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Networking of CD/DVD-ROMS–An Overview

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Abstract

As the collection of CDs/DVD ROMs increases in a library, it becomes important for the librarian to manage and share them effectively. This article discusses the benefits of sharing CD/DVD-ROMs over a network and introduces device called CD libraries/servers for sharing CD title discs over a network. It takes a look at architecture and available technologies for above purpose and concludes by giving an overview of technologies and facilities available at LRDE library.

1. INTRODUCTION

Today CD-ROM has become a popular e-media for archival, retrieval and distribution of information. Now every possible title on commercial and technology products, entertainment, databases, education and business applications are available on CD-ROMs. The raising demand for multimedia applications, due to easy accessibility of PCs is also fuelling its growth.

2. BENEFITS OF CD/DVD ROMS

The success of CD/DVD-ROM over traditional removable storage media such as floppy disks, tapes can be attributed to following key factors:

Cross-Platform Standard—The ISO 9660 format for CD-ROM and Universal Data Format (UDF) for CD/DVD provides common file system specifications for these media to be read from multiple platforms and operating systems (Windows, Mac, Unix flavors, etc).

Capacity—A single CD-ROM can store up to 700-MB of data equivalent to 486 floppy discs and DVD storage capacity range from 4.7 to 17 GB.

Durability—Due to its physical write once nature; CD/DVD-ROM media are very durable and have extremely long shelf life. It can store data for significant period of time and are stable media for future access.

Portability—CD/DVD-ROM media is removable, compact and lightweight and can be transported inexpensively making it extremely cost-effective for software and data distribution.

Inexpensive—CDs are cheaper and replicating media is also simple and inexpensive making it most favourable media for software marketing.

Random Access—CDs/DVD ROMs provide random and quick access to information.

Multimedia Capability—CD/DVD-ROM allows different data types such as text, audio and video to be played in synchronized fashion. For example, an encyclopaedia CD/DVD-ROM can simultaneously show text and video clip while playing sound track.

As collection of CD-ROMs increase with in an organisation, for example in a library, the question now arises on how to effectively manage and control its information dissemination. The conventional method is to lend the disc to user or member to work on his PC, but this approach poses a number of problem such as keeping track of large number of users, to whom, and when it is issued, when to recall, replace the disc if

damaged or lost, etc. From librarian/administrator point of view, important aspect is of effective utilisation of disc information.

The objective of this article is to introduce CD/DVD networking technology and solutions to overcome above problems. By libraries, which are automated and have Local Area Network (LAN).

3. TERMS AND DEFINITIONS

Definitions of some terms used in this article are from Microsoft Press Computer Dictionary, Ed.3.

File server—file-storage device on a LAN that is accessible to all users on the network. Unlike a disk server, which appears to the user as a remote disk drive, a file server is a sophisticated device that not only stores files but manages them and maintains order as network user requests files and make changes to them. To deal with the tasks of handling multiple requests for files (sometimes simultaneous), a file server contains a processor and controlling software as well as a disk drive for storage. On LANs, a file server is often a computer with a large hard disk that is dedicated only to the task of managing shared files.

IDE—Acronym for Integrated Device Electronics. A type of disk-drive interface in which the controller electronics reside on the drive itself, eliminating the need for a separate adapter card. The IDE interface is compatible with the computer but offers advantages such as look-ahead caching.

SCSI—Acronym for Small Computer System Interface, a standard high-speed parallel interface defined by the X3T9.2 Committee of the American National Standards Institute (ANSI). A SCSI interface is used to connect microcomputers to SCSI peripheral devices, such as many hard disks and printers, and to other computers and LANs.

4. CD/DVD NETWORKING

4.1 Benefits

The benefits of CD/DVD networking are as follows:

★ Accessibility

By networking, the CD/DVD-ROMs, are made accessible on local area network (LAN) or intranet and the users/members have no longer to wait for their turn for using the disc until available as in the case of books in a library. Users on a network can simultaneously access the same CD/DVD-ROM and a single user can concurrently access multiple discs. CD/DVD-ROM networking solution provides the convenience of accessing multiple discs under single network.

★ Management and Control

CD/DVD-ROMs are managed from one central location and upgrades or revisions can be administered easily and quickly. Administrator has full control over the data that network clients are accessing. Periodic updates of discs are instantly available to everyone at the same time.

★ Security

As stated above central management gives administrator full control over CD/DVD-ROMs that provides increased security. Expensive discs and important data is not lost as the disks remain in charge of administrator and as a result damage, loss or theft can be avoided. By storing and sharing discs through CD/DVD-ROM libraries, the administrator can also control the access to information regarding whom to permit or not to permit.

★ Cost Saving

CD/DVD-ROM networking eliminates the requirement of multiple copies of same disc. An organisation can save money by purchasing 'n' network licenses to CD/DVD-ROM database or software instead of 'n' individual copies. The hidden benefits include cost savings from having individual disc-drive at each PC, reducing the need to replace the damaged or lost discs and hence increase in user productivity.

★ Productivity

Productivity of a user is increased, if he no longer has to wait for his turn for using the disc until available. A single user can access

multiple discs simultaneously without having to swap discs (as in his local CD-ROM drive). A single title may require multiple discs, for example some encyclopaedias require two discs and Bureau of Indian Standards require more than two discs depending on what standards library has purchased; imagine the time spent on changing discs for browsing each standard.

★ **Performance**

With available high speed network hardware and increased bandwidth, networked CD/DVD-ROMs are capable of achieving higher performance than the local disc drives by providing multiple users simultaneous access at hard disk speeds. The data on disc are mirror copied on to hard disk of a file server or imaging server (discussed later) and this data is accessible to user over the network.

4.2 Copyright

Not all CDs come with network license, hence license should be read before using the disc. Sharing disc on a network should not violate single user disc license agreement, if required extra network license should be purchased. Single-user license agreement allows using the disc information on a single computer by one person at a time and copy it solely for backup purposes. Also some CD-ROM applications may not run from CD/DVD-ROM library as they may rely on calls, which require access to an internal CD-ROM drive.

5. LIBRARY APPLICATIONS

Few examples of shared disc resources for library applications are:

- Supplement of documents such as books/journals/conference, etc.
- Encyclopaedias
- Courseware/tutorials
- Product manuals/catalogues
- Photos and clip art collections
- Standards
- Vendor information.

6. CD/DVD NETWORKING ARCHITECTURE

The hardware and software technology together for sharing CD/DVD-ROMs are called CD/DVD libraries or CD/DVD servers. The solution for CD networking can be differentiated by the way they are attached to a network and the technology that they deploy in order to deliver data across the network. There are basically two methods of connecting a CD/DVD-ROM networking solution to a network. These are: Server Attached Storage (SAS) and Network Attached Storage (NAS).

6.1 Server Attached Storage (SAS)

In SAS technology CD-libraries are connected to a network via general-purpose machine for file serving purpose (Figure-1). The clients then have to communicate with this file server for accessing information from CD-libraries. In this architecture, CD-libraries can be connected easily to existing servers via the SCSI interface. The benefits include high performance as the hard-disk is used to cache the CD/DVD-ROM contents hence the information is shared at hard-disk speed, i.e., the shared CD/DVD-ROM act as the extension of hard-disk. Maintenance and control is easy as the user is already familiar with the network operating system. As it depends on the general-purpose server, user requests have to compete with the server tasks, such as database serving, mail serving, print serving and many other house keeping functions, which may slow down the file serving. But this problem can be eliminated if the general-purpose machine is solely dedicated for file serving purpose. The CD-library has to be located close to the file server, and library software may be tightly coupled with a particular network operating system, which a user may not be having/using, for example we may be using Unix operating system but CD-library software could have been designed for Windows operating system. Also the CD-libraries become inaccessible when the file server is down.

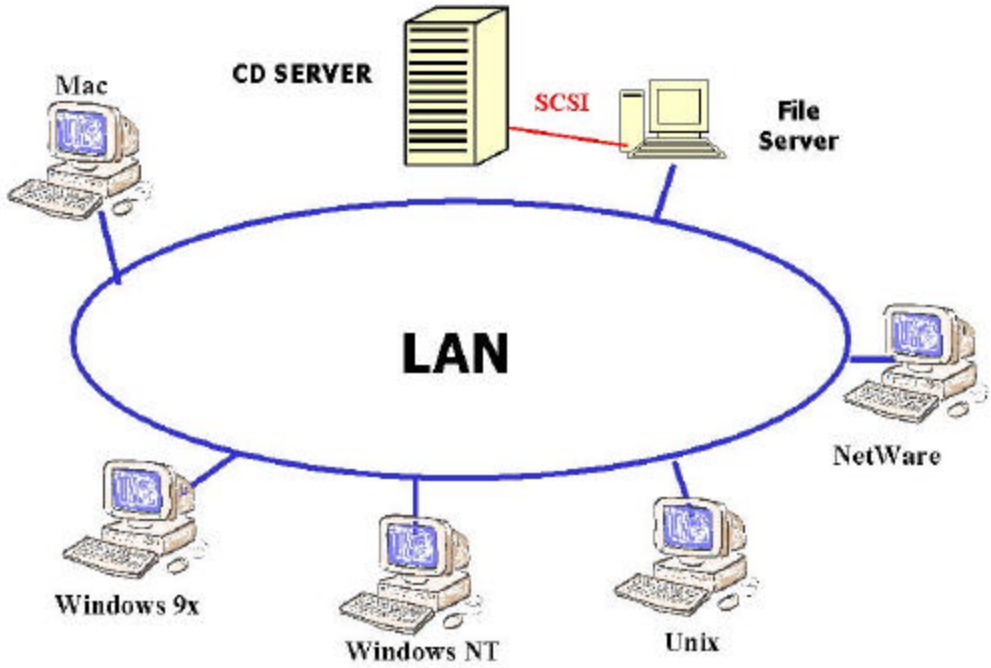

Figure 1. Server attached storage architecture

6.2 Network Attached Storage

In NAS technology, CD-libraries can be directly connected to the existing network as it is designed solely for file serving purpose (Figure-2). It comes with its own operating system, hardware and file system software for sharing storage resources. These are plug-and-play devices, which can be connected to any network port on LAN. NAS is optimized for only serving, storage, and protecting files. As it is not dependent on any other system, the control and management of CD-libraries can be done from client system on the network via a web browser. Client license for using CD-libraries is built-in with usually no restrictions on number of users but as in case SAS it depends on the file server (for example a Windows NT server with license of 20 users allows not more this number for accessing discs, extra license has to be purchased).

7. CD/DVD NETWORKING TECHNOLOGIES

A variety of approaches to CD/DVD-ROM networking solutions have been developed over the years. They can be broadly classified as optical disk and more recently hard disk based solutions. These are internal CD-ROM drives, Changers, Towers, Jukeboxs, Towers of Changers and Caching Servers.

7.1 Internal CD-ROM Drives

This is the most basic and the simplest possible approach. Librarians can connect a CD/DVD-ROM drive to computer via IDE, SCSI, EIDE or parallel port. There are two IDE drives on a computer's motherboard, first allocated to hard disk and second IDE can be used to connect two CD/DVD drives. The more reliable SCSI adapter card can support up to seven disc-drives. These disc-drives, when shared acts as a host for other computers on the network. Today's popular operating system supports these many drives. It is an inexpensive method and all the disc titles are available instantly and response is fairly good. Using internal CD/DVD-ROM drives is generally not a complete solution for networking as it lacks standard management, control and security. Multiple users may slow down the system and it is quite cumbersome to handle so many drives on a single system.

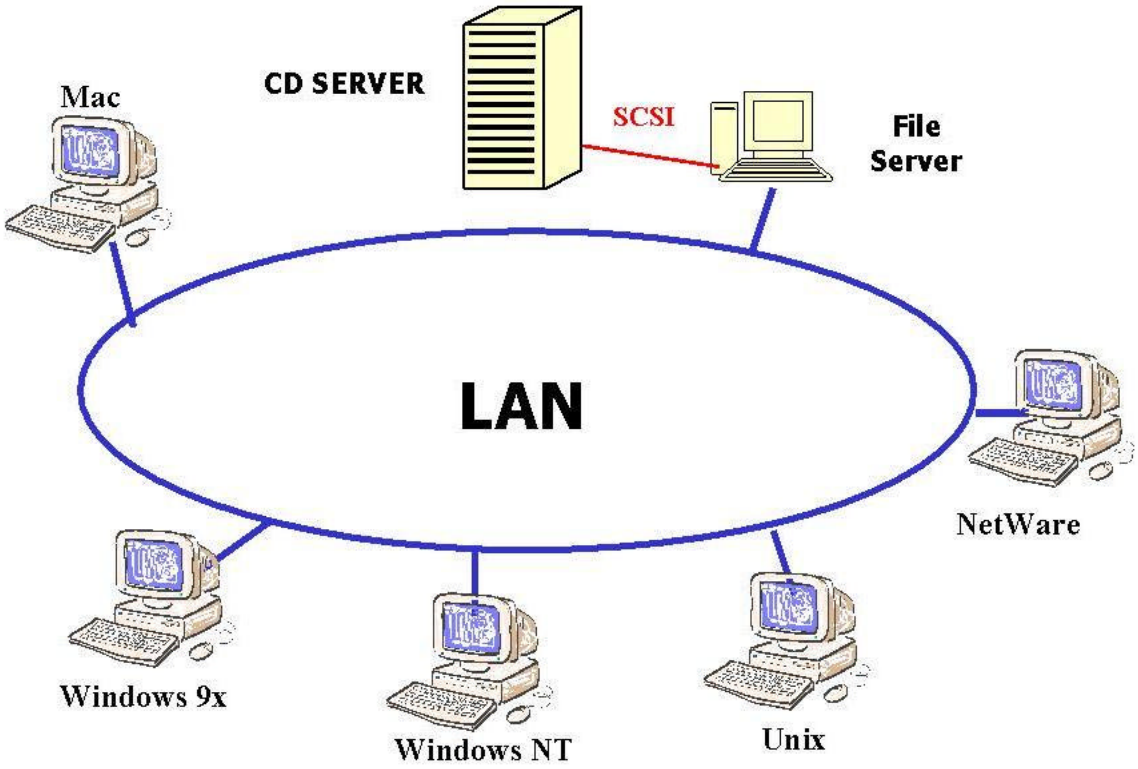

Figure 2. Network attached storage architecture

7.2 Changers

It is similar to multiple audio/video changers, the same technology has migrated to computer based discs. It is a physical unit with single disc drive and can hold a small number of CDs internally in slots for example five to six. These devices are typically connected to a SCSI or EIDE interfaces. These devices avoid shuffling of discs manually and they are fairly economical and reliable where the requirements are not too demanding. The disadvantage is that despite holding multiple discs there is still one drive and so only one disc title can be read at a time. There are time delays in swapping the discs in drive and performance can degrade in network environment with several client trying to accessing different discs.

7.3 Towers

It is separate unit with fixed number of individual CD/DVD-ROM drives arranged vertically or horizontally enclosed with power supply with drive-to-disc ratio 1:1. It is one of the popular solutions for sharing several CD titles. These tower supports discs in multiples of seven. These are excellent for networks since all the discs are available simultaneously to the clients on the network. These towers are connected to networks in two ways first connecting to server via SCSI controller and second directly connecting to the network. The tower comes in two physical shapes with drives arranged horizontally or vertical. The drives arranged horizontal are called racks, the advantage of this is that it takes less space and user can stack rack one above another with growing requirement (similar to left picture in figure 6). The network-ready towers are plug-n-play devices, which are connected directly to network port (Figure-3). These run independently from file server as it has in-built hardware and software for sharing devices and administration and management of a disc can be done remotely via web browser. Disadvantages of towers include limitations in number of discs and poor access time when more than one user tries to read the same disc. The head has to constantly move to different locations of the same disc resulting

in thrashing. Internally towers are provided with caches (RAM) to minimize this thrashing.

7.4 Jukebox

This is an excellent technology for accessing large number (over 200) of CD/DVD-ROMs. These are similar to changers except that they have more number of drives/readers and can store support up to 600 discs in a single enclosure (Figure-3). These devices provide the cost-effective means of handling large storage requirements. Jukebox are connected to computer by a special CD-server software for controlling the robotics that move discs from slot (also called cartridge) to drive or reader, providing single volume for multiple discs and hard disk caching for speeding disc access time. Pioneer jukebox comes with optional in-built CD/DVD-recorder for archiving purpose and JVC jukebox with optional disc label printer. As it is connected to the network server it can slow down the server with increased number of users because its performance depends on network server resources. Maximum number of users who can access the jukebox depends on the network server license (Windows NT, Novell, etc).

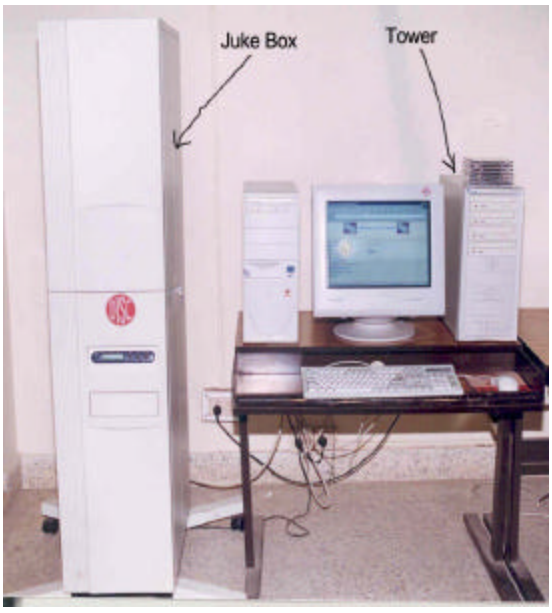

Figure 3. JVC jukebox and Todd's CD tower at LRDE library

7.5 Towers of Changers

This device contains multiples of five disc-changers with a reader (Figure 4). These are available in various configurations from 7 changers and 35-disc combination to 58 changers and 280-discs. A tower of changers with 280-disc capacity has 58 readers allowing 58 users to access simultaneously 58 unique disc titles. As these are combination of tower and changers hence the name. Having a relatively high drive-to-disc ratio (1:5) allows a large number of clients on network to use discs without waiting for along time and by providing many-to-many accessibilities to users. The difference between tower of changers and jukebox is that the former places the disc to drive in its respective changer where as later can place disc to any drive. Jukebox software is complex and expensive, which controls the robotics and manages a large number of discs. A tower of changers does not require expensive software for management. Tower of changers can be connected to network in two ways—connecting to server via SCSI controller; directly connecting to the network

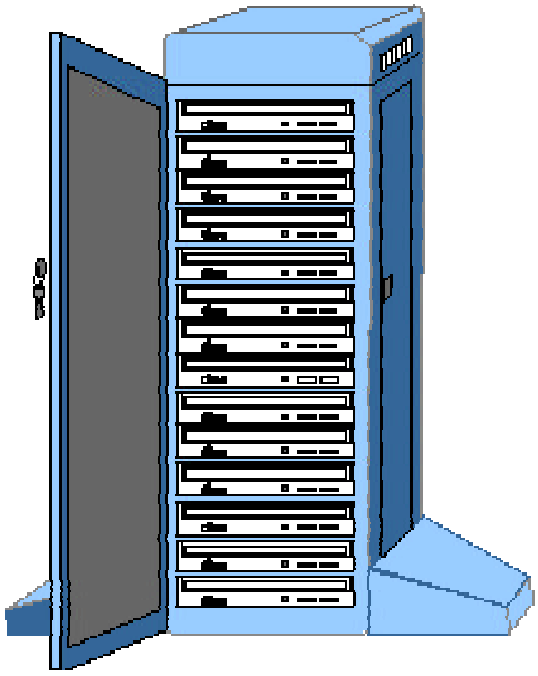

Figure 4. Towers of changers from M/S Kintronics CD-ROM technology

port. The cost/performance ratio of this device falls between the jukebox and tower.

7.6 Caching Server

With falling cost of hard disks, hard disks can be utilised for sharing CD/DVD-ROM information and this is what these systems do. They provide most cost-effective and highest performance solution for CD/DVD networking as they dramatically increases the speed, which facilitates multiple users on a network to access disc concurrently. Network client need not wait for disc to come to reader/drive as in the case of jukebox and towers of changer and there is no limitation on number of readers as in towers. Here sector by sector of CD/DVD is copied to hard disk and then it is used to deliver the disc information over the network. After copying the disc information on hard disk, discs can be locked for safekeeping. Access time and data transfer rates of hard disk are higher than that of optical solutions. Caching server technology is limited by capacity of hard disk rather than the number of CD/DVDs. Hundreds of users can concurrently access the same or multiple disc information without adversely affecting its performance. These devices usually consists of single CD/DVD-ROM drive and IDE or SCSI compatible hard disk with disc caching facility from 20 to 1000 CD/DVD volumes (Figure 5). Some vendors provide multiple disc drives (Figure 6), which can be attributed to: user can load several CD/DVD titles concurrently at a time; user may require combination of readers like CD drive, DVD drive, etc. These devices provide complete scalability, as storage requirements grow over time, this type of servers is readily expandable. These are network ready plug-n-play devices, operating independently from server. Management and control can be done from remote workstation via browser or client software. Physical space is required by bulk CD-tower and jukeboxes. The only down side is the time required copying the entire CD/DVD-ROM content to the hard disk. Approximately 2-5 minutes is the copying time for each CD, which is also a one-time process.

Figure 5. ServStation from M/S Prime Array System, Inc.

8. TECHNOLOGY AT LRDE

Electronics Research & development Establishment (LRDE), Bangalore library has collection of more than 450 CDs. CD collection keeps growing every year (Figure-7). Most of the CDs come as supplement to books and journals. Apart from this, the library has a good collection of CBT CD-ROMs, standard/specifications like BIS, JSS, ITU, conference proceedings, encyclopaedia, catalogues, etc. As the collection of CD-ROMs grew, the need for the jukebox, which helps any one connected to LRDE intranet to access any of the CDs,

Figure 6. Cyclone Z from M/S Excel Meridian Data, Inc.

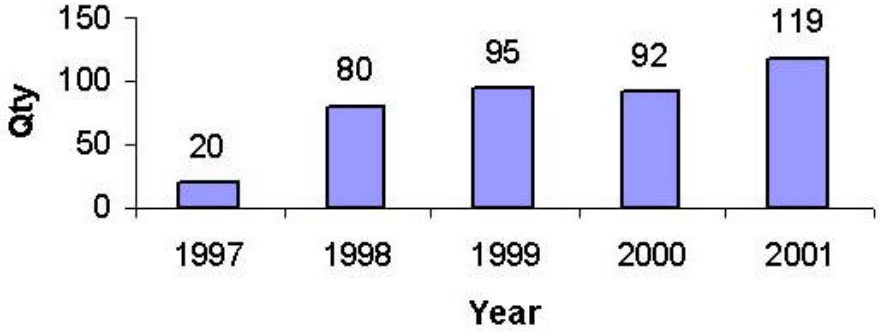

Figure 7. Year wise CD-ROM collection for books and journal supplements

there by eliminating the physical issue, was felt.

Some of jukebox's features are discussed below to know the working principle rather than to promote the product, this shall help readers appreciate technology much better.

- Jukebox is designed as a peripheral of a computer. The features include: Six CD-ROM drives, high-speed disc chang ing operation, compact design and large ca pac ity al lows max i mum of 600 discs to be loaded. Jukebox is software-based CD-ROM server, re quir ed to be con nected to Win dows NT work sta tion (or server) via SCSI con trol ler. Spe cial CD-server soft ware is required to be in stalled on Win dows NT PC, which in turn con verts it to a ded i cated CD-ROM server. SmartStor Ac cess ver sion 3.0 from M/s Smart Stor age is the soft ware that came along with Jukebox. It creates a file sys tem from all the avail able discs (from the juke box) and this file sys tem is avail able to network clients as a single drive. This makes jukebox full of discs looking like a very large net worked hard disk.
- Caching - SmartStor Ac cess soft ware al lows data to be cop ied from disc to the hard disk, and sub se quent re quests are quickly ful filled from the hard disk as data transfer rate of hard disk is faster than the CD-ROM. This facility also allows the disc-drive to fulfil request for other CD ti tles. Given be low are the types of caching supported by this soft ware:
  - File system cache—Here the files and directory listing of CD-ROM contents are stored statically on hard disk for faster information retrieval without loading disc on to drive, avoiding unnecessary delays and swapping.
  - Read-ahead caching—Here additional amount of data is cached on the hard disk along with requested data as user is likely to retrieve information that is located near his previous requests.
  - Express caching—This feature speeds up access to most frequently used or popular disc by caching its entire contents to hard disk
  - Selective slot caching—Software allows overriding the default cache settings of the disc that is not required to cache or to change the read-ahead amount.
- Statistics report helps in monitoring the sys tem, pin point the prob lems and mod ify the soft ware set tings. The features in clude num ber of times disc mounted/dis mounted on disc-drive, mounting and dismounting errors, etc. These features help in generating disc-usage re port on num ber of time a disc is used, most used disc, etc. which can be generated daily, weekly or monthly ba sis as per re quire ment.

Our director, who is very much-concerned about user interface, suggested to make CDs accessible via web browser. So we created a web site with search and browsing capabilities as shown in figure 8. VB Script was used to design web site and MS Access for database. CD catalogue is stored in MS Access with each record having link to jukebox corresponding to its title. If the CDs are browser compatible means that the contents of the CDs can be viewed from

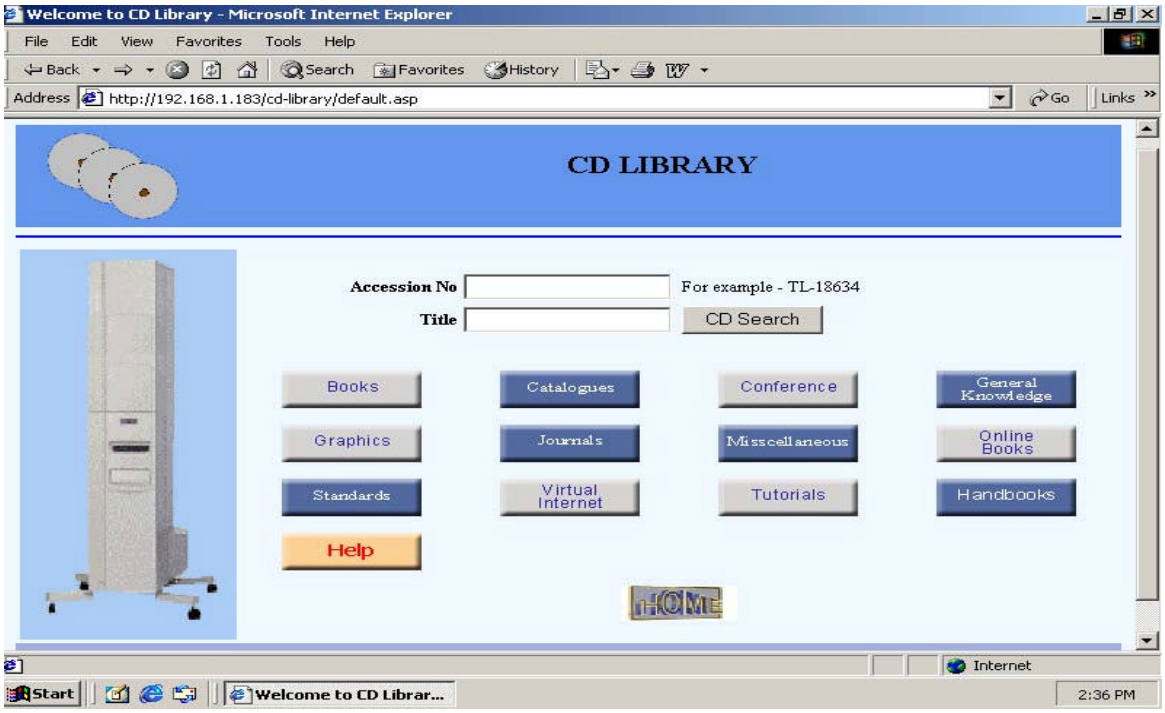

Figure 8. CD-ROM library website at LRDE

Internet Explorer or Netscape Navigator) then contents are accessible by clicking on the hyperlinks as shown in figure 9. Some CDs require installation on client PC to view its contents (like database, tutorials, etc.). The procedure for CD installation is to logon to remote PC, that acts as a CD server by searching the CD server in network

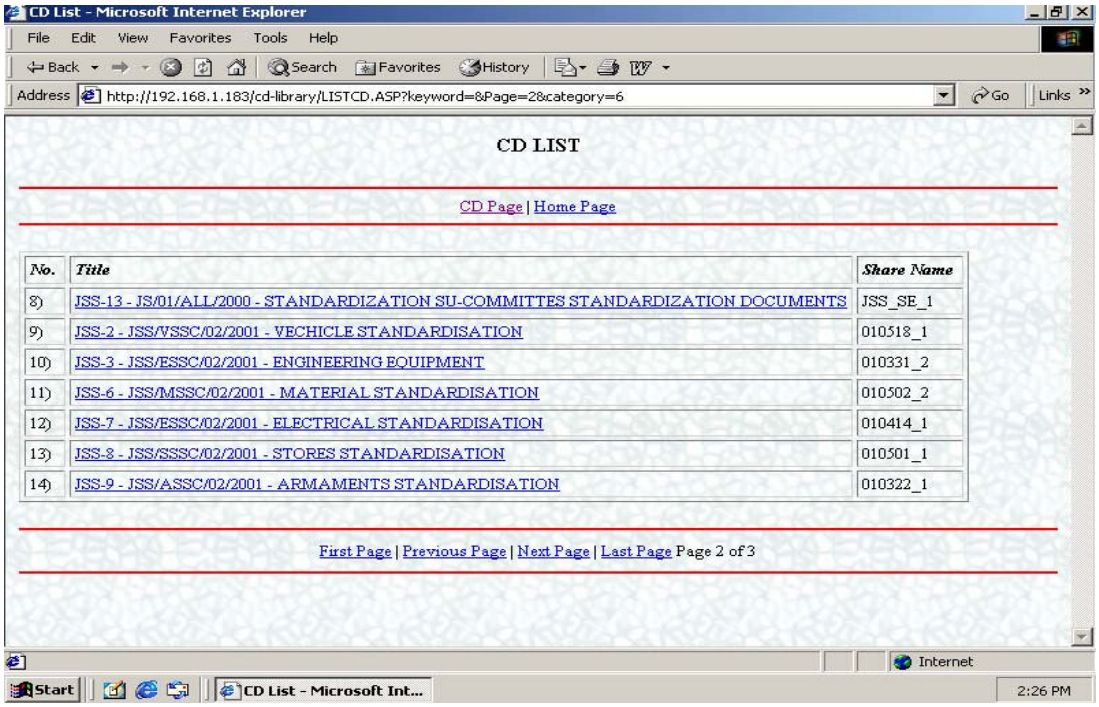

Figure 9. CD-ROM listing of standards

neighbourhood. Browse the CD server contents, which shows the CD titles. Map the required CD title to local drive by right clicking on the CD title. Unallocated drive letter is automatically selected. Then we can start using that mapped drive as local CD-ROM drive, computer allows us to map up to 26 CD titles (out of which first few are utilised for local disk drives e.g., A: floppy disk, C: for hard disk D: for local CD/DVD drive, etc). Mapped drives are available only when the host computer/CD server is available. You can assign a mapped drive to a different drive letter by disconnecting from the drive and then re-mapping it to a new drive letter.

9. CONCLUSION

Networking of CD-ROMs provides significant benefits such as easier accessibility, management and control, cost savings with increased security and productivity and so on. Libraries can benefit from CD libraries with their increasing budget and familiarity with automation. Librarians should understand their requirement, which is crucial in selecting the right technology; even combination of products can be used. Vendors can also help in choosing the product. Please note that we had shown each product from different vendor unbiased, these vendors actually sell all products (7.3-7.6) discussed, some of them are manufacturers themselves. Hence giving customer more room for customising.

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