Tektronix

Using ATM Networks for Video Creation, Editing, and Distribution

Tektronix, a leader in video support products for the news broadcast industry, wanted to improve video networking using asynchronous transfer mode (ATM), an innovative packet transmission technology well suited for video. In the mid-1990s, networked video transmission was impeded by inadequate and conflicting telecommunication standards, incompatible hardware and transmission protocols, and network congestion. Tektronix had many complex technical goals to improve networked video, but primarily they wanted to develop products that would improve networked video delivery to customers in the television broadcast industry. They also wanted to gain a larger share of this highly competitive market that was dominated by Asian manufacturers. For these reasons, the company applied for Advanced Technology Program (ATP) funding under the focused program, "Digital Video Information Networks," of 1995.

During the project, Tektronix successfully completed its technical tasks. The company developed technology that it demonstrated to the National Association of Broadcasters trade show in 1997. The company received eight patents and made progress in video compression, point-to-multipoint broadcasting (multicasting), and digital video server development. However, their technology was outpaced by advancements in concurrent technologies such as Internet protocol and Ethernet; therefore, Tektronix was unable to develop any marketable products. After the project ended in 1998, Tektronix decided to focus entirely on the test and measurement market and sold its Video Networking Division to its former subsidiary Grass Valley.

COMPOSITE PERFORMANCE SCORE
(based on a four star rating)

No Stars

Research and data for Status Report 95-04-0027 were collected during August – November 2004.

Video Networking Poses Technical Challenges

In the 1990s, traditional video production was undergoing rapid changes due to advances in the industry, including the introduction of digital technology and improved video compression, networking, processing, and storage. One of the obstacles facing the implementation of the new technologies, however, was the large installed hardware base of traditional analog technologies. At the time, video production was just starting to make the transition from analog to digital technology.

One of the video applications that needed technology and interoperability improvements was point-to-multipoint (from one sender to multiple recipients) video networking in the television public broadcast industry. Existing broadcast systems had various shortcomings: they had awkward, non-uniform packet sizes; they could not deliver packets reliably over long distances; and they could not support tiered service classes. For example, a real-time television news broadcast requires a higher service class than a non-real-time application like e-mail. (Real-time applications require transmission and reception of packets to happen simultaneously. In television broadcasting, making viewers wait for a video to slowly display [non-real-time] on their TV screens is commercially unacceptable.) In populated areas with the necessary network infrastructure, real-time service must be robust and reliable, or the news broadcast cannot reach thousands of viewers in a timely fashion. Asynchronous transfer mode (ATM), a hardware and software technology that could be used to transmit video from one place to another, offered a possible

reliable solution to these shortcomings. Tektronix, an industry leader in video support products, intended to test ATM to determine if it was an economical solution. If successful, an innovative ATM solution would enable real-time and robust video networking in virtual classrooms and libraries, remote medical diagnoses, telecommuting, remote sensor systems, and home entertainment. However, perfecting ATM for video networking was a significant challenge.

ATM Could Accelerate Video Networking

Developing ATM technology for video networking was a complex problem that required extensive resources beyond those Tektronix could provide; therefore, the company applied for and received ATP funding as part of the focused program, "Digital Video in Information Networks" of 1995. Tektronix believed that ATP support would accelerate Internet and television communications by enabling signal convergence for televisions, computers, and other devices connected to networks. Tektronix's technical goals for the three-year ATP-funded project included developing the following aspects of video networking systems:

- A fiber optic input of networked video into ATM hardware at the transmitting and receiving ends of the video
- A video transcoder to accommodate incompatible video formats and hardware
- A networked Moving Pictures Experts Group (MPEG-2) coder/decoder (abbreviated as "codec") to compress and decompress video quickly. (This process is commonly referred to as "compression" and "decompression". Compression removes redundancy in transmission, thus reducing the number of packets that need to be created and transmitted.)
- The capability to convert video using personal computers (PCs) to enable users to view videos on networked computers
- A video resource management hardware device, managed by software, to optimize network resource use

Tektronix Investigates ATM as Part of the Solution

Tektronix addressed two video networking problems in their ATP-funded research: Could the ATM design for high-speed transfers be applied to video? Could ATM also be a solution that could unify multiple incompatible solutions on the heaviest traveled routes of the Internet? The emergence of digital technology to handle video streams was new in 1995. The enormous size of a digital video stream stretched the existing digital technologies that were designed primarily for transferring large data files. ATM was designed both for high data rates, and to handle content like video. Several organizations were developing technological solutions for handling video in digital form. Thus, partial solutions were proliferating, but they were not compatible with each other. As is the case with many technological transformations, the initial forays into digital video attempted to directly replace comparable analog functions. Merely replacing analog functions with digital functions fell short of maximizing digital technology's power.

The Company Proposed Innovation Via an Ethernet LAN

One of the innovations Tektronix proposed was to transmit a video in a series of transmissions (called "hops") between routers. This transmission would start with Ethernet cable, a type of transmitting cable that was cheap, relatively fast, and commonly used on local area networks (LANs). For the next hop, Ethernet cable would transfer the video transmission to an ATM fiber optic network to continue the transmission to a non-Ethernet, fiber-optic wide area network (WAN). No other company had attempted this, and the telecommunications standards in existence at the time did not accommodate it. A hardware manufacturing company, Cisco, had attempted packet transmission from Ethernet cable to ATM, but only with text files, not with video. Tektronix would be the first to test ATM for video networking capability from Ethernet to fiber-optic cable.

As stated in the technical goals earlier, a major challenge for Tektronix in optimizing video delivery was to develop the most economical compression formula, or algorithm. Tektronix made some progress by developing a video gateway, which was a hardware

component with its own ATM software installed. The gateway created video packets for real-time transmission over dissimilar networks, including Ethernet and ATM networks.

Tektronix Makes Progress on Technical Goals

The company made some progress on several of their technical goals, as described below:

- *Fiber optics from Ethernet to ATM gateway*. Tektronix sought to route packets through WANs and LANs, with delivery service guarantees over Ethernet and ATM networks. (The guarantee was based on whether real-time transmission was needed. If real-time was needed, the service was more expensive than non-real time service.) By the conclusion of the project, the company had achieved a data transfer rate of 76 Mbps, a rate that surpassed the original project goal of 40 Mbps (which was the highest studio-quality video standard for recording at the time).

- *Networked MPEG-2 codec*. MPEG is an International Electrotechnical Commission standard for videos with high-resolution compression formulas built in. At the receiving end of the transmission, the decompression formula uncompressed, or "decoded," the video to a viewable, real-time state. The progress on this technical goal also resulted in the following related achievements:

    - At the start of the project, no MPEG-2 codecs were commercially available in the compression algorithm needed. This meant that Tektronix needed to develop a new algorithm optimized for video networking. By March 1996, IBM offered a prototype MPEG circuit board codec. Tektronix successfully tested this codec and later incorporated it into a video gateway prototype.

    - By March 1997, Tektronix had developed a prototype video encoder device as part of the networked MPEG-2 codec development. This prototype supported multicasting, which is the simultaneous broadcast to several destinations in a group on a network. However, by project end, more development was needed in the area of networked MPEG-2 codecs, a need that continues today.

- *Video conversion of PCs*. Tektronix planned to develop video server and video-player software for PCs to enable clients who used non-real time service (and thus subscribed to the lowest [cheapest] service to access video databases) for browsing, editing, and other applications across dissimilar Ethernet and ATM networks. The video player would also support an Internet browser. Tektronix developed the video player, which integrated the audio and video decoders, and added it to the Video Gateway hardware. It was successfully demonstrated it in 1997 at the National Association of Broadcasters trade show. By the end of the project, the editor, player, and decoder services were mature enough to declare this task a 90-percent success. However, since the decoder boards available at the time did not function with Microsoft Windows NT, further development work would have to wait for a new NT-compatible version of the decoder board. The project ended before Microsoft released the new version; so this problem was not resolved.

An innovative asynchronous transfer mode (ATM) solution would enable real-time and robust video networking.

- *Video resource management*. Under this task, Tektronix would develop a framework to create, store, retrieve, process, and distribute videos across dissimilar networks. The associated applications included interactive video, broadband conferencing, telemedicine, and distance learning. In 1998, the last year of the project, Stanford University provided a basic artificial intelligence (AI) agent management tool called JATlite that facilitated functions such as searching and browsing low- and high-resolution video clips. (An AI agent is a highly specialized computer program that performs a complex function in an independent fashion.) Although the project team demonstrated how an AI agent could be useful in a networked environment, more research and development was needed to fully use the tool to manage videos in the television studio video production environment.

- *High definition television demonstration using ATM*. At the conclusion of the project, Tektronix demonstrated the transmission of a real-time uncompressed high-definition television (HDTV) signal using ATM in a fiber optic network at a transmission speed of about 1.5 gigabits per second. (HDTV presents a high-resolution picture far superior in detail to conventional TV.) This was an expanded task that was added midway through the project. After the conclusion of the project, Tektronix adapted the ATP-funded HDTV technology to Internet protocol (IP) and demonstrated it for the Air Force.

Tektronix would be the first to test asynchronous transfer mode (ATM) for video networking capability from Ethernet to fiber-optic cable.

Although Tektronix achieved its technical goals using ATM, the fast-moving video industry moved on to other technologies, such as IP and Ethernet, during the ATP-funded project. IP governed the rules by which packets traverse networks on the Internet. Ethernet is a LAN standard for connecting PCs, printers, servers, and other hardware on the same network. The large installed base of IP and Ethernet led to less expensive networking equipment than ATM required. By 1998, Tektronix's competitors had achieved gigabit speeds in Ethernet, something that had not been possible or even anticipated in 1995. Consequently, ATM never took off as a solution for video networking.

Tektronix Receives Eight Patents Related to ATP-Funded Project

Tektronix was granted eight patents for research and development related to this project. However, due to a change of business strategy in the company, they transferred six patents to Tut Systems of Pleasanton, California. Tektronix and Tut Systems have both confirmed that, although no commercialization has yet resulted from the patents, both companies intend to hold the patents until they expire in case their future plans for commercialization change. Tektronix has also granted a royalty-free license for the life of one of the patents to its former subsidiary, Grass Valley, which sells broadcast video products.

Shortly after the end of the project, Tektronix decided not to commit company resources to further research in video networking using ATM. The company sold its video research unit to Grass Valley and has refocused on the test and measurement business.

Conclusion

In 1995, Tektronix, an industry leader in video networking, sought to address the problems of creating and editing distributed video on local and wide area networks. The company used a combination of strategies for improving hardware and software interoperability on asynchronous transfer mode (ATM) networks. By 1997, Tektronix demonstrated a personal computer video player, with audio and video decoders, at the National Association of Broadcasters trade show. Although no products were commercialized from this project, Tektronix was granted eight patents based on project-related technology. While the company achieved its technical goals using ATM, the technology never took off as a solution for video networking. The rapidly changing video industry moved on to other technologies, such as Internet protocol and Ethernet, during the project research years. By the end of the project, video management in the television studio production environment needed more research and development. After the conclusion of the ATP-funded project, Tektronix decided not to seek further funding to continue its research in video networking using ATM. The company sold its video research unit to its former subsidiary Grass Valley.

PROJECT HIGHLIGHTS
Tektronix

Project Title: Using ATM Networks for Video Creation, Editing, and Distribution (Advanced Distributed Video ATM Network for Creation, Editing, and Distribution)

Project: To develop technologies to enable a networked, integrated environment for collaborative creation, editing, and distribution of video and multimedia.

Duration: 9/30/1995–9/29/1998
ATP Number: 95-04-0027

Funding (in thousands):

ATP Final Cost	$1,914	85%
Participant Final Cost	344	15%
Total	$2,258	

Accomplishments: Tektronix received the following patents for technologies related to the ATP-funded project. Some of these patents have been transferred to Tut Systems and other companies.

- "Reverse playback of MPEG video"
  (No. 5,739,862: filed December 23, 1996; granted April 14, 1998)
- "Audio/video media server for distributed editing over networks"
  (No. 6,029,194: filed June 10, 1997; granted February 22, 2000)
- "System for network transcoding of multimedia data flow"
  (No. 6,483,851: filed November 13, 1998; granted November 19, 2002)
- "Measuring delay variation of regenerated data clock and of associated data packets"
  (No. 6,574,246: filed February 17, 1999; granted June 3, 2003)
- "Resource constrained routing in active networks"
  (No. 6,650,620: filed May 4, 1999; granted November 18, 2003)
- "Associative management of multimedia assets and associated resources using multi-domain agent-based communication between heterogeneous peers"
  (No. 6,574,655: filed June 29, 1999; granted June 3, 2003)
- "Data resynchronization between modules sharing a common clock"
  (No. 6,744,833: filed July 20, 1999; granted June 1, 2004)
- "Refining a pixel-based segmentation mask derived by unsampling a block-based segmentation mask"
  (No. 6,594,389: filed May 31, 2000; granted July 15, 2003)

Commercialization Status: Tektronix has no plans to commercialize any video networking product from this project.

Outlook: Although the asynchronous transfer mode (ATM) technology explored by the project researchers was successful, its adoption by the industry remains weak. As of 2005, players exploring Internet protocol and the Ethernet standard dominate the market.

Composite Performance Score: No Stars

Focused Program: Digital Video in Information Networks, 1995

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