Chapter 3

Broadband Cable

The National Cable Television Association (NCTA) changed its name in 2001. After 49 years, what would motivate the NCTA to become the National Cable & Telecommunications Association? The industry association name change was a conscious decision intended to signal the beginning of a new era in which cable operators lay claim to being the broadband information services providers of choice for 21st-century homes and small businesses.

At the turn of the millennium there were just over 100 million American homes, about two-thirds of which had become subscribers to the multichannel video services of cable. While subscriber growth had greatly slowed, the number and types of services offered had not. Local and long-distance telephony and the Internet were services still associated with telephone companies. Only about two million U.S. households were equipped to receive high-speed Internet and other digital services via cable, but that number was about to dramatically increase.

Broadband modem growth in cabled households (the percentage of U.S. homes upgraded to digital, subscribing to the faster Internet and new digital services such as VoD, digital video recording [DVR], and HDTV) was up to 14.6 percent by the third quarter of 2003. This number compared favorably to the 6.7 percent of U.S. households connected to high-speed DSL lines. In 2008, the number of broadband households is expected to be approaching 45 percent; cable will represent 25 percent and DSL with 20 percent, according to Jupiter Research.25

The local cable companies that sprung up in the towns and cities of America during the 1960s and 1970s were almost all bought out over the following 20 years by an increasingly small number of

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MSOs. By the advent of the 21st century, the dominant cable players were AT&T Broadband, Time Warner Cable, Comcast Corp., Charter Communications, and Cox Communications. Each of these MSOs had three ambitions in common: (1) to open entirely new lines of business and to extend their reach; (2) to get behind the development of more powerful delivery technologies and the creation of new content; and (3) to capture a larger share of available advertising and consumer revenues.

The turn of the century represented a defining moment for cable in terms of structure and ownership. Industry leadership had basically been taken over from the outside by well-funded telecommunications, media, and Internet providers. Major investments in new technologies were planned with an eye to creating and delivering an unprecedented range of newly integrated services.

But the invaders from outside, specifically AT&T and AOL, did not do as well as had been hoped. The economy turned sour. Cable's once-grateful customers were proving to be much more demanding and fickle, cable investors were impatient for quick demonstrations of success, and the new technologies introduced to outdistance the telephone and satellite competition were not performing to expectation.

As it turns out, the ones pulling cable through the recession and into the new promised land of digital were not the hotshots from outside but the experienced cable hands.

What's Happening in Cable?

What follows are highlights touching on some of the more dramatic changes occurring in cable's corporate structure, technological platforms, and business applications?

MSO Consolidation
In the late 1990s AT&T Corp., the biggest name in telecommunications, strolled from outside to acquire the largest of the cable MSOs: Tele-Communications Inc. and MediaOne Group Inc. In early 2000 AOL, the world's largest provider of Internet access, proceeded to merge with Time Warner Inc., the world's largest media and entertainment company. By 2001 AOL Time Warner was the number two U.S. cable operator after AT&T.

The long-distance carrier AT&T was not just going for local telephony; nor was the Internet provider AOL just going for faster data delivery. The ultimate goal of each of their cable acquisitions was to offer on the broadband cable platform the fullest possible range of advanced information services, including digital television, high-speed Internet, and IP telephony from which entirely new lines of revenue could be expected to flow.

Huge prices were paid in gaining access to the U.S. cable households. In AT&T's 1998 acquisition of TCI, some $52 billion was paid for a system with 10.7 million subscribers. In 1999 Comcast Corp., an MSO with 6 million subscribers, worked out a deal to purchase MediaOne Group with only half as many subscribers for an estimated $60 billion. The Comcast deal lifted system prices from $2,300 to $4,000 per subscriber, nearly 20 times the cash flow. A year earlier, major system groups had been selling for 11 times the cash flow.

AT&T upped Comcast's negotiated purchase price for MediaOne in April 1999, agreeing to acquire MediaOne for an estimated $69.7 billion. The cost of acquiring a single subscriber in the AT&T deal was about $4,700, some 19 times the running-rate cash flow. For TCI, AT&T had paid an estimated 13 times the estimated cash flow, a 37 percent premium according to financial analyst Goldman, Sachs & Co. Upgrading these systems to accommodate Internet, telephony, and other interactive services was expected to add $1,000 or more per subscriber to the cost, quite near the prices that the telephone companies were spending for comparable capacity, interactivity, and speed, using xDSL technologies.

AT&T was quick to begin making deals with fellow MSOs. The company announced that it would spend some $2.6 billion equipping Time Warner and other cable lines for telephone service. Time Warner Cable, a system with 12 million subscribers, would pay AT&T $15 per home passed by the upgraded networks and a monthly fee of up to $6 for each customer signing up for phone
service. The deal gave AT&T a way to directly access some 20 million additional homes, achieving its goal of bypassing the last-mile monopolies of local Bell operating companies. That investment alone was big enough to get vendors such as Lucent Technologies and Scientific Atlanta mass-producing next-generation cable equipment at substantially lower prices.

Time Warner agreed to be acquired by AOL in a deal valued at $183 billion in January 2000, and began the new millennium under new management. The Dulles, Virginia–based AOL had a market value of about $164 billion boasting some 20 million subscribers in 15 countries. New York City–based Time Warner’s market value was pegged at $97 billion. Through Time Warner–programmed outlets an estimated 1 billion people had access to CNN, 35 million had access to HBO, and some 120 million readers subscribed to the company’s magazines. The challenge the new media company faced was to pull together the Internet, TV distribution, and content-generation businesses in a way that would show short-term gains knowing that the real revenue payoffs from consolidation were at least a decade away.

By the time the deal was finalized a year later in a soft economy, the merger of AOL and Time Warner was worth $128 billion. To address further declines in the value of its stock, AOL Time Warner wrote off $54 billion in the second quarter, then another $45 billion in the fourth quarter 2002, and proceeded to once again reshuffle its management team.

Though disruptive, these outsider takeovers were initially welcomed. The AOL and AT&T investments were seen as bold votes of confidence in the future of the cable business. Cable properties were acknowledged to be valuable and cable stocks rose. The technical feasibility of the broadband platform was taken seriously. For MSOs, an old vision was renewed. Cable could offer a bundle of services (in this case local and long-distance telephony, high-speed Internet and transactional services, as well as the best of video) on a single broadband pipe to the home. With broadcasters basically out of the distribution picture, last-mile control of the multimedia services customer would default to cable, and operators could foresee getting a cut of every product and service delivered.

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Cable had several advantages, the biggest of which was that cable lines were already in place in two-thirds of all U.S. homes. Unlike the telephone companies, cable had never been just a common carrier for other people’s services nor did it face the regulatory constraints of the telcos. The dominant U.S.–based cable operators were already vertically integrated with some of the world’s most prolific creators of popular content. Cable had no experience with telephony or data, and very little with engaging interactive services, but it had a lot of experience with television. Cable MSOs owned and had access to the types of video programming that the viewing public liked and were confident that they had the capability to create whatever else their subscribers might want.

The cable industry applauded when AT&T executives spoke of the cable reaching 100 percent of American homes, providing easy access to local and long-distance telephony and Internet services. AT&T’s size and seemingly endless capital was perhaps what was needed to get cable’s stagnating core video businesses going again, thus better positioning the whole industry for the future.

Unfortunately, the super-test model quickly foundered. AT&T found itself in trouble with its acquisitions, with the government, and with the public itself. Running a cable company was not like running a telephone company. The properties AT&T had bought were spread out all over the country, not at all well linked to each other. Many were technically in poorer shape than AT&T had been led to believe. Both TCI and MediaOne had extensive other investments and other commitments, both domestically and internationally. Sorting all of this out was not easy, nor did all the cross-ownership issues make the FCC and Department of Justice approvals easier.

The first of AT&T’s unhappy surprises came from competing ISPs wanting access to its broadband networks. Prior to AT&T’s arrival, TCI, Time Warner, MediaOne, and other MSOs had made substantial investments in two ISPs, @Home and Road Runner. When cable subscribers learned they would need to drop their AOL and other ISP memberships, or pay extra if they expected to benefit from the newly upgraded high-speed lines, they were upset and complained to the local franchise authorities. These authorities
one after another threatened not to transfer the TCI and MediaOne licenses to AT&T so long as its systems remained closed to competing ISPs.

AT&T was ultimately forced to back away from a firm public position that it would not for business reasons and could not for technical reasons consider opening its broadband lines to competitors. The regulatory mess in which the company found itself over “open access” was only the first of several issues making clear that AT&T overestimated the ease with which it could march into last-mile markets and capture a dominant share of the cable, telephony, and Internet business.

By mid-year 2000 AT&T’s stock had hit new lows on reports that it was having “execution problems.” A year later, with the national economy in serious decline, AT&T was putting cable upgrades on hold, laying off workers, shedding assets, and radically reworking its business plan. In 2002 AT&T Broadband was acquired by the third-largest cable MSO Comcast Corp. for $54 billion, giving Comcast control over one in every five TV homes (21 million subscribers), and putting AT&T out of the cable business.26

Meanwhile, the FCC, under a Democratic administration first and then under the Republicans, was treading water trying to figure out whether it liked the AT&T and AOL Time Warner deals or not. The Democratic-appointed FCC chairman William Kennard had been counting on cable giving the telephone companies their first real competition in the local loop, thinking that AT&T was a company with sufficient resources and expertise to take on the Baby Bells.

At the same time, Kennard and many in Congress were worried about consolidation implications. AT&T’s acquisitions had put it in violation of the FCC rule that said no one cable company could serve more than 30 percent of U.S. cable subscribers. Predictably, telcos Bell Atlantic and SBC Communications were each protesting that AT&T’s merger with MediaOne violated cable ownership rules designed to protect consumers from cable monopolies.

Republicans were presumed to be more favorably inclined toward unfettered markets, resulting in a hands-off approach to corporate mergers and acquisitions. The new FCC chair Michael Powell was of this disposition. But cable found little regulatory relief from Congress under the Bush administration, many of whose leaders had strong ties to the incumbent telephone players.

New Content and Services

ABC, CBS, Fox, and NBC all entered the cable business as a way to diversify beyond their broadcast businesses. The commercial broadcast networks were scrambling to reverse the declines they were experiencing in audience share. Even at the risk of creating increased competition for their local station affiliates, new program formats on cable distribution platforms seemed a logical solution for network broadcasters in dealing with the cable threat.

NBC programs two of the highest rated cable channels, CNBC and MSNBC, with CNBC.com and MSNBC.com proving to be popular on-line services. CNBC is NBC’s 24-hour cable TV channel for business news, founded in 1995, reaching some 84 million U.S. homes. MSNBC is a cable TV and on-line news venture managed jointly with Microsoft Corp., pulling some 73 million subscribers. NBC added the arts and entertainment channel Bravo and Spanish language entertainment channel Telemundo in 2003 acquisitions. Although its on-line services are struggling to break even, the cable networks contribute to NBC’s profitability.

In a spectacular boost to its cable programming, NBC secured advanced TV rights to the Olympic Games for 2010 and 2012. NBC had already acquired the U.S. media rights through 2008. Under the new contracts, NBC gets rights to broadband Internet, VoD, and multimedia channel distribution. NBC’s plans are to mount a bilingual multipurpose TV coverage on its national network, MSNBC, and CNBC and on Telemundo.27


E.W. Scripps Co., a Cincinnati, Ohio–based group owner of TV stations, newspapers, and magazines, is also an aggressive programmer of content for cable distribution. Scripps had sold its cable plant to Comcast in 1996, but soon introduced a series of highly successful cable networks, including Home and Garden TV, Food Network, and the interactive Do It Yourself (DIY) channel, leveraging the brands and marketing power of Scripps newspapers and TV stations. While others were struggling to overcome a depressed advertising market, ad sales at Scripps cable networks for 2003–2004 were showing healthy growth.

The number of programs and the variety of services that cable operators are able to deliver has been greatly increased. This is the result of new program services, newly upgraded cable plants, and the fact that digital compression technologies have upped the carrying capacity of cable lines by a factor of 10 or more.

Cable's Competition
In Columbus, Ohio, Ameritech New Media (ANM) was going door-to-door in 1998 trying to woo away subscribers of Time Warner Cable and Coaxial Communications (now Insight Communications Co.), two well-established cable incumbents. Incentives given for switching over to the new telco-turned–cable provider were a consolidated telephone and cable bill, a free installation of the 108 channel American cable service, a fee first month of service, a handful of pay-per-view movie coupons (regularly $2.95 rather than the $3.95 charged by Time Warner Cable and Coaxial), and $60 in free groceries from Krogers.

Ameritech Corp. was the regional Bell operating company for the Midwestern part of the United States, which included Columbus, Ohio. Ameritech was one of the few Baby Bells seizing the opportunity provided in the 1996 Telecom Act to challenge the local cable monopolies in video. With over 100 franchises in hand in 2000, Ameritech New Media was overbuilding some of the cable industry's most profitable operators in Ohio, Michigan, and Illinois using all-new hybrid fiber/coaxial cable facilities.

With penetration up to 15 percent in areas where it was overbuilding incumbent cable operators, and Ameritech New Media's surveys indicating that up to 95 percent of cable subscribers would welcome competition in their local markets, subscribers, and regulators alike were stunned in 1999 when parent company Ameritech Corp. was sold to San Antonio, Texas–based SBC Communications. SBC promptly spun off Ameritech's cable assets to concentrate on local and long-distance telephony, high-speed Internet, and DSL data services in the Ameritech New Media region.

It didn't take long for the telcos to recognize that they had to be in video, however. Qwest Communication made major investments in VDSL (digital copper) for the explicit purpose of competing with the cable companies in video as well as high-speed data services. BellSouth, SBC, and Verizon, who each announced new initiatives to lay fiber-to-the-home beginning in 2003, were taking a second look at movies and cable-type programming as a way to attract and make customers stick to their bundle of services. At the 2003 U.S. Telecom Association conference in Las Vegas there was much discussion of video as "the killer app that will drive broadband adoption."28

Cable overbuilders have appeared in numerous U.S. markets. Privately held WideOpenWest LLC, the new "competitive broadband service provider" acquiring the Ameritech properties in May 2001, had already earned cable licenses in the high-density areas of Portland, Oregon; Seattle, Washington; St. Louis, Missouri; Minneapolis–St. Paul, Minnesota; Denver, Colorado; and Dallas, Texas, all areas in which AT&T Broadband was the incumbent franchise holder. Given the opportunity to vote on allowing WideOpenWest to offer cable, Internet access, and voice services in the region, residents in Denver and Boulder, Colorado, approved the measure by margins of 76-plus percent. Consumers were impressed that WideOpenWest agreed to open its systems to outside ISPs, something AT&T had been reluctant to do.

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With the utility industry's deregulation resulting in consumers being given the option of purchasing their electricity and gas elsewhere, these powerful organizations have begun to search around for the types of business in which they should be. One of the options turns out to be media and communications. Why? The utilities have an in-place infrastructure that reaches every urban and rural home and business. Many of these companies have installed fiber-optic communications lines between substations that can also be used to link cable operations.

An example is Seren Innovations Inc., a subsidiary of one of the largest investor-owned electrical and natural gas utilities in the United States. Xcel Energy Inc., formerly Northern States Power Company, expanded its business to include cable television. Seren received authorization in May 1999 to offer competitive cable, local, long-distance telephony, and Internet access services over an 860 MHz hybrid/fiber coaxial cable system in Walnut Creek and Concord, California, two of San Francisco's East Bay communities being served by AT&T Broadband. These affluent bedroom communities, with well-educated residents and computer penetration rates above 70 percent, were seen as lucrative markets for competitive broadband communication services.

Seren was already operating as a cable overbuilder in its home territory in Minnesota, where Bresnan Communications, Time Warner Cable, and AT&T Broadband were incumbent franchise holders. With penetration rates reaching as high as 30 percent, Seren's high-capacity two-way fiber-intensive networks for offering residential and small business telecommunications and multichannel video services were providing cable's first terrestrial competition.

Broadband Technologies

Time Warner has been a historic innovator in cable technologies. Time Warner Cable was the second-largest cable company in the United States in 1994, at the time it launched its interactive TV tests using advanced digital technologies in 4,000 Orlando, Florida, homes.

Interactive telecommunications services in various forms have been tried over many years with little commercial success. Pursuit of the dream that the big pipelines bringing cable TV into American homes, properly upgraded and reconfigured for two-way communications, can be used to support much more than passive entertainment has absorbed much effort and many dollars.

Cable marketers have long claimed that, given a convenient and economical way to do it, home subscribers will want to use their TVs and PCs to interact with a host of affiliated service providers. With the advent of the Internet and two-way TV, they say, shopping, banking, ordering movies, playing interactive games, sending e-mail, and browsing through digital libraries can be expected to become a daily occurrence for cable customers. The new broadband cable pipelines can be expected to drive thousands of "absolutely must have" interactive applications, thereby boosting per subscriber revenues.

When Time Warner Cable closed down its full-service network in Orlando, Florida, in 1997, the company was not very forthcoming about the results of the experiment and some critics deemed it a failure. Although Time Warner was thought to have spent as much as $100 million on the effort (the exact figure is not publicly known), the executives claimed the trial a technical success. If Time Warner ever expected to roll out two-way cable services, doing a real test was the only way it could gain the engineering and marketing experience it would need. A closer look at the elements of Time Warner Cable's full-service network trial will help in understanding the early perception of what was required to manage such a system at the cable head-end, at the consumer premise, and in the distribution system.

The Time Warner test specified a distribution architecture based on hybrid fiber/coax (HFC), which means that high-capacity fiber-optic lines are used to bring programming from the cable head end into the neighborhood of the user. The head end is the cable operator's central office. From a neighborhood node or connection point, coaxial copper cables are used to carry the programming the rest of the way into the home (see Figure 3.1). In Orlando, Time Warner Cable located powerful AT&T (Lucent Technologies)
ATM switches and Silicon Graphics Inc. (SGI) video servers in the head end and a special set-top box in each home. ATM is a way of managing voice and data as well as video on formerly video-only cable channels. The set-top box was basically a SGI computer workstation programmed to manage two-way services at the TV set, with interconnections to the PC.

In the first phase of the test, TWC sought to learn “best practices” for converting analog video and audio information into digital data and manage this information interactively. Video was broadcast downstream from the cable head end, scrambled, encrypted, and compressed (using MPEG-2 video digital compression) for pay-per-view and near-VoD program services. IP data was switched over the same lines being used for video, and software was developed enabling the set-top terminals to provide home viewers with Internet and World Wide Web access through their TV sets as well as through the PC. High-capacity Ethernet interfaces interconnected the set-top boxes to PC and other external devices. Infrared (wireless) remote controls, including the keyboard in some cases, addressed the set-top box.

The second phase called for an increase in system and set-top capabilities to support a wider range of interactive applications. Digital servers as well as enhanced management support systems were installed in the Orlando head end. The Time Warner Cable guidelines specified that “in no case can the addition of a new application or service require a modification to the underlying system or network in order to support it.” This was a major order given the rapid changes in system and network technologies at the time, and in prospective applications. Lack of established standards and the overly high cost of hardware and software helped to bring the trial to an end.

In the Orlando experiment, installing optical fiber from the head end to the home and the $7,000 Silicon Graphics computer that Time Warner Cable had sitting on top of every TV set in the system pushed the per household cost to above $10,000. This was a long way from the estimated $1,000 per subscriber upgrade cost thought to be financially acceptable to operators.

What follows are explanations and descriptions of what will likely be needed in the way of supporting infrastructure as well as acceptable cost for broadband interactive cable to be widely rolled out by service providers and adopted by consumers.

**Early Cable**

Basic configuration for a traditional cable TV system is a tree-and-branch architecture, in which a main distribution line travels from the head end deep into its service area. The main line is a high-capacity copper line called coaxial cable. Feeder and drop lines, which are also made of copper, branch off the main trunk to serve individual households. Early systems typically offered from 25 to 50 channels of programming, each channel providing the same 6 MHz bandwidth assigned to broadcast TV. Cable traffic was analog audio and NTSC (525 scanning lines of resolution) video traveling in one direction, from source to destination. All subscribers received the same basic programming.

In the larger cable systems, operators were required to make available to the community one or more public access channels as a condition of their franchises, and the over-the-air channels of local broadcasters were usually among the mix of programs carried as negotiated or required by law. The bulk of the operators’ programming came from cable networks such as TBS, ESPN, and HBO from outside the region via satellite.

To the great satisfaction of the majority of subscribers, the cable industry served American homes well as multichannel aggregators and retransmitters of popular information and entertainment programming, and the business proved to be profitable. Cable was predominantly an urban medium. Services were targeted to those subscribers who wanted increased viewing options and could afford the monthly subscription fees. Where available, the cable schedule provided a range of viewer services that neither the terrestrial broadcasters nor any other information provider could match. And because of their exclusive licenses, they were able to operate as monopoly providers to these communities.

Interactive television, in which video and audio travel upstream as well as down, was—and still largely is—an unfulfilled dream
because interactivity requires of cable systems a very costly and
differently configured distribution architecture.

**Hybrid Fiber/Coax**

To increase the number of channels and augment the types of
communications services made available, cable engineers began
expanding cable plant capabilities by linking fiber-optic lines into
copper cable. These reconfigured structures are commonly called
hybrid fiber/coax (HFC) systems (see Figure 3.1).

![Figure 3.1: Hybrid Fiber/Coax Configuration](image)

Fiber optics is the transmitting of information as light (photons)
along flexible glass fibers. Optical fiber offers cable an efficient way
of delivering high-quality signals between head ends and designated
points within the service area without frequent repeaters. Until
now, the cost of running fiber lines directly to the home TV set has
been thought to be too expensive to justify based on current
applications. Fiber’s most promising contribution in cable is its
huge bandwidth (and need for many fewer signal amplifiers) for
delivering multiple video and data services over a very limited
number of fiber strands, each hardly as wide as a human hair.

Beginning in the 1980s, such fibers were installed by telcos and
cable companies as a high-performance replacement for their
copper trunk lines. Then operators began extending these fiber-
optic lines deeper and deeper into the local service areas where they
were terminated at an optical node, or interconnection point,
somewhere short of the individual residence. By increasing the
number of nodes and reducing the number of residences served by
each node, cable operators found they could greatly improve signal
quality in their systems and increase capacity. This linking of fiber
and coaxial cables in the last mile became a popular configuration
among cable operators and was a big step forward in the hoped-for
conversion to digital delivery.

Because of the cost-savings, in-place copper was retained as the
principal way to carry the cable signals into and out of homes. The
big cost in fiber optics was not in the fiber itself but in the opto-
electronic conversion equipment that went with it. Engineers
recommended moving back from fiber to the home (FTTH)
because the translation of optical to electrical signals and the
provision of electrical power on photon-based fiber lines were too
costly on a per-home basis. The large size of early optical
components, their poor performance and lack of reliability, and
their complexity in installation and repair were also constraints.

By the end of the 20th century, a different model was being tried,
driven largely by the pressure on cable MSOs to improve network
performance while keeping costs down. In Salt Lake City, Utah,
AT&T engineers began tests on an HFC design that extended fiber
close enough to individual users that line amplifiers on the coax
network could be eliminated altogether. Instead of 600 or so
households being served from a single fiber node, as was the case
in many existing HFC cable architectures, the number was reduced
to less than 100.

Installation of “mini-fiber nodes” made multiple efficiencies
possible. This configuration greatly reduced the maintenance
needed to keep amplifiers properly tuned and, because of the
shorter coaxial distances, lower powering costs resulted. With new
DWDM (optical multiplexing) technologies, a single fiber strand
could serve more than one node. Free’d-up bandwidth on the
unamplified coax could add as much as 250 MHz to 750 MHz
systems, upgrading 120 channel systems to 160.

Another technological breakthrough was the integration of the
electrical and optical operating components of cable architectures at
the chip level. Complex optical circuits on silicon chips that could be
both dynamic and scalable in switching telecommunications traffic
were being mass-produced. Installation of such chips increased the
speed and reduced the cost of transmission.

Dynamic in this case meant that optical to electrical to optical
conversions could be made on the fly, in real time, and without
awkward delays. Scalable meant that these new signal processors
would be able to flexibly adjust the allocations of digital bit streams to the requirements of specific applications—for example, a smaller number of bits allocated to e-mail, a greater quantity of bits to HDTV.

In some cases, as with Western Integrated Networks' 2001 overbuild of AT&T Broadband in Sacramento, California, coaxial cable was being used to deliver the video services and FTTH was installed for high-speed data and telephone services. Western Integrated Networks assumed its growth services would come from telecommunications, which would justify the cost.

As voice, data, and video applications are added to cable lines, all signals tend to degrade. By consigning video to its own coaxial wire, incremental video services can be added without slowing the data traffic. With Internet and phone services traveling over their own fibers, more bandwidth is freed for data and voice services.

**Digital Conversions**

Running parallel to the innovations in fiber optics that are so rapidly advancing cable system capabilities are advances in digital data compression. Digital compression algorithms have increased by a factor of 10 the quantities of data that telecom networks, both wireline and wireless, are able to carry, and these technologies are said to be still in their infancy. Digitization has doubled or quadrupled the number of programs that a 120-channel cable system can cast down the line, with capacity left over for variable rate return signals traveling from home to the head end.

Using HDSL loops, dropping cable into the homes on the existing coaxial copper of cable has been shown to have a potential transmission bandwidth of one gigahertz (GHz). One GHz capacity represents about 166 video channels uncompressed. With digital compression, capacity can be from 2 to 10 times that. Thus cable TV operators wishing to offer interactive services can afford to think of modifying their cable plant to handle bidirectional information flow. Still, return amplifiers and diplexers (bandsplitting filters) must be added, controllers installed at the head end, and special boxes installed at the subscriber’s premises to separate upstream from downstream traffic.

AT&T Broadband tested a new return-path technique pioneered by Scientific Atlanta Inc. to be used in HFC installations. The approach, intended to increase overall system efficiency, streamlined transmission from the neighborhood nodes back to the head end. Coaxial return traffic was aggregated and converted at local hubs and sped back to the head end, using digital lasers that forwarded the information in uncompressed format on a single fiber strand.

The greater number of residential applications involving two-way data flow will be asymmetric and asynchronous. Asymmetrical in this case means that the few packets of digital information an Internet user sends upstream in search of a Web site will be modest in number compared to the deluge of digital data that must come back when the Web site is downloaded to the home. Asynchronous means that the originator and the receiver of the communication are not on-line at the same time, as with the posting of a message that can be read and responded to at some later time. For the teleworker doing work from home, occasional rather than continuous uploading of files will be the norm. Managing the unequal flow of information traveling up and down the line is one of the technical challenges that cable modems are designed to solve.

**Cable Modems**

As with dial-up and DSL telephony systems, cable operators use special modems to connect their customers to the Internet. The cable modem (see Figure 3.2) is an on-premises device allowing computers to be connected into the same broadband cable that feeds the TV set. Using a signal splitter, the coaxial cable hosts the modem on the PC side of the connection by way of an Ethernet card. The downstream Internet information is carried on either side of the regular television transmission. The digital format, using an information management protocol such as ATM, allows voice, video, and data to be treated as a single stream.
The cable modem business is a huge market for the computer and consumer electronics industries. A big concern has been that this market will evolve into camps supporting separate and incompatible standards, as was the case with international TV line standards, camera/VCR formats, and Macintosh, DOS, Unix, and other platforms that so fragmented the television and the computer industries. Cable operators, as well as consumer groups, also worry about obsolescence and the proprietary nature of the equipment they must buy. More open system architectures are being sought by industry associations.

“We don’t want any proprietary islands like with the Mac and PC,” CableLabs president Richard Green announced in 1996. That was the year Cable Television Laboratories Inc., the R&D arm of the cable companies, joined with the Society of Cable Television Engineers, the Broadband PC Council of the Interactive Television Association, the Digital Audio-Visual Council (DAVIC), the American National Standards Institute, and others to arrive at compatible modem and set-top box standards. “Our objective is to have a modem that will work on any cable system and any PC,” he said.29

By the turn of the century, CableLabs had scrutinizing some 40 cable modem and cable modem termination systems submitted for certification under its version 1.0 Data Over Cable Service Interface Specification (DOCSIS). DOCSIS—certified modems are those that have passed tests ensuring that they are interoperable with system hardware and software made by different vendors. These standards were seen as necessary for the cable industry to conform to FCC guidelines that cable customers be able to purchase cable set-top boxes at retail stores.

CableLabs went further to develop quality of service (QoS) standards that made it possible for operators to better manage and allocate available bandwidth. Rapid growth in cable modem usage has led to frequent traffic jams resulting in Internet access on cable’s shared networks being no faster than dial-up. Without the

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ability to prioritize usage, some functions won't work properly for lack of bandwidth. Video streaming, conferencing, and voice over Internet (VoIP) are examples of bandwidth-intensive applications.

**Set-Top Boxes**

Another preoccupation of CableLabs has been to shepherd the creation and rollout of advanced digital set-top boxes, and TV sets that have set-tops built in. Largely because of the rapid evolution (and obsolescence) of information processing technologies and difficulties gaining consensus over what should go into the box, the effort has not gone well.

Cable boxes (see Figure 3.3) are intended to provide a convergence gateway for video, audio, telephony, Internet, and other signals traveling into and out of the home. Some cable systems use the fully loaded boxes, with the memory and management capabilities of advanced PCs housed inside; others use the “thin-client” boxes, in which the intelligence and the instruction resides in the interconnected network. Both approaches are being sold; some MSO’s are buying both.

![Set-Top Box](image)

*Figure 3.3: Set-Top Box (Scientific Atlanta Inc.)*

It may take until the end of the decade before wide installation and effective use are established. The OpenCable specifications created and branded by CableLabs are intended to ensure compatibility and uniformity of standards in the industry’s transition to digital. The extent to which this will happen given the disparate approaches remains to be seen.

Most cable boxes offer some form of interactive program guide (IPR), allowing viewers to search out content and services and order items of interest. Newer generations of set-tops serve as digital video recorders (DVRs) functioning both as a receiver of broadband cable (or satellite) signals and a recorder of programming. Some boxes allow full Internet capabilities, including the ability to record streaming video. Others offer viewers the option of impulse buying. What is not clear is whether these features will be as add-ons that consumers can bring home and plug in or whether the boxes will simply get more and more sophisticated with greater processing power, memory, and a hard drive built in.

What the OpenCable standards propose is that customers who buy their set-top boxes retail, or lease them from cable companies, will be able to move them from one system to the other and make them work simply by reprogramming them with a specially configured smart card or software download from the network. If the standards-setting process works, cable set-top boxes will be compliant with whatever formats are agreed to for IPR functionality, digital television reception, IP—telephony, multimedia streaming, and interactive applications.

All this is just for starters, however. The challenges not yet addressed lie ahead in deciding whether (and how) to make cable set-tops compatible with the in-coming digital signals of competing telephone, wireless cable, satellite, and Internet service providers, something for which users are already asking.

**Broadband Business**

The transition to the 21st century was characterized by massive consolidation of cable assets, business restructuring, and investment in new technologies. Cable business was very much focused on getting the physical plant converted to digital and figuring out what the profitable applications will be.

Digitization meant that operators would get a lot more capacity and performance flexibility from their systems. Of greatest consequence were the opportunities digital technologies made available for giving subscribers more of what they want.
The Broadband Millennium

The idea of making cable television interactive is not recent. The early Warner-Amex experiments with an interactive cable system called Qube in Columbus, Ohio, began in 1977. As a bargaining point in cable franchise negotiations, the MSO set aside 10 special channels for "enhanced" services. Using a handheld touchpad and a set-top box, Qube subscribers were able to participate in voter polls, respond to questions posed by local politicians, call plays in high-school football games, and interact with teachers at interconnected schools. The return signals were to a bank of computers in the cable head-end; tallied scores were displayed on home TV sets. Home security was also a feature in which burglar and fire alarms were connected via the cable system back to the cable head-end. Qube folded in 1984 due to the considerable expense and insufficient viewer interest.

Throughout the 1980s, cable operators didn't have the capital, technology, experience, or sufficient incentive to work at converting their one-way systems to two-way. In the early 1990s, the technologies for interactivity began to look more promising but operators were skeptical. Would content and service providers be there with compelling applications at roll out? Would subscribers see sufficient reason to purchase either the required technologies or the services if they were made available? Nobody was really sure.

The idea that cable operators might get into voice and data as a complement to their core video services arrived with government deregulation of telecommunications. But who within the cable industry knew the first thing about telephony or the Internet? Upgrading cable lines to carry phone conversations and interactive multimedia could cost billions of up-front dollars. For cable operators used to living on slim margins this did not seem doable. In 1996 the potential cost of installing hybrid fiber-coaxial cable and interactive capabilities in American cable systems was estimated to be as much as $25 billion, roughly equivalent to the industry’s entire annual revenues. Where was the revenue growth to come from to justify these investments?

By the time of the NCTA's annual convention in 1998, the cable industry had grown more confident of its prospects. Wall Street and banking executives were acknowledging that cable's base business was a secure business. Even if new revenues didn't materialize from the rollout of digital cable, high-speed Internet access, and cable telephony, the industry was on solid financial footing as a multichannel provider of video services. Unlike broadcasters, cable's video packages benefited from a dual revenue stream: advertising and monthly subscriptions.

Operators were tackling the upcoming challenges of transmitting digital television (DTV) and negotiating with broadcasters and the government over "must-carry" rules. Broadcasters were insisting that cable providers be required to pick up and carry on their systems all the local over-the-air channels, both analog and digital. Cable operators found the requirement unreasonable, but there were reasons why some of these demands were acceptable. Local carriage was increasingly perceived as a cable competitive advantage over DBS satellite services and conversion to digital was something they were going to do anyway.

Cable operators were especially happy about the quality of their program offerings. Audience ratings confirmed their competitiveness with some of the best the broadcast networks had to offer. Viewership had never been higher. For the first time ever, viewership ratings of the more popular cable programs ranked with those of broadcasters.

A year later, the 1999 NCTA Chicago convention was focused on the "Broadband Millennium" ahead. Cable wasn't just cable any more. Panels and workshops focused on how to make interactive television, high-speed data, and cable telephony work without neglecting cable's core video business. The media described the convention as "a coming-out party for Michael Armstrong," the former Motorola executive who had taken the reins at AT&T Inc. and led it into the cable camp. In 1999 AT&T had become the NCTA’s biggest member. The high-profile entrepreneurs and executives generally credited with building and defining the industry, such as TCI's John Malone and Ted Turner of Turner Broadcasting, had stepped into the background.

By May 2000, on the occasion of the 49th annual NCTA convention in New Orleans, the cable guys were positively
euphoric. “The cable industry is no longer capital-constrained,” the new NCTA president Robert Sachs reported. “We've seen investments by Microsoft and Comcast and AT&T with its acquisition of TCI and MediaOne, Paul Allen with Charter and now AOL with Time Warner.” Sachs was predicting that high-speed broadband service via cable would reach 3.6 million homes by the end of the year.

Third-ranked cable operator Comcast Communications had upgraded 85 percent of its cable systems and was ready to deliver advanced digital TV signals. With the help of a $1 billion investment from Microsoft Corp., Comcast began the year with 500,000 digital set-top boxes installed. The company predicted that the number of installations would reach 1.5 million by year-end. “We're going to make over $100 million more of incremental cash flow this year because of digital set-top boxes than we would have if they didn't exist,” Comcast president Steve Burke told Electronic Media. “We'll double or triple (the number of high-speed Internet subscribers) to 300,000 to 400,000 by the end of this year. At $40 per month, that's a $175 million revenue business.”

In 2001 (the year the NCTA changed its name), the convention was back in Chicago with the theme “We're making broadband happen.” Attendance at the industry's 50th anniversary meeting was off 20 percent and there was an embarrassing amount of unused space on the exhibit floor, largely due to the dramatic slowdown in the national economy and the loss of many dot-com and technology players. Much talk centered on competition from satellite and overcoming barriers to widespread deployment of VoD, which the cable executives saw as their new “killer application.”

Time Warner, Cox, Comcast, and AT&T reported on Hollywood studio reluctance to enter into licensing agreements for VoD because moviemakers did not want to hurt their home-video profits, and worries about possible piracy of digital signals. VoD rollout was still limited to a few test markets. Everyone was aware that broadband champion AT&T had greatly scaled back its deployment of advanced set-tops, citing consumer unwillingness to pay for the advanced features offered. The threat that VoD and the new DVR applications posed to the industry's traditional advertising model was evident.

By the time of the 2003 NCTA annual conference, the cable business was showing some optimism, seeing stock prices turn around (from 40-plus percent declines in 2001 and 2002), broadband offerings were being well received by consumers and advertising revenues were improving. Competition from satellite and declines in basic subscribers were concerns. Investors were still worried about the true valuations and revenue potential of cable properties. Bundled services seemed the way to go.

Cable Industry Mergers and Affiliations

Something cable people have learned very well is the skill of partnering with others to gain access to the technologies, the economic resources, and the programming they need to make their business work. As content aggregators and multichannel content and services redistributors, cable operators very early were working closely with the satellite industry, with local and network broadcasters, and with the program production community.

In the early days, cable operators had little opportunity or reason to be involved with the telephony sector or with the IT industry, either as collaborators or as competitors. Those opportunities presented themselves in the 1990s and loom large on the new millennium agenda of many cable companies.

To realize how important outside partnerships have been in the recent history of cable, and to foreshadow their importance for the future, one only need note that the keynote speaker at the NCTA 1998 annual convention was Microsoft Corp. chairman Bill Gates and five years later Gates was on the podium again. Sharing the spotlight at the 2003 NCTA National Show was Comcast Corporation CEO Brian Roberts, AOL Time Warner CEO Richard Parsons, and Viacom CEO Mel Karmazin.

The connection to Silicon Valley was pivotal for cable. The cable industry needed help making its transition to digital, widely perceived to be the basis for its future economic growth. Seeing cable as an in-place gateway into the home and an enormous market for its products and services, the computer industry began investing money as well as technology and technological expertise in the broadband cable platform.

Microsoft Corp.
As early as 1993, Bill Gates was promoting an expensive and ultimately aborted management system tied to VoD trials being undertaken by cable and telephone companies. Gates's hope was to shape the direction of these new services so that his Tiger video server and related software would be adopted by any and all providers seeking interactive access to homes.

Shortly thereafter, Gates launched an unsuccessful effort to buy Cable Network News (CNN), a major content innovator, before turning to the partnership with NBC that created MSNbc in 1996. In April 1997 Microsoft shelled out $425 million to purchase WebTV Networks, a company with a technology for allowing home TV viewers to access the World Wide Web via the TV set. In June 1997 Microsoft invested $1 billion in Comcast Corp., a progressive MSO with 4.3 million cable subscribers in major East Coast and Midwest markets.

Microsoft also held shares in @Home, the cable-based Internet service provider with ownership connections to TCI, Cox, and Cablevision Systems, and in QVC home shopping services. Gates's decision to partner with cable was motivated by his desire to see Microsoft operating systems and software installed in cable set-top boxes, but also he wanted more direct access to residential customers to further Microsoft's ambitions as content and services provider.

Gates said of the Comcast investment, "It's important to have one company that we have a very close relationship with that we can go out and do the pilot studies and really demonstrate what's possible here."

Gates was reportedly frustrated that the rapid development of personal computer chips and software had far outpaced cable's utilization of its high-capacity pipeline into U.S. homes.

When the 1999 MediaOne sale settled, Microsoft came up with a $5 billion stake in AT&T. Bill Gates had been playing both sides, offering to ally with Comcast to beat AT&T's bid while also negotiating with AT&T. In the end, Microsoft shifted its loyalties to AT&T. The deal gave Microsoft's Windows CE operating system access to twice the number of set-tops that it had under a previous agreement with TCI. By 2002, with smaller and smaller percentages of its revenues coming from sales of operating systems on PCs, Microsoft was turning its attention to investment in enhanced cable TV programming, video games, and Internet software and devices.

Vulcan Ventures
Bill Gates was not the only one from Microsoft making investments in cable. In 1998 Microsoft Corp. co-founder Paul Allen shelled out more than $7 billion to buy into the cable industry. In purchasing Marcus Cable Systems for $2.8 billion and Charter Communications Corp. for $4.5 billion, Allen became head of the seventh-largest MSO in the United States with 2.4 million subscribers in 22 states. The price paid was about 14 times projected 1999 cash flow, a premium even greater than the price paid by AT&T for Tele-Communications Inc.

Paul Allen raised Charter Communications Inc. rank to sixth, then fourth-largest MSO with the addition of at least six additional cable operations, for a total of 6.2 million subscribers in 2000. In addition, he took significant financial stakes in movie producer DreamWorks SKG, in the diversified media company USA Networks, in the women’s channel Oxygen Media, in the cable channel devoted to Internet and computer technologies ZD TV, in competitive LECs Alacatan Telecom and NorthPoint Communications, in cable overbuilder RCN Corp., in Internet retailer Priceline.com, in Internet portal Go2Net, and in broadband cable ISP High Speed Access Corp, assets valued in excess of $10 billion.

Paul Allen’s purchases were intended to provide outlets for distributing multimedia content directly to consumers’ homes, he said. The multimedia reference was interpreted by analysts to mean that Allen was looking to deliver more than traditional cable programming. In an interview with Electronic Media in 1998, Allen noted, “When you consider marrying technologies in new ways, you push the envelope. You ask yourself what wholly new applications, products, or services you can do. I’m trying to come up with those.”

The size of Allen’s investments and the speed with which those investments were made were indicators of his confidence in the future of the cable platform and his commitment to a cable strategy. Team leader Bill Savoy, president and CEO of Allen’s investment group Vulcan Ventures, told Electronic Media, “Cable is the best pipe into the home. High-speed cable modems have the speed these services need. We now have a seat at the table.”

By 2001 Charter’s subscriber numbers had risen to 6.9 million, of which about one million had digital cable installed. Operating cash flow growth of 29 percent was nearly triple the industry average, fueled by aggressive subscriber acquisition for both analog and digital services. The industry was encouraged to see that Charter received not only additional revenues but higher levels of cash flow per customer from digital. The trade press was noting that service wait times and installation times for digital cable modems were much less than for DSL. Customers were spending more time online, and they were taking the opportunity to purchase goods direct from home.

Charter Communications is now the third-largest cable operator in the United States with 6.7 million subscribers. But Paul Allen is struggling to keep his company intact. He saw a 75 percent drop in the share price of his Charter Communications stock in the first two quarters of 2002, estimated to have cost him $5.6 billion of the $7.2 billion he had invested from his personal fortune. Part of this was due to the presence of a federal probe for accounting irregularities. With debuts of $16 billion in 2003, Charter chose to shed a half million subscribers in “non-strategic markets.” Analysts were saying the company was poised to generate free cash flow in 2004.

Intel Corp.

Intel was the company that brought the first microprocessor to market in 1971. Thirty-three years later, Intel was a $122 billion company and one of the world’s largest chip-makers developing interfaces for various networked devices to be installed in residences and businesses.

Intel anticipated that makers of digital TV sets, videodisc players, audio systems, digital cameras, and personal computers would all begin to incorporate broadband interfaces into their products. By creating highly integrated, densely packed circuits, Intel has helped manufacturers of communications equipment to build smaller, more powerful, feature-rich systems at lower cost.

Using an IEEE standard as a base, Intel has developed software for intelligently allocating bandwidth on the new cable modem interfaces at speeds of up to 120 Mbps. These new modems are

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designed for plug-and-play, meaning that the products can be purchased at consumer electronics stores and users can install them without technical assistance.

Fortunately for users, the power of computer chips has gone up while their costs have gone down. First-generation microprocessors tend to cost $500 to $1,000 each, sometimes more. According to consumer electronics industry guidelines, to make future digital TVs, 500-channel cable boxes, video phones, and other communication appliances affordable, the cost of the processors inside need to be less than $100 apiece. Intel's widely adopted Pentium II desktop computer chip runs at speeds of up to 450 MHz; its 2001 release Pentium 4 processor operates at 1.7 GHz (1,700 MHz). Initial costs to computer manufacturers were high but decreased with volume.

The significance for cable is the higher processing performance that allows, for example, the Pentium 4 to display 3-D graphics as well as video. These chips are designed to bring the processing speeds of consumer devices up to the delivery speeds of broadband pipelines, which means that the cause of first- and last-mile slowdown need no longer be blamed on consumer terminals.

Although in 2000 Intel got buried in its move into the media services business, in which it spent some $200 million building facilities for streaming movies and facilitating company meetings and on-line training, it has made a rapid and successful transition into Internet computing. Intel acquired several dot-com companies and entered into a partnership with Real Networks developing an Internet-streaming codec (coder/decoder). Its R&D efforts moved to streaming media software development and to focus on technologies for interactive television and e-commerce. One of its R&D efforts has been to help ISPs personalize information on their shopping services. Excite@Home was an early client.

Excite@Home
An estimated 330 Internet start-ups failed in the economic downturn that heralded the first three years of the new millennium. Perhaps the most prominent of these failures was the largest of the broadband ISPs serving cable. The death of Excite@Home left stranded more than a third (3 million) of all residential broadband customers in the United States.

Promoted as the “new media network for the 21st century,” the 1999 merger of Web portal Excite and high-speed ISP @Home was to create the AOL of broadband. Instead, having gone through $9 billion in capital, Excite@Home Corp. closed its doors in December 2001 with a fight over assets valued at $307 million, the amount of AT&T’s bid for control of the bankrupt company.35

Excite@Home was a creation of MSOs Tele-Communications Inc., Comcast Corp., and Cox Communications. The company was to be the central point of AT&T’s Internet strategy when it acquired TCI. AT&T quickly bought out the shares of the other investors, leaving it with a 23 percent economic interest and a 78 percent voting stake. Excite proceeded to acquire content properties, such as greeting card company Blue Mountain Arts, for which it paid $780 million in October 1999, with the idea of evolving into a content distribution network. Through affiliations with other cable operators, the AT&T-controlled ISP was in position to sell a $40-a-month broadband connection to an estimated 59 million underserved households. In April 1999 Excite@Home’s value was pegged at $2.1 billion and its stock was selling at $91 per share.

The top U.S. Internet service provider at the time was AOL, but AOL’s customer base was still using dial-up telephones for access. After a brief but highly publicized legal battle to gain access to AT&T’s broadband lines as a competitor to Excite@Home, AOL changed strategy and began the process of acquiring a cable company of its own. Even with its 2001 acquisition of cable MSO Time Warner Inc. and its partnerships with DSL and satellite providers, AOL was still behind the curve in broadband access.

Excite@Home quickly ran into financial difficulties. Revenues were lower than expected, especially advertising revenues that supported the media side of its business, and the ISP was running out of cash. Parent company AT&T was forced to take a write-

down of $1.1 billion in the fourth quarter 2000 when the asset was said to exceed its book value. Again, in the first quarter 2001, AT&T took a charge of $740 million, downgrading the asset to $490 million based on the NASDAQ stock market listing at $4.32 per share.6

Finding the cable broadband rollout too slow, Excite@Home pursued agreements with DSL carrier Rhythms NetConnections Inc., to provide high-speed-data services in markets where AT&T did not have a cable presence. The deal expanded Excite@Home’s reach to a total footprint of 87.3 million homes nationwide.

While this partnership was a disaster for AT&T, it did illustrate the ways competition over broadband access will in the future be less about technologies and more about services. Enterprise and new media, cable, and telecommunications players can be expected to play the full orchestra of delivery systems. In some cases, cable will be the broadband solution; in others, DSL, wireless, or satellite will do the job.

Cable Industry Constraints

Some analysts say the problems of cable are overblown, that the future of cable looks quite promising given the voice, video, and data opportunities. Some analysts project 45 percent margins in high-speed data. Yet, there are still risks and multiple unknowns.

On the agenda of the NCTA and its members are worries about the escalating cost of programming, the still-cautious climate for investment, the pace of digital broadband infrastructure buildout, fair treatment on the part of the government concerning digital must-carry rules, Internet open access, and cable ownership, and there are ongoing concerns about customer loyalty and churn. These issues are highlighted in the following sections.

Economic Issues

Cable business strategies are rife with untested assumptions. One of the biggest assumptions is that cable’s best and brightest future lies just beyond the video business in communications and commerce.

Does it make sense that cable companies should transform themselves into “bit factories” for the Web business? Owners and operators had plenty of opportunity to raise this question in the first few years of the millennium. Since cable is a first-class delivery system for video, and since cable’s forays into dot-com enterprises brought them little more than trouble, operators are asking why cable should squander its unique asset streaming poor-quality sounds and images, and whether cable really has a future in local and long-distance telephony when CLECs have fallen to the earth struggling to survive on the margins of that business? Is it plausible to think that cable operators will be successful as competitive access providers for high-speed Internet, on-line transactional services, and electronic commerce when those businesses are far removed from cable operators’ areas of strength?

Long-term projections for the cable business peg industry growth at 8–10 percent compounded annual earnings growth, but who can be sure? The rollout of digital cable, high-speed Internet, and VoD services, which were intended to take the cable business beyond the old CATV broadcast model, have required higher start-up and transition costs, and these are technically complicated services to add on. Adoption rates have been as good as or better than anticipated, but deployment schedules have almost universally been slower. What is more, competition in these new lines of business may be greater than projected and there is no guarantee that regulatory burdens will go away.

Cable stock prices across the board fell in the new millennium, trading at a collective 11 times estimated cash flow, down from earlier cash flow multiples of 20 or more. Some cable stocks plunged 60 percent from their 52-week highs. AT&T Corp., among the hardest hit, responded by selling assets, initiating massive cost-cutting and layoffs, and setting in motion a restructuring that subdivided the company into four major divisions, each as a profit center with its own market listing. Having acquired AT&T Broadband on the cheap, Comcast Corp.’s top priority has been to concentrate on revenue growth, which it concluded could best be

achieved by using its new market power to force down the cost of programming, by going after a bigger piece of advertising spending and focusing on digital services.

Adding to cable's worries is its competition. Four years into the millennium, satellite providers DirecTV and Dish Network, the first of the multichannel video operators to deliver digital video programming direct to homes, had captured more than 20 percent of U.S. households. Studies were projecting 10 percent subscriber growth for satellite compared to 1 percent, and at best 2 percent, for cable. Telephone and fixed wireless operators were in position to provide serious competition in high-speed Internet (and potentially video competition as well) in many markets. Cable rates of return could be less than hoped for as its program and service prices are beaten down in prime urban markets where the competition is the most intense.

Some 100 municipalities in Ohio, Iowa, Utah, and elsewhere have invested in telecommunications networks to deliver enhanced services to government offices, schools, and libraries, and have earned publicly supported financing for capitalization and operation of phone, data-transport, and Internet services, as well as multichannel video direct to homes. Several of these local networks are public/private partnerships in alliance with well-funded public utility companies. Overbuild proposals have had the greatest local support in communities where cable's customer services have deteriorated and where the much-touted advanced services have yet to be made available.

In metropolitan Denver, Colorado, AT&T Broadband was the only name in cable until April 2001, when WideOpenWest LLC began offering broadband cable, Internet, and local phone services there at prices 10 percent under those of the incumbent operator. Two months earlier, Seattle, Washington, officials had granted a 10-year cable franchise to Western Integrated Networks LLC to build a $500 million broadband network capable of competing for subscribers being served by its incumbent operator AT&T. WideOpenWest LLC was already installing a high-speed cable platform in AT&T–controlled neighborhoods in Sacramento, California, and citywide approvals had been secured to overbuild Los Angeles.

RCN Corp. secured a 15-year franchise in 1999 to overbuild incumbent operator Cablevision Systems Corp. in Boston and 24 Boston-area municipalities. At that time, RCN was already serving some 50,000 cable subscribers in Manhattan, New York; it had operations in Gaithersburg, MD, and one other Washington, D.C.–area community and had acquired two ISPs in California as a way to get into the competitive cable business there.

RCN received an infusion of $1.7 billion in cash from Paul Allen's Vulcan Ventures investment group, with which it proceeded to acquire 21st Century Telecom Group Inc., a telecommunications provider offering residential and business telephony, high-speed data, and video services in some of the more affluent cable franchise areas of Chicago. In July 2000 RCN pushed into the Pacific Northwest with a bid for cable franchises in 12 communities in the area of Portland, Oregon.

Making profits as a cable overbuilder was a struggle, however. Even though RCN consistently demonstrated subscriber growth in voice and data as well as video in 7 of the top 10 U.S. markets, by 2002 RCN's stock price had fallen to about $2 from an earlier high of $32.63. The company was slashing expenditures and cutting back on expansion to focus on areas where it felt it had a good chance of competing with incumbents in the more affluent urban neighborhoods.

WideOpenWest LLC, the overbuilder who bought 116 cable franchises from SBC Communications' Ameritech New Media, announced that it was delaying construction plans in Texas and getting out of Denver to concentrate on the Ameritech acquisitions.

Technological Issues
The marketing hype got ahead of cable's ability to deliver a broadband platform capable of meeting subscriber expectations. Had AOL, Excite@Home, or any other of the ISPs been required to open their gates to streaming audio and video, it is now quite clear that even the most advanced of their higher-speed systems would be challenged to keep up.
The Broadband Millennium

In one of the early rollouts of @Home’s high-speed data services, in its oldest market in California’s Silicon Valley, subscribers were up in arms when transmission rates at certain times of the day proved no faster than dial-up. Cable provider TCI had advertised the service as up to 50 times faster, yet the company was imposing speed curbs to keep “bandwidth hogs” from improperly running such businesses as Web publishing under the umbrella of the $40-per-month consumer service.

The capabilities of the recently upgraded 500–875 MHz interactive cable systems are impressive, but at peak usage time, data delivery can stumble and disappoint. The shared nature of the cable plant is one of the principal causes of complaints, for Internet speeds drop in proportion to the increased number of on-line users. This is especially so when users go for multimedia applications, such as file-sharing of music and downloading movies.

Internet providers are now trying to persuade cable operators to set aside separate data channels to accommodate their programming. IP-video of more than the briefest of clips was not envisioned when the OpenCable plans were first formulated. New content suppliers, using advanced audio/video-streaming techniques to link to subscribers with high-speed access, have emerged so quickly that the traffic has exceeded the design limits of the typical HFC (hybrid fiber/coax) cable network. Since the core cable business is widely perceived to be video and not data, this situation will get much worse before it is satisfactorily addressed.

An even more contentious problem is cable’s upstream path. Work-at-home applications, especially those that involve videotelephony and conferencing, put pressure on the limited spectrum assigned to upstream signaling. Yet home surveys show that as many as four different users in a given family may be engaging the data modem at once. With a camera feeding the set-top or personal computer, more than one video session can be in progress from a single location. More than one user may be trying to send large data files. Inevitably, broadband cable subscribers will be expecting additional upstream capacity to be made available when clogged channels affect quality of service.

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Even at 1 GHz, cable pipelines will be insufficient to handle the explosion of interactive services for surfing, communications, entertainment, and commercial transactions currently being promoted. And as cable networks evolve from one-way, tree-and-branch architectures to two-way facilities for delivering multimedia services like video, voice, and data, a very different level of technical management will be required.

Chuck Lillis was on the telephone side of US West before being appointed president and CEO of MediaOne Group Inc. in 1998. He continued in that role during the time of the AT&T merger when its license transfers were being worked out. “The complexity of the industry is going up at a dramatic rate,” he warned. “Compared to the business the cable industry was in three years ago, this is worse than night and day.”

“The telephone business is much more complex than the cable business, because it’s two-way, just to begin with,” he said. “We’re talking about a level of customer service that’s more complex, and if you’re going to be successful in the data business, somebody needs to be able to answer a question about any kind of device that plugs into this network. It won’t be very long before everything’s hung on the network, everything from the microwave oven to the PC. That’s a much more complex customer service challenge than the traditional cable business.”

Tied to the upstream issue is a nagging problem with the set-top box: its rapid obsolescence. Engineers find it difficult to design a platform for applications that haven’t yet been thought of. As cable operators seek to exploit digital (DTV) video and accommodate to the Internet, expectations about what the hardware and software are supposed to do keep changing.

Data processing, storage, retrieval, and networking applications are evolving rapidly, adding to the complexity and probable cost. Operators are hesitant to commit to hardware with a short lifetime. Equipment providers are hesitant to put products on the market.

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when there is uncertainty about what operators will buy. Consumers are wary about buying into systems that may become obsolete and not do everything they want.

Regulatory Issues
Cable has faced an on-again, off-again regulatory environment. In the early days, cable looked to government to protect its right to exist and sought shelters in local franchises. Cable operators were subject to strict rate controls, rules concerning equipment and installation, the carriage of local TV stations, and ownership constraints. With the Telecommunications Act of 1996, operators overbuilt by telcos found they were no longer subject to local or federal pricing controls; they were allowed to consolidate operations and expand into new lines of business such as Internet and telephone.

As the only currently viable competitors to incumbent telephone monopolies, cable figured prominently in the deregulatory agenda of the FCC and the U.S. Congress. Unfortunately for the regulators, telephony competition from the cable sector has been slow in coming. Cable firms host only about 2.6 million phone lines, a small number compared to the 167 million lines hosted by the local telephone companies. With the advent of voice over IP (VoIP), a service that does not require the traditional circuit-switched architecture, cable companies seem to be showing a higher level of interest. The NCTA asked the FCC to hold off classifying IP-telephony (either as an "information service" or as a "telecommunications service") for purposes of regulation until the technology has a chance to mature.  

It was interesting that the telcos demonstrated so little interest in providing competition in TV. When overbuilder WideOpenWest LLC acquired SBC Communications Inc.'s Midwestern cable systems in 2001, the last of the Regional Bell operating telephone companies abandoned any effort to compete with cable in cable TV. This will surely change with new developments in VoIP, especially with extensive installation of FTTH. Broadband IP networks can operate either in broadcast mode for high-data transmissions or as an on-demand service, as in the case of pay-per-view video or movies on demand. IP opens telco TV's first serious challenge to cable TV.

Regulators have found it hard not to micromanage cable when there have been such persistent constituent complaints about poor cable service, limited choices, and ever-increasing cable rates. It has also been hard for Congress not to tell cable operators what they must do to accommodate local broadcasters, as in the case of analog and digital "must carry" requirements, especially when cable is such a key component in the success or failure of the government's DTV/HDTV agenda.

Similarly, regulators have found it hard to resist removing constraints on telephone company expansion and consolidation, even though the telcos were not meeting government requirements for opening their lines to competitors. To be fair, the cable operators haven't wanted to open their lines either.

Under the Democratic administration, the FCC was willing to be more lenient if cable MSOs agreed to enter into "social contracts" under which they would cap rates, invest in upgrades, and provide free hookups to schools in exchange for reduced oversight. Certain prior rules were retained by the 1996 Telecommunications Act, such as the requirement to follow equal opportunity guidelines, place limits on commercial time in children's programming, and to continue filing annual reports with the FCC. The Republican administration tended to see a freer, less-regulated cable as the long-term solution to everybody's problems, but overwhelming lobbying, paid political influence, a failing economy, and outright fraud in corporate practices across almost every sector complicated this particular approach to governance.

In times past, the government had sought to keep the telephone and cable businesses separate. Now, with so many mergers, acquisitions, and cross-affiliations the government seems willing to allow the strongest to dominate the field, blending technologies and services in ways that make it hard to tell which of the old divisions between mass media, cable, and

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telecommunications still exist, and who in government, if anyone, has regulatory responsibility.

Social Issues
The question of what consumers want is very much up in the air. Whether home viewers will be willing and able to pay for the new and enhanced forms of entertainment, communication, and commerce that the cable industry has plans to deliver is still unclear.

The Time Warner tests in Orlando showed that upscale consumers will pay for movies. Internet use is growing surprisingly fast and high-volume users clamor for faster connections. Will the average citizen go for IP-telephony and use the new broadband networks for conferencing, playing interactive games, buying advertised goods, and setting up at-home businesses? These ventures are largely unproven because the connections are still not there and the price of participation offers few incentives.

The cable industry is confident that sufficiently compelling programming and home services can be created. But will subscribers go to their cable-connected TV sets and PCs for things that they now get elsewhere? And will they give up doing things that currently have high priority to spend more time with cable? Cable will not only be up against the aggressive press of products and services from competing telcos, satellite, and terrestrial contenders, it will have to do battle with well-established public habits, social behaviors, and routines, which resist changes that cost money and require new skills.

One thing is apparent. Cable subscribers have been acquired at great cost to the big media and communications companies now dominating the business, costs as high as $4,000–$5,000 per subscriber, with system upgrade costs of $1,000 or more tacked on. Cable users are the only ones that can bail out these investors, in terms of what they ante up for basic and premium monthly packages, pay-per-view channels and VoD services, high-speed Internet usage and shopping transactions.

Chapter 3: Broadband Cable

To solve cash flow problems, operators continue to raise the cost of tiers, and save on service calls. Consumers are expected to purchase the new cable set-tops and modems needed for digital access. To receive and interact with cable's advanced services, home users need digital-ready TVs and PCs and home networks to connect to them, which are additional costs. Business plans appear to be built around the idea that every household is an upscale household, and a healthy economy is assumed.

Applications
Adoption rates in the commercial deployment of digital cable systems give a nod to the possibility that interactive (ITV) services will finally catch on and that there will be financial payoffs in the long term. Cable operators are making these investments, to be certain, as a way to head off the competition and to be assured that they are the ones making money if anyone does. What assumptions cable operators are making about the programs and services that the public will go for, and how their offerings will stack up against the rising competition, is still a bit cloudy.

The new digital set-tops will help cable's core video business. Cable will be in a position to relay the new DTV signals of broadcasters and earn additional revenues through on-demand content. Electronic commerce and other Internet applications will undoubtedly figure prominently in cable's future. What follows is a brief report on some of these developments.

Advanced Digital Television
Cable operators spent a lot of time talking to broadcasters, to the consumer electronics industry, and to the FCC about the conditions under which the new DTV broadcast signals will be picked up and retransmitted over cable plant. By 2002 only about 20 percent of digital cable systems had allocated bandwidth to carry the DTV signals, and the number of U.S. homes with digital TV receivers in place was still few.

All parties agreed, however, that the digital TV of the future, HDTV as well as standard definition television (SDTV), would have to be carried on cable systems if the majority of American
viewers were ever going to see it. Certainly cable operators recognized that when the time came for cable customers to plug in their new digital TV sets and those customers couldn't get a DTV signal, in one format or another, the whole cable industry would have a major public-relations problem to deal with.

Over the years, broadcasters had allowed themselves to become dependent on cable, satellite, and wireless platforms for delivery of their signals. Fewer than 20 percent of U.S. households were still able to receive the big four broadcast networks via over-the-air antennas, and it seemed unlikely that the remaining 80 percent would go buy rooftop antennas to get the new digital signals. The FCC continued to express confidence that the marketplace would resolve these digital signal carriage issues and was on record as preferring that the cable and broadcast industries settle such matters on their own.

Some cable operators were converting the digital signals to analog without waiting for customers to buy digital set-tops. But programmers complained they were having difficulty making the programs look good in both the 3:4 aspect ratio of analog and the new 16:9 aspect ratio of digital, in which the picture is wider.

PC TV-tuner cards were seen as a near-term solution to scarcity of affordable DTV receivers on the market. Plug-in computer cards capable of receiving, decoding, and displaying SDTV/HDTV signals on PC monitors gave early adopters a look at the new digital signals, and provided ancillary data as well. WinTV-D, a DTV card from Hauppauge Digital, was able to handle all 18 DTV formats for less than $500. Panasonic and Zenith also offered similar products that they saw not as a mass-market item but as a catalyst to hopefully propel the digital TV market forward. The problem was that the younger generation of users found satisfaction in watching TV on the PC but that approach didn’t appeal to the large audiences that broadcasters and cablecasters were hoping to reach.

The transition period is going to be difficult for everybody. By September 2003, the consumer electronics industry and the cable industry had hammered out a plug-and-play agreement giving manufacturers a clearer set of guidelines about the components that must go into cable-ready digital TV sets. Matsushita Electric Corp. announced plans to start shipping its 53-inch Panasonic HDTV sets priced at $2,300. Along with the purchase of these TV sets, consumers were to be provided a CableLab’s certified CableCARD that would enable DTV programming to be two-way, as with VoD and interactive program guides (IPG).39

**ITV and VoD**

Premium channels, pay-per-view movies, special events, on-demand content: these tend to be high profit margin services attractive to customers with money to spend. Ultimately, digital cable will make these applications a lot easier to access.

Movies on demand can produce $12 to $14 a month in incremental revenue. Diva Systems Corp., later sold to Gemstar-TV Guide, began offering operators a way to get into digital VoD with a turnkey package of hardware and content in 1998. MediaOne was one of the first to market-test the Diva service based on a subscription (SVOd) model in which differentiated monthly service fees of $4 to $10 were added to the customer’s bill for 24-hour access to a designated number of movies per month.

Although this application was slow to take off, Diva’s servers and software were deployed in 11 of the major U.S. markets in 2001 via deals with Charter Communications, Insight Communications, and AT&T Broadband. Diva was offering cable systems an end-to-end solution, handling nearly everything from technology to content acquisition to marketing. Programming included music on demand and TV returns as well as theatrical releases. Under Diva agreements, Diva kept 40 percent of all VoD revenues generated.

Time Warner Cable launched its first full-fledged VoD service in Hawaii in December 1999. In 2001 its 260,000-subscriber Honolulu system supported a VoD base of 56,000 users. Concurrent Computer Corporation provided the technological

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infrastructure for real-time, on-demand access to programming with digital video recorder (DVR) functionality. Three fiber rings served six to seven hubs, and VoD servers were placed in each hub. Six different servers provided 3,200 streams per head end, allowing numerous subscribers to watch the same movie at the same time without overloading servers.

With declining equipment costs, great leaps in storage capacity, the greater penetration of digital set-tops, and the ability to outsource, the management of interactive networks and the hosting of new services have become more viable as cable-provider options. In addition to VoD and IPGs, some of the new ITV applications include digital television recording and playback, interactive games, electronic commerce, and Internet services.

**Internet Services**

Cable operators feel considerable urgency to be in the Internet business. Telephone companies, terrestrial wireless and satellite providers, even local utilities, are making their pitch to be the access providers of choice for homeowners, schools, and businesses. In spite of the huge losses that dot-coms and the leading media and telecom companies have taken in trying to stay ahead of the Internet curve, almost no one denies the importance of being Internet-ready. Cable operators are committed to this path, and many have turned to third-party providers to assist.

The future of the Internet does not lie only with the PC; it also lies with broadband video, which is closer to what cable people and their customers understand. TV sets are in almost 99 percent of U.S. homes. While PCs are in 55 percent of homes and growing, the TV set is still the greater public source of news, information, and entertainment. As the Web evolves into a delivery platform for broadband content, the cable industry knows it will have no choice but to embrace it fully.

All of the major MSOs understand that unaffiliated ISPs will eventually be given access to their broadband cable lines. In the case of AOL Time Warner, the FCC mandated as a condition of its merger approval that Time Warner could not control the “first screen” seen by subscribers of rival ISPs when accessing service.

Also, direct billing between unaffiliated ISPs and their customers must be allowed.

AOL Time Warner put a positive spin on the FCC requirements, making public assurances that it would be incorporating multiple ISPs on Time Warner systems, noting that it fully expected AOL’s on-line subscribers to gain access via cable systems operated by other carriers. Clearly, the new Time Warner will figure out ways to repurpose its vast media holdings for broadband Internet delivery, whether via cable, DSL, satellite, fixed wireless, or utility services. How this will be done, given the space and speed constraints all those channels pose for cable carriers, is not yet fully resolved.

Media streaming is among the scarest of options from the point of view of cable operators. Cablecasters know that IP streaming is out there as a future potential contributor to their bottom line, but this application may also be the single greatest threat they face. When live audio and video content are broadcast over the Internet, or when prerecorded audio and video programming is retrieved from the Internet in on-demand format, and these transactions are completely under the control of individual users, entire systems could be quickly overloaded and crash. Yet, when sufficient bandwidth is made available and procedures are in place for “per-bit per-stream” traffic management, prioritizing, and payment, operators could see new sources of revenue.

RealNetworks Inc., the streaming software provider, is the global leader in subscription based on-line video. In August 2000 the company initiated a stand-alone premium media service called RealOne Superpass that was almost immediately profitable. For $9.95 per month Superpass subscribers could gain exclusive access to sports, news, and music programming not available elsewhere. By early 2003 the company had 900,000 paying subscribers, producing $75.5 million in revenue for 2002, up from $28 million in 2001.⁴⁰

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RealNetworks researchers have developed compression algorithms capable of delivering VHS-quality video at rates under 1 Mbps, even as low as 300 kbps. These technological achievements, and the development of businesses around them, suggest that IP-video will not just be augmenting the e-mail exchanges of Internet users, but will also move to the World Wide Web, legally and illegally, competing with the offerings of broadcast and cable networks.

Cable plant will be the platform on which many of these streaming applications will get their earliest workout. This will be so partly because cable infrastructure is among the most robust in the business, but also because partnerships with cable will give on-line programmers access to some of the most advanced technologies and attractive content available.

The growth patterns in Internet traffic are exponential and still very much free-form. The quantity of streaming data traveling downstream at the initiative of global Internet providers has no anticipated limit, nor does the future of user-initiated data traffic traveling upstream. Cable operators are still struggling to find a place for the kind of Internet that is somewhat under their control.

Content Creation
The new cable modems will be able to download data to home computers and TV sets at speeds of up to 38 Mbps, and upstream rates of delivery can also be high. Such a data transfer rate is big enough to host video and other broadband applications going both ways. The prospect that homes and offices will be equipped with the means for both receiving and transmitting large multimedia files sets the stage for the creation of locally originated programming not distinguishable from broadcast television. "I expect this will lead to a whole new range of content development," CableLabs president Richard Green predicted in 1997. "It is pretty clear that as the capacity increases, we will begin thinking about content that uses much broader bandwidth and lots more bits. Many of our companies are working on specific content that will take advantage of these added attributes of the cable modem," he said.41

The immediate difference digital modems will make is that they will relieve some of cable's scarcity problems, but the exchange of user-generated content will create a host of other issues. The new set-top boxes will give viewers access to hundreds of additional channels, so new services will have a better shot at gaining carriage. But with the two-way broadband pipes, traffic traveling to and from individual subscriber Web sites will claim larger and larger portions of cable's potential capacity.

Conclusion
There seems little doubt that Cable TV is well positioned to be a major provider for broadband services to the American home. In the competition, cable has a good chance to be the access channel through which the largest number of U.S. users gets its entertainment and communication, information, and commercial transaction needs met. But every one of these opportunities will have to be earned.

Cable now offers the richest variety of video choices. But the question now is how to bring Internet and interactive services to the same scale as TV, and the extent to which this makes sense. How can cable work TV programming and parallel Web content side-by-side to bring immediacy, relevance, and consumer value? How can the cable platform be used to reach out and engage home-dwellers, schoolteachers and learners, hospitals and businesses in a way that enriches work, empowers subscribers, and allows them to learn and enjoy their lives more, at prices they can afford? This has yet to be fully demonstrated.

Like its competitors, cable is looking for the "must have" programming, the "appointment viewing," the "quality time" experiences that will bring viewers to the TV set. But the paradigm has changed. Cable must now attract PC users to the TV, and TV viewers to the PCTVs, in such ways that users and viewers can be converted into paying consumers. Cable will increasingly find itself pushing viewers toward Web sites where they will be exposed to affiliated advertisers, where products and services can be purchased from which cable operators will take their cut. But the happiest customers will be those who are equally free to avoid the "walled

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gards" with which operators circumscribe their viewing behavior, those who are free to package their own content and make their own transport deals.

Cable will need additional revenue streams to augment its infrastructure and create new programming. The sources of this funding will certainly be found. But cable viewers as customers and users are extraordinarily inventive in avoiding places they don't want to go, and the technology will also help them. The industry's most reliable revenue generators falter as the mass audience dissolves into an abundance of choices. The old broadcast model of guaranteeing delivery of "eyeballs to advertisers" ceases to work as viewers are given the technological means to opt out and record only the programs that interest them, reserving the right to view those programs on their own time with the ads deleted.

Consolidation has been a trend in the cable business almost from the beginning, so the size and market power of the remaining multiple systems operators has greatly increased. With deregulation, globalization, and ready financing, most of the local cable companies have now been absorbed into large media conglomerates. The size and strength of these companies bodes well for their competitive position. Quite possibly, consumers will be better served as well, but not without some government vigilance and oversight, and consumers more actively articulating their wants and needs.