SATA allows for hot-pluggable connections, so you can add or remove SATA drives while your PC is running. The connectors are also keyed (that is, designed for one-way insertion), so you don't need to worry about acci-

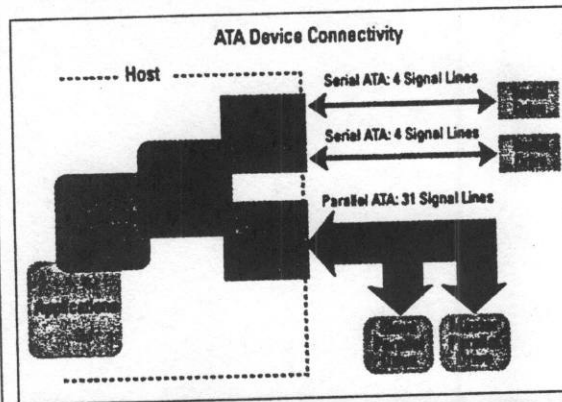


FIGURE 1: Serial ATA and traditional parallel ATA devices can coexist in the same system. (Image courtesy of Maxtor.)

dentally reversing a connection.

SATA is software-compatible with ATA, so you don't need any special drivers or OS upgrades to support the new drives; the SATA controller does the conversion between the drive and host PC. Consequently, SATA drives can coexist on the same system with parallel ATA devices.

Yet because of the differences between SATA and parallel ATA, you can't simply drop a SATA drive into a parallel ATA system. Here's what it takes to implement Serial ATA on your PC.

To start, you'll need a new SATA drive such as the 120GB Seagate Barracuda ATA V ([www.seagate.com](http://www.seagate.com)). The only difference you'll see in the SATA drive is the connector scheme (and the absence of drive jumpers).

The host PC requires a SATA controller with one or more SATA ports, such as the Promise Technology SATA150 TX2plus, which combines two independent SATA ports and one Ultra ATA port and supports up to two serial and two Ultra ATA drives ([www.promise.com](http://www.promise.com)). In new SATA-compatible machines, the motherboard uses a controller chip that supports SATA. The Marvell 88i8030 Serial ATA Bridge Chip ([www.marvell.com](http://www.marvell.com)) is one accepted device available for developers, and integrated chipsets supporting SATA are expected from leading chipset makers including ALi Corp. ([www.ali.com.tw](http://www.ali.com.tw)), Intel Corp. ([www.intel.com](http://www.intel.com)), and VIA Technologies ([www.via.com.tw](http://www.via.com.tw)).

You'll also need new cables. Some SATA drives use different power cables and all use different signal cables, so you may not be able to use the traditional 4-pin power connectors. Serial ATA drives require power connectors with +12, +5, and +3.3

volts. Current 4-pin ATX-type power supplies provide only drive power connectors with the traditional +12- and +5-volt signals. This means your PC may need a power supply fitted with SATA drive power connectors or an adapter.

While only a few SATA drives are currently available, drive makers are certain to embrace the higher data speeds and installation simplicity offered by SATA technology. You can stay abreast of the latest SATA developments at

[www.serialata.org](http://www.serialata.org). For more information on upgrading, see the "Upgrading Your Hard Drive" section of our cover story of March 11, "Speed Up Your PC."

Stephen J. Bigelow is the author of *Troubleshooting, Maintaining, & Repairing Personal Computers* (5th edition).

HOW IT WORKS

# Cram Sessions: The Evolution of an Ever De

By MATT LAKE

**L**IKE almost everything in the electronics industry, compact disc technology started to show its age pretty quickly. A decade after the first CD's appeared in the early 1980's, their 640 megabytes of storage capacity had begun to look paltry, particularly when it came to the holy grail of in-home entertainment: accommodating a high-quality feature-length film on one disc.

For that, other solutions were needed. One was the VideoCD format, introduced in 1993, which uses standard CD's and provides good-quality video and sound. But with the disc's running time of less than 74 minutes, most films could not be contained on a single VideoCD, and the format never caught on in the United States (although it did in Asia, where it is still in widespread use).

Two other solutions were under development around the same time. Both aimed to increase the capacity of a CD at least tenfold, which would allow a single disc to hold a high-quality full-length movie. But the rival formats, the Super Density disc, a

project of Toshiba and Time Warner, and the Multi-Media CD, a joint creation of Philips, Sony and 3M, found no takers among entertainment companies, which were gun-shy after the battle over the competing Betamax and VHS standards in the early days of consumer videotape.

So in 1995 the major electronics and entertainment companies convened as a consortium called the DVD Forum to create a digital video disc standard everyone could live with. The standard it finally settled on, called the digital versatile disc, caught on quickly: more than 14 million DVD players were sold in the first three years after the format was introduced.

There is one fairly straightforward way of cramming more of anything into a fixed space. It's the Manhattan way: you move everything closer together and pile it higher. On CD's, there is a spiral track with a pattern of pits in it that represents the ones and zeros of digital data. On DVD's, the track is narrower and the pits are smaller. That increases the capacity by more than six times, from 640 megabytes to 4.7 gigabytes.

To add even more storage, DVD's add a second layer of data, no more than half a human hair's

breadth deeper into the disc. The layer nearest the surface is a translucent gold material, and the second is an opaque silver color. This bumps the capacity of a DVD to an impressive 8.5 gigabytes and gives the discs their distinctive bronze color.

A bigger problem was mastering the content to store on a DVD. A multimedia standards organization called the Moving Picture Experts Group had already established several standards for compressing and storing high-quality video and audio. Its MPEG-1 specification had been the cornerstone of the VideoCD format. A newer specification, MPEG-2, was adopted for the DVD format.

Even making the MPEG-2 video file itself is complicated. MPEG-2 is "lossy," meaning that some data is thrown away during compression. The knack to getting the best results, according to Craig Eggers, Toshiba's director of product management for DVD products, is to pick what to throw away.

"MPEG-2 is like freeze-dried coffee," Mr. Eggers said. "You take out only the nonessential elements, and you're left with the good stuff."

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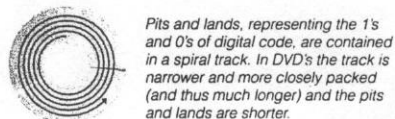
## A Hollywood Blockbuster in the Handy Take-Home Pack

The digital versatile disc, or DVD, standard was developed in the mid-1990's, fueled by the electronics industry's desire for a medium that could store a feature-length film on a single disc. The standard

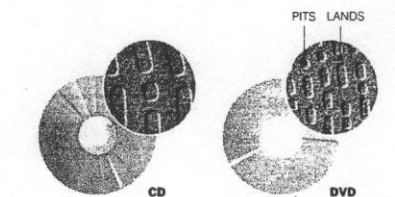
improves on optical storage techniques developed for compact disc compression format, MPEG-2.

### 1 Storing more data

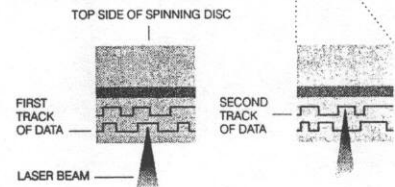
DVD's have the same dimensions as CD's and store data largely the same way — by pressing a pattern of pits and flat surfaces called lands into plastic that is then covered with a reflective metal. By packing the data more closely and including more than one layer, DVD's can store about 10 times as much data as CD's.



Pits and lands, representing the 1's and 0's of digital code, are contained in a spiral track. In DVD's the track is narrower and more closely packed (and thus much longer) and the pits and lands are shorter.



CROSS SECTIONS OF A SINGLE-SIDED, DOUBLE-LAYER DVD (SIDE VIEW)

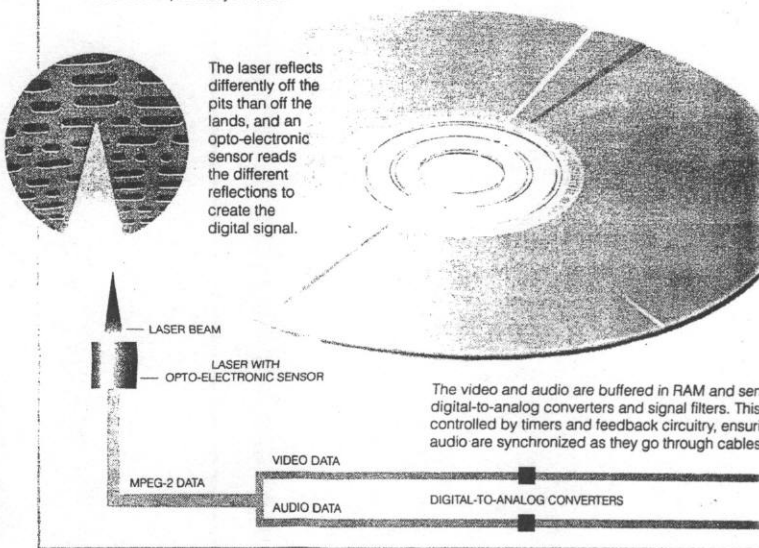


### READING LAYERS

A single-sided DVD can contain two layers of data. The first, or lower, layer uses a semitransparent coating of gold as its reflective surface. The second layer uses aluminum. A single laser reads both. DVD players that can also read compact discs usually have a separate laser, which produces light of a different wavelength, for the CD's.

### 2 Reading the data

Inside a DVD player, a motor spins the disc between 200 and 500 revolutions per minute. The laser reads the first layer, beginning at the inside edge and moving out, and then increases power slightly to read the second layer. The motor speed varies depending upon where the laser is focusing on the disc so that the data stream at a constant rate. The player has a second motor that helps keep the laser beam precisely on track.



The laser reflects differently off the pits than off the lands, and an opto-electronic sensor reads the different reflections to create the digital signal.

The video and audio are buffered in RAM and sent through digital-to-analog converters and signal filters. This controlled by timers and feedback circuitry, ensuring audio are synchronized as they go through cables

### COMPRESSING THE DATA

Even with all the extra space on a DVD, a compression format called MPEG-2 must still be used to fit a feature film on a single disc. An encoder analyzes each frame, determining if it is possible to eliminate redundant data.



### Complete frame

Also known as an intraframe, this has little compression.



### Predicted frame

When there is little difference between one frame and the next — if only the lips move, for instance — only the data bits that change are needed.

### Bidirectional

These use previous frames as well as interframe data to create a frame. They use a lot of code but use less data.

Source: AudioLinks.nl

The New York Times; Illustration by

### WHAT'S NEXT

# Shrinking the Cellular Phone, One Component

By IAN AUSTEN

A CELLPHONE is more than a few chips and a battery. Those things do



hold 62,500 of Dr. Nguyen's MEMS resonators.

Despite its small size, Dr. Nguyen said the tiny vibrating element within his resonator is robust enough to withstand even the



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# Sessions: The Evolution of an Ever Deeper Disc

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frame with a talking head on it has very little  
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ments of the head, eyes and mouth, perhaps. The  
rest remains the same, so such a frame compresses  
well. Since a DVD pumps out the same amount of  
data from second to second, this gives MPEG-2 some  
spare bandwidth to devote to, say, audio quality.

In loud explosion scenes in action movies, on the  
other hand, the picture varies a lot, but the quality of  
the sound is less vital. The audio track uses a  
perceptual coding that removes elements from the  
soundtrack that the human ear can't hear under the  
louder sound.

The high-quality images of a DVD movie often  
do not end up on the television screen. The best  
image is achieved by using component video cables  
between the DVD player and the television set, in  
which the signal is divided into the three basic colors  
a television uses.

But most televisions have only composite video  
(yellow-tipped RCA cables), which creates what Mr.  
Eggers describes as video soup, with all the color  
channels mixed into a single signal. That creates  
bleeding color on the screen, especially in the red  
and orange end of the spectrum.

For the best picture, it seems, most consumers  
would have to upgrade their television sets.

## Good Blockbuster in the Handy Take-Home Pack

or DVD, standard was developed in the mid-1990's, fueled by the electronics  
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improves on optical storage techniques developed for compact discs and also relies on a video  
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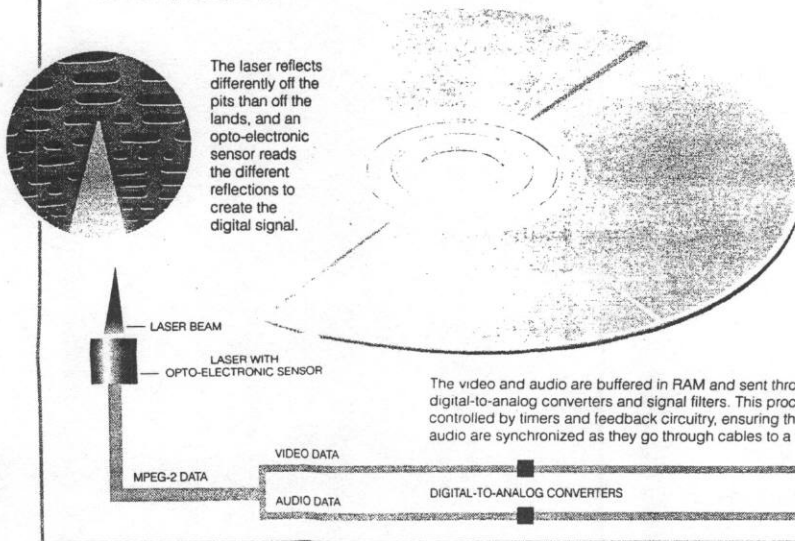
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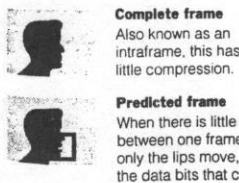
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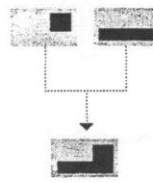
**3 Data processing**

Decoding MPEG-2 video is the most labor-intensive function in a  
DVD player, requiring a dedicated processor with lots of RAM.  
Among other things, the processor steps up the movie standard  
of 24 frames per second to the 30 frames per second a TV  
displays by repeating frames in a particular ratio.

**COMPRESSING THE DATA**  
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**Bidirectional frame**  
These use the  
previous and next  
frames as references,  
and interpolate the  
data to create the  
frame. These provide  
a lot of compression,  
but use much  
processing time.



The New York Times; illustration by Gurka Sampedro; photographs by Tony Conicola/The New York Times

WHAT'S NEXT

# making the Cellular Phone, One Component at a Time



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Despite its small size, Dr. Nguyen said,

current filters are still 80 percent to 90  
percent smaller than comparable SAW de-  
vices.

William Mueller, who acts as a liaison

# HARDWARE

## New DVDs Hold More

You'll be able to record almost twice as much data on a dual-layer DVD. **BY DON LABRIOLA**

If you thought the current crop of multiformat DVD±R/RW drives had finally resolved the long-standing rivalry between the DVD-Plus and DVD-Dash camps, guess again. The DVD+RW Alliance and DVD Forum may now both support high-performance 8X write-once and 4X rewritable media, but the battlefield has simply shifted to another front: dual-layer (DL) recording.

Unlike currently available single-layer media, which hold 4.37GB (about 4.7 billion bytes) of data, DL write-once discs can store a whopping 7.95GB (about 8.5 billion bytes)—matching the capacity of the dual-layer read-only discs used to distribute Hollywood movies. They provide nearly twice as much room for video productions and computer data, and make it possible to back up any dual-layer DVD-Video disc on a single piece of media.

Until a few years ago, most analysts considered it impossible to manufacture DL-recordable media that would work reliably with consumer DVD players. But as has been the case with most advances in DVD recording, the DVD Forum and DVD+RW Alliance now both plan to release proprietary versions of such a technology. Building on research at Philips and MKM (Mitsubishi Kagaku Media, the parent company of Verbatim), the Alliance has already launched its DVD+R DL format. A similar format developed at Pioneer Electronics promises to become the basis of the DVD Forum's imminent (but not yet named) dual-layer version of DVD-R. Although it's too early to know for sure, it's likely that both formats will be equally compatible with most late-model DVD players.

The two specifications have many minor technical differences, and use dissimilar mechanisms for addressing and locating data on the disc. But from an end-user perspective, the only obvious difference is likely to be their write speed. DVD+R DL will initially support 2.4X recording, but the Forum's dual-layer spec will probably run at 2X. Media prices are

not yet set, but they're likely to be similar for both Plus and Dash blanks, though dual-layer discs initially will cost much more than single-layer DVDs of equivalent speed. 4X versions of both formats are already in development.

To comprehend how dual-layer recording works, you first need to understand how DVD players access data on mass-produced single-layer discs. Read-only DVDs store information as billions of microscopic pits stamped in a spiral groove on the surface of a polycarbonate disc. The grooved side of the disc is coated with a reflective material like aluminum, which is then bonded to a protective plastic layer and label. When a laser is swept along the groove, a sensor monitors the amount of light bouncing off the reflective layer behind the pitted surface. Alterations in the beam that occur when it passes through a pit enable the drive to interpret the stamped pattern as a sequence of ones and zeros.

Blank recordable DVDs replace the pits with a blank stamped groove covered by a layer of heat-sensitive organic dye. A virtual pit is recorded by heating a tiny pinpoint of dye with a tightly focused laser.

This permanently changes the dye's physical characteristics at that point, giving it optical properties similar to those of a stamped pit.

Dual-layer media add a second recordable layer behind the first. The metallic coating of *Layer 0*, which is closer to the laser, is altered to become translucent, allowing the laser beam to pass through it when focused on the deeper *Layer 1*.

Producing such a disc may sound like a straightforward task, but ensuring that both recordable layers have the same optical properties as stamped pits was a monumental feat. Even after carefully tweaking parameters like the precise depth and shape of the recorded "pits," the thickness and chemical composition of each dye layer, and the ability of the metallic coatings to reflect or transmit light, first-generation DL media are still subject to constraints. Both formats, for example, require that data on *Layer 0* must be recorded before the corresponding position on *Layer 1* can be burnt.

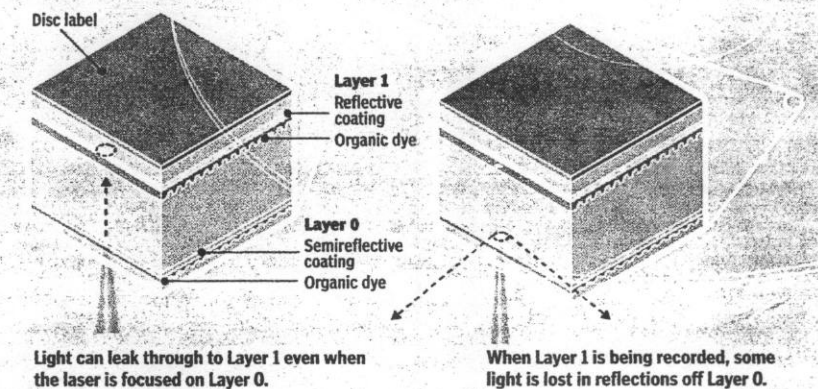
Recordable dual-layer media won't single-handedly revolutionize the DVD industry. But the technology is a giant leap in the continuing effort to make personal DVD recording flexible enough to handle any DVD application.

For an expanded version of this story, please visit [www.pcmag.com](http://www.pcmag.com).

*Don Labriola is a contributing editor and lead analyst in DVD technology for PC Magazine.*

### Recording Two-Layer DVDs

Producing a dual-layer disc may sound like a straightforward task, but ensuring that both recordable layers have the same optical properties is tricky indeed.





# Inside Recordable DVD

## How each of the four competing formats works

One of the first things people wanted to know when the Compact Disc (CD) was introduced was whether they would be able to record on it. At the time, that didn't seem likely. It was hard enough to make the things reliably in clean-room-equipped factories. Fortunately, demand has a way of generating solutions, and now, more than 15 years later, recordable CD has become commonplace.

When DVD came along, history repeated itself, but at a much brisker clip. A recordable DVD was in the plan from the beginning, with the result that you can already buy DVD-RAM burners for your personal computer and will soon be able to add a stand-alone DVD recorder to your A/V system. The reason behind this swift progress is that much of the R&D had already been done in the creation of the CD-R (write-once) and CD-RW (rewritable) formats. This has resulted, however, in not one or two recordable-DVD formats but *four*: DVD-R, DVD-RAM, DVD-RW, and RW (also known as DVD+RW).

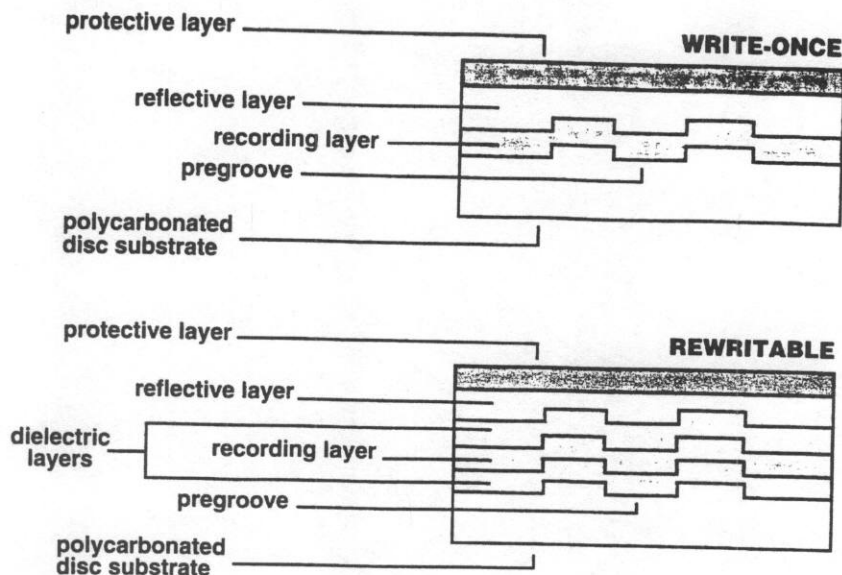
Having four formats was *not* part of the original plan, which called for a single write-once format and a single rewritable format, just as in the CD realm. And from a purely technical standpoint, there is no particular reason for it to be otherwise. The cur-

rent diversity arose mainly from political and economic considerations. Nonetheless, there are important technical differences among the new formats, and understanding them will help you make sense of where each might fit in your future.

Just as CD-R is essentially a recordable version of CD-ROM (read-only disc), DVD-R is a recordable version of DVD-ROM. Except for the difference in data density, CD-R and DVD-R are very similar. The manufacturing process starts with a clear, polycarbonate disc substrate into which is molded a spiral groove to guide the recording laser (see illustration on the next page). The groove is wobbled slightly to provide timing information. Next, the recording layer — a photosensitive organic-dye polymer — is sprayed onto the substrate. To improve the dye layer's reflectivity, a microscopically thin metallic coating is deposited on top of it, followed by a protective coating.

The key characteristic of the dye in the recording layer is that it becomes more absorptive when it is heated past a certain temperature, mimicking the lower reflectivity of the pits in a pressed CD. The recording laser in a DVD-R drive or recorder writes informa-

by Michael Riggs



DVD-R and the three rewritable DVD formats (DVD-RAM, RW, and DVD-RW) are very similar to the CD-R and CD-RW formats. The key difference between write-once and rewritable DVDs is the composition of the recording layer, which is typically sandwiched between heat-absorbing dielectric layers in a rewritable disc.

tion to a disc by burning a sequence of dark spots in the dye lining the spiral guide groove. The change in the dye's reflectivity is permanent, which is why DVD-Rs (like CD-Rs) can't be erased and reused.

Ironically, DVD-R recorders can't write CD-Rs unless they include a laser specifically for the purpose. That's because the dyes used must be optimized for the laser wavelength. Consequently, the 635-nanometer (nm) lasers used to record DVD-Rs won't work with the dyes designed for 780-nm CD standard. But the reflectivity of the dyes at their design wavelength is close to that of pressed discs, so it was relatively easy to make DVD-R compatible with ordinary DVD and DVD-ROM players. And the discs are less costly to manufacture than their rewritable cousins. Although the capacity of a single-sided DVD-R was 3.95 gigabytes (GB) when Pioneer introduced the format in 1997, discs with the same 4.7-GB capacity as single-layer pressed DVDs are now available.

### Rewritable DVD

All three rewritable DVD formats — DVD-RAM, DVD-RW, and RW — are based on the optical phase-change recording technology developed for CD-RW. The physical structure of the discs is similar to that of DVD-R, the key difference being in the composition of the recording layer.

The compounds used for phase-change recording transform from a crystalline structure to amorphous and back again de-

pending on how they're heated. Consequently, the laser in an optical phase-change recorder has to operate at three intensities: a low read power, a medium erase power that makes the recording material crystalline, and a high writing power that melts it into an amorphous state. Because the temperatures involved in writing are very high (500° C or more), the recording layer is typically sandwiched between dielectric layers that function as heat sinks. This is one reason manufacturing costs for rewritable phase-change discs tend to be higher than for write-once dye-polymer discs, which have a simpler physical structure.

The recording layer is more transparent when crystalline than when amorphous, allowing more light to reach the metallic reflective layer behind it. So except for its being reversible, the net effect of the writing process is the same as for DVD-R: creating spots of low reflectivity that are functionally similar to the pits of a pressed disc.

### DVD-RAM

DVD-RAM (so named for its random-access capability) has an unusual track structure, with premolded pits along the groove that are used to establish the exact physical locations of data recorded on the disc. Thus, the groove-wobble serves only as a timing aid for the drive controller. Promoters say that this system enables data to be managed in relatively small chunks, yielding better storage efficiency and error correction than alternative systems.

DVD-RAM is also unusual in that it records data both in the groove and on the "land" between (see illustration on facing page). This allows for a relatively wide groove pitch (distance between grooves), which proponents say makes it easier for drives to maintain correct tracking and to recover from physical shocks. These characteristics, together with the ability of DVD-RAM media to sustain more than 100,000 rewrites, make the format attractive for computer applications.

Unfortunately, DVD-RAM is incompatible with existing DVD-Video players, although future players could be made compatible if the demand were to arise. DVD-RAM discs were originally available with a single-sided capacity of 2.6 GB, with double-sided discs raising the total to 5.2 GB. The format has since been extended to allow standard 4.7-GB sides, and the use of short-wavelength blue lasers could increase capacity up to 15 GB. Because DVD-RAM discs require more care in handling than other discs, they're encased in plastic caddies similar to the housings for MiniDiscs and 3½-inch computer floppies. Recorders will accept the discs both in their protective caddies as well as bare. Double-sided discs cannot be removed from their caddies at all to prevent their surfaces from being handled and possibly damaged.

### RW: The Maverick

Beneath the placid surface of the consortium of manufacturers known as the DVD Forum still lurks the old rivalry — dating back to the days when a digital videodisc standard was still in flux — between the Sony/Philips camp and the pretty-much-everybody-else group that ultimately had the dominant say in determining the final DVD specifications. Unhappy both with some technical aspects of DVD-RAM and with having most of their own patents frozen out of it, Philips and Sony joined with Hewlett-Packard to develop the competing DVD+RW format, now known simply as RW because it's unsanctioned by the DVD Forum.

Like DVD-RAM, RW allows random-access operation, but it can also be operated in a sequential CLV (constant linear velocity) mode like that used for the various CD formats and DVD-Video. CLV enables higher data transfer rates than CAV (constant angular velocity), which is good for video but slows access when searching for data — one reason CAV is preferred for computer read/write storage media.



Another significant technical difference between the formats is that RW records only in the groove, not on the land. Consequently, the groove pitch has to be much tighter to achieve the desired data density. RW proponents say this allows for less expensive media and eliminates the need for the player or recorder to switch back and forth constantly between land and groove. DVD-RAM backers, on the other hand, cite it as a drawback, claiming that the tighter groove pitch is harder to track and that recovery is more difficult if the laser is momentarily knocked off course.

Finally, RW uses modulation of the wobble groove to establish data addresses instead of the pits used by DVD-RAM. Data must therefore be written and read in larger blocks on RW discs than on DVD-RAM. That doesn't matter particularly for audio or video, though it's arguably a drawback for computer data storage.

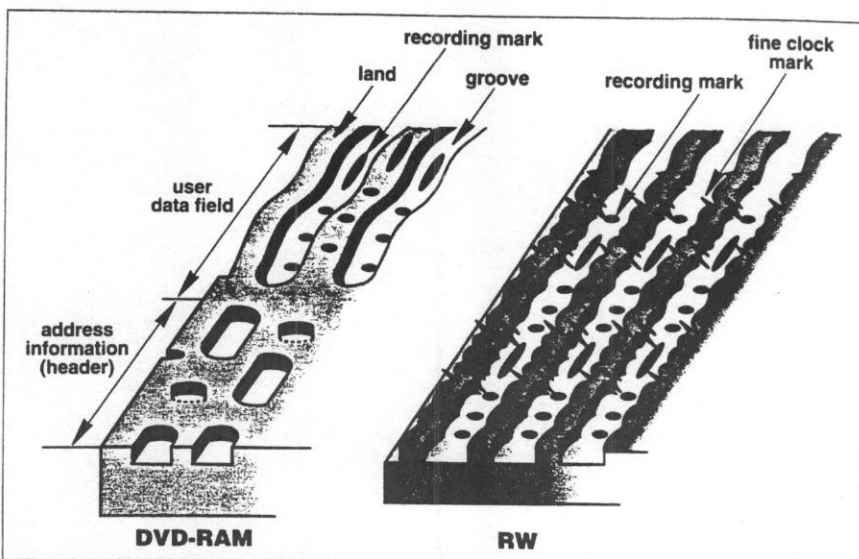
But the most interesting benefit claimed for RW is backward compatibility with existing DVD-Video players. That is, DVD-standard recordings made on RW recorders are said to be playable on almost any DVD player without modification. DVD-RAM and DVD-RW backers have been quick and vociferous in rejecting this claim, but Philips, RW's main advocate in the consumer arena, has been adamant on the point and has demonstrated it publicly.

### DVD-RW

Developed primarily by Pioneer, DVD-RW (or DVD-R/W) is a fairly direct descendent of CD-RW. Unlike the other two rewritable DVD formats, it is strictly a CLV system designed for streaming data and without true random-access capability. As in RW, all recording is in the groove and in relatively large data blocks. Moreover, Pioneer claims most existing players will be able to play DVD-RW discs.

Pioneer does allow that a handful of DVD-Video players may be confused by the lower reflectivity of the phase-change media and think they are looking at a conventional dual-layer DVD. But to the extent this proves to be a problem, it will most likely be limited to old and low-end players. Pioneer says DVD players that read ordinary dual-layer discs without a hitch should do fine with DVD-RW.

There seems little reason to think either RW or DVD-RW will have a substantial compatibility edge over the other. DVD-RW discs can be rewritten only about 1,000 times, as opposed to the more than 100,000 times claimed for DVD-RAM and



The DVD-RAM format records data both in the groove and on the "land" between, while RW records only in the groove.

RW, but that shouldn't be an obstacle to adoption in ordinary A/V applications.

### Where We're Headed

There are basically two markets for recordable DVD: computer storage and A/V recording. All of the formats can be used for both, though each has its strengths and weaknesses. DVD-RAM seems well suited to computer applications, and in that realm it currently has all the momentum. It is the only rewritable DVD format for which drives are now available in the U.S. The rollout of RW in the computer market has been slowed by Sony's decision to essentially back out and concentrate on a higher-capacity, blue-laser-based format that could handle high-definition video data (still years away) as well as by Hewlett-Packard's announcement that it would skip introduction of 3-GB drives, waiting until it could deliver 4.7-GB devices.

The other RW partner, Philips, seems to be concentrating on the home A/V market, with its announced intention to market stand-alone RW video recorders sometime this year. Meanwhile, Pioneer and Panasonic have announced competing recorders based on the DVD-RW and DVD-RAM formats, respectively. (Pioneer says the U.S. version of the recorder it has already introduced in Japan will also support DVD-R recording.) All are treading gingerly, however, in deference to the movie industry's copy-protection concerns, which have significantly slowed the introduction of such devices (see "Judgment Day," page 90).

None of the announced recorders has any sort of digital video input or output, which means it won't be possible to make a digital link even from a DV camcorder.

All recording, including from camcorder tapes and DTV, will have to be through NTSC-grade analog inputs. Presumably there will eventually be agreement on a secure data-exchange system over the IEEE 1394 (FireWire or i.Link) interface, which would open the way to digital A/V inputs on DVD recorders. Even then, however, high-def DTV signals will have to be transcoded down to the 720 x 480-pixel DVD standard (not such a big deal, as the difference between that and higher resolutions is hard to see except on very large screens).

Which format will win out in the consumer A/V market remains to be seen. The backward compatibility of RW and DVD-RW is a definite advantage. In the end, however, the key may be which (and how many) manufacturers line up behind which formats — a consideration that gave VHS a big edge over Beta 20 years ago. The situation might even wind up mirroring the current CD recording market, where the write-once CD-R format dominates because the blank discs are much cheaper than rewritable CD-RWs. (As we went to press, a report appeared that manufacturers might produce a "DVD-3" player capable of playing all three "official" formats: DVD-RAM, DVD-R, and DVD-RW.)

Which one *should* win? I don't know that it matters much to consumers. Any of the four formats could do the job. What I would like, however, is something nobody seems to be talking about: a TiVo- or ReplayTV-type device with a built-in DVD recorder for editing down and archiving the handful of broadcasts I might want to keep for an extended period, watch in another room, or lend out. That would be the best of all worlds.

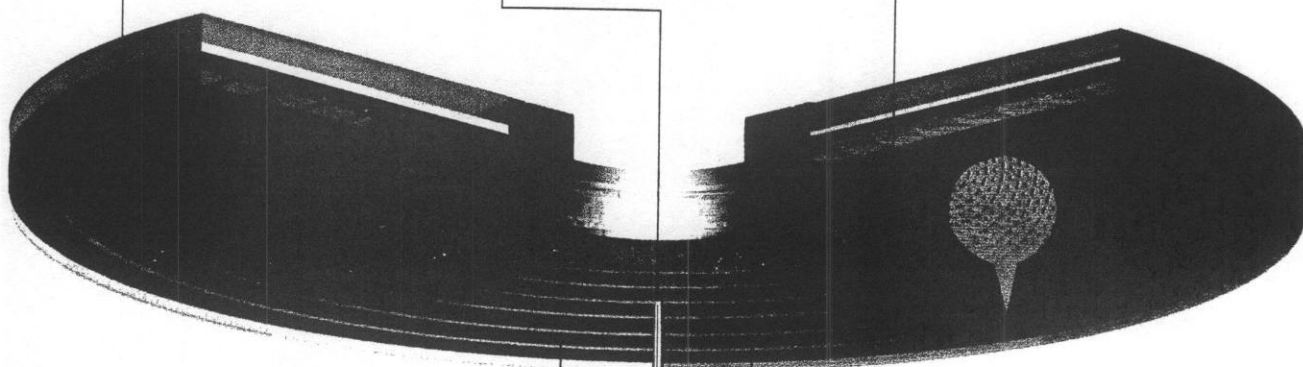
ILLUSTRATION BY ROBERT SANIORA

**DVD Burners** pack seven times as much data as a CD can hold onto a disc that's the same size. The higher-density storage is made possible by the burner's red laser, which uses a much smaller wavelength of light than a compact-disc burner's. This beam can write up to 4.7 gigabytes of data—enough to store a two-hour movie or more than 13 hours of music—on a single-sided digital video disc. The lasers on some DVD burners can be adjusted to a lower power to allow data reading or rewriting, but that capability depends on the burner and the disc. Although there are many DVD formats, two of the most common are DVD-R (readable) and DVD-RAM (random-access memory). **TEXT AND ART BY REBECCA PERRY**

**FROM THE BOTTOM:** DVDs are written and read from below. A grooved track in the disc serves to guide the laser as it travels in a spiral from the center to the outside edge.

**LASER:** DVD burners use a laser that emits light at 650 nanometers—as opposed to 780 nanometers in CD burners. The DVD beam allows for more compact storage.

**SEEING SPOTS:** The laser burns spots into the DVD's recording layer, creating a pattern of low or high reflectivity that represents the 1s and 0s of digital data.

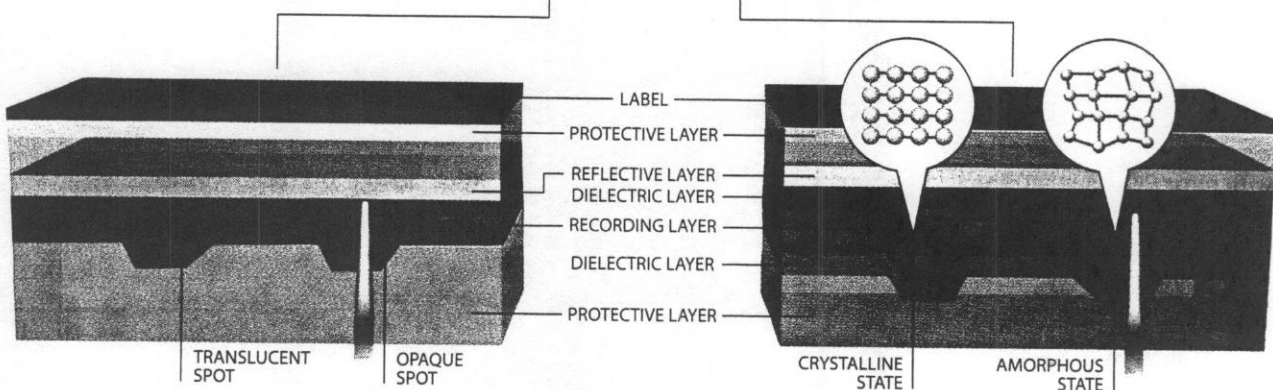


**DVD-R: WRITE IT AND KEEP IT**

DVD-R discs contain a dye in the recording layer. During recording, the laser strikes the layer and the dye changes its reflectivity at the point of contact, which becomes an opaque spot, or a 1. Areas the laser does not contact remain translucent, representing 0s. A DVD-R disc is written once for permanent storage and is compatible with most of the players on the market.

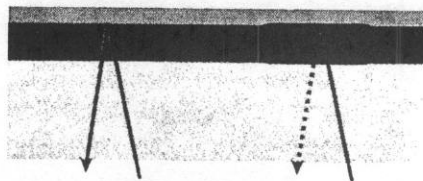
**DVD-RAM: WRITE, ERASE, REWRITE**

DVD-RAM uses a phase-change material to store data. The material is normally crystalline and reflective. A laser can change its atomic structure, producing amorphous, less reflective spots, or 1s. At low power, the same laser erases the disc by melting the material, while "dielectric" layers above and below cool it back into the crystalline state. A DVD-RAM disc can be written and rewritten up to 100,000 times.



**READING DVD-R AND DVD-RAM**

**READING 0:** A low-powered laser reads patterns burned on a disc. Where no spot has been recorded, the laser beam reflects back at full intensity. This light is read by a detector in the DVD player and converted by software into a 0.

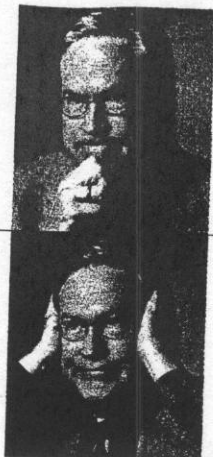


**READING 1:** When the laser beam hits a spot recorded in the dye or phase-change material of the disc's recording layer, less light reflects back to the detector in the DVD player. The software interprets this as a 1.

SOURCE: TONY JASDOWSKI/PANASONIC TECHNOLOGIES



# Inside Track



JOHN C. DVORAK

**O**penOffice Appears Dept.: Much of the recent buzz among computer users has been around the release of the **all-free** office suite OpenOffice.org 1.0, available for download at [www.openoffice.org](http://www.openoffice.org). This open-source spin-off of Sun's StarOffice might become the **biggest threat** yet to the Microsoft Office suite monopoly.

I still give out copies of Software602's popular office suite 602Pro PC Suite 2001 ([www.software602.com](http://www.software602.com)) to people who ask me for free software, but the first release of OpenOffice with the presentation graphics module is **impressive**. Microsoft should be extremely concerned, and I assume the company will find some way to **break this software**, perhaps with a service patch to Windows XP that "accidentally" causes weird problems. This will have to be subtle, lest it draw attention to the tactic.

**The problem for Microsoft** is that open-source code problems get fixed rather quickly by hordes of eager programmers. This has been the case with Linux servers, and OpenOffice should be no different. Microsoft has only a few alternatives.

First, it can **make Office more powerful** and interesting. The problem is that the suite's feature set is full, and now others are copying it. Little can be added.

**Another choice** is to lock down Office by **integrating it tightly** with the OS so that nothing else runs. But that would risk Microsoft's OS cash cow. People might actually dump Windows if the company did that.

**A long-shot approach** is for Microsoft to make the doc format **even weirder** and patent it. This could annoy traditional users, though, who might then flock to the "more compatible" OpenOffice.

The only workable strategy I see is for Microsoft to take a hit and **give away Office for free** until the OpenOffice.org folks dry up and go away, which may take longer than Microsoft wants to wait.

And let's not forget **the problem of association**. If OpenOffice runs beautifully, users may begin to associate open-source software with high quality and gravitate toward Linux and other open-source products. If Microsoft finds ways to **keep breaking the software** and forcing users to upgrade continually, they may get fed up with the irritation. Microsoft may have foreseen the need to do this. Perhaps that's why the company wants users to accept auto-updating with Windows XP.

**The final possibility** is that the OpenOffice folks themselves **will flake out** and begin to make too many updates for every little bug or start **splintering** into competing entities with random versions of the software and thus lose focus. Most companies that have tried to compete with Microsoft ended up shooting themselves in the foot with no help from Microsoft.

If nothing else, I suspect that **Sun's StarOffice suite is toast**. When Sun first got into the office-suite game, I predicted that the company would somehow blow it. Sun has no inkling of what it takes to sell software.

**What's with 48X CD-R Burners? Dept.:** It's been interesting to watch the evolution of the CD-R recorder. Everything began when someone came up with the idea that you didn't need to burn a pit into a CD to make a writable CD. All you needed to do was make something that **looked like a pit**. A gob of goo or a change of color would do.

This led to the development of **three separate CD-R worlds**. The inventor of the technology was **Taito Yuden**, with the cyanine-disk strategy. The medium was the original write-once disks—emerald green or cobalt blue—and the early ones still provide the most compatibility, in my experience, with older CD audio players. The early versions of this technology are believed to have a short life of 20 years or so. With later implementations, this has been improved to 70 years.

Taito Yuden licenses the technology to



**If OpenOffice runs beautifully, users may begin to associate open-source software with high quality.**

just about everyone. I have seen it produce disks with 32X write speeds, and there may be faster formulations. Most of the TDK disks found at Costco are cyanine.

Then came **Mitsui Toatsu** with its phthalocyanine disks. These are the popular disks with a light-greenish-yellow hue. This technology has also been licensed to just about everyone. Most of the **ultra-cheap** disks you find at Best Buy are of this type. They are supposed to last 100 years.

The newest technology is the secretive **Azo** formulation developed by **Mitsubishi**. This disk has a pretty sky-blue appearance. Azo is pushing the high-speed envelope, with Verbatim licensing the technology and promoting 40X and 48X write speeds. I expect even higher speeds as companies such as Plextor and TEAC make high-speed writers. Azo disks are also supposed to last 100 years, and they are currently considered the premium disks.

CD-R drives have to account for all the variations, and that's where compatibility problems occur. If you have an **old CD-R disk** that doesn't load fast, I'd consider making a new copy. Mucking up the scene are some Asian dye makers that have created variations of the licensed technologies. Their disks may not work well in all writers.

From my perspective, the writable-technology wars have begun in earnest.



## JOHN C. DVORAK

**A**s those who read my columns regularly know, I've been hoping that **Adobe would port Photoshop to Linux**. After talking with various folks, I've found out that that likelihood is minimal, at least in the short term. Apparently, Adobe CEO John Warnock (and thus the company) is **not a fan** of the open-source movement, and the sudden emergence of Ghostscript—an open-source PostScript—may be part of the reason. And according to Chris Warnock, Adobe had already ported Photoshop to Solaris and one other Unix platform and got nearly **zero sales** for its efforts. Twice burned, thrice shy.

In the meantime, we should expect to see Photoshop 7. Having seen the features of the new version, I can assure you that the product will remain **entrenched** as the king tool in the professional realm. It's mind-boggling.

**Other feedback** I received regarding my recent Linux columns included numerous **complaints** that Linux needs to have a serious stable of games. Many hot games are now written for the DirectX API. Can't the open-source movement create a DirectX clone for Linux? Maybe.

The Canadian company **TransGaming Technologies** recently released WineX, which lets a lot of Windows-based games run under Linux. The popular game Max Payne, for example, runs on Linux using WineX. Apparently, TransGaming also **optimizes** many popular games for Linux. They're worth checking out, at [www.transgaming.com](http://www.transgaming.com).

**Battle Lines Dept.:** An interesting battle is brewing in the tape-backup arena, as the Linear Tape-Open (LTO) consortium led by IBM (with Hewlett-Packard and Seagate as codevelopers) begins to dominate the industry. It has rolled over the Digital Linear Tape (DLT) folks (Quantum Corp.) and appears to have staved off the Quantum SDLT products.

In fact, under the cobrand name Ultri-

um, **a million LTO drives shipped in their first year** on the market. This is all-cartridge technology that holds 100 to 200 gigabytes. Quantum drives hold 10 percent more data but do not perform as well as LTO drives.

I should note a number of factors. DLT drives still represent the majority of such devices, and the SDLT offering is fully compatible with old cartridges. LTO is new. Also amusing is that Compaq subscribes to SDLT for its servers, although Hewlett-Packard codeveloped LTO. It will be fun to watch the **merger fallout** over that issue.

My advice on these products is simple: **Fret over it**. Unless you've already committed to DLT, I'd go with LTO. Personally, I've always **preferred** the subsystems that used standard 8-mm or DAT (4-mm) tape because of their raw access speed. New standards such as AIT-1 and now AIT-2 seem to offer incredible **capacity and performance** that is impossible to beat (AIT-3 is coming out later this year). They also require less power and less rack space.

Unfortunately, these products will become niche at best, since IT shops prefer the **data integrity** of linear recording. Helical-scan heads make some people nervous. The preference harkens back to the days of reel-to-reel.

The AIT-2 recorders can no longer use easy-to-find standard media: They need media with a chip in the cassette. I've heard the claims of higher quality for "special media." I've found such tape makers' **claims dubious**. I like to cite the special tape for Hi-band 8-mm (powdered metal) and Super VHS technologies. There seemed to be **no difference** between these tapes and regular high-grade tapes except in the lone case of the evaporated-metal Hi-band 8-mm tape. The AIT-2 8-mm cassette costs \$100, which is as expensive as the SDLT cartridge. **Imagine the interest** if you could the cassette for \$20.



**An interesting battle is brewing in the tape-backup arena, as the Linear Tape-Open consortium begins to dominate the industry.**

**So what do I do now for personal backup?** Mirroring. For individual users, my advice is to **buy another hard drive** and mirror a backup on that. It's a lot cheaper than any other method. Archive stuff on a **DVD+RW** drive. You'll worry less about performance and backward compatibility too.

**Genuinely Interesting Hardware Dept.:** This is one of those ideas that I wish I had thought of: the X-Arcade game controller. For \$199, you get what looks like the **top of a real arcade machine** with two joysticks and various selection buttons—just like the big round ones found on arcade machines.

This incredibly rugged and industrial-strength unit doesn't just look like the top of an arcade machine; it obviously is **the top of an arcade machine**. And it looks as though it's built by the same folks who make arcade tops. The only difference between the X-Arcade and a typical arcade top is that the X-Arcade has **a lot more buttons**, all programmable, so the device can work with any PC game. Adapters let it work with all the consoles, too.

You have to see this device to believe it. **It's huge** and built like the proverbial brick outhouse—indestructible. It gets my **highest recommendation**. Contact X-gaming at [www.x-arcade.com](http://www.x-arcade.com), or call the company at 866-942-6464.





## INSIDE TRACK

BY JOHN C. DVORAK

# A

**stonishing Technology in the Palm of Your Hand Dept.:** This September marks the 50<sup>th</sup> anniversary of the now ubiquitous hard drive technology. It made its first appearance in IBM's RAMAC 305 vacuum-tube computer in 1956, toward the end of the vacuum-tube era. The hard drive, dubbed the IBM 350 Disk File, was a 5-megabyte (or so) drive that required **50 24-inch platters** spinning at 1,200 rpm. The device, which can be seen in various museums, is about **the size of a walk-in freezer**. It weighed 2,150 pounds. Nobody would have expected that such a monster would have evolved into the fast, efficient, high-capacity devices we have today. The continued improvements are especially impressive, in view of these being mechanical/magnetic devices, not just ever-shrinking silicon chips.

Alan Shugart, the ex-IBMer credited with inventing the floppy disk, was the first to invent and popularize the small-form factor hard drive—5.25 inches back then—that ended up on the desktop computer. The 5MB ST-506 was introduced in 1979. His company **evolved into what is now Seagate**.

Over 200 companies have manufactured hard drives at one time or another. Now there are **fewer than a dozen** major players. The competition is extreme. Curiously, the legacies of both IBM and Shugart are still alive, in the form of Hitachi and Seagate.

I recall numerous pioneering companies making one misstep or another and landing in bankruptcy, the business being so harsh. The industry is also filled with all sorts of lore, including stories of companies filling warehouses with **boxes containing bricks to fool auditors**.

Over the course of these years, hard drives were habitually pronounced either dead or at the limit of what they could hold. But they kept on doubling in capacity like nothing we've ever seen. They have even **outpaced Moore's Law**.

The only way I can account for this happening is that it was **inspirational to engineers**, who kept seeing ways to make improvements with each iteration of the technology. And this phenomenon has never ended.

I had a long chat with the folks from Hitachi, the inheritors of the IBM legacy, about the hard drive's anniversary, and the engineers there expect that we will see a **1-inch terabyte disk** within the next decade or so.

Here are some fun facts worth chatting up.

Around **three billion hard drives** were shipped in the first 50 years. One research company expects that the next three billion will be shipped within just five years.

Over the past 50 years, areal density—the measurement of how much data can be crammed on an inch of disk space—has increased by **a factor of 50 million!**

The RAMAC disk that I mention above cost \$10,000 per megabyte, or about \$10,000,000 per gigabyte. Today, a gigabyte of storage on a 3.5-inch hard drive can cost less than 50 cents.

In a recent paper, the University of California, Berkeley estimated the total data stored on magnetic media worldwide in 2005 to be 99.5 exabytes,

***Over the past 50 years, areal density—the measurement of how much data can be crammed on an inch of disk space—has increased by a factor of 50 million!***

compared with 7 exabytes in 2000. (An exabyte is **1.074 billion gigabytes**.) Of all new data created, 92 percent is stored on magnetic media, primarily hard drives.

The first 2.5-inch hard drive for notebook PCs was introduced in 1991 and stored 63MB of data. Today's 2.5-inch products hold up to 160GB and are **60 times as shock-resistant**.

The latest thing going on with hard drives is the perpendicular-storage technologies, an idea I first heard about in the 1980s. All the main drive makers are switching to this technology, which will immediately double the capacity of the current drive lineup. The magnetic information is stored **upright on the platter**, meaning more data can be crammed into a smaller space. According to Hitachi, all new drives will employ this methodology within the next year or so. After it saturates the business, the next barrier to face will be something called the *superparamagnetic effect*, which might be described as magnetic interference from adjoining magnetic charges. Hitachi expects to overcome this with a technology called *patterned media*. This requires a specially processed platter with **uniform islands of data cells**. Exactly how this platter will be made is a mystery.

Now is a good time to give a toast to the hard drive and start filling the terabytes you'll soon have on your desktop. Congratulations to everyone in this wild business. Happy 50<sup>th</sup>. □

### » WANT MORE DVORAK?

John writes a weekly column for our Web site, too. [go.pcmag.com/dvorak](http://go.pcmag.com/dvorak) You can e-mail him at [pcmag@dvorak.org](mailto:pcmag@dvorak.org)

Exactly what  
does make the  
new players  
and discs tick?

# Inside &

When DVD appeared in early 1997, it didn't take much prodding for people to trash their collections of primitive VHS tapes and embrace the shiny new disc. The dramatic boost in picture and sound quality had a lot to do with it — when experienced on a widescreen TV along with 5.1-channel sound, watching a DVD was almost like sitting in a movie theater. And all those cool extras and audio commentaries didn't hurt.

Nine years later, we're about to get our first taste of DVD's even higher-quality successors, HD DVD and Blu-ray Disc. There are plenty of fine points separating the two formats, but both can deliver an unparalleled home theater experience — one that combines high-def pictures with high-rez 7.1-channel audio formats developed especially for these discs. And the advanced interactive features that both Blu-ray and HD DVD bring to the table will make the extras we currently enjoy on DVD

look like kid stuff. With so much going for each format, it'll be hard to choose which machine to take home — but most folks will make that decision based on how many movie titles become available for each over the next few years. After all, a player is just a player, but content is king.

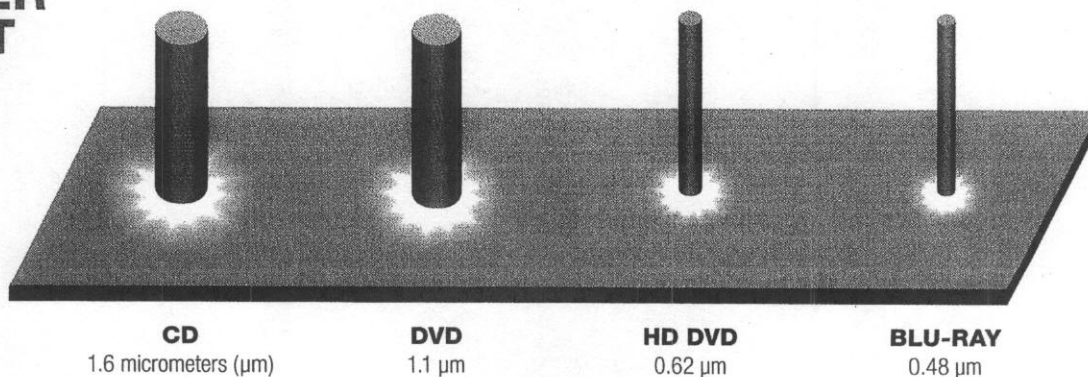
### GETTING PHYSICAL: THE DISCS

The new high-def discs are decidedly different creatures than DVD. Most important, they won't work in a DVD player (both HD DVD and Blu-ray players, on the other hand, can handle regular DVDs and CDs). But both types of disc are 12 centimeters in diameter — the same as DVD. And an HD DVD has the same physical construction as a DVD, with two 0.6-mm substrate layers (only the top one contains data) bonded to make a single disc. Blu-ray discs, in contrast, have a single substrate with

the data layer residing close (a mere tenth of a millimeter away) to the bottom surface. Since this proximity makes the data layer susceptible to nicks and scratches, the initial Blu-ray design called for a protective caddy — an idea that was eventually scrapped when a scratchproof coating was developed.

A newly developed blue laser, with a shorter wavelength than DVD's red laser, allows both formats to store a lot more data on a disc. (See the diagrams below and on page 47.) An HD DVD can hold three times as much as a DVD, while the even smaller beam spot size in Blu-ray players enables those discs to hold five times as much. As with DVD, multiple data layers allow even more information. For example, a dual-layer HD DVD can contain 30 gigabytes of data, enough to hold up to 8 hours of high-def video — plenty of room for the entire *Terminator* trilogy. And depending on what type of encoding is used, a

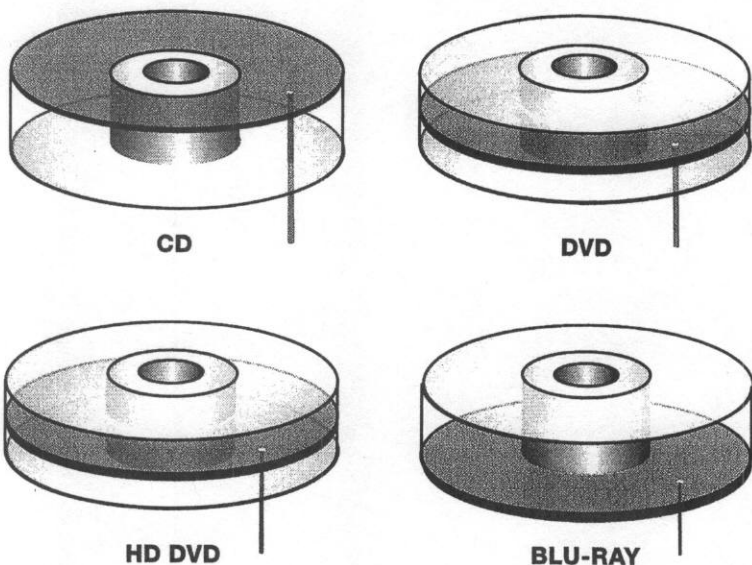
## LASER SPOT SIZE



ILLUSTRATIONS BY DIMITRY SCHLODINSKY



## HOW THE LASER READS THE SURFACE



With CD, the laser goes through the bottom layer of the disc to read the information on the bottom of the top layer. With both DVD and HD DVD, it reads the bottom of a middle layer. With Blu-ray, it reads the bottom layer — which is why Blu-ray Discs require a special protective coating.

50-GB dual-layer Blu-ray disc could handle all three installments of Peter Jackson's *Lord of the Rings* cycle!

Of course, this massive storage capacity will matter most when Blu-ray and HD DVD recorders begin to appear over the next year or so. By then, you can expect to see even higher-capacity discs. The HD DVD camp is working on triple-layer discs that can hold 45 GB of data, and a dual-sided disc that doubles that amount. Meanwhile, Blu-ray has already demonstrated a 100-GB multilayer disc.

Both HD DVD and Blu-ray use Advanced Access Content System (AACS) copy protection. This bit of digital number-crunching works behind the scenes to prevent anyone from distributing pristine high-def copies of movies over the Internet. But AACS's Mandatory Managed Copy feature *will* let you copy discs to a Media Center PC or a home server for distribution over a local area network. You should also be able to copy movies to a portable video player like an iPod or an Archos mobile DVR.

### IMAGE IS EVERYTHING

Most people would agree that DVDs look great. So why do we need a new disc format? Here's one excellent reason: both Blu-ray and HD DVD discs have enough capacity to contain high-def video versions of movies. To put this in perspective, the picture from a DVD is made up of around 345,000 discrete picture elements, or pixels. But the images in the HD DVD or Blu-ray high-def versions of that same movie can have more than 2 million pixels — a fivefold increase in resolution!

High data-transfer rates don't only deliver remarkably crisp images. They also give both formats the potential to deliver more solid, stable-looking high-def pictures than those on cable, satellite, and broadcast TV. While broadcast HDTV channels send data at 19 megabits per second (Mbps) and DVD maxes out at 10 Mbps, the maximum data-transfer rate for HD DVD is 36 Mbps, while Blu-ray can go up to 48 Mbps.

Also, along with standard MPEG-2

compression (the format currently used for DVD authoring and HDTV broadcasting), both HD DVD and Blu-ray support MPEG-4 AVC and Microsoft's VC1 compression. These advanced codecs were designed with high-def in mind and are much more efficient than MPEG-2.

It will be up to individual studios to decide what combination of compression scheme and data-transfer rate ultimately works best for its releases. Sony Pictures, for example, has committed to sticking with MPEG-2 in its initial Blu-ray titles, claiming better image quality at the 18 Mbps data-rate they've settled on for those discs. (See "Tech Talk," page 98, for more on this.)

Beyond mere specs, another reason why it's time for high-rez discs is that more and more regular people — not just early adopters and gearheads — are upgrading their old tubes to swanky new HDTVs. According to the Consumer Electronics Association, U.S. sales of digital TVs and related products in 2005 increased 60% over 2004. It might be easy to get high-def programming via broadcast, cable, and satellite TV, but the number of high-def movies in circulation has been pretty limited. HD DVD and Blu-ray are about to change all that.

### AUDIO ADVANCEMENTS

Both Blu-ray and HD DVD players will put out signals in the standard Dolby Digital and DTS formats. But there's new audio excitement brewing, with Dolby Digital Plus debuting on both formats. DD Plus is an enhanced version of Dolby Digital, able to deliver up to 7.1 discrete audio channels as well as higher audio-bit transfer rates (3 Mbps on HD DVD and up to 4.7 Mbps on Blu-ray).

Two more audio formats we'll be hearing on both HD DVD and Blu-ray are Dolby True HD and DTS HD Master Audio. While both can provide up to eight discrete channels, like DD Plus, they use 24-bit encoding and a 192-kHz sampling rate to deliver increased resolution. And both up the ante for data-transfer rates — 18 Mbps for Dolby and 24 Mbps for DTS — and use "lossless" digital coding that allows for bit-for-bit reconstruction of the original audio signal.

There is a downside, though. While the new discs will remain compatible with current gear by defaulting to stan-

standard DD and DTS bitstreams through the regular digital audio output on your player, you'll need to upgrade your digital surround receiver to one with an HDMI connection and enhanced decoding to experience the new audio formats in their full 8-channel, high-res glory.

### INTERACTIVE EXTRAS

Everybody seems to like DVD extras, whether they're behind-the-scenes features on special effects or Easter eggs unlocking previously unknown treasures. (Although some of these "treasures" might even be unwanted, like the deleted scene on the *Boogie Nights* Special Edition disc revealing actor John C. Reilly's butt.) Happily, both HD DVD and Blu-ray are poised to take extras to interesting new heights. One reason is the sheer storage capacity of both formats. Along with a high-def movie, a single-layer Blu-ray or HD DVD can hold many hours of standard-def video features. But a bigger reason is the new interactive systems designed to exploit the players' data connections.

Most people won't care what flavor of interactivity a player uses because they'll get to experience the same cool stuff regardless. For instance, multiple video and audio streams will let you watch the director commentary via an onscreen overlay while the movie runs in the background. You'll also be able to navigate onscreen menus and perform chapter searches without stopping the movie. And if your player is hooked up to a home network, you'll have access to related Web links, games, and online shopping features.

HD DVD's interactivity specification is called iHD, while Blu-ray uses Blu-ray Disc Java, or BD-J. The main difference is that iHD, which was developed by Microsoft and Disney, is based on XML (Extensible Markup Language), a text-based format that allows a wide range of data to be easily exchanged over the Web. BD-J, meanwhile, is based on Sun Microsystems' Java, an environment that, interestingly enough, was originally created for use in home-entertainment devices.

Microsoft — an exclusive backer of HD DVD — holds a secret weapon in the format war, since it plans to make its forthcoming Windows Vista operating system iHD-compatible. This no doubt sweetens the deal for computer companies, who will have to pay royalties to incorporate third-party software support for Blu-ray disc drives. (Not surprisingly, computer maker HP, which had previously thrown its weight behind Blu-ray, recently decided to support both formats.) Toshiba has announced that its first two HD DVD players — the HD-AX1 and HD-A1 — won't handle the full suite of iHD interactivity when they go on sale. But the company has said it will eventually make a firmware upgrade available so first-gen players can take advantage of all the interactive features on HD DVD releases.

### THE HOOKUP

You'll be happy to know that you won't have to use new types of connectors with an HD DVD or Blu-ray player: they'll be compatible with your current equipment. Both players will fea-

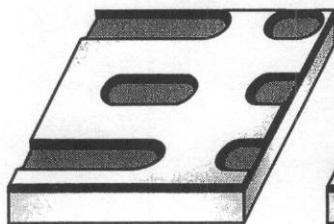
ture digital HDMI connections for newer HDTVs and analog component-video connections for older ones. They'll also have standard composite- and S-video jacks, although the best video resolution you'll get from these is a standard 480i (interlaced) signal. On the audio side, there'll be HDMI, coaxial, or optical digital connections and analog 6-channel and downmixed stereo outputs.

But other connection options — including USB, Ethernet, and RS-232C — reveal the players' networking capabilities. The USB and Ethernet jacks will let you connect a Blu-ray or HD DVD player to your home network to go online or retrieve music, pictures, and video files from a desktop PC. But you won't have to make a networking connection to use the players, since they'll continue to perform basic disc-playing duties even in an "unwired" state.

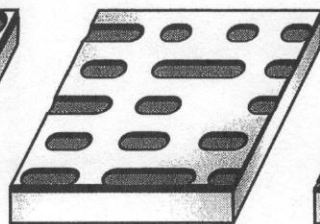
### WHAT WORKS, AND WHAT DOESN'T

Since both HD DVD and Blu-ray players are backward-compatible with current TVs and audio gear, you shouldn't have any trouble making one work with your system. But there are a few caveats. First, AAC copy protection gives movie studios the option to "down-rez" high-def video passing through a player's analog component-video output. This feature, called Image Constraint Token, is triggered by a digital flag embedded on the disc and reduces picture resolution to 960 x 540 pixels — a 50% decrease in detail. How aggressively studios decide to use the Image Constraint option remains to be seen, but, if implemented,

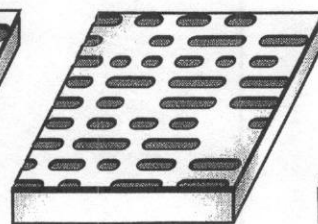
## DISC SURFACE



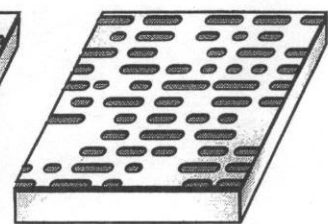
CD



DVD



HD DVD



BLU-RAY

Both HD DVD and Blu-ray Disc use significantly smaller data-carrying pits than those of DVD and, especially, CD. This allows much more information to be packed onto the disc surface.



it would disenfranchise early HDTV adopters whose sets don't have HDMI — the very same group who will be first in line to buy Blu-ray and HD DVD players! Of the studios planning high-def discs, Blu-ray backers Sony, Disney, Fox, MGM, and Paramount have all stated that they don't plan to use Image Constraint on their discs unless piracy becomes a problem.

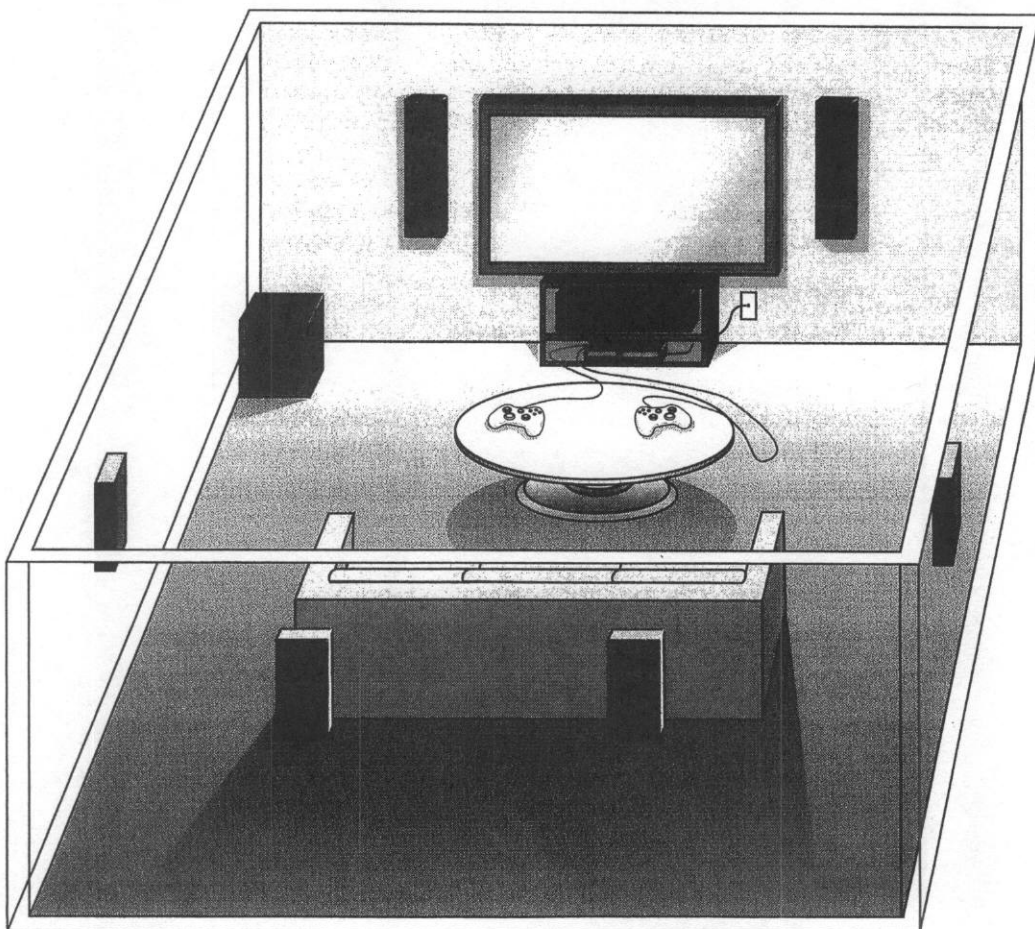
A second issue is that most current HDTVs — including the new breed of 1080p projection and flat-panel sets — can't accept 1080p-resolution video via an HDMI connection. That means most people won't be able to take advantage of the super-high-rez picture quality on many of the discs. This isn't an immediate problem with HD DVD, since first-gen players can only deliver 1080i- and 720p-format signals. But it is a limitation for Blu-ray, since most of its titles

will be mastered in 1080p, and virtually all of the players are capable of native 1080p output. Fortunately, Blu-ray players also provide a 1080i output for compatibility with almost all current HDTVs.

A third issue involves the version of HDMI on most first-gen HD DVD and Blu-ray players and current A/V receivers. To fully experience Dolby True HD and DTS HD Master Audio, you need HDMI version 1.3 — but that specification hadn't been completed as of early 2006. So, even though these formats were designed specifically for Blu-ray and HD DVD, the HDMI jacks on early players can't pass their signals on without some form of downsampling or transcoding. With some discs, however, including Sony's first round of Blu-ray releases, you'll be able to use a multi-channel analog connection to hear an

uncompressed PCM version of a movie's soundtrack.

**W**e could all do without another format war. But given the huge number of corporate interests involved — which include videogame and computer hardware and software companies along with consumer-electronics manufacturers and movie studios — war was all but inevitable. Both sides are bound to do a lot of hyping and swiping, but when you enter your local electronics emporium to check things out, just remember: Both formats are spec'd to deliver a remarkable home theater experience, surpassing that of both DVDs and much of the HDTV programming on cable and satellite TV. With those credentials, they've both got to be good. **S&V**



## THE NEW DIGITAL LIVING ROOM

Blu-ray Disc and HD DVD will dramatically change your home theater experience. Players for both formats can be jacked into your home network, and you'll be able to hook up game controllers directly to some players. Also, both HD DVD and Blu-ray provide high-resolution 7.1-channel sound in the new Dolby True HD and DTS HD Master Audio formats.

# Cover Story:

## Blu-ray Strikes Back

# The Second Contender in the Next-Gen Format War Comes Out Swinging

by Scott Wilkinson

In the struggle to become the next optical-disc format, Blu-ray Disc (BD) suffered the first blow as HD DVD launched in April to generally good reviews, at least in terms of picture and sound quality. (The slow-as-molasses behavior of the Toshiba player was another matter; see our comprehensive coverage

of HD DVD's introduction and review of the Toshiba HD-XA1 in Issue 69.)

Now, it's Blu-ray's turn. The first player to become available in the United States is Samsung's BD-P1000 (\$1000), which made its retail debut on June 25, 2006, though some stores jumped the gun and started selling it the week before. Eager

more following shortly thereafter. And of course, lots of additional titles will be released leading up to the holiday shopping season (see "Coming Attractions").

### What is Blu-ray?

Blu-ray was developed by an organization now known as the Blu-ray Disc Association (BDA), a consortium of companies that includes Panasonic, Pioneer, Samsung, and Sony, among others. Unlike HD DVD, Blu-ray was never submitted to the DVD Forum, an industry association that is responsible for all things DVD. Nevertheless, Blu-ray enjoys the support of almost every relevant consumer-electronics company and seven out of eight major movie studios (some of which are straddling the fence by releasing HD DVD titles as well). Interestingly, LG and Hewlett-Packard were originally staunch supporters of Blu-ray, but both companies recently shifted their position to neutrality.

As with HD DVD, there are three flavors of Blu-ray: BD-ROM (read-only), BD-R (write-once), and BD-RE (rewritable). The technical details of the format are best summarized in a table (see "By The Numbers"). DVD, HD DVD, and Blu-ray are implemented on discs measuring 12cm in diameter and 1.2mm thick, but that's where the similarity ends. Blu-ray was designed to maximize capacity and performance using a different disc structure than DVD. By

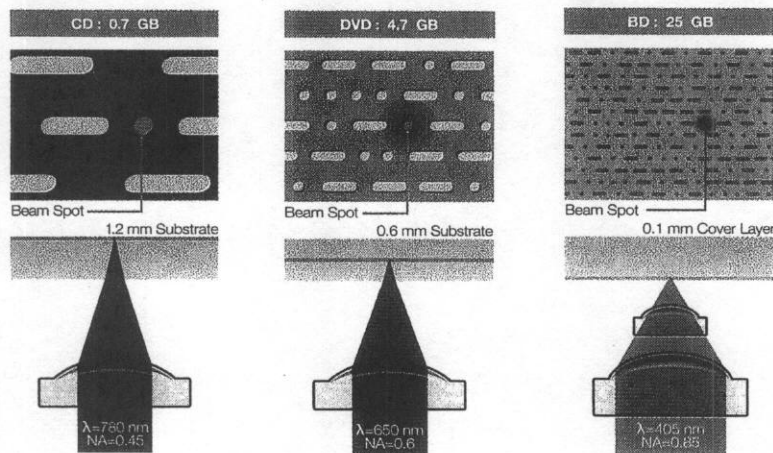


Figure 1. Blu-ray discs store their data under a protective layer only 0.1mm thick; the rest of the disc is supporting substrate. The lens rides much closer to the surface than CD or DVD, and the laser beam is focused to a much smaller spot size to read the smaller pits.

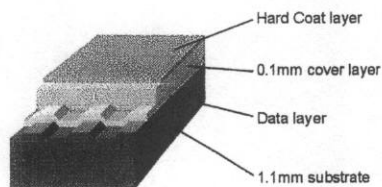


Figure 2. Media manufacturer TDK has developed Hard Coat technology to help Blu-ray discs resist scratches.

buyers snatched initial shipments from shelves as soon as they were stocked, demonstrating once again that consumers are hungry for high-def content to watch on their new HDTVs. (For a closer look at the Samsung BD-P1000, see page 70.)

As for content, Blu-ray launched with seven titles on June 20, with



contrast, HD DVD was designed to be as compatible with the DVD manufacturing infrastructure as possible.

For example, the top surface protecting the data layer of a Blu-ray disc is only 0.1mm thick; the rest of the disc is used as substrate to support the data layer (see Figure 1). As a result, Blu-ray discs are one-sided only, with one or two data layers in the current spec. (In the future, it will be possible to include more layers; research labs are now working on prototypes with up to eight layers.)

The data capacity of Blu-ray is 25GB per layer, which is 67% more than the 15GB per layer offered by HD DVD. How can Blu-ray offer so much more capacity? By using a smaller track pitch (the distance between consecutive turns of the spiral data track) and pit size (the indentations that represent data within the spiral track) as well as a more tightly focused laser beam.

Blu-ray players use a pickup riding just 0.5mm above the disc surface, which is much closer than

### By the Numbers

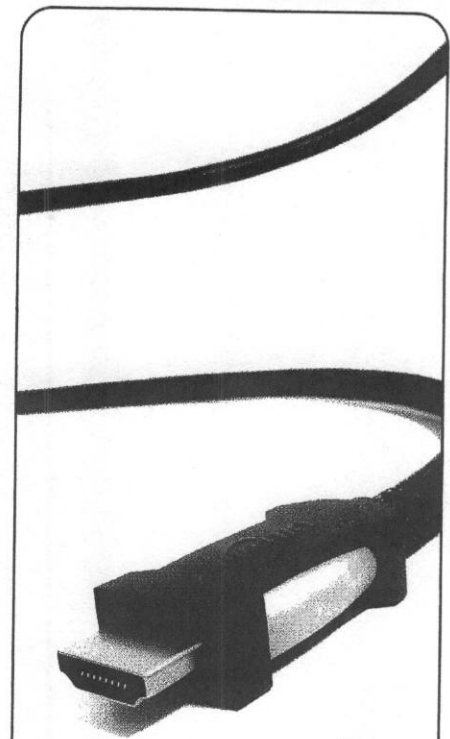
	DVD	Blu-ray
<b>Disc Diameter</b>	120mm	120mm
<b>Disc Thickness</b>	0.6mm x 2	0.1mm (data) + 1.1mm (substrate)
<b>Track Pitch</b>	0.74µm	0.32µm
<b>Min. Pit Length</b>	0.40µm	0.15µm
<b>Beam-Spot Size</b>	1.32µm	0.58µm
<b>Lens Numerical Aperture (NA)</b>	0.60	0.85
<b>Laser Wavelength</b>	650nm	405nm
<b>Working Distance</b>	1.7mm	0.5mm
<b>Capacity</b>	Single-layer: 4.7GB Dual-layer: 8.5GB	Single-layer: 25GB Dual-layer: 50GB
<b>Maximum Data Transfer Rate</b>	10.08Mbps	Video: 40Mbps Audio: 27.7Mbps (depends on compression type, sample rate, bit resolution, no. of channels)
<b>Video Codecs</b>	MPEG-2	MPEG-2, H.264, VC-1
<b>Audio Codecs</b>	Dolby Digital, DTS, PCM	Required: Dolby Digital, DTS, PCM Optional: Dolby Digital Plus, Dolby TrueHD, DTS-HD, DTS-HD Master Audio
<b>Maximum Duration of SD Material**</b>	Single-layer: 2.25 hours* Dual-layer: 4.5 hours*	Single-layer (MPEG-2 @ 4-7 Mbps): 9 hours Dual-layer (MPEG-2 @ 4-7 Mbps): 18 hours
<b>Maximum Duration of HD Material**</b>	N/A (HD on DVD using WMV9 is possible, but not part of DVD spec)	Single-layer (MPEG-2 @ 25Mbps): 150 minutes Dual-layer (MPEG-2 @ 25Mbps): 300 minutes Single-layer (H.264 @ 12Mbps): 300 minutes Dual-layer (H.264 @ 12Mbps): 600 minutes

#### Notes

**Track Pitch:** Distance between adjacent turns in the spiral track. **Min. Pit Length:** Minimum length of data region (pit)  
**Beam-spot size:** Diameter of laser beam. **Lens Numerical Aperture:** Measure of how tightly the laser beam can be focused  
**Laser Wavelength:** Wavelength of laser light. **Working Distance:** Clearance between pickup head and disc surface

\* Maximum duration of SD material on DVD is highly dependent on the bit rate and specific MPEG-2 encoder used, so these numbers are very rough estimates based on typical bit rates.

\*\* The figures given for maximum duration of SD and HD material on Blu-ray include audio information, but the bandwidth required for the audio portion is not included in the specified Mbps.



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## Coming Attractions

(\* Available as of this writing)

### SONY PICTURES

\*50 First Dates  
The Big Hit  
Bram Stoker's Dracula  
Desperado  
For a Few Dollars More  
The Guns of Navarone  
\*Hitch  
\*House of Flying Daggers  
Into the Blue  
A Knight's Tale  
Kung Fu Hustle  
\*Memento  
Resident Evil: Apocalypse  
Sense and Sensibility  
Stealth  
S.W.A.T.  
\*Ultraviolet  
\*Underworld Evolution

### LIONSGATE

\*Crash  
The Devil's Rejects  
Dune (TV miniseries)  
\*Lord of War  
\*The Punisher  
Rambo: First Blood Part II  
Reservoir Dogs  
\*Saw  
Stargate  
\*Terminator 2: Judgment Day  
Total Recall

### PARAMOUNT

Aeon Flux  
Four Brothers  
The Italian Job  
Lara Croft: Tomb Raider  
The Manchurian Candidate  
Sahara  
Sky Captain and the World of Tomorrow  
Sleepy Hollow  
U2: Rattle and Hum  
We Were Soldiers

### BUENA VISTA

Armageddon  
The Brothers Grimm  
Crimson Tide  
Dark Water  
Dinosaur  
Everest  
The Great Raid  
Hero  
Jay and Silent Bob Strike Back  
Kill Bill, Vol. 1  
Ladder 49

### WARNER

Batman Begins  
The Dukes of Hazzard  
Goodfellas  
The Last Samurai  
The Matrix trilogy  
Troy

### MGM

\*Basic Instinct 2  
The Last Waltz  
Robocop  
Species  
\*The Terminator

### FOX

Behind Enemy Lines  
Fantastic 4  
Ice Age  
Kiss of the Dragon  
The League of Extraordinary Gentlemen

### COLUMBIA

\*The Fifth Element  
\*XXX

the 1.7mm used for DVD and HD DVD. However, most Blu-ray player manufacturers maintain that their pickup mechanism is completely compatible with DVD and CD (though some devices will not play CDs due to design decisions), and it can be incorporated into slimline drives for laptop computers, such as the latest Sony Vaio, which includes a Blu-ray read/write drive.

With the lens riding so close to the disc's surface, some claim that Blu-ray might be too sensitive to fingerprints, dust, and scratches. According to the BDA, there is no cause for concern thanks to various coating technologies. For example, TDK's Hard Coat process deposits on the disc's surface a layer of very hard, optically clear material that is essentially impervious to scratches, fingerprints, and other marks (see Figure 2).

### Codecs

DVD uses the MPEG-2 video codec (enCOder/DECOder) developed by the Moving Picture Experts Group (hence its name) to compress video data. This reduces storage and bit-rate requirements so that a standard-definition, full-length movie—and then some—can fit in 4.7GB and spool out to the display at less than 10 megabits per second (Mbps).

Newer, more advanced codecs reduce these requirements further by throwing away even more data and concealing the loss more cleverly. Examples of these new codecs include MPEG-4 Advanced Video Coding (AVC, a.k.a. H.264) and Windows Media Video 9 (WMV9), the latter recently adopted as a standard by the Society of Motion Picture and Television Engineers (SMPTE) and renamed VC-1. (Sorry about the alphabet soup; that's just the way it is in this business!)

In general, the more compres-

sion, the lower the quality, but advances in codec algorithms mitigate this tendency. In fact, the BDA recently completed a round of subjective testing using a slightly modified version of H.264. At bit rates of 8 to 12Mbps, they discovered that viewers found BD to be superior to D-VHS tape; at 16 to 20Mbps, they found it to be equal in quality to the original D5 master (a lightly compressed digital-videotape format commonly used to store movies after they've been telecined from film).

Blu-ray titles can use MPEG-2, H.264, or VC-1, and all players must be able to decode all three video codecs. Early titles from Sony Pictures and Lionsgate use MPEG-2 because there are many available encoders that have reached a high level of sophistication and speed, making them a good choice for getting content to market quickly.

Like HD DVD, Blu-ray titles are not required to include any specific audio codec. Blu-ray players must be able to decode standard Dolby Digital, DTS, and PCM at sample rates of 48 or 96kHz. The new advanced audio codecs, such as Dolby Digital Plus, Dolby TrueHD (what Blu-ray calls Dolby Lossless), DTS-HD, and DTS-HD Master Audio (which, like Dolby TrueHD, is also lossless), are optional. As of this writing, there is no way to digitally output these advanced codecs to an outboard decoder; that must wait until HDMI 1.3 is implemented in both players and receivers, which will likely be sometime in 2007. Meanwhile, they can be decoded in the player and sent from the multichannel analog outputs if the player's manufacturer provides that capability.

If Dolby TrueHD is included on a disc, it must also have a standard Dolby Digital track that can be used if the player can't decode the lossless stream. Dolby Digital Plus and the DTS advanced codecs already



provide the ability to downconvert to standard Dolby Digital or DTS, which means that players will be able to deal with any audio format on any disc.

#### DRM

One goal of Blu-ray—and a stringent requirement from the movie studios—is to make unauthorized duplication as difficult as possible. This is generically known as digital rights management (DRM); like HD DVD, Blu-ray's DRM is based on the Advanced Access Content System (AACCS), which uses a 128-bit key called the Advanced Encryption Standard (AES). Each player (not each model, but each individual unit) includes a unique key, and other unique keys are assigned to the content. These keys are "revocable and renewable"—if the encryption is hacked, they can be changed at the mastering stage.

An additional, optional technology called BD+ allows content providers to respond to any attempts to hack AACCS by reverse-engineering a legitimate player and trying to implement it in an unauthorized player or computer software. When that happens (and it is certain to happen at some point), BD+ allows the disc to detect that it is being played in a device containing known hacks and stop working. Once studios become aware that the DRM has been compromised, the security of a disc with BD+ can be temporarily renewed by the content supplier to continue providing protection. This remains completely transparent to users of legitimate devices.

To further deter unauthorized copying, Blu-ray also uses a physical key called ROM Mark. This technology is designed specifically to thwart large-scale, mass-production piracy, a problem that is estimated to cost the movie industry more than \$3 billion per year in lost revenue. To combat this, ROM Mark embeds a unique identifier in pre-recorded BD-ROM media, such as movies, music, and games.

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## Masters of the Universe

Sony DADC (Digital Audio Disc Corporation) in Terre Haute, IN, will serve as the company's primary U.S. Blu-ray disc-manufacturing facility. Thanks to a \$120 million infusion, the plant has already spun up three of its eventual 15 Blu-ray manufacturing lines. These three lines can now stamp out 25,000 discs per day, or 750,000 units per month—all of them the single-layer, 25GB variety. Of the 12 lines being turned up this summer, six will support 50GB dual-layer disc production. Come October, U.S. capacity will climb to nearly 5 million discs per month, up to 1.5 million of which can be dual-layer.

In order to achieve such copious capacity so quickly, Sony has essentially re-invented the mastering process. Rather than DVD's 12-step, environmentally unfriendly, physically distributed routine, BDs are mastered in just five steps, and all within a single box. The new process is dubbed phase-transition mastering (PTM). Aside from saving time, floor space, and the environment, PTM enables on-the-fly quality assurance as well as the ability to plate discs directly from the master. The resultant end product is tougher and more scratch-resistant than either CDs or DVDs.

Along with production capacity, cost is an underlying factor that can make or break a new format. Sony says it expects Blu-ray production costs to drop to just 15% above those of DVD by this fall, and to continue falling until the new format essentially matches the economies of the old.

Because DADC cannot yet manufacture dual-layer discs, all initial releases will be single-layer. Furthermore, while Blu-ray technology can support dual-format BD/DVDs, none of those first releases will be hybrids. According to Sony, delivering this feature would sharply increase the end-user price, which would discourage adoption during a critical stage.

All initial BD releases will deliver 5.1 channels of 16-bit, 48kHz PCM audio. Make no mistake, this encoding scheme constitutes a marked upgrade from DVD's compressed formats, and it's even theoretically slightly superior to CD quality. Later releases could incorporate new Dolby and DTS formats, each capable of up to eight channels of ultra high-resolution audio.

—Alan Taffel

Invisible to consumers, this ROM Mark can only be mastered with equipment available to licensed BD-ROM manufacturers, essentially preventing unauthorized copies of a disc.

Perhaps the most famous—or infamous—element of AACS is the Image Constraint Token (ICT), which content providers can use to limit the resolution of the analog component output to 540p at most, though most players will likely do 480p. This prevents anyone from recording high-def content from the otherwise unprotected analog output, but it also disenfranchises anyone with an HDTV that has a DVI input without HDCP copy protection or no DVI/HDMI input at all. Fortunately, most studios have announced that they will not implement ICT, at least for now.

Another critical aspect of Blu-ray's DRM is called managed copy, which allows consumers to make authorized copies of discs they buy for their personal use. This could include copying the content to a media server or portable player or burning a backup copy. The process need not be free of charge, and content providers could require consumers to enter into an online transaction of some sort to allow the copy. Every disc will be required to offer some form of managed copy under the final AACS licensing agreement, which is expected

to be in place by the end of this year. Under the current interim licensing agreement, managed copy is not required.

### Interactivity

One of the most touted features of Blu-ray is its enhanced interactivity. For example, the menu system is faster and more seamless than that of DVD. Pressing the menu button brings up the main menu, and selecting one of the menu items pops up a submenu, all while the movie continues to play. In Blu-ray parlance, this is known as the HDMV (High-Definition Movie) mode. More sophisticated interactive features are made possible by a technology called BD Java, which is based on Sun Microsystems' Java programming language.

Then there's integrated Internet access. The first Samsung player does not have an Ethernet port, so that function remains theoretical at this writing, and the principal companies have not said much about it other than it will exist, so it's difficult to say at this time what it might entail. What we do know is that Java is used extensively throughout the Internet, so it should be easy to implement online interactivity with Blu-ray.

The next-generation optical-disc format war is now in full swing, with both contenders out in the marketplace trying to lure consumers to their side. Blu-ray got off to a later start than HD DVD, and its first step stumbled due to a problem in the Samsung player (see review on p. 70).

Can Blu-ray recover from this fumble and ultimately prevail? Only time will tell. Meanwhile, stay tuned to these pages and [www.avguide.com](http://www.avguide.com) for the latest developments. It's sure to be an interesting ride. **TPV**



# Tech

## The Ultimate Laser "Printer"

**Y**ou probably already know that I'm a sucker for unusual peripherals to attach to my PCs. And if they manipulate or measure something in the real world, so much the better. My latest discovery is the Universal Laser Systems VersaLaser, a desktop cutting/engraving/etching system. We're testing one at PC Magazine Labs right now, and it's a blast.

The VersaLaser looks like an oversize printer without feed or output trays. It accepts paper, wood, a variety of plastics, leather, some coated metals, and even stone and marble.

The built-in 25W laser is powerful enough to burn quickly through paper and cardboard without leaving so much as a charred edge. It can cut through wood 1/4 inch thick or more. The thin beam barely discolors the edges of the top surface but leaves the sides of the cut a rich, dark brown. Acrylic plastics such as Plexiglas cut easily, too. The beam moves with surprising speed for wood and paper but slower and at lower power for plastics, so the heat from the beam can melt the plastic edge and leave a smooth, polished surface.

In engraving/etching mode, the beam sweeps back and forth across the workpiece, burning a raster image of your artwork into its surface. Or in the case of anodized aluminum, it bleaches the color out of the anodized layer, leaving the aluminum protected but with the wording or images of your choice shining through in the areas struck by the beam.

When you open the heavy, clear plastic cover, you see a large aluminum platen that rises up and down to adjust to the thickness of the stock, so you can engrave thick blocks of wood and cut thin paper with equal ease. The laser is buried inside the printer; mirrors and lenses guide the beam to the "printhead" and down onto the workpiece.

Lasers on x,y carriages, even relatively small ones, have been around for more than a decade, so you might wonder what's so special about the VersaLaser. It's all in the implementation.

Instead of treating the laser as a machine tool driven by CAD/CAM software, Universal has engineered the VersaLaser from the ground up as a PC peripheral. To your system, it's a USB printer. Through the included driver, you can print from Microsoft Word, Adobe Illustrator, Visio, or any application. But one

of the most laser-friendly applications is CorelDraw. You can easily set up a page the same size as the VersaLaser's platen, and CorelDraw's on-screen rulers correspond exactly to the rulers on the platen's left and top edges.

The printer driver understands color: Black engraves, red cuts, and blue scores. So if you create black text, put a red hairline box around it, and insert a sheet of plastic, the VersaLaser will create an instant name tag. If you use multilayer plastic, the engraving process will burn through the top layer and leave the contrasting underlayer clearly visible. You can also make rubber stamps by creating a black background and using white reversed type or images. The rasterizing process understands gray scale and image density and does a nice job with photographs, too.

The driver has entries for many common materials and adjusts the power and cutting speed accordingly. Many of the materials have numbers that correspond to Universal's catalog of laserable materials: Pop a number into the driver window and it sets the machine automatically.

This level of simplicity makes precision laser cutting and engraving accessible to anyone. But customers have already come up with some amazing and innovative applications beyond Universal's imagination, including custom logos on chocolate bars. There's no setting for chocolate in the driver; a separate custom driver gives you complete control over power levels and cutting speeds yet lets you assign custom levels to colors. Creating artwork remains simple. Customers have also come up with some notably bad ideas, including engraving plastic butane lighters.

Depending on your point of view, the VersaLaser is high-priced or ridiculously cheap, at a shade under \$10,000. Everyone with a shred of entrepreneurial spirit takes one look at it and starts doing the math on building a business around one. Everyone can think of an application or a market that's ripe for a new intersection between custom manufacturing and mass production.

The VersaLaser is an enabler. I like that.

*Bill Machrone is VP of editorial development for Ziff Davis Media. Visit his digs at [www.extremetech.com](http://www.extremetech.com). You can also reach him at [bill\\_machrone@ziffdavis.com](mailto:bill_machrone@ziffdavis.com).*



**This level of simplicity makes precision laser cutting and engraving accessible to anyone.**

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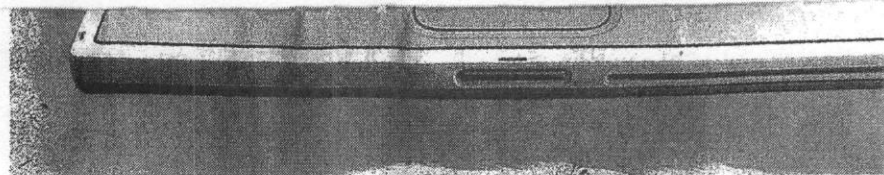
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...files for the most part haven't been set, but could end up slightly cheaper than the average \$18 or so price for new DVD titles. Digital movies can either be rented or purchased, and in some cases, films will be offered as streams rather than downloads. Movies available online on some services that have already have deals with studios include “Syriana” and “Fun With Dick and Jane.”

Major Hollywood studios, long fearful of online distribution because of the potential for piracy, are finally ready to go after the market, much as the music industry warmed up to legal digital downloading a few years ago.

“Our goal is to seek out as many [viable] retail outlets as we can, and put as many titles as we can on those sites,” says Peter Levinsohn, president of News Corp.’s Fox Digital Media, which has signed deals with many of the emerging online outlets. “Ulti-



Studios are fostering movie downloading as a new sales channel. Films like ‘Syriana’ (above

mately, we let consumers decide where they shop.”

The footdragging over digital movies has turned to a sprint this year for several reasons. The studios have become more comfortable with online safeguards against piracy. DVD sales growth has been slowing, underscoring the need to foster new sales channels. And electronic distribu-

tion, which doesn't require packa- ping, has the potential to create fat

For the most part, studio agree- line distributors allow consumers t- movies, but not to burn them on dis- DVD players. That's one reason v-

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## 3D Printers Reshape World of Copying

By WILLIAM M. BULKELEY

**T**OBY RINGDAHL, a computer-aided-design specialist at shoemaker Timberland Co., recently bought a color 3D printer from Z Corp. that allows footwear designers to see their constructions overnight rather than waiting a week for model-makers to carve them. The printer cost \$50,000, but he says it was worth it. “People get pretty amazed when they see a full-color, prototype shoe on the table,” Mr. Ringdahl says.

Computer printing is going three-dimen- sional. In the past four years, designers of a variety of products, including shoes and cellphones, have been buying special- ized office printers costing \$20,000 to \$50,000 that can quickly produce a plastic model using com- puter-aided-design, or CAD, software.

Though they resemble typical office copiers on the outside, these are not ink-on-paper printers. Rapid prototyping machines were pioneered by 3D Systems Corp., of Val- encia, Calif., nearly 20 years ago. They work by taking computer-aided- design data and using it to build a device layer by layer. Inside a 3D printer, either a print head shoots out plastic particles and glue, or an ultraviolet or laser beam passes over a liquid resin bath, hardening a layer of plastic, 3/100ths of an inch thick, in a computer-generated shape. Then the machine builds layer upon layer until the full model is completed, one to four hours later.

Now the technology is reaching ordinary consumers—even young ones. Later this summer, SolidWorks, a U.S. unit of Dassault Systemes SA, a French maker of design software, plans to start up a new business called Cosmic Modelz that will allow kids to use the technology to create their own customized action-figures.

Children can design a figure using Solid- Works’ Cosmic Blob software on their home PCs, then go to a Web site run by 3D printer- maker Z Corp. and order their figures to be “printed” for \$25 to \$50. It will be kind of an electronic version of the Build-a-Bear Workshop concept where children create customized teddy- bears.

Making consumer toys is just the latest expansion of the rapidly growing 3D printing business. Rapid-prototyping machines used to cost well over \$100,000, but some models are now under \$20,000, prompting small businesses and high-school and college shop classes to buy them.

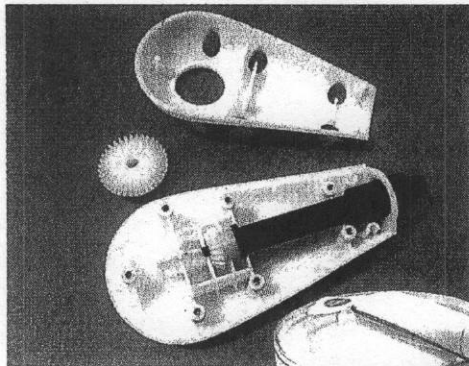
“Our technology mis- sion is to make 3D print- ing as fast and easy as printing on paper,” says Tom Clay, chief executive of Z Corp., based in Burl- ington, Mass.

Terry Wohlers, presi- dent of Wohlers Associ- ates, a Fort Collins, Colo., market research firm, says 3D printing is the fastest growing part of the rapid- prototyping indus- try, which had reve- nue of \$809 mil- lion in 2005, up from an estimated \$705 mil- lion in 2004. Revenues

come from services, materials and the ma- chines themselves, which make models and spe- cialized parts.

Some experts say within a few years hobby- ists will have their own low-cost machines, many created by other 3D printers. Adrian Bow- yer, a mechanical engineering lecturer at the University of Bath in England, says he is devel- oping a 3D printer that, when connected to a PC, will be capable of recreating most of its own parts—allowing individuals to build new 3D printers for little more than the cost of the plastic resin.

3D printers can't replicate semiconductors  
Please Turn to Page B4, Column 3



Prototype for ice cream maker's crank, made by a 3D printer; right, the actual product



Recom-  
the Franklin  
  
The high-perform  
  
© 2006 Advanced Micro  
and combin



"They buy something together but want to put their own swing on it," Mr. Veikkola says.

# Germany's SAP Plans \$1 Billion India Expansion

By NINA MEHTA  
And SANTANU CHOUDHURY

**NEW DELHI**—German business-software titan SAP AG will invest \$1 billion in India during the next five years to expand its operations there, Chairman and Chief Executive Henning Kagermann said.

"It is too early to say in which area the investment will be," Mr. Kagermann said. "Most of it will be on people."

The company, which has 2,750 employees in India, plans to increase the total to 3,500 by December, he said. Of the new recruits, 250 will be hired for the company's new support and services center in the northern city of Gurgaon.

SAP, which makes software that lets corporations manage payroll, client orders and other business processes, plans to double its work force in India in the next five years.

SAP has been in India since 1996 and has invested \$500 million in the country since then, Mr. Kagermann said. The company has a research-and-development center in the technology hub of Bangalore.

SAP joins scores of global technology companies that have announced major investments in India in recent months to boost their presence, taking advantage of its low-cost, highly skilled manpower. In June, **International Business Machines Corp.** said it would triple its investment in India to \$6 billion in the next three years.

In December, **Microsoft Corp.** said it would double its work force in India with an investment of \$1.7 billion over four years. Around the same time, **Intel Corp.** announced a \$1 billion India investment plan. And on Tuesday, **Electronic Data Systems Corp.** said it expects to add 5,000 positions in low-cost countries such as India, Argentina and China by

"Nobody seems to be offering kids a way to have their regular voice-phone bill paid by their parents on contract

# New Copiers Create 3D Plastic Models on Demand

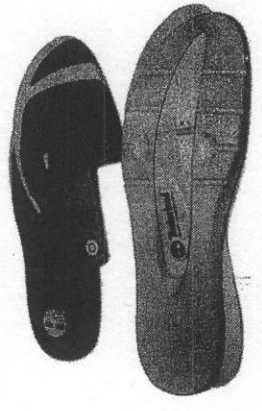
model, "there's always a 'Wow' moment when they really get it," he says.

A number of U.S. companies say they use "3D faxing" to send designs to 3D printers at factories in Asia so manufacturing engineers have a clearer idea of what they're supposed to build.

Cheaper, simpler 3D printers are spawning new applications. Architects often design in two-dimensions, but model-makers like **Alchemy Models Inc.** in Phoenix are using 3D printers to make models to show architectural review boards what new buildings will look like. 3D printing companies say brain surgeons are using the machines to create models of patients' skulls to design protective metal plates.

At **Walt Disney Co.'s Pixar Animation Studios**, animators used a Z Corp. machine to make 250 models of "Toy Story" characters for a museum display. **Warren Trezvant**, an animator at Pixar, says his colleagues were so excited by the figures that the 3D printers produced that "We printed more for people's desks."

tries on their blogs from their phones and create videos with the cameras on their phones. It also has promotions



*Timberland Co. shoe sole designs produced by a 3D printer from Z Corp.*

Army is studying using such systems in war zones to create replacements for broken parts of planes and tanks.

Some designers use 3D printing as a communications tool. **Eric Freitag**, director of engineering services at **Smart Design**, a New York-based design firm that bought one of **Stratasys's Dimension 3D** printers, says "you like to think the client sees what you see" but that a drawing on a piece of paper doesn't always fully communicate a design concept. With a 3D

cate services, like sharing photo albums, that are already popular using sites on the Internet.

*Continued From Page B1*  
or metal screws and bolts. But products made by printers should be as sturdy as the originals once they're assembled. Mr. Boyer predicts this could aid cottage industries making jewelry or home furnishings like hooks and vases, or even lead to homemade cellphones or digital cameras. He expects a 3D printer that can print itself might be ready in a few years. As the self-replicating machine spreads, "It will evolve," he says, with the most successful changes being widely adopted.

Large 3D printers can build models 20 in. high and 24 in. wide. To make bigger parts—for example, engine blocks—users can produce two halves and glue them together.

Industry leader **3D Systems**, and **No. 2 Stratasys Inc.**, of Eden Prairie, Minn., make some systems that are designed for rapid manufacturing of specialized parts. One system uses metal powder that is fused by a laser, layer by layer, to make parts with strength comparable to metal castings. The

# Software Giants Try to Turn Hackers Into Friends

Mr. Moore says Microsoft started wooing him in earnest in 2003 when the company invited him to its **Black Hat** party. Last year, Microsoft also asked him to present to a group of its employees at its security conference, which is known as **Blue Hat**. After he spoke, Mr. Moore met some of the programmers behind the software he researches, as well as some members of the security group with whom he had exchanged heated emails in the past.

Mr. Moore, who says he knew about 10 Microsoft employees previously, now knows close to 40 people who work for Microsoft or do contract work for the company. Over the past year, he notes, Microsoft has hired some of his

company improve relationships with researchers. Last year, Microsoft also invited researchers to give presentations to its employees at its own security conference. Now the company has surpassed other software vendors when it comes to currying favor with researchers, says **Jon Ellich**, a 24-year-old researcher in Monterey, Calif. — "at least in terms of the number of beers (it) bought for me."

Mr. Moore is experiencing this shift by Microsoft firsthand. As director of security research at Austin-based security company **BreakingPoint Systems Inc.**, Mr. Moore has been a white-hat hacker since he found his first software flaw at the age of 14. By the time he

*Continued From Page B1*  
attendees at **Black Hat** this year are representatives from Microsoft and other companies. Microsoft plans to host several sessions on **Windows Vista**, its new operating system, so that researchers can scour the software for security gaps and offer feedback.

Cisco, meanwhile, is sending its chief security officer, **John Stewart**, to **Black Hat**, and has bought a top sponsorship slot at the event. That is a turnaround from last year, when Cisco attracted the scorn of attendees for trying to sue a researcher who presented a flaw in Cisco's routers.

"We had the best of intentions, and it sort of came across wrong," says Mr.

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## Third-Generation AIT Debuts

BY M. DAVID STONE

As hard drive capacity continues to grow at a dizzying rate, tape drive manufacturers are working hard to stay ahead. Among the latest tape formats is third-generation Advanced Intelligent Tape technology (AIT-3), from Sony Electronics, which you'll find in the **Sony SDX-D700C** tape drive.

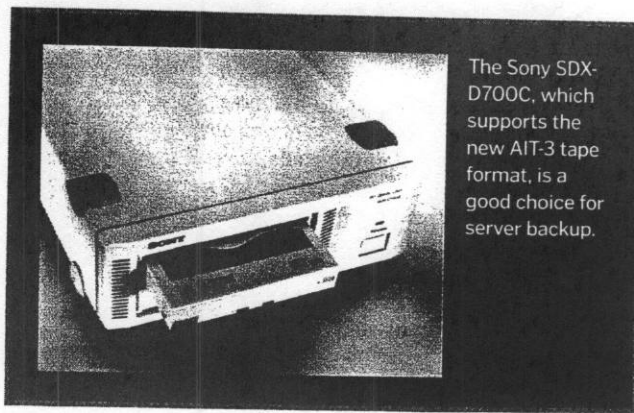
The drive boasts fast throughput, 100GB native capacity per cartridge, and a claimed 260GB compressed capacity. That's an enormous amount of storage for a single cartridge, especially one that is about the size of a thick cassette tape.

AIT-3 gets its high capacity in part from helical-scan recording, which is known for offering high data densities. The technology gets another boost from using

Advanced Lossless Data Compression (originally developed by IBM), which offers a claimed 2.6-to-1 compression ratio instead of the more common 2-to-1.

Another welcome touch is a 64K chip in each cartridge that stores the tape log, so the drive can find the location of files by reading the chip. The payoff is a claimed average access time of under 27 seconds.

Setup is simple: Just plug the cable in and go. The SDX-D700C comes without backup software but includes a utility for copying from non-AIT drives to the SDX-D700C, which makes an upgrade more convenient. (The drive is compatible with both earlier AIT formats.) We used an Adaptec 29160 SCSI card and Computer Associate's BrightStor ARCserve 2000 backup



The Sony SDX-D700C, which supports the new AIT-3 tape format, is a good choice for server backup.

software running on Windows 2000 Server.

On our tests, data throughput came out to 13.2 MBps, or nearly 800MB per minute, with the drive backing up roughly 41GB in less than 52 minutes. This is on the low end of the claimed throughput of 12 MBps to 31.2 MBps, indicating that there was relatively little compression for our test data.

In a nutshell, the Sony SDX-D700C is a practical and useful upgrade that is well worth considering if you're deciding on a tape format.

Sony SDX-D700C

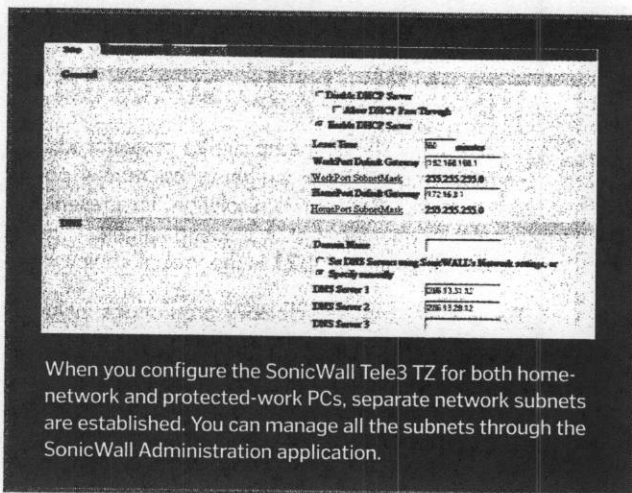
Direct price: \$4,225. Requires: SCSI-2 connection (Ultra 160 Wide SCSI LVD/SE recommended), backup software. Sony Electronics Inc., 800-352-7669, 408-432-1600, [www.storagebysony.com](http://www.storagebysony.com). ●●●●○

## Telecommuter Security Appliance

BY BRUCE AND MARGE BROWN

Installing a hardware firewall for your home network is a great idea. But if you use your home network and broadband Internet access for both personal and corporate-connected computing, other users on your home network can inadvertently threaten your business network's security. The **SonicWall Tele3 TZ** (\$550 street) establishes a "trusted zone" to isolate corporate-connected PCs from your home network while still providing firewall protection and VPN access for the entire configuration.

Setting up the TZ for basic operation is straightforward. The unit establishes separate, parallel connections to the Internet for home and corporate use. You can configure what traffic (if any) is allowed between the security zones. The TZ has three RJ-45 ports: The WAN port connects directly to a broadband cable or DSL modem or router. The HomePort connects to your home network via a hub or



When you configure the SonicWall Tele3 TZ for both home-network and protected-work PCs, separate network subnets are established. You can manage all the subnets through the SonicWall Administration application.

switch (or you can directly connect a single PC), and the WorkPort connects to a single business-related PC (or a hub or switch for those who use multiple PCs to access corporate systems).

The TZ's security specifications are impressive, including an ICSA-certified stateful packet inspection firewall, 3DES (168-bit) encryption, and licenses for five IPsec VPN tunnels and five

firewall users. You can allocate the bandwidth between the two network zones, and if your corporation manages firewalls centrally, the TZ is Global Management System v.2.5-compatible.

We connected the TZ's WAN port to our home network's DSL modem via a D-Link DI-714 combination wireless access point, router, switch, and DHCP server. We plugged a network switch into the HomePort and a single

notebook PC into the TZ's WorkPort. When we ran the browser-based configuration program, the TZ configured one subnet for the computers connected to the HomePort via the switch and a separate subnet for the PC connected to the WorkPort (which we used to connect to the Ziff Davis Media server-based e-mail system).

DHCP functions in the device automatically managed and assigned IP addresses to the PCs on each subnet. We also had wireless PCs accessing the Web via the D-Link DI-714, so we had three subnets working simultaneously. The networks were invisible to one another. All were able to get to the Internet, proving that the two-layered DHCP function was working correctly.

The SonicWall Tele3 TZ isn't cheap. But for companies with remote employees (or frequent work-at-homers), the cost is well worth the extra protection.

SonicWall Tele3 TZ

Street price: \$550. Requires: Cable, DSL, or network WAN Internet connection, Microsoft Windows 95 or later. SonicWall Inc., 408-745-9600, [www.sonicwall.com](http://www.sonicwall.com). ●●●●○



# Tape It to the Limit

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Storage solutions come and go, but tape backup is still king. Which format is best for your business? Read on.

By Davis D. Janowski

Johns Manville—a Denver-based manufacturer of building materials, in business since 1858—has 52 facilities of varying sizes spread over North America, Europe, and China. With more than \$2 billion in annual sales, 9,000 employees, and some 120 servers in its corporate headquarters alone, Johns Manville gives top priority to data backup every night.

Scott Blancett, a manager in the IT department, knew the company's ever-growing backup needs were crying out for a bigger and better solution than the three-year-old StorageTek DLT 8000-based libraries. So Johns Mansville took Hewlett-Packard's new second-generation LTO (Linear Tape-Open) product, the HP Ultrium 460e, for a test-drive.

"The backup speed is really tremendous," Blancett says. "Much faster than our old DLT 8000 systems."

This observation made Blancett's decision to replace the company's backup hardware a no-brainer. He wants to buy automated, multitape libraries containing the 460e drives later this year. With these, the company will need fewer machines to do the job.

"Believe it or not," says Blancett, "the cost, including three years of maintenance and support, will come out being less than paying for another three years of support and maintenance on our DLT 8000 machines."

## AN OCEAN OF DATA

After 50 years, tape remains the king of backup technologies, and manufacturers continue to make tremendous strides in improving their products. Even with the promise of better, more economical technologies for hard drives and optical backup on the horizon, tape will remain the backup medium

of choice for the near term.

What we refer to as *tape backup* started out as a cumbersome, reel-to-reel system. But today, the tape media are self-contained cassettes in different shapes, sizes, and capacities from many manufacturers. And choices abound: From 1998 to 2001, nine new formats were introduced, adding to the dozen or more already in existence, according to research firm Gartner.

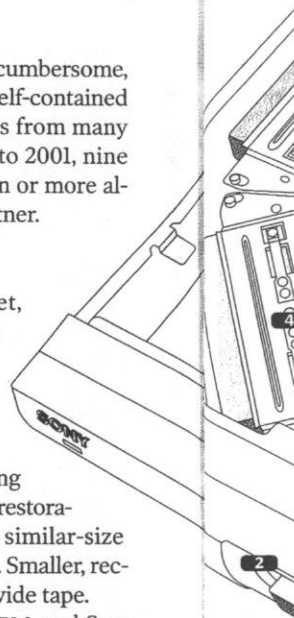
## TAPE FORMATS

This story focuses on the midrange tape market, which targets small to midsize businesses with up to 400 employees. Two tape technology standards, Linear Tape-Open (LTO) and Super Digital Linear Tape (SDLT), dominate the market. A third technology we've reviewed in this story is Sony's AIT-3 format, which has a small but growing market share and interests us with its very high file restoration speed. Both LTO and SDLT technologies use similar-size square, one-reel cassettes with half-inch-wide tape. Smaller, rectangular AIT-3 cassettes use two reels and 8-mm-wide tape.

The LTO standard was created in 1998 by HP, IBM, and Seagate Technology, each of which makes drives that can use any manufacturer's LTO cassettes. First-generation LTO cassettes have a raw or *native* data capacity of 100GB and a compressed capacity of 200GB.

HP started shipping the first drives and automated solutions for second-generation LTO in November 2002. This format has double the capacity—200GB native and 400GB compressed—and provides unparalleled read/write speeds. But attaining these speeds requires a fairly sophisticated network, with high-speed connections between your hardware, and also depends on the types of data being backed up and the speed of the hard drives holding that data.

SDLT 320 is the latest advance in Quantum Corp.'s venerable DLT technology. It has the advantage of backward read compati-



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### SINGLE-TAPE DRIVES

- 120 HP Ultrium 230e ●●●○○
- 120 HP Ultrium 460e ●●●○○
- 121 Quantum SDLT 320 ●●●○○
- 121 Seagate Viper 200 ●●○○○
- 121 Sony SDX-D700C ●●●○○
- 123 Summary of Features

### AUTOMATED DEVICES

- 122 HP StorageWorks 1/8 Autoloader ●●●○○
- 123 Overland PowerLoader SDLT 320 ●●●○○
- 124 Quantum ATL SuperLoader ●●●○○

### 126 Sony StorStation AIT Library

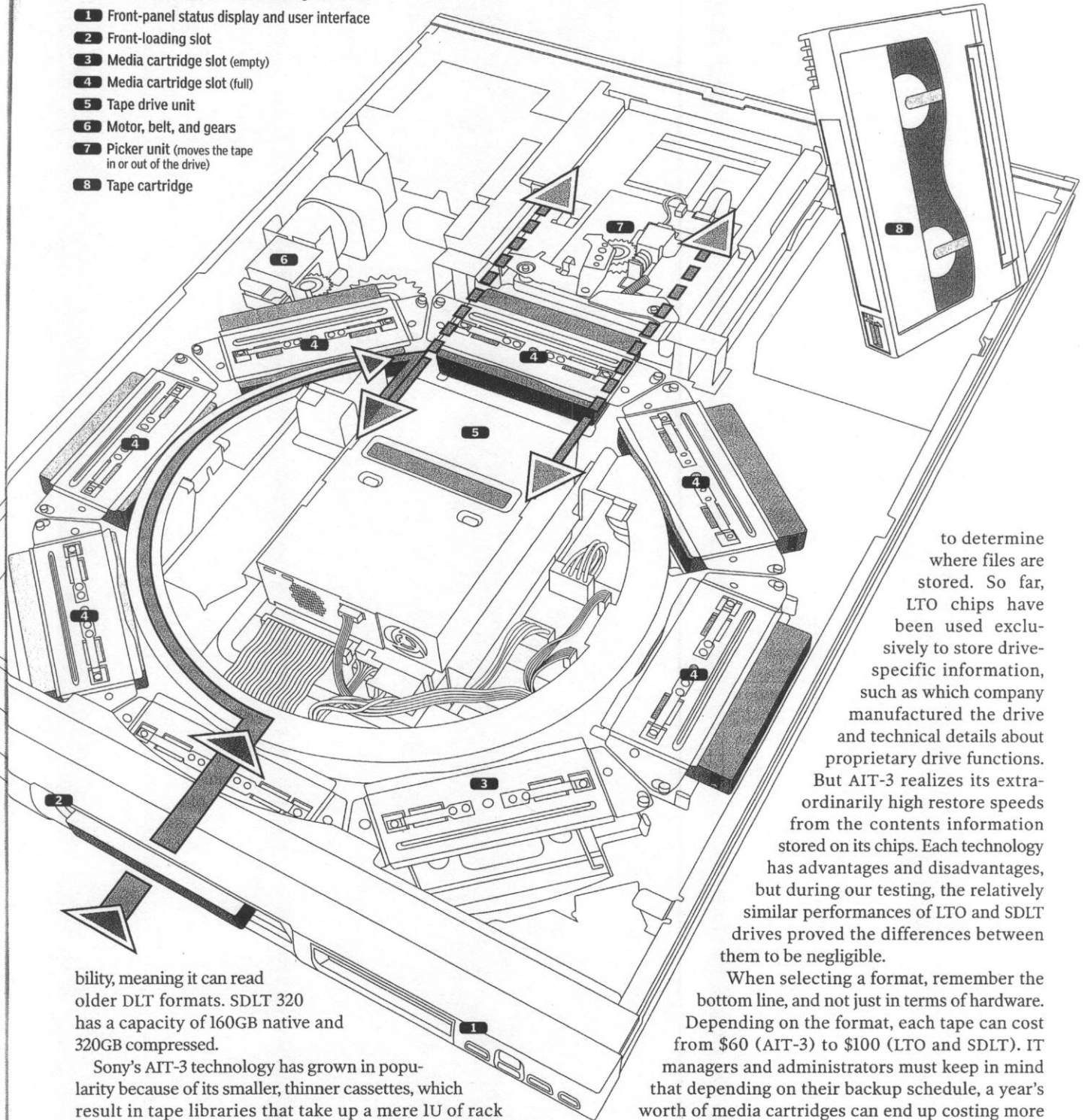
- LIB-81 ●●●○○
- 127 StorageTek L20 ●●○○○
- 126 Summary of Features
- 122 Backup Software
- 124 Performance Tests
- 127 Alternatives to Tape Backup





## Inner workings of the Sony LIB-81

- 1 Front-panel status display and user interface
- 2 Front-loading slot
- 3 Media cartridge slot (empty)
- 4 Media cartridge slot (full)
- 5 Tape drive unit
- 6 Motor, belt, and gears
- 7 Picker unit (moves the tape in or out of the drive)
- 8 Tape cartridge



bility, meaning it can read older DLT formats. SDLT 320 has a capacity of 160GB native and 320GB compressed.

Sony's AIT-3 technology has grown in popularity because of its smaller, thinner cassettes, which result in tape libraries that take up a mere 1U of rack space. AIT-3 has a capacity of 100GB native and 260GB compressed. Though it restores files quickly, it performs backup operations much more slowly than the other formats.

The most obvious difference among the formats is how data file locations and other drive-specific information are stored. LTO and AIT-3 cassettes both have on-board chips that store tape-specific information. While the original LTO Ultrium 1 specification allowed data location information to be stored on these chips, none of the manufacturers built this technology into their drives.

LTO and SDLT drives must read the beginning of a tape

to determine where files are stored. So far, LTO chips have been used exclusively to store drive-specific information, such as which company manufactured the drive and technical details about proprietary drive functions. But AIT-3 realizes its extraordinarily high restore speeds from the contents information stored on its chips. Each technology has advantages and disadvantages, but during our testing, the relatively similar performances of LTO and SDLT drives proved the differences between them to be negligible.

When selecting a format, remember the bottom line, and not just in terms of hardware. Depending on the format, each tape can cost from \$60 (AIT-3) to \$100 (LTO and SDLT). IT managers and administrators must keep in mind that depending on their backup schedule, a year's worth of media cartridges can end up costing more than the hardware.

### DRIVES, AUTOLOADERS, LIBRARIES, AND SOFTWARE

A standalone tape drive can write to or read from one tape at a time. Autoloaders and small libraries are roughly analogous to jukeboxes or carousels handling multiple audio CDs. This type

Our contributors: **S. Jae Yang** is a freelance writer. Associate editor **Davis D. Janowski** and PC Magazine Labs project leader **Oliver Kaven** were in charge of this story.

of device holds multiple tapes and uses robotic mechanisms to load and remove them from the enclosed drive, but still it can only write to or read from one tape at a time.

Autoloaders and libraries are about convenience; a user with a single-tape drive would have to insert one or more tapes every day by hand. But a user with an autoloader can just fill it with properly labeled tapes and walk away, maybe for weeks at a time.

The distinctions between autoloaders and libraries are rather blurry, even within the industry. An autoloader tends to have a single drive, while a library may have more. StorageTek, with its L20, L40, and L80 libraries, has gone even farther by engineering those devices to accommodate multiple tape formats. Libraries are generally considered more complex devices and tend to have more advanced features, such as bar code readers for keeping track of tapes, and they can hold more tapes. In fact, some large enterprise libraries can hold hundreds of tapes.

Unlike many other types of computer hardware, tape backup systems have evolved little in terms of native intelligence. This

means they depend totally on software running on locally or remotely connected workstations or servers to carry out all functions. For an overview of the three most popular software solutions, see "Backup Software" on page 122.

#### FINAL CONSIDERATIONS

The choice of a format and device type depends on many factors, including the kinds of data you need to back up, the range of file sizes, the daily volume, and the quantity and speed of the hard drives you'll back up from. If you have excessive data and a small backup time window, LTO or SDLT may be the best solution. If you need to restore files frequently, AIT-3 may be the answer.

We've reviewed five external single-tape drives and five automated products for small to midsize businesses. The standalone drives range in price from \$4,225 to \$5,775, while the automated solutions range from \$7,500 to \$13,000. AIT-3, LTO, and SDLT products are all represented in both the single-drive and automated-device categories.

#### ALL SINGLE-TAPE DRIVE REVIEWS BY OLIVER KAVEN

**SINGLE-TAPE DRIVES:** Settling on a standard is the obvious first step when buying a single-tape drive. Once you've done that, your choices will be based for the most part on price, performance, and capacity. Aside from these criteria, unmanaged drives are quite similar to one another and are controlled entirely by software.

#### HP Ultrium 230e, 460e

230e, \$4,955 list. ●●●○ 460e, \$5,775. ●●●●○  
800-282-6672, www.hp.com.

HP burst through the gates with the first second-generation LTO product, the HP Ultrium 460e, and in so doing has introduced a new level of performance to half-inch tape backup. Its speed and increased capacity have earned the 460e an Editors' Choice.

Second-generation LTO, also known as Ultrium 2, raises the native data capacity to 200GB, the highest available tape capacity on the market. HP has achieved this boost, up from 100GB for first-generation LTO (used in the HP Ultrium 230e), by raising the number of data tracks from 384 to 512 and increasing the linear data density along the tracks by 33 percent.

Much like SDLT, LTO Ultrium 2 is back-

ward-compatible with LTO Ultrium 1 media. The unit reads the cartridge memory and relays the appropriate specifications for track pitch, tracks, and linear density to the servo electronics.

While the 230e had the fastest backup time among Ultrium 1 devices on our test, and came close to the Quantum SDLT 320, the 460e's backup time of 27 minutes 29 seconds was unmatched, beating the other single-tape drives in this category by anywhere from 4 minutes 21 seconds to more than 38 minutes.

The restore speeds of both HP units, however, were not as impressive. The 230e finished dead last, and the 460e fell behind both Sony's and Quantum's devices.



### SINGLE-TAPE DRIVES: Backup Speed, HP Ultrium 460e; Versatility, Quantum SDLT 320 AUTOMATED DEVICES: Quantum ATL SuperLoader

Picking the Editors' Choice for single-drive tape backup units was difficult. The HP Ultrium 460e was hands-down the fastest unit on our 52GB backup test. But backup tests don't tell the whole story; restore operations are almost as important, though less frequently performed in the real world. Since LTO-based systems were slower at restoring data, we awarded a second Editors' Choice to the Quantum SDLT 320. Although it didn't turn in the fastest timings on either backup or restore tests, the unit's respectable overall performance makes the drive very versatile for administrators concerned with both keeping their backup window small and being able to restore files quickly.

Honorable mention goes to the Sony SDX-D700C, which was

fastest by far on our restore test. If you need to restore files often and quickly, take a close look at this AIT-3 device.

Comparing automated devices is more straightforward. While drives and drive technologies are often similar or even the same, the robotic mechanisms greatly differ. The Quantum ATL SuperLoader offers easy setup and management capabilities and boasts a 17-cartridge capacity. We like being able to administer the device via both its front-bezel display and its Web interface.

While the SuperLoader impressed us with its features, performance, and complexity, the Overland PowerLoader SDLT 320 awed us with its engineering simplicity and receives an honorable mention.



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## SCORECARD: SINGLE-TAPE DRIVES

The **price** rating reflects the relationship between a device's list price and the number and quality of its features. For **backup**, we consider the processing time required for a full backup, as well as the system's verification time.

For the **restore** rating, we look at the device's speed in

restoring selected data. **Capacity** reflects the amount of compressed data each cartridge can hold. The **overall** rating takes all of these individual ratings into account but is not an average: It is an aggregate rating based on rigorous discussions among PC Magazine Labs staff, reviewers, and editors.

	Price	Backup	Restore	Capacity	OVERALL
HP Ultrium 230e	●●●	●●●	●●	●●●	●●●
HP Ultrium 460e	●●●	●●●●	●●●	●●●●	●●●●
Quantum SDLT 320	●●●	●●●●	●●●●	●●●●	●●●●
Seagate Viper 200	●●●	●●	●●	●●●	●●
Sony SDX-D700C	●●●●	●●	●●●●	●●●	●●●

●●●●-EXCELLENT ●●●●-VERY GOOD  
●●●-GOOD ●●-FAIR ●-POOR  
RED denotes Editors' Choice.

We are impressed with the two units' OBDR (One Button Disaster Recovery) feature, which is integrated into the drives' firmware and allows for complete server recovery without having to install the OS or backup software first. Because this option is available only for locally connected servers, it will be most attractive to small-business customers.

If your need for backup speed is paramount, the HP Ultrium 460e is the drive for you, while the 230e is merely adequate. The 460e is also the only Ultrium 2 game in town—for now. IBM's Ultrium 2 offering is reportedly in the works and should be available by the time you read this.

### Quantum SDLT 320

\$4,995 list. 408-944-4000, [www.quantum.com](http://www.quantum.com).  
●●●●○

Our second Editors' Choice in this category, the Quantum SDLT 320, impresses us with its versatility in both data backup and restore operations.

Though it's not as fast as the HP Ultrium 460e at backup or the Sony SDX-D700C at restoring data, the SDLT 320 turned in the most well-rounded performance, scoring above average on both tests.

This single-tape drive uses new technologies such as Laser Guided Magnetic Recording (LGMR) and a Pivoting Optical Servo (POS). LGMR and POS allow for a higher data capacity (160GB native, 320GB compressed) by storing servo-positioning information on the previously unused back side of the tape.

The drive comes with two diagnostic utilities: GSLink, which runs on laptops, and Pocket GSLink, which runs on Pocket PCs. These applications collect statistics and other information through the drive's

built-in IR port. An additional utility, Density Select, lets administrators configure the SDLT 320 to write to SDLT 220 data cartridges. The drive is also read-compatible with all older DLT standards.

For administrators who choose to go with SDLT technology and whose backup and restore needs are equally important, the Quantum SDLT 320 is the way to go.

### Seagate Viper 200

\$4,995 list. 800-626-6637, [www.seagate.com](http://www.seagate.com).  
●●○○○

Despite its excellent documentation, the Viper 200's performance on our tests was lackluster, particularly in backup speed. The device trailed the HP Ultrium 230e, our other Ultrium 1 contender, by more than 9 minutes in backup time, though its restore time was just over a minute faster than that of the 230e.

Like the 230e, the Viper 200 offers 100GB of native media capacity and 200GB compressed. The LED design is another shortcoming, one shared to a lesser degree by several products in this roundup. These products attempt to signal ten or more drive status conditions using just three or four green LEDs; even with documentation, it's a challenge to distinguish the various condition signals. This is surprising for a nearly \$5,000 device, given that some \$200 electric shavers now come equipped with LCDs. And the Viper 200 is exceptionally challenging in this regard, because its LEDs are not even labeled.

Ironically, the Viper 200 is the only product that includes detailed information about necessary configuration steps for Digital Unix, IBM AIX, SCO Open-Server, and Linux. Performance aside,

if you seek a drive that provides support and information for non-Microsoft platforms, this product is worth a closer look.

### Sony SDX-D700C

\$4,225 list. 866-335-7669, [www.storagebysony.com](http://www.storagebysony.com).  
●●●○○

If your organization often finds itself searching for files, this may be the box for you. The Sony SDX-D700C, which uses AIT-3 technology, has Remote Memory In Cassette (R-MIC), an on-board memory chip that provides high-speed access to file location information. The advantage of this technology was quite apparent on our tests.

The SDX-D700C's data restore time of 1 minute 35 seconds made it the undisputed restore champion in this roundup. Unfortunately, the device lagged far behind all of the competition on our backup test.

Using two-reel, 8-mm tape cartridges, the SDX-D700C is by far the smallest drive in the roundup. It's fully backward-compatible with AIT-1 and AIT-2 cartridges, and it offers 100GB of native or 260GB of compressed storage. A design plus: labeled LEDs that provide better status information.

The SDX-D700C and the HP Ultrium 460e are the only single-tape drives in our roundup equipped with SCSI-3 interfaces. The manuals are adequate, but the device ships without a CD containing drivers, electronic documentation, and diagnostic utilities.

If speedy and frequent restore operations are critical for you, but you don't mind letting your backup run all through the evening hours, the SDX-D700C is a contender. And the price is quite nice.



# Backup Software

When designing your backup infrastructure, there is an essential component to consider other than hardware: your backup application software. This software provides the interface for controlling your tape drive or library, performing backups and restores, and managing your rotation schedules. Here is a brief overview of three popular and widely supported solutions.

## BRIGHTSTOR ARCSERVE BACKUP VERSION 9 FOR WINDOWS

8 clients, \$2,255 direct. Computer Associates International Inc., 800-225-5224, [www.ca.com](http://www.ca.com).

BrightStor ARCserve is a long-time favorite among Microsoft Windows users. The latest version offers simplified installation and licensing and includes new features such as backup to disk; support for multiple network interface cards (NICs), network-attached storage (NAS), NDMP; and a universal Windows XP client.

Computer Associates has greatly improved the product's reporting and logging, which can now be thoroughly cus-

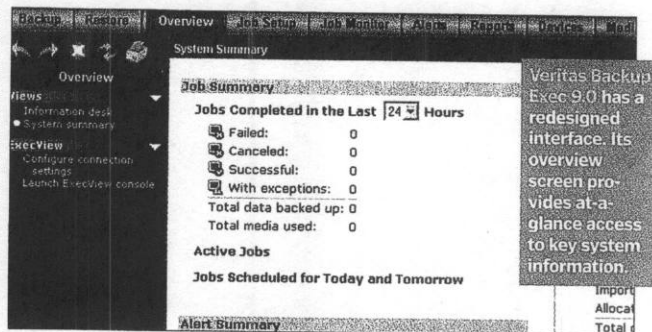
tomized. Other features added to the standard version include virus protection, data encryption, and parallel streaming of data for up to 32 devices. The package includes software agents for several Exchange, Oracle, SQL, and Unix applications, which help make ARCserve a strong choice for growing businesses. Finally, for those wishing to attain peak efficiency from a storage area network (SAN), ARCserve has a serverless backup feature that moves data directly from disk to tape.

## LEGATO NETWORKER 6.1.3

8 clients, \$2,995 direct. Legato Systems Inc., 650-210-7000, [www.legato.com](http://www.legato.com).

NetWorker 6.1.3 is clearly geared toward large companies that want data security. This is proved by its wide range of platform support and abundance of modules for securing databases and application data.

With hierarchical storage management (HSM), file interleaving, and parallel streaming for up to 512 streams, NetWorker is equipped to receive backup data from multiple clients simultaneously. And if you have multiple systems with NAS devices distributed across



your network, NetWorker can address them as designated storage nodes. The product's extensive support for advanced tape libraries, built-in data multiplexing, dynamic drive sharing, and job-monitoring tools emphasize its design for complex storage environments.

Our chief complaint is one we frequently have with enterprise software: poor interface design. When using NetWorker to create complex backup strategies with multiple jobs, you quickly see that it is intricate and demanding.

## VERITAS BACKUP EXEC 9.0 FOR MICROSOFT WINDOWS NT AND WINDOWS 2000

8 clients, \$2,685 direct. Veritas Software, 800-327-2232, [www.veritas.com](http://www.veritas.com).

This package is ideal for small to midsize businesses, easy to use, and designed with future

growth in mind. Though many of the features—such as System State protection for Windows networks, intelligent disaster recovery, and CD-R/-RW support—are included in competing products, Backup Exec excels by tying complex features seamlessly into an intuitive Web-based interface. One interesting recent addition is a test-run option for backup jobs. This feature checks and validates your settings, and credentials, and it ensures that you have the necessary media capacity before actually running a job.

Advanced search facilities for backed-up data, user-initiated backup from Windows Explorer, and backup to disk all round out Backup Exec. Though the new interface takes a little getting used to, the program offers the most intuitive user experience among the three products we looked at.—*Oliver Kaven*

**AUTOMATED DEVICES:** Once you've settled on a tape format, the key factors in choosing a loader or library come down to finding the right balance of complexity and capacity for the money.

## HP StorageWorks 1/8 Autoloader

\$10,600 list. 800-282-6672, [www.hp.com](http://www.hp.com).

●●●○○

For small organizations or workgroups that are committed to LTO technology and have very simple backup needs, the HP StorageWorks 1/8 Autoloader is a good fit. This Ultrium I product is easy to configure, operate, and maintain. And with space for eight LTO cartridges, it provides 1.6TB of compressed data ca-

capacity in a 2U rack-mountable enclosure.

You won't find a bar code reader, a Web-based remote-management interface, or multiple-drive support, which are standard features in more advanced automated solutions. But you will find high-quality documentation and excellent software. The device's mechanism includes an eight-slot carousel and a two-armed picker that feeds the centrally positioned drive through the front slot.

Installing the Autoloader is simple with the help of the quick-start guide, as are configuration and monitoring, which are performed using the LCD control panel. There is no Ethernet port, however, for remote operation.

All of the control panel menus are intu-

itively grouped into three categories: commands, information, and configuration. Although HP took special care to design the power button so that you can't shut off the system inadvertently, there is no password or physical lock to protect the control panel from unauthorized access.

Although the Autoloader has no Web-based interface, the backup software (which runs on the host system) provides an extensive array of tools. With this software, you can monitor the system status, obtain hardware information such as the firmware version and serial number, update the firmware, and run comprehensive diagnostics, including read/write performance measurements, a compression test, a connectivity test, and media valida-



## SCORECARD: AUTOMATED DEVICES

For the **setup** rating, we evaluate all initial tasks involved in getting each device working, including the quality and extent of the supplied documentation. The ease of loading and unloading cartridges from the system is reflected in the **cartridge manageability** rating. The **rack data density** rating is based on compressed storage capacity in relation to unit size. For the **manageability** rating, we look closely at the complexity of maintenance tasks and the included management utilities, as well as the quality of the front-bezel LCD (if any).

The **upgradability and compatibility** rating reflects the

system's growth options. How easy will drive upgrades be? How much rack space does another unit add? Is the system scalable, and can it be equipped with additional features? What about backward compatibility?

The **price** rating reflects the relationship between a device's list price and the number and quality of its features. The **performance** rating takes into account the processing time required for full backups and selective data restoration. We weigh both processes equally. Finally, the **overall** rating is not an average but an aggregate rating based on rigorous discussions among PC Magazine Labs staff, reviewers, and editors.

	●●●●-EXCELLENT	●●●-VERY GOOD	●●-GOOD	●-FAIR	○-POOR	Setup	Cartridge manageability	Rack data density	Manageability	Upgradability and compatibility	Price	Performance	OVERALL
HP StorageWorks 1/8 Autoloader	●●●●	●●●	●●	●	○	●●●●	●●●	●●	●●●	●●●	●●●	●●●●	●●●
Overland PowerLoader SDLT 320	●●●●	●●●	●●	●	○	●●●●	●●●	●●	●●●	●●●	●●●	●●●●	●●●
Quantum ATL SuperLoader	●●●●	●●●	●●	●	○	●●●●	●●●	●●	●●●	●●●	●●●	●●●●	●●●
Sony StorStation AIT Library LIB-81	●●●●	●●●	●●	●	○	●●●●	●●●	●●	●●●	●●●	●●●	●●●●	●●●
StorageTek L20	●●●●	●●●	●●	●	○	●●●●	●●●	●●	●●●	●●●	●●●	●●●●	●●●

RED denotes Editors' Choice.

tion. An additional perk is a license for HP OpenView Data Protector Single Server Edition for Windows 2000/NT, which can perform agent-based backup for up to 25 clients over a network.

HP's version of LTO technology includes a new feature called Adaptive Tape Speed (ATS), which varies the speed of the tape to prevent a *shoe-shining* effect, in which tape repeatedly stops and starts instead of streaming, which causes the tape to wear quickly. Shoe shining is common among linear-scanning devices such as LTO and SDLT tape drives. ATS should improve both performance and longevity when backing up or restoring a data set consisting of many small files. The HP LTO drive, however, was out-

performed by all of the other automated units on the restore test.

For those who are making the transition from a single LTO drive to an automated backup system, the HP StorageWorks 1/8 Autoloader's price and simplicity make it a solid choice.—*S. Jae Yang*

### Overland PowerLoader SDLT 320

Tested configuration, \$13,000 list. 800-729-8725, [www.overlandstorage.com](http://www.overlandstorage.com). ●●●●○

Are you looking for a lean, mean backup machine? The Overland PowerLoader SDLT 320 has the looks and durability of a Humvee and is equipped with only the essentials to back up lots of data.

The impenetrable-looking aluminum-alloy front bezel provides easy access to

the LCD control panel. Inside the black, 72-pound metal chassis is a simple robot that heartily shuttles tapes with no wasted movement. It would be hard to achieve a library design with fewer moving parts.

This entry-level backup library can be ordered with either dual SDLT 320 drives (our tested configuration) or dual LTO drives. Once you've loaded a 15-cartridge magazine, you can back up 2.4TB of uncompressed data. And you'll do it quickly; the PowerLoader had the second-fastest backup throughput rate among the automated systems we reviewed.

The inherent simplicity of the PowerLoader makes for an easy installation. But some heavy lifting on the part of two people is required to rack-mount the device.

## SUMMARY OF FEATURES

### Single-Tape Drives

download at [www.pcmag.com](http://www.pcmag.com)

	HP Ultrium 230e	HP Ultrium 460e	Quantum SDLT 320	Seagate Viper 200	Sony SDX-D700C
List price	\$4,955	\$4,775	\$4,995	\$4,995	\$4,225
Tape formats	LTO (Ultrium 1)	LTO (Ultrium 2, 1)	SDLT 320 (Super DLTape 1), DLTape IV (read only)	LTO (Ultrium 1)	AIT-1, AIT-2, AIT-3
Native capacity	100GB	200GB	160GB	100GB	100GB
Compressed capacity	200GB	400GB	320GB	200GB	260GB
Buffer memory size	16MB	64MB	16MB	64MB	18MB
Interface	Ultra Wide SCSI-2 LVD	Ultra SCSI-3 LVD	Ultra Wide SCSI-2 HVD/LVD	Ultra Wide SCSI-2 HVD/LVD	Ultra SCSI-3 LVD
Connector	68-pin shielded HD-68	68-pin shielded HD-68	68-pin shielded HD-68	68-pin shielded HD-68	68-pin shielded HD-68
Termination	Automatic	Automatic	Termination plug	Termination plug	Termination plug
Dimensions (HWD, in inches)	4.8 x 8.2 x 11.7	4.8 x 8.2 x 11.8	6.3 x 6.9 x 12.8	6.8 x 7.5 x 12.0	2.5 x 7.8 x 9.7
Weight (pounds)	11.7	11.7	21.0	9.5	5.3
Supplied drivers	Windows 2000, NT 4.0; NetWare 4.2, 5	Windows 2000, NT 4.0; NetWare 4.2, 5	Windows 2000, NT 4.0, XP	Windows 2000, NT 4.0	Windows 2000, NT 4.0, XP

RED denotes Editors' Choice. All of the devices have push-button SCSI ID change capability and built-in power supplies and fans.



# Tape Backup



To test backup and restore time and throughput, we used a test-bed consisting of a file server containing sample data, a connecting switch, and a backup server running the backup software. The backup server also held the database and media catalogs and provided the SCSI connection to our tape devices.

Our file server was an IBM xSeries 230 with a 1-GHz PIII and 1GB of RAM. The unit's ServRAID 4M Ultra160 controller was connected to a 64-bit PCI slot and configured for RAID 5. Each of the server's five hard drives ran at 10,000 rpm with 18GB capacity. The total data volume was 68GB and contained our 52GB workload. The data was handed off through a 64-bit Linksys Instant Gigabit Network Adapter EGI064 to a Linksys ProConnect II Layer 2 Management 4-Port Gigabit Ethernet Switch. Also connected to the switch was our backup server, a white-box unit with dual AMD Athlon 2200+ processors and 1GB of RAM. This server was equipped with a Linksys Instant Gigabit Network Adapter EGI064 and an Adaptec SCSI Card 29160 with an Ultra160 LVD interface. Both were connected via a 64-bit PCI interface for maximum performance.

Our test workload was a cross section of last year's *PC Magazine* production data. We used 129,111 files in 12,151 directories, which amounted to exactly 52,483,388,473 bytes (just over 52GB). We chose Veritas Backup Exec 8.6 because it is one of the most advanced yet easy-to-configure backup solutions.

## THE TESTS

We attempted to back up file-server data that closely represented a real-world mix of environments. This included a significant number of files that exceeded the 100K size of typical Microsoft Word or Excel files. The largest files in our tests were 133MB.

To prepare our backup server for testing, we did a clean installation of Microsoft Windows 2000 Server, which included Veritas Backup Exec. We wrote this setup to an image file using Symantec Ghost Corporate Edition 7.0 and then loaded it before installing each new tape device. We also added a verify pass, and we chose settings that would minimize the amount of data logging.

Our first test involved simple data backup (with performance efficiency measured in several ways), and our second measured data restore speeds, representing each unit's ability to find specific data on the tape and then write it back to disk. The restore test used data that was not located sequentially on the tape; thus it required tape forward and seek operations. We restored 97 files in 18 directories, totaling 157,187,873 bytes (just over 157MB).

For the automated devices only, we ran an additional test, which recorded how fast each one could inventory four pre-loaded tapes. This required each unit to load every cartridge into the drive and read its label.

▼ In backup time, the HP Ultrium 460e clearly excelled. Though the Sony SDX-D700C lagged far behind on this test, it was the clear winner in file restoration. The Quantum SDLT 320 was an all-around solid performer.

## A CLOSER LOOK AT THE RESULTS

In our tables, **backup time** represents the period during which data was actually being written to tape. During the **verify time**, the

## SINGLE-TAPE DRIVES

▲ High scores are best.  
▼ Low scores are best.  
Bold type denotes first place.

Tested tape format	MANUAL BACKUP (HARDWARE COMPRESSION ENABLED)				MANUAL RESTORE			
	Backup time (min:sec) ▼	Backup throughput (MB/min) ▲	Verify time (min:sec) ▼	Verify throughput (MB/min) ▲	Job completion time (hr:min) ▼	Restore data processing time (min:sec) ▼	Restore throughput (MB/min) ▲	
<b>HP Ultrium 230e</b>	LTO (Ultrium 1)	33:49	1,480	24:49	2,029	1:02	6:55	21.5
<b>HP Ultrium 460e</b>	LTO (Ultrium 2)	<b>27:29</b>	<b>1,821</b>	<b>12:22</b>	<b>4,047</b>	<b>0:41</b>	4:20	34.6
<b>Quantum SDLT 320</b>	SDLT 320	31:50	1,572	20:46	2,410	0:57	2:38	56.9
<b>Seagate Viper 200</b>	LTO (Ultrium 1)	42:58	1,164	22:11	2,256	1:09	5:50	26.0
<b>Sony SDX-D700C</b>	AIT-3	65:48	761	41:40	1,096	1:53	1:35	94.7

RED denotes Editors' Choice.

The PowerLoader lacks some of the features found in the other devices we reviewed, such as an Ethernet port, a Web-based interface, and a tape insertion slot, but it does have a bar code reader for identifying tapes. Because it lacks a remote monitoring and configuration application, the PowerLoader is not an appropriate solution for an unattended data center or branch office.

If you are invested in older generations of DLT or SDLT technology, the PowerLoader should be on your short list of products: However if you prefer LTO, Overland Storage can ship the Power-

Loader configured with LTO drives.

Overland's no-nonsense approach to data backup is exemplified by the PowerLoader's magazine design and control panel. The utilitarian design prevents misalignment of media and lets you electronically lock down the magazine. The control panel is simple and can be password-locked to guard against accidental or unauthorized access.

Although it lacks some of the fancier features of other libraries in its class, the PowerLoader's simple design makes it suitable for service as the in-house basis of your data.—S/JY

## Quantum ATL SuperLoader

Tested configuration, \$11,300 list. 408-944-4000, [www.quantum.com](http://www.quantum.com). ●●●●○



If you want to install an automated backup system and operate it remotely, the Quantum ATL SuperLoader is your robot. This 2U auto-loader has a built-in Ethernet port and a Web-based interface, features exclusive to libraries in the past. Its many features, strong performance, and impressive capacity make the SuperLoader our Editors' Choice.

An operator can control and monitor



recorded data was checked against the original source. The **job completion time** is the total of backup time, verify time, and all other overhead; this includes calibrating, positioning, and rewinding the tape, as well as the time the backup software required to process the request.

Comparison of the results revealed both significant and insignificant differences. LTO Ultrium 1 and SDLT devices all scored relatively close across the board on the backup test. SDLT devices had a slight edge in backup and verify operations.

Matters became more interesting when we examined the performance of the Sony AIT-3 devices. Both the single-drive Sony SDX-D700C and the automated Sony StorStation AIT Library LIB-81 were far behind all the other products in backup and verify speeds. This could take on real significance if your data volume is extremely large and your backup window is very small.

But both devices' restore speeds were far superior to those of the other products. And since restores are manual operations, this could save administrators a lot of time. When you have ten file-restore requests to process, the difference between 1.5 minutes and 6 minutes per request is no joke. This speed is due to Sony's Remote Memory In Cassette (R-MIC) technology, which uses a built-in chip to store catalog and file location information. This way, the tape need not be rewound for the device to read the catalog from the tape, as with DLT, LTO, or SDLT formats.

LTO Ultrium 2 is the newest technology in our roundup, and at

testing time HP was the only manufacturer shipping it. This format greatly reduces backup time—and especially verify time—compared with LTO Ultrium 1. Yet when compared with Quantum's SDLT technology, LTO Ultrium 2's overall performance advantage was not eye-catching. Restores were still considerably slower. Throughput can vary significantly depending on the mix of data, and most advanced backup applications offer plug-ins to back up databases or mail servers. Since such backups usually involve data from a consistent source, much higher speeds can be achieved. HP claims a native transfer rate of 30 MBps, a throughput we were not able to duplicate with our setup and data set.

The inventory test revealed relatively minor differences among the devices—with the HP StorageWorks 1/8 Autoloader in first place. But when we retested the Overland PowerLoader SDLT 320 with a second drive installed, it raced through the test in 3 minutes 50 seconds.—*Analysis written by Oliver Kaven*

Approximate file size	Number of files
10-100K	60,060
100-500K	24,087
500K-1MB	13,160
1-5MB	9,436
5-10MB	1,722
10-20MB	952
20-50MB	420
50-100MB	63
100-133MB	7

▼ Automated devices had to complete an additional inventory test. The HP StorageWorks 1/8 Autoloader completed this task fastest. But it was outperformed when we equipped the Overland PowerLoader SDLT 320 with two drives

## AUTOMATED DEVICES

Tested tape format	MANUAL BACKUP (HARDWARE COMPRESSION ENABLED)					INVENTORY OF TAPES 1 TO 4		MANUAL RESTORE	
	Backup time (min:sec) ▼	Backup throughput (MB/min) ▲	Verify time (min:sec) ▼	Verify throughput (MB/min) ▲	Job completion time (hr:min) ▼	Inventory time (min:sec) ▼	Restore data processing time (min:sec) ▼	Restore throughput (MB/min) ▲	
<b>HP StorageWorks 1/8 Autoloader</b> LTO (Ultrium 1)	36:54	1,356	28:49	1,736	1:10	<b>5:10</b>	6:23	23.5	
<b>Overland PowerLoader SDLT 320</b> SDLT 320	31:54	1,569	21:10	2,364	<b>0:59</b>	6:55 / 3:50*	4:06	36.6	
<b>Quantum ATL SuperLoader</b> SDLT 320	<b>31:47</b>	<b>1,575</b>	<b>21:06</b>	<b>2,372</b>	<b>0:59</b>	7:10	4:26	33.8	
<b>Sony StorStation AIT Library LIB-81</b> AIT-3	66:46	750	45:42	1,095	1:55	7:40	<b>1:38</b>	<b>91.8</b>	
<b>StorageTek L20</b> LTO (Ultrium 1)	42:54	1,167	22:05	2,266	1:10	6:40	5:45	26.1	

RED denotes Editors' Choice. \* When tested with two drives.

all of the device's components via the Web interface. And when it's packed with 17 SDLT 320 tapes, the SuperLoader boasts the largest amount of backup storage per unit of rack space among the automated systems in this roundup. In fact, if your backup needs do not exceed the SuperLoader's 5TB capacity, and if your tape rotation scheme does not call for swapping tapes, you will seldom have to interact with the unit after installation.

Setting up the SuperLoader is a breeze. Its base package includes the rack-mounting kit and one magazine. The unit we tested came with a second magazine

(\$1,100 direct) and a bar code reader.

Once setup is complete, the simple and intuitive control panel allows for easy configuration of Ethernet and SCSI settings. When you or the DHCP server has assigned the device an IP address, you can control all functions via the Web interface. And you can lock the manual control panel to prevent accidental or unauthorized access.

Quantum has designed the SuperLoader to allow rear-panel access to the drive carrier assembly, so you can replace or upgrade the drive without unmounting the device from the rack.

We appreciate the SuperLoader's interior design, in which the tape picker stays in place while the magazine rotates tapes according to the operator or backup software's instructions. While this active magazine costs more than the passive ones seen in other systems, the design choice was necessary to achieve the 17-tape capacity within a 2U chassis. You can preload the magazine with a batch of tapes, or you can feed in one tape at a time through the front-panel slot. The system's bar code reader enables the backup software to identify tapes instantly without reading the content.

## SUMMARY OF FEATURES

### Automated Devices

	HP StorageWorks 1/8 Autoloader	Overland PowerLoader SDLT 320	Quantum ATL SuperLoader	Sony StorStation AIT Library LIB-81	StorageTek L20
List price (tested configuration)	\$10,600	\$13,000	\$11,300	\$7,500	\$12,000
Tape formats	LTO (Ultrium 1)	SDLT 320, DLTape IV (read only)	SDLT 320, DLTape IV (read only)*	AIT-1, AIT-2, AIT-3	LTO (Ultrium 1)
Native capacity	100GB	160GB	160GB	100GB	100GB
Compressed capacity	200GB	320GB	320GB	260GB	200GB
Maximum number of tapes	8	15	17	8	20
Maximum number of drives	1	2	1	1	2
Drives can be SDLT/LTO/both	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	<input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	<input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/>
Number of removable magazines	0	1	2	0	0*
Interface	Ultra Wide SCSI-2	Ultra Wide SCSI-2	Ultra Wide SCSI-2	Ultra SCSI-3	Ultra Wide SCSI-2
Connector	68-pin shielded HD-68	68-pin shielded HD-68	68-pin shielded HD-68	68-pin shielded HD-68	68-pin shielded HD-68
Dimensions (HWD, in inches)	3.3 x 16.0 x 24.0	7.0 x 17.0 x 29.3 (rack), 8.0 x 17.3 x 29.3 (tabletop)	3.5 x 17.6 x 29.0	1.7 x 16.0 x 26.8	7.0 x 19.0 x 27.5
Rack height	2U	4U	2U	1U	4U
Weight (pounds)	26	72	50	29	48
Available drivers	Windows 95, 98, Me, 2000, NT 4.0, XP, .NET; HP-UX 10.x, 11.x; NetWare 5.x, 6.x	Windows 2000, NT 3.5, NT 4.0	Windows 2000, XP	Windows 2000, NT 4.0, XP	Windows 2000, NT 4.0
Interface for monitoring/configuration	None / None	None / None	Web / Web	Web / Web	Java / None
LCD status and configuration display/lockable	<input type="checkbox"/> <input type="checkbox"/>	<input checked="" type="checkbox"/> <input checked="" type="checkbox"/>	<input checked="" type="checkbox"/> <input checked="" type="checkbox"/>	<input type="checkbox"/> <input type="checkbox"/>	<input checked="" type="checkbox"/> <input checked="" type="checkbox"/>
Single tape loads via front slot	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Cartridges batch-load via front slot	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Automatic cleaning with designated cartridge loaded	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	N/A	<input checked="" type="checkbox"/>
Sequential or cyclical loading mode in hardware	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Bar code reader for cartridge identification	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
SCSI ID change via front panel/Web interface	<input checked="" type="checkbox"/> <input type="checkbox"/>	<input checked="" type="checkbox"/> <input type="checkbox"/>	<input checked="" type="checkbox"/> <input checked="" type="checkbox"/>	<input checked="" type="checkbox"/> <input checked="" type="checkbox"/>	<input checked="" type="checkbox"/> <input type="checkbox"/>
Drives removable with case closed	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>

RED denotes Editors' Choice. All of the devices have upgradable firmware. \* The system has a slide-out drawer for access to all cartridge slots. N/A—Not applicable; AIT drives do not require cleaning.

Like the Overland product, which also uses a Quantum SDLT drive, the SuperLoader outperformed automated systems with LTO Ultrium 1 or AIT-3 drives by a significant margin on the backup test. The SuperLoader backed up and verified 52GB of data in 59 minutes. On the restore test, however, the SDLT systems each took more than two and a half times as long as the AIT-3 system, but they required less time than the LTO units.

The SuperLoader had the fastest backup time (though it tied for the fastest job completion time) and the highest data density among the automated products reviewed. This makes it an attractive solution, particularly for space-constrained organizations or data centers.—S/JY

### Sony StorStation AIT Library LIB-81

\$7,500 list. 866-335-7669, [www.storagebysony.com](http://www.storagebysony.com). ●●●○○

Although the Sony LIB-81 can no longer boast the highest data density (the Quantum ATL SuperLoader now holds the title), those short on rack space will appreciate its minimal 1U stature and its still

impressive 2.08TB compressed-data capacity. But it will appeal most to workgroups that must frequently restore files; this is where the product really shines.

The LIB-81, which uses AIT-3 technology, has a slim silhouette made possible by its medium, a narrow 8-mm-wide tape that fits comfortably into a 3.5- by 2.5-inch rectangular cartridge. The LTO and SDLT media consist of a 0.5-inch tape in thicker 4-inch-square cartridges. The AIT-3 cartridges, however, are flimsier than their LTO and SDLT counterparts.

The LIB-81's AIT-3 drive did not stack up well against the SDLT 320 and LTO Ultrium 1 units on our backup tests. But it excelled at file access speed; on our manual restore test, it performed leaps and bounds above the other systems. Through Sony's Remote Memory In Cassette (R-MIC), the tape's search map is stored in a 64K chip embedded in the car-

### More on the Web

\* For more on tape backup rotation schemes, log on to [www.pcmag.com/networking](http://www.pcmag.com/networking).

tridge. This lets the AIT-3 drive locate desired files on the tape at high speeds.

Installing the LIB-81 is easy. Its front-panel LCD controls are easy to navigate, and its menus are intuitively organized, though the control panel cannot be password-protected. The unit's Ethernet adapter can be configured either with a static IP address or via DHCP.

Unfortunately, the Web interface is poorly designed and difficult to navigate. And some of the information it provides is so esoteric that only a Sony engineer would care. One example: Actual function calls that the library executes are reported in the history panel.

The library's internal mechanics are interesting to watch in action; an eight-tape carousel rotates around the single AIT-3 drive in the middle. And resembling a home audio component more than a backup system, the attractive LIB-81 looks almost too sleek to place in a rack. It is a nicely priced, effective machine built for unattended operation, and it restores files quickly. But for high-volume and speedy backups, we recommend the Quantum or Overland model instead.—S/JY

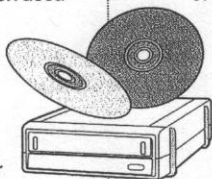


# Alternatives to Tape Backup

**W**here do the server's responsibilities end and the clients' responsibilities begin? This question in corporate computing applies to backup systems as well. If your organization accumulates a lot of corporate data on individual systems, you may want to forget traditional tape backup and move your solution to the client side.

Optical storage, online backup services, and network-attached storage (NAS) are alternatives.

Current optical storage media, such as DVD-R, are good for data archiving; they provide enough capacity to store a small backup set (9.4GB). But the nonrecyclable nature of DVD-Rs makes them unsuitable for day-to-day backup. And while DVD-RW, DVD+RW, and DVD-RAM are economical backup solutions, individual users remain responsible for putting backup rotation schemes in place and for keeping track of the media. With



individual tapes' total data capacity well below that of hard drives found in today's PCs, backups would often have to span multiple tapes, making these tasks even more of a chore.

Online backup services make more sense. Connected Corp. ([www.connected.com](http://www.connected.com)) and NovaStor Corp.

([www.novastor.com](http://www.novastor.com)) sell

subscriptions to their online services as well as server-side software that customers can deploy in-house.

Connected's client software, Connected TLM, scans for files that need to be backed up according to predefined rules such as file extension, age, or location, and once you've scheduled the backups, this once-periodic chore can largely be forgotten. We did not see any significant slowdown in our system while a backup ran in the background. Although the initial backup may last several

hours to a few days, subsequent backups take much less time and bandwidth, because only newly created files and changes are transferred.

Connected offers three types of subscriptions: individual, small-business, and enterprise. An individual account costs \$6.95 per month for 200MB or \$14.95 per month for 4GB. Small businesses can purchase 5 to 200 accounts, at about \$16 per month for each 10GB account. Connected reports, however, that most enterprise customers buy the server-side software, also called Connected TLM, and host it internally rather than subscribing to the Web-based service.

The pricing options are a lot simpler for NovaStor's NovaNet-WEB: \$17.95 per month for a 500MB base account and an extra \$9.95 per month for an additional 250MB. NovaStor also ships NovaNet-WEB Server for customers that want the online backup service in-house.

NovaStor's product and service are similar in features

and performance, enabling scheduled, unattended backup with minimal user interaction.

Sensing the opportunity in the client backup market, some NAS manufacturers ship their storage appliances with client-side backup software. Snap Appliance ([www.snapappliance.com](http://www.snapappliance.com)), a recent spin-off of Quantum, bundles its Snap Server 4400 with an unlimited-user license for PowerQuest's DataKeeper ([www.powerquest.com](http://www.powerquest.com)).

DataKeeper is designed to back up mobile clients to Snap Servers. Backup jobs run in the background whether or not a given client is connected to the network. When the client is offline, the backup job is buffered locally until the network connection is reestablished. Purchasing a NAS device bundled with such backup software is a quick and easy way to create an in-house client-side backup system for a smaller organization—from roughly 5 to 24 employees—while spending under \$10,000.—S/JY

## StorageTek L20

\$12,000 list. 800-786-7835, [www.storageetek.com](http://www.storageetek.com).

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Consider the StorageTek L20—an entry-level tape library device—the baby of the family. Its parent is Storage Technology Corp., a company much more focused on supplying behemoth backup systems to enterprises around the world. This focus on the higher end may explain some of the L20's shortcomings. It is not foolproof and requires the care and maintenance usually associated with larger systems.

We tested an L20 configured with one Seagate LTO drive, but it has room for two. And it has space for up to 20 tapes, the largest number of slots among the devices reviewed and thus provides up to 4TB of compressed-backup capacity.

One feature that sets the L20 apart from the other products is its support for two drives of different standards in the same enclosure. The library can be con-

figured with an LTO drive and an SDLT drive, for example.

The tape slots can likewise accommodate a mix of DLT, SDLT, and LTO cartridges. Tapes can be inserted through the Cartridge Access Port (CAP) in the front or by pulling out the cartridge drawer. But the drawer locks with a physical key—which could be a problem if you lose it. In addition, you cannot load tapes into arbitrary positions. You must consult the documentation and load the tapes in specific ranges of slots, depending on the total number of tapes and whether you need to use the CAP or the autoclean feature. Because the tape picker is exposed as you pull out the drawer, you must park the picker unit before opening it. The user manual repeatedly warns against mistakes that may result in equipment or cartridge damage.

Installation, on the other hand, is a smooth and unintimidating process. The

library can be configured and monitored using the LCD control panel, but the panel is not as user-friendly as those of the HP, Overland, and Quantum devices. It can, however, be assigned an IP address and connected to the network via the Ethernet port for accessing the optional Web-based monitoring tool.

The L20's most impressive features are its drive installation and upgrade flexibility. Rear-accessible drive doors allow an upgrade or installation without the need to unmount it from the rack.

Support for two heterogeneous drives makes the L20 ideal for organizations making the transition from one tape technology to another, or those in the unenviable position of using two different media formats. Still, anyone tempted by the L20 should keep in mind that it requires more management expertise than any of the other solutions in this roundup.—S/JY