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SPECIALIZED SERVERS IN LOCAL AREA NETWORKS

SPECIJALIZIRANI POSLUŽITELJI U LOKALNOJ MREŽI

Summary: This paper discusses the idea of LAN attached computers' specialisation for narrow set of functions, offering specialised services to LAN participants. Case study of specialised server for CD-ROM contained databases is given.

Sažetak: Obrazlaže se ideja specijalizacije računala u lokalnoj mreži za obavljanje posebnog skupa funkcija i pružanje specijaliziranih usluga ostalim sudionicima mreže. Prikazana je izvedba specijaliziranog poslužitelja koji pruža usluge korištenja baza podataka smještenih na CD-ROM diskovima.

Introduction

For more than 30 years, the basic model of computing has revolved around large monolithic applications running on large, centralised mainframes. No matter what other technical or architectural innovations have become available, they either have been adapted to work with this basic model or discarded by mainstream information systems management. The reasons for the overwhelming loyalty of most IS professionals to this traditional model are no mystery. For most of the history of computing, hardware was complex and expensive commodity only cost-justified if it could be used to support large scale, mission critical applications. Furthermore, such hardware could be developed and supported by large, well-financed vendors focusing scarce technical resources on their own proprietary solutions. Once massive investments in traditional hardware and software were made by corporations, only a veritable revolution in the economics of computing would change their planning, implementation, and purchasing patterns.

Such a revolution has been underway for some time now, and has gradually undermined the foundations of traditional computing. If we had to sum it up in two words, they would undoubtedly be "cheaper hardware". Hardware prices have fallen drastically since the effective commercial introduction of the microprocessor. Of course, this new microprocessor hardware is not only cheaper, it is also faster, smaller, more energy efficient, more reliable, more modular, etc. However, the real net effect of all these additional benefits is that computer systems are now cheaper and easier to build, install and maintain.

No longer would IBM and a few other giants be the only hardware vendors able to afford the cost of building and supporting complete commercial computing systems. While no vendor has yet succeeded to completely replace the traditional computing environment, the more nimble ones were able to establish dominance in a substantial number of computing niches that had not previously been effectively addressed. The most prominent of these niches, desktop computing, is now larger than mainframe comput-ing itself.

The proliferation of so many new kinds of computing system inevitably raised the demand among users for these systems to be interconnected allowing data exchange and synchronisation of their activities. As the building blocks of hardware (processors, memory and storage) grow cheaper, smaller and more efficient, it becomes more effective to create scalable arrays of standard, modular components than to create new proprietary systems. In other words, the exactly same components are used to create anything from a user workstation up to a massive parallel processing database server. Similar trend of standardisation and modularisation in communications technology, as well as rapid increase in capacity, has given a possibility to create a highly scalable networking infrastructure that transparently ties together all processing units in an enterprise.

Specialisation

We have just described a brave, new world of scalable, interoperable hardware and transparent, enterprise-wide networking that appears, in terms of available technology, to be amazingly close at hand. However, even if this can induce us to migrate from our traditional hardware platforms to a new, networked solutions, it is very hard to succeed in abandoning our habit of centralist thinking.

More often than not, we could see local networks with only one server loaded with everything needed by all clients - databases, files, print services, communication services, etc. This is only a copy of old mainframe concept to the more available, cheaper hardware. While certain contemporary Intel based servers could compete in performance with mainframes, they are not designed with such all-purpose functioning in mind. Using them this way could result in poor performance and often disappointment.

As its name implies, a server is dedicated to offer some services to the clients in LAN. The more versatile these services are, the more complicated it will be to configure and tune its hardware and software for optimum performance. This makes us think about specialisation. Specialise the server to perform only narrow set of functions, and it could be tuned to do it with all its power.

Specialisation issue is not new, and has already been addressed by developers in computer industry. Today we can buy specialised servers for some common functions as complete, self-contained products: terminal servers, printer servers, communication servers, etc.

We will describe here a development of specialised server offering services of access to the CD-ROM resident data to the clients on the IEEE 802.3 standard based LAN.

CD-ROM troubles

CD-ROM becomes a very interesting media for mass distribution of large amounts of data. Their inexpensive production makes them very interesting for various purposes: multimedia, database, software distribution, imaging, etc. Last few years gave evidence of increasing interest for using CD-ROM resident data at the desktop. The vast majority of CD-ROM users are working at DOS based industry standard personal computers. Therefore, our research was directed toward this platform.

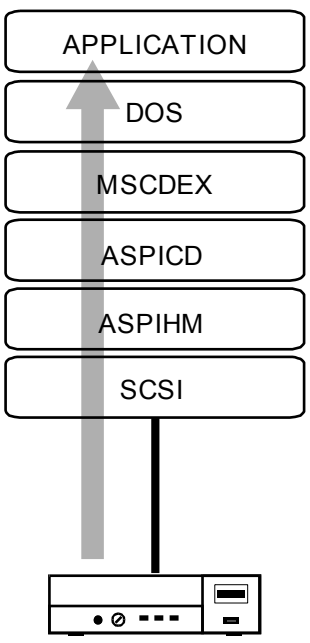

Figure 1.: CD-ROM drive at the DOS workstation

Common equipment used to enable desktop computer user to entertain CD-ROM based application consists of a CD-ROM drive, adapter card, cable and software modules needed to interface the drive to the operating system (Figure 1).

Contemporary CD-ROM drives are designed to comply with SCSI standard for interfacing with host computer. Software support for this type of drives comprises ASPIHM driver for SCSI adapter, ASPICD transport support and extension to DOS file system (MSCDEX) to support ISO 9660 and High Sierra standard formats of CD-ROM discs.

Connecting CD-ROM drive to the desktop workstation is convenient to the particular user of this station. He can easily access data and manipulate CD-ROM discs. However, if there is need for other users to use same CD-ROM discs, there could be troubles with this approach.

There is no possibility for two users to use the same disc at the same time. They could have two copies of CD-ROM, but it may not be always feasible. While CD-ROM disc is inexpensive medium, data stored on it could be very valuable and expensive. Also, sharing the CD-ROM discs involves manual interchange of discs (popularly known as "Frisbee-net"). Keeping track of disc locations is complicated as well. Increasing number of users makes the things worse.

Peer-to-peer solution

Having all this CD-ROM drives already installed at the workstations, and the workstations connected to LAN, it springs to mind that the easiest way will be just to make the CD-ROM drive visible to other users throughout the network. This way of thinking leads to an architecture shown in Figure 2.

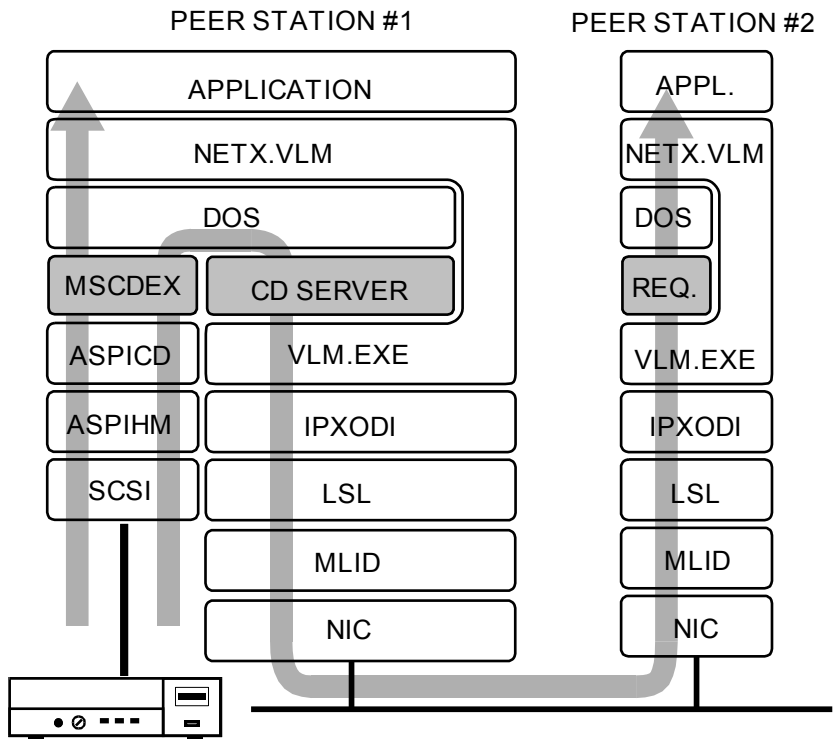

Figure 2.: Peer to peer architecture

Besides the already installed equipment (CD-ROM drive, SCSI adapter, ASPIHM driver, ASPICD transport and MSCEDEX file system extension), we need two more software modules:

- CD-ROM requester at the client station to request the CD-ROM resident data from the network, and
- CD-ROM server to receive requests, process them and send data to clients.

This architecture may be convenient for a small network with only few CD-ROM drives. In larger systems there will be a number of inconveniences.

1. There are three program modules needed to implement this architecture: CD-ROM server, client requester and DOS extension for CD-ROM (MSCDEX). Server and DOS extension modules should be installed in the network station that will function as a CD-ROM server. Every CD-ROM client station should have CD-ROM requester installed. Installation, maintenance and upgrading of such a system is becoming more complicated with increasing number of CD-ROM drives and their clients. These facts complicate the life of network administrators.

2. Accessibility of CD-ROM throughout the network depends on whether the particular server station is powered on and functional. Client needs to know the address of station serving particular CD-ROM title. As CD-ROM discs are removable, client has no guarantee to find the exact CD-ROM title mounted at the server station. These facts complicate the life of CD-ROM clients.

3. Network workstations (DOS based) are neither designed, nor configured, for multiuser operation. Memory space is relatively small so there is no room for enough disc cache buffers to speed up reading from CD-ROM. If more clients are accessing the CD-ROM, server program needs to maintain more request queues, spending more memory and processor time resources (Figure 3). Resources are taken from the resource pool available to applications at the server station, making applications less effective. Furthermore, DOS does not implement effective directory caching, making it slow in finding files in directories with large number of files, common to CD-ROM discs. These facts complicate the life of user at the server station.

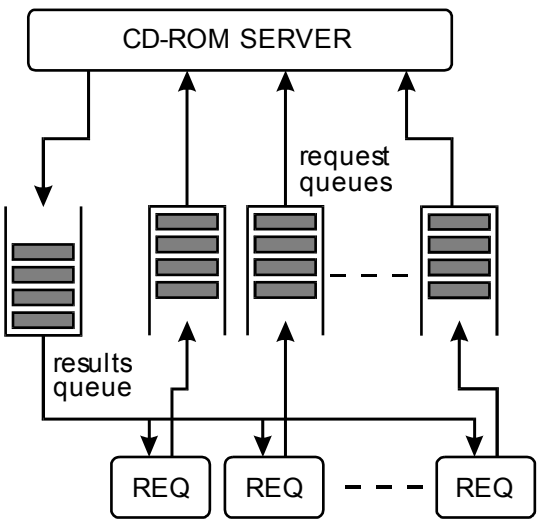

Figure 3.: Request queuing

In general, this solution tends to complicate the life of everyone involved. For a larger number of discs and users, there should be a less complicating solution.

The Specialised server solution

As a completely different solution, specialised server collects all the CD-ROM drives at the one place, and make all of them visible throughout the network simultaneously. Figure 4 shows an architecture based on this idea.

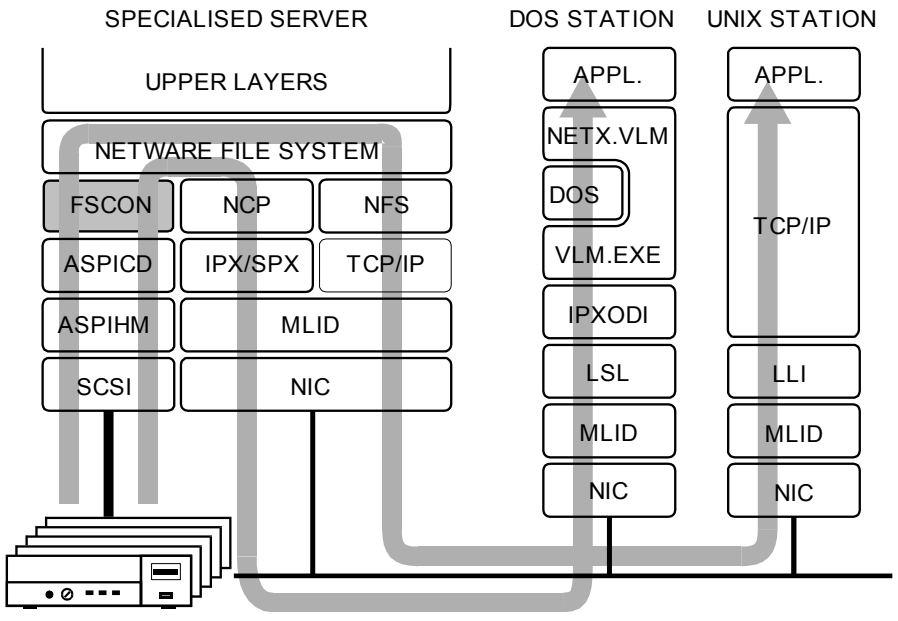

Figure 4.: Specialised server architecture

Let us discuss the possibilities of this architecture and advantages it offers to developers, users and administrators.

1. Only one software module actually needs to be developed - file system converter (FSCON). Its purpose is to translate ISO 9660 and High Sierra format of CD-ROM to NetWare file system. With this translation in place inside the server, client users on the network are seeing the CD-ROM disc as native NetWare volume. Being NetWare clients, they already have all needed support to access NetWare volumes, hence CD-ROM discs are accessible for them as well. No special software is needed at the client workstation to install, maintain or upgrade, not even MSCDEX. All software maintenance is performed at the CD-ROM server. NetWare operating system's modularity allows software upgrading and maintenance to be performed "on line", without bringing down the server itself.

2. Because of its dedication to serving users on the network, CD-ROM server will always be up and running during the work-hours of the network. Access to its services will not depend on whims of any particular user to switch off his workstation. All CD-ROM titles are collected at one place, so there is no need to keep track of their locations. Since CD-ROM server supports large number of CD drives, frequently used CD-ROM titles could be permanently mounted. Users who regularly use the same titles could have drive mappings embedded in their login scripts, so they will establish connection with needed CD-ROM discs automatically upon logging onto the network. Should user have need for CD-ROM title that is not mounted, he can send a request to server administrator to mount the particular title at the one of free drives. By further translation of native NetWare file systems the scope of CD-ROM's availability is significantly enlarged. Figure 4 shows that, by installing NFS module in the CD-ROM server, we can translate NetWare file system to Sun Microsystems Inc.'s NetWare File System. This will enable users at UNIX based workstations to access the CD-ROMs on this server as well.

3. DOS's inability to efficiently serve multiuser environment is here not an issue. NetWare, while DOS compatible, is designed for multiuser and multitasking environment and handles multiple disc access requests very efficiently.

NetWare implements disc caching and directory caching for better storage system performance. Since CD-ROM file system is translated to NetWare file system, CD-ROM drives are transparently supported by this features. NetWare allocates all unused memory for disc caching. If the server's memory is properly dimensioned, access to data on CD-ROM server could be faster than on the locally mounted CD-ROM drive.

Implementation

The architecture described above was implemented using the following of-the-shelf components:

- COMPAQ ProSignia 486/33 computer (486 processor at 33 MHz, 16 MB RAM, 330 MB hard disc);
- COMPAQ NetFlex 32-bit EISA NIC;
- Adaptec AHA 1740, 32-bit EISA SCSI host adapter;
- COMPAQ CDU561 CD-ROM drive;
- Novell NetWare v3.11 network operating system.

With these components it is possible to build the CD-ROM server with up to 28 CD-ROM drives in simultaneous use (up to four SCSI host adapters with up to seven devices per SCSI bus).

The FSCON module gives the essence that turns this collection of components into specialised CD-ROM server.

Installing the particular CD-ROM title onto server involves two steps: preparing structure files for translation of CD-ROM format to NetWare file system format, and mounting a volume.

Structure files are created by a MKSF (Make Structure Files) utility. This utility is loaded by administrator at the system console, with the following command:

LOAD MKSF <cd-drive_#> <volume_name>

where cd_drive_# is unique identification of the physical CD drive, and volume_name is name given to the new NetWare volume that will be created. The MKSF module analyses the CD-ROM disc in the specified drive and creates several files which are stored in the unique subdirectory of the SYSTEM directory on the servers SYS volume. The subdirectory is named volume_name, and files contain the CD-ROM disc structure converted to NetWare file system format. This files actually resemble the NetWare file system's FAT, DET and other tables.

Preparation of structure files is performed only once for particular CD-ROM title. Every title has to be prepared for mounting with its own set of structure files and unique volume name. After the structure files are made, and associated with particular drive and volume name, CD-ROM title could be mounted by standard NetWare console command:

MOUNT <volume_name>.

Afterthoughts

The idea of specialised CD-ROM server was conceived in summer 1992. Research and development lasted through spring 1993, when the first server was tested and put in use. In the meantime, the idea was evidently exercised in other places as well. Novell itself has developed CDROM.NLM module to support CD-ROM drives on NetWare servers. The main intention behind this development was to give support for CD-ROM based software distribution - Novell's as well as third party software. Therefore, it is not known by now how will this support behave in specialised server environment, supporting large number of drives. Few other vendors offered products to support multiple CD-ROMs on NetWare servers, and good ones too.

At least, we could say that we were on the right track with this development.

APPENDIX: List of used abbreviations

ASPI	Advanced SCSI Programming Interface
ASPICD	ASPI compliant CD-ROM transport
ASPIHM	ASPI compliant host adapter support module
CD-ROM	Compact Disc Read Only Memory
DET	Directory Entry Table
DOS	Disc Operating System
EISA	Extended Industry Standard Architecture
FAT	File Allocation Table
IP	Internet Protocol
IPX	Internet Packet Exchange
IPXODI	IPX protocol stack for ODI
ISA	Industry Standard Architecture
LLI	Link Layer Interface
LSL	Link Support Layer
MLID	Multiple Link Interface Driver
MSCDEX	Microsoft CD Extension for DOS
NCP	NetWare Core Protocol
NFS	Network File System
NLM	NetWare Loadable Module
NIC	Network Interface Card
ODI	Open Data-link Interface
SCSI	Small Computer Systems Interface
SPX	Sequenced Packet Exchange
TCP	Transmission Control Protocol
VLM	Virtual Loadable Module