DAT
Backup Devices

A Report from NSTL

In this report:

Synopsis

Focus

This report evaluates eight Digital Audio Tape (DAT) backup devices. NSTL measured the DAT devices' network workstation and server backup and their write verification capabilities.

Products Tested

DATa 1300
Advanced Digital Information Corp. (ADIC)

Model 1300
Emerald Systems

HammerDAT
FWB, Inc.

ServerDAT 116
Gigatrend, Inc.

MaynStream 1300DAT
Maynard Electronics

Filesafe 1200
Mountain Network Solutions, Inc.

FileSecure 1300
Tallgrass Technologies

ProLine DataVault
Tecmar, Inc.

Product Recommendations

- Tecmar ProLine DataVault
- Maynard MaynStream 1300DAT
- FWB HammerDAT

Source

Based on data generated by tests designed and conducted by National Software Testing Laboratories (NSTL), Inc., a division of Datapro Research Group, Plymouth Meeting, PA 19462. Telephone (800) 223-7093.

Ratings Key
(On a scale of 0 to 10)
Ratings
● 7.0 - 10.0
○ 5.0 - 6.9
▨ under 5.0
★ Recommended

Overall Evaluation	Product Name	Performance	Features	Usability	Price
	Server Attached				
7.7	Tecmar ProLine DataVault	●	●	●	$5,995★
7.6	Gigatrend ServerDAT 116	●	●	●	$6,950
	Workstation Attached				
7.6	Maynard MaynStream 1300DAT	●	●	●	$5,995★
7.5	Mountain Filesafe 1200	●	●	●	$5,995
7.3	FWB HammerDAT	○	●	○	$4,515★
7.1	ADIC DATa 1300	○	●	○	$5,995
7.0	Emerald Model 1300	○	●	○	$5,595
6.8	Tallgrass FileSecure 1300	○	●	○	$4.595

Overview

Quarter-inch tape cartridges provide up to 525M bytes of storage and currently dominate the tape backup market for Digital Equipment, LAN, Xenix, and DOS environments. At the high end of the market, 8-mm. helical scan drives with capacities to 2.2G bytes have captured some share of the market. DAT drives using 4-mm. tape cartridges offer a third alternative for backing up network file servers. DAT drives record up to 1.3G bytes of data on inexpensive credit card-size tape cartridges.

DAT technology was introduced for the audio consumer electronics market in 1986, and high-end audio DAT players have been marketed since mid-1989. With the addition of error detection and correction techniques, the tapes migrated to the data processing market. DAT drives use either the Digital Data Storage (DDS) or Data/DAT data format. DDS format drives currently dominate the market, and NSTL focuses on the DDS format because all the test subsystems except the Data/DAT-based Gigatrend are based on DDS.

Evaluation Criteria

NSTL evaluated eight DAT devices marketed by leading vendors (selected from over 50 available DAT devices). Six of the DAT devices were tested as peripherals attached to a network workstation. The Gigatrend and Tecmar install in a network server.

All the test products provide 1G byte to 1.3G bytes of storage in uncompressed mode with 20-second average access times and tape speeds of 0.32 inch per second. Sustained transfer rates are 183K bytes per second, and all connect to systems via SCSI adapters.

Despite their common specifications, the drive packages implement different types of adapters (8 bit and 16 bit) and software interfaces that affect their versatility and performance.

Performance

Of the tape backup technologies (i.e., QIC, 4-mm., and 8-mm.), only 4-mm. DAT devices offer more than a gigabyte of storage capacity in a 3.5-inch disk drive form factor. DAT storage capacities could reach 4G bytes by the end of 1991, and media costs are expected to drop from about $50 to $10 per cartridge. Consumer use of the 4-mm. DAT format for audio applications may bring down the price of 4-mm. data cartridges, even though audio tape cannot be used for data storage.

Storage Capacity

QIC tape subsystems with 150M-byte capacities are the current market leader. QIC drives run tape past a stationary head at 72 inches per second, recording data on a straight track that runs to the end of the tape. The tape is then reversed, and data recorded on another parallel track. QIC tape capacity is currently limited to 525M bytes and should increase to 1.35G bytes if the industry adopts the proposed QIC-1350 standard. The 1.35G-byte QIC-1350 data format is expected to achieve transfer rates of 597K bytes per second, nearly four times faster than the 525M-byte QIC drives (189K bytes per second). Some vendors plan to increase quarter-inch tape capacities using new data compression techniques.

Tape Speed and Track Density

Although the DAT tape moves at only 0.32 inch per second (versus 72 inches per second for 150M-byte QIC tape drives), the combined movement of the heads and tape gives DAT devices an effective speed of 123 inches per second for faster backup speeds than QIC drives. PC-standard QIC-60 and QIC-150 tapes store 8,000 and 10,000 bits per inch per track, respectively. DAT drives using DDS format store 61,000 bits per inch per track. (Older, mainframe-oriented nine-track tape drives can pack 6,250 bits per inch per track.)

Because of the high speed at which the QIC tape passes a stationary head, heat from friction can stretch the metal oxide tape and jeopardize data integrity. High-speed recording imposes significant amounts of wear and tear on the tape cartridges. The 150M-byte QIC tapes withstand roughly 200 passes before data integrity is jeopardized. DAT cartridges' slow tape speeds cause much less friction and wear, ensuring data integrity. All the test DAT cartridges use a rotating head

and are specified for up to 1,000 backup/restore operations per cartridge.

Software Interface and Adapter Throughput

In addition to the foregoing hardware performance factors, the speed of backup and restore operations is determined by the device's adapter throughput. The ADIC and Tallgrass use 8-bit PC AT adapters. The Tecmar, FWB, and Mountain use 16-bit PC AT adapters, and the Gigatrend, Emerald, and Maynard use 8- and 16-bit adapters. The Maynard, Tallgrass, ADIC, Tecmar, and Mountain use direct memory access transfers between the controller and the CPU; the Gigatrend, Tallgrass, and FWB implement slower programmed I/O transfers. Only the Gigatrend and Tecmar offer bus master adapters.

Helical Scan Technology

Helical scan technology used by DAT devices records large amounts of data on very slow moving tape. Magnetic read/write heads are mounted on a rotating drum with an axis of rotation at 6 degrees from perpendicular. The test drives use four heads, two for reading and two for writing. The tape wraps at 90 degrees around the drum's circumference, and the heads move in a spiral motion from the bottom to top of the tape. The drum rotates at 2,000 rpm, and the 4-mm. tape moves slowly in the same direction at 8.15 mm./second (0.32 in./second). The diametrically opposed heads describe portions of the helix on tape.

Each track is written diagonally from top to bottom. The heads are wider than the written tracks, so each new track overlaps the previous track, wasting no tape between tracks. Overlapping tracks would normally result in "cross talk" between adjacent tracks when reading data from the tape, but the devices minimize cross talk by angling the heads 20 degrees (the azimuth angle) in opposite directions.

Each head is set with a different azimuth angle, and alternate tracks have their data written at alternate azimuth angles. When data is read from the tape, the head receives a much stronger signal from data written to the same azimuth angle (as the head reading it). Angling permits extremely close packing of tracks and very high data densities. Automatic track finding (ATF) circuitry keeps the head centered on the track by balancing the weaker signals from adjacent (off-azimuth) tracks.

Data Format Standards

DAT devices use one of two proposed DAT low-level formatting standards: Digital Data Storage (DDS) technology, developed jointly by Sony and Hewlett-Packard, and Data/DAT developed by Hitachi. DDS offers slightly more storage capacity and faster sustained transfer rates than Data/DAT. DDS devices write data sequentially, appending data to existing information, and read data randomly beginning at any point. Data/DAT drives offer random write and random read capabilities. With special control software, Data/DAT drives can overwrite existing data files in place, reducing the redundancies and inefficiencies of multiple copies of the same data file.

Only Gigatrend currently markets a Data/DAT drive. The Gigatrend ServerDAT does not provide direct overwrite, but the necessary control software should be available in the future.

DDS Format

DDS format represents a modification to audio DAT technology. Unlike the continuous datastream produced by the audio DAT format, DDS constructs a sequence of fixed-capacity data groups on the tape. DDS packs up to 1.3G bytes on a 60-meter tape running at the same speed as audio DAT tape. Audio DAT records two hours of music on one tape, and it takes approximately two hours (best case scenario) to fill a DDS tape at a transfer rate of 183K bps.

Data and separator marks, sent from the host system to the tape drive, are mapped into the DDS data groups. Separator marks identify the beginning and end of each logical collection of data (i.e., files). When a data record exceeds the space in a group, the remaining data is written to the next group. All groups have the same logical size and capacity regardless of whether they are completely filled with data. A data structure known as an index is placed at the end of each group, and an error correction frame can optionally follow each index.

The group index identifies and locates data records and separator marks within the group. The index grows as necessary to describe the contents of the group. Indexing groups permits variable-length records and separator marks to be encoded onto the tape without affecting the capacity of a particular cartridge.

Each group consists of 22 logical data frames (a frame is a pair of tracks across the tape). Sixty

percent of each track contains data, and the remaining area carries automatic track finding (ATF; areas used to center head on the track) and subcode areas. Using the subcode areas, individual data files can be quickly located (20-second average access time; up to 200 times the normal read/write speed) and restored to disk. High-speed search capability is crucial for DAT tape drives considering the high capacity and large number of files that can be stored on a single cartridge. The Gigatrend, Mountain, Tecmar, and Emerald handle NSTL's single-file restore benchmark best.

DDS Data Integrity

Data storage demands of DDS require more sophisticated error correction techniques than employed by audio DAT. DDS format implements three levels of error correction coding, read-after-write verification, data randomization, track checksums, and multiple group writing to ensure data integrity. DDS error correction schemes provide a level of data integrity previously unavailable on removable mass storage devices. Accelerated life tests indicate that DDS tape will maintain data integrity for a minimum of 10 years.

Interleaving

DDS borrows audio DAT recording techniques in which analog signals are converted to digital signals and split, or interleaved, between adjacent tracks as they are recorded. When data is read, the information is reconstructed or "de-interleaved." Interleaving makes it easier for error correction techniques to reconstruct corrupted data because the missing data is in smaller pieces. Without interleaving, a damaged section of tape would result in a single long gap, rather than a series of small gaps.

Error Correction Coding (ECC)

Audio DAT provides two levels of error correction coding (ECC), called C1 and C2, which mathematically generate extra bytes of data from the information stored on tape. These parity bytes are stored on tape and used in conjunction with existing data to reconstruct missing data caused by damaged media. The C1 and C2 error correction coding used by audio DAT corrects data within a single frame and can recover up to 792 bytes.

DDS adds level C3 error correction, which enables correction across frames and correction of any two tracks within a group. The C3 error correction bits, stored in a frame at the beginning of each group, primarily guard against head clogs as the tape is read. Head clogs result from tiny particles rubbing off the tape's recording layer onto the head, reducing its capability to read and write data. A head clog may prevent previously recorded data from being overwritten, resulting in a "drop-in" not detected by track-based C1 and C2 codes. DDS format specifies track checksums that detect and locate these helical errors.

Multiple Group Writing

Data reliability can be further ensured by writing each group multiple times. If the first group becomes damaged, the drive skips to the next repetition, until it finds a readable, error-free group. Multiple group writing (optional) is easily implemented, but it decreases tape capacity and slows data reads and writes.

Read-After-Write Verification

DAT drives are available with two heads (both combination read/write) or four heads (two read and two write). All the test units support four heads. Multiple-head design is made possible by the low wrap angle (90 degrees) of the tape on the drum. Four head drives can perform a read-after-write (RAW) check after writing data in the DDS format. The drive repeatedly rewrites the data until it is error free.

DDS Tape Layout

DDS supports single-data space and two-partition tape layouts. The single-data space layout provides sequential storage and access to data and separator marks in a continuous volume that spans the entire tape. The two-partition layout provides the same capabilities with two partitions, each functioning as a separate tape volume. Storage and access within each partition are performed sequentially, and data may be written to either partition without affecting the other. Partition sizes are determined by the user (e.g., a very large database can be stored on one partition and its indexes on the other).

In two-partition layouts, the partition closest to the beginning of the tape is referred to as Partition 1, and the partition closest to the end of the tape is referred to as Partition 0. The tape drive

maintains sufficient space for Partition 1 by placing a physical boundary on the tape. The area used as Partition 1 must be preformatted by the tape drive system before the cartridge can be used. A format pass is necessary to generate two partitions on a blank tape, to change the size of Partition 1 on a two-partition tape, and to convert a single-data space tape to a two-partition tape and vice versa.

Cartridge Interchangeability

Adhering to low-level DDS or Data/DAT standards does not ensure tape interchangeability among products from different vendors. High-level data management formats, including directories and file information, are written to tape in different ways by each of the vendors. The directory structure, entry contents, and location of such structures differ from subsystem to subsystem, making interchangeability impossible.

SCSI Interface

The SCSI intelligent peripheral interface handles devices in terms of data exchange instead of low-level hardware functions. Designed for high bandwidth, short distance, and maximum flexibility, SCSI eliminates problems involved in attaching multiple peripheral devices to a microcomputer while reducing software problems and boosting input/output performance. The SCSI bus defines physical and electrical connections for peripherals.

DAT drives are primarily SCSI devices, especially in the desktop environment. Peak transfer rates can be achieved only if the host can feed the tape drive data as fast as the drive uses it. SCSI controller buffer memory allows the host computer system to transfer data at burst rates and then cease while the drive automatically writes the data to tape. DAT peripherals often employ 512K-byte buffers. DAT devices come with SCSI adapter cards and software drivers for all commonly used operating systems.

Many of the DAT tape drives support components of the SCSI-2 draft standard, which can potentially increase the 5M-byte/second synchronous data transfer rate of SCSI-1 to as high as 40M-byte/second. The SCSI instruction set implemented by DAT vendors varies from manufacturer to manufacturer. Incompatibilities may arise between different SCSI peripherals, SCSI host adapters, and device drivers.

Software

Operating Systems

DAT drives combine large capacity, small size, excellent data reliability, fast access time, and high throughput. DAT devices are compatible with a wide range of operating systems including MS-DOS, OS/2, UNIX, and various network operating systems. All the test DAT devices run on PCs under DOS 3.3x and DOS 4.0x; NSTL tested the systems under Novell NetWare 386 Version 3.1. The Maynard, Tecmar, Tallgrass, FWB, and ADIC also work with Apple Macintosh systems. The Tallgrass and FWB subsystems are available for Banyan VINES, IBM LAN Server, Microsoft LAN Manager, and 3Com 3+Open. The Emerald is available for IBM LAN Server Version 1.2, Microsoft LAN Manager Version 2.0, and 3Com 3+Open. The Mountain runs under IBM LAN Server, Microsoft LAN Manager, and 3Com 3+Open.

Backup Applications

All the workstation-attached systems except the FWB are tested with proprietary software: Data Right with the ADIC, EmSave with the Emerald, MaynStream with the Maynard, and FileSecure with the Tallgrass. The FWB comes standard with Systron's Sytos Plus software. The server-based Tecmar and Gigatrend devices are tested with OEM versions of Arcserve.

All the backup applications support several options for controlling and automating backups. The test systems offer unattended/scheduled backups, script/batch execution, automatic tape formatting, automatic verification, user-selectable verify after backup, and multiple tape backups. The systems can display statistics and keep backup, restore, error, and schedule log files.

The Tallgrass and FWB support data compression. All but the Maynard, Tallgrass, and Mountain provide data encryption, and all but the ADIC support tape password protection. Only FWB does not supply diagnostic software, but Sytos Plus (shipped with the DAT) offers an undocumented diagnostic module.

DAT Applications

In addition to their obvious use for backup and restore operations, DAT drives can be used for distributing data files and system program loading. Applications for DAT devices will continue to

grow as the technology becomes more pervasive. DAT technology is well suited for use in CAD/CAM, desktop publishing, and other arenas that use large files.

Data compression techniques should increase the cartridge capacities. Longer tapes are expected as a result of a new tape coating that allows the use of thinner tape. Thinner tape will increase cartridge capacity without altering recording densities or drive hardware. Other anticipated improvements are tied into advancements in SCSI technology. Improvements in the SCSI interface will yield higher transfer rates and larger command sets to enable advanced features such as detecting remaining tape capacity.

Product Evaluations

ADIC DATa 1300

Product Summary

- ADIC 1050 proprietary 8-bit adapter
- Hewlett-Packard 35450A drive
- Data Right proprietary, Systron Sytos Plus software
- Workstation based
- DMA data transfer method
- Two SCSI ports support up to seven daisy-chained drives
- Large footprint
- Fast workstation backup

Emerald Model 1300

Product Summary

- EmSave proprietary or Adaptec 1540, 1640 adapters
- 8-bit or 16-bit adapters
- WangDAT drive
- EmSave, EmQ, and EmLib proprietary software; Scheduler
- Workstation based
- DMA data transfer method
- SCSI port supports up to seven daisychained devices with dual-port chassis option
- Slow restore capability

FWB HammerDAT

Product Summary

- Always IN-2000 16-bit adapter
- WangDAT drive
- Systron Sytos, Sytos Plus software
- Workstation based
- Programmed I/O data transfer method
- Two SCSI ports support up to six daisy-chained devices
- Fast restore capability

Gigatrend ServerDAT 116

Product Summary

- Adaptec, Bustek, or Future Domain adapters
- 8-bit Future Domain, 16-bit Adaptec adapters
- Gigatrend 1230 drive
- Arcserve software
- Server based
- Programmed I/O data transfer (Future Domain); bus master (Bustek)
- Data/DAT recording format
- Two SCSI ports support up to six daisy-chained devices
- Sophisticated LED indicators
- Good selective file restorations

Maynard MaynStream 1300DAT

Product Summary

- Maynard proprietary adapter
- 8-bit or 16-bit adapter
- Archive drive
- MaynStream proprietary software
- Workstation based
- DMA data transfer method
- Two SCSI ports support up to seven daisy-chained devices
- Small footprint; convenient carrying handle
- Best overall performance

Mountain Filesafe 1200

Product Summary

- Mountain proprietary 16-bit adapter
- Archive drive
- Filesafe proprietary software
- Workstation based
- DMA data transfer
- Two SCSI ports support up to four daisy-chained devices
- Good workstation backup

Tallgrass FileSecure 1300

Product Summary

- Tallgrass dual-mode 8-bit adapter
- Wangtek drive
- Systron Sytos Plus, Arcserve, proprietary FileSecure software
- Workstation based
- DMA, programmed I/O, string I/O data transfer methods
- SCSI port with dual-chassis option supports up to seven daisychained devices
- Strong verification performance

Tecmar ProLine DataVault

Product Summary

- Adaptec 1540 or 1640 16-bit adapter
- Wangtek drive
- ProServe (Arcserve); Tecmar QTOS, QT-Backup; Systron Sytos Plus software
- Server based
- Bus master, DMA data transfer methods
- Two SCSI ports support up to six daisy-chained devices
- Strong server backup and restore

Product Recommendations

Tecmar ProLine DataVault

The Tecmar DataVault's excellent server-based backup and restore performance, very good usability, excellent overall features, and competitive pricing (for backup systems of its class) highly recommend it for NetWare environments. Its Proserve (Cheyenne Software Arcserve based) software is excellent for unattended network backups. Detailed backup and archiving activity logs and a transaction database facilitate occasional quick file restores. Although the Tecmar's quick file access time is slightly higher than the advertised 20 to 50 seconds, it is highly competitive with the other products' QFA times. The Tecmar currently supports NetWare network environments only.

Maynard MaynStream 1300DAT

The Maynard 1300DAT excels at workstation backup and restore operations. The 1300DAT represents a true portable backup drive with a carrying handle at the back and two SCSI ports for multiple peripheral device chaining. The Maynard unit is the smallest of the test drives and provides the best features and usability. A server attachment capability would improve its appeal.

FWB HammerDAT

For the lowest price, the FWB may be suitable for installations that do not need high performance or advanced features. The FWB's performance appears to be handicapped by a poor host interface driver; it ranks third for performance among the workstation-attached DAT devices. Inadequate hardware documentation lowers its usability rating.

Rating Summaries

Figure 1.
ADIC DATa 1300 Ratings

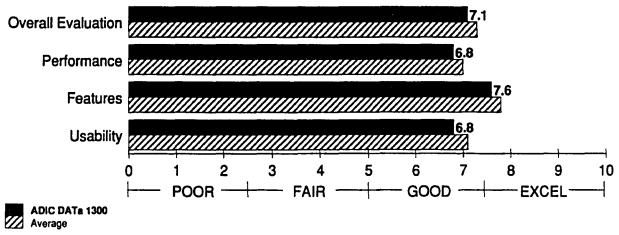


Figure 2.
Emerald Model 1300 Ratings

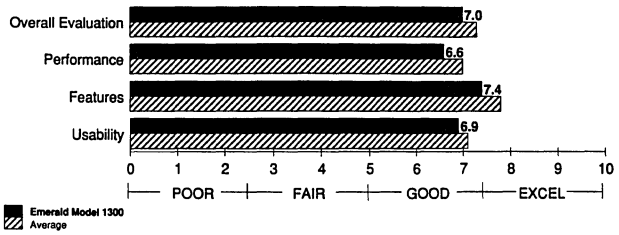


Figure 3.
FWB HammerDAT Ratings

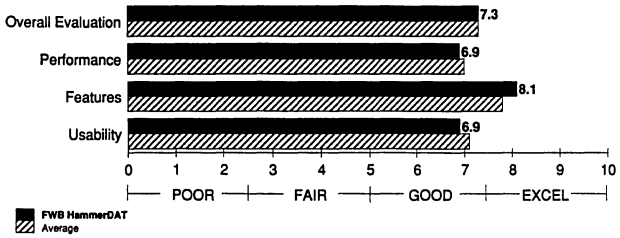


Figure 4.
Gigatrend ServerDAT 116 Ratings

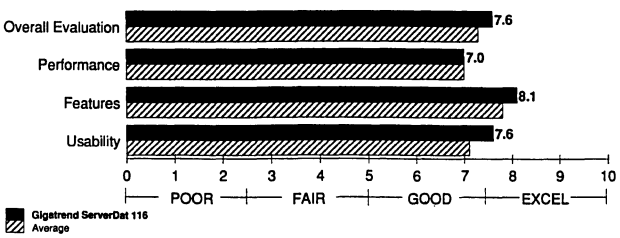


Figure 5.
Maynard MaynStream 1300DAT Ratings

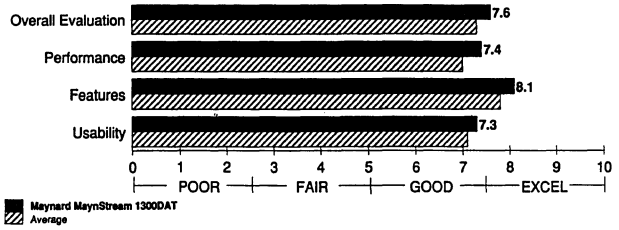


Figure 6.
Mountain Filesafe 1200 Ratings

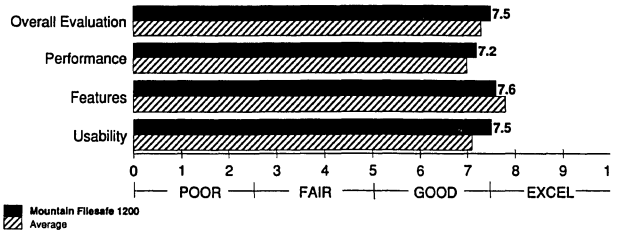


Figure 7.
Tallgrass FileSecure 1300 Ratings

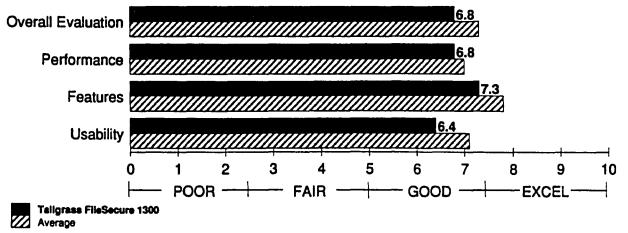
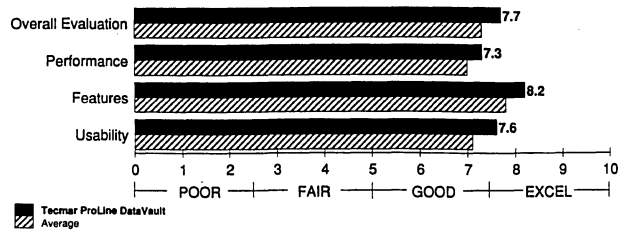


Figure 8.
Tecmar ProLine DataVault Ratings



Overall Evaluation

The Gigatrend and Tecmar tape drives attach directly to a network file server and use OEM versions of Cheyenne Software's Arcserve backup software. The Gigatrend uses the Data/DAT format, which supports random reading and writing of data (not supported by the current driver); the Tecmar (and all the others) uses the DDS format, which records data sequentially and can read data randomly beginning at any point. The Tecmar benefits from the performance advantages of the DDS format, but the Gigatrend is more proficient at restoring single files. The Gigatrend is priced $1,000 higher than the Tecmar and features an LED display from which users can prepare backup media and perform hardware diagnostics.

The Maynard and Mountain drives are the best of the workstation-attached drives. The Maynard outperforms the Mountain in every test except the single-file restore, where its performance is disappointing. Both drives come with backup software that is easy to use and high-quality documentation. Maynard provides more features, including the ability to catalog the tape on disk and Apple Macintosh support.

The FWB, Tallgrass, and ADIC drives provide similar overall performance; Emerald uses a Windows-based backup utility and lags slightly behind the other workstation-attached drives. FWB and Tallgrass support compression technology, which is being touted as the next major advance in DAT technology. FWB, Tallgrass, ADIC, and Emerald provide average usability.

Methodology

The Overall Evaluation is a weighted average of scores for the individual criteria.

Overall Evaluation Score = (3 x Performance Score) + (4 x Features Score) + (5 x Usability Score) ÷ 12.

Performance

Workstation-attached DAT drives offer performance advantages for local workstation backups, which rely on the drive's write performance, host adapter throughput, and device driver efficiencies. The Maynard, with its proprietary adapters and software, provides the fastest workstation backups. The ADIC and FWB provide consistently high performance in workstation backups.

Excellent directory management capabilities enable the Tallgrass system to verify data very quickly. The Maynard uses direct memory access data transfers and a 16-bit adapter for adapter-to-CPU transfers, making it efficient at data verification. The Mountain and FWB also maintain consistently high verification performance. The ADIC is slow to verify data, possibly because of deficiencies in its software interface and directory management scheme.

The ADIC, Maynard, and FWB units excel in the workstation restore tests; the Tallgrass and Mountain are slow to restore data. The Emerald's 8-bit adapter slows restore operations to a level below that of the server-attached units.

Server-attached DAT drives are less prone to problems created by network traffic or transmission problems and provide better performance in server-based tests. The Tecmar and Gigatrend drives take advantage of server memory and disk characteristics to provide faster backup than many of the workstation-attached units. Gigatrend's Data/DAT format makes it slightly slower than the Tecmar in server-based tests. The Maynard approaches the performance of the server-attached units on server-based backup and outperforms the server-attached Gigatrend in the server restore tests. The Mountain drive outperforms the server-attached Gigatrend in the 20M-byte backups.

The Gigatrend, Mountain, and Emerald excel at the single-file restore, probably because of effective software interfaces. The Maynard, which does well in backup tests, takes nearly four minutes to locate a file.

Methodology

Performance ratings are based on tests measuring backup and restore speeds and verification speeds. Performance scores for individual tests are the DAT drive's time divided by the average time, giving an index score. The overall performance score is a weighted average of scores for the individual tests.

Performance Score = 7 + 2 x (Drive Index - Average Index ÷ Highest Index - Average Index).

Features

The drive systems implement multiple combinations of tape backup software, device drivers, and host adapters that differentiate their capabilities

and performance. All the drives except the Gigatrend use the DDS low-level tape format; the Gigatrend uses the Data/DAT low-level tape format. Common functional features present in all the systems include scheduled/unattended backups, automatic verification, tape spanning, backup statistics, and various LED indicators. Most backup by directory, date, modified files, and file by file.

All the drives except the FWB permit disk partition backup. The Tecmar, Gigatrend, Emerald, FWB, and ADIC provide data encryption, which can be an important feature for selected backups. Compression technology, touted as the next major advance in DAT storage, is implemented only in the Tallgrass and FWB subsystems. Gigatrend has announced a high-capacity Turbo-DAT drive using advanced compression algorithms (not tested).

All the subsystems use advanced error detection and correction methods as defined by the DDS or Data/DAT specification. All support three levels of ECC checking and immediate read-after-write verification. Unrecoverable error rates or "hard error rates" are a very acceptable 1 bit in 10^{15} bits recorded. The ADIC subsystem's underlying Hewlett-Packard 35450A DAT drive has a high-humidity warning LED combination to detect potentially damaging condensation.

All the subsystems back up Novell NetWare 2.15 and 3.x files and bindery data. Maynard, Tallgrass, FWB, and Mountain also back up OS/2-based IBM LAN Server, Microsoft LAN Manager 2.0, and 3Com 3+Open. None of the systems claim to be capable of backing up the Banyan StreetTalk naming system data.

Although Gigatrend's server-attached Data-DAT system is slower than Tecmar's server-attached DDS unit, enhanced software drivers from Gigatrend take advantage of Data/DAT's direct overwrite random access features. Direct overwrite implementations under Data/DAT format may provide faster access to files because older copies of files (often littered throughout different backup sessions on DDS-formatted tapes) do not reside on tape, consuming space and encumbering file searches.

Methodology

The Features rating is a weighted average of scores for the individual features. Features and their methodology weights appear in Table 2.

Usability

The Arcserve documentation used with the Gigatrend and Tecmar products is clear, well organized, and includes helpful tab dividers. Gigatrend's hardware supplement, while less organized, has a good DAT technology summary. Software and hardware installation are fairly straightforward for both products. Software installation requires some knowledge of NetWare. The Tecmar lacks LED indicators, and diagnostics cannot be performed from the front panel. The Gigatrend front-panel display console can be used for system setup, diagnostic testing, and tape preparation. The Tecmar and Gigatrend units support system testing from the server console.

The Maynard user manual features clear illustrations, but no technology overview. The Maynard interface is consistent, but effective navigation must be learned. The Mountain user manual is very well organized (with tab dividers) and includes good coverage of command line and batch operation and troubleshooting; it is not liberal with illustrations. Mountain's software provides context-sensitive help screens, good error messages, and a detailed tape directory management utility.

Emerald provides among the best documentation with excellent diagrams and a clear DAT technology summary; the absence of tab dividers hampers the accessibility of information. Emerald's EmSave uses Windows' setup, with share and path statements added to the Autoexec.bat file; no context-sensitive help is provided. Hardware error messages are poor, and the system hangs when configured improperly.

FWB's skimpy hardware manual comes unbound and unindexed. The accompanying Sytos software manual clearly describes backup strategies and procedures with ample illustrations. FWB features ROM-based setup for SCSI installation, and the Sytos Plus software makes its use painless. Although the backup software requires some learning, its features are extensive and quite easy once properly learned. Sytos Plus implements context-sensitive help and command selection options with explanations displayed at the bottom of the screen.

The ADIC documentation provides a good tutorial but lacks somewhat in comprehensiveness, organization, and illustrations. ADIC provides very good error messages when the SCSI driver is disconnected. Tape drive installation is assisted by

an LED display showing tape status and error codes. ADIC provides no software installation utility, and users must copy the contents of four distribution diskettes to a user-created directory on the workstation hard disk. The backup software can be rather confusing at first because of inconsistent interfaces and menu structures and help that is not context sensitive. Familiarity with the menu structure makes the software quite easy to use.

Organizational flaws and poor use of illustrations in the Tallgrass documentation are compounded by the absence of an index. Tallgrass has the easiest software installation and uses only one diskette; SCSI setup is ROM based.

Methodology

The Usability rating is a weighted average of scores for the individual criteria.

Usability Score = (3 x Manual Evaluation Score) + (4 x Software Installation/Evaluation Score + (2 x Hardware Installation/Evaluation Score) ÷ 9.

Performance Results

Network Configuration

NSTL tested the DAT drives with a Compaq Deskpro 386/25 network server equipped with 9M bytes of RAM, a 600M-byte ESDI hard drive, a VGA monochrome monitor, and Novell NetWare 386 3.1. A Compaq Deskpro 386/20E workstation was equipped with 4M bytes of RAM, a 300M-byte ESDI hard drive, monochrome monitor, and Compaq DOS 4.01. The ADIC, Emerald, FWB, Maynard, Mountain, and Tallgrass devices were attached to the workstation; the Gigatrend and Tecmar were installed in the server. The Emerald can be attached to a server, but it was tested only as a workstation-attached device. DAT drives perform fastest with the attached device. Cross-network operations are always slower because data must be transported across the network and channelled through the attached device.

For server backups, workstation-attached DAT drives are slower and less secure. An external server-attached device resides next to the server, but the adapter occupies slots in the server, which is generally secured. Furthermore, for server backups, server-attached units are less subject to network traffic or transmission problems. Businesses will naturally choose one configuration or the other depending on the backup needs. Performance comparisons between workstation- and server-attached devices are not valid except for evaluating the potential effects of choosing the wrong configuration.

Performance may not be critical in all backup scenarios. For backups during peak network activity, faster drives limit the negative impact of the backup on the network's performance. Environments with large on-line storage capacity require fast units to complete full backups with reasonable speed. For small- to moderate-capacity on-line storage and backups during off-hours, the DAT drive's features and usability may be more important.

Drive Configuration

All tests were run with adapters and software supplied by the vendor. Overwrite options were enabled to prevent the drives from creating additional overhead by checking for files on the tape. Compression, verify, and log functions were disabled to equalize test conditions.

NSTL's RandTree program creates a single 50M-byte volume containing one 50M-byte file, and 20M-byte and 50M-byte volumes consisting of multiple files and subdirectories. Each directory has the same number of subdirectories containing files of various sizes. The resulting volumes approximate real-world disk usage and prevent a drive from gaining a performance edge by writing data serially without creating a directory structure on the backup tape.

The DDS-based units (all but the Gigatrend) offer the same sustained transfer rates and tape speeds and similar capacities. Their respective adapters generate different throughput speeds depending on the interface (8 bit or 16 bit) and data transfer method with the CPU. The device driver's buffer size, network driver, and backup software interface to the device driver also introduce performance variances. Directory structure management

overhead varies greatly from subsystem to subsystem. NSTL's tests isolate these performance factors to determine the most effective subsystem for particular applications. Using the average time for multiple runs, NSTL calculates the throughput and the maximum overhead associated with each drive. These values provide relative measurements indicating how each product might perform with larger data backups.

Workstation Backup

Each DAT drive backs up the workstation volumes using its included software. Overwrite is enabled, and settings are adjusted for optimum throughput.

Workstation backup relies on the drive's write performance, the host adapter throughput, and device driver efficiencies. All the drives operate at the same physical speed, but start-up times (before beginning to record) vary. Units with longer start-up times appear to be faster with the 50M-byte volume than with the 20M-byte volume. Performance differences caused by host adapters and software remain consistent for both volumes. Drives using the DDS format are faster than the Gigatrend, which uses the Data/DAT format.

Analysis

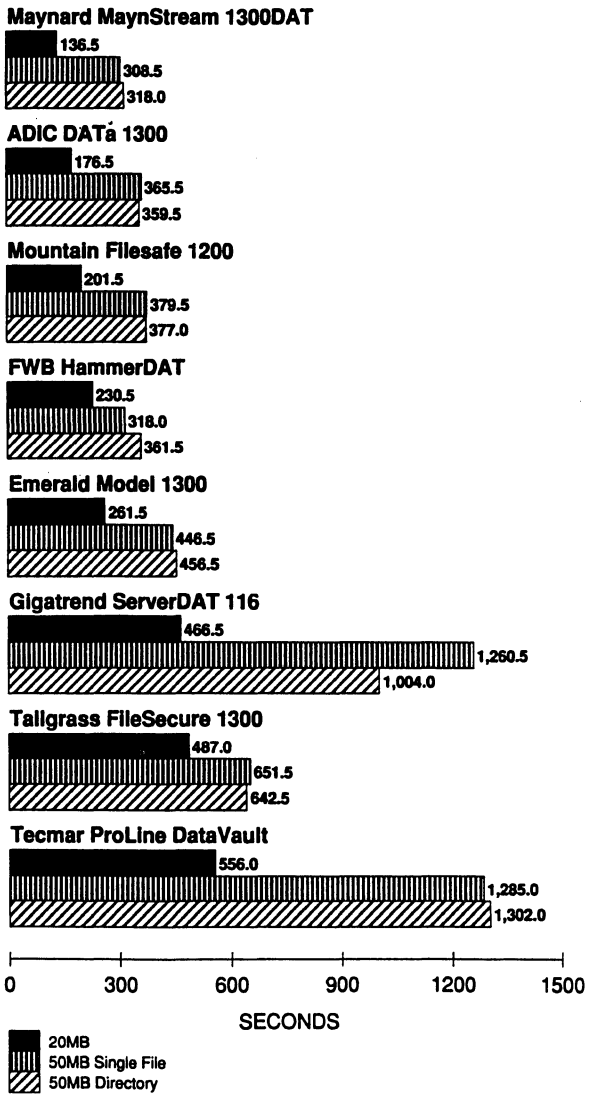
Using an Archive 4330 tape drive and proprietary adapter and backup software, the Maynard produces the least amount of overhead, and its throughput approaches the specified maximum.

The ADIC (Hewlett-Packard 35450A tape drive) performs consistently with the 20M-byte volume but falls behind the FWB with the 50M-byte volume. Although the ADIC uses an 8-bit adapter, it appears to capitalize on fast start-up and low overhead to provide consistently strong performance. The FWB uses a 16-bit adapter and WangDAT 1300 tape drive. It is slow on the 20M-byte backup because of overhead and start-up time. The FWB and ADIC throughputs on the 50M-byte backups approach the Maynard's throughput.

The WangDAT 1300-based Emerald is limited by its 8-bit adapter and Windows-based software interface. The Tallgrass also uses an 8-bit adapter and exhibits high overhead and slow start-up.

As expected, the server-attached Tecmar and Gigatrend are slower for workstation backups. The disparity in times stems from the configuration rather than drive-related performance factors. Both drives perform much faster for server backups.

Figure 9.
Workstation Backup



Workstation Verify

After performing several backups of the 20M-byte and 50M-byte disk volumes, NSTL ran a verify routine comparing the data on tape against the data on the hard disk. Verification exercises the DAT's read capability and the adapter's overall throughput (although the network interface can also change performance). DAT devices feature hardware-embedded error checking, so no errors are expected.

Analysis

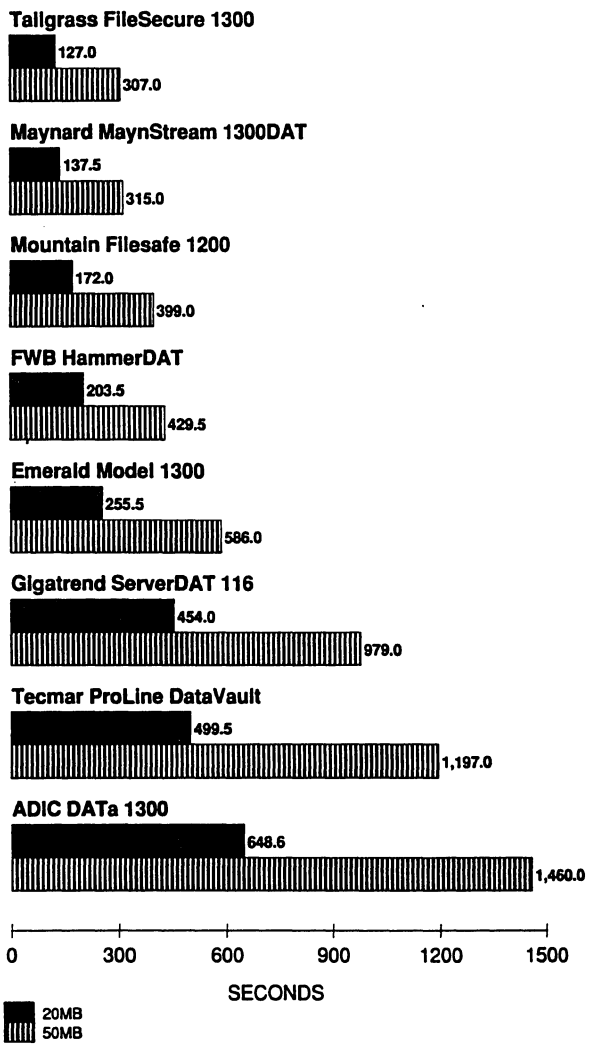
Directory management overhead and start-up delays that slow the Tallgrass in the workstation backups allow it to verify the 20M-byte and 50M-byte backups very quickly. Based on NSTL's calculations of throughput, the Tallgrass maintains consistently high data transfer rates despite its 8-bit adapter. The Tallgrass uses DMA transfers between the adapter and CPU, but 8-bit DMA transfer speeds in an ISA architecture are far from stellar. The Tallgrass' performance can only be attributed to good drivers and data management processes.

The Maynard again shows the power of its proprietary adapter driver; it uses DMA transfers with a faster 16-bit interface. The Mountain and FWB maintain consistently high performance.

Despite DMA transfers, the ADIC slows considerably. Overhead and associated start-up times are greater for the ADIC than for the other workstation-attached devices, probably because of its software interface and directory management scheme.

The Tecmar and Gigatrend demonstrate comparatively poor performance with the workstation backup verification because of their server-attached configuration (i.e., having to send workstation data across the network to the server). Workstation operations are not the intended application for server-attached units, and their times are presented only as reference points for users considering the potential impact of implementing a server-attached configuration.

Figure 10.
Workstation Verify



Workstation Restore

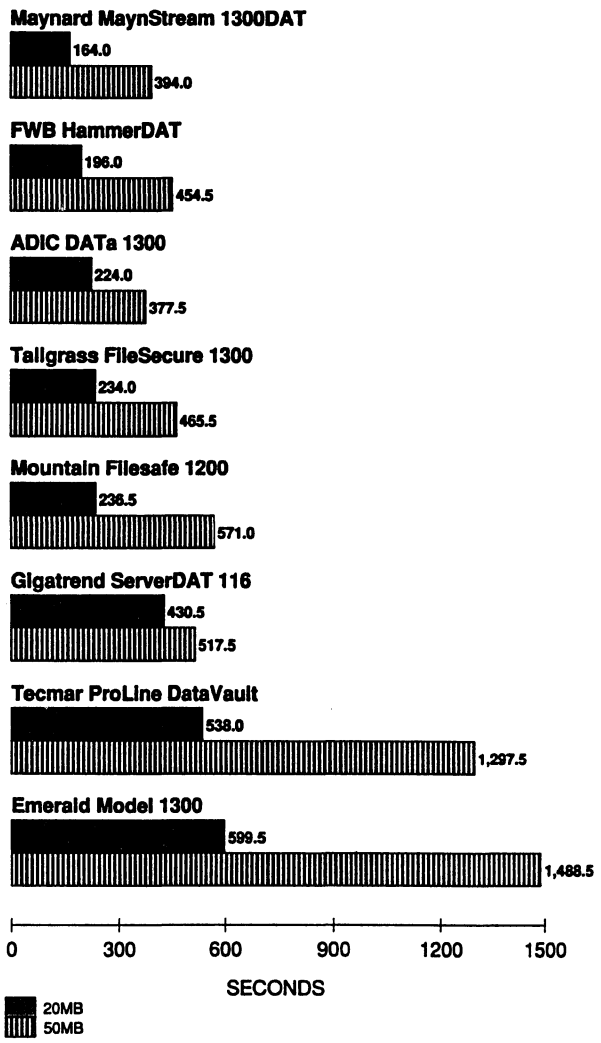
Each DAT drive restores the workstation disk volumes, and NSTL verified the integrity of the restored disk. This test increases the importance of host adapter throughput and decreases the effect of the network interface.

Full restore operations are rare, typically used only to recover from disk failure. Businesses with large on-line storage capacities should extrapolate the test times to determine the full impact of using a slow drive.

Analysis

The faster ADIC, Maynard, and FWB units excel at the full workstation restore. The ADIC still shows signs of excessive start-up overhead, but it

Figure 11.
Workstation Restore



manages the 20M-byte restore in 224 seconds (third fastest) and restores the 50M-byte volume faster than the others.

The Tallgrass shows signs of excessive overhead and performs the 50M-byte restore at a faster throughput than the 20M-byte restore. The Mountain performs consistently below average.

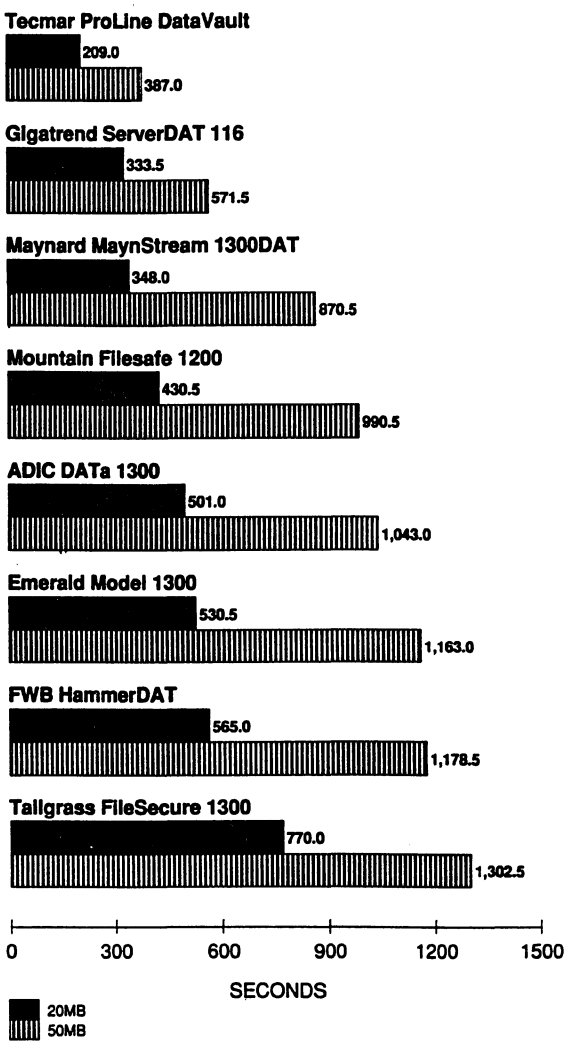
The Emerald's 8-bit adapter and backup software slow its performance unacceptably (behind even the server-attached units). The Emerald may be suitable for restoring workstations with relatively small disk storage, but larger disk storage requires more speed.

Server Backup

Each DAT drive backs up the server volumes using its included software. The workstation-attached devices back up the server across the network. Overwrite is enabled, and settings are adjusted for optimum throughput.

The Tecmar and Gigatrend attach directly to the NetWare 386 server using OEM versions of Cheyenne Software's Arcserve. The Arcserve-based products contain a server-resident program and a workstation-resident module. All backup commands are issued from a menu-driven workstation (client) to the server back-end software. The server-resident software is implemented as a NetWare Loadable Module (NLM).

Figure 12.
Server Backup



Analysis

The Tecmar and Gigatrend demonstrate the power and speed of server-attached backups. Server memory and disk characteristics enhance the Tecmar and Gigatrend performance, and the Tecmar is especially fast with the 50M-byte volume.

On the 20M-byte backup, the Maynard nearly matches the performance of the server-attached units even though it must absorb the overhead of the network and workstation. The time differential grows with the larger volumes.

Times for other workstation-attached devices offer a comparison of the relative merits of server- and workstation-attached configurations. Server-attached systems may noticeably affect the server's capability to process requests during active periods. Reducing the priority of the server backup process during these times mitigates the negative impact of the backup on network performance.

Server Restore

Each drive restores the server volumes, and NSTL verified the integrity of the restored disk. The restore test increases the importance of host adapter throughput and decreases the effect of the network interface.

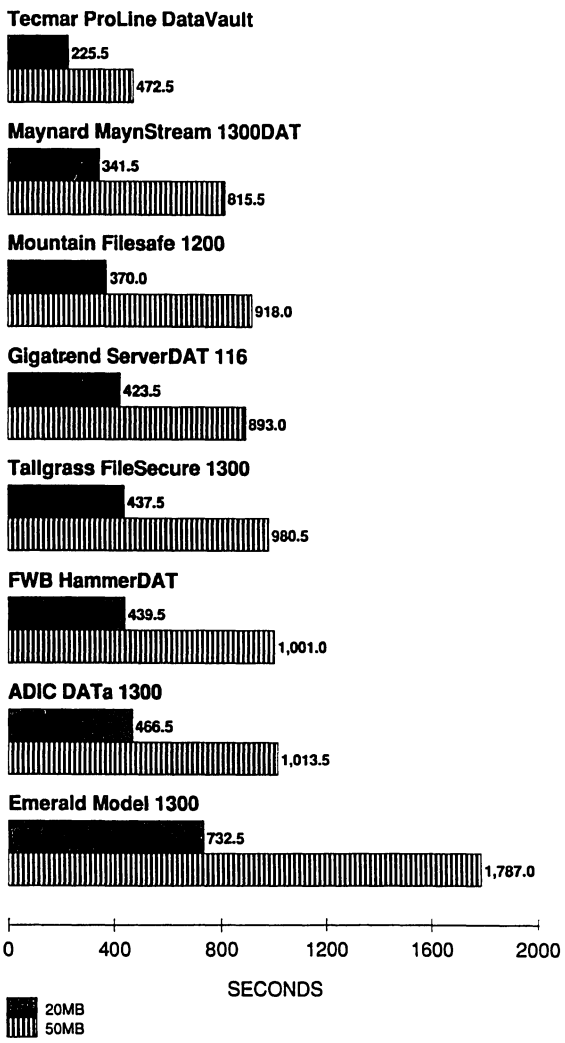
Analysis

The server-attached Tecmar easily outperforms the other DAT devices, restoring the 50M-byte volume almost twice as fast as the nearest competitor.

The Maynard and Mountain restore the 20M-byte volume faster than the server-attached Gigatrend. The Gigatrend matches the Mountain in the 50M-byte restore operations, but the Maynard remains faster. With increasingly larger volumes, the difference narrows, and the Gigatrend gains a slight edge overall despite its use of the slower Data/DAT format.

The other workstation-attached DAT units slow under the overhead imposed by the network and workstations. Most require more than twice as long to restore a server volume than to restore the same size workstation volume.

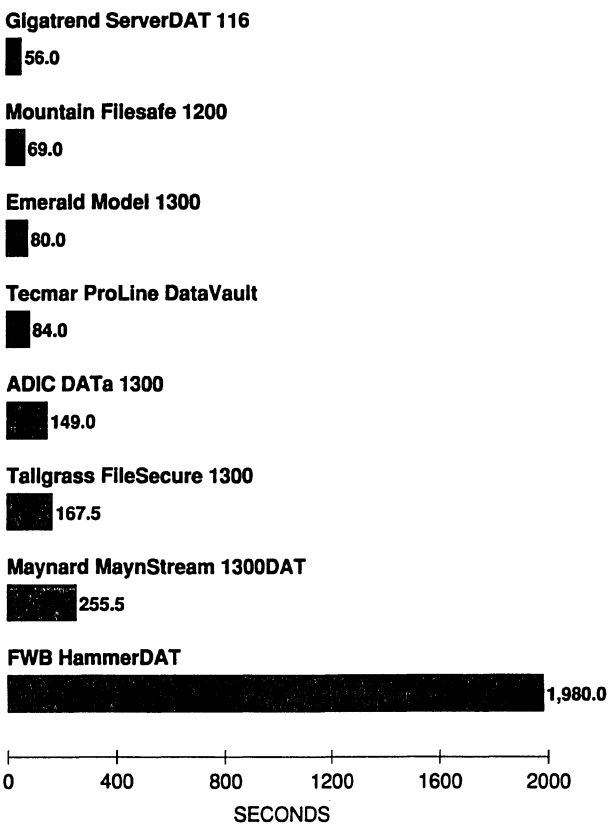
Figure 13.
Server Restore



Single-File Restore

NSTL backed up ten 20M-byte volumes and two 50M-byte volumes to each DAT to test the capability of its software to organize and control multiple-volume backups. Each drive selectively restores a single 1K-byte file in the last volume to a 512K-byte RAM disk. The tape was rewound before testing to ensure that the drive searched the entire tape and did not have to search backward through the tape.

Figure 14.
Single-File Restore



The size of the file and target disk precludes host adapter throughput and hard disk performance as performance factors. The single-file restore isolates the software interface, directory management technique, and the DAT's speed reading the tape. Selective file restores are frequent in network applications. Corrupt files or important files deleted from the server or workstation must be found and loaded from a backup.

Analysis

The Gigatrend, Mountain, and Emerald excel at selective backups, quickly locating the 1K-byte file. The Gigatrend completes the task in less than a minute.

In contrast to its strong backup performance, the Maynard requires nearly four minutes to locate the file, primarily a function of how the directory structure is managed and the effectiveness of the software interface. In earlier tests, the Maynard exhibited little overhead, which may indicate a simplified directory management structure. Products that demonstrated high overhead and start-up times in earlier tests (such as the Emerald), perform well in the selective restore.

The Tecmar would not run the selective restore using its proprietary version of Arcserve. The Tecmar's results are obtained using Cheyenne Software's Arcserve Version 3.0.

The volumes could be appended to the FWB only with its Quick File Access Option disabled. The Quick File Access Option normally provides an index of files that speeds searches. Without this option enabled, the FWB cannot compete with the other DAT devices in this test.

Vendors

Advanced Digital Information Corp. (ADIC)
14737 NE 87th Street
P.O. Box 2996
Redmond, WA 98073 (206) 881-8004

Emerald Systems
12230 World Trade Drive
San Diego, CA 92128 (619) 673-2161

FWB, Inc.
2040 Polk Street, Suite 215
San Francisco, CA 94910 (415) 474-8055

Gigatrend, Inc.
2234 Rutherford Road
Carlsbad, CA 92008 (619) 931-9122

Maynard Electronics
36 Skyline Drive
Lake Mary, FL 32446 (407) 263-3500

Mountain Network Solutions, Inc.
240 E. Hacienda Avenue
Campbell, CA 95008 (408) 379-4300, (800) 458-0300

Tallgrass Technologies
11100 W. 82nd Street
Lenexa, KS 66214 (913) 492-6002, (800) 736-6002

Tecmar, Inc.
6225 Cochran Road
Solon, OH 44139-3377 (800) 624-8560

Characteristics

Table 1. DAT Backup Device Characteristics

	Recording Format	Capacity	Performance	Network Compatibility	Backup Software	Warranty & Support
ADIC DATa 1300	DDS	1.3GB without compression; 2.6GB with compression	Transfer Rate: 183.3K bps; Average Access: 20 seconds; Tape Speed: 0.32 inch per second	Workstation Attached: Novell NetWare 386 3.1 and earlier, NetWare 286 2.1x and earlier	Data Right, MacBack (proprietary); Nbackup (Novell); Sytos Plus	1 year, parts, labor, and return shipment; service through supplier; telephone support
Emerald Model 1300	DDS	1.3GB without compression	Transfer Rate: 183.3K bps; Average Access: 20 seconds; Tape Speed: 0.32 inch per second	Workstation Attached: Novell NetWare 386 3.1 and earlier (Scheduler and EmSave), NetWare 286 2.1x and earlier (Scheduler and EmSave); IBM LAN Server 1.2 and earlier (EmSave); 3Com 3+Open 1.1 and later (EmSave); Microsoft LAN Manager 2.0 (EmSave); Ungermann-Bass Net/One LAN Manager 1.1 and later (EmSave); Server Attached: Novell NetWare 386 3.1 and earlier (Scheduler), NetWare 286 2.1x and earlier (Scheduler)	EmSave, Scheduler, EmQ (distributed), EmLib (data library management), Full Time (continuous)	1 year, parts, labor, and return shipment; service through supplier; extended warranties available; telephone support
FWB HammerDAT	DDS	1.3GB	Transfer Rate: 183.3K bps; Average Access: 20 seconds; Tape Speed: 0.32 inch per second	Workstation Attached: Novell NetWare 386 3.1 and earlier, NetWare 286 2.1x and earlier; Banyan Vines/286, 3.0 and earlier, Vines/386 4.0 and earlier; IBM PC LAN Program 1.30 and earlier, LAN Server 1.2 and earlier; 3Com 3+Open 1.1 and earlier; Microsoft LAN Manager 2.0	Sytos, Sytos Plus	1 year, parts, labor, and return shipment; service through supplier and dealers; extended warranties available
Gigatrend ServerDAT 116	Data/DAT	1.2MB (DDS without compression); 1MB (Data/DAT without compression)	Transfer Rate: 146K bps; Average Access: 20 seconds; Tape Speed: 0.32 inch per second	Server Attached: Novell NetWare 386 3.1, NetWare 286 2.1x	LANsafe (proprietary), Arcserve	1 year, parts, labor, and return shipment; service through supplier; extended warranties available; telephone support

Table 1. DAT Backup Device Characteristics (Continued)

	Recording Format	Capacity	Performance	Network Compatibility	Backup Software	Warranty & Support
Maynard MaynStream 1300DAT	DDS	1.3GB without compression	Transfer Rate: 183.3K bps; Average Access: Under 20 seconds; Tape Speed: 0.32 inch per second	Workstation Attached: Novell NetWare 386 3.1 and earlier, NetWare 286 2.1x and earlier; IBM PC LAN Program 1.30 and earlier, LAN Server 1.2 and earlier; 3Com 3+Share, Microsoft LAN Manager 2.0; Server Attached: IBM PC LAN Program 1.30 and earlier	Maynstream (proprietary)	1 year on drive, 5 years on controller, parts, labor, and return shipment; service through supplier; telephone support
Mountain Filesafe 1200	DDS	1.2GB without compression	Transfer Rate: 183.3K bps; Average Access: 20 seconds; Tape Speed: 0.32 inch per second	Workstation Attached: Novell NetWare 386 3.1 and earlier, NetWare 286 2.1x and earlier; IBM PC LAN Program 1.30 and earlier, LAN Server 1.2 and earlier; 3Com 3+Open 1.1 and earlier; Microsoft LAN Manager 2.0; Server Attached: IBM LAN Server 1.2 and earlier; Microsoft LAN Manager 2.0	Filesafe (proprietary); upgrade required for OS/2	1 year, parts, labor, and return shipment; service through supplier and dealers; telephone support
Tallgrass FileSecure 1300	DDS	1.1GB without compression; 2.2GB with compression	Transfer Rate: 183.3K bps; Average Access: 22.5 seconds; Tape Speed: 0.32 inch per second	Workstation Attached: Novell NetWare 386 3.1 and earlier, NetWare 286 2.1x and earlier; Banyan Vines/286 3.0 and earlier, Vines/386 4.0 and earlier; IBM PC LAN Program 1.30 and earlier, LAN Server 1.2 and earlier; 3Com 3+Open 1.1 and earlier; Microsoft LAN Manager 2.0	FileSecure (proprietary), Sytos, Sytos Plus, Arcserve, Retrospect	2 years, parts, labor, and return shipment; service through supplier and dealers; extended warranties available; telephone support
Tecmar ProLine DataVault	DDS	1.3GB without compression	Transfer Rate: 183.3K bps; Average Access: 20 seconds; Tape Speed: 0.32 inch per second	Server Attached: Novell NetWare 386 3.1 and earlier, NetWare 286 2.1x and earlier	ProServe (proprietary; included with external model); Tecmar QTOS, QTBackup; Systron Sytos Plus	2 years, parts, labor, and return shipment; service through supplier; extended warranties available; telephone support

Table 2. DAT Backup Device Features

	Weight	ADIC DATa 1300	Emerald Model 1300	FWB HammerDAT	Gigatrend ServerDAT 116	Maynard MaynStream 1300	Mountain Filesafe 1200	Tallgrass FileSecure 1300	Tecmar ProLine DataVault
Data Recording									
Cartridge type	0	4 mm.	4 mm.	4 mm.	4 mm.	4 mm.	4 mm.	4 mm.	4 mm.
DDS recording format	0	▲	▲	▲	▲	▲	▲	▲	▲
Data/DAT recording format	0	—	—	—	▲	—	—	—	—
Maximum capacity with compression (GB)	0	—	—	2.6	3.0(DDS)	—	—	2.6	2.6
Maximum capacity, no compression (GB)	0	1.3	1.3	1.3	1.3(DDS)	1.3	1.2	1.3	1.3
Helical scan recording method	0	▲	▲	▲	▲	▲	▲	▲	▲
Number of read/write heads	0	4	4	4	4	4	4	4	4
Track density (bytes per track)	0	4,096	4,096	4,096	4,096	4,096	4,096	4,096	4,096
Tracks per inch	0	1,869	1,870	1,869	1,869	1,869	1,870	1,869	1,869
Linear recording density (bits per inch)	0	61K	61K	61K	61K	61K	61K	61K	61K
Areal density (M bits per inch^2)	0	114	114	114	114	114	114	114	114
Tape length (meters)	0	60	60	60	60	60	60	60	60
Tracks per frame	0	2	2	2	2	2	2	2	2
Frames per group	0	22	22	22	22	22	22	22	22
Performance									
Average access time (seconds)	0	20	20	20	20	20	20	22.5	20
Sustained transfer rate (KB per second)	0	183	183	183	146	183	183	183	183
SCSI controller buffer size (KB)	0	512	512	512	512	512	512	512	INS
Asynchronous burst transfer rate (MB per second)	0	4.0	4.0	4.0	1.2	5.0	4.0	2.8	INS
Drum rotation speed (rpm)	0	2K	2K	2K	2K	2K	2K	2K	2K
Actual tape speed (inches per second)	0	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32
Head-to-tape effective speed (inches per second)	0	123	123	123	123	123	123	123	123
Load time (seconds)	0	20-30	<33	3.2-18	60	25	20	7	INS
Unload time (seconds)	0	20-30	<33	3.2-18	10	9	20	7	INS
Reliability									
MTBF (hours/duty cycle, %)	0	40K/12	30K/30	50K/25	20K/10	40K/30	40K/30	50K/10	50K/10
Nonrecoverable read error rate	0	1x10^{15}	1x10^{15}	1x10^{15}	1x10^{15}	1x10^{15}	1x10^{15}	1x10^{15}	1x10^{15}
ECC error recovery methods	1	C1,C2,C3	C1,C2,C3	C1,C2,C3	C1,C2,C3	C1,C2,C3	C1,C2,C3	C1,C2,C3	C1,C2,C3
Read-after-write verification	1	▲	▲	▲	▲	▲	▲	▲	▲
Physical Specifications									
Interface (SCSI, proprietary)	0	SCSI	SCSI	SCSI	SCSI	SCSI	SCSI	SCSI	SCSI
Drive manufacturer	0	HP	Wang	Wang	GT	Archive	M1	Wangtek	Wangtek
Drive model	0	35450A	DAT1300	DAT1300	1230	4330	M1	6130	6130FS
FCC classification	1	Class A	Class B	Class B	Class B	Class B	Class B	Class B	Class B
Software Functions									
Unattended/scheduled backup	2	▲	ES	▲	▲	▲	▲	▲	▲
Script/batch files	2	▲	ES	▲	▲	▲	▲	▲	▲
Data compression	2	—	—	▲	—	—	—	▲	—
Data encryption	1	▲	ES	▲	▲	—	—	—	▲
Command line execution	1	▲	—	▲	—	▲	▲	▲	—
Backup remote workstation	0	▲	ES	▲	▲	▲	▲	—	▲
Automatic tape formatting	1	▲	ES	▲	▲	▲	▲	▲	▲
Automatic verification	1	▲	ES	▲	▲	▲	▲	▲	▲
Verify concurrent (read-after-write)	0	▲	ES	▲	▲	▲	▲	▲	▲
User-specified verify after backup	1	▲	ES	▲	▲	▲	▲	▲	▲

Table 2. DAT Backup Device Features (Continued)

	Weight	ADIC DATa 1300	Emerald Model 1300	FWB HammerDAT	Gigatrend ServerDAT 116	Maynard MaynStream 1300	Mountain Filesafe 1200	Tallgrass FileSecure 1300	Tecmar ProLine DataVault
Software Functions (Continued)									
Resume backup after interrupt	1	▲	ES	—	▲	—	—	▲	▲
Backup and erase data from source	0	—	—	—	▲	▲	—	—	▲
Resume original position after restore	0	—	—	▲	▲	—	—	▲	▲
Backup can span multiple tapes	1	▲	ES	▲	▲	▲	▲	▲	▲
Tape directory print	1	▲	—	▲	▲	▲	▲	—	▲
Catalog tape contents on disk	1	▲	ES	▲	▲	▲	—	—	▲
Tape password protection	1	—	ES	▲	▲	▲	▲	▲	▲
Display backup/restore statistics	1	▲	ES	▲	▲	▲	▲	▲	▲
Redirected restore	1	▲	ES	▲	▲	▲	▲	▲	▲
Diagnostics software	1	▲	ES	—	▲	▲	▲	▲	▲
Backup log file	1	▲	ES	▲	▲	▲	▲	▲	▲
Restore log file	1	▲	ES	▲	▲	▲	▲	▲	▲
Error log file	1	▲	ES	▲	▲	▲	▲	▲	▲
Schedule log file	1	▲	ES	▲	▲	▲	▲	▲	▲
Backup/Restore Methods									
Specific directories	1	▲	▲	▲	▲	▲	▲	▲	▲
Specific date	1	▲	▲	▲	▲	▲	▲	TG1	▲
Data range	1	—	▲	▲	▲	▲	▲	TG1	▲
Modified files only	1	▲	▲	▲	▲	▲	▲	▲	▲
File by file	1	▲	▲	▲	▲	▲	▲	▲	▲
Disk partition	1	▲	▲	—	▲	▲	▲	▲	▲
Disk image	1	—	—	—	—	▲	▲	—	—
Host System Support									
ISA compatible	1	▲	▲	▲	▲	▲	▲	▲	▲
EISA compatible	0	▲	▲	▲	▲	▲	▲	—	▲
IBM PS/2 Micro Channel	1	▲	▲	▲	▲	▲	▲	▲	▲
Apple Macintosh	0	▲	—	▲	—	▲	—	▲	▲
Operating System Support									
DOS 3.3x	4	▲	▲	▲	▲	▲	▲	▲	▲
DOS 4.0x	4	▲	▲	▲	▲	▲	▲	▲	▲
OS/2 1.1	1	—	—	▲	▲	▲	—	—	▲
OS/2 1.2	1	—	—	▲	▲	▲	▲	—	▲
SCO UNIX/SCO Xenix	1	—	—	▲	▲	▲	▲	▲	▲
Apple A/UX	0	—	—	▲	▲	▲	—	—	▲
Network Support, Server Attached									
Novell NetWare 2.1x	3	—	—	—	▲	—	—	—	▲
Novell NetWare 3.0	2	—	—	—	▲	—	—	—	▲
Novell NetWare 3.1	3	—	—	—	▲	—	—	—	▲
Banyan Vines 3.x	0	—	—	—	—	—	—	—	—
Banyan Vines 4.0	0	—	—	—	—	—	—	—	—
IBM PC LAN Program 1.3 and earlier	0	—	—	—	—	▲	—	—	—
IBM LAN Server 1.1	0	—	—	—	—	—	—	—	—
IBM LAN Server 1.2	0	—	—	—	—	—	▲	—	—
3Com 3+Open	0	—	—	—	—	—	—	—	—
Microsoft LAN Manager 2.0	0	—	—	—	—	—	▲	—	—

Table 2. DAT Backup Device Features (Continued)

	Weight	ADIC DATa 1300	Emerald Model 1300	FWB HammerDAT	Gigatrend ServerDAT 116	Maynard MaynStream 1300	Mountain Filesafe 1200	Tallgrass FileSecure 1300	Tecmar ProLine DataVault
Network Support, Workstation Attached									
Novell NetWare 2.1x	3	▲	▲	▲	—	▲	▲	▲	—
Novell NetWare 3.0	2	▲	▲	▲	—	▲	▲	▲	—
Novell NetWare 3.1	3	▲	▲	▲	—	▲	▲	▲	—
Banyan Vines 3.x	0	—	—	BA1	—	—	—	BA1	—
Banyan Vines 4.0	0	—	—	BA1	—	—	—	BA1	—
IBM PC LAN Program 1.3 and earlier	0	—	—	▲	—	▲	▲	▲	—
IBM LAN Server 1.1	0	—	—	▲	—	▲	▲	▲	—
IBM LAN Server 1.2	0	—	EM1	▲	—	▲	▲	▲	—
3Com 3+Open	0	—	EM1	▲	—	▲	▲	▲	—
Microsoft LAN Manager 2.0	0	—	EM1	▲	—	▲	▲	▲	—
Host Adapter Features									
Adapter manufacturer	0	ADIC	EM2	Always	GT1	Prop	Prop	Prop	Adaptec
Adapter model	0	1050	EM2	IN2000	—	—	—	—	1640
8-bit AT bus	0	▲	▲	—	FD	▲	—	▲	—
16-bit AT bus	0	—	▲	▲	A,B	▲	▲	—	▲
16-bit AT bus master	0	—	—	—	A,B	—	—	—	▲
Shared memory data transfers	0	—	—	—	—	—	—	—	—
DMA data transfers	0	▲	▲	—	—	▲	▲	▲	▲
Programmed I/O data transfers	0	—	—	▲	FD	—	—	▲	—
Bus master data transfers	0	—	—	—	A,B	—	—	—	▲
Diskette controller included	0	—	—	▲	▲	—	—	—	—
Miscellaneous Characteristics									
Supports SCSI-1 mandatory commands	0	E	E	E	E	E	—	E	E
Supports SCSI-1 optional commands	0	E	P	E	E	E	—	P	P
Supports SCSI mandatory commands*	0	E	E	E	P	—	E	E	E
Supports SCSI-2 optional commands*	0	P	P	P	P	—	E	P	P
SCSI ports on drive	1	2	1	2	2	2	2	1	2
Maximum daisy-chained drives	0	7	7	6	6	7	4	7	6
Power-on self-test	0	▲	▲	▲	▲	▲	—	▲	▲
Write protect switch on cartridge	0	▲	▲	▲	▲	▲	▲	—	▲
Cartridge present/not present	1	▲	▲	▲	▲	▲	▲	▲	▲
Load/unload operation in progress	1	▲	▲	▲	▲	▲	▲	▲	▲
High humidity warning	1	▲	—	—	—	—	—	—	—
Excessive read-after-write error signal	1	▲	—	—	—	—	—	—	—

▲—Yes, has feature.
A—Adapter.
B—Bustek BT-X42A.
E—Entire.
P—Partial.
ES—Using EmSave software.
FD—Future Domain TMC 850.
GT—Gigatrend.
HP—Hewlett-Packard.
M1—Want DAT 1300, Archive UNIX/Xenix.
BA1—Backup data and applications only, not Banyan's StreetTalk global naming and security system.
EM1—Using EmSave for LAN Manager.
EM2—Proprietary; Adaptec 1640.
INS—Information not supplied.
GT1—Adaptec, Future Domain TMC 850, Bustek BT-X42A.
TG1—User must manually flag files with specific dates to be backed up.
Prop—Proprietary.
**Drives support SCSI-2 commands; subsystem may not use SCSI-2 commands due to limitations of the SCSI host adapter and driver software.*

Equipment Prices

		Purch. Price ($)
DAT Backup Devices		
	ADIC DATa 1300	
	External Subsystem with Controller	5,995
	Emerald Model 1300	
	With EmSave and EmLib	5,595
	With Scheduler	6,295
	FWB HammerDAT	
	Without Controller	3,995
	Controller	295
	Sytos Plus	225
	Gigatrend ServerDAT 116	
	External Model with Controller	6,950
	Maynard MaynStream 1300DAT	
	External Subsystem with Controller for PC AT	5,995
	External Subsystem with Controller for PS/2	6,195
	Internal Subsystem with Controller for PC AT	5,495
	Internal Subsystem with Controller for PS/2	5,695
	Mountain Filesafe 1200	
	External Subsystem with Controller	5,995
	External Subsystem with Controller for MCA	6,095
	Internal Subsystem with Controller	5,495
	Internal Subsystem with Controller for MCA	5,595
	Tallgrass FileSecure 1300	
	External Subsystem with Controller	4,595
	Internal Subsystem with Controller	4,395
	Tecmar ProLine DataVault	
	External Subsystem with Controller	5,995
	Internal Subsystem with Controller	4,695

■

Ethernet Network Monitoring Tools

A Report from NSTL

In this report:

Synopsis

Focus
This report contrasts six network monitors and protocol analyzers and compares the products' features, performance, diagnostics/error handling, usability, and overall suitability for specific network environments.

Products Tested

Monitrix
Cheyenne Software, Inc.

LAN Watch
FTP Software, Inc.

Watchdog Network Monitor
Network General Corp.

TXD
Thomas-Conrad Corp.

Network Inspector
Tiara Computer Systems, Inc.

EtherVision
Triticom

Product Recommendations

- Network General Watchdog Network Monitor
- Triticom EtherVision
- FTP Software LAN Watch

Source
Based on data generated by tests designed and conducted by National Software Testing Laboratories (NSTL), a division of Datapro Research Group, Inc., Plymouth Meeting, PA 19462. Telephone (800) 223-7093.

Ratings Key
(On a scale of 0 to 10)
Ratings
● 7.0 - 10.0
○ 5.0 - 6.9
▨ under 5.0
★ Recommended

Overall Evaluation	Product Name	Version Tested	Features	Diagnostics/ Error Handling	Usability	Price
8.4	Network General Watchdog Network Monitor	2.0	●	●	●	$1,995★
7.7	Triticom EtherVision	2.01	●	●	●	$225★
7.7	Cheyenne Software Monitrix	2.0	●	●	●	$895
7.5	Thomas-Conrad TXD	1.01	●	○	●	$195
7.0	FTP Software LAN Watch	2.0	●	○	○	$1,200★
6.7	Tiara Computer Systems Network Inspector	1.0	○	○	●	$199

Overview

While the industry anxiously awaits a common management standard based on open architectural frameworks, third-party vendors are flooding the market with network utility products and administration tools. Network monitors and protocol analyzers are designed to provide many essential services in network administration and management. Employed as adjuncts to full-scale network management products, network monitors and analyzers can be invaluable in examining and understanding the "bit-level" exchange between communicating devices. At different levels of the communications exchange, network monitors and protocol analyzers can selectively track network traffic patterns; establish performance thresholds to circumvent critical failure points; and isolate, decipher, and correct network problems.

Evaluation Criteria

The variety of products available for network monitoring and analysis spans a wide range of price and performance. Businesses select these products mainly on the basis of specific functions and price.

NSTL selected software-only and software/adapter network monitors and protocol analyzers that serve a broad range of business users. Most high-end protocol analyzers target software developers, systems integrators, very large organizations, and other specialized users. Most protocol analyzers offer many more protocol decoder modules than are supported in a standard LAN environment, and NSTL decided against evaluating only a subset of these multifaceted products. Although NSTL focuses on Ethernet network monitors, many vendors offer Ethernet and token-ring monitors using the same core software.

Network Management Standards

Many of today's network installations consist of several hundred nodes with multiple file servers and mixed topologies; network segments and/or multiple file servers are linked using bridges and routers. Client/server network architectures embody not only the basic printer and file sharing functions on simple networks, but integrate a complex array of discrete multitasking and multiprocessor application environments into homogeneous computing platforms. It is not uncommon to find networks with several layers of communications protocols, all coming from different vendors, not necessarily adhering to a common standard, and all achieving specific application goals. Interoperability and compatibility in such situations are generally achieved through numerous translations at the various protocol interface levels.

The International Organization for Standardization's (ISO's) Open Systems Interconnection (OSI) seven-layer reference model encompasses more than a dozen major protocol implementations. A single network installation can conceivably have multiple implementations working together because a specific implementation may be best suited to a given application or group of applications, and LAN segments tied to a remote host (another LAN, a minicomputer or mainframe system, or a wide area network) via gateways inevitably mix different implementations. For example, a NetWare-based LAN would probably use a Transmission Control Protocol/Internet Protocol (TCP/IP) interface to communicate with an Ethernet installation running a CAD/CAM application.

Networks of such complexity test the limits of even the most skilled administrator's ability to maximize network security, availability, and accessibility. Market research translates each hour of LAN downtime to a five-digit dollar amount in lost productivity in a typical *Fortune* 1000 company. Strategies to counter such trends vary, and the goal of a unified network management standard may be to integrate several existing approaches adopted by organizations with large network installations. Until a standard network management goal is fully achieved, network administrators will have to continue using a combination of troubleshooting, maintenance, and management tools.

The absence of a common network management standard and businesses' tendency to avoid implementing their own unified management strategy encourage the development of modular network management products and solutions. Network traffic counters, statistical monitors, alert monitors, protocol analyzers, and other network

Network Standards

ISO/Network Management Forum

The ISO/Network Management Forum, a group of vendors and users, has promoted definition, implementation, and testing of OSI network management products since 1988. Although most modules of the ISO network management specification are still in the draft stage, several important milestones have been achieved. The delay in adopting ISO's network management standards in their entirety stems from the specification's broad definitional scope. The specification attempts to define a network management standard offering services at all seven layers of the OSI reference model. Despite these obstacles, a number of vendors have committed support to ISO's efforts even in the draft stage.

Among the ISO management modules, the Common Management Information Services (CMIS) and the Common Management Information Protocol (CMIP) form the foundational network management specifications, defining the collection and exchange of management information among network entities based on well-established protocols. Other specification modules include the Management Information Base (MIB) and Directory Services.

Simple Network Management Protocol (SNMP)

The Internet Activities Board (IAB), the standard-setting body for TCP/IP networks, developed a more modest network management standard in its SNMP (originally developed by computer scientists from research and educational establishments). SNMP enjoys the support of a large number of vendors, and SNMP-based network management products flourish. Using primarily the TCP/IP protocol standard, SNMP fills a transitional niche in the same way TCP/IP-based network products proliferate in advance of true OSI-based versions.

SNMP Components

1. The Management Protocol.

2. The Management Information Base (MIB) defines object groups or network entities and their functions.

3. The Structure of Management Information (SMI) governs characteristics of network entities, how they are entered in the MIB, and how SNMP management protocols get information about them.

4. The Network Management Station (NMS) is the central console from which the administrator controls network objects or agents (bridges, terminal servers, communications servers) and views network status.

5. The User Datagram Protocol (UDP) is part of the TCP/IP protocol stack and handles the basic exchange of SNMP management data between the agent and NMS nodes.

Also like CMIP, SNMP uses the OSI Abstract Syntax Notation 1 Basic Encoding Rules (ASN.1) to represent machine-coded information in a format that can be understood by humans. Although theoretically both SNMP and CMIP are capable of using any message transport method, SNMP generally uses TCP, and CMIP depends on OSI transport mechanisms such as TP4 (CMIP over TCP/IP is known as CMOT).

Both CMIP and SNMP carry out basic management tasks using three common action verbs known as primitives. The GET command is used by the management system (the part of the SNMP software that runs in the NMS) to request values of object attributes from the program residing in managed objects (agents). SET changes or adjusts the performance parameters of a managed node to balance the network load or to optimize network traffic. Agent nodes send EVENT messages to a management station to signify connection failure, authentication failure, agent initialization, and other important occurrences. CMIP also uses CREATE, DELETE, and ACTION primitives. CREATE and DELETE commands instruct an agent to create an object (e.g., start an application remotely) or delete it (e.g., shut down a server). An ACTION command requests that an object perform a specified task (e.g., reset a workstation).

Unfortunately, none of the test products are compatible with either CMIP or SNMP. FTP Software offers an optional product that provides SNMP-compatible network management; the product is not compatible with LAN Watch. Cheyenne Software is developing SNMP compatibility for Monitrix.

utilities and administration tools help ease routine network management and maintenance burdens until a more unified standard emerges.

Many computer and network product vendors offer their own interim solutions to network management in tools unique to their products. In fact, some proprietary and de facto network management standards from manufacturers such as IBM and Digital Equipment have become very successful. Proprietary products are not widely

available in the PC LAN market because their proprietary nature makes them unsupportable or because of their high cost for LAN installations (e.g., IBM NetView).

Network Management Functions

In translating network management theory to practical implementation, vendors must define and administer network entities and integrate elementary management functions. In order to simplify the development of network management programs, ISO defines five basic functions in the CMIS specification.

Configuration Management defines the setup, monitoring, and maintenance of a network's basic resources.

Problem Management defines and specifies methods of detection, isolation, and correction of network failures and abnormalities.

Account Management attempts to define and establish controls on charges for network resource usage.

Performance Management monitors, fine-tunes, and maintains network performance at acceptable levels.

Security Management defines network authorization, access control, encryption, and key management functions and strategies for information networks.

These management tasks can be applied to local and wide area networks, but LAN components and resources are affected to different degrees by the individual task definitions and functions. Ideally, an integrated view of LAN management would incorporate the five individual administration and management functions, but functionally, each of the management tasks can be performed separately without affecting the others. In the same way, network monitors and protocol analyzers perform separate and specific tasks that help keep a network operational.

Network Monitoring versus Protocol Analysis

Network management in its ideal and simplest form oversees network resources: management of users, peripherals, and optimal transmission media usage. If networks functioned without failure or security breaches, the network administrator's tasks would primarily involve adding and removing users, assigning access rights to network resources, making application and peripheral resources available to users, periodic backups, and monitoring network capacity and resource usage.

Even in an ideal environment, network administration and management require careful planning and flexible organizational tools. Tools such as NetWare's fast, menu-based network administration utilities (e.g., Syscon, Filer, Session, Fconsole); VINES' StreeTalk global naming service; and automated backup and archiving utilities from third-party vendors greatly simplify routine network administration.

Real networks are seldom ideal. In addition to the complexities of size and heterogeneity, networks experience breakdowns caused by hardware failures, software bugs, protocol-related errors, and performance threshold limitations. Good diagnostic software, some experience, and good documentation are the only tools needed to isolate and correct hardware failures and occasional software bugs; however, some types of software bugs, protocol incompatibilities, and network failures due to critical load conditions are less straightforward. Such problems can be so baffling that only a protocol analyzer or other specialized tool can possibly pinpoint the problem.

Network monitors and protocol analyzers have different troubleshooting functions. Using a simple medical analogy, a network monitor is like an operational technique used to prevent network problems before they occur; a protocol analyzer is more like a diagnostic tool used to find the "cure" when a network "ailment" occurs.

Network Monitors

Network monitors provide network traffic statistics, performance threshold setting and monitoring activities, and alert notification. These typically device-independent, software-only products are much less costly than protocol analyzers.

For specific implementations, some network monitors depend on the underlying network operating system for traffic statistics, status reports, and other network database information. Most network operating systems currently on the market offer some network administration services (e.g., setup, performance monitoring, security, accounting). Although not all of these services are open to application programmers, some operating systems offer application programming interfaces (APIs) to these services. A disadvantage to relying on the host operating system is the monitor's inability to provide reliable services when the operating system is experiencing problems.

Judging from the number of available third-party enhancement products, NetWare is probably the most open system interface service at present. Cheyenne's Monitrix and Thomas-Conrad's TXD integrate well with the NetWare environment, thanks to Novell's NetWare System Interface specification and its availability to application developers. Network Inspector's LAN diagnostic functions use IPX/SPX protocol APIs to NetWare's Diagnostics Services (the monitor uses a Data Link layer interface to the network). Using NetWare's extensive Diagnostics Services function calls, TXD and Monitrix provide complete inventories of network nodes and their configurations, which are helpful in resolving configuration conflicts, driver version incompatibilities, and similar problems.

Monitors that interface the network through a MAC driver cannot provide node configuration information without some higher level protocol driver such as NETBIOS. MAC-level monitors are completely independent of the network operating system and, as such, are not affected by changes in its status.

Network Protocol Analyzers

Unlike network monitors, which basically identify and count frames and then provide a statistical summary, protocol analyzers offer more detailed information on the inner workings of a network. With the exception of a few software-only products such as LAN Watch, most protocol analyzers are turnkey systems with specialized hardware. Like network monitors, protocol analyzers count frames and manipulate captured packets according to specified filter and trigger conditions. Protocol analyzers also dissect a frame's protocol layers and embedded data, making them indispensable for diagnosing network failures.

Protocol analyzers receive all the packets transmitted over the communications medium. In almost all LAN architectures, nodes can "see" all frames traveling over the medium, but each node copies only those frames carrying its specific address. Unless otherwise instructed through a filtering option, the protocol analyzer captures all traffic on the network cable. Protocol analyzers analyze and interpret all captured frames. The most advanced analyzers turn arcane streams of bits into understandable commands, responses, and text.

More protocol analyzers are available for Ethernet networks than for token-ring, but most of the major protocol analyzer vendors offer products for both. Network General offers over a dozen protocol interpreter (PI) suites for the major implementations of the OSI model and for wide area networks. LAN Watch decodes Novell and Banyan protocols, most TCP/IP-based protocols, and several Digital Equipment protocols.

Monitoring Performance

Beyond the obvious issue of packet capture rates (frames per second), a network monitor's capability to count and identify (and a protocol analyzer's capability to capture and analyze) all network traffic without losing packets (and to indicate when it cannot keep up) is a very important performance parameter. Protocol analyzers should be capable of storing captured data to a RAM disk or hard disk when RAM buffer capacity is exceeded. Background monitoring helps streamline network resource usage.

Packet loss is much more serious for protocol analyzers than for network monitors. Monitors should be capable of identifying and reporting packets missed because the network adapter cannot keep up, because the buffer is full, or because the network monitor itself cannot keep up. For protocol analyzers, losing packets may mean losing the key to diagnosing a problem. Although normal network traffic rarely approaches the saturation point (normal usage statistics are usually below 50 percent saturation), a protocol analyzer should be capable of handling even abnormal operational conditions.

According to NSTL test results, LAN Watch loses significant numbers of packets even under

low to moderate traffic conditions (about 3,000 pps). FTP Software attributes that high packet loss to the 3Com 3C505 Ethernet adapter's use of DMA and suggested testing LAN Watch with a faster Western Digital WD8013 adapter. NSTL did not receive the appropriate driver in time to verify FTP's claim.

The products' many performance features are compared in detail in Table 2.

Applications

Troubleshooting tools available to network administrators include cable testers and TDRs, traffic counters, and protocol analyzers. The functionality afforded by these different classes of products is varied. The application of network monitors and protocol analyzers in the network control room can be as extensive as the network administrator needs. Typical applications are as follows.

Problem Identification: By establishing network-wide and individual station threshold settings, the network monitor can alert the administrator to potential problems.

Usage Patterns: By gathering statistics over a period of time, a monitor can help the administrator establish network and resource usage patterns for individual users and servers.

Performance Analysis: A network monitor's primary purpose is to gather statistics on normal network performance as baseline values against which performance deviations can be measured.

Continuous Monitoring: Monitoring can be set up as a 24-hour activity. The software can gather selected statistics or discard all data unless a threshold is exceeded. Exceeding threshold values can trigger an alert message to the administrator and possibly an audible alarm.

Summary Analysis: Using built-in report generation and the ability to export captured statistics to a spreadsheet-compatible (comma-separated or CSV) format, administrators can combine studies and analyses and integrate monitor statistics into management reports for billing, accounting, or expansion justification.

Not all the monitoring products support all these applications, but most perform the major functions with varying limitations. Watchdog and EtherVision excel in their capability to perform the specified applications. The NetWare-specific Monitrix and TXD offer less flexible report generation and threshold specification options. TXD does not save data to a CSV file format. Network Inspector does not offer report generation, nor can it save statistics to a CSV file format.

Protocol analyzers evolved from software developers' need to verify that applications comply with the protocol specification of a particular network architecture. Protocol analyzers' extensive application in network troubleshooting centers on this same capability. Additional capabilities make protocol analyzers effective for detecting network anomalies like broadcast storms, excessive collisions, time-out patterns, and lost tokens (token-ring). Protocol analyzers offer these capabilities in addition to the applications listed previously. LAN Watch displays all the basic application requirements; its report generation feature is not as flexible and user friendly as Watchdog's.

Product Summary

Network performance varies unpredictably in that the combination of factors affecting performance at any one time is unpredictable. The network environment includes the nodes, their physical and electrical connections, and their peripheral resources; the physical laws that govern the status and operating speed of discrete network elements; and abstract architectural elements such as the protocol rules and other software elements. A static network environment would theoretically perform at a constant level, but such an environment is neither possible nor desirable.

It is impossible to control all the elements that affect network performance. A sudden surge of electrical or magnetic interference from an outside source can generate a broadcast storm on the network. A software virus can inadvertently be introduced. In most situations, safeguards against such incidents are adequate, but the possibility of unwarranted intervention highlights the need for the administrator to observe, analyze, and characterize normal network operation in order to discern deviations.

Network monitors and protocol analyzers offer excellent services in network administration and management, whether implemented as part of a total network management strategy or in a modular fashion. Organizations that require the protocol decoding capability of a network analyzer and the statistical data collection capability of a network monitor should consider a software-only protocol analyzer such as LAN Watch and a low-cost network monitor such as EtherVision, instead of a turnkey protocol analyzer product that costs several times the combined cost of the software products. Businesses must also consider potential incompatibilities between such products and their lack of integration against the assets of enhanced performance, support for multiple topologies, and other versatile features of turnkey protocol analyzer systems.

For NetWare environments, Monitrix and TXD are reasonably useful for most network monitoring alarm notification needs. Both are device independent, and both offer network monitoring across bridges and routers. In addition to its advantage of being a server-based product, Monitrix offers a unique virus detector, a flexible alert notification option, and interfaces to external devices.

Looking ahead, the development of network management standards and artificial intelligence seems to hold the key to advances in powerful network monitoring and management tools. However sophisticated, the current network management products invariably require human intervention for analysis, interpretation, and decision making. Monitoring packages such as Frye Computers' NetWare Early Warning System embody some of the characteristics required for fully automated, computer-aided monitoring, notification, and response. Even these are far from network management products based on an expert system.

Product Evaluations

Cheyenne Software Monitrix

Strengths

- Server-based monitoring
- Adapter independent; works with any NetWare-supported adapter
- Excellent network inventory (hardware and software configuration) management
- Helpful network topology diagram
- Very good learning and usability features
- Good documentation

Limitations

- Network operating system dependent
- Cumbersome realtime display of traffic statistics
- Limited network threshold setup option
- Limited report generation and formatting options

FTP Software LAN Watch

Strengths

- Full OSI seven-layer protocol decoding
- Full customization and programming option
- Robust and dependable software
- Network operating system independent
- Versions available for Ethernet and token-ring
- Competitively priced as a protocol analyzer

Limitations

- Poor user interface features
- Limited report generation options
- No hardware diagnostics
- Documentation limited in comprehensiveness, organization, and quality

Network General Watchdog Network Monitor

Strengths

- Highest-rated product overall
- Very good documentation
- Network operating system independent
- Versions available for Ethernet and token-ring
- Feature-rich software
- Background monitoring

Limitations

- No user customization/programming
- Limited network adapter driver options

- No network management standard interface

Thomas-Conrad TXD

Strengths

- Adapter device independent; works with all NetWare-supported adapters and topologies
- Very good features/price ratio
- Very good usability
- Manual includes excellent sections on "Solving Common Network Problems" and "Daily Operations"

Limitations

- Network operating system dependent
- Limited error handling
- Limited setup options

Tiara Computer Systems Network Inspector

Strengths

- Fast performance
- Only product with TDR function
- Good user interface features

Limitations

- Limited functionality and features
- Undependable diagnostics, including TDR function
- Limited configuration options
- Poor error handling capabilities
- Fewest features

Triticom EtherVision

Strengths

- Full network operating system independence
- Very good versatility score
- Fast performance
- Competitive price
- Core product supports Ethernet, token-ring, and Arcnet topologies

Limitations

- Documentation limited in comprehensiveness and quality
- Software interface lacks on-line Help
- Limited error recovery procedures

Product Recommendations

Network General Watchdog Network Monitor

NSTL recommends the Watchdog network monitor on the strengths of its excellent features and solid performance and the proven record of its predecessor, the Sniffer Protocol Analyzer. Without the protocol decoding capability of its more powerful sibling, Watchdog offers a wealth of monitoring, statistical analysis, and report generation functions for effective network management and administration. Watchdog's wide variety of options justifies its comparatively high price.

Triticom EtherVision

Triticom's EtherVision (and its TokenVision and ArcVision) offers very good performance at a very competitive price. Although the software is still evolving (several revisions have greatly enhanced the product in the past several months), EtherVision is worth serious consideration.

FTP Software LAN Watch

The LAN Watch protocol analyzer gives businesses a software-only alternative to turnkey protocol analyzer systems. The product offers protocol decoding, full user programming, API options, and a subset of monitoring features (e.g., performance options, statistical display options, and some report generation and output options). After learning its command interface, users will find it a very solid and cost-effective product.

Rating Summaries

Figure 1.
Cheyenne Software Monitrix Ratings

Figure 2.
FTP Software LAN Watch Ratings

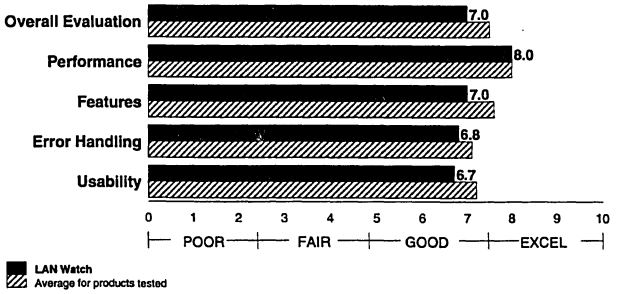


Figure 3.
Network General Watchdog Network Monitor Ratings

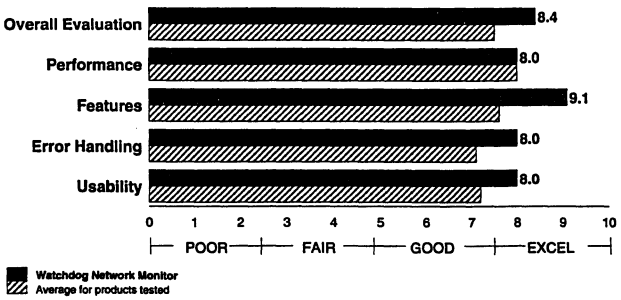


Figure 4.
Thomas-Conrad TXD Ratings

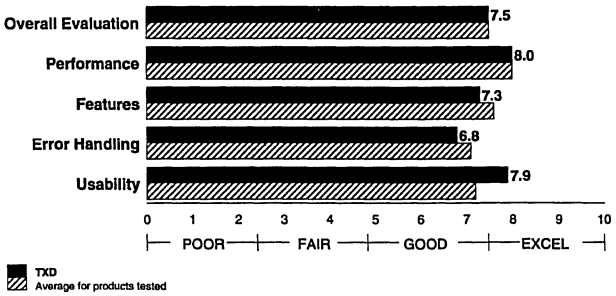


Figure 5.
Tiara Computer Systems Network Inspector Ratings

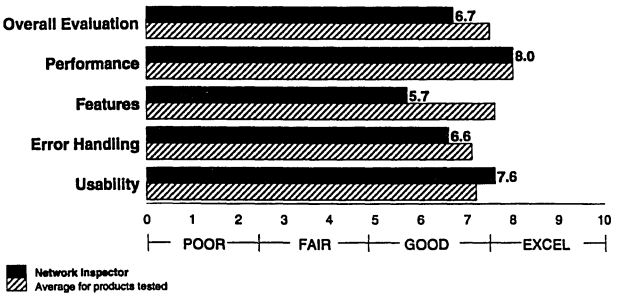
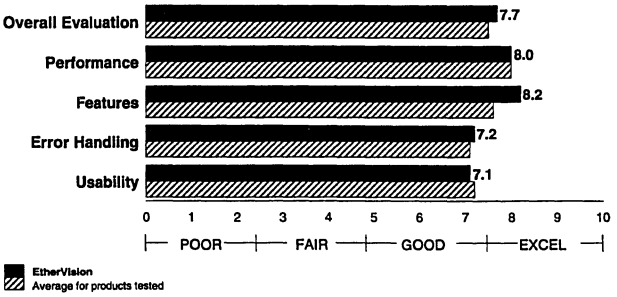


Figure 6.
Triticom EtherVision Ratings



Overall Evaluation

Although none of the test products provide interfaces to network management standards, network monitor and protocol analyzer software are best understood when viewed from an integrated network administration and management perspective. (FTP's LAN Watch is a protocol analyzer.) Both network monitoring (employed to characterize normal network performance patterns with the objective of avoiding problems) and protocol analysis (a management tool used to diagnose and correct network failures) are part of ISO's CMIS management task definition. ISO's CMIP network management standard is still in its formative stage, but none of the test products have an interface to the more mature SNMP standard. Cheyenne Software claims to be developing a network monitor compatible with SNMP. FTP Software offers a separate product with SNMP support.

Network General's Watchdog sets the standard for network monitor products in its class with excellent features, very good error handling, and usability.

Monitrix and EtherVision come close to Watchdog's standard. Between the two programs, EtherVision possesses more features, and Monitrix has a slight advantage in usability and error handling. EtherVision offers full network operating system independence, better statistical display features, many more report generation options, and superior alarm/threshold settings and event/error log options. Monitrix comes with very good documentation, device-independent installation, and uncomplicated setup. EtherVision's hardware diagnostics are adequate, with occasional unreliable response in some modules (see Diagnostics/Error Handling).

TXD makes a cost-effective, workstation-based monitor for NetWare environments with average features and marginal error handling capability. Its user manual provides one of the best problem determination and resolution sections, and it uses a good device-independent, NetWare installation procedure.

LAN Watch is probably the best software-based protocol analyzer in its price range. (Comparisons with strict network monitoring products are inappropriate.) Given its rudimentary network monitoring capability, LAN Watch offers a valuable tool for organizations needing protocol analysis with minimal monitoring functions at a low cost. LAN Watch is fully programmable. The unpretentious command interface can be somewhat difficult (the interface becomes easy, once learned), and documentation is limited.

Network Inspector may be a good product for Ethernet environments using Tiara adapters. Despite its single-network topology support, minimal network performance features, alarm/threshold settings, statistical display, network inventory management, and report generation capabilities, Network Inspector is a DLC-level monitor (a slight edge over workstation-based NetWare-only monitors). A recent price reduction brings the product more in line with competing monitor products, but Network Inspector's limitations do not justify even the lower price.

Methodology

The Overall Evaluation is a weighted average of scores for the individual criteria.

Overall Evaluation Score = (2 x Performance Score) + (6 x Versatility Score) + (2 x Diagnostics/Error Handling Score) + (4 x Usability Score) + (Testers' General Evaluation Score) ÷ 15.

Performance

The variety of network monitoring implementations represented among the test products precludes a fair comparison of their performance. Although performance receives low priority in the overall evaluations, all necessary performance factors are thoroughly tested and evaluated.

Strictly in terms of packet capture rates, Network Inspector and EtherVision outperform the other products. EtherVision's performance on a 286/12 system appears to peak between 3,000 and 4,000 packets per second (pps), after which the software begins to lose packets. On a 386/25, the capture rate rises to about 6,000 pps before excessive packet loss is detected. On a 486/33, packet loss is virtually eliminated even at the Ethernet saturation point of over 14,000 pps.

Network Inspector's results are somewhat inconsistent and a bit difficult to interpret. Its network utilization and packet capture statistics are very unreliable under high network saturation conditions on any hardware platform. Despite the faulty network utilization and capture statistics reporting, Network Inspector does not lose packets when running on the 386/25 and 486/33. On the

286/12, it loses packets under high traffic load conditions, but its cutoff point could not be reliably determined.

Packet capture rates reported by EtherVision and Network Inspector can be verified by the Network General Sniffer Analyzer's Ethernet monitor option at moderate traffic rates. At high traffic rates, the Sniffer Analyzer (in its basic analyzer mode) keeps up with the intense traffic only using its high capture rate option. Verifying packet capture rate (pps) became imprecise because a stopwatch was used for external timing.

Monitrix does not appear to lose packets even on the 286 platform at traffic rates below 10,000 pps. Again, the results do not characterize Monitrix' performance, but NetWare's.

Watchdog Network Monitor is somewhat slower than EtherVision and Network Inspector on all three processor platforms. Neither competitor generally loses packets on the 486/33 even at very high traffic intensity levels (around 14,000 pps), but Watchdog begins to miss packets even with minimal background traffic. EtherVision and Network Inspector report traffic intensity rates of approximately 8,000 pps; Watchdog reports 35 percent network utilization. Watchdog gives a precise count of all missed frames.

Up to its maximum error count rate of 65,535, Watchdog correctly reports missed packets as Unsaved Frames (frames it could not save to memory) or Missed Frames (frames it could not analyze). In the same context, EtherVision's Missed/Unprocessed status indicator reports when the hardware (adapter/PC) misses a frame and when the EtherVision software is unable to process a frame before its buffer fills up.

Protocol analysis slows LAN Watch's performance in comparison to simple network monitors. The other monitors simply check the source address field of each Ethernet media access control (MAC) frame; LAN Watch also checks the contents of each frame and filters out layers 3 through 7. Furthermore, the 3Com EtherLink Plus adapter's use of DMA may have caused LAN Watch to lose packets even at moderate traffic rates. FTP suggested using a faster network adapter, but the appropriate drivers were unavailable to accurately measure LAN Watch's performance.

Features

Highlighting Watchdog's excellent features are the software's full network operating system independence; very good user interface features such as flexible display options, numerical and graphical statistical displays, and topology display options; and excellent report generation. Watchdog's only limitations are a lack of user programming capability and alert notification and response options. The versatile EtherVision also provides full network operating system independence, with very good statistical display options, flexible report generation and output options, and excellent alarm/threshold setting and event/error log features.

Monitrix and TXD share the limitations characteristic of NetWare-specific monitors: network operating system dependence and inflexible performance options. An advantage of NetWare-specific monitors is their support of multiple topologies and internetworks. Server-based Monitrix supports reporting of LAN driver-level packets, a symbolic workstation naming service, and slightly better report generation and output flexibility; it also supports Microsoft Windows.

LAN Watch's dual network monitoring and protocol decoding capabilities give it an uncontested advantage over simple monitors. LAN Watch offers a protocol decode feature, user programming, and API options. Users are faced with a command line interface and only a subset of performance options, statistical display options, report generation and output options, and no alert notification and response options.

Network Inspector supports a single topology. Network performance monitoring limitations include no alarm/threshold settings, limited statistical display options, and an inability to automatically query nodes and obtain configuration information (at the minimum station addresses) compounded by the absence of report generation features.

Methodology

The Features rating is a weighted average of scores for individual network monitor and protocol analyzer functions. Features, grouped by category for scoring, and their methodology weights are presented in Table 2.

Diagnostics/Error Handling

A limitation common among the test products is an inability to detect specific Ethernet network errors such as a disconnected adapter in the host PC or unterminated network cables. Unlike the token-ring specification, Ethernet does not enforce diagnostics built into the adapter for such problems. Ethernet networks must rely on software products to circumvent such network problems.

NetWare-based monitors depend on NetWare for most network status checks and assessment of network-related error conditions. These products download network node configuration information when the monitor software is initialized (not a dynamic function); if a workstation is subsequently disconnected, the monitor continues to report the node's configuration information. Receipt of network configuration information is no guarantee that the network is up or that a workstation is still connected to the network.

Most DLC-level monitors do not detect or indicate network error conditions. LAN Watch, EtherVision, and Network Inspector return no error messages indicating that the network is open or that a workstation is disconnected when the monitor is activated. Watchdog returns error messages for these conditions. If these conditions develop once the monitoring session has been activated, none of the DLC-level monitors return corresponding error messages.

If the Monitrix front-end module is loaded on a workstation attached to a downed server, the workstation returns the correct error messages (e.g., "Failed to Find a File Server with Monitrix VAP/NLM Installed"), depending on the function being accessed. Statistical data gathered once the workstation-server link is broken may be erroneous.

TXD's error recovery is very poor and its error messages misleading. In the event of a disconnected workstation, TXD's Retry option almost always forces a break in the link; the only time TXD's Retry option does not break the link is upon exiting the program. When run from a disconnected workstation, TXD reports completely erroneous results, indicating no transmit or receive errors even though the workstation is physically disconnected from the network.

Among the DLC-level monitors, only Watchdog provides consistent error handling and error recovery capabilities. Except for the anomaly when a monitoring session is active (common to all the DLC-level monitors), Watchdog correctly recognizes error conditions such as unterminated cables, cable shorts, and disconnected adapters.

EtherVision's cable testing utility correctly detects unterminated cable, improper connections, and cable shorts; on rare occasions it completely locks the system. When a report is written to a printer port that is not physically connected, EtherVision locks the system. Network Inspector's cable testing and TDR functions exhibit problems similar to EtherVision's cable test utility. Even when the adapter is physically disconnected from the network, the Network Inspector's TDR function indicates "No Cable Problems Detected." Although TDRs primarily detect physical cable breaks, the information is of little use if the software cannot detect whether an adapter is connected to the cable.

LAN Watch does not offer hardware diagnostics such as a cable test or echo test. Adapter board diagnostics are separate from LAN Watch.

Methodology

The Diagnostics/Error Handling rating is a weighted average of scores for the individual criteria.

Diagnostics/Error Handling Score = (2 x Adapter Diagnostics Score) + (2 x Cable Test Score) + (2 x Point-to-Point Test Score) + (2 x Error Message Accuracy Score) + (Intuitiveness of Error Messages Score) + (Consistency of Error Messages Score) + (4 x Recovery from Error Conditions Score) ÷ 14.

Usability

Overall, the test products are extremely easy to install and, with the exception of LAN Watch, easy to operate. NSTL encountered problems configuring monitor products that come with an adapter and custom driver. Network General's Racal Interlan NI5210 driver and Tiara's LanCard/E*AT driver would not function properly when adapter configurations were changed from the default values. The Tiara card permitted login to a NetWare

network using any configuration option; the Network Inspector software would not work consistently except at the default setting. Similarly, the NI5210 would not communicate with the Watchdog driver when the default interrupt was changed to 7. Since interrupt 7 is generally used by the parallel printer port on ISA systems, the software probably requires that the printer port be physically disabled (other adapter/driver combinations do not require this). These configuration complications do not create problems unless several devices will be installed in the monitoring system.

NetWare-based Monitrix and TXD use accessible Novell-style menu interfaces and provide very good network inventory and configuration statistics that track workstations entering and leaving the network. Monitrix offers background operation, graphical representation of network topology and server/bridge nodes, and symbolic naming for workstation addresses as an alternative to 12-digit hexadecimal addresses.

Watchdog users will have to give slightly more thought to setup, option selection, and operational specifications. The feature-rich software uses a tree-structured menuing structure that requires a left-to-right movement to access submenus. Watchdog's structure is very logical and consistent, and once learned, becomes extremely easy to use. The Watchdog manual is well organized, clearly written, and comprehensive. The manual provides concise discussion of network basics and functional overviews, but no glossary of network monitoring and management terms.

EtherVision is extremely easy to install and operate. The software provides no on-line Help and comes with average documentation (it lacks organization).

Network Inspector uses the uncomplicated, Novell-style menu interface, and its user manual follows through with a similarly concise presentation. Although somewhat lacking in comprehensiveness and depth, the documentation provides a glossary, appendixes, and a good problem determination section.

The LAN Watch network monitor/protocol analyzer uses a command-driven interface with an unintuitive command syntax. Screen handling attributes are limited. The documentation is less than comprehensive, poorly organized, and not well illustrated. LAN Watch's hardware and software configuration and setup are cumbersome and demanding.

Methodology

The Usability rating is a weighted average of scores for individual criteria.

Usability Score = (4 x Hardware/Software Installation Score) + (2 x Configuration and Setup Score) + (4 x Interface Score) + (6 x Ease of Learning/Ease of Use Score) + (4 x Error Handling Score) + (5 x Manual Evaluation Score) ÷ 25.

Performance Results

The test products include two NetWare-specific monitors, one protocol analyzer, and three DLC-level Ethernet monitors. Any test methodology developed to evaluate performance tends to have an inherent bias toward one or another product. For example, using DLC-level packet capture as the basis for performance metering creates problems for NetWare-based monitors that select NetWare's IPX packet counts without necessarily reporting the DLC-level component separately. TXD reports IPX/SPX and shell driver transmit/receive packets, but not LAN driver packets. Monitrix reports IPX/SPX, shell driver, and LAN driver components. Furthermore, NetWare-based monitors make it difficult to isolate broadcast and other informational packets from the test packets. With some computation, NSTL was able to identify and count the test packets in Monitrix, but there is no simple way to get at DLC frames in TXD.

Faced with a multitude of similar testing and measurement problems, NSTL decided to consult with the product vendors in developing a comparative performance methodology. Discussions with most of the vendors revealed that a monitor's operational speed is not a very important factor.

Performance Factors

Packet Capture Rates

A network monitor's maximum packet capture rate is not always a meaningful predictor of performance. Provided a network performs normally (and given the fact that network applications rarely operate at the architecture's saturation point), having the product with the best packet capture rate will not necessarily be useful.

Raw capture rate (frames per second) statistics may be much more important for protocol analyzers than for network monitors. If a network monitor loses packets when broadcast bursts approach the network's saturation limit, the loss is not important as long as the product can count the lost packets. More important for a network monitor are its threshold setting flexibility, the thoroughness of its statistical reporting capability, and alert notification options. With a protocol analyzer, lost packets may contain the key to diagnosing an abnormal condition.

Hardware and Network Environment

The hardware and network environments under which a monitor or protocol analyzer operates dictate performance to a large degree. Packet size, interval spacing between successive packet transmissions, the application blocking factor (how many bytes the application can send as a block), and the PC hardware environment (CPU speed, memory read/write speed, and screen write speed) all influence network monitor performance. On an Ethernet network, any condition that contributes to increased collisions will reduce the performance of the monitor and analyzer products because of the increased processing required to identify and count collision fragments.

Software-only products that operate on generic hardware platforms offer more limited performance than network monitors and protocol analyzers that run on customized hardware. When software is designed to run on off-the-shelf network adapters, the vendor has limited flexibility in interfacing the adapter. Products running on customized adapters can be optimized for improved performance.

Although performance is weighted uncharacteristically low in NSTL's overall evaluation, all relevant performance factors were tested: frame capture rates (frames or packets per second; fps or pps), number of dropped packets as a percentage of pps, and the fidelity of monitor/analyzer statistics.

Test Network Configuration

The test network consisted of a Compaq 386/20 server running Novell NetWare/386 Version 3.1 and a number of workstations for a step-wise saturation of the network with traffic (Dell 486/33, two Compaq 386/25s, and several Everex Step 386iS systems). Monitrix and TXD were tested with Novell NE2000 Ethernet adapters in all nodes. Triticom supplied an NE2000-compatible Ethernet adapter for EtherVision. Watchdog uses a Racal InterLan NI5210 Ethernet adapter. FTP Software supplied a 3Com EtherLink Plus (3C505) for its LAN Watch protocol analyzer. Network Inspector software runs only on Tiara's Ethernet adapter products (tested with LanCard/E*AT).

As a standard procedure in NSTL LAN product evaluations, all test data, scripts, application programs, and custom program files are archived to a Maynard MainStream 1300 DAT backup system when each test project is completed. At the start of a new testing cycle, the applicable test data, scripts, application programs, and custom program files are restored to a control workstation. Test data, scripts, and programs are generated and/or modified based on the test methodology's specification. A batch program on the control workstation uploads all the application programs and custom test automation files to the server.

The network monitor and protocol analyzer products were tested on three processor platforms (Compaq 286/12, Compaq 386/25, ALR 486/33) in order to gauge the effect of CPU, memory read/write, and screen refresh speeds on performance. Results were verified by the Network General Sniffer Analyzer.

Tests were run once without background traffic. A fixed number of IPX packets (65,535) at the minimum Ethernet packet size were sent from a fixed send station on the network to an address not on the network. For the traffic scenario, a continuous blast of IPX traffic was generated by the Dell 486/33, incrementing gradually by adding traffic from the Compaq 386/25 and Everex systems as necessary. In all cases, only packets from the fixed send station were captured, and performance measurements are based only on the captured result. For products with filtering capability, all traffic from stations other than the IPX send station was filtered out.

Effect of Relative Processor

To analyze the effect of relative processor performance (286/12, 386/25, 486/33) on the monitor/analyzer products, NSTL repeats a test procedure with the software running on 12MHz 286, 25MHz 386, and 33MHz 486 systems. All other setup and configuration parameters remain constant. Relative performance index figures (with the 33MHz 486 as an index of 1) are used to calculate a CPU computing index, memory read/write time, and direct screen write time.

Analysis

The processor-relative performance test was prompted by NSTL's noticing that one product appeared to freeze at around 8,000 to 10,000 pps. According to the vendor, the software had not frozen, but it could not refresh the video fast enough to exhibit response to a command. Although the vendor corrected the problem, NSTL was compelled to examine the effect of the host hardware environment on monitor performance more closely.

The results of low-level processing, memory read/write, and direct screen tests show the Compaq 386/25's computing index to be 60 percent of the ALR 486/33's, and the Compaq 286/12 provides a mere 20 percent of the ALR 486/33's computing index (i.e., the 486/33 can perform arithmetic operations nearly five times faster than a 286/12). Differences in memory read/write speeds among the three processors exhibit the same general trend.

More surprising are the results of the low-level video test. Although the relative performance figures for the 486/33 and 386/25 using the same video board and monitor are almost equal (the slight difference attributable to the combined influence of driver software and CPU speed), the 286/12 with built-in video adapter takes only half the time required by the 486/33 to perform a direct screen write. These relative processor performance differences are borne out by the packet capture rate tests.

Missed Packets

Exactly 65,535 minimum-size Ethernet packets are transmitted across the network from a fixed send station to a nonexistent address with varying levels of background network traffic (verified by the Network General Sniffer Analyzer's Ethernet monitor option). Background traffic is generated by the Dell 486/33 at an average rate of 7,150 pps; then by the Dell 486/33 and one Compaq 386/25 averaging 9,350 pps; then by the Dell 486/33 and two Compaq 386/25s at 9,560 pps; then to the full load of the Dell 486/33, two Compaq 386/25s, and several Everex 386iS systems approaching the Ethernet saturation maximum of 14,800 pps.

The entire test suite is conducted with the test product running on the 286/12, then repeated with the product running on the 386/25 and 486/33. Results are expressed as the ratio of packets counted with traffic to the count obtained with no traffic (65,535).

Analysis

The increase in packet loss as Ethernet traffic levels increase seems to correlate with performance differences found with the three Intel processor platforms. On the 286/12, packet capture rates for most products seem to peak at around 3,500 to 5,000 pps, after which the software begins to lose a significant number of packets. Packet loss increases at between 6,000 and 8,000 pps on the 386/25 and at over 10,000 pps on the 486/33. EtherVision and Network Inspector rarely lose packets when running on the 486/33, even with network traffic approaching the Ethernet saturation limit of 14,800 pps. Because the Monitrix back-end traffic collection and monitoring function runs on the server, the processor platform at

the front end is not critical. The software does not appear to lose any packets even under heavy traffic conditions (over 10,000 pps), attesting more to the efficiency of NetWare than Monitrix.

Monitor software loses packets for a variety of reasons. The hardware (the network adapter and the CPU) may not be capable of keeping up with the increased network traffic activity. The software itself may not be capable of keeping up because of increased packet identification and sorting at higher traffic levels. On Ethernet networks, intensified network traffic activity increases the number of collisions, thereby increasing the likelihood of lost packets. Higher level (e.g., Transport layer) protocols cause retransmission of lost packets to ensure error-free delivery and data integrity. The effect of multiple retransmissions is appreciable network performance degradation.

Fidelity of Performance Statistics

The statistics reported by each product (for all the test configurations) are noted and compared with results for the other products and for the Sniffer network analyzer.

Analysis

A consistency check among the various network monitor and analyzer products compares their network traffic statistics reporting schemes. Although the utility of this test is limited, it shows that statistics obtained from network monitors may need to be verified independently, and the meaning of statistics should be closely analyzed to prevent misinterpretation. On the ALR 486/33, Network Inspector and EtherVision report frame transmission rates of 3,500 pps without traffic. When two Compaq 386/25 traffic-generating stations are added to the network, Network Inspector reports a transmission rate of 3,200 pps and EtherVision reports 10,000 pps. Presumably, Network Inspector is reporting the relative transmission rate of the network station being monitored rather than the absolute rate of the network.

Network utilization percentages should also be interpreted with caution. In the same test, Network Inspector, EtherVision, Watchdog, and the Sniffer Analyzer report very close network utilization statistics without traffic (16.3, 18.0, 16.94, and 16.9 percent, respectively). With the traffic load added by the two Compaq 386/25 stations, the corresponding values change to 15.1, 52.0, 14.1, and 13.5 percent, respectively. Again, EtherVision appears to be reporting on absolute network utilization, while the others indicate network utilization of the monitored station as a percentage of the total network bandwidth.

Vendors

Cheyenne Software, Inc.
55 Bryant Avenue
Roslyn, NY 11576 (516) 484-5110

FTP Software, Inc.
338 Main Street
Waterfield, MA 01880 (617) 246-0900

Network General Corp.
4200 Bohannon Drive
Menlo Park, CA 94025 (415) 688-2700

Thomas-Conrad Corp.
1908-R Kramer Lane
Austin, TX 78758 (512) 836-1935, (800) 332-8683

Tiara Computer Systems, Inc.
1091 Shoreline Boulevard
Mountain View, CA 94043 (415) 965-1700

Triticom
P.O. Box 11536
St. Paul, MN 55111 (612) 937-0772

Characteristics

Table 1. Ethernet Network Monitoring Tool Characteristics

	Workstation Requirements	Operating System Support	Network Operating System Support	Network Topology	Warranty and Support
Cheyenne Software Monitrix	System: ISA or EISA, 8088 and higher; Memory: 512KB; Operating System: DOS 3.0 and higher; Disk Space: 400KB	DOS 3.3x, 4.0x; Windows 3.0	Novell NetWare, Banyan VINES	Ethernet, token-ring, Arcnet; any NetWare-supported topology; multiple topologies in internetwork	Toll-free telephone support
FTP Software LAN Watch	System: ISA or MCA, 8088 and higher; Memory: 256KB; Operating System: DOS 2.0 and higher; Disk Space: 600KB	DOS 3.3x, 4.0x	Novell NetWare, IBM LAN Server, Microsoft LAN Manager, Banyan VINES, 3Com 3+Open	Ethernet, token-ring	Telephone support; license customers pay annual fee covering technical support and software upgrades
Network General Watchdog Network Monitor	System: ISA, EISA, or MCA, 80286 and higher; Memory: 512KB; Operating System: DOS 3.1 and higher; Disk Space: 500KB	DOS 3.3x, 4.0x	Novell NetWare, IBM LAN Server, Microsoft LAN Manager, Banyan VINES, 3Com 3+Open	Ethernet, token-ring; supplied adapter comes with 8KB onboard RAM	1-year warranty covering parts, labor, and two-way shipping; toll-free telephone support
Thomas-Conrad TXD	System: ISA, EISA, or MCA, 80286 and higher; Memory: 400KB; Operating System: NetWare 2.1x; Disk Space: 400KB	DOS 3.3x, 4.0x	Novell NetWare	Ethernet, token-ring, Arcnet, Starlan, TCNS; any NetWare-supported topology using IPX	3-month warranty covering parts, labor, and return shipment; 24-hour, toll-free telephone support
Tiara Computer Systems Network Inspector	System: ISA, EISA, or MCA, 8088 and higher; Memory: 640KB; Operating System: DOS 3.0 and higher; Disk Space: 360KB	DOS 3.3x, 4.0x; OS/2 1.1, 1.2 in DOS session	Novell NetWare, IBM LAN Server, Microsoft LAN Manager, Banyan VINES, 3Com 3+Open	8-/16-bit Ethernet (16 bit recommended); requires Tiara Ethernet adapter	3-month warranty covering parts, labor, and return shipment; toll-free telephone support
Triticom EtherVision	System: ISA, 8088, 80286 (recommended); Memory: 512KB; Operating System: DOS 3.1 and higher; Disk Space: 360KB	DOS 3.3x, 4.0x	Independent of network operating system; Novell NetWare, IBM LAN Server, Microsoft LAN Manager, Banyan VINES, 3Com 3+Open	8-/16-bit Ethernet; versions available for token-ring and Arcnet	3-month warranty covers parts, labor, two-way shipping; telephone support; software upgrades

Table 2. Ethernet Network Monitoring Tool Features

	Weight	Triticom EtherVision	FTP Software LAN Watch	Cheyenne Software Monitrix	Tiara Network Inspector	Thomas-Contad TXD	Network General Watchdog
Configuration Options							
Monitor Configuration Parameters							
Software Only	0	▲	▲	▲	—	▲	—
Software/Adapter Combination	0	▲	▲	—	▲	—	▲
Server Based	0	—	—	▲	—	—	—
Workstation Based	0	▲	▲	—	▲	—	▲
Maximum Servers	0	N	N	U	N	U	N
Maximum Workstations	0	1,024	1,024	U	1,024	U	1,024
Host System Support							
ISA Compatibles	0	▲	▲	▲	▲	▲	▲
EISA Compatibles	1	—	—	▲	▲	▲	▲
IBM PS/2 Micro Channel	1	—	▲	▲	▲	▲	▲
Apple Macintosh	0	—	—	—	—	—	—
Other	0	—	—	—	—	—	—
Operating System Support							
DOS 3.3x and Earlier	2	▲	▲	▲	▲	▲	▲
DOS 4.0x	2	▲	▲	▲	▲	▲	▲
Windows 3.0 under DOS	1	—	—	▲	—	—	—
OS/2 1.1	1	—	—	—	—	—	—
OS/2 1.2	1	—	—	—	—	—	—
SCO UNIX/SCO Xenix	1	—	—	—	—	—	—
Apple A/UX	0	—	—	—	—	—	—
Other	0	—	—	—	—	—	—
Network System Support							
Novell NetWare 2.1x	5	▲	▲	▲	▲	▲	▲
Novell NetWare 3.0	2	▲	▲	▲	▲	▲	▲
Novell NetWare 3.1	5	▲	▲	▲	▲	▲	▲
Banyan VINES 3.x	2	▲	▲	—	▲	—	▲
Banyan VINES 4.0	2	▲	▲	—	▲	—	▲
IBM PC LAN 1.3 and Earlier	1	▲	▲	—	▲	—	▲
IBM LAN Server 1.1	1	▲	▲	—	▲	—	▲
IBM LAN Server 1.2	2	▲	▲	—	▲	—	▲
3Com 3+Open 1.1	2	▲	▲	—	▲	—	▲
Microsoft LAN Manager 2.0	3	▲	▲	—	▲	—	▲
Other	0	—	—	—	—	—	—

▲—Yes, has feature.
INA—Information not available.
N—No distinction between server and workstation.
U—Unlimited.

Table 2. Ethernet Network Monitoring Tool Features (Continued)

	Weight	Triticom EtherVision	FTP Software LAN Watch	Cheyenne Software Monitrix	Tiara Network Inspector	Thomas-Contad TXD	Network General Watchdog
Network Topology Support							
Ethernet (IEEE 802.3)	2	▲	▲	▲	▲	▲	▲
Token-Ring (IEEE 802.5	2	▲	▲	▲	—	▲	▲
Token Bus (IEEE 802.4)	0	—	—	—	—	—	—
PC Network	1	—	—	▲	—	▲	—
Starlan	1	▲	▲	▲	—	▲	—
Arcnet	1	—	—	▲	—	▲	—
LocalTalk	1	—	—	—	—	—	—
Other	0	—	—	—	—	—	—
Internetwork Support							
Single Server	1	▲	▲	▲	▲	▲	▲
Multiple Servers	2	▲	▲	▲	▲	▲	▲
Single Segment	1	▲	▲	▲	▲	▲	▲
Multiple Segments	2	—	—	▲	—	▲	—
Remote Monitoring	1	▲	—	▲	▲	▲	—
Monitoring Performance							
Performance							
Frame Capture Buffer Size	0	INA	INA	INA	INA	INA	INA
Maximum Packet Capture Rate	0	INA	INA	INA	INA	INA	INA
Time Stamp Resolution	0	▲	—	—	—	—	▲
Realtime Traffic Monitoring	1	▲	▲	▲	▲	▲	▲
Background Traffic Monitoring	1	—	—	▲	—	▲	▲
Monitor Filters	1	▲	▲	—	▲	—	▲
Historical Overview	1	▲	▲	▲	▲	▲	▲
Missed/Unprocessed Frames	2	▲	▲	▲	▲	—	▲
Alarm/Threshold Settings							
Network Threshold Setting	2	▲	—	—	—	—	▲
Station Threshold Setting	1	▲	—	▲	—	▲	▲
Auto Alarm Clear	0	▲	▲	▲	—	▲	▲
Network Idle Time Alarm	1	▲	—	—	—	—	▲
Network Usage Alarm	1	▲	—	—	—	—	▲
Network Usage Time Interval	1	—	—	—	—	—	▲
Frame Error Alarm	1	▲	▲	▲	—	▲	▲
Frame Count Interval Alarm	1	▲	—	—	—	—	▲
Broadcast Alarm	1	▲	—	—	—	—	▲

▲—Yes, has feature.
INA—Information not available.
N—No distinction between server and workstation.
U—Unlimited.

Table 2. Ethernet Network Monitoring Tool Features (Continued)

	Weight	Triticom EtherVision	FTP Software LAN Watch	Cheyenne Software Monitrix	Tiara Network Inspector	Thomas-Contad TXD	Network General Watchdog
Alarm/Threshold Settings (Continued)							
Broadcast Interval Alarm	1	—	—	—	—	—	▲
Intruder Detection Alarm	1	—	—	—	—	—	—
Audible Alarms	1	▲	▲	▲	▲	▲	▲
Console/Station Message	1	▲	▲	▲	▲	▲	▲
Event/Error Log							
Log Error Frames	1	▲	▲	▲	—	▲	▲
Log Peak Utilization	1	▲	—	—	—	—	—
Write Event to File	2	▲	▲	▲	—	▲	▲
View Error Log	1	▲	▲	▲	—	▲	▲
Write Error Log to File	2	▲	▲	▲	—	▲	▲
Clear Error Log	0	▲	▲	▲	—	▲	▲
Protocol Interpretation							
MAC/LLC	3	▲	▲	—	▲	—	▲
Novell IPX/SPX	1	—	▲	▲	▲	▲	—
IBM NETBIOS	1	—	▲	—	—	—	▲
Other High-Level Protocols	1	—	▲	—	—	—	—
Troubleshooting and Diagnostics							
Adapter Diagnostics	2	▲	▲	—	▲	—	▲
Cable Test	2	▲	—	—	▲	—	▲
Single-Station Test	2	—	—	▲	▲	▲	▲
TDR	1	—	—	—	▲	—	—
Advanced Features							
User Programming	3	—	▲	—	—	—	—
APIs	2	—	▲	—	—	—	—
Programming Utilities/Libraries	2	—	▲	—	—	—	—
SNMP Interface	1	—	—	—	—	—	—
CMIP Interface	0	—	—	—	—	—	—
Other Interface	0	—	—	—	—	—	—
External Device Attachment	1	—	—	▲	—	—	—
Station Name Service	1	▲	—	▲	—	—	▲
User Authentication	1	—	—	▲	—	▲	—
User Interface							
System Interface							
Menu Interface Only	1	▲	—	▲	▲	▲	▲
Command Line Interface Only	1	—	▲	—	—	—	—

▲—Yes, has feature.
INA—Information not available.
N—No distinction between server and workstation.
U—Unlimited.

Table 2. Ethernet Network Monitoring Tool Features (Continued)

	Weight	Triticom EtherVision	FTP Software LAN Watch	Cheyenne Software Monitrix	Tiara Network Inspector	Thomas-Contad TXD	Network General Watchdog
System Interface (Continued)							
Menu and Command Line Interfaces	2	—	—	—	—	—	—
Graphical Interface	2	—	—	—	—	—	—
Online Help	1	—	▲	▲	▲	▲	▲
Display Options							
Text Mode Only	2	▲	▲	▲	▲	▲	▲
Skyline/ASCII Graphics Display	3	▲	▲	▲	▲	▲	▲
Station Display	1	▲	▲	▲	▲	▲	▲
Network Summary	2	▲	—	▲	—	▲	▲
Statistics Display							
Global Statistics	3	▲	—	—	—	—	▲
Single-Station Statistics	2	▲	▲	▲	▲	▲	▲
All-Station Statistics	1	▲	▲	—	▲	▲	▲
Frame Distributions	1	▲	▲	—	—	—	▲
Ethertypes	0	—	▲	—	—	—	▲
Alarm Log	1	▲	▲	▲	—	▲	▲
Topology Display							
Network/Internetwork List Table	2	▲	—	▲	—	▲	▲
View Servers/Bridges	2	—	—	▲	—	▲	—
View Workstations	2	▲	—	▲	—	▲	▲
Update Network Inventory	2	▲	—	▲	—	▲	▲
Graphical Network Component Display	3	—	—	▲	—	▲	—
Report Generation							
Report Options							
Report Scripts	3	▲	▲	—	—	—	▲
Script Editor Included	1	—	—	—	—	—	▲
Save Report to Disk	2	▲	▲	▲	—	▲	▲
Print Report	2	▲	▲	▲	—	▲	▲
Sorting	2	—	—	—	—	—	▲
Filtering	2	—	—	—	—	▲	▲
Export to Database	3	▲	—	▲	—	—	▲
Report Types							
Global Network Statistics	2	▲	—	▲	—	▲	▲
Station Statistics	1	▲	▲	▲	—	▲	▲
Network Utilization	1	▲	—	—	—	—	▲
Error Distribution Statistics	1	▲	▲	—	—	—	▲
Station Management Report	1	▲	—	—	—	—	▲

▲—Yes, has feature.
INA—Information not available.
N—No distinction between server and workstation.
U—Unlimited.

Table 2. Ethernet Network Monitoring Tool Features (Continued)

	Weight	Triticom EtherVision	FTP Software LAN Watch	Cheyenne Software Monitrix	Tiara Network Inspector	Thomas-Contad TXD	Network General Watchdog
Alert Notification and Response							
Notification Options							
E-Mail Message	5	—	—	▲	—	—	—
Voice Message	2	—	—	—	—	—	—
Numeric Pager	1	—	—	—	—	—	—
Alpha Pager	1	—	—	—	—	—	—
Fax	1	—	—	—	—	—	—
Other Notification	1	—	—	—	—	—	—
Response Options							
Clear Connection(s)	1	—	—	—	—	—	—
Backup/Delete Server Files	0	—	—	—	—	—	—
Server Shutdown	0	—	—	—	—	—	—

▲—*Yes, has feature.*
INA—Information not available.
N—No distinction between server and workstation.
U—Unlimited.

Glossary of Terms

Configuration Options

Monitor Configuration Parameters

Software Only: A software-only product is fully device independent.

Software/Adapter Combination: The product is marketed as a combination software/network adapter module. The product may work with a single network adapter or offer multiple software/adapter combination modules.

Server Based: The monitor runs on the network server as VAP (NetWare 286) or an NLM (NetWare 386) and works with all network adapters the server supports. On NetWare networks, the monitor can collect traffic statistics across bridges/routers and realizes all security measures imposed on the network server. Monitoring is limited to information NetWare gathers on the network.

Workstation Based: The network monitor runs on a workstation and gathers server traffic statistics like any other network node. Some workstation-based monitors are limited by dependence on the network operating system for gathering statistics. Monitors that interface the network at the Network layer, rather than at the Data Link layer, use the network operating system's transport agent. Workstation-based monitors are judged on the efficiency of the code (i.e., not occupying too much memory) and their capability to run in the background (i.e., not requiring a dedicated workstation).

Maximum Servers: This indicates the maximum number of interconnected servers for which the network monitoring software can gather traffic statistics while recognizing the server as distinct from workstations. The capability to distinguish servers and workstations suggests dependence on the network operating system for gathering traffic statistics.

Maximum Workstations: This is the maximum number of workstations for which the network monitor can collect network statistics. Normally, network monitors that are independent of the network operating system do not distinguish between servers and workstation nodes. The theoretical maximum for workstation nodes should be the same as the theoretical maximum for the underlying network topology.

Host System Support

ISA Compatibles: The monitor runs on all Industry Standard Architecture (ISA) bus (IBM PC AT) hosts, including all 80286, 80386, and 80486 systems, without additional hardware and software products.

EISA Compatibles: The monitor runs on all Extended Industry Standard Architecture (EISA) bus (80286, 80386, and 8486) host systems without additional hardware and software products.

IBM PS/2 Micro Channel: The monitor runs on all IBM Micro Channel Architecture (MCA) bus (PS/2) hosts, including all 80386 and 80486 systems, with minimal changes in the device driver software.

Apple Macintosh: The monitor runs on Motorola 68000 processor-family Apple Macintosh systems with additional device driver software.

Other: The monitor supports hardware platforms other than those listed previously.

Network Topology Support

Ethernet (IEEE 802.3): The monitor interfaces with, and collects traffic on, IEEE 802.3 Ethernet networks, in addition to any other topologies it might support.

Token-Ring (IEEE 802.5): The monitor interfaces with, and collects traffic on, IEEE 802.5 token-ring networks, in addition to any other topologies it might support.

Token Bus (IEEE 802.4): The monitor interfaces with, and collects traffic on, IEEE 802.4 token bus networks, in addition to any other topologies it might support.

PC Network: The monitor interfaces with, and collects traffic on, IBM PC networks (baseband and broadband), in addition to any other topologies it might support.

Starlan: The monitor interfaces with, and collects traffic on, Starlan networks, in addition to any other topologies it might support.

Arcnet: The monitor interfaces with, and collects traffic on, Arcnet networks, in addition to any other topologies it might support.

LocalTalk: The monitor interfaces with, and collects traffic on, Apple LocalTalk networks, in addition to any other topologies it might support.

Other: The monitor can run on network architectures other than those listed, such as Digital Equipment DECnet Ethernet and Sun Microsystems NFS Ethernet.

Internetwork Support

Single Server: The monitor collects traffic on a network controlled by a single server; it recognizes the server as a node with special resource management and request servicing attributes.

Multiple Servers: The monitor collects traffic on a network with multiple servers identified as being distinct from workstations.

Single Segment: The monitor collects traffic statistics on a single-segment (nonbridged) network. Single-segment monitors are unaffected by passive repeaters.

Multiple Segments: The monitor can gather traffic on multisegment networks, across bridges and/or routers by virtue of the host operating system's support for mixed topologies and internal bridging (especially those run on a server as NLMs in NetWare 386 or VAPs in NetWare 286). NetWare-specific monitors can function in a multisegment environment, whether they are server based or workstation based, because of the embedded NetWare feature.

Remote Monitoring: The monitor software can be run remotely via a gateway or modem connection.

Monitoring Performance

Performance

Frame Capture Buffer Size: This is the amount of host memory the software can set aside for name tables, workstation traffic statistics, global statistics, event and error logs, alarm threshold specifications, and all other data items it requires to monitor and report on network activity for a specified period. Protocol analyzers require much larger buffers than network monitors; analyzers that take advantage of expanded/extended memory are more desirable than those that run only in conventional memory.

Maximum Packet Capture Rate: This is the maximum number of incoming and outgoing packets the software can "see" and process for filtering and statistical reporting without dropping packets.

Time Stamp Resolution: The monitor supports variable time interval settings for a specified monitoring session or defined alarm threshold specifications.

Realtime Traffic Monitoring: The software displays monitoring activity as it is being performed in the foreground session.

Background Traffic Monitoring: Monitoring can be carried out in background mode while the host runs other

applications in the foreground. Collected data can be viewed in the foreground at a later time.

Monitor Filters: The monitor can collect traffic data based on preset criteria. Filters let administrators focus on suspect devices or critical nodes or simply screen out unwanted data.

Historical Overview: The monitor can track traffic history on the entire network or on selected stations over a specified time.

Missed/Unprocessed Frames: The monitor tracks frames that were missed or unprocessed because the buffer is full or because the hardware (adapter/host PC) or monitoring software cannot keep up.

Alarm/Threshold Settings

Network Threshold Setting: The monitor allows one uniform network-wide threshold alarm setting, in addition to any individual workstation settings.

Station Threshold Setting: The monitor provides separate threshold settings for individual workstations.

Auto Alarm Clear: The monitor automatically clears alarms from the alarm buffer after a specified interval.

Network Idle Time Alarm: The monitor generates an alarm when it detects a specified period of no network activity.

Network Usage Alarm: The monitor generates an alarm at a specified percentage of absolute network usage.

Network Usage Time Interval: The administrator can specify the interval of time over which the network usage alarm will be monitored.

Frame Error Alarm: The monitor generates an alarm after a specified absolute frame error count.

Frame Count Interval Alarm: The administrator can specify the time interval during which a given number of frame errors (soft errors, alignment, CRC, collision fragments) will be tolerated before an alarm is generated.

Broadcast Alarm: The monitor generates an alarm after a specified number of frames are sent to a broadcast address.

Broadcast Interval Alarm: The administrator can specify the interval of time during which the broadcast alarm threshold setting will be checked.

Intruder Detection Alarm: A threshold setting indicates whether the monitor should generate an alarm when it detects an unknown station address entering the network.

Audible Alarms: The monitor can sound an audible alarm on critical error conditions or exceeded threshold settings.

Event/Error Log

For most network monitors, network event and error logging options include logging error frames, logging peak network utilization, writing an event to a file, viewing the error log, saving the error log to a file, and clearing the error log.

Protocol Interpretation

MAC/LLC: The monitor can decode protocols at the Data Link layer's MAC and LLC sublayers in order to identify source and destination address information and possibly filter traffic based on station address ID.

Novell IPX/SPX: The monitor can decode the Novell IPX/SPX protocol for diagnostic purposes.

IBM NETBIOS: The monitor can decode the IBM NETBIOS protocol for executing remote status request commands in order to assign symbolic names to stations.

Other High-Level Protocols: The product can decode high-level protocols other than those listed.

Troubleshooting and Diagnostics

Adapter Diagnostics: The monitor software includes an adapter diagnostics module.

Cable Test: The product supports continuous testing of the network cable for shorts, improper terminations, and cable breaks.

Single-Station Test: The monitor software can test for a single-station response using one or any combination of the following test frame protocols: NETBIOS, IEEE 802.2, XNS Echo, and DIX Loop.

TDR: The monitor software provides an intelligent time domain reflectometer test for precise determination of cable breaks and open or shorted electrical circuits.

Advanced Features

User Programming: The vendor encourages user programming to create special filters and protocol interpreter suites.

APIs: The monitor software provides application programming interfaces for users and application programmers.

Programming Utilities/Libraries: The monitor's main software module incorporates libraries and utilities for programming extensions or enhancements.

SNMP Interface: The monitor software has an interface to the TCP/IP-based SNMP network management standard.

CMIP Interface: The monitor software has an interface to the ISO model's CMIP network management standard.

Other Interface: The monitor software has an interface to any proprietary network management standard.

External Device Attachment: The monitor software has an interface to an external device for alert notification.

Station Name Service: The monitor software can automatically scan network addresses, and the user can attach symbolic names to those addresses.

User Authentication: The monitor software provides a means of authenticating a user before granting access to traffic on the network.

User Interface

System Interface

This specifies the monitor's primary interface method.

Display Options

Text Mode Only: The monitor displays collected data in text mode only, giving individual station and network summary statistics numerically.

Skyline/ASCII Graphics Display: The monitor can display captured traffic data in an ASCII summary graphics form, in addition to the normal numerical data display.

Station Display: The monitor can display captured traffic data for selected stations or for all stations, including total frames counted, amount of data (KB), usage rate, average frame size, and error count.

Network Summary: The monitor can display captured traffic data for the entire network in summary form, showing total frame count, amount of data (KB), usage rate, average frame size, and error count.

Statistics Displays

Global Statistics: The product can display traffic statistics numerically or graphically for the entire network, showing total stations that have transmitted frames, average usage, total frames counted, bytes transmitted, average frame size, number of active stations, error counts, and time stamps.

Single-Station Statistics: The product ca display single-station statistics graphically or numerically, showing most of the items as in the global statistics with few exceptions.

All-Station Statistics: A view gives statistics for all stations on the network either numerically or graphically, sorted by any key in ascending or descending order.

Frame Distributions: The product can display the distribution of frames by size and each size's percentage of the group.

Ethertypes: The product can display the number and percentage of bytes or frames for each protocol or Ethertype associated with a packet.

Alarm Log: The product can display a list of alarms generated in the current session that have not been cleared or logged to a file or a printer.

Topology Display

Network/Internetwork List Table: The product scans and displays a list of network nodes in single- and multi-segment networks, including node addresses and configuration parameters.

View Servers/Bridges: The product provides a view of servers and bridges and their configurations (available only with NetWare-specific monitors).

View Workstations: The product provides a view of workstations and their configurations.

Update Network Inventory: The product automatically updates the network (internetwork) list as nodes are added or deleted.

Graphical Network Component Display: The product offers a graphical representation of nodes on the network or internetwork.

Report Generation

Report Options

Report Scripts: The monitor software supports templates defining items in specific statistical reports. Some products provide report types with fixed items (e.g., traffic statistics, frame size distribution).

Script Editor Included: The monitor includes a built-in script editor for modifying sample scripts.

Save Report to Disk: The monitor software can write collected data to a disk after monitoring has been stopped.

Print Report: The monitor software can write collected data to a printer after monitoring has been stopped.

Sorting: The monitor can sort report items.

Filtering: The monitor can filter some items from collected statistics for inclusion in reports.

Export to Database: The network monitor software can export captured traffic data to comma-delimited format files for incorporation into spreadsheets and database programs for further analysis.

Report Types

Global Network Statistics: The monitor software provides a summary report highlighting total frames and bytes captured, the peak and average frame/byte capture rates, specific error types and counts, and resource usage.

Station Statistics: The product provides information on selected workstation(s) or all network stations in alphabetical order or sorted on some other key, showing name, number of frames, number of bytes, and percentage of relative usage per station.

Network Utilization: The product generates a summary report on absolute network utilization by individual stations.

Error Distribution Statistics: The product reports on error distributions among all network stations, selectively showing stations with the most errors.

Station Management Report: The product reports the names and addresses of all known network stations.

Alert Notification and Response

Notification Options

E-Mail Message: The product sends alerts and warnings to the designated administrator via an E-Mail or other network messaging system.

Voice Message: A voice message notification option transmits alerts and warning by telephone.

Numeric Pager: The product can use a Hayes-compatible modem to call a paging system and send a numeric code to the system using tone dialing.

Alpha Pager: The product can send alert messages via an alphanumeric paging system.

Fax: The product can send alert messages to a fax machine or fax modem.

Other Notification: The product supports a user-specified alert notification method, including batch files and custom programs.

Response Options

Clear Connection(s): The monitor software can initiate an action to disconnect a station with excessive error conditions.

Backup/Delete Server Files: The monitor runs batch files to back up and delete user-specified files on the server disk (currently supported by NetWare-specific monitors only), suggesting that the product monitors critical network resources.

Server Shutdown: The monitor can log out users and shut down the server without data loss in order to avert a disaster condition.

Product Prices

		Purchase Price ($)
Ethernet Network Monitoring Tools		
	Cheyenne Software Monitrix (maximum 4 internetworks)	895
	FTP Software LAN Watch	1,200
	Network General Watchdog Network Monitor (software/Ethernet hardware combination)	1,995
	Thomas-Conrad TXD (per site)	195
	Tiara Computer Systems Network Inspector	199
	Triticom EtherVision	225

■

QIC-525 Backup Devices

A Report from NSTL

In this report:

Synopsis

Focus

NSTL evaluated ten quarter-inch cartridge (QIC) tape backup systems, rating the devices on performance, features, and usability. NSTL also describes QIC technology and compares it with competing backup technologies.

Products Tested

Retriever/525
Alloy Computer Products, Inc.

RapidRecover 525
Emerald Systems

Excel 525
Everex Systems, Inc.

IDT 320/525
Identica

MaynStream 525Q
Maynard Electronics

FileSafe 7500
Mountain Network Solutions, Inc.

ST 525
Sankyo Seiki

FS1000
Tallgrass Technologies

Panther 525
Tandberg Data, Inc.

Proline 525
Tecmar, Inc.

Source

Based on data generated by tests designed and conducted by National Software Testing Laboratories, Inc. (NSTL), a division of Datapro Information Services Group, Plymouth Meeting, PA 19462. Telephone (800) 223-7093.

Ratings Key
(On a scale of 0 to 10)
Ratings
● 7.0 - 10.0
○ 5.0 - 6.9
◍ under 5.0
★ Recommended

Overall Evaluation	Product Name	Performance	Features	Usability	Price (Test Configuration)
Workstation-based					
8.6	Maynard MaynStream 525Q	●	●	●	$3,695★
7.9	Mountain FileSafe 7500	●	●	●	$3,995
7.6	Alloy Retriever/525	●	○	●	$2,295
7.5	Tandberg Panther 525	○	●	●	$2,595
7.2	Tallgrass FS1000	○	●	●	$2,695
7.1	Everex Excell 525	●	○	●	$1,995
6.7	Identica IDT 320/525	◍	●	●	$2,145
6.6	Emerald RapidRecover 525	○	○	●	$3,495
Server-based					
8.0	Sankyo ST 525	●	●	●	$2,470★
8.0	Tallgrass FS1000	●	●	●	$4,390
7.9	Tecmar Proline 525	●	●	●	$4,495
6.4	Emerald RapidRecover 525	◍	○	●	$4,390

Overview

Personal computers and network servers with on-line, mass storage capacities of several gigabytes necessitate the use of high-capacity backup and archiving subsystems. Even when backup and archival of data on primary storage media are not critical, the finite capacity and nonremovable nature of PC hard disk subsystems make secondary storage almost a necessity. Streaming tape recording media continue as the backbone of computer backup and archiving.

Quarter-inch cartridge (QIC) systems currently compete with two other tape technologies from the consumer electronics market: 4-mm. Digital Audio Tape (DAT) and 8-mm. videocassette tape. Based on the videocassette recording technique and using the digital data storage (DDS) specification advanced by Hewlett-Packard and Sony Corp., DAT technology offers recording capacity from 1G byte to 2G bytes on a minicartridge and from 2G bytes to 5G bytes on the 8-mm. videocassette tape (sourced only by Exabyte Corp. of Boulder, CO). Rewritable optical and write-once-read-many (WORM) optical drives are also among the alternatives.

The attraction of QIC drives centers on high-capacity, low media cost, and fast file access capability weighed against high drive costs, low data transfer rates, and incompatibility between different manufacturers' drives and data recording formats. The ratings chart summarizes the specifications and other performance characteristics of several secondary storage media and technologies.

Evaluation Criteria

NSTL evaluated ten QIC-525 tape drive subsystems marketed by leading backup and archiving subsystem vendors. The Emerald, Sankyo, Tallgrass, and Tecmar were tested attached to a server; the other six worked with workstations (the Emerald and Tallgrass were also tested as workstation-attached units devices).

Archive Corp. (Costa Mesa, CA), Sankyo Seiki America (Torrance, CA), Tandberg Data (Westlake Village, CA), Wangtek Corp. (Simi Valley, CA) supplied the drive mechanisms for the test products. All the products use 16-bit Adaptec 154X SCSI adapters or proprietary SCSI adapters. The Tallgrass FS1000 uses an 8-bit adapter in the workstation-attached configuration.

None of the commercially available 1G-byte QIC-1000 or 1.35G-byte capacity QIC-1350 drives were available for testing.

QIC Drive Technology

QIC-525 and QIC-320 recording technology writes data to tape using a complex, multihead assembly. Current QIC-320/525 drive configurations employ two pairs of read/write heads on two tracks and a full-width erase head. (QIC-320 and QIC-525 drives differ with respect to recording media.) QIC-320 drives use a 600-foot DC-6320 tape cartridge, and QIC-525s use the 1,020-foot DC-6525 cartridge. The drives record data by running tape past a stationary-head assembly at up to 120 inches per second (ips). (Most QIC-525 drives also operate at 90 ips to maintain compatibility with QIC-120/150 drives.) Data is recorded serially on a straight track using Group Coded Recording (GCR) encoding method. The tape then reverses direction, and data recorded on a parallel track (26 tracks total vs 18 in QIC-120/150 format) in a serpentine pattern.

Host Adapter Interface

Like DAT backup systems, QIC drives are gradually adopting the SCSI peripheral interface standard as a means of connecting to desktop systems. The SCSI-I specification defines a standard interface consisting of a cascaded or multiplexed bus of nine data bits and nine control signals. The bus supports the connection of any combination of up to eight host and peripheral devices (known as Initiator and/or Target devices), with SCSI bus functions assigned to both the host and peripheral. A SCSI peripheral device such as a QIC backup tape drive connected to the SCSI bus is known as a Logical Unit (LU).

The SCSI peripheral interface provides some unique advantages not available with other types of fixed-function device interfaces. The SCSI interface affords great flexibility in connecting a combination of peripheral devices and high throughput rates. SCSI controller buffer memory allows the host computer to transfer data at burst rates and then attend to other tasks while the drive automatically writes the data to tape. Buffer memory for 525M-byte QIC devices often ranges between 128K bytes and 512K bytes; 256K bytes being the standard. Cooperation between QIC manufacturers and SCSI adapter vendors has resulted in readily available device drivers for all commonly used operating systems.

QIC-525 Drive Design

Major QIC-525 tape system manufacturers use Archive, Sankyo, Tandberg, or Wangtek drive components. The Alloy and Maynard use Archive drives; Emerald, Tallgrass, and Tecmar employ the Wangtek drive; and the Everex, Identica, and Sankyo are based on a Sankyo drive. Mountain and Tandberg use the Tandberg drive. Specific electronics and drive component interconnections may vary, but the major functional components of state-of-the-art QIC drives are quite similar.

QIC Media Technology

Quarter-inch data cartridge technology developed and marketed by 3M claims over 6 million installations. Advances in materials technology and polymer chemistry have contributed to the media's performance, capacity, and longevity. Improvements in media formulation (high coercivity, cobalt-modified gamma ferric oxide pigments), better tape substrate and binders, and improved mechanical design (double-textured drive belt, corner-roller and hub, and better lubrication) give rise to data cartridges with capacities exceeding 1G byte.

Current Market

Until a year ago, QIC-150M-byte tape models dominated the market, but QIC-525 is quickly taking the lead. QIC-1000 (1G-byte) drives are being released in limited quantities until QIC-1350 devices are fully established. Tandberg Data and Wangtek currently manufacture 1G-byte drives that are plug compatible with QIC-525 drives. The 1.35G-byte QIC-1350 data format should achieve transfer rates of 600K bytes per second, nearly three times faster than the 525M-byte QIC drives. Even more interesting, an

upcoming QIC-6000 standard promises a 6G-byte tape capacity by the mid-1990s. Several vendors add advanced data compression techniques to double effective quarter-inch tape capacity. Although DAT devices have gained momentum in the high-capacity backup and archiving arena because of several attractive features (e.g., quick file access, high capacity, low form-factor, low media cost), QIC drive manufacturers are unwilling to give up on the quarter-inch cartridge tape technology.

Applications

QIC drives are compatible with a wide range of software platforms including MS-DOS, OS/2, UNIX, Apple Macintosh, and various network operating systems. All the test QIC devices run on PCs under MS-DOS 5.0. Tecmar, Tallgrass, Identica, Sankyo, and Tandberg offer units that work with Apple Macintosh systems. Alloy, Identica, Maynard, Mountain, Sankyo, Tallgrass, and Tandberg supply drivers for the UNIX/Xenix environment. Except for Alloy, Emerald, and Everex, all the vendors support OS/2 Versions 1.1 and 1.2.

NSTL tested the systems with Novell NetWare 3.11, and the systems support all NetWare versions in workstation- and server-attached configurations with few exceptions. Emerald does not support NetWare 286 2.15 and earlier versions. Emerald, Sankyo, Tallgrass, and Tecmar support direct attachment to NetWare servers operating with VAP or NLM drivers. The others were tested attached to a workstation. The Alloy, Identica, and Tandberg also work with Cheyenne Software's ArcServe, indicating that they can be used in server-attached configurations as well. Support for Banyan VINES and its StreetTalk global naming service is less universal. Currently, only Maynard provides workstation support for VINES, backing up both data files and the StreetTalk-based resource database.

Support for OS/2-based networks is somewhat mixed. Identica, Maynard, Mountain, Tallgrass, and Tandberg support IBM LAN Server, Microsoft LAN Manager 2.0, and 3Com 3+Open as workstation-attached devices; Mountain does not support IBM LAN Server 1.3 or Microsoft LAN Manager 2.0. All drives supporting the OS/2 version of Sytron's Sytos Plus backup software should work as server-attached devices in OS/2 LAN environments, although many do not specify support for OS/2 LAN server-attached configuration. Tandberg Data indicates that its IBM OS/2 LAN Server attachment provides full support for backing up OS/2 1.3 HPFS partitions.

Workstation-based units are best for backing up and restoring both workstation and server disks and when security is not a primary concern. Server-attached devices are best suited to the needs of organizations with centralized file storage strategies and in environments where security and fault-tolerance are primary concerns. Remote workstation backup (i.e., backing up workstation disk files to server-attached devices), while conceptually attractive, may be impractical because of very slow performance. Most server- and workstation-attached QIC-525 devices that support NetWare environments back up and restore NetWare bindaries and access rights very well and provide workable strategies for handling open files and locked records (e.g., maintaining a skipped files list).

Similar concerns should be addressed when considering QIC-525 backup devices in other network environments with different filing systems. For OS/2 LANs, the backup device must work with the OS/2 High Performance File System (HPFS), not just the old FAT format file structure. For Banyan VINES networks, the backup software should be capable of handling VINES' StreetTalk global naming and resource database structure. To date, only Maynard provides full support for the StreetTalk resource database and file backup in a workstation-attached configuration.

Performance test results reveal a variety of workable configurations for the NetWare/386 environment. While the performance of workstation-attached QIC-525 devices compares with or surpasses the server-attached devices, an argument can be made for a lower cost workstation-attached configuration rather than loading the server with an NLM application. The advantage begins to disappear as the performance of workstation-attached devices begins to deteriorate in the 50MB directory tests, with the potential for poor performance in server disk backups with multiple

Quick File Access (QFA)

QFA is a relatively new tape technology whose primary design objective is to locate files very quickly, thereby allowing fast restores. Selective restores are the most frequently used tape operations in realtime in network applications. Random files can become corrupt, or users can delete important files from the server or workstation, and these files must be found and restored from tape backup. The QFA performance measures mainly the effectiveness of the backup system in managing its directory structure.

Most tape backup software products implement the QFA feature by creating a volume table on tape (or on disk), containing address information for directories and files for the particular backup set or volume. Tape drives that are equipped with the QFA feature use a special directory track that enables them to locate the directory and file block addresses. When accessing files for restore, the drive has the capability to locate those address blocks rather than making a sequential serpentine sweep of the tape. In addition to selective restores, the QFA feature also speeds up the process of small file appends and modified file backups.

Although QFA was not fully implemented on some systems and partially implemented on others (except on the Mountain FileSafe 7500 and Tallgrass FS1000 among workstation-attached devices and Tecmar Proline 525 and Tallgrass FS1000 among server-attached ones) as originally received for testing, the test was not used as one performance criterion. Instead, systems were awarded scores in the features evaluation section. Tandberg and Maynard sent us upgraded firmware and drivers to test the QFA feature close to the end of our test cycle.

For QIC-525 tape backup systems evaluated with the QFA feature, the time required to restore the 1K-byte file to a RAM disk ranged from just under two minutes for Maynard to over five minutes for the server-attached drives. Only Mountain currently makes full use of the QFA feature for quick appends as well. The FileSafe software was capable of appending the 1M-byte file to the end of the 300M-byte, 12 backup set (see QFA Test in Performance Results section) in a record 1 minute 26 seconds.

volumes and extended directory structures. Placing the backup workstation in a secured room increases the configuration cost by adding a dedicated workstation. Traffic congestion on the wire becomes a nonissue when backups are run during off-peak hours. No single solution satisfies all network and application environments; users must select a configuration that best meets their application needs.

Backup programs supplied with the test devices offer similar options for controlled and automated backups, including unattended/scheduled backups, script/batch files, automatic tape formatting, automatic verification, user-selectable backup verification, and multiple tape backups. All keep backup, restore, error, and schedule log files.

Features such as quick file access (QFA), data compression, and data encryption are less universal. Only the Tallgrass, Identica, and Tandberg Identica support data compression. All support tape password protection. Most come with built-in diagnostics, and a few offer separate diagnostics utilities.

The Future of QIC Backup Systems

In addition to backup/archive capabilities, QIC tape drives can distribute software and data files; load system programs; transfer data between locations; and exchange data between systems. Although capacity may not be a factor in some of these applications, quarter-inch tape may be the only viable medium available. Applications for QIC drives will continue to grow as technological advances for capacities of 1G byte to 6G bytes and beyond mature and stabilize. Data compression techniques complement advances in high-capacity QIC drives.

Longer tapes are expected as new tape coatings permit the use of thinner tape. Thinner tape will increase cartridge capacity without altering recording densities or drive hardware. Other anticipated improvements are tied into advancements in SCSI technology (e.g., higher transfer rates, larger command sets), enabling advanced features such as the ability to detect remaining tape capacity.

Product Evaluations

Alloy Retriever/525

Product Summary

- 16-bit Adaptec 154X B adapter
- Archive drive
- ResQLAN proprietary software (basic code licensed from Performance Technology)
- Workstation based
- Bus master DMA data transfer method
- Two SCSI ports support up to seven daisy-chained devices
- Second ranked performance for workstation-attached devices

Emerald RapidRecover 525

Product Summary

- Emerald Systems proprietary 16-bit SCSI adapter
- Wangtek drive
- EmSave (workstation attached), EmQ (server attached), XPress Librarian proprietary software; ArcServe (server attached)
- Workstation or server based
- DMA data transfer method
- No support for daisy-chaining
- Slow restore capability

Everex Excel 525

Product Summary

- Everex EV8116 16-bit proprietary adapter
- Sankyo Seiki drive
- STape proprietary software
- Workstation based
- DMA data transfer method
- Supports up to seven daisy-chained devices
- Very good restore and verify performance among workstation-attached units

Identica IDT 320/525

Product Summary

- 16-bit Adaptec 1542 B adapter
- Works with 8- or 16-bit adapter (tested w/16-bit adapter)
- Sankyo Seiki drive
- Sytos Plus software
- Workstation based (or server based with ArcServe software)
- DMA data transfer method
- Supports up to seven daisy-chained devices
- Limited performance

MaynStream 525Q

Product Summary

- Maynard 16-bit proprietary SCSI adapter
- Archive drive
- MaynStream proprietary software
- Workstation based
- DMA or programmed I/O data transfer method
- SCSI port supports up to seven daisy-chained devices
- Excellent performance; fastest overall among workstation-attached devices

Mountain FileSafe 7500

Product Summary

- Mountain 16-bit SCSI proprietary adapter
- Tandberg drive
- FileSafe proprietary software
- Workstation based
- DMA or programmed I/O data transfer method
- Two SCSI ports support up to three daisy-chained devices

Importance of Buffer Size on Backup Performance

It is common knowledge that the number of disk buffers that DOS assigns as cache at start-up time affects the performance of different applications to different degrees. Hence, the exact number of buffers for optimal performance is application dependent. Applications requiring lots of random disk read/write requests would generally benefit from a relatively larger number of buffers. Although the DOS recommended range for database type applications is between 10 and 20 buffers for optimum performance, this is only a guide. Most users must run the their particular application several times with different buffer size values until they determine the optimum figure for their specific application needs and performance levels. Naturally, this has to be weighed against other factors such as the availability of expanded memory, and memory left for the application to conveniently fit the executable program and its data, thereby avoiding a negative penalty on performance due to limited memory space for program and data.

Most of the vendors of the QIC-525 systems we tested either indicated the use of buffer size ranging between 3 and 20 (between 15 and 20 being the desired ranges if availability of memory were not a problem), or did not recommend any particular value for this parameter. Emerald recommends between 16 and 20 for files and between 3 and 20 for buffers for an efficient performance of EmSAVE, and further indicates that better performance could be obtained by increasing the number of files and buffers. Mountain recommends the use of at least 35 buffers and 20 files for optimum performance. The recommended values for Alloy's ResQLAN and Sytos Plus for both files and buffers are at least 20. Everex, Maynard, and Tallgrass do not suggest any recommended values for the number of files and buffers.

Although we started the performance tests with Files=40 and Buffers=30 in the workstation CONFIG.SYS file under DOS 4.01, we were forced to decrease the corresponding values for files and buffers to 15 and 20, respectively, in order to be able to fit Maynard's MaynStream Version 3.1 program into base memory (after loading regular network drivers and test automation TSR software). Very slow performance for Alloy, Maynard, and Mountain in the 50M-byte single file workstation backup and restore tests (particularly excessive in the restore test) made us suspicious of the results. When we called Mountain, the company suggested we try increasing the number of buffers. Surprisingly, the FileSafe 7500's workstation backup and restore time for the 50M-byte directory was reduced by more than a third when the number of buffers was increased to 40 (from roughly 20 minutes with 20 buffers to around 6 minutes with 40 buffers). We used DOS 5.0 instead of Version 4.01 on the workstation as a workaround for the Maynard software problem (since this allowed some freed up memory in the 640K-byte conventional memory area), thereby maintaining a uniform configuration for all tested products. The Tallgrass FS1000 with the FileSecure software and the Sytos-based systems did not show any significant improvement in performance when configured with 40 buffers. Alloy's ResQLAN, Emerald's EmSAVE, Everex' STape, Maynard's MaynStream, and Mountain's FileSafe programs gained anywhere from 35% (for the backup test) to over 65% (for the restore test), Everex showing the least amount of gain.

- Very good performance; best overall usability among workstation-attached devices

Sankyo Seiki ST 525

Product Summary

- 16-bit Adaptec 1520, 1542, 1640, and 1740 adapters
- Sankyo Seiki drive
- ArcServe (server attached), Sytos Plus (workstation attached), or Retrospect (Macintosh attached) software
- Workstation or server based
- Adaptec 1520 uses programmed I/O or DMA data transfer
- Adaptec 1542 uses DMA or Bus Master DMA data transfer
- Two SCSI ports support up to seven daisy-chained devices
- Fastest server-based performance; best product overall

Tallgrass FS1000

Product Summary

- Adaptec 8-/16-bit 1510 and 1542 adapters
- Wangtek drive
- FileSecure (workstation-attached) proprietary or NetSecure ArcServe-based (server-attached) backup software
- Workstation or server based
- DMA data transfer method
- Single SCSI port does not support daisy chaining
- Very good features score

Tandberg Panther 525

Product Summary

- 16-bit Adaptec 1540/1542 adapter
- Tandberg drive
- Sytos Plus (workstation-attached), ArcServe (server-attached), and Retrospect (Macintosh) software
- Workstation or server based
- Bus master DMA data transfer method

- Two SCSI ports support up to seven daisy-chained drives
- Good performance and features

Tecmar Proline 525

Product Summary

- 16-bit Adaptec 154X, 1640 adapter
- Wangtek drive
- ProServe (ArcServe based) software (server attached)
- Sytos Plus or QTOS proprietary software (workstation attached)
- Standard DMA or bus master DMA data transfer method
- Two SCSI ports support up to seven daisy-chained devices
- Very good performance

Product Recommendations

Maynard MaynStream 525Q

Maynard's 525Q workstation-attached device offers excellent workstation performance and among the best features and usability. Its performance surpasses even the server-attached devices on several server disk backup and restore tests. The proprietary nature of the product's adapter and software limits its use to a single environment.

Sankyo ST 525

The Sankyo couples excellent server-based backup and restore performance with good usability and features at a competitive price. The system is appealing for NetWare environment backup and archiving applications and supports server- and workstation-attached configurations (using Cheyenne Software's ArcServe and Sytron's Sytos Plus). The Sankyo drive has not yet fully implemented the Quick File Access (QFA) feature.

Rating Summaries

Overall Evaluation

NSTL tested the Emerald, Sankyo, Tallgrass, and Tecmar tape drives as server-attached devices, and with the appropriate software, all can be attached directly to a workstation. NSTL tested the other QIC-525 systems in workstation-attached configurations.

The server-attached QIC drives (except the Emerald) use Cheyenne Software's ArcServe backup software (available as a Value-Added Process for NetWare/286 and an NLM for NetWare 386) in its generic form or a private-label version. The Emerald drive uses a proprietary NetWare Loadable Module (NLM) backup software called TBS on the server side and Windows-based front end (EmQ) on the client side.

Figure 1.
Alloy Retriever/525 Ratings

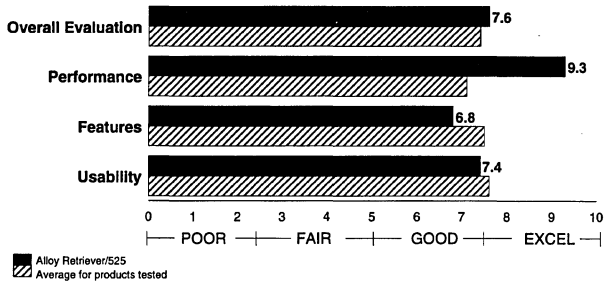


Figure 2a.
Emerald RapidRecover 525 Ratings (Workstation-based)

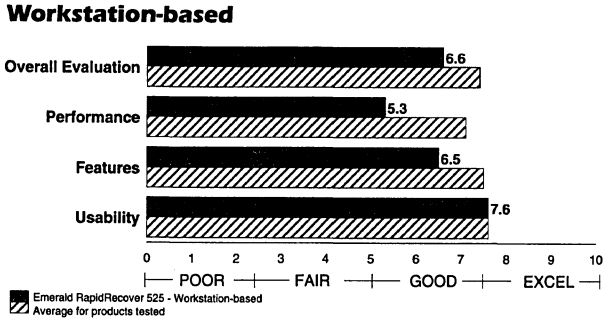


Figure 2b.
Emerald RapidRecover 525 Ratings (Server-based)

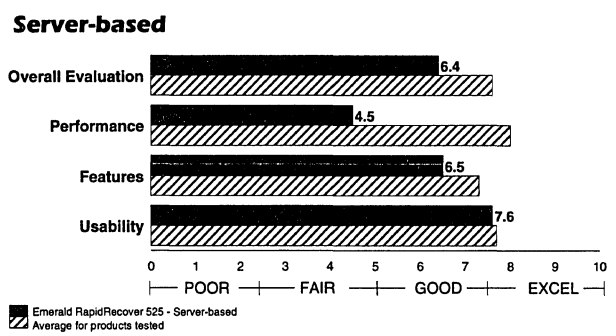


Figure 3.
Everex Excel 525 Ratings

Figure 4.
Identica IDT 320/525 Ratings

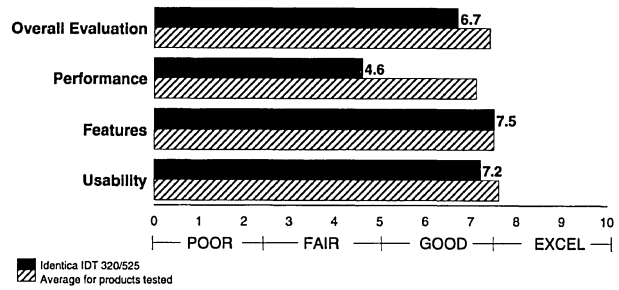


Figure 5.
Maynard MaynStream 525Q Ratings

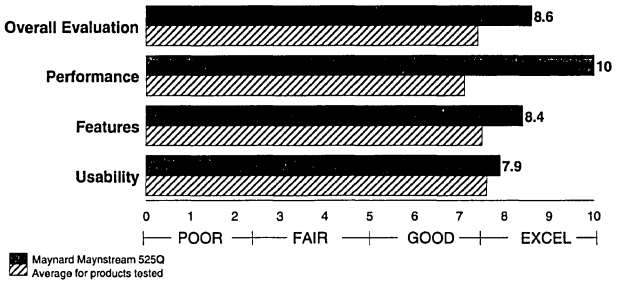


Figure 6.
Mountain FileSafe 7500 Ratings

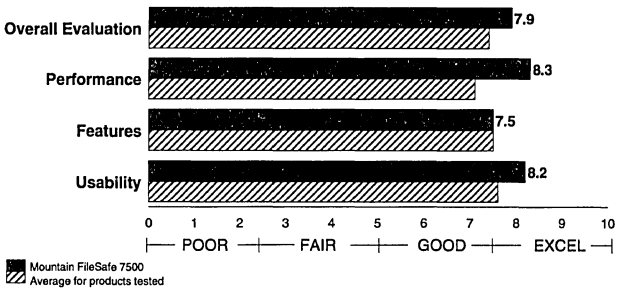


Figure 7.
Sankyo ST 525 Ratings

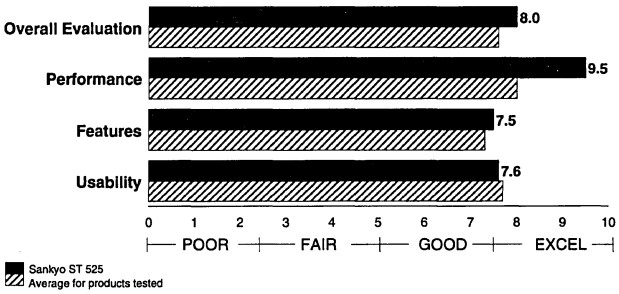


Figure 8a.
Tallgrass FS1000 Ratings (Workstation-based)

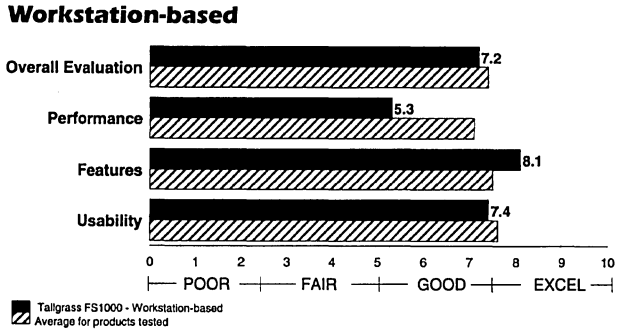


Figure 8b.
Tallgrass FS1000 Ratings (Server-based)

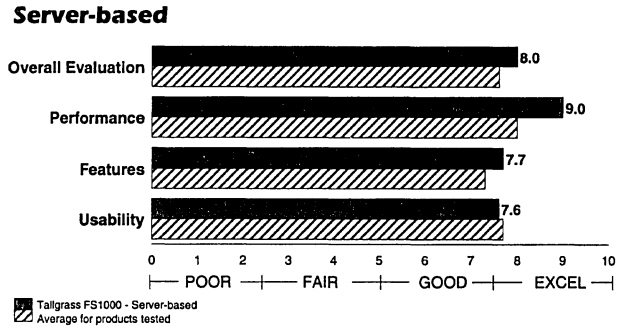


Figure 9.
Tandberg Panther 525 Ratings

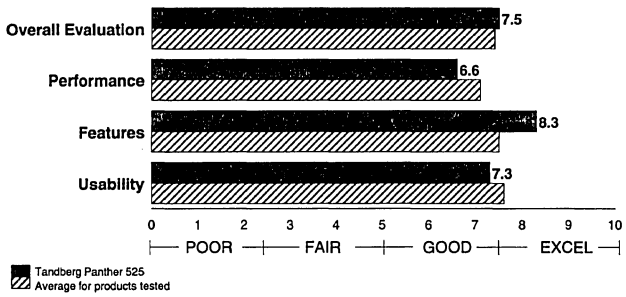


Figure 10.
Tecmar Proline 525 Ratings

Sankyo uses the generic ArcServe, while Tallgrass and Tecmar use private-label versions, NetSecure and Proserve, respectively. Most of the workstation-attached drives use proprietary backup software. Identica and Tandberg QIC drives were tested with Sytron Inc.'s Sytos Plus.

Among the server-attached devices, scores are very close, except for Emerald, which scores lower in performance and features. The Sankyo unit offers excellent performance, but the Tallgrass and Tecmar systems surpass it in features and usability, respectively. Sankyo and Tecmar benefit from ArcServe's excellent documentation and good full-featured backup software. Tallgrass uses a highly abridged version of the ArcServe user manual reproduced in its own format, with less organization and comprehensiveness.

Among workstation-attached drives, Maynard and Alloy outperform the others in backup, restore, and verify performance categories. The Tandberg, Tallgrass, and Maynard earn the top three features scores, and the Mountain tops the usability ranking with its easy software and high-quality documentation. The Emerald, using Windows-based EmSave backup software, performs slower than the other workstation-attached drives. Tallgrass and Tandberg feature multiple backup software support, good network environment support, data compression capability, and optional data encryption algorithm (Tallgrass only). Alloy, Identica, Tallgrass, and Tandberg provide average usability because of limitations in hardware/software user manuals, user interface features, diagnostics, and troubleshooting tools. The Alloy and Tallgrass user manuals lack organization and comprehensiveness.

Methodology

The Overall Evaluation is a weighted average of scores for the individual criteria.

Overall Evaluation Score = (3 x Performance Score) + (5 x Features Score) + (4 x Usability Score) ÷ 12.

Performance

QIC backup and restore performance are determined by the tape drive's write speed, backup software code efficiency, host adapter throughput, and efficiencies in device driver software (e.g., separate SCSI device drivers that work with the backup software). The Maynard uses a proprietary SCSI adapter and software and provides the fastest workstation backup, restore, and verify times. The Alloy performs well overall, except in the verify test where the Mountain posts the second best time. The Maynard and Alloy workstation-attached drives outperform server-attached subsystems when executing backup and restore operations on server disks.

Workstation-attached QIC drives generally offer performance advantages in local workstation backup and restore operations if the SCSI device (which most QIC-525 subsystems are) is not hampered by a limited buffer and/or slow disk transfer rates at the host. In NetWare environments, restoring to a server disk should be much faster than to a local workstation disk because of the server's large cache, turbo FAT, and "lazy write" design (i.e., writing to disk when no priority tasks are executing in the foreground). These factors effectively enable the device to complete portions of the restore task before the actual transfer of the data block to the server disk.

Assuming the network throughput (16M bps test configuration; 2M bps token-ring) is close to the burst mode throughput of the SCSI device (2.4M bps in asynchronous mode), it is conceivable that writes to a network disk could be much faster than writes to a local disk because of NetWare's optimized disk subsystem and large disk caching advantages. Test results do not strongly confirm this fact because NSTL uses more buffers than recommended by most of the vendors (see sidebar on Buffer Size and Backup Performance) and because the effect is cumulatively significant on large volumes. Some drives restore the 50M-byte directory to the server disk slightly faster than to a workstation disk.

Low start-up delays and reduced directory management overhead give the Maynard, Mountain, Alloy, and Everex systems a performance edge in the restore and verify tests: Maynard, Alloy, and Everex lead in the restore and the Maynard, Mountain, and Everex in the verify tests. The Tandberg unit performs consistently well (ranking fourth in the backup and fifth in the restore and verify tests). Excellent directory management capabilities enable the Maynard and Mountain systems to verify data very quickly.

The server-attached QIC-525 devices are generally less prone to performance differences than the workstation-attached devices. The exception, the Windows-based Emerald system exhibits consistently poor performance. The server-attached subsystems suffer from slightly longer start-up delays (although with less variance) than some of their workstation-attached counterparts in both backup and restore operations. Emerald shows the least start-up delay in the backup and restore tests (Tecmar the longest), but the advantage is easily offset by a high directory management overhead.

Methodology

Performance ratings are based on tests measuring backup, restore, and verification speeds. Performance scores for individual tests are the time for the fastest device divided by the drive's time (index score). The overall performance score is a weighted average of index scores for all the individual tests.

Workstation-Attached Drives

Performance Score = (Backup-Network Server, 20MB [1,000 files] Score) + (Backup-Network Server, 20MB [42 files] Score) + (Verify/Compare-Server, 20MB [42 files] Score) + (1.5 x Restore-Network Server, 20MB [42 files] Score) + (Backup-Network Server, 50MB Directory Score) + (1.5 Restore-Network Server, 50MB Directory Score) + (Backup-Network Server, 50MB Single File Score) + (2.5 x Backup-Workstation, 20MB [1,000 files] Score) + (2 x Backup-Workstation, 20MB [42 files] Score) + (2 x Verify/Compare-Workstation, 20MB [42 files] Score) + (3.5 x Restore-Workstation, 20MB [42 files] Score) + (2 x Backup-Workstation, 50MB Single File Score) + (2.5 x Backup-Workstation, 50MB Directory Score) + (3.5 x Restore-Workstation, 50MB Directory Score) ÷ 26.

Server-Attached Drives

Performance Score = (3 x Backup-Network Server, 20MB [1,000 files] Score) + (2 x Backup-Network Server, 20MB [42 files] Score) + (2 x Verify/Compare-Server, 20MB [42 files] Score) + (3.5 x Restore-Network Server, 20MB [42 files] Score) + (4 x Backup-Network Server, 50MB Directory Score) + (3.5 Restore-Network Server, 50MB Directory Score) + (2 x Backup-Network Server, 50MB Single File Score) + (Backup-Workstation, 20MB [42 files] Score) ÷ 21.

Features

The test QIC-525 systems use different combinations of backup software, device drivers, and host adapter characteristics. Standard functional features include scheduled/unattended backups, batch/script file options, automatic verification, tape spanning, and backup statistics. Most systems support options for selective backup by directory, date, or file modification; file-by-file; or complete disk mirroring.

Backward compatibility with earlier QIC standards (e.g., QIC-150/-120) may be important for certain applications. In almost all cases, U.S. government purchasers require compatibility with earlier-generation products. Maynard, Sankyo, Tandberg, and Tallgrass provide read compatibility with QIC-24 (QIC recording format for 60M-byte backup drives) and standard and full read/write compatibility with the QIC-150 and QIC-120 specifications. The other subsystems provide full read/write compatibility with the QIC-150 standard and read compatibility with the other two formats.

The Alloy, Everex, Identica, Maynard, and Tandberg support disk partition backup, and the Everex, Maynard, and Mountain drives provide disk image backup. Only the Emerald and Identica support data encryption. Tallgrass, Identica, and Tandberg provide compression technology.

Advanced error detection and correction methods include immediate CRC read-after-write verification and Reed-Solomon error recovery algorithms. Supported unrecoverable "hard" error rates are very high at 1 in 10^{14} bits recorded across all systems.

The subsystems backup Novell NetWare 2.15 and 3.x files and bindery data. The vendors of the server-attached systems do not indicate support for OS/2-based LANs such as the IBM LAN Server and Microsoft LAN Manager, but that does not necessarily preclude their use in that environment. Most of the subsystems (Sankyo, Tallgrass, Tecmar, Identica, and Tandberg) indicate support for Sytos Plus for OS/2, and Sytos Plus supports full OS/2 1.3 HPFS conventions; therefore, the systems should support server-attached configurations under OS/2-based LANs. (In fact, Microsoft bundles Sytos Plus for OS/2 with LAN Manager 2.0.) Among workstation-attached subsystems, Identica, Maynard, Mountain, Tallgrass, and Tandberg claim their products back up OS/2-based IBM LAN Server, Microsoft LAN Manager 2.0, and 3Com 3+Open; Mountain does not yet support IBM LAN Server 1.3. Only Maynard claims to back up the Banyan StreetTalk naming system data.

Methodology

The Features rating is a weighted average of scores for the individual features.

Usability

The user manual with the Cheyenne Software's ArcServe NetWare NLM (supplied by Sankyo in its original form and reprinted by Tecmar) is clear, well organized, and includes helpful tab dividers. Tecmar's hardware supplement, organized in the same format, adds to the usefulness of the product's complete documentation set. Tallgrass offers an abridged version of the Cheyenne manual. The Tallgrass NetSecure user guide is short on details and lacks an index. Tallgrass's useful hardware supplement is similarly lacking in organization, but includes good descriptions of installation procedures and ample illustrations. Software and hardware installations are fairly straightforward for all the server-based products, and software installation requires some knowledge of NetWare. The Tecmar unit's LED indicators help the user determine the drive status; the Emerald, Sankyo, and Tallgrass drives provide no LED indicators.

Mountain's well-organized user manual (with tab dividers) includes good coverage of command line and batch operations and a helpful troubleshooting section. It does not use illustrations liberally. Mountain's FileSafe software features context-sensitive help screens, good error messages, and the best tape directory management utility. A separate diagnostics utility is also included.

The Maynard user manual features clear illustrations, but not enough examples of batch operations and script-based backup and restore operations. The MaynStream software interface is consistent, but effective navigation through different submenus and software options requires some learning.

Emerald provides good documentation with helpful diagrams; the absence of tab dividers limits the usefulness of the manuals somewhat. The EmSave software (workstation attached) and the EmQ front end for the NetWare/386 NLM (server attached) use the Windows setup and screen interface (executed from a network workstation). Neither requires a complicated setup and configuration; the installer need only include the Share command and path statements in the autoexec.bat. Context-sensitive help is not provided, although Help is available in the standard Windows format.

The Identica and Tandberg drives come with Sytron, Inc.'s Sytos Plus backup software. The Sytos Plus manual is less than comprehensive, but includes a section with clear descriptions of backup strategies and procedures and ample illustrations. The Sytos menu options and functions require some learning; the software includes a good scripting feature, context-sensitive Help, and command selection options with explanations displayed at the bottom of the screen. The Tandberg manual is the better of the two; the Identica hardware manual lacks organization, detail, and clarity.

Tallgrass documentation suffers organizational flaws, and only the workstation-attached version includes an index. The Tallgrass FileSecure software is the easiest to install (one diskette) and quite easy to use; its screen handling features are outdated (e.g., does not refresh the screen when the user exits). The software features and capabilities are more than adequate for routine backup and restore operations; it supports command line and batch mode operations using user-created batch and script files.

The Alloy ResQLAN software installs easily, but uses some inconsistent command syntax for network environment backup and restore operations. The menu-based software features a functional (if plain) screen interface. The user can build script files for batch operation, and a separate scheduling option enables fully unattended backup and restore operations. The Alloy documentation is above average in organization, clarity, and comprehensiveness, but lacks an index.

Methodology

The Usability rating is a weighted average of scores for the individual criteria.

Usability Score = (3 x Manual Evaluation Score) + (4 x Software Installation/Evaluation Score) + (2 x Hardware Installation/Evaluation Score) ÷ 9.

Performance Results

Network Configuration

NSTL tested the QIC drives with an AST Premium 386/25 network server equipped with 12M bytes of RAM, a 110M-byte IDE hard drive, and a VGA monochrome monitor running Novell NetWare 3.11. An AST Premium 386/25 workstation equipped with 6M bytes of RAM, a 110M-byte IDE hard drive, and monochrome monitor running MS-DOS 5.0.

Following standard procedure for NSTL LAN product evaluation tests, all test data, test scripts, application programs, and custom program files archived on a Maynard MaynStream 1300 DAT Tape Backup system were restored to a control workstation. Test data, scripts, and programs are generated and/or modified according to the test methodology. A batch program running on the control workstation uploads the application programs and custom test automation program files to the file server.

Server- versus Workstation-Based Systems

The Alloy, Everex, Identica, Maynard, Mountain, and Tandberg subsystems attach to the workstation. The Emerald, Sankyo, Tallgrass, and Tecmar units attach to the server, and the Emerald and Tallgrass can also be used as workstation-attached devices.

In most cases, a tape backup system performs fastest with the disk subsystem of the attached system. Operations performed across a network are slowed by data transport across the network and channeling through the attached device. Server-attached devices perform much slower with workstation disk drives than with the server drive. Likewise, workstation-attached QIC devices offer superior speed with MaynStream disks than with server-attached disks, but restore operations to a server disk can conceivably be faster than to a local disk. In this case, the network environment's operational resources (e.g., large protected mode memory allocation for disk caching) improve performance.

Workstation-attached QIC drives are not ideal for network drive backups because they are slow and less secure than server-attached devices. Large network installations will find it advantageous to enforce a centralized file storage strategy at the server and use server-based high-capacity QIC backup systems for file backup and archival functions. An external server-attached device resides next to the server, sharing the server's secure environment. Server-attached units are less subject to network traffic or transmission problems.

Client/server model tape backup programs such as ArcServe provide flexible task management. ArcServe queues job requests and allows the front (MaynStream Manager) and back ends (ArcServe Server) to communicate effectively. Up to eight priority queues can be established for each ArcServe Server, and up to 250 jobs can be scheduled for each queue. Queues can be assigned priorities from 1 (the highest) to 8. The client/server software model also offers flexible job scheduling for unattended operation. Unlike workstation-attached backup tasks that must run in the foreground, server-attached backup devices can perform backup and restore tasks completely in the background, preventing network server overload and giving the supervisor the option of running backup and restore operations during work hours. Workstation-attached configurations cannot run operations during working hours except

Figure 11.
Selective Workstation Backup

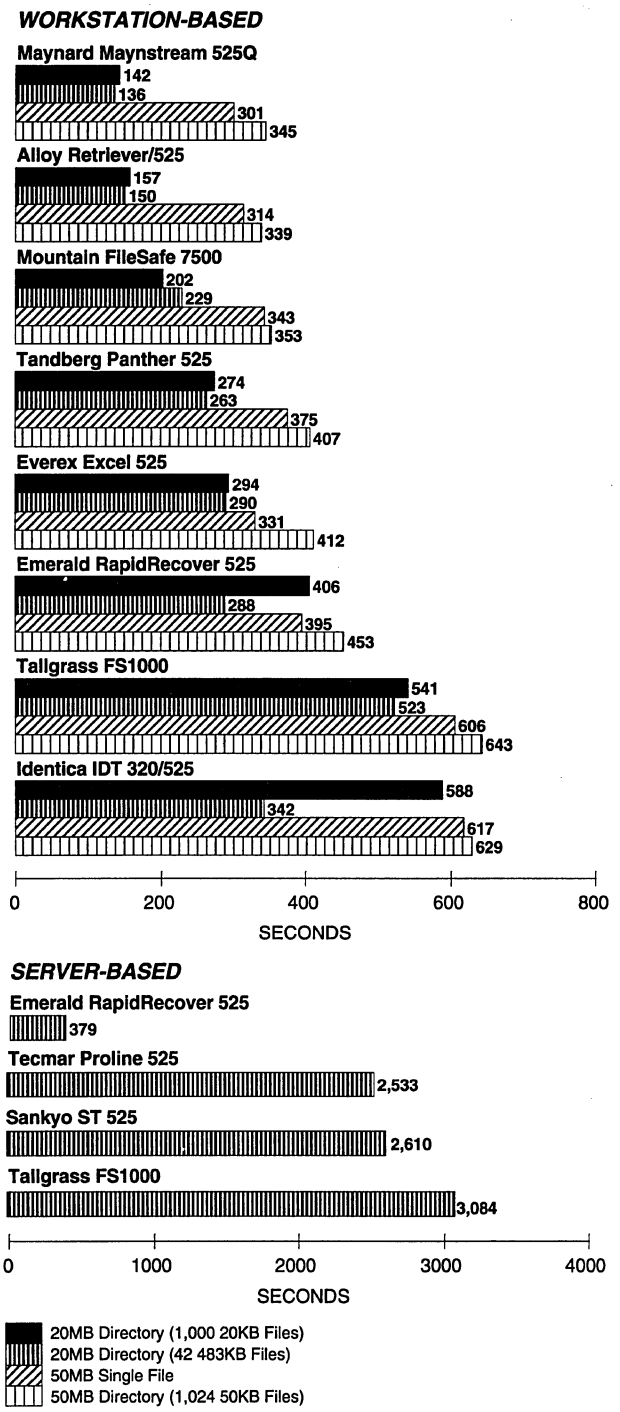
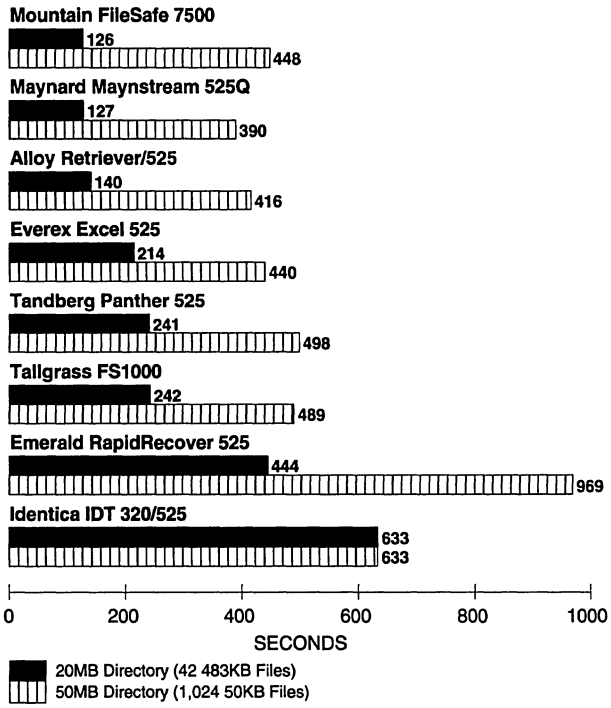


Figure 12.
Selective Workstation Restore



with a dedicated backup and restore application or dedicated workstation (for the duration of the backup or restore task).

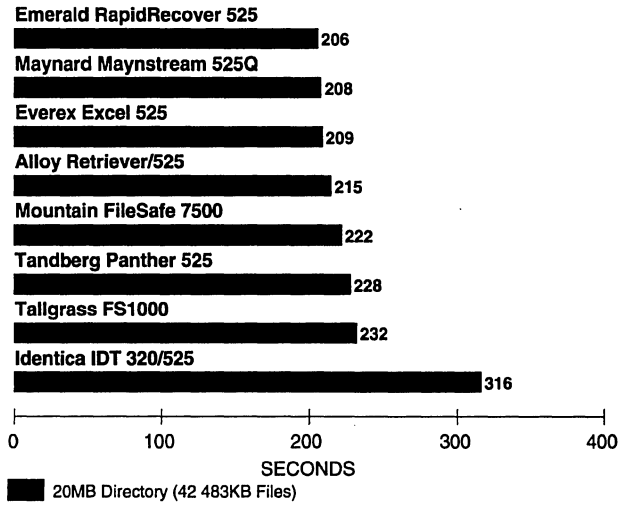
Backing up workstation volumes to server-attached QIC devices provides ideal security, but the backup runs painfully slow. If a centralized file storage strategy is not impractical for some reason, security must be weighed against the speed limitation in this configuration. Otherwise, a portable QIC backup unit for remote workstation backups may be preferable.

For businesses choosing a configuration based on environmental considerations, performance comparisons between workstation- and server-attached devices will not be a controlling factor against the potential effects of choosing the wrong configuration. Performance is rarely a critical factors in network environment backup devices because most backups run during off-peak hours. Selective file restores will be more frequent than complete backups in network environments, focusing more on file restore and QFA features than on backup speed. Installations with large on-line storage capacity require fast devices for full backups. Overall, network and multiuser installations may be served best by a QIC drive's features and usability than by its performance.

Drive Configuration

The subsystems were tested with the vendor-supplied adapters and software. Tapes were rewound before each test, and overwrite and/or tape erase options were enabled to prevent the drives from creating additional overhead by checking for files on the tape. Compression, verify/compare, and log functions were disabled to equalize test conditions. Verify/compare options were enabled only during the verify/compare test. Emerald Systems, Everex, Maynard Electronics, Mountain, and Tallgrass Technologies

Figure 13.
Workstation Verify/Compare



use proprietary SCSI host adapters; the other vendors' products use the generic Adaptec 154X SCSI controller.

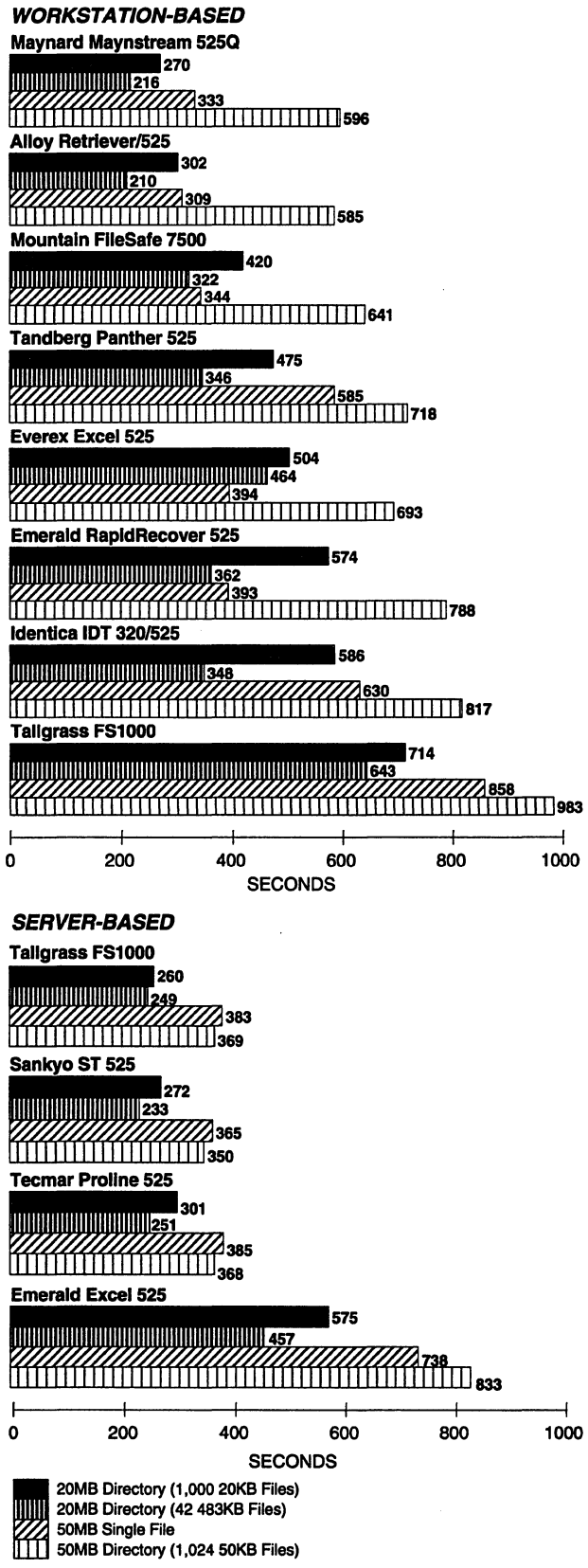
Performance variances are largely determined by the efficiency of the backup software code and the device driver interface. Efficiencies in directory structure management and overhead associated with filemark seeks vary appreciably from subsystem to subsystem. Using the average time for multiple runs, NSTL calculated the throughput and maximum overhead associated with each drive. These values provide relative measurements indicating how each product might perform with larger data sets.

Test Methodology

NSTL used several, backup, restore, and verify scenarios with different workstation and server file structures to evaluate the QIC devices. The bulk of the backup and restore speeds were between workstation disks and workstation-attached QIC devices and between network disks and server-attached QIC devices. Selective cross-network backup and restore tests give an indication of performance variations for the different configurations.

NSTL uses two custom programs to create the test files. The RANDTREE C program generates a directory tree with random file sizes according to user-specified directory size, branch size, and directory depth on three backup volumes: a 20M-byte directory tree of 42 files in 13 directories and 3 directory levels (average file size 483K bytes); a 20M-byte directory tree of 1,000 files with the same directory structure and average file size of 20K bytes; a 50M-byte directory tree of 1,024 files with the same directory structure and 50K-byte average file size; and a 50M-byte single file. The NSTLDT C program performs random or sequential disk reads and writes with selected command-line arguments; it is used to create the 50M-byte single file and the 1M-byte append file. The 1K-byte ASCII file is created in a text editor. The test volumes are created on a freshly formatted workstation disk partition and Xcopied to a network disk. Similarly, a NetWare volume is removed and created anew before copying a backup test volume and before restoring files.

Figure 14.
Selective Server Backup



Selective Workstation Backup

The test device backs up the 42-file 20M-byte directory tree residing on a local workstation disk.

Analysis

The Maynard with proprietary adapter and software clearly provides the best performance among workstation-attached drives in all backup test categories, followed by the Alloy. Both use Archive Model 2525 drives. According to NSTL calculations, the Maynard creates the lowest operational overhead with excellent throughput. The Alloy provides comparable throughput with slightly more overhead, especially in the network backup directory management. The ratio of times for backups of all the test volumes is a good indicator of directory management overhead. Similarly, the ratio of times for the 1,000-file, 20M-byte volume and the 50M-byte directory tree indicates system start-up delay time. Assuming a linear relationship between backup time and backup volume, the time required to back up the 1,000-file, 20M-byte directory tree should be roughly 40% of the time to backup the 50M-byte directory. A much higher ratio (over 60%), generally reflects some start-up delay. The Maynard and Alloy drives have the lowest start-up delays; the Emerald and Identica have the highest.

The Mountain (using a Tandberg drive) has the next lowest start-up delay (after Maynard and Alloy), but its directory management efficiency is a little less consistent. The Mountain software can use extended or expanded memory, provided the host system is configured with memory management utilities. Building directory trees in higher memory areas improves performance; otherwise, the system goes to the disk directory structure when it runs out of standard memory for building directories.

The Everex is far faster than the remaining four subsystems (including Tandberg and Tallgrass). The Emerald suffers from long start-up delay time as well as inefficient directory management properties. Only the Identica has a slower start-up time and more directory management overhead. The Wangtek-based Emerald's poor performance is most probably caused by its limited adapter buffer size and Windows-based software interface.

The Tallgrass, using an 8-bit adapter and Wangtek drive, is slow with the 20M-byte volumes because of the adapter's limited throughput and start-up delay. Although its performance in the 50M-byte backup improves slightly, it is still comparatively low. On the other hand, the Tallgrass displays the narrowest disparity between different directory structure backup times (between 3% and 6%). Tandberg Data has a similar ratio.

The Sankyo CP525SE-based Identica drive performs somewhat inconsistently, indicating a hardware problem or inefficient adapter driver. (Although it completed all the single-volume tests on both workstation and server disks without any discernible problem, the append operation was problematic. Tallgrass did not propose a solution.) Not only does the Identica have the longest start-up delay, but its directory management is also bad (except for the 50M-byte single file to 50M-byte directory tree time comparison on the workstation disk backup test).

As expected, the ArcServe-based, server-attached QIC devices perform poorly in the workstation backup test (only the 42-file, 20M-byte directory backup tested), with Tallgrass the slowest. Only the Emerald with its proprietary EmQ, Windows-based workstation, and NetWare

server NLM software performs anywhere near the performance of the workstation-attached units. It surpasses even the performance of the same Emerald unit tested with the EmSave in the workstation-attached configuration.

Selective Workstation Restore

Each workstation-attached device restores the two 20M-byte and 50M-byte directory trees to a workstation disk. Using these disk volumes, NSTL checks the integrity of the restored disk.

Analysis

The Maynard and Alloy again display excellent performance. The Everex, Mountain, Tallgrass, and Tandberg units also do very well. The Mountain performs best in the 20M-byte restore test, but less impressively in the 50M-byte test. The Everex, Tallgrass, and Tandberg drives show a higher level of start-up overhead than the Mountain, Alloy, and Maynard. The Mountain drive shows the least amount of restore start-up overhead, followed by the Maynard and Alloy. The Emerald, Everex, Tallgrass, and Tandberg exhibit the same levels of restore start-up delay times.

Although the Identica unit's restore performance is better than the Emerald's, it exhibits an excessive level of start-up delay, indicating potential inefficiencies with its adapter driver. Emerald's Windows interface impairs restore performance, just as it does the backup. The Emerald's performance may be acceptable for small volumes with relatively few files, but may be very slow for large volume restore operations.

Workstation Verify/Compare

The verify/compare test is performed using the 42-file, 20M-byte volume. Verify/compare is performed during the file backup or restore stage, depending on how the backup system implements the file comparison. Some systems perform file verification after a restore operation (e.g., Everex STape), and some allow verification after a backup or restore (i.e., Maynard), but most systems verify after the backup pass. Unless the backup software's verification option is limited to simple read verification (to ascertain that the file that has been backed up or restored can be read back), the system is tested with the full bit-by-bit comparison to compare the data on the tape against the data on the hard disk. The test exercises the read capability of the drive and the overall throughput of the host adapter.

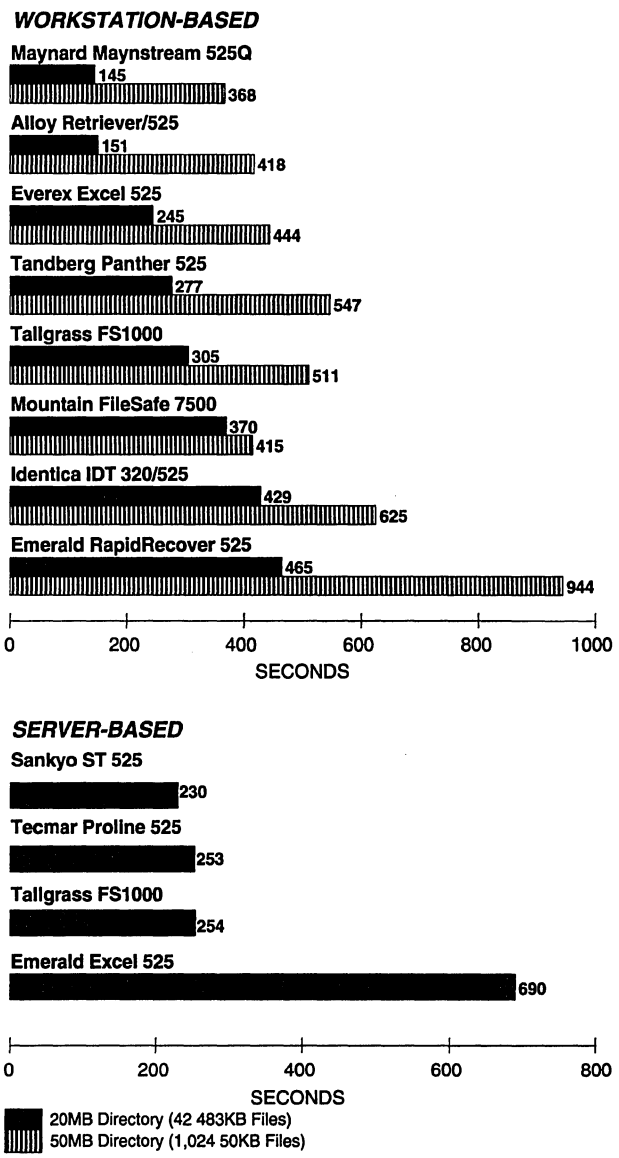
Analysis

Ideally, the compare operation should take no more than a 50% overhead than the restore operation time, according to some industry experts. Directory management overhead and start-up delays that hamper the Emerald in the backup and restore tests are less evident in the verify/compare test because the system does not compare the disk and tape files bit by bit. The Identica also performs read verify (not a bit-by-bit compare), but its performance remains poor (probably due to an inefficient adapter driver).

Selective Server Backup

Each device backs up two 20M-byte directory trees, one 50M-byte directory tree and one 50M-byte single file located on the server disk.

Figure 15.
Selective Server Restore



Analysis

All the server-attached devices except the Emerald perform quite well in the network backup tests, and some of the fast workstation-attached devices surpass their performance with the 20M-byte volumes. The server-attached units excel with the larger volume, 50M-byte single file, and 50M-byte directory backups compared to the workstation-attached devices.

The Sankyo drive attains the best backup time, followed closely followed by the Tecmar and Tallgrass. The Windows interface in the Emerald's EmQ backup software, coupled with its limited adapter buffer memory, cause a bottleneck in performance. (Only in the 20M-byte workstation backup test does the Emerald outperform the other server-attached units.) Normally, server-attached backup units benefit from NetWare's performance-enhancing factors (disk caching and directory hashing) and other memory

management and file handling characteristics of the network server. The server-attached units fail to translate these advantages into performance, especially in the low-volume backups. The Maynard and the Alloy closely match (and surpasses in some tests) the performances of some server-attached units in backing up the 20M-byte and 50M-byte directories, even though they are inevitably handicapped by the combined overheads of the network and workstation. Times for other workstation-attached systems offer a comparison for users to evaluate the relative merits of server-attached and workstation-attached configurations. The server-attached systems may noticeably affect the server's capability to process other requests during peek periods. Users may have to reduce the priority of the server backup process during these times to reduce the negative impact on other time-critical tasks at the expense of the backup performance.

Selective Server Restore

Each device restores the 42-file and the 20M-byte and 50M-byte directory trees from a network disk to the corresponding network volumes. All other conditions are the same as for the workstation restore tests.

Analysis

Surprisingly, the server-attached devices do not perform as well as some of the workstation-attached units. The workstation-based Maynard and Alloy surpass all the server-attached tape drives in the 20M-byte volume restore, while Maynard, Alloy, and Mountain excel in the 50M-byte restore.

Among the server-attached systems, the Sankyo outperforms the Tallgrass and Tecmar in both the 20M-byte and 50M-byte volume restore tests. The performance gap between the Sankyo and Tecmar narrows in the 50M-byte restore test, and the gap between the Sankyo and Tallgrass units widens, indicating the Tecmar's slightly longer start-up delay. The Emerald takes more than twice as long as the Tallgrass to restore the 20M-byte volume and more than three times as long for the 50M-byte volume.

Server Verify/Compare

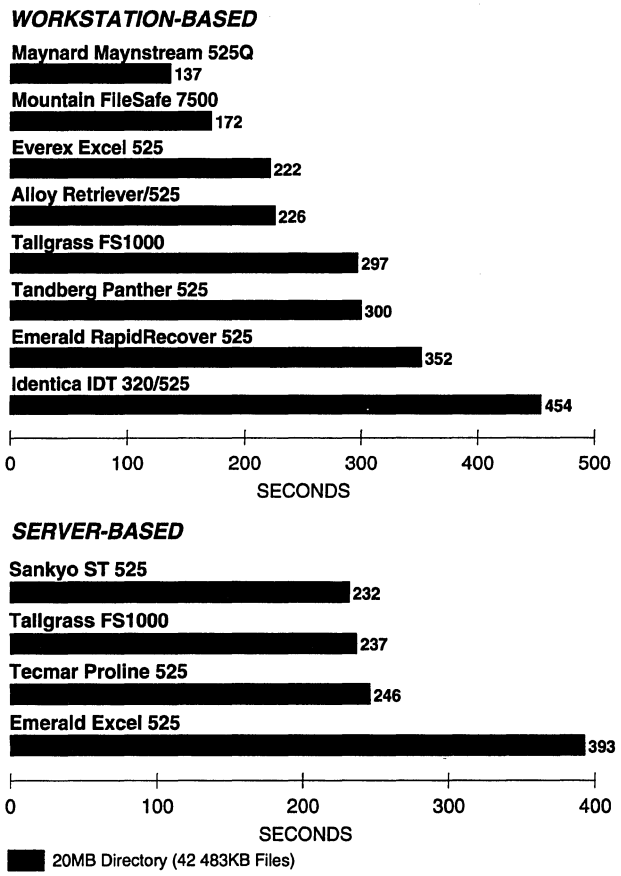
The verify/compare test is run in the network disk configuration using the 42-file, 20M-byte volume.

Analysis

As in the restore test, several workstation-attached devices surpass the performance of the server-attached counterparts. Maynard, Mountain, Everex, and Alloy excel in the server file compare, performing much faster than the server-attached systems and the remaining workstation-attached drives. The performance differential between the best server- and workstation-attached devices is quite significant: the Maynard takes only 40% of the time required by the Sankyo to verify the volume.

The Sankyo, Tallgrass, and Tecmar provide comparable verify times, with less than a 3% difference in times between the Sankyo and Tallgrass less than 4% between the Tallgrass and Tecmar. The Emerald takes 60% longer than the third-ranked Tecmar.

Figure 16.
Server Verify/Compare



QFA

NSTL backs up a 20M-byte volume (with 1,000 files) and appends nine 20M-byte and two 50M-byte directory volumes. The twelfth 50M-byte directory backup set is appended after a 1K-byte text file has been copied into a third-level subdirectory of that volume. The 1K-byte file is selectively restored to a RAM disk in order to test the quick file access (QFA) feature of the backup device.

Append

The append test attempts to measure the devices speed locating multiple file marks on tape and appending a small file to existing multiple backup sets (12 sets; combined volume capacity of 300M bytes). The append procedure and volumes are the same as described for the QFA test above. The server- and workstation-attached configurations use same test methodology and setup.

Vendors

Alloy Computer Products, Inc.
165 Forest Street
Marlboro, MA 01752 (508) 481-8500

Emerald Systems
12230 World Trade Drive
San Diego, CA 92128 (619) 673-2161

Everex Systems, Inc.
48431 Milmont Drive
Fremont, CA 94538 (800) 628-3837

Identica
350 Scott Boulevard, Building 7
Santa Clara, CA 95054 (408) 727-2607

Maynard Electronics
36 Skyline Drive
Lake Mary, FL 32746 (800) 821-8782

Mountain Network Solutions, Inc.
240 East Hacienda Avenue
Campbell, CA 95008 (800) 458-0300

Sankyo Seiki
2649 Campus Drive
Irvine, CA 92715 (714) 724-1505

Tallgrass Technologies
11100 West 82 Street
Lenexa, KS 66214 (800) 736-6002

Tandberg Data, Inc.
2649 Townsgate Road, Suite 600
Westlake Village, CA 91361 (805) 495-8384

Tecmar, Inc.
6225 Cochran Road
Solon, OH 44139 (216) 349-0600

Specifications

Features/Functions

Features	Alloy Retriever/ 525	Emerald RapidReceiver 525	Everex Excel 525	Identica IDT 320/525	Maynard MaynStream 525Q
Host System Support	ISA, EISA, Micro Channel PS/2	ISA, EISA, Micro Channel PS/2	EISA, ISA	ISA, EISA, Micro Channel PS/2, Macintosh	ISA, EISA, Micro Channel PS/2
Capacity	525MB without compression	525MB without compression	525MB without compression	525MB without compression; 1050MB with compression	525MB without compression
Performance	Transfer Rate: 240K bps; Tape Speed: 120 ips	Transfer Rate: 240K bps; Tape Speed: 120 ips	Transfer Rate: 240K bps; Tape Speed: 120 ips	Transfer Rate: 240K bps; Tape Speed: 120 ips	Transfer Rate: 200K bps; Tape Speed: 120 ips
Compatibility	QIC-24, QIC-120, QIC-150 read	QIC-24, QIC-120, QIC-150 read	QIC-24 read; QIC-120 read; QIC-150 read and write	QIC-24, QIC-120, QIC-150, and QIC-320 read	QIC-24 read; QIC-120, QIC-150 read and write
Operating System Support	DOS 3.3x, DOS 4.0x, DOS 5.0x	DOS 3.3x, DOS 4.0x; DOS 5.0x through XPress Librarian	DOS 3.3x, DOS 4.0x, DOS 5.0x	DOS 3.3x, DOS 4.0x, DOS 5.0x; OS/2 1.1, OS/2 1.2/3; SCO UNIX/SCO Xenix	DOS 3.3x, DOS 4.0x, DOS 5.0x; OS/2 1.1, 1.2/3 with MaynStream for OS/2 software; SCO UNIX/SCO Xenix with Maynard device driver

Features/Functions (Continued)

Features	Alloy Retriever/ 525	Emerald RapidReceiver 525	Everex Excel 525	Identica IDT 320/525	Maynard MaynStream 525Q
Network Compatibility	Workstation-Attached: Novell NetWare 286 2.2, NetWare 386 3.1, 3.11; Server-Attached: Same	Workstation-Attached: Novell NetWare 286 2.2, NetWare 386 3.1, 3.11; Server Attached: Same	Workstation-Attached: Novell NetWare 286 2.1x, 2.2, NetWare 386 3.0, 3.1, 3.11	Workstation-Attached: Novell NetWare 286 2.2, NetWare 386 3.0, 3.11; Banyan VINES 386 4.0, 4.1; IBM LAN Server 1.1, 1.2, 1.3; Microsoft LAN Manager 2.0	Workstation-Attached: Novell NetWare 286 2.1x and earlier, 2.2, NetWare 386 3.0, 3.1, 3.11; Banyan VINES/286 3.0, VINES/386 3.0, 3.1; IBM PC LAN Program 1.3, LAN Server 1.1, 1.2, 1.3; Microsoft LAN Manager 2.0 (requires MaynStream for OS/2); 3Com 3+Open 1.1
Interface/Controller	SCSI-1, SCSI-2 Adaptec 154X (16 bit)	SCSI-1, SCSI-2 proprietary (16 bit)	Everex EV8116, SCSI-1 (16 bit)	Adaptec 1542B SCSI-2 (8 bit, 16 bit)	Proprietary MaynStream 16 bit SCSI controller
Backup Software	ResQLAN (proprietary); Sytos Plus; ArcServe	ArcServe; Windows-based EmSave and EmQ; XPress Librarian	STape (proprietary)	Sytos Plus	MaynStream for DOS
Warranty/Support	1-year warranty covers parts, labor, and return shipment; unlimited telephone support; warranty service through supplier and dealers	1-year warranty covers parts, labor, and return shipment; toll-free telephone support; 24-hour hot line after business hours ($75); service through supplier; on-site service and extended warranties available	2-year warranty covers parts, labor, and return shipment; service through supplier	3-year warranty covers parts, labor, and return shipment; service through supplier; toll-free hot line; extended warranties available	1-year warranty covers parts, labor, and return shipment; 5-year warranty on SCSI controller; service through supplier; toll-free hot line

Features/Functions (Continued)

Features	Mountain FileSafe 7500	Sankyo Seiki ST 525	Tallgrass FS1000	Tandberg Panther 525	Tecmar Proline 525
Host System Support	ISA, Micro Channel PS/2	ISA, EISA, Micro Channel PS/2, Macintosh	ISA, EISA, Micro Channel PS/2, Macintosh	ISA, EISA, Micro Channel PS/2, Macintosh	ISA, Micro Channel PS/2, Macintosh
Capacity	525MB without compression	525MB without compression; 1050MB with compression	525MB without compression; 1050MB with compression	525MB without compression	525MB with compression; 1050MB without compression
Performance	Transfer Rate: 240K bps; Tape Speed: 120 ips	Transfer Rate: 240K bps; Tape Speed: 120 ips	Transfer Rate: 240K bps; Tape Speed: 120 ips	Transfer Rate: 240K bps; Tape Speed: 120 ips	Transfer Rate: 240K bps; Tape Speed: 120 ips
Compatibility	QIC-24 read, QIC-120 read, QIC-150 read and write	QIC-24 read; QIC-120, QIC-150 read and write	QIC-24, QIC-120, QIC-150 read	QIC-24 read, QIC-120 read and write, QIC-150 read and write	QIC-24 read, QIC-120, QIC-150 read and write
Operating System Support	DOS 3.3x, DOS 4.0x, DOS 5.0x; OS/2 1.1, OS/2 1.2/3; SCO UNIX/SCO Xenix	DOS 3.3x, DOS 4.0x, DOS 5.0x; OS/2 1.1; SCO UNIX/SCO Xenix; Pick	DOS 3.3x, DOS 4.0x; OS/2 1.1, OS/2 1.2/3 with Sytos Plus; SCO UNIX/SCO Xenix with FileSecure IX; Macintosh with Retrospect	DOS 3.3x, DOS 4.0x, DOS 5.0x; OS/2 1.1; SCO UNIX/SCO Xenix; A/UX	DOS 3.3x, DOS 4.0x, DOS 5.0x; OS/2 1.2/3; SCO UNIX/SCO Xenix
Network Compatibility	Workstation-Attached: Novell NetWare 286 2.1x, 2.2, NetWare 386 3.1, 3.11; IBM LAN Server 1.1, 1.2; 1.3; 3Com 3+Open 1.1; Server-Attached: IBM LAN Server 1.1, 1.2; 3Com 3+Open 1.1	Workstation-Attached: Novell NetWare 286 2.1x, 2.2, NetWare 386 3.0, 3.1, 3.11; Banyan VINES/286 3.0, VINES/386 3.1, 4.0; IBM PC LAN Program 1.3, LAN Server 1.1, 1.2, 1.3; Microsoft LAN Manager 2.0; 3Com 3+Open 1.1; Server-Attached: Novell NetWare 286 2.1x, 2.2, NetWare 386 3.0, 3.1, 3.11	Workstation-Attached: Novell NetWare 286 2.1x, 2.2, NetWare 386 3.0, 3.1, 3.11; Banyan VINES/286 3.0, VINES/386 4.0, 4.1; IBM PC LAN Program 1.30, LAN Server 1.1, 1.2, 1.3; Microsoft LAN Manager 2.0; 3Com 3+Open 1.1; Server-Attached: Same	Workstation-Attached: Novell NetWare/286 2.1x, 2.2, NetWare/386 3.0, 3.1, 3.11; IBM PC LAN Program 1.3, LAN Server 1.1, 1.2, 1.3; Microsoft LAN Manager 2.0; 3Com 3+Open 1.1; Server-Attached: Same	Workstation-Attached: Novell NetWare 286 2.1x, 2.2, NetWare 386 3.1, 3.11; IBM PC LAN Program 1.3, LAN Server 1.2, 1.3; Microsoft LAN Manager; Server-Attached: Novell NetWare 286 2.1x, 2.2, NetWare 386 3.0, 3.1, 3.11; Banyan VINES/286 3.0, VINES/386 4.0, 4.1; IBM PC LAN Program 1.3, LAN Server 1.2, 1.3; Microsoft LAN Manager
Interface/Controller	Mountain SCSI-2 (16 bit)	Adaptec AHA 1520 or 1542, 1640 and 1740; SCSI-2 (16 bit)	SCSI-2 (16 bit)	Adaptec 1540/42; SCSI-1,SCSI-2 (16 bit)	Adaptec 1540B and 1640; SCSI-1 and SCSI-2 (16 bit)
Backup Software	FileSafe	Cheyenne ArcServe	FileSecure	Sytos Plus, ArcServe, Retrospect	QTOS, QTBackup; ProServe VAP and NLM; Sytos Plus
Warranty/Support	1-year warranty covers parts, labor, and return shipment; service through supplier; telephone support for dealers and distributors	2-year warranty covers parts, labor, and return shipment; service through supplier and dealers	2-year warranty covers, parts, labor, and return shipment; service through supplier and dealers; extended warranties ($215/year)	1-year warranty covers parts, labor, and two-way shipping; service through supplier and dealers; extended warranties available	2-year warranty covers parts, labor, and return shipment; service through supplier and dealers; 24-hour bulletin board

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