



WHITE PAPER

Reducing LAN Client TCO with Server-Based Virtual Hard Drives

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Centralized storage with 3Com® Virtual LAN Drive is designed to reduce client system management expense, increase user productivity, and enhance data security.

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Local Storage: Client-Server's Achilles' Heel

Ask IT managers to name the biggest drain on human and financial resources and nearly every one will point to users. The typical corporate mix of variously competent users and sophisticated computing systems is a perfect recipe for help desk meltdown. Estimates of annual PC ownership costs range as high as \$12,000 per machine, and much of that frightening expense is associated with emergency maintenance and lost productivity from systems disabled by their own users.

Much of this occurs because operating systems and application software are stored locally on client system hard drives and firmware. A carelessly deleted driver or an ill-advised edit in the Windows registry is quickly followed by a panicky call to the help desk and a costly on-site administrative rescue. On-client storage simply puts too much volatile software too close to the flame of inexperience.

And local storage puts data at risk as well. Unsecured desktops expose sensitive documents to unauthorized access, theft, or tampering; and haphazard backup discipline can mean large-scale data loss when a system fails or disaster strikes. On-client storage is a root cause of runaway LAN management expense and an uncontrolled threat to data security and integrity. An alternate solution for persistent client storage is highly desirable.

3Com Virtual LAN Drive: A Centralized Storage Solution

Virtual LAN Drive is a complete software solution that provides bootable, centralized storage for

networked desktops and other client devices. It allows administrators to create server-based virtual drive image files that provide all of the functionality of a local physical hard disk. Client systems can use these virtual drive images to store operating systems, application software, and user files, but continue to perform all application processing locally. The result is a new, highly versatile type of client-server computing that leverages the distributed processing power of all connected devices, but stores operating software and data centrally.

This paper will examine Virtual LAN Drive technology in the context of conventional and alternative storage solutions for desktop PCs and network appliances, and evaluate its effects on data security, network manageability, and client hardware requirements.

Storage Alternatives for PC Clients

Local Hard Drives

Local, built-in hard drives are the conventional medium for persistent storage in PCs. Fast and spacious, they provide ample capacity for the bulkiest files, operating systems, and applications. But as explained above, local drives in a LAN environment dramatically escalate the complexity and cost of administration, and compromise data security. Operating system files and configuration settings are under the control of users who may not understand them, and the capacity of current drives encourages unauthorized software installations and discourages regular backups. As convenient as the local hard drive is for users, it is a liability for administrators when used for long-term storage.

But eliminating the local hard disk and substituting network-based persistent storage raises a problem for most PCs. During the system boot, BIOS programs for Intel architecture PCs usually point to the first sector on the local hard drive for initial program load instructions that start the operating system. For a client system to boot from a server-based copy of an operating system requires alternate storage that precisely emulates the sector format of the local drive. This obstacle has frustrated most attempts to network boot Windows-based operating systems.

The Thin-Client Option

The most prominent development to affect desktop storage has been the emergence of thin-client solutions such as Windows Terminal Server and Citrix MetaFrame. This is a rapidly expanding market segment in which annual sales of thin-client workstations grew from 10,000 units in 1998 to nearly 1 million units in 2000, according to IDC research reported in January 2001. Continued growth is expected, with unit sales of thin-client devices nearing the 5 million mark by 2004. Significantly, these figures include hardware sales only, and do not reflect thin-client conversions of existing fat-client workstations.

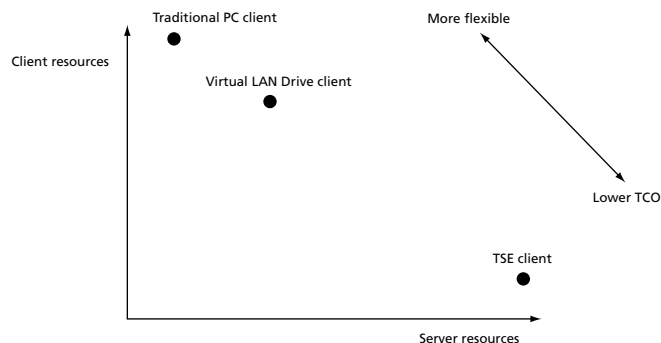
Thin-client solutions shift all application storage and processing from client devices to network servers. This reduces the complexity and cost of client hardware, cuts

network traffic volume, and simplifies management overall. All connected clients are served from a single copy of a program, running on a server that also performs all associated processing. Only keystrokes, mouse clicks, and screen display data travel between client and server. User files are stored on the server along with application software.

The thin-client approach offers significant advantages for organizations where many users run an identical suite of programs—MS Office, for instance—and for transaction-oriented environments. It is particularly suited to situations where the shared applications require no local I/O or processing support and to remote workstations that communicate at sub-LAN speeds.

Other applications, however, are less compatible with thin-client infrastructures. For example, console applications for network management may require a workstation host with independent processing capacity. Legacy systems may require extensive recoding or configuration to run on network application servers. Multimedia applications with their dependence on peripheral hardware support are particularly challenging for thin clients. Software solutions are available, but expensive. In a Citrix MetaFrame environment, for instance, streaming media delivery requires the addition of a costly VideoFrame server. In short, current thin-client

Virtual LAN Drive Resource Model



Offers a server-centric Windows client with many of the management advantages of a thin client, yet retains the flexibility of traditional desktop and allows access to more client resources.

solutions do not offer a universal solution for off-client storage.

Network Boot Support in Windows 95

With Windows 95, Microsoft offered a different approach to thin-client infrastructure. Server-based shared installation allowed multiple client machines to share and boot from a single, server-based copy of Windows 95. This capability put the operating system safely beyond the reach of users, but significant shortcomings limited its utility as an overall storage solution. Chief among these were:

- Lack of support for 32-bit NICs with protected mode clients
- Lack of support for Internet Explorer
- Limited support for Microsoft Office
- An inability to add network protocols or devices after Windows 95 client installation
- Chronic instability and complexity

As a result, server-based shared installation is not supported in Windows 98 and later releases, leaving no viable solution for network boot with later Windows operating systems.

Resorting to RAM Drive

Another alternative to local disk storage is technology that allows a 32-bit Windows operating system image to be downloaded from a network server into local RAM and executed as a RAM drive. But this solution requires the dedication of considerable RAM (64 MB+ for most applications) to operating system support. This tends to increase the capital cost of client systems and limits their ability to accommodate changing storage needs.

Storage Alternatives for Network Appliances

Flash memory is the conventional solution for persistent storage in network appliances—networked computers that for reasons of simplicity, durability, and expense typically have no built-in hard drive. But like hard drives in PCs, flash memory has its drawbacks. Expensive flash chips can

represent a significant portion of the build cost of a device, and footprint restrictions may limit the feature set that can be implemented. An additional inconvenience is that cumbersome flash upgrades can complicate system maintenance.

The Evolution of Flash

Two types of reprogrammable flash memory have been used to provide persistent storage in network computers. Linear flash, the first type deployed, lacked a standard file system and required proprietary drivers to interface with a host system. Despite its relative affordability (as little as \$1 per megabyte), linear flash has largely been replaced with newer ATA flash memory that conforms to addressing standards associated with the ATA interface. Although ATA flash chips eliminate the need for host translation, their higher cost (as much as \$8 per megabyte) can add significantly to the capital expense of a Windows-based network device requiring 70-80 MB of non-volatile storage for its operating system and application.

An additional limitation common to all flash memory solutions is inflexibility. Once a network appliance is configured and deployed, modifications that affect storage requirements can be difficult or impossible to implement. An application update to incorporate new capabilities may exceed available memory resources. Adding memory means adding chips and expanding the physical footprint devoted to storage. Depending on the foresight of the original layout, additional space may or may not be available.

The Small Disk Option

Network appliances can also be equipped with small form factor hard drives. While much cheaper than flash memory in terms of dollars per megabyte (as little as a penny a megabyte and falling), the smallest drive will still add about \$100 to the appliance build cost. Additional indirect costs can include a larger power supply, provisions for heat dissipation, and a larger appliance

form factor to accommodate the drive and support components.

In summary, both flash memory and compact hard drives have significant shortcomings as persistent storage solutions for network appliances. A more affordable technology that provides greater and more flexible capacity without compromising form factor constraints is needed.

The Virtual LAN Drive Alternative

3Com's Virtual LAN Drive provides persistent server-based storage for LAN clients that is affordable, flexible, and secure. It allows local hard drives and flash storage to be eliminated without otherwise affecting client device capabilities or performance.

The Real Solution Is a Virtual Hard Drive Image

Virtual LAN Drive lets administrators create and manage server-based hard drive image files for client systems, and transfer to those image files all the functions normally performed by local hard drives. Virtual drive images are seen and managed by the server like normal files. Clients, however, see a sector-by-sector disk emulation that can be accessed, formatted, partitioned, and configured exactly like a physical hard drive. Client systems can perform a complete operating system boot from the server-based images, and use them for all OS,

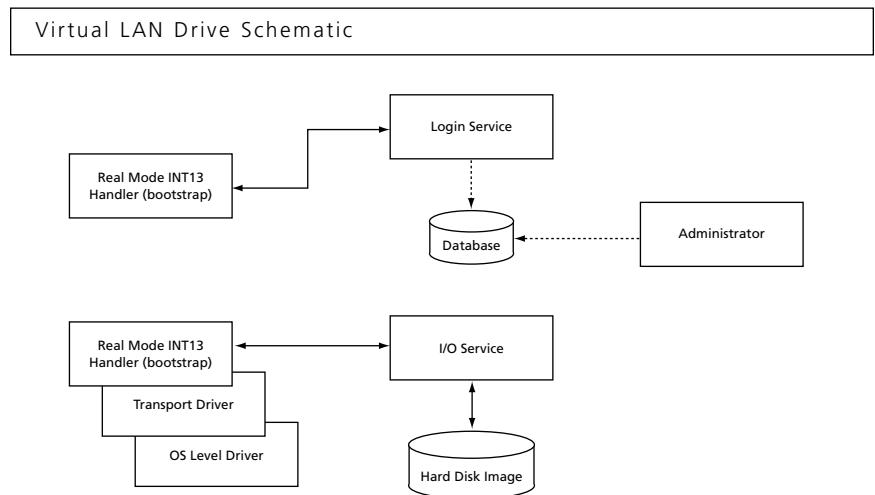
application software, and data storage. Application processing is performed entirely on the client CPU, creating a unique LAN architecture that combines distributed processing with centralized storage.

Virtual LAN Drive establishes a middle ground between traditional fat and thin clients. Because the CPU capacity required to support multiple clients is distributed, Virtual LAN Drive can be a more scalable architecture than thin clients, depending on the application.

Reducing Administrative Costs While Tightening Data Security

Server-based virtual drive images are easily created, modified, and assigned to client machines using the Virtual LAN Drive Administrator application. The ability to centrally manage the operating systems, applications, and user files of LAN clients eliminates most on-site visits for routine and emergency maintenance. Systems that crash when caused by deleted drivers or corrupt file systems can be quickly restored by simply assigning a new or archived drive image. Software updates and distributions can be managed centrally and executed as batch operations from administrative workstations.

Central storage also enhances data security and simplifies disaster recovery planning. Centrally stored drive images are physically secured in restricted-access server rooms, and can be easily included with scheduled



server backups. A secure authentication process ensures that only the actual data owners gain access to drive images.

Flexible Storage for Inflexible Devices

A further benefit of Virtual LAN Drive is the ability to provide more affordable and flexible storage for network appliances than is possible with local flash chips. A megabyte of storage on a server disk array is much cheaper than a megabyte of flash memory, and the server-based storage is instantly and vastly expandable without affecting the local device form factor, power supply, or cooling requirements. With Virtual LAN Drive, network devices can be made far more adaptable to evolving applications and roles.

Based on Exclusive 3Com/Lanworks Technology

Virtual LAN Drive leverages exclusive network boot technology developed over the course of 15 years by Lanworks Technologies, and acquired by 3Com with the purchase of Lanworks in 1998. Portions of this technology have previously been commercialized in two 3Com products that significantly advanced the state of remote PC management.

- **Managed PC Boot Agent (MBA)**—a client-based multiprotocol network boot firmware that complies with the Wired for Management PXE standard.
- **3Com Boot Services**—a framework of client, server, and administrative tools that support pre-OS management and network booting of client PCs and network devices. Boot Services includes PXE, TFTP, and BOOTP servers.

With the release of the patented Virtual LAN Drive product, 3Com adds a client networking component that complements and extends the company's end-to-end solution portfolio of server NICs, NIC firmware, and network client software.

Identifying Virtual LAN Drive Applications

While the requirements of an ideal storage solution depend on the

application, certain criteria indicate the opportunity for capital and operational savings with Virtual LAN Drive.

PC Indicators

- Task-oriented environments where each machine is similar in configuration, such as schools, call centers, training institutions, data entry, and kiosk installations
- All machines are LAN connected, not remote
- Support for Windows 98 or 95 clients is required
- Client applications include multimedia or other CPU intensive tasks
- PC platforms exist and have been capitalized
- Broad application compatibility is an issue, including legacy apps

Network Appliance Indicators

- Devices with medium to large non-volatile storage requirements (≥ 4 MB)
- Devices where non-volatile storage requirements may increase over time
- Devices designed to support ATA flash
- Devices where a data store must be rewritten frequently (i.e. data logging)
- Devices that cannot store sensitive data due to security concerns

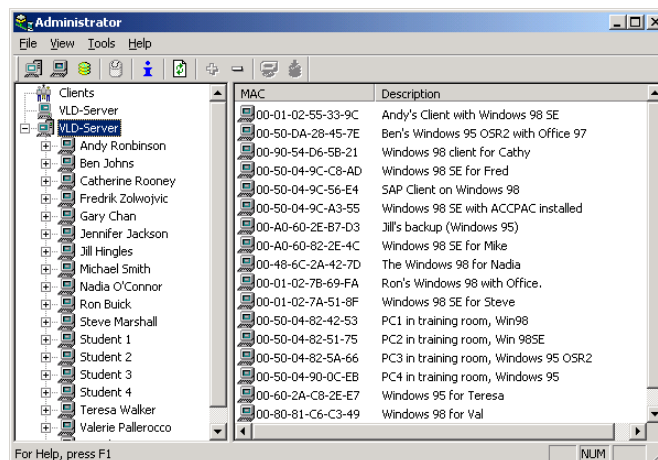
Components of the Virtual LAN Drive Solution

3Com Virtual LAN Drive is a complete software solution that consists of the following components.

- **Virtual LAN Drive client files** are installed on client machines and are required to establish network connectivity and boot Windows 98 and 95 operating systems from the server-based hard drive image.
- **Virtual LAN Drive Administrator** is the management application used to set up, modify, track, delete, and define the relationships between virtual drives, client systems, and servers that together comprise a Virtual LAN Drive network.

- Configuration databases store client, disk, and server information such as client names, image file allocations, MAC and IP addresses, user names, passwords, and UDP ports.
- Virtual LAN Drive Login Service processes and validates logon requests. First it verifies usernames and passwords (if enabled), and then establishes a connection to the virtual hard drives and the Virtual LAN Drive input/output service.
- Virtual LAN Drive Input/Output Service responds to requests from Virtual LAN Drive redirectors running on client machines to access the Virtual LAN Drive image files, and handles read and write requests to the sectors that make up the image file.
- Preboot and virtual hard drive images store essential initialization instructions and up to 2 GB of data using 16- or 32-bit file systems.
- TFTP service uses the Trivial File Transfer Protocol (TFTP) to read, write, and transfer files between a client and server, or between two clients on a TCP/IP network. In remote boot and preboot environments, TFTP downloads a designated boot image file or network bootstrap program (NBP) from the network server to a client PC. In a Virtual LAN Drive network, the TFTP service is used to download the virtual drive bootstrap file to the client PC.
- BOOTP service often substitutes for a DHCP server to provide client IP addresses using the Bootstrap Protocol (BOOTP). It also provides boot image file names and configuration information to client PCs equipped with a BOOTP-compatible boot ROM. This data is stored in a text-based BOOTPTAB database. In a Virtual LAN Drive network, the BOOTP service provides the client PC an IP address and also specifies the filename of the virtual drive bootstrap file to be downloaded.
- PXE service is an extension of Dynamic Host Configuration Protocol (DHCP) that is used primarily in Wired for Management (WfM) remote boot and preboot environments where client PCs contain PXE boot ROMs. This service provides the boot ROM with the boot image filename and configuration.
- BOOTPTAB editor is an easy-to-use, Windows-based configuration utility used to create and maintain the BOOTPTAB database from which both BOOTP and PXE services dispense client configuration information. The editor eliminates many of the errors and inconsistencies that occur when simple text editors are used to prepare database records.

All software components of the 3Com Virtual LAN Drive product are delivered on a single CD and are packaged with a Quick Start Guide to simplify installation and setup.



Booting a Virtual LAN Drive Client, Step by Step

Virtual LAN Drive leverages network boot firmware that is present in client PCs. Using either PXE, DHCP, or BOOTP protocols, this firmware allows the host system to view the network as a bootable device, just as it would a local hard drive.

1. To begin the boot process, the client boot firmware contacts a PXE, DHCP, or BOOTP server and uses TFTP to download a Virtual LAN Drive bootstrap file into client memory.
2. The client then authenticates itself to the Virtual LAN Drive Login Service.
3. A session is established with the Virtual LAN Drive I/O Service, which creates a mapping of the client hardware to a designated Virtual LAN Drive hard drive image file on the server.
4. The client then loads the 32-bit Windows operating system, sector by sector, just as it would from a local hard drive.

Managing Virtual LAN Drive Clients

As discussed earlier, centralized client storage with Virtual LAN Drive simplifies client administration and support by eliminating many opportunities for user-inflicted system damage. It provides remote solutions for many routine administrative tasks, and allows data to be physically secured through routine server backups.

In addition, Virtual LAN Drive lets administrators view and edit the contents of a virtual drive by simply mapping the hard drive image file. The mapped file is added as a removable

drive icon in the administrator's My Computer window. Administrators can also make quick changes to multiple image files using the Virtual LAN Drive Administrator's batch update option. A batch update reduces the time required to update multiple drive images by sequentially mounting each selected file and running a selected batch program against it. A batch program can be an executable file, a batch file, or a Windows Scripting Host (WSH) script.

Summary

3Com Virtual LAN Drive can lower the total cost of networked PCs and appliances by dramatically reducing the administrative time devoted to client setup and maintenance. It allows administrators to manage LAN-connected client devices, update their operating systems, drivers, files, and software applications without visiting—or even turning on—the client PC. It provides a computing environment that takes maximum advantage of existing distributed processing power while realizing the benefits of centralized storage and administration.

Virtual LAN Drive helps extend network disaster recovery, redundancy, and security options to include client devices. It provides a security-based network boot solution for 32-bit operating systems and implements a fault-tolerant strategy. Finally, it facilitates the creation of virtual hard drives that act as master or slave drives even if physical hard drives are present at the client PCs.

For more information on 3Com Virtual LAN Drive, visit <http://www.3com.com/vld> or email us at VLD_Info@3com.com.

About 3Com Corporation

3Com simplifies how people connect to information and services through easy-to-use connectivity products and solutions for consumers and commercial organizations. The company also provides access infrastructures and IP services platforms for network service providers. For further information, visit www.3com.com or the press site at www.3com.com/pressbox.

About Lanworks Technologies Company, a subsidiary of 3Com Corporation

With over 16 years of experience, Lanworks is the leading supplier of network boot firmware to OEM manufacturers worldwide. Lanworks products are included in a wide range of connected devices, including network interface cards, embedded PCs, point-of-sale systems, factory floor equipment and, data acquisition tools. The company's services include flexible licensing options, quick turnaround, in-house lab and production facilities, customized design, and dedicated OEM support team. For further information, visit www.Lanworks.com.

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To learn more about 3Com solutions, visit www.3com.com. 3Com Corporation is publicly traded on Nasdaq under the symbol COMS.

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