Broadband Access Ramps—The Inevitable Next Horizon

Terry L. Wright

Whether you refer to the fast-evolving on-line world as the Internet, cyberspace, Information Highway, or other favorite name, one aspect of it is assured—there will be broadband access to it in the future. In fact, some form of broadband network service will likely be the *dominant* form of cyberspace access in the not-too-distant future. Whether this access is provisioned by your local cable television operator, power utility, telephone company, municipal government, or an Internet service provider (ISP) collaborating with one of these players, there will be a broadband access ramp in your future.

When? We'll explore that a little later. How? We'll get into that too. But first, it is important to understand "why" broadband access ramps will dominate the future cyberspace access arena, and why you might want to devote some serious thought to the potential effect this dominance could have on your existing long-term telecommunications strategy.

The word "inevitable," especially when applied to the characteristics of future technological infrastructure, is a very strong term. We all know that the only thing certain in telecommunications and information technologies is that they are constantly evolving. How can anyone be certain about anything in these dynamic industries and market climates? To answer this question as it pertains to broadband cyberspace access ramps, and to understand why "inevitable" is an appropriate term to describe their emerging role, we must look at the underlying currents helping to drive the widespread emergence of broadband access.

Evolutionary Currents of Change

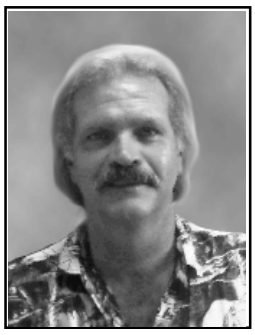
There are a host of forces creating demand for high-performance access to cyberspace. Among these, however, are several fundamental currents that warrant further exploration. These include:

- Digitization of entertainment and other content.
- Video-, audio-, and multimedia–ready browsers and software access platforms.
- Transformation of information into entertainment.
- Effects of the convergence economy.
- Standardization and specification consortiums.
- Compression and encryption of information.
- Effects of the convergence on regulatory bodies, governments, and institutions.

Probably the best way to venture into these underlying drivers is to weave them into an exploration of the present market climate that begins with a step back to earlier times. Then, similar change agents produced paradigm shifts we can probably all relate to—and that have more to do with potential shifts ahead than you might imagine.

Historical Precedence and Wave Characteristics

Sometimes it's important to look around and under something in order to gain a proper perspective on what it is, why it is as it is, and what effect it might have on the future. For example, consider a typical



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ocean wave approaching your favorite resort beach. It has a shape, magnitude, velocity, amplitude or height, and will temporarily claim some area of the beach as an extension of the ocean floor before retreating back into the sea. In order to understand all of the attributes of this wave, we would need to know such things as water temperature, time of day and month, season of the year, wind direction and velocity, area weather conditions, and the terrain of the ocean floor extending a good distance out from the shoreline.

The wave of the Information Age now crashing onto the human agenda is much the same, and if we hope to understand it in similar detail, then we must look around, behind, and under it in much the same way.

Service Access Devices and Paradigm Shifts

The concept of publicly-accessed services has been around for a long time. The earliest example of service access in modern times is probably the Post Office, which provided the general public with community access to the postal system's messaging and parcel delivery system. The telegraph station is another example of community-based service access, as it provided an indirect form of access to early telecommunications networks.

However, the early postal and telegraph systems were centralized, offering no devices to access their service. Thus, they provided the general public with only an indirect access to their respective services. The concept of a service access *device* is something that provides access to services from individual households. Probably the first good example of this was the mailbox. A much better example of a service access device, for the purpose of understanding and comparing the forces that drove an earlier fundamental shift and the potential for a similar shift in today's telecommunications climate, is the telephone.

The telephone quickly became the first (electronic telecommunications) service access device to reside on the customer premises, providing the general public with access to voice communication services. Consequently, the telephone itself (in its many forms) has come to be synonymous with the voice service it represents. In similar fashion, the radio, upon its introduction and general availability to society, quickly became the de facto service access device for news and entertainment. Telephones and radios continue to play substantial service access device roles. However, it didn't take long for radio to be overshadowed by television. Figure 1 illustrates the general evolution of service access devices.

The persistent and perpetual *digitization of audio/visual content*, and the undeniable and growing drive to *express* and *consume* digital information *audibly* and *visibly*, represent fundamental underlying technical shifts capable of defining the market's association of particular services with particular devices.

Digitization of Entertainment and Other Content

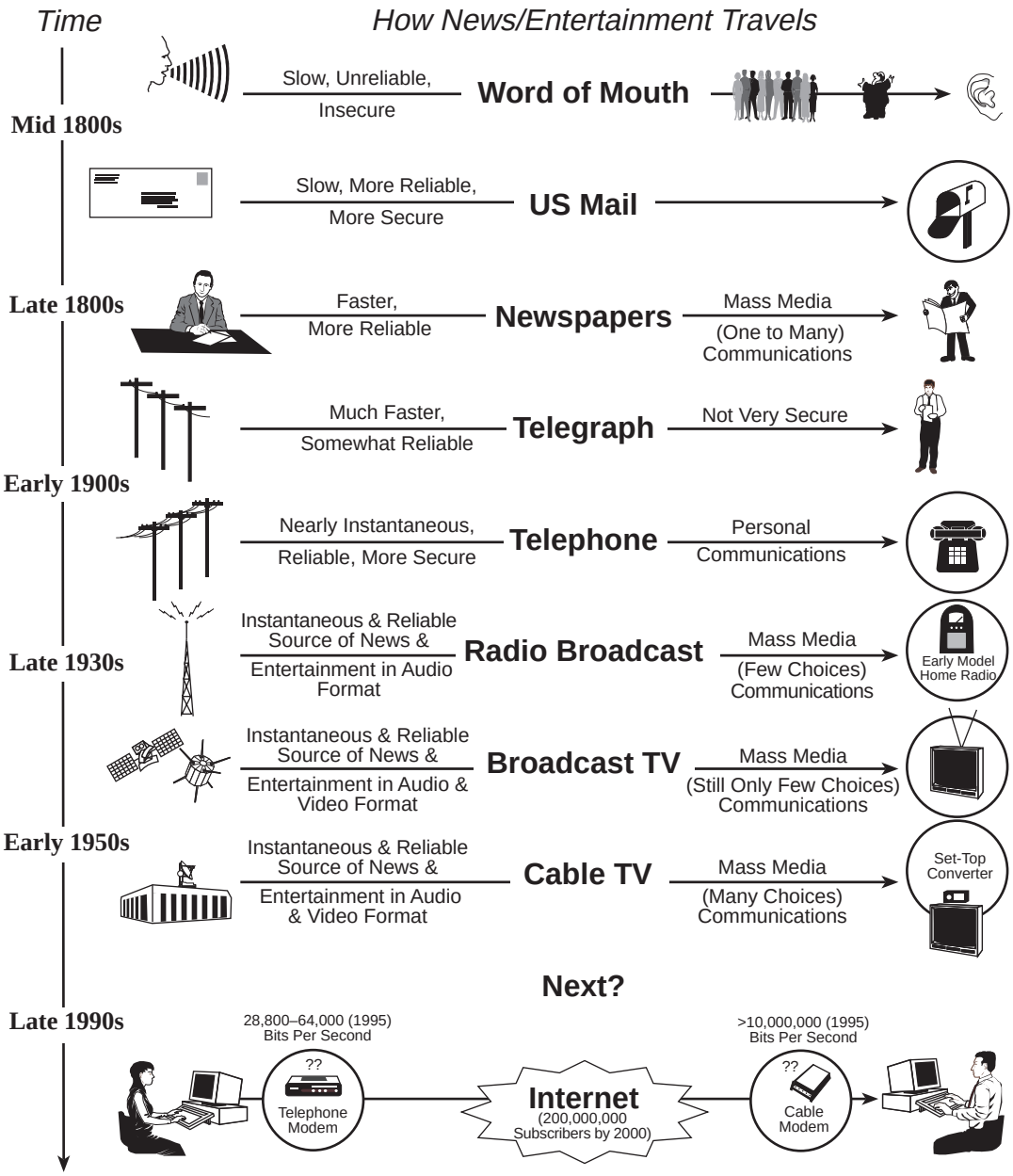
Extraordinarily, the same kind of less-visible, yet fundamental underlying technical shift that allowed television to displace radio as the preferred news/entertainment service access device is occurring now in on-line services. Today's persistent and perpetual *digitization of audio/visual content*, and the undeniable and growing drive to *express* and *consume* digital information *audibly* and *visibly*, represent fundamental underlying technical shifts capable of defining the market's association of particular services with particular devices. Ubiquitous content digitization and the user community's drive to express content audibly and visually are the primary factors behind the race to define the cyberspace service access device.

Compression and Encryption of Information

In case you are not familiar with the network capacity required to deliver audio and visual content, try pulling down a few video clips over your dial-up modem from the Internet. The length of time the persistent little hourglass stays visible while you're waiting should give you a relatively good idea that audio and visual information requires considerable bandwidth capacity, even if compressed. (Without compression, standard NTSC television requires well over 100 megabits of bandwidth per channel.)

Tolerable (i.e., VCR-like) quality can be achieved through compression that reduces

Figure 1
The Evolving Service Access Device



Source: T. L. Wright

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bandwidth consumption down to approximately 1.5 Mb/s. Depending on the picture size, color depth, percentage of the picture that is changing, rate of change, and so on, some compression/encoding schema can deliver decent video in as little as 384 Kb/s. However, all of these rates are well beyond the physical capabilities of traditional dial-up modems over the standard local loop.

Of course, the telephone companies are hoping to exploit various approaches for enhanced digital subscriber line (e.g. ADSL,

HDSL, VDSL, xDSL) services to accommodate the growing capacity of on-line content. But these xDSL services have accompanying distance limitations that could easily translate into local loop construction requirements that are on par with what cable operators are undergoing in their two-way and hybrid fiber/coax (HFC) plant upgrades.

The majority of publicly deployed accessible broadband networks currently deliver entertainment (i.e., cable television). Television in the United States is delivered over channels of broadband spectrum that are 6 MHz wide. Depending on the number of unused channels, cable operators can allocate one or more of these outbound channels to deliver data services. A 6 MHz broadband channel is capable (with today's technology) of delivering more than 50 Mb/s of digital information, assuming it is properly configured and adheres to FCC requirements. This is approximately 1,736 times the capacity of your typical 28.8 dial-up telephone modem, and 892 times the capacity of even 56 Kb/s modems.

However, the nature of deployed broadband networks dictates that this bandwidth must be shared among data users. Even with compression schemes, and even if cable operators devoted their entire spectrum to delivering data, this bandwidth would have to be shared. (The performance capacity of these shared networks are, however, such that users spend only small amounts of time actually consuming the bandwidth, thereby allowing many users to share the same network capacity. Broadband networks simply extend the capacity sharing that currently exists beyond the central office or ISP on major Internet backbone networks out to subscriber premises.)

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Transformation of Information into Entertainment (Customer Value)

The inevitability of broadband access ramps is all about *perceived value* in the customer's mind, and what it takes to deliver that value. A picture has always been of much greater value for expressing ideas and entertainment than just words. Thus, television's displacement of radio was natural; customers perceived more *value* in both hearing *and* seeing entertainment and news, than they did in simply hearing it on the radio or reading about it in the newspaper.

Due to the blurring demarcation between entertainment and information content, the trend is to convey all forms of content as visually, audibly, and graphically as the telecom infrastructure permits. The fundamental underlying technical shifts at the heart of today's preferred on-line service access draw an even closer parallel to television's displacement of radio than is evident on the surface.

Leveraging Greater Value from Existing Technology

Television utilized fundamental radio technology to overshadow the radio (rapidly-encoded visual images with integrated audio streams delivered via radio carrier). Then, at the height of television's success in providing its superior audio/visual value to the marketplace, cable TV came along and provided even greater value by offering customers more individual choice and audio/visual content diversity. This suggests that fundamental changes in market directions and service consumption behaviors can be effected by the introduction of new services that leverage existing technologies and offer greater diversity.

Broadband-based cyberspace access will leverage existing Internet network backbones, switches and routers, server and storage farms, server and subscriber software, technical support infrastructures, billing mechanisms, and existing—and in many cases installed—network interface cards. With regard to content diversity,

cyberspace provides access to literally millions of content sources or "channels" as they are being increasingly referred to.

Cable's success as an industry is compelling evidence that enhanced service value can create substantial shifts in established service markets and consumer behaviors. Given the option, over 63 million households, or about two-thirds of the 95+ million television households in the United States,[1] continue to prove that they would rather *pay* monthly fees for television *they* choose, instead of consume a steady diet of what the dominant broadcast networks would rather they watch. Cable television enabled consumers to *channel surf* which, in turn, seems to have facilitated the onset of the "instant gratification" society. There are millions of potential "channels" on the Internet, and these already offer much more interactivity than channel surfing on cable television.

I believe the Internet phenomenon is the market's way of imposing its will again on the nature of service value. As the Internet continues to evolve technically, and the market's uses (associated value) for such a medium continues to grow, cyberspace will do to cable television what cable did to broadcast television—as it was basking in the success of what it did to radio. Ten thousand-channel television from cyberspace in some form or another is not that distant a concept.

Video, Audio, and Multimedia–Ready Browsers and Software Access Platforms

With the major subscriber software clients (i.e., Netscape and Microsoft) supporting built-in video, audio, graphics, and enhanced multimedia in current and future releases, market demand for increased cyberspace access capacity can do nothing but grow. The cable industry has the opportunity to be a substantial and influential catalyst in shaping the nature and timing of this evolution to a broadband-accessed cyberspace, as it remolds its installed broadband competitive advantage into the fundamental on-line services access transport. The key to determining how much of a catalyst the cable industry will be is a function of its timing, focus, and commitment.

Repeating History

What is most uncanny is that the market's shift from both radio to television, as well as telephone modem to cable modem (in terms of a preferred cyberspace access device), will be for the identical reason: people would rather *hear and see* on-line content, rather than simply hearing or reading about it.

The alignment of these kinds of underlying technical forces, and fundamental market values and preferences, comes along very rarely. Just as early television was crude and even considerably more expensive than radio at the time, the market's desire to see and hear content was compelling enough to give birth to the television industry as we know it today. So it will be with cable modems and on-line services. I believe history will repeat itself as the technology enabling the convergence of entertainment into bits—and bits into entertainment—creates a climate where the market's desire to see and hear on-line digital content imposes its will on the underlying infrastructure. This will take the form of increasing demand for broadband-based access to the Internet and other on-line services.

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Effects of the Convergence Economy

What I call the convergence economy is the by-product of the arrival of the Information Age. It is the result of the fusion or convergence of the computing, telecommunications, and consumer electronics/entertainment industries—all enabled and driven by the digitization of content.

Just as the transition from the Agricultural Age to the Industrial Age produced ripples throughout the established economy of the time, the transition to the Information Age will be equally—if not more—chaotic. The Industrial Age produced thousands of large companies whose profitability, num-

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bers of employees, and other value system components had a significant impact on the economy. Many of these giants were caught off guard as the convergence emerged, failing to anticipate the permanent changes it would bring with it.

For example, the proliferation of personal computers that will continue well into the future wreaked havoc on the rank-and-file of large computer manufacturers. Significant downsizing activities at such companies as Digital Equipment Corporation and IBM were the direct result of the growth in personal computing popularity and the steadily increasing power of PC platforms. These same factors made giants out of small personal computer software startups like Microsoft and, later, Netscape, and enabled a silicon specialist such as Intel to become the powerful force it represents today. These are just the obvious impacts of the convergence.

Less visible is the vast information infrastructure re-engineering necessary by all users of centralized and departmental computing approaches, while simultaneously trying to cope with the changing nature of content ushered in by digitization and the Internet. These re-engineering efforts and the content revolution have ripple effects throughout the extensive value systems of all these large companies. Adding to this challenge, among large established corporations and small startup companies alike, the convergence has fostered the need to create or modify products and services to appeal to a market that is itself rapidly experiencing an uncertain transformation into the Information Age. These effects are still being felt today. Digitization and improved computing power continue to level the playing field, creating a competitive climate where the established powers of yesterday (with their significant administrative overhead) must struggle to remain competitive against smaller and leaner startups.

A major driver of broadband access ramps is visible to most of us every day. Traffic in today's major metropolitan areas is already at a standstill and getting worse. The obvious answer to part of this problem is telecommuting. However, the vast majority of corporate information networks are based on wide-area connected pockets of high-speed LANs. In order for telecommuting to work, employees must be able to access this information in a timely manner, similar to the performance they enjoy at the office. Dial-up access works well for e-mail, but many developers (engineers and programmers), support groups, and others need access to large files and databases too unwieldy for dial-up circuits to deliver in acceptable timeframes. Since many employees also subscribe to cable television, and cable television networks are capable of delivering LAN-like performance, the crowded conditions on the nation's metro highways represent still another driver in the emergence of broadband access ramps.

Effects of the Convergence on Regulatory Bodies, Governments, and Institutions

When the digitization movement gained sufficient momentum, regulatory bodies like the FCC had little choice but to allow market forces to define some form of structure on telecommunications. (Bits are bits, regardless of whether they represent voice, compressed video, digital radio, data files, or software executables.) Until extensive standardization of digital content streams emerge and take root in the market, attempting to impose regulations on emerging digital telecommunications services would be impossible.

One of the largest users of centralized and departmental computing and information infrastructure is the federal government. The government is now attempting to keep pace with technology directions through a massive re-engineering of these infrastructures. The sheer volume of information associated with an interactive federal government will impose significant capacity consumption on any network access scheme.

Schools, libraries, and other institutions (e.g., hospitals and clinics) are also feeling

the impact of the convergence. The nature of funding for public institutions has compounded the challenge of modernizing the educational infrastructure, as much of the funding base is still attempting to find its own way through the dynamics of the sweeping changes.

In the case of education, cyberspace itself has taken a front row seat in the mainstream curriculum in an attempt to better prepare students for the cyber-oriented future awaiting them. With cyberspace as dynamic and evolving as it is, this challenge is tantamount to trying to teach a course where a new chapter is added to the textbook every week. And don't forget that as cyberspace goes with respect to content, so goes the access capacity needs of education. Fortunately, the cable television industry's "Cable in the Classroom" program has resulted in broadband cable into most schools.

The medical community has the potential to be the most demanding of all in terms of access capacity demands. Patient records, X-rays, EKGs, MRI scans, and real-time videoconference-based second opinions and specialist conferences all create tremendous demand for network access capacity. Fortunately, most hospitals already have broadband network access capability through making cable television available to patients.

Driving Factors

As government regulated entities, the telephone, cable TV, and power utility industries represent substantial forces driving the emergence of broadband networks as cyberspace access mediums. Some telephone companies have already acknowledged the inevitable role of broadband networks by their acquisitions. For example, U S WEST's early investment in Time Warner Entertainment (which controls Time Warner Cable, the second largest cable operator) was followed by its acquisition of Continental Cablevision. This suggests that (at least U S WEST believes) it is economically more viable to acquire existing broadband infrastructure than to overbuild it.

Power utilities are finding it necessary to provide managed energy services in order to effectively compete with rural cooperatives and other alliances. To accomplish this, they will need networks to homes and businesses. In the growing competitive climate, it is folly to think that these utilities, given the option, would settle for simply providing managed energy services. Their control of rights-of-way may prove to be an interesting ticket into the advanced telecom services fray, and such services may represent a good way to offset stranded costs and expand their value to communities.

Municipalities are already looking for ways to provide their citizenry with low-cost advanced telecom services. Many are considering increasing the utility of their traffic control device broadband networks to serve as backbone networks among public institutions. In several instances, municipalities are already leveraging existing broadband network assets to overbuild and compete with incumbent cable TV companies.

As mentioned earlier, the degree to which the cable industry will be a player is a function of its timing, focus, and commitment. If the cable industry can focus its existing network capacity advantage on where the telecom market is going and growing (e.g., the Internet, packet voice and video, digital television, and so on), it stands a good chance of becoming a serious advanced telecom services player. To spend resources and energy by attempting to garner a share of where telecommunications has been (plain old telephone service or POTS) is to be sidetracked into costly battles with powerful incumbent telephone companies fighting to retain their share of traditional core services.

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How Broadband Access Works

We've already explored a good deal of how broadband access works. To elaborate, cable television networks have the lion's share of deployed broadband networks. What we didn't explore earlier was how the return spectrum factors into the equation.

Many cable operators, as they upgrade to fiber-rich trunk architectures called HFC networks, are also replacing one-way amplifiers with the two-way kind. This allows them to provide a complete access package without the need for dial-up circuits from the telephone company.

While many cable operators will also utilize existing and emerging cable modems that do utilize telephony return, this is not the ideal. Other than the inherent performance advantage of broadband networks, a complete broadband connectivity package (i.e., two-way):

- Enables operators to offer competitive commercial services.
- Eliminates the need for costly business telephone lines.
- Provides ergonomic advantages such as constant connectivity.

This also makes broadband-based access more appealing to subscribers, as it frees up the family telephone line (and/or obviates the need for and cost of a second line), and enables new "push"-like applications to their PC (even when subscribers are not actively on-line themselves). Cable operators, however, especially those still in the process of upgrading their broadband networks, will use telephony return modems at least until network upgrades are complete. Beyond this, these hybrid cable/telco modems may still warrant use in delivering a lower class of data service that offers dial-up performance for subscriber transmissions, but allows very high-speed performance for subscriber receipt of Web pages, video clips, and other information requested from cyberspace.

These specification and standards developing groups hope to produce guidelines where interoperable cable modems can be developed that will work across different cable systems, and be acquired via retail channels.

When Will Broadband Data Services Emerge?

As discussed above, the answer to this question is a function of the focus and commitment the cable industry can apply to delivering data services over their broadband cable networks. The cable TV industry represents, by far, the majority of publicly-accessible broadband networks already deployed. Determining when broadband-based data services will be widely available will require cable operators to:

- Construct a viable business case for these services.
- Obtain the necessary financing for two-way plant upgrades.
- Either acquire or enlist the help of experienced data services resources.

Standardization and Specification Consortiums

Another aspect many observers believe will drive availability of broadband data services are standards and specifications defining the functionality of cable modems. Excluding similar specification/standards efforts from cable set-top converter concerns (e.g., the Digital Audio Visual Council's DAVIC specification), there are two efforts of interest. These specification and standards developing groups hope to produce guidelines where interoperable cable modems can be developed that will work across different cable systems, and be acquired via retail channels. Accomplishing either of these goals will accelerate cable modem deployment and broadband-based data services.

The MCNS-LP[2] is an industry consortium comprised of top North American cable companies, network equipment vendors, and a project management group. The group recently released a cable modem purchasing specification to the supplier community. The MCNS specification is in the process of being implemented now by nearly all major cable modem suppliers, with compliant products expected to hit the market as early as this fall (for the dial-up return option), and early next year for full two-way cable modems.

The specification development process imposed strict non-disclosure requirements on participants, and was initiated at least partially due to the cable industry's impatience with more formal standards-making bodies. The MCNS specification defines functionality that is based on IP packets and

MPEG compressed video. The effort invested in the MCNS specification is evidence of the urgency felt by member cable operators to respond to the high-speed data services opportunity over broadband.

The IEEE 802 Working Group, an accredited standards-making group under the charter of the U.S. State Department's ANSI group, is also nearing completion of the IEEE 802.14 Draft International Standard (first letter ballot will be issued this summer). This is the same standards body that developed the Ethernet 802.3 and Token Ring 802.5 standards, among others. This effort has lagged that of the MCNS-LP consortium, mostly due to its governing "open" process and related procedural bylaws.

A Draft International Standard (DIS) is expected to be released late this year to higher-level international standards organizations. The approval process of these international organizations will take several months; however, implementation work will get underway at many vendor shops once the draft has been released. Many of the same vendors endorsing the MCNS purchasing specification have announced their intent to develop IEEE 802.14 compliant cable modems as well. IEEE 802.14 compliant cable modems may be available as early as mid-1998. IEEE 802.14 cable modems, like MCNS, will also support IP packets and MPEG streams. However, this standard defines an ATM cell-level interface to enable standards-based variable class of service implementations.

In the interim, however, there are many cable operators moving forward with limited and full-blown cable modem and data service deployment agendas. Several proprietary cable modems (dial-up return as well as two-way cable) already exist on the market today, some even with multiple product generations to their credit. Many operators believe the benefits of standards- or specification-based cable modems may take several years to be realized, while increasing demand exists for high-speed broadband data services today.

Summary

While there are a variety of issues yet to be worked out in detail, the inevitability of broadband access to cyberspace seems to be as certain as the future existence of cyberspace itself. When given the choice, consumers of news, entertainment, and information have historically demonstrated their preference for audio/visual formats, giving rise to the emergence of the television industry. The desire of subscribers to interactively control (via channel remote) the content they consume—and to have increased content choices—gave rise to the emergence of the cable television industry.

A few minutes of surfing the Net should prove to anyone that cyberspace is rapidly evolving toward an increasingly audio/visual content base, and it already represents the most interactive medium in existence. Historical precedent has shown that when pictures and control are pitted against mundane text, audio-only content, and narrow content choices, major shifts can occur where entire industries are born. Is there any doubt that a broadband cyberspace access ramp is in your future? ntq

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[1] A. C. Nielsen Company as cited in National Cable Television Association, *Cable Television Developments* (Washington, DC: Research & Policy Analysis Department, Spring 1996), p. 1.
[2] Multimedia Cable Network Systems Limited Partners.