Convergence of Telephony & Cable:
Vital Step in the Creation of an Information Superhighway

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Abstract

This paper argues that an essential step in the evolution to the information superhighway, is the convergence of a host of discrete information industries into one. Most importantly among these is the integration of the telephony and CA TV networks. This convergence is occurring primarily because of changing technological and competitive forces. The integration of these networks is not only inevitable but will provide significant benefits in the area of economics, education and the environment.

1: Introduction

Recently, much public discussion has focused on the creation of an advanced communication network capable of carrying vast amounts of information in many forms and accessible by populace at large. No consistent definition for this network has yet emerged, but in its place, a metaphor, the information superhighway, has entered the popular vernacular.

This paper posits that the convergence of the telephone and CATV networks is an essential step in the creation of the information superhighway. This convergence is in fact taking place now, but in the context of a larger convergence of a number of communications industries and players. This paper also argues that the convergence of telephony and CATV is a logical and necessary extension of the undeniable economic and technological forces shaping the communications industry today. Also, it is important to note that the convergence evident today is part of a history of such convergence dating back to the mid-70s, including most notably IBM's acquisition of Rolm Corp., Sony's acquisition of Columbia, AT&T's acquisition of **NCR** and McCaw, Southwestern Bell's joint venture with Cox Enterprises, and U.S. West's investment in Time Warner, and Nynex's investment in Viacom, and literally hundreds of others. Some of these mergers and alliances will, for short term economic, regulatory and other reasons, fail. But the convergence of these industries is real, and, over the long term will continue unabated, because the economic, technical, and social forces creating convergence are overwhelming. This paper outlines those reasons and discusses the major trends and benefits of combined video and telephony services, a major component of convergence.

A comprehensive definition of the information superhighway would be of real value, but it is beyond the purpose of this paper to attempt one. For the purposes of this paper however, it is worthwhile to describe at least some of the elements of the information superhighway. To this author, the information superhighway will not be a single network, but a network of networks, comprised of both new networks and virtually all the existing voice, data and video networks, public and private (although this is not meant to imply unrestricted access). As such, the information superhighway will be ubiquitous, allowing at least some form of access to essentially everyone. There will be a huge variety of access terminals and devices ("appliances"), but the most sophisticated will be highly intelligent, multimedia, and often portable. Although not exclusively so, the highest level network architecture will resemble a client-server configuration, with widely distributed nodes (data base "servers") consisting of virtually unlimited services and information. It will be a switched network capable of connecting any party to any other. Its transmission infrastructure will be both wireless and wireline, with the wireline portion being a hybrid of fiber, copper and coax cable. The adjective "super" refers most specifically to the information carrying capacity of the fiber network, which is expected to exceed five Terabits per second by the year 2000. Just as the road system includes a hierarchy of local, and state and federal roads and highways, the information superhighway will contain narrow, wide and broadband networks, with the latter being capable of carrying multimedia information (voice, data, image and video). Finally, the information superhighway will be global in scope; although most of what follows in this paper will be addressed to the "U.S. hub" of this infrastructure (parenthetically, the metaphor of a highway loses its power when viewed from a global perspective).

The technical and commercial convergence of telephony and cable TV creates a variety of efficiency benefits from existing and emerging communications services to U.S. business and residential consumers. These benefits include:

*innovation in new communications services for business, consumers, education, entertainment, heath care, and others
* improved quality of service; and
* lower costs for both new and existing services,
* lower transaction costs for all goods and services,
* improved physical environment because of the significant trade-offs between transportation and multimedia communications.

The economic and social logic of the convergence is to be found in:

the changing nature of competition in the provision of traditional services in both telephony and cable, and the convergence of a whole host of new industry players into a single communications market;

- the reduction of significant risk in provisioning for new communications services through the sharing of resources and expertise; the technological architecture's of telephone and cable networks;
  the need for the U.S. communications service and equipment providers to remain globally competitive in world communications markets; and
- the need for the U.S. to maintain a leading edge communications infrastructure to support the country's economic, social and military goals.

While an in-depth discussion of each of these factors is beyond the scope of this paper, it will provide a look at the major factors creating convergence, and the principal benefits.

2: **Convergence**

A myriad of previously discrete industries (among them, telecommunications, cable, computer hardware and software, news and entertainment, consumer electronics, and office automation) are converging into a new $1 trillion market in 1993.[l]

There are four kinds of players in this new marketplace. The first can be called **content** companies: the news and information service providers, entertainment services, computer and video game software developers, and the musical and movie producers. The second, **packagers,** consists of broadcast networks, local television stations, cable TV program services, and on-

line information services. The third, **distribution** organizations, includes transport companies such as telecommunications, cable networks, wireless communication systems, and competitive access providers. And the fourth group, access enablers, consists of computer business, software, network switching and plant, satellite and wireless equipment, consumer electronics, and office automation companies. (See Exhibit 1)

2.1: **Content: From Analog to Digital**

The most important technological change behind the convergence of communications industry is the conversion of virtually all these businesses from analog to digital products, formats, and services. This conversion from analog to digital means that all information content -whether a movie, telephone conversation, or computer data - is available in a common format that can be accessed, manipulated, and used on the same or similar types of equipment. This means that all information, voice, data, image, and video can be available to users simultaneously and in a multimedia format. Bellcore estimates the RBOCs plan to make ISDN (Integrated Services Digital Network) available on 62 million lines or 54% of the U.S. access lines by the end of 1994.[21

2.2: **Distribution: From Electronic to Photonic**

In terms of the distribution of digital information, fiber optic technologies are permitting a dramatic shift from electric to photonic transmission. This will create an economical and secure network that offers virtually unlimited capacity. An additional change in transmission technologies, from a wire base network to a wireless network, will make any form of information (voice, data, and video) portable and available anytime and anywhere. The U.S. now has approximately 12 million miles of fiber installed - compared to 1.2 billion of copper phone wire.[31

2.3: **Access: From Single to Multimedia**

Nowhere will convergence be more visible and perhaps significant than in the area of access technologies. Ultimately, the office and home access terminal will include a combination of the telephone, computer, and television. Importantly, from the users' perspective, a technological shift from proprietary systems to open systems will enable the user to have tremendous choice in access equipment that will be compatible with other equipment and its network. Additionally, new access technologies will free the users from the tyranny of the keyboard, mouse, or touchpad by allowing users to voice activate telephones, computers, and even television. Sprint is already offering voice-activated calling service.

2.4 Semiconductors: The Key Technical Driver

Despite all the technological changes described above, the primary driver in the marketplace is the dramatic cost/benefit performance of semiconductors. Because it is composed of a confluence of essentially mature businesses, this new industry is moving quickly from concern about technical compatibility and product deployment, to one that is much more competitive and cost-focused. Semiconductor (computer chips) technology is the principle force driving the convergence of these businesses and reducing costs. The dynamics of semiconductor business are such that every ten years they experience one hundred fold decrease in costs, and every ten years they experience a one hundred fold increase in functionality. If nothing else, this promises to keep the new market competitive and cost conscious. Recent semiconductor and PC prices bear this out.[4] Intel has been introducing new chip designs at a rapid rate,

each of them being faster and more powerful than the previous models. In benchmark tests, the 80486 chip was nearly 1,000 times faster than the 80286 chip used for the first time in 1982. When new models are introduced, previous models are heavily discounted, for example, Dell Computer Corp. sold a computer with an 80386 CPU chip running at 33MHz for $4,500 vs. just $1,500 for the same computer today. [5]

3: **Convergence of Telephony and CATV**

One of the most important aspects of convergence among communications industry players is that of telephony and CATV. With the possible exception of the Internet, these are the giants of communications distribution in the U.S. with large, ubiquitous, sophisticated, "user-friendly" networks. However, within the vision of the information superhighway, both have significant shortcomings that can overcome by their convergence. The convergence of these networks is being driven by the technologies described above, but also by the competition that technological convergence (and regulatory changes) creates.

3.1: **Competition in CATV and Telephony**

Despite popular claims to the contrary, U.S. prices for basic telephony and cable services are among the lowest in the world, while service quality is among the highest.[6) New competition in both the telephony and cable businesses will make services in these two industries even more competitive with higher consumer

value-added. In addition to the potential competition between cable and telephony companies themselves, each industry faces significant additional competition from other new competitors in their core businesses.[7)

3.2: **Competition in CATV**

Local exchange carriers (LEC) are a major source of potential competition for cable companies because of the telephone suppliers' ubiquitous customer presence and installed base, new video compression technologies such **as ADSL, and** their evolving fiber networks.[8] A critical component of the LECs' potential entry into the CATV business is the experience they have gained in the international market. With the exception of Bell South, all the RBOCs are involved in some type of foreign cable venture. U.S. West, for example, has become the largest cable television operator in the U.K. through its TeleWest joint venture with TCI. It owns 16 cable operations, nine of which provide telephone services, and has the potential to reach 2.9 million housebolds.[91 Given further regulatory relief, the RBOC6 could easily transfer their cable and information services experience gained abroad to the U.S. marketplace.

Furthermore, traditional wireline CATV is increasingly facing competition from new wireless CATV services and perhaps more importantly from direct broadcast satellite (DBS) from suppliers such as DirecTv and Cross Country Cable.[10] With the emergence of digital compression technology, wireless cable, and DBS, CATV will become even more competitive as it becomes possible to expand channel capacity from 33 to 300 channels.[1 I]

3.3: **Competition in the Local Loop**

Telephone companies on the other hand have been experiencing increasing competition in the local loop since the Carterphone decision in 1967. Since that decision, interconnect companies have been providing an alternative to Centrex (telephone company central office switches) services through customer owned PBXs. Today, virtually anyone with a comparatively small investment in a switch can not only handle his or her own telephony needs but also supply local telephone service to others as well. (According to media reports, the Archdiocese of New York is offering local telephone service.) Even some utility companies with extensive property right-of-ways, such as the Tennessee Valley Authority, have developed fiber optic networks with the potential to offer competitive telephony services. One such company, Williams Natural Gas Company, from Tulsa, Oklahoma, has an extremely active telephony subsidiary, Wiltel, which offers a wide range of communications services largely based on their fiber network overlaid on their gas distribution pipeline network.

3.4: **Customer Premise Equipment (CPE)**

Companies that provide telephony CPE services and equipment to customers are commonly called interconnects, and sell traditional telephony switching and access equipment. The PBX equipment market, which represents a big slice of this segment may have reached maturity as sales have been declining for the past several years. The market for PBXs and key systems plunged 15% in 1991, some analysts estimate the decline being twice that.[12] However, of growing importance is the increasing competition from PC LANs and other networking systems that could potentially offer integrated multimedia communications to large groups of users. Despite the fact that annual U.S. revenues for LAN products now exceed $10 billion, the LAN market continues to grow at double-digit rates.[13] With the availability of such equipment, large users can essentially by-pass traditional LECs and create huge

internal networks that span the country and the globe. Even smaller users can increasingly by-pass the local telephone companies by connecting directly to new suppliers known as alternative or competitive access providers (ALTs or CAPs).

3.5: **Competitive Access Providers (CAPs)**

The increasing penetration of CAPs such as Teleport and Metropolitan Fiber Systems (MFS) is skimming the high revenue customer base of the LECs, primarily the Bell Operating Companies (BOCs). The U.S. "alternate access market" is projected to be about $2 billion by the year 2,000. In addition to this estimate, it has recently been indicated that MCI would invest some $20 billion in the provision of local loop services for its major customers by 2,001.[141

With the FCC's co-location decision in September of 1992, the local exchange is clearly under competitive siege. The FCC's ruling states that the LECs must aflow co-location for interstate special access traffic. Ibis permits CAPs to collocate their switching equipment in LEC facilities, which allows them to reach customers not directly linked by their own fiber network. As a result, the CAPs are driving innovation not only in network architecture, but also in new applications and services. The CAPs are able to provide superior pricing, reliability, and quality of service through the use of more efficient technology, by avoiding the large staffs and overheads (a result of years of non-market regulatory oversight of prices and profits), and by being relieved from the need to provide non-economic services in rural areas.[15] As a

result, CAP marketing efforts and business strategies are often seen to be much more responsive to the needs of large telephony-intensive businesses.[161

3.6: **Competition in CATV**

Just as the LECs have been developing their interests in **CATV, the** cable companies have been entering the local loop through their ownership of CAPs (for example, **TCI, Cox, Comcast,** Continental, and Time Warner each own a share in the largest CAP) and Personal Communication Services (PCS) suppliers, and by developing their telephony experience in overseas ventures.[17] Today, over 90% of the CAP industry is controlled by cable television companies. Synergy between the residential cable networks and the business customer linkages provided by CAPs has been a driving force towards competition in the local loop.

Today, the convergence of the cable TV and telephone industries has resulted in cooperation as well as competition. And, there are many advantages to the fit between them. The cable companies,are looking for the telephone industry's financial stability and expertise in switching, network management, and R&D; while the telephone companies are interested in cable companies' competencies of wideband communications and fiber infrastructure.

In the next few years, cable companies will increasingly invest in upgrading and building their networks. This is not only to prepare for interactive information and programming services but also to ensure that they will be able to integrate into cellular and PCS.

3.7: **Wireless**

Although CATV, CPE, and **CAP** suppliers have successfully penetrated the local loop, perhaps the greatest potential source of competition will be current and emerging wireless services. The rapid decrease in the cost of cellular service, the emerging potential for specialized mobile radio services (SMR) to provide consumer services, and the imminent availability of PCS are perhaps the most significant threats to the wireline local loop. Cellular and PCS product penetration is expected to be some 30 percent of U.S. households by 1999.[18] A number of diverse companies are entering the telephony arena through ownership in cellular, SMR, and PCS organizations. Interestingly, for example, the Washington Post and Cox Enterprises jointly hold a 70 percent interest in American Personal Communications, a PCS company.[19]

The convergence of telephone and cable businesses is taking place within the context of a larger communications industry environment that is changing rapidly and dramatically. Over the next several years, the communications landscape will be radically altered, with a number of heretofore separate and distinct industries converging into a single market.

4: **Market Maturity**

While there is little dispute about the overriding role of technology in shaping the new communication market, today's communications environment has clearly evolved from one driven by core technologies to one driven by user applications. The telephony and cable industries are no longer in a growth phase characterized by fundamental technology change. Instead, these industries are in a mature market environment characterized by the entrance of a large number of new competitors who can offer similar products and services for a variety of applications. These are markets are also characterized by intense price and feature competition.

Likewise, the traditional mainframe computer industry and the relatively newer PC business are clearly in a mature stage as industry leader IBM faces significant and well documented challenges from a number of competitors. Currently, market observers estimate that there are some 200 million PCs on the planet with some 45 different architecture's. Even the computer software market is

in a mature phase as there are today, for example, some seven different competitors with PC operating systems. The telecommunications service industry can also been seen to be in a mature phase, as growth in new lines has slowed considerably, while revenues from traditional services have not increased for several years. The cable industry, after their rapid growth in the '80s, is also entering a mature phase as their subscriber growth will grow just 2.9% in 1994, to 59 million households.[20)

4.1: **Market Demand**

These technological and regulatory forces described above are dramatically reshaping the communications market structure. Above all, this new market is increasingly being shaped by the wants and needs of the U.S. consumer: residential consumers demand to shop at home and want "video on demand" while commercial organizations want high-speed voice, data, image, and video, anytime, anywhere in the world, The users want to have not only worldwide voice over the wire network, but also data, video, and all kinds of new wireless, or untethered services.

To date, the most comprehensive study on market demand for telecommunications and information services is the Pennsylvania Telecommunications Infrastructure Study.[21] The Pennsylvania state government

commissioned Deloitte & Touche to gain a better understanding of the social and economic implications of emerging telecommunications services. While the study revealed an anticipated high demand for information services in the commercial sector - especially in the areas of health care, education, government, and financial services - the most surprising result was the strong demand from residential consumers who were not only interested in different types of information services but also willing to pay higher access fees and monthly service charges for them. Respondents indicated strong willingness to pay for a large variety of new information services.

5: **Convergence: Leveraging Core Competencies**

The convergence of cable and telephony networks and the creation of the information superhighway will occur more quickly and less expensively if users receive increasing functionality and information providers can lower costs and increase services. The most effective way to accomplish this is the integration of CATV and telephony networks, leveraging of core competencies of each in terms of technologies, customer service, and information provisioning.

5.1: **Leveraging Core Competencies**

The cable television industry operates the nation's only ubiquitous, wireline local broadband network. The increasing use of optical fiber and video compression technologies will dramatically alter CATV networks by the end of the decade. However, current CATV network configurations and characteristics do not permit the fall realization of the "information superhighway" without significant new costs. Cable operators are also experts in the packaging and delivery of video information.

On the other hand, local and long distance telephone companies have a ubiquitous, nationwide, broadband fiber, integrated, and interactive multipoint network with a capacity for real time switching and billing. In addition to a hundred years of experience as open access common carriers of interactive voice and data communications on wireline network, the telephone companies have also gained experience in wireless network in the last 15 years. However, the absence of a broadband connection to individual homes and offices is a severe limitation. Costs to upgrade the local loop to broadband are excessively high.

The complementary technological and service characteristics of the two networks suggests that a hybrid network would constitute the most logical, quality and service-oriented, and inexpensive approach to provision new multimedia services.

5.2: **Cable Networks**

Cable network operators primarily use a proprietary (does not interconnect with other networks), uni-direction (one-way only), point-to-point (as opposed to any point to any point), tree and branch network, where the signal is split and re-amplified many times before reaching subscribers farthest from a distribution hub. In this configuration, television signals are sent as electromechanical impulses or waves from a cable operator's headend through large trunks made of coax cable, to smaller feeder cables, or branches, into local neighborhoods. A drop cable connects the branch to a subscriber's home television set. The cable network today offers ubiquity (cable systems pass 96 percent of U.S. households) and capacity, with the standard coax drop cable able to carry 150 television signals - some 900 times the capacity of telephone copper twisted pair cable. Today's cable system typically provides some 40 channels.

However, the distribution and service of a quality video signal demands a large number of amplifiers that require frequent maintenance and attention. Subscribers closest to the hub generally get a better signal than those in more remote locations, but for the same price. In addition, the network is arranged in a serial fashion so that an amplifier failure near the hub results in a loss of signal to the rest of the branch. These tree and branch networks are comparatively more expensive to upgrade, expand, and maintain. In terms of maintenance, it should be noted that cable companies do not provide the real time, on-line systems and service that telephone companies provide.

With this standard cable network configuration, all services are prearranged and programmed. Cable's limited pay-per-view services require preplanning and manual user and provider actions to effect (although many cable providers are now using addressable converters - TV set-top boxes that allow increased communication with the cable source or use telephone company provided automatic number identification (ANI) to simplify this interaction). Some cable systems have announced plans to explore multisystem, interconnected regional hubs to address the proprietary issue mentioned above, although this is still very limited.

Recently, cable operators have installed fiber backbones to alleviate some of these problems and to provide improved signal quality, increased channel capacity and availability, and reduced maintenance costs. In addition, fiber allows cable operators to reduce the rather large tree and branch network into smaller and more manageable networks (although still tree and branch) that can, with the addition of new video sources or servers, customize services to selected neighborhoods. Digital compression technologies (squeezing more signals into the same space) also allow cable systems to provide more video signals over the same cable. Over the next decade, cable industry forecasts suggest that cable operators will spend some $14 billion to upgrade their networks and that almost 40 percent will be for fiber optics in the trunk and feeder plant.

The cable television industry has changed dramatically over the past two decades, from alternatives for broadcasting in areas of poor or no broadcast reception (mostly in rural areas), to the dominant supplier of television signals in metropolitan markets. Technologically, they've evolved from pure coax to hybrid fiber-coax technology. Increasingly, they will undertake a transformation from providing CATV only to full service residential broadband service using fiber ring technologies similar to telephone companies.

In order to achieve this new network architecture, the cable companies maintain strong vertical relationships with their suppliers. Cable companies theoretically have only practiced point-to-point services, digital compression technologies are allowing the cable companies and their suppliers to develop the hardware and software necessary to face the future of information technologies. With rapidly evolving technology and distribution architecture, CATV is ideally suited for delivering vast amounts of two-way video, voice, and data to homes and businesses with high speed and quality. For example, over the next four years, TCI intends to spend $2 billion in reengineering its cable systems with fiber optics. The plan will involve 400 communities in 37 states, affecting 9 million customers, or 10% of all homes in the U.S.[22]. Current cost estimates indicate that cable company Fiber To The Curb (FT7C) costs will be at least $1,000 per customer. There are no current estimates for their potential Fiber To The Home (FTTH) costs.[23] (See Exhibit 2)

5.3: **Telephone Networks**

Telephone companies, on the other hand, have provisioned an open access interconnected, interactive (two way flow of information), centralized electronically switched (virtually anyone can connect to anyone else anywhere in the world using the telephone dialpad) network. The network is tariffed and offers nondiscriminatory access by any party. It is a flexible, expandable configuration that can readily enlarged to add both information users and suppliers. In a broadband configuration (typically fiber optic instead of a copper one), the capacity of the network can be arbitrarily expanded in terms of inputs (i.e., video channels) without any modification to the access and distribution plant which comprise some 80 percent of the network costs. By comparison, a typical CATV system upgrade, for example, from 50 to 100 channels would require a total duplication of the current 50 channel network. and would still limit access to the 101st service provider. The central switch network also offers lower cost of maintenance and control; and as noted above, the maintenance and operations control of the telephone is significantly more advanced and dynamic than that of the cable networks. Telephone company costs for FTTH range from $1,500 to $3,000 per subscriber.[24, 25]

As can be seen, CATV networks would operate to limit both provisioning of services and user access, tending to push prices higher, while the centrally switched, expandable broadband telephone network would work to decrease prices as new users are added, as seen in the traditional, common carrier narrowband network of today.

In addition to their long history and experience as common carrier providers of quality, service-oriented, and ubiquitous communications channels, the LECs are able to provide automated, real-time billing without pre-subscription. Further, given the high degree of customization and control provided by the intelligent central office switching system, the LECs are able to control, as needed, access to certain information sources such as those with adult content.

6: **The New Infrastructure**

During the Industrial Era, physical infrastructure such as roads, electrical and telephone networks was a precondition for economic success. For example, the TVA was perhaps the most important component in the modernization of the Southeast. The development of the interstate highway system provided the U.S. one of its principle economic advantages (and perhaps creating the metaphor of the information superhighway). Today, however, the need for an integrated cable and telecommunications network has become the most critical component of that infrastructure.

With evolving technologies, the current telecom transmission network which based on copper wire is, figuratively, being turned into gold. It is a wellspring for entrepreneurial endeavors and a major contributor to other areas such as education, entertainment, and health care.

For example, the network is already creating significant transformations in delivery of medical services. Currently, remote diagnosis teleradiology (transmitting x-rays over the network) is improving medical services. Heart pacemakers are already being monitored over the phone.

'Me innovative U.S. health care industry is becoming a leader in using new media to reduce costs and improve

service. Innovative news, entertainment, and other information service providers are closely behind. The benefits to the nation's long-term growth and prosperity can best be summarized by the big three E's: economics, education, and environment.

In the area of economics, the advanced network will have two major advantages: it will reduce costs for existing commercial and residential users (transaction and administration costs can be greatly reduced through the use of shop-at-home, video conferencing and EDI); and it will help create new businesses. Also, this new network will allow companies to operate anywhere in the country to reduce costs . For example, a unit of Bankers Trust recently relocated from New York to Nashville Tennessee.

In terms of education, distance learning will be one of the first and most important benefits of the country's advanced network. Some envision that it could potentially change the nature of education by eliminating the time and distance constraints on students. Students and teachers in different locations will be able to meet face to face via video conferencing. It will give students - of any age, requiring instruction in virtually any subject - access to the best teachers available, no matter where they're located. And it will allow students to take courses at home or at school at the time they choose. Students can also communicate with others in various areas to share ideas and to learn from each other.

Distance learning has already well underway and is experiencing rapid growth. Mind Extension University (MEU), a cable channel based in Englewood, Colorado began in 1987 and now reaches 23 million homes. MEU offers interactive high school courses and students can earn bachelor's or even master's degrees from Colorado State University.[261 The University of Maine and the University of Maryland have 4-5,000 students at over 70 locations throughout the world.[27] Learning Link, which connects about 22,000 teachers and students nationwide has allowed students to conduct Roadkill project to study the number of animals killed on the road. Students in different regions were assigned to observe the dead animals on the road. They learned not only the number of animals killed on the road, but also the variety of animals in different areas and the migration patterns of some animals.[28]

Rural areas have also embraced the idea of distance learning with enthusiasm for obvious reasons. They are no longer isolated from other communities by distance and constrained by their limited resources. At five high schools in rural Gibson County, Tennessee, students can take calculus and advanced English by live video which connects them to eight universities and 20 other counties, [29] Patrick Portway, executive director of the U.S. Distance Learning Association in San Ramone, California also envisions improved communication between teachers and parents through telephones, answering machines, and voice mail.[30]

Even in the area of the environment, the information superhighway will play a major role. Two of the most compelling features of the advanced network are shop-at-home and work-at-home. Each area is growing rapidly and together can substantially reduce America's oil consumption and in turn reduce auto emissions. A recent study determined that shopping trips accounted for the majority of U.S. fuel consumption. [31] Shopping on the network will greatly reduce fuel use and the related pollution.

The new information superhighway may also be the solution to the ever growing traffic problem of America. Even though $100 billion was spent in building the Interstate highway system in America, it has exceeded the demand of the fast growing number of cars (estimated at 1.8 cars per household). People spend more time driving than ever before not only because of the increased traffic but also because of the greater distances they commute to get to work. This creates a huge consumption of fuel, waste of time and productivity spent in the car, worsening pollution, and very unhappy drivers suffering stress from fighting the traffic everyday. The new technology can reduce the number of cars on the road by allowing more people to telecommute to work, allowing people to shop at home, substituting business trips with video conferencing, and eliminating unnecessary paper documents.

7: Conclusion

U.S. is about to enter into a new era of communications that will bring together disparate industries. The realization of this new information superhighway will not only be a major step forward in advanced technology but will also provide a tool that will improve all other sectors of our society in a variety of ways. As this paper has shown, the convergence of telephony and CATV will be a vital step in this evolution. The CATV and telephone industries have complementary core competencies that through convergence will the reduce the costs and time necessary to create an important part of the new communications infrastructure.

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Exhibit 1

Content
• Entertainment & News Media
• Programming & Video

($5504W b)

New Education

Transport
• Interexchange carriers
• Cellular & Wireless
• Telephony
• CATV
• CAP ($180-190 b)

Publishing

New Media
Market

Consumer Electronics

Software

Packagers
• Broadcasting Networks
• Cable TV Programming
• Audio & Video Gateways On-Line Services
($40 b)

Kno ts

Information rvices;

Access
• CPE Equipment
• Digital Switches & Siqrvers
• Fiber Optics & Cable
• Satellite & Wireless ($80-100 b)

Based in part on: Deloitte & Touche, 'Speeding Toward The Interactive Multimedia Age,' December 1993.

Exhibit 2

Cable Industry Capital Expenditures by Segment

Coax/Fiber (22%)
Headend/Antenna (119%)
Line Extenders/Taps/Connectors (29%) 777

	1994	1995	19%	1997
	603	751	928	984
	519	646	798	847
		967	1195	1267
Converters/Traps (30%)	805	1002	1239	1314
Total Capital Expenditures	$2704	$3366	$4161	$4413

Digital Expenditures by Segment

D-99	1999
973	960

837	826
1253	1236
1299	1282
$4362	$4304

2000
945
813
1217
1262
$4239

	1994	1995	19%	1997	1998	*M*	*M*
Headend/Antenna (39%)	131	370	698	906	882	859	837
Converters[Traps (61 %)	204	342	348	443	432	420	410
Annual % Growth		182%	89%	30%	-3%	-3%	-3%
Total Digital Expenditures	$335	$945	$1782	$2311	$2250	$2191	$2136