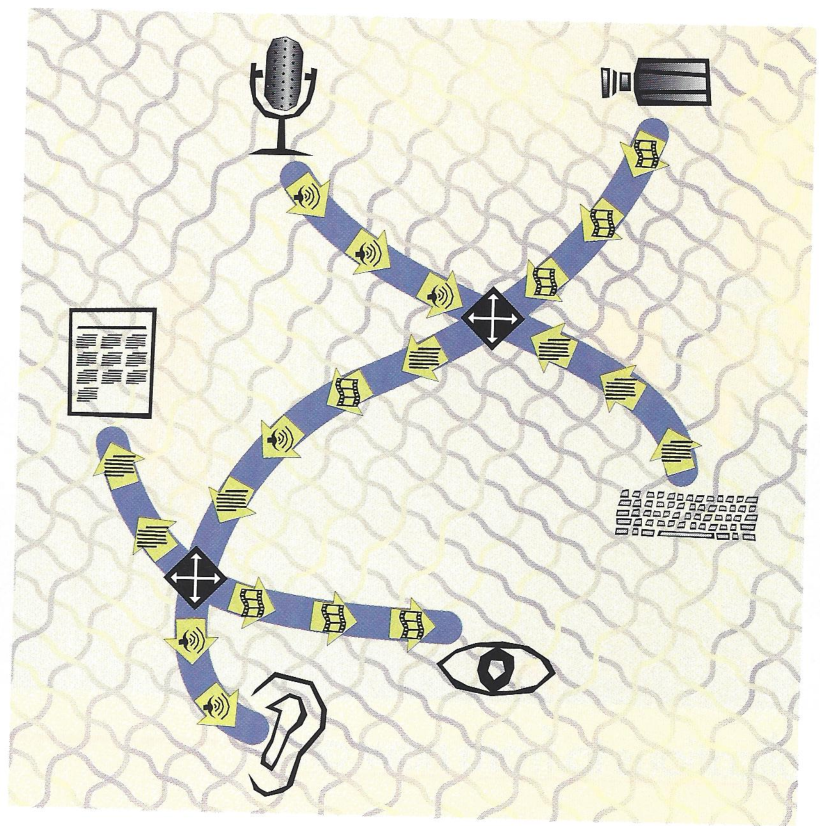
FEATURE

MULTIMEDIA

Making It Work on the Network

By Laura Chappell, Roger Spicer, and Dan E. Hakes



As we discussed in the last issue of *NetWare Connection*, multimedia applications and PCs optimized for multimedia are now widely available. (See "Multimedia: It's Not Just for Video Games Anymore," Sept./Oct. issue, p. 8.) And following the path of other computer technology, multimedia is making its way to the network. Implementing multimedia applications on the network, however, presents unique challenges. In this article, we will discuss the current applications for multimedia on the network, review PC and network requirements for multimedia, describe where multimedia bottlenecks currently occur on networks, and list guidelines for implementing multimedia on your network using today's technology.

Multimedia on the Network: Work or Play?

Why would you want to run multimedia applications on the network? After all, the majority of multimedia applications are games. Is multimedia just a passing fancy, a curiosity that will fade with time like the hula-hoop or 8-track tapes? Or is there some tangible business value to running multimedia on the network?

Although development of multimedia applications is relatively new, the media has captured the imagination of users and developers alike. This interest, combined with the falling costs of hardware and the increased capabilities of today's operating systems, suggests that multimedia will continue to mature and become part of the corporate enterprise. Although multimedia applications for the network are currently somewhat limited, your company may find some implementations both interesting and useful—especially if your company is looking for innovative training materials.

A common network application is teleconferencing to the desktop. Most corporations have used teleconferencing in conference rooms to save the expense and lost productivity that result when employees must travel to attend meetings. Even in the best circumstances, however, employees must schedule the time and room, gather all the resources they may need from their desk, and move to a central room for the conference. With teleconferencing to the desktop, a company could hold a conference with an unlimited number of employees on the network, and no one would need to leave his or her desk.

Teleconferencing to the desktop may seem impractical since everyone must have a video camera and CODEC (video digitizer) on his or her workstation. (See "Glossary," p. 42.) As the network offers better multimedia support, however, vendors will create more usable teleconferencing products for the desktop, and the price and size of electronic components will keep shrinking. There are several ways to implement teleconferencing to the desktop:

One-to-Many Teleconferencing. This multimedia network service is a unidirectional teleconference from a single source to all users on the network. For example, the CEO of a global corporation may want to deliver a message to all employees. Although the CEO would like to talk to all of the employees directly, she doesn't have time to travel to all the sites. With one-way teleconferencing across the network, her message can be played live on every workstation. All the employees can see and hear the CEO at a fraction of the cost, in time and money, of her visiting each site personally. Another use may be to transmit a television broadcast to all users on the network (CNN on demand, for example).

Because this service is a single session being sent to all users simultaneously, it can be transmitted just once in packets addressed to a multicast address. A multicast address includes the addresses for a group of network devices. Using multicast, you can copy a single transmission to a number of devices, saving valuable bandwidth.

In one-to-many teleconferences, all workstations with the appropriate playback drivers installed on the network interface boards will copy and process the single transmission—a judicious use of network bandwidth, especially where video is concerned. The teleconferencing session, however, is subject to the network implementation problems explained later in this article.

One-to-One or One-to-Many Bidirectional Teleconferencing. Teleconferencing can be used for interactive, live training that spans multiple sites or for a one-on-one conference across the network. Like unidirectional teleconferencing, bidirectional teleconferencing uses multicast packets. Any device that can copy the multicast address can participate in the conference. As a result, this form of teleconferencing brings up some security issues. For example, someone could create an application that enabled network interface boards to receive all multicasts.

On-demand Multimedia. The most sought-after as well as the most difficult multimedia solution to implement is on-demand multimedia, which allows network users to run a multimedia application across the network at any time. Because every user's session is independent from other users, multicast addresses cannot be used. In this case, the network must be able to supply enough bandwidth to accommodate a number of simultaneous, independent isochronous transmissions, which provide consistent and uninterrupted streaming of data across the network. On-demand video service also requires a server that can store multimedia files and support simultaneous multimedia sessions.

Training. Another multimedia application that is poised to explode on the corporate world is training. Multimedia can take a classroom setting, including instructor and lab, to the desktop. To learn, you work interactively with the application. Not only are you entertained with sounds and images, but you can also practice the tasks being taught using product simulations. For example, it is entirely conceivable that you could learn to install a network and then practice doing it on your computer screen. You could practice common management tasks—anything from connecting cables and setting jumpers on boards to editing configuration files and bringing up the server.

With this interactive training, employees can learn on the job. Companies will save money and avoid lost productivity since employees will not need to attend as many traditional, offsite classroom training sessions. In addition, the multimedia application is always on-line as a reference and as a refresher course.

Product Support Systems. Advanced applications that combine training and expert systems will be another driving force for multimedia on the network. These applications, known as product support systems (PSSs), feature interactive multimedia training built into a product. For example, if a company purchased a network management system with complex console software and advanced features such as remote packet capture and protocol decode, the company would probably send its employees to training to get the most from the product. If the system included a PSS, with the touch of a button the employees could start a context-sensitive training session complete with video, simulations, and a monitored interactive simulation for practice. The PSS could even track each employee's growing expertise and automatically increase the training's difficulty level to match.

Multimedia E-mail. Another hot development area is multimedia E-mail. If your E-mail and other network applications supported multimedia, you could send a video clip of a presentation along with a progress report—all within your E-mail program. Many E-mail packages support the attachment of a variety of file formats, but a separate application is usually required for playback or viewing of nonstandard files, such as video or sound files.

Databases. Video databases are another much-talked about application. Imagine looking to buy a beach house in Hawaii and being able to walk around the grounds and visit all the rooms from a computer on the mainland.

These are just a few of the possibilities for multimedia applications on the network. Once the network problems have been overcome, however, the only limit to multimedia applications for the network will be our imagination.

We may not have to wait long for companies to overcome the barriers. Many vendors, such as Hewlett-Packard and Oracle, are developing specialized hardware and software to meet the heavy demands that multimedia applications, and video in particular, place on networks.

Reality Check: What's Possible Today?

The first obstacle to networking multimedia applications is the vast amount of bandwidth required to move multimedia files across the network and, more importantly, the way that bandwidth is allocated and controlled, especially for playing real-time audio and video. In the Sept./Oct. issue of *NetWare Connection*, we talked about the enormous amount of data a PC has to process and store in order to play back audio and video files. Let's review some of the numbers and add the network requirements as well.

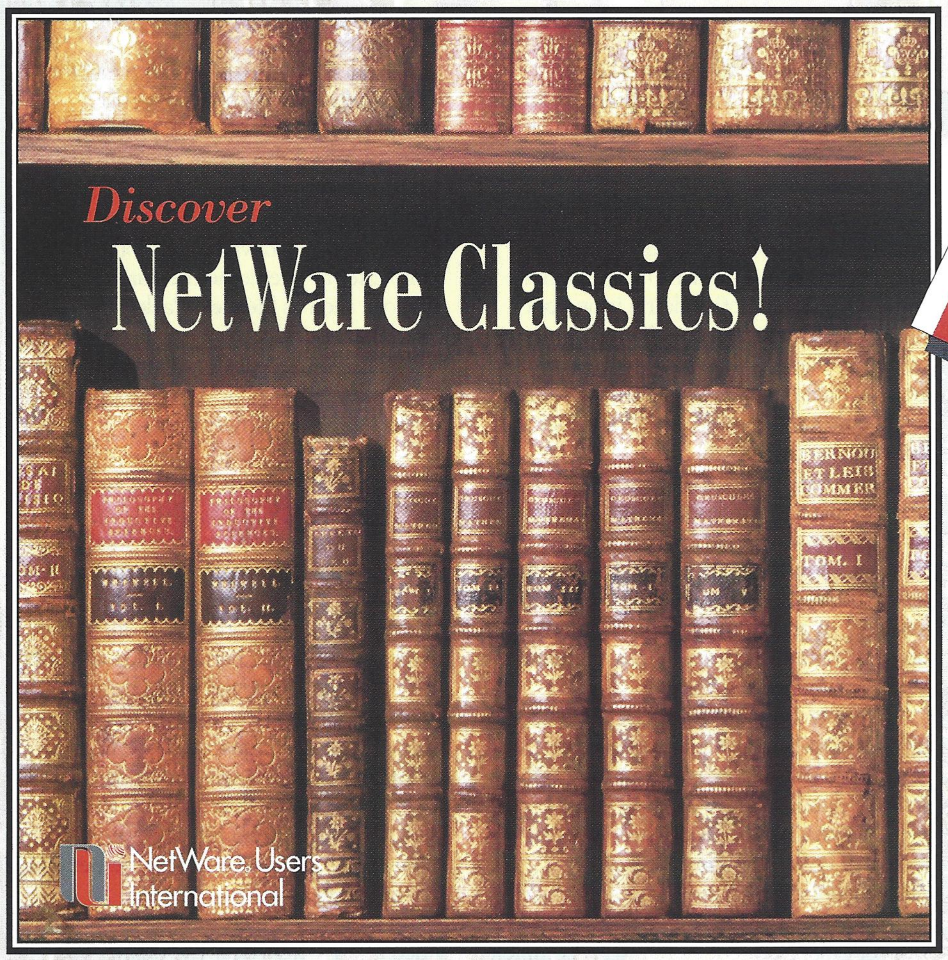
Playing full-screen (640 x 480 pixels) video at anywhere near the quality you expect from your VCR and TV requires 24-bit or 3-byte (16 million) color depth per pixel. As the following equation shows, the requirements add up quickly:

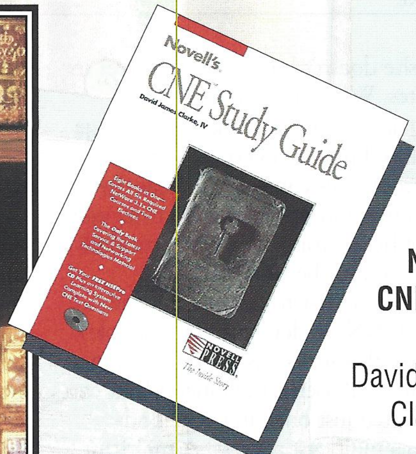
640 pixels x 480 pixels x 3 bytes per pixel = 921KB per video frame

In North America, the National Television Systems Committee (NTSC) standard specifies that video should run at 30 frames per second. The following equation shows how fast the PC must process the video:

921KB per frame x 30 frames = 27.6Mbyte/s

To play full-screen, VCR-quality video, the PC must be fed and must process 27.6MB of data per second. If you haven't quite grasped the enormity of this number, look at it this way: to feed one second of this video would require a network bandwidth of 221Mbit/s for each PC running the video. Not many networks have that much spare bandwidth, but then no known PCs (none that we're aware of anyway, but we don't get out much these days) can process that volume of data.





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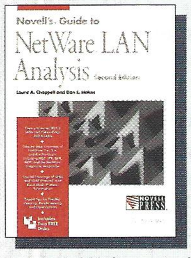

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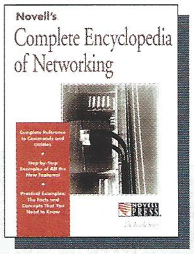

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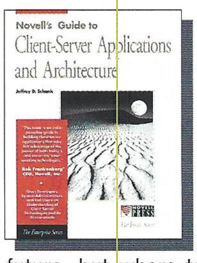

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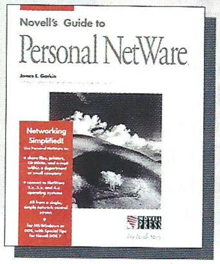

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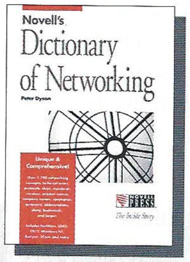

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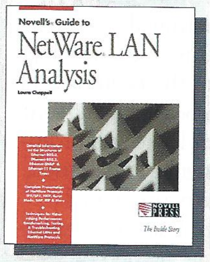

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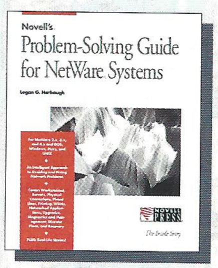

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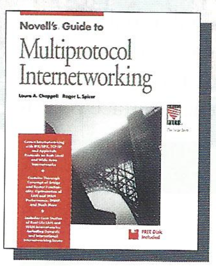

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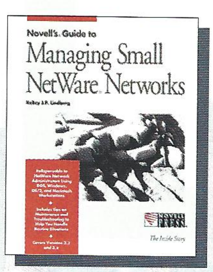

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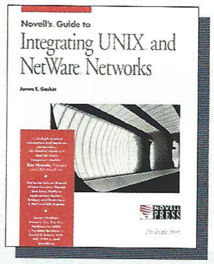

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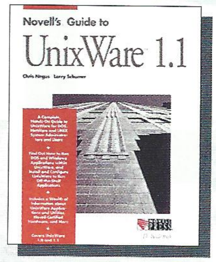

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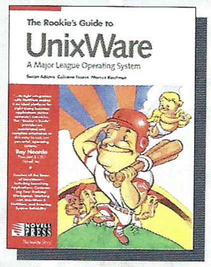

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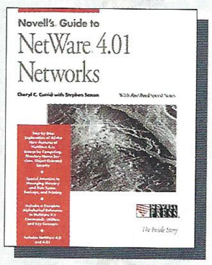

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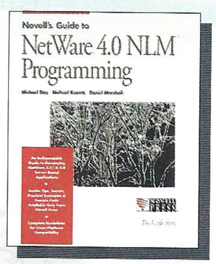

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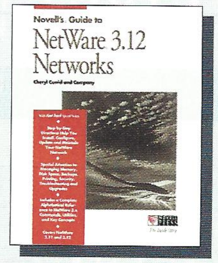

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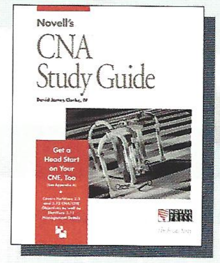

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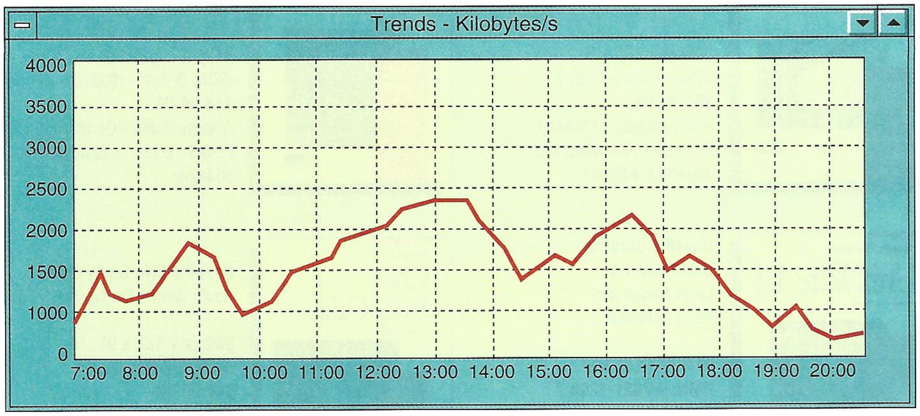

Figure 1. *Network communications are typically characterized by "bursts" of activity.*

The next question is, how much disk storage space is needed to store the digitized video files? Let's look at the numbers again:

27.6Mbyte/s x 60 seconds = 1.65Gbyte/min

1.65Gbyte/min x 90 min = 149GB

As you can see, you would need about 149GB to store your favorite 90-minute movie, and we haven't even included sound yet. You must add 5.3MB (mono) to 10.5MB (stereo) per minute for audio. Under normal circumstances that would seem like a lot, but it pales in comparison to the size of the video.

The Great Video Compromise

These numbers tell us that we have a ways to go before we can realistically store and play full-screen, VCR-quality video on PCs, and definitely a while before regular networks can handle the load. However, video is being played on PCs and over networks as we speak, thanks to some carefully thought-out compromises.

First, we compromise the quality of video by compressing it. Most compression algorithms use a "lossy" type of algorithm, which basically removes part of each frame, hoping to fool your eyes so they won't miss it. Software compression techniques, such as Intel's Indeo and SuperMac's Cinepak, provide about 25:1 compression. Hardware-assisted techniques such as those defined by the Motion Picture Expert Group (MPEG) provide 100:1 to 200:1 compression levels. The advantage of software compression is that it doesn't require hardware in the playback station.

By compressing the data, lowering the frame rate per second (typically to 15 frames per second), and reducing the size of the video window to 240 x 180 or 160 x 120 pixels, we can bring the required data rate down to a level that can be handled by PCs and some networks.

The data rate generally associated with a video session on the network is 1.2Mbit/s. This rate is based on the 150Kbyte/s transfer rate of a single-speed CD-ROM (150,000 bytes x 8 bits = 1,200,000 bits). Because digitized video files are quite large (2 to 25MB per file is typical), their distribution on diskettes is severely limited. On the other hand, the 600MB of storage on each CD-ROM have made it a standard for shipping multimedia applications. CD-ROM "juke boxes" (players capable of holding multiple CDs) are being used on networks to store transitional multimedia files and applications.

If a single multimedia session with video requires 1.2Mbit/s, a 10Mbit/s Ethernet segment will theoretically support eight sessions if it is running at 96 percent efficiency. This efficiency rate is not likely, however, even assuming you could reserve the entire bandwidth for multimedia sessions. For standard Ethernet, you will be lucky to get five simultaneous sessions. 16Mbit/s Token Ring, due to its deterministic nature, will support 10 to 12 simultaneous sessions. To take advantage of every bit of available bandwidth on the current Ethernet and Token Ring access technologies, you can use fast-switched hubs, which we will discuss later.

However, just over the horizon are 100Mbit/s Ethernet, 32Mbit/s full-duplex Token Ring, and ATM. These new technologies will increase bandwidth and open up the network to more multimedia applications.

Removing the Biggest Roadblock

Having sufficient bandwidth, however, does not a multimedia network make. The biggest problem facing multimedia on the network has roots in the historical development of networking. From the beginning of the networking era, even before the advent of the PC, networking hardware and protocols were engineered, designed, redesigned, tuned, and tweaked to carry text-based computer data. This type of data communication generally used some method of packet switching, and the characteristics of the traffic can best be described as "bursty."

Figure 1 shows a protocol analyzer trace of typical bursty network traffic. The inconsistent levels, or bursts, of data traffic are readily apparent.

Most network applications can tolerate the minimal delays in communications that result from this kind of traffic. For example, if it takes a half a second (more or less) to read or write a file to a remote host, the application can still successfully complete the process, and the user will usually not notice any delays. If it takes a little too long, the application will simply try again. Network hardware (such as interface boards,

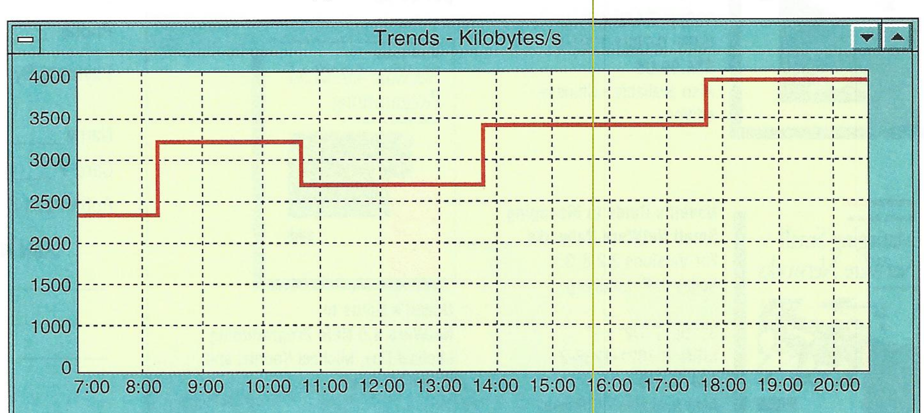

Figure 2. *To run videos, the network must provide consistent and uninterrupted streaming of data. Such communication is shown as flat traffic.*

	5 User	10 User	25 User
Machine	386 DX/33	486 DX/33 (EISA or PCI/Local Bus)	486 DX/50+ (EISA or PCI/Local Bus)
RAM	8MB	12MB	16MB
Network Interface Board	(1) 16-bit Ethernet or (1) 16-bit Token Ring	(2) 32-bit Ethernet or (1) 32-bit Token Ring	(4) 32-bit Ethernet or (3) 32-bit Token Ring
Drives	1 drive with (1) 16-bit controller	2 drives with (1) 32-bit controller	4 drives with (2) 32-bit controllers
Access Time	12ms	12ms	10ms
Transfer Rate	2 Mbyte/s	3Mbyte/s	5+Mbyte/s
Network Operating System	NetWare 3.1x or 4.x	NetWare 3.1x or 4.x	NetWare 3.1x or 4.x

Figure 3: *The recommended minimum hardware and software configurations for video servers running on NetWare.*

repeaters, bridges, and routers) and protocols (such as TCP/IP, XNS, IPX, SNA, and AppleTalk) designed for a buffered, store-and-forward model do not guarantee consistent, uninterrupted streaming of data. However, streaming is exactly what multimedia video, audio, and 3D animation playback require.

Figure 2 shows a protocol analyzer trace of a network that uses data streaming. Notice how flat the traffic levels are compared to the burst-type traffic shown in Figure 1. To achieve such streaming, the network must use isochronous communication to provide data for every video session.

The reason multimedia requires streaming is simple: people cannot tolerate even the slightest delay or mismatch in sight or hearing. For example, if it takes a few hundred milliseconds longer than usual to start an application on the network, you won't notice. But try watching a movie when the audio is a few hundred milliseconds out of sync with the lips of the person speaking, or worse, when intermittent frames of the movie are missing, breaking up the dialog and making the picture jerky (remember the 16mm educational films in school?). Or how about talking to someone on the phone and experiencing a minor delay in sound? It doesn't take much to frustrate the people talking and force a reconnection.

Although you may have enough available bandwidth and online storage for network video sessions, chances are your network hardware and protocols will not provide the required streaming. Thus, playback of multimedia audio and video files over the network will not be acceptable to the users. But don't despair; there are some things you can do now while waiting for the network industry to catch up with multimedia. First, let's identify some areas on the network where streaming bottlenecks commonly occur.

Network Interface Board (workstation). Network interface boards have been tuned to receive and transmit typical burst data. All but the high-performance boards may have trouble retrieving, parsing, buffering, and processing a constant 1.2Mbit/s stream of audio and video data in addition to any media access and network protocol overhead.

Network Media Access. Only the highest speed network media access protocols are suitable for multimedia traffic. At the low end is 10Mbit/s Ethernet, which theoretically supports four concurrent video sessions per segment. At the high end is 100Mbit/s FDDI, which can support up to 75 concurrent sessions.

Due to the predictable nature of the media access protocol and its high-speed clock, 16Mbit/s Token Ring and 100Mbit/s FDDI would be the media of choice for multimedia applications. Ethernet fundamentalists need not worry too much: fast-switched hub technology and 100Mbit/s Ethernet (often called Fast Ethernet) have saved Ethernet from multimedia oblivion.

Bridges and Routers. In their current state of development, bridges and routers provide the biggest bottleneck to using multimedia on an internetwork. These store-and-forward devices use large packet buffers that introduce a latency delay in any data stream. Networks can be optimized for multimedia playback, but all the best-laid streaming enhancements become inconsequential as soon as the data must cross a bridge or be routed to another network. Bridges and routers have their own agenda, and it does not include isochronous communications. The inherent delays, WAN bandwidth limitations, and high cost are the reasons the majority of multimedia network implementations are LAN-based.

Repeaters and 10Base-T Concentrators. Repeaters and concentrators repeat and recondition all signals indiscriminately. They provide for more devices on a network segment, but what is really needed is a way to isolate traffic and provide increased bandwidth to each station, not to add more bandwidth users. Consequently, repeaters and concentrators are not recommended for networks running multimedia applications.

WAN Links. You cannot run real-time multimedia applications over packet-switched WAN links such as X.25 and frame relay. Such links are used solely for burst-style traffic. Leased T-carriers (such as FT1, T1, T3, or T4), on the other hand, are actually ideal for multimedia if you can afford the bandwidth. A T-carrier provides a direct physical link with consistent bandwidth that can be allocated predictably. New WAN technologies such as Synchronous Optical NETwork (SONET) and Asynchronous Transfer Mode (ATM) promise high bandwidth (Gbit/s), isochronous WAN communications for the future.

Servers. Network servers have the same problems running multimedia as workstations. First, servers need to store the data. Not only does video require high-volume storage, but it works best when the data is stored contiguously on the server's hard drive. Storing data in contiguous blocks makes it easier for the server to support streaming.

Although workstations only have to deal with one session at a time, the server must be able to handle the aggregate of all the sessions, including reading the file, providing CPU time, and transmitting the data for each session using isochronous communication. These demands are usually

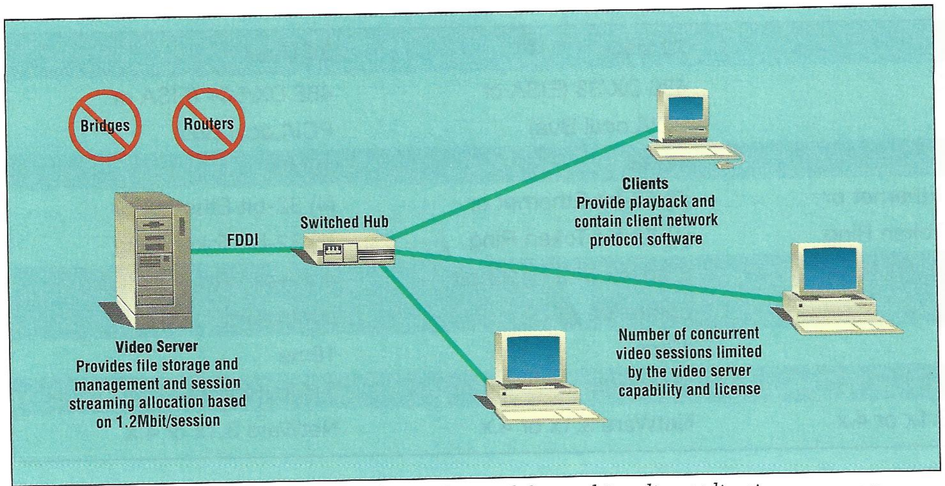

Figure 4. If you have heavy to moderate demand for multimedia applications on your LAN, you will need a dedicated video server.

too much for most general-purpose file servers to handle. The task is made even more difficult because popular network protocols are not optimized for streaming-type transmissions.

Network Protocols. Like network hardware, network protocols have evolved to support burst-style data communications. They do not support end-to-end isochronous transmission with guaranteed bandwidth and priority throughput allocation. While most protocols do support end-to-end, guaranteed delivery, this service does not benefit a video session. If a frame containing live audio and video is lost, retransmitting the frame will not help the receiving station provide the video clip as it is needed. For multimedia, network protocols should ideally provide priority delivery of the video traffic, with reserved bandwidth and throughput across intermediate networks and devices so that the data stream is maintained across the entire internetwork.

Running Video on Your Network

Despite these challenges, you can implement on-demand multimedia with audio and video on your network using current technology. There are three basic strategies:

- You can "turbo charge" all of the bottlenecks. Upgrade or replace crucial network hardware with the fastest equipment available. However, this solution is expensive and doesn't solve the root of the problem: the network equipment still supports only short burst-type traffic; it just does it faster.
- Install a dedicated video network parallel to your existing data network. This solution works well if you can justify the cost. A number of companies specialize in audiovisual-only networks.
- Use the existing video server and fast-switched hub technology to provide video services to users on a single network. Reaching everyone on an internetwork while avoiding bridges or routers is not yet practical, and so multimedia services are, at least for now, usually implemented on a local basis. However, you can expect that to change in the near future.

Because of the tremendous interest in on-demand multimedia, network vendors are in a frenzy to deliver multimedia-enabled network devices. The one with the most impact of late is the fast-switched hub. Look, it's a repeater! It's a bridge! Actually, it's neither, yet it's both, and it is almost a necessity if you are considering on-demand multimedia for your network.

Devices such as Kalpana's EtherSwitch or Cisco Systems' Catalyst line of manageable workgroup switches can increase the available bandwidth of your current Ethernet network by segmenting the network and isolating traffic.

A fast-switched hub acts much like a repeater: it retransmits a frame from one network segment or port to another network segment or port without buffering the frame first. The fast-switched hub, however, takes a microsecond or so to check the destination address field in the frame header (usually the first field). In this way, the fast-switched can redirect, or switch, the frame to the segment or port where the destination device is located—thereby functioning as a bridge but without the delay induced by buffering.

The fast-switched hub offers the best of both worlds—the speed of a repeater coupled with the traffic segregation associated with a bridge. Every port on a fast-switched Ethernet hub supports the full 10Mbit/s. For multimedia, the fast-switched hub is an ideal solution for network bandwidth and traffic control. (See Figure 4.)

Although most fast-switches are associated with Ethernet, Token Ring fast-switched hubs are soon to be released (if they haven't been already). These new hubs will make Token Ring a full-duplex media access protocol with no token and 32Mbit/s throughput. With full-duplex, stations can transmit and receive separate communications simultaneously. Again, this fast-switched hub should be ideal for multimedia implementations.

Fast-switched hubs do have some drawbacks. Unfortunately, they do not provide internetworking services associated with

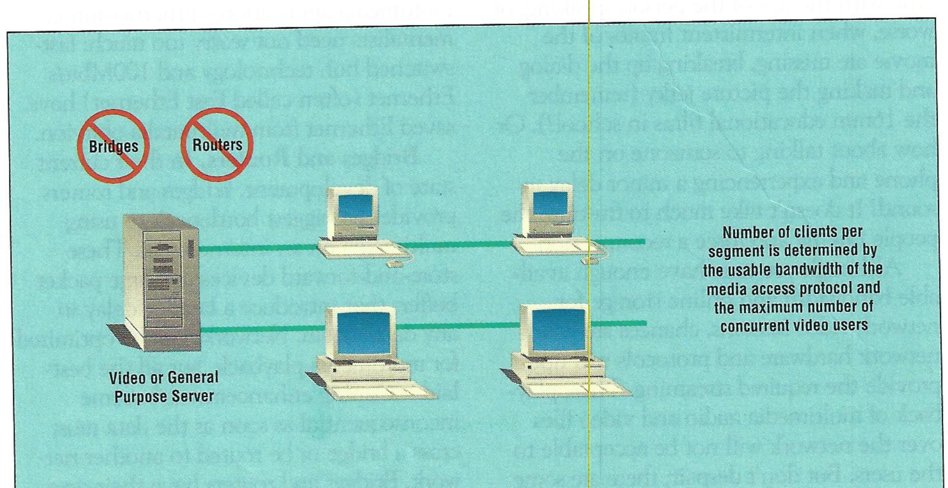

Figure 5. If you only run multimedia applications occasionally, you may be able to use a general purpose server. However, such a server can handle only a few simultaneous sessions.

routers, such as intelligent route selection and fragmentation, making this type of multimedia solution difficult to implement on an internetwork at this time.

Recommended Server Configurations

After you set up the network to handle large data streams, you must optimize the server for multimedia. If you are serious about running multimedia on your network, you should use a dedicated server with sufficient CPU power, transfer rate, and bus speed to support the number of desired users. Moreover, you will need adequate storage space. Trust us, video files are hard drive gluttons (we currently have no files under 2MB), and you can never have enough disk space. We recommend storage systems that provide level 5 Redundant Array of Independent Disks (RAID) with tens or hundreds of gigabytes of space.

CD-ROM "juke boxes" are also a nice addition to a video server. Juke boxes provide a removable source for multimedia applications and files for the network. Companies have even started "burning" their own CDs, offering flexibility in the creation and storage of company-specific, multimedia applications and files.

Figure 3 lists some recommended minimum hardware and system configurations for video servers running on NetWare. (See p. 39.) You can use these configurations as a guideline for video services. Of course, if the server will be used for general purposes as well as for video services, these requirements will vary.

Figure 4 shows an ideal configuration for multimedia services on the network using current technology. This configuration uses a dedicated video server designed specifically for that purpose. The video server is connected to a switched Ethernet or Token Ring (when they are available) hub through a 100Mbit/s FDDI link. The number of users that can be supported by this configuration will depend on the capabilities of the server.

Some companies, however, may not require a dedicated video server because they do not have a heavy demand for multimedia. Figure 5 illustrates a solution for an environment where multimedia is not the primary application on the network. In this case, the server must handle both video and standard data sessions. The server in this scenario will handle only a few video sessions—typically no more than two to five at a time.

The Server Software

You will also need specialized software for the video server. This software allows the server to optimize disk, stream, and session management for video.

A number of vendors offer video server software, which is available for shared server configurations (video and normal data) or for high-end, dedicated video servers that deliver and manage multimedia sessions. The software typically includes a server piece and a client piece for the workstations that will use the video services.

The video server software sets up video file management on the server's storage system and ensures that the files are stored in contiguous blocks on the hard drives. Storing data in contiguous blocks enhances the streaming capabilities of the video server.

The other important function of the video server software is managing the video

GLOSSARY OF TERMS

ATM (Asynchronous Transfer Mode)
A method of audio, video, and data transmission over LANs or WANs that uses 53-byte packets, 5 for control functions and 48 for data.

AVI (Audio Video Interleave)
A standard file format for Video for Windows, which specifies how audio and video data are mixed in a single file. A compressed video file is interleaved with the audio file on a per-frame basis.

Data streaming
Required by multimedia to keep network communications traffic levels flat, thus preventing even slight delays or mismatches in audio and video transmissions.

Fast-switched hub
A network device that retransmits a frame from one network segment or port to another segment or port. By checking the destination address field in the frame header before transmission, the hub can redirect the frame to the segment or port where the destination device is located.

Isochronous communication
The consistent and uninterrupted stream of data across the network that is the necessary form of communication for video sessions.

Lossy
A compressor that loses data every time an image is compressed.

MPEG (Motion Picture Expert Group)
Group formed to work on compression/decompression of motion video with digital audio. The MPEG group is defining and redefining the MPEG standard.

MTP (Media Transport Protocol)
A network protocol that was specifically designed as a streaming protocol for supporting video sessions on a network.

Multicast address
An address to a group of devices on the network that allows you to copy a single transmission to a number of devices.

NTSC (National Television Systems Committee)
NTSC is the video standard for North America and many countries.

Packet Switching
A type of data transmission that optimizes line use by routing and transmitting data packets from many different customers over a single line.

RAID (Redundant Array of Independent Disks)
An array of disk drives under the control of one device driver. Defined in levels for specific uses, RAID provides fault tolerance in the event one disk fails.

SONET (Synchronous Optical NETwork)
A fiber optic infrastructure that is capable of transfer rates in the gigabit range. Used with ATM protocols.

session. The video server must deliver a consistent and predictable data stream to each session. Video servers are rated by how many 1.2Mbit/s sessions they can support and still maintain an acceptable data stream to each client. The combination of the video server software and the hardware capabilities of the server determine how many sessions can be supported.

The video client software consists of a driver that helps the network interface board and the underlying network transport protocols to better handle streamed data. If you are using a dedicated video server such as Starlight Network's StarWorks, the client may include a network transport protocol specifically designed for video streaming.

A few vendors have released video services for NetWare 3.11 and above servers. These services are usually implemented as NetWare Loadable Modules (NLMs). Two of these products, their main features, and some recommended server platform configurations are outlined below:

Novell's NetWare Video Services (NVS)
- Server (NLM) and client components
- 5, 10, or 25 concurrent sessions
- MS Windows client only (must have Microsoft Video for Windows)
- Supports Audio Video Interleave (AVI) video files only
- Supports any Video for Windows supported compression

Starlight Network's StarWare
- Server (NLM) and client components
- 12Mbit/s streaming throughput (10 users at 1.2Mbit/s)
- Shared video and non-video storage option
- Supports any DOS or Windows video file format
- Supports any DOS or Windows supported compression

As we mentioned, several companies offer dedicated video servers. For example, the Starlight Network's StarWorks Video Server uses a network protocol called Media Transport Protocol (MTP) that was specifically designed as a streaming protocol for supporting video sessions on a network. The StarWorks Video server offers the following:

StarWorks Video Server
- Runs on standard 486 EISA server
- 50Mbit/s (40 simultaneous users at 1.2Mbit/s per session)
- Dedicated video storage
- Streaming RAID storage management (up to 100GB)
- Cross-platform client options (Macintosh System 7.0 or higher)
- Video file format and compression technique independent
- Proprietary network streaming protocols (MTP)
- Compatible with popular network operating systems

If you are a fan of Hewlett-Packard or Oracle, you should also investigate their video server/multimedia networking solutions. For desktop video conferencing, you might explore the products offered by Datapoint or GTE.

Conclusion

If multimedia is ever to be an integral part of networked applications, networking hardware and protocols will have to change. Look for fast-paced changes in the near future as corporations start looking to networked multimedia for communications, training, and general productivity applications. Then, watch out as network vendors race to fill the mushrooming demand for networked multimedia applications and the networks that can support them.

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