

CHAPTER 9

Networking

Windows-based desktops are being connected to corporate networks at a steadily increasing rate. As a result, demands for better network integration, improved network and system management capabilities, and better network performance and reliability are growing as more business-critical functions rely on the PC network. Because of these demands, companies are faced with increased costs to run PC networks and are investing in tools and staff to meet the challenge of day-to-day network management.

Windows 95 is constructed to address the needs of corporate network administrators with a well-integrated, high-performance, manageable 32-bit network architecture. Windows 95 is also designed to address the needs of the Windows user by making access to and control of the network consistent, and by making network browsing and printing much easier through the many enhancements in the UI. In addition, Windows 95 is designed to address users' mobility needs by enabling remote access to the network from portable PCs.

Given the size of customers' current investments in both Windows and their PC network infrastructures, one overriding goal for networking in Windows 95 is compatibility. Compatibility involves ensuring continued support for existing real-mode components, as well as making the new 32-bit protected-mode components in Windows 95 compatible with existing 16-bit MS-DOS-based applications and device drivers and existing 16-bit Windows-based applications and DLLs.

This chapter introduces the 32-bit, protected-mode networking architecture built into Windows 95 and shows how it provides well-integrated network support, manageability, improved performance, user-level network security, and dial-up access to the network.

Summary of Improvements over Windows 3.1 and Windows for Workgroups 3.11

The primary improvements in networking for Windows 95 include the following:

- A robust, open, high-performance 32-bit network architecture, with 32-bit network client software, 32-bit file and printer sharing software, 32-bit network protocols, and 32-bit network card drivers
- Support for using multiple redirectors, multiple protocols, and multiple network card device drivers simultaneously to facilitate integrating the desktop into a heterogeneous network environment
- Support for industry standard connectivity and systems management solutions, including TCP/IP, IPX, SNMP, and DMI
- Great integration with Novell NetWare, including high-performance, 32-bit protected-mode NetWare-compatible client software for connecting to NetWare 3.x and 4.x servers, and peer sharing for NetWare environments
- Great integration with Windows NT Server to support a powerful client/server solution
- Built-in support for systems management, including the ability to remotely administer, monitor, and view the configuration of PCs over the network
- Improved dial-up network access support, providing remote access to Microsoft Network servers, Novell NetWare servers, and UNIX servers. Support for remote protocols such as PPP and SLIP is provided.
- Improved network printing, making it easier for users to connect and configure printers in network environments

Easier Networking with Windows 95

The Microsoft Network support provides full interoperability with other Windows 95 PCs, and PCs running Windows for Workgroups, Windows NT, Windows NT Server, LAN Manager, and any other Microsoft-compatible servers. Windows 95 includes support for both client access and peer services capabilities on a Microsoft Network. Additionally, other network servers and services are provided by third parties—for example, Artisoft, Banyan, DEC, Novell, and SunSelect provide Windows 95 support for their respective network servers.

This section summarizes the key features and concepts in Windows 95 that make networking much easier to implement and use.

Great Novell NetWare Integration

Windows 95 has built-in support for two networks: the Microsoft and Novell NetWare networks. (Built-in support for Novell NetWare is new with Windows 95.) Installation of support for one or both networks is as simple as clicking the Setup program for Windows 95 or the Network icon in the Control Panel. Both the Client for Microsoft

Networks and the Microsoft Client for NetWare Networks are implemented as high-performance, high-reliability 32-bit protected-mode components.

Microsoft Client for NetWare Networks

The Microsoft Client for NetWare Networks in Windows 95 provides interoperability for NetWare 3.x and 4.x servers. Systems running Windows 95 can use all NetWare server services, browse NetWare servers, connect to servers, and queue print jobs either using the UI in Windows 95 or using Novell's NetWare command line utilities. The Microsoft Client for NetWare Networks in Windows 95 even run "TSR clean" NetWare logon scripts. In addition, Windows 95 provides continued support for Novell NetWare real-mode components, thereby supporting both the NetWare 3.x NetX shell and the NetWare 4.x VLM shell.

File and Printer Sharing Services for NetWare Networks

Windows 95 also provides NetWare-compatible peer services for file and printer sharing. These services feature user-level security by implementing a "pass through" security link to an existing Novell NetWare server to leverage the existing user database. Windows 95 doesn't introduce a new security scheme; rather, it fully leverages the existing user-level security built into NetWare's bindery.

The "Well-Connected Client" Operating System

Today's networks are heterogeneous and becoming even more connected. Companies are linking their Windows PCs to multiple PC network servers, mainframe and mini-computer host systems, UNIX machines, and a variety of services like the Internet. The desktop operating system must meet this challenge and provide support for often very disparate connectivity needs on the network. Today's desktop operating systems do not provide the necessary support for running multiple network clients simultaneously. Windows 95 has been explicitly designed with multiple network support as a key design goal.

Because integrated networking support is a key focus of the design of Windows 95, it's much easier to install and manage support for a single network or even multiple networks simultaneously using Windows 95. Building upon the support in Windows for Workgroups 3.11, which was capable of supporting up to two networks, Windows 95 can simultaneously support up to ten 32-bit, protected-mode network clients using its Network Provider Interface. This interface defines a set of APIs used by Windows 95 to access the network for tasks such as logging onto the server, browsing servers, connecting to servers, printing, and so on.

Installing network provider support is simple; it's done via the Network Setup icon in the Control Panel or from the Network Setup dialog box when first installing Windows 95. A Windows 95 desktop can run client support for NetWare, Windows NT Server, Banyan, DEC PathWorks and Sun NFS simultaneously.

PC users in a network environment that includes Apple Macintosh computers can use Windows 95 to exchange documents and share information with Macintosh users when Macintosh-compatible file services are used with Windows NT Server or Novell NetWare to connect to the common file server. (Long filename support in Windows 95 further simplifies the integration of the two systems.)

Internet Information with a Mouse Click

With Windows 95, you have easy access to the Internet, whether you dial into a commercial Internet provider or you gain access via your corporate network over TCP/IP. Windows 95 provides all the “plumbing” you need to tap into the information on the worldwide Internet network. Built-in support for TCP/IP, dial-up protocols, such as Point to Point Protocol (PPP) and Serial Line Internet Protocol (SLIP), and Windows Socket services make connecting to the Internet and the information highway just a mouse-click away.

TCP/IP, the protocol used on the Internet, is implemented in Windows 95 as a fast, robust, 32-bit Windows-based TCP/IP stack. This implementation does not have the conventional memory footprint common with MS-DOS-based drivers or TSRs.

Dial-up protocol support gives users flexibility in choosing the Internet access provider they want to dial into. Connection can be via a standard asynchronous modem or an ISDN connection.

Support for Windows Socket services allows use of any of the large collection of third-party and public-domain Internet utilities, such as Mosaic, WinWAIS, and WinGopher, to easily connect to the Internet and access the thousands of worldwide information servers.

Additionally, Windows 95 includes telnet and ftp to help users take advantage of the Internet. Windows 95 also supports sending and receiving e-mail messages over the Internet through the use of a provided mail driver that integrates with the Microsoft Exchange client, the universal inbox in Windows 95. For more information about Internet mail support in Windows 95, see Chapter 14, “Microsoft Exchange: E-Mail, Faxes, and More.”

“Point and Click” Networking

For users, running even one network client can be confusing and running multiple network clients is nearly unmanageable. Each server has its own set of unique client-side utilities and commands that are often difficult to remember and use. When the desktop PC has support for multiple networks loaded, the user is faced with at least twice the number of commands and utilities to remember and may have to remember multiple passwords to access network resources.

The easy-to-use Network Neighborhood in Windows 95 makes it easier for users to perform common network operations on disparate servers. First, the network manager can establish one password to log a user onto the appropriate Windows 95 PC and network resources. These services could, for example, include e-mail, group scheduling applications, dial-in support, or database access. Additionally, common network actions, such as browsing servers, managing connections, and printing, are all performed identically through the UI in Windows 95, regardless of the type of server Windows 95 is connected to. As a result, users can locate, connect, and start print jobs on a NetWare print server as easily as they can with a printer attached to a Windows NT Server. All the common network actions can be accomplished visually, using the mouse to navigate through the network resources, the connections, and so on. Users aren't required to memorize any new network commands. For both the Client for Microsoft Networks and Microsoft Client for Novell NetWare Networks, users can run the corresponding command line utilities as well. This ongoing backward compatibility is necessary to support batch files that are currently in use and to ease the transition to the Windows 95 environment.

The Network Neighborhood also helps to manage the complexity of the network by showing it from the user's perspective—that is, it shows only what the user is interested in seeing. When the user initially opens the Network Neighborhood, the window contains only the servers the user has logged onto or the servers the user most frequently connects to, unless the user has explicitly customized the network view by dragging and dropping the server into the Network Neighborhood. This context-sensitive view of the network reduces the number of network resources the user initially encounters to a more manageable number of objects. For Windows NT domains and NetWare 3.x and 4.x, the network context presented is the “login server” and any other connected servers.

For a more in-depth discussion of the Network Neighborhood and the UI, see Chapter 3, “The Windows 95 User Interface.”

Easier Mobile Network Support

Two features in Windows 95 make connecting to a network easier for mobile PC users: Plug and Play and Dial-Up Networking.

- **Plug and Play.** Plug and Play in Windows 95 solves several problems that face mobile PC users. Mobile users no longer have to maintain multiple configurations, such as desktop and portable configurations. Windows 95 recognizes when they add or remove peripherals, such as when they remove a network card and add a modem for dial-up network access. Because Windows 95 supports hot and warm docking, users no longer have to reboot their systems each time they make a change to the configuration. In addition, Windows 95 has built-in Card and Socket services that allow for hot removal and insertion of PCMCIA cards, including network cards.

Network Plug and Play support in Windows 95 also includes application-level support. An application that is network-aware understands whether or not the network is available. If the network adapter is removed, the application automatically put itself into “offline” mode to allow the user to continue to work, or it shuts down gracefully.

- **Dial-Up Networking.** Maintaining data access to their corporate network while working in a remote location is another challenge for mobile users. Currently, several solutions for dialing into the corporate network exist, but most of these solutions are not well integrated with Windows, requiring a different set of tools. The Dial-Up Networking client in Windows 95 provides modular support for multiple dial-up providers, including Windows NT RAS servers and NetWare. It also supports several protocols, including NetBEUI, IPX/SPX, and TCP/IP via PPP and SLIP. Support for dial-up can also be offered by third parties—for example, Shiva has implemented Windows 95 support using the modular architecture of the Dial-Up Networking client in Windows 95.

Windows 95 Client: Designed for Manageability

Many corporations have rapidly growing networks that in some cases run worldwide. Keeping the networks and the ever increasing number of systems connected to the networks running at peak performance is a challenge for both end-users and network managers. Corporations are beginning to deploy network and desktop management tools to help them meet this challenge.

Windows 95 has built-in network and system management instrumentation to enable current and future management tools to remotely monitor, query, and configure Windows 95 PCs. Using these tools, network managers can quickly inventory the software and hardware used on their networks. Working from a Windows 95 PC, network managers can remotely diagnose and reconfigure Windows 95 systems, as well as remotely monitor system and network performance on a Windows 95 PC. The following key components make Windows 95 very manageable:

- **The SNMP agent.** Windows 95 incorporates an agent that implements the Simple Network Management Protocol (SNMP). This agent complies with the Internet Engineering Task Force (IETF) SNMP specification, responding to queries and sending notifications of events that take place on the PC to an SNMP console. The SNMP console allows a network manager to remotely monitor and manage the Windows 95 PC. Events can be managed from a central SNMP management console.
- **The SNMP MIB, MIB-II.** The SNMP MIB describes what information about the system is available to the SNMP console. Windows 95 includes the MIB-II, which describes the Microsoft TCP/IP protocol and allows information about the protocol stack to be communicated back to the management console. For example, the management console can query the MIB-II for the IP address, the name of the user at this IP address, or IP routing information.
- **The DMI agent.** DMI applications provide cross-platform desktop management capabilities. Version One of the DMI specification was finalized this spring, and Microsoft, as a founding member of the DMTF, will follow the specification's ongoing evolution. Soon after its release, Windows 95 will offer a DMI agent, with support for the agent built on top of the Registry.
- **Registry-based system management.** Central to the operation of Windows 95 is the Registry. Similar in design to the Registry in Windows NT, the Registry in Windows 95 replaces the many .INI files previously used by Windows and Windows-based applications. The Registry contains information used by Windows 95 that describes the hardware configuration of the PC, preferences defined by the user, and application specific information. The Registry is a database containing keys and values. For example, HKEY_USER_NAME is the key for the user's name, and the name "Fred Smith" is the value associated with this key. A special category of keys, called *dynamic keys*, are memory resident and can contain frequently changing data updated by system components, device drivers, or applications. For example, the number of packets sent per second could be registered by the network adapter device driver.

The Registry consists of three components: SYSTEM.DAT, which describes the PC configuration and computer-specific application information; USER.DAT, which defines user preferences and user-specific application information; and POLICY.POL, which defines "system policies" relating to either of the other two components. Each component is a file that resides on the PC or on a network server. The Registry is remotely accessible via an RPC-based interface. The Win32 Registry APIs are used to access the Registry, both locally and remotely.

Management Tools for Windows 95

Several tools for Windows 95 make managing the system or the network much easier. These tools include the following:

- **The Registry Editor.** Allows local or remote editing of the Registry in Windows 95.
- **The System Policy Editor.** Used by network managers to set per-user or per-group “policy” overrides on Registry entries. It creates the POLICY.POL component of the Registry. This tool (the Windows for Workgroups’ admincfg tool) contains a superset of those settings.
- **The System Monitor.** Allows local or remote viewing of the performance of the various I/O components of a local system or remote PC. For example, the file system, the network components, or data from the network card can be monitored. The data is updated dynamically using the Registry’s dynamic keys.
- **NetWatcher.** Allows local or remote viewing and management of the network connections of peer services in Windows 95.

Easier to Set Up and Install

PC and network managers faced several challenges when installing Windows in the past. Some network managers installed Windows on the network server for later installation onto users’ PCs or to run Windows from the server. In the case of later installation, network managers had to decide on an approach for a number of variables: making the process appear transparent to the user; rolling out Windows using a “push” or “hands-free” installation; using specific settings for different categories of users; and updating these configurations when either Windows, Windows applications, or device driver updates were available. In the case of running Windows from the server, network managers had to manage variables such as having local swapping files and some local .INIs and applications; allowing user-level configurations; supporting disparate hardware configurations; and handling the roving user on the network.

Windows 95 addresses several elements of these problems with an improved Setup utility and the Registry. The new Setup streamlines the installation of Windows 95 on a network server for both later installation onto users’ PCs and running Windows 95 from the server. In fact, the Windows 95 Setup utility has a scripting feature, making it possible to implement “hands-free” installation of Windows 95 from a network server to client PCs.

Running Windows 95 from a server becomes much simpler largely because of its Registry. The Registry is a centralized database of all hardware, software, and user information that is easy to maintain remotely on the server. This simple mechanism contrasts sharply with the state of configuration under Windows 3.1, with CONFIG.SYS, AUTOEXEC.BAT, and a myriad of .INI files for Windows and Windows-based applications. Moreover, the separation of hardware configuration and user profiles in the Registry means that if users move around on the network, their preferences follow them from PC to PC, regardless of the hardware configuration they’re currently working on.

Network Architecture in Windows 95

The Network architecture in Windows 95 radically improves on the level of network support and integration that existed in Windows 3.1. The key design points of the networking architecture in Windows 95 are the following:

- **Fast, 32-bit VxDs.** The networking components in Windows 95 are built as 32-bit virtual device drivers, which have no conventional memory footprint, and are loaded dynamically when needed by the system. In addition, because the operating system and the device drivers are all running in protected mode and overhead for mode

switching and virtualization between protected and real-mode operation is no longer incurred, network I/O performance is 50 to 200 percent faster than under Windows 3.1.

- **Reliability.** Because the networking components in Windows 95 run in protected mode and are designed to a well-defined set of interfaces, they are more reliable than real-mode network components. Real-mode network components may conflict in memory or attempt to exclusively chain the same set of interrupts, which commonly leads to system hangs or error conditions. These errors don't occur with protected-mode network components because Windows 95 arbitrates the hardware resource allocation.
- **Modular, open design.** The network architecture in Windows 95 is highly modular and includes a new Network Provider Interface (NPI), an Installable File System (IFS) interface, and a version of Network Driver Interface Specification (NDIS) version 3.1 that has been enhanced for Plug and Play support. The specifications for all three interfaces are available to third-party network vendors.
- **Multiple network support.** Windows 95 is designed to accept multiple network providers, multiple network redirectors written to the IFS interface, and multiple NDIS drivers as needed. As a result, client support for Microsoft Networks and Novell NetWare can be run simultaneously. Windows 95 is capable of concurrently supporting the use of multiple 32-bit, protected-mode network clients and one real-mode network client.
- **Multiple protocol support.** One of the NDIS components in Windows 95, the Protocol Manager, supports the loading of multiple transport protocols. The Protocol Manager enables Microsoft and third parties to independently write protocol stacks that coexist well for Windows 95. Windows 95 includes built-in support for IPX/SPX, TCP/IP, and NetBEUI.
- **Plug and Play.** All of the networking components in Windows 95 are designed for dynamic Plug and Play operation. For example, when a PCMCIA network card is inserted, the NDIS 3.1 network card driver is automatically loaded, and the network is available. When either the PCMCIA network card or the network cable is removed, Windows 95 doesn't hang as many real-mode networks do, but instead notifies any applications using the network that the network is no longer available and continues to run.

Figure 49 shows the general layout of the network architecture built into Windows 95. The following sections in this chapter describe key aspects of this architecture, including the NPI, the IFS, and NDIS 3.1.

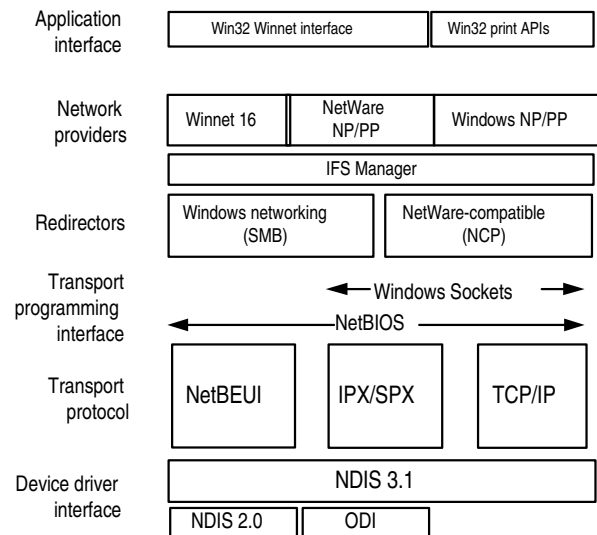


Figure 49. The layered network architecture of Windows 95

Network Provider Interface: Concurrent Support for Multiple Network Servers

Windows 95 has an open, modular Network Provider Interface to allow support for multiple networks to be installed in Windows 95 simultaneously. The NPI enables Microsoft or any third party network provider to integrate various network services seamlessly into Windows 95. The NPI has the following key benefits:

- The open interface allows network vendors to supply tightly integrated support for their network servers for Windows.
- All supported networks are identically accessed and managed through the Windows 95 Network Neighborhood UI.

The NPI abstracts the network services for the Windows 95 UI components, as well as the various Windows 95 network and desktop management components. The NPI consists of two parts: the network provider API and the network providers. The network provider API is a single, well-defined set of APIs used by Windows 95 to request network services, such as those for browsing servers, connecting to and disconnecting from servers, and queuing a print job. These requests are then passed to the network providers. The network provider layer sits below the API layer and provides the network services requested by components of Windows 95. Conceptually, this model is similar to the design of the various device driver interfaces of Windows 95—a well-defined set of interfaces used by the operating system to request services, and the services themselves, which are provided by a device driver that is often written by a third party.

The most obvious abstraction of the various network services provided by the NPI is the Windows 95 system login. Each network provider can provide a unique logon dialog box to suit the needs of the network server's security model. For example, the logon dialog box shown in Figure 50 is for logging onto a Windows NT Server domain:

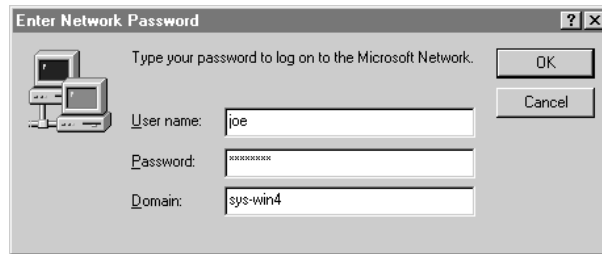


Figure 50. The network logon dialog box for the Windows NT Server domain

The dialog box for logging onto a Novell NetWare 3.x server, shown in Figure 51, offers additional information to allow users to log on as GUEST. This dialog box is invoked when a user first accesses a NetWare server.

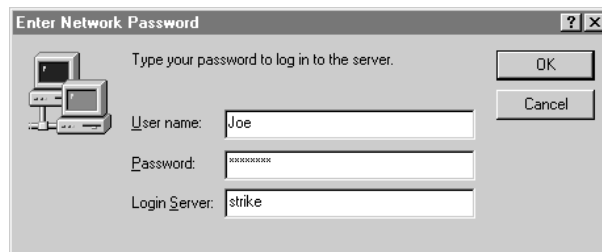


Figure 51. The network logon dialog box for Novell NetWare 3.x or 4.x

When the logon information from the dialog box has been validated against the requested server, the password is passed back to Windows 95, which can then use the password as the “password control” and unlock any linked system or network resources. In this fashion, Windows 95 can accommodate the various ways that network servers provide their services, while offering the user a very consistent interface.

Another example of support from the network provider that is visible to users occurs when they specify server name strings. For example, Microsoft-compatible networks use the Universal Naming Convention, which takes this form:

\\server-name\share-name

However, NetWare servers are specified in this form:

server-name/volume-name:directory-name

The respective network providers correctly parse the syntax of their server name strings, so users who are accustomed to using the NetWare server syntax can type name strings in that form wherever strings are required by the Windows 95 UI to access NetWare server resources.

Installable File System: Support for Multiple Network Redirectors

The Installable File System interface built into Windows 95 is a well-defined set of APIs that are used to implement all file systems in the operating system, including the VFAT (32-bit FAT) and CD-ROM file systems. The IFS implementation in Windows 95 is functionally similar to the IFS implementations in Windows for Workgroups and

Windows NT. For networking, the IFS is used to implement network redirectors. The IFS interfaces are documented for use by vendors of network servers when implementing their redirectors for Windows 95. The IFS offers the following key benefits for network redirectors for Windows 95:

- **Multiple redirector support.** The IFS interface was designed for multiple redirectors.
- **Increased reliability.** The IFS model arbitrates resource requests, removing the source of many real-mode redirector conflicts.
- **Improved performance.** Network redirectors benefit from the unified IFS cache, which makes client side network redirector caching available.

The IFS consists of a set of file system APIs and loadable file system drivers (FSDs). Multiple FSDs can be resident in the system simultaneously. The FSDs provide the logic necessary for the file system to provide a consistent view of devices and arbitrates access, update, and control of devices of very different physical media types. For network redirectors, the FSDs provide mechanisms to locate, open, read, write and delete files, as well as services such as named pipes and mailslots.

To illustrate the flow of control, take as an example opening a file that is actually a link to a file on a server from a Windows 95 desktop. The user double-clicks the icon. The Windows 95 shell parses the link and determines that the file is a network object. The shell passes the filename to the NPI, which if necessary reestablishes the network connection to the server on which the object resides. The NPI then calls the network redirector to open the file on the file server. The network redirector translates the file request into a request formatted for the specified network file server, transmits the request to the server via its link through the NDIS layer, and returns to the NPI and the shell a handle to the open file.

The Microsoft-supplied redirectors for the Client for Microsoft Networks and the Microsoft Client for NetWare are both implemented as IFS FSDs.

NDIS 3.1: Multiple Protocol Support

Network Driver Interface Specification version 3.1 is a superset of the NDIS 3.0 functionality that exists for Windows NT and Windows for Workgroups 3.11. NDIS 3.1 has enhancements for Windows 95 in the following key areas:

- **Plug and Play enhancements to the Protocol Manager and Media Access Control (MAC) layer.** These enhancements enable network drivers to be dynamically loaded and unloaded.
- **A new NDIS mini-driver model.** The mini-drivers for use with Windows 95 are binary compatible with the mini-driver implementation used in Windows NT 3.5.

The primary changes to the NDIS model were extensions for Plug and Play support, and upgrading an NDIS 3.0 driver to NDIS 3.1 is very straight-forward—for example, in some cases Microsoft engineers have taken only one hour to update an NDIS driver's source code. However, instead of making this type of upgrade, vendors can instead choose to provide a mini-driver. The mini-driver model dramatically decreases the amount of code that a network adapter vendor must write, and NDIS mini-drivers developed for Windows 95 and Windows NT are binary compatible.

Conceptually, the mini-driver model is similar to the driver models implemented for printers, disk drivers, and display drivers. Essentially the mini-driver divides the existing NDIS Media Access Control (MAC) layer into two halves. The mini-driver half implements only the code that is specific to the network adapter card, including specific implementation details, such as establishing communications with the card, turning electrical isolation on and off (if implemented) for Plug and Play, doing media detection, and enabling any value-added features the card may contain. The mini-driver is wedded to the NDIS wrapper, which implements the other half of the MAC functionality. This NDIS wrapper contains the code that is “common” to all NDIS drivers. (NDIS 3.1 mini-drivers are roughly 40 percent smaller than existing NDIS 3.0 MACs because in earlier versions of NDIS, each MAC carried this redundant code.)

An NDIS 3.1 stack is composed of three components: the protocol, the MAC or mini-port, and the mini-port wrapper. NDIS contains the Protocol Manager, which loads and unloads the protocol. This manager can manage multiple protocols loaded simultaneously. Immediately below the protocol is either the MAC or the mini-driver, if a mini-driver is used. Multiple MACs or mini-drivers can be loaded in systems in which multiple network adapter cards are loaded. Finally, the mini-port wrapper layer below the mini-port does a mapping of Windows NT Hardware Abstraction Layer (HAL) layer APIs for I/O. This mini-port wrapper layer is very thin because Windows 95 can always assume that it's being run on an Intel architecture.

Novell NetWare Integration

Windows 95 provides a complete, Microsoft-supplied Microsoft Client for NetWare Networks for Windows. This client can be installed as the default network support for Windows 95, or it can coexist with the Client for Microsoft Networks, as shown in Figure 52. The Microsoft Client for NetWare Networks for Windows 95 provides interoperability with NetWare 3.x and 4.x servers.

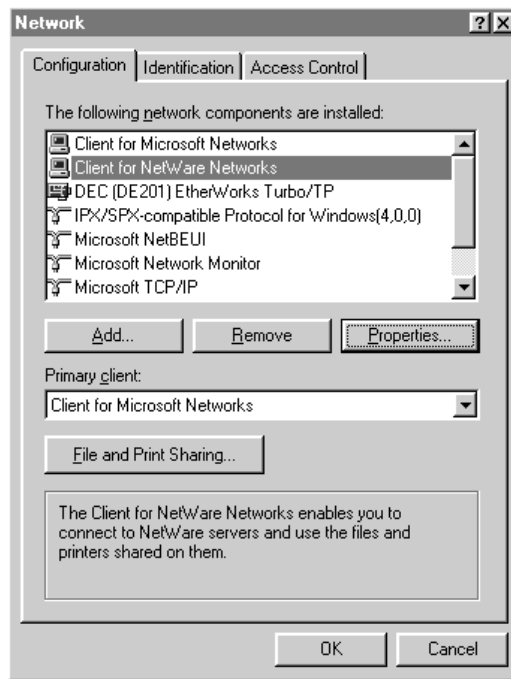


Figure 52. The Control Panel’s Network tool, showing the Client for Microsoft Networks and the Microsoft Client for NetWare Networks running simultaneously

Windows 95 can also run on top of the existing Novell NetWare 3.x or 4.x clients, the NETX or VLM shells. This support is intended to help customers make the transition from their real-mode network to the fully 32-bit protected-mode network implementation in Windows 95, using smaller steps if necessary.

The 32-Bit Microsoft Client for NetWare Networks

The Microsoft Client for NetWare Networks has the following key features:

- High performance—up to 200 percent faster for some network operations compared with Windows 3.1 with the NetWare VLM shell installed
- Robust and reliable client support
- Zero conventional memory footprint
- An auto-reconnect feature
- Packet burst protocol support
- Client side caching
- Plug and Play awareness
- Full integration with the UI in Windows 95
- Full interoperability with Novell NetWare 3.x and 4.x clients and servers
- The ability to run NetWare command line utilities

- Graphical logon to NetWare 3.x, or 4.x via the NetWare Bindery
- User-level security implemented using “pass-through” to the Bindery
- A NetWare-compatible logon command processor
- Point and Print support

The client is fully implemented as 32-bit virtual device driver components. Designed to run in protected-mode and operate in a multitasking environment, the client is much more robust than real-mode networking components and takes no conventional memory.

The Microsoft Client for NetWare Networks has great performance characteristics. On large block transfers over the network, it is up to 200 percent faster than Windows 3.1 using the VLM shell; in fact, it is up to 200 percent faster than Windows 95 using the VLM shell. For most network operations that are a mix of reading and writing, the Microsoft Client for NetWare Networks is between 50 and 200 percent faster, depending on the mix of network I/O.

The Microsoft Client for NetWare Networks is enabled for Plug and Play. Portable computers that support this capability can be hot-docked or undocked and the networking support is properly loaded and unloaded without hanging the system. (Hot-docking and undocking is the equivalent of connecting and disconnecting the network cable from a Windows 95 PC. Under Windows 95, the system continues to function, whereas in real-mode networks, connecting and disconnecting causes the system to hang.) PCMCIA network cards also function in the same manner.

Logon to Windows 95 is linked to a NetWare Bindery. This link logs users onto both the Windows 95 system and their preferred NetWare server via a single graphical logon process.

As shown in Figure 53, users can specify that the Microsoft Client for NetWare Networks should process NetWare logon scripts. If drive mappings and search drives are specified in a logon script, the same user configuration is implemented under Windows 95, with no changes necessary. The Windows 95 logon processor can also parse conditional statements in NetWare logon scripts. One key difference in logon processing is that because the Windows 95 logon processor operates in protected mode, it cannot load TSRs. Logon scripts that load TSRs must be updated to remove the TSR-loading commands, and the TSRs must be loaded in the 16-bit driver load prior to the protected-mode operation. (In some cases, these TSRs have protected-mode equivalents built into Windows 95, and loading them may not be necessary.)

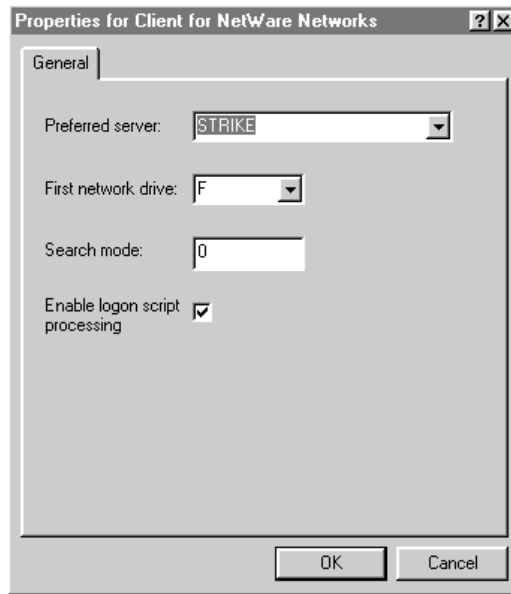


Figure 53. The property sheet for the Microsoft Client for NetWare Networks, showing that a preferred server has been specified and logon scripts have been enabled

The Microsoft Client for NetWare Networks in Windows 95 can also load and run NetWare command line utilities. It supports the MS-DOS level NetWare APIs, and the 16-bit Windows DLLs that NetWare supplies can be run on the Microsoft Client for NetWare.

File and Printer Sharing for NetWare Networks

Windows 95 provides peer services for NetWare clients. During the installation of Windows 95 and via the Network icon in Control Panel, users can install either the NetWare Compatible Peer Services or Microsoft Network Peer Services. The peer services in Windows 95 are meant to work in concert with an existing Novell NetWare server and add complementary sharing services.

The NetWare Compatible Peer Services enable the sharing of local files and printers on the Windows 95 system. For the NetWare Compatible Peer Services to be activated, a Novell NetWare server must be on the network. Without this server, file and printer sharing cannot be enabled because of the pass-through security model. Under this model, user-level security is implemented using the Bindery, the NetWare server's security authority, which passes the validation of users through to the NetWare server. (Unlike with file and printer sharing services for Microsoft Networks, share level security is not supported.)

Before sharing is enabled, a NetWare server must be specified via the Security tool in the Control Panel. The Control Panel's Network tool is then used to specify which server or domain controller is the PC's designated security authority, as shown in Figure 54.

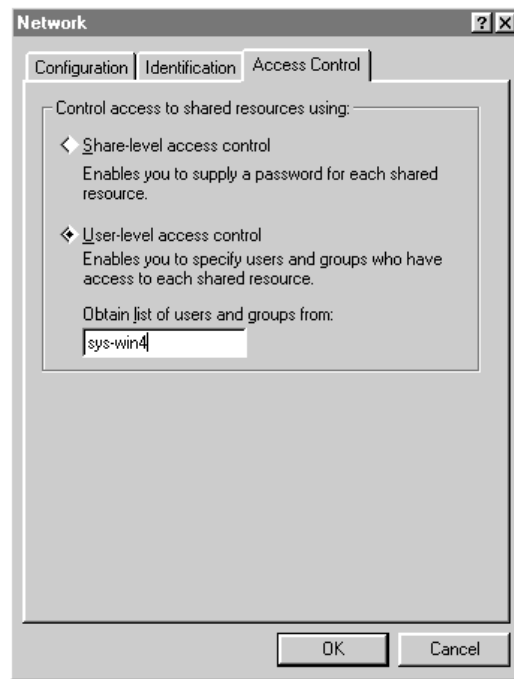


Figure 54. Specifying user-level (pass-through) security from a Windows NT domain named SYS-WIN4

Adding users to the list of those who can share the PC's hard drive is accomplished via an Add Users option on the hard disk's property sheet. Selecting this option displays the dialog box shown in Figure 55, where access privileges are specified. The list of users that can share the hard disk is obtained from the security authority specified in the Control Panel's Network tool—SYS-WIN4 in this case.

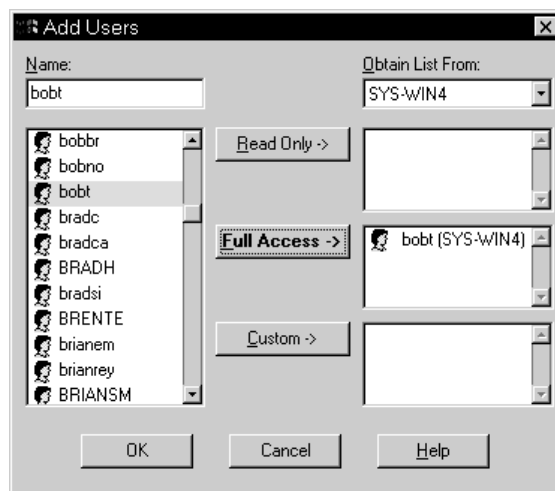


Figure 55. Specifying access privileges for a user through user-level security

When a user attempts to access a shared device on the Windows 95 system, the Windows 95 PC receives the connection request and validates the user name or group membership with the NetWare server. If the name or group membership is valid, the peer

services in Windows 95 then check whether the name or group has been granted access rights to the shared resource and grants or denies the connection request accordingly.

The sharing-enabling process illustrates two points:

- User management is all done in the namespace of the existing NetWare server. Windows 95 doesn't add another namespace to administer, and the NetWare server is administered using the tools that are currently in use—for example, tools that the NetWare network manager currently uses, such as SYSCON, are used for user account management for Windows 95 user-level security.
- Only valid user accounts and groups can be shared with NetWare Compatible Peer Services.

Peer services in Windows 95 are remotely administrable via the NetWatcher. The network manager can monitor connections to any resource on any Windows 95 peer services PC on the network, and can disconnect users and remotely change access rights for specific users. By default, remote administration is limited to user accounts with the administrator privilege.

The Microsoft Print Server for NetWare Networks

In Windows 95, the file and printer sharing services for NetWare networks include a Win32-based PSERVER capability, which can despool print jobs from NetWare queues to printers on Windows 95 PCs. Consequently, a NetWare server queue can be serviced by a printer attached to a system running the file and printer sharing services for NetWare. One benefit of this capability is that because print queues can all be managed centrally from the NetWare server, users can print to one queue. If the network includes several systems running Windows 95 with peer services enabled, each system can despool from one queue, increasing overall network-based printer capacity. Alternatively, queues can be designated specifically for printers attached to a system running the file and printer sharing services for NetWare networks.

NetWare 4.x Support

The Microsoft Client for NetWare Networks supports a NetWare 4.x server if it is running Bindery emulation. The NetWare 4.x server is then browsable from the Network Neighborhood like any other NetWare server.

Microsoft is working to provide an updated Microsoft Client for NetWare Networks with support for NDS logon and browsing and will make this client support available for little or no cost when it is complete. Current plans call for this support to be available shortly after Windows 95 is released.

The Microsoft Client for NetWare Networks includes support for both the MS-DOS-based APIs and Windows-based APIs defined by Novell. Both of the 16-bit Novell DLLs for Windows—NWNED.DLL and NWCALLS.DLL—can be run with the Microsoft Client for NetWare Networks, ensuring that any MS-DOS or Windows-based applications and utilities that are NetWare-aware run compatibly with the Microsoft Client for NetWare Networks.

Other NetWare Interoperability

Windows 95 offers these additional interoperability features:

- Full support for Novell command-line utilities (client and server) for NetWare 3.x
- Support for booting diskless workstations from NetWare servers
- Floppy boot capability
- Dial-up connectivity to Novell's NetWare Connect server

Microsoft Network Integration

Windows 95 includes a network client that implements support for Microsoft Network functionality. This client allows Windows 95 to connect to Windows for Workgroups, Windows NT Server, and LAN Manager and interoperate with IBM LAN Server, DEC Pathworks, AT&T Starlan, and LAN Manager for UNIX, as well as other SMB-compatible networks.

The 32-Bit Client for Microsoft Networks

Key Client for Microsoft Networks features include the following:

- Robustness
- Zero conventional memory footprint
- An auto-reconnect feature
- Client-side caching
- Plug and Play awareness
- Full integration into the UI in Windows 95
- Protocol independence
- Point and Print for one-click printer setup

The Client for Microsoft Networks is implemented as a collection of 32-bit, protected-mode components. The Network Provider, the Redirector, and NDIS 3.1 drivers are implemented as VxDs, and because the components execute in protected-mode without the overhead of switching to real-mode, they provide great performance. The Network Provider implements client-side caching for an additional performance boost. The client's components have higher reliability than real-mode components, they are designed for operation in a multitasking environment, and they run in kernel Ring 0 context. As a result, they are not affected by errant Windows-based applications as real-mode network components are. And because they run in protected-mode, they have no conventional memory footprint.

The client is enabled for key features of Windows 95, such as long filenames, links, auto-reconnect to servers, Point and Print, and Plug and Play, and it is integrated tightly into the Windows 95 shell via the NPI. The client is protocol-independent, and it can use IPX/SPX (the default installed protocol), TCP/IP, or NetBEUI.

The client provides full interoperability with Windows for Workgroups, Windows NT Server, LAN Manager, and LAN Manager for UNIX. It also provides compatibility with AT&T StarLAN, IBM LAN Server, 3Com 3+Open and 3+Share, and DEC Pathworks.

For compatibility and to help customers implement floppy boot or better manage the transition to Windows 95, a real-mode client for Microsoft Networks is also included. The Microsoft real-mode components can be “unloaded” by the operating system after the protected-mode networking software is loaded.

The 32-Bit Microsoft Network Peer Services

Windows 95 includes enhanced peer services for Microsoft Networks. The peer server in Windows 95 supports the user-level security model when used in conjunction with a Windows NT Server, and the peer services can be linked directly to domain-based user accounts. As a result, network administrators can centrally control access to peer services at the domain controller. This domain controller can be either a Windows NT Server or a LAN Manager domain controller.

User-level security begins with sharing a device on a Windows 95 system. The list of users that appears in the sharing dialog box are provided by the domain controller, so only validated domain users can share the device. After the share is established, user logons are specified for access rights. When a user requests access to a shared Windows 95 resource, the Windows 95 peer services check the user’s logon name against the domain controller’s list. If the user logon is valid, the peer services then check whether this user has access privileges for this resource. If the user has access privileges, the connection is established.

Like Windows for Workgroups, Windows 95 includes share-level peer services. This level of security associates a password with a shared disk directory or printer. Share-level security can be implemented in a network consisting of only PCs running Windows 95 or in a network that includes other Microsoft Networks-compatible servers.

Peer services in Windows 95 are remotely administrable via the NetWatcher. A network manager can monitor connections to any resource on any Windows 95 peer services PC on the network and can disconnect users and remotely change access rights for specific users. By default, remote administration is limited to user accounts with the administrator privilege.

Network Compatibility

Windows 95 includes built-in support for Microsoft Networks and Novell NetWare Networks. In addition, the Setup program in Windows 95 can correctly install and configure Windows 95 for a variety of existing real-mode networks, including, but not limited to the following:

- 3Com: 3+Open and 3+Share
- Artisoft LANtastic
- Banyan VINES
- Beame and Whiteside’s B&W-NFS
- DEC PATHWORKS
- IBM: LAN Server, LAN Program, and PC LAN Program
- Microsoft LAN Manager and MS Net
- Novell NetWare
- SunSelect PC-NFS
- TCS 10net

Protocol Support

Protocols for networking components in Windows 95 are implemented as 32-bit protected-mode components. Windows 95 can support multiple protocols simultaneously. Protocol stacks can be shared among the installed networks. As an example, a single TCP/IP protocol stack can serve the needs of both the Client for Microsoft Networks and the Microsoft Client for NetWare Networks.

All three protocols included with Windows 95 (IPX/SPX, TCP/IP, and NetBEUI) are Plug and Play enabled. As a result, the Windows 95 system continues to run if the network is unavailable, either because a portable computer has been undocked or a PCMCIA network card has been removed. If the network is unavailable, the protocol stacks unload themselves from the system after sending notification to any dependent applications. Plug and Play enabling also means protocols can be loaded automatically. For example, if a portable computer is undocked and attached to an infrared (IR) line-of-sight network, the TCP/IP protocol is unloaded and the appropriate IR protocol is loaded.

The IPX/SPX-Compatible Protocol

The IPX/SPX stack is the new default protocol for Windows 95 and is compatible with the Novell NetWare IPX/SPX implementation. This protocol stack can be used to communicate to either a NetWare server, or a Windows NT Server 3.5. This protocol is routable, and will run compatibly on most network infrastructure (such as bridges, routers, and so on) that are designed for IPX/SPX routing. The IPX/SPX protocol in Windows 95 includes support for “packet burst” which can offer improved network performance.

One enhancement made to the Microsoft IPX/SPX implementation is Windows Sockets programming interface support. The Windows Sockets interface is supported using IPX/SPX as the protocol. Hence, any WinSock applications can run on top of IPX/SPX with Windows 95. Support is provided for only Win32 WinSock applications.

The IPX/SPX implementation in Windows 95 also has support for the NetBIOS programming interface.

The TCP/IP Protocol

The TCP/IP protocol is becoming widely accepted for connectivity to the Internet and as an industry standard for many corporate networks. In Windows 95, TCP/IP is fully implemented as a 32-bit, high-performance VxD that consumes no conventional memory. It includes several of the more commonly used command-line utilities, such as telnet, ftp, arp, ping, route, netstat, nbstat, ipconfig, tftp, rexec, rcp, rsh, and traceroute.

The TCP/IP protocol support in Windows 95 includes the Windows Sockets programming interface and a WinSock DLL. (A 16-bit WinSock is provided for compatibility with existing WinSock applications, and a 32-bit WinSock is provided for Win32-based WinSock applications.)

NetBIOS programming interface support is also supplied with the TCP/IP support.

DHCP Support

Working with other industry leaders, Microsoft has created a *bootp* backward-compatible mechanism for automatic allocation of IP addresses to make implementation of the

TCP/IP protocol more manageable. The Dynamic Host Configuration Protocol (DHCP) runs from a Windows NT DHCP server and allows network managers to centrally establish a range of IP addresses per subnet for any Windows 95 TCP/IP client requesting an address. It also allows network managers to centrally establish a “lease time”—how long the allocated IP address is to remain valid. Unlike bootp, the address allocation is dynamic, not preconfigured. In this fashion, it is possible to move from subnet to subnet and always have a valid IP address mask. Windows 95 includes a ipconfig utility that allows a user or administrator to quickly examine the allocated IP address, its lease time, and other useful data about the DHCP allocation, as shown in Figure 56.

```
Windows IP Configuration Version 0.1
Host Name . . . . . :
DNS Servers . . . . . :
DNS Lookup Order. . . . :
Node Type . . . . . : Mixed
NetBIOS Scope ID. . . . :
IP Routing Enabled. . . : No
WINS Proxy Enabled. . . : No
WINS Resolution For Windows Sockets Applications Enabled : No
DNS Resolution For Windows Networking Applications Enabled : No

Adapter Address 00-AA-00-18-B0-C4:
DHCP Enabled. . . . . : Yes
IP Address. . . . . : 11.105.43.177
Subnet Mask . . . . . : 255.255.0.0
Default Gateway . . . . : 11.105.0.1
DHCP Server . . . . . : 11.105.43.157
Primary WINS Server . . : 11.101.13.53
Secondary WINS Server . : 11.101.12.198
Lease Obtained. . . . . : Tue 10th. May 1994 6:44:40 am
Lease Expires . . . . . : Wed 11th. May 1994 6:44:40 am
```

Figure 56. The output of the ipconfig utility, showing useful data about the DHCP allocation

DHCP support can be specified at installation time or enabled via the Control Panel’s Network tool. If DHCP support is disabled, an IP address can be entered in the Microsoft TCP/IP property sheet, as shown in Figure 57.

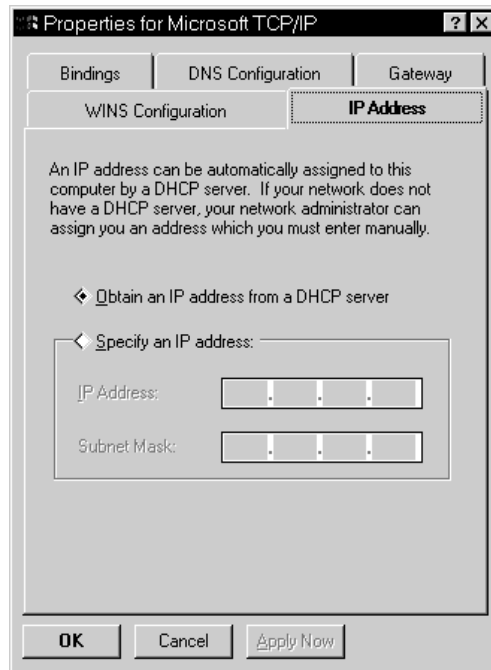


Figure 57. The Microsoft TCP/IP property sheet, showing the DHCP configuration

WINS Support

The TCP/IP protocol stack in Windows 95 lets users choose to install support for either the Windows NT Windows Internet Naming Service (WINS) or the OSF DCE Domain Naming Service (DNS). These naming services provide name resolution by binding the node name and the currently allocated IP address, providing for correct addressing of any requests for resources from a node anywhere on the network. The amount of network traffic needed to locate the node on the network is thus minimized. Windows 95 supports a single DNS server and up to two WINS servers.

The NetBEUI Protocol

Windows 95 includes a NetBEUI protocol stack that is compatible with existing networks using NetBEUI. This stack provides compatibility with Windows for Workgroups, Windows NT Server, LAN Manager, and other networks. A NetBIOS programming interface is also supported.

Network Interprocess Communications Interfaces

Windows 95 includes support for a variety of distributed computing programming interfaces, including the following:

- Client-side named pipes
- Mail slots
- OSF DCE-compliant Remote Procedure Call (RPC)
- Network DDE

- The Windows Sockets interface

Long Filename Support

The network clients in Windows 95 support the use of long filenames. If the Windows 95 system is connected to a network server that supports long filenames, then support for filenames on the server is identical to the local long filename support in Windows 95. (On some servers, the length of filenames and the list of restricted characters may differ from those of Windows 95.) Long filename support is possible on both the Windows NT Server and NetWare servers if the servers are properly configured.

Network Printing

Windows 95 includes a number of enhancements designed to make printing easier over the network, including the following:

- **Point and Print.** A printer driver can be automatically installed when connecting to a printer attached to a Novell NetWare, Windows NT Server, or Windows 95 print server. As a result, Windows 95 printer drivers can be located on a Windows NT Server or Novell NetWare server and automatically installed by their Windows 95 clients.
- **The Microsoft Print Server for NetWare Networks.** For compatibility with NetWare's PSERVER functionality, Windows 95 peer services can despool print jobs from Novell NetWare print queues.
- **Deferred printing.** When a Windows 95 PC is disconnected from the network, print jobs are deferred until the PC is once again attached to the network. Print jobs that have been deferred automatically start when the PC is reconnected.
- **Remote printing management.** Print jobs can be held, canceled, or restarted remotely. In addition, on systems that have ECP ports, information about the print job status can be returned, such as paper tray status, paper jams, or other error conditions.

Network Security

Windows 95 implements a full user logon. The first thing most users encounter after booting their Windows 95 systems is a logon dialog box, which varies depending on the type of network. For example, the Windows NT Server logon dialog box may prompt for a username, password, and domain name. The Novell NetWare 4.x logon dialog box may prompt for a username, password, and preferred server name. When the username and password pair have been validated against the network server's security authority, the Windows 95 UI is displayed.

Network managers can configure the Windows 95 system to allow entry into the UI with no network access if users fail to log on. (This configuration is the default.) As an alternative solution to this problem, network managers can specify guest accounts that have limited network access.

The Windows 95 user logon should not be construed as a mechanism to fully secure PCs. Because the PCs are still vulnerable to a floppy boot, all data stored on their hard disks is potentially available. The underlying file system in Windows 95 is the MS-DOS FAT file system, which has no built-in encryption or other security mechanisms.

Network resources are secured under Windows 95 using the same security mechanisms employed by network servers on corporate networks. The username and password in Windows 95 can be configured to be the same as those used by the network server so as to control network access, provide user-level security for access to shared resources on the local PC, and control the various agents in Windows 95, as well as limit who has remote administration authority on this Windows 95 system. In this fashion, Windows 95 leverages the existing investment in network servers, management tools, utilities and infrastructure. Network managers can manage user accounts centrally on the server, just as they always have. They can also use familiar tools for managing user accounts.

Password Control: Unified Logon

The Password Control in Windows 95 can provide a unified logon for all system components requiring password authentication services, as well as for any applications that choose to use the Password Control services. For example, protected spreadsheets or databases might use the Password Control services.

The Password Control associates the username and password supplied at Windows 95 logon with other authentication-conscious programs or system components. However, for higher security, network managers can choose to associate other passwords with access to vital corporate data or other sensitive network services.

Figure 58 shows the Password Control dialog box, which is accessible from the Control Panel:

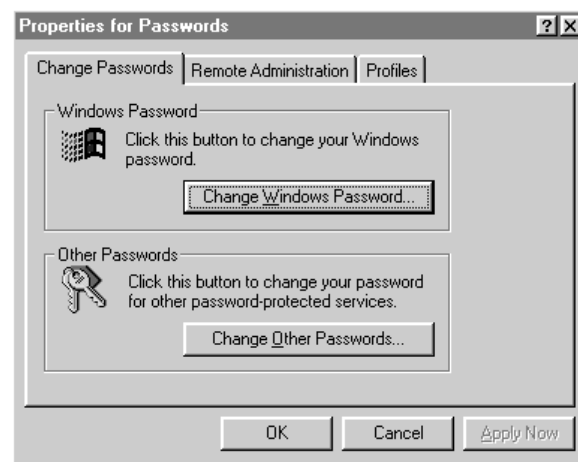


Figure 58. The property sheet for security, showing the Password Control settings

The Password Control provides a mechanism to individually manage components that choose to use the unified password cache. Windows 95 can be configured to use the Windows 95 logon for authentication on a service by service or application by application basis, making it possible to access all resources on the Windows 95 system, as well as on the network, using the Password Control in Windows 95. One example of how the Password Control service is used within Windows 95 is to provide a single logon to both the network and the Microsoft Exchange client, the mail client provided with

Windows 95. Then when users log onto their PCs, the password they entered to log onto Windows 95 also automatically logs them onto e-mail. This single logon provides a solution for the problem of password proliferation.

User-Level Security

Windows 95 uses the logon process to provide user-level security for a variety of services beyond network resource access, including the following services that are remotely accessible:

- File and printer sharing
- Dial-up network Access gateway control
- Backup agent
- Network and system management

Pass-Through Security

Pass-through security is implemented in Windows 95 as the mechanism to enable user-level security. Pass-through literally means that Windows 95 passes authentication requests through to a Windows NT Server or NetWare server. Windows 95 does not implement its own unique user-level security mechanism but instead uses the services of an existing server on the network.

File and Printer Sharing

For file and printer sharing using Windows 95 peer services, enabling pass-through security is a two-step process. First, user-level security must be enabled using the Control Panel. Second, the device must be shared and users with access privileges must be specified. Right-clicking the drive C icon in My Computer displays a property sheet that shows what shares already exist and which users have access, and allows new devices to be shared and new users to be added to specific shares. The usernames listed in this property sheet are supplied by either the Windows NT Server domain, the NetWare Bindery, or NDS.

Remote Administration

The Remote Administration function of a Windows 95 PC specifies the users or groups who have authority to manage the Windows 95 system, including the following:

- Dial-up network access gateway control
- Backup agent
- Remote access to the Registry
- Remote NetWatcher access
- Remote system performance monitoring

Remote Administration is controlled via the Network Security tool in the Control Panel. Figure 59 shows Remote Administration enabled. In this case, Remote Administration is limited to the Domain Admins network manager group—any user who is a member of this group can remotely administer this Windows 95 system. Individual users can also be designated as remote administrators—for example, sophisticated users could be given remote administrator access to their systems.

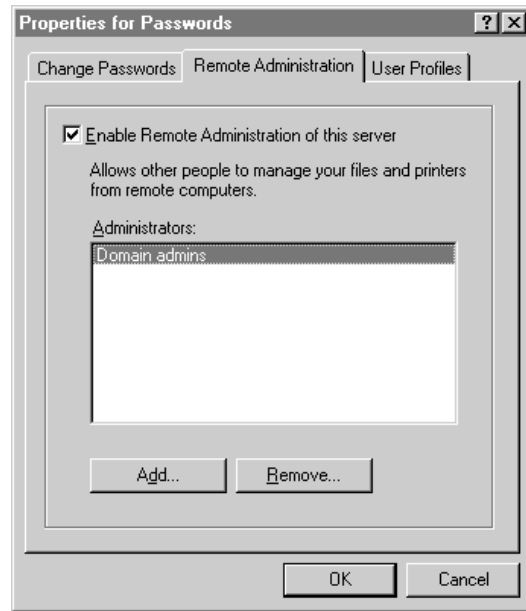


Figure 59. The property sheet for security, showing the Remote Administration settings

Dial-Up Server Remote Access Gateway

Windows 95 includes a single-line, dial-in gateway that allows a Windows 95 PC with peer services enabled to serve as a gateway to the network. The gateway is established via the property sheet shown in Figure 60.

Like the Dial-Up Networking client, the Remote Access Gateway supports the following protocols:

- TCP/IP via the Point to Point Protocol (PPP)
- IPX/SPX via PPP
- NetBEUI

The Remote Access Gateway implements pass-through security, so only authenticated users can log onto the Gateway services. After connecting to the Gateway, Dial-Up Networking clients can access any network resource that they have privileges to use, including network server resources and peer services.

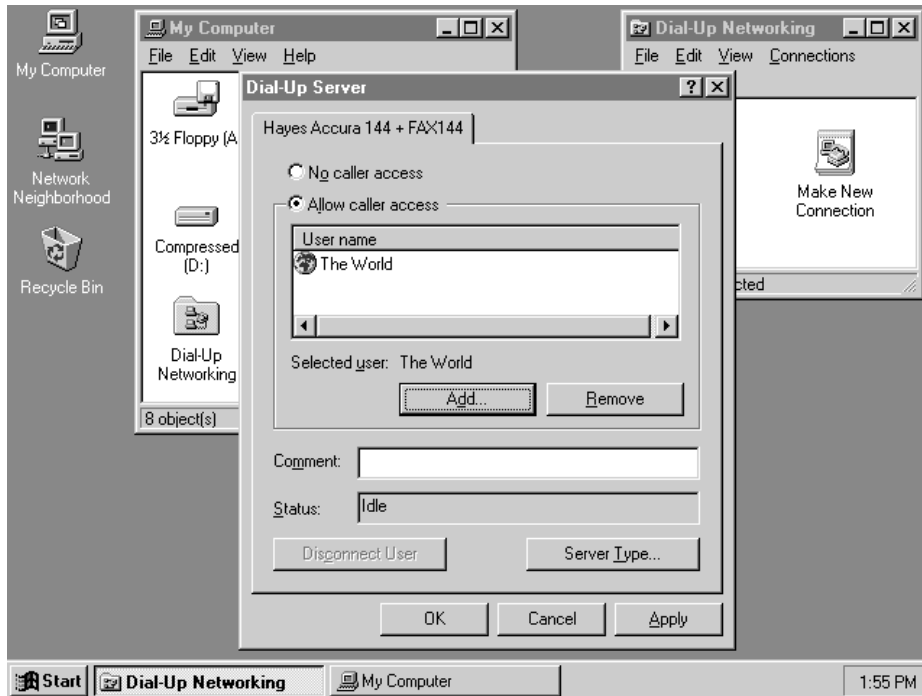


Figure 60. The Remote Access Gateway dial-in property sheet, which shows that dial-in access to the network is available via this Windows 95 PC

