This is the fourth in a series of short articles reviewing the theory and practice of making backups.

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Removable Media

The density of data storage on removable media has increased thousands of times in the last quarter century. For example, in the 1970s, an eight-inch word-processing diskette could store up to 128 KB. In contrast, at the time of writing (September 2001), a removable disk cartridge three inches in diameter stored 20 GB, provided data transfer rates of 15 MB per second, and cost around $100. Moore’s Law states that computer equipment power and capacity doubles every 12 to 18 months for a given cost; this relationship definitely applies to mass storage and backup media.

Diskettes

Because of the growing size of application files (e.g., an empty document created with MS-Word 2000 can take 24 KB – 1.6% of a 1.44 MB 3.5” diskette), old-style diskettes are no longer practical for any but the simplest manual backups. In addition, floppy disk drives are so slow that users revolt against requirements to do backups using this medium.

The modern equivalents of floppy disks are in fact hard disks, but they are almost the same size as 3.5” floppy disks despite carrying hundreds or thousands of times more data. For example, IOMEGA Corporation <http://www.iomega.com> is the leading provider of the widely-used ZIP diskette-like storage media with 100 MB and 250 MB capacities. Many PCs and servers being sold today (2001) include ZIP drives as well as or instead of 3.5” floppy drives. In addition, add-on drives are available as portable or in-system units with a variety of interfaces (SCSI, parallel port, and USB).

Large-Capacity Hard Disk Cartridges

IOMEGA also makes JAZ drives in 1 GB and 2 GB capacities. Their Peerless units provide cartridges of 10 GB or 20 GB and drives with a high-speed Firewire interface. Their DataSafe product, intended for servers, has capacities of 160 GB or 320 GB per unit.

Optical Storage

Many systems are now using optical storage for backups. Compact-Disc Read-Write (CD-RW) disks are the most widely-used format; each disk can hold approximately 700 MB of data and costs only a few dollars. The read/write drives cost a few hundred dollars in 2001. In addition, large numbers of CDs are easily handled using “jukeboxes” that apply robotics to access specific
disks from collections of hundreds or thousands on demand.

**Tape Cartridge Systems**

The old 9-track, reel-to-reel 6250 bpi systems used in the 1970s and 1980s held several hundred MB. Today’s pocket-sized tape cartridges hold GBs. For example, the industry leader in this field, StorageTek (<http://www.storagetek.com>) makes individual tape drives with uncompressed capacities of 20 GB, 60 GB, and 110 GB; compression typically doubles, triples or quadruples these capacities, depending on the nature of the data. Data seek can take 40 seconds; data transfer rates for such systems are typically in the range of 10-15 MB/second. Cartridges have mean-time-between-failure (MTBF) of 250,000 hours with 100% duty cycles and can tolerate 1,000,000 tape passes. All such systems have streaming I/O using about 10 MB of RAM buffer to prevent interruption of the read/write operations from and to the tapes and thus keep the tape moving smoothly to maximize data transfer rates.

In conjunction with automated tape library systems holding many cartridges and capable of automatically switching to the next cartridge, these systems are ideal for backing up servers and mainframes with TB of data. Small library systems keep 10-20 cartridges in position for immediate access (approximately 9 seconds for an exchange). These libraries have approximately 2,000,000 mean exchanges between failures with MTBF of around 360,000 hours at 100% duty cycle.

The largest library systems (e.g., the StorageTek L700) can have up to 678 cartridges loaded at once, up to 20 drives for concurrent access, and total capacities of up to 149 TB with compression. Total throughput can exceed 2 TB/hour.

In the next article, we'll look at labeling backup volumes.

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The author has no financial interest whatever in any of the companies mentioned in this article and references to products should not be construed as endorsement or recommendation.

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