CD-ROM NETWORKING: A CASE STUDY

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ABSTRACT

This paper is to examine the connection of a CD-ROM network implemented on a campus-wide network. A realistic situation of such system in the National Chiao-Tung University (NCTU) in Taiwan is used as an example to illustrate such connection. Technical aspects of a CD-ROM network are described and discussed. NCTU connects personal computers on an Ethernet network and uses a FDDI fiber optic network with TCP/IP protocol to access the NCTU library CD-ROM databases. Advantages of CD-ROM network are also discussed.

Introduction

The utilization of CD-ROM in libraries goes back to 1985 when Bibliofile was first announced by the Library Corporation. With the enormous storage capacity of approximately 600mb, CD-ROM has been gradually replacing some of the printed counterpart of indexes and abstracts. Many European and American academic libraries have started to subscribe to CD-ROM databases. Currently, there are over 86% of academic libraries which have CD-ROMs installed in their libraries.1

A major disadvantage of most of the CD-ROM workstation is that it can allow only one person to use a CD-ROM at a time.2 A CD-ROM network can remedy this problem and offer other benefits such as facilitating searches of databases containing more than one CD-ROM.3 A CD-ROM network, implemented on LAN using standard protocols such as ethernet, FDDI and TCP/IP, allows multiple users to simultaneously access the same CD-ROM disc. Academic libraries in Taiwan have not yet installed CD-ROM network. In the U.S., Dartmouth College Library has developed a system for accessing online databases via a campus-wide networks of Macintosh and mainframe computers and the Miami University Libraries have installed an ethernet local area network using Novell Netware which will be installed to provide multiuser access to multiple CD-ROM databases through selected workstations in the libraries. Dial-up access is available to users outside the libraries.4
The Theoretical Analysis of Library CD-ROM networking

Figure 1 shows library CD-ROM campus network environment of which a Personal Computer (PC) using ethernet and FDDI network protocol to communicate with each other.

![Diagram showing network environment](image)

Figure 1: Using FDDI as a backbone to connect an ethernet LAN

The following shows some kinds of communication modules.\(^5\)

1. **PC to PC**

   Any client-PC which runs on IPX protocol and a 386-PC as the CD-ROM server. This setting is recommended for installing in libraries.

2. **PC to Local Area Network (LAN)**

   This is the standard set up for a campus network because most libraries already have their CD-ROM drives on PCs connected to a LAN. A CD-ROM network usually have one PC installed as a server which is dedicated to running the CD-ROM drives and software. The PCs on the network can then access all of the CD-ROMs on the server. Figure 2 shows a client uses LAN workstation for DOS on IPX, TCP/IP.
and IP tunnel software through router to remote server. The CD-ROM server uses IPX protocol on this setting which is the model used at the National Chiao-Tung University Library CD-ROM campus networking system.

3. LAN to PC

A remote PC communicates with any PC on a LAN through the file server which has remote access features.

![DOS TUNNEL Diagram]

**Figure 2: National Chiao-Tung University Library CD-ROM campus network system**

4. LAN to LAN

Some LANs using routers or bridges to build a larger network as shown in figure 3. In this environment, a network can have several file servers which uses TCP/IP protocol to communicate with other networks through routers or bridges. Resources can then be shared more widely. This can be set up to support a CD-ROM network in an academic library.

**Library CD-ROM Network Module**

1. Hardware Module

A PC can access a CD-ROM reader by installing one in it or connecting it to a CD-ROM network. Most academic libraries in the U.S. and Europe already have PC-based LANs with CD-ROM capability. One of the challenges is to connect this local CD-ROM network to a campus-wide network. Although there are discussions
of establishing a CD-ROM network on ethernet protocol in Taiwan, there is not one set up yet now. However, it is easier to install a CD on one PC and attach it to the campus-wide network or to a VAX machine. Followings are some other options in a CD-ROM network.

Figure 3: Several IPX networks connecting to create a larger network.

a. PC access CD-ROM drives via LAN

A PC is connected to the LAN. The CD-ROM drives are attached to a LAN which allows multi-users to access the CD-ROM network simultaneously. Advantages are that the setup cost is usually affordable for many academic libraries and the installation is easy when a LAN is already exist. Disadvantages are that the speed of a CD-ROM is slow due to the CD-ROM drive and it is difficult to connect the CD-ROM network via campus-wide network router.

b. A CD-ROM PC server connection to a VAX using V/Server gateway

This connection to a VAX requires additional hardware, namely, "V/Server", which is developed by Virtual Microsystems. The V/Server contains four chips within one card which enable up to four users to have access to the CD-ROM drives simultaneously. The maximum is four cards
per VAX, therefore, there are only 16 simultaneous users per VAX. Figure 4 shows this type of configuration. One of the advantage of this setup include a PC running Vterm can login into a VAX and access to the CD-ROM network even though there is no LAN. The disadvantage is that VServer hardware and software is very expensive and VAX uses DECNET to communicate with PC, not TCP/IP. This will not work with TC/IP.

![Diagram of VAX Terminal, PCs, and Macintosh Users](image)

**Figure 4: VAX Terminals, PCs, and Macintosh Users Connect to VAX via V-Server/Gateway System**

c. CD-ROM drives on a VAX/VMS or Sun/Unix running NFS

NFS is a public domain network software which consists of two parts: the “server” part which runs on a machine that manages the CD-ROM drive and the “client” part which runs on a machine that access the CD-ROM drive on the “server” machine. Any PCs connected to a network running the “client” part of NFS can access the CD-ROM drive whether or not the network runs on a ethernet protocol. The advantage of this connection is obvious because the setup cost should be very low since NSF is free but special hardware is required on the VAX or Sun machine.
2. Software Module

Theoretically, if a LAN file server is connected to the ethernet and defined as a node on it, any PC with ethernet card running TCP/IP should be able to access it directly from the network to the CD-ROM drives. The LAN software will provide access to a CD-ROM drive for a PC. Following is some of the software programs which can be used in a CD-ROM network.

a. PC-anywhere

A network PC installed with PC-anywhere can be accessed by other remote PC. If the network PC is connected to a CD-ROM network, the remote PC can then access to the CD-ROM drives on the network.

b. V/Server Gateway

This software allows a network PC to be connected to a VAX but the software requires CD-NET.

c. Logicraft 386ware

A network PC is connected to a VAX, unlike V/Server, this does not require CD-NET.

d. Gandalf Data

A network PC access a CD-ROM network via TCP/IP but the access requires CD-NET. This software is quite expensive and may require technical experts in setting up in the library.

Practical Design Structure

As described above, each users on a CD-ROM network must have a PC with ethernet card and network software such as Novell Netware as well as CD-ROM network software such as CD-NET. The network software maps the network CD-ROM drives to a logical drive on a PC. Figure 5 shows the CD-ROM campus-wide network at the National Chiao-Tung University. The network consists of 13 CD-ROM drives and a 386 PC as a CD-ROM server.
Performance Analysis and Discussions

To analyze the theoretical performance of a CD-ROM network, it is assumed that the FDDI backbone's circumference is equal to a maximum distance of 200 km. The FDDI backbone runs at 100 MBps and each of its ethernet network runs at 10 Mbps. The ordinary delay for a FDDI station is 600 ns and the total delay for the 200 km token ring cable is 1.017 ms.\(^6\) Theoretical analysis calls on ethernet LAN concurrently, but each LAN also has a limit of the number of remote PCs. By reducing this limit from 281 to 140, it can be increased the maximum number of FDDI router from 10 to 21.\(^7\)

![Diagram of network structure](image)

Figure 5: Hardware structure of the National Chiao-Tung University Library CD-ROM Campus Network.

Using the above data, the campus-wide network can support 100 users who are able to access the library CD-ROM database concurrently. For normal testing, multiuser access to the same library CD-ROM database from the campus-wide network is faster than a local standalone CD-ROM workstation. It is because a dedicated server is needed to overcome the slow access time of
CD-ROM drive and to allow multiple users to access the same CD-ROM without appreciable delay. Large cache memory is frequently being used on a CD-ROM server in order to improve physical CD-ROM access time and to boost access speed for remote PCs. Therefore, data can be read from all drives simultaneously high dramatically increase performance during heavy network traffic. Memory caching is to transfer data from CD-ROM to RAM and thus reduce the time to access data from CD-ROM.

Conclusion

Ethernet and FDDI are a high performance and high bandwidth network system which can be used as the backbone of a campus-wide network. In this paper, the author has presented that an ethernet CD-ROM network, using a router, can be accessed to a FDDI campus-wide network which provides faculty and students access to the CD-ROM databases in the Library from remote PCs in their offices. Advantages of CD-ROM networks on a campus-wide network include:

1. It offers a practical high performance way to allow multiple users simultaneously access to a single CD-ROM.
2. Provide access to multiple CD-ROMs simultaneously.
3. Campus-wide network compatibility with most CD-ROM products.
4. Data access speed is faster than single user CD-ROM drives.

NOTES


