Multimedia Server for AIX

By Eddie Ho, Sam Juliano, and Gary Linker

With the explosion of interest in the Internet and the ever-increasing capabilities of personal computers, streaming multimedia presentations over your corporate network is as easy as browsing through your stored electronic documents. Business and educational institutions are fervently seeking new ways to exploit the power and the impact of multimedia for their benefit. The IBM Multimedia Server for AIX can deliver audio or video information using your existing business infrastructure.

The Multimedia Server is designed to turn your RISC System/6000 (RS/6000) into a scalable media server that can deliver multiple, simultaneous streams of audio or video data. Running on AIX 4.1.4 and later, the Multimedia Server delivers uninterrupted multimedia data to PC, Macintosh®, and UNIX clients using the industry-standard Network File System (NFS) protocol. Client workstations use standard multimedia applications, such as the MediaPlayer in Windows 95, to play the multimedia data as if it were stored on the client's local disk. Multimedia Server can also deliver data through intranet browsers and Lotus Video Notes clients to add audio and video capabilities to the existing corporate information system.

Typical Applications for Multimedia

Applications for multimedia are limited only by the imagination. Multimedia can be used to extend and enhance business processes to make them more efficient and more competitive. Many current applications include training, education, entertainment, publishing, collaboration, and product demonstrations. Elements of these applications are pervasive across all industries and customer types. The following are a few examples:

- **Training:** Employees can receive important job training at their convenience and at their own pace. Self-paced instructional courses are a natural application for multimedia, permitting the trainee to view and review material until it is understood and the trainee feels ready to continue.

- **Education:** Educators can reach a broader audience in more places with distance learning using distributed data across multiple locations. High-quality multimedia communications make traditional lectures and laboratories more interesting—and more fun.

- **Public information:** Multimedia can be used to create virtual museums, where artifacts and information displayed at the museums are immediately accessible to multiple users.

- **Demonstrations:** The most effective way for a customer to understand the value and operation of a product is to see a demonstration of its use. Multimedia demos can be replayed with no loss of quality. Multimedia kiosks can make these accessible to the public in a 24x7 environment.

Figure 1 summarizes some context and data types.

Network Multimedia Challenges

Traditional data processing equipment and networks are designed to process and deliver a small amount of data. The nature of the data is

usually not timing dependent, and information quality would not be affected if a slight delay occurred during processing or retransmission. On the contrary, multimedia data is very sensitive to timing and cannot tolerate any jitter or latency; thus, it changes the foundation of the data processing principle. In general, the operating system requires major restructuring and cooperation for data delivery to achieve normal quality. System components that can affect multimedia quality are as follows:

- **Operating System (OS):** Multimedia data transmission must take precedence over OS-scheduled activity in order to maintain consistency when streaming data.
- **Filesystem and Storage:** Filesystem technology must be restructured to handle large data reads and read aheads for each stream to sustain the final quality.
- **Network Technology:** The traditional LAN is shared. It is ideal for a bursty commercial environment, which is tolerable since commercial data is random and small in quantity. To deliver massive amounts of timing-sensitive data in a similar environment and maintain acceptable quality, the number of clients in a shared segment must be controlled to achieve consistency. In LAN switching, where each client owns a segment, micro-segmentation is not required.
- **Client Decoding:** Error recovery is critical in a commercial environment, and retransmission is required. Multimedia data does not require retransmission when an error is detected. This places a heavy burden on client real-time decoding technology to avoid network congestion and retransmission.

The Multimedia Server for AIX, engineered to solve these challenges, can deliver multiple simultaneous streams in a LAN environment.

Multimedia Server Model

The multimedia streaming solution is a two-tiered client/server data model that consists of three major areas: server system, network, and client workstations.

Typical Multimedia Environments

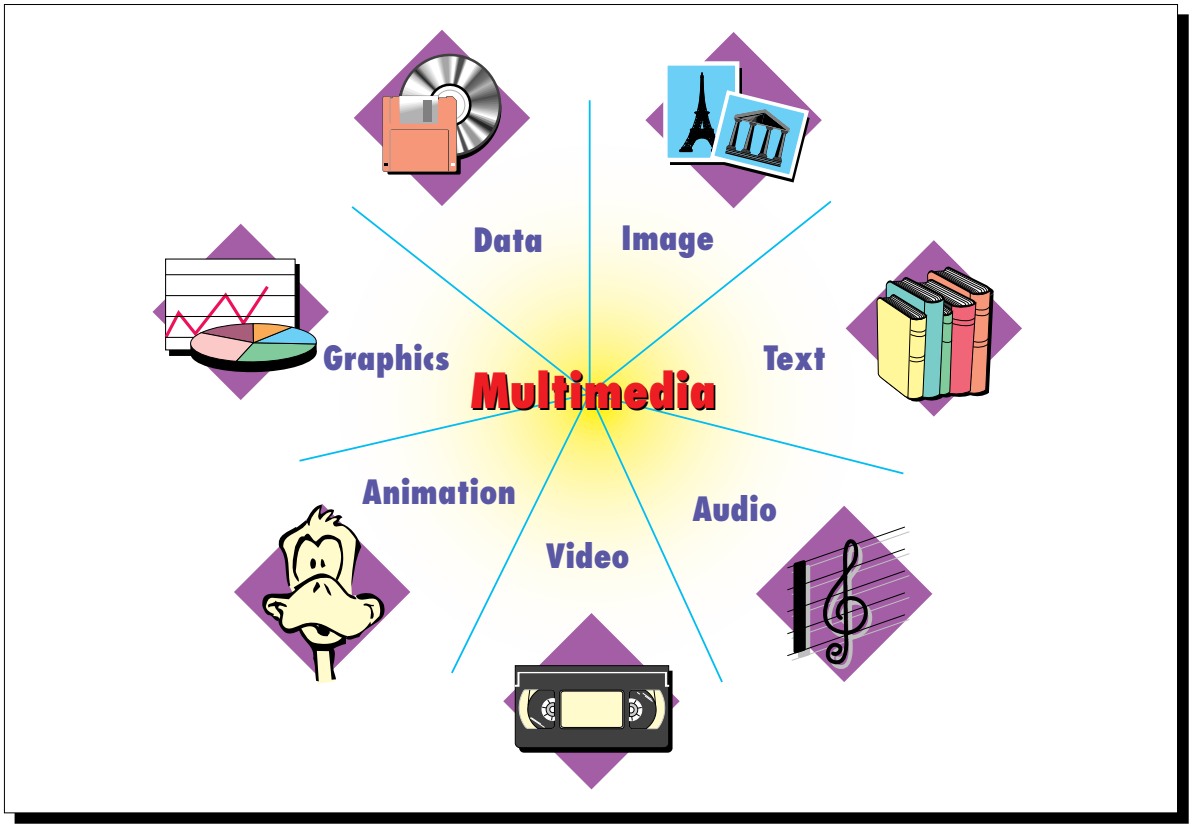

Figure 1. Multimedia content and data types

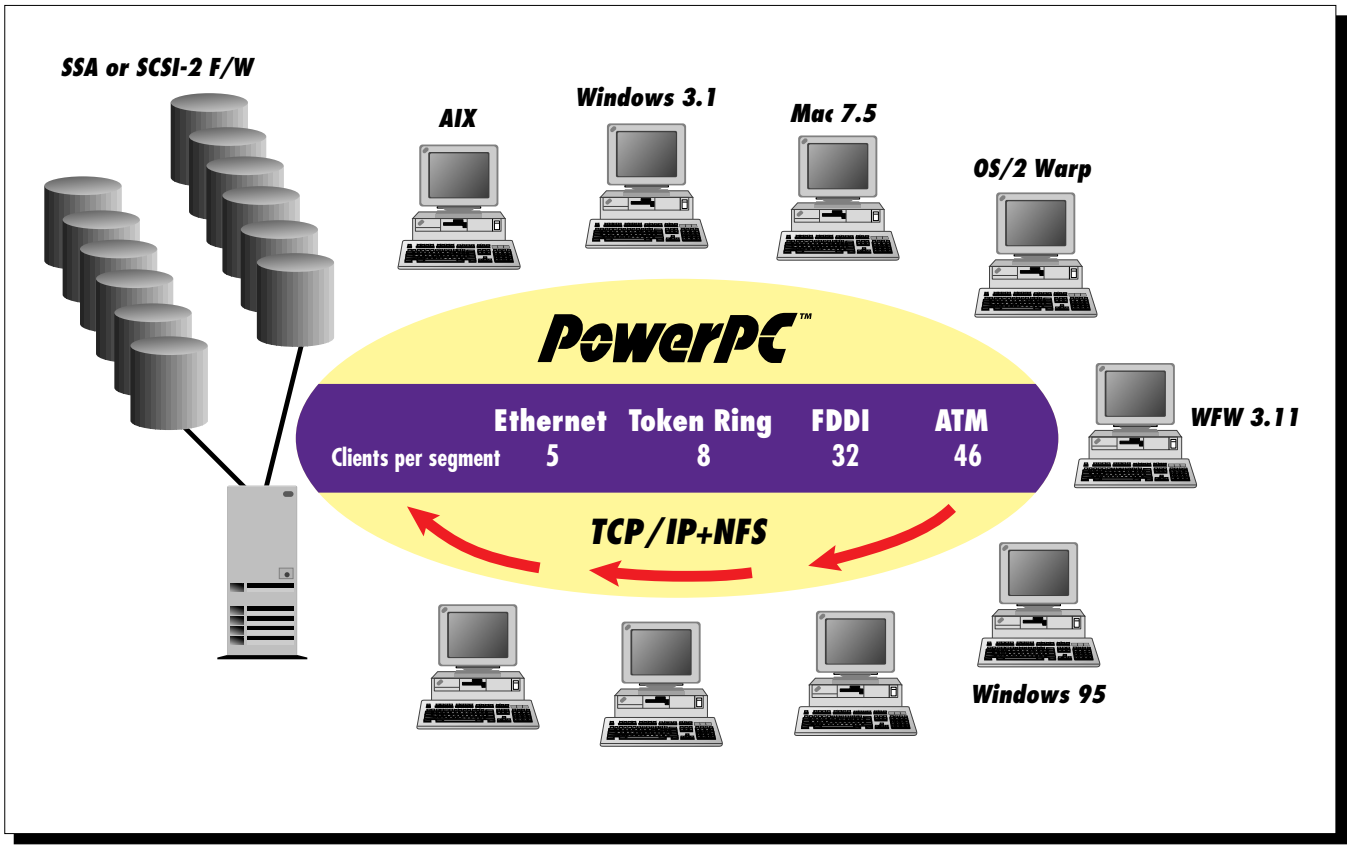

Figure 2. Multimedia server network environment

Server System

The server system is the repository and distribution center for multimedia assets. Figure 2 shows the server in a network environment. Digitized audio and video, in a variety of industry-standard formats (such as MPEG-1, Microsoft's AVI, and Apple® Computer's Quicktime), are stored in the server filesystem. These multimedia files are exported to client workstations using the TCP/IP NFS protocol. Multimedia Server is rated by the aggregate data bandwidth available from the server. The number of concurrent streams or clients that can be attached to the server can be derived from the aggregate data bandwidth and the bandwidth required by the application.

A video and audio application, such as a library of movies, requires much higher bandwidth than an audio-only application; thus, the number of streams provided by a server varies with the application and affects the number of concurrent users.

For example, a WAV audio-only data stream typically requires 384 Kbits/sec per client. In contrast, an MPEG-1 data stream, containing both video and audio, may require more than three times as much bandwidth, typically 1.2 Mbits/sec per client. Figure 3 shows samples of audio/video compression data rate.

Several RS/6000 servers, such as E20 to G40, have been tested as Multimedia Servers. Aggregate data bandwidths range from 25 Mbits/sec for the E20 to over 75 Mbits/sec for the G40. That ranges from 20 to more than 60 concurrent clients playing the MPEG-1 data type. For audio-only applications, a 75 Mbits/sec server can potentially serve over 190 clients. The server models and related streams are shown in Figure 4.

Network Assumptions

Networks play a major role in delivery infrastructure—it is the audio/video lifeline to the client. Industry-standard TCP/IP is the primary transport protocol with four different data link controls: Ethernet, Token Ring, Fiber-optic Distributed Data Interface (FDDI), and Asynchronous Transfer Mode (ATM).

Audio Quality and Data Rate

Quality	Sample Rate (KHz)	Bits/Sample	Mono/Stereo	Uncompressed Data Rate
Telephone	8	8	Mono	64 Kbit/sec
AM Radio	11.025	8	Mono	88.2 Kbit/sec
FM Radio	22.050	16	Stereo	705.6 Kbit/sec
CD	44.1	16	Stereo	1411.2 Kbit/sec

Video Compression/Decompression Standards

Standard	Quality	Compression Ratio	Compressed Data Rate
MPEG1	Med-High	35:1	1.2 Mbits/sec
MPEG2	High	40:1	1.65-60 Mbits/sec
MJPEG	High	20:1	3 Mbits/sec
H.261	Poor	200:1	50 Kbits/sec

Figure 3. Audio/video data compression rates

Traditionally, Local Area Networks (LANs) share bandwidth, which can affect the quality of video as more users are competing for the shared bandwidth. Most RS/6000 network testing for multimedia is done in a shared configuration except the ATM transport, which is based on a point-to-point dedicated environment. ATM provides the highest throughput to the client workstations, but even 10 Mbits/sec Ethernet can support up to five MPEG-1 clients using segmentation. Network segmentation controls the network collision domain to ensure a fair share of network resources for each client.

Figure 5 shows network types and their maximum number of clients.

LAN switching with a switching HUB can eliminate the number of clients-per-segment restriction in topology, but the maximum number of clients that each server can support remains the same.

Model	Data Throughput	Number of MPEG-1 Streams
E20/E30	25 Mbits/sec	20
59H/F20	50 Mbits/sec	42
G30/G40	75 Mbits/sec	62

Figure 4. Server models and related streams

Connectivity Type	Maximum Clients Per Segment	Topology
Ethernet	5	shared
Token Ring	8	shared
FDDI uplink with Ethernet hub	32	shared
ATM	46	point-to-point

Figure 5. Network type versus number of clients

Client Workstations

Client workstations can run the gamut from PCs to Macintoshes to UNIX workstations; in fact, any computer that can communicate using the NFS protocol and can play the desired multimedia data can be used as a client. IBM-compatible PCs from 486 DX2 to 133 MHz Pentium™ systems have been tested successfully with the Multimedia Server. The following operating systems have been tested by IBM: Windows 3.1, Windows 95, Windows NT, OS/2 2.1, OS/2 Warp, Mac System 7.5, and AIX 4.1.4/4.2.

Many recent PC models have a built-in MPEG-1 decoder; older PCs should use a decoder board for MPEG-1. Software decoders generally have poor video quality. In most cases, the client processor was overloaded performing NFS Remote Procedure Call (RPC) transactions;

therefore, software MPEG decoding can result in unacceptable skipped frames in video.

Multimedia Server Infrastructure

Multimedia assets such as audio and video are time-based. Continuous data streams of information must be delivered to the viewer at the proper rate in order to preserve human perception of motion and sound. The proper data rate, or bandwidth, must be maintained from the server to the client; otherwise the viewer will see "glitches" in the video and hear dropouts in the audio. Even the smallest imperfections in the video and audio data delivery are perceptible, which is unacceptable for quality multimedia delivery.

Multimedia assets are typically very large. A two-hour movie, digitized and compressed to a typical rate of 1.2 Mbit/sec (VHS videotape quality), results in a data file size of 1.2 GB. Most filesystems in a commercial data processing system are not optimized to handle many large files concurrently.

The Multimedia Server is optimized for the storage, management, and distribution of very large multimedia files.

The distinguishing feature of the Multimedia Server is the multimedia filesystem. Unlike standard UNIX filesystems designed for storing and retrieving relatively small files, the multimedia filesystem was designed from the ground up for the efficient delivery of multimedia assets, providing guaranteed bandwidth for data delivery. This file infrastructure is optimized for the storage, management, and distribution of very large multimedia files.

Some features of this file infrastructure include support for the following:

- **Data striping.** Striping spreads the workload evenly across multiple disks, which increases the aggregate bandwidth of the filesystem. It also permits concurrent reads that enable support for multiple clients.

- **Large files and filesystem.** Each filesystem can support up to 64,000 disks (up to 256 terabytes) architecturally.

- **Up to 1.3 terabyes of disk storage** and both SCSI and Serial Storage Architecture (SSA) technology are supported.

- **Large block reads**—256 KB and up. Reading large blocks of data reduces the number of read requests the server must handle.

- **Data replication.** Replication spreads multiple copies of multimedia files across filesystem disks to protect against disk failure. Replication factors can be assigned to the entire filesystem or to individual files.

- **Deadline scheduling.** This ensures multimedia data delivery takes priority over other OS services.

- **Error recovery and online reconfiguration.** Disks can be added and removed while the system is running with no data loss and no interruptions to the clients.

This filesystem is designed to be scalable and to provide continuous operation, so a minimal configuration can be expanded without the need to backup files, reformat disks, and recopy assets. Once the multimedia server is in production, it will never need to be shut down for maintenance.

Video Streaming over Intranet/Internet

Delivering video over the Internet or within an intranet is a complicated proposition. There are two approaches:

- Distribution of multimedia files as data that is played back later

- Streaming video, in which the client software decodes and plays the video on-the-fly

The Internet lacks the high-bandwidth carrier. Also any noise or delays while transmitting any of the data packets that make up a single frame of video can corrupt the entire stream.

This makes streaming video the preferred delivery method. Users do not have to wait to download the video clip, which is dependent on the workstation connection bandwidth. Although streaming video speeds the "time-to-gratification" for the user and creates a more interactive situation, it places greater demands on the underlying video technology. With streaming video, lost packets can result in lost video frames. And because video requires a predictable frame rate—30 frames per second is required for TV quality—keeping the frames flowing to the client at a continuous, predictable rate is important.

The Multimedia Server for AIX can be used to stream video in an intranet environment. Intranet Web pages can include links to

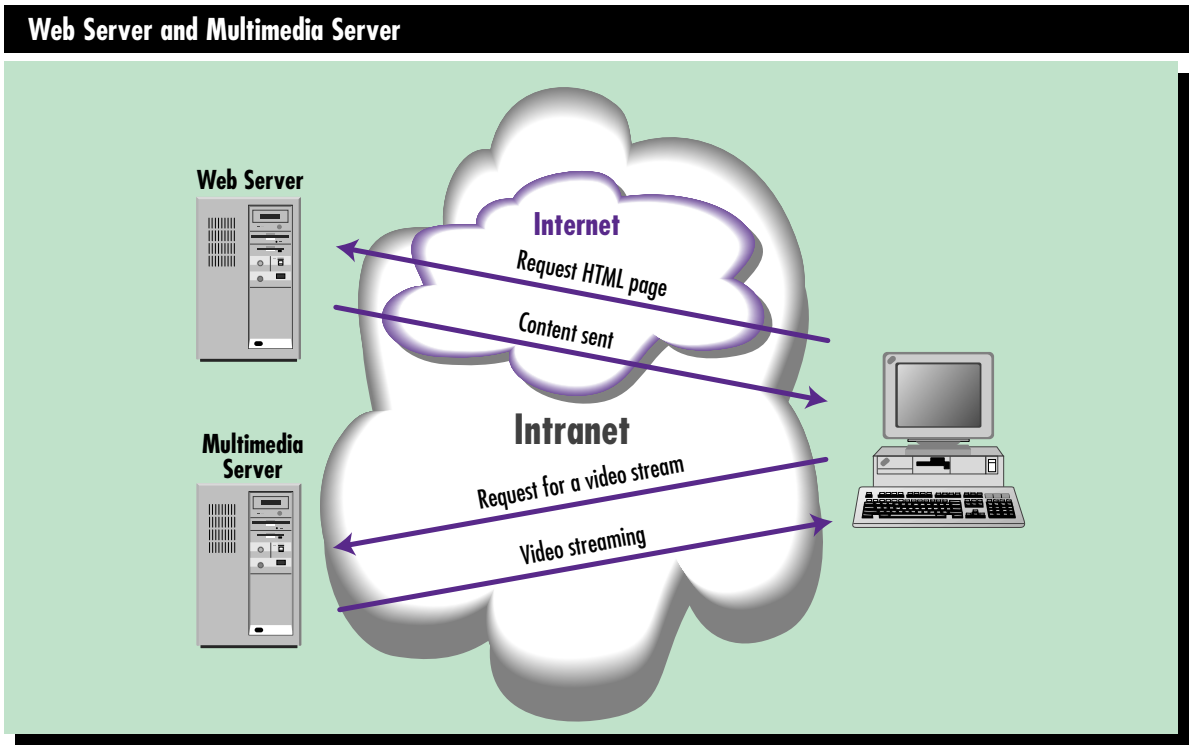

Figure 6. Web server and Multimedia server

multimedia assets resident on the Multimedia Server. When these hyperlink fields are selected, the assets begin playing immediately on the client workstation. In multimedia streaming, the communication between client and server is separate from the actual Web page transmission. The Web server transfers control to media players, which have their own links to the media server using either a local helper application or plug-in approach.

Figure 6 summarizes the client workstation relationship to the Web server and the Multimedia Server.

Conclusion

Multimedia is changing the way we work, allowing us to be more productive by bringing all data types to the desktop. The spiral effect of faster server systems and higher-speed information networks can bring end users closer to the real-time environment. The Multimedia Server technology provides a building block to launch the second-generation wide-area multimedia system with dynamic content delivery from anywhere using the nationwide ATM infrastructure.

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