

# Digital Television Services in the United States

## 米国のデジタルテレビ放送事情

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### Abstract

Digital television services are provided in the U.S. market via three competitive media: satellite, cable and terrestrial broadcast. In the nine years since the first launch of digital satellite services, the digital TV industry has developed through a series of competitive responses between each of these media, with major contributions from consumer electronics manufacturers. This paper traces the origins of digital TV services in America, and points out some of the key developments, current market sizes, and prospects for the future. This article also focuses on the recent development of Plug & Play standards for digital-cable-compatible consumer DTV receivers, as well as some key FCC actions and their expected positive impacts on the U.S. market.

米国でのデジタルテレビ放送は、3つのメディア—衛星、ケーブル、そして地上波放送—を通して提供されている。最初のデジタル放送（デジタル衛星放送）がスタートしてから9年が経ち、各メディア間の競争によるサービス向上と端末メーカーの努力により、デジタルテレビ業界は発展を遂げてきた。本稿では米国における最初のデジタル放送サービスを振り返り、デジタル放送発展のキーポイント、現在のデジタル放送市場、更には将来の見通しについて述べる。またデジタルケーブル対応受信機を可能にした「プラグ・アンド・プレイ」規格の最新状況、及び重要な各種政府規制や今後市場与える影響なども合わせて説明する。

### Digital Satellite Challenges Cable

The first digital television service was launched in the United States in mid-1994.

It was a 90-channel service called "Primestar", a direct-to-home satellite product from a company called K-Prime Partners, a partnership between seven cable operators. None of the partners was yet ready to launch digital service over their cable systems, but they knew the cable industry needed to present some type of competition to counter the serious satellite threat being prepared by Hughes Electronics. A few weeks later, the Hughes "DirecTV" service was launched. Then, in early 1996, Echostar Communications Corporation launched another direct-to-home service: the "Dish Network".

From the beginning, DirecTV and Dish Network

attracted substantial numbers of paying customers that would otherwise have belonged to cable operators. These digital orbital competitors, with their nationwide reach, large channel capacity and excellent picture and sound quality, established a clear competitive incentive for the launch of digital cable.

The first response came in early 1997 when TCI, then the nation's largest cable operator, launched digital services in Hartford, Connecticut. In the years that followed, the cable industry invested heavily to add digital channels via a standard methodology - placing the digital carriers at the upper end of the frequency spectrum in the cable system, thus adding the new digital programming while retaining the existing analog NTSC signals at the lower end. (Note that these analog RF channels continue, to this day, to be important for low-cost, direct RF cable connection to the

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second and third analog TVs in many American homes - an advantage for cable operators over their digital-only DTH competitors).

By mid-1999, the channel-limited Primestar service had been acquired by DirecTV, which promptly shut it down and converted its subscribers to the DirecTV dish and set-top receiver. At this point, the fundamental U.S. multi-channel television industry structure had been established - consumers now knew they could choose one of two national digital satellite services, or cable service from the local franchise holder, with both analog signals and optional expanded digital offerings. In many locations, though, consumers had to wait a few years until their local cable operator had upgraded its headend and transmission plant bandwidth to carry digital signals. So while the satellite services had instant national reach, and could therefore sponsor efficient national advertising and acquire key professional sports programming, the digital cable marketing effort was more fragmented and challenging. These early differences helped assure a permanent place in the U.S. landscape for digital satellite services.

### **Satellite Market Size Today**

In retrospect, the cable industry was correct to have respected the power of satellite-based competition. At the end of 2003, DirecTV and Dish Network together served more than 21 million subscribers, as compared with the cable industry's 71 million customers. Today, each of these satellite providers is among the top four multi-channel television providers in the United States. Comcast and Time Warner Cable are the two cable operators among these top four. Note that a only tiny fraction of U.S. homes (less than 3%) are served by other entities: microwave, satellite master antenna systems, and alternative broadband providers.

### **Terrestrial DTV Pioneers HDTV**

Due to long-standing rivalries between the U.S. cable and broadcast industries, broadcasters were forced, from the beginning, to follow their own path to digital services. Having received little cooperation from the cable industry, broadcasters had no choice but to pursue technical and business-planning paths almost completely uncoordinated with the standards and operational practices of cable. It was not until 2003 that some key steps were finally taken to

harmonize digital broadcast and cable services in a sensible way for American consumers. Later in this paper I will discuss the digital cable receiver "Plug and Play" agreement that promises to inject a new phase of growth in the U.S. digital television receiver market in 2004 and beyond.

Despite these difficulties, terrestrial broadcasters led the way in introducing HDTV to the U.S. market, because they had correctly identified that high definition quality would be the most important differentiating factor for their new digital broadcasts. Attempting to compete with cable and satellite on the basis of multicast-SDTV channel quantity would not have been successful.

In 1996, after nine years of research & development and standards committee work focused on digital transmission of HDTV (with SDTV multicasting as a last-minute addition), the industry completed the ATSC Digital Television standard. The Federal Communications Commission fixed this standard in its regulations and allocated each analog NTSC broadcaster a second 6 Mhz terrestrial channel for its digital transmissions. The first Digital Television (DTV) stations went on the air in late 1998, and the first ATSC DTV receivers were introduced to the American public, including a set-top ATSC receiver from Sharp. As of January 2004, there are 1,129 DTV stations on the air, in a total of 202 markets. There is discussion of broadcast HDTV programming later in this paper.

### **Cable's Expanded Digital Features**

From 1997 onward, cable operators found it necessary to expand their channel capacity with digital transmission and program-guide enabled set-top boxes (STBs) in order to prevent their subscribers from defecting to satellite. Along the way, however, cable has discovered additional opportunities for service enhancement that have raised its level of excitement and investment.

### **Video On Demand**

Initially, it was believed that the first few generations of digital cable STBs would have to give way to much more expensive but powerful "advanced set-top boxes" before interactive services could begin. But to the surprise of many, industry ingenuity proved that many of the least

capable STBs (in terms of MIPS and memory), could be made to run a basic VOD client that communicated with disk-based VOD servers at the headend. Though the graphic quality and responsiveness of such low-end STBs was far from ideal, it was sufficient to support the start of VOD services by cable operators, allowing them to demonstrate yet another strategic advantage they hold over their satellite competitors - an upstream control path, and the ability to host true interactive services. Today, Kagan World Media estimates that 16.5 million U.S. cable homes utilize VOD services (up from 7.4 million at the end of 2002), out of a total of about 36.9 million homes where VOD service is available. VOD was the vehicle for an estimated \$265 million in programming sales in 2003. More recent digital STBs do contain more processing power, and the user interfaces grow more attractive and capable.

### Digital Video Recorders

A few years ago, cable MSOs began experimenting with incorporating hard-disk-based Digital Video Recorders (DVRs) in their leased digital cable STBs. This began shortly after DVRs began to see some success as standalone products from companies such as Replay Networks and TiVo, and in satellite receivers for the Dish Network. This effort by cable is still in its infant stages -- currently only about 1 percent of deployed digital cable STBs have integrated DVRs. Cable operators typically charge \$9.99 per month for the DVR service, and there is expected downward pressure on these monthly rates. Many are predicting rapid growth in the cable DVR business as consumers discover their special advantages: ease of program search, recording & deletion; commercial skipping; pausing of live TV, and recently, schemes for whole house distribution of recorded programs, and interconnection with the home PC for enjoyment of music and photos stored there.

Of course, cable operators have no monopoly, or even any fundamental position in DVR technology. Beyond the standalone DVRs from Replay Networks and TiVo, the Dish Network has five current models of satellite STBs with built-in DVRs, not counting a new high definition DVR introduced at the 2004 Consumer Electronics Show. DirecTV receivers with integrated TiVo are available from Hughes, Philips, Sony and Samsung, with a monthly DirecTV/TiVo service fee of \$4.95. HDTV-capable DVRs

may be of particular interest to consumers with HDTV displays who feel they want a device to conveniently capture HDTV programming around the clock, since it is in relatively short supply in this early stage of the market.

### Cable Market Size Today

Digital TV services have grown tremendously in the past six years, and are seen as a primary revenue growth mechanism for cable operators. Since 1996, cable has invested \$85 billion in capital to upgrade its technical infrastructure to support its own digital cable program services and carriage of broadcast DTV channels, as well as Video-On-Demand and DVRs (not to mention cable modems and telephony).

Kagan World Media reports that at year-end 2003, there were 23 million digital cable subscribers, with a total of 33.5 million digital cable STBs installed (many homes lease more than one STB). In the great majority of present cases, these digital cable STBs are only SDTV-capable, and are leased to customers. A few STBs are sold to subscribers, mostly HDTV-capable STBs in selected MSO markets in order to test the concept. As a result, most currently deployed units decode only digital SDTV cable-specific premium programming, Pay Per View, and VOD. Broadcast DTV signals do not pass through the non-HDTV STBs. Over-the-air DTV signals have their 8-VSB modulation converted at the cable headend to digital QAM modulation and are passed in-the-clear over the cable system for direct tuning by consumer-owned DTV receivers with QAM demodulation capability. Where cable HDTV STBs are deployed (about 700,000 so far in the U.S.), broadcasters' 8-VSB signals are often converted, in the clear, two at a time, to 256-QAM modulation for reception by the HD STB. Cable-specific HDTV program services are encrypted with the operators' conditional access system, in order to protect their premium, pay status.

### Broadcast & Cable HDTV Programming

The first HDTV programming originated with the "big four" broadcast television networks: CBS, NBC, ABC and PBS. CBS has been the clear leader in terms of being first to the market (the past four seasons) and providing the most HD programming (recently, all of its primetime situation comedies and dramas, and many sporting events). American viewers with HDTV displays have begun to

expect HDTV production of top events in football, tennis, and golf. Note that in the past few years, some of the cost of broadcast network HDTV programming has been sponsored by CE manufacturers such as Samsung, Zenith, Mitsubishi, RCA and others, who are given an on-air banner-type identification at the start of much HD programming. Commercials are not yet often produced in high definition, except for major events like the football Super Bowl. Most commercials are up-converted, and appear in their normal 4:3 aspect ratio with gray or black side-panels.

The Fox Network has been the laggard in HD, to the present preferring to originate what they call "Fox Widescreen": 480-progressive video in a 16:9 aspect ratio. Recently, however, Fox has announced its intent to originate true HDTV in the 720-progressive format beginning with the Fall 2004 program season. CBS, NBC, WB, HBO, Showtime and Discovery HD Theater have all settled on the 1080-interlaced HD format. Fox and ESPN HD have chosen the 720-p HD format.

In addition to the advertiser-supported broadcast networks, there are a number of premium channels available over cable (and satellite as well). These include high definition versions of the HBO and Showtime pay movie channels, which are provided free to subscribers of their respective SDTV pay program "multiplexes". Also popular is Discovery HD Theater, a high definition version of the nature and science-oriented Discovery Channel; and ESPN HD, an HD version of the ESPN sporting events channel. There are a handful more of such pay channels, and they tend to get priority in carriage on cable systems, because they generate new revenue for cable operators, unlike with carriage of free over-the-air DTV channels. There is even a regional sports network, Comcast SportsNet HDTV, that is the first to cover local sports in high definition (in the Philadelphia, Baltimore, Washington DC area).

The NCTA claims that 96 of the top 100 markets - including all of the top 30 markets - are now served by at least one cable operator offering high definition programming. This claim is made in order to indicate the cable industry's responsiveness to the FCC Chairman's April, 1992 proposal for voluntary industry actions to accelerate the transition to digital television. Note this doesn't mean the entire market is passed by cable HDTV

services; and it doesn't mean all broadcast HDTV signals are carried on cable. Sometimes only a few over the air signals are carried, supplemented by pay HDTV services.

### **Cable Carriage of Broadcast DTV**

Cable carriage of broadcaster's DTV signals remains controversial. Cable operators argue that because a great number of broadcast DTV stations simply upconvert their NTSC analog signal, there is no market-based reason for cable operators to carry these duplicative DTV signals. Broadcasters, on the other hand, say that until their DTV signals receive wide cable distribution, they have insufficient incentive to invest in pass-through of network HD programming or creation of local HD programming. Many broadcasters try to negotiate fees for providing their DTV signals for carriage by cable operators. Most cable operators rebel at such requests for payment, since the signals are also provided free over the air, thus "proving" their lack of market value. As a result, cable carriage of broadcast DTV is quite uneven across the country. The FCC has been entertaining arguments for years on whether it should expand the cable "must-carry" rules to include terrestrial DTV channels during the current period (before shut-down of the analog NTSC broadcast service). No one knows if or when the FCC might rule on this, but the Commission certainly seems reluctant. The FCC has already ruled that must-carry of broadcast DTV will apply once NTSC analog broadcast has been shut down, in effect transferring the current analog "must-carry/retransmission consent" rules to their digital replacements.

Cable carriage of broadcast DTV is therefore far from universal. The NCTA claims, as of December 1, 2003, that cable systems are carrying the digital signals of 304 broadcast stations. This is a small fraction of the 1,129 DTV stations on the air.

### **Consumer DTV Products**

In the past five years, despite the inability to present consumers with DTV receivers having digital cable compatibility, growth in sales of DTV displays has been rapid. Many HD displays are connected to cable or satellite SDTV or HDTV STBs, fed with analog signals, or used to view DVDs. Less rapid has been the sale of ATSC-only STBs or integrated receivers. The Consumer Electronics Association (CEA) cites the DTV product adoption rate as

surpassing that of Color TV, the PC, and the VCR. Note that the CEA focus is on "product" adoption, and counts any home in which a DTV "product" is purchased, even if that product is an HDTV monitor with no ATSC DTV receiver capability yet present in the household. Nevertheless, DTV products have been an important source of new revenue for CE manufacturers.

The CEA has reported that factory-to-dealer DTV product sales totaled 4,102,365 units in 2003. Sales in the month of December 2003 alone totaled 640,443 units, just 7,986 units short of DTV unit sales for the entire year of 2000. And the future appears bright. CEA forecasts 5.8 million DTV units to be sold in 2004, 8.3 million in 2005, 11.9 million in 2006, and 16.2 million in 2007.

### **The Broadcast Flag**

On November 4, 2003, the FCC issued a new set of rules designed to protect unencrypted over-the-air DTV content from being mass-distributed over the Internet. The rules can be thought of as a way to avoid the "Napster problem" with over the air digital TV programming. Another approach might have been to encrypt DTV broadcasts at the source, but this was not possible, for it would have caused a million existing DTV receivers, already in consumers' homes, to fail to operate properly. The problem involved how to protect in-the-clear broadcast DTV programming in the same way that encrypted premium programming on cable is protected from in-the-clear output transmission via the Internet.

The so-called "Broadcast Flag" is a digital code that can be embedded into an ATSC digital broadcast stream. This can be done at the election of DTV broadcasters when they wish to protect their content from Internet retransmission. Beginning on July 1, 2005, DTV receiver products must detect the presence or absence of the Broadcast Flag, and act accordingly. If the Flag is present, the receiver product may only pass the content to the following types of outputs: analog outputs; digital modulated RF outputs; digital outputs protected by an FCC-authorized digital output protection technology (likely to be IEEE-1394 w/DTCP and DVI/HDMI w/HDCP). In the case of computer products, an unprotected DVI output is permitted, but it can have no more than 350,000 pixels per frame (e.g. 720x480 pixels).

In the absence of the Flag, the product has no output restrictions imposed.

The CE, broadcast and content industries support this solution, and believe it will reassure content owners that their programs will not be economically damaged via indiscriminate distribution via the Internet. This should encourage the provision of high-value HDTV programming to broadcast DTV stations, and help promote the market for DTV receiver products.

### **The Cable "Plug and Play" Agreement**

The Telecommunications Act of 1996 called for the FCC to establish rules that assured the commercial availability to consumers of digital cable-compatible receiver products, so that cable subscribers would have an alternative to leasing set-top boxes from cable operators. For years, the cable industry feared a loss of control of their terminal equipment and their networks, which had up to that point been under their proprietary control, and so they resisted. With continuing FCC pressure to move the DTV transition forward, however, the major cable MSOs agreed to join the consumer electronics industry in serious negotiations. From August to December of 2002, the two industries hammered out an agreement on technical standards, operating practices, CE product capabilities and labeling and marketing terms. The negotiations resulted in a Memorandum of Understanding (M.O.U.) that was submitted to the FCC in December, 2002. It covered "unidirectional" digital cable receiver products (but not interactive services utilizing an upstream path - these "advanced interactive" requirements are still being negotiated by the CE and cable industries). Proposed FCC rules based nearly exactly on the submitted M.O.U. were issued for public comment in January of 2003, and finally approved on September 10, 2003. The detailed rules were issued in a 78-page report on October 9, 2003.

While no CE manufacturer is required to make such products, those companies that wish to make products labeled "digital cable ready" must comply with the new FCC rules, often loosely referred to as the "Plug & Play" rules. In addition, cable operators must comply with a set of standards and operating practices that will assure that this new class of DTV products will work when connected to cable systems.

In summary, CE manufacturers must make sure such products: tune NTSC channels transmitted in the clear; tune digital channels in accordance with the SCTE 40 standard; allow navigation of channels based on the virtual channel map and source names (the cable operator's IPG is not provided for); include a "POD-Host" conditional access (CA) interface according to certain standards (to accept a cable operator-owned CableCARD CA module); respond to emergency alerts per the ANSI/SCTE standard; and include a broadcast tuner (per the FCC's August 2002 "broadcast DTV tuner mandate" rules); and include a DVI or HDMI digital interface based on a phase-in schedule.

Cable operators must, in turn, support such digital cable-ready products with proper signals and provision of CableCARD modules in systems with greater than 750 Mhz activated system bandwidth, no later than July 1, 2004. Cable operators STBs must also adhere to certain standards for pass-through of certain remote control and power control commands for cases where cable STBs will be connected to CE receivers. They must also replace any leased HD-STB with one that has an IEEE-1394 interface at the request of any cable subscriber, so that digital CE recorders can be used with the cable STB. After July 1, 2005, cable operators must include both a DVI (or HDMI) and an IEEE-1394 interface on all HD-STBs distributed to consumers. Cable operators may not utilize "Selectable Output Control" to shut off a particular output or connector on a program-by-program basis. Also, cable operators may not utilize "down-resolution" for off-air DTV content (may not reduce HD content to SD quality). Finally, cable operators may not set copy protection for programs more restrictively than as follows: PPV & VOD may be marked "copy never". Basic and extended basic and monthly pay cable may be marked "copy once". Unencrypted off-air

DTV signals may have no restrictions on copying.

A full exploration of the details and impact of the FCC Plug & Play rules is beyond the scope of this paper. For the current purpose, it is sufficient to state that the rules establish obligations on both industries that will make possible a new class of unidirectional digital cable-compatible product that is expected to provide improved ease of use to consumers. Virtually all CE manufacturers appear to be preparing new products in this class, including Sharp, and both the CE and cable industries are optimistic that they will be enthusiastically adopted by consumers.

### Conclusion

This paper has reviewed many of the key issues associated with the current state of digital television services in the U.S. While there are some difficult problems yet to be resolved, it seems clear to the author that a complete transition to all-digital television, in all media, is a certainty. It remains for all parties to capitalize on this inevitable and beneficial transition to create sustainable, profitable businesses that will move the industry toward continual enhancement of this most valuable of electronic media.

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