CD Technology & LAN Storage Solutions:

Market Changes and Technological Advances Point to CD as the New Storage Standard

CD Technology--
The New Storage Standard

CD technology has witnessed explosive growth in the last few years and is now almost synonymous with multimedia and electronic publishing. Low cost CD-Recorders, media and jukeboxes are enabling CD technology to move into large storage applications once dominated by the WORM and Magneto Optical (MO) technologies. The presence of CD in large storage applications such as document imaging and COLD is gaining tremendous momentum as systems integrators are beginning to understand the inherent benefits of CD technology. At its current acceptance rate, CD will become the standard medium for archival storage on LANs within the next two to three years.

CD Technology's Price and Standards Advantages

CD Audio Legacy. CD-ROM publishing and CD-Recordable technologies have benefited tremendously from the standards and subsidies created by the Audio CD. The CD-Audio industry, fresh from the Beta/VHS video wars, created a logical and physical standard to enhance the adoption of CD-Audio in the consumer marketplace. In 1984 the standards were modified to give personal computers access to the technology, and CD-ROM was born. With CD-Audio mastering plants already in place for audio replication, CD-ROM quickly became the lowest cost digital delivery medium. In addition, CD-Audio drive manufacturers, with manufacturing lines established, enabled CD-ROM readers to be manufactured in large quantities at reasonable prices. Inexpensive replication, low drive costs, and the legacy of the audio standards created the initial impetus for the development of the CD-ROM publishing industry in the early 1990's. CD-Recorders are riding this economic wave in that they are actually modified CD-ROM readers. The CD-Recordable drive market has experienced and will continue to

experience significant price declines. In a few years, CD-Recorders will cost slightly more than CD-ROM readers and replace them as the standard storage peripheral in personal computers.

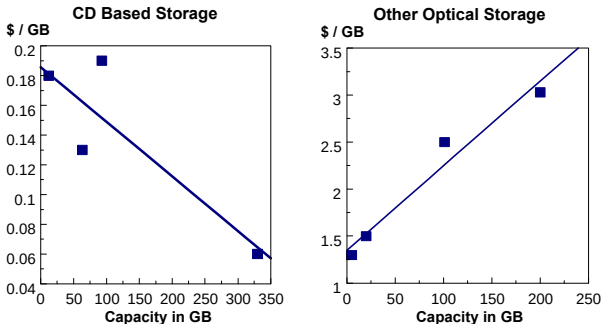
As a result of CD-Recordable technology, the CD-R disc is poised to become the equivalent of "digital paper." CD technology distinguishes itself in six major categories from competing storage technologies such as tape, WORM and MO:

Inexpensive Hardware Costs. CD is a unique computer storage medium in that its heritage, unlike other media, is from the consumer world. As a result, CD rides the cost curve of the CD audio industry. Today, retail CD-ROM drive prices have fallen to less than $200, while CD-Recordable drives are priced at $995 and expected to be less than $600 by the middle of 1996. In addition, CD jukeboxes, subsidized by the size of the audio and karaoke markets, are being sold at a cost of 30% of competing optical jukebox technologies.

Many systems integrators for document imaging and COLD believe that WORM and MO jukeboxes are more economical than CD jukeboxes for very large storage applications. Recent product introductions and improvements in CD jukeboxes allow for equal or better performance than optical jukeboxes, for large storage applications. And due to the compounding price advantage of CD jukeboxes, they become significantly more economical versus WORM and MO as the storage requirements increase.

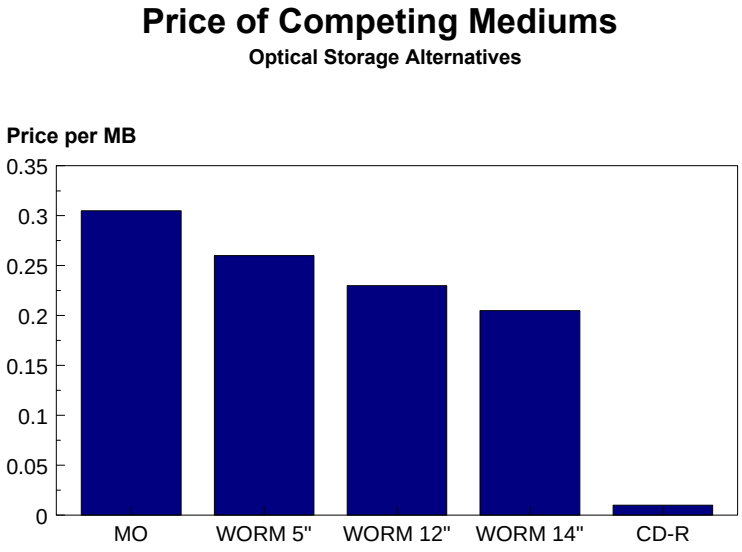
Media Costs. With capacities of 650 MB (or the equivalent of 450 floppy discs) and costs of about $6 per blank disc (or less than $.01 per MB), **CD-R has the lowest cost per MB** of any randomly accessible media available today. WORM is approximately six times more expensive than CD on a cost per MB basis and MO is thirty times more expensive. With this capacity, the media can store approximately 20,000 scanned pages at a price of $.0003 per page. The newly announced Digital Video disc, the next generation CD, will have capacities of up to 9 Gigabytes and will store up to 7 hours of digitized high definition

CD Jukeboxes Versus Other Optical Jukeboxes



video. With media prices for blank CDs expected to fall to $3 and capacities increasing, the price/performance of this media will dominate other archival storage media in the next decade.

As companies look to replace microfilm or paper with optical storage, the cost of the electronic media becomes extremely important. In the past, the high cost of WORM and MO have precluded companies from adopting electronic document imaging systems or COLD systems. CD media prices are comparable to microfilm on a cost per image basis. The low cost of CD allows more companies to justify COLD and document imaging applications on a return-on-investment basis.



Interchangeability. CD is the only storage technology that is interchangeable across hardware and across platforms. Because of this standardization, a CD made on *any* operating system using *any* CD-Recorder can be accessed from *any* computer using *any* CD-ROM reader. The standard logical and physical interchange format of CD is especially important for companies wishing to archive information, since it minimizes technology risks from changes in operating systems and hardware in the coming years. WORM and MO are hardware and software proprietary, and provide no flexibility or scalability to meet changing customer needs.

Random Access. Archival storage media such as tape does not allow random access to any file on the media. This means that data is sequentially retrieved leading to delays up to potentially several minutes between data access. Compact Disc, on the other hand, is randomly accessible, allowing access to any byte of data within 150 milliseconds. CD's random access makes it highly suited for large storage applications (such as archiving, document imaging

and COLD) where the jukebox switching time is more critical than the access time of the reader.

Longevity. In order to store digital documents for significant periods of time, the medium must be stable enough so that data can be accessed in the future. Magnetic media, such as tape, is not stable for more than a year and requires constant updating if it is to be used for long term storage. Due to its physical write-once nature, CD is extremely stable over time. Stamped CD-ROMs have life cycles of up to 250 years, and CD-R media life-cycles are in the 25 year range. In addition, the non-erasable nature of CD guarantees a legal audit trail to prevent fraud, for security-minded institutions such as banks and insurance companies.

Multimedia capable. Unlike other storage technologies, CD's audio heritage guarantees a constant, synchronized stream of audio and video. The technology is extremely suitable as a storage medium for the future when data, audio and video will be delivered digitally.

Why CD Technology Has Been Limited as a Storage Medium

With all of the previously mentioned advantages of CD-R technology for archival storage, why isn't the use of the technology more widespread?

Historical Costs. In the early 1990s, when systems integrators involved with large storage applications (such as document imaging, digital imaging and COLD) evaluated storage technologies, CD-Recordable was too expensive and immature. CD-Recorders and software were priced at $50,000 and media costs were over $80 per blank CD-R. In addition, CD-Recording technology was burdensome and inaccurate. The shelf life of CD-R media was approximately 90 days, suitable for "one-offs" for premastering, but not appropriate for archival storage purposes. As a result, the technology was quickly dismissed and WORM, despite

its proprietary structure, became the industry standard for archival storage.

Complexity of CD-Recording Technology. CD-Recording software was initially developed to assist CD-ROM publishers in making "one- offs" before sending the data to a mastering plant for replication. Consequently, the software tended to be too complicated and sophisticated for users to write data as if writing to a hard disk

Absence of Read/Write CD Jukeboxes. The ability to read and write data simultaneously to a jukebox on the network is an important component of large storage applications. WORM and MO jukeboxes inherently allow for simultaneous reading and writing of data. Until recently, users of CD had to make CDs with a CD-Recorder and then place them in the CD jukebox by hand. In many large storage applications, the unavailability of a viable CD-Recordable jukebox has limited the technology's use.

Absence of Viable CD-R Storage Management Software. CD-ROM networking products traditionally have not been geared for large storage applications. Typically CD-ROM networking products allow for access of published CD-ROM applications by presenting each CD as an icon. Large storage applications, on the other hand, require the data to be presented as a file system. Furthermore, large storage applications require read-ahead, data, and directory caching to minimize jukebox thrashing in a multi-user environment. Integrated CD read/write software is also necessary to enable CD-Recordable jukebox technology to enter the mainstream of LAN storage solutions.

CD-R Technology and Smart Storage Software Advancements

Costs. CD-R technology is the clear price/performance leader in the archival storage segment when compared to WORM and MO. This trend will be accelerated by CD's continued price decline.

CD-Recording Technology. Recent advances in CD-Recording software by Smart Storage allow for fully ISO compatible incremental writing. This lets users write data directly to CD-R as if writing to a hard disk, without premastering software. Users can write small amounts of data, and write again without incurring large amounts of overhead per writing session. This capability shifts CD-Recording technology from a publishing to a storage paradigm. It enables CD-Recorders to move into the mainstream computer segment and, at the right price, replace the CD-ROM drive as the standard large storage peripheral. In addition, Smart Storage has introduced software which lets organizations share CD-Recorders on their local area networks. For high-volume CD-Recording applications, Smart Storage provides enhanced network software to allow for unattended, automated operation of fast CD-Recorders and disc autoloaders.

CD-Recordable Jukeboxes. Because CD-Recording is sensitive to vibration, CD jukebox manufacturers have had to sheathe CD-Recorders in their jukeboxes in order to allow for combined CD-Recording and jukebox movements. Currently, only Pioneer, NSM Jukebox and DISC offer viable CD-Recordable jukeboxes. There are expected to be a plethora of inexpensive CD-Recordable jukeboxes available in the marketplace by the fourth quarter of 1996.

Storage Management Software. Over the last two years Smart Storage has introduced products for large scale CD-based storage. These products allow for multiple jukeboxes to appear as large hard disks on your network via Novell, Windows NT, UNIX or peer-to-peer LANs. Recently introduced products allow integrated reading and writing in CD-Recordable jukeboxes. This software

technology will position CD into the mainstream of large storage applications.

CD-Recordable technology enjoys tremendous standards and price advantages versus competitive optical technologies. As CD-Recordable jukeboxes become more prevalent and as costs decrease, CD-R will dominate the archival storage segment.

Evolution of CD-R in Archival Storage

Early Adopters - Law Firms for Litigation Support
The litigation support segment was the first defined segment to use CD as an archival storage medium in 1993. The nature of large corporate litigation is that tremendous amounts of paper are generated, many corporate general counsels and law firms are involved, and the clerical problems and costs associated with managing the paper are tremendous. Sophisticated service bureaus recognized that the economics of litigation were ideal for document imaging. These service bureaus scanned documents (up to five million in some cases), wrote them to CD-R, and provided a turnkey document imaging system to enable lawyers immediate access to the documents. The costs associated with scanning the documents were shared across all of the law firms involved with the case. Furthermore, law firms saved significantly on the costs of having paralegals index and file millions of pieces of paper.

Replacement of WORM
CD-R replaced WORM as the medium of choice for service bureaus because CD-ROM readers and CD jukeboxes are inexpensive and standardized. Because WORM is proprietary, each site's hardware and software had to be precisely duplicated at the service bureau. In 1993, CD-Recorders were $20,000, but they were cost-justified by the service bureaus because the CD-Recorder could service all sites, minimizing the need to duplicate each site's hardware and software. Service bureaus, in essence, acted as vertical publishers and CD was the ideal medium because of its

low cost, the moderate number of duplicates required, and the low cost and availability of CD-ROM drives and jukeboxes. Today, over 800 law firms involved with corporate litigation are running CD-based document imaging systems.

In 1994, as the price of CD-Recorders fell to under $10,000, additional market segments emerged. Corporations that wanted to archive and/or disseminate large amounts of internal information looked to CD as a replacement for microfilm. Whereas document imaging involves a complicated scanning process, this data was already in electronic form, generally on a mainframe. Corporations looked to CD to reduce their mainframe storage costs and to increase productivity by providing for faster access than microfilm. Large companies generally have many office locations requiring this type of information and CD is an ideal dissemination technology. Each site need only have a networked CD-ROM reader or jukebox, and each personal computer attached can access the information. Thus, productivity is increased and costs are reduced.

Today, CD-Recorders are priced at under $1,000 and falling fast. All types of companies, including banks, manufacturers, insurance, and service companies, are adopting the technology to archive and disseminate all types of information to their customers and employees. The technology is revolutionizing the information industry on the same scale as the printing press. Instead of paper, the information types are check or document images, pictures, large data files, and video. In the near future, as CD-Recordable jukeboxes become more robust and available in varied configurations, CD technology will become a mainstream archival storage technology--the electronic filing cabinet for large scale document imaging, workflow, prepress, COLD, and hierarchical storage management (HSM) applications.

Recent Adopters - Commercial Banks for Check Imaging

Prior to the advent of CD technology, the banking industry used microfilm to distribute check images to customers who generated more than 15,000 checks per month. For other customers that required access to specific image data sets, banks typically provided dial-in access to mainframe-based electronic archives.

Maintaining these archives, as well as moving data to microfilm for distribution, proved to be a time consuming, laborious process for both banks and customers. Immediate access to a specific check--even just to verify a deposit date, endorser's name, or for tax purposes--was impossible.

Major banks have already accepted imaging into their solutions--and now they're looking for a storage solution to replace paper and microfilm. CD-R technology offers benefits to a variety of check imaging applications. CD is ideal for storing check images, because it's a random access medium that is platform and application independent. A single CD can hold over 30,000 check images. Using low-cost CD jukeboxes and SmartCD software from Smart Storage, it's possible to provide access to millions of check images at a very reasonable cost.

Distribution of CD-based data is also easy, because front-end software can be included on disc and read on any machine. The ongoing evolution in CD technology provides banks with the ability to deliver new levels of customer service and accessibility to check image information. The payoff is less manual interaction, lower overhead and increased customer satisfaction. A side benefit to banks is the reduction of check fraud, because data written to a CD cannot be deleted or changed.

Fleet s CD Solution. The banking industry is already identifying areas where CD technology has a particularly good fit. Fleet Bank of Boston, Massachusetts, is an excellent example of the use of this technology for check imaging, and is already investigating its use in other core business functions. While Fleet offers its customers the option of receiving check image data on CD (in addition to remote access or microfilm), they took the process one step further by developing a user-friendly application that enables customers to access check-image information scattered across several CDs by simple form-based querying. This search and retrieval engine is included with all CDs distributed.

As one of the first banks to embrace the move to CD-R storage, Fleet is already reaping the benefits. They maintain archives of check images on CDs in jukeboxes, which are effortlessly accessed

from CD jukeboxes over the network. They are delivering CD-based data to customers that demand easy search and retrieval, and thereby eliminating the need for dial-in access. Fleet has entirely automated the production, creation, labeling and distribution of hundreds of unique CDs each week. The benefits to Fleet customers include:

- Long-term storage of check images
- Easy network access to check image data
- Ability to store much more data than previously possible
- Cost-effectiveness
- Increased responsiveness and customer satisfaction

In effect, Fleet, like other major banks moving to CD, is doing the job of a service bureau.

Future Applications at Fleet. In addition to check imaging applications, Fleet Bank believes that other functional areas with similar system characteristics are ripe for a CD-based solution. For example, cash management or proof of deposit applications that involve both an imaging and data distribution component are suitable for CD.

About Smart Storage

Smart Storage is the industry leader in CD storage software and is committed to applying emerging CD technologies to corporate enterprise networks. Our vision is to create high-performance, cost-effective storage management software that will lead the market into the 21st century. The company markets its desktop and network CD-Recording and network storage products through VARS, distributors and OEMs.

With more than 15,000 sites worldwide, Smart Storage enjoys an enviable position in the CD industry. Our innovative solutions

have been adopted by major VARs, OEMs and systems integrators for large storage applications such as document imaging, COLD, CAD and prepress. In addition, we have major partnerships with a large and growing list of key technology providers who increasingly turn to us for CD storage software expertise.

Smart Storage is working with the premiere VARs and OEMs in document imaging and COLD who use CD technology, including Kodak, Data General, Andersen Consulting, Docutech, MicroBank and INSCI.

Smart Storage principals have been at the forefront of the CD wave since the technology's inception more than a decade ago. Our technologists lay claim to a number of industry firsts including:

- First to use CD technology for data dissemination 1984
- First low-cost desktop CD recording software 1992
- First network software for CD storage 1993
- First integrated read/write CD storage software 1995

The company's software products all are created to move CD into the mainstream of storage technologies. The company continues to pioneer network CD storage software for Novell, UNIX, Windows NT, and all PC LANs. Recently, the company introduced the first integrated read/write CD storage software for Novell and will shortly introduce similar products for Windows NT® and UNIX. The company is currently working on a file based CD-recording product to allow for standards based incremental writing. This technology, coupled with the company's CD storage software, will move CD Recordable jukeboxes to the mainstream of large storage applications by making the device look and act like an enormous hard disk.

Smart Storage is the only software company which offers cross platform CD-Recording and CD storage software and is uniquely positioned to drive the market for CD storage products. Smart Storage's leading edge software products and CD technology offer tremendous promise to revolutionize the network storage marketplace.

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