C H A P T E R   8

Networking

Windows desktops are being connected to corporate networks at a steadily increasing rate, along with it are growing demands for better network integration, improved network and system management capabilities, and better network performance and reliability as more business critical functions rely on the PC network. As a consequence 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 management of their growing corporate PC networks. Windows 95 is the version of Windows constructed to address the needs of the 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, making access to and control of the network consistent, and easier to use through many enhancements in the Windows user interface making network browsing and printing much easier to use. In addition, Windows 95 is designed to address users mobility needs both roving on the corporate network, as well as enabling dial-up access to the network from portable PCs.

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

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This section will introduce you to the 32-bit, protected-mode networking architecture built into Windows 95 and will show you how it provides well integrated network support, manageability, improved performance, user-level network security and dial-up access to the network. The discussion of networking in Windows 95 is structured as follows:

Easier Networking with Windows 95. Summarizes the key features and concepts in Windows 95 that make networking much easier to implement and use.

Network Architecture of Windows 95. Details of the internals of the 32-bit protected-mode networking infrastructure of Windows 95.

Managing Windows 95 Systems. Outlines the support built into Windows 95 to enable both System Management and Network Management.

Summary of Improvements over Windows 3.1 and Windows for Workgroups 3.11:

The primary improvements in networking for Windows 95 are:

u   A robust, open, high-performance 32-bit network architecture—32-bit network client software, 32-bit file and printer sharing software, 32-bit network protocols, and 32-bit network card drivers

u   Support for using multiple redirectors, multiple protocols and network card device drivers simultaneously to facilitate integrating the desktop into a heterogeneous network environment

u   Support for industry standard connectivity and systems management solutions including TCP/IP, IPX, SNMP, and DMI

u   Great integration with Novell NetWare including high-performance, 32-bit protect-mode NetWare-compatible client software for connecting to NetWare 3.x and 4.x servers, and peer sharing for NetWare environments

u   Great integration with Windows NT Server to support a powerful client/server solution

u   Built-in support for systems management, including the ability to remotely administer, monitor, and view the configuration of PCs over the network

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Improved dial-up network access support providing remote access to Microsoft Networking servers, Novell NetWare servers, and UNIX servers. Support for remote protocols such as PPP and SLIP is provided.

u   Improved network printing, making it easier for users to connect and configure printers in network environments.

Easier networking with Windows 95

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

Windows 95 Provides great Novell NetWare Integration

Windows 95 has built-in support for two networks—Microsoft and Novell NetWare networks. (Built-in support for Novell NetWare is new for 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 Control Panel. Both the Microsoft 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, browsing NetWare servers, connecting to servers, queue print jobs either using the user interface in Windows 95, or using Novell's NetWare command line utilities. In fact the Microsoft Client for NetWare Networks in Windows 95 will even run "TSR clean" NetWare login scripts. In addition, Windows 95 provides continued support for Novell NetWare real-mode components. This means the NetWare 3.*x* NetX shell and the NetWare 4.*x* VLM shell are both supported by Windows 95.

Microsoft File and Printer sharing for NetWare

Windows 95 also provides NetWare compatible peer services for File and Printer sharing that 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 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.

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Windows 95 includes support for both client access, and peer services capabilities on a Microsoft Network.

Additionally, other network servers and services will be provided by third parties, for example Artisoft®, Banyan®, DEC®, Novell ,and SunSelect will provide Windows 95 support for their respective network servers.

Windows 95 is 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 even 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.

Integrated networking support is a key focus of the design of Windows 95, and it's now 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 has the capability to simultaneously support up to ten 32-bit, protect mode network clients using the Network Provider Interface of Windows 95. This interface defines a set of APIs used by Windows 95 to access the network for things like logging on to 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 when first installing Windows 95 from the Network Setup dialog box. This means that a Windows 95 desktop can run client support for NetWare, Windows NT Server, Banyan, DEC PathWorks and Sun NFS simultaneously. For users with a mixed environment with Apple Macintosh computers, Windows 95 can be used to exchange documents and share information with Macintosh users when Macintosh-compatible file services are used with Windows NT Server or Novell NetWare and connecting to the common file server—long filename support in Windows 95 further simplifies the integration of the two systems.

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Windows 95 Puts Information on the Internet Just a Mouse-Click Away

With Windows 95, you have easy access to the Internet, whether you dial into a commercial Internet provider or you have access to the Internet via your corporate network over TCP/IP. Windows 95 provides all the plumbing you need to access information on the world-wide Internet network. Built-in support for TCP/IP, Windows Socket services, and dial-up protocols such as Point to Point Protocol (PPP) and SLIP, make connecting to the Internet and the information highway just a mouse-click away with Windows 95. 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 Windows–based TCP/IP implementation also does not have the conventional memory footprint commonly found in MS-DOS–based drivers or TSRs. Dial-up protocol support such as PPP and SLIP in Windows 95 give users flexibility in choosing the Internet access provider they want to use to dial into using a standard asynchronous modem or ISDN connection.

Support for Windows Socket services in Windows 95 allows users to use 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 world-wide information servers. Additionally, Windows 95 includes telnet and FTP to help you take advantage of the Internet. Windows 95 also supports sending and receiving electronic mail messages over the Internet through the use of a provided mail driver that integrates with the universal inbox in Windows 95, the Microsoft Exchange client. For more information on Internet mail support in Windows 95, see the Microsoft Exchange section of this guide.

Windows 95 Makes Using the Network as Easy as "Point and Click"

For users, running one network client can be confusing and multiple network support 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 multiple network support loaded, the user is now faced with minimally twice the number of commands and utilities to remember and may now have to remember multiple passwords to access network resources. The easy to use Network Neighborhood user interface in Windows 95 makes it easier for users to perform common network operations on disparate servers. First, it's now possible for network manager to establish one password to log the user into the Windows 95 PC and any network resources or services that they are entitled access to. These services could include email, group scheduling applications, dial in support or database access.

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Additionally, common network actions like browsing servers, managing connections and printing are all done identically through the user interface in Windows 95 regardless of the type of server Windows 95 is connected to. This means a user can easily locate, connect, and start a print job on a NetWare print server as easily as they can for 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, manage connections, and so on. The user isn't required to memorize any new network commands. For both Microsoft Networks and Novell NetWare Networks, the user can run the corresponding command line utilities as well. This ongoing backward compatibility may be necessary to support batch files currently in use, or to help manage the transition period moving to the Windows 95 environment.

Lastly, the Network Neighborhood helps to manage the complexity of the network by showing it from the user's perspective. That is, it will show only what the user is interested in seeing. When the user initially opens the Network Neighborhood the window will only contain the servers that the user has logged into, or servers that the user most frequently connects to, or has explicitly customized the network view by dragging and dropping the server into the Network Neighborhood. This context-sensitive view of the network thus reduces the number of network resources that the user initially encounters to a more manageable number of objects. For Windows NT domains and NetWare 3.*x*/4.*x*, the network context presented is the "login server" and any other connected servers.

For more in depth discussion of the Network Neighborhood and the user interface in Windows 95, see to the "The Windows 95 User Interface" section in this Guide.

Windows 95 Makes Mobile Network Support Easier

Two features in Windows 95 make connecting to a network easier for mobile PC users—Plug and Play and Dial-up Access.

Plug and Play. Plug and Play in Windows 95 solves several problems that face mobile PC users. are faced with a variety of challenges to keep their PCs running smoothly today. 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-in network access. By supporting 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 which allow for hot removal and insertion of PCMCIA cards, including network cards.

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Finally, network Plug and Play support in Windows 95 includes application-level support. An application that is network-aware understands whether the network is available or not. If 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-in to the corporate network exist. However, 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-in 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-in can also be offered by third parties, for example Shiva has implemented their Windows 95 support using the modular architecture of Dial-Up Networking client in Windows 95.

Windows 95 Client: Designed for Manageability

Many corporations have rapidly growing networks, networks that in some cases run worldwide. Keeping the networks and ever increasing number of systems connected to the networks running at peak performance is a challenge for both end users and network managers. These 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 PCs running Windows 95. Using these tools, network managers will be able to quickly inventory software and hardware used on their network. Working from a PC running Windows 95, network managers can remotely diagnose and reconfigure Windows 95 systems as well as remotely monitor system and network performance on a PC running Windows 95. The following key components make Windows 95 very manageable:

u **SNMP Agent.** Windows 95 incorporates an agent that implements the Simple Network Management Protocol (SNMP). This agent complies to 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 PC running Windows 95. Events can be managed from a central SNMP management console.

u **SNMP MIB, MIB 2.** 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.

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u **DMI Agent.** Windows 95 offers a DMI agent soon after final Windows 95 release. DMI applications offer cross-platform desktop management capabilities. Support of the DMI agent is built on top of the Registry in Windows 95. The DMI specification version One became final this spring,, Microsoft as a founding member of the DMTF will follow its ongoing evolution.

u **Registry-based System Management.** Central to the operation of Windows 95 is the Registry. Similar in design to the Registry found in Windows NT, it replaces the many .INI files previously used by Windows and Windows 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 defines the key for the user's name. The name "Fred Smith" is the values associated with this key. There also exist a special category of keys called Dynamic Keys. These 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 that defines user preferences and user specific application information, and POLICY.POL which defines the "system policies" relating to either previous component. 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 APIs used to access the Registry both locally and remotely are the Win32 Registry APIs.

Management Tools for Windows 95

There are several tools for Windows 95 that make managing the system or the network much easier for a PC or network manager. These tools include:

u **Registry Editor.** It allows local or remote editing of the Registry in Windows 95.

u **System Policy Editor.** This is used by network managers to set "policy" over-rides on Registry entries per user or per group and creates the POLICY.POL component of the Registry. Even though it bears the same EXE file name, this tool contains a superset of the Windows for Workgroups' "admincfg" tools settings.

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u **Performance Monitor.** It allows you to locally or remotely view the performance of the various i/o components of the local system or remote PC. For example, you can monitor the file system, the network components, or data from the network card. The data is updated dynamically using the Registry "dynamic keys."

u **NetWatcher.** This allows you to locally or remotely view and manage the network connections of peer services in Windows 95.

Easier to Setup and Install

PC and network managers faced several challenges when installing Windows in the past. Some network managers installed Windows on the network for later installation onto users' PCs, or to run Windows from a network server. In the first case, the network manager 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 are available.

Running Windows from a network server, network managers had to manage variables such as having local swapping files and some local .INIs and applications, allowing user-level configurations, how to support 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 previously discussed Registry. The new Setup streamlines the installation of Windows on a network server for either installation from the server, or running Windows 95 from a server. In fact, Windows 95's Setup utility has a scripting feature, making it possible to implement "hands-free" installation of Windows 95 from a network server to the client PCs.

Running Windows 95 from a server becomes much simpler largely due to the new Registry in Windows 95. The Registry is a centralized database of all hardware, software and user information, hence, is easy to maintain remote on the server. Contrast this to the state of configuration today with CONFIG.SYS, AUTOEXEC.BAT and the myriad of Windows and Windows applications .INI files. In addition, the separation of hardware configuration from the user profiles means that users can rove on the network, their preferences will follow them from PC to PC regardless of the hardware configuration they're currently running on.

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Network Architecture in Windows 95

The Network Architecture in Windows 95 radically updates 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:

Fast, 32-bit VXDs. The networking components in Windows 95 are built as Virtual Device Drivers (VxDs). VxDs are 32-bit, and have no conventional memory footprint, and loaded dynamically when needed by the system. In addition, since the operating system and the device drivers are all running in protected-mode, network I/O performance is 50 to 200% faster than Windows 3.1 because there's no more overhead for mode switching and virtualization between protected and real-mode operation.

Reliable. Since 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. Today's real-mode network components may conflict in memory or attempt to exclusively chain the same set of interrupts, this commonly leads to system hangs or error conditions. Windows 95 arbitrates the hardware resource allocation, hence these errors don't occur with protected-mode network components.

Modular, Open Design. The network architecture in Windows 95 is highly modular, which includes a new Network Provider interface, an Installable File System (IFS) interface, and an enhanced version of Network Driver Interface Specification (NDIS) version 3.1 which has been enhanced for Plug and Play support. The specifications are available for all three aforementioned interfaces for 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. This means it is possible to run Microsoft Network and Novell NetWare client support simultaneously. Windows 95 is capable of supporting up to 10 32 bit, protected mode network clients, and one real mode network client concurrently.

Multiple Protocol Support. The Protocol Manager in Windows 95 supports loading multiple transport protocols. Protocol Manager is one of the NDIS components, and makes it enables Microsoft and third parties to independently author protocol stacks for Windows 95 that coexist well. Windows 95 includes built-in support for IPX/SPX, TCP/IP and NetBEUI. Protocol support is extensible, Windows 95 can support up to N protocols.

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Plug and Play Enabled The whole of the networking components in Windows 95 are designed for dynamic Plug and Play operation. For example, when a PCMCIA network adapter is inserted, the NDIS 3.1 network card driver is automatically loaded, and the network is available. Alternately, if the PCMCIA network card is removed, or the network cable is removed, Windows 95 will not hang as many real-mode networks do, but will notify any applications using the network that it's no longer available and will continue to run.

Figure 1 shows an overview the network architecture built into Windows 95. The following sections describe key aspects of this architecture, including the Network Provider Interface, the Installable File System, and NDIS 3.1.
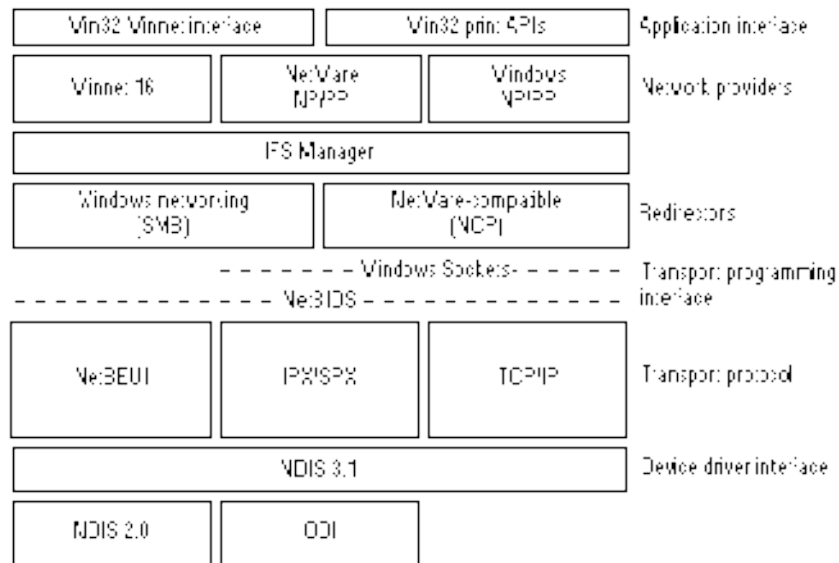
Figure 1. Diagram of the Layered Network Architecture of Windows 95

Network Provider Interface: Concurrent Support for Multiple Network Servers

Windows 95 has an open, modular Network Provider Interface (NPI) to allow multiple network support to be installed in Windows 95 simultaneously. NPI enables Microsoft, or any third party network provider to integrate varied network services seamlessly into Windows 95. Key benefits of the NPI are:

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u   An open interface that allows any network vendor to supply tightly integrated support for their network servers for Windows 95

u   All supported networks are identically accessed and managed through the Windows 95 Network Neighborhood user interface

The NPI abstracts the network services for the Windows 95 user interface components, as well as the various Windows 95 network and desktop management components. The Network Provider Interface consists of two parts—the network provider API and the network providers. The network provider API is a single, well defined set of API used by Windows 95 to request network services such as browse servers, connect and disconnect to servers, queue a print job, and so on. These requests are then passed to the network providers. The network provider layer sits below the API layer, and provides the needed network services to honor the request for network specific services of components in 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, and the services provided by a device driver often written by a third party that honors the request.

The most apparent abstraction of the various network services provided by the Network Provider Interface is the Windows 95 system login. Each Network Provider can provide a unique login dialog box to suit the needs of the network servers security model. For example, the login dialog box shown in Figure 2 is for logging in to a Windows NT Server domain:

Figure 2. Network Logon Dialog Box for Windows NT Server Domain

Note that the dialog box shown in Figure 3 for logging in to a Novell NetWare 3.*x* server offers additional information to allow users to logon as GUEST. This dialog box is invoked when a user first accesses a NetWare server.

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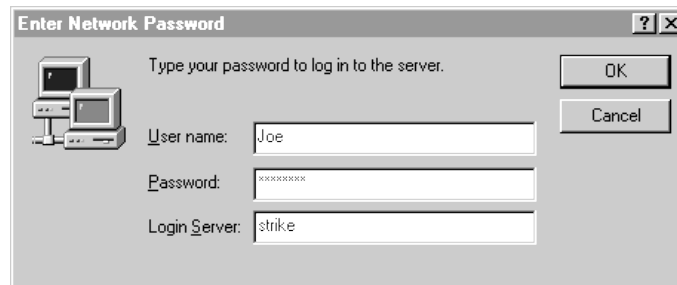**Figure 3. Network Logon Dialog Box for Novell NetWare**

To complete this example, once the login is validated against the requested server, the password is passed back to Windows 95. Windows 95 can then use this password as the "Password Control" and unlock system or network resources that are linked to the Password Control password validation. In this fashion, it's possible for Windows 95 to accommodate various ways that network servers provide their services, yet still offer the user a very consistent user interface.

Another example of user visible support from the Network Provider occurs when specifying server name strings. For example, Microsoft compatible networks use the Universal Naming Convention (UNC) which appears in this form:

*server-name**share-name*

However, NetWare servers are specified in this form:

server-name/*volume-name*:*directory-name*

The respective Network Providers will correctly parse the syntax of their server name strings. This means that users who are accustomed to using the NetWare server syntax can type the NetWare server syntax string wherever required by the user interface in Windows 95 to access NetWare server resources.

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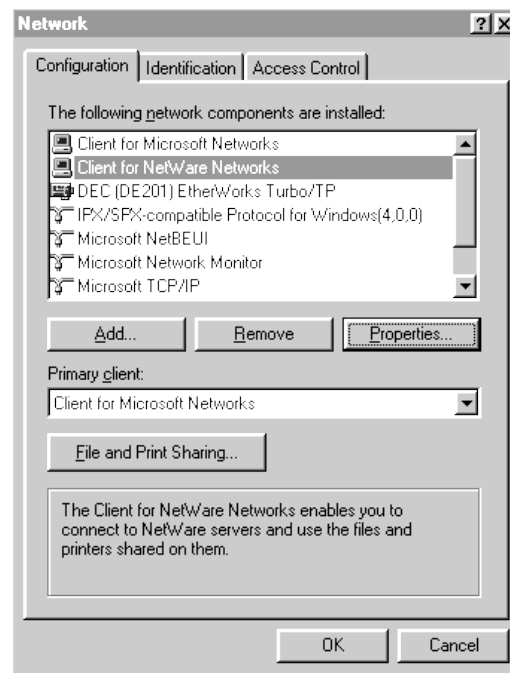Revision #: 2   Page: 143 of 35   Printed: !Unexpected End of Expression

Figure 4. Network Control Panel showing both the Client for Microsoft Networks and the Microsoft Client for NetWare Networks running simultaneously.

Installable File System: Support for Multiple Network Redirectors

The Installable File System (IFS) 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 following; VFAT (32-bit FAT) and CD-ROM file systems. The IFS implementation in Windows 95 is functionally similar to the IFS implementations on Windows for Workgroups and Windows NT. For networking, the IFS is used to implement network redirectors. The IFS interfaces are documented, and are meant to be used by vendors of network servers to implement their redirector for Windows 95. The IFS offers a number of key benefits for network redirectors for Windows 95:

u Designed for multiple redirector support
u Increased reliability, the IFS model arbitrates resource requests, removing the source of many real-mode redirector conflicts

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u   Improved performance, network redirectors will benefit from the unified IFS
cache making available client side network redirector caching

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 logical view
of devices, and arbitrates access, update and control of devices consisting of very
different physical media types. For network redirectors, the FSD provides
mechanisms to locate, open, read, write and delete files, as well as services like
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 your Windows 95 desktop. The user double-clicks
the icon, then 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 may re-
establish the network connection to the server on which the object resides, if
required. The NPI then in turn 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 a handle to the open file back up
to the NPI and the shell.

Both Microsoft supplied redirectors for the Microsoft Networks Client and the
Novell Compatible Client are implemented as IFS FSDs.

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NDIS 3.1: Multiple Protocol Support

The Network Driver Interface Specification (NDIS) 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 two key areas:

u   Plug and Play enhancements to the Protocol Manager and Media Access Control (MAC) layer that enables network drivers to be dynamically loaded and unloaded

u   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.

Upgrading an NDIS 3.0 driver to NDIS 3.1 is very straight-forward. (For example, in some cases the changes have taken one hour for Microsoft engineers to update an NDIS driver source code.) Instead of making this type of upgrade, vendors may instead choose to provide a mini-driver. As noted previously, the primary changes to the NDIS model were extensions for Plug and Play support.

The mini-driver model dramatically decreases the amount of code that a network adapter vendor must write. Conceptually, this 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. These include specific implementation details like establishing communications with the card, turning on and off electrical isolation (if implemented) for Plug and Play, doing media detection and enabling any value added features the card may contain. The mini-driver is wed to the NDIS wrapper, which implements the other half of the MAC functionality. This contains the code that remains "common" to all NDIS drivers. In prior releases of NDIS, each MAC carried all this redundant code, hence, the mini-drivers are much smaller than existing NDIS 3.0 MACs, roughly 40% smaller in size. NDIS mini-drivers developed for either Windows 95 or Windows NT are binary compatible.

An NDIS 3.1 stack is composed of three component parts—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. Just below is either the MAC or mini-driver wrapper, if using mini-drivers. Multiple MACs or mini-drivers can be loaded in systems that have multiple network adapter cards 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, since Windows 95 can always assume that it's being run on an Intel architecture.

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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 Microsoft Networks client. The Microsoft Client for NetWare Networks for Windows provides interoperability with NetWare 3.*x* and 4.*x* servers.

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.

32-bit Microsoft Client for NetWare Networks

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

u   High Performance—up to 200% faster for some network operations compared to Windows 3.1 with the NetWare VLM shell installed

u   Robust and reliable client support

u   No conventional memory footprint

u   Auto-reconnect feature

u   Packet burst protocol support

u   Client side caching

u   Plug and Play aware

u   Fully integrated into the user interface shell in Windows 95

u   Fully interoperable with Novell NetWare 3.*x* and 4.*x* clients and servers

u   Runs NetWare command line utilities

u   Graphical logon to NetWare 3.*x*, or 4.*x* via the NetWare Bindery

u   User-level security implemented using "pass-through" to the Bindery

u   NetWare compatible login command processor

u   Point and Print support

The client is fully implemented as 32-bit virtual device driver components. The client runs in protected-mode and designed for operation in a multitasking environment, hence will be much more robust than real-mode networking components. By running in protected-mode, the drivers take no MS-DOS conventional memory space.

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The Microsoft Client for NetWare Networks has great performance characteristics. On large block transfers over the network it is up to 200% faster than Windows 3.1 and the VLM shell, in fact it's up to 200% 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% up to 200% faster depending upon the mix of network I/O.

The Microsoft Client for NetWare Networks is enabled for Plug and Play, meaning that it's possible on a portable systems that support it, to hot-dock or undock a notebook computer and have the networking support properly load and unload, without hanging the system. This will also function in the same fashion for the emerging market of PCMCIA network cards. One easy way to understand how this work is to disconnect the network cable from your Windows 95 PC, and the system continues to function. In real-mode networks, this causes the system to hang.

Logon to Windows 95 is linked to a NetWare Bindery. This logs the user onto the Windows 95 system and to their preferred NetWare server via a single graphical login process.

The Microsoft Client for NetWare Networks has the ability to process NetWare login scripts. This means that if drive mappings and search drives are specified in the login script then under Windows 95 the same user configuration will be implemented, with no changes necessary. The Windows 95 login processor will parse conditional statements in the NetWare login scripts. However, if the login script is used to implement loading of TSRs, then the login file needs to be updated to remove these TSRs from being loaded. One key difference in login processing is the Windows 95 login processor operates in protected-mode, hence, loading TSRs is not possible. Rather, these TSRs should be loaded in our 16-bit driver load prior to the protected-mode operation. In some cases the TSRs loaded are backup agents, and so on. that have protected-mode equivalents built into Windows 95, hence, loading these TSRs may not be necessary.

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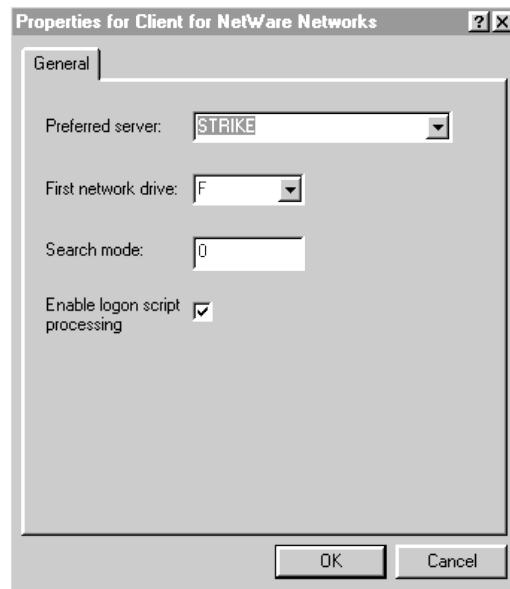Revision #: 2   Page: 148 of 35   Printed: !Unexpected End of Expression

Figure 5. Property Sheet for the Microsoft Client for NetWare Networks showing a preferred server has been specified, and login scripts have been enabled.

The Microsoft Client for NetWare Networks in Windows 95 can load and run NetWare command line utilities. It also 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 Networks in Windows 95.

Microsoft File and Printer Sharing for NetWare

Windows 95 provides Peer Services for NetWare clients. The NetWare compatible Peer Services provide sharing for local files and printers on the Windows 95 system. During the installation of Windows 95 and via the Network icon in Control Panel, the option is provided to 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.

For the NetWare Compatible Peer Services to be activated there must be a Novell NetWare server on the network. Without this server, Microsoft File and Printer sharing cannot be enabled because of the "pass-through security" model. Unlike Microsoft File and Printer sharing for Microsoft networks, share level security is not supported.

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User-level security is implemented using the NetWare servers security authority namely the Bindery, hence "passing through" the validation of users to the NetWare server. Before sharing is enabled, a NetWare server must be specified via the Security Control Panel tool. To specify which server or Domain Controller is the designated security authority for this PC, the following dialog box is used in the network Control Panel tool:

Figure 6. Specifying User Level a.k.a. "Pass-through" security From a Windows NT Domain Named SYS-WIN4

From the properties dialog of the PC's hard drive, Windows 95 gives the option to add uses to share the hard disk. If the user selects the option to add another user to this share, the following dialog box appears:

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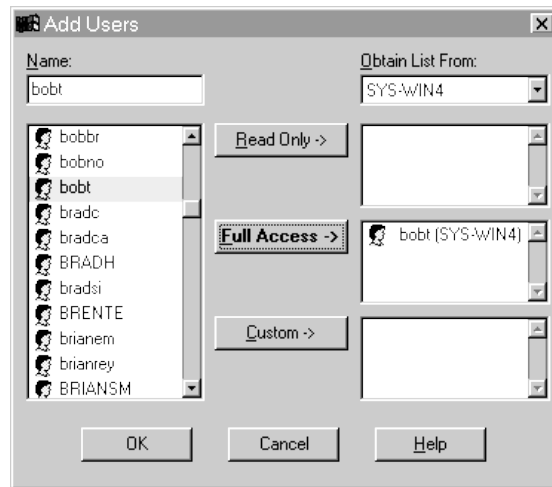Revision #: 2   Page: 150 of 35   Printed: !Unexpected End of Expression

Figure 7. Configuring Access Privileges for a User Through User-Level Security

Notice that the list of users offered to add to access this directory are those from the SYS-WIN4 server's bindery.

This means two things. First, user management is all done in the namespace of the existing NetWare server. The NetWare server is administered using all the same tools that are currently in use, Windows 95 hasn't added another namespace to administer. For example, tools that the NetWare network manager currently uses, such as SYSCON is used for user account management for Windows 95 user level security. Secondly, only valid user accounts and groups can be specified for sharing on NetWare Compatible Peer Services.

If the user now attempts to access a shared device on the Windows 95 system, the Windows 95 PC upon receipt of the connection request validates the user name or group membership with the NetWare server. If the name or group membership is validated, the peer services in Windows 95 then checks if this validated name or group has been granted access rights to the shared resource and grants or denies the connection request.

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

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Microsoft Print Server for NetWare

The Microsoft File and Printer sharing for NetWare in Windows 95 includes a Win32-based "PSERVER" capability which can despools print jobs from NetWare queues to printers on Windows 95 PCs. This means that a NetWare server queue can be serviced by a printer attached to a system running the Microsoft File and Printer sharing for NetWare services. There are certain benefits, the print queues can all be managed centrally from the NetWare server hence users print to one queue. If several systems running Windows 95 with Peer Services enabled are on the network, each 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 Microsoft File and Printer sharing for NetWare.

NetWare 4.*x* support

The Windows 95 client for NetWare will support NetWare 4.x servers if they are running "Bindery emulation."The NetWare 4.x server is then browsable like any other NetWare server from the Network Neighborhood.

Microsoft is working to provide an updated Microsoft Client for NetWare Networks with support for NDS login and browsing. Microsoft plans to make this client support available for little or no cost once it's completed. Currently, this support is planned 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—NWNET.DLL and NWCALLS.DLL DLLs—can be run with the Microsoft Client for NetWare Networks. This ensures compatibility of any MS-DOS or Windows applications and utilities that are NetWare-aware will run compatibly with the Microsoft Client for NetWare Networks.

Other NetWare Interoperability

Windows 95 also offers these interoperability features:

u   Novell command-line utilities (client and admin) are fully supported for NetWare 3.*x* before final product shipment.

u   Support for booting diskless workstations from NetWare servers

u   Floppy boot capability

u   Dial-up Connectivity to Novell's NetWare Connect server.

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Microsoft Network Integration

Windows 95 includes a network client that implements support for Microsoft
Network functionality. This allows Windows 95 to connect to Windows for
Workgroups, Windows NT Server, 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.

32-bit Microsoft Client

Key Microsoft Networks client features include:

u   Robust

u   No conventional memory footprint

u   Auto-reconnect feature

u   Client side caching

u   Plug and Play aware

u   Fully integrated into the user interface shell in Windows 95

u   Protocol independent

u   Point-and-print for one-click printer setup

The Microsoft Networks client is implemented as a collection of 32-bit,
protected-mode components. The Network Provider, Redirector, and NDIS 3.1
drivers are implemented as VXDs, and hence provide great performance since the
components execute in protected-mode without the overhead of switching to real-
mode. The Network Provider includes the implementation of client-side caching
for additional performance boost. The client has higher reliability than real-mode
components, it is designed for operation in a multi-tasking environment and the
components run in kernel Ring 0 context, hence they can't be touched by errant
Windows applications like real-mode networks. And finally, since they run in
protected-mode, they have no conventional memory footprint.

The client is enabled for key features in Windows 95 such as long filenames,
links, auto-reconnect to servers, "point and print," Plug and Play, and integrated
tightly into the Windows 95 shell via the NPI discussed previously. The client is
protocol-independent, 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.

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For compatibility and to help customers implement floppy boot, or better manage 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 once the protected-mode networking software is loaded.

32-bit Microsoft Network Peer Services

Windows 95 includes enhanced peer network services for Microsoft Networks. The peer server in Windows 95 supports the user-level security model when used in conjunction with Windows NT Server. The peer services for Microsoft Networks in Windows 95 can be linked directly to Domain based user accounts. This means that for network administrators, control over access to peer services is centrally controlled 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, hence it's only possible to share the device to validated Domain users. The share is established and user logons are now specified for access rights. When a user requests access to a shared Windows 95 resource, the Windows 95 peer services PC checks for the users logon name against the domain controller. If this is a valid user logon, the peer services in Windows 95 then checks if this user has access privileges for this resource. If the user logon has access privileges, then the user connection is established.

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

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

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Network Compatibility

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

u   3Com: 3+Open, 3+Share

u   Artisoft LANtastic®

u   Banyan VINES®

u   Beame and Whiteside: B&W-NFS

u   DEC PATHWORKS

u   IBM: LAN Server and LAN Program and PC LAN Program

u   Microsoft LAN Manager, MS Net

u   Novell NetWare

u   SunSelect PC-NFS

u   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 networks that are installed. As an example, a single TCP/IP protocol stack can service both the needs of the Microsoft 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. This means that if the network is unavailable either due to undocking a notebook PC, or removal of a PCMCIA network card, the Windows 95 system continues to run. The protocol stacks will unload themselves after having notified any dependent applications that they will be unloaded from the system. Additionally, this also means protocols can automatically be loaded. For example, if a mobile PC user goes from network attached to an infrared (IR) line of sight network, the TCP/IP protocol can be unloaded and the appropriate IR protocol loaded, automatically.

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IPX/SPX

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.

TCP/IP

For connectivity to the Internet, or for many corporations implementation of an industry standard network protocol, TCP/IP is becoming widely accepted. The implementation of TCP/IP in Windows 95 is a 32-bit VxD, is high performance and consumes no conventional memory.

Windows 95 includes a full TCP/IP implementation that includes several of the more commonly used command line utilities, which include 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 includes a WinSock DLL. Support is provided for both 16-bit WinSock for compatibility with existing WinSock applications, and 32-bit WinSock for Win32 WinSock applications.

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

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DHCP Support

In an effort to make implementation of the TCP/IP protocol more manageable, Microsoft, working with other industry leaders have created a *bootp* backward-compatible mechanism for automatic allocation of IP addresses. The Dynamic Host Configuration Protocol (DHCP) runs from a Windows NT DHCP server, and it allows a network manager to centrally establish a range of IP addresses per subnet automatically to any Windows 95 TCP/IP client requesting and address. It also allows the network manager to centrally establish a "lease time" or how long the allocated IP address is to remain valid. Unlike bootp, the address allocation is dynamic, not pre-configured. In this fashion it's 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 IP address allocated, lease time and other useful data about the DHCP allocation, as shown below.

```
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
```

DHCP support can be specified at install time, or enabled via the Network Control Panel tool. If the user prefers, a "hand-entered" IP address can be used and DHCP support can be disabled.

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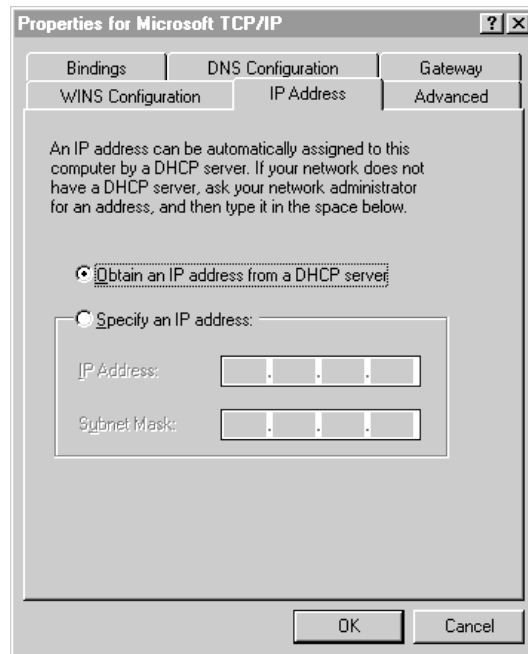Revision #: 2   Page: 157 of 35   Printed: !Unexpected End of Expression

Figure 8. Properties for Microsoft TCP/IP Showing DHCP Configuration

WINS Support

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

NetBEUI

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

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Network Interprocess Communications Interfaces

Windows 95 includes support for a variety of distributed computing programming interfaces, these include:

u　Client-side named pipes

u　Mail slots

u　OSF DCE compliant Remote Procedure Call (RPC)

u　Network DDE

u　Windows Sockets Interface

Long Filename Support

The network clients in Windows 95 support the use of long filenames. If the network server that the Windows 95 system is connected to supports long filenames, then filenames on the server will include identical support to the local long filename support in Windows 95. On some servers the length of filenames and restricted characters may differ from that of Windows 95. This means that it's possible to have long filename support 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:

Point and Print. Automatic installation of a printer driver when connecting to a printer attached to a Novell NetWare, Windows NT Server, or Windows 95 print server. Windows 95 printer drivers can be located on Novell NetWare servers and Windows NT Server servers and automatically installed by the Windows 95 clients.

Microsoft Print Server for Netware Networks. Windows 95 peer services can "despool" print jobs from Novell NetWare print queues. This is compatible with NetWare's Pserver functionality.

Deferred Printing. When the Windows 95 PC is disconnected from the network, print jobs are deferred until a later date when the PC is once again attached to the network. Print jobs that have been deferred will automatically be started when the PC is reconnected to the network.

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Remote Printing Management. Print jobs can be held, canceled, or restarted remotely. In addition, on systems that have ECP ports, more information about the print job status can be returned concerning paper tray status, paper jams, or other error conditions.

Network Security

Windows 95 implements a full user logon. The first thing most users will encounter after booting their Windows 95 system is a logon dialog box. This dialog box varies depending on the type of network that they are logging into. For example, the Windows NT Server logon dialog may prompt the user for a username, password, and domain name. The Novell NetWare 4.*x* logon may prompt the user for a username, password, and preferred server name.. Once the username and password pair have been validated against the network server's user authentication, the user is allowed in to the user interface in Windows 95.

If the user fails to logon, the network manager can configure the Windows 95 system to allow entry into the user interface in Windows 95, albeit with no network access. This is the default configuration. Additionally, administrators can specify guest accounts that have more limited network access as an alternative solution to this problem.

However, because Windows 95 has a user logon, it's not to be construed as a mechanism to fully secure the PC. The PC is still vulnerable to a boot floppy and thus all data stored on the hard disk is available. The underlying file system in Windows 95 is the MS-DOS FAT file system, hence has no encryption or other security mechanisms built-in.

Instead, the focus of Windows 95 is to provide that network resources are secured using the same security mechanisms in place today via the network server on the corporate network. The username and password in Windows 95 can be configured to be the same as those used by the network server, and can thus control network access, user-level security for access to shared resources on this PC, control of the various agents in Windows 95, as well as limiting who has remote administration authority on this Windows 95 system.

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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 do today. They can also use the same tools that they do today for managing the 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 any applications that choose to use the Password Control services. For example, protected spreadsheets, or database access may use the Password Control services.

Password Control associates the username and password supplied at Windows 95 logon to other authentication conscious programs or system components. However, it's also possible to maintain separate password, in essence for higher security a network manager may choose to associate other passwords with vital corporate data access or other sensitive network services.

Figure 9 shows the Password Control dialog box from the Control Panel:

Figure 9. Properties for Security, Showing Password Control Password Settings

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Note the Password Control provides a mechanism to individually manage components that choose to use the unified password cache. On a service by service, or application by application basis, Windows 95 can be configured to use the Windows 95 logon for authentication. This makes it possible for a user to achieve a "single logon" for access to all resources on the Windows 95 system, as well as the network using the Password Control in Windows 95. One example of how the Password Control service is used within Windows 95 is providing a single logon to both the network and the Microsoft Exchange client, the mail client provided with Windows 95. Once a user has logged onto their the mail client provided PC, the password they entered to logon to Windows 95 will also automatically log them onto email. This finally provides a solution for the password proliferation problem that confounds many users today.

User-level Security

Windows 95 uses the logon process for user-level security to implement control for a variety of services beyond network resource access, including many services running on a Windows 95 system that are remotely accessible, namely:

u   File and printer sharing

u   Dial-up network access gateway control

u   Backup agent

u   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 quite literally means that Windows 95 passes authentication requests through to a Windows NT or NetWare server. Windows 95 does not implement its own unique user-level security mechanism, rather it 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, using the Control Panel user-level security must be enabled. The second step is to share a device, and specify users with access privileges. By clicking the right mouse button on the drive C icon in "My Computer," a properties sheet is revealed that allows sharing on the second tab. This property sheet shows what shares exist, and which users have access.

The user names returned in this property sheet are returned from either the Windows NT Server domain or NetWare bindery or NDS.

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Remote Administration

Remote administration of the Windows 95 PC specifies users or groups that have authority to manage the Windows 95 system. This includes:

u   Remote network access gateway control

u   Backup agent

u   Remote access to the Registry

u   Remote NetWatcher access

u   Remote system performance monitoring

Remote administration is controlled via the Network Security tool in Control Panel. Figure 10 shows remote administration enabled.
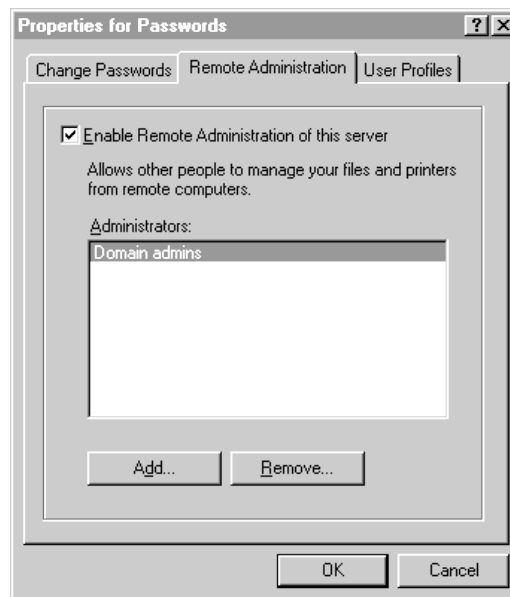

Figure 10. Properties for Passwords, Showing Remote Administration Settings

In this case, remote administration is limited to the network manager group of "Domain Admins." Any user that is a member of this supervisor group can remotely administer this Windows 95 system. It is also possible to specify user names in addition to groups for remote administration capabilities. For example, sophisticated users may be given remote admin access to their systems.

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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 Remote Acces Gateway supports the same protocols as the dial-up networking client, namely:

u   TCP/IP using the Point to Point Protocol (PPP)

u   IPX/SPX via PPP

u   NetBEUI

The RNA Gateway also implements pass through security, so only authenticated users are allowed to logon to the Gateway services. Once connected to the Gateway, RNA clients can access any network resource that they have privileges to use. This includes network server resources, or peer services.
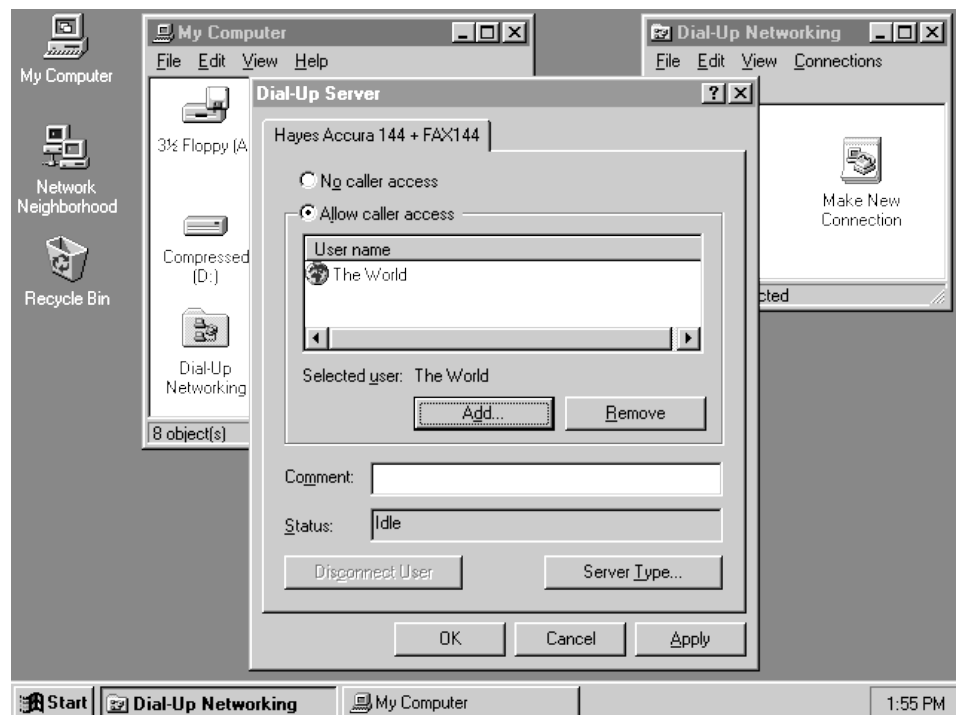

Figure 11. Dial-Up Server property sheet shows enabling dial in access to this Windows 95 PC

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<u>BLANK PAGE</u>

IMPORTANT: This text will appear on screen, but will not print on a PostScript printer.

This page should be the last one in this file; it was inserted by running the InsertBlankPage macro.

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