MPEG-2 over IP/ATM

Introduction

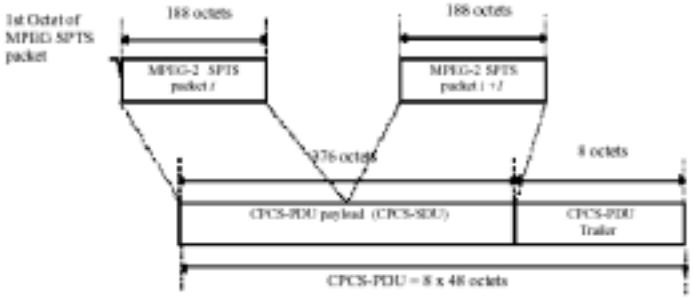
ATM has well-known capabilities for the delivery of real-time data, but it has not been widely deployed in enterprise networks, except as a backbone networking technology. In carrier networks, ATM is the technology of choice for the delivery of multiple services due to its ability to deliver Quality of Service and high-bandwidth profile.

Many years ago the networking industry debated the advantages of ATM vs. IP. Those debates were settled with the explosion of the Internet, and IP became the de facto network protocol. Today, the most common use of ATM is to transport IP traffic*. In fact, it is estimated that some 80% of all Internet traffic is actually carried over ATM, and most DSL service is delivering IP over ATM (although the ATM layer is as invisible to the user as SONET, SDH, and other higher layer transport mechanisms).

DVD-quality MPEG-2 video can be easily and seamlessly delivered over ATM networks using IP, and this paper explains the basics.

MPEG over ATM

There are standards that describe MPEG-2 over ATM. In fact, the very architecture of MPEG-2 was guided by ATM's 53-byte (48-byte payload) cell structure. MPEG-2 Transport Streams are delivered in 188-byte sections which fit precisely into ATM's AAL-5 layer. These standards are promoted by the ATM Forum, DAVIC, and were adopted by early MPEG-over ATM systems.



MPEG-2 over ATM Structure

The main advantage of direct MPEG-to-ATM mapping is that it takes advantage of ATM's ability to deliver Quality of Service in order to deliver very robust performance. The disadvantage is that there is no IP layer, and therefore deployment requires a complete end-to-end ATM solution.

Such a solution is fine for homogeneous ATM networks, but it eliminates the possibility of delivering that video to Ethernet-connected devices such as PC's or other IP-connected devices.

* Historical Note: IP and ATM were contending for network dominance circa 1995. While some may think ATM lost the battle for market acceptance, it turns out that ATM is still growing and IP may be the best thing that happened to ATM!

MPEG over IP/ATM

MPEG-2 video that is formatted for delivery over UDP/IP can take advantage of the existing standard, well-supported mechanisms for the delivery of IP data over ATM. For example, a VBrick connected to an OC3c ATM switch can interoperate with a VBrick or PC that is connected to the network via Ethernet. Furthermore, ATM-connected devices can be managed with SNMP, a web browser, or Telnet only when the device encapsulates IP into ATM, because the management occurs at the IP layer.

There are several methods for sending IP traffic over ATM. Some of these methods encapsulate layer 2 data (RFC 1483 bridging) and some encapsulate layer 3 data (IPoA). These encapsulation processes are considered layer 2 or layer 2.5 protocols, as layer 3 and other layer 2 protocols rely upon them for transport over ATM.

IPoA, Classical IP (RFC 1577) -- User data in the form of IP packets (Layer 3) is encapsulated into AAL-5 PDUs for transport over ATM per the RFC-1483 Routed method. The fact that the user data is routed at the IP layer instead of bridged at the MAC layer allows the source and destination to be on different subnets. This is the preferred standard for the delivery of IP MPEG data over ATM PVC's and is supported by VBrick MPEG-2 products.

(RFC 1483 Bridged) provides a simple method of connecting end stations over an ATM network. User data in the form of Ethernet packets (Layer 2) is encapsulated into AAL-5 PDUs for transport over ATM. This method is simple, but since it operates at the MAC layer, routing is not provided and there is no exposure to the IP contents carried.

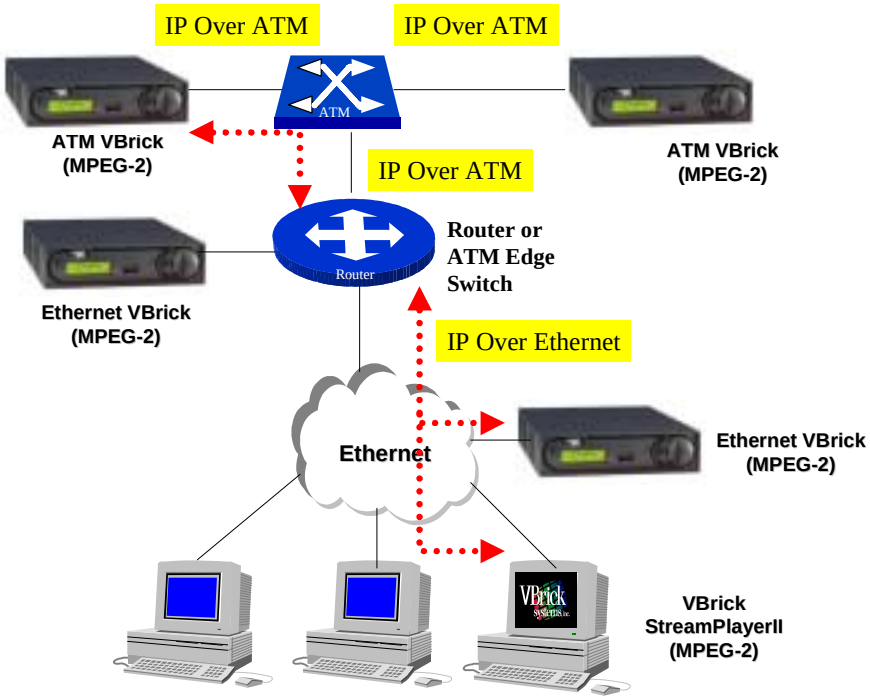
LAN Emulation (LANE), as the name applies, is a method that causes connection-oriented ATM circuits to appear as a shared-media LAN. In the simplest case, computers connected to a ATM network run a special software client (LAN Emulation Client, or LEC). To the computer, the LEC "looks" like an Ethernet segment. To the ATM network, the LEC "looks" like an ATM client. The LEC communicates with a LAN Emulation Server (LES) and LAN Emulation Configuration Server (LECS) that must be present in the ATM network. Another component is the Broadcast Unknown Server (BUS), required for the ATM network to send data to more than one point at the same time. In operation, the components automatically setup and tear down ATM circuits as needed, and effectively providing a connectionless service (IP) with a connection-oriented technology (ATM). Today, much of the complexity in getting these components to work together has been eliminated, and LANE works quite well. One disadvantage to LANE is that the commonly deployed version does not support wide scale IP multicasting, although some implementations do. Typically, IP multicast traffic will be sent via the BUS (performance issue) to all users of the network (traffic issue). Because LANE establishes point-to-point (a so called "data direct") connections after establishing a call, LANE can work very well for the unicast transport of video over ATM.

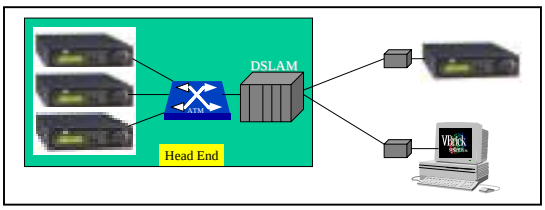
VBrick IPoA

VBrick's MPEG-2 Video Network Appliances send MPEG-2 over ATM using IP Over ATM (IPoA). As a result, a VBrick connected to an ATM network can interoperate with a VBrick connected to an Ethernet Network, enabling universal video networking.

For integrated ATM/IP Video Networking, the conversion of IP Over ATM to Ethernet, if necessary, occurs within the network:

- An ATM port on a router that supports RFC-1577 will accept the IP data and deliver it as native IP packets to other interfaces on the router.
- Edge Switches that have an ATM uplink and Ethernet user ports provide internetworking services. An ATM-connected VBrick is fully interoperable with an Ethernet-connected VBrick.
- ATM-to-ATM VBricks are supported via ATM PVC. The IP layer is invisible to the ATM network.





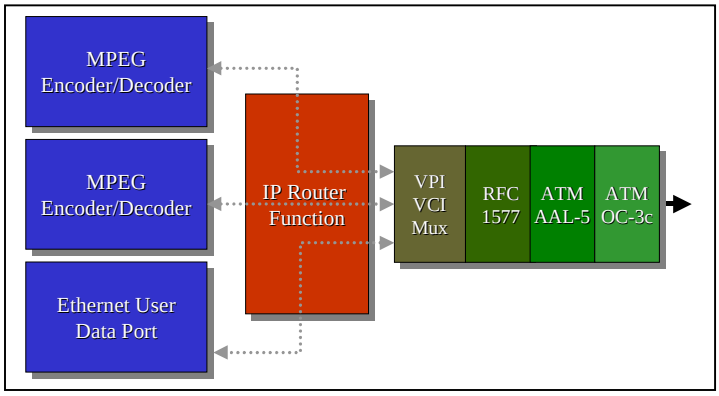
Service providers, cable operators, and content aggregators benefit from IP over ATM because, at some point along the delivery chain, the network infrastructure will presuppose IP. Some Digital Subscriber Line Access Multiplexes (DSLAM) accept ATM, making it possible to provide higher density Head End solutions with fewer inside ports while maintaining the QoS necessary for premium content delivery.

Architecture

The VBrick IPoA facility takes advantage of VBrick's integral IP routing function. This function exchanges RIP tables with other routers, making it virtually transparent to the user and enabling seamless IP connectivity where each 'port' of the router may be a unique IP network.

The block diagram illustrates how the IPoA works.

Each MPEG encoder or decoder may be configured with a different IP address, and a routing facility can direct that traffic to an appropriate ATM VPI/VCI where the IPoA and AAL-5 encapsulation occurs. Similarly, the local Ethernet Data Port supports native IP data, allowing high-speed access to the Internet and other common network resources. The ATM Virtual Circuits are delivered over the ATM OC3c interface.



VBrick Video Network Appliances can be configured with multiple address assignments, to concentrate IP traffic across the ATM network. The VBrick internal routing function automatically knows which ATM interface is most appropriate to use based upon routing knowledge leaned through the RIP processing. VBrick can seamlessly convert between Ethernet and ATM IP layers, and automatically extract video and management IP packets. The local Ethernet interface port may be used as an data access port, such that IP data presented to it is automatically routed to a particular ATM PVC.

Importantly, VBrick allows the MPEG-2 video to be delivered on any valid ATM Virtual Circuit, and allows the same or different ATM Virtual Circuits to be used for various combinations of video or data sources. For example, you might use:

- one VC for receiving and a different VC for sending
- one VC for encoder #1 and a different VC for encoder #2
- one VC for all video
- one VC for Ethernet User Data and a different one VC for video

ATM Advantages

ATM, and IPoA has several important advantages. First, ATM networks are widely supported and available from public carriers and within large corporations.

- An ATM PVC may be configured with certain Quality of Service parameters, and the ATM network enforces these parameters on an end-to-end basis. To the extent that MPEG video is transported over a particular PVC via IPoA, the IP layer inherits the QoS for that PVC. This means that even though IP is used, ATM's robust support for low delay, high bandwidth service is preserved though a public or private portion of any ATM network.

- ATM establishes virtual circuits within a physical media (e.g. a fiber). Because each virtual circuit may have its own unique bandwidth characteristics, and because VBrick enables video or data traffic to be sent over IP on different ATM VC's, Quality of Service is maintained even though it is sent via IP. Mission-critical data applications, voice, web traffic, email, etc. cannot interfere with the video traffic and visa-versa.

- IP over ATM also enables end-to-end QoS in a Multi-Protocol Label Switching (MPLS) network, since VBrick supports DiffServ. VBrick's IP traffic can be mapped into MPLS flows without additional processing because the video packets are tagged with DiffServ priority at the source.

- ATM operates over fiber, providing extended reach. Inexpensive multimode fiber is typically used for distances up to 2 km, and single mode fiber for distances to 40 km.

VBrick Advantages

VBrick's MPEG-2 products provide significant advantages for the delivery of MPEG-2 over ATM:

- Seamless ATM to Ethernet, end-to-end, one-way or two-way DVD-quality television

- Quality of Service preservation

- Elimination of network edge devices for ATM-to-IP conversion

- Reduced complexity

- Professional Composite, S-Video and SDI video

- High Density (Dual Encoder)

- Integral Web Server

- Standard MPEG-2 Transport Streams, interoperable with VBrick decoders, desktop software decoder (StreamPlayerII), and 3rd party Set Top Boxes

- Highest Value Proposition in the industry