The Future of IPTV: Business and Technology Challenges

IPTV White Paper

Introduction

In the struggle for survival, the fittest win out at the expense of their rivals because they succeed in adapting themselves best to their environment."

Charles Darwin, The Origin of Species

Technology innovation fast-forwards natural selection in the telecommunications marketplace by destroying old markets and creating new ones in their place. As examples: VoIP (Voice over IP) and the competition it allows have combined to destroy the long-distance telephony market; similarly, cell technology has untethered users' dependence on home wireline phones. As VoIP and cell phone usage increases, the revenue that long-distance and local carriers collect from residential users decreases. Due to the widespread adoption of these two technologies, incumbent telephone companies have had to look for ways to generate revenues outside of residential voice service.

The good news is that even as traditional voice markets have collapsed, emerging technologies have created new opportunities for telcos. Advancements in DSL (Digital Subscriber Line) technology allow for increased throughput. Coupled with progress in video compression, like H.264-MPEG 4 Part 10 and Microsoft Windows Media Player 9, telephone companies now have the ability to deliver broadcast-quality video over their copper access lines. These technological innovations and the race to control customer content delivery are now driving the largest investment in network infrastructure since the late 1990s.

New Opportunities Present Technology and Business Challenges

With the promise of new revenue streams, delivering video to the home brings dramatically higher bandwidth requirements. Since today's DSL networks were designed for web surfing, this will force telcos to significantly upgrade their access networks. This upgrade cycle is happening now as traditional voice carriers make haste to enter the video-delivery market to match or stave off competition.

This whitepaper discusses the technological barriers that DSL providers face in supporting video applications while upgrading their current ATM (Asynchronous Transfer Mode) networks. We present a new approach that will allow telcos to quickly and cost-effectively deliver video services over their current DSL networks today and, as the video subscriber base grows, to seamlessly evolve these networks into the Ethernet-based broadband architectures of the future.

The Competitive Outlook

Today's incumbent telcos are at a disadvantage to their cable competitors who already offer broadcast video and Internet access. By bundling VoIP-based voice services, cable multiple service operators (MSOs) can deliver on the triple-play trifecta. Telcos must race to achieve video-service parity with cable operators and, by so doing, compete for control of what will become the single communication channel to the subscriber's home: the broadband port. It doesn't matter whether that channel is DSL, FTTH (Fiber to the Home) or an emerging technology like WiMAX, this household communication port will become the "one-stop shop" for consumer content, yielding recurring subscriber revenue and opening potential new income streams from application service providers (ASPs) looking for access to subscribers.

There is another technology shift that offers an advantage to the telcos. Thanks to the videocassette recorder (VCRs) and the new personal video recorders (PVRs) from companies like Tivo, viewers are time-shifting their video consumption and watching programming when it's convenient instead of when it is first broadcast. The wide embrace of this technology means that more and more video is being watched at the viewer's discretion. Video on Demand (VoD) is the natural extension of this trend. MSO networks are optimized to support broadcast video. In the move to VoD and the unicast traffic that drives it, telcos have the advantage. New DSL technology allows carriers to deliver significantly more directed bandwidth to the home, positioning DSL providers to take the lead in VoD delivery.

The race is on.

Barriers to Offering Video

Today's DSL service networks were designed for residential access to the Internet at greater speeds than dial-up modems could provide. Internet access previously meant simple web surfing. The web-surfing model allowed DSL providers to assume relatively low, relatively bursty bandwidth utilization per user. In fact, many of today's DSL networks have been provisioned to support less than 20 to 30 Kbps of average bandwidth per subscriber.

The advent of peer-to-peer file sharing has changed bandwidth consumption significantly, much to the dismay of DSL operators. The requirements for video delivery will blow these networks out of the water. Do the math: A standard definition channel requires 3.5Mbps using MPEG-2 compression. A competitive video offering must support at least 3 channels of simultaneous viewing per home. For basic broadcast video parity a provider must offer more than 10Mbps per household, and that's independent of Internet service.

In short, video delivery requires a significant upgrade to the DSL access infrastructure. To see why, look at Figure 1.

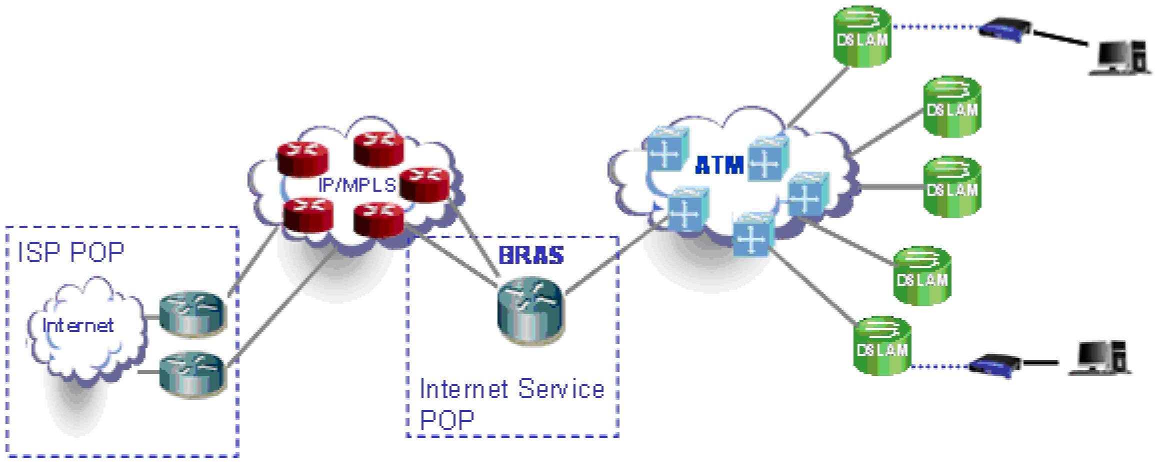

Figure 1: A typical DSL aggregation network

Barrier #1: Today's Unreliable B-RAS (Broadband-Remote Access Server)

In a typical DSL network, ATM-based DSLAMs (Digital Subscriber Line Access Multiplexers) are aggregated through ATM switches that are, in turn, connected to a B-RAS. The B-RAS controls subscriber access to the DSL provider's network. It performs a large variety of tasks, including subscriber authentication and accounting, IP address assignment, service advertisement, dynamic binding to virtual routing domains, and layer 2 handoff to a retail ISP. The B-RAS has a lot to do – and that's the problem.

The strains on the typical B-RAS make it one of the least reliable devices in the network. Today DSL providers are able to tolerate B-RAS outages that affect their Internet service offerings. Video, however, is not just another Internet service. Telcos will not be able to compete by offering a video service that consistently goes down due to B-RAS flakiness.

The typical B-RAS also tends to support lower speed interfaces (OC-3c/STM-1 ATM) and few of the gigabit Ethernet ports required for cost-effective video services.

Video delivery must avoid the traditional B-RAS.

Barrier #2: Today's Centralized, ATM-based DSLAMs

Most of today's DSLAMs are deployed in central offices where they can support thousands of DSL subscribers. This was an efficient and cost-effective model when the goal of the network was to deliver Internet access to as many households as possible. But even with compression, delivering video services to the home requires an order of magnitude more bandwidth. Since DSL rates increase only as the DSL loop length decreases, DSLAMs must be placed closer to residential subscribers to service their video bandwidth needs. This means deploying DSLAMs in remote terminals (RTs) or service area interfaces (SAIs) where they will serve only a few hundred subscribers. As a result, new DSLAMs will likely be smaller. The days of the single, large CO-based DSLAM are numbered.

Broadcast video delivery also requires efficient IP multicast support. To minimize core network load it will be necessary to perform multicast replication as close as possible to the subscriber. The first commercial deployments of video over DSL have relied on replication from deep in the network at the IP multicast router level or via ATM point-to-multipoint PVCs (Permanent Virtual Circuits) in the DSLAM. However, most of today's ATM-based DSLAMs are not able to support multicast or the necessary protocols, such as IGMP (Internet Group Management Protocol) snooping, to make multicast delivery practical.

Video delivery requires increased functionality on the DSLAM to scale.

Barrier #3: Video Distribution Within the Home

Telcos must meet the challenge of distributing video within the subscriber's home. Several options exist including reuse of the subscriber's existing cable plant, CAT5 cabling, wireless networking or use of the existing interior telephone lines using the Home Phoneline Networking Alliance (HomePNA) standards.

Video delivery requires an adequate inside wiring solution.

Stepping Up to IP Video Quickly

For many telcos the fastest way to support broadcast and VoD services is to deliver them over their existing ATM-based DSL infrastructures. This can be done even as investments are being made in DSL access-network upgrades.

Developing a parallel network, shown in Figure 2, is probably the simplest approach. Using this model involves three basic activities: procuring content, supporting IP multicast protocols, and installing multi-service broadband routing technology.

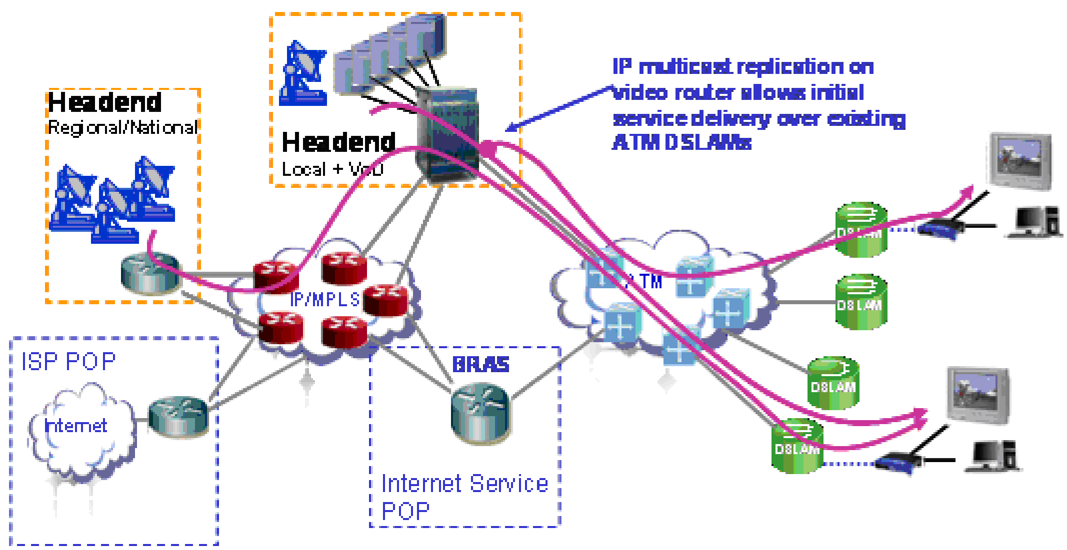

Figure 2: The drop-in video solution

Procuring Content: Local Versus Regional Headends

Procuring content is the first step in migrating to an infrastructure that can provide IP video services. It typically involves investing in headend video equipment that consists of satellite feeds passing through video codecs. A codec converts incoming video channels to compressed video, which is encapsulated into IP PDUs (Protocol Data Units) and delivered to subscribers via a particular multicast group. The video delivery network must ensure that each channel is replicated to each of the service provider's current downstream DSL subscribers.

VoD servers are generally deployed in a local headend so that frequently-accessed content can be cached and delivered efficiently. The local headend usually contains a middleware server that controls set-top box (STB) configurations, channel lineups, and access to VoD content

The headend represents a significant fixed cost. For smaller telcos a single headend is often adequate. In some cases, smaller operators may be able to share a headend. Larger operators will likely deploy a hierarchy of local and regional/national headends. These may be used to deliver national content as well as infrequently accessed VoD content.

IP Multicast Takes Center Stage

IP multicast protocols and delivery mechanisms have been around for years but have experienced relatively little use on the Internet. However, broadcast video over DSL relies heavily on IP multicast forwarding and routing protocols. As a DSL line has nowhere near the capacity to receive all available channels, the subscriber's set-top box must signal the network when it expects to receive a particular video channel. The typical set-top box will issue an IGMPv2 membership report when it seeks to receive traffic from a particular multicast group

The IP Video Router™

The third component companies need to quickly adapt their networks for video delivery is reliable, high-performance broadband routing technology. To fill this need, Laurel Networks has introduced new technology – the IP Video Router™.

The Laurel Networks IP Video Router is a highly-reliable IP multicast router that can support the IP multicast replication necessary to deliver broadcast video – even without relying on DSLAMs.

Besides high reliability and IP multicast, the IP Video Router comes equipped with these "must-have" attributes:

- **Scalable IP multicast replication on ATM interfaces** – In order to roll out broadcast video services immediately, the IP Video Router replicates IP multicast across a very large number of physical and logical ATM interfaces. This allows the telco to use its current ATM-based DSLAMs that lack multicast replication capabilities.

- **High-density gigabit Ethernet** – Due to the clear price/performance advantages of Ethernet, the next-generation DSL access network will make use of Ethernet aggregation and Ethernet-based DSLAMs. As DSL access networks grow to support increasing numbers of video subscribers, they will transition from ATM to Ethernet. Laurel's IP Video Router supports a gigabit Ethernet port density that allows direct connectivity to these new DSLAMs. VoD is another technology driving gigabit Ethernet densities higher as servers connect to the video router via this mechanism. Traditional B-RAS routers do not come close to the required Ethernet densities required for this phase of the video network build.

- **10 gigabit Ethernet direct to the IP backbone** – Video content will be delivered to the VoD servers not only through the headend but through the IP backbone via content sharing and non-traditional sources like ASPs. The Laurel IP Video Router, consequently, allows high-speed connectivity to the IP backbone as VoD becomes a critical application. In smaller telcos, the IP Video Router may serve as a backbone router as well.

- **Local layer-2 switching to the existing B-RAS** – Telcos must keep in mind that video delivery, not Internet access, is the strategic service. In order to concentrate on the new video service it may be useful to leave the Internet access model alone by directing Internet connections, such as PPPoE (Point-to-Point Protocol over Ethernet), to the existing B-RAS. Of course, given traditional B-RAS functionality in the video router, a provider may choose to consolidate the network immediately and offer a combined video/Internet service from the video router. Based on the ST200 platform, Laurel's IP Video Router can be deployed as a video router and as the B-RAS simultaneously.

Migrating to Ethernet-based DSL Aggregation

Once the initial IP video network equipment is in place, the next step in widening video deployment is to continue expanding the DSL access network. To reduce DSL loop length and support the higher DSL rates necessary for multiple simultaneous channels, Ethernet-based DSLAMs must be deployed closer to residential subscribers. These new DSLAMs must function – at a minimum – as Layer 2 Ethernet switches with support for multicast replication and IGMP. (See Figure 3.)

The DSLAMs must be able to make the decision to transmit a given multicast stream on a DSL line. Most new DSLAMs have the ability to listen to or "snoop" IGMP messages sent by the set-top box and build multicast forwarding tables accordingly. IGMP snooping implies that multicast joins from the set-top box pass upstream transparently.

Many new DSLAMs have the ability to perform an IGMP proxy function as well. IGMP proxy aggregates and suppresses upstream IGMP messages to ensure that only one message per group is transmitted to the video router.

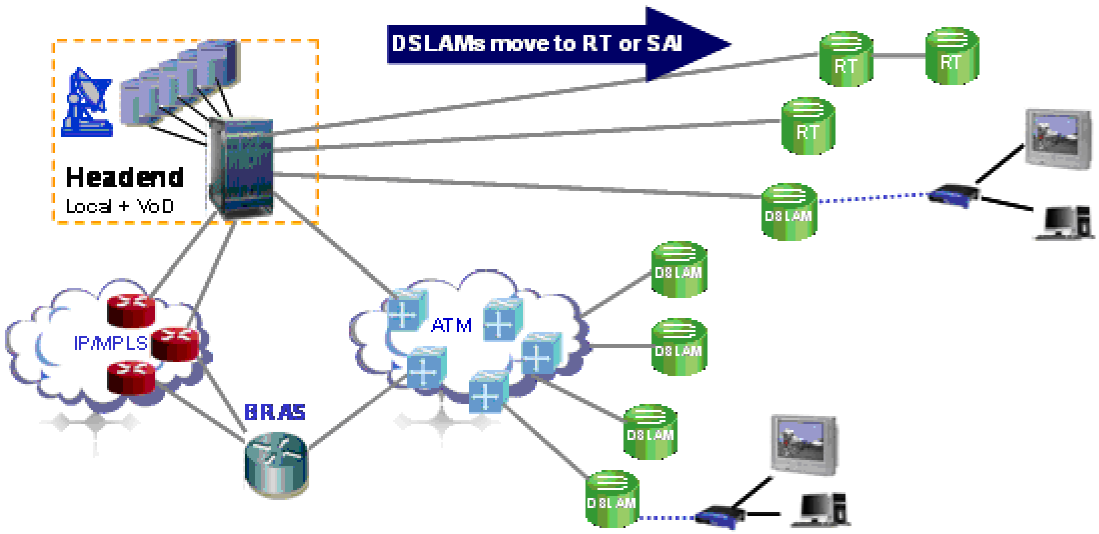

Figure 3: Adding Ethernet-based DSLAMs

What Is an IP DSLAM?

"IP DSLAM" is a popular term today and one that can mean many things. Sometimes it means that the DSLAM acts as a full IP router and, perhaps, may even incorporate B-RAS functions like authentication and accounting. IP DSLAM can also refer to a relatively simple DSLAM with a gigabit Ethernet uplink and IGMP snooping or IGMP proxy support.

To efficiently support broadcast video, it is clear that the DSLAM must support multicast replication and understand IGMP. Due to their remote locations and short local loops in an IP video-optimized network, the number of subscribers per DSLAM is likely to be less than a few hundred. In order to keep costs low, these remote DSLAMs will generally require a single gigabit Ethernet uplink towards the backbone.

IP routing is required where the network topology demands it – where there is a choice of network links towards a destination. Adding IP subnets, routing, and IP address management for single uplink devices complicates the network with no appreciable gain. Given that most of today's B-RAS must support dynamic bandwidth changes to maintain evolving Internet access services, any DSLAM that claims B-RAS functionality would also require policy interfaces.

It is in the telcos' best interest to keep DSLAMs simple and cost-effective. This translates to a DSLAM with layer 2 Ethernet forwarding capability and basic IGMP awareness.

Distributing the IP Edge

As the DSL access network grows, it will become desirable to build an aggregation layer between the new DSLAMs and the IP Video Router. If the topology includes multiple paths, it will be beneficial to use routers as aggregation devices, as shown in Figure 4. As the IP edge is pushed closer to the Ethernet-based subscribers, the IP Video Routers will be able to assume the B-RAS function in order to support Internet service. Of course, these routers will still be highly reliable and capable of advanced IP multicast support.

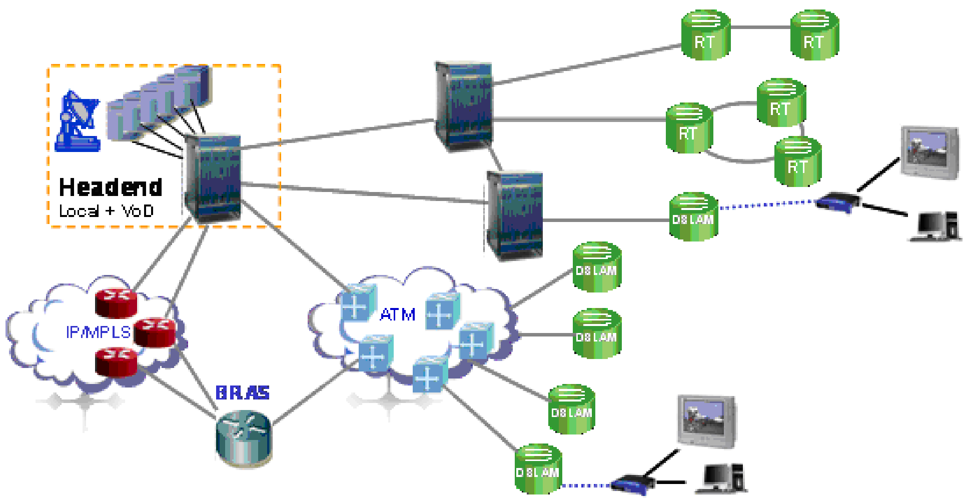

Figure 4: Distributing the IP edge

As the network grows over time, the telco can decommission the legacy ATM-based DSL network completely and combine the video and Internet services as shown in Figure 5.

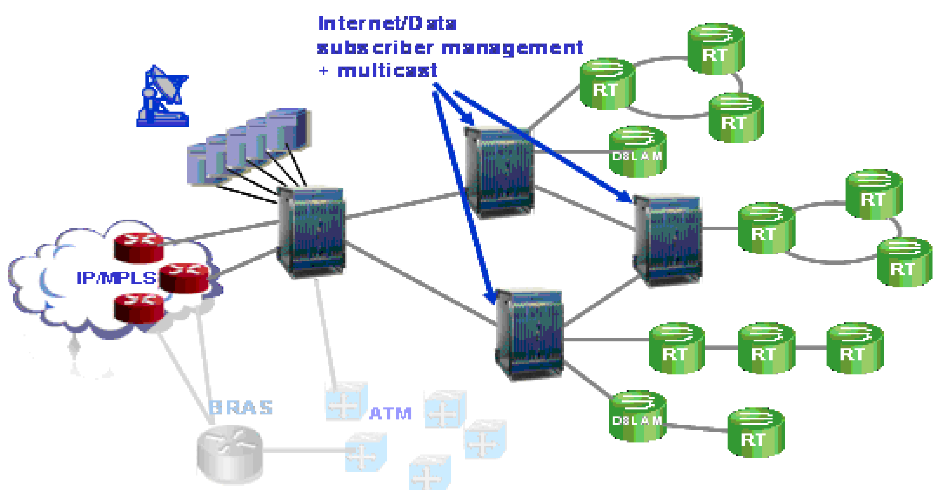

Figure 5: Combining Video and Internet Services at the IP Edge

Conclusion

As their traditional voice revenue stream continues to dry up, telcos are turning towards video services as a means of replacing lost revenue. This puts them up against cable operators in a bid to own what will become the single communication channel to subscribers' homes. Fortunately, advances in DSL throughput and video compression now allow incumbent voice providers to deliver broadcast-quality video and video on demand, giving them the means to compete head on with cable providers. In order to strike quickly, telcos must be able to offer video services over their existing DSL infrastructures. To remain economically competitive, telcos must be able to deploy video routing technology that will not have to be replaced as video service scales and new topologies move to Ethernet. The Laurel Networks' IP Video Router is unique in its feature coverage, enabling both video over ATM and a seamless transition to next-generation, Ethernet-based DSL as the video deployment grows.

The Laurel Networks IP Video Router

Laurel Networks' IP Video Router is designed to meet the needs of DSL access providers building converged IP networks. Based on Laurel's widely deployed ST200™ broadband services router, the IP Video Router includes hardware and software designed to deliver IPTV and video on demand services. Cost-optimized, the new "drop-in" solution allows service providers to decrease capital and operational expenses while increasing per-subscriber income through the delivery of video over Ethernet-based access networks.

Laurel's ST200 broadband services router, which forms the basis for the new IP Video Router, provides the high scalability needed to reliably meet the bandwidth demands of delivering video services. Since gigabit Ethernet density is required for video deliver, the ST200 supports a line rate 10-port gigabit Ethernet physical interface card and new cost-optimized 10Gbps Network Processing Blade (NPB-E).

The solution also includes the Laurel's ShadeTree™ 3.2 system software with support for automated discovery, authentication, and network configuration of home media devices such as IPTV set-top boxes. These features, which are designed to simplify video delivery to the home, also offer the ability to migrate Internet subscribers onto a converged broadband services router.

About Laurel Networks

Laurel Networks delivers reliable, future-ready routing for multi-service broadband networks. Laurel's technology helps service providers transition from the standard Internet-only service delivery model into full-fledged triple-play networks. Designed for enhanced network scalability, Laurel's ST-series™ routers allow carriers to add advanced broadband applications, like video on demand or voice over IP, without incremental cost as the subscriber base grows.

Headquartered in Pittsburgh, Pennsylvania, Laurel operates sales and support facilities across the US, Europe and Asia. Its routers are deployed by some of the world's largest service providers including: Level 3 Communications, KT, Dacom, and Arsys. The company also maintains strategic partnerships with Ciena, the network specialist, and with Marconi, a global telecommunications equipment, services and solutions company. For more information, visit www.laurelnetworks.com.

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