IP Data Over Satellite To Cable Headends And A New Operation Model With Digital Store And Forward Multi-Media Systems

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ABSTRACT

The success of the Internet has proved it will be an important service component for cable operators. The advent of high-speed IP access has opened the door for rich multi-media content to be played out on consumer PC's.

High-speed cable modems with data rates up to 5Mbps allow the savvy PC user to not only use his PC for surfing the Internet, but also for downloading streaming video and audio. Increasingly, the PC is being used to receive multi-media content while its user is also punching out a little work .

However, delivery of rich media content requires high performance from high-speed IP access systems. Today, performance has not been a critical issue as high-speed Internet users believe they are receiving improved performance over analog dial-up. But, this is changing and fast. As more users come on-line, the infrastructure to access the huge amounts of content will become the bottleneck.

This paper will analyze the growing problem IP Data delivery to high-speed access systems. And, will offer technical solutions that include satellite IP Data backbone to overcome the limitations of the terrestrial infrastructure.

INTRODUCTION

The Internet explosion has created a new and lucrative revenue source for the cable operator. With modem technologies standardized using the Data Over Cable Service Interface Specification (DOCSIS) 1.0 standard, subscribers can realize access rates up to approximately 5 Mbps. Although, few if any, cable operators are actually delivering that performance today. Most are rate-limiting service rates to about 1 Mbps.

Subscribers are signing up for cable modems with the belief they will have the fastest access performance available. And, in a market with relatively few subscribers, performance limitations go unnoticed. However, that is about to change.

Three factors will soon uncover the limitations of cable's Internet access infrastructure and the need for an alternative solution. First, the number of subscribers signing up for cable modems is outpacing the build-out of infrastructure. Currently, there are approximately 1.8 Million cable modems installed in North America. However, by 2003, that number is forecast to exceed 15 Million.

Second, the cumulative demand of high-speed cable modem users will exceed the economic feasibility of the terrestrial infrastructure to deliver content at the same high performance.

Third, Internet users are signing up for high-speed access because they want fast access to rich media content. This does not mean simply surfing the web, but downloading rich multi-media files such as streaming audio and video multicast services. A growing number of Internet Service Providers are providing streaming multi-cast services.

Background

Cable's infrastructure has evolved over the last 10 years from being a distributed network of headends to a more centralized architecture. The old distributed model required many headends serving far fewer customers than today. The reason for this distributed architecture is that the distribution or transport technology was all coaxial cable. Coaxial cable transport is very lossy and requires distances from headends to be relatively short so that picture quality is maintained.

Today's new cable architecture model has moved to a fiber-based model that is more centralized serving much larger subscriber bases. This model has great appeal because it allows consolidation of headends within a given market while increasing bandwidth and maintaining constant quality of video service (QoS). Fiber to the serving area (FSA), as it is called, has in large part created the massive cable system consolidation and horse-trading of cable systems among multiple system operators (MSO's).

By using FSA architectures and centralizing cable headends, operators achieve excellent economies of scale for video services. Since traditional video services are broadcast only, reducing the number of headends also reduces the expense of operating multiple headends and improves service quality.

The Problem

The problem with the centralized model of FSA is that it was never intended to deliver all the advanced interactive services being placed upon it. In addition to traditional broadcast cable services, the network is delivering video on demand (VOD), Internet access and IP telephony. The very nature of interactivity requires unique session with each subscriber and distributed access.

And, unless the network has been designed to provide 100 per cent availability, there is the high likelihood subscribers will not gain access to some services. In particular, high-speed Internet access will be seen as taking a step backward with very slow performance.

As a result, a centralized architecture will not economically scale in bandwidth performance.

Subscriber Growth

One of the factors that will stress the current IP infrastructure is cable modem subscriber growth. Cable subscriber growth estimates for high-speed Internet access varies widely among forecasters. Figure 1 below offers a range of projections. Low estimates are for only six million cable modem subscribers by 2003. High estimates have the penetration exceeding sixteen million over the same period.

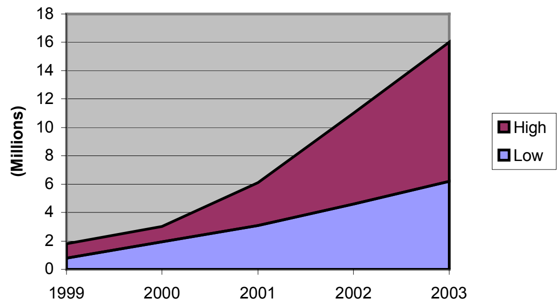

Fig. 1 Cable Modem Shipment Estimates

If the conservative estimate of six million by 2003 is used, cable modem penetration of almost 10 per cent would be achieved. In a cable system of 250,000 subscribers, 25,000 would be using cable modems for high-speed access. If the aggressive forecast is used, over 57,000 users would subscribe to cable modem access. While its unlikely that all subscribers are on-line simultaneously, cable Internet access is being billed as always on service. The following table illustrates the potential demand from the system.

	1.5 Mbps	5 Mbps
Low Estimate (25,000)	37.5 Gbps	125 Gbps
High Estimate (57,000)	85.5 Gbps	285 Gbps

Figure 2 Maximum Bandwidth Demand

Running out of Bandwidth

Cable Operators are deploying the latest fiber technology available. Using SONET and ATM, gigabit transport within the cable fiber network is possible. See Figure 3, Cable's Fiber Architecture. Connected to these internal pipes are incoming terrestrial transports up to OC-48 rates. These huge pipes virtually guarantee plenty of bandwidth for IP Data.

However, Internet access over terrestrial infrastructure creates a session or connection with the backbone for every subscriber. As subscriber penetration increases and the demand for more rich multi-media content increases, the terrestrial connection to the Internet will become the weakest link in the transmission chain. Even though software caching systems can be used to distribute Internet content, the cost of having high bandwidth terrestrial pipes up to OC-48 in every cable system becomes prohibitively expensive for an MSO.

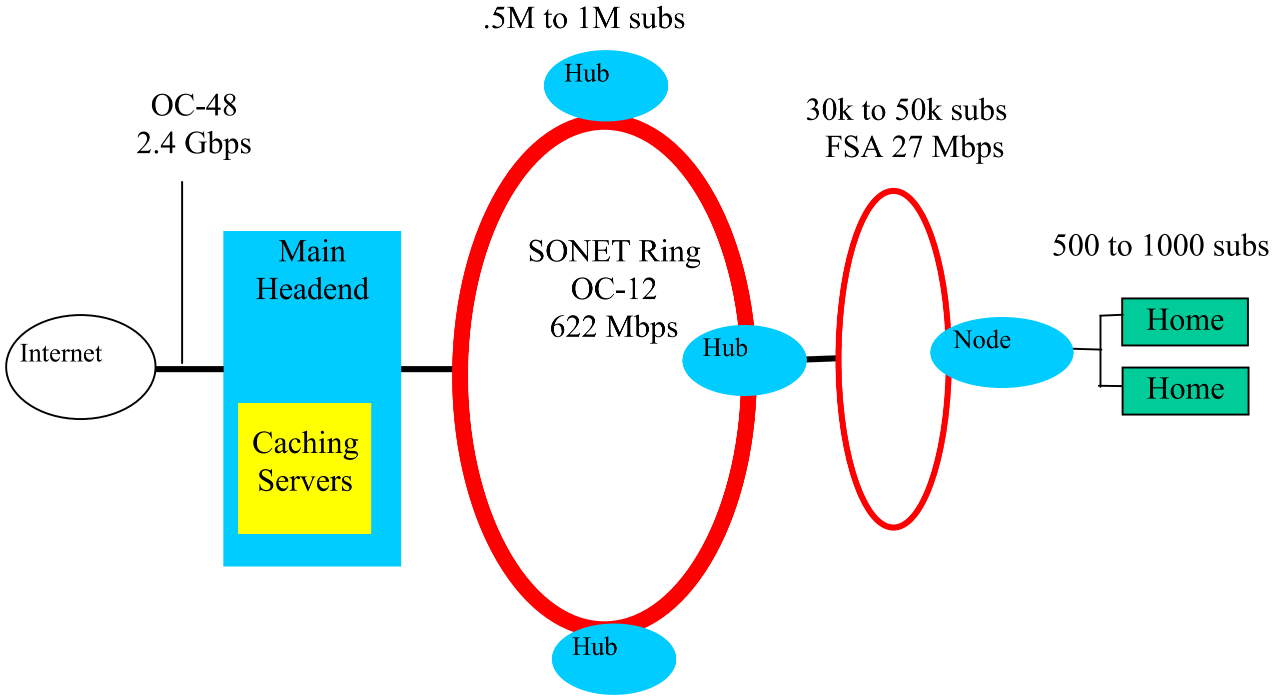

Figure 3. Cable's Fiber Architecture

Rich Multi-media Content

The final factor that will affect high-speed Internet access performance is the demand for rich multi-media content. Internet users today are already downloading multi-media content. In addition to large file download, audio files are in high demand. Many web sites have sprung up offering MP3 audio files for download. And while the copyright issue for downloading MP3 files is still hotly contested, the technology has proved the Internet can deliver CD quality audio. Its only a matter of time before the business enterprise infrastructure supports the commerce of MP3 distribution.

Streaming video is also one of the fastest growing content areas on the Internet. Users want instant and immediate access to news and information without waiting for television to broadcast the story. In addition, many Internet users want live events and previously recorded content for viewing. Users are willing to accept a lower quality video on their PC in order to get immediate access to information. However, again the technology is making it possible for video delivery over the Internet. MPEG2 and MPEG4 encoding and decoding provide a good quality real-time video, if the network can deliver the bandwidth needed for bitrate performance. Acceptable performance for streaming video at rates of 500 kbps provides good quality on small PC viewer.

However, as more subscribers use high-speed Internet access for streaming video and audio, the incoming terrestrial infrastructure becomes more of a bottleneck.

IP Data over Satellite Alternative

As high-speed Internet access over cable continues to grow, cable operators will have to look at alternatives for accessing rich media content. Satellite provides an excellent alternative to high-bandwidth terrestrial pipes. Terrestrial Internet access alone does not provide enough bandwidth to satisfy real-time demand. Nor, does the cost for high-bandwidth terrestrial access compare with satellite transmission costs.

In order for the high-speed Internet access experience to remain enjoyable as penetration grows, a distributed approach to Internet rich media content must be considered. In figure 4 it can be seen that using satellite backbone infrastructure along with a content caching system, high demand content is pushed to the edge of the network where it is cached locally on IP Data servers at the cable headend. The distributed model can be further extended to the edge by locating IP Data receivers at fiber nodes.

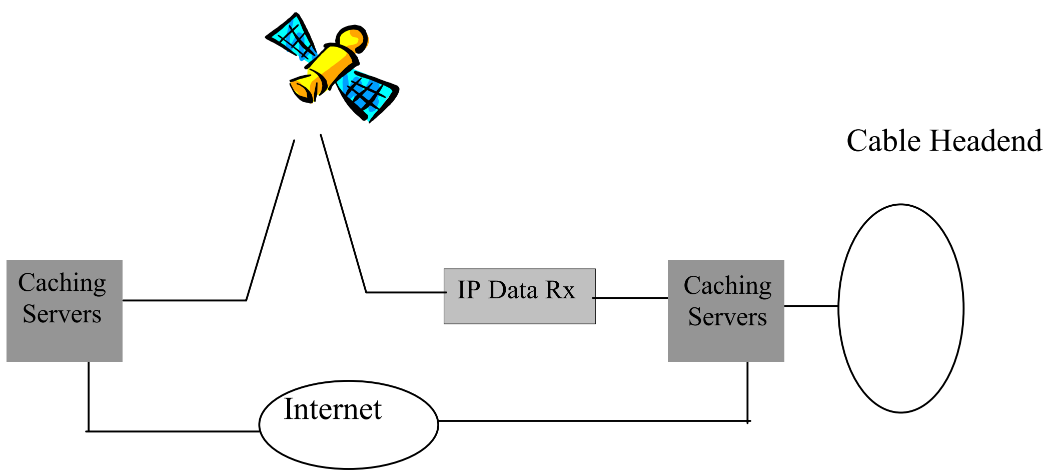

Figure 4. Satellite IP Data Backbone

Intelligent software manages the content and transmits only the information that has changed. This relieves the burden of repeat transmissions of the same content in terrestrial networks. It also eliminates multiple sessions of the same content to different users.

Satellite transmission augments the terrestrial infrastructure with data rates up to 70 Mbps. In a 24 hour period 756

GigaBytes of information can be replicated at thousands of downlink locations at a fraction of the cost. By augmenting terrestrial with satellite backbone the Internet Service Provider can provide a high QoS and rationalize the cost of Internet access.

Conclusions

Today's fiber rich cable networks are designed as centralized access points to traditional media content. As services such as high-speed Internet access delivering rich multi-media content emerge, the centralized model will no longer work. ISP's and cable operators will need to look at alternatives to provide high bandwidth desirable content to the network's edge.

The best technology to do this is a satellite IP Data backbone infrastructure. Terrestrial networks are expensive fat pipe access points which are required for every cable headend or ISP. Satellite overlay provides a store and forward content distributed model which eliminates congestion caused by repeat transmission in the terrestrial backbone. Internet access costs can be significantly reduces using satellite for cached content and terrestrial for occasional real-time access.

However, both infrastructures are still required for effective high-speed Internet access. While satellite provides an excellent method to distribute content economically to the network's edge, real-time performance is superior with terrestrial networks.

High-speed Internet access infrastructures will be challenged as rich multi-media content develops and personal computing power increases. The interactive experience of the PC as a multi-media tool is limited only by the infrastructure where it is connected. High-speed Internet access providers will ultimately differentiate themselves by the quality of service delivered by their networks and the technology used to provide high-speed access.

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