The Potential Economic Externalities of IBM: A Case for Public Subsidies and Regulatory Reform

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The Ultimate Vision: Comprehensive and Universal Networks

Integrated broadband networks relying on fiber optics technology in transmission constitute an important step in the evolution toward an ultimate comprehensive telecommunications network (CTN) of the future. IBNs, and ultimately CTNs, will make use of the low loss and low dispersion properties of fiber to offer a clean, high capacity, high speed, close to error free, integrated medium of communications primarily over the successors of today's telephone networks. A national CTN, and eventually a global CTN, would provide wide access to voice-video-data services and would be likely to reduce substantially the need for physical proximity in the consummation of a wide spectrum of human transactions. Realization of these technological opportunities is bound to have profound macroeconomic implications. In view of the order of magnitude of the potential socioeconomic externalities associated with the evolution of IBN, regulatory and public policy, as they relate to telecommunications, should take a broad, long-term view of societal benefits and costs.

I would like to clarify in this context the distinction between the CTN terminology used in this paper and Egan's (1988) the Universal Broadband Networks (UBNs). The main difference is that the UBN scenario assumes universal access, while CTNs assume wide but not necessarily

universal access. I certainly agree with those who advocate the desirability of universal access. The development of the technology does not, however, inevitably lead in my view to universal access without some resort to public subsidies. IBN costs to customers are likely to decrease to a sufficiently low level to induce widespread use, but may be high enough in the foreseeable future to preclude effective access by significantly large segments of the population. The policy implications of aiming at universality are discussed later in this paper.

For the purpose of discussing the potential economic externalities of widespread use of IBNs, I focus on aggregate demand for services induced by IBNs, inclusive of residential, business and government demand. Clearly, there are great differences between prospective demands of big users and small users. The former represent currently evolving demand patterns likely to generate over 75% of revenue opportunities.[1] The latter represent tentative and speculative and future demands which are bound to generate negative cash flows for relatively long periods of time. However, I would argue that from the viewpoint of benefits to the national economy, demands by big and small users are interrelated with the large customers possibly providing the demand pull, and the prospective small consumers potentially justifying the technology push. Only widespread use of IBNs is likely to generate the sizeable economic externalities which are discussed below.

To illustrate the potential effectiveness and cost efficiencies of a wide use of IBNs and CTNs, I would like to focus on what appear at

1 For a more detailed discussion of large user demand see Phillips (1989).

present to be two very important prospective sources of demand for IBNs: (a) telecommuting and (b) on-demand information and entertainment services. Clearly, there are many other important potential applications of IBNs, but telecommuting and on-demand information and entertainment services are likely to be sufficiently pervasive to serve as points of reference for the discussion of regulatory and public policy implications.

Telecommuting

Telecommuting is not a prospective future phenomenon. It has been with us for decades. Indeed, the substitution of communications by telephone for physical commuting for the purpose of face-to-face contacts, exchanges and transactions began virtually with the commercial introduction of basic telephone service. Had we been presented at the beginning of this century with a scenario detailing the scope, importance and order of magnitude of telecommunications in the eighties, most of us would have dismissed our present reality as far fetched science fiction. Consider the possibility that for some entirely unexpected reason all telephone service were terminated for good as of next year. Doubtless, the socio-economic ramifications would be momentous. The required investments in alternative logistics needed to maintain the same scope and level of contacts and transactions would be enormous, if at all attainable. Telecommuting has been rapidly invading, in varying degrees, all walks of life. Consequently, the question is not whether we will be telecommuting, but when, how and to what extent will we expand our telecommuting?[2]

2 For discussion of telecommuting opportunities and practices in a pre-IBN environment, see Cross and Raizman (1986), Stone and Luchetti (1985), and Telecommuting Review (1985).

IBNs significantly enhance alternative modes of interaction which are likely to lead toward acceleration in telecommuting. For adequate economic motivation one needs only to observe the growing congestion in traditional modes of transportation and assess the current and future costs of maintaining and expanding transportation networks, along with the costs of enduring longer commuting schedules. IBNs and ultimately CTNs will provide more viable and economically advantageous opportunities for greater reliance on work-at-home practices in a growing number of organizations and occupations.[3] More than half of these homeworkers, however, are not telecommuting in the sense of relying extensively on high technology telecommunications to substitute for physical proximity. Nevertheless, it is noteworthy that telecommuting in some forms already facilitated significant penetration of work at home practices.

Clearly, telecommuting has its limitations and boundaries. Its growth will be faster in certain occupations, industries and segments of the economy, and slower in others. Physical proximity and contact will always remain either the essential or the preferable ingredient in numerous modes of interaction. A number of surveys suggest that many employees currently prefer office to home as a place of work.[4] Nonetheless, history shows that we often tend either to misestimate or underestimate the long-term economic imperatives of major technological

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3 Presently, without IBN technology in the home, close to 25 million people in the U.S. work from home. This number is projected to exceed 30 million by 1992. (See Link Resource Corporation, quoted in Denver Post, 20 November, 1988).

4 See, for example, Cross and Raizman (1986), p. 21.

innovations. A case in point is the mass appeal of computers judged as late as the early sixties by most experts to be a remote possibility.[5] At this juncture, however, the controversy over whether the expected surge in telecommuting spawned by IBN technology will have a further 20% or a 40% penetration into the workplace by the year 2020 is unimportant. Even a 10% substitution will generate sizeable savings in resources for the economy at large, as will be illustrated below.

From the viewpoint of technical feasibility, work-at-home scenarios are by no means strictly futuristic. Much of the technology required for this mode of operation exists already in an embryonic form. Integrated Broadband Networks (IBNs) based on present day technology are capable of providing adequate capacity and quality for some small system requirements for integrated transmissions of voice, video and data. Current switching capabilities still impose significant constraints on volume and speed, which could be at least partially alleviated with continuous progress in switching technology[6] and the likely advent of optical switching. Current technology used as customer premises equipment, in the form of personal computers, smart terminals and improved definition monitors, video recorders, and compact laser discs, is already partly consistent with the CTN scenario. Future likely introduction of optics into computer hardware is bound to facilitate further the technological integration.

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5 For example, Thomas F. Watson, Sr., President of IBM was reported to believe in the late forties that computers had no commercial possibilities. See Landau and Rosenberg (1986) p. 30.

6 See Phillips (1989) pp. 23-24 and Sezuki et. al. (1988).

The market size and scope of telecommuting in the twenty first century and its ensuing socioeconomic benefits defy even the most tentative and approximate forecasts. It is possible, however, to offer "educated guesses" in the form of order-of-magnitude speculations.

Consider the following seemingly conservative scenario. By the year 2020, an additional 15% of total work hours are "converted" by IBN induced telecommuting from work-at-workplace to work-at-home hours. Let us assume that half of this incremental IBN induced work-at-home segment will represent employees who work full time at home, and the other half those who divide their time equally between their workplace and their home. For a speculative order of magnitude evaluation of the potential economic benefits of telecommuting under these circumstances, we proceed with the following crude but reasonably conservative estimates: 150 million employees in the U.S. by 2020, savings of an average 30 miles in daily commute to work at a $.20 cost per mile in 1988 dollars, time savings of an average of one hour commute a day for 235 days a year at an average value of $10 an hour, $15 billion annual reductions in costs of construction and maintenance of roads, bridges, railroads, and parking facilities. Adding those numbers gives us estimated present value savings of over one trillion dollars per decade. This figure does not include savings in office space, congestion, health costs, day care centers etc., as well as the value of enhanced productivity and quality of life. With less conservative assumptions, IBN induced telecommuting benefits alone can well exceed two trillion dollars per decade.

The reader should bear in mind that the educated guess offered above pertains only to potential benefits of telecommuting. Allowing for other important benefits of IBN, the two trillion dollars can easily

double or triple. With an estimated 40 year useful life span for a fiber network, we can put the widely quoted $200 billion dollar required investment in widely accessible IBNs in an appropriate cost-benefit perspective, even if we allow for several hundred billion dollars of additional required investment in peripheral equipment over four decades. Given these orders of magnitude, the prospective social rate of return to IBN induced telecommuting is likely to be very high, even if a less than 10% incremental penetration of telecommuting is assumed.

On-Demand Information and Entertainment Services

On-demand information and entertainment services encompass those services that can be rendered instantaneously or on very short notice in response to specific demand by individual customers. Clearly, some on-demand services already exist. Primary examples are on-demand movies by VCRs, information services available by phone, and information retrieval services from time shared computer data banks. Further integration of voice, data, and video services via IBN will significantly speedup and enhance the quantity and quality of the information disseminated to users. Cable TV, on its own, cannot provide such an integrated spectrum of on demand information services since in contrast to the telephone network its technology is non-interactive.[7] Improved access to and availability of information will enhance the quality of decision support systems and coordinating efforts, thereby contributing to the overall quality of planning, decision making, management, production and implementation throughout society.

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7 See Baer (1984) for additional discussion.

A lead article in the September 19, 1988, issue of Forbes entitled "Good-bye Cable TV, Hello Fiber Optics" enumerates many potential on-demand video uses. Among other things. This article points out that the combined high capacity and "two way" messaging capability of fiber makes it ideal for video on demand: "This service will enable viewers to phone up all manners of video database - from network programming to feature film libraries" (page 177). There is increasing evidence that access tO such services could be provided at a low enough cost to generate effective demand by the end of this century. (See, for example, Sirbu et. al. (1988), pp. 20-24).

If we accept the notion that we are in the midst of a post industrial information revolution entering the information age, then it is reasonable to posit that competitive advantages of microeconomic and macroeconomic systems will depend to a large extent on ready access and instant availability of information to all economic agents operating within these systems. Consequently, proliferation of on-demand information services is likely to confer substantial positive externalities in terms of better informed public, business, professional, and private decision makers, leading to more efficient allocation and use of resources throughout the economy.

Potential Economic and Regulatory Barriers to IBN Development

A number of economic and regulatory factors may pose economic and regulatory impediments to the pace and scope of the development of IBNs and their evolution toward CTNs. Economically, very large investments in the basic telephone network will be required to attain rapidly wide access to digital and optical technology. Large sunk costs embedded in current telecommunications, broadcasting, and cable TV technologies can

erect economic entry barriers which may in turn slow the proliferation of IBNs. These barriers could be reinforced by outdated public policy considerations giving rise to complex regulatory regimes whose structures and procedures typically lag behind technological advances and their economic implications. Traditional rate of return regulation lacks sufficient incentives for the introduction of timely technological change. Regulatory prohibitions against cross ownership of telephone and cable is a case in point.[8] Excessively long depreciation schedules for existing plant prescribed by regulatory agencies who lack political incentives to be attuned to long term potentials of IBN technologies is another example. These depreciation constraints tend to slow incremental replacement of copper by fiber in telecommunications networks. It follows that current and prospective public policies and modes of regulation via direct prohibitions and direct and indirect incentives and disincentives could have profound effects on paths and patterns of IBN growth. Consequently, "business as usual," "muddle through" types of public policy may prove to be extremely wasteful and inefficient in overseeing the development of IBNs. A thorough and comprehensive review of public and regulatory policies in this field may be in order.

A Major Public Policy Issue: Positive Externalities and Subsidies

The potential for large economic opportunities and spillovers afforded by developments of IBNs and their evolution into CTNs pose a major public policy issue concerning the sizeable potential positive externalities likely to be generated by IBNs. The previous illustration

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8 See Baer (1984) for additional discussion.

of the order of magnitude of prospective socioeconomic returns to IBN-related telecommuting, coupled with the availability of substantial positive returns from on-demand information and entertainment services, helps us grasp the importance of such externalities.

Significant portions of these potential pervasive societal benefits are external to the firms that generate them. This means that the owners and operators of the basic networks and the producers and providers of the enhanced equipment and services would be unable to appropriate many of the social benefits generated by the IBN-related commodities and services that they could otherwise provide. For example, the one to two trillion dollars per decade estimated range of benefits to be generated by IBN induced telecommuting contain positive externalities in the form of savings to the public sectors in investments in infrastructure and safety and health services, as well as quality of life enhancements to telecommuters and their families which could not be appropriated by IBN providers. Very crude estimates indicate that the present value of such externalities are likely to well exceed a hundred billion dollars annually for telecommuting alone. Consequently, even in the absence of additional burdens imposed by regulatory constraints, private firms acting in a wealth maximizing manner, will tend, from the viewpoint of social welfare, to underinvest in IBNs. These underinvestments are likely to be compounded by current regulatory rules and the uncertainties regarding prospective regulatory changes.

This disparity between private and social rates of return is a well known dilemma created by the presence of positive externalities.[9]

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9 For a classic study on this subject see Mansfield (1968).

In what sense then is IBN special? In my view, our "educated guesses" for IBNs suggest that for this technology, the "market failure" and the ensuing disparities between the pace and scope of IBN development dictated by myopic private optimization relative to the pace and scope called for by long term social optimization are likely to be unusually large by historical standards. Present regulatory structures, if extrapolated into the future with only minor modification could further aggravate these disparities.

The traditional economic solution to bridge over IBN generated market failures is to institute a policy of public subsidies to induce IBN development and investments at higher levels, broader scope, and faster pace than would have been optimally prompted by cost benefit considerations induced by specific user demands. Such subsidies could also be designed to facilitate universal access to IBNs so that the external benefits afforded by the extended use of the network can be internalized.

It may be useful at this point to put the discussion of subsidies in telecommunications in a historical context. Public policy via regulation in effect cross-subsidized local telephone service in the U.S. for decades. In principle, a policy of public subsidization of local telephone services was economically justified by the sizeable socioeconomic externalities to the national economy at large conferred by the attainment of universal telephone services. The principle of subsidization was generally less controversial than the manner by which the policy was implemented. One can easily question the economic efficiency of the departure from Ramsey prices by "undercharging" local

telephone customers at the expense of long distance telephone customers. Alternative modes of subsidization via taxation may be deemed economically more efficient, even if politically more difficult. However, it is important to keep in mind that the reliance on subsidies as a public policy instrument is neither a new nor a revolutionary idea, but an established and, at times, an economically justifiable practice.

Subsidization of universal access to stimulate the evolution of IBNs past CTNs toward UBNs should become an important public policy issue. The costs of IBNs, even with the allowance for sharp unit cost reductions due to technological refinements and the realization of economies of scale and scope, are likely to preclude lower income groups from full or even partial access to IBN services for a long time to come. In the information age such exclusion may aggravate economic inequality. It follows that universal access is desirable on the grounds of economic justice, but also not only by the logic of internalizing the positive economic externalities of universality for all users, but also on the grounds of economic justice. These considerations provide additional reasons not to foreclose the option selectively to preserve, modify, and possibly expand the long standing tradition of public subsidies in telecommunications.

If public subsidies are to be considered a viable policy option, then the most effective form of the IBN subsidies becomes an important policy issue. Given the potential desirability of widely accessible IBNs, and the presumed economic efficiency of allowing the competitive pricing of enhanced IBN services to be related to their marginal costs, it may be desirable for public subsidies to focus mainly on the access to and the processing of commodities provided by core networks. One

reasonable straightforward policy option would consist of the use of Federal and State tax incentives in the forms of investment tax credits, and highly accelerated depreciation formulae for tax purposes, as well as capitalization and very rapid amortization of R&D expenses. These tax savings could be explicitly identified with a portion used as incentives to IBN providers with the balance passed on to customers in terms of lower basic network access and processing fees within the framework of "rate of return" or "price caps" regulation. Resulting lower tariffs are likely to stimulate volume and breadth of demand, thereby further decreasing average and marginal costs (via utilization of network economies of scale and scope) and moving closer to universal access, without allowing significantly higher than normal return on the provision of basic network commodities.

IBN enhanced services and the equipment on customer premises should also be subsidized to a certain extent via liberal investment tax credits and depreciation and amortization schedules. As long as all eligible existing and potential parties are allowed to compete freely in the markets for enhanced IBN services, the proposed subsidies, applied across the board are unlikely to discriminate significantly among suppliers.

Basic research and early development of advanced IBN technologies require large commitments of scientific resources. Bell Labs, the research arm of AT&T and Bellcore, the research consortium of the RBOCs, already have substantial investments in IBN R&D. It may be advisable for public policy to encourage the establishment of additional and/or broader R&D consortia with the participation of all potential IBN actors including computer, broadcasting and cable TV companies. To date, more

than 70 R&D consortia are in operation in the U.S., ranging from steelmaking and chipmaking processes to semiconductors.[10] The proliferation of these consortia was facilitated by the 1987 National Cooperative Research Act easing antitrust laws and allowing companies in the same industry to band together to develop new technologies. For example, as of December 1988, the American Electronics Association has signed up 17 companies to form a high-definition television (HDTV) consortium funded 49% by the government and 51% by members.

Given the potential high benefits of IBNs, it may be reasonable to consider similar direct government funding of broadly participative IBN R&D consortia which will not only ease the burden of R&D costs, but may also encourage joint cross-industry R&D ventures. Such joint ventures may be scoope-efficient considering the integrated nature of the broadband networks, and may facilitate the resolution of ownership conflicts (in particular, between telephone and cable TV companies). Consequently, joint ventures of this kind may merit additional tax subsidies. Changes in antitrust laws may be called for to remove most remaining constraints with respect to consortia and joint ventures.

It should be noted that the positive externalities conferred by IBNs are quasi-public goods in the sense that fiber optics technologies in transmission and possibly in switching may render network costs insensitive to volume within broad ranges of output. Regulated commodities exhibiting significant scale and scope economies cannot endure strict marginal cost pricing and sustain profitable production. Public IBN subsidies can therefore produce direct economic welfare gains

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10 See Business Week, January 30, 1989, p. 63.

to direct IBN users by augmenting production levels toward a social optimum. Such gains are separate from the sizeable beneficial spillovers previously discussed.

The potential benefits of public subsidies to IBNs could be viewed in an even broader context if the following additional factors are taken into consideration. First, the economic benefits IBN, CTN and UBN operators are likely to be realized over very long periods of time (e.g., at least several decades into the future). The private sector tends to be myopic with respect to very long term decisions. Consequently, even in the absence of significant positive externalities, the timing and pace of IBN development, given the length of required lead times, is likely to lag behind private, as well as social optima. Second, Japan and some Western European countries seem to be considering policies implying public subsidization of IBNs. Absence of actively supportive public policy may, by retarding development, put the U.S. at a competitive disadvantage in one of the major industries and major technologies of the future. If IBN induced positive externalities prove to be sizeable and pervasive, then significant lags in U.S. developments in IBN technologies could hurt its global competitive position more than the combined adverse effects of U.S. technological lags in automobiles and steel in the seventies and eighties.

In conclusion, I would argue that from a public policy viewpoint, we consider the option of "technology push" development path first, to be reinforced and overtaken by a subsequent "demand pull" path for facilitating IBN development. In view of the potential pervasive benefits of earlier and faster development of IBN, and the inherent difficulties for many potential customers to assess the benefits of a

complex technologies, adopting a public policy of benign neglect to allow market demand alone, whenever and however realized, to bring in the technology may prove to be socially inefficient. A cautious technology push subsidization policy, based on careful analysis of data from numerous market tests, seems worthy of consideration. This type of policy has been successfully practiced in Japan with regard to major industries (e.g. consumer electronics and computers).

IBN Network Costs, Industry Structure, and Ownership Configurations

There appears to be a majority view among telecommunications scientists, engineers and economists that IBNs are likely to exhibit significant cost sub-additives which are largely attributable to the combined effects of pronounced network economies of scale, economies of scope, and economies of density.11 This usually implies that it will be economically more efficient to provide commodities by one integrated network, rather than by two or more separate networks. However, the cost dominance of a single network does not necessarily mean that such a network should be either owned and/or operated by a single owner. For example, provisions could be made for joint ownership of IBN networks by telephone, cable, computer and broadcasting companies. Furthermore, as long as providers of network services are required to afford and facilitate interconnection and interface, numerous suppliers can freely compete, within any given segment of the network, in the supply of basic network commodities, let alone the provision of a range of enhanced

11 Some researchers are much less confident of expectations of prevalent economies of scope. For a discussion of potential diseconomies of scope see Lehr and Noll (1989).

services. This, after all, is one of the major unfolding lessons of the recent divestiture experience in the telecommunications industry.

From the standpoint of general economic welfare, issues of ownership appear to be of secondary importance. At the same time, changes in ownership configurations do, more often than not, cause significant transfers of wealth. As a result, relaxations of cross-ownership restrictions are likely to encounter political difficulties.

Presently, a number of regulatory restrictions on ownership and operation could pose significant obstacles to development of IBNs by being unnecessarily rigid. For example, the overall economic rationale for the prohibition of cross-ownership between cable and telephone is questionable. As a result, the FCC recently proposed the elimination of many cross ownership restrictions. Specifically, the FCC has tentatively decided to allow local telephone companies to provide cable service in their local service area, and has invited comments on this decision.[12] Politically, in this context, the particular economic concerns of the current participants however may have to be addressed. Under one policy option, for example, political and wealth distribution concerns may be accommodated or alleviated by making any provision of cable services via telephone networks contingent on joint ventures between cable TV companies and telephone companies.[13] The latter requires reconsideration of some of the present line-of-business restrictions on telephone companies. Another possibility is for telephone companies to be facility providers rather than service

12 For more detail see Selwyn (1988).

13 For further discussion of some of the merits of cooperation between CATV and telephone companies see Baer (1984) and Amparano (1988).

providers. Under this arrangement, telephone companies by being restricted to provision of network facilities may end up offering gateway kiosks. Leasebacks of some network facilities is another option. Any of these industry structures or variations thereof should not pose significant obstacles to IBN development, provided that regulation remains otherwise flexible.

In view of the existence of cost sub-additives, some basic network commodities have to be subject to price regulation of the access and process commodities they provide because the providers of such commodities are likely to possess at least local, if not global, natural monopoly positions over transmission and/or switching.

Note that an economically rational regulatory system should not ordain "artificial" monopoly boundaries via legislation or franchising. Local monopolies should be allowed to evolve naturally. The present regulatory system under which so called "natural" monopolies are artificially and arbitrarily defined is a contradiction in terms and makes little, if any, sense. A truly integrated system of the IBN type should impose minimal horizontal or vertical boundaries on competition within the network, subject to legal constraints with respect to the establishment of local monopolies of certain broadcasting and electronic print media. Thus, within the framework of price regulation, interface and interconnection rules, and other legal requirements, all existing and potential producers should be allowed free competition and free entry in all parts of the network for all services. In other words, all IBN markets should be contestable, and none should be preordained as natural monopolies. Otherwise, the full extent of inherent IBN economies of scale will not be realized thereby, slowing IBN

development. Regulation will remain overly political, needlessly arbitrary and complex, resulting in diminished efficiency incentives and posing additional uncertainties for potential entrants.

IBN Regulatory Systems

Once local monopolies are firmly established through economic competition within certain segments of IBNs, they may have to be price regulated if the contestability of these markets is severely reduced by the high sunk costs of the incumbents, thereby sustaining above normal profits. The current Rate of Return (ROR) system however is flawed in a number of areas. In particular, the ROR system is largely devoid of in-built efficiency incentives, encourages over capitalization, "gold plating," and excessive risk taking, relies to heavily on largely arbitrary separation procedures for plant and equipment, gives rise to severe information asymmetries between the regulators and the regulated, and imposes substantial transaction costs on all participants. Such flaws of the ROR regime are likely to be compounded by the broader scope of IBN services, as well as by their greater complexity, and the more intricate patters of interdependencies among their components.

While these regulatory difficulties cannot be eliminated, some are likely to be alleviated via the replacement of ROR by alternative systems of regulation. Consider, for example, a regime of automatic rate adjustment formulae which establish price caps for network commodities. To provide built-in efficiency incentives it would be desirable for Price Cap Regulation (PCR) of IBN should contain targets for multi-factor productivity offsets. Productivity based PCR adjustment clauses could be anchored in "stand alone" cost estimate for each core network service, and be subject to periodic monitoring and

possible revisions by the regulator. PCR adjustment clauses are likely to reduce regulatory transaction costs by simplifying oversight and reducing the frequency and scope of full-fledged regulatory procedures.

In line with this rationale, the FCC unanimously approved on March 16, 1989 a "price cap" plan for AT&T. This new price cap index, effective July 1, 1989, is to be adjusted each year by the difference between the general inflation rate (measured by the CPI) and a 3% productivity allowance which is based on an estimated record of AT&T average annual productivity growth exceeding that of the economy by 2.5%. The balance of 0.5% is viewed as a "consumer productivity dividend" since it is assumed to increase the likelihood that PRC rates will be lower than comparable ROR based rates. The new PRC regime allows AT&T to reduce rates on short notice. However, consumers are guaranteed that new services will not be cross-subsidized by existing services. While the new PRC applies so far only to AT&T, the FCC set July 1, 1990 as the target date for local telephone companies to begin operating under price-cap regulation.

This transition of ROR to PRC is an encouraging step in the direction of loosening regulatory constraints to the introduction of new technology. The FCC price-cap index, however, is a crude formula allowing for general rather than input-specific inflation adjustments and setting arbitrary productivity standards. IBNs may require more refined price cap procedures.

One specific option is an automatic PRC adjustment formula based on the difference between a weighted average of input price <u>standards</u> and a multi-factor productivity standard. Such clauses contain built-in

efficiency and cost economy incentives.[14] If the regulated company surpasses the cost and productivity standards, it can increase its earnings by pricing at price cap level, but only to the extent that pricing of substitutes provided by other regulated competitors permit it. To the degree that public subsidies are provided to IBN operators, part of the ensuing cost savings could be incorporated as offsets to the price caps to pass on some of the benefits to IBN customers. All enhanced services which do not evolve to "natural" monopolies could be deregulated to face unrestricted competition. Ultimately, this may be a good way to insure a competitive approximation to marginal cost pricing of those services.[15]

Other regulatory options to consider are reliance on franchise bidding procedures of the type used in regulating cable, or deregulation and reliance in Anti-Trust enforcement via the courts based on the requirements for reasonable pricing of essential facilities. Both regulatory systems seem to be relatively more problematic than price caps. The overall quality and price performance of Cable TV under franchise bidding has been controversial. Zupan (1989), however, highlights some of the potential advantages of franchise bidding, and buit-in incentives may be further enhanced by instituting multiple franchise systems. The courts may be overburdened and ill equipped to undertake a consistent interpretation and timely enforcement of "reasonable" pricing.

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14 See, For example, Sudit (1979).

15 For a comprehensive discussion of PRC options see Vogelsang (1988).

Cost Allocations and Cross Subsidization

The regulatory policy issues related to appropriate allocations of joint and common costs among regulated and nonregulated services are likely to become more acute with the development and proliferation of IBNs. IBN technologies are likely to give rise to substantial economies of scope in the provision of an array of voice, video and data services. The recommended economic procedure of allocating common and joint costs to the regulated services on the basis of the "stand alone" costs of those services may be in need of adjustments.[16]

Sizeable economies of scope are likely to reduce the real, and largely unobservable, costs of rendering regulated services considerably below the "stand alone" standard. Consequently, price caps determined on the basis of the incorporation of stand alone standards into PCR automatic adjustment formulae (or ROR formulae) could be overstated. This may allow companies subject to lesser competition in the rate regulated natural monopoly sectors to price their regulated network services so as to continuously earn significantly higher than normal returns on those services. Such rents may enable companies to charge predatory prices for nonregulated services in an attempt to deter and/or drive out part of the competition. Consequently, with the proliferation of IBNs it may be advisable to adjust stand alone cost allocations downward by the estimated magnitude of IBN induced economies of scope. These potentially difficult adjustments may complicate the regulatory process, but they appear instrumental to a sustainable "competitive" deregulation of all but basic network services.

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16 For a comprehensive discussion of costing and pricing issues see Egan (1987)

The Transition to IBNs and the Evolution toward CTNs and UBNs

The transition to IBNs and the expansion of their scope is likely to be a slow, gradual and protracted process even under optimistic technological scenarios and an accommodating regulatory and political environment. The large sunk costs embedded in existing networks are likely to attenuate speedy proliferations of IBNs. Consequently, small IBN subsystems oriented toward (or operated by) big business and government users, partial networks, and even parallel integrated networks operated by competing cable TV and telephone companies are likely to develop in the initial stages of the IBN technology cycle. Such incumbent subsystems may inhibit rather than enhance CTN development. In this context, it becomes important for public and regulatory policies to be clear, comprehensive, and forward-looking, with an overriding purpose to reduce rather than magnify the technological and economic complexities and uncertainties detering the introduction and development of IBN.

Historically, public and regulatory policies often tended to lag behind new technologies and the economics of their development and implementation. Such lags did not always converge over time. The stakes for the U.S. economy of incurring similar Malthusian lag patterns with IBNs could be very high in terms of potential postponement of large external benefits, as well as in terms of possible loss of competitive advantages in telecommunications and related information systems software and hardware. These dangers call for a high level, comprehensive and integrated public policy review. In the emerging information era, policy decisions related to the development and introduction of IBN technology may be too important to be left

exclusively to the captains of industry, and the ultimate demand pull mechanism of the market.

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