# Digital Cable Television in the United States

## 米国のデジタルケーブルテレビ事情

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### Abstract

Digital television services have been rapidly deployed in the U.S.A. since the first direct-to-home satellite systems were deployed in mid-1994. By the end of 2000, there will be more than fourteen million digital DBS subscribers, more than 160 digital terrestrial TV stations on the air, and more than nine million digital cable subscribers. Despite this rapid rollout, the U.S. is still in its first phase of digital television deployment. In this introductory phase, digital technology has been focused primarily on providing more channels, higher picture and sound quality, and electronic program guides. In 2001, a new phase begins in earnest. Digital cable systems, in particular, will be used to provide true interactive features that will transform television, both for its viewers and for the businesses that pioneer these new capabilities. This article reviews some of the key technical, business and regulatory factors that will be important in this new phase, and also highlights some of the important technical work being performed at Sharp Laboratories of America.

最初の直接衛星放送サービスが開始された1994年中頃から，アメリカ国内でディジタル放送が急速に広がり続けている。2000年末には，ディジタル衛星放送を視聴するユーザは1,400万人以上，ディジタル地上波放送を行う放送局は160局以上，ディジタルケーブル契約者は900万人以上になると見られている。この急速なディジタルサービス拡大にもかかわらず，依然としてアメリカはディジタルテレビ普及の第１ステージにある。この導入期に，ディジタル技術は主にチャンネル数の増加，高画質／高音質，そして電子番組ガイド（EPG）などの提供を中心に焦点が当てられてきた。2001年には，更にディジタル革新の新しい段階に移行しようとしている。特にディジタルケーブルは，真の双方向サービスの提供手段として利用される。この双方向サービスは，視聴者にとってもその新技術を使った新しいビジネスにとっても，テレビを変えるものと期待されている。本稿では前述の新しいディジタル革新期を迎えるにあたって，重要になると思われる技術／ビジネス／規格の立場から見た要点を解説する。また，シャープ米国研究所（Sharp Laboratories of America）が果たすべき重要な技術要件についても解説していく。


### Introduction

During the past six years, digital television technology has been rapidly deployed in the United States. By the end of 2000, the direct broadcast satellite industry will serve more than 14 million of the 100 million U.S. TV households. Digital cable will be in more than 9 million homes. Terrestrial digital television receivers will be in an estimated 114,000 homes by year-end 2000, with more than 158 digital stations on the air. The terrestrial DTV market penetration is growing more slowly because the focus on HDTV services and receivers is a more expensive, more challenging proposition than it is for the primarily standard definition services deployed by satellite and cable.

Despite consumer enthusiasm for all of these services, existing digital TV deployments are still part of a relatively simple first phase. Their primary attraction to consumers is due to the large number of channels offered, the presence of on-screen interactive program guides, and improved picture and sound quality. They have yet to incorporate the more sophisticated features possible with digital television systems.

In the coming five years, television will be transformed in even more profound ways as digital deployments enter their second major phase. The capabilities of digital technology will begin to be used to deliver far more than the real-time broadcast of traditional television content. New services include true server-based video-on-demand,

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television programs with special data enhancements, standalone data broadcast services, and true interactive television programs. These technical capabilities will generate wholly new direct revenue from the sale of new services to viewers, but they will also give new life to the television advertising business by allowing ads to be targeted to specific consumers, with accurate audience measurement fed back to advertisers. In addition to these network-based digital features, there will be new standalone features implemented in consumer equipment, such as hard disk-based personal video recorders (PVRs) and intelligent applications for program navigation and selection.

Whatever the mix of new features, it has become clear that the cable industry's two-way hybrid fiber-coax systems are best suited to deliver these new services. This paper will focus on the U.S. cable industry's plans for introduction of this next generation of digital television services and features, and the business thinking that will govern many of their decisions.

## A Review of Digital Television in the U.S.A.

In the United States, direct broadcast satellites have been providing digital television service for more than six years. It began in mid-1994, when K-Prime Partners (later called Primestar), a partnership of seven cable MSOs which had launched a 30-channel medium-power DBS service four years earlier, converted its system to a 90-channel digital service. The new service utilized equipment from General Instrument Corporation based on its DigiCipher compression and transmission technology. The Primestar business was intended by its cable system owners to blunt the competitive effect on cable systems of the planned launch of a high-powered, small dish DBS service being planned by Hughes Electronics. Cleverly, the Primestar service offered consumer equipment for a monthly lease payment, allowing subscribers to avoid committing to an up-front purchase of a dish and satellite receiver. It was quite effective in signing up customers, in large part because of this relatively risk-free consumer approach.

On June 17, 1994, just a few weeks after the launch of the Primestar digital service, Hughes Electronics launched the "DirecTV" service by making the first Ku-band dishes and satellite receivers available for purchase to retail consumers in Jackson, Mississippi. Purchase of the equipment was required, but the dish was smaller due to the high power transponders, and DirecTV offered more channels.

On March 4, 1996, a third major player entered the DBS field -- Echostar Communications Corporation, which launched the "Dish Network", a DBS service that has had substantial success since that date. At the end of the year 2000, the Dish Network will serve about 4.5 million subscribers.

On April 28, 1999, Hughes Electronics' DirecTV acquired the Primestar DBS business, which had grown to 2.3 million subscribers. Over the next 18 months, DirecTV converted most Primestar subscribers to the DirecTV system, and shut off the Primestar satellite feeds on October 1, 2000. DirecTV is now the leading U.S. DBS provider. At the end of 2000, it is expected to have nearly 10 million subscribers.

Cable followed DBS out of competitive necessity - it was rapidly losing subscribers to these new multichannel competitors in the sky. The first deployment of digital cable took place in February, 1997 when cable operator TCI introduced the service to residents of Hartford, Connecticut. The U.S. cable industry has continued to move aggressively, and by the end of 1999 had 4.7 million digital subscribers. Estimates for year-end 2000 range from 9 to 11 million digital cable subscribers.

Finally, in November, 1998, the first U.S. digital terrestrial television stations went on the air, utilizing the ATSC Digital Television Standard. Twenty-eight DTV stations began operations six months in advance of the required start date imposed by the rules of the U.S. Federal Communications Commission. Today there are more than 158 DTV stations on the air, although ATSC receiver sales are slow due to the relatively high prices for these high-end devices, and the low quantity of high definition programming from most of the major broadcast networks. Another factor in recent months has been the ATSC's recent re-evaluation of the RF performance characteristics of the 8-VSB modulation technique.

## The Motivation for Digital Cable Deployment

The motivation emerges from the need to increase cable system revenues. The analog television side of the U.S. cable business is distinctly mature, having been in existence since the mid-1950s. Ninety-eight percent of American homes are already passed by cable plant, and subscriber penetration of those households is on the order

of 70 percent, with very slow growth seen ahead. In other words, the 30 percent who are able but don't yet subscribe to cable, are unlikely to do so anytime soon. Therefore, cable operators know that little revenue growth will come from increases in the size of their subscriber base. They must introduce new services on their existing systems - and sell these services to their existing customers - in order to generate fresh sources of revenue.

### The Cable Platform is Ready

Fortunately, hybrid fiber-coax cable systems provide a very capable platform for such service and revenue enhancement. Even before digital headends and set-top boxes are installed, the basic system capabilities are largely in place in the U.S.: upgraded bandwidth and two-way "return" capability. At the end of 2000, more than 70 percent of cable systems will have been upgraded to 750 MHz total bandwidth, with another 10 percent of systems at 550 MHz. Both provide sufficient room for attractive downstream digital tiers to be introduced at the upper frequencies above the existing analog signals (which will be retained for their consumer "friendly" attributes in multiple-set households). About three quarters of cable systems have two-way trunk, feeder and optical capabilities activated - an essential pre-condition to deployment of truly advanced services that require an upstream channel from home to cable headend.

### Digital Broadcast in Phase One

In the first phase of digital cable, roughly from 1997 to 2001, cable operators are adding digital channels as a competitive response to DBS competition, in an attempt to gain parity in terms of channel quantity and in the offering of an interactive program guide.

Digital set-top boxes for this relatively simple, non-interactive digital broadcast reception originally cost in the $350 to $400 range, but have recently dropped to the $285 range. They have MPEG-2 video and AC-3 audio decoding, 2D graphics, microprocessors in the 20 to 50 MIPS range, and 2 to 8 MB of RAM. These have been sufficient to provide the extra channel choices subscribers are demanding, and to provide the first on-screen interactive program guides. In the past year or so, even video-on-demand services are being introduced via these relatively simple boxes. But soon, when it is time to introduce more sophisticated applications, these devices will run out of steam.

### Digital Interactive in Phase Two

In the coming phase, cable expects to pull ahead of satellite and all broadband competitors by deploying two-way services with more powerful set-top boxes often referred to as "advanced digital STBs". Such advanced boxes are typically characterized by a much more powerful processor (a few hundred MIPS and more), 8 to 32 Mbytes of RAM, expanded I/O ports including USB and IEEE-1394 connectors, 2D/3D graphics acceleration, a built-in DOCSIS cable modem for two-way data communications, and as an option, a hard disk drive for application and data storage, and even personal video recording. Prices for such set-top boxes will be higher, naturally, perhaps as high as $600 or more in fully configured versions. These devices come closer to being powerful personal computers with digital television capabilities built in. In addition to the expected MPEG-2 video/Dolby AC-3 audio decoding functionality, these STBs will be expected to run web browsers, e-mail clients, downloaded Java applications, secure e-commerce applications, VOD, networked games and more.

### Economic Factors

In mid-size to large cable systems with high digital service penetration, the capital cost of the set-top box and its installation is the dominant factor in determining payback period and ultimate profitability. Costs for headend digital broadcast equipment is a much smaller investment factor, particularly in the first phase, where headend equipment is primarily broadcast in nature. True interactive services for phase two will introduce server, subscriber management and Internet routing infrastructure that will raise costs. For now though, the strategy of overlaying digital on existing analog cable systems allows operators to deploy the capital investment for the box only in the homes that have ordered the services enabled by the box. This means that the digital set-top investment is always associated with new service revenue, keeping financial returns manageable, or at least predictable.

If it were not for the competitive spur provided by competing DBS systems, cable operators would certainly be moving much more slowly with digital set-top

deployments so that advanced digital boxes could be developed and deployed in greater number, rather than the low-end boxes. The revenue opportunities created by advanced set-top units will far exceed those of the simpler boxes. These opportunities include cable modem service to external personal computers using the DOCSIS modem in the set-top; interactive advertising that can be both targeted and measured, and TV commerce -- shopping service and direct marketing. Telephony is another major application being deployed and planned by cable operators, but it is beyond the scope of this paper, and typically won't involve the television set-top box.

## Retail Distribution for Digital STBs

The U.S. Telecommunications Act of 1996, a major piece of legislation which reformed the Communications Act of 1934, required the Federal Communications Commission to establish regulations which will insure the commercial availability of set-top boxes from sources other than the cable operator. The rules established by the FCC in 1998 and 1999 have been the subject of much controversy, and it is not yet clear that they will achieve what the Congress intended.

The view of the Congress was that cable operators operate in a semi-regulated monopoly fashion in most markets in the U.S., under the authority of municipal franchise agreements, and that introduction of any competitive elements possible to their business would be in the public interest. The cable operator's traditional model, for both analog and digital set-top devices, is to purchase them in volume from a few favored manufacturers (Motorola and Scientific-Atlanta being the dominant ones), and lease them to subscribers for a monthly charge. The Congress felt that customer premises equipment was one area where cable customers could benefit from competition if alternative sources of supply were allowed to develop.

## Conditions Required for Retail Sale

Alternate sources of supply required technical standards to be developed, of course. This task which was delegated by the FCC to the OpenCable consortium, a group of leading cable operators led by CableLabs, the cable industry's R&D consortium. The ultimate goal of the OpenCable standards is to publish an architecture and standards that will allow any electronics manufacturer to design and market set-top terminals that will work on any cable system in the United States, and allow the set-top to be moved by the consumer from one cable system to another in a seamless fashion, with full interoperability. The OpenCable standards are approaching this goal, but still fall short, particularly in the area of electronic program guides, which tend to be tightly controlled by cable operators and guide information suppliers. Another shortfall is in the planned middleware standard, recently dubbed the OpenCable Application Platform (OCAP), that remains undeveloped, but which is intended to provide a uniform platform for applications to be downloaded to and executed on set-top devices from any manufacturer, regardless of their choice of microprocessor or operating system.

In mid-September, CableLabs announced that the cable industry had designated three firms to serve as the primary authors of the OCAP middleware system. They are Sun Microsystems, Liberate Technologies, and Microsoft Corporation. Sun will take the lead on developing the Java-based "Execution Engine" programmable environment, while Liberate and Microsoft will be the lead contributors to the definition of the "Presentation Engine", which will be based on HTML and ECMAScript. Additional contributors will be CanalPlus, OpenTV and PowerTV. Consumer electronics manufacturers will be given periodic opportunities to comment on the development of the OCAP system. CableLabs' announced target was to complete the bulk of the specification by the end of 2000, with product implementations to be completed shortly thereafter. This work is complex, however, and can be expected to take longer than planned - the original CableLabs middleware RFI called for the system to be fully defined by January, 2000, nearly a year ago.

The second major requirement for retail availability was for separable signal security so that cable operators could retain ownership of, and control over, the method of protecting their premium signal content. Cable operators had initially argued that since signal security was embedded in their set-top devices, it would constitute an intolerable loss of security to have such boxes manufactured by multiple manufacturers and sold for permanent ownership by cable subscribers, because the signal security might be breached there and be unrecoverable.

The FCC responded by ruling that signal security must

be placed on a separate module, the so-called POD module, for "Point of Deployment" module, and supplied by the cable operator upon request to any consumer who purchases a cable set-top unit from an independent source. The FCC set a deadline of July 1, 2000 for these POD modules, with a standardized interface, to be supplied by cable operators to any consumer who requested one. Cable operators have generally complied with this deadline, and presumably have small quantities of these devices on hand. The PODs may be ready, but what hasn't yet developed is the availability of OpenCable set-top boxes for consumer purchase.

A number of new manufacturers have, in fact, entered the cable set-top business for the U.S. market, but they have announced traditional high volume contracts for sales to cable MSOs. Among these companies are Pioneer, PACE, Philips, Sony, and Panasonic. The entrance of such non-traditional vendors is clearly welcomed by cable operators, but it remains to be seen whether retail sales will come to pass. Theoretically, cable operators are interested in having consumers pay a cost the operator now bears, and in having a position of visibility in retail stores where cable services can be sold in competition with DBS services.

## Factors Affecting Prospects for Retail Success

One of the significant barriers to retail sale of digital set-tops to consumers is the alternative that will likely always be presented to the cable subscriber - the low cost monthly lease of the same or an equivalent device from the cable operator. Today, digital cable set-top boxes lease for monthly rates ranging from $3 to $10. It is natural for cable operators to provide such low-cost lease terms - their goal, after all, is to gain new subscribers, and if removing the purchase decision can facilitate a consumer's decision to subscribe to cable, then it is natural for a cable operator to offer such a lease. However, this creates a difficult hurdle for the potential retail customer - is it worth spending hundreds of dollars for a device that can alternately be obtained for a low monthly lease price with the added advantage that maintenance and compatibility issues remain the responsibility of the cable operator?

It is also not clear that cable operators ultimately favor the sale of set-top units to their subscribers. A loss of control results when the terminal device on a sophisticated digital communications network is no longer owned by, and maintained by, the network operator. In addition, a sense of entitlement to continuing service is likely to occur on the part of the consumer who spends heavily on such a device, which may be counter to cable operators' wish to be free to change content types, transmission techniques and security strategies to take advantage of advances in technology.

\Until it becomes abundantly clear that digital set-tops sold at retail are: a) truly priced competitively with the leasing alternative (perhaps via a price subsidy from the cable operator), b) supported by the cable operator, and that c) OpenCable set-tops are truly portable, interoperable devices that a consumer can take along wherever he may move, commercial availability is not be likely to be successful.

## Review by the Federal Communications Commission

On September 14, the U.S. FCC issued a "Further Notice of Proposed Rulemaking and Declaratory Ruling" which sought public comment from interested parties on whether the FCC's rules for commercial availability of "navigation devices" have indeed been effective. The FCC was acting, as it had promised in its original ruling on this topic on June 11, 1998, to evaluate the effectiveness of its rules and consider modifying or supplementing them to assure they achieve the intended effect. Interested parties were given until November 15 to comment, with reply comments due by December 18, 2000. Further FCC action based on these public comments can be expected in the first or second quarter of 2001.

## Technology Development by Sharp Laboratories of America

Sharp Laboratories of America is tracking the business, regulatory and technical issues associated with the coming phase of advanced digital services to be deployed by the U.S. cable television industry.

Technical development efforts by Sharp Labs' Digital Video Department include prototyping of the middleware environment of the developing DASE standard. This standard, nearly complete, has been underway within the Advanced Television Systems Committee since late 1997. Sharp Labs' software development laboratory in Huntington Beach, California has long been a participant in the DASE standards work, and has kept its prototype

system in pace with the developing standard. The OpenCable OCAP middleware standard will have much in common with the ATSC DASE standard. It shares a common architecture and will have a highly similar API set.

Sharp Labs has also developed a complete software implementation of the digital television closed captioning standard embodied in EIA-708B. This standard migrates closed captioning from that of NTSC television to HDTV, with significantly increased bit rates and service features.

Sharp Labs is also a key a participant in two key global industry efforts to define specifications for multimedia content definition and management. These include MPEG-7, the ISO/IEC standard under development which will standardize a set of descriptors of audiovisual material, a set of description schemes for structuring descriptions, a language to specify description schemes (and descriptors); and ways to efficiently store and transport descriptions. MPEG-7 utilizes W3C's XML standards to define powerful, extensible metadata schemas which will make possible applications in the area of content search, navigation, selection and retrieval, as well as content management, filtering and personalization.

Finally, Sharp Labs is a regular contributor to the TV-Anytime Forum, an international association of organizations which seeks to develop open specifications to enable audio-visual and other services based on mass-market high volume digital local storage in consumer platforms. The specifications will enable interoperability between Personal Video Recorders (PVRs), or Personal Digital Recorders (PDRs), interactive TV systems, and associated services. The adoption of standardized tools and technologies will help consumer electronics manufacturers to optimize new products, such as set-top boxes and TV receivers with integrated storage, in-home servers and networks, and other home appliances.

## Conclusions

The prospects for new services and new revenues for U.S. cable operators is indeed bright, although there remains a daunting array of technical and business decisions to be made by all parties concerned: cable operators, cable equipment manufacturers, consumer electronics manufacturers, software companies, and the U.S. legislative and regulatory entities.

Tracking all aspects of this multi-dimensional activity is essential to being positioned to introduce products and services that will gain a significant and sustainable share in the coming market for advanced digital television to be introduced by the cable television industry.

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