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Integrated Broadband Networks: Balancing the Risks

by Martin C.J. Elton

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

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Center for Telecommunications and Information Studies.
Graduate School of Business. 809 Uris Hall.
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INTEGRATED BROADBAND NETWORKS: BALANCING THE RISKS*

MARTIN C. J. ELTON

INTRODUCTION

The subject of Integrated Broadband Networks (IBNs) is provoking considerable controversy. There is disagreement about what they are; when, if ever, they will be economically viable; and whether, if viable, they will be socially desirable. On one point, however, there is likely to be agreement: today's de-facto public policy regarding IBNs is to operate in the "Prevent" mode. The main issue in the public debate is whether to adopt a national policy in either the "Permit" or "Promote" mode. There are risks in all three positions: selecting among them is a matter of balancing risks.

This paper argues that we can have little confidence in our ability to forecast demand for new services, hence to obtain reliable estimates in answer to questions about externalities, commercial viability, and economic efficiency. Limited trials of the kind now under way will do little to reduce such uncertainties. With technological progress and increasing corporate demand for bandwidth, the economic case for IBNs will probably continue to improve. Sooner or later, then, we will have to decide whether and how to rely on the market to obtain some answers.

THE CONCEPT

Different commentators have ascribed different meanings to the term, "Broadband network." This has further confused some already difficult issues. A consensus seems to be emerging, however, that an <u>integrated broadband network</u> is defined by the following characteristics:**

- it carries traffic in an integrated digital bit stream

- it extends all the way to the subscribers'

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** The term "Broadband-ISDN" or "B-ISDN," is in wider currency. We prefer our terminology, because the implied relationship between (narrowband) ISDN and B-ISDN is likely to prove misleading. In this paper, "ISDN" refers only to narrowband ISDN.

premises

- subscribers' connections to it operate at approximately 150 Mbps or higher.

- it provides switched, two-way broadband service.

IBNs will be based on the use of optical fiber technology, but there are many other ways of designing optical fiber into a public network. Cable companies may deploy fiber "backbones" to improve signal quality and increase bandwidth. Telephone companies may use it, for example:

- to provide plain old telephone service (POTS) in small and scattered, new, upmarket residential developments

- to provide residential and business ISDN

- to provide a combination of residential POTS or ISDN with analog cable television service.

It may be used in other ways, too. Such configurations would provide less functionality than an IBN and would cost less, in some cases much less. Telephone companies would be able to economize further by terminating the optical fiber in the handhole or pedestal near subscribers' premises and employ a combination of copper wire pairs and coaxial cable for the last hundred feet or so.

These alternative fiber optic networks may turn out to be stepping stones en route to an IBN or they may represent a stage at which the public network will rest for several decades. While it may seem less risky to proceed to IBNs via such stepping stones, there are some who argue that this would be much more costly and, in some respects, actually more risky. The difference in viewpoints is associated with how far one looks ahead. The majority of analysts adopt an evolutionary approach, seeing IBNs as supporting those telephone and television applications which we enjoy today, plus certain specific new applications. Others adopt a visionary perspective, seeing the new technology as revolutionizing the way we use computers, television, and the telephone and, thereby, revolutionizing the way we conduct transactions throughout society. These two viewpoints are not mutually exclusive; they are complementary and each is necessary. However, there does appear to be considerable intolerance between the two camps. The visionaries are impatient with analyses to determine whether revenues would be sufficient to cover costs, regarding them as examples of "horseless carriage" thinking. Their counterparts are exasperated by the idea of recklessly pursuing high technology investments which may never pay for themselves. We return to this point below.

IBNs can be seen as the next evolutionary stage of the public network, following ISDN, which itself followed digitization of the interior of the network. For two reasons, however, the relationship between IBNs and ISDN is more complex. First, as Solomon (1987) emphasizes, IBNs are not just speeded up ISDNs. Their architectures could be radically different. Backward compatibility of IBNs may involve distinctly undesirable design compromises and costs.

Second, each could be regarded as a spoiler for the other. If ISDN is widely deployed, will the additional investment for IBNs be readily forthcoming? If ISDN turns out to fall short of expectations, will regulators be in the mood to give the telephone industry another chance soon after? May the prospect of IBNs reduce the perceived attractiveness of investment in soon to be outmoded ISDN? These questions have not yet received much public attention.

What ISDN and IBN do share is the concept of integration. Noll (1989a) points out that to establish the economic case for integration, one must show that economies of scope outweigh diseconomies of scope; this has not been done. Suppose, for the sake of argument, that experience with ISDN in the short to medium term is disappointing, should one then conclude that the case for integration, as envisioned in the concept of IBNs, has been weakened? The answer is far from clear.

DEMAND FOR NEW SERVICES

It is hardly surprising that there is disagreement about whether demand for the new applications which IBNs will make possible will be sufficient to justify investment in them. Before turning to this question, it is worth noting that, especially in the short term, the main contribution of the new infrastructure to its end-users may not lie in new applications. Of greater immediate significance to large corporate customers may be a considerable reduction in unit costs of bandwidth. To achieve comparable savings without IBNs would require an investment in upgrading existing private networks which they may prefer not to make. For residential customers in the short term, what may be important is the competition that IBNs could bring to the market for wired distribution of entertainment television.

Figure 1 shows the "new" services and applications which are most frequently discussed in connection with IBNs. While telemarketing and telecommuting already exist, the deployment of IBNs might change and extend them quite radically. These two types of application cut across the frequently employed dichotomy between residential and business services. They may be of particular significance because of the large sums which business outside the telecommunications industry may be prepared to invest in exploring and developing them; also because of their pervasive impact on society should the succeed. Sudit (1988) estimates the externalities related to telecommuting as being in the range of a trillion dollars per decade. (However, there is no evidence that telecommuting is being held back by technological barriers. Nor is it clear that IBNs would have much to offer beyond what ISDN would provide.)

	SERVICES	APPLICATIONS
RESIDENCE	HDTV Video on-demand Picture telephony	
BUSINESS	Videoconferencing Picture telephony High resolution graphics CAD/CAM LAN interconnection	
BUS. - RES.	(Various) (Various)	Telecommuting Telemarketing

Figure 1: Proposed New Services and Applications

At first sight, the proposed services in the residential and business categories do not inspire confidence that IBNs will generate significant new revenues in the short to medium term. Even if the demand for HDTV were assured, it could be transmitted by less sophisticated means, for example, by cable television systems upgraded with optical fiber trunks. Picture telephony is a narrowband application, within the capacity of today's copper wire pairs. Video on-demand appears to be regarded as the most promising of the residential services currently under discussion, but the necessary storage and retrieval subsystems may not be cheap; it will place additional demand on the switching subsystem; and margins will be low if the service is to be an appealing bypasser of video stores.

Certainly, one can anticipate the proposed business services generating increased traffic, even if they are not all "new" services. The question is the extent to which IBNs are necessary for them. Not only is picture telephony a narrowband application, videoconferencing is successfully accomplished today, with relatively inexpensive codecs, at bit rates down to a quarter of the T1 rate, i.e., within the compass of primary rate ISDN. Private networks and metropolitan area networks will probably prove more cost-effective means of providing transmission for some of the other services.* Moreover, bandwidth compression technology, which has made such a major contribution to the economics of videoconferencing, may reduce the bit rates required for other services. The incentive to develop and to use such capabilities depends, in part, on the differences in price as between high and low bit rates. At present, pricing is a matter of speculation.

Maybe, however, estimation of potential demand on a service by service (or application by application basis) sells the new technology short. With IBN technology widely in place, it will often be possible to try out new applications much more quickly, more conveniently, and, quite probably, more cheaply. The environment for innovative applications will be considerably better. If it is unnecessary to economize on bandwidth, terminals could be cheaper and compatibility less of a problem. This underlies the view of some that, as has been the case with new transportation and communications infrastructures before, the "highway effect" will generate the new demand; it is futile to second-guess the future creativity of entrepreneurs and users themselves. On the whole, history is on the side of those who believe in technology push in this area. That it offers no guarantees for the future, however, is illustrated by the Anglo-French Concorde, an example of pushing too soon, and nuclear power generation, an example, perhaps, of pushing too fast. Unfortunately, to adopt the technological push standpoint is, essentially, to remove the issue of economic viability from the realm of analysis and to place it in the realm of faith. Yet this does not mean that the belief is mistaken.

In addition to the positions of the believers and the atheists, there is the position of the agnostics. This is based on our inability to forecast, even at the crudest levels, the demand for new telecommunications applications and services. History supplies ample evidence of this: there are examples of unanticipated market successes (e.g., audiotex and facsimile), as well as unanticipated market failures (e.g., picture telephony, videotex, and many others); there are very few examples of successful prediction.

An examination of forecasting methodologies shows one of the reasons: the analytical tools available are totally inadequate. The Delphi technique rests on the distinctly dubious assumptions

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* Private networks may use dedicated or public facilities. Increased high bit rate traffic over private networks which use public infrastructure will probably further the case for using optical fiber in the public switched network.

that there are expert individual forecasters of demand and that their consensus provides a reasonable view of the future. Diversion (or substitution) methods rest on simplistic models of rational economic women and men, models which are rarely tested even when they may be testable. In addition, they ignore the fact that new technologies often succeed because they allow us to do new things that were previously impossible, rather than because they allow us to do old things more cheaply. The historical analogy approach makes a comparison with past successes, thus begging the important question, and makes untestable assumptions about similarities between the future and the past. And so on. There is absolutely no prospect of significant improvement in the foreseeable future: our theoretical understanding of relevant aspects of individual behavior and organizational change falls far too far short of what would be necessary.

Even though they are exceedingly unlikely to resolve key uncertainties relating to demand for services provided by IBNs, we can look for improvement in two respects. First, we should be able to do a better job of testing and refining the conceptual models underlying the assumptions that the new application or service will be used.* Second, we should be able to make field trials more useful in exploring issues relating to demand. Their frequent lack of value in this respect in the past should not be ignored. Far too often, for example, the conclusion has been that disappointing uptake of a trial service should be ignored because the trial was too small; the question of scale is crucial and demands attention at the outset; it should not be left till the *post mortem*.

In sum, there is good reason to have little confidence in forecasts of substantial demand for new services; similarly, there is no reason for confidence in forecasts that there will be little or no demand. Regarding this topic, a sense of humility would be appropriate.

EXTERNALITIES

Almost certainly IBNs will produce substantial positive externalities when (and if) they are used for the variety of new applications envisaged by their proponents. But we cannot forecast when (and if) there will be demand for these new applications. Using the prospect of such externalities to justify government subsidy or cross-subsidy from telephone subscribers requires a combination of confidence and lack of

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* For example, through most of the 1970s it was assumed that the comparative advantage of videoconferencing lay in its substituting for in-person communication. In fact its more significant use was as a substitute for non-communication.

confidence in IBNs: confidence that the demand for new services will develop within the foreseeable future; lack of confidence that it will develop if the services are priced to provide to launch them. These two views are not inconsistent with one another, but in combination they suggest less uncertainty than many would feel is warranted.

The successful deployment of IBNs would probably produce negative social impacts too. As the telephone became established, the telegraph became less viable, which had an adverse impact on some sectors of the population, in this case, an impact mitigated by policy of universal service. As a society, we accept this kind of impact as the price of progress. Sometimes adverse social impacts are considered sufficiently significant, relative to benefits, for a new technology to be tightly circumscribed or to be outlawed, but no such arguments have been advanced regarding IBNs.

REVENUE REQUIREMENTS

Published estimates of the cost of deploying an IBN relate only to residential customers. They vary widely, seemingly from a low of about $2,000 per subscriber to a high of almost ten times this amount.

One could be forgiven for concluding that some of the authors concerned are putting forward a case and choosing the assumptions that would best advance their cause, but there is much more to it than this. It turns out that many of the estimates are for optical fiber networks that are less than IBNs: for example, they may not carry broadband signals in digital form. Moreover, some estimates pertain to the costs of the whole system, including switches and terminal equipment, but others pertain only to the cost of the transmission subsystem and its installation. Also, different authors assume different starting points: Sirbu et al. (1988), for example, consider the costs of upgrading an existing ISDN, while some others consider upgrading a POTS network. While authors may be commendably clear about stating their assumptions, their estimates are regurgitated by others who show less care.

The foregoing confusion can and should be avoided. There are, however, some major uncertainties which cannot yet be resolved. One concerns the broadband switches which are still under development. Clearly they will be very expensive. It would help to know how much switching capacity will be needed, but this depends on the network's topology: a wide range of possibilities exists in trading off switching against transmission. Unfortunately, there is no consensus yet on the optimal configuration. Sirbu et al. (1989) argue that there is a strong case for favoring a higher investment in switching, a lower investment in transmission. This is because switching capacity can be expanded incrementally as demand rises, while transmission cannot. Should this policy be adopted, possible errors in overall cost estimates due to switching cost uncertainties would be higher.

A further cause of uncertainty is that average costs will depend heavily on demand. One reason is economies of scale in the production of switches and terminal equipment. Another is because average costs of an IBN are likely to be highly sensitive to the percentage of potential customers who choose to subscriber. For these reasons and also because of learning curve effects, costs will decline through time in real terms. (For an estimate of learning curve effects, see Schumate, 1989.)

The questions we would like to answer about the costs of an optical fiber network installed by a telephone company are (1) would it cost less than a copper network? and, (2), if not, would the additional revenues to be derived from the more capable optical fiber option compensate for the difference? These questions need to be made more specific before they can be answered. Figure 2 indicates four generic possibilities.

CAPACITY	NEW BUILD	
	Yes	No
Narrowband		
Broadband		

Figure 2: Alternatives Needing Cost Estimates

For this discussion, it is unnecessary to consider whether narrowband means POTS or ISDN, nor whether broadband provides analog transmission of video or is an IBN, although a comprehensive analysis would have to cover all these options and more.

The narrowband designs cannot be expected to generate additional revenues, so the question is only whether they would cost less. Some analysts (e.g., Schumate, 1989) estimate that within a few years they will indeed cost less. These estimates, however, assume rapid deployment of optical fiber so as to achieve substantial economies of scale and learning curve effects. The rate of deployment is faster than would be required for new builds and replacement of plant at the end of its useful life. Replacement of plant which is still serviceable may be justifiable on the grounds of savings in operating and maintenance costs; otherwise the likely consequence is telephone rates that will be higher than they would otherwise need to be. Will rapid deployment of optical fiber for residential POTS or ISDN have the latter effect? No answer has yet been provided.

The narrowband designs do not raise the wider issues of public policy with which the broadband debate is concerned. Primarily because of the costs of the associated electronic and photonic subsystems, the broadband designs will cost more. No claim has been made that, even in a new build, a broadband optical fiber network would be cheaper than a conventional narrowband network: revenues from the carriage of television will be necessary. If, in a new build, the costs of a broadband optical fiber network were less than the combined costs of a conventional telephone network and a conventional cable system, then additional revenues from new services and applications would be unnecessary, but this claim has not been made. To create a business case, it must be assumed that broadband optical fiber networks will need to generate additional revenues.

Other than in new builds, a telephone company deploying a broadband network will generally have to deal with an existing cable television system. Various possibilities arise. If permitted, it might buy up the cable company, in which case the considerable cost must be considered. It may compete with the cable company, in which case realistic estimates must be made of its future market share. Or it may provide transport for the cable company. The probability of the last option is likely to depend on whether or not the telephone company is required to operate as a common carrier of television programming. If it is not so required, an exclusive lease could be attractive to the cable company when it faced the need for heavy investment to upgrade its system. If, however, the common carrier model were to prevail, the cable company, by accepting transport, would contribute substantially to the viability of the new network which, sooner or later, would distribute competitive programming: a much less attractive possibility. It is, therefore, very difficult to estimate the revenues available to a telephone company from the distribution of television.

One conclusion is safe: on a national scale the costs of deploying broadband networks are enormous. Some authors have multiplied the average cost per subscriber by the number of subscribers across the nation to obtain a cost for connecting all homes to IBNs. The result lies between several hundred billion dollars and over a trillion dollars. By comparison, NASA's nine-year program to put a man on the moon cost about 120 billion dollars in today's terms.

Egan (1989), assuming an evolutionary approach, regards such costs as far from unmanageable. The investment would be spread over many years and BOCs are currently making capital investments in excess of $20 billion a year. The total investment necessary would not be committed at the start of such an undertaking: telephone companies could speed up, slow down, change direction, or stop entirely in the light of ongoing experience. What matters, then, is, if the concept proves not to be viable, how much wasteful investment will have been made before deployment ceases and who will bear the associated costs?

Two assumptions underlying the perspective raise troublesome issues for public policy. One assumption is that capital investment by Bell Operating Companies will continue at or above current levels. Investment is funded almost entirely from depreciation, which is the largest element in BOCs' revenue requirement; lower investment rates would mean lower prices. What is the appropriate balance between the conflicting objectives of modernizing the network and keeping prices down? Should we assume that today's answer is correct and will continue to be?

The other troublesome assumption concerns priorities for capital expenditures. A top priority at present is installation of digital switches. In the early part of the next decade this could be replaced as a priority by a rapid deployment of optical fiber in the local loop. The result would be that the more attractive customers would be served by both digital switches and more fiber in the local loop; the less attractive customers would be served by neither. While this may be efficient in an economist's sense, it would raise questions of equity.

THE TELEPHONE AND CABLE TELEVISION MARKETS

The public telephone network is in a state of transition. Originally, all signals were carried in analog form. Then came the digitization of the interior of the network, initially long-distance trunks, subsequently other connections from one switch to another. The industry is just starting the next stage: providing end-to-end digital service by means of integrated service digital networks (ISDNs). IBNs can be seen as the evolutionary stage after next: converting the all-digital narrowband network to an all-digital broadband network. The initial deployment of ISDNs is encountering some problems,* so there is also the possibility of a direct transition to IBNs, leap-frogging ISDNs in some or most parts of the country.

Complicating this picture are the related trends towards greater competition in the local telecommunications market and

* See, for example, "ISDN: What's Holding Up Implementation?" Center for Telecommunications and Information Studies, 1989.

towards greater use of private networks. These increase the uncertainties to which telephone companies are subject and, at the same time, they increase the strategic desirability of large new sources of revenue. Without these, there is the long-term risk that the product they sell will become a commodity.

Another trend should be noted: optical fiber is already diffusing into the local loop. On the customer's side of the local switch the network increasingly comprises a feeder portion which may employ fiber, and a distribution portion, which uses the existing copper wire pairs. The feeder portion surrounds the switch and carries concentrated traffic for groups of customers; the distribution network comprises the circuits dedicated to the individual subscribers to whose premises it is connected. The distinction is irrelevant in the case of high-traffic corporate customers: in some cases, optical fiber already extends all the way to their premises.

It has long been an objective of the telephone companies to enter the field of cable television. Though GTE owns and operates cable systems, as do some of the smaller independent telephone companies, the Bell Operating Companies (BOCs) are prevented from doing so by the 1984 Cable Act, the Modification of Final Judgement, and the FCC's cross-ownership rules. In the last year or two, suggestions that these restrictions should be relaxed have come from the FCC, the NTIA, and members of Congress.

Depending on where one stands, the relationship between the deployment of IBNs and the BOCs' entry into cable television can be seen in different ways. It may be thought that the primary objective of the BOCs is to enter the cable television market and IBNs are the latest ploy to achieve this. It may, alternatively, be thought that their primary objective is to deploy IBNs or some lesser residential optical fiber network and that revenues from cable television are necessary to justify the investment. Yet another viewpoint is that if the cable industry is first to run optical fiber to the home, the outlook for the telephone industry in the next century is decidedly bleak, and vice versa. Whether this would actually be the case is an exceedingly complex matter, depending on the extent of economies of scope and the regulatory regimen then in force, but it is understandable that the prospect of the other being first makes each industry uneasy.

Currently, the possibility that the cable industry may be first has received little attention. Nevertheless, the industry's strategic position is far from weak. The use of optical fiber backbones in cable television systems has been a subject of intense study within that industry for the last year or two, Recent announcements suggest that the average costs of such an upgrade would be in the range of $35 to $250 per subscriber. For this sum, cable companies could improve signals and, through reduced maintenance and consolidation of headends, save on operating costs; they could also increase capacity.

While such upgrades of the analog infrastructure would fall a long way short of IBNs, they would provide the industry with a good jumping-off point for future advances; they would provide it with experience in the use of optical fiber; and they would put it in a better position to compete with the telephone industry, defensively by protecting existing markets, offensively by facilitating the provision of by-pass services. It may also be noted that the telephone industry's labor costs are appreciably higher than those of the cable industry.

A good reason for cable companies' current caution in competing with the telephone industry is to avoid being regulated as common carriers by state utility commissions. Provided they avoid this fate, they will probably continue to be unburdened by regulation in their deployment of optical fiber.

There is also a distinct possibility that cooperation could replace conflict in the relationships between (some) cable television companies and (some) local telephone companies serving the same area. The attraction of partnership would come in part from reduction of the downside risks of increased competition. However, the downside for these two industries may be the upside for their customers.

With complementary expertise, moreover, each partner could help the other in implementing systems which jointly provided each's traditional services. Possibly, therefore, the short to medium term public interest associated with increased competition is in conflict with the longer term public interest associated with optimal use of fiber optics in the local provision of services. This possibility has been envisaged by Phillips (1989) and by Egan and Conn (1989). The former raises the possibility that the switching node closest to the subscriber should be owned not by the telephone company alone, but by a cooperative which would include the cable company. The latter suggest that the most economical way forward may be to leave the last leg of a public broadband transmission network in the hands of the cable company and to rely on the telephone company to interconnect neighborhood hubs. Such an arrangement would be similar to the situation in Sweden (though optical fiber is not used for this purpose).

The public policy issue here is a difficult and important one. To allow partnerships may be to avoid waste of national resources; it may also reduce somewhat the cable industry's political opposition to telephone companies' use of optical fiber to transmit television programming. The engineering and economics issues involved deserve careful analysis. If the case turns out to be strong, it must be weighed against the value to the public that might be derived from future competition between television delivery infrastructures. Here it should be noted that requiring jointly owned broadband systems to be operated as common carriers would still allow competition in the marketing of cable television programming.

Another set of issues arises when one considers the possibility of an out-of-area local telephone company or an interexchange carrier buying or entering a joint venture with a cable television company. Again this would bring together complementary expertise; while there would be less potential for synergy, the possibility of competition with the local exchange carrier serving the area would be retained.

In this context, the position of AT&T is of some interest. The resources and expertise it could invest are of obvious significance and it is now free to offer information services. One complication, however, is that it may need to be careful not to alienate the customers of its manufacturing arm. Another complication may be opposition at a political level from the smaller interexchange carriers who might be concerned about the advantage it would thus obtain in interconnecting IBN "islands."

BALANCING RISKS

When the costs of installing optical fiber drop to the level of installing copper wire, telephone companies will be able to use fiber in new builds. Until then, today's regulatory system will operate in a "prevent" mode as far as residential fiber optic systems are concerned. Even then, it would prevent both provision of television service by the local exchange carrier and, till costs dropped further, replacement of existing copper loops with optical fiber.

For the purposes of this paper, two public policy positions are contrasted with the "prevent" position: "permit" and "promote." Both would remove legal and federal regulatory barriers to telephone companies' provision of television service. For the sake of argument, it is assumed that they would differ in the following respects:

- <u>financial incentives</u>. To speed the deployment of optical fiber, the "promote" policy would allow for federal subsidies (including changes in the tax system) and-or cross-subsidies (including accelerated depreciation) by telephone subscribers and-or by corporate broadband users. The "permit" policy would allow no significant subsidies or user cross-subsidies.

- <u>competition</u>. To reduce financial risks, the furtherance of competition in local television distribution would not be an objective of the "promote" policy. In particular, telephone companies would be permitted to buy out or form partnerships with cable television companies; and common carrier regulation would not be applied to the carriage of television programming. The "permit" policy would not allow today's near monopoly by cable television companies to be replaced with a near monopoly by telephone companies (alone or in partnership).

- standards. In the "permit" policy, any federally mandated technical standards would leave open a wide variety of evolutionary pathways toward IBNs. The "promote" policy would use standards to achieve greater uniformity, so as to reduce costs and risks to manufacturers of the necessary technology and so as to reduce possible costs arising from the early write-off of investments in some components of optical fiber systems less advanced than IBNs.

- safeguards. Protecting the public from risks associated with the economic viability of broadband networks would be a primary objective of the "permit" position but, at most, a secondary objective of the "promote" position.

- state regulation. The "permit" policy would not interfere with the rights of state regulators or legislators to act in ways that would hinder the deployment of broadband networks. The "promote" policy would use incentives and/or federal preemption to avoid such obstacles.

A "promote" policy would be based primarily on two beliefs. The first is that there is a sound economic case for deploying IBNs in the near future, provided, perhaps, that one takes externalities into account and removes uncertainties relating to regulation. The second belief is that delay would be costly, because it would postpone the benefits to be derived from the new infrastructure and put the international competitiveness of the U.S. telecommunications industry at risk. Some would add that the window of opportunity for IBNs may start to close as large corporate users become impatient and expand their private networks and as new technologies (direct broadcast satellites, maybe) start to cream off potential residential demand.

Proponents of a "promote" policy are likely to argue that a "permit" policy will fail to generate significant deployment of fiber. Some argue that, to the contrary, its flaw is that it will succeed, but on too limited a basis, creating a large gulf between the information "haves" and "have nots". In one view, this argument is weak: a policy of universal service can be adopted later when the new technology has proved itself. In another view, the danger arises because, as noted above, investment for fiber could be diverted from installing digital switches in areas which will not yet have them.

The "permit" policy would be based primarily on four quite different beliefs. The first is that a sound economic case for deploying IBNs has not been made and very probably cannot be made without substantial field experience. (Nevertheless, the economics of optical fiber relative to today's transmission media will continue to improve, so that it is very likely to become the optimal choice for local distribution at some point in the future.) This leads to the conclusion that it is too risky, at least for now, to make the major national commitment to IBNs associated with a "promote" policy. The risks arise both from possible misallocation of national resources and from sacrifice of certain safeguards for the general public. The second belief is that an evolutionary approach, with strong public safeguards, minimizes the overall risk. Some telephone companies, it appears, believe there is a business case for broadband networks extending all the way, or almost all the way, to the end-user. They will, presumably, proceed accordingly if legal and regulatory obstacles are removed. This will provide empirical data, which will be valuable to decisions about whether, at what rate, and how to proceed elsewhere. Besides, provided the necessary public safeguards are in place, it runs counter to American values to deny willing and informed investors the right to take the risks they wish to take. Finally, the "permit" policy rests on the belief that the necessary public safeguards can be designed into the regulatory regimen.

The conflict between the two positions has the flavor of the conflict between industrial policy and laisser faire. There maybe no unique right answer. Those who believe in the "promote" position may argue that the "permit" position is based on a self-fulfilling prophecy: because it overestimates the risks, it is too timid and this timidity increases the risks. But a similar argument can be made in the other direction: by siphoning off some demand and, perhaps, by accelerating depreciation, implementation of a "promote" policy would make use of the existing infrastructure more expensive than it need be.

One clear point of difference between the two positions lies in their respective senses of urgency. Although the argument about international competitiveness is unconvincing,* the case for moving ahead fast cannot be dismissed out of hand. This point of difference merits further scrutiny.

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Different issues arise when comparisons are made with the "prevent" position. We limit ourselves to brief comments comparing the "prevent" and "permit" policies. (If the "permit" policy were the worst of the three, the other two would need to be compared with one another.)

Against the "permit" position, the argument for the "prevent" position rests on two beliefs. The first is that the necessary public safeguards cannot be provided. The second is that there is no economic case to be made for broadband networks, so it is unnecessary to trade off public safeguards for economic benefits.

Of the opposing beliefs, one is that the necessary public safeguards can be provided. In addition, it is also necessary to hold either that the economic case for broadband networks in the foreseeable future cannot be disproved, or that government has no business making and acting upon a determination against the economic case for such an infrastructure.

Those proposing a "permit" policy would probably advance the argument that an evolutionary approach need not rely on the prospect of revenues from new services. Optical fiber could be introduced only when and where it would be no more costly than copper wire pairs. After the new technology had been in place for a while, new applications would develop. Proven revenues from these would justify both upgrading the optical fiber infrastructure and extending it to other localities.

Those preferring the <u>status quo</u> may claim that, since the high fixed costs of broadband networks offer substantial potential for cross-subsidy and since telephone companies have such deep pockets, the broadband networks of telephone companies could drive cable companies out of business despite being economically suboptimal. Somewhat related is the concern that the prospect of a bruising battle between the cable and telephone industries could have a serious impact on the market value of

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* For example, a report from the EC's RACE program concludes that European manufacturers of broadband switches must sell in the U.S. market if they are to achieve necessary economies of scale (see "Establishing Advanced Communications in Europe," 1989). Without a U.S. market, presumably, a European market would not be viable. If this is so, it would, perhaps, apply to Japan as well.

highly leveraged cable stocks, thus precipitating a financial crisis for the industry.

Again, it seems most unlikely that the conflict between these two positions can be resolved by analysis based on currently available data.

A clear point of difference between the two positions is whether adequate public safeguards can be devised and implemented. This issue requires further analysis.

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The above discussion has implications for the design of a "permit" policy. Of particular importance would be what relationships are permitted between cable companies and telephone companies. One objective would be to minimize the business risks involved in exploratory deployment of broadband networks. This suggests allowing telephone companies to buy the assets of cable companies or enter into partnerships with them. Another important objective, however would be to promote more competition in the cable television marketplace. And this suggests requiring the relationship between the two types of company to be one of competition.

The solution to this problem may be to place no restriction on the relationship between the two entities, but to require that any television distribution service in which a telephone company had a stake be operated as a common carrier.*

If this view is accepted, what would be the broad requirements for "permit" policy? They may be as follows:

1. Protection of telephone subscribers. It is necessary to minimize the risk that subscribers pay more for telephone service because their local exchange carriers are deploying broadband networks. The best means to this end would appear to be price caps incorporating service guarantees. (Some authorities, however, consider the effectiveness of price caps to be overrated. See, for example, Noll 1989b.) Considerable care will be needed in assessing depreciation rates, since depreciation is

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* There may be some urgency in dealing with this issue. A telephone company could install a residential optical fiber system with the ability to transmit only a modest number of analog television signals. The broadband capacity might be insufficient for a common carrier model to be sensible. The capacity might then be leased on an exclusive basis to the cable television franchisee, who would continue to be protected from competition. Providing greater video capacity at the start would probably not be expensive. Later on it might be.

a major component of the costs which will need to be considered when price caps are set initially or revised subsequently. Accelerated depreciation could provide a concealed cross-subsidy for broadband networks. (See, for example, Egan [1989] and Gabel [1989].)

2. Protection of cable television subscribers. It may be necessary to protect cable television subscribers from price discrimination resulting from a cable company's response to competition. This could be because the local telephone company may attempt to skim the cream, deploying a broadband system so as to compete only in the most profitable parts of a cable television company's service area. If free to do so, a cable company may respond by adjusting its prices so that subscribers elsewhere have to pay more. See, for example, Shooshan (1989). (Possibly this could be done by increasing the price of basic service, reducing the price of premium services.) The result could be avoided by requiring cable television companies to price uniformly within their franchise area (which is a common, but not universal, requirement in today's franchises). There may also need to be explicit protection against redlining.

3. Provision of television service by telephone companies. It will be necessary to allow telephone companies to own and to operate television distribution operations in their own service areas, since, otherwise, the concept of integrated broadband service will not be properly tested. (The alternative, whereby telephone companies would be restricted to leasing television transmission capability to cable companies, leaves too much power in the hands of cable companies, which may not have enough incentive to make the new systems work.)

4. Access to diversity of television programming. Three related policy objectives apply. First, diversity of voice should be promoted. Second, if telephone companies, alone or in joint ventures, become monopoly providers of wired distribution of television, they should not have power as gatekeepers. Third, competition in the television marketplace should be furthered when transmission capacity restrictions are removable. These objectives can be met by requiring any broadband network in which a telephone company has an interest to be operated as a common carrier of all content, including video programming. (This would rule out, in future, a telephone company offering an exclusive lease of broadband transmission to a cable television franchise.) Probably this should apply even if the telephone company is an out-of-town area local company or an inter-exchange carrier. To avoid further complexity in the regulatory system, it should not be necessary for a telephone company, already franchised by the state in question, to be franchised by local government too. However, a telephone company should inherit the existing franchise obligations of a cable company which it acquires or with which it forms a joint venture.

Again in the interests of simplicity, there should be no change in the regulation of cable television companies which remain structurally independent of telephone companies (except as required by point 2 above).

5. Access by telephone companies to television programming. As Jackson (1988) has noted, much of the programming a common carrier would need initially, in order to attract subscribers, is controlled by the cable television industry; the industry may not perceive it as in its interests to make this programming available. Nor, initially, will broadcasters necessarily be happy about antagonizing the cable television industry. Vigorous legal action (and, if necessary, new legislation) relating to refusals to deal may be insufficient to overcome this problem. In consequence, it would probably be necessary to allow telephone companies to prime the pump. Through an arms-length subsidiary, a telephone company could be allowed to produce and-or acquire the rights to television programming and transmit it over its system. Two restrictions would be advisable. First, there should be no discrimination between its subsidiary and its service provider customers. ONA principles may be applied here. Second, it could do this only so long as there was excess capacity in the system. If these restrictions were judged to be inadequate, a time limit could be placed on the carriage over a broadband network of programming in which the telephone company in question, or its parent holding company, had a financial interest.

6. Provision of data and telephone services by cable television companies. There is a perception among outsiders to the telephone industry that state public utility commissions are captives of their telephone companies. If so, we can expect continuing regulatory barriers to cable television companies competing in traditional telephone company markets. This would be undesirable on grounds of equity. It would be undesirable, too, on grounds of efficiency: the best interim broadband infrastructure in some areas may turn out to be upgraded cable plant. This potential conflict between the federal government and state governments will need to be resolved.

7. Incentives for operators of broadband networks. It is important that there be sufficient prospect of rewards for investors who believe broadband networks would be commercially viable. This could be achieved if broadband (as opposed to narrowband) and new services could be priced, for at least some reasonable, predetermined period of time, at what the market

would bear.* Of course, telephone companies would need to be confident that state regulators would uphold such a bargain. Another necessary qualification is that the competitor of a cable television company should not be able to raise prices drastically if it succeeds in driving the cable company out of an area.

8. Interconnection. Local broadband networks should be capable of economical interconnection with one another and with metropolitan area networks. There is an obvious conflict between this and the objective of leaving open as wide as possible a variety of evolutionary pathways. As Marcus (1989) has noted, for example, it may be optimal for some broadband networks to transmit television in digital form and others in analog form. There is a challenge here for the standards community.

9. Obtaining value from natural experiments. The case for a "permit" policy rests, in part, on the belief that the only way to be sure about the economic case for broadband networks is to permit their deployment; limited field experiments are likely to be inadequate. It is important, then, that full advantage be taken of the potential for learning from such a policy. A barrier to this may lie in the proprietary nature of some of the information that could become available. There is a possible leadership role here for the federal government that requires further thought.

CONCLUSION

Whatever public policy is adopted, optical fiber will continue its diffusion in the nations' separate communications infrastructures. Telephone companies will continue its deployment in the feeder portion of the local loop and to the premises of large business users. It is the medium of choice for metropolitan area networks. Cable companies seem poised to adopt optical fiber backbones. It will be used in private telecommunications networks owned by large business customers. The five broadcast television networks have recently started a trial, coordinated by Bellcore, using optical fiber links to some of their affiliates. The continued diffusion of optical fiber is not in question. What is in question is the vision of integrated broadband networks serving residential and small business users, not just large corporations.

The case for the economic viability of broadband networks of the kind envisaged by the telephone industry is unproven. The case against their future economic viability is unproven. In all

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* For an alternative position see Gabel (1989). He accepts that telephone ratepayers will bear more than minimal risks and argues that they should, therefore, be treated as partners entitled to a due share of the subsequent financial rewards.

probability, neither case can be proved without considerable experience from the field.

Public policy should fully acknowledge these uncertainties. If the champions of integrated broadband networks within the telephone industry truly believe the risks are far outweighed by the rewards, a sensible way out of today's controversies about the economic merits of IBNs would be to allow them, if they are proved right, to enjoy the rewards. What would not be acceptable, with today's understanding, would be to allow them to pass off substantial risks to captive telephone ratepayers. With such an approach, the problem would no longer be primarily one of economics; it would become primarily one of politics, namely deciding on the sufficiency of public safeguards.

If, however, the industry champions of IBNs are not prepared fully to accept the risks, then we must wait until a decision can sensibly be made about the economic merits of the technology or, as Noll (1989) argues, until the advent of competition in local telephone markets provides safeguards for telephone subscribers.

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