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BENEFITS AND COSTS OF PUBLIC INFORMATION NETWORKS: THE CASE FOR NARROWBAND ISDN

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Abstract

Recently, due to market pressures between states and countries to become more competitive and productive, achieving an advanced telecommunications network infrastructure has become prominent as a public policy imperative to help stimulate economic activity. Clearly this policy objective may only be attained through increased investment to modernize current network infrastructures.

High levels of network investment requires that business incentives to invest be increased. Obviously this occurs when business opportunities for all firms, public and private, to profit from such investments are not restricted by regulatory and legal rules like those typical of the current institutional and political environment.

A concerted and coordinated national effort to upgrade America's public telecommunication network infrastructures is, from society's perspective, more efficient than a haphazard piecemeal approach. Unless there is a broad sharing of the costs of an advanced telecommunication infrastructure, many individual subscribers will not be able to participate in the "Information Age," as the costs of private access to such information will be prohibitive.

The discussion herein describes the potential costs and benefits of digital network upgrades and recommends changes in existing government policies to help valorize telecommunication network infratructures.

Introduction

There has been much discussion and debate among telecommunication researchers and policymakers regarding the future of advanced telecommunications infrastructures or Public Information Networks (PINs). The primary issues are whether or not we should spend the money necessary to promote the rapid adoption of new telecommunication technology in public switched networks, and who should bear the costs of doing so.

The realization of widely available advanced telecommunication networks could contribute significantly to our economic productivity and international competitiveness in the "Information Age". Worldwide, it is becoming clear that not only is economic power in terms of raw natural resource endowments and physical production important, but that substantial economic empowerment derives from the efficient production and distribution of information and ideas. We cannot overlook the advantages to society from advanced and efficient public communication infrastructures.

There are equity issues as well. Not having PINs may mean that access to information may be available only to those who can afford sophisticated private networks and customer owned devices, such as personal computers. The substantial information gaps which already exist, as evidenced by the great disparity in education based on income levels and geographic location, will widen. The social risks from a society of information "haves" and "have nots" is unknown, but the availability of PINs would minimize whatever risks there are.

Everyone agrees that an advanced public communication infrastructure is a good idea, but many do not agree that it is worth the cost. This is the key issue facing American policymakers, and it is a serious "chicken and egg" problem.[1]

Supply-siders, believe the U.S. should incur the cost of PINs, because public benefits will far exceed the costs of timely deployment. They see PINs as public information highways, with demand and usage developing rapidly once the technological capability is in place. Because PINs are partly public goods,[2] supply-siders favor an infrastructure approach to the problem

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[1] These were the words used by U.S. Senator Al Gore as he described the problem in an article in Scientific American, September 1991.

[2] There are network "externalities" which make the telecommunication network infrastructure partly a public good. In other words, the sum of the private benefits of individual subscribers is less than the total social benefits of network infrastuctures. The main reason has to do with

and advocate sharing the costs between all subscribers. They believe the future definition of basic telecommunications includes information and services beyond traditional voice telephony.[3]

On the other hand, demand-siders believe rapid development of PINs are neither necessary nor desirable. They see information and communication as private goods which are best provided for in a market setting according to the forces of supply and demand. Consequently, those who demand advanced communication and information services should pay for them individually. This assures that demand-drivers will guide the development of the technology and the network. Demand-siders view public switched networks only as basic telecommunications like traditional voice and perhaps low-speed data services.[4] They see PINs as expensive solutions for which there is no corresponding problem. They also think technology will eventually "trickle down" from the private sector, as those who demand and pay for advanced telecommunications will eventually make the technology widely available to the general public.

This is a very dubious argument. Such supply-side "trickle down" theories have failed recently; these policies have guided our economy throughout the 1980s and failed to curb the expansion of social income and education gaps.

Demand for PINs

There is much disagreement over the future demand for advanced information and

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efficiency in access to the relatively large number of users on the larger network vs. smaller private and closed networks.

[3] FCC Chairman Al Sikes has indicated in a number of forums that his initiative for telephone companies to provide "video dial tone," is an important step in expanding the traditional definition of "basic" telephone service. For recent research into the potential social benefits that an infrastructure approach to technology adoption in the public telecommunication network would provide, see Francis Fisher and Arthur Melmed, "Towards a National Information Infrastructure: Implications for Selected Social Sectors and Education," Center for Educational Technology and Economic Productivity, New York University, December, 1991, and references therein.

[4] For a review of these arguments and others relating to the relative <u>in</u>efficiencies of an infrastructure approach to network upgrades see, Mark Cooper, "Divestiture Plus Eight: The Record of Bell Company Abuses Since the Break-Up of AT&T," Consumer Federation of America, Washington D.C., December, 1991.

communication services. Demand-siders claim it is insufficient to justify spending for public network infrastructures required for PINs. They believe that the average consumer does not want anything more than basic telephone and cable television services. They point to the very low levels of demand for early information services relative to traditional voice services and claim that if demand were truly high, we would observe more widely available service offerings from private vendors, such as videotext, audiotex, distance learning, etc. In addition, anyone who wants sophisticated services has the option of purchasing a personal computer and modem. This view is based largely on casual observations made over the last decade, which indicate that the average household does not consume any significant amount of advanced information services.[5] However, this trend will surely change in future decades.

Supply-siders respond that low demand occurs for lack of an affordable vehicle through which the average household can obtain useful information services. The traditional telephone network will only support basic analog services such as plain voice telecommunications unless a private network and/or sophisticated devices are purchased. The private cost of obtaining many advanced services is simply out of reach for many households. Furthermore, there is an extremely important interaction of supply and demand that is generally overlooked by those who do not see the potential net benefits of PINs. It is likely that the reason for the low levels of observed demand is the insufficiency of public network infrastructures. In short, it is simply the lack of a widely available high speed digital distribution network which prevents private enterprise from offering new information services. If there were efficient national distribution channels in place, service offerings and demand would take off, and the system would thrive financially once a critical mass of demand was achieved.

The possibilities for new telecommunication services are truly exciting. They range from known services such as: shopping at home, news and information, video telephony, entertainment video, etc. to new services not yet conceived. These services could fulfill a wide range of everyday consumer activities including: "telecommuting" (working from home), distance learning, shopping, home health care, transaction services, entertainment, monitoring, recording -- the list goes on. Someday, communications technology will allow us to enjoy the wonders of "virtual reality"; a multimedia environment where experiences and situations may be simulated to let us know all about them without them ever actually occurring. Simultaneous combinations of video, audio, and text will be available over the telephone access line. We are in the very early stages of the use of multimedia to assist us in our everyday activities, and growth in this area depends directly on the rate at which we adopt new telecommunication technology.

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[5] In fact, Professor A. Michael Noll of the University of Southern California quantifies non-voice telecommunications demand to be minuscule compared to traditional voice services in his recent article, "Voice vs. Data: An Estimate of Future Broadband Traffic," IEEE Communications Magazine, June, 1991.

Initially we will experience "telepresence", a situation where video telephony allows us to directly interact with one another from great distances, as if we were actually present. The savings in terms of travel time and money would be substantial. After we achieve such obvious things as saving on travel and education costs, we will begin to explore new ways of using the technology that we cannot even conceive of today.

Another important aspect of universal access to advanced telecommunication concerns businesses and their efficient interaction with customers and suppliers. For example, through the use of information services, "narrowcasting" is possible. In other words, businesses may utilize advertising more effectively by targeting it to those customers that are in the market for information on particular goods and services. Electronic communication would significantly enhance the effectiveness of advertising and would displace less efficient forms, such as direct mail, a $25 billion dollar a year business, and growing. Total advertising expenditures are about $160 billion a year and could serve to defray some of the cost of PINs. Orders for purchases, sales, and customer service would become much easier, reducing overall transactions costs and stimulating sales and service quality. Without a national infrastructure network, such everyday business activities must take place over a patchwork of private and public networks, which may or may not be able to talk to each other.

Thus, there is tremendous potential demand for advanced telecommunication services. However, there are two critical problems regarding the demand for information services and both must be addressed if demand is to reach its full potential. The two linchpins affecting the growth of information services demand is "end-to-end" service capability and improvements in consumer devices. Common to both of these is an especially important problem -- raw speed. Consumers' time is valuable. If they cannot save time and money by using information services, they will opt to continue getting the information they need in other ways, if at all. It is both the opportunity cost of a consumer's time and the unit cost (price) of goods and services which is critical. We would all appreciate the convenience of working, learning, entertaining, or shopping at home, but only if it is more convenient or enjoyable that way. In simple terms, if consumers have to sit down at a terminal device and spend ten minutes navigating through numerous display screens to order a plane ticket, or find a phone number, they will simply prefer to call a toll free "800" number because it is faster and easier. Similarly, if they cannot quickly find and examine the specific item they're shopping for, they would rather go to the store and do price and quality comparisons all at once. Unless the public network and the individual subscriber phone line, **and** the subscriber terminal device are as fast and convenient as other alternatives for accomplishing day to day tasks and activities, electronic information services will not reach their demand potential.

The requirement for end-to-end service capability is obvious. It does no good to be able to make a digital call to a network switch. The called party must also be hooked up with similar capability. Thus, it is critical that public networks become the vehicle for transporting advanced telecommunication services. Otherwise, the use of new and advanced services would require being connected to private networks, which will not be ubiquitous and which may not be able to communicate with other private networks. This causes information services demand to flounder and never reach its potential.

Regarding the second issue, the terminal device, it must be user friendly and relatively inexpensive. A lot of research and development is required to create a device that average Americans would be willing to use, even if they have never used a computer. Initially, this means that the digital terminal should be as easy to use as a fancy telephone, or a television set with a remote keypad and perhaps a keyboard; ultimately, devices with such user-friendly features as touch sensitive screens and voice recognition systems will emerge. A primary reason for the abysmal showing that demand for information services exhibits in the mass market is due to the average consumer's inexperience regarding the use of terminals to access the network.

As evidence of this, according to market research, 50% of American VCR owners do not know how to use many of the features of their own device, like how to program them for recording. It is not likely that a solution to the device problem will be solved by growth of such complex devices as PCs and modems. They are simply too expensive and sophisticated to use. A whole new line of research into "smart" terminal devices must occur to make new advanced information services easy to use, yet, the device itself must appear uncomplicated to the casual user. In other words, such a device should support the advanced requirements of relatively sophisticated users (for example by allowing them to skip certain unnecessary steps the way PC "hackers" create programs or short-cuts to accomplish certain tasks), and at the same time not intimidate the unsophisticated user, who has no detailed knowledge of how it works.

Unless this is possible, then every user in a household may want a different device to match their skills. It is not that it is bad for devices to meet the specific needs of the individual user, just that requiring multiple devices per household may raise costs significantly; not to mention the fact that the various devices may not work together. As progress in microchip and digital signal processing technology increases, the cost of high speed chips will fall and their capacity will rise to support artificial intelligence software. The software will ultimately constitute a user-friendly "front end" for the digital terminal device such that any "couch potato" would not be afraid to use and enjoy it. Eventually, the device may be able to recognize voice commands, and even talk back. This would be a welcome development indeed resulting in the elusive effortless machine/human interface.

One possibility for the earliest devices may be to introduce some type of "smart TV", which is really part computer and part TV. Many current generation TVs on the market already have many advanced features through the use of special digital signal processing chips. One problem which potentially arises, if this "smart" device must in fact double as a regular TV, is that the extended uses as an interactive communications device would have to compete with its use as a standard TV. Currently, the average household TV is already tied up for about 7 hours each day just for video entertainment. Of course, most households have multiple (traditional) TV sets, and many information services obtained over the "smart" TV are for entertainment anyway, thereby mitigating this issue.

Another possibility which has already been developed is the "smart phone," and simple videophones which AT&T and others have recently announced. However, these phones are a far cry from what is needed to help stimulate the demand for information services. Advanced videophones and other advanced consumer terminal devices, especially those which are compatible with the new Integrated Services Digital Networks (ISDNs) being deployed by telephone companies and others, are still too new and expensive to consider for the mass market. However, the point remains that, without end-to-end digital network connectivity, it will be that much more difficult to achieve price reductions in terminal devices through mass marketing.

To summarize, if the information services industry is to grow and prosper in America, providing for increased productivity, it is necessary that both consumer terminal devices and the telephone network itself become faster at processing the enormous amounts of signals and data which will be required to make the services attractive to use and purchase. Otherwise the industry will languish due to a lack of efficient national distribution networks, and unfriendly consumer terminal devices. Without solving such problems, we will have to wait for the average American consumer to own and use a PC or similar device. This would probably take at least a generation. It would be better to take a coordinated public network approach to the problem. Such an approach maximizes the possibilities for demand drivers to get off the ground and ultimately reach their potential.

PIN Technology

If technology evolves apace in public switched telephone networks, it will be able to support the rapid growth and distribution of many new digital telecommunication services, causing "economies of scale" for information service providers who, in turn, would respond with even more ideas for services. As more and more new services are added, "economies of scope" will lower the average cost of all of them combined.[6]

The process of technological evolution in public telephone networks must start with a

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[6] Economies of scale is an economist's term which means that as the level of network system capacity and utilization expands, the average cost per minute of use for any given service will fall. Economies of scope means that as more new and different network services are offered over the same digital network facilities, that the total cost of running the entire network system is lower than the costs of doing so on physically separate networks (the way it's generally done today).

program of digitization. The current analog household telephone connections severely limit the range and availability of new digital information services. Occasionally, it is enough to purchase analog-to-digital conversion devices, but these are still expensive and the signal conversion itself causes service quality to suffer. Even though both digital and analog signals are subject to degradation as they traverse the network,[7] digital signals are much less fragile, and errors are easier to detect and fix.

The next generation of digital telecommunication technology for residential customers is called Narrowband ISDN or N-ISDN. This technology allows current local telephone lines to support digital information services; any digital customer equipment, such as a PC or fax, or videotext terminal, may be directly connected to the phone line.

Also on the horizon is the second generation of technology for residential phone lines providing for Broadband ISDN or B-ISDN. This technology generally requires the use of digital fiber optic or radio phone lines instead of the traditional copper lines which may be used for N-ISDN. B-ISDN technology has potentially limitless capability for supporting new advanced customer services, including real time two way (interactive) "on demand" video services. Full motion color entertainment video services, including High Definition Television (HDTV), will not fit onto a traditional copper phone line and will probably require fiber optics. However, this is a very expensive technology that costs five to six times that of achieving N-ISDN.[8]

It is possible to support advanced applications such as high resolution video services using copper coaxial cable, the same technology currently used by cable television companies, as long as transmission distances are not too long.[9] Furthermore, N-ISDN can support almost all other residential information services which are currently envisioned.

In fact, the N-ISDN line can do at least three times the communications of today's analog access line -- all at a much higher quality. Today, to transmit or receive digital data signals on normal copper phone lines, one needs to purchase and connect signal converters and

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[7] This degradation comes from many sources. In engineering terms, signals propagate (disperse), attenuate (weaken), and are subject to interference from other sources of "noise," especially electromagnetic disturbances.

[8] For a review of the costs of residential broadband networks see: Bruce L. Egan, "The Case for Residential Broadband Networks," Research Working Paper #456, Columbia Institute for Tele-Information, Columbia University, 1992, especially ch. 2 and the references therein.

[9] Copper technology, whether "twisted pair", like regular residential phone lines or coaxial cable used for cable TV service, has inferior transmission characteristics holding distance constant. Fiber optic cable is preferred whenever transmission distances are very long, e.g. several miles to several hundred miles.

reliable transmissions would be limited to perhaps only 9,600 bits per second (commonly referred to as 9.6kbs service), and then only if the phone line is in good physical condition. This is quite slow for many things one may want to do. Not to mention the fact that the phone line and telephone number are tied up by whatever single service is in use at any one time. One of the main reasons for low demand for digital information services is that most modems in use today, which cost $100-$300, only support 1.2-2.4kbs service. Indeed, this is very slow compared to N-ISDN which provides 144kbs service and is almost like having three phone lines while only paying for one telephone number. With an ISDN phone line a household could use two seperate voice (64kbs each) and one data (16 kbs) service simultaneously; all of which are of high quality. The services used may be very sophisticated including such things as high quality graphics, real time videotext, high resolution fax, on-line information and news, videophone, etc. In the near future, advances in digital signal processing technology may allow for good quality full motion color videophone service on an N-ISDN line. There continues to be tremendous advances in digital signal processing technology which uses signal "compression" techniques and codec devices to allow high bandwidth video signals to be "squeezed" onto a single 64kbs communications channel on an ISDN phone line.

The Cost of PINs

For information services to become widely available in public switched telecommunication networks consumers must be able to convert their access lines to digital service. Basically, this requires only a few steps. First, the traditional copper telephone line must terminate at a digital central office switch. Second, electronic equipment must be applied to the phone line itself. This generally refers to a central office digital termination or "line card" which handles the signals and conditioning for the phone line to provide a high quality digital connection. Lastly, the consumer needs to purchase a digital telephone or other ISDN compatible digital terminal, or purchase an adaptive device for the old analog telephone or terminal. With a digital phone line and a digital terminal, a modem is not required. Beyond the per subscriber costs of the ISDN line and terminal devices, the telephone companies need to deploy a core intelligent network to provide for end-to-end ISDN connections and to support the various information services that are contemplated. This requires the installation of a network signaling system, including signal transfer and control points for message routing and database memory "look-up" type functions. Once all of this is in place, the central office "gateway" network switch would enables information vendors to offer many new types of services over the public telephone network expanding the demand for existing services to the mass market.

The per subscriber costs of coverting the nationwide telephone network to ISDN is about $30-$60 billion dollars or about $300-$600 per household depending on the level of mass deployment. This figure includes both the costs of upgrading the subscriber access line and the core network. It does not include the cost of the subscriber terminal(s) which must be added, but which may not be a shared cost of ISDN depending on public policies regarding how deployment of the technology is planned. While the cost appears to be very high, in fact it is only about one-sixth the cost of installing fiber optic broadband phone lines.

Digital Central Office Switching Costs

Currently almost 40% of the phone lines in America are connected to a digital telephone company central office switch. The ratio of digital access lines to total lines is growing steadily every year, and it is the stated goal of telephone companies to move rapidly toward universal availability. Consequently, there does not appear to be a bottleneck in introduction of widely available information services over a reasonable time horizon of about 10 years. It is simply impossible to accomplish universally available digital information services overnight, but the process must begin if timely adoption is to occur.

At today's cost levels, it is estimated that all analog central office switches could be changed to digital for about $150-$300 per residential phone line. This translates into a total cost of about $10 billion for all lines not currently served by digital switches.

There are other costs to upgrade a digital central office to support ISDN, including the upgrade of the generic switch software. This usually is in the form of recurring "right-to-use" fees that the telephone company must pay to the switch vendor to use the proprietary software. The ISDN line connections (line cards) are about $150-$250 per subscriber line and the frame that the lines terminate on is also different than those used for analog service; this cost must also be added in but is not substantial in volume applications. The last major category of incremental cost of ISDN conversion is a "packet handler", which is an electronic device required to handle the ISDN line "D" channels for message control and data services. When any of these costs are able to be spread over all of the working line capacity of a central office, the incremental per line costs are quite low and are dominated by the costs of the line cards themselves. For universal ISDN, the total per line incremental costs for central office switching and line terminations are estimated to be about $30 billion.

Interoffice transmission and the Core Intelligent Network

The installation of fiber optic backbone networks can significantly lower the operating costs of the shared interoffice network. It is estimated that the construction costs of fiber optic trunk ("backbone") network facilities is about $100 per residential subscriber or a total cost of about $10 billion for the nation as a whole (100 million lines x $100). The intelligent interoffice signaling and transmission network requires the placement of switching nodes, or signal transfer points, and network database nodes, or signal control points. All of these nodes are connected to the interoffice signaling network using a technology known as

Signaling System No.7 (SS7). The total cost of placing these nodes and installing SS7 are estimated to be about $5 billion.

Total Cost

Thus, at today's cost levels, a reasonable estimate of the total cost of widely available digital public information networks is about $45 billion. This figure is much lower than the costs of "Fiber-To-The-Home" (FTTH) or even "Fiber-To-The-Curb" (FTTC) broadband telecommunications networks, which are estimated to cost between $200 billion to $1 trillion, depending on the capability of the system.

When the $45 billion dollars cost for N-ISDN is put in perspective, it is not all that high. Local telephone companies already are spending about $20 billion annually on new construction; a significant portion of which is allocated to digital switching and fiber optic trunk cable. Furthermore, the more intensive use of fiber optics in the shared trunk network is yielding some fundamental new network architectures achieving greater cost efficiencies than those which occur from simply upgrading the traditional telephone network as we know it. For example, fiber optic rings may substantially reduce costs and increase the reliability and flexibility of service for all consumers. The incremental capacity costs for some novel fiber trunk network designs can be orders of magnitude lower than today's copper based networks.

The key for public policy is to achieve the lowest possible per subscriber costs of PINs, and this requires an infrastructure approach to the problem. If the cost estimates above were based on only limited deployment, economies of scale would suffer, and the per subscriber costs would likely be many times the costs which are achievable with mass deployment. Such cost levels would simply be out of reach for most residential customers.[10]

Not included in the above cost estimates are the subscriber terminal costs. Little work has been done on the terminal design or the likely costs and is therefore left for later research. Of course, as previously stated, the network must be able to support whatever terminal devices are created, and the more intelligent the network infrastructure is, the lower the basic terminal cost should be.

Also not included in the above costs is the costs associated with those embedded copper loops which will not support ISDN because they are either too long, in which case they have signal repeaters or load coils on them, or the cable is of poor quality, and therefore the noise

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[10] The costs are broad averages useful for public policy. For a discussion of the costs of network upgrades for more costly rural areas see Bruce L. Egan, "Bringing Advanced Telecommunications to Rural America: The Cost of Technology Adoption," Telecommunications Policy, February, 1992.

levels are higher than that tolerated by ISDN. Generally speaking, customer lines less than 18,000 feet long are compatible with ISDN requirements. The vast majority of existing customer lines are shorter than that and will work with ISDN. For those customers with problem lines they will have to be upgraded on a location-by-location basis. Fortunately, many such problem lines tend to be older and nearer retirement than most others.

Capital Recovery and Cost Sharing

The $45 billion cost estimate is not out of reach of consumers. In fact, the entire project would be paid back over 10 years at an interest rate of 12% for only about $7 additional per subscriber per month. This assumes that all of the money is borrowed immediately, which of course would not be the case. If the project costs were treated in the context of an on-going construction program over a reasonable time interval of say, 10 years or so, the monthly per subscriber costs to support such a program would only be about half the previous amount or about $3.50 per subscriber in current dollar terms.

Those who believe this to be an unfair burden on ratepayers, should understand that no new revenues have been assumed. Surely these could be substantial as demand takes off. Furthermore, the average residential phone bill is about $45 a month and the increase to cover the cost of PINs is less than 10% of the total monthly bill. Local telephone rates rose more than 40% since divestiture, mostly due to the FCC's access charge program, which added about $3.60 per line, and yet, telephone penetration is up almost 2%, from 92% to about 94%. For those ratepayers who cannot afford to pay more for telephone service, "lifeline" service will still be available.

There are several points to keep in mind besides the incremental costs of achieving widespread PINs. There is substantial evidence that there are also cost <u>decrements</u> due to operating cost savings over the traditional analog network. Capacity costs of plant expansion are also less with digital facilities, which generally come in larger investment "lumps" than analog plant due to economies of scale. Advanced digital networks are more easily maintained and real time error detection and correction is enhanced. Furthermore, the above costs include the cost of upgrading remaining analog central office switches to digital. This cost is not really an incremental cost of ISDN since this conversion is already considered in the fundamental network plans and construction budgets of all large Local Exchange Carriers (LECs), and simply represents the next generation of switching plant. There will no longer be any new installations of analog switches.

Essentially, a concerted and coordinated national effort to upgrade America's public network infrastructure is, from society's perspective, more efficient than a haphazard piecemeal approach. Unless there is a broad sharing of the costs of an advanced telecommunication infrastructure, many individual subscribers will not be able to participate in the Information Age, as the costs of private access to such information will be prohibitive.

Public Policy Conundrums

Unfortunately, in the various policy debates about development of telecommunications network infrastructures, American policymakers are political animals subject to extreme pressure from both public and private network lobbies. These lobbies represent entrenched interests trying to protect their turf by restricting entry of competitors. The response of politicians is often to take neither side and thereby avoid directly offending anyone,[11] which effectively results in no policy at all. This leads to a tendancy for maintaining the policy *status quo* since both sides in the debate generally provide funds in support of the same individual lawmaker(s). At least the incumbent politician is a known quantity even if they do not always vote for your lobby's preferences.

In this highly politicized environment, much of the potential for informed policy making to promote public welfare through private and public network cooperation is lost. The ultimate loser is the American consumer who will pay relatively higher prices and enjoy fewer options for obtaining telecommunication services. In many cases, like joint provision of services by telephone utilities and cable television firms, cooperation is explicitly prohibited by public policy;[12] this point notwithstanding, there are many situations where good business sense dictates cooperation between public and private network providers and we are observing more of this.[13] Slowly, but surely, technological progress and market forces of supply and demand keep the pressure on policy makers to relax business restrictions.

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[11] In a recent paper, a former state and federal public utility regulator Prof. Charles Stalon describes the political economy of regulatory decisions and why the decision making process is seriously flawed resulting in economic inefficiency and losses in consumer welfare. See: "Recent Developments in the Political Economy of Regulation," draft, NARUC Advanced Regulatory Studies Program, Williamsburg, VA, February 21, 1992.

[12] This is because of government legislation passed in 1984 restricting financial arrangements between large urban telephone companies and cable television firms. Even though non-financial cooperative relationships are allowed under the law, the prohibition of joint financial interests has effectively eliminated meaningful progress is joint (physical) provision of service.

[13] The trend toward cooperation is clear. Many current or announced field trials of residential broadband networks involve partnerships between cable and telephone companies. Before such partnerships could become commonplace changes in the current cross-ownership restrictions must occur.

There are many public policy imperatives in U.S. telecommunications and some are inherently conflicting. For example, the traditional policies of widely available and affordable basic telephone service stem from the so-called regulatory doctrines of Universal Service and non-discriminatory prices (broad rate averaging). The natural result of these policies is cross-subsidies among subscriber groups and between services. Since all residential subscribers in any given geographic area pay the same (low) rate for basic phone service, high cost customers are subsidized by low cost ones, high priced business customers pay for residence, and, in the case of high priced toll calling, high usage customers subsidize low (or no) use ones. At the same time however, competition policies to promote economic efficiency, productivity, and innovation, continue to grow in importance. These policies naturally purge cross-subsidies from the system.

How can the two fundamentally different policies of competition and universal service possibly co-exist over the long term? The answer is that they probably can't, at least not under current regulatory regimes. About the only way to preserve intra-industry subsidies in the face of open competition is through a value-added tax on all telecommunications service companies.[14] This seems to be the best way to allow competition between firms on a level playing field at the margin while preserving some internal subsidies on the average. A carefully planned value-added tax would be relatively non-distorting and would favor no firm, incumbent or entrant, at the margin; competition for the next sale should be equal, giving consumers the benefit of head-to-head price competition.

Recently, due to market pressures between states and countries to become more competitive and productive, achieving an advanced telecommunications infrastructure has become prominent as a public policy imperative. Clearly, this policy objective may only be attained through increased investment to modernize existing telecommmunication networks. There are only three other ways to pay for accelerated network upgrades: 1) general tax revenues; 2) rapid increases in regulated depreciation rates and the tariff rate increases they imply; or 3) increased borrowing in capital markets. None of these appear any easier, and all are likely more difficult, politically to implement relative to the value-added tax concept.

High levels of network investment requires that the incentives to invest be heightened. Obviously this occurs when business opportunities for all firms, public and private, to profit from such investments are not restricted by regulatory and legal rules like those typical of the current institutional and political environment.

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[14] Currently in the telephone industry there is an example of such an explicit internal subsidy called the "access charge." This is a charge that carriers of toll service must pay to support a portion of the costs of basic local phone service. While it is effectively a tax it is not officially characterized as such by regulatory authorities.

Policy Prescription

Several policies need to be implemented to solve the current regulatory morass. By removing barriers to entry and various restrictions on business opportunities the following list of policy recommendations would lead to higher levels of infrastructure investment than the *status-quo* while achieving the efficiency benefits of competition:[15]

1) telephone company line-of-business restrictions on manufacturing and information services should be lifted so that whatever synergies there are from economies of scale and cooperation among firms will be realized;

2) exclusive franchises for cable television or telephone companies should be removed to enable them to compete with one another to discipline prices and profit levels;

3) rules and regulations for easy and efficient non-discriminatory interconnection and resale between competitive networks and public telephone networks should be developed rapidly, implemented and vigorously enforced by regulators;

4) price-cap regulation should be implemented for telephone utilities to eliminate incentives for cross-subsides among regulated and unregulated lines of business, and costing and pricing flexibility should be phased in so that they may compete in non-basic service markets;

5) rules prohibiting financial and operating arrangements between cable and telephone companies should be abolished, so that these firms may work together to provide new advanced services whenever it make sense, but in no case would competition by other such cooperatives be prohibited (this is similar to the Japanese model of "cooperative competition", where firms may cooperate but will be subject to direct competition from other such cooperatives);

6) radio frequency spectrum allocation policies should be reformed from the current

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[15] The case of competition in long distance services and relaxed regulation of AT&T is instructional for the future of local exchange competition and the heightened incentives to invest which competition brings about. Many industry observers believed, and conventional wisdom suggested, that it was regulatory protection and barriers to entry that allowed for the telephone companies to invest in network upgrades. Competition and price cap regulation, and the attendant incentives to cut costs were thought to harm investment due to risk and uncertainty in capital recovery. In fact, in the case of AT&T, the opposite occurred as they significantly accelerated digital network upgrades to meet the competitive challenge, even when it meant reduced earnings at first. At the same time incentives to drasticaly cut costs were still at work, but were mostly on the expense side of the cost equation.

speculative lottery and subjective comparative hearings process to a more market based approach; the government could raise funds and at the same time improve the efficiency of use of the spectrum;

7) finally, there should be a more active participation of the government in the standards setting process. The current voluntary system does not work as technology half-lives are much shorter than standards-setting cycles. Cellular and ISDN technology adoption problems were largely caused by standards delays. The government must not set standards. Rather, they must force industry groups to adopt timely and relatively stable public network standards so that manufacturers would be more willing to introduce new production equipment. The standards which are set will not be static or exclusive, but must be relatively stable. Of course, any manufacturer or private network vendor is free to pursue any standard it wishes. It is only public network service and equipment providers which must conform to public network standards.

Beyond these measures, if policymakers still desire more investment in network infrastructures, there are a number of alternatives including the aforementioned value-added tax, investment tax credits, and loan interest rate subsidies to qualified infrastructure network providers.