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Towards a Sound Public Policy for Universial Broadband Networks

Bruce L. Egan

Columbia Institute for Tele-Information
Graduate School of Business
809 Uris Hall
Columbia University
New York, New York 10027
(212) 854-4222

Towards A Sound Public Policy for Universal Broadband Networks

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1.0 Introduction

All stakeholder groups agree the domestic U.S. economy will derive great strength and vitality from the development of ubiquitous high-speed (broadband) public information networks. Yet those responsible, or at least in a position to help create such networks, cannot agree on who should do it or how and when it should be done. In fact, there are currently no serious formal or informal negotiations taking place in the U.S. among the major players to work toward a universal broadband communications network standard. This is not the case in many foreign countries, where much activity is directed toward developing a public policy consensus for a broadband standard. Some attribute progress in other countries to factors which cannot be duplicated in the U.S., such as their socialist bent or their smaller and more centralized economies. Whatever the reasons, the various stakeholder groups in the U.S. should not use them as an excuse for inactivity. The public policy goal of universal broadband information networks is one that deserves active participation and cooperation among those groups in a position to bring it about.

The purpose of this article is to focus on the issues which a sound public policy must concentrate on in order to stimulate development of universal broadband networks in the U.S. This article and many others are intended to encourage positive stakeholder activity and a spirit of cooperation among those interest groups that can help make the social goal a reality.

The conclusion reached herein is that the existing communications networks in the United States suffer from serious fragmentation and that the situation is getting worse. While casual observation would suggest that much of the network fragmentation is a result of competition, tne evidence indicates that this is not the case at all; the economics of the communications marketplace could quite logically support many different network owners and operators. Rather, it is the institutional barriers constructed by various statutory, judicial and government agency decisions which have created incentives for public network fragmentation and hindered the adoption and deployment of new technologies. Although many of these institutional restrictions were designed to promote federal competition policy, an effective policy need not promote network fragmentation to achieve a market with many suppliers. Government rules that provide artificial incentives for segmentation and unduly restrict the evolution of network technology are competition policy gone awry. As a result, telecommunications firms operate in an environment of uncertainty about what behavior is or is not ultimately acceptable.

Yet, out of the apparent chaos is order. An analysis of underlying patterns of firm behavior reveals that firms are gradually cooperating and adopting technology in spite of institutional constraints. There is now ample evidence that many of the institutional roadblocks to Universal Broadband Networks are being relaxed in response to the behavior of firms and the desires of customers. While many believe that a technologically efficient public communications infrastructure would require government intervention, the strong conclusion herein is that government intervention is actually the primary force preventing it.

1.1 What are Universal Broadband Networks

The words "Universal Broadband Networks" (UBNs) lack a single accepted definition. Since this article addresses the public policy goal of establishing UBNs in the U.S., it is worth clearly explaining the term. First, UBNs should be universal in the sense that members of the public, both businesses and residences, will have nondiscriminatory access to high-speed information networks. While this does not mean access for everyone at the same time, the public policy goal of UBNs will be to make the system as widely available as practicable, subject to physical, political and institutional constraints.

Second, UBNs will have one uniform, universal, and sufficiently stable standard for basic switching and transmission so that firms will be willing to invest in facilities required for the network. This is necessary to optimize the amount of time required to introduce and adopt new technologies and the physical network devices which use them. The standards requirement is critical but it must not be static. The problems with fixing standards are well known and some flexibility is needed. With the development and adoption of technical network standards, supplier entry is encouraged and there is no limit to the number of network equipment suppliers, owners and operators.

Third, the goal of UBNs will require the creation of new political and institutional arrangements and changes in some existing regulations and statutes. The resulting political and institutional environment must be conducive to stimulating voluntary cooperation among the key suppliers of telecommunications equipment and services. This is not to say that illegal collusion in restraint of trade must be allowed; rather, the institutional environment should encourage competitive suppliers to contract with each other whenever the public interest goal of UBNs is served. For example, obsolete regulations regarding telco line of business restrictions eventually may have to be removed.

Under any scenario, achieving UBN capability is an expensive and time-consuming process, but it is one that offers even greater public benefits. It is therefore incumbent upon public policymakers to allow for an efficient and timely deployment. Political and institutional roadblocks may cause significant losses of economies of scale and scope due to inefficient deployment of resources and could even preclude reaching the goal of UBNs. Finally, failing to reach a timely agreement on domestic UBN development would aggravate the already deteriorating international competitiveness of the U.S. economy.

The remainder of this article is devoted to a high-level analysis of the current and future environment within which the potential realization of UBNs must occur. The analysis focuses primarily on the political economy of creating a market consensus among key supply-side players for the adoption and deployment of UBN technology in public networks. Due to time and space constraints, the next three sections only briefly address technology, economics and institutional considerations, respectively. Section 5 begins to analyze the views of major stakeholder groups that will have an impact on UBN deployment. Section 6 provides a short discussion of customer concerns or the demand side of UBNs. Section 7 examines producer concerns or the supply side of UBNs. Section 8 is a more detailed analysis of the UBN supplier marketplace and Section 9 concentrates on the political economy of developing a supply-side consensus regarding UBN deployment. Finally, Section 10 summarizes major conclusions and provides a public policy prescription for achieving the goal of UBNs and discusses a future research agenda.

2.0 Future Communications Technology: A New Paradigm

It is clear that the communications technology of the future will provide for integrated communications services on both public and private networks. Although the direction of the technology-push is known, it is not yet clear exactly how the integration will occur due to unsettled institutional and public policy issues. The rapid advances in digital and photonic technologies and fiber-optic transmission systems represent a technological paradigm shift in the information processing and transmission industry, allowing transmission and switching speeds to be measured in billionths and even trillionths of seconds. Network hardware and basic control software may eventually provide for a standardized generic information highway on which any conceivable service application may travel. The least common denominator of digital encoding and signaling will allow for service integration without perceptible loss of transmission speed. This appears to be the technological goal. Clearly, universal high-speed integrated digital communications networks are technically possible and technological change is occurring so rapidly that forecasts of the time required to effectively achieve UBNs are constantly being revised. Whether this trend represents technological revolution or merely an evolution, those who fail to keep pace with the changes will be left behind, struggling to solve new problems with old tools.

2.1 Communications Networks of the Future

In terms of both supply and demand, the communications network of the future is fundamentally different from today's. In today's service-oriented marketplace, the facilities of telcos and other communication providers are specific to the particular service offered. In the future, these facilities will be capable of offering a broad range of services. With broadband technology, network functions such as basic switching and transmission are commodity-like and customers will use these capabilities for whatever final services they demand. Current examples of commodity functions are circuit and packet switching. It is important to distinguish network functionality from services. Network functionality refers to information processing and transmission which derives from network hardware and control software capable of high-speed digital processing. Specific software applications which use the functionality of network facilities to provide network intelligence for the final customer represent communications services. Current examples of communications services are video and voice-store-and-forward service. Generally, telecommunications network functionality is not obtained from CPE or other facilities outside the telco network; on the other hand, many telecommunications services may be, and often are, derived from network peripherals or CPE.

In summary, future communication networks are very different from today's both in architecture and functionality. Customers will obtain a host of basic network functions over a single digital access facility. Such arrangements may eventually allow customers to reconfigure their own virtual network requirements in real time.

2.2 Forecasting Technology

Needless to say, forecasting is a very risky business, especially since paradigm shifts usually are the result of unanticipated events which cause inflection points and destroy trends. However, the technological paradigm shift in the case of broadband communications has largely already occurred. The next several years will yield new trends as adoption of fiber optic network capability occurs and as fiber-compatible, next-generation switches reach the design and production stages. The new paradigm will also signal the phasing-out of networks based on the old technology. Figure 1 presents estimates of future technology adoption. While the preferred technology for the next several years is probably certain,[1] the exact form of technology adoption once physical deployment begins is unknown. Much of this article is devoted to examination of this question. Even though the new paradigm favors fiber optics, there are still some fundamental deployment questions. There has been some discussion of a move toward photonic switching, coherent optics, and "connectionless" networks.[2] As one who is not technically capable of evaluating such deployment alternatives, I choose to assume that the broadband communication standards currently under

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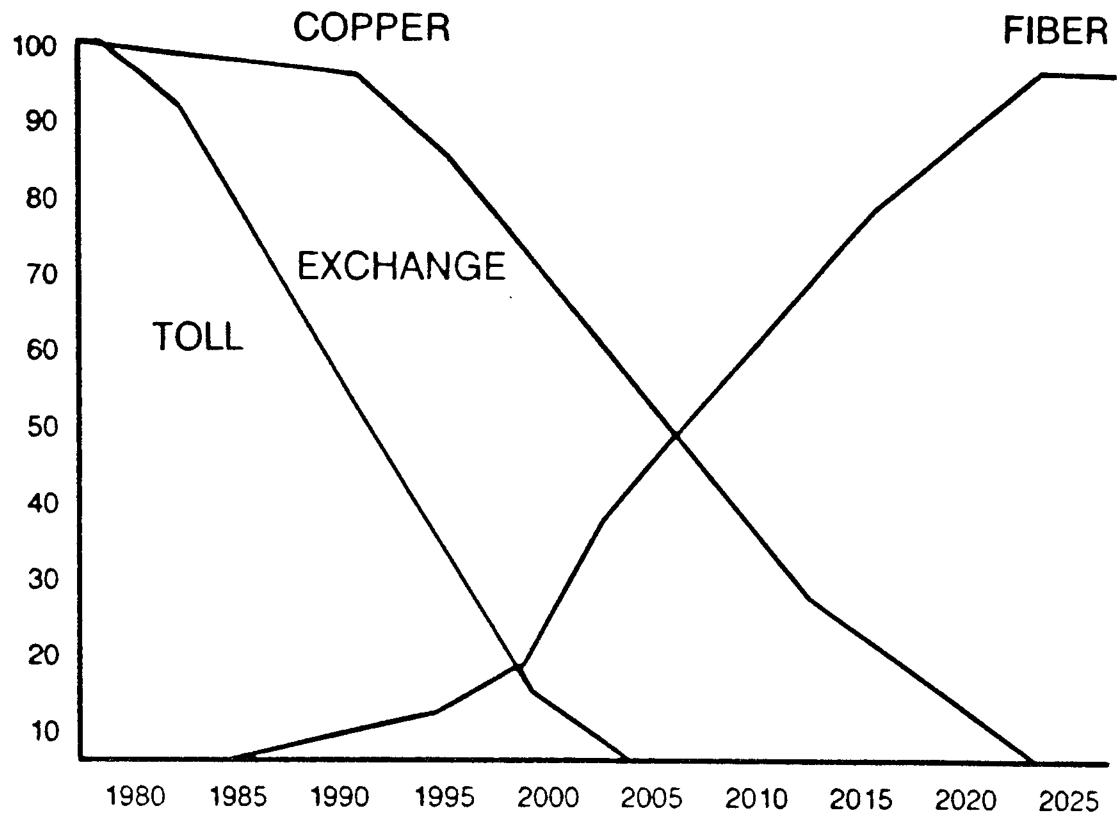
[1] CCITT Study Group XVIII Task Group on BISDN Aspects (BBTG) was formed in 1985 and by July 1986 its first report was issued. A recommendation from the BBTG is to be published by the end of the current study period, which is 1988.

[2] One recent article puts the time required for practical application of coherent optics in public networks at 5-15 years, "Coherent Communications - The Fourth Generation in Optics," Telecommunications, June 1988.

Figure 1



Source: Pacific Bell in Lightwave

discussion at ANSI and CCITT prevail. This should result in a basic transmission rate of about 150 Megabits per second (Mb/s) and a "building block" rate of about 50 Mb/s. Broadband switch architectures and optical switching are being actively discussed, but VLSI digital electronic technology is assumed to prevail in the next generation of production switching devices.

2.3 Technology-"Push"

There is some controversy about the ultimate relative impact of the technological paradigm shift on the deployment and social realization of the communications networks of the future. The other half of the technology-adoption picture, demand-"pull", will be discussed later. It is the opinion of the author that the underlying structure of the supplier marketplace makes technology-push, in the specific case of broadband communications at least, a very powerful force in technology adoption.

The supplier marketplace is characterized by a small group of scientists and engineers endorsing a technological paradigm and designing production equipment using a very homogeneous, indeed standardized, technology. Relatively few scientists are qualified experts on development of the new communications technology, and at many recent, well-attended technology and standards-setting forums, these experts have come to remarkably similar conclusions regarding the optimal design approach to broadband communications systems. To the casual observer, they seem to have jumped on the bandwagon of high-speed asynchronous time-division multiplexing (ATM) and fiber optic transmission. However, there is still some discussion of high-speed synchronous transfer mode (STM) and various hybrids.[3] Due to the scarcity of scientific talent, these same experts often work for designers and manufacturers of large-scale switching and transmission systems, which represent a highly concentrated industry with only a handful of major firms. Indeed studies have shown that only a few firms may survive in the future production market for large-scale network systems.[4]

It is thus only logical to forecast the convergence, or at least fundamental technological similarity, of supplier equipment to serve expected demand for next-generation networks. Not only is technology pushing the major manufacturers to keep their equipment line state-of-the-art, but due to the immense production costs, it will probably not be possible to continue production of older generation equipment. The importance of the oligopolistic or highly concentrated structure of the switch supplier market reinforces the power of technology-push

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[3] "Toward an International Broadband ISDN Standard," Steven E. Minzer, Telecommunications, October 1987.

[4] Some recent data on the supplier concentration of the switch market is contained in, "U.S. Central Office Switch Market," Telecommunications, February, 1987 by Joe Kellagher. As capacity of new switches increases, the market should become even more concentrated.

regardless of demand-pull activity. This is because state-of-the-art equipment for the communications network of the future will require broadband capability regardless of its ultimate use, which for some time may be primarily to support demand for narrowband services. Fortunately, broadband "capable" communications networks are also quite efficient at handling narrowband service applications.[5]

2.4 Broadband Standards

Domestic (ANSI) and international (CCITT) standards-setting agencies are codifying the new technological paradigm for public communication networks. In contrast to the historically slow rate of standards development and adoption for fundamentally new network systems,[6] the broadband standards are being established at an unprecedented pace. Assuming that the engineering compromises recently reached in the international scientific community prevail, production of standard-compatible network equipment could occur by the early 1990's.

The new broadband network transmission standard currently under consideration in the T1 committee of the Exchange Carrier Standards Association (ECSA) of ANSI and in CCITT Study Group XVIII is called SONET (for synchronous optical network). To date, the standards negotiations have identified a digital transport mechanism for carrying all information in the communications network of the future. It is an extremely flexible transmission standard whereby network routing and control signaling, or message "overhead", is part of the message itself. This is sometimes referred to as "in-band" signaling and is a key feature of a general purpose asynchronous digital network. In a synchronous transfer mode, such message overhead is not required for every information packet since a time or space "slot" may determine message routing and control. The "payload" portion of a transmission is the user-supplied message, which is defined as required by the user. The basic rate signal for SONET is about 150 Mb/s. Commitment on the part of CCITT committee members to include current basic transmission rates of national telecom authorities in the SONET digital transmission hierarchy has aided progress in adoption of the SONET standard. Through the design of a flexible optical interface, SONET could accommodate the current North American network transmission rates

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[5] "Broadband" is really a misnomer as a characterization of public networks until customer demand for truly broadband services takes off. For the next decade at least, "broadband capable" is a more accurate characterization as digital fiber networks are deployed. The high speed of network signaling is used to efficiently multiplex many narrowband service applications. To see how this may be done, read Hsing and Minzer, "Preliminary Special Report on Broadband ISDN Access," Bellcore, Dec. 1987.

[6] ISDN standards developed slowly over more than a decade and still are not complete. For some information on ISDN deployment problems in the U.S. see: Dwight Davis, "Phone Companies Argue Over New Standards," High Technology, August 1987 and Kenneth L. Phillips, "ISDN's Built-In Problems," Telecommunications, October 1987.

of 1.544 Mb/s (DS1) and 45Mb/s (DS3) and the European rates of 2.048 Mb/s and 34 Mb/s. Effectively, the agreement will allow inclusion of current public telco transmission rates within the SONET "building-block" rate of about 50 Mb/s which in turn can be built up to the basic rate of 150 Mb/s and so forth to even higher rates such as 600 Mb/s.[7]

Beyond the recent agreements for broadband transmission rates and interfaces, the SONET standard constitutes a fundamental change in formatting information to be transmitted. Today, network messaging is dominated by continuous transmissions at fixed rates (bandwidth) for the duration of the transmission. This is commonly referred to as circuit switching. The signaling is synchronous and multiplexed in space and time. In the future, bandwidth may be dynamically allocated as needed due to the fact that the transmission in SONET is asynchronous in time but synchronous in format. In other words, the transmission rate is so fast that packets or cells of information are initiated and transmitted as the need arises without perceptible delay. The format of the packets, however, is fixed. It is analogous to sending messages in the form of a relational database where there is a logical matrix of "cells" which contain information or are simply empty as required. These cells are multiplexed into frames of fixed size. Thus, the digital transmission of information in the future, instead of looking like a continuous string of 0s and 1s, (bit and bytes), will send data in cells as packets of information within a rectangular frame, like a logical database. The exact frame structure for SONET has yet to be worked out. As of this writing, a domestic and international agreement is very close.[8]

In summary, the new transmission standards for broadband communications are a vast improvement in speed and efficiency of information transfer over today's methods. The real-time dynamic bandwidth allocation which broadband networks allow is very effective for narrowband applications as well. It is clearly much better to transmit packets which may or may not be full of information as required, than it is to tie up an entire circuit whether or not it is being used during a given transmission.

3.0 Economics

Just as the technology of future communication networks is fundamentally different than today's, so it is with economics. Today's communication networks are fragmented; those of tomorrow will be integrated. Fundamental networking is transforming from service-specific functions to commodity functions. Network control is moving from centralization to decentralization.

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[7] See Rodney J. Boehm, "SONET: An International Standard," Telecommunications, March 1988, and "Toward an International Broadband ISDN Standard," Steven E. Minzer, Telecommunications, October 1987.

[8] Refer to footnote 5 and 7, Minzer.

Production technologies are converging to a rather homogeneous technology base and process. Economies of scale and scope are expanding. These events have significant economic implications for the future industry structure and optimal pricing and costing practices. Although profound changes in the supply side of the market are certain, it is less clear what significant changes in the demand side of the market will be. In the future, customer control and use of networks will be limited only by the capabilities of application software and network peripheral devices and CPE.

3.1 Cost Structure

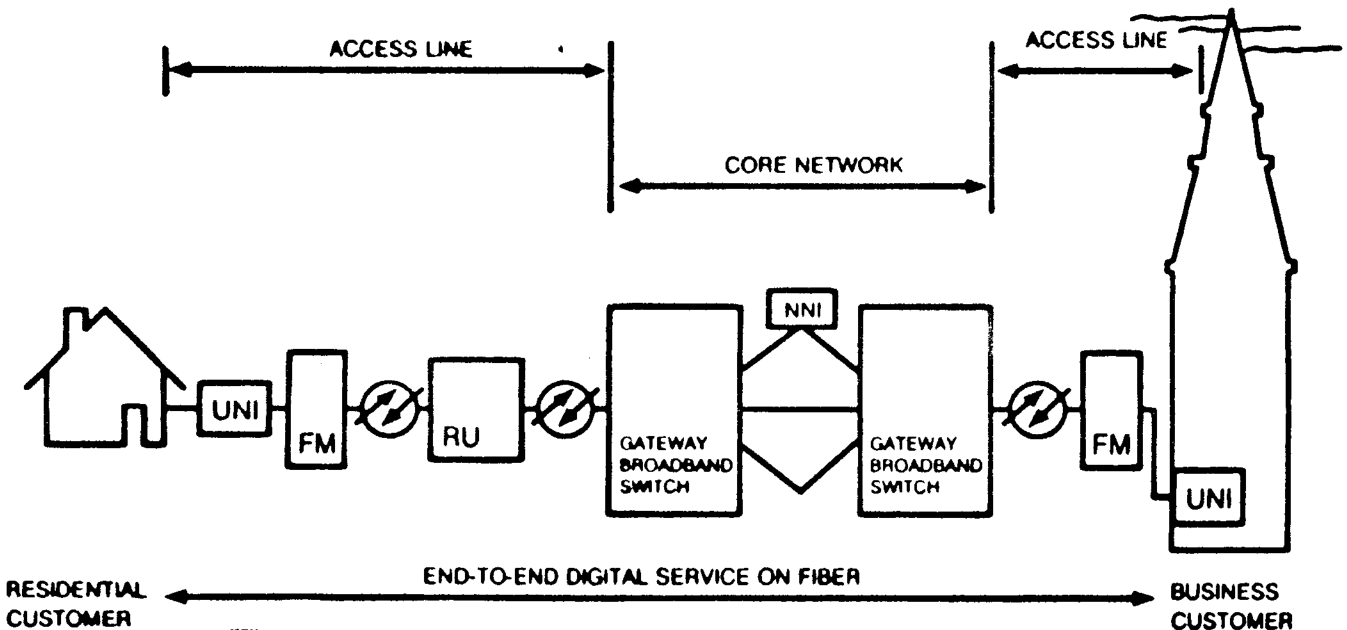
Figure 2 presents an illustration of a UBN network featuring end-to-end digital connectivity. To date very little is known of the cost structure of UBNs since production equipment has not yet been specified. Nevertheless, as an integrated digital public network, some basic cost characteristics can be assumed. It is convenient for purposes of analysis to break the picture into two separate pieces -- access to UBNs and the interoffice core network itself. The core network features all-digital switches and interoffice links. Customers may purchase or lease access facilities to the gateway or host broadband switch in any quantity they desire to meet their perceived bandwidth requirements. Ultimately, telcos will flexibly provide access bandwidth using a combination of physical fibers and electronic and photonic devices. Customers will also be able to purchase hardware and software which can dynamically allocate the bandwidth at their discretion to satisfy their requirements for voice, data and video service. There is an economic cost tradeoff between placing additional fiber circuits and upgrading the necessary electronics and lasers to increase bandwidth on the existing fiber circuits. Once access is obtained, the telco has an obligation to serve the customer by engineering for sufficient core network capacity to provide an acceptable level of reliability and service.

For the telco, the problem is how to efficiently allocate the engineered capacity of the gateway or host switch. Processing capacity of the switch and photonic and electronic signaling devices must be constructed, added, or upgraded. This is also true of network peripheral devices and remote switching and signaling nodes. Engineering for interoffice transmission capacity in the core network is less of a problem. Fiber optic facilities used in an all-digital network provide tremendous bandwidth capacity. Also, technological advances in transmission continue to occur at a staggering pace and are forecasted for years to come, assuring continued progress in bandwidth capacity. Nearly all industry observers forecast a significant glut of telecommunications transmission capacity by the early 1990's, at least in major metropolitan areas.

A brief digression may be useful to contrast UBNs with a "super" network with no capacity cost. In theory, as communications technology continues to advance, a "super" network

Figure 2

BROADBAND NETWORK OF THE FUTURE



KEY:
UNI - User/Network Interface
FM - Fiber Mux
RU - Remote Unit
NNI - Network/Network Interface

infrastructure could be constructed to serve all possible demand and still be non-blocking. In other words, switching and transmission will be so fast that congestion will not be possible (or not perceptible). This, of course, would eliminate the peak capacity cost problem discussed above. It is conceivable that someday, the least-cost public network design alternative at the margin would be non-blocking. In such a scenario, the economic implications for pricing will be completely changed and the economic pricing strategies will be driven solely by demand-side considerations. In other words, being the first to serve a customer's demand in a timely manner will lead to a sales contract based on the value of the service to the customer. This would likely result in some sort of two-part pricing scheme for access and usage, even though usage cost at the margin will be effectively zero. Presumably there will still be a cost associated with customer access to the "super" network and various administrative and operations functions and activities. Notice that expense, rather than capital related costs, will dominate the marginal costs of providing customer service. This has clear implications for those wishing to compete in such an environment. In this abstract world, capital does not physically wear out; it simply becomes technologically obsolete. Accordingly, a producer recovers costs and makes a profit through customer price discrimination or value-of-service pricing. While this digression is purely hypothetical, it is nevertheless useful to see the changing pricing and cost recovery implications of significant advances in communications technology. For now and in the foreseeable future, however, network capacity cost will remain important.

Thus, it is reasonable to assume that the main cost and capacity problem for managing the future network will be congestion of the host UBN processor. It is inefficient, and probably prohibitively expensive, for a telco to construct network switching capacity to handle all demand contingencies. An efficient pricing scheme may help solve this problem. The costs associated with switching are most sensitive to peak hour demand. In a network, the situation becomes very complicated due to "non-coincident" peaks, in which any given network switch may be busy at any time.

The problem of non-coincident peaks is aggravated in a future network which provides for direct customer control. Large surges and shifts in customer usage over time and locations are increasingly likely due to smart customer-controlled bandwidth and routing processes. A dynamic capacity charge has been proposed as one pricing solution for this important supply problem.[9]

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[9] A discussion of costing and pricing issues for high-speed digital networks can be found in, Bruce L. Egan, "Costing and Pricing the Network of the Future," IEEE, ISS '87, March.

3.2 UBNs as Public Goods

UBNs offer the potential of an efficient communication infrastructure where the network is a public good. As a result, everyone can benefit when communications externalities are maximized and thus overall economic activity is stimulated and social economic efficiency is improved. If, on the other hand, the communications possibilities offered by UBNs were only available on private networks, the main beneficiaries, of course, would be those individuals and firms with access, and thus external benefits (economies) would be relatively small. As usual with public goods, the political economy considerations of consensus, voting and property rights are significant, but these are especially difficult to achieve with UBNs since, as often is the case with major changes in technological capability, customers will be among the last to learn about the technical changes. This is only natural since the information flow between small groups of trained technicians is very efficient, while the body politic is confused by technical buzzwords. However, once a new technological capability emerges, it cannot succeed until customers understand how to use it. Thus, the speed of adoption critically depends on customer information.

In the case of a public good like UBNs, consumer understanding and acceptance are even more important since a universal network will lead to public benefits far beyond those which any one customer can enjoy: the sum is greater than the parts. In the case of UBNs, a private and fragmented approach to technology adoption will cause total social costs to be higher since economies of scale are not utilized. A good example of this failure is the attempt to bring videotex service to the home. Theoretically, individual customers would like services such as electronic yellow pages and home shopping. Without widespread simultaneous customer understanding and acceptance, however, such public services never get off the ground and a critical mass of customer demand is not attained.[10]

There is nothing new about the problem of technology adoption and customer information. Without adequate information the "demand-pull" of customer acceptance hinders the progress of "technology-push." Personal computing is a useful modern-day example of how customer understanding and acceptance reached a critical mass and generated sales. Unlike personal computing, the benefits of UBNs are not obtainable by simply purchasing a piece of equipment, but may only be realized by a publicly available system. For only one consumer, the cost of obtaining advanced communications capability is generally prohibitive and

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[10] The political and economic problem of forming a public consensus to adopt socially beneficial projects is well known. This is especially so when reaching such a consensus requires the public at large to acquire a high level of information about a technologically complex project. There are several articles devoted to this subject. One which combines economics with aspects of politics and sociology is "Network Externalities and Critical Mass in New Telecommunication Services," by David Allen of MIT, presented at the Fifteenth Annual Telecommunications Policy Research Conference, Airlie, Virginia, Sept. 27-30, 1987.

the level of benefits is reduced if others are not connected to the system. The public-good nature of an efficient communications infrastructure makes it unacceptable to wait for demand-pull for UBNs to take hold. The infrastructure is an expensive proposition, but is also an extremely beneficial one. If institutional and regulatory arrangements in the U.S. cause broadband communications capability to appear slowly and haphazardly, consumers ultimately will lose.

There are many efficiencies inherent to a market-based economy, but unfortunately efficient provision of public goods is not among them. As a result, government involvement is sometimes necessary to launch socially beneficial programs. This is not an endorsement of direct government intervention to develop and deploy UBNs, but is simply a recognition of the unique economics of providing capital intensive, socially beneficial projects within a political paradigm that embraces atomistic market-driven decision making. In most developed foreign countries, telecommunications remains under the government's jurisdiction. In Germany for example, a plan to deploy a public UBN is already in place: not by customer mandate, but by government and PTT decree.[11] The situation in France, where the government-owned PTT did not wait for customer demand-pull to provide a nationwide public information network,[12] is by now familiar to many. The political situation in the U.S. in not necessarily disadvantageous. Indeed, we may attain a much better UBN capability than Europe or Japan by taking a market based approach. In the U.S., it may turn out that the worst adversary of UBN development is the hodge-podge of existing rules and regulations and institutional barriers which prevent or prolong deployment of public UBN capability. Regulatory barriers may need to be relaxed to allow for network integration. This topic deserves much attention and no doubt entire monographs will be devoted to it.

3.3 Economics of Scale/Scope

UBNs exhibit very strong economies of scale and scope. In other words, as UBNs are used more extensively and are used to provide a wide variety of services, the unit costs of providing service actually decrease. These UBN production economies, however, imply nothing about ownership. Indeed, with such a homogenous technology and standardized interconnection, economies of ownership are likely to be very small if they exist at all. Thus, the declining unit cost production economies of UBNs may

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[11] See Peter Kahl's article, "The Broadband ISDN, An Upward-Compatible Evolution of the 64kbits ISDN," Deutsche Bundespost, Proceedings of ISS '87, Phoenix, Arizona. Another good reference is a recent report on Broadband Communications, August 1987 by Ovum Inc. Consultants, Princeton, NJ. The details of past experience and future plans in France are also covered in the report by Ovum Inc.

[12] The Minitel success story may be reviewed in David Lytel, "Tout le Monde! C'est Telematique Francaise," U.S. Black Engineer, Winter 1987.

still be consistent with the notion of many owners and operators nationwide. However, in any one very small area (e.g. a subdivision or town) only one owner, such as a local franchise, may prove to be the most economical arrangement. If UBN standards cannot be agreed on, including the standardization of network interfaces, then economies of production may be lower and conversely, economies of ownership may be higher.

Once UBN capability is in place, the network will be so fast and efficient, and the maintenance and monitoring costs will be so low, that for a given capacity level the cost of an additional customer's usage will be zero for all practical purposes. This contributes to the economies mentioned above, and derives from the fact that most of the costs of UBNs are up-front construction costs (fixed and sunk). Due to integration and the tremendous processing capacity of UBNs, customer orders for new or additional service will be relatively easy to provide. For example, an order for cable TV subscription (or more channels), an order for a private line, or a database or videotex service, will not necessarily require any new construction to the customer's premises since the same physical access facility may be used simultaneously for all of them. Thus, while the addition of new customers and service offerings will exhibit non-zero marginal cost for both installation and operation of new capacity, it would be relatively less than what we observe today. The various possible network architectures for UBN deployment are still largely unknown and therefore meaningful cost data to quantify marginal cost characteristics is scarce. Economically speaking, it is clear that UBN marginal operating costs are close to zero and marginal capacity costs are low relative to the levels achieved with today's technology. Continuing with the qualitative analysis, UBNs exhibit greater economies of scale and scope than existing networks. Thus most of the network related costs of UBNs are capacity construction costs and are non-traffic sensitive (NTS) in an economic sense (not to be confused with the connotation of NTS in current telco cost accounting procedures).

Until more is known about the likely cost structure of UBNs it is difficult to identify optimal pricing schemes. Any detailed pricing analysis must await more production cost data. While it appears that nearly all UBN costs which are relevant to pricing are associated with network capacity additions, the actual functioning of network devices is important. For example, certain network devices are "passive" and others are "active" depending on the extent to which their use is sensitive to fluctuations in network traffic levels. Some preliminary qualitative analysis of the potential network architecture has been performed and[13] many authors have suggested some prototype

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[13] Refer to footnote 9, Egan.

UBN architectures.[14]

3.4 Demand for UBNs

Because there is only limited information about applications and the marketing information on customer attitudes is sketchy, the demand for communication services on UBNs is very difficult to forecast. There are several potential markets for services which have already been identified and a handful of demand estimates do exist,[15] but much more will be known in the near future as market research continues. For the residential market most of the emphasis is on entertainment video, both broadcast and interactive. There are various degrees of interaction possibilities but some of the more well known, such as "dial-up" movies and pay-per-view video and video library type services,[16] allow relatively little customer interaction. Much less has been said about other known service applications such as video browsing through shopping malls or real estate for sale at distant locations etc. Other applications include sophisticated interactive videotex and graphics capability, but this is only the beginning.

In the long run, service applications of UBNs will abound. In the case of some business customer applications however, important potential applications of UBN technology such as high-speed, high-resolution medical imaging and transfer as well as full-motion color videoconferencing are surfacing. Such niche markets for business customer applications are likely to develop rapidly as customer demand-pull may cause early deployment of high-speed digital capability for a limited number of network locations.

New customer service applications of UBN technology are critical to long-run economic viability since capital recovery must occur if the system is to achieve stability and prosper. The initial decision to begin deployment will not be very sensitive to the availability of new services; it will, however, depend heavily on public policy considerations and telecom production cost structures. It appears that broadband "capable" public network deployment will occur regardless of service offerings. The requirements of growth and operations costs will drive replacement of copper with fiber and analog with digital

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[14] For a discussion of various broadband network architectures and costs, see "An Engineering and Policy Analysis of Fiber Introduction into the Residential Subscriber Loop," by Sirbu, Ferrante and Reed, Carnegie Mellon University, Nov. 1987 (revised 1988), and Harrold and Strock, "The Broadband Universal Telecommunications Network," IEE Communications Magazine, January 1987.

[15] Many papers on potential demand for broadband communications were presented at the MIT Workshop on Universal Broadband Telecommunication held on October 29, 1987. Proceedings are available from the MIT Research Program on Communication Policy, W. Russell Neuman, Director - MIT E53-367, Cambridge MA, 02139.

[16] For example, see Judice et al., "Video on Demand: A Wideband Service or Myth?," IEEE, ISS '87, March 1987.

technology wherever possible.

The lessons of the past imply that sufficient demand for broadband services will materialize once network capability is available. History has many examples where fundamental technological change has created large and long-lived increases in demand. Broadband communications should be viewed as a whole new and powerful technological paradigm. In fact, historically, paradigm shifts of fundamental technology have created demand that greatly exceeded the most optimistic forecasts as consumers "learned" how to play the game under the new rules and conditions.

Pessimists often refer to broadband networks in terms of "ghosts" of early market failures such as picturephone, two-way cable television, and the supersonic transport plane (SST); while optimists refer to recent successes, such as xerox and facsimile machines. Using past technological experiences to extrapolate trends and make forecasts for broadband is a difficult process and often very wrong. This is why demand forecasting for UBNs, which is based on knowledge of today's consumer, may not have any sound basis in a cost/benefit type framework for evaluating the future economic viability of UBNs.

3.5 Costing and Pricing Summary

In summary, the economics of both demand and supply of UBNs remain unclear. Much more is known about the supply side as standards are developed. The costing and pricing puzzle on the production side is more clear due to the apparent homogeneity of UBN technology and production processes. There is some issue about the future of regulation and cost recovery for UBNs. For lack of evidence to the contrary, the assumption herein is that costs for basic UBN network functions will require tariff rates, even if telcos face competition for network access and usage.

As the telecommunications industry evolves, regulatory costing and pricing practices must move in a direction which will allow the realization of the benefits of efficient public communication networks for all customers. Fully distributed cost allocation practices are inappropriate to accomplish this goal, and costing and pricing flexibility should be adopted gradually. Integration and flexibility will be the key to the network of the future and the same is true for its costing and pricing, if such public networks are to be developed to their fullest extent.

Telecommunication service is becoming digitized and consequently the physical difference between purchasing telecommunication service and purchasing video and computing services is gradually disappearing. The evidence on this point is clear: more and more voice and voice-type communication is taking place over computer networks (e.g. digital voice and voice messaging, electronic mail). Similarly, increasing amounts of traditional computer network services are taking place over telecommunications facilities (e.g. videotex, data services). The same is becoming true for traditional broadcast services. Any movement toward costing and pricing telephone service as an integrated digital information medium would be a step in the right direction for the network of the future. Rational pricing structures would not only promote competitive markets, but also would encourage the use of advanced communications services over an efficient public network by the greatest possible number of subscribers. To take the economics much further requires more market demand intelligence and a further discussion of the likely dynamics of industry structure. The nature of firm entry and exit conditions and price discrimination possibilities have not been sufficiently investigated.

4.0 Regulation and Institutional Considerations

Much of what the future holds for UBN development is a function of the regulatory and institutional environment in the U.S. The goal here is to provide a framework for understanding the effects of current and future regulatory policies and institutional arrangements which can affect adoption and deployment of UBN technology.

4.1 Current Regulation

Various degrees of regulation govern communications in the U.S. There are three major types of communication networks: telco or common carrier, broadcasting, and private networks. For purposes of regulatory analysis, the broadcasting category must be broken down further to distinguish traditional over-the-air networks from cable TV since over-the-air broadcasting is subject to a host of federal regulations and cable is not.

Only common carriers are subject to pervasive regulation, including regulation of profits and prices. Over-the-air broadcasters are subject to federal regulations affecting ownership and operations while cable television and other private systems are virtually unregulated, except for some federal rules governing cable operations. The most important of these are "compulsory license" rules and other industry revenue and cost or capacity sharing arrangements,[17] which are the result of the Federal Cable Television Act of 1984 and a multitude of court decisions. In effect, cable television faces some "regulation" at the local level since operators are subject to the municipalities' franchise contracts. There are any number of "hybrid" broadcast systems that do not require such certification.[18]

The three most glaring regulatory asymmetries that affect the structure of the electronic communications industry are: (1)

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[17] For Background and analysis, see the recent NTIS report, "Video Program Distribution and Cable Television: Current Policy Issues and Recommendations," U.S. Dept. of Commerce, June 1988.

[18] A review of the competitive TV market including Multichannel Multipoint Distribution Service (MMDS), Single Master Antenna TV (SMATV) and Low Power TV (LPTV) is in Video Media Competition, Noam ed., Columbia University Press, New York, 1985.

the unique profit, rate regulation, and service obligations of common carriers, (2) the minimal but important residual regulation of cable television by municipal franchise requirements, and (3) the virtual deregulation of private networks and hybrid broadcasting networks. There are various other more detailed regulatory arrangements to consider and some of these will be mentioned later.

4.2 Current Politics

The unique mix of regulated and unregulated sectors of the communications industry, as well as their high visibility and social impact create a tremendous marketplace for political maneuvering. Furthermore, the very heavy capitalization of various sectors coupled with the extremely asymmetric rules and regulations give rise to large and powerful political lobbies. Current politics and regulations create artificial distinctions within the communications media which the marketplace would not support. Digitization of networks allows for many different service applications using one homogenous signal transmission, thus the difference in service application is no longer inherent to the network, but is simply a matter of the speed and content of the signal. Network integration allows for a convergence of broadcasting and telephony, however, communications service markets will never completely converge. Only in portions of the market, where network processing is transparent to service application and production outputs are highly substitutable, will integration be a natural result. Other markets for communications applications such as software and programming production services will likely remain a many-vendor, highly competitive industry segment, featuring a high degree of product and service differentiation.

4.3 MFJ

The Federal Court Judge presiding over the AT&T divestiture decree, the Modified Final Judgement (MFJ), represents an important public policy problem for deployment of UBNs. First, suppliers must base their investment decisions on unpredictable interpretations and enforcement of various aspects of the MFJ. The most important policy provision of the MFJ that could affect deployment are the line-of-business (LOB) restrictions placed on the Bell Operating Companies (BOCs). These restrictions preclude BOCs from offering new and enhanced network services including videotex, broadcast video, and information services. As a result, BOCs may invest in some non-telecommunication lines of business when the economics would dictate otherwise.[19] Fortunately for the BOCs, it does not appear to be a Decree violation to provide basic network switching and transmission functions on behalf of other vendors, but in doing so they must conform to a number of strict regulations. Telco investment

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[19] "RBOCs as Juicy Takeover Targets," CQ, March 1988.

decisions must now account for the complex structure of the marketplace. For example, the now profit-conscious BOCs must weigh investment options and payback periods over a host of telecommunications and non-telecommunications alternatives, both national and international.

The uncertainties of the future of LOB restrictions affect others in the industry as well. Certainly if a vendor believes that LOB restrictions may be lifted, the risk/return matrix for each investment strategy is much different. Since the risks are higher, so is the cost of capital. In addition, these vendors face the costs of lobbying and other protectionist rent-seeking activities to keep the restrictions in place.

Overshadowing this whole process is growing discontent with the MFJ by other government authorities such as the Federal Communications Commission (FCC), National Telecommunication and Information Administration (NTIA) of the executive branch, and several Congressional legislative committees. Beyond the MFJ contingencies, other legislative possibilities threaten deployment of UBNs. The legal representatives of industry pressure groups could well achieve court rulings that would effectively bar natural technological events such as the integration of broadcast video services on common carrier fiber networks.

4.4 U.S. Congress

Congress could also play an influential role in the adoption and deployment of UBNs, since several legislative overrides of MFJ restrictions are under consideration. As might be expected, the process is very slow since the politics of such socially important issues as public communications are extremely complex, and they have become even more complicated with the recent addition of the important and highly visible issue of Advanced Television Standards (ATV).[20] Although various segments of the mass media entertainment industry are entrenched in a political tug-of-war, technology-push may settle some of the disputes as the paradigm shift becomes increasingly apparent. In the future, various industry segments may not be able to rationalize the risk of investing in their own new information distribution networks, or in a fiber optic rebuild, if another suitable alternative is expected to be available. In light of this possibility, it is unlikely that any broad constituency will organize on behalf of consumer interest in UBNs since their public value is still unclear. Optimally, the industry's special interest lobbies will not succeed in fragmenting national communications policy any

[20] For a brief Summary of the politics of ATV, see "Technology Brief," <u>The Economist</u>, Jan. 30, 1988; "Another Standards Issue: HDTV," <u>Lightwave</u>, Feb. 1988; "Up against the Clock," <u>Cable Television Business Magazine</u>, May 15, 1988; and "The Push for a Sharper Picture," <u>High Technology Magazine</u>, April, 1988. A lengthier and more academic discussion is in "The Politics of International Standardization : The Case of HDTV," Suzanne Chambliss Neil, Draft MIT, Proceedings of 7th International Conference - ITS, Cambridge MA July 1, 1988.

more than it already is. A renewed political fervor for competition, however, could increase market fragmentation even though technology and cost efficiencies argue for network integration and standardization. In the worst scenario, a new ATV standard that is incompatible with the notion of UBNs would be adopted, or other legislation, such as the disallowance of carriage of broadcast video service on common carrier networks, could force further supply-side segmentation.

4.5 Federal Regulation

The FCC is a key player affecting the prospects for adoption and deployment of UBNs through its policies regarding: (1) cost allocation, (2) rate regulation, (3) depreciation, (4) interconnection, and (5) common carrier/broadcaster/private radio classifications.

(1) Cost Allocation

Currently, the FCC's cost allocation policy emphasizes disaggregation, unbundling, classification and separation of telco costs into "regulated" and "unregulated" categories. The recent rules in CC Docket 86-111 are indicative of the trend. The details of this process are very complicated, but the underlying method of separation is based on the relative use of network facilities: the percentage of total network traffic caused by regulated services determines the proportional allocation of costs.[21] Based on the discussion of UBN technology and cost structure in Sections 2 and 3, the disaggregation and unbundling trend at the FCC is the opposite of what should be occurring for social economic efficiency. In the future digital network environment such cost allocation rules will simply not work and will lead to instability and confusion in common carrier cost accounting. To accommodate an efficient transition to UBNs, changes in costing practices for regulatory ratemaking purposes are imperative. The most pressing costing and revenue requirements issue is the determination of the amount of total network cost which should be allocated to regulated basic network services as opposed to new and enhanced (unregulated) network services. From this process, rate levels for the regulated part of the business can be set to recover costs. Difficulties arise because the production efficiencies created by network integration imply that the same facilities provide both basic regulated and enhanced non-regulated services. Furthermore, the common plant facilities are generally fungible between regulated and non-regulated services. Indeed customers will eventually be able to switch among basic and enhanced service capabilities in real time. This creates a seemingly impossible situation for any reasonable cost allocation procedure since it implies movement of

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[21] The paper by Robert Pepper, "Through the Looking Glass: Integrated Broadband Networks, Regulatory Policies, and Institutional Change," (OPP Working Paper No. 24), provides an excellent discussion on cost allocation issues.

network costs between regulated and non-regulated services. The question then is: "How can such a cost allocation occur and not jeopardize the efficiency and customer convenience that network integration achieves? What costing system would serve the public welfare?"

First, a cost system for the future should be flexible in order to minimize economic distortions and discourage rather than codify sub-optimal pricing and investment decisions. Second, an efficient costing system should avoid, wherever possible, the problem of existing systems whereby costs potentially move between regulated and non-regulated lines of business. While economic efficiency requires prices for telecommunications services to be based on marginal costs, the use of a marginal cost standard, at least for competitive lines of business, does not imply price should equal marginal costs, but that they should be allowed to approximate marginal costs in the long run in order for the telco to be a viable competitor. FCC allocations of telco costs by category of service and between basic and enhanced services do not allow for such economic efficiencies.

Currently, local telcos are generally prohibited from providing many types of enhanced and competitive services over public network facilities and thus, the issue of allocating common public network costs to these new and enhanced services is moot. The issues and confusion surrounding the allocation of costs among existing service categories (e.g. local and toll) should be separated from the cost allocation problems of new digital services. Otherwise, rapid progress in the introduction of new public network services could become the victim of a regulatory morass. In developing a costing methodology for future integrated networks, one primary maxim should prevail: <u>new services cannot cause old costs</u>. Rather, the introduction of new services contributes to total costs.

A marginal or incremental cost standard for new and enhanced services would produce three very desirable social outcomes. First, basic service ratepayers will never have to pay more (and likely would pay much less) than the stand-alone cost of providing service, even if the new and enhanced services can not survive financially in the marketplace. Second, to the extent that economies of scope exist, the integrated network will offer an efficient, low-cost alternative for customers to obtain enhanced services at competitive prices based on marginal, instead of fully allocated, costs. Third, rate payers will be able to purchase and use enhanced services at minimum and efficient prices.

(2) Rate Regulation

As with current FCC costing rules, ratemaking rules are also very complex and the trend is toward unbundling and disaggregating tariff rates into finer "rate element" categories. As with costs, this is the wrong direction. Again, the FCC is striving to maintain competition policy, and admits that preventing price and service discrimination and cross-subsidization, not cost efficiency, is the primary motivation for its rate setting policies. However, the efficiency and total costs of telco network operations should also be considered in developing policy. Although the regulatory process is typically slow to respond to market conditions, a gradual transition from pervasive and complex ratemaking rules toward a more flexible market-oriented framework is already well underway at the FCC.[22] In this process, it is important that any new rules which may unduly restrict the natural evolution of technology adoption in public communication networks are not adopted.

(3) Depreciation Policy

As with costing and pricing, the depreciation of telco network investment follows a complex and strict set of guidelines. In general, depreciation policy has historically favored slow accounting depreciation rates relative to actual (economic) depreciation. While this practice is gradually being corrected with some recent rule changes at the FCC, much more needs to be done. Due to the rapid advances in communications technology, the market obsolescence of existing technology is accelerating. The unregulated sectors of the communications industry may alter accounting depreciation to respond to the marketplace, but the regulated sector may not. The restrictive depreciation policies of the past could seriously delay the adoption and deployment of UBN technology.

(4) Interconnection Policy

The FCC has recently made great strides in the area of interconnection policy, and Open Network Architecture (ONA) is stimulating cooperation among suppliers of various communications services for the public benefit. UBN technology adoption will continue this process and even accelerate it. As standards for user and network interfaces are developed for UBNs, interconnection and networking will become easier and more efficient. The danger, however, is that other State and Federal regulatory policies may not be consistent with the principles of easy and open interconnection. It is likely that retention of restrictive costing, pricing, and depreciation policies will hinder the realization of some ONA goals. Increasing the flexibility of current rules could stimulate voluntary cooperative arrangements among regulated and unregulated suppliers of network services. New combinations and synergies could result to provide public network services which heretofore were not even conceptualized.

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[22] There are numerous papers written on the issue of price caps and nearly all of the scholarly ones conclude that they are effective in dealing with many of the aforementioned problems. The FCC's latest price cap proposal in CC Docket 87-313 was released on May 23, 1988.

(5) Regulatory Classifications

Currently, the FCC categorizes communications service providers into three major categories: common carriers, broadcasters (mass media), and private radio. These designations carry various restrictions on ownership and service offerings. There is pervasive regulation of common carriers, significantly less in the case of broadcasters, and virtually none in the case of the private radio classification. Advancing technological capabilities that allow for functional equivalence among communications networks have made the once bright line of distinction between the 3 categories very gray. In addition, new methods of efficient interconnection and interworking have also blurred distinctions. Consequently, the classifications are now much more arbitrary and subjective than in the past. Most importantly, UBN digital technology is now allowing broadcasting, other mass media, and common carriage to converge. Clearly, these trends will render the distinctions of the past obsolete and require revisions to accommodate the technology of the future. The retention of such carrier/network classifications simply magnifies the market distortions which asymmetric regulatory constraints create.

The natural evolution of technology is again the victim. In the case of the heavily regulated telcos, current restrictions and rules make the integration of broadcast video and telephony very difficult. In the case of private carriers and cable television network providers, current rules do not make integration of telephony attractive, as they are careful to avoid common carrier designation and all of the accompanying regulations. Just as the chain of rulemaking proceedings in the Computer Inquiries failed to keep pace with technological realities, the same problems are likely to occur with UBNs. If the regulatory construct is not fundamentally revised, might we expect to see a new docket to determine "regulated" and "non-regulated" video -- Video Inquiry? It is inevitable that technology will destroy the old classifications. The FCC should not have to rule on what constitutes broadcasting and what does not; there will be no clear, or even workable answer. The future of UBNs will begin an era of interactive multi-media communications.[23]

In summary, Federal regulatory policies are currently very fragmented. A host of rules for cost, price, and other operating restrictions such as ownership and service limitations apply differently to a number of categories of communication service providers. One major change under foot is the movement from pervasive rate-of-return regulation of common carriers to direct price regulation. This move is entirely consistent with the implications of UBN technology adoption. By regulating only the key policy variable of most public concern -- price levels for basic regulated service -- much of the aforementioned

[23] See footnote 21, Pepper.

problems of cost allocation, inflexible pricing rules and even depreciation policy are largely moot.[24] To the extent that such proposals for changes in Federal regulatory policy are neutral with respect to the marketplace for technology deployment, they should be adopted.

4.6 State and Local Regulation

Most of the above discussion of Federal regulation also applies to the states; the same pervasive common carrier regulation exists at the state level. It must be emphasized that progress in changing the regulatory framework at the state level is no less important than it is at the Federal level, and could be more important. Currently, the states have virtual total policy responsibility for the cost allocation, pricing and depreciation practices for intrastate public network investment. Thus, the prescriptions for policy change to accommodate UBN technology adoption are the same. Price-caps or other new regulatory regimes are needed; otherwise the same technology/ regulatory policy conflicts will also occur at the state level. In fact, the states are arguably the most important policy stakeholder in considering UBNs since the most important technological aspects of UBNs concern service integration over the customer access line, which is primarily under the jurisdiction of the individual states. States are also much more directly responsible to public network subscribers than are Federal regulators, since the dominant issue for subscribers is local service.

Local regulation is a different matter. Currently, state regulation of common carriers preempts local regulation. However, local municipal regulatory policy is very important to cable television. By federal law, the power to certify the operators of cable television systems lies with municipal authorities, although some state oversight agencies for cable television do exist. This certification power is very important since it is the only vehicle by which municipalities may require certain cable television service and quality standards. Recently, the National League of Cities has taken an interest in development of advanced public communication networks. Support appears to be building for cable television operators to provide high-quality fiber optic distribution networks.[25] It is not yet clear what ultimate impact the municipalities will have in deployment of UBNs.

In summary, the impact of state regulation on UBN deployment may be significant. If the cost of telco network modernization to a fiber-based digital network is not approved

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[24] See John R. Haring and Evan Kwerel, "Competition Policy in the Post-equal Access Market," FCC OPP Working Paper #22, Feb. 1987.

[25] See "Will Cities Force CATV to Build Fiber Loops," and FCC Joining Telco-CATV STruggle Over Broadband," Lightwave Magazine, 1988.

for ratemaking purposes, there could be a significant delay in UBN technology deployment. In the worst case, it may never develop as a ubiquitous public offering at all. State regulators should be proactive to assure that the future digital network technology is ultimately made available to the public telco network subscriber.

4.7 Fragmentation of Policy

The discussion in this section makes it painfully clear that timely deployment of UBNs will be an uphill battle in the public policy arena. Many people need to become informed about the new technological paradigm in communications so that sound public policy may be formulated. Politically, it is extremely difficult to achieve a public policy consensus about a technologically sophisticated issue such as UBNs. However, this is the challenge. The risk of not meeting the challenge is that the benefits of information-age technology might be skewed toward private networks, and the opportunity to deploy an efficient public communications infrastructure may be lost, or at least delayed sufficiently to allow other developed countries to exploit the economic advantages of UBNs first.

5.0 Stakeholder Analysis

Since technological advances in digital communications network capability are progressing rapidly, various stakeholder groups will struggle to identify their role in deployment and use of UBNs. To add to the confusion surrounding UBN deployment, many suppliers are ready to begin deployment of narrowband Integrated Services Digital Network (ISDN) capability, while at the same time broadband network capability is becoming technologically feasible. Additionally, national and international standards for narrow and broadband public network service standards are nearly worked out. The ultimate adoption of UBN standards will enable deployment of this very powerful technology. For the first time advanced home video services may be available over the phone line. At the same time however, a lack of customer and regulatory acceptance and understanding is widening the gap between technological capability and the social desirability of technology deployment. Indeed, things are moving so fast that industry managers and regulators themselves can barely keep pace with the latest in cost effective communications technology. All of this activity could hinder technology deployment by suppliers and may foreclose many important future market opportunities.

While the potential of broadband network capability opens up many new revenue opportunities for suppliers, it also serves to aggravate the already troublesome problems with the deployment of new narrowband technology. New public network capabilities and architectures are very capital-hungry propositions. Due to a combination of factors, it is apparent that in many possible scenarios there may be a serious capital shortage hindering deployment of new network technology.[26]

A comprehensive national plan would help accommodate the deployment of new network technology for both narrow and broadband services in order to minimize the total capital requirements. Once the optimum capital requirements are established, a capital recovery plan is essential. At the same time, it is difficult to envision any supplier group(s) raising sufficient capital in private markets to accomplish timely deployment in a competitive environment without establishing a customer and/or regulatory mandate. The constraints and requirements of the regulatory environment must be considered in lieu of pure market solutions if technology deployment plans are to be taken seriously. Any feasible plan must also satisfactorily address concerns of the other major stakeholder groups, customers and investors.

In sum, one large plan for public network modernization is likely to be much less expensive than an array of little plans.

It is too early to detect the emergence of any significant public consensus concerning UBN infrastructure deployment alternatives. The purpose of much of this article is to discover if a marketplace consensus is likely, or if widely available UBNs would require direct government action.

5.1 Stakeholder Groups

When considering broadband technology adoption and deployment, virtually everyone is a member of one or more stakeholder groups since nearly everyone will eventually be interested in accessing and using communication provided by public UBNs. To facilitate the high-level stakeholder analysis here, the following four categories are used to classify key stakeholders: (1) Customers, (2) Regulators, (3) Financial Community, (4) Suppliers. These are not necessarily listed in order of importance.

Among the stakeholder groups, many customers are also service suppliers. These groups include vendors of high speed computing, databases and video services, all of which may utilize UBNs as an input to the final service provided. In some clear cases an entire division of a large firm is a supplier (e.g. EDS division of GM). Similarly, various government agencies are both users and suppliers of communications. Such dual roles can make a customer-stakeholder analysis very tricky. For purposes of this discussion, however, the purchase of public network usage is sufficient to include a group among the customer stakeholders. To the extent that the same customer provides final communications services, then he also is included in the supplier stakeholder group. This is most convenient for purposes of analysis and avoids prejudging the dominance of a firm's

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[26] For a discussion of the problem, see "Gordon Bell Calls for a U.S. Research Network," IEEE Spectrum, Feb. 1988 and Richard J. Solomon and Loretta Anania, "Capital Formation and Broadband Planning: Can We Get To There From Here?" Telecommunications, Nov. 1987.

communications procurement or communications sales divisions, which in fact may see the development scenario of UBNs quite differently.

The direction and rate of UBN technology adoption and deployment is sensitive to the behavior of all four stakeholder groups. Thus a thorough understanding of the posture of each group, and how their singular and interactive behavior is likely to develop, provides the best model for predicting the future UBN marketplace. Of course, many different outcomes are possible depending on the circumstances. An exhaustive stakeholder analysis would require a much deeper understanding of stakeholder posturing than will be covered in the present article. However, the foundation for such an analysis will be made, with particular emphasis on the supplier marketplace participants.

6.0 Customers as Stakeholders

The broad customer-stakeholder group includes all users and potential users of UBN services at both the intermediate service or wholesale level and the final service or retail level. There are many important customer subgroups to examine, each with unique interests. Among these are: residential customers, large business customers, small business customers, and governmental and quasi-public customers. Even within these classifications, the possible subgroups and coalitions to examine are innumerable, depending on the desired scale of analysis. Generally, the discussion will be limited to the most important subgroups and will be included in the supplier analysis in sections 7 and 8. This section focuses on the customer as user of final communications services.

For the purposes of this analysis, customers are separated into two distinct groups: Business and Residence. Beyond this, both groups have special interest subgroups, and it would be overly ambitious to try to analyze all of them. So what follows is a high-level examination of the concerns of only major groups. After all, even in the case of residence customers, not everyone uses the telephone (or watches TV). But there is a notion of a "typical" customer which provides the basis for the discussion.

6.1 Business Customers

There are any number of ways to categorize business customers for purposes of stakeholder analysis. Generally, groups can be classified by the common interests of individual customers with similar demand or usage patterns. Some well-known political lobbies work on behalf of business customers based on their size. For example, the International Communications Association (ICA) and Committee of Corporate Telecommunications Users (CCTU) lobby for large users and the Small Business Administration (SBA) and others for small user groups. Members of all of these groups also tend to be members of at least one other industry lobby group based on common business interests. The major categories which appear to be most active and therefore must be included in any stakeholder analysis include: (1) telecommunication service providers; (2) broadcasters and cable television; (3) mass media; (4) information technology (IT); (5) public and quasi-public; and (6) other special interest groups which represent market niches.

These groupings represent a convenient point of departure. However, at least one further level of disaggregation is helpful to begin to identify the particular interests of each classification uregarding UBNs.

6.1.1 Telecommunication Service Providers

Group 1, telecommunication service providers, must be broken down further because of some very diverse subgroup interests. The class as a whole represents the largest purchaser of telecommunications in the U.S. Four major subgroups under the heading of telecommunication service providers are: (1) common carriers, including long distance and other network service providers; (2) enhanced service providers (ESPs); (3) information service providers; and (4) resellers.

Probably all firms in this category would support development of a UBN infrastructure as long as quality of service is high and prices for public network usage are reasonable and stable. The extent to which the public UBN owner/operators will become vertically integrated and therefore a potential competitive supplier will be the issue of contention within this group. Although these firms will all be large purchasers of at least basic UBN usage, their function as suppliers will be the dominant factor in a stakeholder analysis.

Common carriers and other network service providers represent that part of network service which is not classified as a public utility. AT&T is perhaps the exception in this group since it has a public service obligation. Firms in this category are heavy purchasers of traditional public network service and their very existence usually depends on interconnection with regulated public telco networks. Some firms in this category are common carriers in the sense that they hold themselves out to the public as providers of final, on-demand telecommunications service, however, they are not required to do so. Other firms in this category are simply large businesses which own or operate telecom networks which service private interests, but which interconnect to the public network. Included in this group are Value Added, Local Area, and Metropolitan Area Networks (VANS, LANS, MANS). The firms in this category not only represent some powerful lobbies, but are the product of several decades of Federal competition policy. As long as public UBN development includes a policy of open, standardized interconnection, this group would support it. Its political and economic stance is fundamentally driven by its role as final service provider since intermediate purchases of telecommunications are viewed as an input. But to public telcos, the firms in this group are large customers, since the identity of the final service customer is transparent to them. Analysis of stakeholder concerns for this group is deferred to the supplier discussion in the next section. Like all customers of public telecom service, they want good service at reasonable and stable prices.

The second subgroup among final service providers is enhanced service providers or ESPs. These firms deliver value added service to final customers through specific software and hardware applications used in conjunction with the public telco network. Examples are telephone answering and alarm services. Public UBNs are double-edged swords for this stakeholder group. While intermediate purchases of UBN usage may enhance the quality of service and the market opportunities for ESPs, it may also increase competitive pressure and jeopardize certain value-added features by increasing the functionality of the public network. However, at least for ESP firms which are at the cutting-edge of their business, public UBNs would clearly enhance revenue potential by providing an infrastructure which can support a wide range of new value-added service applications.

The third subgroup, information service providers, is a relatively new stakeholder group. This group is primarily interested in using the functionality of public telecom networks as a distribution channel for its primary business -- providing information to end users. There are any number of potential sources and uses of such information, and thus to the extent that purchasing UBN usage and functionality will improve distribution possibilities, they would support its development.

The last subgroup, resellers, should be a great supporter of UBNs. Resellers of public network services survive by packaging telecommunications usage and using price discrimination to cater to the needs of certain user groups. To the extent that open interconnection to UBNs is maintained, then it is clearly beneficial for resellers to expand their business. UBNs, when viewed as information "highways," should provide maximum opportunities to package and resell usage.

6.1.2 Broadcasters and Cable Television

As consumers of telco network usage, radio and television broadcasters and cable television do not currently represent a large purchasing group. However, as public UBNs develop this will likely change because UBNs represent a new high-quality distribution channel along which to expand their business. Broadcasters and cable television are well organized through their several lobbies including the National Association of Broadcasters (NAB), Maximum Service Telecasters (MST), Independent Television Broadcasters (INTV), National Cable Television Association (NCTA), and others including satellite and over-the-air broadcasting firms. Even though their current use of public network facilities is low, the potential makes this stakeholder group an important consideration and a rather natural supporter of UBN deployment, at least for over-the-air firms. For satellite broadcasters to support UBN, they would have to become convinced that UBNs would not displace, but would complement their basic business. The same is true for cable television businesses. For years, cable television firms have used telecommunications network facilities to complement their own distribution plant. As the cable television industry grows, demand for telco distribution facilities grows. Thus, cable television is expected to be a large demander of UBN usage in the future. Already many situations exist, though on a very small scale, whereby local cable television companies use telco trunk and loop distribution plant as a primary source of signal transmission. However, if fiber becomes a viable cable television distribution technology, this source of demand for UBN usage could become quite substantial.

There are various scenarios for UBN technology deployment which may be viewed as overall complements or substitutes for the basic business of cable television and broadcasters. These scenarios concern supply-side considerations which will be discussed later.

6.1.3 Mass Media Customers

Mass Media firms also represent a relatively new market for usage of public telecommunications networks. For the purpose of analysis, Mass Media is related to, but different than, broadcasting. Mass Media represents non-broadcast, generally addressable, large-scale information distribution companies. The most familiar examples are electronic announcement services, videotex and electronic publishing services. Communication with such services is generally two-way; meaning actively "accessing" the service, but not necessarily "interactive". Many subgroups in this category have common business interests and active lobbies to represent them. The members of this business customer group overlap with membership of other subgroups like ESPs and ISPs, to form powerful coalitions. As usual, from a network user perspective, this group should strongly support public UBN development. Their support as users is currently dominated by whether UBNs, from the supply side perspective, represent a complement or substitute to their basic business.

6.1.4 Information Technology (IT) Customers

The firms in this category are computing companies that use public telecom facilities to complement their own information networking software and hardware requirements. Many firms in this category also are members of the network service provider category offering VANs, LANs, and MANs. Software-oriented computing service suppliers -- for example, businesses offering services for high-resolution and interactive graphics, computer-aided design, manufacturing and engineering (CAD, CAM, CAE), and artificial intelligence (AI) -- are also included, as are firms offering database and digital library services with new applications such as video libraries. While currently only a relatively small user group, the potential for growth is clear and thus they are very important new markets for UBN usage. In addition, information technology hardware vendors offering remote high-speed computing services are another potentially important customer group. These companies may offer strong support to UBN technology adoption and deployment since much of their growth potential lies in networking and distribution of computing power. Real-time transfer capability for high-resolution image and graphics are an obvious advantage to these vendors.

6.1.5 Public and Quasi-Public Customers

Very strong support for UBN deployment will likely come from this stakeholder group. Government agencies have, and will remain, large users of public telecom networks. One heretofore small but growing voice in support of the concept of UBNs is the nationwide academic research community. Much computing-hungry research is performed by universities and quasi-public, government-funded research centers, and the members of the research community are plagued by slow and incompatible network computing and communication facilities. Very strong demand for high-speed and widely available networking exists, and is getting even stronger.[27]

6.1.6 Other Special Interests

Certain other market niches exist in various industry segments for UBN applications. Examples are the health care community, which demands real-time, high-quality image transfer, and videoconferencing and financial (transaction) services. Many other niche UBN applications are just being identified and no doubt many others will soon be identified.

6.2 Business Customer Concerns - Summary

Potential business customers of UBN services all have common desires for telecom services, and they all share the problems of existing networks. Business communications have been quite fragmented, owing mostly to technological constraints and public network deficiencies. Functionally separate networks are maintained for voice, data, computing and video applications. There are also many other distinctions within the data category such as high-speed, low-speed and packetized. A multitude of signaling and transmission technologies make integration impractical.

The fragmentation of the telco network along service-specific lines causes the customers' tariffs to be fragmented. Due to regulatory requirements, burdensome telco costing techniques are used to identify and allocate the total costs of providing each type of service. Then for any given level of service demand, service-specific unit costs are developed. This in turn leads to a host of disaggregated rates, one for each unit cost developed. Due to cost-allocation techniques, the costs and tariffs for many business users included a cross-subsidy for residence customers. Such costing and tariffing practices explain why business customers are not happy with many aspects of

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[27] Refer to footnote 26, Bell

public telco networks. Not only do they have no control over the network, but they face a host of tariff rates when most of their other procurement activity is on a customer-specific contract basis. These are some of the reasons why large business customers prefer to bypass the telco and build or lease their own facilities. But private bypass networks serve to further fragment business communications since each serves a special purpose and each requires redundancy for back-up.

Overall the historical and current situation is relatively expensive and cumbersome compared to UBNs. Beyond the communication requirements of any specific business customer, there are other important communications needs -- especially with outside suppliers and customers. It is safe to say that large business users are not happy with the current situation and that public telco networks simply do not cater to their needs.[28] They also do not enjoy bearing the financial risks of constructing or operating what amounts to a small telephone company (in some cases, a large one). Study after study reveals that business customers want communications systems that exhibit a high degree of (1) interconnectivity, (2) reliability, (3) security, (4) flexibility and (5) control -- at a cost which does not subsidize large numbers of other network subscribers. In general, interconnectivity does not exist and is certainly not standardized. This is mostly a problem of differences in encoding, protocols and signaling, much of which are due to the proprietary nature of communication network software. Understanding the current situation sets the stage for understanding why business customers should be very concerned about the development of UBNs. How often do we hear business customers say, "I wish I could tie all my systems together."

A public standarized broadband information network may address all five of the major concerns of business customers, however policymakers need to address the political problem of subsidies to reduce their impact as a roadblock to progress in achieving UBNs.

6.3 Residence Customers

Residential customers have much at stake in the development of UBNs. The reasons that they should care about public UBNs are somewhat different from, but critically dependent on, those of business customers. The fundamental proposition for residential customers is straightforward: do they want the capability of interactive broadband telecommunications services in the future? It is a reasonable assumption that new UBN technology will develop and become useful, but the question is: "Useful to Whom?" Those with enough financial resources to implement and access the technology or to the public at large? Most residential customers do not know what UBNs are or what they

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[28] Some problems are discussed in Thomas E. Bolger, "Unrest Hits Hard Among ISDN Constituencies," Communications Week, Oct. 12, 1987 and also refer to footnote 6, Phillips.

offer. Naturally it is difficult for them to judge the value of something they do not understand or use. Consequently, they tend to reject UBNs because public and even private value has not been established.

To demonstrate what is at stake for residential subscribers, an examination of the status-quo is useful. Today and in the future, a household will still communicate over the plain old telephone service (POTS) line. A cable television line and perhaps an outdoor antenna feed for over-the-air radio and TV reception also reach into the home. Each communication medium has its own network, transmission standards, physical access medium, operator, and customer billing system, etc. In the future, more and more add-on systems will be marketed to individual residence customers. There will be various adaptors, converters, and controllers for using different systems and for allowing limited interworking. For example, the telephone keypad's capability of limited interworking with shopping at home on cable television is becoming feasible. A problem with this is the spaghetti of different wires and the proliferation of adaptive devices in the home and the telco central office. Additionally, the reliability of the various communications modes and mediums is limited to the reliability of their least reliable component. In other words, if one network goes down, connected systems will also go down and thus back up may be required. For example, the network architecture for cable television distribution causes the whole system to go down when there is a problem within it. No possibilities for redundancy or rerouting of transmission signals exist. This might be avoided with an integrated switched architecture like that of UBNs.

To summarize, high-quality service and reliability, as well as the cost and time involved in putting a system together, are all at stake for residential subscribers. It could be argued that most residential customers will never want any more than basic one-way cable television and POTS service. A more important consideration however, is, "What if they do want more, and there is no public infrastructure through which it may be readily obtained?" It is reasonable to expect that residential customers of the future, like business customers of today, would like to "tie their systems together" to achieve maximum service flexibility and reliability at minimum total cost. Also residential customers' demand for advanced network services may be stimulated by their availability on the public network. The existence of a high-speed communications infrastructure would stimulate the creation of service options by opening up an inexpensive distribution capability to service vendors. The same infrastructure will lower the marginal cost for new customer services thereby increasing demand.

Since the network is a public good, public policy and the social welfare of residential customers should be primary determinants in the decision to deploy a broadband communications infrastructure. This requires a thorough investigation of the goals of national public policy, not of a single consumer group's needs. Without knowing the appropriate public policy prescription for UBN technology adoption, but assuming that it would call for progress in the establishment of UBNs, then the concerns of residential customers are clear.

Tremendous economies of scale and scope exist in the production of UBN services. It should concern residential customers that such economies are used for their benefit through cost savings in deployment. Assuming UBNs will eventually be available to residential customers, the pressing public policy issue is how to use the economies of scale and scope and attain UBNs at minimum cost. The economics imply only one local access supplier in a given location and standardized switching and transmission. This requires residential customers or their public policy representatives to get involved early or forego the opportunity of achieving UBN capability at minimum cost.

For example, if residential customers or their public policy representatives do not get involved in the process early, certain high-quality digital video services, such as "dial-up" movies and interactive videotex, may only be enjoyed by business and the wealthy few who can afford special equipment to access such services. Others will continue to watch the relatively mediocre picture quality of one-way over-the-air or cable TV, which is periodically unreliable. Of particular concern is the recent growth of cable television investment in fiber distribution to improve the quality and reliability of service facilities. The potential investment cost of a cable television fiber overlay or rebuild is significant and subscriber rates would likely rise. More importantly, such an overlay network is not integrated with telephony which features a highly reliable nationwide switched network. As previously mentioned, the possibilities for service integration at a reasonable cost may be foregone and nonstandardized multiple networks could occur. One could eventually end up with two or more fiber loops (or satellite dishes) to a single residence to obtain a full panoply of services -- clearly a more costly proposition. However, politics, regulation, and the competitive market paradigm may preclude the least-cost approach as a path toward efficiency in technology adoption.

The more fragmented the approach to UBN deployment, the more costly and slowly its development will proceed for basic residential customers. Small UBN "service islands" will develop as private facilities are constructed. There is nothing inherently wrong with the "service-island" concept; in fact, UBN deployment would likely occur in this manner as digital network capabilities are first made available to large businesses and dense urban areas where initial demand for broadband service is relatively high. However, if a many-vendor, private "service-island," deployment scenario obtains, the opportunity for a meaningful public sharing of deployment of UBN costs may be foregone to the detriment of residential customers in general.

6.4 Summary

Both business and residential customers are major stakeholders in the development of public integrated broadband information networks in the United States. A public UBN capability would be less expensive to deploy in the long run and would be efficient, offering a high degree of reliability and flexibility to provide for a wide range of customer service applications, not the least of which is multi-media interactive communications. Public UBNs would be simpler for customers to use and understand as a single physical access facility could provide for all service demand.

A major roadblock to achieving customer acceptance of the concept of UBNs is the difficulty of organizing a public consensus and establishing a high level of public social value. This is primarily because UBNs are the product of a fundamental technological paradigm shift. The public value of the technological advances are difficult to establish since entire new service concepts, many of which customers do not understand, are possible. The ability of customers to benefit from the technological paradigm shift depends very much on the willingness of policymakers and industry participants to accept progress and change. Political rhetoric and special interest maneuvering will be sure to slow the process of UBN adoption. The entrenched positions of traditional communication service suppliers must become more flexible and regulatory barriers must be relaxed. Policies and institutions which unduly restrict the natural evolution of communications technology toward integrated fiber-optic based systems should be discouraged.

7.0 Suppliers as Stakeholders

The list of potential suppliers of broadband networks and services is long. For purposes of analysis the following categories of stakeholder suppliers are used: (1) Network Service Suppliers (NSSs), including entertainment and video distribution; (2) Enhanced Service Providers (ESPs); (3) Electronic Mass Media (MM); (4) Information Technology (IT); (5) Manufacturers; (6) Resellers; (7) Motion Picture/Programming; (8) Other niche suppliers. This section will concentrate on identifying and classifying the wide range of UBN supplier/stakeholders. Section 8 will then identify key players in major stakeholder groups and their respective interests, and Section 9 will discuss the behavior patterns of the major players and how UBN technology adoption and deployment is potentially affected.

Based on the discussion throughout this paper, it does not appear (unfortunately) that customers will have much influence over how UBN will ultimately be deployed or who will do it.

The lack of any strong public consensus about the correct direction for UBN technology deployment places the ultimate technology adoption/deployment scenario in the hands of the key stakeholder/supplier groups and their political lobbies, along with a handful of bureaucrats, regulators and members of the judiciary. Since deployment ultimately requires large amounts of investment funds, UBN suppliers and their business strategies for acquiring and spending capital will be the ultimate driving force. The primary role of bureaucrats and regulators will likely serve to validate the market intentions and actions of potential UBN suppliers.

Thus, the remainder of this paper concentrates on the key supplier/stakeholders as the rate of UBN technology adoption becomes a matter of business strategy in the competitive marketplace, while demand-pull initially takes a back seat.

The following tables provide a convenient classification of UBN supplier/stakeholders. Table 1 indicates supplier activity areas and Table 2 gives examples of firm types.

7.1 Network Service Suppliers (NSSs)

From the Tables, it is clear that the dominant supplier/stakeholder group affecting deployment of UBNs is Network Service Suppliers. This group of firms represents the bulk of potential revenues and investment funds required for UBNs. Collectively they represent nearly all of the distribution media for broadband networks including wireline, radio, and satellites. The subgroups within this category are of particular interest.

7.1.1 Public NSSs

This stakeholder group includes all firms currently classified as common carriers, including the Local Exchange Carriers (LECs), Other Common Carriers (OCCs), and AT&T. Among the local exchange carriers are the Bell Operating Companies (BOCs) and Independent Companies (ICOs). The distinguishing feature of all LECs and AT&T is that they represent the telco-as-public-utility and therefore must supply telecommunications service on demand in designated service areas. OCCs include all local and toll network telecommunications service providers which are common carriers, but exclude the LECs and AT&T. Included in this category are competitive interexchange carriers and cellular radio carriers.

In any analysis of UBN deployment, network common carriers are the economic, political, and social choice to be primary providers of the UBN infrastructure for a number of natural reasons. First, they represent a formidable communication infrastructure already in existence. Second, they have the most expertise and experience in the communications business. Third, characteristic of most regulated utilities, they have a legal and social obligation to provide high-quality, low-cost basic service. Finally, they represent the largest asset and revenue base in the communications sector, providing the potential to support the heavy financing requirements of UBNs.

7.1.2 Private NSSs

This group of NSSs is composed of many firms engaged in

Table 1

PLAYERS AND ACTIVITY AREAS

	TELECOM INFRA-STRUCTURE	BROADCAST INFRA-STRUCTURE	CATV	DBS	VOICE	DATA	VIDEO	TELECOM SERVICE	ENTER-TAINMENT SERVICES
Public NSSs									
BOCs	X		X		X	X	X	X	
AT&T	X		X		X	X	X	X	
OCCs	X		X		X	X		X	
Mobile	X				X			X	
Private NSSs (LANs, MANs, VANs)				X	X	X	X	X	
Video									
Cable Television			X	X		X	X		X
Cable Net			X				X		X
Satellite TV			X				X		X
Broadcast TV		X	X				X		X
Comp. TV		X					X		X
ESPs					X	X	X	X	X
Mass Media			X		X	X	X	X	X
ITs						X	X	X	
Manufacturing	X	X	X		X	X	X		
Resellers					X	X	X	X	X
Motion Pict./ Programming		X	X				X		X

Table 2

Supplier/ Stakeholder

Network Program Supplier	ESPs	Mass Media	ITs	Manu-facturers	Resellers	Motion Picture/ Prog.	Other
Public	Alarm	Electronic Publishing	CAD	CPE	Service Packagers	Production Studios	Medical Imaging
LECs	Answering Services	Videotext	CAM	Switch	Secondary Market	Production Companies	Industry Specific
OCCs	Announcement Services	Advertising	CAE	Transmission	Voice	Program Distribution	Research Nets
AT&T	Talk Line	Special Events	Digital Library	Fiber	Data	Program Sales	Data Nets
Private	Videophone	Audiotext	Computing	Computer	Video		
LANs	Conference	Home Shopping	Graphics	Television			
MANs	Database	Polling	Image	Video Cassette Recorders			
VANs	Transaction Processing		Software	Software			
VSAT	E-mail		High Cap Data	Satellite			
Video	Voice-mail		AI	Electronic Devices			
CATV			Data Base				
Broadcast TV							
Satellite TV							
SMATV							
MMDS							
LPTV							

providing network communications on a private, as opposed to strictly common carrier basis. The modifier "strictly" is important since in many cases the network operation of private NSSs may resemble smaller common carriers. This category comprises firms providing LANs, MANs, and VANs. Obviously, LANs and MANs could be operated on a common-carrier-like basis; however, the important distinction for this analysis is that public or common carrier operations face many regulatory restrictions, while the private carriers face virtually none. The market for VANs, LANs and MANs is burgeoning and is expected to continue high growth in the future as technology, telecom deregulation, and distributed network processing advance. The role of private NSSs in a UBN environment is not yet clear. However, it is likely to continue to grow rapidly and may play a very important role if UBN "islands" become the trend in technology adoption. Almost certainly, private NSSs will serve to extend the functionality of UBNs for their customers.

Public common carriers also will likely provide LANs and MANs in the future, but these will remain in the first category -- public NSSs. It will remain important to conceptually separate private and common network suppliers even when physically and functionally they appear similar, because different institutional and regulatory treatment can mean all the difference in a stakeholder analysis.

7.1.3 Video NSSs

In the playout of the UBN technology deployment game, this group of stakeholders represents the joker in the deck. This is true in many foreign countries, as well as in the U.S. While subgroups of firms in this category are all basically in the same business, their distribution and delivery systems are very different -- so potentially are their respective stakeholder roles. For this reason separate consideration should be given based on the primary technology of the delivery system.

Cable Television

Cable television firms will be a key stakeholder group in any UBN development scenario since this industry is the precursor to UBNs in the sense that it is generally a publicly available broadband delivery system. Although it is neither integrated nor interactive, it does deliver broadband services on a terrestrial basis. For well-known applications of UBNs, cable television represents the value-added portion for residence subscribers. Only the future can determine the potentially substantial value-added of UBNs relative to today's communications networks. This stakeholder group deserves much attention in any analysis of UBN deployment because it is the only group whose primary business could be entirely complementary to UBNs or entirely displaced by them. This contradiction will be investigated later.

There are several dominant cable television firms and many small ones which belong to this category. The National Cable Television Association (NCTA), a very well organized and effective industry organization and political lobby, represents member firms. Even though a large "competitive fringe" exists in the industry, most of them enjoy exclusive rights to provide service in a given area.[29]

Broadcast Television

Broadcast television is the largest stakeholder group in the Video NSS category, both in terms of viewers and sales. It includes all over-the-air network and independent TV broadcasters and distribution affiliates. NAB and INTV are their primary respective industry organizations and political lobbies.

The role of this stakeholder group in UBN development is potentially very important as it appears that UBN deployment will complement their basic business. Optimism is cautious however, since the degree of complementarity is very sensitive to the direction of any particular deployment scenario.

Satellite Television

This Video NSS stakeholder group is smaller in revenues than either of the other two, but is also potentially very important in any UBN deployment scheme. First, it is a group of technologically sophisticated, rapidly growing video distribution firms. Satellite, currently the dominant video distribution technology, is closely aligned with, and often jointly financed by, cable television firms. In fact, cable television network companies are part of this group, providing satellite programming to local distributors. Perhaps more importantly, a subset of this group of firms is engaged in a potentially very high-growth activity called Direct Broadcast Satellite (DBS), which uses "rooftop" antenna (dish) reception to bypass both cable television and telephone terrestrial distribution facilities. However, DBS does not necessarily rely on this customer distribution alternative, but may also use terrestrial distribution (coax, fiber) between an earth receive station and customer premises. Like cable television, DBS may be complementary to UBNs or displaced by them, and therefore will be a key stakeholder group to watch. However, DBS firms will not be separated from the traditional satellite networks since joint ownership and operating arrangements are likely to be the norm. It is less clear how DBS firms will line up with local cable television firms since they could potentially be strong competitors. The stakeholder analysis depends on the local distribution technology of the video delivery system.

DBS systems are new satellite video delivery systems which are capable of providing higher quality TV signals than today's. For this reason, they may simply represent the next progression

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[29] Even though the municipal franchise is not legally exclusive, cities often limit franchises, and in practice, exclusivity in any given area of the municipality is the norm.

for technology adoption of existing satellite cable networks.[30] This is another reason for including the DBS group with existing cable network firms.

Other Video NSSs

There are several smaller competitive providers of video distribution service including MMDS, SMATV and LPTV. As with other video NSS subgroups, they are distinguished by the technology of the delivery system. It is unclear whether any of these will play a key role in UBN technology adoption and deployment. Most of these firms are niche suppliers that exist largely due to a unique physical delivery system with local cost or demand advantages (e.g. first available supplier). Since they generally do little programming or production, they likely will oppose UBNs, perceiving the threat of displacement or substitution. Little exploration of potential compatibility has been done, but it appears that UBNs are not complementary to alternative video NSSs. If this group aligns with another powerful stakeholder group, they could play an important role. This is unlikely however, since cable and broadcast television view this group as a threat to their own markets.

7.2 Enhanced Service Providers (ESPs)

ESPs include firms that depend on public and/or private telecom network usage to create specific service applications. Some examples of final services which they provide today are alarm/security services, announcement and answering service, e-mail, voice mail, conference and "talk" lines, videoconferencing, database service, reservation lines and transaction services. It is not known what types of new services ESPs will provide using UBNs, but it is well known that basic telecommunications network functionality is directly related to the number of different service offerings the market will develop. This stakeholder group stands to benefit the most from standardized and widely available UBNs, since most of their services are value-added in terms of software, operations, and peripheral hardware. As ESP service offerings mature however, competition is tough and margins are low, so their support would probably be conditioned on tight regulation of usage rates and equal interconnection.

7.3 Electronic Mass Media

Currently, this telecommunications stakeholder group is quite small relative to print and video services. Representative firms include: electronic publishing, news wire services, audio and videotex, home shopping, some advertising, and special events (e.g. mass polling and announcements). As with ESPs it is unknown how this supplier group would use UBNs. Many believe

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[30] This view was recently expressed by HBO Inc. Vice President Robert Zitter at the Bellcore Broadband Conference, April 7-9, 1988 in Salt Lake City, Utah, and was reinforced at the same time by another cable executive, Frank J. Biondi, Jr., President of Viacom.

that UBNs will enhance the publishing and videotex service markets and finally open the door to truly interactive multi-media personal communications.

Through the use of advanced information technology, firms in this category could become a very large stakeholder group. For example, the print mass media is currently a powerful political and financial force in the communications industry. As electronic communications technology advances, a host of new mass media services will become possible. Large print mass media firms today have substantial information gathering resources and expertise which, combined with information technology, may open up large new markets for electronic databases. Such novel applications could include in-home TV schedules and program previews on demand, or up-to-the-minute racing information with opportunities for betting and even watching the race (or some electronic representation of it). These are only two of the innumerable possibilities for the growth of electronic mass media which may be substantially boosted by the financial support of traditional print mass media firms. Vertical integration of mass media enterprises, such as that achieved by the Murdoch media conglomerate, could prove to be harbingers of the future demand for interactive multi-media communications.

These possibilities are indeed exciting and are probably just what this troubled industry needs. Current applications of mass media services are plagued by a lack of network and device standards, problems of limited access and difficult use. The concerns of this group would likely be the same as the ESPs -- low and stable basic rates for UBN access and usage.

7.4 Information Technology Firms (ITs)

ITs represent one of the most exciting and high-growth prospects for the use of high-speed digital communications networks. Numerous computing applications are not utilized to their potential due to networking and interworking problems. A standardized UBN communications infrastructure could unlock the door to high-capacity computing applications for many customers that could not afford a full time computer or private access to a remote. A primary source of demand for IT services is real-time information transfer. Some of the IT applications in this group could include computer-aided design, manufacturing and engineering (CAD/CAM/CAE), electronic databases, digital libraries, hypertext, interactive and high-resolution graphics and imaging, software development and testing, high-capacity data, and artificial intelligence. Such services only begin to foreshadow the potential offerings accessible via UBNs. There are many niche markets in high-tech fields such as biotech, mathematics, aerospace, and medicine.

It would seem natural for this stakeholder group to support the deployment of public UBNs, at least for product and service development. But many firms in this category may feel that their market advantage lies not just in specialized and proprietary service offerings, but also in proprietary access and distribution to customers. This group of firms would not favor a UBN environment. To date, ITs are not well organized on the issue of UBN development, but preliminary indications from recent years show a great willingness to support standards for networking and interworking. Recently, many IT firms have actively adopted, or at least agreed on, compatibility with digital telecom network standards. This process is accelerating the realization of long-awaited computing/communication network integration possibilities for customers.

While there seems to be a lot of promise for IT support of UBNs, there is not yet any significant formal activity in public policy that would serve to raise public awareness levels. IT is a growth industry where potential UBN applications abound. However, active public policy support may not be in the cards since the IT industry is so highly competitive and its products are so differentiated that ubiquity, standardization, and interworking are relatively new philosophical concepts to be adopted very gradually, if at all. Telecom, on the other hand, is fairly accustomed to such an infrastructure philosophy. The IT firm's stakeholder impact on UBNs would probably be important only as a coalition with other groups such as manufacturers. Unfortunately, part of the problem with computer/communications network integration has been institutionalized by the FCC's long-held desire to create a bright line between information processing and transmission where one simply did not exist.

7.5 Manufacturers

This stakeholder group contains a very diverse mix of firms that may logically be separated into subgroups. Specifically, firms involved in the manufacture of large scale telecom network equipment potentially used for UBNs, such as digital switching and transmission systems, should be classified separately. Clearly this group would be avid supporters of UBN deployment. Most such firms exist in a relatively concentrated industry structure (oligopoly) with limited product differentiation, with competition focused on market share. UBNs offer a great opportunity for growth and new sales potential for all. Furthermore, strong domestic manufacturers exist for large-scale telecom network equipment and software.

The second set of manufacturing firms, which have more competitors and product differentiation, comprises manufacturers of customer premises equipment, (e.g. basic phones and computers), personal network devices like portable computers and phones, video devices including TVs and VCRs, and related hardware and software for all of the above.

On the surface, it appears that UBNs are quite complementary to all of the firms in this second stakeholder group. But, as in the case of IT firms, many manufacturers may be concerned that standardized interfaces or signaling requirements of UBNs will obsolete their production plans or plans for product differentiation. If ISDN is any indication, this concern is unlikely. Many firms are welcoming ISDN compatibility standards for network peripheral devices and are happy to find ways to differentiate their product through software, appearance or otherwise.

A problem remains, however, because most computing and video network devices are produced overseas, adoption of UBN technology domestically could require major changes in foreign production and R&D plans. Since standards for public UBNs are being developed with international compatibility in mind, this might not develop into a problem. Furthermore, UBNs are conceptualized as public information "highways" on which any information "vehicle" can ride. Major complaints from manufacturers would only arise if, for example, Japan were to adopt video device production standards that simply were not capable of working with UBNs. Even then it is hard to believe an adaptive device could not make the problem manageable. The same is true for domestic manufacturers. The issue of video device compatibility and production and technological obsolescence is really most affected by the current controversy over advanced television standards (ATV). It should be possible with UBNs to ultimately convert any video signaling format acceptable to production video devices to that of UBNs (though arguably it may not be the most technically and economically efficient).

7.6 Resellers

This stakeholder supplier group constitutes firms engaged in network service "packaging" and all sorts of secondary markets for communication services, including resellers of voice, data, and video services. It appears that UBN development and deployment is a potential boon for this industry group. As with ESPs, and perhaps even more strongly, reseller market opportunities are enhanced as network functionality increases. Reselling of video programming and individual video shows in any form are clear examples of new markets. Difficult copyright protection issues notwithstanding, firms in this supplier group should be ardent supporters of UBNs.

7.7 Movie/TV Producers and Programmers

Large, visible, and socially influential, producers and programmers represent a potentially powerful player in the UBN deployment game. In general, they see UBNs as making the market for movie and television program distribution more competitive by providing another outlet for video service. Increasing distribution competition should trim distribution company margins and expand demand, benefitting both producers and programmers. Again however, UBNs do raise copyright problems which can adversely affect the producer, artist, and programmer's profits.

Included in this stakeholder group are production companies and studios, writers and artists, programming distribution and sales companies. Preliminary analyses indicate that UBNs will provide significant growth opportunities for production/ programming related businesses, a potentially important source of support for the concept of UBNs. However, to the extent that some firms are already financially tied to certain distribution technologies through contractual arrangements or otherwise, support for UBNs may not be forthcoming.

To assure maximum support for UBNs, network suppliers will have to address the difficult property rights issues which arise, especially in secondary markets for video production and programming.

7.8 Other Niche Suppliers

Many other supplier stakeholder groups serving niche markets will appear on the horizon as potential UBN service applications increase. Market research continues to identify new possibilities. None of these industry groups is expected to play a key role in UBN development or deployment. Of course, within their own niche market, firms in this category may be quite influential in affecting UBN technology adoption.

8.0 Supplier Analysis

The previous section identified supplier stakeholder groups and briefly discussed their collective views regarding UBNs and their widespread deployment; this section will examine in greater detail those stakeholders with the largest potential impact. The added information should illuminate why individual firms regard the prospects for UBN development quite differently. In Section 9, those prospects are examined based on supplier behavior patterns. The degree of financial benefit or harm to each stakeholder is somewhat dependent on the usefulness of their embedded asset base to continue to produce viable services in a UBN environment, and the usefulness of investment for planned future construction. This consideration will likely determine the degree to which each firm will take a stand pro or con. The data provided in the following analysis should help put key stakeholder positions in perspective.

8.1 Players and Activities

Table 1 summarizes much of the discussion in the last section. The left column describes the players, and the top row lists activity areas where each is currently generating business. From this table some observations are worth noting. Cable television and telecom services are the most competitive based on the number of players. In the case of cable television however, many players have the same business interests, but nearly all these interests are associated with exclusive local franchise rights. The video communications and telecom services markets have the most competition. Even private NSSs have entered the market for video communications with VSAT technology. Voice and data communications is also very competitive in urban areas.

Importantly, public NSSs, especially the BOCs and AT&T, are active in almost all areas; they even participate to a limited degree in the two areas not indicated: entertainment services and broadcasting infrastructure. The only other player with such broad activity is manufacturers, but their industry structure is generally characterized by only one or more firms in the same activity area with little downstream integration. Major manufacturers are too numerous to list by individual firm.

Thus if a UBN infrastructure were to develop, the logical primary players would be public NSSs, based on their wide range of business activities.

8.2 Market Size

Chart 1 indicates the size of the market by major network services activity in terms of annual revenues. As is often the case in analyses of market size and market share, the results are extremely sensitive to market definition. Defining markets for final communications services is especially difficult and no attempt to do so is made here. It is possible, however, to ascertain revenues generated from upstream <u>network</u> activity for various providers of communications service since these revenues are largely represented by data on average monthly subscriber fees for basic network access and usage. In the case of over-the-air broadcasters and some cable television providers, network "access" fees are paid by advertisers. Nevertheless, those revenues are clearly associated with the network and the size of the subscriber base, rather than ancillary business activities. These data are most meaningful for analysis of UBNs since the demand for the network infrastructure is of primary concern. There are many indirect connections between UBNs and profitability of non-network supplier groups, and these were mentioned in the last section.

8.3 Investment Share by Activity

Chart 2 shows market share in terms of value of network assets. These data are important for a number of reasons. First, the size of an asset base is an indicator of financing capability. Of course, the cash positions and debt structure are also important because some industries/companies may be leveraged much more than others. The basic capital structure of each NSS group is provided with the understanding that it may be quite unrepresentative of individual firms within each NSS group. Second, network assets indicate the financial risk to industry groups from technological obsolescence if existing network facilities are displaced by UBNs. Conversely, the amount of existing network assets that are useful in a UBN environment and viewed as complementary indicate the degree of commitment and capability of the network supplier in the new environment. Third, large embedded investments in network facilities may be an indicator of the amount of social and political clout of the stakeholder group. The very size of the industry group also indicates its importance in the formulation of a national policy for a communications infrastructure.

8.4 Share of Annual Investment

Chart 3 illustrates the annual investment spending for

Chart 1

MARKET SIZE OF NETWORK COMMUNICATIONS ACTIVITY

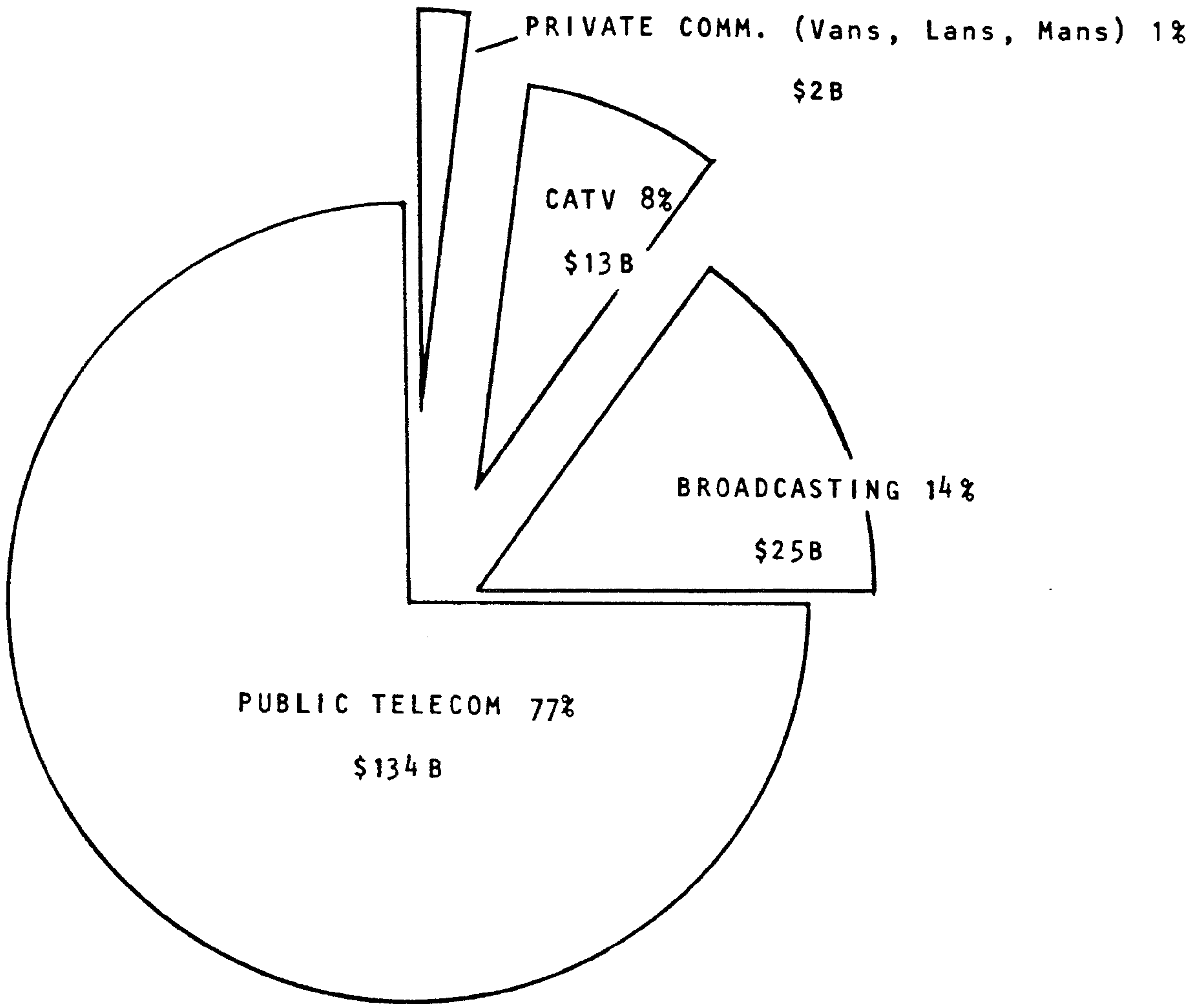
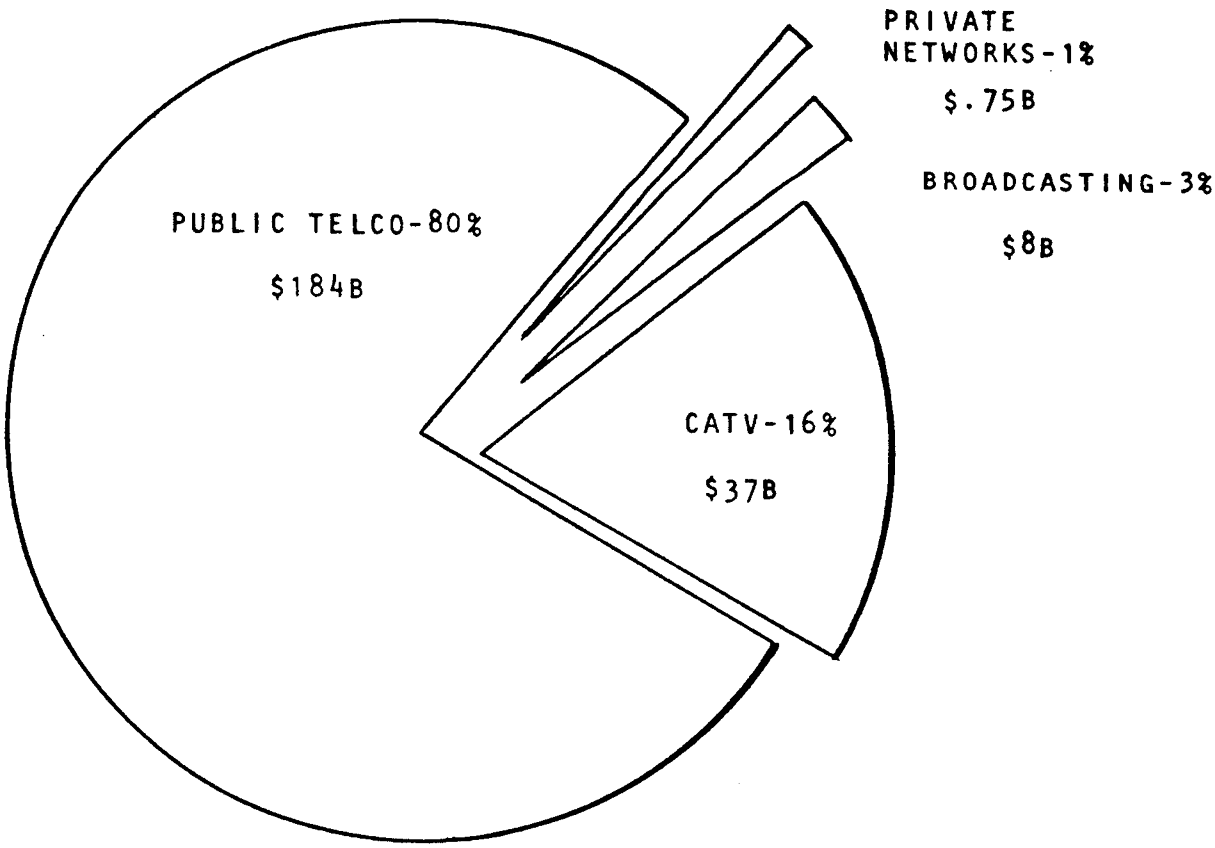


Chart 2

INVESTMENT IN NETWORK ASSETS

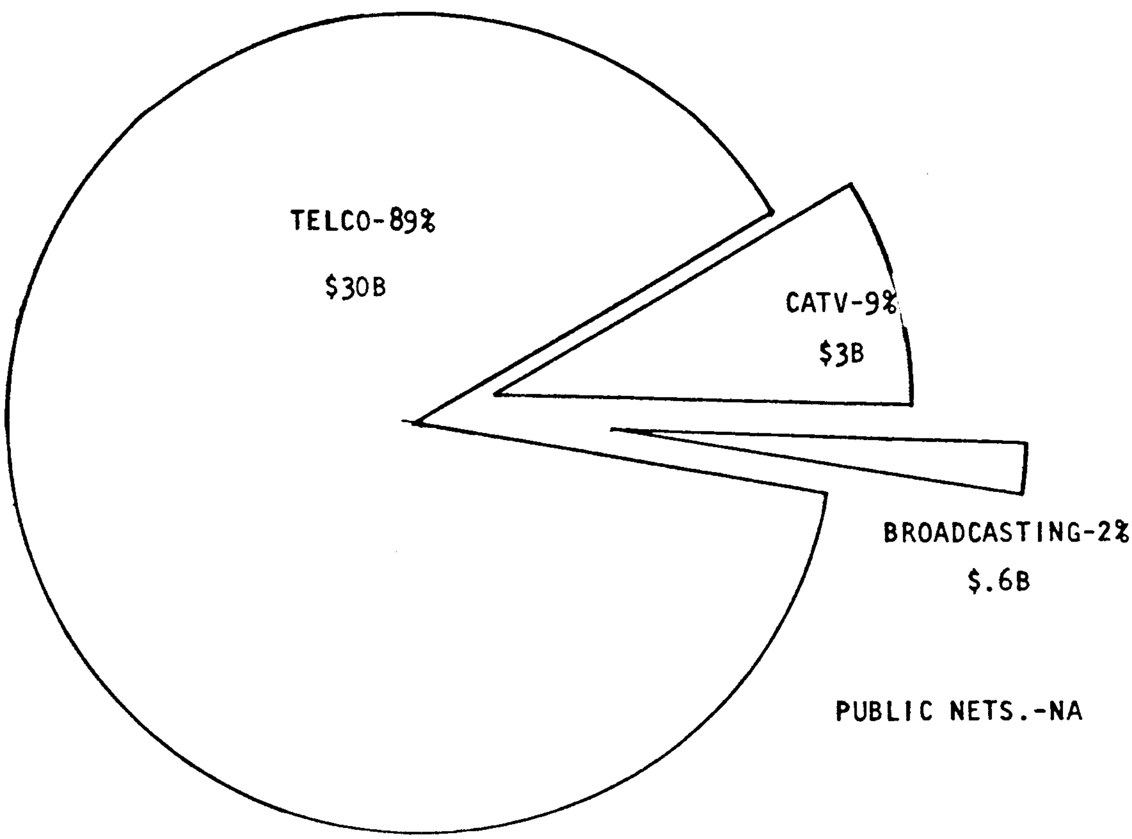


Basic Capital Structure

	Telco	Broadcasting	CATV	Private Nets.
Debt	42%	44	80	12
Equity	58%	56	20	88
% Annual Inv.	16%	10	8	
From Internal Sources	100%			

Chart 3

ANNUAL NETWORK INVESTMENT



5-Year Average Growth Rate

Private Networks - NA
CATV - 7%
Broadcasting - 8%
Telco - 14%

network assets by each NSS group, including network replacement, improvement, and expansion costs. It is a useful indication of growth and asset turnover, and of the degree of inertia in the current business plans--which may be important evidence of resistance to the concept of UBN development at the margin. Also provided are average investment growth rates for the last five years.

8.5 Revenues

Chart 4 displays total revenues by industry segment for the last ten years. It is impossible to calculate revenues exactly for private NSSs since many NSSs are internal cost centers of large corporate entities. The revenue trends are quite revealing. The following discussion summarizes these trends.

8.5.1 Telecom

Telecom revenues have experienced healthy and stable growth over the past ten years and this pattern is expected to continue. The compound average annual revenue growth rate for the period is approximately 8%. Individual BOC stocks have indicated strong investor confidence since they became publicly held in 1984. However, the BOCs, which have over 90% of industry network assets, continue to face increasing competition and limits on entry into some high-growth portions of the business. Growth prospects in the basic voice telecommunications business are stable but relatively low as nearly everyone who wants a telephone has one, and total per capita usage exhibits sluggish growth, even throughout the recent unprecedented post-war economic expansion period. Public UBNs represent higher growth prospects for the basic telco business especially with the possibility for entry into the market for video services. Unless many line of business restrictions are lifted, however, the primary prospect for telecom network revenue growth is from new digital network services of other vendors.

AT&T and other common carriers generally face the same situation, except that they serve a higher growth portion of telecom services--domestic and international long distance--and they are free to enter other growth markets. For basic voice services, however, even long distance will be a slow growth market relative to those for new video and digital services. Thus AT&T also foresees great benefits from UBN development and views itself as a major infrastructure player.

8.5.2 Cable Television

Cable television revenues have exhibited very strong growth, and the market value of individual companies is very high. Growth prospects remain positive as innovation in the industry continues. The emergence of satellite and cable networks have significantly improved programming and advertising revenues. Additionally, firms in this industry view DBS technology adoption as an investment prospect which can spur even more growth if it lives up to current expectations. Satellite technology offers

Chart 4

INDUSTRY REVENUES

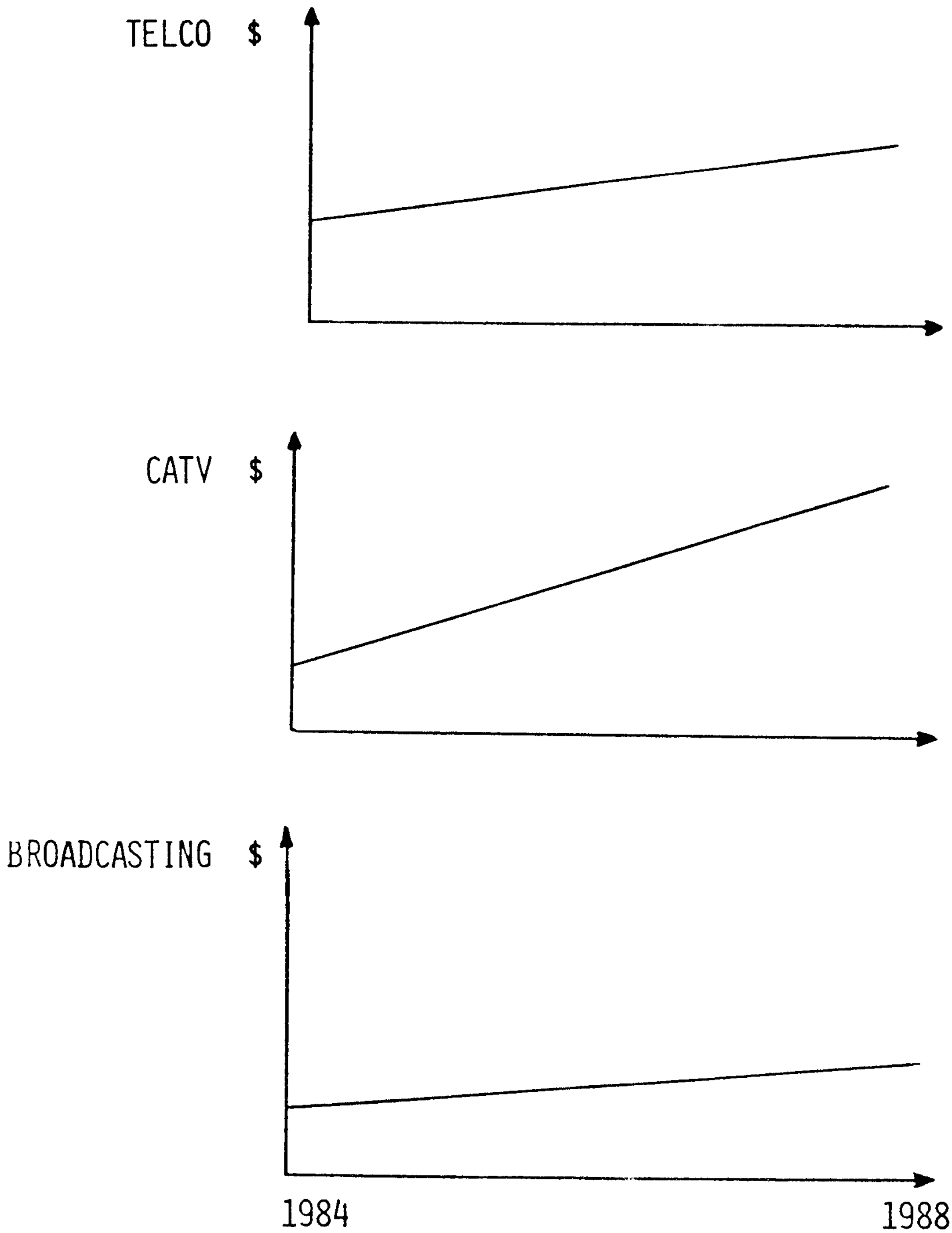
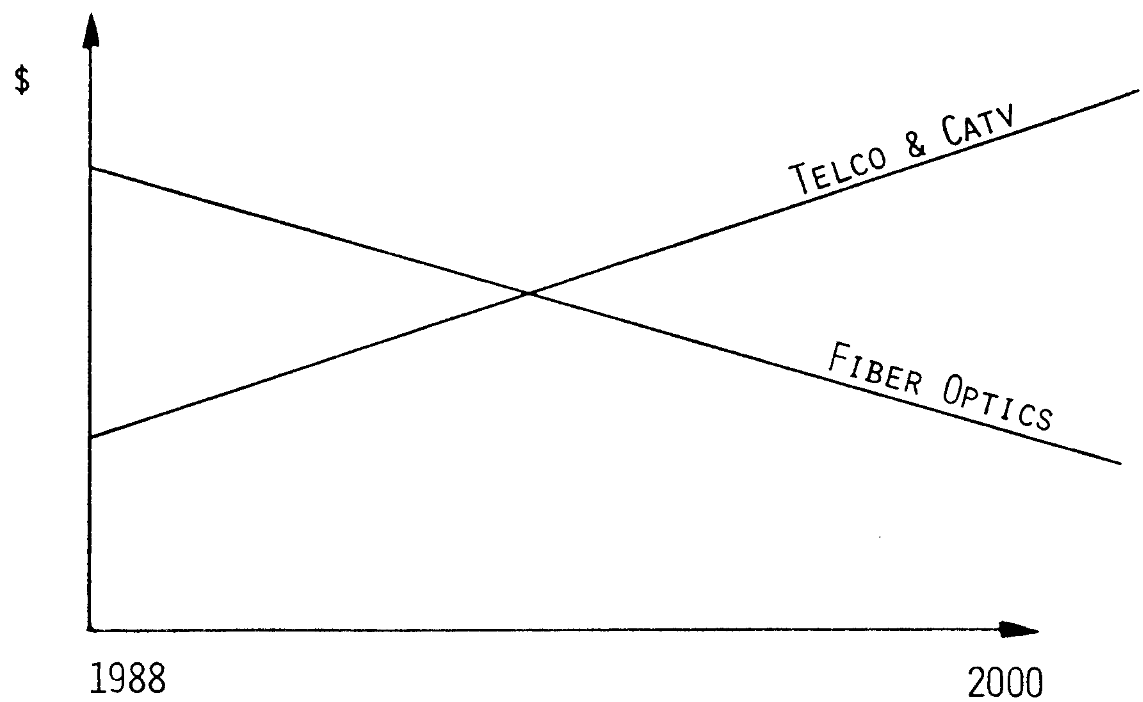


CHART 5



mixed opportunities, however, since it complements programming quality, but may displace cable signal distribution.

8.5.3 Broadcasting

Revenue growth for network broadcasters and their affiliates has been sluggish, largely due to cable television's competitive impact. A recent boost comes from videotape sales; however, this is beginning to level off. UBN deployment may offer a significant recovery opportunity by increasing broadcast program distribution and quality. For now, growth prospects are dim and may even be negative.

8.6 Demand and Cost of Infrastructure

Clearly the telecom and broadcasting industries place a high demand on a national network infrastructure. An UBN infrastructure would greatly enhance market opportunities and the same is true for most other non-network communication service supplier groups. Cable television is the exception since their basic business is adequately served by private local distribution facilities. The only requirements for an effective cable industry "infrastructure" are the satellite-based networks which provide high-quality programming. However, if the definition of a communications "infrastructure" requires 2-way or interactive capability, then cable television and broadcasting industries fall far short. The appropriate video distribution infrastructure cannot be considered in a vacuum, and the cost of each distribution technology is important. Chart 5 shows per-subscriber distribution costs, and forecasts of those costs per-subscriber connection. The total cost of a fiber connection is compared to that for a telephone line plus cable television for new and replacement connections.

Even without factoring in the per-subscriber cost of over-the-air TV and radio distribution networks, the cost of fiber distribution facilities will be less than that of cable television plus telco by the early 1990's. It is important to note that the additional costs of electronics and optical devices for a UBN environment are not included for at least two reasons. First, such devices are not yet produced and are just beginning to be conceptualized and designed; hence, the cost of the first experimental devices is simply inappropriate. Second, the existing telco and cable television networks would also require significant and as yet undefined device improvements (e.g. for multi-media and interactive services), if they were to provide a base for a UBN communications infrastructure of the future.

8.7 Capital Recovery Prospects

UBN deployment will require a substantial investment for the communications infrastructure. Since production network equipment does not exist, good cost data, especially for devices, are elusive. Much more is known and forecast for optical signaling and transmission components. Although the trends in both electronic and optical device costs continue to exhibit rapid decline, other costs such as R&D, design and installation costs will be unprecedented. Nonetheless, speculation as to the total cost of a UBN infrastructure is occurring and, naturally, estimates vary considerably (between $1,500 to almost $20,000 per subscriber). No further speculation will occur here, but a broad brush examination of capital recovery prospects will be offered.

8.7.1 Raising Capital

An UBN infrastructure will require enormous amounts of investment funds, however such capital intensive projects are typically long-lived and have extensive construction intervals. This simple perspective is sometimes overlooked by those who wish to deal in sensationalism, pointing to the high total cost of a UBN infrastructure as if this project required a huge lump-sum financial commitment. Of course this is not the case. By definition, the annual cost of a large total expenditure occurring over an extended period of time for projects with a long useful life is relatively small. In other words, total cost should not to be confused with annual cost.

Historically, socially and economically useful projects, no matter how large, always seem to get financed. Sometimes it takes government assistance, as in public highways and the space program, and sometimes not. Many foreign governments are already committed to helping fund and develop an efficient communications infrastructure for the future. In the U.S., this is much less likely, though not beyond the realm of possibility. Nevertheless, such government intervention for financing is not required.[31] If anything, existing government rules and regulations are preventing progress in financing a quality and highly functional future communications infrastructure.

The market value of cable television firms and telcos is currently well above their book investment. Cash flow is at an all-time high, credit worthiness is good, and growth prospects for the communications industry abound, but the artificial market constraints that government has placed on telcos bother capital market analysts. Many financial analysts are skeptical of demand for UBN services, but that is probably the nature of a public utilities analyst since risk aversion is often the name of the game in public utility financing. Communications, broadly defined, is coming out of the age of public utility domination, and it will be one of the most high-growth major industries of the future.

8.7.2 The UBN Investment Decision

Many managers view the UBN investment decision in a simple framework whereby the total cost is recovered over some desirable (in the eyes of the beholder) payback period. It is most

[31] For estimates of broadband subscriber costs and financing alternatives, see B.L. Egan and L.D. Taylor, "Capital Budgeting for Technology Adoption in Telecommunications: The Case of Fiber," - Draft, CTIS Working Paper, Columbia University, April, 1989.

convenient for purposes of analysis to view the UBN investment decision in terms of the familiar net present value formula. This framework allows for an evaluation of the interaction of all of the primary components of the UBN investment decision, including cost and revenue streams and the time horizon and discount rate. UBN investment projects may have any number of acceptable deployment strategies and certainly the timing of construction intervals is a strategic decision variable. It is far from an all-or-nothing-at-all type of cost stream. Furthermore there are a number of possibilities for UBN service demand and these are sensitive to market growth rates and competition. The discount rate chosen for the analysis will be sensitive to the uncertainty of the estimated revenue stream. The possibilities are innumerable, but many different scenarios must be considered. When all factors are considered together, a private firm will invest in UBN if the NPV is positive. Those analysts or firms who believe UBNs are worthwhile probably use relatively low discount rates, optimistic revenue projections, and extended construction intervals or some combination.

While a detailed analysis of the likely set of UBN investment scenarios would require much more work than could be attempted here, a few observations regarding the NPV decision rule are worth making. First, the cost stream for the UBN project is roughly as flexible as the construction schedule. No construction costs are sunk until actually committed. Furthermore, construction may be postponed in any year if cash flow in insufficient to support it or conversely, it may be accelerated in periods of high cash flow. Due to the spatial distribution of UBN plant, strategic deployment in market niches is possible and therefore certain UBN markets may see completed construction while others may not.

Further, discount rates of various firms also vary widely. Relatively large firms that are diversified and not heavily leveraged would tend to have lower discount rates; telcos would tend to have lower rates than cable television and broadcasters.

8.7.3 Revenue for Capital Recovery

The asset and revenue base of the communications industry is huge. The average monthly customer bill for cable television service is just below $30 (including premium channels), and for telephone service it is just about $35.00 (local plus toll). Broadcasting industry revenues are also about $25 per month per household, and radio receives about $10. Network vendors, not including all of the related communications service supplier groups, have an enormous revenue base, and each operates its own distribution network. For both telephone companies and cable television operators, the monthly charges are well in excess (perhaps 300% and more) of the marginal cost of providing basic network service. This is because most network costs are sunk. The available estimates of average investment required for fiber access lines indicate a cost range that is about twice as high as current telco loop costs using copper. Thus, if one were granted the luxury of abstraction, it is clear that this industry could easily support the cost of development and deployment of UBNs. Most of the controversy involves the fragmentation of the potential UBN service revenues. If one considers the revenue base of only one major network supplier (e.g. telcos or cable television) for financing the total costs of UBN deployment, then without imputation of a share of the other network suppliers' revenues, UBN would appear on the surface to be a real loser. New demand applications are not sufficiently well defined to allow significant additional revenues to enter the cost/benefit calculations.

Using standard NPV analysis, if the average cost of UBN access lines is $2,000 per subscriber household, then the owner/operator of the access line would require $30 per month to recover the initial investment cost over a ten-year period (assuming a 12% discount rate). At $40 per month revenue, the payback period is only five years. Currently local telcos receive about $25 per month per subscriber, but this figure is expected to grow significantly over ten years.[32] Limited available evidence indicates that cable television operators are willing to pay telcos a tariff rate of approximately $8 per month per subscriber for use of the telco provided loop plant.[33] On a per household basis, there is clearly enough revenue potential to support recovering the cost of fiber loops at a cost of $2,000.

The problem with such simple analysis is that the $2,000 loop cost only represents the resource costs of access line construction and central office connections; it does not include operating costs or other network and device costs. Useful data on these are not yet available, but it will be important to establish these costs on a net present value basis and make the comparison to the access line construction cost. In the telecom industry, the non-capital related cost on a monthly basis is about 25% of the total average subscriber cost of local service. This includes measurement and billing for usage, operations, maintenance, and central office device costs associated with subscriber access lines. Not included in this 25% is device costs at the customer premise or interoffice facilities. In a UBN environment, the non-capital related costs should be lower due to greater efficiency of the digital facilities for measurement, billing and other administrative and maintenance functions.

The potential revenue from new UBN services and from broadcast networks for use of the fiber distribution plant are also ignored. These could be substantial indeed. Television advertisers currently pay about $30 billion a year or about $25

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[32] For a brief look at the plans of telcos to diversify to continue revenue growth, see the Cablevision article "Prepping for the Big Catch," July 4, 1988.

[33] The $8 per month is the approximate monthly tariff rate per subscriber paid by CATV to the telcos where such arrangements exist, e.g. Heathrow trial in Florida.

per household per month ($300/yr.), and radio broadcasters represent about a third of this. This figure seems high, but considering the average disposable income per household per month is $1,666 ($20,000/yr.), the returns to advertising may be great even after deduction of necessities such as basic food and housing. Broadcasters wishing to use the fiber distribution network would pay the UBN supplier with a portion of advertising revenues. The same is true for advertising revenues of cable television companies. In sum, there appear to be significant increases in current per-subscriber monthly revenues available to the UBN supplier over today's basic telecom and cable television charges.

Many recent per household UBN cost/benefit analyses approach the problem incorrectly. Typically, household surveys ask customers how much per month they would be willing to pay for various electronic communication services, especially new ones. The amount that producers are willing to pay for access to consumers also should be considered. The fundamental problem is that everyone (probably) agrees that the cost of UBN is great, but not everyone agrees with the revenue potential. But this should not make a difference in the UBN deployment decision if the likely revenue stream from all existing network suppliers is included. If it is true that network integration technology is more cost-efficient, and therefore that the per-customer cost for fiber access will be much lower than the sum of other competing network costs, then clearly financing and capital recovery for UBN deployment is a reasonable proposition. The appropriate time horizon of the capital expenditure stream may be altered to match the likely net present value of revenue streams. Certainly if the future network alternative includes cable television fiber rebuilds and overbuilds <u>and</u> a gradual telco fiber deployment, then having the foresight to begin planning for integration is clearly the least cost infrastructure proposition. Another, less socially desirable alternative exists. If UBNs as an investment project do not meet the nominal cost/benefit test for a target rate of return level, then the usual business response is to invest in non-infrastructure (perhaps non-communications) projects.

8.7.4 NPV Analysis

The previous exercise is only a first cut at evaluating a UBN investment project in NPV terms. A more sophisticated (and correct) approach would compare NPVs of alternative investment scenarios for UBN deployment. An appropriate comparison would juxtapose the NPV of future revenue and cost streams from continued use of existing facilities to that of UBNs.[34]

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[34] Professor Lester D. Taylor has recently written an article on telco costing which captures the essence of the network investment decision facing the firm in "On the Measurement of Marginal Cost," Draft, University of Arizona, 1988. Some quantitative analysis is performed in the article by Egan and Taylor, ref. ftn. 31.

The firm considering a UBN investment decision must ask whether the total future UBN net revenue stream, including revenues from new services not provided by existing facilities, is sufficient to justify the UBN investment. In the case of existing network suppliers, the requisite investment stream may imply early retirement of existing network facilities. However, the capital cost of the existing plant, undepreciated or not, is still largely sunk and therefore unavoidable in any scenario.

8.7.5 Pricing

Whatever the target monthly revenue per subscriber for UBN profitability, there is still the issue of pricing strategy. Some combination of flat-rate access and usage-sensitive charges will be necessary to recover UBN costs. If flat rate charges are initially too high, the market may not develop optimally. High usage prices could seriously discourage network use, unless UBN competitors are attracted to enter the market and undercut the existing prices. A balancing act is required, and only the market will eventually sort out the "right" UBN prices.

Some researchers believe that flat monthly charges for UBN must greatly exceed existing cable television and telco charges, and are therefore pessimistic about UBN's chances of development. This may not be the case, and, in fact, monthly flat-rate access fees may even be lower in real terms as cost savings from UBN technology are eventually realized. The previous economic discussion indicated that short-run marginal costs of UBN usage are effectively zero, implying an economically efficient price close to zero. However, demand or value-of-service considerations will provide many opportunities to price UBN usage sufficiently high to provide a sizeable contribution to covering costs of UBNs.

9.0 Political Economy of Supply-Side Consensus

The stage is set for the last act -- deployment of technology for a universal high-speed public information infrastructure. The actors are the potential UBN suppliers, and they are in the midst of determining their roles. The behavior of network suppliers will determine the direction of the development and deployment of UBNs, or whether it will occur at all. Customers, regulators, and the financial community also represent major UBN stakeholder groups, and their behavior is important. However, it is the impact of these and other groups on suppliers that is the key. Thus a comprehensive view of supplier strategies and intentions as they respond to the behavior of others will reveal the net effects of other stakeholder groups.

Since customers do not know the range of potential services that a UBN infrastructure could provide, a direct demand analysis is very difficult and would likely overlook important issues. This has been the unfortunate history of long-range demand forecasting. Since understanding the political economy of the

UBN marketplace will inevitably be a process of discovery, careful planning can allow network suppliers to hedge bets on a number of alternative UBN deployment scenarios. In any strategic market planning process, the expected behavior of rival firms demands the most attention; so it is with UBN strategy. In performing a careful strategic analysis, potential suppliers hope to achieve a future investment plan that simultaneously maximizes usage of their own network and minimizes their vulnerability to investment strategies of rivals. Such an investment plan will be flexible and robust to alternative scenarios which account for various responses of rival firms. Investment in fiber technology is a strategic plan which is flexible enough to be useful in most scenarios.

The economic analysis in the remainder of the paper will concentrate on the strategies of three major network service supplier groups -- telcos, cable television and satellite TV, and over-the-air broadcasters. Two other less influential but important supplier groups also discussed are private network suppliers and motion picture/TV producers and programmers. The motivations for the posture of the players regarding UBN technology deployment are quite different, but interestingly lead to similar conclusions regarding their own future behavior.

9.1 Telcos

This network supplier group includes all public telcos designated as common carriers. Collectively they provide virtually all public and the majority of private telecom service. Although the following discussion only references the Bell Telephone Companies (BOCs) and AT&T, most of the analysis would also apply to other common carriers. The BOCs and AT&T are the industry leaders in UBN technology R&D. Bellcore does centralized R&D for the BOCs, and Bell Labs for AT&T.

Since the UBN concept depends on customer access over fiber optic lines, and since the BOCs currently provide nearly all network access facilities, Bellcore is in the driver's seat regarding UBN technology. Most of the standards to date are in some form or another endorsed by Bellcore. Since fiber optic technology in the intercity network is well developed, the most interesting deployment issue is BOC fiber access development.

It is reasonable to assume that low-cost optical and electronic devices such as the adapters, codecs, lasers, muxes, batteries, and network interfaces required to allow customer equipment to hook into and work on UBNs, will be developed. The major stakeholder issue for UBN deployment, then, is the investment in fiber access lines and upgrading or replacing current network switching and transmission equipment to handle the high-speed digital technology of UBNs. Many might wonder: If demand for broadband services is not known to be huge, why would the telcos want to spend so much for fiber facilities for UBNs? The answer to this question must be made on two levels.

First, telcos believe that in the near future fiber lines will be cheaper to install and maintain, and will provide clearer connections for voice conversations. Telcos therefore will be installing fiber at the margin for new construction anyway. Note the all important words "at the margin."

Secondly, and much more importantly, telcos want to invest in and deploy UBN capability for two primary strategic reasons: market share and revenue growth. The latter will be discussed first because it is the most obvious to the informed observer. The first, market share is less automatic because in the discussion to follow it implies more risk.

9.1.1 Growth

Competition and a host of legal and regulatory rulings which are the result of the political trend toward competition policy have radically transformed the telecom business. Where the telco had primarily been a service provider, it is now becoming a network provider. Telcos are not allowed into markets for new and enhanced services, yet at the same time are encouraged (or forced) to provide easy and affordable connection for other vendors of communications service. Telco management has responded logically by investing where market opportunities are not so restricted, and doing what is necessary to increase usage on the network. Since basic network usage is expected to grow very slowly relative to the very high potential growth in service markets, it is important to encourage the providers of new services to use the telco network. UBN is analogous to a super highway made to accommodate almost anything. By standardizing and digitizing telecom network transmission and switching, and by using fiber optic technology for huge capacity, anything that can be digitized can travel on telco networks. That is why much current telco R&D focuses heavily on creating technology to convert various types of analog and digital signals to the telco network signal format.

It would be a great social and economic achievement if the day should come where most any communication requirement is met by one ubiquitous, high quality, easy-to-use network. However, based on the discussion so far, some would be tempted to throw stones at telco strategy and somehow forbid them from pursuing UBN as anticompetitive and just plain folly. This would be very wrong. The other option available to telcos is to invest elsewhere. Public policymakers should be very concerned about adopting policy positions that provide artificial incentives for telcos to invest heavily in non-telecom lines of business at the expense of efficient infrastructure development. Removing the line of business restrictions would test the market viability of UBNs.

9.1.2 Market Share

Formerly a virtual monopoly, telcos now face institutional competition policy and have been forced to shed market share at artificially high rates due to asymmetric legal and regulatory policy. To telco managers "bypass is forever." In other words, once a customer obtains alternative access lines from a competitor, it is highly unlikely that customer will ever go back to using telco access to obtain service. For this reason bypass is a serious competitive threat. UBN access is one way to keep a customer happy and prevent bypass. With the possibility of cable television deployment of fiber distribution facilities and loops, and the adoption of DBS technology and rooftop receivers, telcos' bypass concerns are heightened. Consequently, telcos want to be the first with fiber to the home, especially if cable television fiber or DBS is perceived to be an imminent threat to the telcos' potential revenues from video and to their last bastion of dominance, basic communications services for residential customers. Being first to deploy fiber loops could be a great market advantage.

The traditional telco management style is sometimes referred to as asset "protection." In contrast, there is a Japanese-type philosophy which places an emphasis on being first in the mass market and remaining the dominant supplier through growth. Aggressive investment in capacity expansion--even when demand is lacking--assures that when demand develops or the business cycle recovers, your market share increases at the expense of rivals. Once production capacity is in place, costs are sunk, so new production at the margin will have a very low unit cost. Rivals struggle to squeeze more production out of existing facilities causing high unit costs. The firm with large capacity then continues to dominate the market through downward pricing flexibility to levels the rival cannot match (and cover his costs). In response, the rival may complain to authorities of predatory pricing or "dumping" by the dominant firm.

Telco deployment of UBNs represents the American counterpart of this effective management strategy. Most BOCs have already created their own technology R&D divisions and have given them officer-level direct management support; the BOC technology VPs view fiber-to-the-home as a prime objective. Once the fiber is in, the marginal costs of additional usage are low (close to zero) and pricing flexibility to protect market share is achieved. UBNs could give the telco some control over future market share. Public statements of telco executives and lobbyists often emphasize the public service aspects of fiber deployment, but the strategic implications in a competitive telecom marketplace are a primary motivation.

9.2 Cable and Satellite Television

This supplier group primarily sees telco UBN deployment as a serious competitive threat. The industry is always looking over its shoulder to keep well away from the threat of telco entry into the cable television business. Conversely, cable television is very supportive of UBNs if collectively they are the primary operators of the local distribution networks. While most cable television executives' public statements indicate a strong commitment to coax technology for the future, fiber optics and telecommunications technologies have become a major R&D and strategic priority. On the surface, there appears to be no middle ground, but many cable television companies are actively investigating joint telco/cable television network arrangements.

The cable television industry stakeholder group is much more diverse than telcos or broadcasters. Many firms are primarily distribution network operators, others perform production and programming functions, and some are in the broadcast satellite business. Even though many of these activities are wholly or jointly owned by the same corporate entity, it is useful to separate them for stakeholder analysis.

9.2.1 Local Cable Television Providers

These firms mainly offer cable television service by authority from the municipality where they operate. There are significant differences in the philosophies of cable television managers. Many perceive their basic business from an engineering or network operation perspective, while others perceive it as an entertainment business. The significance of the distinction cannot be overlooked. The "network" group, which is declining in numbers but still controls industry public policy through various law firms and the NCTA, sees UBNs as a death knell and is fighting to keep their local cable television monopolies. The "entertainment" group sees the distribution network as a delivery system for the larger entertainment business. Should public policy require a movement toward UBNs, the "network" group feels it is the logical choice for infrastructure operation since they already provide broadband service to the home. As such, they would lease network capacity in a UBN environment to telcos and others. However, as cable television firms, free of strict common-carrier regulations, they have been very reticent to use their facilities for telephone service for fear of "achieving" common-carrier status.[35] The future of regulation in this area is unclear. Currently, state regulation of local telephone service providers, viewed almost strictly as public utilities, makes it very difficult for cable television to vertically integrate POTS, and even many enhanced local telecom services, into their operations. Some large cable television companies, such as Rogers Communications, based in Canada, are leading the way. Rogers recently sold their U.S. cable television interests with the intention of making further investments in the telecommunications business in Canada. This move could prove quite lucrative since telecom competition in Canada is very young. Of course, U.S. restrictions on cable television/telecom partnerships are much tighter than Canadian restrictions, but Rogers' experience may provide a useful model for U.S. operators seeking to expand into the telecom business in the future.

In the U.S., other cable operators are beginning to envision intercity video distribution using fiber optic technology to

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[35] Warner Cable filed an application to provide telephone service in Milwaukee in May 1988, only to withdraw it on June 23 when the corporate policy implications became clear. See Multichannel News, June 27, 1988, p.1.

provide the programming requirements for several local systems.[36] If such ventures are undertaken and prove successful, this could set the stage for cable television vertical integration into the telecom business for intercity transport, and ultimately to end users. It will be important to watch such developments since they could significantly enhance the possibility of cable television playing a larger role in the deployment of UBNs.

"Entertainment" cable television firms are more flexible than the "network" group. The former would contract with a better or cheaper network delivery system as long as terms were favorable. Of course, exclusivity must be among the favorable terms, or they are simply inviting competition. In fact, many local cable television firms are voluntarily entering into agreements with local telcos for cable television signal distribution.

Cable television firms' strategies call for growth through diversification; they would like to see new service applications for their technology. Many are upgrading their networks with fiber in anticipation of this growth. Newer satellite technology, such as DBS, gives these firms some hope to be the first to offer and provide ATV to their customers. If ATV on DBS is too bandwidth hungry to provide many channels, then a fiber distribution alternative is required. UBNs could become that alternative. The only other viable option for the customer would be rooftop dish reception. Clearly, this is unattractive to cable television network operators.

9.2.2 Satellite Television

Cable network companies are included this category. These firms perform production, programming, sales and distribution functions for local operators. Some firms in this category are heavily committed to satellite technology, and would therefore resist UBNs. Others see UBNs as potentially strong complements since they increase program marketing and distribution possibilities. No firms in this category would support the UBN concept if it implied telco ownership and telco vertical integration into programming. These firms currently enjoy unique market advantages of joint financial programming/transmission arrangements and would not want to see competitors attain similar advantages.

Some firms in this category plan to provide high quality video distribution using DBS technology. Some also have plans to provide, or team up with others to provide, low-cost rooftop dishes for reception. To these firms, UBNs represent an unequivocal negative force. There may be a tremendous first-mover advantage in the market for high-quality video production and distribution. Vertical integration or partnerships among major satellite networks and reception device manufacturers could create a formidable force in the UBN deployment game. Even though

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[36] See "Kahn Plans All-Fiber Overbuild in N.J.," Cablevision, October 12, 1987.

no such powerful alliance has yet formed, their potential should not be overlooked. This is especially so if new high definition video via DBS becomes available to consumers significantly in advance of high quality video on fiber. Besides the activities of the Murdoch group and others in Europe, other DBS programming/ manufacturing and distribution consortia loom on the horizon, not the least of which may be NHK, Japanese video receiver manufacturers and Hughes Communications Satellite Co.[37] Current plans call for a new satellite launch in 1990 to beam down DBS programming to the U.S.

9.3 Broadcasters

Generally, broadcasting companies would favor UBN deployment. Many feel very vulnerable to further inroads into their business from cable television or other alternative TV providers, and UBNs would provide a delivery vehicle that would enable them to enter some potential high-growth markets. If cable television were to provide local UBN distribution facilities, broadcasters would claim unfair advantage of content and conduit in the same way that cable television makes similar claims on telco provided UBNs.

Broadcasters, and the production and programming firms who deal with them, represent a potentially strong lobby to support the UBN concept. UBNs present the best growth prospects for this industry group by helping solve potential future bandwidth problems of ATV broadcasting. With the size, political clout, and visibility of this industry group, the formulation of a sound public policy to develop UBNs will have much better chances. This is the only stakeholder group with a strong presence in the electronic communications industry that is not clamoring to be a supplier of UBNs itself. So far they appear content to be considered a user, even though their current network infrastructure investments and those of distribution affiliates may become obsolete more rapidly.

9.4 Compromise

Given the UBN supplier stakeholder positions, it is interesting to evaluate the possible outcomes of behavioral interaction. Much of the difficulty in reaching a supply-side consensus regarding UBN deployment is the result of past actions on behalf of various institutional forces, including the judiciary, Congress, and the FCC. The competition policy of the FCC and that which results from MFJ line-of-business restrictions have effectively restrained telco adoption and deployment of basic network infrastructure technology for new digital

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[37] Amstrad PLC plans to market a rooftop dish for only $350.00 by early 1989 and is joining up with Murdoch's News International PLC to obtain high quality programming. See "Amstrad to Market Low-Priced Home Dish for Satellite TV," International Herald, June 9, 1988.

communications services.[38] At the same time, cable television suppliers have enjoyed the benefits of several legal and statutory decisions that allowed them to become the virtual local monopoly suppliers without regulatory restrictions.[39] To the casual observer it would appear that current institutional arrangements have polarized the positions of cable television and telcos to the point that cooperation to bring UBN technology to the marketplace is very unlikely. However this is not the case. Recent patterns of behavior indicate a steady movement toward cooperation. As is often the case, the political rhetoric lags behind the real progress.[40] The trend is clear: Federal legislation has been introduced to eliminate the telco/cable television cross-ownership restrictions,[41] and the FCC has recently indicated a willingness to eliminate these restrictions.[42] Some in the judiciary are struggling with the legality of upholding such restrictions as a constitutional matter,[43] and FCC waivers for cable television/telco cooperative service arrangements are surfacing.[44] At the local level, municipal authorities are now openly encouraging cable television/telco cooperation. Regulations of broadcaster ownership of local affiliate stations, print media and portions of the cable television industry are continuing to be liberalized.

The strong conclusion here is that even without these recent developments, an industry market consensus was forming anyway. Market pressure was constantly being applied, and the bureaucracy is simply responding with deregulatory policies to try to accommodate the marketplace. Even with a veritable gauntlet of regulatory and institutional barriers to run, individual industry suppliers were actively pursuing novel business relationships

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[38] AT&T, on the other hand, was very aggressive to modernize its network since divestiture.

[39] See article on p.12, Television/Radio Age, March 7, 1988.

[40] For example, "The Baby Bells vs. the Big Gorilla," Barrons, August 1, 1988; "CATV and Telcos Square Off," Telecommunications, Jan., 1988; and "Loop Fiber Projects Multiply as Telco-CATV Turf War Looms," Lightwave, August, 1987.

[41] A bill to relax telco/CATV cross-ownership rules is pending in Congress, see "Telcos talk about Cable Possibilities," Broadcasting, March 14, 1988.

[42] The FCC has tentatively concluded to allow telcos into the CATV business. See Telecommunications Reports, p.1, p.35, July 25, 1988.

[43] For example a recent court case in Indiana is pending which challenges the constitutionality of telco/CATV cross-ownership ban. See Telecommunications Reports, April 11, 1988.

[44] The FCC recently granted a telco/CATV waiver for GTE of California to build and operate local cable distribution facilities on behalf of franchisee Apollo Cablevision in Cerritos, California. See Telecommunications Reports, April 18, 1988, p.22.

with former potential competitors. While hard line lobbyists make antagonistic remarks in Washington D.C., their own member firms are engaging in more conciliatory behavior, often leading to partnerships for service provisioning or at least financial support. What once were very distinct and financially independent supplier groups are now emerging as joint providers of communications services.

The increasing level of industry cooperation is hardly coincidental. Market forces, such as technology, are causing traditional business strategies to change. At the same time, the marketplace for video products and services is becoming increasingly competitive, and customer alternatives for video and telecom services are growing. Institutional restrictions notwithstanding, the appropriate strategic supplier stakeholder response is to diversify. Diversification strategies can insulate the primary line of business from competitive displacement while opening opportunities for growth in other lines of business. This strategy has led some cable television firms to acquire other local cable transmission firms, creating large MSOs, and to acquire production and programming interests, and therefore a piece of the growing satellite business and even broadcasting interests. In turn, broadcasters have been acquiring interests in cable television industry firms and various other mass media. For several years now telcos have been increasing joint service provisioning arrangements with broadcasters, and cable television network operators. More recently, they have sought interests in ITs, ESPs, and mass media interests. These marketplace developments will drive innovation and stimulate UBN development. All major potential supplier groups are considering fiber as an investment strategy because it appears to be robust to many possible market scenarios.

Based on this discussion there would appear to be plenty of room for cooperation among the various supplier stakeholder groups for developing a consensus regarding UBNs. However, there are still other possible scenarios which could develop; some of these do not bode well for UBNs and some do.

9.4.1 Current Trends

Since it is generally believed that UBN capability requires fiber access for users, a few possible cable television/broadcaster strategies could seriously delay deployment. The two contingencies that could greatly affect the demand for, and capital funds available to, UBN suppliers are: (1) continued emphasis on coaxial cable for cable television service and (2) potential use of rooftop dish reception for DBS. Success of either of these technologies in the long-run could diminish much of the demand and attendant revenue support for deployment of UBN fiber access. If public UBN deployment is delayed significantly, and to the extent that fiber is not utilized for all major customer service applications, then UBN as it is conceptualized today may not be achieved. However should the powerful broadcasting industry align to form a coalition with telcos for use of their fiber distribution network, this would cause cable television and others' defection to other local distribution technologies to have much less impact on UBN development.

Telcos cannot accept any of this as a given. Such coalitions are not yet assured for two reasons. First, broadcasters, producers, and programmers are in a very competitive business. Furthermore satellite technology is increasing competition on an international scale. Often in the video entertainment industry, being first to the marketplace with a new or better video product is very important to retain or improve market share. If a suitable distribution alternative lends the advantage of being first to the marketplace, then it will be preferred, at least for a while. Much of the information available today indicates that DBS, coax and VCRs will be able to be used for new ATV video products before fiber.[45] As a result, the broadcast industry could reconsider some of its support for UBNs.

Second, a strong broadcast industry/telco UBN coalition is not assured since many firms in the broadcast stakeholder group may ultimately view telco-provided UBNs as an overall substitute for, not a complement to, their business. At the present, telco networks look extremely attractive to broadcasters as another distribution channel and cable television competitor. However a combination of broadcaster and cable television interests could cause these competitors to become partners, especially if broadcasters buy into DBS production, programming and distribution interests. Perhaps more importantly, telcos plans to vertically integrate into programming and production looms as a competitive threat to broadcasters. On the other hand, if telcos did vertically integrate to gain expertise in the broadcasting and entertainment business, they would likely seek acquisitions and partnerships with the broadcasting industry,[46] thereby preserving a potentially critical stakeholder coalition. In any event, early telco plans for vertical integration could alienate many stakeholder groups. In the stakeholder analysis presented earlier nearly every service supplier group advocates UBNs as long as they appear to be a distribution infrastructure offered on a common carrier basis. As soon as telco vertical integration is announced or even perceived, support of other

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[45] Japan's ATV system, High-Vision, uses DBS analog technology and is the most "market-ready" with program production just around the corner in 1990 and new high-definition TV sets and VCRs soon to follow. HDTV will be available well before digital fiber even begins to become available to households. Thus CATV firms will be sure to compete with satellite dish reception and VCR sales by providing HDTV on coax. Satellite dishes, VCRs and coax will all be available for HDTV in the home before fiber. The big policy question is: will the head start of these technologies take away the chances of fiber UBN development by removing a major demand source.

[46] Telco executives have already publicly stated this view in anticipation of future freedom to get into the content end of the business.

stakeholder groups for telco UBN deployment may be withdrawn.

9.4.2 Cable Television

Another important consideration in the UBN stakeholder game is the potential adoption of fiber access by the cable television industry. Both cable television and telcos are acutely aware that being first to the marketplace may be a very important business strategy. If cable television is first, then widespread bypass of telco local facilities is possible. If telcos are first with fiber to the customer location, cable television would have to seriously consider the competitive viability of investing in a fiber overbuild. In one sense, the fiber race is on, yet in another it isn't. Cable television firms have an embedded base and expertise with satellite, radio and coax technology, while local telcos have embedded copper and radio plant. Both have a drag on their flexibility. Cable television enjoys the most flexibility, however, since it is unregulated regarding treatment of its embedded plant for business purposes. But coax is the only short-term prospect for high-quality video.[47] Realizing the potential importance of fiber, most large cable television companies are actively expanding their knowledge and facilities base in fiber.

The telcos have solid plans to go from copper to fiber and do not have the same "drag" on their plans that cable television does, since phone service on fiber seems to be the most effective strategy even for existing lines of business. Also telco expertise and experience in the use of fiber is unsurpassed.

There seems to be a compromise brewing in all of this. If cable television believes: (1) that fiber distribution is ultimately preferred and (2) that telcos indeed will naturally deploy it, regardless of their own deployment in any given local area, they (cable television) must seriously consider the viability of investing in a fiber overbuild. This is especially so as local cable television markets are opened up to competitive network overbuilds by others - currently the clear trend. Cable television companies found investment recovery of new network costs difficult even when they were sole providers. Naturally, they are concerned about recovering the cost of fiber new-builds, rebuilds or overbuilds, and thus lease-back arrangements with the telcos are increasingly attractive. Telcos welcome this as a new source of business and try to tiptoe around regulatory or institutional restrictions to make it work. Especially difficult is the problem of simultaneous common carriage requirements of the telco and exclusive carriage agreements with the cable television franchisee, an apparent contradiction. Telcos also see these arrangements as great (and rare) opportunities to gain experience and expertise at building and operating cable television networks, thereby enhancing the network integration prospects for the long term. It is a lot easier to integrate

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[47] HBO claims that HDTV on coax is very near. Refer to footnote 30, Zitter.

systems once you own them.

Cable television would like to pursue a similar strategy, whereby they would lease network capacity to telcos for use in telecommunications, thus gaining experience and expertise in telephony. Again however, restrictive institutional considerations hinder this process. The converse of the telco-as-cable-television-signal-carrier problem occurs when the cable television franchisee is unregulated, but as a public telecom network provider must also be considered a common carrier, thereby violating cable television franchisee conditions.

The most likely short-term compromise, which works quite successfully in some foreign countries, is for telcos to provide both cable television and telephony on "hybrid" tree-and-branch (coax, radio, satellite) and switched (copper, radio, fiber) networks. Where this exists, the telco is not engaged in the "entertainment" end of the business. If telco vertical integration into entertainment services is allowed or anticipated, cable television suppliers would likely be reticent to get involved in any cooperative joint service provisioning arrangements.

9.4.3 AT&T

AT&T, and other interexchange common carriers have been conspicuously absent from the UBN discussion because there is little action among them in this arena. There is, however, one potentially important development. First, the MFJ, which precludes the BOCs from the long-distance market, seems to assure AT&T's role in the long-haul part of UBN development and deployment. Of course, a radical change in MFJ restrictions may occur, but this is unlikely since the agreement has been durable so far.

Second, there are no major competitors in the potential interexchange market that are not already apparent. One that could potentially arise is the submarket of UBN service suppliers that may utilize satellite. However even if satellite ultimately has a role to play in UBN deployment, AT&T already has significant expertise and resources development.

AT&T's one potentially significant new role would be its entry into the local network marketplace, probably through acquisition of cable television interests. There are no apparent institutional restrictions against this and therefore the lack of AT&T activity in this area is curious.

9.5 Standards

The importance of development and adoption of UBN standards cannot be overlooked since incurring the costs of development and production of network components and facilities is too risky without standards. Any significant supply-side consensus of UBN service providers would require the support of industry standards.

10.0 Summary and Future Research Agenda

In conclusion, supply-side consensus appears to be emerging in the marketplace regarding UBN technology adoption and deployment. The current dominant trend is for telcos to be the primary UBN infrastructure provider. The speed with which stakeholder coalitions are forming, especially in light of the diversity of the players and the harsh political and institutional environment toward supplier cooperation, is indicative of the importance that the stakeholders attach to UBN deployment. Ultimately, the legitimate business interests of supplier groups, and the advance of technical knowledge are prevailing. The public policy agenda should aim to eliminate institutional barriers that encourage fragmentation of public communications networks. This is not to say that past public policy has necessarily been wrong so far and that competition policy of the last several decades should not have prevailed. It is apparent, however, that the existing political and institutional arrangements are not compatible with the new technological paradigm. As important issues are clarified, institutional arrangements will become more flexible to accommodate UBN development in the market arena. Healthy and vigorous competition among supplier groups may provide a domestic communications infrastructure that is technologically better and more responsive to social needs than those which may come about in other, more centralized foreign countries.

The picture of widespread UBNs is not rosy under a number of different scenarios which were examined. Telco vertical integration is the most likely linchpin to achieving a relatively cooperative and productive deployment scenario. If other supplier groups believe their financial future is at risk due to telco entry into their primary business, then their support for UBN deployment will likely dissipate. For now these supplier groups should be neutral or favorable to development of UBNs, because telcos are primarily viewed as complementary distribution channels. The exception here is cable television firms who believe that the most significant business risk for them is telco entry into the network end of the cable television business. The best way for the marketplace to handle this problem is already occurring -- increasing voluntary financial arrangements between local cable television companies and telcos. As these financial ties grow, cooperation will seem natural. It is not very risky for telcos to invest in and learn the cable television network distribution business. Due to the protection offered by local franchising, telco entry into some local cable television markets requires only a small marginal investment, and thus market experience is gained while being insulated from competition.

Two important areas for research include the likely effects of DBS technology on UBN deployment and how ATV issues will affect network technology adoption, especially the continued preference of cable television companies to utilize non-fiber network alternatives, such as satellite, radio and coax.

Another important research area is the feasibility and timing of replacing traditional broadcasting facilities with UBN distribution, and the potential impact on production and programming markets. Other significant issues concern the use of proprietary customer information by UBN network service suppliers and copyright protection.