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IBM Operating System/2 Local Area Network Server Version 1.0

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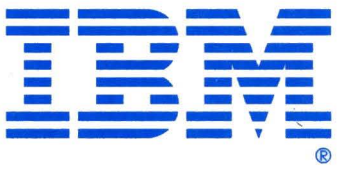

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Contents

Foreword

The IBM® Operating System/2™ Technical Update Seminars and their proceedings provide information about new product announcements and enhancements to existing products, and are intended to assist the application developers in their software development efforts.

Over the past several years, the success of the IBM Personal Computer family was due in part to the efforts of the software developers, whose products have become widely used. IBM helped these developers by holding relevant technical seminars and publishing proceedings of those seminars. The result was a mutually beneficial partnership and transfer of technical knowledge.

With the advent of the IBM Personal System/2® computer and its accompanying IBM Operating System/2, IBM's seminar program continues. Through these seminars and the corresponding proceedings, IBM will address the software developers' needs for technical information about the latest IBM products.

In this proceedings document, you will find technical information about the IBM Operating System/2 Local Area Network Server, including such subjects as:

- Network services
- Network devices
- Network administration
- Network access control
- Network application management
- Network messaging
- Network utilities
- Remote initial program load
- Migration and coexistence

Through the seminars and proceedings, IBM intends to maintain its partnership with software developers and assist them in successfully producing software products for the IBM Personal System/2 computer.

IBM Operating System/2™ Local Area Network (LAN) Server Overview

The IBM Operating System/2™ Local Area Network (LAN) Server provides comprehensive local area networking capabilities to interconnected IBM Personal System/2 computers or Personal Computers (running the IBM Operating System/2 system) on the IBM PC Token-Ring Network, IBM PC Network II, and IBM PC Network Baseband. The IBM OS/2™ LAN Server has increased function over the IBM PC LAN Program while providing server resources to that product. The IBM OS/2 LAN Server provides resource sharing for disks, printers, and serially attached devices, plus facilities for defining, controlling, and managing access to these local area network resources. The IBM OS/2 LAN Server includes features such as a high performance non-dedicated server, an advanced security system, print job management, and powerful network user/administrator interfaces.

Highlights of the IBM OS/2 LAN Server

The IBM OS/2 LAN Server incorporates the following features:

- Full support of the IBM Operating System/2 protect mode and multitasking environment
- High performance non-dedicated server takes advantage of the large memory support and protect mode operation of the IBM Operating System/2 system
- Installation and configuration facilities
- User and administrator interfaces
  - Full-screen interface consistent with Systems Application Architecture Common User Access
  - OS/2 command line interface
- Network software startup and shutdown
  - Manual-start and auto-start capability
  - May be stopped and restarted
- Access Control system modelled on the IBM Resource Access Control facility (RACF)
  - Concept of users and groups of users
  - Logon/logoff
  - Control of access to resources based on user identity
  - Generic resource profiles to simplify administration of access controls and to improve performance.
- Ability to share and control access to:
  - Disk directories
  - Disk files
  - Application programs
  - Printers and print queues
  - Serially attached devices and queues.
- Multiple servers supported as a single logical system
- Comprehensive administrative facilities for managing the IBM OS/2 LAN Server
  - Full remote control and administration of all system facilities from any LAN connected machine (server or workstation)
  - Network usage and diagnostics
  - Network auditing
  - Time-scheduled operation of server functions.
- Exploitation of the Presentation Manager print spooler function, with extensions to support networking function. The extensions include:
  - Start and stop times for print queues
  - Notification of print job completion
  - Print job separator pages
  - Queue priority.

- Network Application Management allows network administrators to create tailored application environments for each user or group.
- Network utilities
  - Network copy and move file utilities
  - Network help facility.
- Remote device sharing provides I/O level access to remote COM and LPT devices as if they were local
- User to user message facility
- Remote program execution enables users to run programs on a remote server
- Remote IPL of PC DOS
- Support of real mode applications under OS/2 DOS mode
- Compatibility with IBM PC LAN Program Version 1.30 requesters.

Hardware Supported

The minimum hardware configuration for the LAN Server Version 1.0 is as follows (unless otherwise specified):

- IBM Personal Computer or IBM Personal System/2 system unit as listed:
  - IBM Personal System/2 Model 50 (8550): Model 021
  - IBM Personal System/2 Model 60 (8560): Model 041 or 071
  - IBM Personal System/2 Model 80 (8580): Model 041, 071, 111 or 311
  - IBM Personal Computer AT® (5170): Model 099, 239, 319, or 339
  - IBM Personal Computer AT (5170): Model 068 with fixed disk to make the system unit equivalent to a Model 099.
  - IBM Personal Computer XT™ (5162): Model 286.
- One diskette drive (1.2MB 5.25-inch or 1.44MB 3.5-inch, high-capacity), as described here
- One fixed disk drive, as described here, with a minimum 20MB capacity if the requester function is to be installed or a minimum 30MB capacity if the server function is to be installed.

  Users needing large data bases, large numbers of programs and files, or execution of several concurrent applications should assure they have the capability to expand their fixed disk capacity above 20MB.
- Keyboard
- Display and associated display adapter, as described here (the mono-printer adapter is not supported).
- For use of the Communications Manager, add one or more modems or communications adapters supported by the Communications Manager.
- Local Area Network adapter as described here.

Devices Supported by the LAN Server Version 1.0

- Diskette Drives
  - IBM 3.5-inch diskette drive (720KB; #0357, 6450357) for the Personal Computer AT and Personal Computer XT Model 286
  - IBM 3.5-inch high-capacity diskette drive (1.44MB; #3057, 6450353) for the Personal System/2
  - IBM 5.25-inch diskette drive (360KB; #0207, 6450207) for Personal Computer AT and (#0360, 6450360) for the Personal Computer XT Model 286
  - IBM 5.25-inch high-capacity diskette drive (1.2MB; #0206, 6450206) for the Personal Computer AT; and (#0359, 6450359) for the Personal Computer XT Model 286
  - IBM 4865 Model 2 External 3.5-inch Diskette Drive (720KB)
  - IBM 4869 Personal System/2 5.25-inch External Diskette Drive (360KB) for IBM Personal System/2
  - IBM Personal System/2 5.25-inch External Diskette Drive Adapter (#8760, 6450245).

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XT is a trademark of the IBM Corporation.

- Fixed Disks
  - IBM 20MB Fixed Disk Drive for the Personal System/2 8550 or Personal Computer XT Model 286
  - IBM 20MB Fixed Disk Drive for the Personal Computer AT (#0205, 6450205)
  - IBM 30MB Fixed Disk Drive (#0210, 6450210)
  - IBM 44MB Fixed Disk Drive (#3046, 6450354)
  - IBM 70MB Fixed Disk Drive (#3051, 5450355)
  - IBM 115MB Fixed Disk Drive (#8730, 6450377)
  - IBM 314MB Fixed Disk Drive (#6023, 6450381).

  One of the adapter and display combinations listed here:

- IBM Personal Computers AT and XT Model 286
  - IBM Color/Graphics Monitor Adapter (#4910) with IBM Color Display (5153)
  - IBM Enhanced Graphics Adapter (#1200) with one of the following Displays:
    - IBM Enhanced Color Display (5154)
    - IBM Color Display (5153)
  - IBM Personal System/2 Display Adapter (#4050, 1887744) with one of the following displays:
    - IBM Personal System/2 Color Display (8513)
    - IBM Personal System/2 Monochrome Display (8503)
    - IBM Personal System/2 Color Display (8512)
    - IBM Personal System/2 Color Display (8514).
- IBM Personal System/2
  - IBM Personal System/2 system unit (Model 50, 60, or 80) with one of the following displays:
    - IBM Personal System/2 Color Display (8513)
    - IBM Personal System/2 Monochrome Display (8503)
    - IBM Personal System/2 Color Display (8512)
    - IBM Personal System/2 Color Display (8514).
  - IBM Personal System/2 Display Adapter 8514/A (#4054) with one of the following displays:
    - IBM Personal System/2 Color Display (8513)
    - IBM Personal System/2 Monochrome Display (8503)
    - IBM Personal System/2 Color Display (8512)
    - IBM Personal System/2 Color Display (8514).
- LAN Server Version 1.0 support for specific adapters is as follows:
  - IBM Color/Graphics Monitor Adapter: IBM OS/2 Extended Edition Version 1.0 only supports text mode (25 lines) in the Operating System/2 mode and CGA compatibility modes in the DOS mode.
  - IBM Enhanced Graphics Adapter: IBM OS/2 Extended Edition Version 1.0 only supports text mode (25 or 43 lines) in the Operating System/2 mode and CGA compatibility modes in the DOS mode.
  - IBM Personal System/2 Display Adapter (#4050, 1887744) for IBM Personal Computers AT or XT Model 286: IBM OS/2 Extended Edition Version 1.0 only supports text mode (25 or 50 lines) in the Operating System/2 mode and CGA compatibility modes in the DOS mode.
  - IBM Personal System/2 system unit (Model 50, 60 or 80); Same support as for IBM Personal System/2 Display Adapter (#4050, 1887744)
  - IBM Personal System/2 Display Adapter 8514/A (#4054, 1887972); Same support as for IBM Personal System/2 Display Adapter (1887744, #4050).

  The IBM OS/2 Extended Edition Version 1.1 support for each adapter includes all Version 1.0 support for that adapter, plus all-points-addressable (APA) support in the Operating System/2 mode.

- Printers
  - IBM 4201 Proprinter™, Model 1
  - IBM 4201 Proprinter II
  - IBM 4202 Proprinter XL, Model 1
  - IBM 4207 Proprinter X24
  - IBM 4208 Proprinter XL24
  - IBM 5152 Graphics Printer Model 2 (withdrawn from marketing)
  - IBM 5182 Color Printer, Model 1 (withdrawn from marketing)
  - IBM 5201 Quietwriter®, Model 1 and 2
  - IBM 5202 Quietwriter III
  - IBM 5216 Wheelprinter, Model 1 (parallel attached)
  - IBM 5223 Wheelprinter E, Model 1 (parallel attached).

  Note: IBM OS/2 Extended Edition Version 1.1 supports each of the printers as an IBM Graphics Printer (5152 Model 2). Version 1.1 provides all-points-addressable (APA) support to the printers, where appropriate.

  Parallel-attached printers are supported in both Operating System/2 and DOS modes. Serially-attached (asynchronous) printers are supported in the Operating System/2 mode only.

- Other Input Devices
  - Keyboard
    - IBM Personal Computer AT keyboard for the Personal Computer AT Models 068, 099, 239, and 339
    - IBM Enhanced Personal Computer keyboard for Personal System/2, Personal Computers AT Model 339 and XT Model 286
    - IBM Personal System/2 Pointing Device (attaching to the system pointing device port on the system board).
  - Serial pointing device (serially-attached, asynchronous, pointing devices are supported in the IBM Operating System/2 mode only).
    - Microsoft™ Mouse for IBM personal computers, 100ppi
    - Microsoft Mouse for IBM personal computers, 200ppi
    - PC Mouse™ 100ppi
    - Visi On™ Mouse, 100ppi.
  - Parallel pointing device for IBM Personal Computers AT and XT Model 286
    - Microsoft Mouse for IBM personal computers, 100ppi
    - Microsoft Mouse for IBM personal computers, 200ppi.
  - InPort Microsoft Mouse for IBM Personal Computers AT and XT Model 286, 200ppi.
- Local Area Network and Serially Attached Device Adapters
  - IBM Personl Computers AT and XT Model 286
    - Token-Ring Network Personal Computer Adapter (#3391, 6339100)
    - Token-Ring Network Personal Computer Adapter II (#5063, 67X0438)
    - IBM PC Network Baseband Adapter (#1221, 1501221)
    - IBM PC Network Adapter II (#1220, 1501220)
    - IBM Token-Ring Network Trace and Performance PC Adpater II (#5773, 96X5773)
    - IBM PC Network Adapter II - Frequency 2 (#5645)
    - IBM PC Network Adapter II - Frequency 3 (#5646)
    - IBM Personal Computer AT Serial/Parallel Adapter Card (#0215)
    - IBM Personal Computer AT Memory Expansion Adapter (#3395 or #3400)
    - Realtime Interface Co-Processor Multiport RS-232 Interface Board (#6240 or #6241).
  - IBM Personal System/2
    - IBM Token-Ring Network Adapter/A (#4790, 69X8138)

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Quietwriter is a registered trademark of the IBM Corporation.

Microsoft is a trademark of the Microsoft Corporation.

PC Mouse is a trademark of Metagraphics/Mouse Systems.

Visi On is a trademark of the Visi-On Corporation.

- IBM Token-Ring Network Adapter/A (#4790, 69X8138)
- IBM Token-Ring Network Trace and Performance Adapter/A (#5774, 96X5774)
- IBM PC Network Baseband Adapter/A (#1223, 1501223)
- IBM PC Network Adapater II/A (#1222, 1501222)
- IBM PC Network Adapter II - Frequency 2 (#5647)
- IBM PC Network Adapter II - Frequency 3 (#5648)
- IBM Personal System/2 Dual Asynchronous Adapter/A (#3033)
- IBM Personal System/2 Multiprotocol Adapter/A (#3042) in asynchronous mode
- Realtime Interface Co-Processor Multiport/2 (#6263).

Note: A maximum of three COM ports are supported by the IBM Operating System/2 system.

Supported Hardware for Family Applications

The application developer can write a family application portable from Operating System/2 to IBM DOS. A family application is an executable module that can run in all three environments:

- An Operating System/2 mode that runs Operating System/2 applications
- An Operating System/2 mode that runs an IBM DOS application
- The IBM DOS Version 3.3 environment.

A family application has the same or similar capabilities as an IBM DOS 3.3 application, and cannot use the new IBM Operating System/2 capabilities, such as larger memory addressability and multitasking. Assuming that there is sufficient memory, display, and other appropriate hardware, a family application can run on the following system units:

- Any system unit supported by IBM Operating System/2
- Other system units
  - IBM Personal Computer XT: All models
  - IBM Personal Computer
  - IBM PC Convertible
  - IBM Portable Personal Computer (withdrawn from marketing)
  - IBM Personal System/2 (Model 30).

Requisite Program Products

The IBM OS/2 LAN Server is released to work with the IBM OS/2 Extended Edition Version 1.1 system. The requester function is included with the IBM OS/2 Extended Edition Version 1.1 system. The IBM OS/2 LAN Server contains the server function and is packaged and priced separately.

Functional Description

The IBM OS/2 LAN Server is comprised of two distinct software packages, the requester function and the server function. The requester is included with the IBM OS/2 Extended Edition Version 1.1 system while the server function is packaged and sold separately as the IBM OS/2 LAN Server. The server function must be installed on at least one machine on the LAN to enable the requester function.

IBM OS/2 workstations can be run in one of two configurations: a requester or a server. The requester configuration allows a Personal Computer or a Personal System/2 computer to access network resources that are shared by other Personal Computers or Personal System/2 computers running the server configuration. A Personal Computer or Personal System/2 computer must run the server configuration if it needs to let other Personal Computers or Personal System/2 computers access remote LAN resources.

The server configuration is a superset of the requester configuration. That is, the server configuration includes all the capabilities of the requester and runs in a non-dedicated mode.

Note: In some cases, it may be advisable to dedicate the server for performance reasons.

Multiple OS/2 LAN Servers are supported per network. These servers do not require any special hardware other than a local area network adapter. A Personal Computer or Personal System/2 computer running OS/2 Extended Edition Version 1.1 may start and stop the server and/or requester software when desired. The memory used by the LAN software will be freed for other applications to use.

The IBM OS/2 LAN Server allows one or more servers to be managed as a single logical system, called a domain. A System Administrator defines entities with unique names within the scope of a domain. These entities are:

- Users and groups of users
- Directories and their contents
- Network applications
- Print queues
- Serially attached device queues.

A user logs on to the network by entering a user ID and, optionally, a password. These are validated by the IBM OS/2 LAN Server before the logon process is allowed to proceed. The user also specifies a domain for initial access. This domain contains information about the user and the set of resources the user requires.

Interfacing With the IBM OS/2 LAN Server

The IBM OS/2 LAN Server uses knowledge of the user's identity to control access to shared resources. When users log on to the network, a set of previously defined, individually tailored, resources are automatically connected. These resources may be virtual drives, queues or network applications. These resources have been defined for the user by a System Administrator. Figure 1 on page 8 shows a user who has logged on to a hypothetical domain. After logon, users may add or delete network resources to further customize their environment. Users must have proper authorization for each resource they add.

Before logon, the user's Presentation Manager Start-A-Program Menu contains only local applications. After logon, the user may select from these same local applications, plus any network applications that a System Administrator has allowed the user to access. The set of network applications is first established by a System Administrator. Users may then modify their own menus, to add private applications, or to add or delete network applications that have been provided by a Systems Administrator.

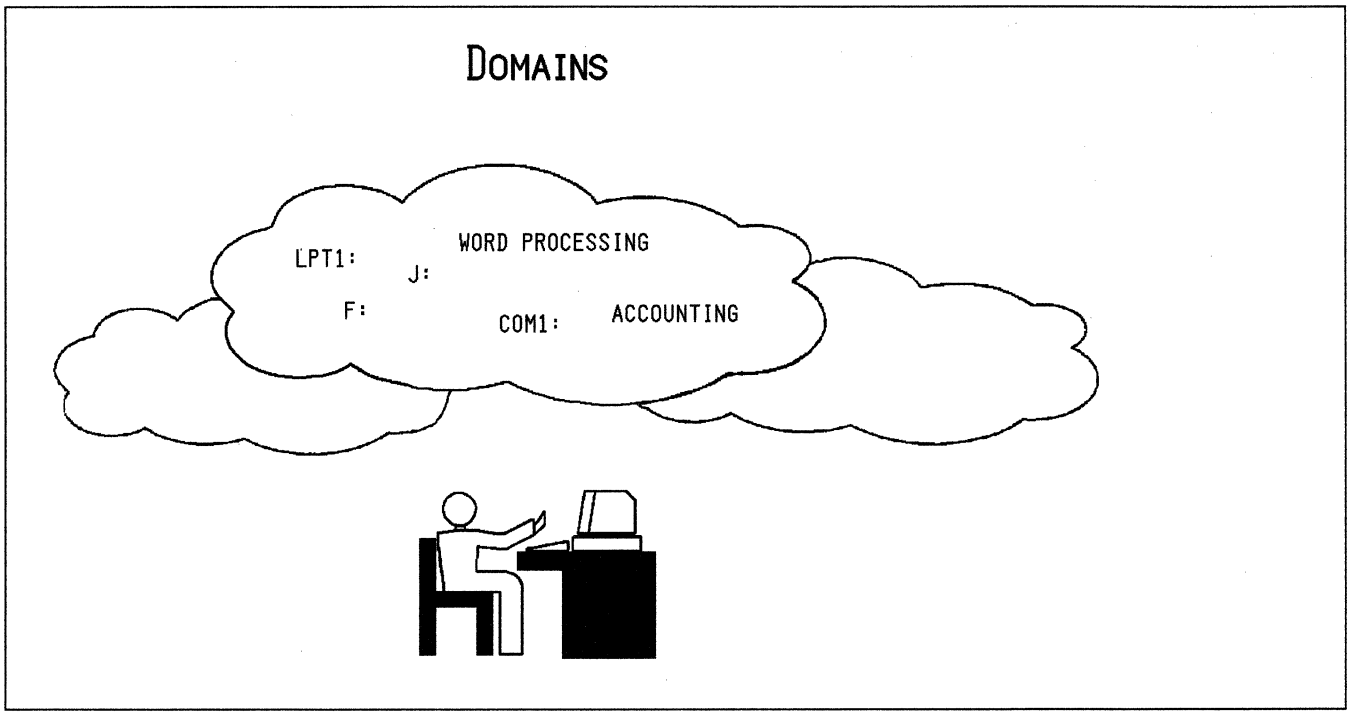

Figure 1. How Users View the Network

Using Commands

The command line interface is a superset of the IBM PC LAN Program Version 1.30. The design of the command line interface allows networking operations to be automated through command files, while preserving backward compatibility with the IBM PC LAN Program.

Using Screens

The full-screen interface allows the user to interact with the IBM OS/2 LAN Server through a series of panels that have a consistent style and method of use. The following functions are supported:

- Administration of users, user groups, and resources
- Full control of System Administrator functions from any IBM OS/2 LAN Server or OS/2 workstation
- Multi-user application management
- Full control of the IBM OS/2 Presentation Manager Print Spool System as extended by the IBM OS/2 LAN Server
- Synergy with the OS/2 Presentation Manager Start-A-Program Menu
- Logon/Logoff of network
- Messaging
- Support of daily operation
  - Startup
  - Shutdown
  - Audit Control
  - LAN usage monitoring.

IBM OS/2 LAN Server Services

The IBM OS/2 LAN Server consists of a number of separate services that control the function of the network. These services support the two configurations, requester and server:

- Workstation
- Server
- Messenger
- Popup
- Alerter
- Netrun
- PCDOSRIPL
- PCLP130.

Workstation

The Workstation service redirects I/O operations from a user's machine across a network to a server. I/O operations that can be redirected are:

- File I/O
- Printer I/O
- Serial Device I/O.

The workstation then receives the response to the request and returns the data to the application as if it has been satisfied locally. This process provides local/remote transparency and prevents applications from having to be network aware.

Server

The full function server configuration receives and responds to network requests for disk, printer, and/or serially attached device input/output.

The Workstation service must also be running for the server to function.

Messenger

The Messenger service supports the sending and receiving of messages between users or groups of users.

Popup

The Popup service displays received messages as pop-up panels on the user's screen.

Alerter

The Alerter service runs in the server and sends alert notifications to designated users. These alerts are sent as IBM OS/2 LAN Server messages.

Netrun

The Netrun service runs in the server and processes requests for remote execution of programs.

PCDOSRIPL

The PCDOSRIPL service runs in the server and supports the remote IPL of PC DOS.

PCLP130

The PCLP130 service runs in the server and is required if any IBM PC LAN Program Version 1.30 users are to be supported.

Starting and Stopping the System

System Startup

The IBM OS/2 LAN Server supports the IBM PC LAN Program Net Start command for manually starting the requester and server software. The IBM OS/2 LAN Server also supports an auto-start capability. The auto-start causes the appropriate networking software to load and begin operation as needed.

The following commands can trigger auto-start of the requester software:

- Net Use
- Net Load
- Net View
- Net Print
- Net Comm
- Net Share.

The following commands can trigger auto-start of the Server software:

- Net Share
- Net Load.

When the network software auto-starts, configuration parameters are taken from an initialization file. Explicitly starting the network with the Net Start command allows users to override any of these configuration parameters through the use of command line switches. Additionally, the Net Start command may be used to individually start any of the network services.

For example:

```
Net Start Workstation [Computername]

          and

Net Start Server [Computername]
```

are used to start the Workstation and Server services, respectively.

Additionally:

```
Net Start Messenger [Computername]
```

starts the Messenger service. The messenger is normally configured to start automatically when a Net Start Workstation is performed. The Net Start Messenger command is provided as a way to start the messenger when the workstation has previously been started without the messenger (or when the messenger has previously been stopped).

The messenger can display incoming messages in a character mode popup window. This Popup service may be controlled with:

```
Net Start Popup
```

The Popup service is normally configured to start automatically when the workstation is started.

The remote program execution server (see "Remote Execution" on page 17 for details) may be started with:

```
Net Start Netrun
```

The IBM OS/2 LAN Server also provides a service that forwards administrator and print server alerts across the network as station-to station messages. This service may be started with:

```
Net Start Alerter
```

Logon

Access to IBM OS/2 LAN Server controlled resources is on the basis of user identification. A user identifies himself to the network through the Logon function. No network resources are available until the user is logged on. Logon may be invoked by:

- The Net Logon command
- Auto-start of the network
- An application selected from the start-a-program list (OS/2 or Presentation Manager).

A System Administrator is responsible for defining the valid user IDs in a domain. The System Administrator controls whether a password is required for a particular user or not. System Administrators may also specify the interval before which passwords expire. The IBM OS/2 LAN Server ensures that the new password is different from the old password. Passwords are encrypted at the workstation before being sent to the server for validation.

Upon completion of logon, the user has access to:

- Network applications that are added to those already displayed by the Presentation Manager Start-A-Program Menu.
- Network directories assigned by default at logon
- Printers assigned by default at logon
- Serial devices assigned by default at logon.

Logoff

Logoff is one of the functions provided by default on a user's selection menu. Logoff is also available through the use of the Net Logoff command. After logging off, the workstation has no redirected devices and no network sessions. The workstation is left "clean" for another logon, without the possibility of the next user gaining access to the previous user's resources. Network applications are removed from the user's Presentation Manager Start-A-Program Menu.

System Shutdown

Unlike the IBM PC LAN Program, the IBM OS/2 LAN Server requester and server software can be stopped and unloaded from memory at any time (except for necessary device drivers). The Net Stop command is used to halt network operation.

The ability to stop and restart the system can facilitate the job of tuning the network configuration parameters, because some of the parameters can only be set at start time. If a System Administrator plans to shut down the domain, a function may be used to prevent further users logging on, and the Net Sessions function can be used cancel the sessions of currently logged on users.

Access Control System

There are two facets to the access control system

- Control of access to the system
- Resource protection.

Access to the system is controlled by the logon function, see "Logon."

Resources are controlled by identifying the relationship between the resource and the requester requiring access to the resource. The following

categories of resource can be protected through the access control system:

- Disk directories
- Individual disk files
- Groups of disk files (specified via wild card)
- Application programs
- Print queues
- Serial device queues.

Each time a user requests access to a resource, such as an application opening a file, the requested level of access (for instance, read/write) is checked against the level of authority recorded for the user in a profile associated with the resource in question. If the user has sufficient authority, the request is granted; otherwise, it is denied.

Entries in a profile can specify the authority for an individual user or for a group of users. By organizing users into groups, and specifying access control in terms of groups, an installation can considerably simplify the administrative effort required to manage the access controls of the system.

For example, if there is a group called ACCOUNTS consisting of all the users in the accounting department, the department's resources can all be protected by a single entry for the ACCOUNTS group in each resource's profile. This single entry has the effect of specifying that all users belonging to the ACCOUNTS group have the same level of authority over that resource. Thus, when a new user joins the department, just add this user to the ACCOUNTS group and the new user will automatically have access to the department's resources. Equally, when a user leaves the department, all that is required is the removal of the user from the ACCOUNTS group.

If the authority had not been specified in terms of group membership, it would have been necessary to add or delete the user from all the profiles individually. Considerably more administrative effort would be required, significantly increasing the opportunity for human error, such as overlooking some resource whose profile should have been updated.

Resource profiles also contain a Universal Access Authority. This entry contains the level of authority given to all users that are not covered by any User or Group entries in the profile. This could be used to give all users EXECUTE authority over the generally available programs in a system.

Access control is transparent to users, except when access is denied and when defining or modifying access control profiles.

Using Net Commands

The Net Share/Net Use mechanism for offering and connecting to server resources may be used under the IBM OS/2 LAN Server Access Control System. These commands may be used to modify the set of resources automatically connected at logon. These commands are compatible with those used with the IBM PC LAN Program, but supplied resource passwords are ignored. The Access Control System makes the Use and Share commands more flexible as follows:

- Users may freely issue Net Use commands or the full screen equivalent. Their access is validated with their logon identity when the resource is opened.
- Multiple users may access the same Net Share yet be granted different permissions to the resources offered by that share. The resource profile specifies which users or groups get what kind of access to that resource. Therefore, multiple shares of the same resource are never needed. See Figure 2 on page 12 for information on these file access permissions.

Three significant extensions have been made to the use of Net Commands. These enhancements apply to file, printer, and serial device sharing.

1. The uniform naming convention is now fully supported. Users can now use the extended network pathname format \\COMPUTERNAME\NETNAME in any OS/2 command that currently accepts a PATH. For example, the following commands are now acceptable:

   ```
   DIR \\BIGSERVE\LIBRARY
   COPY FILE.TXT \\BIGSERVE\ANYNAME
   ```

   Note that \\BIGSERVE\ANYNAME can be any type of resource to which a file can be copied—a shared disk, printer, or communication device.

2. The IBM OS/2 LAN Server will perform implicit Net Use operations on behalf of programs using UNC style I/O.

3. The IBM OS/2 LAN Server will automatically reestablish Net Uses that have been terminated due to losing a server session. Server sessions may be lost because the server auto-disconnects the session or the server is stopped and later

restarted. The disconnected Uses will be reconnected the next time a program performs an operation that references the Used resource. Note that files that were opened at the time of disconnection are not automatically re-opened; an error is instead returned when that file is next accessed.

Profiles

There are four types of access control profiles.

User Profile
Describes a user who is defined to the Access Control System.

Group Profile
Describes a group of users.

Discrete Resource Profile
Describes a discrete resource such as a file, and the authorities that users and groups have over the resource.

Generic Resource Profile
A single profile that generically describes the access controls for a number of resources.

Resource profiles (discrete or generic) contain authorities for resource access. These authorities are associated with particular users or groups within the profile. IBM OS/2 LAN Server supports five types of access authorities:

Authority	Function
None	The named user or group is explicitly denied access to the resource.
Execute	The named user or group is allowed to execute the resource. This authority has no meaning for resources other than executable program files. If this authority is specified for a non-executable file, it is treated as if NONE were the specified authority.
Read	The named user or group is allowed to open the resource for reading, but not for writing.
Update	The named user or group is allowed to open the resource for read and write. If the resource is a disk directory, this authority allows the user or group to create and delete files and subdirectories in the named resource. Update authority is required to access a print or serial device queue.
Alter	The named user or group is allowed to update the resource profile. If the resource is a file, the named user or group may delete or rename that file.

Figure 2. IBM OS/2 LAN Server Access Authorities

Network Auditing

The IBM OS/2 LAN Server supports the writing of an audit trail for recording accesses and attempted accesses to protected resources. The System Administrator can control whether the audit trail function is active or not. Be aware that enabling network auditing can adversely affect network performance. The System Administrator also may select which resources should have their accesses recorded. Events that are audited include:

- Server
  - Started
  - Paused
  - Continued
  - Stopped.
- Session
  - Logon
  - Logoff.
- Share
  - Use
  - Unuse
  - Unshare
  - Session disconnection
  - User limit exceeded.
- Access
  - Description of resource access and operation performed.
- Access Denied
  - Description of access permission violation and operation attempted.
- Access Ended
  - Resource access ended.

Audit information may be displayed from the full screen or command line interfaces.

Network Administration

The IBM OS/2 LAN Server provides comprehensive facilities for administering the local area network servers. These include:

- Total system management from any OS/2 requester.
- Availability of detailed network usage and diagnostics information.
- Time-scheduled operation of server functions.

Network Usage and Diagnostic Information

The IBM OS/2 LAN Server allows administrators to browse user sessions to see who is using a server, how long they have been connected, what resources they are using, and when they were last active.

The network error log and key network operating statistics are also available. All configurations of the IBM OS/2 LAN Server software maintains statistics and an error log that includes comprehensive diagnostics information about errors that have occurred. Statistics include network traffic and response time indicators, plus error and other service-related counters.

Some errors, like Disk Not Ready or Disk Full, require immediate attention by an administrator or network technician. IBM OS/2 LAN Server servers automatically send administrative alert messages to a designated user or users when such conditions arise. Alerts are generated in case of printer and disk problems, excessive bad password attempts, and excessive error occurrences.

Remote Server Control

All system functions can be controlled locally or remotely from an OS/2 workstation. For example, System Administrators can work from any Personal Computer or Personal System/2 computer running the OS/2 requester software to:

- Share and unshare resources at a PC running the server software
- Browse and update the user, group, and resource control profiles
- Browse, reconfigure, and control the server print queues and print devices
- List and force user sessions or file instances closed
- Monitor server statistics, error log, and audit trail information.

Time Scheduled Execution

Many applications require that a server's configuration or availability be changed on a time-scheduled basis. For example, it may be necessary to reconfigure printer options at various times of day or to run utility programs (such as disk backup) at specified intervals. The IBM OS/2 LAN Server provides a new command (AT) for automating server functions on a time-scheduled basis. The AT command can run any OS/2 command periodically at a specified date/time. The schedule for periodically executed commands is saved on disk and loaded when the server starts.

Network Application Management

To an IBM OS/2 LAN workstation, an application is the use of a particular program, optionally associated with some particular data or sets of data. Applications are defined once by a System Administrator, and can be made available to users, either selectively, or globally for all users. Giving a user access to an application automatically updates that user's application selection menu after logon.

Users can also define private applications for the application selection menu. These applications can use local or shared programs and local or shared data.

The Presentation Manager Start-A-Program Menu is the function that presents the application menu to the user. Presentation Manager also provides facilities for starting applications and switching among running applications.

Within the IBM OS/2 LAN Server system, each application is uniquely named. An application has the following attributes:

- A network identification
- A description of the application
- The OS/2 command line required to invoke the program. This command line may contain fixed parameters for the application.
- An indicator to say whether or not to prompt the user for parameters when the application is invoked.
- The location of the program, including
  - The network directory and optional drive identifier to be assigned to that directory.
  - The path to the program within the network directory.
- A list of network directories which are required to be assigned to (virtual) drives when the application is invoked, and unassigned when the application has finished. These resources may optionally be assigned to specific virtual drives. Any resource not specifically assigned will have its assignment dynamically selected when the application is invoked.
- Which network directory to make current, including:
  - The network directory and optional drive identifier to make current when the application is run.
  - The sub-directory within this network directory to make current when this application is run.
- Whether the application is capable of being executed remotely on a server.
- The maximum number of users connected to the application. This resource use count may be used in conjunction with authorized user lists to restrict which and how many users have access to an application. The resource use count may be used to help enforce software application site licensing agreements.

Network Printing

The IBM OS/2 LAN Server provides a complete set of printing services:

- Print redirection
- Extensions to the Presentation Manager print spooler
- User and administrator interface to print queue management
- Local and remote interrogation and manipulation of print queues.

Using Network Printers

To use network printers, users redirect local printer ports to queued network printers. The redirection is accomplished either through the full screen interface or by using the Net Use command. For example, to send print output to a server, a user may issue one of the following Net Use commands:

```
NET USE LPT1 \\PRTSERVE\DRAFT
NET USE LPT2 \\PRTSERVE\LASER
```

Similarly, the names DRAFT and LASER may be made available immediately after logon. Under the IBM OS/2 LAN Server, the names DRAFT and LASER refer not to actual printers but to Presentation Manager print queues that are on the server. Any output reference to the redirected LPT printer port, such as from an OS/2 command or file system API call, will result in the output being redirected to the server.

Workstations using Presentation Manager access network printers through the Presentation Manager print queue names. These print queue names are redirected by assigning the queue name to a redirected LPT device.

The IBM OS/2 LAN Server, in conjunction with the Presentation Manager, provides a full-screen interface and the Net Print command for users to display remote print queues and to hold, release, and delete their own print jobs. Administrators have extended capabilities to add, delete, and reconfigure print queues, reposition print jobs, and control print job and printer status.

The server automatically sends a network message to a user when his print job is complete, when a printer problem (like out of paper) occurs, or when a job is paused or cancelled by an administrator.

Sharing Network Printers

Print sharing under the IBM OS/2 LAN Server works just as it did under the IBM PC LAN Program, except the Net Share and Net Print commands have been extended to make print sharing more flexible. The new print sharing facility supports the Presentation Manager spooler and extends it in several ways to allow:

- Time-scheduled printing
- Full remote control
- Print notification through network messages.

Net Share now lets print jobs be automatically routed to any of a pool of compatible printers. This is done by sharing each of the pooled printers under the same network name as follows:

```
NET SHARE LASER=LPT1;COM1
```

Here, a print job queued to LASER will be printed on either LPT1 or COM1, whichever is the first available.

A device may be shared under more than one network name. Each name represents a print queue that can be independently controlled. Assigning different priorities to these queues allows the user to create low- and high-priority print services that drive the same printer. In this manner, administrators may share a device with all users, while granting particular users higher priorities.

Multiple queues may be created for a configurable printer (changeable fonts, paper trays). Users may simultaneously submit different types jobs, as long as they are destined for the appropriate queue. Use of the Net Pause and Continue commands will allow only one type of job to print while other jobs are held in the paused queues.

The Presentation Manager print spooler provides a mechanism for the user to install customized print queue processors that are invoked by the spooler to print specialized document formats, such as compact metafiles or application specific file formats. Being able to spool high-level file formats across the network can reduce the amount of network traffic and reduce the workload on the requester. The expansion of the data stream takes place when the file is printed and can be delayed until server's workload is appropriate to support this activity.

Serial/Parallel Device Sharing

The IBM OS/2 LAN Server serial/parallel device facility allows COM and LPT devices to be shared for direct I/O access (nonspooled) in a manner similar to the way printers are shared for spooled access. Sharing these devices in a direct manner allows remote interactive devices such as modems, scanners, and Postscript printers be accessed and controlled as if they were local.

Sharing and Using Serial/Parallel Devices

By convention in the IBM OS/2 LAN Server, all LPT and COM devices are shared for spooled service as was described in "Network Printing" on page 14. The IBM OS/2 LAN Server introduces a new switch, /COMM, that causes the share to be for direct I/O.

Direct I/O is required if an application must read information from a COM or LPT device as well as write to it. An example would be an application that wished to use a shared modem. Spooled access is write only and is insufficient for network access to such a device.

LPT or PRN devices may be redirected for direct I/O by using the /COMM switch on both the Net Share and Net Use commands. For example:

```
NET SHARE PRINTER=LPT2 /COMM
NET USE LPT1 \\SERVER\PRINTER /COMM
```

After a COM or AUX device has been shared for direct access, the corresponding Net Use of the device will be for direct I/O. That is, the /COMM switch is not specified with the Net Use. A Net Use of a COM device is always for direct access. Spooled access to a COM device may be obtained by assigning a local LPT device name to a remote COM device. For example:

```
NET SHARE PLOTTER=COM1
NET USE LPT1 \\SERVER\PLOTTER
```

assigns the local LPT1 device to the remote COM1 which is attached to a plotter. All local output to LPT1 will be routed to SERVER and sent to COM1 after all jobs ahead of it have completed.

Pooling Serial/Parallel Devices

Direct access of serially-attached devices allows only one user to do so at a time; other requesting users will find the device busy. Multiple equivalent devices (for example, modems) may of course be present on the same server, but it is inconvenient for users to manually hunt for an available device.

The IBM OS/2 LAN Server simplifies this situation by letting shared devices be pooled; that is, shared under a single network name. For example:

```
NET SHARE MODEM=COM1;COM2 /COMM
```

Attempts to use MODEM will automatically connect to either COM1 or COM2, whichever is first available. This operates much like spooled printer pooling. The IBM OS/2 LAN Server full screen and command line queue management facilities may be used to control serial device queues. In fact, a Net Comm command is available that is analogous to the Net Print command. The Net Comm command allows a user to display remote communication status and to cancel jobs from a list of waiting users.

Even with device pooling, users may find that all devices are busy. To alleviate this problem, attempts to open a remote device can be made to wait for a specified time limit until a device is available. An error is returned if a device does not become available within the specified time.

Network Messages

The IBM OS/2 LAN Server provides a simple user-to-user message facility for exchanging short interactive messages. Messages may be typed in at the workstation or retrieved from ASCII files. The message facility is compatible with the IBM PC LAN Program. All previously defined Net commands are supported for sending messages and adding, deleting, or forwarding extra message names. The full screen interface also provides access to the IBM OS/2 LAN Server message sending capabilities.

The IBM OS/2 LAN Server includes the following extensions to the message sending facilities:

- Servers can generate messages automatically to notify users of specified events.
- Administrators can use a single command to send messages to all logged on users or all users in a group.
- Send messages from files.

Network Utilities

The IBM OS/2 LAN Server includes extensive help features and three network utilities, Copy, Move, and remote execution. These utilities are available from the full screen interface or from command line commands.

Network Help

As a participant in Systems Application Architecture, the IBM OS/2 LAN Server provides extensive context sensitive help with the full screen interface.

The Net Help command can be used, without arguments, to display a list of all Net commands. The user may also specify the name of the command that help is needed for. The Net Help command then displays the syntax for the various possible uses of that command.

Network Copy

Net Copy is a complete replacement for the OS/2 copy command. Unlike OS/2 Copy, Net Copy optimizes server-to-server copy operations so that data is not transferred through workstation memory when the source and destination files are on the same server. When operating on purely local files, Net Copy behaves exactly like the standard OS/2 Copy command. Net Copy can also be used with UNC names, which eliminates the need to redirect drives to do the copy. For example:

```
NET COPY \\DA13\LCE\inc.h \\DA13\DCB\inc.h
```

Network Move

Network Move is identical to Network Copy, except it deletes the source file after it has been copied. Network Move does not support the + concatenation operator. When the source and destination files are on the same physical disk, the operation is performed without actually copying data.

Remote Execution

Remote execution is available from the full screen interface or from the command line as the Net Run command. Net Run is a general purpose remote program execution facility that enables a Workstation operator to run a program on a remote Server machine.

The following steps must be followed when using Net Run.

- Before using Net Run, the user must Net Use the proper network directory where the run is to occur, and must change the current drive/directory to the Used Server drive.
- The program being remotely run must be accessible on an execution path defined by the network administrator and the user must have execute access to that program.
- The program will only be able to access files in the Used subtree on the Server from which it is run. If specific machine or drive references are found in the command line arguments to the program, the command will be rejected.

The standard input, output, and error streams of the remote program are redirected back to the Workstation. This redirection makes it possible to interactively control the remote program and to receive its output.

Remote Initial Program Load

The IBM OS/2 LAN Server contains the following remote IPL functions:

- IPL of PC DOS from an IBM OS/2 LAN Server
- IPL of non-DOS systems (such as diagnostic diskettes) from an IBM OS/2 LAN Server
- Support for any other LAN-attached PC that can invoke the Remote IPL function
- The Remote IPL Server may operate concurrently with the IBM OS/2 LAN Server
- Support for Multiple Remote IPLs in parallel
- Support for multiple Remote IPL Servers on a single LAN
- Supports both IBM PC Network II, IBM PC Network Baseband and IBM Token-Ring Network adapters
- Economical usage of server disk storage for storing IPL images
- User selection of images
- Image-build function.

Command Line Interface

The IBM OS/2 LAN Server supports a superset of the IBM PC LAN Program commands. Figure 3 is a list of the IBM OS/2 LAN Server commands.

Command	Command Function A
At	Schedule unattended server tasks
Net	Run full screen user interface
Net Admin	Execute Administrator command at server
Net Audit	Display/clear server audit trail
Net Comm	Manage server serially attached device queues
Net Config	Display/change workstation or server configuration parameters
Net Continue	Continue a paused function
Net Copy	Copy file from one location to another
Net Device	View/control status of shared devices
Net Error	Display/clear the error log
Net File	List/force closed server files
Net Forward	Forward messages to another user
Net Help	Provide help on Net commands
Net Log	Control message logging
Net Logon	Log a user on to a domain
Net Logoff	Log a user off a domain
Net Move	Move file from one location to another
Net Name	Display/control message names
Net Pause	Pause server, workstation or other function.
Net Print	View/control server print queues
Net Run	Run a program in a remote server's memory
Net Send	Send a message to a user or group
Net Separator	Specify separator page for print spooling
Net Session	Display/close user sessions
Net Share	Share a disk, print queue, or communication device
Net Start	Start the specified network service(s)
Net Stats	Display/clear network statistics
Net Status	Display server shared resources and configuration parameters
Net Stop	Stop the Workstation, Server or other service
Net Use	Use a network resource
Net View	View network servers and shared resources

Figure 3. IBM OS/2 LAN Server

Installation

Because the IBM OS/2 LAN Server comes as two separate products (the requester function and the server function), installation is accomplished in two phases. In the first phase, the user installs the Requester program which is packaged with the OS/2 Extended Edition Version 1.1. In the second phase, the user optionally installs the Server program. The Server is packaged separately and purchased by the user. Both the requester and server functions are installed using the OS/2 Installation Aid.

Planning an IBM OS/2 LAN Server installation involves identifying the machines to be requesters and installing the Requester program on those machines. The Server machines are identified next. The server function is then installed on each of these machines. These Servers may already have the requester function installed.

Programming Interface

Protect Mode Applications

Applications written to run under OS/2 mode need not be network aware. These applications need only use the existing file and device I/O function calls provided with OS/2 to access network resources. Applications should make use of the existing file sharing and byte range locking features of the file system in order to protect their data or to provide concurrent access to this data. Operating in this manner, applications can manage simultaneous access to data, whether the concurrent operations were from local or remote processes. Since the IBM OS/2 LAN Server establishes these connections automatically at logon, both the user and application program need not be aware that they are working with remote data. A System Administrator specifies these network connections when a user ID is set up.

If an application needs to be network aware, the full support of the uniform naming convention allows network machine names and paths to be specified on these same OS/2 file and device I/O function calls.

Applications that do not require local/remote transparency or need more than the OS/2 file and device I/O interfaces for communication purposes should consider one of the OS/2 Extended Edition Communications Manager application program interfaces. The Communications Manager supports many different communication protocols, including the Application Program-to-Program Communications (APPC) protocol and the Server Requester Programming Interface (SRPI) for link independent program-to-program communications. The Communications Manager also includes the IBM NETBIOS and IEEE 802.2 programming interfaces (in the OS/2 Extended Edition Version 1.1 system) for local area network based communications. The IBM LAN Server uses these last two interfaces for its own communication purposes.

Real Mode Applications

The IBM OS/2 LAN Server supports real-mode applications running under the OS/2 DOS mode. These real-mode applications can access network devices redirected by OS/2 mode applications, but they cannot redirect devices themselves. Note that the following PC DOS networking specific APIs provided by the INT 21 functions are NOT supported:

- 5E00H—Get Machine Name
- 5E02H—Set Printer Setup
- 5E03H—Get Printer Setup
- 5F02H—Get Redirection List Entry
- 5F03H—Redirect Device
- 5F04H—Cancel Redirection.

The INT 21 function 440AH (I/O Control for Devices) will not return whether a device is local or remote.

Additionally, the IBM PC LAN Program networking specific APIs provided by the INT 2A and INT 2F functions are NOT supported (except for the INT 2A functions to submit synchronous NCBs to IBM NETBIOS and the IBM NETBIOS INT 5C itself).

Migration and Coexistence With the IBM PC LAN Program

This section addresses the differences that programmers and users will encounter when switching from the PC DOS IBM PC LAN Program to the IBM OS/2 LAN Server.

Compatibility With the IBM PC LAN Program

The IBM OS/2 LAN Server is functionally a superset of the IBM PC LAN Program Version 1.3. All features and commands of that product are in the IBM OS/2 LAN Server and are supported compatibly, except as noted here:

1. The Net Print command can no longer print a file to a network printer.
2. The server no longer allows resources to be shared without a network name. That is, NET SHARE C:\MYDIR is forbidden. The share, for example, must be specified as NET SHARE MYDIR=C:\MYDIR.
3. The server no longer allows passwords on shares.
4. No message editor is supplied. Users can switch to another OS/2 screen group and use a text editor of their choice.
5. The formatted output and messages of some commands such as Net Print differ from those produced by the IBM PC LAN Program because more information is now presented.
6. Because the IBM OS/2 LAN Server supports network auto-start and UNC resource access, some commands that would fail under the IBM PC LAN Program may now succeed.

The IBM OS/2 requester function does not permit drive letters to be redirected that correspond to local disks, nor can disk redirection be paused. The IBM OS/2 LAN Server allows a drive to be redirected back to the same machine if that machine is running the server software.

Coexistence With the IBM PC LAN Program

IBM PC LAN Program Version 1.30 workstation users can access an IBM OS/2 LAN Server domain, and it's resources in that domain. The IBM OS/2 LAN Server must be running the PCLP130 compatibility service. Access controls for the resources of the domain apply equally to IBM PC LAN Program Version 1.30 and IBM OS/2 LAN Server users with the following exceptions:

1. Network Administration functions can only be done from an OS/2 workstation.
2. If an IBM PC LAN Program Version 1.30 user attempts to access a file for which EXECUTE authority is the highest available to that user, the access will be denied. EXECUTE authority is effective only for IBM OS/2 requesters.
3. The "AT" function is only available to IBM OS/2 requesters.
4. The Net Run function is only available to IBM OS/2 requesters.

PCLP Base Services users may access an IBM OS/2 LAN Server if that user knows the OS/2 LAN Server machine name and individual resource password. This resource password is specified in the resource profile by a System Administrator.

An IBM OS/2 LAN Server requester cannot access resources on a PC DOS machine. Therefore, in planning a migration to OS/2, upgrade the network servers before migrating the workstations to the new operating system.

IBM PC LAN Program Version 1.30 may be remotely IPLed from an IBM OS/2 LAN Server Remote IPL Server.

Workstation/Server Protocol

The Server Message Block (SMB) protocol implemented by the IBM OS/2 LAN Server is a new dialect, which is a superset of that implemented by the IBM PC LAN Program Version 1.30. The IBM OS/2 LAN Server supports the prior SMB dialects and subdialects so that the IBM OS/2 LAN Server can operate compatibly with an IBM PC LAN Program Version 1.30 requester.

Hardware Compatibility

The IBM OS/2 LAN Server uses the IBM NETBIOS support in the OS/2 Extended Edition Communications Manager. This IBM NETBIOS support is only compatible with the PC DOS IBM PC LAN Support Program. Therefore, the PC DOS systems running the PC LAN Program Version 1.3 will require the PC DOS IBM PC LAN Support Program. The IBM PC LAN Support Program provides support for all IBM LAN-attached workstations, including those that use the original PC NETWORK Adapter. Additionally, the Operating System/2 Extended Edition Communications Manager IBM NETBIOS does not support the original IBM PC Network Adapter. IBM OS/2 workstations wishing to participate in a PC Network LAN need to use the IBM PC Network Adapter/II.

Summary

The IBM OS/2 LAN Server extends the reach of the application programmer using the standard OS/2 commands and programming interfaces. An application's environment need not be limited to just the physical boundaries of the machine on which it is run. Network devices and data may be centralized on a single server or distributed on multiple servers as the environment dictates.

The IBM OS/2 LAN Server extends the flexibility of the OS/2 environment through the use of:

- Local/remote transparency
- Network device/queue management
- Network application management
- Security
- User to user messaging
- Migration from PC DOS to OS/2.

Glossary

A

additional server. Any server in a domain other than the Domain Controller.

D

domain. An IBM OS/2 LAN Server domain comprises the set of servers whose resources are administered as a single logical system. There may be one or more servers in a domain. It is possible for multiple IBM OS/2 LAN Server domains to coexist on the same LAN. IBM OS/2 LAN Server domains are independent of each other, except that both user and machine names must be unique not only within a domain but across all domains on a physical LAN.

domain control database (DCDB). This consists of those files which describe the current IBM OS/2 LAN Server system. It resides on the domain controller.

domain controller. One server within a system is designated as the Domain Controller; this is the machine which provides the details of the IBM OS/2 LAN Server to the rest of the machines within the system. The Domain Controller is additionally responsible for coordinating and maintaining the overall system status.

E

external resource. This is a resource provided by a server which may be outside of the current domain, called an external server, and which is accessed via commands provided by the System Administrator. The IBM OS/2 LAN Server allows a user to connect and disconnect to/from such resources by invoking these stored commands. A user will refer to external resources by name in exactly the same way as normal managed resources and normally will not be aware of any difference.

I

image. An RIPL'd workstation is IPL'd using a specific image provided by a specific server. The system maintains a list of image names, each with an associated description. An image itself is a file found on an RIPL server which contains a diskette image and which is read by the RIPL handling software as if it were a virtual A: diskette. Such image files are found in a specific directory on each server and have a name of <image name>.IMG.

image recipe. Associated with each named image on the system is a file containing a description of how the .IMG file is to be built. Each such file is maintained within the DCDB and is referred to as the image recipe. A recipe may specify one of two types of image, one which is built by copying an actual bootable diskette, and the other is specified by listing the files which are to be collected to form the image.

R

requester. The software function shipped with the IBM OS/2 Extended Edition Version 1.1 system that enables an OS/2 workstation to access network resources.

RIPL server. Any server can be an RIPL server. This indicates that it has the RIPL support code running and has details of a range of workstations which may be RIPL'd by it.

S

server. Any machine providing the IBM OS/2 LAN Server resources to an IBM OS/2 LAN Server or IBM PC LAN Program Version 1.30 system.

system administrator. A technically skilled person who will be responsible for planning, installing and configuring the LAN. This person may be assigned special privileges within the IBM OS/2 LAN Server to carry out their duties, such as assigning user IDs and passwords and assigning resource access permissions. There may be more than one System Administrator per domain.

W

workstation. This term is used to refer to any machine which may be in use by a user. Servers may also be workstations.

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G360-2637	V5.3	IBM Personal System/2 Models 50, 60, 80 Micro Channel™ Architecture, Hardware Features and Design Considerations
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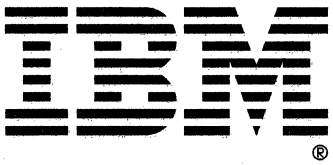

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