

The IPTV Revolution: New Opportunities, New Challenges for Satellite Communications Systems



June 23, 2006



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Introduction

Advances in technology, improvements in communications infrastructure, and growing user demand are driving toward the creation of a single, common digital medium. It will be a unified global platform capable of enabling transmission of digital information in virtually any form across broadband networks. We call it digital convergence. While the term has been used (and perhaps misused) for years, it is clearly the right term for the revolutionary paradigm shift that is taking place in the telecommunications world today. ¹

With the advent of Internet protocol television (IPTV), the vision of a universal communications platform is quickly becoming a reality. The convergence of IP-based content delivery networks with traditional voice and data communications is creating exciting new services in multiple markets. In the coming years, consumers will enjoy access to customized content, rich applications, and personalized interactive entertainment in homes, automobiles and hand-held devices, all enabled by IP-based communication networks.

IPTV Defined

Internet Protocol Television (IPTV) is the television element of a multimedia offering, which may also include Internet, telephony, gaming, cellular, mobile, and/or home networking services. In the context of this paper, IPTV is not streaming television broadcast over the Internet, but is a part of an overall managed service provided to a subscriber base through a closed network.

More than likely, that network is an existing telephone company's broadband network, developed for voice and data communication, and rapidly transitioning into a digitally convergent multimedia network utilizing IPTV to deliver television content. Necessitated by the fear that cable operators will and are addressing their residential voice markets, carrier operators are embracing IPTV as a weapon to not only counter the cable attack, but to capture new revenue from a market that they are not presently serving.

The major advantage of IPTV is its ability to provide a much richer television experience to the viewing audience through its addressability and interactive functionality. In today's fast paced world, the subscriber wants to watch what they want, when they want, and where they want. Instead of paying for channels that are rarely viewed, because of its addressability, IPTV allows the service provider to deliver to the subscriber only those channels that he or she wants to see. Programming is available to anyone who wants to see it and a la cart pricing will become the norm.²

The most unique and compelling feature of IPTV is the promise of its interactive functionality. Unlike most legacy cable television architectures, IPTV service necessitates two-way communications between the subscriber and the service provider. For IPTV, that communications medium is Internet protocol

over the service provider's broadband network. Two-way communication gives the subscriber access to customized television content as well as networked gaming, video conferencing, home networking, catalogue shopping, video-on-demand, information-on-demand, interactive education and much more. In turn, the service provider has the ability to provide targeted advertising, focused programming, and other value added features that will add to their revenue stream.

Today's incumbent telephone companies are at a disadvantage when compared to multiple service operators (MSOs) who can deliver triple-play service (Voice, Internet and Television). As such, they are in a race to achieve video-service parity with cable operators and are looking at IPTV as means to compete and leapfrog the offerings of the competition.

The Cost of Content Aggregation

While a cable network transmits all channels to each user, the IPTV network transmits only the channels the viewer is actually watching. That means an IPTV network can offer an effectively unlimited number of channels. The number of channels that can be offered on a cable network, however, is limited by the 850 MHz spectrum allotted on its hybrid fiber coax plant.

In order to provide unlimited channels, hundreds of video program channels must be aggregated and made available for distribution to the subscriber. This lends itself well to point-to-multipoint distribution over satellite. That is, a central content receive site or "IPTV Super Headend" will aggregate content from satellite downlinks and then distribute that content to local access points or regional headends over IP all the way to the subscriber.

Building an IPTV Super Headend can impose a high capital expenditure burden since multiple antennas are required to receive existing video content from multiple satellites across the satellite arc and each video stream must be transmitted in its own self-contained single program transport stream (SPTS) as opposed to a multi program transport stream (MPTS). Each channel must be received, decoded, de-encrypted, and then encoded, encrypted and IP-encapsulated for distribution to the regional sites. With hundreds of channels and redundancy, the cost for a large IPTV Super Headend can exceed 20 million dollars. Even more difficult for the uninitiated service provider is the acquisition of content where each individual channel of video content must be negotiated with the individual content owners. This can be long and burdensome process with both legal and financial considerations.

As a solution to the issues described above, companies including SES Americom with its IP PRIME service and Intelsat with its Amplitude service are building IPTV Super Headends and offering pre-packaged, bundled, programming to the telephone companies.³ This alleviates the significant initial capital burden on the service provider and allows them to focus on their access

network and new product offerings. Prior to these new offerings, some of the smaller telephone companies have developed shared super headends and/or built their own smaller capacity headends.

Inside the IPTV Super Headend

At the IPTV Super Headend, the Satellite Program Acquisition System receives video content from geosynchronous satellites in the local orbital arc for turnaround retransmission. Because the content is coming from diverse providers, the received video formats and standards may be different. Some of the programs will be analog and some will be digital. They may or may not be encrypted. Some analog signals will use the NTSC video format and some may be PAL or SECAM. For digital transmission, there may be programs that are in the clear and others that are encrypted. In the U.S., depending on the encoding, the encryption may be Videocipher (Motorola), PowerVu (Scientific-Atlanta), and/or DVB (Tandberg, Scopus and others).

Until the individual channel acquisition rights have been negotiated, there is no way of knowing the exact receive channel composition. The initial approach is to provide a flexible design for the Super Headend that can accommodate multiple formats and make provision for standard converters and video processing equipment for some of the channels.

The Super Headend antenna diameter and type is provided in accordance with the expected EIRP of the carriers to be accessed and broadcast quality signal-to-noise reception of the carriers. Low Noise Block (LNB) converters with L-band outputs are typically used allowing reception of the entire satellite band. If the distance between the antenna and receivers is greater than 100 meters, then usage of L-Band fiber optic transmission of these wideband-received carriers for distribution within the facility is recommended.

The sizes and type of satellite receive-only antennas is determined by the proposed channel line-up. If the majority of the channels can be accessed via satellite transponders located within a 70° viewing arc from the Super Headend location, then a multibeam receive-only antenna system may be a good.

For its IP PRIME service, SES Americom utilizes a 7-meter Simulsat multi-beam antenna. The Simulsat antenna is parabolic in one plane and spherical in the other. At its maximum capacity, this unique design allows the Simulsat to perform like nearly three-dozen parabolic earth station antennas. The Simulsat antenna is 2° FCC compliant and can capture satellite signals from up to 35 satellites within a 70° arc view. SES Americom has a 4.5-meter full motion antenna in reserve as a backup in case of a failure of a feed or low noise block converter (LNB).

Signals from the low noise block converters (LNB's) are routed to L-Band patch panels located in an environmentally controlled equipment cabinet mounted on the antenna pad.

The equipment cabinet houses the subsystems required to support the antenna-located equipment, which includes patch panels, fiber optic transmitters and test facilities. This equipment cabinet can be mounted on the Simulsat antenna foundation or on a small foundation in close proximity to the antenna system. Once terminated at the patch panel, the LNB outputs interface to the fiber optic transmitter assemblies.

Fiber-optic L-Band interfaculty links (IFLs) offer a high performance, cost effective alternative to conventional coaxial-cabled systems. They cover the range of 950 to 2150 MHz and are used for transmission over single mode fiber optic cables of block down-converted C, extended C, X or Ku-band signals. The fiber-optic IFL functions as a transparent link between the satellite antenna and the Network Operations Center (NOC) or control room. System limitations in using coaxial cable are overcome by the simplicity and performance of fiber-optic connections to provide the highest levels in signal quality.

The Value of Redundancy

For a Super Headend content aggregator, such as SES Americom, providing a highly reliable service offering is paramount. Meeting this requirement providing 1:1 redundant Integrated Receiver Decoders (IRDs) with switching. That may require row upon row of cabinets with up to 400 IRDs and switches as well as associated support equipment. Because the content is coming from diverse providers, video formats and standards may vary. Some of the programs will be analog and some will be digital. They may or may not be encrypted. Some analog signals will use the NTSC video format and some may be PAL or SECAM. For digital transmission, there may be programs that are in the clear and others that are encrypted. There will be programs that are standard definition and programs that are high definition.

All of these programs must be received and transformed into one common format and, therefore, final selection of Integrated Receiver Decoders (IRDs) depends on the channel line-up, who the content providers are, and where their resources are located, as well as other factors.

Because the telephone companies are new to providing television to their customer base, they are able to take advantage of the latest technological advances. The latest IPTV systems use advanced MPEG-4 AVC (H.264) compression techniques to reduce bandwidth requirements significantly as compared to legacy MPEG-2 compression systems. These new encoders, repurposed specifically for IPTV, not only compress and encode the program channel, they also IP-encapsulate the stream and output it via 10/100 base-T Ethernet ports.

Each individual video channel is encoded, IP-encapsulated and processed as a separate stream utilizing User Datagram Protocol (UDP). Following that, all of the individual video channels are multiplexed together using an Ethernet Service Switch (ESS) and are distributed to regional headends or other edge location via fiber or by satellite. For an IPTV Super Headend such as SES

Americom, the most cost-effective method of distribution to many headends is via satellite. In this case, a dedicated satellite with multiple IPTV transponders is used for distribution, with each transponder carrying a minimum of twenty standard definition program streams or one high definition and ten standard definition program streams. The transponder's capacity can be improved using the new DVB-S2 modulation standard.

Protecting Intellectual Property

The IPTV Super Headend provider has to guarantee that the content owners' valuable program material reaches only authorized paying customers. As a minimum, they have to provide a Conditional Access (CA) system that encrypts the programming over the satellite link. They may instead provide a Digital Rights Management (DRM) system that protects the program material from the source to the subscriber. Integrators of IPTV Super Headends are presently offering service providers the option to receive the content with managed middleware and CA/DRM provided along with product life cycle support. The decision as to what is ultimately provided depends upon the capabilities of the service provider (telephone company).

The multi-channel IPTV stream also requires automated monitoring to ensure signal quality during acquisition and distribution. Within the Network Operations Center (NOC) at the Super Headend, there is a video monitor wall that not only provides the visual indication of quality but also measures video and audio parameters for quality. In addition, the Super Headend has IP transport test equipment such as an IP Multicast Media Analyzer, which monitors each stream at the headend for jitter and delay, and an IP Probe to monitor the downstream remote sites for packet arrival.

Satellites can and do play a significant role in content aggregation and distribution of IPTV to not only the telephone carrier community, but can also provide the same service to the enterprise and mobile markets.

Regional Headends

The Regional Headend (RHE) is the local gateway to IPTV programming for telephone companies, broadband carriers, enterprises, and other new entrants into video services. The Regional Headend provides for content acquisition, content management, subscriber management, packaging and delivery of the programming to the carrier's distribution network. An effective RHE is also the access point for other revenue generating services including ad insertion and video on demand.

With the advent of IPTV Super Headends, a new model of operation has become available. In the "old model," the Regional Headend negotiated for and purchased all programming, built a program acquisition facility for acquiring content, encoded and IP-encapsulated all channels, purchased a Middleware System, and installed an Encryption System.

In the “new model” pioneered by SES Americom and Intelsat, the Regional Headend –

- Purchases pre-packaged, bundled, programming
- Builds a regional program acquisition facility consisting of one 3.7 to 4.5-meter antenna
- Acquires the packaged programming already MPEG-4 encoded and IP-encapsulated
- Has the option to receive the content with managed middleware and CA/DRM provided
- Has the option to receive product life cycle support

This approach offers low initial capital expenditure, a pay-as-you-grow philosophy, proven technology, a proven integration solution, lower operating costs, aggregated buying, and one source for content and distribution rights

Assuming that the Regional Headend subscribes to the new model, small 3.7 to 4.5-meter antennas are installed and pointed at the each satellite of interest carrying aggregated video content. Multiple edge receivers located within the Regional Headend acquire the IPTV streaming content where, typically, one Edge Receiver will down-convert a full satellite transponder with 20 to 25 programs (standard definition) in each IP stream. The Edge Receiver subsystem is designed to monitor, aggregate and distribute the outputs of multiple receive streams simultaneously to an Ethernet Service Switch (ESS) for distribution to the subscriber base.

IPTV providers typically need to receive local channels either off-air or via local cable or fiber sources and integrate them into the overall content provided to the subscribers. After local reception, the content must be digitized, encoded, IP-encapsulated and aggregated for transfer to the ESS. All of these channels, as well as the channels received from the Super Headend, must be monitored to ensure signal quality during acquisition and distribution. This requires a multi-view processing system that not only provides the visual indication of quality but also measures video and audio parameters for quality much the same as described for the Super Headend, but sized for the number of operating channels.

The Power of Middleware

Unlike satellite Direct to Home (DTH) service, where the Conditional Access (CA) System is key to the operation of the system, IPTV networks are managed by a Middleware System. Middleware is the “operating system” of IPTV, which supplies all of the essential tools for end-to-end management. The Middleware System is involved with service management, content management, subscriber management, marketing, transactional processing, data interchange and reporting and more.

IPTV Middleware interfaces with the operator's legacy subscriber management and billing system. As such, it is responsible for the management and creation of bundled packages of content, the pricing of packages, and the assignment of packages. As a content manager, IPTV Middleware is used to create, configure and manage the metadata associated with the video content, determining asset location, integration of content synopsis, posters, trailers and is used to assign ratings and genres, and rate codes.

IPTV Middleware also provides for channel management, interfaces with the Electronic Program Guide, WEB portal and most important provides for the Graphical User Interface (GUI) and navigation system within the subscriber's set top box.

Video on Demand

With today's demanding constraints on time, viewers prefer to watch programming when it is convenient rather than when it is broadcast. Video-on-demand (VOD) provides the viewer with that option. Described as a "killer application", IPTV video-on-demand provides each user with a world of choices – not in more channels to view, but in the ability to enjoy what they want, when they want. VOD is one of the most important value-added products that the Regional Headend operator can offer subscribers. It provides the viewer with the ability to pause, fast-forward, and rewind programming as often as they like.

Satellite plays an important role with regard to VOD where content aggregators, such as TVN, "pitch" the content over satellite to "catchers" at video distribution headends. At the Regional Headend, VOD servers are deployed so that frequently accessed content can be cached and delivered efficiently. As was the case for "live" content, Middleware is the central foundation for VOD as well. The VOD Server is the playout engine of the system. It interfaces with the Middleware Server, which controls set-top box (STB) configurations, channel lineups, and access to VOD content. The VOD Server also has the appropriate software to interface with the catcher in order to transfer the video assets and metadata on an automated basis.

Since VOD content can come from multiple sources, an Ingest Gateway is used to provide an appropriate interface to each of the incoming sources. VOD content is delivered as a file transfer, which may be used upon receipt or stored for later use. The incoming VOD usually consists of a package of two to three files. For example, the video and/or audio source material is encoded and converted to a digital file; with it is a metadata file of descriptive material about the content, and also a file that is sometimes known as a "smile page", which provides the television user interface screen related to the content.

Local content is extremely important with regard to VOD services. As a part of the Regional Headend provider's offering, a local encoding studio can

generate local content for storage in the VOD Server. The local encoding studio includes VTRs and other playout equipment, MPEG encoders, metadata generation software, VOD file packaging software, and other enhancements.

The security and management of the VOD content is also critical, which requires the VOD System to interface with the existing CA/DRN system.

Interactive Enhancements

One of the main attractions of IPTV is its ability to provide a much richer television experience through its addressability and interactive functionality. That interactive functionality includes:

- Provision of customized content both with streaming video and VOD. Instead of paying for channels that are rarely viewed, IPTV subscribers receive only those channels that they want.
- Communications capabilities such as video telephony, e-mail, chat, and other options are all available on the television screen
- Multiple Picture-in-Picture (PIP), with the option to chose any specific one and to change camera angles, follow a favorite sports player or watch a favorite car in a race.
- Networked Gaming, where viewer can play any game they want, when they want, with whomever they want.
- Home networking, where the viewer can control electronic devices within the home from the television screen or by remote web access.
- Real-time shopping from the television set.
- Targeted Advertising, where the operator knows the subscriber's preferences along the lines of the Amazon.com model.

Interactive enhancements mean an added source of revenue for telephone carriers, greater subscriber satisfaction and lower churn, bringing benefits to the operator and subscriber alike.

Conditional Access and Digital Rights Management

The ability to acquire licenses from content owners is critical to the IPTV service provider's deployment plans. Content owners want assurance that their content is secure from piracy from the moment it leaves their hands to the instant that it is played out of the subscriber's set top box. In order to provide that assurance, service providers must demonstrate that they are providing a totally secure conditional-access and digital rights management system from end-to-end. At the same time, all of the elements associated with the IPTV distribution

network must be compatible with and integrate with the CA/DRM system,⁴ from the streaming video platform and the VOD platform to the middleware and the subscriber's set top box.

The encryption process must ensure that the content stays encrypted and secure as it moves from one device to the next and at the same time guarantee that interactive options such as the VOD "trick play" (pause, fast forward, rewind) work without any problems.

IPTV Issues

In the rush to deploy IPTV, the major issue facing the new technology is the lack of standards. This is particularly strange since the telephone industry has always been standards-conscious and has previously had some of the most comprehensive industry standards available. As of today, there is no standardized solution for an end-to-end system to deliver rich content over IP.⁵

Presently, all operational IPTV systems are operating as closed networks. The system elements are purchased from various providers, integrated together to insure interoperability, and placed into service. One manifestation of this lack of standards becomes evident when selecting set top boxes. Manufacturers must design their set top boxes to work with multiple middleware software providers, multiple CA/DRM providers, multiple compression schemes and multiple access networks. The number of permutations is too many to count.

For example, there are operational IPTV systems utilizing MPEG-2, MPEG-4 AVC (H.264), Windows Media 9 VC1, and various other proprietary versions of video compression all marketed for IPTV.

Another area where standards could play a critical role is in the management of quality of service (QoS), particularly in the metrics needed to create a reference design for end-to-end QoS testing that takes all traffic into account. Several organizations, such as the Alliance for Telecommunication Industry Solutions (ATIS) and the International Telecommunications Union (ITU)⁶, have announced that they will be developing standards for IPTV. It remains an open question whether deployment will outrace the generation of these new standards. As identified by the ATIS IPTV Interoperability Forum (IIF) "there is a need for industry-accepted standardized metrics and requirements for content security and the quality of content delivery; the need for end-to-end QoS functionality to support multiple services on the same network; and the need for interoperability standards and testing of components in the video delivery network."⁷

The Future of IPTV and Satellite's Role

With all of the major and many of the smaller telephone companies around the world either deploying or committed to deploying IPTV, it seems apparent that Internet Protocol Television is an important driver of digital convergence. The catalyst for this transformation is the competitive environment that exists today because of MSOs providing "triple play" services to the telco customer base. The emergence of IPTV is enabling telephone companies to rapidly transform their business model in order to compete and survive in this new environment.

While IPTV has been identified as the technology of the future for the transmission of television over telephone networks, these same fundamental concepts can be applied to Digital Cable Broadcast, Digital Multimedia Broadcast, DVB-T, DVB-H, Enterprise Networks, and other applications. This is because IPTV is a digitally convergent element of a much larger universal IP platform. It therefore benefits from IP's fundamental architecture, which makes the transmission medium independent of the Internet layer.

Satellite has both a present and future opportunity to provide content aggregation and edge distribution via Super Headend providers. Satellite will also provide a key role in the delivery of video-on-demand content to the edge. Northern Sky Research foresees a healthy niche market for IPTV via satellite that reaches over US\$500 million by 2010, up from only \$50 million in 2005. This increase primarily will come from revenue-sharing arrangements among satellite-based service providers, content providers, and IPTV service providers. Worldwide IPTV service revenue estimates vary anywhere from \$17 billion to \$38 billion by the year 2010, depending on whose report you read. Forecasts aside, it is clear that IPTV Super Headends are presently in service and the future of Internet Protocol Television appears bright.

About Globecomm

Globecomm integrates satellite into network applications in order to provide reliable, high-quality connection to the edge of the network, broadcast one-to-many, and support bandwidth-hungry applications. Globecomm is the only company in the industry that can, under one roof, design, install, integrate, support, manage and operate a customer's systems and networks, or provide turnkey services that offer the same features and functions as a customer-owned facility. Globecomm specializes in providing total solutions that free its customers to focus on their core mission, whether it is telecommunications, broadcasting, retailing, serving constituents, maintaining security or projecting force. More information is available at www.globecommsystems.com.



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Acknowledgements

The author would like to thank all of his colleagues at Globecom Systems who have helped develop our IPTV solutions.

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