CHAPTER 2

The PC NetLink Software Architecture

This chapter provides an overview of the Solaris PC NetLink software and describes its server functionality.

The four basic components of the PC NetLink software are:

- PC NetLink base code—This software consists of several processes that support the fundamental functionality of the Solaris PC NetLink server.
- PC NetLink Server Manager software—This application, based on Java, lets you configure the Solaris functionality to administer the PC NetLink servers and clients. It consists of both a client and server code as well as all the support software required to execute the application.
- NetBIOS driver—This driver supports requests from both the clients and the PC NetLink server and is installed as a network driver. While included with the PC NetLink software, the NetBIOS driver works independently of other PC NetLink software components.
- PC NetLink utilities—These are the WIN16 and WIN32 utilities used to configure the Windows NT domain items in the PC NetLink server. These are the same tools used on Microsoft Windows NT 4.0 server to administer Windows NT servers.

Knowing what is and is not required by the PC NetLink server base software can help keep the `/opt` directory as small as possible. TABLE 2-1 shows the software components in each package and whether the package must be installed on all PC NetLink servers, or is optional and can be installed elsewhere. Large Solaris servers sometimes contain over 100 packages.

TABLE 2-1 PC NetLink Server Software Packages

Package Name	Content	Optional
`SUNWlzac`— PC NetLink Server Adm Common	Java Runtime Environment needed to support both the client and server sides of the PC NetLink Manager. Also contains the uninstaller for the entire product	Not optional
`SUNWlzag`— PC NetLink Server Adm GUI	PC NetLink Server Manager client Java application	Optional only if you have access to the package from some other server or do not plan to use PC NetLink Server Manager to configure your server.
`SUNWlzas`— PC NetLink Server Adm Srv	The server side of the PC NetLink Server Manager application	This package requires the `SUNWlzac`. Optional only if you will not use the PC NetLink Server Manager.
`SUNWlzcl`— PC NetLink Server-Client Utilities	A TCP/IP stack used by the PC NetLink environment	Required only if you will not perform system administration tasks from Windows for Workgroup 3.11 machines.
`SUNWlzd`— Administration Documentation	The full PC NetLink Server documentation	Required only if the documentation has not been installed on another accessible server.
`SUNWlzm`— PC NetLink Server Man Pages	The man pages for every Solaris command-line executable that installed with the PC NetLink Server	Needs to be installed on only one server at a site. The man pages can then be exported to all other servers.
`SUNWlznb`— Sun NetBIOS Transport	The code needed to create the `/dev/nb` and `/dev/nbdg` driver that support the NetBIOS interface layer	Required for basic functionality.

TABLE 2-1 PC NetLink Server Software Packages *(Continued)*

Package Name	Content	Optional
`SUNWlzs`— PC NetLink Server base	The base Sun Link Server functionality	Required for basic functionality.
`SUNWlzst`— PC NetLink Server Tools	The Win32 and Win16 utilities for performing Windows NT Server Administration. They consist of the User Manager, System Manager, and Event Manager	Required if the Windows NT 4.0 workstations, or Win 9X PCs will be used to configure PC NetLink.
`SUNWlzsr`— Data configuration information	This package was introduced in Version 1.1. The files in this package were in the `SUNWlzs` package in Version 1.0	Required in every PC NetLink 1.1. Does not exist in Version 1.

At a bare minimum, only the `SUNWlzs` and `SUNWlznb` and `SUNWlzsr` (for Version 1.1) packages must be installed if the following restrictions apply:

- You can configure Solaris and PC NetLink Server using the command-line options only.
- You have access to Windows NT 4.0 server tools User Manager, System Manager, and Event Manager.

PC NetLink Server Manager Architecture

The PC NetLink software is a layered product that requires some unique administration requirements. These requirements are met by the PC NetLink Server Manager tool—PC NetLink server manager software (also known as SunLink Server Manager, path =`opt/lanman/sbin/slsmgr`). Knowing something about its architecture may help avoid problems that can occur with complex server configurations.

The PC NetLink Server Manager software consists of client and server Java applications. Its user interface was designed to be familiar to Windows NT administrators. The client component of the PC NetLink Server Manager is supported on Solaris clients as well as Windows NT 4.0, Windows 95, Windows 98, and Windows 2000. The software uses Remote Method Invocation (RMI) and the `rmiregistry` to bind the client to the server.

The PC NetLink Server Manager software supports the administrative tasks normally performed during the initial installation and configuration of a Windows NT server, such as:

- Setting the name, domain name, and role (PDC vs. BDC) of the server
- NetBIOS configuration, including B or H node and WINS address
- Configuration of Solaris printers, which must be done to map Windows NT printers to Solaris printer queues

These various services can be started and stopped with this tool.

The PC NetLink software provides configuration parameters that allow access from both Solaris and Windows NT environments. The PC NetLink Server Manager software supports the configuration of these parameters together with a rich set of informational and help text that describes their effects.

While standard Windows NT tools can be used to manage the PC NetLink server after it is installed and working, they cannot control the Solaris administration that may be required to support the PC NetLink server software. Solaris commands facilitate monitoring the Solaris resources needed by the PC NetLink software. The functionality offered by the PC NetLink Server Manager duplicates the functionality provided by the Solaris or the PC NetLink command-line interface. The man pages for these command-line interfaces are documented in Appendix C.

Note – The Java Runtime Environment is required only if you want to use the PC NetLink Server Manager GUI. It is not required for base level Solaris PC NetLink software support that PC clients require.

Runtime Architecture

The GUI, which is based on Java, runs on all the PC clients that the server supports (except for Windows for Workgroup 3.11), as well as the Solaris clients or servers. The PC NetLink Server Manager server code is installed by default when you install the Solaris PC NetLink software via the install script, or, in the case of PC NetLink 1.1, during the Solaris Easy Access Server (SEAS) installation. The client portion of the PC NetLink Server Manager software is shipped with PC NetLink server software and is available in the `/opt/lanman/shares` directory after a standard installation.

PC NetLink Server Manager software requires the use of the Java Runtime Environment (JRE) software that comes with a specific version of the Java Development Kit (JDK™). If you have a previously installed version of JDK that does not work with the JRE software required by the PC NetLink Server Manager software, in some instances you can install the required version of the JDK in addition to any version required by other software. Special attention should be made to issues that may exist by having two different versions of the JDK existing on the same server at the same time. If these issues become too difficult to resolve, you can

install and administrate the Solaris PC NetLink software without the need of the PC NetLink Server Manager software. This requires administrating the PC NetLink software via command-line options alone.

The PC NetLink Server Manager client application, while based on a specific version of the JDK, does not interfere with other client applications based on Java. It is developed and installed in such a way that the JDK virtual machine (VM) and Java support libraries are used privately by the PC NetLink Server Manager client software. The JRE running on a PC client may require additional memory resources, so be sure to run the PC client Java code on a PC with sufficient memory.

Client-Server Architecture

Remote Method Invocation (RMI) is the framework used by the client portion of the software to initiate a PC NetLink Server Manager session (see FIGURE 2-1). After a standard installation of the PC NetLink server software, the Session Manager process will start as part of a normal PC NetLink server startup. Its role is to handle a secure login by a system administrator on a PC or Solaris client. Once you are logged on, the Session Manager process acts as remote object factory to support your requests, using the PC NetLink Server Manager client software. While the actual API interface used by client and server portions of the software to communicate is not documented, Appendix C provides a well-documented set of commands. You can use these commands to develop tools to extend PC NetLink Server administration. Chapter 8 shows how to combine these commands in scripts to perform a variety of functions.

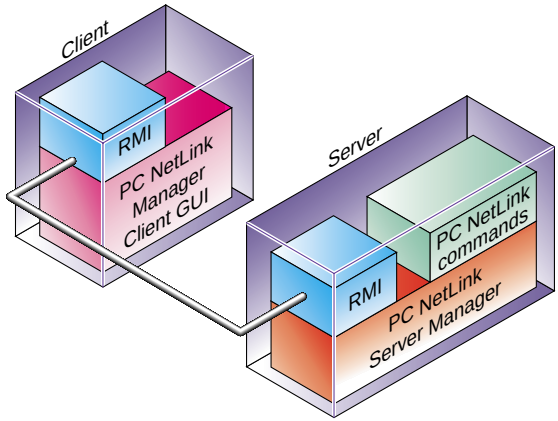

FIGURE 2-1 PC NetLink Server Manager Client-Server Architecture

PC NetLink Server Manager Security

The PC NetLink Server Manager software implements a security envelope above the RMI layer using the Java Cryptography API of the JDK. This API enables:

- Client connection is authenticated at login.
- No password is ever transmitted in clear text.
- All client-server communications are authenticated.
- Required access level is verified for all client requests.
- All client-server communications have the option of data integrity.

Installing PC NetLink Server Manager on Microsoft Clients

The PC NetLink server media contains a `setup.exe` file that installs the PC version of the PC NetLink Server Manager client. It was constructed with InstallShield. An auto-run file automatically invokes this installer when the CD is placed in the drive if the PC is running Windows NT 4.0, Windows 95, or Windows 98. This software's use of the Microsoft Registry conforms to the requirements listed in *Meeting Windows Logo Requirements With InstallShield 5.5*. The software is installed in the appropriate software directory (determined by the ProgramFileDir Registry parameter). The Solaris PC NetLink software installation creates the Registry parameters in TABLE 2-2.

TABLE 2-2 Installation Data Parameter Keys

InstallLocation	The path of the installation executable
JavaRuntimeVersion	The version of Java Runtime installed by this product

Solaris PC NetLink Server Architecture

Under normal operation, no one needs to be concerned with the architecture for simple installations of the Solaris PC NetLink software. However, for server consolidation and some of the tuning techniques to improve performance, an understanding of the architecture may be necessary. FIGURE 2-2 shows a functional diagram of the Solaris PC NetLink server architecture.

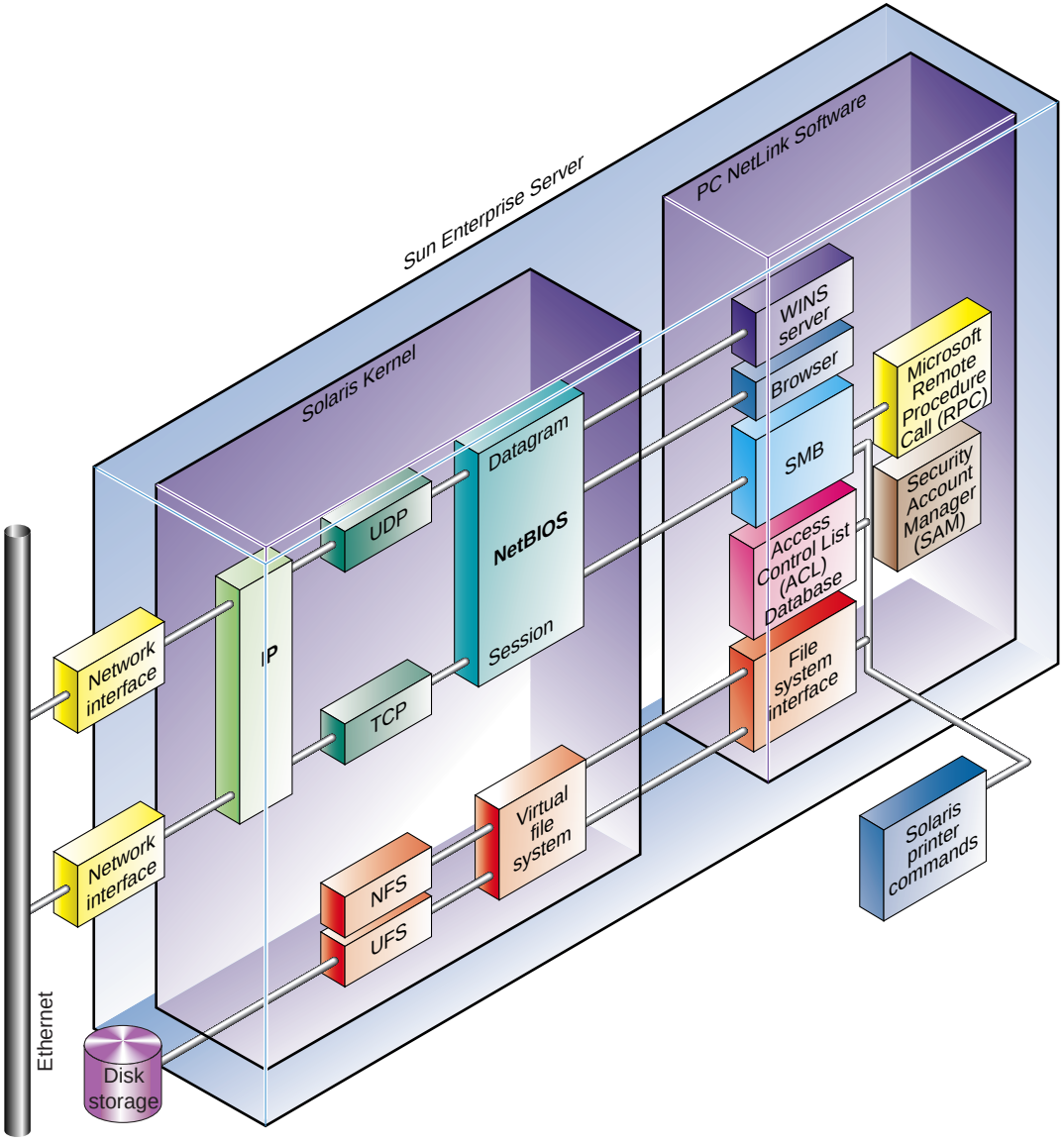

FIGURE 2-2 Interaction Between the PC NetLink and Solaris Software

FIGURE 2-2 shows how the various services are layered. In addition it shows where the PC NetLink Server functionality ends and the Solaris functionality begins. Important points to note from FIGURE 2-2 are:

- Most of the PC NetLink server code runs in user mode. Only the supplied NetBIOS layer runs at the kernel level. This feature protects all other Solaris processes from any possible problem the PC NetLink server might have. Outside of resource allocation, these user-level processes cannot directly interfere with other user processes on the system.
- The PC NetLink server software makes its calls to and from the network layer through the NetBIOS layer.
- The NetBIOS layer, in turn, uses TCP and UDP protocols through the IP layer.
- The Access Control List (ACL) and Security Account Manager (SAM) are supported by the PC NetLink server privately maintained database. On a Windows NT machine, this Windows NT domain style ACL is stored in the NTFS file system.
- File lock information is handled at the user level and is maintained inside shared memory.
- The actual server processes that support this functionality are not shown, but will be explained later in this chapter.

Supported Windows NT Network Services

File and print sharing services require implementation of the Server Message Block (SMB) protocol. Many versions of this protocol have been released over the years. Documentation of the most recent version, renamed the Common Internet File System (CIFS), was released by Microsoft. The CIFS protocol was implemented in Windows NT 4.0 and is supported by the PC NetLink server. The CIFS specifications are available at `http://www.cifs.com/`. The specific version of the CIFS protocol that comes closest to what the PC NetLink software supports is the NTLM 0.12 version.

This information may be useful if you need to diagnose some obscure problem that requires sniffing the network wire. Knowing the specific protocol the PC NetLink software supports is of little value to customers that know only that they are running a specific operating system. It is not always easy to determine which network protocol version a PC client operating system supports. Sun Microsystems bases its support in terms customers can relate to, namely the PC Client operating systems that will be using the PC NetLink functionality. For example, it is stated by the Solaris PC NetLink specifications that it supports the `file` and `print` operations originating from PCs running the Microsoft Windows 98 operating system (among others). Without knowing the exact protocol designation, you know that if you have a Windows 98 PC Client it is officially supported by Sun.

The NTFS security model associates ACLs with each file and directory. While the PC NetLink server maps file and directory paths to the Solaris file system name space, it maintains a separate database of ACLs associated with the paths. This enables the PC NetLink server to provide NTFS semantics over the network. The PC NetLink server also maintains DOS file attributes for each file. The attributes are maintained in special Solaris group ownerships assigned to the file, rather than in a separate database as the ACLs are. The PC NetLink server installation creates these special Solaris groups (`DOS----`, `DOS---h`, and so on) in the `/etc/group` file if they do not already exist in the naming service.

Naming and network address services require NetBIOS, WINS, DNS, and DHCP. NetBIOS supports the registration and lookup of NetBIOS name/IP mappings on a subnet. WINS extends this service across subnets. Microsoft extended its DNS server so that it will communicate with WINS servers for lookups that cannot be resolved from its static database. Therefore, after a client has registered its NetBIOS name/IP mapping with the WINS server, it can be located using the Microsoft DNS. The PC NetLink server supports NetBIOS and WINS, but does not support DNS or DHCP directly. However, both DNS and DHCP support are provided by the Solaris platform. The lack of a WINS interface in Solaris DNS is a drawback that can be mitigated by a combination of the Solaris Dynamic DNS and DHCP.

The Windows NT Browser service publishes lists of shared resources (printer and file shares) that are available in a workgroup or Windows NT Domain. The familiar Network Neighborhood listing is derived from a browser. The PC NetLink server includes a port of the Windows NT Browser service.

The Windows NT Directory Replication Service supports export and import for directories. If a directory is exported, the contents of the files and directories below it are periodically copied to remote systems that imported that directory. The PC NetLink server includes a port of the Windows NT Directory Replication Service.

The Windows NT Authentication service supports user authentication within a Windows NT Domain. The Windows NT Security Account Manager (SAM) is the store of user accounts for the domain. A copy of the SAM must exist on any server designated as a domain controller capable of authenticating a user. Updates to the SAM are directed to the primary domain controller (PDC). Changes to the PDC's SAM are periodically sent to the Backup Domain Controllers (BDC). A PDC can be demoted to a BDC, and a BDC can then be promoted to the PDC (only one per domain). The PC NetLink servers can be configured as either a PDC or BDC, and fully support the Windows NT network authentication protocols.

The Windows NT management protocols are layered on the Microsoft RPC (MS-RPC). The PC NetLink server includes an implementation of MS-RPC along with the RPC procedures that implement the server side of the Windows NT management protocols. Therefore, the PC NetLink server supports the common Windows NT management GUIs (run from a PC client), including Event Viewer, User Manager, Registry Editor, and Server Manager. Support for Windows NT management interface means that the PC NetLink server supports a large subset of the Microsoft

WIN32 API because it relies upon these management interfaces.

FIGURE 2-3 provides an architectural overview of the implementation of services and protocols.

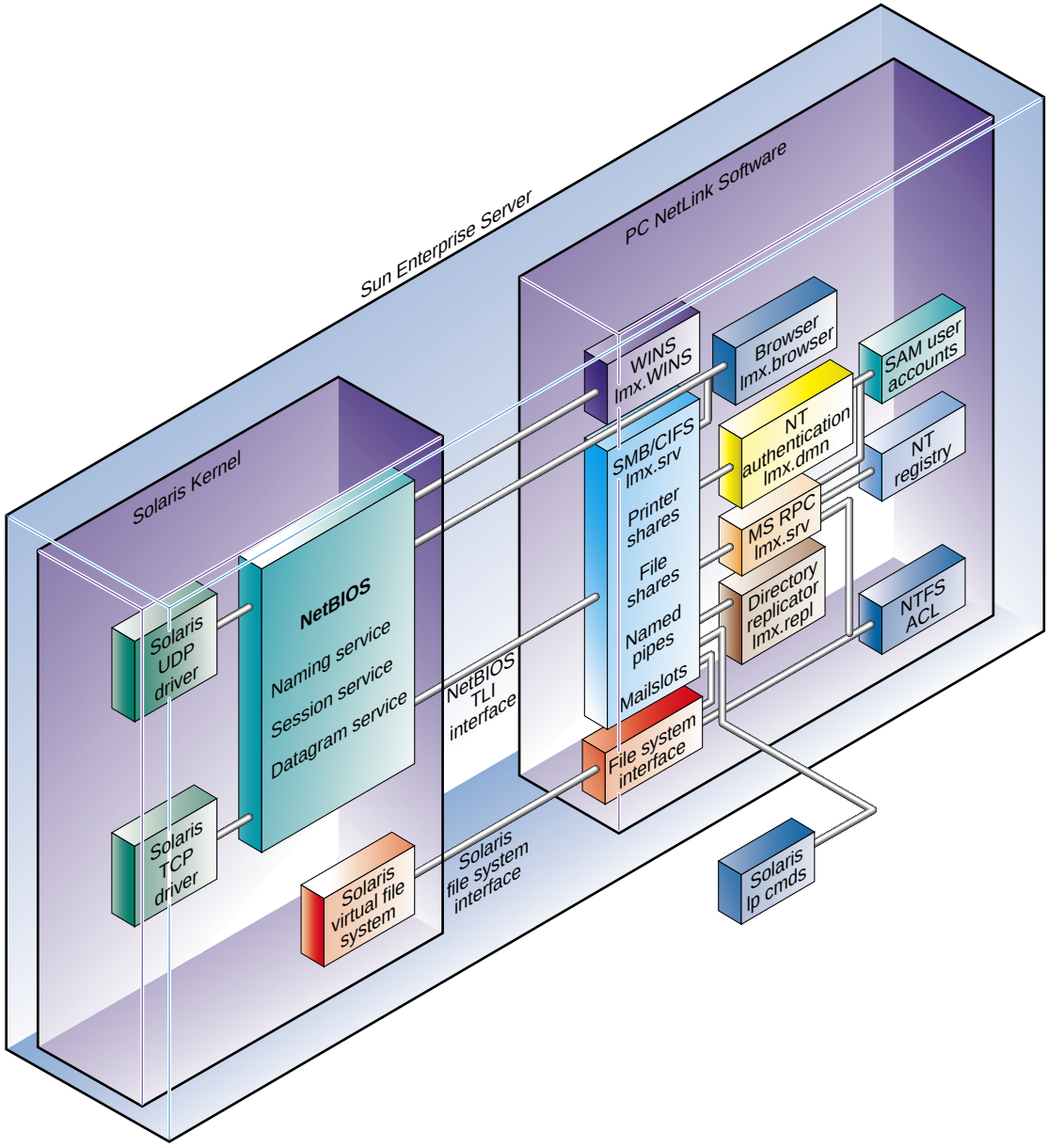

FIGURE 2-3 Relationships Between Major PC Netlink Components

FIGURE 2-3 illustrates the relationships between the major components of the portion of the PC NetLink server that supports the Windows NT protocols and services. The name of the PC NetLink server daemons (`lmx.browser`, `lmx.srv`, etc.) are seen within the block labeled “PC NetLink Server”. The lines from the “PC NetLink Server” block are shown going to and from the “Solaris Kernel” block which highlights the primary interfaces the PC NetLink software uses to support it’s functionality.

The Registry maintains configuration and tuning parameters for nearly all of the services. Even though lines were not drawn between the Registry and the other services, the services do query the Registry.

The lines from MS-RPC to the ACL, Registry, and SAM support the APIs used to manage those components from client management tools.

The interfaces between the Browser, Authentication, MS-RPC, and Replication services and the SMB/CIFS modules are *named pipe*s and *mailslots*, which are network communication endpoints. The services create well-known named pipes or mailslots in the SMB name space, and service the requests that arrive on them through connections from the client. The SMB connection is layered on a NetBIOS connection created by the NetBIOS Session service. Mailslots (class 2) are layered on the NetBIOS Datagram service. The NetBIOS session and datagram services use the TCP and UDP drivers respectively.

The alerter is an Windows NT service that sends alert messages to clients or to specific users. For example, a server can be configured to send a message to a particular client if a power failure occurs. The alert is displayed in the center of the client's monitor.

The daemons that provide the various services are controlled by the control daemon—`lmx.ctrl`. The control daemon spawns (and stops) the others as appropriate and communicates with them through a Named Streams pipe. A client request for a connection is initiated with a request to the control daemon, which creates a NetBIOS connection and passes the corresponding file descriptor to the appropriate daemon. Each `lmx.srv` process can support connections to more than one client. However, additional `lmx.srv` daemons are spawned as the number of connections per daemon reaches a threshold. The number of file descriptors per daemon is set to a hard limit—1024 in the default Solaris configuration.

The states of open files and locks are maintained in a shared memory segment. This shared memory segment also contains the set of shared resources and client connections. Each daemon maps this segment.

Shared libraries contain code that implements the ACL, Registry, and SAM subsystems, as well as the file system and printer interfaces. The `libasusec.so` library implements the ACL and Registry subsystems. The `libsam.so` library implements the SAM. Much of the file and print system is implemented in the

`liblmx.so` library. The `lp_ops.so` library is used to support the PSI functionality while the PSI API itself is supported by the `libmxpsi.so` library. Portions of the `lmx.srv` process that make the PSI calls are in the `liblmx.so` library.

The ACL, Registry, and SAM data are stored in what are known as Binary Large OBject (or BLOB) files. The format of a BLOB file consists of a free block map, a key map that maps keys to blocks, three hash lists that map some searchable value to a key, and the data blocks themselves. This format is intended to support efficient lookups, but updating a record requires updates to many structures within the BLOB file. Because of the small chance that the structures of the BLOB file could become inconsistent as a result of a crash, the PC NetLink software provides command-line utilities that restore the consistency of BLOB files—`acladm`, `regadm`, and `samcheck`. You can use the PC NetLink Server Manager GUI to run these utilities.

The administration of the WINS service is unique in that the WINS RPC management interface is layered directly on TCP/IP, rather than on Named Pipes over SMB. Without a well-known Named Pipe name, the WINS service needs the help of the endpoint mapper, which maps a request for the WINS administration interface to the TCP/IP port that the WINS service has registered. The endpoint mapper is implemented as the daemon `lmx.ep` and listens at port 135.

Integrating Solaris and Microsoft Environments

The PC NetLink server software provides services that are usually provided by the operating system, such as user authentication and file locking. The relationships between these PC NetLink services and the Solaris services are configurable in order to support two general types of environments—one in which users access the server resources only from a Microsoft client, and the other in which users can access resources from either Solaris or Microsoft clients.

User Account Mapping for Microsoft-Only Accounts

For Microsoft-only accounts, users have an identity in the Windows NT Domain (the PC NetLink server SAM) and have no identity in any Solaris naming service. Files created by any user in this environment are owned by the Solaris user `lmworld`—one of the password accounts created by the PC NetLink software installation. (The PC NetLink server installation also creates `lmxadmin` and `lmguest` accounts to

which the special Windows NT accounts Administrator and Guest are mapped.) File locking is provided solely by the PC NetLink server, without support of Solaris locking.

User Account Mapping for Solaris and Microsoft Accounts

In accounts mapped for both Solaris and Microsoft accounts, users can have an identity in both the Windows NT Domain (SAM) and a Solaris naming service. You can create mappings between the Windows NT (SAM) account and a Solaris account using the `mapuname` command. Newly created files are owned by the Solaris user to which the Windows NT account is mapped. You can also configure locking so that the PC NetLink Server locks are propagated to Solaris locks.

For dual-mapped accounts, the PC NetLink server provides the tools `passwd2sam` and `sam2passwd` to maintain mappings between Windows NT and Solaris user accounts. If updates to accounts are made to the Solaris naming service, the `passwd2sam` utility migrates these updates to the Windows NT SAM. Since passwords cannot be migrated, this tool can create a file with a list of random passwords for the new accounts, or assign a single password to all of the new Windows NT accounts. Use `sam2passwd` utility in environments where the updates are made to the Windows NT SAM. The utility will generate a file in `/etc/passwd` format that can be merged with an `/etc/passwd` file or with NIS maps.

NetBIOS Transport Support

The PC NetLink server supports network protocols by way of the NetBIOS over the TCP/IP layer. This layer is based on the RFC1001/1002 NetBIOS protocol and is a standard networking protocol used primarily by PCs. It is one layer below the SMB (Server Message Block) protocol used by Windows NT networking, and one layer above the TCP/IP protocol. In the PC NetLink server, the NetBIOS protocol is implemented in kernel space using the standard STREAMS framework (FIGURE 2-4.)

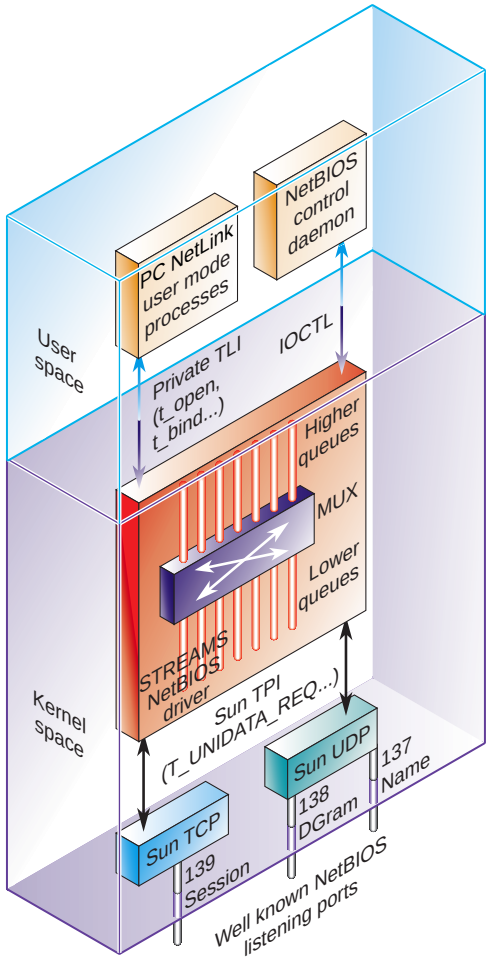

FIGURE 2-4 Network Paths and Components

The PC NetLink server NetBIOS kernel component is a regular kernel STREAMS multiplexing network protocol device driver that implements the RFC1001/1002 NetBIOS protocol. It exposes a private TLI interface to the user mode PC NetLink server components. It uses regular TPI STREAMS messages to communicate with Sun TCP and UDP STREAMS drivers. It is controlled by a user mode daemon that starts up at boot time to control and manage the multiplexing STREAMS driver. The daemon controls the driver through private `I_STR ioctls`. It has no dependency on other PC NetLink server components and can be viewed as a self-contained software component (FIGURE 2-5.)

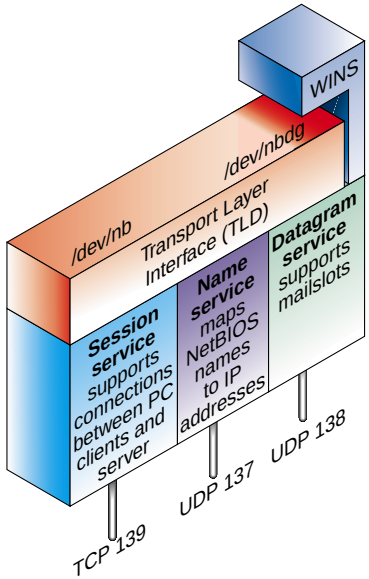

FIGURE 2-5 NetBIOS Architecture

The NetBIOS layer attaches to specific TCP/IP sockets on the system and also responds to specific broadcasts to support NetBIOS naming requests. For this reason, only one NetBIOS layer can be active on a server at one time. Neither SunLink PC (Syntax Totalnet), nor Samba can have active NetBIOS functionality while the PC NetLink software is running. See Chapter 6 for help with making a transition to and from these environments.

When Sun Microsystems started developing the Solaris PC NetLink software, it evaluated many UNIX-based NetBIOS layers. The one chosen to bootstrap the work was from NCR, which had been used to support other AT&T AS/U implementations. This NetBIOS layer has since undergone many changes to make it more robust and better able to take advantage of multiprocessor environments. Little of the original code now exists in the current shipping product.

NetBIOS is typically supported on three different transport layers. The PC NetLink 1.0 software only supports NetBIOS over TCP. Use of the TCP transport is the most scalable solution, so it is the preferred transport for any large organization. Microsoft Windows operating systems (Windows 95, 98, and Windows NT 4.0) all support the TCP protocol. Users who have been using other protocols on their PC clients (such NetBEUI, and NetBIOS over IPX) and have *not* installed TCP, must install the TCP protocol from the appropriate OS CD-ROM or diskette. This situation is highly unlikely, however, as all web browsers and Internet-aware applications use the TCP protocol, exclusively requiring the installation of the TCP layer.

The PC NetLink software NetBIOS supports both B- and H-node types. A full description of these node types is beyond the scope of this book. Refer to Windows NT 4.0 documentation for a full description of B- and H-node types.

The important points to keep in mind about the NetBIOS architecture is its use of specific TPC and UDP sockets to support its functionality. Specifically these sockets are:

- TCP Socket 139 Session Service
- UDP 137 Name Service (WINS involvement)
- UDP 138 Datagram Service mail slots

Note that the NetBIOS layer used by Sun Microsystems is a multi-threaded version of NetBIOS. This means that as the number of concurrent PC client operations are processed by a multiprocessor PC NetLink server, multiple processors can process instructions within the NetBIOS layer without interfering with one another (FIGURE 2-6.) One processor handles the request for one PC client, while another processor handles a request for another PC client without slowing down because of resource contention. It does, however, maintain `mutex` locks around data memory that maintains NetBIOS state information. The code executed while these `mutex` are in effect is small, and will cause only slight delays as threads running on other processors attempt to flow through the code and are blocked by the `mutex`.

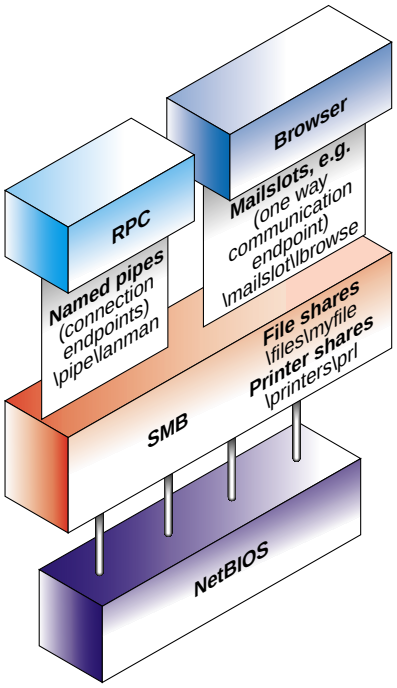

FIGURE 2-6 NetBIOS Named Pipes and Mailslots

NetBIOS Changes to the Solaris Operating Environment

When the PC NetLink server NetBIOS is installed, the following changes are made to the Solaris environment:

1. The netbios script is placed into `/etc/init.d`. The `/etc/rc2.d/S98netbios` and `/etc/rc1.d/K20netbios` symbolic links are created to point back to this script. This script is used to start and stop the NetBIOS layer.
2. `/kernel/drv`—The `nbx` driver and the configuration file are placed in the directory.
3. Device links `/dev/nb`, `/dev/nbdg` are created.
4. The NetBIOS control daemon is installed into `/opt/SUNWlznb/sbin/nbdaemon`
5. Configuration and monitoring utilities are installed: `/opt/SUNWlznb/sbin/`…
6. Network interface related config files are created and initialized: `/etc/opt/SUNWlznb/`…
7. Other config files are installed: `/var/opt/SUNWlznb/`…
8. The NetBIOS man pages are added. `/opt/SUNWlznb/man`

NetBIOS Relationship With the Java Admin Tool

In addition to allowing the user to configure the NetBIOS component through command-line utilities, the Java-based PC NetLink Server Manager (`slsmgr`) enables the user to change parameters through a Graphical User Interface (GUI). Any change requiring a restart of the NetBIOS layer will require the user of the GUI to give permission for the restart. The GUI can be used remotely.

PC NetLink Server Printer Architecture

The PC NetLink server's role in handling printing requests for PC clients falls into two categories. First, the security measures are enforced to allow users to access a particular printer. Second, the PC NetLink software works with Solaris software to maintain a printer spooler to accept print jobs. The PC NetLink server only moves the data from the client to the printer. It has little notion of what kind of printer it is

spooling output to. If the PC client creates a network printer using the wrong printer driver, the PC NetLink software will send this incorrectly matched printer output to the printer, resulting in garbage output or a confused printer.

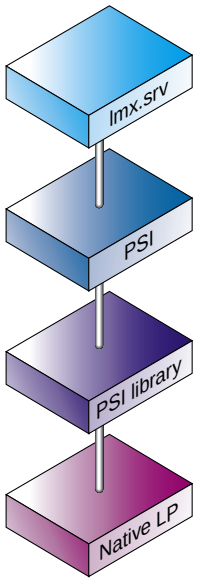

FIGURE 2-7 PC Netlink Printing Subsystem

The PC NetLink server printing system has four layers (FIGURE 2-7.) Each `lmx.srv` process can handle printer-related functions. Within a server process is a full set of Windows-style printer server components, such as the spooler. The Printer Subsystem Interface (PSI) layer is the API that the server process uses to contact the underlying Solaris print services. Support for PSI calls are scattered throughout the parts of the server that need access to the printing subsystem. PSI is completely ignorant of the print subsystem. The PSI layer simply calls the corresponding functions in the PSI library for each function in PSI that was called by the `lmx.srv` process.

The PSI library is the interface library between the PSI API and Solaris print services. The PSI library, which is implemented as a shared library, converts each PSI function call into its corresponding Solaris `lp` command. All communication between the PC NetLink software and Solaris software within the printing subsystem occurs inside the PSI library. Unlike the PSI layer above, the PSI library from the original AS/U code was rewritten for PC NetLink to take full advantage of Solaris software.

Printer Names

Four different names appear in the printing subsystem of the PC NetLink server. Each name has its own purpose and restrictions.

- Solaris Printer Name—This is the name of the Solaris print queue that prints the requests passed in from the PC NetLink server PSI library. As with any other `lp` print queue, this name must adhere to the `lp` naming restrictions. Legal characters are [A–Z], [a–z], [0–9], and "_". This name must be between 1 and 14 characters long. No other characters or white space are permitted in an `lp` printer name. Follow instructions in the *PC NetLink Server Administration Guide* to avoid problems with the naming rules.
- Windows Printer Name—This is the actual name that Windows clients will interact with. This name is a Windows NT-style long name, and it can have any of the following characters: [A–Z], [a–z], [0–9], and "_". Unlike Solaris printer names, Windows printer names can have white space, and can be as long as the Windows NT long name limit (255 characters). Downlevel clients, however, may not be able to see the entire name.
- Windows Share Name—Every PC NetLink server printer consists of both a printer and a share. The printer share name must adhere to the DOS 8.3 naming length (that is, 12 characters). The share name for a printer is automatically created from the first 12 characters of that printer's Windows printer name. Users never directly interact with the Windows share name of a printer from Windows clients. It is visible while browsing the root level of the PC NetLink server from a Windows client. It is also visible from other commands, such as `net share`.
- Solaris Class Name—Each Windows print queue is mapped on a one-to-one basis with a Solaris printer class. This printer class is generated automatically whenever a Windows printer is created by the PC NetLink server. The name of this class is the first 14 characters of the Windows printer name, with the white space converted to underscores. This class is never seen from the Windows side, but it should not be removed from the Solaris server.

Printer Installation With the PC NetLink Software

Printer installation is a three-step process, and is covered in the *PC NetLink Server Administration Guide*. This section describes only the architectural details of printer installation.

1. Solaris Printer Install—To be used by the PC NetLink software, a Solaris printer must be configured so that it is locally spooled. The Install Solaris Printer task in the PC NetLink Server Manager was created to ensure proper configuration of Solaris printers. Any printer properly set up with the PC NetLink Server Manager is a potential PC NetLink shared printer.

The PC NetLink software supports only locally spooled printers because the PC NetLink software must have access to the spool directory of the Solaris server that is actually doing the printing. Without this access, it would not be possible for Windows clients to have job control.

A locally spooled printer is not the same as a local printer. Network printers can be locally spooled, in fact, to many different machines at the same time. The PC NetLink Server Manager correctly configures `lp` print queues for network printers so that they are locally spooled. Using other tools for this task, such as Solaris Admintool, is not recommended because they do not force users to set up a local spool for their network printer.

A Solaris printer that is being used as a PC NetLink shared printer is still a viable Solaris printer for use by Solaris clients.

2. PC NetLink Printer Installation—The creation of a PC NetLink server shared print queue is basically the construction of a link between a Windows print queue and a Solaris `lp` print queue. This link takes the following form:

Upon completion of the Add Printer Wizard on Windows, three new entities are created: a Windows print queue, a Windows printer share, and a Solaris printer class. The Windows printer name is entered by the user, and the share and `lp` class are constructed based on that name, adhering to the naming rules. Note that while the Windows Add Printer Wizard also asks for a printer share name, the information entered there is ignored. The share name that the PC NetLink software uses is constructed from the Windows printer name.

Note also that the Windows printer name cannot be the same as the Solaris printer name because of the Solaris class that is constructed. `lp` uses a single name space for class names and printer names. Because the Solaris class name for the printer is constructed from the Windows printer name, if the Windows printer name was the same as the Solaris printer name, the PC NetLink software would attempt to create a Solaris class with that name, which is not possible in `lp`.

After a successful installation, browsing the PC NetLink server from the Network Neighborhood on a Windows NT client will display the printer in two locations. The printer share appears at the root level of the server. This printer icon has the Windows share name for that printer. Inside the printers folder is the Windows print queue. This printer icon has the full length Windows printer name. The Solaris printer class is not visible from the Windows side. If you look at the Solaris `lp` configuration, you can see that an `lp` class was created, and its members are the Solaris printers that are to receive the print jobs from that particular Windows printer. This is usually one printer, but can be more if multiple Solaris printers were mapped to a single Windows print queue.

The printers folder of a the PC NetLink server is not visible from Windows 95 or 98 clients. These clients can see the printer only at the share level.

3. Client Printer Install—Each client uses the full length Windows NT long name as the printer name when performing the local install. The printer driver must match that of the actual printer.

Printing Queues and Communication

The PC NetLink software maintains the list of Windows printer queues internally. Information about the Solaris print queues is available from `lp`. Communication between the PC NetLink software and `lp` is a critical issue because they do not use the same name space. The PC NetLink software only uses the Windows printer and share names, while `lp` is only aware of the Solaris class name(FIGURE 2-8.) This can be a problem. If the PC NetLink software sends an API call with the Windows printer name, everything is fine because the Windows printer name can be used by the PSI library to construct either the Windows share name or the Solaris `lp` class name as needed. However, if the PC NetLink software sends an API call with the Windows share name, there will be a problem. From the 12-character share name, it is not possible to reconstruct either the full length Windows printer name or the Solaris `lp` class name. The solution is to ensure that all communication between the PC NetLink software and the PSI library uses the long Windows printer name.

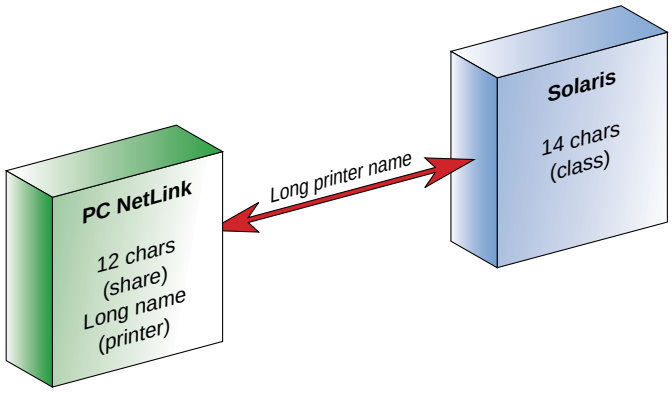

FIGURE 2-8 PC Netlink Printer Communication

A potential problem with this mechanism, which the PC NetLink software deals with, is that when an `lmx.srv` process starts (either because a new one was spawned to deal with the load, or because the server was restarted), the server process must be able to rematch `lp` class names with Windows printer names. To solve this problem, a storefile provides stable storage of (longname, classname) pairs. This file is located at `/var/opt/lanman/datafiles/.lpstorefile`.

Because the `lpstorefile` is written to each time a printer is created, and multiple `lmx.srv` processes can create printers at the same time, the `lpstorefile` is protected by a write-lock mechanism. This is a straightforward exclusive write-lock. Any number of `lmx.srv` processes can read the `lpstorefile` at once, but only one at a time can write to it.

`lpstat`

In the PC NetLink 1.0 software, all time consuming calls to `lpstat` (such as those with the `-s`, `-t`, or `-v` flags) were replaced with a PC NetLink software specific function, referred to here as pseudo-`lpstat`. Pseudo-`lpstat` returns only the names of locally spooled printers. In Solaris networks that use both Solaris print servers and the PC NetLink print servers, this saves a lot of time because the machine acting as a PC NetLink server does not have to contact all the Solaris print servers on the network to generate a list of names.

Pseudo-`lpstat` works by listing all the printers that have directories inside `/etc/lp/printers` (by a call to `ls`). This is a complete listing of all the locally-spooled printers (and therefore all the printers that can potentially become PC NetLink shared printers). Pseudo-`lpstat` is much faster than a call to the traditional `lpstat` for these purposes, especially when the number of print queues is large.

The creation of pseudo-`lpstat` also solves a conflict between the PC NetLink server and the `lp` interest list. The `lp` interest list is the list of Solaris print queues returned by `lpstat`. While you can create and use printers that are not on the interest list, they will not be returned by `lpstat` even when `lpstat` is set to list all printers. The `lp` interest list can be modified by either the `lpset` command or by directly editing `/etc/printers.conf`. Because the PC NetLink software no longer uses `lpstat` to list the Solaris print queues, users need not worry about adding printers created by the PC NetLink Server Manager to the `lp` interest list. The `lp` interest list does not interact with the PC NetLink software in any way. The PC NetLink software can continue to use the `lp` interest list to control the list of printers that Solaris clients see when using that machine as a Solaris print server.

Printing Registry Keys

A variety of registry keys are associated with printers. The most important thing to note about the keys is that the registry always uses the share name for permanent storage. By using the smallest name in the registry, you can find the proper key regardless of whether the procedure doing the search has the share name or the long name.

Print Jobs

Each PC NetLink server print job corresponds to a specific `lp` print job. However, the life cycle of a PC NetLink server print job is more complicated than that of an ordinary Solaris print request. The following operations occur:

1. Starting a Job—When a PC NetLink server receives a print request from a Windows client, the PSI library starts an `lp` job request. A paused `lp` job is created to hold the information for the print job, and resumes in order to print it. This paused `lp` job is simply created by a call to `lp` with the `-H hold` flag.

At the time of job creation, a Solaris job is assigned a *jobid* that is unique to the `lp` system on that Solaris server. A full Solaris *jobid* consists of a number and the name of the Solaris print queue. For example, job number 10 on printer `prntbw` has a Solaris *jobid* of `prntbw-10`. The numerical portion of the *jobid* is unique among *all* printers on that server. In other words, if you have a job `prntbw-10`, there will not be a job `prntcol-10`, but there could be a `prntcol-9` or `prntcol-11`.

When Solaris `lp` creates a job, it creates two files in the spool directory for that job (for reference: the `lp` spool directory is `/var/spool/lp/tmp/`*uname*, where *uname* is the Solaris hostname). The two files have names *jobid*`-0` and *jobid*`-1`, where *jobid* is the numerical portion of the Solaris *jobid* of that job. For example, for Solaris job `prntbw-10`, the two files created are `10-0` and `10-1`. The *jobid*`-0` file is the `lp` status file. This file contains a variety of fields reflecting the status of the job in `lp`. The *jobid*`-1` file (hereafter referred to as the `lp` spool file) is the corresponding data file for that `lp` job.

When the PC NetLink server creates the paused print request, it must supply `lp` with a filename. Ideally, this would be the name of the `lp` spool file, but the PC NetLink software cannot get an `lp` *jobid* before submitting the job. Therefore, the PC NetLink software creates a unique filename to provide to `lp`. These files are named `lptmp`*pid*`-`*nonce* where *pid* is the `pid` of the `lmx.srv` process that started the job, and *nonce* is the job's PC NetLink server *jobid*. This file will hereafter be referred to as the PC NetLink server spool file.

Each job actually has two different *jobid*s. The PC NetLink server *jobid* is taken from an internal counter held by each `lmx.srv` process. Each `lmx.srv` process starts counting with job 1, and the counter rolls over after 8192 jobs on a particular process. The Solaris *jobid* is created by `lp`. Because the PC NetLink server *jobid*s are not unique, two different `lmx.srv` processes can be concurrently using the same PC NetLink server *jobid*. Therefore, all translations from the PC NetLink server *jobid* to Solaris *jobid* also require the `pid` of the server process. With a `pid` and a PC NetLink server *jobid*, the PSI library can figure out the Solaris *jobid* by looking in the PC NetLink server status files.

The PC NetLink server status file is the fourth (and final) file involved in a print job. The PC NetLink server status files have names similar to the PC NetLink server spool files: `lptmp`*pid*`-`*nonce*`-0`. The PC NetLink server status files have three lines.

The first is the corresponding Solaris job number. The second is the name of the Solaris class that is going to print that job. The third line contains a string with the user name in the format *username* on *Windows client*. This information is needed so that the PC NetLink software can perform security checks and identify the Windows user associated with the print job. This allows only the submitter of the job or a system administrator to cancel a print job.

The group ID of the PC NetLink server status file is used to store the Windows job bits (paused, q_paused, and others). These are the same group IDs used by the PC NetLink software to store the Windows file attributes for shared files (hidden, archived, and so on). The use of the group ID to store status was inherited from AS/U. The group ID of the PC NetLink server status file is used rather than the `lp` status file, because Solaris `lp` changes the group of an `lp` status file back to `lp` whenever it is touched by `lp`. This would cause loss of status information if they were not stored in a file that was not actually being used by `lp`.

2. Spooling—The PC NetLink software spools directly to the `lp` spool file. The `lp` job, instead of printing that file, prints the PC NetLink server spool file. To make sure that `lp` prints the correct data, the PC NetLink software copies the contents of the `lp` spool file into the PC NetLink server spool file, once it has finished spooling the data. After the PC NetLink server spool file is correct, the `lp` spool file is deleted.

While a job is spooling, the spooling status bit is set. It is turned on when the first function call is made that indicates a job is going to start, and it is turned off when the spool file has been written to the spool directory on the server.

3. Printing—Once the PC NetLink server spool file has the data to be printed, unless the job is paused on the Windows side, the PSI library tells `lp` to resume that job. Solaris `lp` takes control of the job and activates it to be printed. Sometime after `lp` has sent the job to the printer, the PC NetLink software will detect that `lp` has done this, and the PC NetLink software will delete the PC NetLink server status file. Once the printer is printing, the spool directory no longer contains any of the four files for that print job.

Printer Job Status

The group IDs of the PC NetLink status files for each job are used to store the job status. These are the same group IDs used by the PC Netlink software to store Windows file system attributes. The meanings on spool files are shown in TABLE 2-3.

TABLE 2-3 Group IDs as Job Status

Group ID	File System Attribute	Meaning on Spool File
`DOS-a--`	Archived	Queue Paused
`DOS--s-`	System	Job Paused
`DOS---h`	Hidden	Spooling

There are actually two different pause bits. One represents the actual pausing of a job, and the other the state of a job on a queue that has been paused. A job can have both pause bits set at the same time. The job will not resume and print until both pause bits are cleared.

Supported Printer Types

The three main categories of printers supported by the PC NetLink software are: PostScript™, PCL, and non-PostScript non-PCL (RAW). Through the PC NetLink Server Manager, you can properly configure a Solaris printer queue for any of these types. The Solaris printer queues appear as shown in TABLE 2-4.

TABLE 2-4 Solaris Printer Queues

Queue	Content Type	Printer Type
PostScript	simple	PS
PCL	simple	hplaserjet
RAW	simple	unknown

The content type is left as simple for all types of printers. This prevents `lp` from using any of its filters on the data, possibly corrupting the data in the process. The `nobanner` flag can be set on printer queues created via the PC NetLink Server Manager (Please refer to Chapter 9 for methods for turning banner pages off and on.) The reasoning for this is that RAW printers should print without Solaris banner pages, but the PC NetLink software cannot detect the printer type each time a job is sent off (`lp` requires the `nobanner` flag to be sent with each job as well, to prevent it

from printing a banner.) Users who want to have Solaris banner pages on their PC NetLink printers can force them manually by using the command `lpadmin -p` *printername* `-o banner.`

PC NetLink Software Use of Solaris File Systems

The PC NetLink software uses normal Solaris files, supported by UFS (UNIX file system), to support PC client files. Unfortunately, there is not a one-for-one match between Solaris and Windows NT-style ACLs and Solaris file permissions. For this reason, the PC NetLink software allocates eight Solaris group IDs (GIDs) to represent the eight possible bit patterns of the DOS attributes (hidden, system, or archive). As the DOS attributes are changed by PC client applications, the PC NetLink software will store the files into the Solaris UFS files with the appropriate GIDs to represent the correct DOS attribute bit pattern. By default, the PC NetLink software allocates GIDs below 100 unless most of the GIDs below 100 have already been used. When this happens the PC NetLink software will use other unused GIDs to support this function. Therefore, the GIDs needed to support this functionality can vary from server to server. Always login to a PC NetLink server directly to see what GIDs have been used to support this function.

PC NetLink Server Processes

Once the PC NetLink software is installed and running, several processes and drivers work in concert to support PC clients. These processes are started at boot time by scripts in the `/etc/init.d` directory. The following processes run when needed to support the various functionality of the Solaris PC NetLink product:

- `lmx.ctrl`—This process is the master process for all PC NetLink functionality running on the server. It controls all other processes, listens to connection requests, and spawns `lmx.srv` processes as needed to support PC client requests to the server.
- `lmx.srv`—This process is spawned repetitively to support PC clients. A PC client is assigned to a specific `lmx.srv` process for the duration of its connection to the server. One `lmx.srv` process typically will support more than one PC client at a time. Chapter 4 describes this algorithm in detail.
- `lmx.repl`—This process supports the directory replication services supported by the PC NetLink software.

- `lmx.browser`—This process supports the browser requests made by PC clients of the PC NetLink server.
- `lmx.dmn`—This is the net login daemon that handles the authentication of users attempting to login to PC clients on the domain (PDC or BDC) of which the PC NetLink server is a member.
- `lmx.alerter`—This process supports Windows NT style Alerter service which logs system-level messages in the PC NetLink software.
- `lmx.ep`—This process acts as the endpoint mapper which maps a request for the WINS administration interface to the TCP/IP port that the WINS service has registered. The endpoint mapper listens at port 135.
- `lmx.wins`—This process supports the Windows Internet Naming Service (WINS).

Control of these processes, especially `lmx.srv`, is crucial for obtaining maximum performance in your Solaris server.

SAM Database

The Security Account Manager (SAM) database is maintained as a *BLOB* file. The data storage is composed of 128-byte fragments, and a hash table is used to map search values into the database. The key mapped values are offsets into the data file. Any data larger than 4 Kbytes is stored in a separate file named by the BLOB and the key value becomes the name of the file (for example, `registry.55`).

The SAM database stores user and group accounts keyed by Security ID (SID). Other secret accounts are also stored in the database. These accounts are used during such procedures as directory replication service, handling PDB/BDC synchronizing, and handling trusted domains.

The database resides in `/var/opt/lanman` and grows as it is used. Therefore, it is important to set aside space for its growth (see Chapter 5). Information pertaining to each domain name is kept in `/var/opt/lanman/domains/`*domainname*. This includes the administrator and guest account information.

Changes to the SAM database that are to be replicated to domain controllers reside in `/var/opt/lanman/datafiles/chglog.lmx`.

Domain-independent SAM objects, such as SID to UNIX user name mappings reside in `/var/opt/lanman/datafiles/lsa`.

The `samcheck` command (`/opt/lanman/sbin/samcheck`) is supplied in the PC NetLink software to dump the data of the SAM database. See Appendix C for the man page of this command A summary of the `samcheck` command is listed in TABLE 2-5.

TABLE 2-5 Commands for Displaying SAM Database Information

Command	Operation
`samcheck -a`	Dumps the accounts database
`samcheck -b`	Dumps the built-in database
`samcheck -l`	Dumps the `lsa` database
`samcheck -c`	Dumps the change log

The PC NetLink Server Directory Structure

Tables TABLE 2-6 through TABLE 2-13 list the package names and contents for the PC NetLink Server directory structure.

TABLE 2-6 NetBIOS Installation Package (`SUNWlznb`)

Package	Contents
`/opt/SUNWlznb/sbin`	Control daemon (`nbdaemon`) and the utilities used to configure it
`/opt/SUNWlznb/man`	Man pages for the utilities
`/kernel/drv/nbx`	The NetBIOS driver
`/etc/opt/SUNWlznb`	Directory for configuration files
`/var/opt/SUNWlznb`	Directory for persistent configuration data
`/etc/init.d/netbios`	Initialization script
`/etc/rc0.d/K20netbios`	Symbolic Link to `/etc/init.d/netbios`
`/etc/rc1.d/K20netbios`	Symbolic Link to `/etc/init.d/netbios`
`/etc/rc2.d/S98netbios`	Symbolic Link to `/etc/init.d/netbios`

TABLE 2-7 PC NetLink 1.1 Installation Package (SUNWlzs, SUNWlzsr)

Package	Contents
/opt/lanman/bin	User commands and utilities
/opt/lanman/sbin	Administration commands and utilities
/opt/lanman/lib	Daemons, shared libraries, and scripts that are for internal use only
/opt/lanman/msgfiles	Help files (.hlp) used by the net command, a port of Windows NT's net
/opt/lanman/shares	Message DLLs (Microsoft-style dynamically linked libraries) used by the net command
/var/opt/lanman	Directory where the persistent datafiles are maintained (BLOB files such as Registry, SAM, and ACL) (Moved to SUNWlxsr for V 1.1)
/etc/opt/lanman/ lanman.ini	A configuration file available to users with the same format as Microsoft's lanman.ini. Its format is documented in the Admin Docs. (Moved to SUNWlxsr for V 1.1)
/etc/init.d/ms_srv	Initialization script
/etc/rc0.d/K19ms_srv	Startup script
/etc/rc0.d/K19ms_srv	Startup script
/etc/rc2.d/K19ms_srv	Startup script
/etc/rc3.d/S99ms_srv	Startup script
/etc/rcS.d/K19ms_srv	Startup script

TABLE 2-8 PC NetLink Server Manager Install Packages (SUNWlzac, SUNWlzas)

Package	Contents
/opt/lanman/lib/java	The server classes and “common” classes
/opt/lanman/lib/scripts	The scripts invoked by the Java server application and used to configure the PC NetLink Server
/etc/init.d/slsadmin	Initialization script
/etc/rc0.d/K19	Symbolic Link to /etc/init.d/slsadmin
/etc/rc1.d/K19	Symbolic Link to /etc/init.d/slsadmin
/etc/rc3.d/S99	Symbolic Link to /etc/init.d/slsadmin

TABLE 2-9 PC NetLink Server Client Installation Package (SUNWizag)

Package	Contents
/opt/lanman/lib/locale/XXX/html	Documentation for use of the SLS Manager (XXX = Locale)
/opt/lanman/lib/images	Images (.gif) used by the client gui
/opt/lanman/lib/java	Client Java classes
/opt/lanman/sbin/slsmgr	Client Java SLS Manager application

TABLE 2-10 PC NetLink Man Pages Package (SUNWlzm)

Package	Contents
/opt/lanman/man/man1	User command man pages
/opt/lanman/man/man1m	Administration command man pages

TABLE 2-11 PC NetLink Server Documentation Package (SUNWlzd)

Package	Contents
/opt/lanman/lib/locale/XXX/html/admindoc	The .htm and .gif files that comprise the administration guide (XXX = Locale)

TABLE 2-12 Windows NT Server Tools Package (SUNWizst)

Package	Contents
/opt/lanman/shares/astools/win95 /opt/lanman/shares/astools/winnt.40 /opt/lanman/shares/astools/winnt.351 /opt/lanman/shares/astools/windows	These directories contain the Windows NT server tools (Microsoft binaries) for the client operating systems Windows 95, NT 4.0, NT 3.51, and Windows 3.11. The astools directory is shared so that clients can access these subdirectories over the network. The clients can either install these binaries on the local system or run them remotely from this share.

TABLE 2-13 Windows TCP Stack Package (`SUNWlzcl`) Contents

Package	Contents

`/opt/lanman/shares/msclient/tcp32wfw`
`/opt/lanman/shares/msclient/update.wfw`
`/opt/lanman/bin/makeclients`
	The Microsoft TCP stack for Windows 3.11 (WFW) and Microsoft's update to the TCP stack. The `makeclients` script copies the `tcp32wfw` and `update.wfw` directories to diskettes which can be used to install TCP on Windows 3.11 clients. Alternatively, a client which already has a TCP stack can be used to copy these directories from the `msclients` share to local diskettes

How PC NetLink Software Supports Windows NT File Systems

Just as Solaris operating environment shares (or exports) UNIX file system (UFS) volumes through the NFS™ file system, a PC NetLink server can share the same volume by a different protocol. Windows NT shares a Windows NT file system (NTFS) by these same protocols. A PC client sees no difference between shares on either system. Full functionality for Windows NT ACLs and MS-DOS file attributes are maintained. Because the UFS does not have native support for Windows NT ACLs or MS-DOS attributes, the PC NetLink software must perform a bit of magic to support these extensions of the file system.

How PC NetLink Software Supports MS-DOS Attributes

To support MS-DOS attributes, the PC NetLink software utilizes UNIX groups to store the three bits of information needed to store the system, archive, and hidden attributes. The Read/Only attribute is supported by standard UNIX permissions. An `/etc/group` file after a typical Solaris PC NetLink software installation is shown in

FIGURE 2-9. Note that groups 92–99 have been used to define groups `DOS----` where `----` defines the attributes represented by that group. While in this case 92–99 group IDs were utilized for this purpose, the PC NetLink software installation will use other unused group IDs on the system if the group has already been defined. This normally causes no problems because the PC NetLink software maintains the files for the users. Using unused groups normally causes no problems when accessing the files from UNIX

```
root::0:root
other::1:
bin::2:root,bin,daemon
sys::3:root,bin,sys,adm
adm::4:root,adm,daemon
uucp::5:root,uucp
mail::6:root
tty::7:root,tty,adm
lp::8:root,lp,adm
nuucp::9:root,nuucp
staff::10:
daemon::12:root,daemon
sysadmin::14:
nobody::60001:
noaccess::60002:
nogroup::65534:
DOS----::99:lanman
DOS-a--::98:lanman
DOS--s-::97:lanman
DOS---h::96:lanman
DOS-as-::95:lanman
DOS-a-h::94:lanman
DOS--sh::93:lanman
DOS-ash::92:lanman
lmxsrvgid::91:
```

FIGURE 2-9 Typical `/etc/group` File After a PC NetLink Installation

To help illustrate this point, an MS-DOS batch file that produces every possible combination of the four MS-DOS attribute bits for 16 files were used to change the attributes of files on a volume shared by a PC NetLink server. The batch file is shown in CODE EXAMPLE 2-1.

CODE EXAMPLE 2-1 Batch File Used to Change MS-DOS File Attributes

```
REM Make sure all files are set to default.
attrib -a -r -h -s *.*
REM set individual MSDOS attribute bits
attrib +a +s +h +r allon
attrib -a -s -h -r alloff
REM Attributes one at a time
attrib +a a
attrib +h h
attrib +s s
attrib +r r
REM attributes two at a time
attrib +a +r a_r
attrib +a +h a_h
attrib +a +s a_s
attrib +h +s h_s
attrib +h +r h_r
attrib +r +s r_s
REM attributes three at a time
attrib +a +h +r a_h_r
attrib +a +h +s a_h_s
attrib +a +s +r a_s_r
attrib +h +s +r h_s_r
```

After the execution of the batchfile in a Windows 95 MS-DOS window, the MS-DOS `dir /v /a` command returns the output shown in FIGURE 2-10. Note the archive (A), system (S), hidden (H), and read only (R) attributes change exactly as expected.

```
   I:\don\SLStest> dir /v /a
 Volume in drive I is WGS40-03
 Directory of I:\don\SLStest
   File Name         Size        Allocated      Modified      Accessed  Attrib
   .              <DIR>                     01-21-99 10:44a  01-21-99      D
   ..             <DIR>                     01-21-99  9:41a  01-21-99      D
   attrtest bat           507               01-21-99 10:45a  01-21-99
   allon                    0               01-21-99 10:41a  01-21-99  RHS  A
   alloff                   0               01-21-99 10:41a  01-21-99
   a                        0               01-21-99 10:41a  01-21-99       A
   h                        0               01-21-99 10:41a  01-21-99   H
   r                        0               01-21-99 10:41a  01-21-99  R
   s                        0               01-21-99 10:41a  01-21-99    S
   a_r                      0               01-21-99 10:42a  01-21-99  R    A
   a_h                      0               01-21-99 10:42a  01-21-99   H   A
   a_s                      0               01-21-99 10:42a  01-21-99    S  A
   h_s                      0               01-21-99 10:42a  01-21-99   HS
   h_r                      0               01-21-99 10:42a  01-21-99  RH
   r_s                      0               01-21-99 10:42a  01-21-99  R S
   a_h_r                    0               01-21-99 10:42a  01-21-99  RH   A
   a_h_s                    0               01-21-99 10:42a  01-21-99   HS  A
   a_s_r                    0               01-21-99 10:42a  01-21-99  R S  A
   h_s_r                    0               01-21-99 10:42a  01-21-99  RHS
       17 file(s)            507 bytes
        2 dir(s)     364,052,480 bytes free
                   1,999,405,056 bytes total disk space,  81% in use
   I:\don\SLStest>
```

FIGURE 2-10 Output of the `MS-DOS dir /v /a` Command

In contrast, the UNIX `ls` command gives the result shown in FIGURE 2-11. Notice that the UNIX file permissions were changed (to "`-r--r--r--`" (or 444)) only when the MS-DOS read-only attribute was changed. The rest of the MS-DOS attributes change the group ID of the file with a different group representing every possible combination of the system, hidden, and archive bits.

```
wgs40-03 127 =>ls -l
total 2
-rw-r--r--   1 don      DOS-a--        0 Jan 21 10:41 a
-rw-r--r--   1 don      DOS-a-h        0 Jan 21 10:42 a_h
-r--r--r--   1 don      DOS-a-h        0 Jan 21 10:42 a_h_r
-rw-r--r--   1 don      DOS-ash        0 Jan 21 10:42 a_h_s
-r--r--r--   1 don      DOS-a--        0 Jan 21 10:42 a_r
-rw-r--r--   1 don      DOS-as-        0 Jan 21 10:42 a_s
-r--r--r--   1 don      DOS-as-        0 Jan 21 10:42 a_s_r
-rw-r--r--   1 don      DOS----        0 Jan 21 10:41 alloff
-r--r--r--   1 don      DOS-ash        0 Jan 21 10:41 allon
-rw-rw-r--   1 don      DOS----      507 Jan 21 10:45 attrtest.bat
-rw-r--r--   1 don      DOS---h        0 Jan 21 10:41 h
-r--r--r--   1 don      DOS---h        0 Jan 21 10:42 h_r
-rw-r--r--   1 don      DOS--sh        0 Jan 21 10:42 h_s
-r--r--r--   1 don      DOS--sh        0 Jan 21 10:42 h_s_r
-r--r--r--   1 don      DOS----        0 Jan 21 10:41 r
-r--r--r--   1 don      DOS--s-        0 Jan 21 10:42 r_s
-rw-r--r--   1 don      DOS--s-        0 Jan 21 10:41 s
arab64
wgs40-03 128 =>
```

FIGURE 2-11 Output of the UNIX `ls` Command

Also, remember the archive bit is normally set by default by the PC NetLink software every time a new file is created. Setting the archive bit signifies the file needs to be archived or backed up.

During installation, the PC NetLink installation software decides which group IDs will represent these MS-DOS attributes states. The choice of group IDs is not guaranteed to be the same from one PC NetLink installation to the next.

How PC NetLink Software Supports Windows NT ACLs

The PC NetLink software does not support Windows NT ACLs using Solaris POSIX-based ACLs. Unfortunately, POSIX ACLs do not map well to Windows NT style ACLs. Instead, the PC NetLink software uses a private database that normally resides in the `/var/opt/lanman/datafiles/acl` file. As users on PC clients use ACLs to access a PC NetLink server based file, the PC NetLink software will maintain a separate database that defines the ACL for each directory and file.

By default, ACLs are supported at the directory level only to save space in the database. As files are created in a directory, they take on the ACL of that directory. However, if a file is assigned an ACL that differs from its parent directory, the PC NetLink software will insert a separate file ACL entry into the database.

Maintaining a separate database for ACLs allows the PC NetLink software to support ACLs when files are being accessed by only one PC NetLink server. Because the directory and file ACL database used to support the system message block (SMB) or common internet file system (CIFS) protocol supported by the PC NetLink software exists only on the PC NetLink server where the access to the file has been made, avoid situations that allow the access of the same file from two different PC NetLink servers at the same time.

Native file system access from one Solaris system to another is supported via Solaris's own NFS protocol. If a local file system on a Solaris server A were mounted from NFS by two Solaris servers B and C running the PC NetLink software, then multiple PC NetLink servers (B and C) could access the same file on server A using the native NFS protocol. If this file is accessed by one user via the PC NetLink software on server B and by another user via the PC NetLink software on server C, the ACL database on both servers can easily get out of sync. A more restrictive ACL on the file set by one user using the PC NetLink software on server B would not be seen by the PC NetLink software running on server C and the restriction would *not* be enforced.

If ACL functionality is used by a user community, it should never be allowed to support access to files from two different PC NetLink servers at the same time or security problems can occur. Instead, make sure only one PC NetLink server is used to support access to any one file system.

If the data to be accessed is read-only, or ACL support is not required, accessing the same Solaris supported NFS from multiple PC NetLink servers may be desirable.