VCTV: A Video-On-Demand Market Test

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The market potential for interactive video services and the broadband networks necessary to support these services are of great interest to both the telecommunications and cable television (CATV) industries. Both industries are involved in intensive evaluations of interactive video services. The cost to provide and maintain broadband networks is being compared to potential consumer demand and willingness to pay. This paper presents these issues and describes a market trial being jointly conducted by AT&T Network Systems, U S West, and Tele-Communications, Inc. (TCI), under the name of Viewer-Controlled Cable Television (VCTV).

Introduction

The market potential for interactive video services and the related broadband networks necessary to support these services are of great interest to the telecommunications and cable television (CATV) industries. Both of these are involved in intensive evaluations of interactive video services. Because the cost to provide and maintain broadband networks is substantial, we must evaluate these services — ranging from enhanced telephony, to transaction and information services using high-quality images, to interactive "video on demand" — from the point of view of consumer demand and willingness to pay.

This paper presents two asymmetric video services, the technology that makes them possible, and a trial to assess their marketability. Asymmetric video services are those in which the traffic, or data, going *to* the customer is far greater than traffic coming *from* the customer.

Market characteristics, those of a mass market in particular, cannot be gathered by studying only consumers, competitors, or environmental trends. They deal with supply and demand, and the dynamic interaction between the two. In this paper, we confine supply-side analyses to an assessment of the enabling technologies and technical building blocks that we envision will someday deliver enhanced asymmetric video services. The market trial described later in this paper provides "real world" insight into a demand-side analysis.
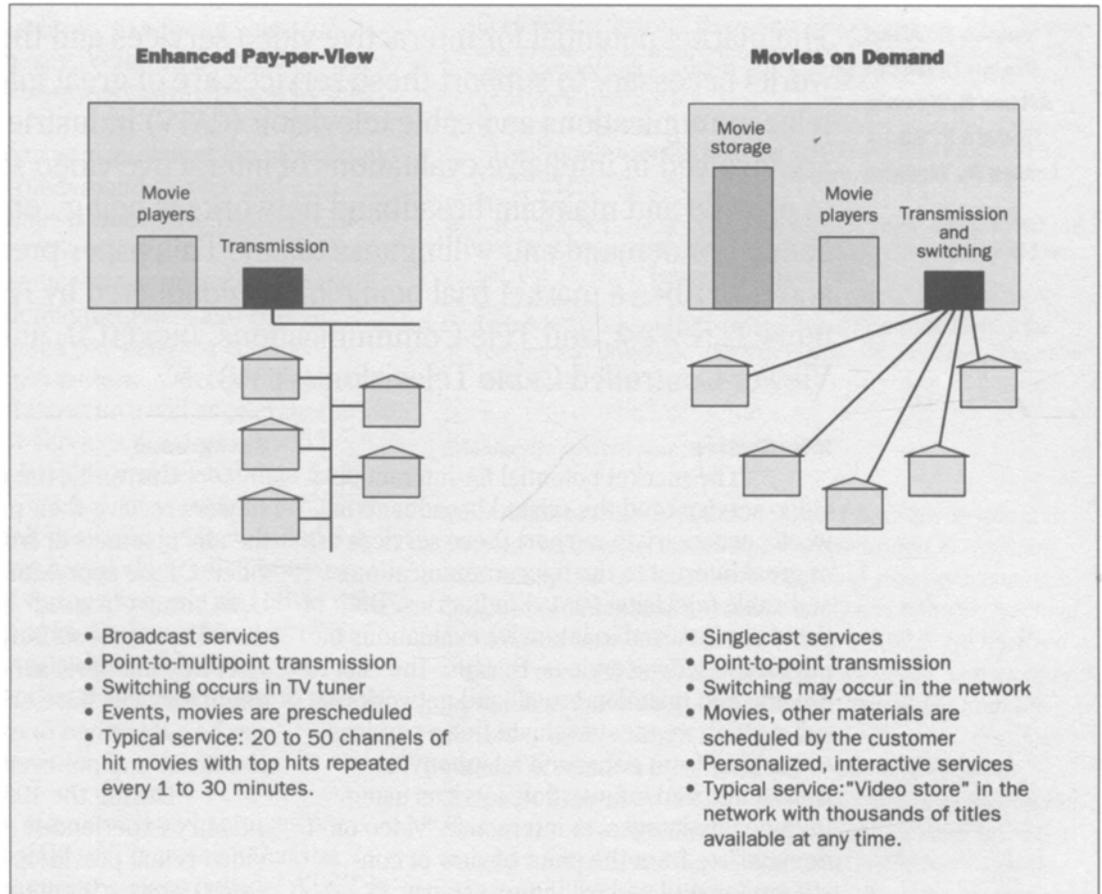
Background

Currently, the majority of television viewers receive their programming from "off the air" channels or from their local CATV provider. Of the approximately 90 percent of U. S. homes "passed" by CATV service, more than 60 percent subscribe to at least basic service. Beyond basic services, two forms of premium services have been developed. These can be subscribed to monthly (premium channels) and per event (pay-per-view).

During the 1980s, the video rental industry experienced enormous growth. Video rental providers offered the customer a vast choice of content and the ability to view a feature as many times as desired during the rental period. To take advantage of this service, the customer had to own a videocassette recorder (VCR) and be willing to pick up and return the rented material.

Cable providers and telephone companies would like to develop an environment that could offer some of the same products offered by the rental stores, enhanced by increased access and convenience. A consortium of AT&T Network Systems, U S West, and TCI has identified two alternative product categories:

- An enhanced pay-per-view service, which would offer a greater selection of movies than is currently being offered by pay-per-view, with more frequent start times
- A video-on-demand service, which would allow a subscriber to select a movie from a

Figure 1. Enhanced pay-per-view versus movies-on-demand architecture.

Enhanced Pay-per-View

Movie players

Transmission

- Broadcast services
- Point-to-multipoint transmission
- Switching occurs in TV tuner
- Events, movies are prescheduled
- Typical service: 20 to 50 channels of hit movies with top hits repeated every 1 to 30 minutes.

Movies on Demand

Movie storage

Movie players Transmission and switching

- Singlecast services
- Point-to-point transmission
- Switching may occur in the network
- Movies, other materials are scheduled by the customer
- Personalized, interactive services
- Typical service:"Video store" in the network with thousands of titles available at any time.

large library of titles, order it, and view it immediately or reserve it for later viewing.

The market trial described later in this paper addresses the issue of measuring consumer preference for each type of service.

Enabling Technologies. What only a few years ago seemed the province of science fiction is nearly reality. Rapid advances in image compression, digital signal processing, and high-speed transceiver technology, coupled with cost reductions in memory and processing, are largely responsible for this remarkable shift. These advances affect the technology underlying video on demand. Full-scale deployment of a movies-on-demand service will require these technologies.

Compression. Image compression, based on digital signal processing, reduces the number of bits needed to transmit visual data. Today, research in compression algorithms allows North American Television Standards Committee (NTSC) quality video to be

compressed from more than 100 megabits per second (Mb/s) to 3 to 4 Mb/s, while somewhat degraded "Video Home System (VHS) quality" can be compressed to 1.5 Mb/s. (VHS is a registered trademark of the Victor Company of Japan, Limited.)

Digital transmission. NTSC video is analog, with each channel requiring 6 megahertz (MHz) of bandwidth. Advanced technology can modulate about 20 to 22 Mb/s on one 6-MHz cable channel. Using digital compression technology, each analog channel could support between 4 and 12 "channels" of entertainment video, depending on the quality required. Cable providers that currently offer 30 to 80 channels of analog video will be able to increase their capacity to support between 300 and 500 channels.

Moreover, many telecommunication companies are evaluating alternative approaches to delivering video to the home over existing twisted-pair telephone lines. On twisted-pair lines, today's asymmetric digital subscriber line (ADSL) technologies can support transmission

rates of 1.5 Mb/s over distances up to 18,000 feet. Video signals compressed to this rate can be transmitted on existing telephone networks.

Data storage. Currently, analog storage is much more efficient for uncompressed video. Several commercially available video jukeboxes can store nearly 1000 analog tapes; each jukebox can access and play over 30 tapes simultaneously on VCR devices. Current technology, whether magnetic tape or laser disk, does not support multiple concurrent extractions of video data. Devices that store video in a compressed digital format are now being marketed. Although they are expensive, they allow many subscribers to view a single, compressed, stored video simultaneously (see Figure 1).

These enabling technologies and improvements in transport, routing, storage, and control will provide the environment necessary to support a large range of video services.

Market Demand. The economic considerations of deploying interactive video services include all costs associated with its development and implementation, and the potential revenue it will generate. Regulatory and public policy considerations, industry structure, and supply-side analyses of the cost have been undertaken by others. The remainder of this paper will address the demand-side analysis, which has been largely ignored.

A complete demand-side analysis would focus on the total revenue that might be generated by a variety of video services, ranging from the pay-per-view class of services to new services, such as video on demand. A partial list of applications requiring substantial downstream bandwidth (from the provider to the subscriber), at 1.5 Mb/s or greater, and a limited return upstream path (from the subscriber to the provider) include:

- Entertainment video
- Instructional and educational services, such as distance-learning (delivered to the classroom), interactive access to educational materials from the home, and work force training
- Games and other interactive entertainment services
- Enhanced catalog shopping and other transaction services
- Information services, including electronic Yellow Pages, listings of local events, travel, real estate, etc.

As we try to assess future demand, it is impossible to predict the entire spectrum of services that will emerge. Nevertheless, we can make one basic assumption: the demand for video services will be driven by the public's desire for entertainment. For example, only a dramatic change in consumer behavior would enable information services to rival entertainment video as a source of revenue. We have concentrated on direct, user-paid entertainment services delivered by CATV providers rather than advertiser-supported services provided by "off the air" networks for two reasons. First, compared to broadcast television, this category has grown substantially in the past few years, indicating that the consumer is willing to pay for added choice, control, and convenience. Second, it is impossible to assess, in a direct way, the consumer's "willingness to pay" or "willingness to tolerate" advertising without a full-scale market test.

The VCTV market trial offers two new asymmetric video services: enhanced pay-per-view and video on demand.

Enhanced pay-per-view has many more channels than pay-per-view services currently in the marketplace. The service provider selects the features and sets the schedule. Enhanced pay-per-view can be delivered using a broadcast network such as conventional cable TV, satellite, or wireless cable (microwave).

Video on demand, which can be thought of as a network-provided "video store," has a library of several thousand movies accessible at any time and controlled by the consumer. Video on demand is an asymmetric, point-to-point service, rather than a broadcast service. It requires an individual channel to be allocated and available for each customer ordering a movie. In the downstream direction, it requires a broadband capacity with limited bandwidth necessary to support real-time upstream signaling. The combination of real-time upstream signaling and the bandwidth allocated to each subscriber makes video-on-demand service more expensive to deliver than enhanced pay-per-view service. Figure 1 compares enhanced pay-per-view and video-on-demand services.

Our goal is to assess the market value of video on demand, hereafter known as movies on demand, because we believe that the economic viability of asymmetric services will depend on how desirable the consumer finds this type of service. Enhanced pay-per-view is a potentially important piece of the competitive environment to the consumer, along with current alternatives such as going to a movie theater, renting or buying videotapes, or subscribing to CATV premium channels.

Market Research. The attempts to assess consumer demand for both movies on demand and enhanced pay-per-view were initiated in the AT&T Bell

Laboratories' Consumer Laboratory in early 1988. This work consisted of:
- Service simulation and prototyping
- Consumer testing (of over 1000 subjects), to assess demand as a function of price, service characteristics, demographics, and characteristics of competitive services.

The simulation environment assesses demand for a new service by having consumers touch, feel, and interact with these services. This approach provides a more extensive evaluation than do traditional surveys, which are conducted by phone, mail, or by canvassing people in shopping malls.

The market research estimated market size, usage per household, and price elasticity for each type of service under varying service characteristic assumptions. The characteristics considered and varied included service scope (number of channels for enhanced pay-per-view, number of titles for movies on demand), title vintage, user interface, and of course, price. For example, enhanced pay-per-view services incorporated from 2 to 70 channels, with date of availability ranging from current home video release to current Pay-Per-View release. For movies on demand, the library sizes evaluated ranged from 150 to 4000 titles.

Desirable service features identified by test subjects in our earlier market research and analyzed in the Consumer Laboratory included:
- Control, especially as represented by a "pause" feature
- Integration with television, VCRs, and especially remote control units
- A single, transparent user interface whose characteristics were tested and guidelines established.

Results from these studies showed:
- A large potential demand for both services
- A significant incremental willingness to pay for either of these services over the typical price, for example, of video rental service
- A significant incremental willingness to pay for movies on demand over enhanced pay-per-view.

Because these results were derived from simulated studies, it is essential to evaluate similar services in a realistic environment using actual subscribers spending real money to purchase these services. The market trial described in the remainder of this paper was designed to confirm, calibrate, and, if necessary, modify the earlier demand estimates.

VCTV Trial

A consortium was formed in 1991 by AT&T Network Systems, U S West, and TCI to extend testing to a realistic market environment using a field test. This was structured to test the market, not to evaluate technological feasibility. The field test relies on previous research to identify key parameters, including service definition, initial user interface characteristics, and pricing structures to evaluate enhanced pay-per-view and movies-on-demand services. The test, which began in July 1992, offers both services to a sample of approximately 300 users residing in a suburb of Denver, Colorado.

VCTV Services. Of the asymmetric services that we have discussed — movies on demand and enhanced pay-per-view — we have decided to offer one version of each to subscribers in our market trial.

Take One Service. *Take One* service, the name under which movies on demand is marketed, makes available for immediate viewing a catalog of at least 2000 movies, any of which can be ordered by using the VCTV remote control device. A subscriber can interrupt the movie being viewed up to five times, for a total of 10 minutes. In addition, a subscriber can reserve movies up to one week in advance.

Hits at Home Service. The enhanced pay-per-view service being sold as *Hits at Home* consists of 24 channels programmed mostly with recent titles. All programming, marketing, and merchandising decisions associated with both services are made by experienced cable service (and particularly pay-per-view) marketers from TCI.

VCTV Research Objectives and Methodology. The principal goal of the VCTV test is to estimate "steady-state" demand for the new video services and to evaluate the relative demand for movies on demand versus enhanced pay-per-view.

Secondary goals of the test are:
- To identify changes in overall household video usage
- To track VCTV usage patterns (peak viewing periods, title preferences, etc.)
- To evaluate the user interface and other service attributes.

To accomplish these objectives, we are conducting the test in two phases. In the first phase, movies on demand is being made available to one set of participants (a cell), and enhanced pay-per-view service is being offered to another cell. After steady-state usage is reached, the competing services will be introduced to

both cells; for the remainder of the test, the service offerings will be identical.

Selecting Test Cells. A suburb of Denver was selected for the test based on general demographic criteria and technical considerations related to cable availability and accessibility. Census surveys were then conducted within this general area to select two test areas. Our main criterion was to find two well-matched neighborhoods with similar demographics. We evaluated key demographic parameters of age and income to ensure that the demographic profiles of the VCTV subscribers in the selected neighborhoods were similar.

The participants in one neighborhood comprised the Take One cell, and the participants in the other neighborhood comprised the Hits at Home cell.

Survey Instruments. All prospective subscribers were surveyed. The goals, aside from collecting demographic data, were to gather some information on current video usage and other "lifestyle" characteristics, and, most importantly, to measure reactions to descriptions of VCTV services, such as price, movie availability, and schedules. These reactions were measured using a variety of metrics, including likelihood of subscription, predicted rate of use, and value for the money. Later, these assessments will be compared with data obtained from the non-VCTV homes within the Denver area and from a national sample of homes to project the results of VCTV demand on a national scale.

All subscriber interactions with VCTV are recorded as transactions in a database. This transaction monitoring program not only measures service usage accurately, but also tracks order cancellations, system errors, and user errors. In addition, problems reported to the VCTV service representatives are recorded.

Between one-half and two-thirds of the households in each cell are metered by Nielsen Media Research using their household meter system to monitor not only VCTV usage, but all TV viewing. We began metering households at least three months before VCTV services were introduced to track any changes in viewing patterns related to service introduction. National and local (Denver) Nielsen panels are used as controls to measure changes related to VCTV service introduction more accurately, as well as to detect purely local effects on purchase behavior.

To make national projections of demand, we are conducting national surveys to measure reactions to descriptions of VCTV services, as we are doing in the surveys being conducted in the Denver neighborhoods. We will build models that use these measurements to predict actual usage of VCTV services on a national basis. VCTV test households will provide key data needed to design these forecasting models, which project national usage rates, buying behavior, and revenue associated with each of the competing services.
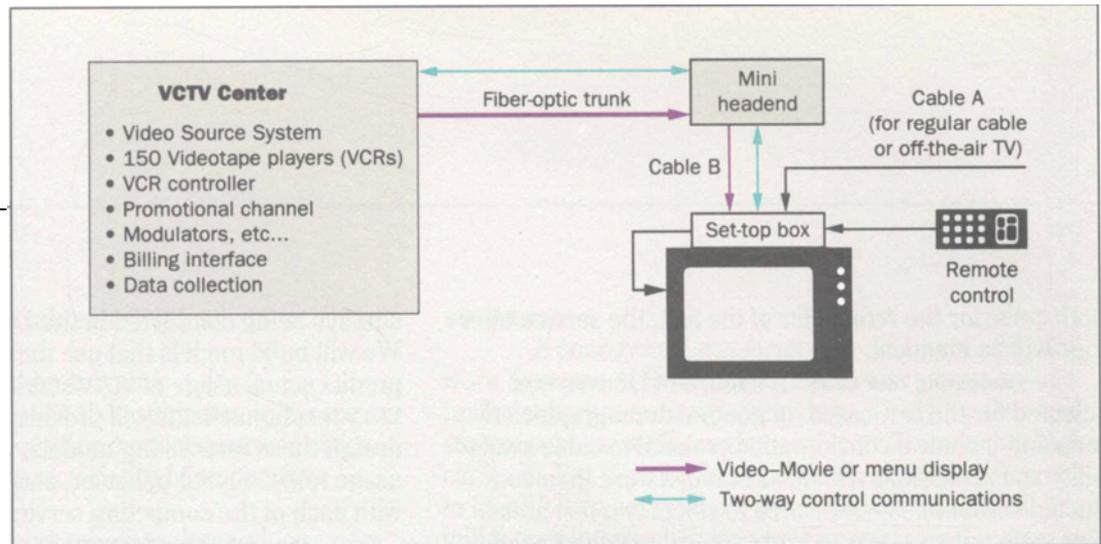
User Interface for VCTV Services. Acceptance of new services by the consumer generally can be linked to how easy the interface is to use. The subscriber accesses either VCTV service through four specially designated buttons on a remote control device. The scroll buttons (which double as channel scrollers) and the OK button are used to traverse menus and make selections. For Take One service (movies on demand), the subscriber presses a special Take One service button to access the service; a series of on-screen menus lead the subscriber through all transactions. For example, a subscriber can order a movie by entering a catalog number.

To access Hits At Home service, the subscriber selects the channel displaying the movie desired. Each of the 24 channels can be accessed just like any other channel, but until an order is confirmed, the subscriber only sees a text screen displaying the movie title, price, and ordering information. An order is confirmed either by entering a personal identification number, if the subscriber has activated the lock-out capability, or by pressing the OK button on the remote control.

Marketing and Pricing. All aspects of the VCTV test are designed to simulate, as closely as possible, an actual video service offering. The simulation includes traditional marketing and promotional materials, such as guides and catalogs. Subscribers receive a separate bill for VCTV services. Installers, repair personnel, and service representatives are trained to assist subscribers and are perceived by them to be part of the total VCTV package. The test cannot include extensive mass media exposure, but we have observed a generally high level of awareness of the VCTV trial in the community. Direct mail materials include monthly guides and promotional information for each service. On-screen marketing takes place on two promotional channels (one for each service), which provide movie clips, features, and instructions for using these services.

Pricing for Take One service is slightly higher than Hits At Home service. Special price promotions are part of the overall research plan.

Figure 2. VCTV trial architecture.

Within the figure:
VCTV Center
- Video Source System
- 150 Videotape players (VCRs)
- VCR controller
- Promotional channel
- Modulators, etc...
- Billing interface
- Data collection

Fiber-optic trunk — Mini headend

Cable A (for regular cable or off-the-air TV)

Cable B

Set-top box

Remote control

→ Video–Movie or menu display
↔ Two-way control communications

VCTV System Architecture

VCTV is provided over a cable that is entirely separate from any existing CATV service. If a VCTV subscriber also subscribes to CATV, two cables would enter that subscriber's home. One (cable A) would deliver CATV service, and the other (cable B) would deliver one or both of the VCTV services (see Figure 2). Basic and premium CATV services are not affected by this trial.

Overall Service Distribution. The VCTV subscriber community is partitioned into two separate VCTV service areas, Cell One and Cell Two, each containing 150 homes and served by its own 77-channel coaxial cable. Both cells are identical from an architectural perspective. The VCTV service for each of the two cells is carried from the VCTV building on three strands of single-mode fiber-optic cable. Two of the fibers carry the video channels and downstream signaling. The third fiber carries two upstream signaling channels. At a remote pedestal near each of the subscriber cells, Laser Link II equipment converts the optical signals to electrical signals, which are carried into subscribers' homes by coaxial cable (cable B). (Laser Link II, developed by AT&T Bell Laboratories, is a trademark of Anixter Cable TV.) This configuration supplies each cell with 77 channels of downstream video and audio, consisting of 24 channels of Hits at Home service, 6 promotional channels, and 47 channels of Take One service. The video content of all Hits at Home service and promotional channels is identical in both cells, but the video content of the 47 Take One channels differs from cell to cell. This permits each cell of 150 subscribers to have its own group of 47 Take One service channels.

VSS Hardware. An entirely new headend control platform and new subscriber set-top converters were developed to deliver VCTV services. The platform, which we call the Video Source System (VSS), supports requirements for both enhanced pay-per-view (Hits at Home

service) and movies on demand (Take One service). Its five key components are:
- A computer control complex with three UNIX system processors connected over an Ethernet backbone. (UNIX is a registered trademark of UNIX System Laboratories, Inc.).
- A specially designed set of VCR controllers, each connected to UNIX system processors through a serial line. Each VCR controller, which controls a bank of eight videotape players, monitors their status, and recognizes Touch-Tone signals encoded on the videotapes for automatic tape identification.
- Video/audio source equipment, consisting of Super-Video Home System (S-VHS) VCRs, time-based correctors for frame synchronization, and stereo encoders.
- A radio-frequency (RF) component, consisting of a video scrambler feeding an RF modulator, which, in turn, feeds an RF combiner. The output of the combiner is then fed into Laser Link II transmitters.
- A bidirectional RF signaling capability for communicating with the set-top converter in each subscriber's home.

VSS Software. The software running in the UNIX system processor complex contains four major subsystems: an on-line multiresource reservation system, a process control subsystem, a CATV signaling subsystem, and a subscriber interface subsystem.

The *on-line multiresource reservation system* schedules all the facilities needed to deliver a movie (videotape, videotape player, RF channel, and converter channel). This subsystem includes automatic reservation backup and recovery mechanisms, as well as the necessary subscriber database, tape catalog, and billing system interfaces.

The *process control subsystem* operates the video players (using the VCR controllers) and directs the activity of the human attendants using video monitors

stationed around the facility. More than one attendant can load tapes, and normally no human action is required other than the simple insertion of the videotape into a player. To reduce the rate of operator error, a red light on each tape player indicates which players need to be loaded. Touch-Tone signals recorded on each tape can be used to automatically verify that the correct tape has been loaded. A system of audible alarms alerts the attendant to potential or existing problems.

The *CATV signaling subsystem* manages all communications with the set-top converters. Downstream messages are divided into two categories. Low-priority messages download on-screen menus, service profiles, and program schedules, and poll converters for enhanced pay-per-view information. High-priority messages carry responses to subscribers who are using their infrared (IR) remote controls to order movies, to interrupt or restart a movie, or to review or cancel their existing movie reservations. Upstream communications are transmitted on one of two RF channels. One upstream channel carries remote maintenance messages and polling for enhanced pay-per-view purchases and the other is reserved for Take One service subscriber requests. Error detection and automatic retry mechanisms are used to overcome the relatively high error rate on CATV signaling systems.

A subscriber can order movies or review or cancel previous orders using the *subscriber interface subsystem*.

These four subsystems are built on an infrastructure that allows processes running on any of the three UNIX system processors to communicate freely with one another, without regard to processor boundaries. This same infrastructure features automatic fault recovery and very low mean-time-to-repair. The goal of the system is to deliver highly reliable, problem-free service that will not color the subscriber's opinion of the service concept. Viewing a movie requires nearly two hours of subscriber involvement; system failures during this period can leave a lasting negative impression.

VCTV Premises-Based Equipment. The VCTV set-top converter consists of a pair of boxes. Box A looks like a current state-of-the-art CATV converter; Box B was designed specifically for this trial. Functionally, from the subscriber's perspective, these boxes act as one. They communicate over a serial link and together perform all functions of the original converter. They allow the

subscriber to lock out unwanted channels (parental control), preset a favorite channel or channels, and program future channel changes. In addition, these boxes provide on-screen menus, text overlays, and bidirectional signaling on cable B. They also receive the existing downstream signaling on cable A for downloading channel maps and service permissions needed to maintain all existing cable A (CATV) services uncorrupted.

Both the frequency and signal level of upstream signaling can be changed using software control. This permits the converter to switch between the two upstream signaling channels, depending on the type of message being sent.

The VCTV converter (Box B) is controlled by a microcontroller with 64K of read-only memory and 64K of battery-backed random access memory. The 12 × 24 character on-screen display sends information to subscribers. Characters can be displayed overlaying a portion of the video picture or on a color background.

The trial system's remote control device is an off-the-shelf, hand-held, IR controller with four buttons relabeled.

The VCTV architecture was designed and implemented to provide Hits at Home and Take One services to a few residences in a short time. It should not, therefore, be regarded as an example of how such services might eventually be delivered. The architecture of Take One service, in particular, is clearly not scalable to real-world, nontest environments. (For Hits at Home service, however, no such limitations exist.) Still, many of the lessons learned during this trial may provide valuable insights into the problems inherent in large-scale systems.

What's Next?

The aim of the VCTV test is to measure how consumers will use and react to Take One and Hits at Home services. We will generalize from these observations by metering all TV usage, conducting surveys both on site and nationally, and building analytical forecasting models, under various assumptions. The results of this study will enable us to estimate the potential national demand for services such as movies on demand and enhanced pay-per-view. If the findings reveal a high level of potential usage and revenue for movies on demand, commensurate with the cost of deployment, we will be more confident that there is a real opportunity for such a service.

The aim of this trial is to help define the video services of the next decade and, in particular, to receive a meaningful signal from the marketplace before we invest in its development. This represents a new paradigm, where assessment of market need is given equal weight with understanding technological feasibility and cost. It is a strategy that tries to reduce some of the risk in high-technology development, while simultaneously accelerating the rate of that development. We are confident that the VCTV trial will reap real benefits, not only in promoting our understanding of the evolving marketplace, but also in helping to define its products and services.

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