

INTEGRATED WIDE-AREA ATM SOLUTIONS FOR BROADCASTERS AND PRODUCTION

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ABSTRACT

Broadcasters production and post facilities use a variety of public and private wide-area network technologies to connect remote studios to broadcast centers for voice, data and video communications services. By migrating all these services onto a single ATM infrastructure, a number of broadcasters production studios are now gaining significant operational and economic benefits. This paper describes how these integrated wide-area network services are deployed and provides details of the new TV networking services supported by an ATM infrastructure.

INTRODUCTION

Broadcasters with production studios, as well as production and post production facilities today are distributed over regional, national or even international area require a variety of wide-area communications services in order to support their day-to-day operations. These include general communications services such as telephony, ISDN, LAN interconnection and internet access, together with specialized TV communications services such as real-time TV contribution links, non real-time video file transfer, live two-way interviews, remote archive retrieval, talkback and studio control. Production preview, review and approval are critical to completion of a project today.

The majority of broadcaster professionals lease a number of different public and private wide-area communications services from a Telco or NSP (Network Service Provider) in order to link their studios for the support of these operational requirements. Increasingly Production companies are installing links to post production facilities, and advertising agencies.

The charges and administrative overhead associated with leasing and operating multiple services can be considerable. In addition, the legacy TV services that are typically offered by many Telcos do not provide adequate support for the new studio production systems and their associated formats, protocols and interfaces.

ATM technology provides the solution. Broadcast and TV Professionals can integrate all their inter-studio communications services over a wide-area ATM infrastructure. A single ATM network link into each facility is able to provide wide-area connectivity for PBXs, IP routers and TV and Electronic Cinema production equipment.

This paper first provides an overview of ATM technology and then proceeds to describe its support for general communications services, for TV Broadcast and Content creation communications services.

A number of ATM-based wide-area TV networking applications are described including details of the support for new formats, protocols and interfaces.

This includes a discussion on the control of ATM based TV networking services and their integration within studio control systems to support end-to-end seamless networking.

A description of the various implementation options available will be given together with some suggestions and guidelines for deployment.

ATM OVERVIEW

ATM is a networking technology designed to provide support for the integrated transport of voice, data and video traffic.

ATM enables many connections to be multiplexed over a single physical link (fiber-optic or copper coax). Each connection can be used to carry a separate service by configuring it with the precise bitrate and quality of service required for the service traffic type. This allows, for example, multiple bi-directional MPEG-2 stream transfers and video file transfers to simultaneously take place over a single physical link that is also carrying telephony and LAN traffic.

End-to-end ATM connections over the wide area (i.e. spanning multiple links that are connected via ATM switches) may be either permanent or switched. Through a network manager, permanent connections or (PVCs) are established for long-term guaranteed connectivity between locations. Switched connections (SVCs) allow temporary connections to be automatically established and terminated using standard protocols. SVC networks provide dial-up, on-demand connectivity similar to that offered by the telephone network. SVC operation optimizes network utilization since bandwidth is only allocated when it is required and it offers great flexibility since each subscriber can dial-up any other subscriber, locally, nationally and internationally.

ATM networks can provide support for simultaneous PVC and SVC operation. ATM networks also support multicasting to allow the same material to be simultaneously received at multiple destinations.

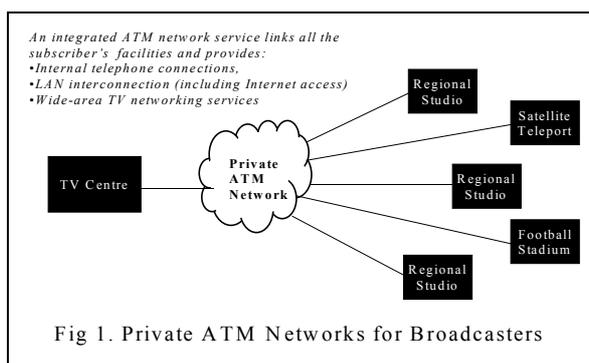
ATM Network Services for Broadcaster and Production

ATM network services are available to broadcasters and content creators on either a public or private basis. A key difference between a public and a private service is the tariff structure. Subscribing to a public service requires users to be charged per contribution connection made between their own studios and to those of others. Leasing a private network service provides broadcasters and content creators with unlimited contribution (and other

services) between studios with no per-connection charges.

Public ATM based contribution services are now being deployed by Telcos and Network Service Providers (NSPs) to replace the aging ANSI and 45 Mb/sec based contribution systems that have provided connectivity between studios for many years. Each subscriber is provided with access to the ATM network through a specialized ATM service access multiplexer (a gateway that is provided as part of the service). The gateways typically integrate support for multiple TV contribution interfaces such as SDI, DVB ASI, SDTI and video file transfer and provide the interface to the public ATM network over fibre or coaxial copper circuits. Public ATM based contribution services are also able to provide dial-up connections and multicast facilities. Typically the TV Professional pays for installation and a monthly line rental and a charge per-connection that is based upon a combination of service-type, bandwidth, distance and duration.

Private ATM based networks link each of the subscriber's facilities together over a dedicated network that supports TV communications services, LAN connectivity and telephony. ATM gateway devices (and in some cases, ATM switches) are deployed at each premises to connect to the TV production equipment, PBX and IP router. All traffic is integrated and transported over a single, bi-directional fiber or copper coaxial link into a private ATM network. The TV interfaces typically supported on specialized broadcaster ATM gateways are PAL, SDI, SDTI, ASI, video file transfer etc.



In addition, it is possible to create links between independent private networks to allow contribution transfers between different broadcasters and other content providers such as news agencies. These connections are usually charged on a per-use basis rather than being included within the service charge.

If network bandwidth is temporarily insufficient (due to exceptional circumstances such as a major news

story) then additional capacity can be made available by the Telco or NSP on-demand.

Other broadcaster and content creation network services such as teleport backhaul and simple point to point connections can also be deployed using ATM technology. Such services benefit from the associated improvements in bandwidth utilization and support for the latest formats, protocols and interfaces.

ATM SUPPORT FOR BROADCASTER'S, TV PRODUCTION OR MOVIE STUDIOS NEEDS

The following sections describe how ATM provides the services that are required by TV Professionals and content creators within a private ATM network service.

Support for telephony services

The Virtual Private Network or VPN is a well-established service used by many large companies to increase convenience and reduce costs. VPNs link up the PBXs in each office and allow all phones within the company (regionally, nationally or internationally) to be dialed directly through their extension number, without having to use the public telephone network. In addition services such as call transfer, hunt-groups and multi-party calls are available.

VPNs can be provided over a variety of network infrastructures. Today linking each PBX on the ATM network, using T1/E1 circuit emulation creates VPNs based on ATM-telephony

Support for LAN interconnection

Companies with multiple offices generally need to connect their LANs together so that all the corporate network resources including databases, email services and Internet access are available to each employee.

ATM is frequently the technology selected for interconnecting LANs over the wide-area. This is typically achieved by connecting each office's IP router to the ATM network. IP routers can be supplied with ATM interfaces for direct connection or with Frame-Relay or E1/T1 links for interworking.

Support for MPEG-2 streaming

The transport of MPEG-2 streams on ATM networks is a standardized and well-established means of providing real-time contribution feeds. The combination of MPEG-2 and ATM has a number of benefits over fixed ANSI or 45 Mb/sec codec based contribution systems.

- Network Architecture, Switching and Routing

ATM based contribution systems are based upon a distributed architecture that allows dial-up connections (uni-directional, bi-directional and multicast) to be established on-demand (dial-up) or permanently between different locations.

ANSI or 45 Mb/sec based contribution systems only provide fixed point-to-point links necessitating a star based network topology, hubbed on a central switching matrix for the provision of any-to-any connections.

- Bandwidth Optimization

MPEG-2 supports video bitrates of between 4 and 50 Mbps, the bitrate selection is based upon the desired contribution quality. The bandwidth of the ATM virtual circuit created for the contribution link can be configured to meet the precise bandwidth requirements of the MPEG-2 stream – you only use what you need.

ANSI and 45 Mb/sec codecs require dedicated, fixed bandwidth links so you use a high bitrate connection even if you only want a low-quality review feed.

- Support for Multiple Interfaces

ATM access devices that support MPEG-2 typically provide 525/625, SDI (with AES/EBU audio) and DVB ASI interfaces to the user. In the case of SDI, the device integrally provides the MPEG-2 compression and adapts the resultant MPEG-2 transport stream to ATM. ASI interfaces allow an external codec (or satellite IRD) to present an MPEG-2 transport stream for ATM adaptation and transport over the wide-area.

Support for Video File Transfer

Video File transfer between servers within the studio environment is an essential part of day-to-day operations. ATM enables broadcasters to transfer video files between studio at high bitrates. Interfaces to video file servers are typically IP (100baseT or gigabit Ethernet) or Fibre-channel.

Support for DVCPRO and Betacam SX

DVCPRO (25 and 50) and SX equipment such as camcorders, editing systems and file-servers now provide SDTI interfaces to enable the streaming of native content between devices within the studio in real-time and 4xreal-time. This enables broadcasters to keep the material in the compressed domain throughout the entire production process thus avoiding the introduction of multi-generation artifacts.

ATM access devices for broadcasters provide SDTI interfaces thus allowing the compressed material to be transported directly over wide-area contribution links. The ATM access devices simply extract the material from the SDTI input, adapt it to ATM for transport and then output it on SDTI at the far-end.

Support for SDI transport

SDI streams can be transported over ATM using either a direct mapping or lossless compression. This is a relatively new capability and standardization is in process.

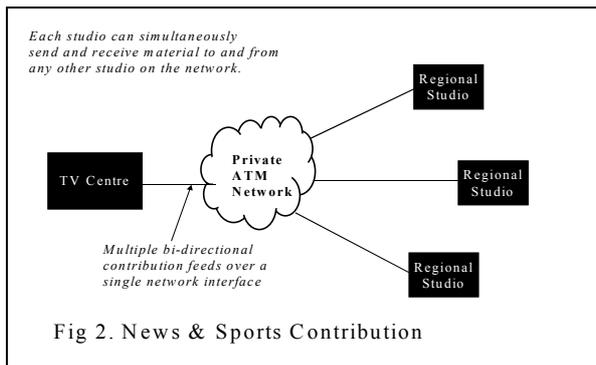
PRIVATE ATM NETWORK TV APPLICATIONS

This section describes how the capabilities listed above can be used by broadcasters or content creators, within a private ATM network, to enhance their existing TV networking services and to provide valuable new services.

News and Sports Contribution

Studio staffs are able to independently dial up their colleagues in remote studios and transfer material desk-to-desk in real-time or faster than real-time over ATM. Permanent connections can be created in advance to provide guaranteed feeds (for sporting events or breaking news) and ad-hoc occasional feeds can be created on-demand using the remaining available capacity. Management of the system (i.e. establishment and termination of the feeds) can be centrally controlled, distributed amongst the users or be a combination of the two.

ATM contribution links between studios provide significant enhancements to the legacy point-to-point leased lines based on ANSI or 45 Mb/sec codecs.



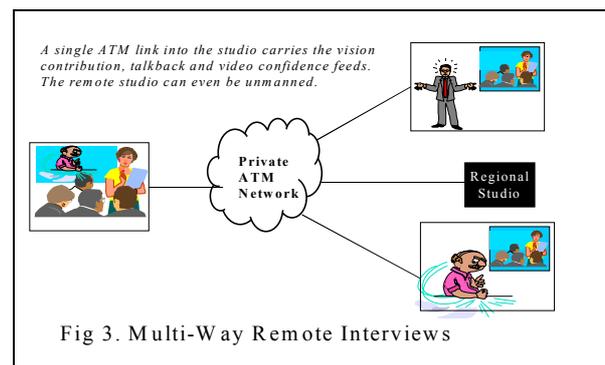
A single ATM network connection to a studio can support multiple simultaneous bi-directional contribution feeds. Each feed can be transmitting to or receiving from a different remote studio. Multicasting is also possible. The only limitation to the number of contribution feeds into or out of a studio is the capacity of the ATM network connection link (typically 155 Mbps). The bandwidth of each feed can be selected according to the picture quality requirements thus optimizing the bandwidth utilization.

An integrated ATM access device in each location provides multiple user interfaces and access to the ATM network. NTSC/PAL or SDI transfer services use MPEG compression for transport over the network. SDTI interfaces enable the transfer of DVCPRO or SX material to be performed entirely in the compressed domain (i.e. no multi-generation encoding/decoding cycles) at real-time or 4xreal-time. SDI interfaces with direct mapping to ATM or lossless compression can be used for high quality post-production work.

Remote Facility Contribution

ATM-based contribution links can also be extended to Outside Broadcast or Remote Truck locations such as football stadiums, opera houses and government buildings. A single ATM link into a football stadium can transport multiple individual feeds back to the studio as well as provide talk-back and confidence pictures return feeds to the remote facility. Studios shooting content can be tied in real-time to editing and post facilities for increased production efficiencies.

Live Interviews Between Studios

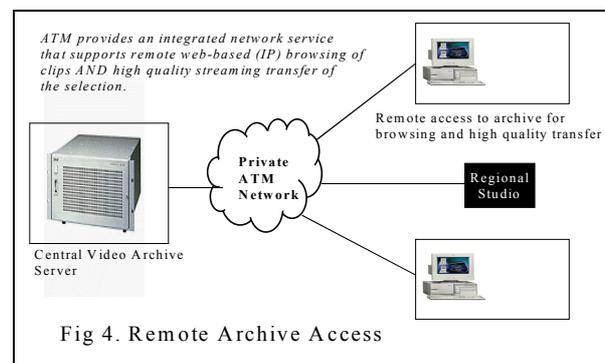


ATM services are bi-directional enabling broadcasters and producers to set-up contribution links between studios for two-way (or multi-way) interviews. Mix-minus audio and even low bandwidth confidence pictures can be sent to the remote studio over the same ATM network link that is carrying the vision feed into the broadcast center. Many MPEG encoder manufacturers now provide a low-delay mode specifically to support this type of application.

Links to satellite teleports

Public or private satellite teleports can be linked to a broadcaster's or movie studios private ATM network to transport MPEG-2 satellite feeds directly to and from the studio. An ATM access device linked directly to the satellite modem over an ASI interface enables the content to be transported directly to and from the studio without additional encoding or decoding. ATM support for multicast allows many studios to receive the feed concurrently.

Remote archive retrieval



Manufacturers are now producing video file servers with an integrated web-based browsing capability. By linking such servers to the ATM network it is possible for staff in remote studios to browse the clips using a low-bandwidth IP over ATM connection and then file-transfer or stream the selected clip over the ATM network.

Control and Management

The TV interfaces on an ATM gateway are typically linked to studio equipment such as SDI matrices, file servers and VTRs that are under the control a studio management system. In order to enhance the usability of the wide area TV network services it is often considered beneficial to put the ATM gateway under the control of such a studio management system as well. ATM gateways often provide management interfaces (RS-422 and SNMP) to support this.

Newsroom control systems can be extended to support the management of wide-area contribution links. Control panels on newsroom desks can be used to establish an end-to-end connection across the studio and wide-area networks to a remote studio or OB location.

Such an integrated system enables end-to-end connections to be established between newsroom desks or production offices in, New York, Los Angeles and London with the same ease with which they can be established within a single studio. Users select sources and destinations not caring that the far end may be in another city or country.

CREATING AN INTEGRATED ATM NETWORK

Broadcasters and content creators wishing to take advantage of an integrated ATM-based networking solution have a number of implementation options available to them. The choice is typically based upon the technical and operational capabilities available within the organization and on cost.

All the options described in the following sections enable users to create an integrated wide-area network and are based upon leasing a network service from a Telco or NSP. Consequently they all offer the same principle benefits, namely:

- One contract for all wide area network services.
Reduces administration and offers the potential for cost savings through economies of scale and competitive bids.

- No per-use charges

Network service contracts are typically framed around the leasing of a specified amount of network capacity. The services operating over this capacity such as internal telephone calls, web browsing, contribution link connections or video file transfers incur no additional charges. This reduces costs and simplifies budget forecasting.

- Reduced Complexity

A single (typically redundant) network connection to each studio for all wide-area communications services reduces equipment ownership costs (maintenance, administration and operations), reduces equipment requirements and frees up space in the equipment room.

- Scalability and Future Proofing

There is no danger of the infrastructure being unable to meet increases in capacity requirements since ATM networks can be expanded by simply increasing link speeds (e.g. 155 to 622 Mbps) and by deploying additional equipment such as ATM switches.

The choice of ATM for TV wide-area networking services by the EBU-SMPTE JTF, the Pro-MPEG Forum and DVCPRO Partners suggests that equipment manufacturers and standards bodies will ensure ATM devices support new broadcasting formats, protocols and interfaces.

Leasing a Managed Service

Broadcasters and content creators can lease a fully or partially managed service from a regional, national or international network service provider or Telcos.

A managed service from a Telco typically starts with the design of a custom system according to the user's individual requirements. The Telco is generally responsible for providing the network capacity, installing the equipment at the Broadcaster's or content creator's premises and maintaining the infrastructure. A service level agreement (SLA) defined within the contract will specify characteristics such as system availability (e.g. 99.999%) and video interface compliance (e.g. bit-error rate and jitter).

The Telco typically provides the broadcaster with the TV networking interfaces (e.g. NTSC/PAL, SDI,

SDTI), the PBX (or a connection to the broadcasters existing PBX) and a link to the IP router for LAN interconnection.

The Telco (or a sub-contacted broadcast systems integrator) may also integrate the wide-area TV networking system into the broadcaster's studio control system (or provide an integrated control system).

The management of the TV networking services may be performed by either the broadcaster or by the Telco.

Leasing an ATM Service

Alternatively, broadcasters and content creators can lease a raw ATM network service from a Telco and deploy their own ATM access equipment to support the connection of studio equipment, PBX and LAN.

Leasing an SDH/SONET Service

The final option is for a broadcaster to lease SDH/SONET (fiber-optic) or dark-fiber links between facilities and deploy their own ATM infrastructure (i.e. ATM switches) together with ATM access equipment to support the connection of their studio equipment, PBX and LAN.

While this option may seem daunting it is quite straightforward if the expertise is available within the broadcaster's organization. Such an approach has recently been implemented by the Danish Broadcasting Corporation (DR).

DR linked seven regional studios to their main broadcast facility in Copenhagen over ATM using the ECI Telecom Hi-TV as the integrated access device for TV networking services.

CONCLUSIONS

This paper has described the technological and economic advantages that make private integrated wide-area ATM networks so attractive to broadcasters.

ATM is a flexible and scalable networking technology that can be used for many broadcaster and content creator applications; from simple point-to-point links between two locations over a leased line (with no ATM switches involved) to fully integrated private broadcaster networks that

integrate telephony, LAN and TV networking applications.

A number of broadcasters throughout Europe and now in the USA are have deployed such integrated solutions and have gained considerable operational and economic benefits.

Electronic Cinema can benefit from these wideband ATM network distribution techniques. One suggested plan would provide a movie studio a direct connection to the exhibitors with encrypted secure distribution paths. At theaters patrons would be able to provide direct feedback to producers about likes and dislikes as well as purchasing cassettes and disks after the showing.

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