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DEVELOPING THE NATION'S TELECOMMUNICATION INFRASTRUCTURE

HEARINGS

BEFORE THE

SUBCOMMITTEE ON TECHNOLOGY AND NATIONAL SECURITY

OF THE

JOINT ECONOMIC COMMITTEE CONGRESS OF THE UNITED STATES

ONE HUNDRED SECOND CONGRESS

SECOND SESSION

MAY 22 AND JUNE 12, 1992

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DEVELOPING THE NATION'S TELECOMMUNICATION INFRASTRUCTURE: LEGAL AND REGULATORY ISSUES



FRIDAY, MAY 22, 1992

CONGRESS OF THE UNITED STATES,
SUBCOMMITTEE ON TECHNOLOGY AND NATIONAL SECURITY,
JOINT ECONOMIC COMMITTEE,
Washington, DC.

The Committee met, pursuant to notice, at 9:05 a.m., in room SD–628, Dirksen Senate Office Building, the Honorable Jeff Bingaman (Chairman of the Subcommittee) presiding.

Present: Senators Bingaman and Kerrey.

Also present: Charles Stone, professional staff member.

OPENING STATEMENT OF SENATOR BINGAMAN, CHAIRMAN

SENATOR BINGAMAN. Throughout our history, advances in transportation and communications have been a driving force in our economic development. Today, advances in our ability to transmit and process information can be as important as the development of the transcontinental railroad, long-distance telephone service, or the interstate highway system were for boosting American productivity and enhancing our standard of living.

The promise of modern telecommunications and information processing technology is enormous. It is critically important to American business in its struggle to revitalize and rejuvenate in response to the challenge of international competition. It is also important for ordinary Americans.

A modern telecommunications and information infrastructure can greatly enhance the quality of life in such areas as education, health care, household management, entertainment and culture. I am concerned, however, that we may lack a national telecommunications policy vision that would allow us to take full advantage of the technological possibilities that lie before us.

I know that many economists and others with a vision of the power of the market to develop and implement new technologies see existing regulatory policies as the major impediment to the efficient development and use of our telecommunications infrastructure. To them, government's primary role is to get out of the way.

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But I know also that many experts doubt that market incentives will be sufficient to bring forth adequate investment, even if all regulatory restrictions were removed.

The private market can and should provide the primary energy and impetus for the development and deployment of new communications and information processing technologies. But government has an important and inescapable role to play in shaping these developments.

I think we need to examine government's role in at least two critical areas. Obviously, they are the regulatory and technology policies.

With respect to regulatory policies, it is not necessary to endorse complete laissez faire to recognize the benefits of alternatives to traditional rate regulations and limits on competition that might provide greater incentives for innovation. Neither should most advocates of introducing greater competition into telecommunications be offended by the understandable concern that there be some regulatory safeguards against monopoly abuse where the viability of competition has not yet been proven.

With respect to technology policy, there may well be a role for public investment analogous to our public investment in the highway system or scientific research and development. Prudent public investment in the development of the telecommunication infrastructure represents a bet on the genius of American entrepreneurs to develop creative and productive uses for that infrastructure. And, of course, the bulk of the investment in expanding and modernizing the network would be private, generating jobs and technological spillovers in the American economy.

A visionary telecommunications policy cannot avoid confronting the tension between the traditional regulatory goal of keeping rates low for existing services and a desire to encourage the rapid technical progress that will be necessary to keep the Nation competitive.

What concerns me about the current state of debate, however, is that it seems to be hampered by the lack of a clear vision of what our telecommunications policy objectives are. And also the lack of a clear vision of how different approaches to regulation or deregulation contribute to those objectives.

I think it is critically important that we find a way to establish an integrated communications infrastructure that offers our citizens affordable access to greatly expanded services, while at the same time enhancing our productivity and international competitiveness.

This hearing today is going to be the first in a series that we hold here in the Joint Economic Committee to address these issues. We are fortunate to have three witnesses who can discuss the current state of our telecommunications industry and the suitableness of the current legal and regulatory environment for fostering the development of a modern telecommunications and information infrastructure.

Before I introduce the witnesses, let me defer to Senator Kerrey for any comments that he would like to make at this point. I know of his

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leadership on this issue, particularly when he was at the National Governors Association. We are very pleased to have him here as part of this hearing today.

OPENING STATEMENT OF SENATOR KERREY

SENATOR KERREY. Thank you, Mr. Chairman.

I would say that in the area of telecommunications, there is perhaps more economic opportunity, more potential, to create real American jobs than in any other area of our economy. And I would further say that I believe that we have both a regulatory and an investment strategy that is, at best, incoherent and does not at least give me a sense that we are consciously attempting to both create economic opportunity in the area of telecommunications and to take advantage of the tremendous educational potential of telecommunications to change, in a rather fundamental way, the way that our children learn.

Yesterday, there was a demonstration of communication technology, and the way that it is used and applied for military purposes. When we have a military objective, such as, for example, teaching a 22-year-old how to fly a bombing run over Baghdad without hitting a mosque, we will use supercomputer graphics, we will use all available resources in order to be able to accomplish that objective. We do it effectively and astonishingly, I would say, to get the job done.

My own feeling is that the entire Communications Act of 1934 is going to have to be written with a different objective, that we have essentially stabilized the arguments as to what broadcasts should be allowed to do, what common carriers should be allowed to do, and what the producers, notwithstanding Dan Quayle's dislike of Murphy Brown, ought to be doing as well.

And my own wariness of watching the big guys fight over economic turf is wearing rather thin. I'm at a point, right now, where I am very anxious to proceed with a new objective for that Communications Act and a new regulatory environment, a new investment strategy in order to accomplish it.

The educational purpose for me is my number one attention. And I believe that if we take care of the eight-year-old child out there who is trying to learn, or the 28- or 38-year-old adult who is trying to figure out how to adjust to a world economy, the economic environment will necessarily follow. In short, if we take care of the educational component, we will create an environment for increased employment and growth in our own economy.

We still, in the age of telecommunications, when it is possible for us to withdraw and extract information of astonishing clarity and accuracy, we still spend 80 percent of our time—that is, 16,000 members of America's school boards—if not more times, simply arranging a meeting eight times a day between 35 million American students and approximately two million American teachers.

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Those physical requirements of just getting those people together every single day, getting the bodies in the school every single day, dominate the concerns of the policymakers. I am quite aware that today it is possible, tomorrow it would be even more possible, for people with communications technology to learn in very fast efficient ways, and at their own pace.

So it is the educational component, Mr. Chairman, that brings me to this hearing. And I am very excited about your interest in it, and very enthusiastic about listening to the witnesses.

SENATOR BINGAMAN. That makes me think of Woodie Allen's line that 90 percent of life is showing up. What do we do if we don't have to show up? It's going to be tough.

Why don't we start in.

Our witnesses are Peter Huber, Fellow at the Manhattan Institute, and author of the first and only, so far, triennial report on competition in the telephone industry, submitted by the Justice Department in accordance with the AT&T divestiture decision.

Second, Henry Geller, a Communications Fellow at the Markle Foundation. He was general counsel of the Federal Communications Commission and head of the National Telecommunications and Information Administration in the Commerce Department during the Carter Administration.

And third, John Linkous, Executive Director of the National Association of Area Agencies on Aging.

We appreciate all of you being here.

Why don't we go in that order, if that's good. Peter, do you want to start? Give us your views. Previously, we have told witnesses to try to summarize their views in 10 minutes. I think if you want to take longer than that, that's fine. This is our only panel this morning, and we would like to get your perspective on this extremely complex but important area.

Go right ahead, Mr. Huber.

STATEMENT OF PETER HUBER, SENIOR FELLOW, THE MANHATTAN INSTITUTE

MR. HUBER. Good morning, Senator.

I suppose we should start by acknowledging that we have already switched broadband digital capabilities out there. Over fifty-five million Americans already have a broadband cable television in their homes. Over eighty million could pick up broadband capabilities if they wanted to, they just don't care to subscribe. The numbers may be higher than that; those are the last numbers I have seen.

Over 100 million Americans already have switched capabilities in their home—addressable capabilities. That is, they have telephone service and digital capabilities in personal computers, and in the higher levels of the telephone network, where everything is already digital.

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What's missing is that none of these pieces have come together. They are in quite different networks. The high-order digital capabilities are in stand-alone computers. The switching capabilities are in an analog, narrowband telephone network. The broadband capabilities are in a one-way, analog, cable and over-the-air television system.

There simply can be no serious doubt that these industries are converging. The television world is surely going digital. HDTV will be digital, without a doubt. You simply cannot move that much information efficiently through the air without digital compression capabilities. And the FCC, as I understand it, has already made that call. The computer world is already fully digital. The telephone network is going digital. It is digital already for all practical purposes at the higher levels of the network, at the tandem switches and above, and the digital capabilities are moving down toward the end user. It is only a matter of time before it is digital end-to-end.

At the same time, everybody is going broadband. The computer world is already broadband. Local area networks are broadband. Television and cable are broadband systems, of course. You're pumping a lot of information through those systems. And we are already doing that very well. Telephone is the bottleneck in this instance. The last mile, at least telephone is still a narrowband network—a very tiny straw through which we are trying to deliver lots of information.

Everybody is going addressable. Here the telephone network is leading the way. We have tremendously good switching capabilities in the network. You can set up a dedicated private connection between any point, at l 30 million different locations. That is a lot of very powerful switching capability.

Computers, of course, insofar as they are connected at all, are also addressable. Every local area network is an addressable network. But our broadband network is not addressable. The television network, over-the-air or cable, is essentially a couch-potato technology; it is one way. We send out masses of information, but without any specificity as to where it goes.

But again, these capabilities are coming together. Television becomes far more valuable once you can address it. Wrestle Mania earns more than the Superbowl because it is pay-per-view. The producers can select who is going to get what and charge people directly. So cable television is already experimenting actively with addressable two-way capabilities. So here again, we see all four of these industries moving toward addressable capabilities. And finally, we are seeing a complete convergence of land-lines and airwaves. The tradition in all of these industries was land-line, roughly speaking, for common carriage, while the airwaves were for couch-potato television broadcast. That division was embodied in the 1934 Act. Today, telephone is moving to the air. Television is going underground.

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So everywhere you look, the traditional barriers between these four industries—computers, telephones, and the two branches of television, cable and over-the-air television—are disappearing.

I will not dwell at length on the economic implications of this. I think this audience, at least, is clearly in agreement. The economic impacts are huge, from education to entertainment, to education, to energy management, and to manufacturing. I cannot think of any major sector of our economy—either the competitive private market, or public activities like education—that cannot and will not and should not be transformed by this.

The biggest mistake one can make is to say: Prove it to me, show me all the impacts, prove that the telecommunications' revolution is important. Nobody can foresee all the impacts. I think if you want to imagine the impacts of what we're going through today, you have to ask yourself: A hundred years ago, who would have imagined the impact of the telephone? Suppose we took the telephone away today? How different would our lives be? Obviously, our lives would be drastically different, but you can't even assess the impact of the telephone itself?, even though we have had it for over a hundred years.

I don't think you can foresee every single detail of how our lives will be changed by the ongoing revolution. But it does not take a great deal of optimism or daydreaming to recognize that these impacts will be very important.

It is quite clear, in my mind at least, that the major single cluster of problems that one has to identify—this is an unusual thing to say on Capitol Hill—but the major problems are not money. Money is a big problem, but the opportunities are so huge here that there will be money if the environment is attractive for investment.

The main problem is the legacy that Senator Kerrey mentioned, a regulatory structure that is simply not adapted to this technologically converging world. It is a history of regulatory apartheid. The entire conception of the 1934 Communications Act is one of dividing up two different types of activities, common carriage and telephony on one side, and broadcast, mass audience dissemination of information on the other.

The first divestiture decree in 1956, now largely forgotten, likewise embodied in a principle of apartheid. The telephone industry would remain telephone. Computers were hardly imagined at that time, but everything else, noncommon carriage activities would be separated out.

In the FCC's first two computer inquiries—Computer 1 and Computer 2—the overwhelming thrust was to separate the telephone and computer industry. We spent 15 years on Capitol Hill, and more importantly at the FCC, seeing how we could build up walls between computers and telephones. And we have only just begun to dismantle those recently.

The Modified Final Judgment in 1984, of course, contains a whole cluster of rules as to which business companies are not supposed to

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enter. The Regional Companies are not supposed to do computers, not supposed to get into manufacturing, supposed to stay geographically limited and so on. Then came the 1984 Cable Act, enacted at the same time as divestiture. Again, a major component of that act is trying to separate what is becoming inseparable—telephone and television.

On top of all this, since the 1920s and continuing to the present day, jurisdiction has been heavily fragmented by geography. We have a division of geographic jurisdictions, of course, between federal and state authorities. That division has since been reinforced by the 1984 divestiture decree, which separates interexchange from local services.

It is a curious thing to see all these geographic barriers in the telecommunications industry, an industry in which, after all, the whole objective is to erase geography, to make geography unimportant. And what do we find everywhere we look on the regulatory scene? We have divisions based on whether the industry is local or long distance. The objective of the industry, of course, is to be neither.

The industry is going to be investing money whatever Congress does or doesn't do. It is going to be investing huge sums of money in the next decade. Most of that money will not come from you; I understand you are short of it up here these days. Most of it is going to come from the private sector.

But regulatory uncertainty is a major problem in this industry today. Over-the-air television, cable television, telephone, and the computer industry all collide, either at the federal or the state level, with exclusionary, regulatory, and legal rules that are designed to prevent people from encroaching on each other's turf.

Recently, just a month ago, NYNEX ended a criminal trial The issue in the trial was whether NYNEX had provided a forbidden "on-line information service" to MCI, or whether it was simply selling a computer. That is an interesting thing for lawyers. It keeps us well employed.

But the idea that months and months should pass deciding whether a telephone company was providing a computer service is somewhat worrying.

I think these divisions are going to go away. The quarantine provisions of the Modified Final Judgment are being dismantled slowly, although there is a reactionary move against that on Capitol Hill these days. But I think that process is going to continue. I do not believe the 1984 Cable Act can endure. Although, when it will collapse, I don't know.

The old lines between computers and telephones are slowly being dismantled by the FCC, and within the Modified Final Judgment. Various lines of business restrictions on broadcasters and the television and cable companies are slowly being dismantled, as well. The geographic boundaries are still fairly firmly in place.

I think it is important and necessary for this Subcommittee and the Congress to consider the problem of the absence of leadership in the

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industry. To be very candid about it, we have a problem of fragmentation of leadership in the government itself.

Every branch of government in this city is regulating every branch of this industry. The telephone industry alone is being regulated by Congress, and by the Cable Act, the judiciary, by Judge Greene, and by the FCC, too. And this doesn't even begin to count the local jurisdictions.

This level of fragmentation of authority and leadership, especially when the different camps are often pulling in different directions, breeds a great deal of uncertainty. That alone, I think, is a very costly burden.

[The prepared statement of Mr. Huber starts on p. 33 of Submissions for the Record:]

STATEMENT OF HENRY GELLER, COMMUNICATIONS FELLOW, THE MARKLE FOUNDATION

MR. GELLER. I agree fully with what Peter has said. I could say "ditto" and quit. I think the most important thing in the message that I would like to convey is that market segmentation confining people to certain areas is a very flawed policy. It has never worked. It is being slowly dismantled, but there is a huge cost in the time that it takes to do it.

I am going to rely on my statement for the broad things. I would like to focus and respond to your letter on the switched broadband network and on what is needed there.

The technology is very dynamic. So is the market, as Peter has made clear. The problem is that the policy has not been dynamic. There has been a lag in policy determination.

Let me come back and give you examples. They do affect, as I say, the switched broadband network.

As Peter has made clear, the 1984 divestiture had an enormous flaw in it. People do forget, as he points out, that there was a 1956 consent decree. That consent decree restricted AT&T to "apartheid," as he put it, to simply doing communications services that were subject to regulation. That was a very flawed policy. The computer field was coming together with the telephone field. AT&T recognized that it had to get into not just the information movement—the telephone business—but it had to also be in the business of information management.

If it wasn't in the business of information management, using the computers, its counsel said:

> We're just going to be the Penn Central of the 1 990s. The railroad thought that they were just the railroad business; they were in the transportation business. So we have to get rid of that consent decree.

One of the reasons they agreed to divestiture was to get rid of it. They are rid of it. They are free to do what they want. But the 1956 consent decree came back in spades as to the divested Bell operating companies.

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One half of the U.S. telecommunications industry is under the same stricture, the same "apartheid." Don't go into information management. Don't use the computers that are coming onstream. The entire telephone network is just a giant computer network. And so it was against technology.

That did not survive. In the 1988 triennial review that Peter was involved in, Judge Greene admitted that it was a mistake to have quarantined the divested Bell companies. He said that if we don't let them into what is called transmission information services—voice mail, electronic mail, voice storage and forwarding—the Nation will suffer. Small businesses upon which the Nation is so dependent will suffer. The residential consumer will suffer. Therefore, he allowed them in.

The one area in which he did not let them in was content. That made no sense at all. The Court of Appeals has knocked it off, and it is still pending. The issue is still around in the Brooks Bill. So you still have some uncertainty in this area. You haven't settled it.

When you look at manufacturing, it isn't going to go anywhere this year. They are still precluded. One half of the U.S. telecommunications industry cannot manufacture, cannot make a full contribution to R&D. It affects information services.

If you want to design, develop, and go along with developing equipment for an information service, you can't do it. You can do software, but if you want to put the software in a chip, it is called firmware; you cannot do that. Again, that makes no sense.

If you look at the interexchange prohibition, if you go to do an information service, you may very well, as Bell Atlantic wanted to do, put your processing in one place and serve your outlying areas or rural areas out of Philadelphia. You can't do it. You are crossing what is called the LATA, and you are not allowed to do that. So you get inefficiencies.

While I think these prohibitions will disappear, the question is when? Peter mentioned the 1984 Act. That does bear upon the switched broadband network. That act codified a 1970 FCC rule that said that telephone companies cannot do cable television in their service area.

Whatever the merits of the 1970 Act, the complete ban makes no sense at all, now. The cable television industry is a very powerful and entrenched industry—63 percent penetration and passes 90 percent of the households and scores of programs. If Telco is going to compete, to say that they can't even do three, four, or even five channels of programming—can't "prime the pump"—makes no sense at all. As a matter of fact, I think it is unconstitutional, and it will be broken by a court suit. Because, what you are dealing with is a telephone company that has hundreds of channels. If they exercise their First Amendment right to put on even one channel of programming themselves, the court will see the United States saying that the sky will fall—that is, it is just awful. That doesn't make any sense.

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So I think the court is going to say this is crazy. And under a case called O'Brien, the court will probably throw it out. But in the meantime, you have the delay.

It is important to recognize that cable is a monopoly over these clusters of services. And you need competition to it, and the best competition is the Telco. Furthermore, when the Telco comes, you can make it come as a common carrier, and I believe that that is very important from a First Amendment point of view.

In the 21st century, it will be particularly important. People get their information from video. It is unfortunate, but more and more that is happening. Therefore, it is very important that early in the 21st century, you have video publishing available the same way we do in print. If you want to start a newsletter or magazine, you can do it—send it out over the postal service. If you want to start a fax service, you can send it out over a common carrier—the telephone.

You need the same thing in video. You need a bedrock common carrier service.

I am not saying that the other services shouldn't be available—cable, direct broadcast satellite and others. But you need that bedrock common carrier service for First Amendment purposes, and that is the Telco; that is not cable television.

If you want to see an example that was adduced by the FCC in a hearing, NBC spent $300 million a year on news, so they decided since cable is the new, moving entity, let's go compete with CNN. We have the news already; we have accumulated it. Let's have a 24-hour competing news channel on cable. In order to do that, it has to go through the powerful cable operators—TCI, 24 percent of the subscribers; Times-Warner, 12 percent. TCI and Times-Warner have very close connections to Turner and CNN. They actually control CNN. They said, no. And the only way NBC could get on cable was to come as CNBC—the financial news. The contract says, "you are not to engage in general news.

So what you have is the equivalent in the broadcast area as if you only had ABC Nightly News. There was no other CBS or NBC because of the industry's structure. I am telling you that cable is a First Amendment horror, and you do need this bedrock outlet for video publishing.

Now, Telco is coming with fiber. As Peter mentioned, they are using it in trunking between central offices; they are using it in feeder plant; and they will begin going to the curb with it next year or the year after. The drop into the home, no one can tell now. In the beginning, it may be just a copper wire that will allow VCR quality motion picture. It may be coaxial cable. A lot of people believe that you will go into the home with digital radio toward the end of the decade.

We don't know the topology. But what I'm saying is, they are going to lay the fiber and it will be upgradable when the optoelectric switches come. Even perhaps a photonic switch later in the decade.

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The important point is that it will be used then for new developments. It will be used to replace the copper when it wears out. But copper wears out at the rate of about 2 to 3 percent a year, and if you run that out, what you're talking about then is 33 to 40 years.

Now, the real issue isn't whether Telco will come with fiber. The issue is whether or not you're going to accelerate that development so that it comes a generation earlier. You accelerate development of analog switches. They may last a long time. But in order to get the benefits, you will bring on digital switches, even though the analog switch is not worn out. And that is the very same issue you have here.

I believe it is worthwhile to get it a generation earlier, in the years 2010 to 2015. It is worthwhile for the First Amendment reasons that I said. It is worthwhile also because multimedia computers, very powerful computers that do voice, data, imaging and video are coming on stream now. They need to be linked. And they need high-speed data links. Businesses are going to make full use of them in getting to all their suppliers and big customers.

Finally, you need it for the reasons that Senator Kerrey said. It is a contribution in distance learning, and that can be very important. You don't have enough physics and math teachers. You may have to use interactive distance learning, using fiber in order to solve educational problems. You will need it in health care, in telecommuting, and in workstations at home that may need high-speed data links. So I think it is worthwhile doing.

In order to do this, remember you are dealing with Telco as a monopoly. You need a regulatory umbrella to do that; you need governmental permission. And that governmental permission can come in the form of what is called price caps. It is an inflation figure minus the productivity index. You can wiggle the productivity index. Instead of lowering it to 3.3 percent, you can lower it to 3.0 percent, and you get enough money to do it.

Thirty states use price caps and so does the FCC. You can also do it in rate of return by accelerated depreciation, just as you do accelerate analog to digital switches. That can result in a surcharge of $1.00 or $1.50 a month for some time in order to accomplish that on the ordinary ratepayer. That is the problem.

The problem you mention, Mr. Chairman, is a reluctance to do that because there is a tendency to say, 1 want the lowest possible rates, and that interferes with modernization.

Some states like Tennessee and New Jersey have said yes, others no. And you can have this lag that goes on.

Finally, there is a federal role because 25 percent of the investment is in the federal area—interstate. And that means that Congress can lead here. Senator Burns has been trying to do so, along with Senator Gore. It is not clear that they are making a lot of headway in getting legislation enacted.

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The FCC could lead also. When Telcos come in, they could say, we favor this accelerated deployment. We are going to wiggle that productivity index.

What happens here is that people then raise the flag of industrial policy. I think that is a silly thing to say. It is policy no matter what you do. When Bell Atlantic or Bell South go to Tennessee or New Jersey or go to the FCC and say, we want to accelerate, you can say, yes, and that's policy. You can say, no, and that's policy. But either way, the government can't get out of making policy during these years because it is a monopoly.

Let me finish. I would argue to you that the technology is a marvel. The market responds to the dynamic technology. Where we are at fault, as Peter says, is in the policy area. It isn't dynamic, it lags, and the main reason why it lags are the two that I think I have emphasized. One of them is the market segmentation. We put industries in a box and say, that's it, and the box is gone, the convergence is there. And that's not just Telco. I have used that as an example.

But when cable wants to move in the local level, it runs into the state PUCs saying no, we don't want you to move into telecommunications. Why? Because they want to protect the subsidy scheme—the low rates that they have worked out—and that makes no sense there. I think we have to get rid of that.

The second lag comes from the inordinate desire to have the lowest possible rates, and that interferes with modernization.

Michael Porter, in the work "The Competitive Strength of Nations," said:

> The most important thing you can do in this area of global competition is to have a very strong, fierce domestic competition. And to do that, we have to move on those two policy fronts.

Thank you.

[The prepared statement of Mr. Geller starts on p. 50 of Submissions for the Record:]

SENATOR BINGAMAN. Thank you very much.

Mr. Linkous, why don't you go right ahead.

STATEMENT OF JOHN LINKOUS, EXECUTIVE DIRECTOR, NATIONAL ASSOCIATION OF AREA AGENCIES ON AGING

MR. LINKOUS. Talking to the other two panelists, you will find uniformity in some of the things that we are saying and in some of our conclusions. However, I guess I am coming at it from a different perspective.

I represent, I guess, a segment of the end users of the telecommunications system—the older Americans. I represent a nonprofit private association of the 670 Agencies on Aging around the country, whose mission is to assist older Americans to stay in their homes and communities, with maximum independence, for as long as possible.

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Today, the National Network on Aging represents the 57 state units on aging—670 area Agencies on Aging, and approximately 27,000 local service providers around the country. They are the ones responsible for the multitude of home-delivered meals, senior center programs, transportation, and many other community services.

One of the most important services that they provide is information to the elderly, and to the elderly's care givers about how they can get access to these services, as well as other emerging new telecommunications services that can provide them this independence and dignity.

Before joining N4A, I had communications experience in broadcasting, television, and worked with community outreach groups, and I have a particular interest in this area. I am happy to be invited to come before you on this subject. I believe the potential benefit is going to be especially important to older Americans.

Developments in telecommunication service may well be the key to increasing independent living as people age, and will keep older Americans at home for as long as possible. These services can also help care givers in their various supports to keep an older person at home.

I realize this hearing is on regulations and laws, and some of the other speakers spoke much to the history of the regulations and to the economics of the industries. But first I wanted to focus on the benefits of the improved infrastructure to older Americans, because I feel this issue is little understood.

I am going to address a few policy issues at the end of my remarks.

N4A has long been involved in a variety of the telecommunications issues for a long time. I mentioned earlier the area agencies' involvement in information services. We have something called an elder care locator service, which is a nationwide service, provided through an 800 telephone number, to help older relatives and care givers who live in different locations to get access to much of the information and services. We are also involved in a lot of other telecommunications devices, such as emergency response systems and other systems that help older people stay in their homes.

Because N4A realizes how vital this issue of telecommunications is to older Americans, we commissioned a report and the report is titled, "Realizing the Benefits of New Computer and Telecommunication Technologies for Older Americans." This report was endorsed by the National Council on Aging and Senior Net, and is the basis for many of my comments today. I have attached a copy of the report to my testimony for inclusion in the record of the hearing.

It shows universally that available, affordable, fiber-based technology over the public telephone network can be a benefit to older persons. I think the public telephone network should be thought of as an infrastructure that can support applications and services beyond the plain old telephone service.

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However, at the same time, I strongly believe, and my association believes, that these services should be available with a framework that guarantees affordable basic voice services. The cost for the development and deployment of these services should be paid by the end users and not subsidized by customers using basic services.

Just why are infrastructure improvements so important to this group of people? The American population ages, and the need to develop technology for assuring independence and social isolation is critical. The advanced services can empower older Americans to maintain control of their lives and significantly reduce the cost of support services if they are needed.

Use of this technology will be instrumental in keeping older Americans at home longer and cutting down on the escalating cost of nursing home care. Advanced technologies can help them overcome distance barriers and age discrimination by allowing them to work at home, for example.

Unfortunately, there are several stereotypes and assumptions about older Americans that lead some people to believe that new computer and telecommunication technologies are irrelevant to them. Perhaps, the most striking misperception about older Americans is that they are an homogenous group. The 52 million Americans over age 55 also represent some of the richest and the poorest segments of our population, making it difficult to characterize the economic circumstances of older Americans at all. However, as a group, they have generally a lower economic status than other adults in our society. Advances in telecommunications technology, along with widespread deployment, can make new technologies much more affordable.

Another stereotype that needs to be eliminated is that older Americans are afraid of technology. They are not. It is up to developers and policymakers to make sure of the production of products that fulfill the real needs of these segments of our older population, and make everyone aware of their potential benefits.

Innovative policies have already been developed to bring fiber optic technologies to the public without imposing undue costs on ratepayers, and should be encouraged.

Earlier, Mr. Geller referred to the New Jersey legislation. New Jersey did pass legislation that encourages the implementation of the fiber-optic network while still providing rate protection. And as an association, we supported that legislation. Until fiber-optic technology is readily available, the existing telecommunications infrastructure is capable of supporting a wide variety of information services that travel over existing telephone lines.

Policymakers and planners should promote dialogue among the many potential users of these applications, including the senior citizen advocates, educators, health-care institutions, and government agencies. They should support research to develop new applications to im-

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prove interface designs and to explore new ways of organizing and delivering services to maximize their benefits.

With planning and cooperation, new computer and telecommunications technologies can be a potent tool to help older Americans to maintain their independence and their contact with their friends, relatives, and communities. It is in the interest of our society, as a whole, to make this a national priority.

From my perspective, working with the end users in suppressing the ability of the Bell operating companies, as well as other major industries, to compete and bring into the market their capital and their expertise for improving telecommunications infrastructure, and providing information services, would be wrong. It would delay the deployment and perhaps raise the price of services that would benefit older Americans.

I guess, generally, I would like to say that Senator Kerrey's comments really sum up my view that we have to keep in mind, throughout all of this negotiation and lobbying on behalf of the various industry giants, the needs of the end users. I think it is very important, from the people that I work with, that we move out with deployment in use of the expertise and capital that all of the industries have to bring to the system as soon as possible.

Thank you very much.

[The prepared statement of Mr. Linkous starts on p. 59 of Submissions for the Record:]

SENATOR BINGAMAN. I will start with a few questions and then defer to Senator Kerrey.

The starting point on this, at least from my perspective, is whether we are in a position to define our national objectives. Clearly, as we go forward from this stage, it seems as though we have never had, up until this point, a very proactive government role in accomplishing the providing of some of the services, or accomplishing the upgrading and modernization of the technology. But I guess the consensus that I hear from all of you is that we do need to have that as a national objective. We need to have the modernization of our network as a national objective which, from that objective, would flow a lot of other things.

I would like any of you to comment on the extent to which you think there is agreement or disagreement about what the objectives of the country ought to be in this area.

That is an awfully broad question. Peter, do you have a comment?

MR. HUBER. Unfortunately, I think there is something of a schism. I think the techno-utopians like me—and perhaps like you, Senator—will typically say that we should be moving ahead and bring some money into this network. Without picking particular providers, we see tremendous potential in spending the money to deploy a broadband switched digital network. I certainly am of that view and I think most engineering types are of that view. Most of the people who are of the supply-side of this industry believe it.

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I think you will collide quite quickly with a second school of thought that says most people don't need this. There are certain consumer groups who say that this is a large waste of money, that it will push up local phone rates, that we are buying a white elephant. And they are a powerful force, and they are very vocal. They are being heard on Capitol Hill.

So 1 think, even at that basic level, unfortunately, you will find disagreement. I think that disagreement is disastrous. 1 do not think that there is that much doubt on these same issues in France or Germany or Britain or Japan. Those countries have done a lot that is wrong in their telecommunications industries over the years. But of late, they are doing quite a few things right. In many of those countries, I discern clear and determined commitments to build a telecommunications infrastructure.

Fifteen or twenty years ago, if you looked at our phone system, you would, without a doubt, have said: The best in the world. Today, we can say: Among the best in the world. Ten years from now, we may be saying: Formerly the best in the world. The rest of the world, I think, is having less trouble than we are in pushing ahead here.

SENATOR BINGAMAN. Mr. Geller, do you have thoughts on this?

MR. GELLER. I agree with what Peter has said. I think we do have to be more proactive. There is a schism that he refers to, and I think that this emphasis on lowest possible rates makes no sense at all. It is as if we were back in the old days when you could have very slow depreciation. Equipment used to be depreciated 30 years. Now, this has merged with the computer field. The computer field has very fast depreciation. Even though something is useful, you get rid of it because the market demands that you move on with the new technology. And I believe that this emphasis on the lowest possible rate would mean that we're going to help the grandmother but lose the grandson's job because we aren't going to get the contributions to productivity that is so needed in the Nation.

Let me go on besides that and add a policy issue that ought to be determined. It has been determined now that at state levels, if the governor of a state, such as in Nebraska or New Jersey or in Tennessee, seems to favor this and is willing to take the hit of it, then the state moves to get this modernization network.

If the governor and the rest of them want to say, I don't want anything to happen that looks like higher rates, then they don't move. And I think that the Federal Government, because it can show leadership, has 25 percent of the investment. It can supply very needed guidance in this area, but it's not now doing so.

Finally, it was mentioned in the opening statement of yours, Mr. Chairman, that the act is totally outmoded. It is not even the 1934 Act; it is the 1910 Act. It is based on the 1910 ICC Act. If you came back now and looked at it from 1910, you would see no basic difference other than the segmentation in the 1984 Cable Act.

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It does not recognize that we have to get to all-out competition, that we have to get rid of this "apartheid" that Peter referred to. It does not say that we're going to even rely upon competition as the main guide. It doesn't say that when we get effective competition that you're going to deregulate. The Supreme Court case indicates that you have to adhere to the tariffs, even though there may be no need to do that any longer.

There are some petitions pending to FCC, based on the outmoded act. AT&T filed one. I don't blame them. They wanted to be able to deal with large business the same way their competitors do—MCI and U.S. Sprint. So, when they found that MCI does not adhere to tariffs, that it just makes deals, they said, we're going to make deals. Why shouldn't they? That's competition.

You run into this cockamamie language that would appear to forbid it, including the case of MCI. So it is a big issue now pending before the FCC. There are a number of issues like that.

What I am saying is that we ought to go through and specify now what we think are the proper policies. Besides the all-important proactive one, competition is the one that drives prices to the marginal cost and spurs innovation.

When you get effective competition, deregulate. And here is the way we are going to protect competitors, and then go on to the fair interconnection, and things of that nature. Then deal with the subsidy issue.

We have a large subsidy scheme that now doesn't fit this competitive environment. Subsidies ought to be explicit, ought to be targeted to those in need, and ought not to skew that competitive process. I am not arguing that we do it tomorrow. You have to do it gradually, or it's too much of a shock. But every year you don't do it is a year wasted, and we are wasting years.

SENATOR BINGAMAN. Mr. Linkous, did you have a comment?

MR. LINKOUS. I want to add that I very much agree with, every year that we delay is a year wasted. I think that is an important point. Generally, I am all in favor of it. I don't necessarily believe that maintaining basic rates is going to hold us back. I think that the Bell Companies have made a commitment in many areas to hold basic rates the same, and yet still get involved in many of these new technologies and services.

I think the marketplace, the competition and the ability to raise prices for these new services and provisions of information technology is what is going to do it, as well as any support that the Federal Government can make, in terms of accelerated depreciation or other mechanisms.

SENATOR BINGAMAN. Let me see if there is a valid distinction here. The one thing that we have identified is that the schism and opinion as to how proactive governments should be, how important it is that we modernize the system, what the benefits really are going to be.

Regardless of how you come out on that question, though, from everybody, even if you come out on the side that government should

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not be any more proactive than it is, there really is no justification, at least as you folks are describing it to me, for maintaining the substantial authority that we have at the state level in regulation at this point. That is an anachronism, given what has happened to technology.

I think that's what I'm hearing from the panel.

Mr. Geller, did you have an opinion on that?

MR. GELLER. Yes. 1 am not sure that you would be able to do anything about that.

SENATOR BINGAMAN. I'm not saying that we can do anything about it.

MR. GELLER. Let me explain something. The argument will be made against you. It is true that geography doesn't control nationwide services and information. These are artificial state lines. But the argument is going to come back to you, with some force, let the states do experiments, they are laboratories, as Justice Brandeis said. And they have gone ahead of the Federal Government in experimenting, for example, in price caps and co-location—and I won't go into detail—in allowing competitors co-location in New York. They have grass roots. They are closer.

If this is a monopoly and you have to regulate it, they are the closer one to make a deal about it. All right, we will give you the following price caps and we want the following modernization.

SENATOR BINGAMAN. I thought you were saying that it's not a monopoly?

MR. GELLER. It is a monopoly today, a lot of the local exchanges. The problem I believe that you ought to focus on is, we do need a federal captain. Peter said, Germany has one, Japan has one, and the United Kingdom has one.

We have divided up the system again with an anachronism. I won't take you into it, but in my statement about the Louisiana case, we have two hands on the wheel.

Congress does not give guidance. You have been trying for 20 years and Congress has not given any guidance at all, not changed this old act.

The FCC is handicapped in its preemption of the states in saying, here is the federal policy. If you are interfering with the full effectuation of federal policy, we will preempt you. And it's not clear that they can do that.

They have to show that the federal policy is being negated, thwarted, maybe. Congress ought to at least amend the law to say that the FCC can preempt.

I don't mean to get too technical, but you will find some benefits from state regulation. But you need a federal captain, you need Congress to act, and you need to give the FCC more authority.

SENATOR BINGAMAN. Peter, did you have thoughts?

MR. HUBER. I think that is roughly right. We start with the paradox that we are talking about an industry that is supposed to obliterate dis-

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tance, and we immediately bump into the reality of not only the division between the FCC and the states, but also within the Modified Final Judgment, everywhere we look, regulation is divided geographically.

There is not any chance at all that we are going to abolish the state regulators here. But I do think that we can use some strong federal guidance, trying to recreate a national policy and encourage harmonization, if you will, between state and federal forces.

Basically, in my view, the Bell breakup came when the federal and state policies began to diverge. The Federal Government began moving toward a policy of competition in its jurisdictional turf, and many state governments were lagging. We solved the problem, in a sense, by dividing the company. But it is not solved for the longer term. Somehow, we do have to recreate a sense of national coordination and direction here.

SENATOR BINGAMAN. Let me just ask one other question, and then I will defer to Senator Kerrey for questions.

You refer to the need for a federal captain. Do the existing institutions have the authority in law, or in the statute, what they need to accomplish that. Or, do we need something different?

Mr. Geller, you were head of NTIA, is that right?

MR. GELLER. YES.

SENATOR BINGAMAN. Is that institution properly constituted to perform this federal captain role? Who is?

MR. GELLER. I think the FCC has the power, but you haven't given it sufficient power. You have to wipe out what I call the Louisiana decision and say, anytime a state regulation interferes with the full effectuation of federal policy, we want the FCC to be able to preempt.

If the states want to regulate the prices of information services—an area that is competitive—the FCC ought to be able to come along and preempt. They preempted equipment and that was the right preemption. They ought to be able to preempt here.

I think that you have to give the FCC more power realistically. NTIA has authority only with regard to federal spectrum. All it can do is to make proposals, proposals to Congress, proposals to the FCC. It is possible to merge NTIA and the FCC, and to have a Federal Telecommunications Agency in the way you have it in EPA. Appoint one administrator responsible to the President, and removal by the President, and subject to the oversight of Congress.

But I think it is difficult to accomplish such a move. That would centralize all of the spectrum authority. You would have entire centralized control. I think it would be a very good development. It is very hard to evolve to that. I would be very grateful, in this area, if you could just make some progress and revise that act. The act, as I say, is totally outmoded.

If we go through it and say competition, deregulate wherever you have effective competition, do the following with regard to subsidy, and

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FCC, you are the captain. You can preempt in order to get this national policy that we want.

SENATOR BINGAMAN. I think part of the problem, from what I'm hearing, is that the institutions that we have set up have been set up in order to regulate and keep this so-called apartheid in place. And if we are talking about doing something more proactive, is the FCC able to take up that kind of job?

MR. HUBER. At this moment, in this city, the power center is on a little triangle. One is Third and Pennsylvania—Judge Greene. One is about five blocks down the road in Commerce—the NTIA. You go another nine blocks and you get to the FCC. The main schism is between the FCC and Judge Greene.

If you look at any of the sort of specific, well-defined issues, the FCC and Judge Greene often have been about a decade apart on policies. For example, on the integration of computers in the telephone network, you see a sharp divergence in 1984 between where the FCC is heading and where Judge Greene is heading. They are walking in opposite directions.

Now, on that point, they have been pretty much brought together again, although it is still in litigation today. It took seven years to do that. Judge Greene lost that one. I am not even trying to say who called it right.

It is just that we had that division. I don't know how much longer it lasts, but that kind of fragmentation of authority does cost. Because whatever kind of decision you make, it takes a long, long time to work out who is really in charge.

MR. GELLER. It doesn't make any sense to have Judge Greene in this at all. No sense at all. He did a remarkable job in working out divestiture. Now, he can't run telecommunication policy. It ought to be run from one central place—the Federal Telecommunications Agency, FCC—give it any name you want. Today, I think it is the FCC. But if you don't like the judgments they make, change the law. I agree with Peter, it makes no sense to have both of them going.

SENATOR BINGAMAN. Senator Kerrey.

SENATOR KERREY. I hate to jump in and be the defender of Judge Greene. But one of the things that we do have to observe, it seems to me, is that there is still a considerable amount of monopolistic characteristics at the local loop. And all of the discussion of the need for competition must be discussed, it seems to me, in that environment. And I want to leave that aside, actually; that is not my purpose.

I have engaged on the opposite side of Judge Greene in many arguments. I believe the fundamental problem that we are dealing with right now is that when divestiture occurred, it occurred inside the context of the Administration, which was very hostile to any government, for express purposes of trying to promote economic growth.

Thus, unlike 1934 and 1910, where we had an historical context, where we said we were going to use eight monopoly powers in govern-

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ment's perpetuation of this monopoly to accomplish an objective. The Reagan Administration was hostile to that kind of action. And thus, the divestiture occurred without any expressed intent of doing anything other than to merely divest AT&T into moving into God-knows-what-direction.

The historical context of the divestiture, it appears to me, is very relevant to this argument. One of the things that I am wrestling with is just one frail little policymaker trying to figure out what we ought to be doing. In 1910 and 1934, there was a sense of what the telephone could do, what telecommunications could do. Where, indeed, we ought to be going, particularly in 1910.

You could see the telephone, and there was an urgency acquired as a consequence of knowing what the telephone could do for you, to change the nature of our regulation to invest a great deal of power in AT&T, and to run contrary to our own free-enterprise system in that one example, because we had a tremendous sense of urgency that every single American ought to have a telephone in their home. That's why we took that action, it seems to me, as I reach back, trying to understand what was going on in the early part of this century.

Today, there is no similar sense of urgency. And thus we are reduced to fighting over market share. All of the high-sounding rhetoric, to the contrary, is a struggle for market share, it seems to me. Other than policymakers like myself—who aren't at our best when we are not raising money—to try to figure out, indeed, what is the best policy, what is the best objective? I keep coming back to the home. There are 100 million homes in America, plus or minus, depending on whose numbers you use.

The question, it seems to me, is what should that home have? What do we want each one of those homes to have? Do we want them to have a telephone, a computer, a television, a radio, a boom box, disconnected and in different parts of the home? Or, do we want to try, as I believe we should, to bring those communication tools together into a single tool. Talking about subsidies for elderly Americans, I get rather miffed at the thought that we are running our regulatory policies for the purpose of subsidizing teen lines, as well. I mean, I am more concerned about that than I am about any other sort of subsidy that might be in place.

Notwithstanding Mr. Linkous' reference to older Americans not being afraid of technology. Perhaps, as I get older I won't be afraid of it, but now I am, and one of the problems that we have as policymakers is that we may not have the imagination that is required to picture what we should have in each one of our homes. And I am putting out an appeal here in the form of a question.

Can you describe to me what American homes could have if we regulated and invested properly? And I emphasize the second part.

We are making a substantial government investment in our intelligence networks and in NASA, both of which have tremendous commu-

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nication technology applications. Again, because we have a purpose. We want to explore space and prevent some kind of surprise attack. Thus, we have this investment in communication technology that is a tremendous investment.

I emphasize both the investment and the regulatory environment. But I need a purpose. I need to be able to describe to my citizens what we can have in the home if we regulate and invest differently.

MR. HUBER. I can talk at almost any length on that, Senator, and it's almost all speculation.

We will change the way we live. I think the worst example, to begin with—and the one most people think of first—is the entertainment side. That is least important. We have plenty of avenues of bringing entertainment into the home on video and in other forms.

You asked about which sectors of the economy might be transformed. I think a very intelligent network will do extraordinary things to energy consumption—one of the Nation's problems.

SENATOR KERREY. If I could interrupt you, I think we will lose in that if we don't break the stalemate. I think we will not have correct policy if we just focus on the network. For the average individual, the network is a meaningful sale. What I'm trying to do is to describe, in some compelling fashion, what that home can look like.

MR. HUBER. I was about to get to that.

SENATOR KERREY. I'm sorry.

MR. HUBER. Every month, your electricity bill reflects the fact that there is a large amount of electric capacity that sits idle all the time for that one hot day in summer when everybody turns on the air conditioner. A smart telecommunications system will be load shedding, could knock $5.00 a month off your electric bill.

You're talking about schools and education and contact with your parents. It is a cliché', but that is the central problem in education—bringing together an intelligent teacher and a willing student. Intelligent teachers are few and hard to find. We have lots of good and dedicated teachers. If you want to get the very best, spread out and into the home, and interacting students. It can be done; the technology is there.

One of the great export centers of America today is the American university. People clamor from all around the world to come to your universities. We have the power to put those universities in Hong Kong, Beijing, Moscow and so on. It is a telecommunications problem, and it has export implications.

The transportation sector. You're trying to move taxis and trucks and furniture and vegetables around the country. There is tremendous wastage in coordinating traffic, making people move to the right places at the right time, and not getting lost on the way. A wastage of fuel, a wastage of time—it is irritating.

Telecommunications is a major part of the solution, if it is only in terms of taxi dispatch and so on. And, of course, the whole idea of the telecommuting industry, the idea that the single parent, or the part-time

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parent, can do productive work for four hours a day at home and also raise a family, or engage in other activities, is part of the telecommunications picture.

One can describe these things, and I have and will continue to do so. That is your role, especially. That is the vision you have to project. Maybe, that's a starting point.

The problem that you will immediately run into is a large consumer movement—well organized in this city—that says this is pie in the sky; it is a waste of time; we don't believe it; we haven't seen it proved; prove it to us before you ask us for any money.

SENATOR KERREY. Do you have the capacity to discuss what it was like in 1910? Did we have similar arguments then, with people saying it was pie in the sky to talk about?

MR. HUBER. Senator, when Alexander Graham Bell first brought his telephone to the White House and demonstrated the gadget, the remark he got in response was: This is a marvelous device, very clever, but I can't imagine any possible use for it. The President of the United States said that to him.

Now, the fact of the matter is, the industry got kicked off in a completely different environment. It wasn't competitive. It started off as a patent monopoly. And when patents expired, the industry broke wide open, and there was complete wide open competition—highly dynamic. We saw tremendous growth in the industry. Frankly, the slowdown came when the industry matured a bit, and government decided it was all a monopoly and it should be heavily regulated. But we didn't have the debate early on simply because there was no government policy at all. There was a patent and then there was a free market.

MR. GELLER. Let me answer that. You are going to get development from an industrial policy that we are following now called high- definition television. The FCC correctly is pushing toward a digital receiver because people want entertainment. It will eventually get into 98 percent of the homes, unlike computers which are only in 28 percent, and only 9 percent have modems.

What I am saying is, once you get the digital terminal in there, you can put all kinds of peripherals on it. And that is why it is so important to have this bedrock switched broadband network in place to connect up to that, to bring you the education, the high-speed data, along with the entertainment that people want. Entertainment is a driving factor. But you run into what Peter has said when you start putting it in now and saying, no, it is not necessary.

1 believe it is also necessary in order to have ubiquitous linking of the multimedia, the very powerful computers that are coming on stream. We are moving somewhat in terms of changing universal access.

California says it's touchtone so everybody can get narrowband information access. It will expand it to include advanced 911, 800, 900 numbers, access to an interexchange carrier. But I believe that we have

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to move to get the broadband network in place too, per common carrier switches.

SENATOR KERREY. From my own personal experience, I have acquired the capacity to discern the difference between legitimate positive reinforcement and phony positive. That is, somebody says, you're a wonderful guy, and they don't mean it because they think I might do something bad to them, and somebody who says, what you have done is terrific.

We wired a school in the inner city called McMillen Junior High School, in Omaha. We're trying to get every school in Nebraska similarly wired from this experience.

It came coincidentally with a visit I made to the National Science Foundation Computer Center at the University of Nebraska at Lincoln.

Again, an illustration of the kind of investment that is there, that is not done in a very coordinated or coherent fashion, but it is a significant advancement in a high-speed computer network. I visited a junior high school that had a computer laboratory, run by a first-rate teacher.

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Again, an illustration of the kind of investment that is there, that is not done in a very coordinated or coherent fashion, but it is a significant advancement in a high-speed computer network. I visited a junior high school that had a computer laboratory, run by a first-rate teacher who is very enthusiastic, working nights, working weekends, getting the kids all fired up. The problem was that they had copy coming in and out of the building. We got the local RBOC to agree to essentially bypass itself, for all practical purposes, and these students had tears in their eyes on the day that this thing went on. They now have access to libraries and they are using maybe 20 percent of the available technology. My guess is 20 percent. It is certainly a fraction of the available technology, compared again to what we do when the purpose is to teach a young person to do a bombing run over Baghdad without getting lost.

We have a military or intelligence purpose or a space purpose, we just turn out, and the engineering objective is seen, and we get the job done. The thing that is driving my voice higher and higher and my urgency higher and higher is knowing that we are missing an educational opportunity, and with human beings, you miss that opportunity and never get it back again. These kids are learning faster, better, cheaper. That is a deadly combination.

When they go home, by the way, they turn on the television set. The technology in the home is different from what they have in the school.

My view is that the technology in the home, the technology in the school, the technology in the community, whether it is a business, a

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library, the art gallery, ought to be the same. And I come back at that to the question, what should we be putting in that home?

You visualize a workstation? Do you visualize a piece of hardware that combines telephones, that combines television, both aspects of television, that combines the computer? Do you have in your own mind's eye some dream of what American homes ought to have, comparable to the picture that we gave to Americans of a telephone in the early part of the century?

MR. LINKOUS. Senator, from our perspective, you have to look at the group that we work with. The driving force for frail, older Americans. You look at some of the things that they are most concerned about, one of them is fear, fear of being alone, fear of crime, fear of being institutionalized. And then you look at what technology has done for them and you look at some of the potential uses of telecommunications devices and what it can do in the future. Not only has the telephone itself linked them to their relatives and helped the concern of fear, but if you look at some of the new devices, the emergency response systems, if you look at the possibility of linking to doctors' offices, doing direct assessments of individuals who are home-bound, if you look at even some of the simple technology that is available today.

My mother-in-law is 85 years old. She lives in Rehobeth, Delaware. She is very afraid of crime, of being alone. She goes to sleep every night with a portable telephone in bed with her because she feels much more secure by having that portable telephone with her.

I think there are a lot of things that we're seeing already. But, I think, if you look at some of the devices and some of the innovations that are coming down, I guess most of my time is not spent in the telecommunications field, it is spent looking at national health-care policy.

We all know this country is way behind the rest of the world in developing a national health care system. I see the same parallel to telephone communications.

As we look at national health care and at what other countries have done, we can look at what some of the other countries have done with telecommunications. If we look at France's Minitel system, if you look at the progress that some of the other countries have made, I think this country has a long way to go. I very much agree with the other two panelists. I think it is going to take a federal leadership to really push us further ahead.

MR. HUBER. If I may, Senator, I would resist the urge to try to reduce it to a single object. When Congress began the National Highway Program, you couldn't really answer exactly what was going to be on the highway. You figured it would move, but it might be trucks, some ambulances, some pleasure vehicles.

What will be in the home depends on what is in your home now. If you have kids, it will be education, we hope, along with other things. If you're elderly, it's going to be nursing assistance or monitoring. If you're using electricity, which most of us do, it's going to be energy

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management. In the evening, it may be entertainment. If you are a business or part-time worker, it will be part of your office. It will be all of those things.

I would resist the urge to think that it's going to convert into one provider, one box that will be up there or down there in the den, and somehow it is all going to work. This is a much more subtle and multi-faceted industry than that. And that's why people like me tend to lapse into talk about the network and so on, which puts everybody else to sleep. I recognize the problem.

But it is a mistake to say that there is one pipeline, one box that's going to do it. That's not the way this industry works.

MR. GELLER. I would add that one of the first things you have to do is, do no harm. And you're doing a lot of harm now by your market segmentation, both with regard to the Telcos' cable television and the other areas, and putting them in a box and saying, that's it.

The second thing is the proactive policies that you're talking about. When they come and want to accelerate the digital switches, I think that they ought to be allowed to do that reasonably. The same thing for the broadband switch network, the same way for ISDN and SS-7, and a lot of other things.

This is a fascinating area. But it is a combination of those two areas. One, don't do harm. We are doing that now. And second, allow them to move forward, move reasonably with the technology.

SENATOR BINGAMAN. Let me ask, the schism we're talking about between those that think we should go ahead and hook everything up, use most of this technology and make the investment, and others who say, don't raise rates, how big a schism is that? Are we talking about major increases?

Mr. Linkous represents a group who obviously would like the benefits of the technology, but they don't want to see their rates increase. And that's true about everybody in the country.

Are we talking about extra dollar amounts on people's bills? Are we talking an extra $10.00 a month? What are we talking about?

MR. HUBER. It's not even that. This is enough to make you wake up screaming in the night, because all of the costs in this industry are going down and down and down. The technology is doing fantastic things. The switching costs are going down every year; transmission costs are going down ever year; compression technology is getting cheaper every year.

This is a tremendous opportunity because all of the costs are dropping. Much of the quarrel, in fact, is whether we should drop the costs, as Henry was saying, to 3.0 percent a year, or to 3.5 percent a year.

If we simply said, we will freeze prices at current inflation-adjusted levels, that would create very rapidly a large reservoir of money to be invested productively because costs, for the most part, are dropping.

Now, one can overgeneralize on that. There is plenty of money there. It is not a matter of sticking people with another $10.00 a month. At the

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moment, telephone is in the $10.00 to $15.00 range. Monthly cable television is $20.00 a month. Lots of households are already spending $30.00, $35.00, $40.00 a month, plus the depreciation on the television for over-the-air broadcasts. There is money being spent there.

The question is, let it be spent more productively and let the industry move. We are talking about saving consumers money in the long run, saving on transportation, on electricity, saving them on prisons and remedial schools for kids who don't get educated.

It is a false debate. This may be the only thing you will debate on Capitol Hill where money should not be the issue. And why it has become such an issue mystifies me.

MR. GELLER. I agree fully with that. If you use price caps, the formula is inflation minus productivity. The FCC productivity is 3.3, meaning if inflation were level, the rates would drop 3.3. If you drop that to 3.0, you get enough money probably to modernize anything you want to modernize. Really, three-tenths of 1 percent would do it.

People wouldn't notice. There wouldn't be any revolution. You would get the modern system and the benefits. It is not a boondoggle. You get all the benefits that Peter is talking about.

The fight is still there, though. Even if you didn't use the formula that freezes rates—it was pioneered in the United Kingdom and is being used, as I say, in 30 states—if you used rate of return and decided to use accelerated depreciation, you are therefore going to put a surcharge on all the ratepayers to pay for it.

The surcharge, when they looked at it in Pennsylvania, was very modest. To do it in the most progressive fashion, I believe, was $1.50 a month, and you would get this modernized system. In Pennsylvania, in order to get what is called enhanced 911, which promotes security and is a very good thing to do, they allowed a surcharge of $1.00 for a specific period of time.

If you get the benefits and you explain what they are, there would be no revolution. It could be done. And I agree with Peter, you wake up screaming. I think we're making a mistake not doing that. We will regret it.

SENATOR BINGAMAN. Senator Kerrey, do you have other questions?

SENATOR KERREY. Yes.

First of all, let me put some foundational arguments out so that you know where I stand.

I supported expeditious removal of the obstructions of the Modified Final Judgment. And I believe that we ought to have a competitive environment, although I must say I don't see a competitive environment.

Some of the people who are advocates for a competitive environment aren't very darned competitive at times. You know, if you retain monopolistic characteristics, you have to be willing to surrender those, if you're talking about the need for competition. It seems to me that is a crucial element and that you can look at the reduction of unit costs and

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the improvement of quality side-by-side of computers and telephone technology over the last 10 years, for example, and it is rather stunning. One is a very competitive environment and one is not a very competitive environment.

So I declare that I want the competitive environment. Indeed, I don't want the government to go out and select and say, we're going to have this hardware and I don't want it to have a prejudicial decision, except where there is the need with HDTV for some sort of unified technology. Otherwise, you get massive confusion.

But I don't think we should, in a willy-nilly fashion, discount the economic impacts on costs to American families, and say that there are people out there spending $50, $60 a month for cable. There are 15 million Americans who earn less than $10,200 a year and work full time. For them, it is unlikely that they are spending $50, $60 a month for cable. I think we need to be conscious of the fact that some of the promises that I make don't sometimes come true.

For example, we deregulated the telephone companies in Nebraska in 1985. J believe it has worked for us to do that. However, when I look at what AT&T has done over the past three or four years, they have invested five billion dollars in new technology, new equipment, but the work force has gone down 4,000 or 5,000 in that period of time. I have to explain why that has happened.

Now, I explain this phenomenon with health care and imbedded cost of employees, but the explanation falls on deaf ears to the 4,000 people who no longer have jobs. They are not terribly persuaded when they hold up the piece of paper and say, Senator, you said we were going to get a direct increase in investment and there would be new employment opportunities, and we don't see it as having happened.

I think we have to be very conscious. As Mr. Geller said, don't do any harm, and we can do harm to individuals if we aren't careful with these changes that we make. We have accomplished a great thing, a very remarkable thing, in the penetration of access to telephone and the high-quality telecommunications services that we have in this country.

Although I quite agree that we have to be careful not to do any harm, I am conscious of the fact that there's going to be creative destruction, no matter what we do. And the creative destruction may not feel very painful when you look at it in the abstract. In the concrete, it will be very painful indeed.

Once again, 1 like to focus on the educational aspect. Do you see direct benefits in the educational arena? Do you see the need for us at the federal level to focus our attention on the purpose of the Communications Act, and to debate the purpose of the Communications Act as a precursor to making decisions about how we're going to regulate and invest?

MR. HUBER. I find it impossible to believe that education will not be transformed. That is a double negative. Education will never be the

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same again in the telecommunications age. It has to happen. It will happen.

To repeat my numbers, to get them straight, the average household today has already spent $10 to $15 a month on phone services and another $20 on cable. Not $60 on cable; $20 plus $15. We had one direct test on the effect of dollars on service here.

You may recall six or seven years ago, the FCC made a change and was going to move a subscriber line charge onto the local rates. It has become a total of about $3 a month, a little more than that. There was a very vigorous debate on Capitol Hill at that time as to whether that additional $3 a month, imposed by the FCC on residential rates, would have a dramatic impact on subscribership.

A number of studies were presented, saying this would pull down subscribership a great deal and cause significant pain. We now have seven years of history with that and the data are in.

I certainly do not want to be insensitive to the needs and concerns of poor Americans, for whom a dollar or two or three a month is real money. And I recognize that. But the fact of the matter is, we have had that experience, and it did not have any visible impact on subscribership, or anything else.

It is important to look at costs, but the benefits are the real promise. This is the technology that can bring the best teachers in the country to the poorest students, the best university professors to anybody who cares to study.

We are already doing it with videos, but there's far more to be done here. And I truly believe that the greatest beneficiaries will, in fact, be the rural consumers who, at the moment, simply don't have access to the major educational and cultural centers, and the poor who face similar problems. They are living in isolation from the very best the country can produce, and that is not just in education, not just in entertainment, but access to jobs and everything else.

At the moment, we are exporting jobs to the Caribbean and Hong Kong and England by way of telephone wire. And often our connections across the oceans are better than our connections to our own rural areas and to our own urban cities. Maybe, we can export some of these jobs back to America if we can connect up these people.

MR. LINKOUS. I worked for ten years for the Appalachian Regional Commission, which is an economic development agency, serving some of the poorest areas in the country. And for many years, one of our biggest concerns was education for the younger Appalachians. One of the things we did was, we spent a considerable amount of money setting up a satellite educational transmission system that put some of the best and brightest teachers and beamed them into the local schools. We had to do it by satellite because there wasn't any local available service that could transmit those services via telephone wire.

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Today, that no longer exists because the economics were so great and the federal funding was so little that we could no longer afford to do that.

I think that is a specific application, with the advent of fiber-optic cable, if we could get those into the schools of the remote areas of Appalachia, as well as Nebraska and other parts of the country, that type of new educational environment for some of these children who cannot get access to some of the teachers and some of the materials that you could use by getting access through some other systems that would be available with new technology.

MR. GELLER. I agree with what Peter said on education. I want to note two aspects of what you said. One is the need to make sure that the poor stay on the system. And I agree with that. But what you have to do is target those who are in need.

One part of the schism comes from the fact that the middle class and the rich get subsidized. My bill is subsidized. There is no reason to do that. You don't do that in power, electric, and you don't do that in food. If you fly over a town in order to get to the people who need food, you would not drop food on everybody, or knock on every door.

In a competitive system, you have to compete. Those who are truly in need are targeted and supported by giving them the subsidy, not the middle class who don't need it.

While we keep arguing competition, competition, I am in full agreement that we still have monopoly in the local exchange. That means you have to regulate in order to prevent improper cross-subsidization, in order to have fair interconnection so that the competitors can use the network. That is a regulatory function, and we can go into detail on that.

Our policies ought to be, however, though it is a monopoly, don't suppress the competition of the monopolists. They could make an enormous contribution in many ways. Regulate it to make sure you don't get too many detriments from their entering. What is wrong with the modified final judgment is its suppression. The basis of it was that the local monopolies will always remain that way. That was a mistake in economic theory.

What we should do is to introduce more and more competition. Then, in the 21st century, that monopoly will be broken just as the interexchange one has been broken. Then you can turn to straight market forces with some regulatory overlay, very little. We ought to be promoting that competition.

SENATOR KERREY. I would add to that, as I indicated in my earlier statement, I believe what was missing at the time the divestiture and consent decree occurred is the President coming to the American people saying, here is where we're going, here's the vision, here's the follow-on. If Ronald Reagan ever gave a speech about telecommunications in 1983, 1984, 1985, stating to the American people that there will be confusion, there will be questions now, you're going to be going

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to different sources to buy things than previous, I never heard it. I know you think there is going to be a deterioration of services, but here is the objective, here is what we're trying to do. Here is where, indeed, I see telecommunications going. I think that there needs to be that compelling vision and description out there of where we're going. Otherwise, we're not going to break the impasses. Because, as I indicated, it seems to me, almost every impasse that you break is going to provide a moment of creative destruction. Somebody is going to have to give up something. Thus, it seems to me, that one of the most important elements is the description of what we could have if we regulated and invested differently. I think you must do it in a way so that parents say, instead of watching four hours of broadcast television, my child might still watch four hours of broadcast television, but my child should have the opportunity to do their own programming, their own access to information, in a different fashion, without having to depend upon somebody else doing the programming.

If I can describe, in some compelling fashion, a changed environment in the home, it seems to me that we might be able to break the impasse.

SENATOR BINGAMAN. Let me ask Mr. Linkous, as a result of this, what are your views about the issue of increases in consumer bills? Both Mr. Huber and Mr. Geller indicated that they didn't think that was a major issue. They felt that you could do what we are talking about without having an impact on consumer bills. Do you have an opinion on that?

MR. LINKOUS. I agree, I don't think it is a major issue. I don't think it will inhibit. I think, if you look at it like New Jersey where they have an agreement with Bell Atlantic to go ahead and fiber optic the entire state, in the end, rates were really not the issue. The legislation went through. We supported the legislation. It did not go on the backs of a lot of the basic ratepayers because the costs are going down.

I have lobbied for a long time for all of the Bell operating company executives to get together with a statement saying, if we can get a free rate to get an information service, we-will guarantee basic rates for the next 10 years. I think that there is a real possibility to do that.

I don't think that is a big issue. I don't think that that ought to inhibit the country from taking advantage of the new technologies.

SENATOR BINGAMAN. Do you have any other questions?

SENATOR KERREY. No.

SENATOR BINGAMAN. I think this hearing has been very useful. We will do another hearing down the road. I thank you all very much for taking the time. I appreciate it.

[Whereupon, at 10:39 a.m., the Committee adjourned, subject to the call of the Chair.]

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SUBMISSIONS FOR THE RECORD

PREPARED STATEMENT OF PETER HUBER

I am here in a purely private capacity, as one who has studied and written about the telecommunications industry for some years. I am Of Counsel to the Chicago law firm of Mayer Brown & Platt, and that firm has represented the Regional Bell Telephone Companies in various telecommunications matters. But the views I am expressing this morning are strictly my own. They are drawn from M. Kellogg, J. Thorne & P Huber, *Federal Telecommunications Law* (Little Brown, forthcoming, August 1992).

* * *

The telecommunications industry is in a period of enormous transition. For most of this century, telephony was viewed as a natural monopoly. The high cost of fixed plant, the steadily declining average costs of service, and the need for all customers to interconnect with one another, made it seem both sensible and inevitable to have a single, monopoly provider. The Bell System was born on that premise, and with it an elaborate body of regulation designed to reconcile private monopoly with the public good.

The old regulatory paradigm contained three basic elements. First, the protected franchise: would-be competitors were barred from competing or even interconnecting with the enfranchised carrier; natural monopoly thus becomes a self-fulfilling prophecy. Second, the quarantine: the monopolist was restricted to his regulated sphere and barred from exporting his expertise (and the corrosive influence of his monopoly) into adjacent competitive markets. Third, cradle-to-grave regulation: prices, terms, and conditions of the monopolist's services had to be sold to regulators before they could be sold to customers.

The old regulatory paradigm served the country adequately for over fifty years, permitting the Bell System to deploy the best, most technologically sophisticated telephone system in the world. Bell also deployed Bell Labs and funded it with the enormous profits of the Bell System. And Bell Labs, apparently unfamiliar with regulatory paradigms, developed new technologies that made competition in telephony inevitable.

Today, the two overarching technological trends are fragmentation and convergence. There are more switches, more lines, more networks, many more levels of interconnection—the old integrated, centralized media are being fragmented into many smaller, more independent, parts. At the same time, interconnections are proliferating and becoming much more seamless. The media themselves are converging. Television is leaving the air in favor of wires; the telephone is leaving the wires in favor of the air.

Regulators are adapting, albeit slowly. Precisely the same technological developments support new competition by the phone company and against it, but the incumbents on opposite sides of the traditional regulatory fence have quite different views about which kind of competition should come first. Thus, television broadcasters want to contain phone and cable companies, just as radio broadcasters once hoped to contain television, and just as newspapers once hoped to contain radio. Cable companies want to contain phone companies and vice versa, and providers of on-line information services would prefer to contain both. Landline phone companies see a real threat in mobile services, which provide far more convenience; mobile carriers see a real threat in the landline system, which still provides a hub for ubiquitous interconnection.

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Much of the time, for many of the protagonists, the paramount regulatory objective is to preserve the status quo, and so to fend off the instability of untrammeled new competition.

The dynamics of the new technology have forced regulatory change regardless. The protected franchise has eroded as new entrants have been permitted, at first, to serve niche markets and, later, to engage in more extended competition. The quarantine has been partially lifted as the boundaries between regulated and competitive markets have eroded. Pervasive regulation of prices and such is gradually given way to competition.

A new paradigm of unfettered competition—without entry barriers, quarantines, or unnecessary regulatory restrictions—is now beginning to emerge. The transition is by no means complete. Indeed, regulation today is in fact at its apogee, because a smooth transition between paradigms require that new rules be erected before the old can be dismantled.

Under the old model, for example, there was no need for interconnection or equal access standards—the only interconnection was between customers and their monopoly carrier. We may likewise anticipate a day when interconnection regulations will once again become unnecessary: competitive forces will balance out, and interface standards will then be set through market forces, voluntary agreements, and evolutionary consensus as they are in other industries, most notably the computer industry. Today, however, while dominant carriers still mingle with fledgling competitors, interfaces must be regulated along with everything else. And day by day the interfaces multiply, as equipment providers, long distance carriers, information providers, mobile providers, and others, all clamor for new forms of access; steadily blurring the lines between customers and providers.

Price regulation too has become vastly more complicated. With a single monopoly provider, the regulator's task was relatively simple: ensure that the monopolist enjoys no more than a "fair" rate of return. Within that overall stricture, the regulators were free to shuffle costs and prices as they thought best, and they did so with enthusiasm, mostly in pursuit of universal service. Through the "separations" process—the division of costs between interstate and intrastate services—the FCC and state regulators built in a heavy subsidy for local services by loading costs on to interstate services. This helped attract long distance competition. The competition arrived in due course, and with it today's dismaying spectacle of regulators who aspire to embrace competition, maintain subsidy, and protect fledgling competitors all at the same time.

Most complicated of all have been relations among regulators themselves. Telecommunications began as a local industry heavily regulated by local authorities. The technology for interstate calling was slow in coming and, for most of this century, local exchange revenues dwarfed long distance revenues. But the whole point of telephony is to erase geography—so the better service gets, the more intolerable it becomes to regulate through a hodge podge of independent, uncoordinated, geographically defined authorities. In the end, local, introverted regulation is irreconcilable with a network that must function outward, nationally and beyond. The major trend today—pushed by the FCC, though resisted by many States and some courts—is thus toward a steady contraction of local power. Opposing this trend is another major force: the divestiture decree. In breaking up the Bell System, it divided markets once again along strictly geographic lines.

We are thus at a high water mark of regulation, with major components of both the old and the new regulatory regime still in place. Progressive shifts from managing monopoly to managing competition is accelerating, however,

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and it is one of the great if unheralded regulatory initiatives of our day. Our ability to compete in the new global markets will turn, in significant part, on how—and how quickly—critical disputes are resolved.

* * *

Before the advent of the transistor, both computers and telephone exchanges had required large, cumbersome, costly, custom configured, labor intensive, centers. With the new electronics, much more powerful telephone switches and computers could be built into much more compact and reliable units—minicomputers and private branch exchanges (PBXs). Larger institutions—hospitals, universities, corporate headquarters, and so on—had once relied on a few, centralized mainframes to do their computing, and on "Centrex" services handled through public telephone exchanges, even for internal telephone calls. Now these same functions could be—and rapidly were—located in stand-alone units on private premises. Competing manufacturers of PBXs and mini-computers proliferated. By the late 1970s, even Bell was systematically downgrading Centrex service and migrating its larger customers to PBXs.

This dispersion of electronic intelligence created a host of new centers, held in private hands, capable of communicating by wire and in need of the connections to support the same. As had happened almost a century earlier, with the rise of the telephone itself, the new talking boxes created new demand. What was critically different about the new-generation local exchanges, whether true PBXs or communicating computers, was that they were owned and controlled not by a small number of quasi-governmental, monopoly phone companies, but by a larger number of private, competitive institutions. For the most part, these private owners welcomed competitive bidding for their telecommunications needs.

At the same time, the transistor was also fulfilling its original mission, which was to transform the public telephone exchange: a new generation of electronic switches was deployed in the 1960s and 70s. These switches were far more efficient, powerful, and flexible than the old switches they replaced. They could support levels of interconnection—and thus offer customers a variety of choices—that would have been prohibitively slow, complex, and unreliable in the days when switching was accomplished by human operators or electro-mechanical devices.

The integrated circuit continued the transistor's restructuring of telephony, but accelerated the pace of change a thousand- fold. Transistors were shrunk from the size of a fingernail to the size of a hair, to the size of a microbe and smaller. The economics of producing electronic equipment shifted dramatically. Designing a single, advanced microprocessor may require a bill ion-dollar investment. Thereafter, any number of copies can be stamped out at very little cost. The technology thus triggered an efflorescence of new desktop and office systems, as well as consumer electronics. All depended on the same fundamental component—the transistor. All operated digitally. All could be mass produced at little cost once the electronics for the first unit had been designed.

The result has been a radical technological transformation, characterized by two, seemingly contradictory trends: fragmentation and convergence.

The first major technological trend today continues to be one of fragmentation. The once centralized network is becoming decentralized. "Terminals" —dumb end points to the network—are giving way to "seminals"—nodes of equal power that can process, switch, store, and retrieve information with a

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power that was once lodged exclusively in a few fortified centers massive switches and mainframe computers.

Control of electronic information capabilities has thus continued to migrate from central systems toward dispersed alternatives. In 1974, when Intel introduced its 8080 microprocessor, the computer on a chip matched the power of the IBM 704, a mainframe introduced twenty years earlier. It was in this environment that Justice had initiated its suits against AT&T and IBM, and that the FCC formulated its policies of "maximum separation" between telephone and computing services. By 1977, however, Zilog had cut the gap between centralized mainframes and microprocessors to fifteen years: the Zilog Z-80 microprocessor roughly matched IBM's 1962 Model 7094. By 1981, the gap had closed to six years, when Intel introduced its 8088 (the brains of the original IBM personal computer), which offered roughly the same computing power as a 1975 Digital Equipment machine, the PDP 11/70. Intel's 80386, introduced in 1987, had about the same raw power as Digital's VAX 8600, introduced in 1984. Intel's 1989 offering, the 80486, comes close to matching IBM's 3090, introduced in 1985. Thus, in the space of a decade, the performance gap between microprocessors and mainframes has been closed from twenty years to less than five. A $5,000 PC in 1990 had the processing power of a $250,000 minicomputer in the mid-1980s, and a million-dollar mainframe of the 1970s.

As cheap storage and computing power move onto the customer premises, the use of data communications has increased, but dependence on data communications has actually declined. How is this possible? People still use the public network—use it more than ever, in fact, because they have more devices to connect to it. But their use is also much more elastic. At the margin, they can cut usage almost at will.

The battle between Centrex and PBXs illustrates this most clearly. A typical mid-sized office may opt to have all its telephone switching done in a telco's central exchange. Or it may install a PBX and do all intraoffice switching on its own premises—typically one-third of all calls. If it opts for a PBX, it will then be in a position to make direct connections over dedicated lines to any one of several long distance carriers, who will typically take care of a second one-third of its business. The office's use of telephone service may be rising steadily. But its dependence on the local exchange will decline.

Telephone users today make similar trade-offs when they opt to install a faster modem or fax machine, or to install a CD-ROM as a substitute for on-line electronic services, or to assemble a local area network of personal computers to replace on-line time-sharing on a remote mainframe. In each instance, greater electronic power on a user's own premises becomes a strong substitute, at the margin, for greater usage of the telephone network. The link to the network is never severed; indeed, usage of the network probably increases steadily as businesses themselves become increasingly decentralized. But relations between consumers and providers of telephone service are nonetheless shifting profoundly, with the consumer's power increasing, while the telco's declines. Each new generation of equipment—computers, local area networks, metropolitan area networks, mobile switching offices, pay-per-view TV systems, and so on—offers a new cluster of possibilities for interconnection. Exchanges multiply and are dispersed; pathways across the network proliferate. Where once there was a monolithic provider of plain vanilla service there are now multiple providers offering an array of ever-more exotic flavors.

This has triggered a further round of restructuring in the telco central-office. The first generation electronic switches were based on analog technology; the next generation were digital. Digital switches entered the public tele-

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phone exchange in the late 970s; by1985, half of all telephone calls were digitally switched. The new switches were even more powerful and flexible than the analog electronic switches they replaced. The prior generation had been powerful enough to accommodate the rise of competition in interexchange services; the new generation was powerful enough to accommodate competition among myriad providers of communications and computing services of every description.

Prodded by regulators and providers eager to supply new services through the telephone network, equipment manufacturers and telephone companies have most recently begun to develop a new conception of the role and function of the public telephone exchanges. With open network architecture (ONA), the plan is to disaggregate the individual components of a telephone connection—the line, the signaling (such things as dial and busy tones), switching, and so on—into "basic service elements" that can be priced and sold separately, and integrated into a rich variety of enhanced services. ONA, it is hoped, will vault telephony from POTS—the "plain old telephone service" that differs little from the service conceived by Alexander Graham Bell—to PANS —the pretty amazing new services that tantalize the futurists.

ONA is probably the inevitable technological culmination of the disaggregation and decentralization of telephony triggered by the electronics revolution. Theodore Vail's vision of universal service is not repudiated, but instead carried to its logical conclusion. The telephone network will provide universal service not only to consumers but also to producers—to competing telephone companies (as already occurs in the long distance markets), to radio-telephone competitors who need to interconnect their service with the landline network, and to a limitless range of competing providers of "enhanced" or "information" services, who will monitor burglar alarms, link together bank teller machines, transmit electronic mail, publish electronic newspapers, run shopping malls, or deliver on-line horoscopes.

The latest generation of network signaling systems is tailored specifically for open networks. Signaling and indeed all informational aspects of telephony are increasingly being separated, leaving the bulk of the network to supply only brute transport. At all levels, both local and long distance, transport is increasingly becoming a commodity. The real value, the real control, lies in processing, storing, and retrieving electronic information. Carriers control some aspects of that in the first instance—the first tier of information about who is making a call, to whom, and on what billing terms. But the FCC's Open Network Architecture initiatives are directed at ensuring reasonably equal access to essential electronic information generated in the first instance in the public network itself. Thereafter, in all higher tiers, a fully competitive world beckons.

Competitive or otherwise, the new world is not likely to be segregated by media any longer. In digital systems, a bit is a bit, whether it represents a hiccup in a voice conversation, or the price at which AT&T stock is selling at this particular instant, or a strand of hair in a rerun of I Love Lucy. The lines between media formerly segregated by mode of transmission (radio vs. landline) and function (telephone, cable, broadcast, computer) are quickly disappearing. We are moving rapidly toward a myriad of mixed media (radio/landline), integrated (digital), broadband networks, all interconnecting seamlessly to one another.

One vivid illustration of this convergence is cellular telephony, made possibly by the synthesis of radio, telephone, and computers. The key problem with the early radio telephones, which persisted until the 1980s, was that there just

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didn't seem to be enough spectrum available to allow simultaneous use of very many of them. A few dozen stations pretty much fill up the dial of a radio—and radio telephone requires radio stations in pairs to sustain two-way conversation.

In the 1940s, researchers at Bell Labs proposed an ingenious solution. Radio telephones should be low-power, short-range devices. The same frequencies could then be used again and again (just as they are with cordless home telephones); a radio conversation of East 42d street would not interfere with another one on the same frequency on West 51st. A city would be divided into many separate "cells," each one served by its own, low-power transmitter. The capacity of a cellular system could then be increased almost indefinitely by shrinking cells and increasing their number. But cellular telephony required, in exchange, highly sophisticated transmitters and receivers, and massive coordination among cells to "hand off" calls and coordinate frequencies as the car phone on 42d street moved toward 51st. No one had the technology to perform this—until the advent of microelectronics.

After the FCC finally approved commercial cellular telephone systems in 1982, the market grew explosively. The new exchanges—"mobile telephone switching offices"—secured the right to interconnect with the established land-line exchanges. By 1990 entrepreneurs and regulators were considering a second generation of over-the-air telephone systems—"personal communications networks (PCNs)—based on "microcells," with base stations linked to either private or public exchanges. Each new cluster of exchanges that appeared on the scene opened up new possibilities for service from competing networks. Cellular companies have quickly recognized the advantages of "clustered" service, and established dedicated links between their own exchanges and those of the long distance carriers. PCN operators have turned to cable companies to provide transport among the transceivers that will be used to support their service.

A less visible but equally revolutionary merger of radio and telephone technologies has occurred below ground, during almost exactly the same years as cellular systems were being deployed above. This too evolved directly from technological developments set in motion at Bell Labs several decades earlier.

The development of coaxial cable and microwave transmission marked major advances in the continuing quest for ever more capacious, reliable, secure transmission systems. For telephonic purposes, microwaves represented an important advance over ordinary radio because they operated at much higher frequencies, capable of carrying much more information over focused paths. Push the frequencies higher still, and you get ultra-high frequency radio waves, better known as light. A light beam can be shaped and modulated to carry information just like Marconi's radio waves, but in vastly larger amounts. It is best transmitted in a wave guide, similar (in principle) to those developed by Bell Labs in the 1930s. Extremely pure, hair-thin, stands of pure glass serve admirably.

Fiber optic systems represent today's pinnacle of telecommunications technology, the finest merger (so far) of radio, telephone lines, and electronics. Integrated circuits provide the highly sophisticated transmitters and receivers at each end of the line. The telephone line itself is now a strand of glass. The radio wave is now a beam of light, generated by a laser. A single strand of glass can today transmit thousands of simultaneous telephone conversations, or hundreds of color television signals.

With such capacities, demand for fiber has come primarily from the higher levels of the network, where traffic from many callers is consolidated into

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interexchange trunks. Fiber is now rapidly replacing copper, coaxial cable, and microwave everywhere in the telephone network, except (so far) in the short last stretch to the user's home. (At one point, MCI, showing little respect for the "M" in its own name, ran ads showing the dynamiting of a microwave tower, as its network was converted to glass.) Competing local carriers have begun deploying independent fiber-optic systems in larger cities across the country, aiming to replay the MCI history again, with a new technology (fiber instead of microwaves) in response to burgeoning new levels of demand.

As the media converge, so too, inevitably, do messages, information services themselves. One low-tech example is the burgeoning new industry that might be called pay-per-listen radio, but is better known as 900 or 976 audiotex service. Carriers are likewise deploying various forms of switched video services, which marry television with telephony. These are still reserved for high-end users, but within a decade or so we may expect digital video to move out toward the home. The old, media-specific lines between the world of broadcast and telephony are fast disappearing.

Ithiel de Sola Pool anticipated this trend as early as 1983, in his landmark *Technologies of Freedom*. "For the first three-quarters of the twentieth century the major means of communications were neatly partitioned from each other, both by technology and by use," Pool wrote. "Now the picture is changing. Many of the neat separations between different media no longer hold . . . [t]he explanation for the current convergence between historically separated modes of communication lies in the habitability of digital electronics."[1] A major study by Congress' Office of Technology Assessment reached identical conclusions in 1990. "With digitalization all of the media become translatable into each other—computer bits migrate merrily—and they escape from their traditional means of transmission. A movie, phone call, letter, or magazine article may be sent digitally via phone line, coaxial cable, fiber optic cable, microwave, satellite, the broadcast air, or a physical storage medium such as tape or disk."[2]

Today, large institutions and telecommunications providers already use fiber optics to link together communicating systems of every description. Traffic still originates in telephones, but also in computers, facsimile machines, and other electronic devices.

Despite the revolutionary advances in stand-alone office and consumer electronics, the low-end of the telephone network remains less advanced. Over half of U.S. residences actually subscribe to a broadband service—cable television—and 90 percent could subscribe if they chose to. But coaxial cable, laid in the 1970s and early 1980s, is still the dominant distribution technology. Telephone service remains a separate network, more capable in that it supports two-way, point-to-point communications, but far less capacious, unsuited for carrying much more than ordinary voice conversation.

While there is much debate about when the journey will be completed, there is now little doubt about where communications networks are heading. Telephony, television, and much of computing share the same future—a future of one (or more) switched, digital, broadband networks, networks that combine the broadband carrying capacity of cable television, the digital power and flexibility of computers, and the switched addressability of telephones. At the ends of the network, a rapidly growing number of users will demand mobility, at the very least for voice and data communications.

[1] Pool, Technologies of Freedom at 26-27.

[2] Office of Technology Assessment, U.S. Congress, Critical Connections 50 (1990) (quoting S. Brand, The Media Lab 19 (1988)).

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This future seems assured today by the forces similar to those that created the telephone network a century ago. Telephones created demand for telephone networks; the power of the networks evolved to accommodate the terminal equipment that required interconnection. Today, residences and offices across the country are rapidly being equipped with a new generation of telephones—computers, facsimiles, electronic burglar alarms and meter readers, remote medical monitoring systems, and soon, high definition, digital televisions. The "picturephone" that the Bell System unsuccessfully attempted to market in the 1960s is now owned by millions of Americans: they call it a video camera. Such devices are already, or soon will be, capable of taking advantage of vast amounts of new, addressable, network capacity. One way or another, it seems certain that new network capabilities will be developed to accommodate the new demand.

* * *

Just how they will be regulated, if at all, remains much less clear. Our regulatory legacy, from both the FCC and the Department of Justice's Antitrust Division, remains substantially rooted in the very divisions that technology is rapidly transcending.

One may begin with the venerable lines between broadcasters and common carriers. These largely mirrored divisions by media: broadcast by air, carriage by land. And as these divisions ripened and aged, it somehow became accepted that the conduit and content were logically separate and should remain so. Then there were critical divisions within telephony itself. Carriers were one thing, customers quite another. Ordinary local exchange telephone customers were to be subsidized; long distance carriers were to do the subsidizing. A third pillar of regulatory policy was to deny many differences that were real. Rates were to be averaged across users, across carriers, across all sorts of different uses and services, so as to promote government conceptions of fairness and universal service. Over the years, these policies of arbitrary distinction and equally arbitrary averaging accumulated. Today, the regulatory landscape is littered with distinctions not founded on real differences, and papered with randomly stuck-on averages intended to conceal the most profound differences. Regulators and antitrust lawyers thus toil endlessly to average the unaverageable, and to distinguish the indistinquishable.

It is the sort of environment in which vocabulary and metaphor can completely eclipse substance, in which the battle of the vague analogy becomes critically important to success or failure. From a tariff perspective, it is tremendously advantageous, for example, to be ranked as a long distance "customer" that operates equipment and happens to resell some interexchange services, rather than as a "carrier" that sells interexchange service but happens to operate some of its own equipment. What then are providers of on-line information services, that clearly do both? For tariff purposes, they are "customers"—they pay no access charges on their long distance traffic. For purposes of the Bell divestiture decree, they remain "carriers"—so the Regional Bell Companies remain rigidly barred from joining their ranks, at least insofar as interexchange services are concerned. The FCC focused on the equipment, and analogized information services to customer premises equipment (CPE). The framers of the divestiture decree and Judge Greene focused on the wires, and analogized information services to interexchange services. This one battle of analogies has undoubtedly consumed several hundred million dollars of legal and lobbying effort in Washington in the last decade.

And how should regulators view pay phones? Over the past decade the FCC has moved solidly toward the view that pay phones, like other telephones,

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are CPE—like a toaster with sound, as one former chairman of the FCC might have put it. Any owner of a restaurant, stadium, or taxi should be allowed to install one and run it much like a vending machine, perhaps alongside the public telco's competing unit, at least in public places like street corners. Under the divestiture decree, by contrast, payphones and indeed CPE initially fit nowhere in particular. When they were finally shoe-horned in under the decree's equal access obligations, they were placed there on the logic that interexchange carriers sometimes install pay phones.

How about providers of cellular or paging services? Almost from the earliest days of mobile telephony, the FCC has articulated an objective of competitive mobile services seamlessly integrated nationwide, so that a briefcase phone really works just like a home phone, for making or receiving calls, wherever the briefcase may happen to be. The FCC's objective, in short, was to erase considerations of geography as completely as possible. In decree jurisprudence, by contrast, mobile services have been lumped in with the local landline exchange. Systems owned by the BOCs continue to be confined geographically. And, at least at first, the BOCs were not required under the decree to provide equal interconnection to anyone else.

This sort of game is destined to be played out device by device, service by service, exchange by exchange so long as critical constraints, quarantines, or inequalities in price turn on how a new service is described, rather than on what kind of connections it requires. For decree purposes, the Regional Bell Companies (RBOCs) will insist that all services they seek to provide are like CPE" or (since 1991) "like information services," and therefore not logically part of the decree quarantine. For tariff purposes, RBOCs will insist that all new services are interexchange carriage, and therefore logical candidates for contributing to the subsidy of local service. Long distance carriers will embrace the RBOCs' analogies when discussing subsidy, for otherwise long distance carriers must continue carrying all the subsidy freight alone, but will vehemently disagree with these same characterizations when discussing the quarantine, for otherwise they might face new RBOC competition. Mobile carriers will insist that they are "co-carriers"—alternative local carriers, entitled to free interconnection—when they are discussing tariffs, but will characterize RBOC affiliates as "long distance carriers" when they seek decree waivers to extend the geographic range of their radio services.

Demands for new and different forms of interconnection—and with them, opportunities for this sort of gamesmanship—will multiply as the process of fragmentation continues, as communicating computers and telephone systems proliferate, as telephones and computers come to be incorporated all but invisibly into other devices. Open network architecture will further increase the number of possible interconnections. The convergence of media, the development of mobile services, the rise of value added networks, metropolitan fiber networks, pay-per-view television—all of these and more will trigger new demands for new forms of interconnection. Every new arrival will want to position itself on the right side of the subsidy pipeline. Every new arrival will need to work its way around any exclusive franchises or quarantines that might otherwise apply. Every new arrival will wish to steer clear of equal access obligations imposed by regulators, for it is far more desirable and competitively advantageous to work these things out dynamically, in a give and take with customers and competing providers.

All of this is the technological legacy of the transistor. All of this is likewise the legacy of FCC principles developed in the 1960s and 1970s, which established that independent interconnection with the public telephone network is both feasible and desirable. Those legacies are now secure. But, each of the

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three traditional pillars of telephone regulation—franchise, quarantine, and price regulation—will still have to be reexamined completely. All three will, in time, be largely discarded. There has already been much progressive movement. Yet on all three fronts there remains much still to be done.

The exclusive franchise began its slide into oblivion with Carterfone (which gave independent providers the right to connect terminal equipment to the public network) and Execunet (which allowed competing long-distance companies to interconnect with the public exchange), slid further with the rise of mobile services, and will all but disappear with the deployment of ONA. From end to end, the technology of telephony is becoming inclusionary, not exclusionary. The Execunet battles are now being refought at every level of the network. The divestiture decree neither contemplated nor required competition inside "LATAs," i.e. inside the "local access and transport areas" regions the defined in the course of divestiture; by 1983, however, Judge Greene would characterize the failure of state regulators to open up intraLATA competition as "intolerable." Metropolitan Fiber Systems has pending before the FCC a petition to mandate a new tier of interconnections one level of switches below those developed after Execunet. The rights of independent mobile carriers to interconnect with and—and compete against—landline local carriers have been firmly reaffirmed by the FCC, and have also been grafted as an afterthought on to the decree. Despite setbacks in one court of appeals, the movement to Open Network Architecture is proceeding more or less on course.

Without doubt, the breakup of the Bell System did much to hasten the end of the exclusive franchise. The old Bell was simply too overpowering a competitor for competition truly to flourish under its shadow. But the framers of the decree, despite grand language in the document itself, clearly did not grasp what equal access really implied. They—Judge Greene most emphatically of all—still accepted a top-down vision of telephony, a world with small consumers at one end of the network, and gargantuan carriers at the other. They still embraced the core notion of a monopoly franchise, of a single, anointed local carrier dominating the bottom two thirds of the network with the government's blessing. The trouble with this vision was that it missed all the important activity in the middle—the large customers who might become providers, the resellers who would combine services and equipment in new packages of services, the upstart mobile carriers. The decree was strong on equal access for the few companies like MCI that had complained long and loud about unfair treatment. But the decree ranged from weak to wrong on equal access for everyone else.

Since 1968, the FCC has had a much more unified vision of what equal access might become, but has lacked either the will or the jurisdictional authority to implement it fully. Here too, as a result, equal access has been implemented piece-meal and inconsistently, one cluster of equal access regulations for CPE and enhanced services, another (quite different) for mobile services, another for coin phones, another for long distance carriers. And retrograde state policies continue to block competition in some aspects of the local exchange.

What has yet to emerge, from either the FCC or antitrust jurisprudence, is a single, solid principle: carriers sell carriage, and their obligation to do so does not depend on whether the customer is itself a competing carrier. Sooner or later courts and regulators will get it right. Carriers are customers, customers are carriers, terminals are seminals, equipment is service, service is equipment, the vocabulary is all irrelevant—all that can count is the nature of what is bought or sold. Sooner or later we will reach the point where service is simply service, where common carriage is truly common, where equal access is truly

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equal, and carries with it the implication that all who give or receive equal access are also equally free to compete.

The quarantine is crumbling as well, at least within the United States. But here too one cannot yet report that all has yet crumbled. One-third of the old Bell System—the post-divestiture AT&T—has indeed been freed of line of business restrictions contained in the 1956 antitrust decree, and of separate subsidiary obligations imposed by the FCC. But two-thirds is still subject to significant limitations. There has been some progress. In 1991 the Regional Bell Companies won relief from the decree's information services restriction; they currently have pending other requests for relief relating to interLATA mobile services and interLATA deliveries of information services. Additional relief for RBOC involvement in international markets also seems like a good prospect. The D.C. Circuit court of appeals has hinted that with FCC promulgation of suitable regulations, even the restriction on providing landline interLATA services might be ripe for removal. All of these changes mark real if sometimes glacial progress.

But here again, the decree reflected as much old thinking as new. Instead of following the highly successful model of the breakup of Standard Oil—whereby one giant company is broken into a group of smaller ones, all of whom are then set loose to compete freely with one another—the consent decree that broke up the Bell System adopted the retrograde policy of apartheid. Judge Greene even tried to read into the decree a prohibition against the regional companies competing in one another's territories (though he was quickly overruled by the Court of Appeals).

The FCC likewise still faces the challenge of dismantling walls of its own creation. In 1970, for example, the FCC established regulations preventing cable TV companies from competing with telephone companies and vice versa. By 1989 the FCC was plainly ready to repeal these rules, but in the interim—in 1984—Congress had codified them in the National Cable Act. As the bandwidth of transmission media increases, cable companies providing telephone service and telephone companies providing switched video are natural competitors. Suppressing that competition by regulation simply stifles developments in both areas, and at the same time impedes the free flow of ideas and entertainment.

The reform of pricing regulation has been most difficult of all. Here too there has been some real progress, but here too there is much yet to be done. And schizophrenia between the FCC and antitrust authorities remains endemic.

Start with AT&T itself. The assumption embodied in the decree was that after divestiture AT&T would face competition, AT&T's monopoly share of the long distance business would disappear, and there would be no need for any further quarantine or price regulation. In fact, however, AT&T has retained a large market share, and the FCC has thus been slow to declare competition victorious in the long distance market. With larger customers, AT&T has more or less won the right to custom tailor service packages according to individual needs. And in recognition of the great efficiencies that new technology offers, the FCC has moved away from rate-of-return regulation toward price-cap regulation for all carriers. This shift leaves carriers with far more flexibility to adjust prices as competitive circumstances and technological opportunities may dictate.

Nonetheless, the overall pricing picture remains a schizophrenic mess. Somewhere along the regulatory path it became accepted that local residential service must be priced as an all-you-can-eat buffet: the owner of a PC modem and fax machine that run for hours every business day must pay no more than

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the reclusive widow who needs phone service only for rare, evening emergencies. Thus, long distance callers pay inflated traffic-sensitive rates to cover unrelated, nontraffic-sensitive costs. Local callers pay deflated, flat rates, even for costly, traffic-sensitive usage. Providers of mobile, information, and other services fall all over the map in terms of what they do or don't contribute to local exchange subsidies.

With prices set far out of line with costs—both above and below, depending on which side of the subsidy pipeline people stand—it has often been impossible to determine whether new competition is a result of real competitive opportunity or simply a creation of regulatory ineptitude. It has become almost impossible to distinguish inefficient new entrants—who in fact increase the total costs of providing service—from efficient competitors—which may revitalize an industry. It has likewise become impossible to distinguish unnatural monopolists, whose dominance is propped up not by the efficiencies of their networks, but by the size of their locked-in subsidies. So long as the FCC deregulates new entrants while maintaining regulation of incumbents, so long as exclusive franchises are protected and subsidized, no one can really know whether pro-competitive initiatives have achieved anything useful at all.

The price of carriage must depend on what is being sold, not on who is doing the buying. There are no coherent lines to be drawn between mobile, long distance or information services, between carriers who buy equipment and sell service, or customers who buy service and operate equipment, except insofar as those lines track real differences in services supplied. In the rapidly fragmenting world of telecommunications there is really no other choice. Telcos will have to price services according to the nature of the service, or they will be engulfed in a quagmire of complexity, with tariffs proliferating and network arbitrageurs rushing in to exploit and broker every misallocated subsidy, every misaveraged price, buying subsidized services in excess to cannibalize the services that do the subsidizing.

All of this has important implications for the division of regulatory authority between federal and state jurisdictions. Since 1934, the regulation of telephony has been cleaved along geographic lines, one center of authority in the states, a second at the FCC. Endless reams of paper have been published in the interim, about the "naturalness" (or "unnaturalness") of monopoly in one part of the telephone network or another. The only thing known for sure, however, is that monopoly persisted for as long—and only for as long—as both sets of regulators agreed to it. The eventual breakup of the Bell System was inevitable when federal regulators began moving toward competition in their sphere of influence, while local regulators continued to embrace monopoly. The process was accelerated by subsidies, through which interstate services were priced well above cost, while in-state services were priced well below.

Viewed in this light, it is no coincidence that the announcement of the Bell System divestiture occurred at almost exactly the same time as the FCC recognized that the grossly inefficient pricing legacy of prior years could be maintained no longer. For all the fanfare of the battle between the Department of Justice and the Bell System, the real battle had been fought within the government itself, indeed within a single federal commission, the FCC. It had been a battle between monopoly, with all its attendant subsidies and price-averages, and competition, with its attendant demands for cost-based pricing. At the federal level, the forces favoring competition had finally prevailed; a new policy of open entry was already in place; and prices were at last being readjusted accordingly, in anticipation of the further price deregulation that in fact materi-

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alized a few years later. Prices were readjusted sharply; despite many gloomy predictions beforehand, universal service did not suffer in the least.

Nonetheless, the political forces arrayed against further moves toward efficient pricing are probably stronger today than ever. State regulatory commissioners who aspire to higher office understand that any mention of usage-based pricing at the local level is political poison. Further pricing corrections at the federal level have likewise proved politically impossible. The subscriber-line-charge now in place discriminates sharply between residential and business users. Data carriers and providers of information services pay no traffic-sensitive access charges at all: they continue to be treated as ordinary business "users," not carriers, and pay only local business rates. A 1987 attempt by the FCC to correct this latter imbalance was crushed by a torrent of opposition. The FCC's open network architecture proposal will over the next few years require the local exchange services to be unbundled into more elemental access and service elements. But the States will continue to tariff intrastate ONA services. The FCC anticipates "full federal tariffing of interstate BSEs and state tariffing of intrastate ONA services," but has stopped short of attempting to preempt across the board.

Absent a profound change-in regulatory attitudes, the expectation is for more of the same. More and more things are going to be interconnecting with the local exchange. Information services and data services. Mobile systems. PCNs. Other "local" telcos, such as Teleport. All will move traffic into and out of the local exchange—as well as into and out of the long distance network. And every newcomer (together with many old hands) will demand that common costs be paid by someone else.

The current trends are revealing ever more clearly the fundamental problem with Smith and its embodiment in the separations process of the Communications Act. The point of telecommunications technology is to erase geographic lines; the point of separations is to affirm them. The technology is winning out on this battle. In 1930, it was still intellectually plausible to think of telephony as a marriage of two, geographically discrete halves, one local, the other long distance. It is only barely so today, and will not be tomorrow. The two fastest growing areas of telephony—mobile services and information services—obliterate geographic boundaries to a degree never before imagined.

Start with information services. Today's on-line services are already highly interconnected. The traffic flows that result from such interconnection can be marvelously intricate; providers do not know—and cannot feasibly track—where calls to their systems originate. Indeed, much of the time no one but the machines know how the information is really moving. Service is thus jurisdictionally blind. This is, after all, precisely what telecommunications is intended to do—to transcend distance, to erase the dividing effects of geography. Mobile services double the level of jurisdictional blindness, by allowing the telephone to move too.

What then will happen to the whole rickety array of separations and subsidies, when, as is inevitable, mobile and information services become the dominant services? What will happen to the regulatory empires themselves, structured as they are around strictly geographical state or LATA lines, when telephony finally fulfills its core purpose, of obliterating geography entirely? There are really only two possibilities. One is for Congress to create regulatory authority that is geographically commensurate with what is being regulated—in other words, transfer power from the states to the FCC, and (eventually) from the FCC to international authority. Congress clearly has the power to take this first step; it almost certainly lacks the political will. The other pos-

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sibility is to make regulation itself less intrusive, less important—in other words, to give way to competition and market forces.

Whatever Congress does or does not do, market forces are likely to continue pushing us down this second road. The FCC has won full control of the one segment that really counts—customer premises equipment. It is this segment that has grown fastest of all. The microprocessor revolution on customer premises accounts for much of the growth in demand for telecommunications services, for everything from fax machines, to information services, to mobile phones. Less well recognized is that CPE can also take care of much of the supply—with on-premises processing a substitute for on-line delivery, and powerful data compression methods substituting, at the margin, for more telecommunications capacity. Total demand for transport will continue to grow, but so will end- user elasticity. In response to a 20 percent boost in rates by the phone company, the speed of modems and facsimile machines can be boosted by 200 percent.

The more general implications of this trend are indisputable. As on-premises equipment rises inexorably in power and importance, the relative importance of "common costs" in the public network will decline. Not disappear, nor even decline in absolute terms. But we will move back to a world in which the lion's share of costs are (so to speak) in the private telephone itself, not in the public network. The problem of common costs will therefore decline in relative importance. So too, then, will the importance of whatever natural monopoly may remain, after the increasingly sophisticated equipment on customer premises has accomplished all it can. The world of telephony, like the world of computers, is migrating away from the shared, common-cost, "mainframe," and toward the privately owned, privately controlled, alternative. This represents the true—the ultimate—"privatization" of telephone service.

What then will happen to long cherished ideal of universal price-averaged service?

So far as averaging goes, the irony is that the new competitive world of telecommunications is already outdoing the most ambitious of regulators in its willingness to sell bundled packages at averaged, distance-insensitive, or even traffic-insensitive rates. Mobile carriers vie with each other to advertise the largest "free calling" areas; calls in these areas are metered by the minute, but not by distance. Most major information service providers today sell their services "free on board", "delivered," or "freight included"—they bundle nationwide transport with the service and don't bill it separately at all. Long distance carriers are eagerly (and successfully) peddling their own alternatives to subscriber-line-charge—flat monthly fees that then entitle callers to cut-rate long distance calling. Competitive providers have quickly discovered that any efficiency from billing telecommunication costs by the minute or by the mile is often outweighed by the convenience, efficiency, and customer premise for uniform, nationwide pricing, 800- or 900- number access, nationwide advertising, and the like.

And as for maintaining cheap service, local telephone service remains vastly cheaper than cable television and than all other utilities. If it achieved nothing else, the federal subscriberline charge demonstrated beyond doubt that the vast majority of local users can readily afford local rates and will not be driven off the network by even substantial increases in prices. Technology is going to continue to drive real prices downward across the board. Residual problems for the truly indigent should be handled through well-targeted subsidies, funded by way of very modest interconnection surcharges, paid equally by all who interconnect with the local public network—long distance carriers

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along with providers of mobile and enhanced services, and other customers. The ideal of universal price-averaged service has, for all practical purposes, been attained. It is time to declare victory and get on with more important and difficult regulatory objectives.

* * *

The competitive struggles discussed in this book are not abstract lessons in economics. They have a very real effect on American competitiveness and the quality of American life. Broadly defined, the "information" sector of the economy now accounts for 34 percent of GNP and 41.23 percent of the work force. By all indications, these fractions will continue to grow rapidly. Any analysis of telecommunications must, therefore, clearly recognize that creating, processing, and distributing information will be the dominant activities of the U.S. economy in the 21st century.

Even companies outside the information arena are allocating a steadily increasing fraction of their budgets to telecommunications—by 1993, for example, telecommunications expenditures are likely to constitute approximately 10 percent of the Fortune 1000 companies' budgets. Since most unit costs of telecommunications are dropping rapidly, even a slowly growing telecommunications budget represents a much more rapid growth in telecommunications usage.

To remain competitive in manufacturing, virtually all analysts agree, U.S. firms must be able to accommodate dispersed production facilities, just-in-time delivery of supplies, rigorous inventory control, customized production, stringent quality control, and rapid feedback from the consumer. Dispersion, fragmentation, and flexibility of this order are only possible with a communications system to match. Major manufacturers like General Motors are even defining their own electronic communications protocols (such as the "manufacturing automation protocol," or MAP) to smooth and accelerate information transfers.

Telecommunications is more critical still to financial and commodities markets, in which information processing and transfer represent virtually the entire business. Indeed, all financial markets, and currency itself, use or manipulate commodities whose value depends almost entirely on their informational content. The point need not be belabored—every aspect of banking, credit processing, and stock and commodities exchange is now being transformed by telecommunications. Many of the larger institutional players have become major telecommunications companies as well—it is more than coincidence that the most ambitious competitive metropolitan area fiber network in the country—New York Teleport—was launched by Merrill Lynch, a financial service company. Banks and other financial institution have already developed specialized communications services such as the Society for Worldwide Interband Financial Telecommunications (SWIFT). As the telecommunications infrastructure evolves, and regulatory constraints are relaxed, we may expect the electronic bank, check book, and credit card to reach out all the way to the consumer. The telephone network is already the backbone of the now ubiquitous automatic teller machine. Predictions of a paperless office have proved to be very premature, but a paperless financial world is a much closer prospect.

The transition promises great new efficiency in retailing and other transactional services, as well as greatly enhanced consumer convenience. Telecommunications allows the small retailer to create a national presence by listing a single 800 number. Even such seemingly modest advances as automatic number identification, which supplies the called party with the calling party's

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phone number, can considerably streamline credit verification, as well as retail sales and virtually all other forms of on-line customer service.

Telecommunications is fundamentally transforming the transportation sector as well. For national and international airlines, much of their corporate value, and even a larger part of their competitive edge, depends on seamless operation of a highly dispersed reservation system. Vehicle locators, for everything from interstate trucks to downtown taxis, promise important new efficiencies (and thus lower demand for energy and less pollution) in getting the right vehicles to the right place at just the right time. (Somewhat similar technology is being developed for the related function of tracking down stolen vehicles.) Nationwide paging systems already operate as efficient "people locators," and the rapid rise of cellular telephony promises more of the same. Just as in manufacturing telecommunications is critical to efficient control of the flow of materials and parts, so to in transportation, advanced telecommunications promise great new efficiencies in the movement of vehicles and people.

There is undoubtedly much dispute about what the "right" regulatory policies really are, but no one can seriously doubt that getting the policies right is critical to the future economic health of our nation. Once, unqualifiedly, we had the best phone system in the world. Now, "among the best" is more like it. "Formerly among the best" may yet be our epitaph. Japan in particular is moving aggressively forward with the deployment of new technologies and the modernization of their telecommunications infrastructures. Integrated digital service is available to approximately 70 percent of all Japanese homes today and will be available to 100 percent of all Japanese homes by 1995. By 1990, over 60 percent of the interexchange circuits in Japan will have been digitized, and full digitization is scheduled for 1994. Local exchange digitization stood at 31 percent in 1989, with full digitization now targeted for 1996. NTT plans to complete its fiber-to-the-office program by 1995. Its fiber-to-the-home schedule calls for complete fiberization by the year 2006; however, it appears increasingly clear that this schedule will be accelerated. Other countries are showing similar foresight. We are not.

Instead, are engaging in endless regulatory disputes over who can offer what services, and the resultant delays are costly. In the late 1970s, for example, AT&T introduced an early version of voice messaging built into the telephone network. Shortly thereafter, the FCC in its Computer II decision concluded that such "enhanced" services could only be offered through subsidiaries separate and apart from the telephone operating companies. Bell technicians were sent in with bolt cutters to rip the capacity out of the telephone network. A few years later, the FCC changed its mind and decided to permit such services to be collocated with the network. But, meanwhile, divestiture intervened, and the FCC's information services quarantine had traveled by way of an unenacted Senate bill into the divestiture decree. In 1988, the Department of Justice and the decree court changed their minds and decided that letting the BOCs provide such services did not pose a threat to competition after all. So now the Bell companies are starting to offer this service once again. It took the Justice Department another three years of litigation—still not finally resolved as of this writing—to remove the information services restriction in its entirety.

The case of paging illustrates a similar saga. From the outset it was clear that unless the BOCs could expand the geographic scope of their paging operations they would quickly lose competitive ground to other providers not subject to any geographic restrictions. Even before divestiture, AT&T immediately sought a general waiver to permit the BOCs to provide wide-area paging. The decree court turned down the request on November 1, 1983. Following that decision, the Department recommended and the Court granted a series of geo-

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graphic waivers for one-way paging, but only after extensive proceedings and costly delays. In 1988, the Department supported a blanket waiver permitting all BOCs to provide one-way paging over any geographic range—without any equal access requirement. In February 1989 the decree court finally granted the blanket waiver that had been denied six years earlier.

When the Russians sent Sputnik spinning into space in the 1950s, American policymakers were shocked into action. A vigorous space program, coupled with intensified training in the sciences in our schools, was launched. Within the decade, an American took the first steps for mankind on the moon (with some help from the inventions of Bell Labs). Today, a similar response to the challenge to U.S. hegemony in telecommunications is in order. And that response, rooted firmly in the American tradition elsewhere, will have to revolve around competition and open markets. We must let the technology follow (or even create) the market, rather than restricting technology to fit preconceived ideas of how the market should develop. We will be constantly surprised by the developments in technology, and efforts to regulate those developments (through a planned economy) are bound to fall far short of market solutions.

We stand today in the middle of a progressive shift away from managing a monopolist to managing competition. There is more regulation of the competitive interfaces; less of the competitors themselves. Issues that required little regulatory attention in the days of a single phone company providing everything—interconnection standards, for example—are now increasingly important. Decreasingly important is the single thing that once most dominated regulatory attention—regulation of prices.

For better or worse, however, we are moving toward a new regulatory paradigm, one of competition rather than exclusive franchise, of competition rather than quarantine, of competition rather than price regulation, of plenty rather than scarcity. The regulation that remains will be imposed, if at all, at the interfaces of competition, at any remaining bottlenecks such as they are, where competition alone cannot provide appropriate a discipline.

The regulatory debates will not disappear in the new competitive world that is evolving, but they will shift to a higher plane. Beyond the quarantine, beyond the exclusive franchise, beyond pricing regulation, beyond even the endless quarrels about state and federal regulatory jurisdiction lie the two great issues of the information age: free speech, and its mirror image, privacy—the right to telecommunicate, one might say, and the right not to. Close government regulation of the electronic media has historically been justified on the theory that over-the-air were scarce, and that landline media were monopolies. The differences between the two media were also thought to justify fundamentally different approaches to the twin problems of privacy and free speech. But the media are rapidly converging, and scarcity has been abolished. Television—even "cable" television—is delivered by both air and wire, and can now be addressed with the precision of a telephone dialer. Telephone is moving to the air, and by land or air can provide broadcast-like services as indiscriminately as a nationwide television network. Cellular management for broadcast, and fiber-optics for narrowcast, have put an end to scarcity. In the universe of telecommunications now evolving, people will be permitted to cry fire whenever they wish. The theater will no longer be crowded.

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PREPARED STATEMENT OF HENRY GELLER

I am a Communications Fellow at the Markle Foundation and a Duke University professor. My statement is based on my experience in the telecommunications field, as General Counsel at the FCC and as the head of NTIA at the Commerce Department during the Carter Administration. The views expressed are my own, and they are disinterested, as I am not in the employ of any private party or retained as a consultant to such a party.

We live in an era of global competition. All our industries face such competition. To win or hold their own, they must be as efficient as possible. Telecommunications is a crucial enabling technology to achieve such efficiency. It is therefore important that telecommunications make a maximum contribution to improved productivity.

To do that, telecommunications entrepreneurs must be able to respond in the market very quickly to dynamic technology. It is no longer desirable to keep equipment in place because it is not worn out. The field has become very similar, and is clearly allied to, the data processing field where enormous gains in efficiency occur so rapidly.

The main technological trends are:

(1) from analog to digital transmission, and to great capacity through use of digital radio (with new access techniques like time division multiple access (TDMA) or code division (CDMA), digital compression, and fiber optic cable.

(2) to portability or mobility using digital radio (cellular; personal communications services (PCS) — light weight (7 oz.), low cost ($100-150) phones that would be carried by the person).

(3) to greater intelligence in the network (e.g., Signalling System 7 (SS7) making possible new enhanced services like Caller ID, call forwarding, etc.).

(4) to more user friendly systems, tailored to the large customer with greater user control of the network (and by the end of the decade, voice commands to the telecomputer).

This last point merits emphasis: The customer will call the tune, making use of the bandwidth and "bells and whistles" that it wants. Further, a major portion of the competitive struggle in the telecommunications field itself will be for the large multinational customer, by affording it a network or virtual network that meets its every demand globally.

Industrial countries therefore have all recognized the need to modernize their telecommunications infrastructure. Some have followed privatization schemes, with incentive regulation (price caps—e.g., the United Kingdom), and have introduced significant competition (UK; Japan). Others have retained the PTT (monopoly but the "P", for postal, has been cut loose), but have allocated great resources to modernization and have allowed competition so far only in value added (data) services (France).

The recent NTIA Infrastructure Report, October, 1991, concluded as to international comparisons (at xvii-xviii):

Our comparisons show that U.S. telecommunications firms:

- feature one of the most developed public telecommunications systems with respect to per-capita telephone penetration and network usage;
- spend the highest percentage of their average annual investment on network modernization;
- currently lead in the conversion to electronic switch technology;

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- rank in the middle ranges in such areas as average investment per line, deployment of such technologies as digital switches and SS7, and service quality; and
- trail, and according to some estimates, are projected to trail other large countries in the implementation of ISDN (integrated service digital network), digital switching, and SS7.
- The significance of these findings is not clear-cut. With such technologies as digital switching, fiber optic transmission, and SS7, the critical question is whether deployment is occurring at an efficient rate in the United States, not whether this country is "keeping up" with our trading partners. The continued prevalence of monopoly control and centralized government planning for telecommunications in many of these countries creates the real possibility that inefficient levels of investment (whether over-or-under investment) may be taking place. Nevertheless, the ambitious schedules of other countries should cause U.S. firms to evaluate their own plans, and U.S. policy makers and regulators to reexamine policies that may be hindering the achievement of efficient levels of investment in infrastructure development in this country.

Attached are tables setting out the deployment of advanced technology features and services in several important areas.

The above has dealt with the global scene. In the U.S., the states are also in competition with one another to attract new industrial development or to hold on to what they now have. Jobs, an adequate tax base for education, highways, etc., and a whole complex of considerations are obviously involved. That competition is healthy and benefits the whole nation, since it is based on providing a solid infrastructure and a good educational and environmental, etc., milieu. And while telecommunications is not the be-all and end-all, it is a most important part of the modern infrastructure sought by all industries in making this location decision. Thus, New Jersey's recent decision to accelerate deployment of a statewide fiber optic network puts pressure upon New York State.

The policies that I believe should be followed to obtain the desired efficiencies are the following:

First and foremost, to rely upon competition and open entry. Competition is, after all, the norm in the U.S.; it spurs efficiencies and drives prices to marginal costs. In telecommunications, the technology has permitted and fostered the emergence of new entrants. Competition is now rife in interexchange, customer premises equipment (CPE), and the information services, and has brought great benefits. It is coming gradually to the local exchange field, first to the large business user. But it will come to the small business and the residence also, probably through digital radio developments (PCS). Significantly, the competitors are coming with the latest technology, such as self-healing fiber optic rings or digital radio with new access techniques. In this connection, cable television appears now to be poised to afford vigorous competition to the LECs; such competition will markedly serve the consumer and the public interest and should be encouraged.

The competitors need interconnection with the local exchange carrier (LEC) and in this area, states like New York have been the leader. It has "unbundled" the network by allowing Teleport to co-locate its interconnection at New York Telephone's central office for special access service (private line toll service). Other states and the FCC are now following New York's lead, and, while difficult problems remain to be worked out, such co-location will be extended to switched access in a few years.

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As a further aspect of open entry, it is wrong, in my view, to suppress the competition that the divested Bell Operating Companies (BOCs) can supply in the information services, manufacturing telecommunications equipment, and even some aspects of interexchange service. The Modified Final Judgment (MFJ) is a hindrance here to achieving efficiencies and innovation. Great progress has been made in removing the block as to information services, although as H.R. 5096 (the Brooks Bill) shows, this is still an area of considerable controversy. This form of market segmentation is really just cartel management by the government at the behest of some of the competitors. As Senator Magnuson once aptly stated, "All each industry seeks is a fair advantage over its rivals." Thus, the newspaper industry wants to protect its classified advertising base by blocking BOC entry into electronic yellow pages.

There may be progress next Congress as to manufacturing, and again this would greatly serve the national interest. It makes no sense to tell over one half of the U.S. telecommunications industry that they cannot participate in manufacturing equipment and thus have little incentive to engage in R&D. No developments are on the horizon as to interexchange, even as to allowing greater efficiencies in providing information services within the respective regions.

Clearly, if the BOCs are permitted to enter these fields, there must be protective action to insure full and fair interconnection (called comparably efficient interconnection (CEI) or Open Network Architecture (ONA)) and against improper cross-subsidization (e.g., accounting and, preferably, the use of a separate subsidiary in the case of electronic publishing). There are several other protective measures that have been soundly taken by the FCC.

All LECs except those operating in sparsely populated areas are banned from providing cable television services under-the provisions of the 1984 Cable Act. But as recent hearings have established, cable is a monopoly service that is much in need of a strong competitor such as the local telcos. Not only should there be accelerated deployment of telco's broadband capability, a matter I discuss within, but also the telcos should be allowed into content to the extent of permitting "pump priming" (e.g., an interest in up to five channels of programming in large capacity systems).

Another principle is that when services are subject to effective competition, they should be deregulated. Regulated competition makes no sense in such circumstances and holds back obtaining the efficiencies and innovation so desirable in this competitive era.

Another important area is the consideration of accelerated deployment of the new technologies. As stated, the regulatory commissions cannot simply employ the old depreciation method of maintaining long use of facilities because they are not worn out. Even "if it ain't broke," there may well be a need "to fix it" to turn from analog switches that still have useful life to digital switches, from copper that does not need "rehab" to fiber, because of the efficiencies and new services thus made possible. If commissions do not take into account this "economic depreciation" factor, they may have protected grandmother's low rate today, but at the expense of her grandson's job tomorrow. The telecommunications area is now integrally related to the data processing (computer) field. Just imagine the state of the U.S. industry and its productivity if it held on to computer equipment until it was fully worn out instead of moving to new technology in order to gain great efficiencies.

This is not to say that there should be drastic or flash-cut action. On the contrary, it is important to make good use of time. While it is sound to turn to, say, digital switches, no one would argue that all analog switches should or can be replaced at once. What is needed is an orderly process, starting with the

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dense urban business areas and moving out gradually throughout the telco's territory. The job is then done over a period of years so that its effect on rates charged the consumer is also spaced over the time period. But each year that is "wasted"—in the sense that a significant part of the job was not undertaken—is therefore a distinct cost hindrance to the modernization effort needed.

The transition must be gradual—evolutionary rather than revolutionary—for another reason, namely, the rapid changes in technology. It is not possible to lay out plans that will be operative for 10 or 20 years in the face of that dynamic technology. Today the focus is soundly on digital switches, ISDN, SS7, the Advanced Intelligence Network, and the replacement of copper by fiber. But in the latter example, fiber in the loop, while one can see the great merit today in proceeding to introduce fiber in the feeder plant (within one mile of the subscriber) and, very shortly, to the curb, it is not now possible to definitively set out the topology (e.g., passive or active, single or double star, etc.) or even the eventual way into the home (copper for VCR quality video in the beginning, coaxial or fiber optic cable or digital radio in the future). The LEC must make difficult planning decisions for the next five years or so, always subject to revision, and so also must the reviewing regulatory commissions, affording considerable latitude in the circumstances.

I have recently issued a report prepared for the Annenberg Washington Program, "Fiber Optics: An Opportunity for a New Policy?", October, 1991. The report notes that the copper subscriber loop is replaced at a rate of roughly three percent a year, and thus at the present schedule, replacement would entail a period of over 30 years. The critical policy question is whether to accelerate the replacement of copper with fiber, in order to complete the task almost a generation earlier, say by the year 2015.

In view of First Amendment benefits—video publishing over a common carrier and strong competition to the existing cable monopoly—the report contends that such accelerated deployment is warranted. It is also desirable because of the impending demand for local common carrier broadband networks. New and extremely powerful multimedia computers, combining data, voice, imaging, and video, are coming on stream. If their potential contributions to economic efficiency and the quality of life are to be fully realized, common carrier broadband networks will be needed for every research institution, business, and home. The federal government is actively supporting linking all research institutions. Business has developed its own fiber and similar networks, but needs common carrier networks to reach all its suppliers and customers. In addition, networks will be needed in the home, both for home work stations and for access to new educational and health-related services.

As a further principle, I fully concur with the recommendation of the NTIA report (at ii) of "...the importance, when full competition is not feasible, of regulatory approaches that replicate, to the extent possible, the incentives for efficient operation and investment that characterize competitive markets." The report suggests that rather than rate base/rate of return regulation, the federal and state agencies turn to price regulation whereby the charges for non-competitive basic services such as to residences or small businesses are set for a period of time (four to five years), with appropriate adjustments specified for inflation minus projected productivity (and with appropriate quality controls). This is not deregulation. It simply institutionalizes regulatory lag, in order to provide the greatest possible incentive to the telco to be efficient. If it is more efficient, this is then a win-win situation for both the ratepayer and the shareholder—and more important, the nation. Further, such price regulation can be joined to an upfront commitment, over the period, to specific modernization plans, including for rural areas. Several states have proceeded in this fashion. I

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suppose the process could be called, "Let's make a deal," but is seems to me to be a most pragmatic way to proceed.

As a further principle, I would cite the need-to deal with the present subsidy scheme. Today charges are not cost based; in light of the wholly monopoly situation that existed and the desirability of following certain sound social policy goals, there have been subsidies in the pricing process—toll and business charges subsidizing residential, urban subsidizing rural. With the introduction of competition, there are obvious strains in maintaining these subsidy schemes. The competitors are attracted to the areas where prices are artificially high and avoid those where they are low because of the subsidy. In a competitive milieu, it is not sensible to give such false economic signals. Further, the subsidies constitute a drag on obtaining the desired efficiencies in this time of global competition.

The clear answer is that set out in the NTIA Report (at ii) that "... to the extent that subsidies are found desirable for universal service purposes, they be made explicit and targeted to those who are in most need of assistance in obtaining telephone service." Again, the process of moving prices to costs cannot be a flash-cut one. Rather, it must be carried out over time. And again, it is important to start now when the competition is small. A year lost in this evolutionary process can be a significant setback.

We must also deal more effectively with the radio spectrum, a precious resource that is the-foundation for so many new services such as PCS. Spectrum authorization is today largely carried out by either comparative hearings or lotteries—both time consuming and stultifying processes that should be replaced by competitive bidding (auctions). The fault here is clearly at Congress's door. As a further matter, Congress is burning billions of dollars of revenues in a time of fiscal need. It is a national scandal.

We should also use market forces more effectively in the allocation of spectrum. This can be accomplished by giving many of the present spectrum occupants flexibility to engage in any telecommunications endeavor that is non-interfering, and where spectrum is cleared, as in the proposed transfer of Government spectrum to the private side, auctioning large chunks with complete flexibility. The blunt fact is that our present system strongly resembles the discredited Soviet approach of the Government determining what enterprise can go forward and subject to what conditions—and in a dynamic field like this, that is simply too difficult for any governmental body.

In sum, technology and the market are moving forward rapidly in the telecommunications area. The third factor, policy, is lagging. The 1934 Act, really patterned on a 1910 ICC Act, is outmoded. Despite two decades of intense consideration, Congress has been unable to revise the Act to give the necessary new guidance, along the above general lines. There is no consensus in this area, and Congress simply does not want to make decisions that will adversely affect some of the powerful contending private interests. The number of such interests is large and growing larger because of the convergence of several formerly separate industries. Today, it is clear that the telephone, cable television, broadcasting, newspaper, data processing, etc., businesses are colliding. The result is Hill paralysis and the present pendency of some truly astonishing petitions to the FCC that make no sense at all in the present circumstances but nevertheless must be given serious consideration in light of the Act's existing language and directives—for instance, the AT&T petition to require its competitors also to file and adhere to all tariffs.

Further, Congress has not made clear what the powers of its delegatee, the FCC, are in this field vis-a-vis the States. No one would argue that the States

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should not have an important role; they are closer to the regulated industry (the grass roots factor) and can and have been laboratories for new regulatory experiments. But when their actions have national effects, there should be a Federal captain—Congress or, in the absence of Congressional action, the FCC. In light of an apparent anachronism in the 1934 law, it is not clear that the FCC can fully and effectively play this necessary role. A 1986 Supreme Court decision (Louisiana Public Service Commission v. FCC, 476 U.S. 355) would indicate that the Commission can preempt the States only where state action renders nugatory the Federal policy—not where it simply interferes with the full effectuation of that policy. Recent lower court actions do use the term, "thwart or impede", but until the Supreme Court rules again, it is not clear that the FCC can preempt on the basis of impeding rather than thwarting the Federal policy. Again, this area should be dealt with, but Congress "ducks" because of state opposition.

The arguments that I have been making should not be rejected on the ground that they constitute "industrial policy." The plain fact is that there is no way the Government can avoid making policy decisions in the telecommunications field unless and until the local monopolies, both telco and cable, are broken. A monopoly such as the LEC cannot accelerate deployment of some new technology such as digital switches or fiber without a regulatory umbrella permitting such action. Stated differently, New Jersey can say "yes" or "no" to Bell Atlantic's proposal for expediting the installation of a state-wide fiber network, but either way, the state government is making policy.

The AT&T divestiture has served the nation well. It has promoted competition in long distance and in network equipment. And creating seven other large telecommunications companies, with their own distinctive strategic planning, will benefit the U.S. The problem has been that we are much too taken with market segmentation—with protecting competitors through what is, in practical effect, a cartel since it suppresses competition. Michael Porter, in his seminal work, "The Competitive Strength of Nations," has stated that strong and open domestic competition is the most vitally needed element if our industries are to succeed in this era of global competition. We need to put our domestic telecommunications house in order.

Thank you for this opportunity to present my views. In light of the complexity of the area, I have necessarily had to oversimplify. I would be glad to try to expand on any area in response to your questions.

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Advance Technology Features
SS7 Deployment

This is the most widely deployed standard for out-of-band signaling. It is now seen as the foundation for future advanced intelligent network services.

- Deployment of SS7 by RBOC's:

RBOC (% of all access lines)	1992	1994 (est)
Ameritech	45%	70%
Bell Atlantic	92%	99%
Bell South	76%	94%
Nynex	55%	85%
Pacific Telesis	50%	94%
Southwestern Bell	30%	67%
U.S. West	21%	70%

(Telephone, July 27, 1991 & FCC Inquiry)

Fiber Deployment

Fiber has been widely deployed by local exchange carriers, by competitive access providers, by cable companies and others.

- Fiber Deployment by RBOCs:

Company	Sheath Miles		Fiber Miles		Lit Fiber
	(1985)	(1990)	(1985)	(1990)	(1990)
Ameritech	3,200	12,100	77,700	285,500	57.8%
Bell Atlantic	1,240	16,038	83,085	501,428	na
BellSouth	3,830	24,181	50,807	591,938	50.9%
Nynex	1,606	12,008	83,384	482,326	na
Pacific Telesis	2,318	4,790	84,310	168,782	43.9%
Southwestern Bell	1,913	11,700	70,490	352,300	45.9%
US West	3,527	16,082	47,341	300,442	34.8%

(Note: Sheath miles = the total number of miles of fiber cable used in the network, i.e., two cables laid for 100 miles equals 200 sheath miles.

Fiber miles - the sum of the number of miles of each owned cable weighted by the number of fiber strands, i.e., two cables laid for 100 miles with 10 fibers each equals 2000 fiber miles.

Lit fiber = the proportion of fiber miles activated with optoelectronic equipment at both terminal and repeater sites so as to provide at least one voice grade circuit.

All Fiber Data Drawn from *FOC Fiber Deployment Report*, March 1991.)

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- Fiber Deployment by Competitive Access Providers (selected):

Company	Sheath Miles	Fiber Miles	Lit Fiber
City Signal	67	5,628	27%
DFW/MetroLink, Inc.	25	151	na
Diginet	24	1,147	32%
Eastern Telelogic	149	3,666	31%
I.C.C.	148	6,121	45%
Indiana Digital Access, Ins.	59	469	42%
Inter-Media Communications	32	972	50%
IOR Telecom	65	1,600	50%
Kansas City Fiber Net	88	1,204	na
Metrex Corporation	10	342	1%
Metropolitan Fiber System, Inc.	84	12,154	77%
New England Digital Distribution	10	1,440	na
Penn Access Corporation	32	1,865	na
Public Service of Oklahoma	127	2,631	73%
Teleport Communications Group	308	15,519	85%

ISDN Deployment

Integrated Switched Digital Network is an overall application of digital technology to integrate voice, data and video traffic. The basic appeal of ISDN is that it can provide six to seven times the throughput of an analog line for about twice the price and all user services from premises can be integrated on a single ISDN link. Deployment of ISDN in some European and Asian countries will exceed U.S. deployment for the foreseeable future.

- Comparative ISDN Deployment:

Country	1989	1990	1992	1994	1995
Singapore	100.0%	100.0%	100.0%	100.0%	100.0%
France	na	100.0%	100.0%	100.0%	100.0%
Germany	na	na	100.0%	100.0%	100.0%
Japan	69.0%	76.0%	92.0%	100.0%	100.0%
United States	.1	.5	na	49.8%	na

* coverage refers to percent of equipped access lines
* Germany refers to former West German through 1994; refers to unified country in 1995
* US data refers to RBOCs only. 24.2% of central offices are planned for 1994

(Drawn from the *NTIA Infrastructure Report: Telecommunications in the Age of Information* (forthcoming).)

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Deployment of Digital Switches

Digitized switches are widely used as a measure of network modernization, but opinion differs as to which features give the best measure of modernization.

- Measurement by percent of lines served indicates that the U.S. trails other countries in digitized switching capacity.
- Comparative Deployment of Digital Switches (as measured by percent of lines served)

Country	% Digital Lines	1989 Rank	% Digital Lines	1994 (est) Rank
France	70.7	1	86.5	3
Canada	51.4	2	87.5	2
United States	42.5	3	68.2	5
United Kingdom	38.0	4	92.0	1
Japan	31.0	5	76.0	4
Italy	16.1	6	na	na
Germany	2.6	7	38.0	6

* US includes 7 RBOCs and 40 independents. Drawn from the *NITA Infrastructure Report: Telecommunications in the Age of Information* (forthcoming).)

- Measure by percent of computer controlled lines is a different measure. Some argue that computer controlled switches are more significant than fully digitized switches. By this measure, the U.S. leads the same set of countries as shown above.
- Deployment of Computer Controlled Switches (as measured by percent of electronic lines)

Country	% Electronic Lines	1989 Rank
United States	96.6	1
France	75.9	2
Canada	57.9	3
Japan	44.8	4
United Kingdom	23.5	5
Italy	17.6	6
Germany	1.5	7

* Percentage for Italy based on COs.

(Drawn from the *NITA Infrastructure Report: Telecommunications in the Age of Information* (forthcoming).)

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PREPARED STATEMENT OF JONATHAN LINKOUS

Good morning. My name is Jonathan Linkous, and I am Executive Director of the National Association of Area Agencies on Aging (NAAAA), or N4A. We are a nonprofit private association of 670 local Area Agencies on Aging. Our mission is to assist older Americans to stay in their own homes and communities with maximum independence and self dignity for as long as possible.

We are a product of the 1965 Older Americans Act, which created structures at the federal, state and local level to establish programs that help our nation's elderly maintain their health and independence in their homes and communities. Today, the National Network on Aging includes 57 state units on aging, 670 Area Agencies on Aging, and approximately 27,000 local service provider organizations under contract to Area Agencies. They are largely responsible for the multitude of home delivered meals, senior center programs, transportation and many other community services available across the country.

Area Agencies on Aging may be part of a city or county government, a regional planning organization, or a private nonprofit agency. Each Area Agency is responsible for a specific geographic area—either a city, a single county or a multi-county district. Every Area Agency on Aging is required to have an advisory council, comprised primarily of older persons, to review and comment on all programs affecting the elderly at the community level. Nationally, more than 15,000 advisory council members work in partnership with Area Agencies on Aging.

Before joining N4A, I had communications experience in broadcast and cable television, and worked with a community outreach group. I am happy to have been invited to come before you on the subject of telecommunications infrastructure because I strongly believe the potential benefits of a state-of-the-art telecommunications infrastructure are going to be especially important to older Americans. Developments in telecommunications services may well be the key to increasing independent living as people age, and will help keep older Americans at home for as long as possible, minimizing the cost to society, and increasing the dignity of the individual. These services can also help care givers in their support to keep an older person at home.

I realize this hearing is on regulation and laws pertaining to telecommunications infrastructure, but first I want to focus on the benefits of an improved infrastructure for older Americans because I feel this issue is so poorly understood. I will address some policy issues at the end of my remarks.

N4A has already put telecommunications technology to work to help mobilize resources on behalf of older Americans who are at risk of losing their self-sufficiency. Since many relatives and close friends of older Americans do not live nearby, we saw the difficulty they faced in finding out about community services at the location of their relative. Our Eldercare Locator is a nationwide service provided through an 800 telephone number to help connect relatives and friends to information for such services as home delivered meals, transportation, legal assistance, housing options, adult day care, home health services, recreation and social activities, and senior center programs.

But this is just a start. There are many more things that could be done to improve resources for older Americans. Because N4A realizes how vital the issue of telecommunications is to older Americans, we commissioned a report entitled, "Realizing the Benefits of New Computer and Telecommunication Technologies for Older Americans." This report was endorsed by the National Council on Aging, and SeniorNet, and is the basis for many of my comments

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today. The National Council on Aging helps professionals and volunteers in aging's many disciplines better service older Americans. SeniorNet is an international community of older adults brought together to acquire computer skills and utilize communications technology.

The report shows that universally available, affordable fiber-based technology over the public telephone network can be of particular benefit to older persons. I think the public telephone network should be thought of as an infrastructure that can support applications and services beyond "plain old telephone service."

A public system will be the key to providing these services to older Americans, because the telephone is already in most homes. Therefore, enhancing the existing universal telephone network seems to be the best chance for older persons to acquire access to advanced telecommunications services. Through the existing telecommunications system, new services can be quickly developed and made available to all telephone subscribes at relatively low cost.

With an advanced infrastructure, attention can be focused on providing simple, easy-to-use communication devices for the home. Technology or software can and should be designed so that a new user can begin using it to do at least rudimentary transactions or interactions with only a few hours of training and practice. Services also need to be accessible to users with disabilities. For example, prescriptive hearing service adjusts incoming voice transmission to accommodate specific hearing impairments. Encouraging technology designs that facilitate communication by users with disabilities will benefit everyone.

At the same time, I strongly believe that advanced services should be available within a framework that guarantees affordable basic voice services. The cost for development and deployment of these new services should be paid by the end users and not subsidized by customers using basic services.

Until fiber optic technology is widely available, the existing telecommunications infrastructure is capable of supporting a wide variety of information services that travel over existing telephone lines. Older Americans have the potential to benefit much more extensively from existing computer and telecommunications technologies than they currently do, without the expenditure of significant public or private money. Some services that could now be more widely available include home health monitoring systems, information and transaction services, and basic "smart home" services like utility monitoring and alarm systems.

Innovations that might help bring these services more rapidly to the market are primarily related to data and voice service, voice-to-text conversions, and similar switching and software based technologies.

We do not discourage the continued development of private networks for those organizations that need or desire a limited-access network. We only encourage policy makers to make sure that the many individuals and organizations that do not have the financial or technical resources to set up networks of their own have access to such an infrastructure.

As we all know, the number of older Americans is growing. There were 52.5 million Americans over age 55 in 1989, making up 21 percent of the population, with those 65 and over accounting for 12 percent of the population. The percentage of people over age 65 will grow from 13 percent in the year 2000 to 21.8 percent in 2030, and 24.5 percent in 2080.

Just why are infrastructure improvements so important to this group of people? As the American population ages, the need to develop technology to assure their independence and avoid social isolation will be critical. An advanced telecommunications infrastructure can help them attain that goal by

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making it easier to manage finances through home banking services. Home health care monitoring can help older Americans orchestrate health care and reduce difficult office doctor and clinic visits. Most importantly, advanced technologies can help older Americans communicate with friends and relatives, and prevent social isolation that now plagues many older Americans with functional limitations.

These advanced services can empower older Americans to maintain control of their lives, and significantly reduce the cost of support services if they are needed. All care givers, whether they are relatives or health professionals, can use advanced telecommunications services to help provide the necessary support for older Americans in their homes. Use of this technology will be instrumental in keeping older Americans at home longer, cutting down on the escalating costs of nursing home care.

Many older Americans are interested in supplementing their retirement income, and pursuing new career opportunities. Advanced technologies can help them overcome distance barriers and age discrimination by allowing them to work at home, and maintain control over their working environment.

Unfortunately, there are several stereotypes and assumptions about older Americans that lead some people to believe that new computer and telecommunications technologies are irrelevant to them. I am glad to see that these stereotypes are beginning to break down. Applications of these technologies in education, community service, health care, and business are advancing rapidly, and older Americans stand to benefit from these advances. However, these myths still persist among industry and policy makers looking at older Americans as beneficiaries of investment in infrastructure.

Perhaps the most striking misconception about older Americans is that they are a homogeneous group. While some older Americans experience health problems that are confining, and may require nursing home care, most do not. It is important for policy makers to recognize the wide variety of situations experienced by older Americans when thinking about the potential contributions of new computer and telecommunications technologies.

The 52 million Americans over age 55 also represent some of the richest and poorest segments of our populations, making it difficult to characterize the economic circumstances of older Americans as a whole. However, as a group they have a lower economic status than other adults in our society. Advances in telecommunications technology, along with wide-spread deployment, can make new technologies more affordable. This will assist low income elderly in gaining much-needed services such as personal emergency response devices and other services. A wide variety of other applications of new computer and telecommunications technologies can address the range of income levels, living arrangements, and lifestyles.

Another stereotype that needs to be eliminated is that older Americans are afraid of technology. Whether an older person uses a personal computer is not a good indicator of his or her attitudes toward technology in general. It is likely that as older Americans see potential benefits in using newer computer and telecommunications technologies, they will continue their life-long pattern of adopting useful innovations. It is up to developers and policy makers to insure the production of products that fulfill the real needs of segments of the older population, and make everyone aware of their potential benefits.

Innovative policies already have been developed to bring fiber optic technologies to the public without imposing undue costs on ratepayers, and should be encouraged. Earlier this year, New Jersey passed legislation that allows for implementation of a fiber optic network that includes rate protection. The new

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law allows the New Jersey Board of Regulatory Commissioners (BRC) to provide incentives to telecommunications companies to insure aggressive investment in deployment of the latest technology. The bill prohibits price increases for services targeted to low or limited income customers during each phase of deployment. It also prohibits rate increases for basic services for half the term of each deployment phase. Other states are considering such measures.

New Jersey's legislation is a thoughtful step toward bringing the Information Age to the public. It does not abandon traditional regulatory safeguards, but it does seek to give regulatory commissioners the flexibility to permit free enterprise where appropriate. This legislation will encourage the development of services such as remote diagnostics, which can bring the highest quality of medical care to all New Jersey residents in their homes. Distance learning is another technology that could become the norm throughout the state.

Policy makers and planners should promote dialogue among the many potential users of these applications, including senior citizen advocates, educators, health care institutions, and government agencies. They should support research to develop new applications to improve interface designs and to explore new ways of organizing and delivering services to maximize their benefits. With planning and cooperation, new computer and telecommunications technologies can be a potent tool to help older Americans maintain both their independence and their contact with their friends, relatives, and communities. It is in the interest of our society as a whole to make this a national priority. Finally, in my personal opinion, suppressing the ability of the Bell Operating Companies to compete and bring into the market their capital and expertise for improving our telecommunications infrastructure and providing information services would be wrong. It would delay the deployment and perhaps raise prices of services that would benefit older Americans. Thank you for allowing me to share my thoughts on this important issue with you today.

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DEVELOPING THE NATION'S TELECOMMUNICATION INFRASTRUCTURE: THE INFORMATION NETWORK OF THE FUTURE



FRIDAY, JUNE 12, 1992

CONGRESS OF THE UNITED STATES,
SUBCOMMITTEE ON TECHNOLOGY AND NATIONAL SECURITY,
JOINT ECONOMIC COMMITTEE,
Washington, DC.

The Committee met, pursuant to notice, at 9:30 a.m., in room SD–628, Dirksen Senate Office Building, the Honorable Jeff Bingaman (Chairman of the Subcommittee) presiding.

Present: Senators Bingaman and Kerrey.

Also present: Charles Stone, professional staff member.

OPENING STATEMENT SENATOR BINGAMAN, CHAIRMAN

SENATOR BINGAMAN. The powers arrive, so we'll go ahead and start. I know Senator Kerrey is on his way and will be here very shortly.

This is the second in a series of hearings in the Joint Economic Committee to explore issues associated with the development of the nation's telecommunications and information infrastructure.

I'm concerned that since the break up of the Bell System, the United States lacks a strategic plan for developing this infrastructure.

I'm impressed with the technological capabilities of the existing telephone network, and even more so with the possibilities offered by the switched broadband fiber optic network of the future. But I'm also concerned that without a strategic development plan, we may fail to realize the full possibilities of the network.

The first hearing that we had three weeks ago focused on legal and regulatory issues associated with getting from where we are to where we want to be.

Today's hearing will focus on where we want to be, the promise that the technology provides, and what we want the network in the future to accomplish.

We have a distinguished panel of witnesses, very qualified on this set of issues.

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Michael Dertouzos, Professor and Director of the MIT Laboratory for Computer Science, also Chairman of MIT's Commission on Industrial Productivity, which produced the study *Made In America.*

Mitch Kapor, developer of the Lotus 1-2-3 spreadsheet program and former CEO of Lotus Development Corporation. He's appearing today as the founder and president of the Electronic Frontier Foundation, a public interest organization organized to educate the public about new computer and communications technologies. He's accompanied by Jerry Berman, the Washington Director of the Electronic Frontier Foundation.

Also we have Robert W. Lucky, Executive Director for Communications Sciences Research Division at AT&T Bell Laboratories. I appreciate him being here.

And also Steven R. Dimitt, Director of Corporate Planning for Southwestern Bell Corporation.

Why don't we go ahead and proceed in that order. I'd like to ask each of you to take 15 minutes or so, however much time you need, to make your main points.

We will include all of the statements that have been prepared in the record, so you don't need to go through it in great detail. But we do want to hear your point of view, with particular emphasis on what the Federal Government and the Congress should try to do to assist in this area.

Professor Dertouzos, it's very nice to see you again. Thanks for coming.

MR. DERTOUZOS. Likewise, Senator.

STATEMENT OF MICHAEL L. DERTOUZOS, PROFESSOR AND DIRECTOR, THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY (MIT) LABORATORY FOR COMPUTER SCIENCE, AND CHAIRMAN, MIT COMMISSION ON INDUSTRIAL PRODUCTIVITY

MR. DERTOUZOS. Thank you very much for this opportunity, Senator Bingaman, and members of the Committee.

Since I have submitted a fairly lengthy testimony, I'll try to speak without reference to any written material.

I've also brought a little tape to show you. Since it's Friday, I thought we might have some fun.

SENATOR BINGAMAN. Good.

MR. DERTOUZOS. I can't resist the temptation, as a professor, to try and lay a little bit of the groundwork as to what an information infrastructure is and is not.

So let me start by telling you that I'm testifying here from these two streams of experience that you mentioned in your introduction of me.

The Lab of Computer Science where we've been working for the last 12 years with the technology behind these infrastructures, and the MIT

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Commission on Industrial Productivity, which was very much concerned with the economic health and welfare of America.

And the two come together, in fact, in our book that you mentioned, *Made In America*, the report of the MIT Commission, where we urged that this Nation construct such an information infrastructure.

I've submitted for the record three related articles from the *Scientific American*, the *Technology Review*, and an older one that defines what I like to call the *Information Marketplace.*

Now, an information infrastructure, to me, is a complex of wires, fibers, satellite and cellular links. That's the telecommunications part that ensures that the tens of millions of computers in this Nation can be effectively interconnected with each other.

The telephone network is a precursor of this kind of an information infrastructure, but it's not quite there. And the reason is that it was designed to cater to the human voice. And that is a very limited activity compared to what computers do.

In particular, computers need variable speed, variable reliability, and variable security.

If you're sending photographs around to assess by human analysts the wheat production in the Midwest, you can afford 1 or 2 percent error. If you're sending software or money or critical medical data, nothing less than a 100 percent reliability will be tolerated.

The same goes with contracts. They should go over the network securely; legal contracts, private communications, but advertisements could go freely.

And, of course, the speed. Some information has to go at millions of bytes per second, millions of characters per second. Other information could flow at a few thousand characters per second.

So the current network of the telephone system just cannot reach the levels that I think most of us here envision, although it can begin to do so.

And there is a path of going from here to there, and I'll address how this could happen.

Now, in the telephone scheme of things, there is an approach called BISDN, which stands for Broadband Integrated Services Digital Network. And that approach, which is not yet here, but coming and agreed upon by many of the telephone companies around the world, would satisfy the requirements of an information infrastructure, as I see it.

So my first exhortation to the Committee is that to the extent that there are legal obstacles toward moving in that direction, they should be removed, and Congress should ensure that the underlying network toward this broadband direction is legally enabled and accelerated.

I should say on this that the current network, offered by the telephone company and called, surprisingly, by the same name, ISDN or NISDN—Narrowband ISDN—is not yet capable of achieving these

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things. Even though it has the same name, it's a radically different approach that still caters to the human voice.

One more word, a word of caution. Telephone companies and cable companies, the aspiring carriers who see a great deal of revenue in this business internationally, not just in the United States, are very anxious to offer a great wealth of new services to the public. So they are a little bit at a conflict in viewing themselves, on one hand, as carriers of the information, but on the other, as providers or offerers of services.

And I'd like to flag this because, in my opinion, it is a terribly important point. I do not think we should allow this duality any more than we would allow the electric power grid offerers to also sell appliances, or anymore than we would allow the Highway Act, that created our highways, to then go ahead and offer buses and other kinds of cars to carry people around. In other words, we should decouple the carrier activity from the service offering activity.

And I'll explain a little more what I mean by this.

In the United States especially, where the free market is so important, we should try to ensure that the people who transact on this infrastructure are the people of the United States, the companies, the individuals, and that they're buying and selling from each other information, information services, and informational labor.

So the carriers are really providing the infrastructure, and it's the tens of millions of computers with their users that are buying and selling information, much like we do with goods over a market.

And it's not just buying and selling for money, as I'm sure Mr. Kapor will testify. This is very much like an old market where you gossip, you publish, you exchange freely information, you democratize the media. So there's a lot more here than just sale and purchase of information.

The point I'm making here is that at the governmental level, we should resist this tendency of the phone companies. Some European and Asian countries have ventured in that direction. I think that for the United States, this would be a great mistake, for roughly the same reasons that the Eastern European economies failed to succeed, because of too much central planning.

I'm sure if the cable companies and the phone companies wish to offer services on the same basis as everybody else that, at some point, this ought to be considered. But if it's allowed, I think we should be very, very careful to assure that their aspirations as offerers of services and their obligations as carriers of information are not in conflict.

Now, I understand that these two things are not clearly separable, but in the sense that I'm mentioning them here, they can be distinguished.

This brings me to a related step that I think is very important for Congress. There are so many other issues surrounding the use of an information infrastructure; namely, the privacy, the security, the potential for trouble, and the notion of what it means to get wiretaps legally. I think that we should tackle these issues professionally. Perhaps, the FCC is the best vehicle, and should be empowered to develop and en-

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force a comprehensive regulatory policy for the U.S. information infrastructure.

So far, I have spoken about the underlying telecommunications.

What makes the aggregate useful is that on top of the communications base, there are conventions for people and for computers to understand each other. Let me explain.

I happen to like a very simple-minded approach, which I call E-Forms. E-Forms, for Electronic Forms, is very much like conventional forms which have slots that you fill in. So, if you're buying produce or fruit, there will be slots for the amount of fruit, the kind of fruit, the bid price, ask price, and what-have-you, so that computers can understand the transaction and accelerate the process, rather than having to pass everything through the eyes of a human being. The way we gain productivity is by having the computers do more and more of that routine work.

The E-Forms don't have to be filled in by typing. They can be filled in by speaking. In fact, at our laboratory at MIT, we've developed such a system.

I'd like to take just a short break, and show you an E-Form for booking airline flights.

[Film shown to Committee.]

I think we can stop.

Now, in addition to what we see here, Senator, we can also use the E-Forms to translate from one language to another. And we have done this in our laboratory.

The reason this is easy is because you know what is expected in each slot of an electronic form, so you can do the translation a lot more easily than if you are trying to translate free, wide-open speech.

This is terribly important for international trade. As the information infrastructure of the United States becomes connected to those of the European Community and Asia—and I think this will happen much like the airlines became connected to each other and the telephone systems of the world—then this should help international trade.

I've been asked to comment on the uses of the information infrastructure, and I'd like to say, at the outset, that this is an impossible task. It's almost as if you had asked a counterpart of mine, a hundred years ago, to give you a list of all the uses of the telephone.

The telephone pervades so much of our life that we use it for everything, and the same is true with the information infrastructure. Computing today—hardware, software, and data processing within the nation's companies—accounts for 10 percent of the gross national product. Communications adds another 4 to 5 percent.

So, roughly speaking, about 14, 15 percent of the GNP of this nation is devoted to computers and communications. It's a huge chunk of our economy and it pervades everything we do.

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Therefore, to first order, the information infrastructure uses are for everything. They support every economic and personal activity, and affect the way we live, learn, play and conduct our lives.

I have provided, nevertheless, a list, and I will not elaborate here on it because of the time pressure. The headings on my list are:

Business mail—$40 billion a year of business mail currently takes five days to reach its destination. What would happen if it could reach its destination in five seconds? What would happen to the productivity of this nation? I think it would make a big difference. So would buying products, looking at them, trying them from a distance, tailoring products to individual needs.

The second category is recreation. There's so much talk about HDTV—High Definition Television. Well, if we have an information infrastructure in place, we just set the parameters to the right place for the speed, the reliability, and the security of HDTV, and we have it for free. It reaches all our homes through the fibers and the other pieces of the infrastructure.

People could rent any one of the millions of movies made, or concerts, or what-have-you, from entrepreneurs that would be selling these, download them to their homes in five minutes, and sit down and enjoy them.

They would not have to store information on tapes, unless they wanted to. They could play community games, they could interact with one another and meet new people.

In the corporate milieu, one of the biggest potential gains here is in collaborative work across space and time. It's hard enough to communicate across space, but most people are not where they should be at the same time. And the infrastructure offers means for doing this.

A lot could be done by convening teams of marketeers, designers, production specialists, individually, as well as across companies.

There are a lot of other activities that I describe here: Business simulators, the ability to order complex systems like cars, and instantly explode the order into the various subassemblies needed, ordering the parts, remotely delivering them to the factory, constructing the car in a matter of a couple of days, to fit individual needs.

The area of publishing is a rather big area. Besides democratizing the media and reaching a lot more people, we will see, I think, a very large video component and a very large interactive component, which means a new form of magazines and a new form of newspapers.

However, publishing will largely remain the same because there will be so much information flowing around, I call it "info-junk," that we will have to shield ourselves from it, and select the diamonds and the pearls. And so publishers will still perform the role they always did; to help us do that.

Education, I think, is a very important area. Interactive video could do a lot. The ability to link teachers and retired engineers in Florida to

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inner city children in New York could change the dynamics of who can teach whom.

There's a lot there on tutors, training simulators on all kinds of skills and so forth.

There are many other applications. In the medical area, for example, being able to access one's records regardless of where one is. In the governmental area, there is just this huge amount of interactions of the citizenry with the government through the tax system, and all the other ways in which we interact with government, that could be speeded up, and so on, and so on.

Now, the impact of this infrastructure could be rather large for the United States.

First, I believe, by automating old work, making it faster and more efficient, we could substantially increase the productivity of the United States, the quality of our products and services and so forth.

But, second, I think a whole lot of new activities would be possible, activities that would open new horizons. For example, being able to work from home, if you're a spouse with children, or a physically disadvantaged person. And, of course, as I said before, being able to cooperate with people that are thousands of miles apart.

And another thing, this infrastructure would become so embedded in the fabric of this nation that it would be very hard to rip off and copy. So there's a premium here for starting early.

On this count, I would like to remark that other nations are not standing still. Singapore has published a volume on their system called IT2000. The Prime Minister of Singapore has declared that this is a nationally important activity. And they see themselves as international brokers. They see themselves as creating an information infrastructure that is going to help the nations of the world conduct their business.

Recently, I was in Sweden, and I heard the same noises from the Swedish BTPTT and the Swedish Government. I think soon Switzerland will discover that that's another role a neutral country can do in the future.

In addition to that, in what used to be East Germany, they are rebuilding everything from scratch, so they're deciding to go with this broadband telephone system that would strangely turn that part of the world into perhaps the most advanced information infrastructure.

Let me now turn to what I think the most important part of my testimony.

I do not see how an information infrastructure for the United States could or would emerge spontaneously any more than the telephone system, the electric power grid, or the highway system could have emerged spontaneously.

This is where government comes in, in its role and obligation to carry out actions for the common good. I therefore suggest that the biggest thing we can do, from the Federal Government, is to get this national information infrastructure going. To seed it.

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To that end, I would like to suggest, although this is not the only way, but it could be a neat way to do it, that we legislate the formation of a new agency, an agency that would help develop the National Information Infrastructure of the United State. This agency, through its staff, would stimulate and coordinate the actions of several agents.

Now, who are these agents? I envision that this agency, which need not be very large, would convene the telephone companies, businesses with their high interest in using these systems, academia and government. The agency's staff and these people would slowly seed an information infrastructure, choosing the first E-Forms and very rational applications that would help business.

Take for example, electronic mail, which, as I said, entails $40 billion a year. Companies could pay as they use it with electronic stamps. The capital costs for the infrastructure would be provided by the carriers who see a future revenue in this business.

So the role of government would not be as a sponsor of this activity, but as a coordinator. Money would surely be needed, but that money could be kept, I believe, under control. I estimate, very roughly, that a one-billion-or-under-a-year level would be need to get this activity going.

Another thing that this agency could do is to plan a path from the current system, because we could start using the current telephone network, even though it's not perfect to the future. For example, they would talk with the telephone companies to find out when the fibers would reach businesses and when they will reach homes; at what point do we kick in a few more of these E-Forms; when do we connect to the NREN—the National Research and Engineering Network—and how do we take the ten thousand or more networks that are already around and blend them into this kind of a system, and so on.

So, Mr. Chairman, in closing, let me note that I see no major technological obstacles before us. The only obstacle I see is one that has plagued us in the past in many other activities of U.S. industrial performance; namely, our inability to easily agree on a common course.

Yet, agree we must, if we are to move from the steam engine of computing and communications to the jet-engine age of information, and if we are to enter the 21st century with computers and information technology, sustaining and enhancing the economic primacy of the United States.

Thank you.

[The prepared statement of Mr. Dertouzos starts on p. 105 of Submissions of the Record:]

SENATOR BINGAMAN. Thank you very much. I think that's useful testimony and I'll have questions.

I'm sure Senator Kerrey will, too.

Did you have a statement you wanted to make, before we go on, Senator Kerrey?

SENATOR KERREY. No.

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SENATOR BINGAMAN. Okay. Why don't we go ahead with Mr. Kapor. Thank you very much for being here.

STATEMENT OF MITCHELL KAPOR, FOUNDER, LOTUS DEVELOPMENT CORPORATION; PRESIDENT, ELECTRONIC FRONTIER FOUNDATION: ACCOMPANIED BY JERRY BERMAN, DIRECTOR, ELECTRONIC FRONTIER FOUNDATION, WASHINGTON OFFICE

MR. KAPOR. Thank you very much.

I'm going to speak for perhaps ten minutes or so, and then I'd like my colleague, Mr. Berman, to make, if that's okay, a few remarks about some of the specific policy activities and legislation that follow from the open platform approach that we're going to be talking about.

Let me start by saying that the task of talking about where we should go with information infrastructure has been complicated by an identification between progress, on the one hand, and fiber optics, on the other hand.

And, in most of the conversations that you will hear, I believe people will be saying that we need to get going with a national information infrastructure, and that we need to do this through a nationwide broadband fiber optic network.

Well, that marriage of progress to fiber optics, I think, is unfortunate, in a sense. It's also true, in a sense, and I want to talk about that. But it leaves open only seemingly the position of being a Luddite, as an alternative. In other words, to oppose a gigantic national program to create a broadband network now is seemingly to be in the Luddite position of opposing all progress and all modernization. And who would want to do that?

SENATOR BINGAMAN. We have some.

[Laughter.]

Go ahead.

MR. KAPOR. There are some. And that is indeed exactly why there is a deadlock on this issue, not a technological deadlock but a policy deadlock.

So, to break through this deadlock I think, requires, to an extent, getting involved with some messy details of technology. And I hope that you won't think it too presumptuous of me, as a technologist, to try and translate some of the underlying technical issues into choices that can be appreciated by lay people. Because I think this is really necessary to do.

We come down on the side of wanting better infrastructure and getting to an eventual broadband network in this nation. But we think we have to do it in a way that goes beyond this deadlock. And so what we have is, we believe, a fresh approach to the tactical issues of implementation, of how to get the country off the dime, of how to get moving on this issue.

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And we think that we have a kind of middle way that stands between the Luddite position and the position that says the only other choice now is a national fiber optic network.

Just by way of one additional preface, I should say, why is that seemingly simple, straightforward alternative not the one to follow? There is a variety of practical problems that I want to mention.

The first is that actually bringing fiber optics to everyone's home through the public switch telephone network would involve digging about 130 million new trenches, one to every household in this country. Digging trenches is expensive and a lot of manual labor.

The cost of a national fiber optics system will be in the hundreds of billions of dollars, and estimates have ranged as high as a trillion. And there are those people, as you know, who will say that it is insane to spend that amount of money if we don't know that this is a system that people are actually going to want to use.

And that is one way at which we arrived at the deadlock.

Well, as I initially began looking at this issue over a year ago, I came to it with my perspective as an entrepreneur and as a person from the personal computer industry, where we've gone through an extraordinarily rapid growth, as you know, in the past 15 years, from nonexistence, to being a hundred billion dollar industry worldwide, if you add up the total value of all the hardware and software and peripherals. And I believe that there are some dynamics to the innovation that took place in that industry which, if properly understood, provide the key that's going to break the deadlock. And I'd like to spend a couple of minutes talking about that.

What happened in the PC industry was extraordinary, because the industry was founded by people who were totally outside of the industrial mainstream. It really was done, as the myth would have it, in attics and garages. Steve Jobs and Steve Wozniak invented the Apple II in a garage in Los Altos. They raised the necessary funds by selling an HP programmable calculator and an aging Volkswagen microbus.

When they put out the original Apple II in 1977, they, themselves, saw it as a platform for development, as a system on which other people would come and would build the applications that people would use.

In fact, there was a tremendous flourishing of new software and new software companies that followed the introduction of the Apple II. And I was in that wave. There were literally thousands of people who tried their hands at making software products for it.

In that wave of new entrance came groundbreaking new products. First, there was VisiCalc, which was the first spreadsheet for the Apple II. Later, there was 1-2-3 for the IBM PC, which I was responsible for. And still a bit later, the whole desktop publishing field was really enabled by the creation of a single software program called "Pagemaker" which came out and ran on the Apple Macintosh in the mid-1980s.

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And now desktop publishing is an enormous industry of tens of billions of dollars a year.

The point that I'm trying to make is that it was the platform; it was the existence of a system that others could build on; it was readily available because you could get an Apple II at your corner computer store, was affordable, and had a critical mass of features.

And the Apple II was not a powerful computer. By today's desktop computer standards, it was puny. But it was just good enough to get started and to create a kind of a chain reaction that was economically self-sustaining. The platforms grew more capable and more powerful, the applications grew more sophisticated, stable product categories emerged, and we created a whole new industry.

In looking at telecommunications, in particular, in looking at the Regional Bell Operating Companies, one sees that the history and tradition of it could not be more different. This is, in no sense, finger-pointing. We did a wonderful job in this country and in the old Bell System, in creating a network that could serve 97 percent of households and provide plain old telephone service.

But it was done with a model of a single, extremely tightly controlled, centralized network that nobody else could get their hands on and do anything with.

In fact, as recently as the mid-1960s, there was a long and bitter court fight about whether you had the right to attach suction cups to your telephone. The claim was made, in all seriousness, that attaching that type of mechanical device threatened the integrity of the network.

It's a real contrast.

Now, things have changed a lot in the phone companies, but cultures do not change as rapidly as technology. And we are still, to some extent, dealing with a mindset issue here. There's no tradition among the RBOCs which supports faith in the marketplace as the provider of application solutions.

I think that that is not giving enough credit to the innovators, to the entrepreneurs, to the current willingness, for instance, of the computer industry to come in and build innovative new services and applications on top of the public switch telephone network.

However, trying to build them on top of what we have today, which is a plain old telephone service, an analog system, that would be like trying to build a skyscraper out of bamboo. It is just not sufficient.

On the other hand, we can try to wait until we have a national broadband network, which is anybody's estimate, that is at least 20 years off. I don't think we can afford to wait that long.

There is the possibility of a transitional strategy, therefore, which begins with what we have today, and systematically and incrementally adds capabilities to what we have. And we wind up eventually with a broadband network, but rather than focusing attention on that omega point, let us focus attention on the alpha, on the first step.

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And the first step, we believe, is to take the analog phone system of today and make it digital, fully, end to end, so that it supports the movement of bits of information, whether text or images or video, similar to the movement of bits of information within the computer.

It is possible to upgrade the phone system to be end-to-end digital, and to continue, for the time being, to use the large investment in copper local loops. And this is what Professor Dertouzos referred to as narrowband ISDN.

We think of it as an incremental step which provides just enough in the way of capabilities to jump start the information revolution.

Now, the Telco's RBOCs will tell you that they are rolling out narrowband ISDN. That is quite true, and they are to be applauded for that. But it's being done extraordinarily unevenly. Some regions have full commitments to it. Other regions are really lagging.

In many areas, while the technological capability is there, the pricing of the service is such that it is unaffordable to the average consumer.

If you charge fifteen cents a minute for a new service, that's nine dollars an hour. Obviously, for a local call, the usage is going to be extraordinarily less than if you were to charge about one cent a minute, which is closer to the actual cost.

In order to attract investment on the part of the computer industry, new entrepreneurs, and others, we have to see the possibility of a mass market; not the actuality, but the possibility that anybody who wants this kind of digital service can call up, order it, and get it.

To do that, we need a kind of widespread deployment, at least 80 percent availability, if not 100 percent. And we need a policy of affordability. It has to be made to be affordable. And we need to make it easy to get.

In Massachusetts, for instance, the Prodigy Services Company, the on-line venture of IBM and Sears, waged a long and successful battle to get inexpensive ISDN rates in Massachusetts.

A colleague of mine had the extraordinary experience of calling up to order the service—and mind you, this is now a residential service—and being told by the service representative that he needed to send in a photograph of the equipment that he had at home which he was going to connect to this network, and that he also had to complete a twelve-page questionnaire about it.

Well, obviously, those practices are not in the state of maturity sufficient to create a mass market. Computers went through an enormous transition from the mainframe era to PCs. In the mainframe era, if you wanted to buy one, you had to be qualified as a customer, you were called upon by a dedicated sales force, whether it was IBM or another company, and you went through a long and expensive proposition to get your equipment.

We can't sell digital phone services that way because it will restrict the market. We need to have the ability to hook up an information pipe

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in your home as easily as you can go down to the corner computer store and buy me an inexpensive PC, and walk out with it in boxes.

A lot of people in the technology community have said, and will continue to say, look, why are you talking about narrowband ISDN based on copper? It's obsolete, it's old, it's too slow, it's been tried, it's failed.

And I think we have to examine the options, not from the point of view of what is technologically optimal, but what is politically achievable.

After all, the Apple II, as I observed, was a pretty wimpy computer to begin with.

What we need to be concerned with, if we start with narrowband ISDN, is that it's not a dead end. And in fact, if you go, as we have to Bellcore, to the research labs of the phone companies and to AT&T, the technologists inside those companies are, in fact, beginning to say that the path to fiber is through copper. And what that means is we need to have the experience of the deployment of some kind of digital service now, based on copper, in order to understand how actually to build that broadband network, how to build the switches, what are going to be the patterns of usage in the network, and what kind of traffic is there going to be.

Once real users start paying real money for new services, serving consumer markets, education and health markets, as I believe will happen because entrepreneurs and computers are standing by waiting to deploy new services, if we could just get a platform now—not 20 years from now—I believe it would fundamentally change the terms of the debate about the infrastructure argument.

For one thing, if there are real users of a system, even though we know, technologically, you can only do some of the things you want —not all of them—but if those some things let people telecommute and work at home and let people do inexpensive video teleconferencing, it will prove the case that an advanced infrastructure is good for the country.

And if we prove the case, I think, then we silence the skeptics that say that further investment is unwarranted. And I believe that we need to get going on this and transform the debate.

At this point, I want to turn it over to my colleague, Mr. Berman, because this translates down to some specific policy alternatives that can be taken up today.

STATEMENT OF JERRY BERMAN, DIRECTOR, ELECTRONIC FRONTIER FOUNDATION, WASHINGTON OFFICE

MR. BERMAN. Permit me just a few minutes to place this into context.

Over the copper plant, you can provide voice, data and video services; many of the information services that people think will require a broadband fiber optic network.

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Now, let's talk about that in policy terms. If this hearing was before Mr. Dingell, Mr. Markey, Mr. Hollings or Mr. Inoue, you could not get in this room because it would be crowded with lobbyists from one end of the room to the other and down the hallway, because of the stakes that they believe are involved in modernization of the telephone network.

A giant battle is going on over who will control information services in the future.

As Mitch points out, it is not possible to go down to Ma Bell and order up ISDN or broadband, because there is no longer a Ma Bell. We have a fractured and diversified telecommunications industry made up of many players. That diversity has brought on competition and innovation with many positive results for America.

But in terms of modernization, in the post-divestiture world, we must go out and create a consensus across a wide range of interests, to move forward.

The result is a gridlock in the fight between fiber optic and plain old telephone service because of fears of what the Telcos will do to the network, who's going to control information services.

Narrowband ISDN is a technological platform, a step towards broadband. It is also becoming a step that you could take politically and build a consensus around.

For example, Telcos are now in information services, so they don't have to push the button so that the only way the country can get to broadband is to allow them into information services.

Their technicians are saying, much can be done over narrowband, and we have to start there. But there must be a policy consensus, too. Because the tariffing and the pricing and the deployment across the spectrum varies so greatly, it's not currently possible to make it a real platform that's affordable and within the reach of residences.

You need to bring the consumer movement along. Consumers have been opposing fiber optics because they say it's a field of dreams and it's going to cost the ratepayers a fortune.

I have a paper that has just been released by the Consumer Federation of America, which is endorsing the narrowband alternative, as saying that we need to modernize the telephone network, we need more than plain old telephone service, and for the first time, I think, recognizing what EFF is saying: You cannot build an information infrastructure over POTS, because with the new computers and the power of a digital world you cannot drive these fast cars over a dirt road. So we have to step up and improve that highway for all citizens.

What the Consumer Federation of America and the consumers are learning is that you can do this for a magnitude less cost than fiber optics and you can create an information platform that you can build on now.

Here is another paper from Lee Selwyn of Economics and Technology, making the argument that consumers have already paid for most of

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the modernization that involves moving to ISDN, because in upgrading to modern digital switches and signaling system seven, Telcos have already invested in large parts of the network of modernization that will take us to ISDN.

So, if you're saying that it's just the incremental cost of moving and tariffing ISDN and we've already absorbed those costs, then you have an economically and politically feasible case to say we can take a modernizing step without spending a bundle.

And, by the way, in this country with this deficit and where people don't get telephone service in some places, there is simply no bundle to spend.

What's interesting is that there are other information providers and others who have been opposing the Telcos entrance in information services, and whether they can pass the Brooks bill or any of those other bills, they know that sooner or later the Telcos are going to be in the information services.

What they see in narrowband ISDN is a more level playing field that allows many more players to come in and provide modern applications over the telephone network.

For example, the Telcos talk about bringing a mini-tel system to every resident in the home over a digital pipe. You would be able to have competition not only with the Telcos bringing their mini-tel to the consumer, but letting Apple and IBM and others build those appliances.

Over the last six months, EFF has enlisted the support for this network modernization from many of the large computer firms in the country. While they want a broadband network in the long term, they're saying the current network is inadequate and they want to build on top of that. It is a barrier to making the consumer a mass market tool that reaches into every home in the United States.

So Microsoft and IBM and Apple and Novell and Sun and others are saying, we will help EFF, join in a coalition, come to Congress, and take part in a telecommunications debate that we've left too long to old players—the mass media and publishers.

In the heart of telecommunications in the 1990s is the computer. And the computer industry has not played a significant role in this to this point.

When we can hold a hearing with legislation proposing making a platform step along this old platform, and you have Bill Gates and Mr. Akers and Mr. Scully up here saying, this is going to help America move forward, I think we have changed the terms of the debate.

So we think it is a position that is technically correct. It is the next step. It is economically feasible within the terms of how we talk about rates and the economics of network modernization.

It has the chance of being politically of interest to a wide range of interests who either want to move forward or who want to get away from POTS, or who want to have a positive position for the future, and

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who want a more level playing field in the post-divestiture era that we're now in.

Thank you.

[The prepared statement of Messrs. Kapor and Berman starts on p. 111 of Submissions of the Record:]

SENATOR BINGAMAN. Thank you very much.

Mr. Lucky, please proceed.

STATEMENT OF ROBERT W. LUCKY, EXECUTIVE DIRECTOR, COMMUNICATIONS SCIENCES RESEARCH DIVISION, AT&T BELL LABORATORIES

MR. LUCKY. Thank you, Mr. Chairman. Thank you for inviting me here today.

I'm a technologist, and I work for AT&T Bell Labs on research. I've been there for a long time. I feel like I was born there, and until 1984, we worked for the Bell System.

And until then, I would have felt responsible for realizing Michael Dertouzos' dreams about infrastructure. I would have felt guilty sitting up here and not doing that.

But I don't feel that way now. Now, my goal in life is to make money for AT&T. That's not intrinsically bad, it's just different. That's the way this world works today.

So how does communications evolve? Well, the marketplace rules supreme today that that is the mechanism that determines what gets done and what doesn't get done.

And beyond that, two other things. First, international standards, very, very pervasive. They control what we do. In fact, our chief architect at AT&T a year or so ago had a meeting with some of us researches and he pointed his finger at us, and he says, whether you like it or not, the new networks are being designed by the standards committees.

Now, unfortunately, those standards committees are not necessarily run by people from the United States at all. We have no special power there whatsoever. In fact, we don't have our act together nearly as well as other countries have together.

So it's run by the marketplace. It's run by standards, and it's run by governmental forces.

And that's where you people come in. And somehow, the culmination of those things has to make up for what we had before 1984, which was an integrated planning of how we go about the infrastructure in this country. That integrated planning no longer exists because you have a lot of players who are all trying to make money. That's what they've been told to do.

You have the international standards telling them how to do it, and you have the governmental barriers. And sometimes you even have governmental help. And things like NREN, for example, and Internet, which I'd like to mention a little bit later as we get on.

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Now, what I'd like to do is talk about various parts of the infrastructure today, and what is state of the art, and what's happening to them. And, in doing so, I'd like to perhaps echo or comment on some of the things that you've heard already.

Basically, I agree with many of the things that were said before. Just to get the record straight, before I start, I agree with what Mitch has said. That narrowband ISDN is a revolutionary step that looks very good right now. You don't have to wire this country with fiber to the home to do an awful lot for the information infrastructure.

I agree, though, that Mike has set out a dream of an information marketplace, and I think we have to keep that in mind, too, and we have to be sure that we're going toward that dream.

He suggested a Federal agency. I'm not going to comment on that. But he also suggested that the carriers would be very glad to pay the tab for the infrastructure, and I'm not so sure about that.

Now, I've brought some viewgraphs to echo some of my points. I'm always amused that we talk a lot about multimedia and how wonderful it is, but we so seldom use it in real life. We just use words and stuff.

So if we can see these viewgraphs, I'll put them up, and they will just merely echo some of my points.

SENATOR BINGAMAN. We have advanced far enough to use viewgraphs around here.

[Laughter.]

MR. LUCKY. These don't fit on all the way, but it's probably better, because then you'd be trying to read what the labels were, and you don't need to do that.

This just says that we have something new here in optical fiber. And the capacity of these systems is just taking off. And it's creating a whole new philosophy and economics of transmission. It's getting cheap, really cheap.

Now, this comes about not from burying more fibers along side the roads of America, but it comes about from research and learning how to send information better through fibers.

And, as a result of our research, we've doubled the rate that we can send information through fibers every year for over a decade, and we'll continue to do that. So the fibers already buried in there have a tremendous, unrealized capacity yet to go.

So where we stand today, in terms of transmission, is that a fiber carries 2.5 gigabits per second. Typically, there are a couple of dozen fibers in a bundle beside the roads when you drive out there. Each of those fibers carries about 50,000 voice channels. That's an enormous capacity. But bear in mind, those fibers will transmit twice as much the next year. We'll just learn how to do it better.

We're developing 10 gigabits systems now, 20 gigabits is feasible within five years. And using wavelength division multiplex, which is like just putting more colors of light over the same fiber, just like you

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put more radio channels over radio today, can be used to increase the capacity still more.

And we're installing optical amplifiers right now, a new invention that even makes the economics of transmission better.

So a new economics and philosophy of bandwidth is emerging. Bandwidth between cities is cheap. There's lot of it, and the challenge is, what can you do with it.

In fact, just to highlight that kind of a thing, a friend of mine quipped, not so long ago, that if we didn't watch out, one day before long, telephone calls between Los Angeles and San Francisco would be switched in Tokyo.

Now, that sounds stupid. But think about it. It means transmission is so cheap that you'll go anywhere to get cheaper processing, because it isn't going to matter.

So what I see happening is that the cost of communication will become not free, because, as we all know, this is a service business, it's a last mile business. This has very little to do with the costs of communication. But it does mean that it will become relatively independent of distance. It won't matter how far you go. And it will become relatively independent of bandwidth. It won't matter how much bandwidth you have.

Now, of course, this is just in the long haul network. Mitch talked about making the networks digital. AT&T network is digital. AT&T network is end-to-end digital, switches to transmission, all this is digital.

The problem is the connections to the subscribers, which is very largely analog. And I don't mean to imply any slothfulness on the operating telephone companies. They jut have a much harder job because of the enormous embedded plant of analog copper that goes out to the homes and small businesses of the country.

Now, let me turn from transmission and look at the access, because this is where the costs are. You've already heard from some other witnesses what's going on here today. And I want to basically agree with the philosophy of Mitch in that you don't need to put fibers out there to do an awful lot of things.

I often think that if I were Rip Van Winkle and went to sleep for 40 years and I woke up, I fully expect to see fibers wiring the country to the homes, but I just don't think you're going to do that overnight.

There's a lot that can be done without them. Today, we have existing copper loops. If you get a modem on your home computer today, maybe it transmits 2400 bits per second. You can get faster modems and that kind of thing.

ICN is being unrolled slowly out there and then you get 64 kilobits, you get two of those channels. So you've upgraded the capability enormously with those same copper loops that you have. A new economics, a new transmission speed.

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Now, we have this ADSL, which is a high speed modem which sends 1.5 megabits over that same loop. Because of modern technology for picture compression, you can then get what we think of as VHS quality video over the existing copper loops today. So you could have switched video into the homes with the existing plant today.

If you want more than that, we have CATV out there. CATV has an evolutionary plant. Fifty channels today typically, a hundred channels soon, as they make their network better—200 channels. They're going to go digital and are going to free up a lot of bandwidth in order to have video on demand, and they're also putting fiber in their plant.

So the fiber's coming to the homes from both CATV and from the operating telephone companies. The broadband services, right now, come from CATV and switched narrowband services come from the telephone company.

As I mentioned, fiber to loop would provide a thousand channels, switched video, but there are economic barriers. Basically, it costs more. And it's going to continue to cost more for quite a few years to go.

We estimate, though, if you want to break even on fiber in the home, in a new start on a desert environment, if four homes share a fiber, that kind of thing, you can make it competitive with copper. So I mean, there are economic games you can play here.

Wireless is also coming to the home. And we have analog cellular today, digital cellular very soon. Then we're going to these personal radio systems where we will have very small, several hundred feet cells. As you walk down the street, you'll talk to the telephone poles.

People even want to bring television to the homes using wireless systems too, so a lot of players are coming at the homes.

And people ask me, as a technologist, they say, which is better? And there isn't any answer to that. There's going to be a battle of economics, of power, of the marketplace.

Now, let me turn to the networking that puts this all together.

First, the present switches and signaling system. The signaling system is the network that controls the network. It sends information about the calls to set them up, it is approaching exhaustion. They were designed a long time ago, 20 years or so ago. We have patched them up, we've put a lot of computers around them, but the system is creaking at the seams.

This is an enormously complex network. The switches out there have about ten million lines of code associated with them. At Bell Labs, we have about a thousand programmers just trying to write simple new telephone features to put on these switches.

This is perhaps the most complex program ever written by mankind, so it's enormously complex and funny things do happen, as we found out, and that's why I put great emphasis on reliability and self-healing. That is of such paramount importance today. This doggone thing, as complex as it is, has to work.

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Now, the kind of thing that concerns AT&T and other carriers is not this transmission so much, but what can we do with it to sell it in creative ways.

For example, you may be unaware that perhaps the majority of the call attempts on AT&T are now 800 number calls. A simple service invention just changed the face of the country. It's curious that that's not used in any other part of the world. But this has changed the way America does business, 800 number calls.

But it's that kind of thing where you have a database out in the network, and the company sells and bases services on it—an intelligent network that they want to wheel and deal. They say, give me a platform that we can create new services. And that's the most important thing to the business people at AT&T. Give us a platform that can be used for service creation. We don't know what people are going to want, but whatever it is they want, we want to be able to build it and sell it tomorrow.

As I said, the architecture is driven by international standards. And this is evolution toward a broadband network.

I want to digress for just a couple minutes to talk about that, because this is a very important technological happening—Mike Dertouzos mentioned it—the BISDN, the Broadband Integrated Services Digital Network.

That has been coming along slowly for perhaps a decade. But within the last two years, in one part of it, a mushroom explosion has happened; it's something called ATM.

AT&T bought NCR a year or so ago. Now half our company thinks ATM stands for Automatic Teller Machine. The other half thinks of ATM as this new communication called Asynchronous Transfer Mode.

But you don't need to know that. It's just called ATM. What it is, it changes the whole philosophy of communications. It's like the whole world opened up, and now there's an opportunity to rebuild the whole infrastructure based on this new principle. And the engineers love it. All the conferences are filled with it. Every company in the world is going hell-bent-for-leather to try and implement this new thing called ATM, because ATM is a new philosophy of communication based on packet communication.

So you have a packet that unfortunately didn't quite fit on the thing we have here, but it says that all communication will take place in packets. There'll be 48 bytes of payload and a five-byte header that tells you where this packet is going to go. So it's going to be like the post office; you mail packets. And each packet has an address.

So the elements of this philosophy are that one size fits all. Regardless of what you're doing, you're going to package it this way. It's like having a standard envelope in the post office. Everything will be done this way. And, very importantly, bandwidth on demand; however much bandwidth you need, you mail more packets.

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Finally, totally standardized throughout the world. Just to emphasize this point of the flexibility, for example, if you have a voice, then you have a 64-kilobit stream and it's continuous, so you have to mail a packet just occasionally—one little packet every so often carries your voice.

If you have video, you need more bandwidth, so you just mail packets more often. But if you're trying to transfer a computer file, in one big burst, you mail a lot of packets. And the basic rate of transport of those packets is about 155 megabits per second. They really go. When you mail your packet, it disappears and zaps through the network.

The idea of bandwidth on demand, a whole new philosophy of communications, everybody's going after it, and a chance to build a new infrastructure. So there are already international competitors like Fujitsu, NEC, Alcatel, building and marketing these switches to do this.

Everybody's trying to get in the game and to rethink communications. It's like the world just opened up and gave us an opportunity to redo this. And so there is an infrastructure revolution on the way.

Finally, let me spend a few minutes on applications.

I've seen these long lists—I'm sure you have, too—of applications that people think the network can do.

Unfortunately, I think the history is that there's a lot of unwarranted optimism in the things that people think they can sell. And historically, we've had problems, for example, with home information. Everybody thought that everybody wanted to access the Library of Congress from their basement and stuff like that, and I just don't think it's true.

So I'm a little skeptical about many of the uses that people say, from a personal standpoint.

But the big things that people are pushing today: Video telephony, video conferencing, multimedia messaging, data networking—I've named a few. These are basic applications for the purposes of education, economic competitiveness, health care, and things like that. These are the applications that you can build those human needs upon.

Recently, a few months ago, AT&T started marketing our first consumer video phone. It has a three-inch color LCD screen. For about $1,000, you can buy this thing, plug it into the wall into an ordinary telephone line, and basically wait for someone to call. And it's going to be a long wait.

[Laughter.]

This is a very important point, though, because it shows you how hard things are to start. Fax kicked around for about 30 years, because what good is it to have the first fax machine in the world. You have to build up a base of users before it becomes good for everybody.

And that's the problem with this information infrastructure thing, too. Who is going to put all the money up front to build this when there's nothing on it?

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So you have a chicken and egg problem with communications services.

This is very popular—the video telephone—but catalog stores and such mainly buy it. So we're going to see how it goes.

But it'll be the first of many video offerings. For example, we'll have video windows in your PC. This is a work station, and you can see two little windows on it. And you just buy a plug-in board for your PC. You plug it into your ISTM line, and you're up with video windows on your PC, seeing the people that you're talking to; simple things.

There'll be other things that work in conjunction, for example, with CATV, and there'll be all different kinds of resolution and price points on video telephony.

The reason why this can happen now is because we have cheap bandwidth, we have very powerful video compression. And we have fairly cheap consumer video equipment. So the time could be ripe for this.

But it remains to be seen how this takes off, because video provides an emotional dimension. I think of it as a grandparent telephone. You buy two of these and give them to your grandchildren, and one for you, and it provides an emotional link for a family; that kind of thing.

But in business, I had a picture phone back in the 1970s for a couple of years, and I'm not convinced personally that in business it provides much in the way of information to have this thing.

I had the British Minister of Commerce grab me, and he said, video conferencing will never work. He grabbed me and embraced me and he said, I have to smell the person I'm dealing with.

[Laughter.]

Of course, I thought my deodorant had failed, or something like that, but it turned out, I have to confess, I couldn't think of a single thing to say. Later on, I figured out that he just meant it as a metaphor for something that wasn't conveyed by the electronics.

So we'll have to see how we use this new technology. It's not obvious that it fits into the way we do things today.

Multi-media conferencing is yet another capability, and I regret that this doesn't fit in all the way.

Here, we have a work station screen, and a number of people are working together at a distance, and you see the pictures of the people who are involved in the conference there at the top part of the screen, and they might be writing on a blackboard.

Unlike the video telephone, here you have a shared video space, just like being in the room where you have a blackboard, and everybody can see what you're writing on. Instead of a video telephone, you see me, I see you. We don't see the same thing. There's no shared space that we can work in. So multimedia conferencing provides the shared space.

Let me finish up now. People are working on new concepts for telephony, and new models of telephone calls that make them more amenable to things like this.

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We have this concept of an electronic room. Now, a room is a place and it has properties that we'd like to emulate in the telephone network. A room like this, we can all come here, because we knew that at this time this meeting was here. And if you went to this place, you could join in.

Telephone calls are not like that. If I call you, these people can't find us. There's no place where we are.

If you get bored, as many people do in these, you could go across to another room and join another meeting. You ought to be able to do that in the telephone network, too.

Furthermore, a room that you can bring not only people into, but resources. You can bring libraries, documents, computers, projectors. Things can be brought in. You ought to be able to do that in telephone calls. You ought to be able to put a library on line to help you in your call. Moreover, a room has persistence. We can all leave this room and it's still here. You might want to come back and see some things that were left here from our conference. Telephone calls ought to be like that too.

You ought to be able to come back, read things that were left, perhaps replay things that happened. And so we're building those kinds of mechanisms.

I really want to quit, but I forgot to say something about Internet. I think it's incredible that we could talk about information infrastructure for as long as we have without mentioning that.

Because something is happening out there, totally out of the control of the government and all of us. Internet is growing. Internet, as you probably know, is the worldwide network of networks. It started in the academic community. It's largely guided by NSF, but that's very loose, because it's really an anarchy in many ways.

It is growing at 15 percent per month. Now, the ordinary telephone traffic is growing at 6 and 7 percent per year, that kind of thing. But Internet, which comprises of about 5,000 networks throughout the world today—there's connectivity to about 105 nations—it's growing at 15 percent per month, and it has about ten million users.

There's a phenomenon happening here, which is out of the control for everybody, because it's a social happening.

The people at NSF and the other government agencies are very adamant in disavowing their role in creating an information infrastructure. They have more modest ambitions. They say, look, we're just trying to connect up the academics. No one chartered us to build an information infrastructure.

But I'll leave you with the thought that they are.

[The prepared statement of Mr. Lucky starts on p. 122 of Submissions of the Record:]

SENATOR BINGAMAN. All right. Thank you very much.

Mr. Dimmit, please proceed.

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STATEMENT OF STEVEN R. DIMMIT, DIRECTOR, CORPORATE PLANNING, SOUTHWESTERN BELL

MR. DIMMIT. Thank you, Mr. Chairman.

For the past ten years, I've been involved in technology with research and design in telecommunications and strategic planning for both Northern Telecom and Southwestern Bell.

Southwestern Bell appreciates your efforts to address a strategic plan for the nation's information infrastructure, and we believe your initiative is very timely.

The communications marketplace today is rapidly changing.

Digital technology is the driving force behind a worldwide convergence of information-based industries.

In the May 25 issue of *Business Week*, John Scully, the CEO and chairman of Apple Computer, predicted that today's telecommunications, computer, consumer electronics and publishing industries are going to merge together into a huge $3 trillion industry by the year 2001.

I don't know if he's correct or not, but a lot of other countries are seeing the same thing.

Japan has decided that their nationwide broadband network is going to be the foundation of its 21st century economy.

MITI, the Ministry of International Trade and Industry, projects that the revenues from their nationwide broadband network will be at least one-third of their country's national product by the year 2020.

Susan Oliver, who is the managing director of the Australian Commission of the Future and who is looking at their future, has predicted that broadband multimedia interactive applications and technologies are going to enable her country to do things they never thought were possible.

I can go on and on. There are myriads of studies and reports that would show that a nation's information infrastructure is critical to its economic competitiveness.

I'd like to share a couple of examples with you about how a broadband telecommunications and information infrastructure network will change our ability to think, work and communicate.

Imagine students in a classroom where each desk is an interactive, multimedia personal computer. The teacher of this class augments his or her lecture on zoology by including recorded and live videos of animals in their natural habitat, computerized graphics of the environment in which the animals live, as well as text on these animals' eating and mating habits.

Does it sound impossible? Well, it already exists. It exists at the St. Louis Zoo in what they call the classroom of the future. It's an amazing place to go visit. The only problem is, students around the St. Louis area have to drive to that classroom to be able to experience this. A broadband telecommunications and information infrastructure could

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bring this to schools across the country, people that won't ever get a chance to visit the St. Louis Zoo.

In election year, I'm sure you return to your office from trips to find mounds of news clips, reports, constituent letters and other correspondence that your aides hopefully have gone through. But if you're like me, and I'm gone for a week out of the office, the first thing I do with the eight inches of stuff on my desk is to look for the recycling bin, because there's no way I'm going to get through it.

But a broadband information infrastructure can give you another alternative. Using very powerful supercomputers and software called artificial intelligence and neuro-networks, the network could personalize or customize this mass of information for you.

It would present only the most relevant and important information to you. What would have taken days or weeks to accomplish will now be able to be done in just a few hours, or even less than that.

Again, this sounds impossible. We have examples in Southwestern Bell's laboratories of technology like this, which are is customizing and personalizing information so that I, the user, don't have to worry about the tons of information that's not relevant to me. It helps me solve the information overload problem that has been talked about many times.

There's too much information for me, as a user, to be able to deal with. A broadband information network is going to bring more information than people can comprehend to them. But when you put computers in there with it, and artificial intelligence software, you'll be able to reduce the amount of irrelevant information and customize and personalize services for people.

What are some other examples?

Think of an information marketplace where you model what the stock market has done, which is a good model for selling and buying stocks. Apply that to normal goods and services. An information marketplace where you, as a user, say, I'd like to buy a 1988 Buick LaSabre. I want it to be blue, I want it to have 25,000 miles, and I want to get one for this price.

How do you do that today? Well, you can't. You might look through the newspaper and all the classified advertisements. Again, that's a very difficult process. With a broadband information infrastructure of the future, you'll just be able to send that request out and the system will be able to find that for you. It may be in your city, it may be across the country, but it will find one for you.

Think of the applications in health care. Something as complex as diagnosis and looking at x-rays and having collaboration between doctors across the country looking at an x-ray, to something as simple as processing insurance claims.

Today, there are billions of dollars being spent in processing insurance claims manually, going through the mail to do that, and it takes forever. And it's adding to the high cost of health care. But a broadband

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information infrastructure could ease that process and make that process faster and reduce the number of errors that occur in that industry.

It's been mentioned before, work at home and telecommuting. The ability to do things at home that you can do at the office, but you don't have to drive to the office, and it will enable a lot more people to work in a much more efficient way.

Entertainment, another application that is beneficial, as simple as video on demand at your house, to something as complex and futuristic—but it's not that futuristic—is something called virtual reality, where you, as a user, see yourself inside an environment.

I'll give you an example of that. I know that Japan is working on an application where you put on these specialized goggles that you look through, and what you see is a golf course. And it can track the movements of your arms, and you play a round of golf without ever having to go to a golf course.

Now, the problem there is that there's not enough golf courses in Japan, so they're having to do this. You see yourself playing golf and you visualize it.

To something as simple in the United States, I've seen prototypes of a person riding an exercise bicycle. Instead of looking at a blank wall and just riding, riding, riding, they have these goggles on and they see themselves riding through the streets of Seattle, and they see video. And as they turn their bike, they go through different streets. And, as an added incentive, if they pedal over 30 miles an hour, they fly. The take off over the city.

These are applications that are possible that would take fiber and broadband network to deliver to businesses and to homes alike.

It's difficult to predict the future. A lot of people have tried to do that and failed, but I'll try to do it here.

I think the future is going to be this integration that's been talked about of telecommunications and computers. I mean, telecommunications networks are just large computers. And we're going to see this merging and collaboration between computers and telecommunications networks to provide these types of services.

The future is going to be multimedia. We, as humans, have many senses that we have available to us, to be able to perceive what's going around us in our environment. The same is going to be true as we try to understand and perceive the information that we have to deal with.

If information is presented only in text, it's very difficult just to read and read and read, and be able to understand and comprehend what's there. But if you augment text with video, animation, graphics and images, it enhances the process to understand and assimilate information.

The future is going to be collaboration. People are not feeling like they want to make decisions on their own. They want to be able to collaborate and ask somebody else. And be able to look at the same

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problem and have a joint decision made. And these types of systems are going to be able to provide that.

The future is going to personalized and customized and not having to deal with mass amounts of information that you can't wade through. You're going to have pieces of software sometimes known as intelligent agents or intelligent guides, that are going to help you wade through this massive information.

And I would agree with many of my colleagues up here that it will be a migration from copper to fiber. There are many things you can do today over copper. But some of the applications that we envision can't yet be done over copper, and are going to need some fiber. But there will be a migration.

What can Congress do to make this happen?

I think Congress has already started to play a major role in building this infrastructure by passing the High Performance in Computing and Communications Act and the starting of the National Research and Education Network.

I think you can do even more. The Cable Act of 1984, as well as the manufacturing unilateral restrictions of the MFJ, are stifling the building of this infrastructure. And anticompetitive bills, like House Bill 5096, are attempting to make the situation even worse.

We see our role as being an information enabler. We want to be able to be in a position where we can provide platforms, which have been described before, that will enable information consumers to get at the information they need, and so that information providers can get information to the consumers.

We're going to be that value-added intermediary there, an information broker, and not trying to be the information content providers for all things. We don't know about that. Those are not our skills; that's not our core competencies. But we know how to match up users. And I think that's our role, as we go forward. We'll be an information broker.

We welcome the prospect of working with Congress, regulators, and business entrepreneurs to bring communication solutions to economic, education, health care, and other U.S. concerns.

Thank you.

[The prepared statement of Mr. Dimmit starts on p. 127 of Submissions of the Record:]

SENATOR BINGAMAN. Thank you very much.

Now, let me ask a few questions here and then defer to Senator Kerrey.

Professor Dertouzos, let me ask you, first, whether you agree with this point that Mitch Kapor is making, that ISDN. narrow ISDN is a necessary transition step on the way to a broadband system?

MR. DERTOUZOS. I think practically it is. In fact, at the next-to-the-last paragraph of my testimony, I say, starting immediately via the current communication substrate.

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So I sense that there is really no disagreement among any one of us here that this is path to take us there. We all agree that the broadband is going to take time. It will be gradual, and we have to start with a narrow one.

But I think that discussion, Senator, is very much like a discussion about whether the pipes carrying water to our homes should be copper or brass or steel. And while there is a very healthy debate on what the pipes should be and what their diameter should be, a far more important issue is to lay the pipes and to make sure we use the pipes that are there for something useful.

I think we're all looking for this takeoff, what Lucky calls going from one fax to several—or maybe it was Mitch—or having the platform equivalent, the dream that Mitch is trying to resurrect from the computer era where millions of entrepreneurs and people are going to start something.

We need to get this jump going. To my thinking, that's not going to happen spontaneously. And if it does, it may be like the Internet, and then we may find that all we can do is type electronic mail over it, debating and commenting on what we call flaming issues, rather than all these other services that I have talked about today.

So the important thing, I think, for Congress is to help seed this infrastructure.

SENATOR BINGAMAN. Let me ask, if this is happening, if in fact AT&T is already digital—and I guess the Bell Companies are moving in that direction—what should the role of the Federal Government be in getting to this next step, which is what Mr. Berman and Mr. Kapor were talking about.

Let me ask Mr. Kapor to respond first, and then any of the rest of you.

MR. KAPOR. If I might just comment on one of the assumptions about where we are today.

It is not true that we're making even and uniform progress towards narrowband ISDN.

For instance, Southwestern Bell plans to have only 20 percent of their lines support ISDN by 1994. They are at the absolute bottom of the pack of the seven regional Bell Operating Companies. If you only provide a service to, at most, 20 percent of the population, that is just insufficient to create the conditions for a potential mass market.

Now, other regions are further ahead. But in order to really stimulate development, this needs to be done at a national level.

MR. BERMAN. Let me add to that.

I think that because we see wide variation in deployment and in tariffs across the country, Prodigy has spent a lot of money and a lot of time trying to get ISDN priced before the Massachusetts DPU at residential rates, and they ultimately succeeded. They had to fight with the telephone company for a long time.

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If it is to be made available to residences as a basic service at a dollar per hour, that's still too high for everyone, but it's low enough to bring it within reach for many.

We have to create a consensus that ISDN will be deployed, end-to-end, so that you can reach from one part of the country to the other, that you can get it at a residential tariff in New England and in Santa Fe, New Mexico, and that you can communicate between those two points. To do that requires a national consensus.

It requires, one, a commitment at the policy level to make this a matter of national policy. I think that Congress could take steps to mandate, at least the interstate part of it, by requiring Telcos to deploy and make widely available ISDN in many of their residences as a prerequisite for entering the information services market.

The other part is whether the Public Utility Commissions will come along. While that cannot be mandated by Congress, there are lots of public utility commissions who have talked to us. They are saying that we want to modernize too. If we can convince them that the next step is to implement narrowband ISDN at residential rates with a national push and states coming along, I think we have the makings of a policy consensus.

SENATOR BINGAMAN. Senator Kerrey had a question.

SENATOR KERREY. Can I just do a follow-on of that? What's the rationale given by Telcos for charging $15 an hour if the costs are less? And what's the rationale given for the variance from one area to the other?

MR. KAPOR. The rationale in Massachusetts, where the original filing by New England Telephone was for fifteen cents a minute or nine dollars an hour, is that ISDN ought to be thought of as a premium service. And by the terms under which they're regulated, if something is a premium service, they can price it at that level at which they think they will maximize their overall revenue.

The reason I believe that the high price will maximize revenue is that the concept of a spontaneous development of a mass market, based on an inexpensive platform, which is so obvious to us in the computer industry, is something that is totally outside their mindset, their culture, and their history.

They are so accustomed to doing everything themselves, and they are so used to the notion that what consumers get is plain old telephone service, that the idea of pricing something attractively to create demand pull and bring the entrepreneurs in is just not there.

And the converse argument, why are prices low, I've just given it. If you price it at its cost—we're not saying that it should be priced below cost; but rather, it should be priced at the marginal cost of actually providing the service just as residential voice service is priced today—that is one of the necessary criteria to stimulate this information revolution.

Now, some things will happen spontaneously; other things need a push. They need legislation at the federal or state level.

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I wish it were the case that we could do the whole thing in the garage and in the attic, just like the Apple II, but telecommunications is regulated. So what we're looking for, in some sense, is the minimal intervention at the federal and state level required to create widespread affordable availability of the service, based on a real faith in the marketplace that private parties will make the necessary investments to produce inexpensive equipment, to develop new applications, and that it doesn't require a massive program.

I think honestly that the RBOCs need a little push in this area on public policy grounds.

MR. DIMMIT. I'd like to respond to that, if I may?

MR. BERMAN. Can I add one more point, and then you can respond to both.

SENATOR BINGAMAN. Why don't we have Mr. Berman complete his thought.

MR. DIMMIT. Okay.

MR. BERMAN. I want to just complete this.

I think that there is another reason why the Telcos are advocating fiber optics. While the telephone companies have been talking about bringing the information aids through fiber optics, part of their strategic thinking—and I'm not faulting them for this—is that they think the real market in information services is entertainment. And they would like to provide competition to the cable companies over the telephone wire. And that may not be possible with narrowband ISDN.

Only through a national consensus agreeing to deploy fiber optics and allowing Telcos to write off the cost in the near term can they get that end-to-end pipe to provide high definition television to the consumer.

So the issue, in policy terms, is whether we want to wait to untangle the cable-Telco debate over who's going to provide the alternative to entertainment wire and be held hostage to jump starting the information age for the rest of us.

SENATOR BINGAMAN. Mr. Dimmit?

MR. DIMMIT. I disagree with Mr. Kapor in the sense that it's not out of a lack of entrepreneurialism that we'd like to price things like narrowband ISDN at an appropriate price. It has to do with the way that we're regulated.

He made a statement that we'd like to have this price similar to how we do residential voice services. Well, residential voice services are priced way below cost because that's the way we're regulated.

I think what really needs to be done to get the prices where we want them is to move away from rate of return regulation to incentive regulation. And each RBOC is different. They all have different states they are operating in and different PUCs that they're dealing with. And some states are moving towards incentive regulation, but some are still weighed very deeply in rate of return regulation.

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And that highly influences much more than culture and skill sets and whatever Mr. Kapor would suggest; it much more highly influences the price of the systems that we're putting out there.

SENATOR BINGAMAN. Mr. Lucky?

MR. LUCKY. I'd just like to make a couple of comments, although it's probably best for me to just keep out of this and let them sling arrows back and forth. But many people said that the reason ISDN hasn't taken off is that there's no killer application that it's good for, and that what we need is for Mr. Kapor to write a Lotus 1,2,3 kind of thing that carries ISDN to popularity.

Lacking that, the problem now is that it's not enough just to buy ISDN for yourself; you have to have someone else that has ISDN. And it's developed in islands. And it's like this getting started problem in communications again.

SENATOR BINGAMAN. But aren't you arguing for Mr. Kapor's point and Mr. Berman's point and Professor Dertouzos' point? I think that the government needs to step in and somehow or other ensure that this inexpensive platform is made readily available to folks, or otherwise folks are not going to write Lotus 1, 2, 3 or the equivalent of it.

MR. LUCKY. Right. I'm always leery about arguing that the government should jump in anywhere.

SENATOR BINGAMAN. Well, I know you are, but I'm just——

MR. LUCKY. Let me stop short of that, and just say that people often use this term "jump start." It is a problem getting started, and so it's possible that something like that is needed.

But I want to say too, that more than just a physical infrastructure is required here. There's an information infrastructure too that has to be provided.

For example, it always bothers me that there's no national data network and there's no telephone book for data users. I mean, there's no telephone book. Can you conceive of this? Because nobody's responsible for this. But you have to provide this kind of informational support for this, so it has to get more universally available and it has to be richly supported with information.

I guess the problem is highlighted by a meeting I attended here in Washington. We had an executive from MCI talking and people were asking, why isn't there a national data network? He said that there was, and all you would have to do is to join MCI mail.

[Laughter.]

And there you have the nub of the problem, you see.

SENATOR BINGAMAN. Professor Dertouzos?

MR. DERTOUZOS. Yes. I'd like to reinforce the point made by Bob Lucky.

I think the impression might arise here that all we need to do is make ISDN and narrow ISDN ubiquitous, and magically everything would happen.

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But let me give you an analogy. There is something different involved here than was involved in the computer era. If we make available an ISDN to everybody fairly rapidly, and people can plug in easily, it's like having a way of screaming at each other. Think of us as computers. We can scream at each other. But do we understand each other? No. These are grunts that we're issuing, and we don't understand each other. There are no conventions.

How will the computers start engaging with one another to process transactions, to handle sales? They need, as someone said, for Mitch Kapor to invent the Lotus 1,2,3 for that environment. They need somebody who is going to have big enough grunts, important enough grunts, that everybody's going to learn them.

Well, that's possible, but we could do a lot more by worrying about what Bob Lucky is talking about; starting with simple things—a phone book so that you can find computers, white pages, yellow pages.

Who's going to maintain, and who's going to issue that phone book.

Then go beyond the phone book. I spoke of E-Forms, conventions. It doesn't have to be E-Forms, but ways in which we can transact with one another for routine things. And there are thousands of routine things that we're going to be doing.

So there's a lot more to this than just providing an end-to-end digital link, I believe.

SENATOR BINGAMAN. Let me defer to Senator Kerrey for his questions.

SENATOR KERREY. Well, Mr. Chairman, I'll talk long enough for you to get back.

Maybe, I should declare for the panelists that my principal interest is in the education area. But I happen to believe that if we can solve that problem, that the marketplace itself will find all kinds of opportunities, and we'll be able to adjust as well.

Mr. Kapor gave a precise number of 130 million homes in America. I will assume that's an accurate figure. That's where most of the education is going to occur. And all of us who have spent time examining the problems of public education, particularly those who, like myself, were governor in 1983 when the Nation At Risk Report came out; and immediately launched into this concerted effort to try and reform our public schools, increasing standards for graduation, changing the curriculum in the school itself, doing an examination of what kinds of teachers we had, trying to set in place procedures whereby those who were terrific could get higher levels of reimbursement, and those who were not, we'd find ways for them to move into other occupations.

We essentially focused our attention on about a hundred thousand buildings where 35 million American students K through 12 go during the 180-day school year to meet with approximately two million public school teachers seven times a day to get their instruction.

We focused upon, and continue to focus upon, an awful lot of our attention upon that, and we spend approximately $220 billion a year to provide that instructional effort inside of these buildings.

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All of us have examined that. Now, I think there's consensus to believe that there's a correlation, if not a causative effect, between the education that occurs inside that home and the education that's possible and that will occur inside the school.

And thus, if I can improve the extent to which people are educated in their home, or have the opportunity to become educated in their home, I will have a very dramatic impact not only about what goes on in the school, but the nature of schools themselves.

Thus, if you can imagine, as I'm able to do, even with the diminished neurons that I have in store, work stations at home where children and adults both—and there's a big market there, by the way, 35 million students, 40 million under trained workers, another 70 million people in the work place—who perhaps would like to learn something additional, but find it a bit inconvenient, to say the least, to drive their car down, which will probably be ticketed at some postgraduate center, and then go up and file their cards, and then park every single night, and get a babysitter and all the other sorts of things; very often training doesn't occur as a consequence of the physical barriers of having to move the body from point A to point B.

There's a tremendous market, in other words, that we are already serving. We are already intervening in people's lives, and we're extracting money from the gross national product in the form of taxes, and investing it in a variety of ways. And I would argue that most of the time, the majority of the hours taken by the 15,800 school boards out there, is given just to this task of physically moving people and making sure that they are there at the appointed hour; making sure that the buildings are heated and cooled and that the food is served at the right time, and the transportation is done, the printing press is rolling, and all the other sorts of things that have to be done in order to operate those buildings.

I'd like to focus a bit on this Internet as one possible way to accelerate this deployment of narrowband ISDN, with the hope and the belief that we should go to broadband and to try and create some enthusiasm among the American people for what might be possible, which, to me, is a missing link.

The missing link is generalized enthusiasm, frustration, indeed, at times, even anger, that we're not doing more than we already are, given that if you lose the opportunity to educate a child, you're apt not to get that opportunity back.

In the Internet system, one of the things that's going on out there, Mr. Lucky, is that in the schools, schools as well as homes, but mostly schools are struggling to try and get hooked up to Internet—the primary and secondary schools. They do find themselves up against, I must say, Mr. Dimmit, some barriers from time to time in the cost of being able to hook up; not just the deployment cost of getting wired, but the access charges once they are hooked up, and the charges, par-

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ticularly for ISDN, if we ever get to a point where those schools can use those services.

Is there anything in your thoughts, Mr. Lucky, that would help someone like myself who would like to see homes in an increasing fashion be able to hook up to the Internet system itself.

And, Mr. Dimmit, those of us who have worked trying to provide an incentivized system for the RBOCs to earn their living, do you all have any ideas on what indeed policymakers like myself can be doing, both to push the RBOCs, to push cable, to push the policymakers, both in the private and the public side, so that these homes can increasingly be centers of education and learning?

MR. LUCKY. Well, I'd like to say that I'm glad you recognize the opportunity and the problem. Because certainly Internet, in particular, provides a wonderful platform for sharing education, as you pointed out.

And there are a lot of good experiments going on right now where schools have been networked together. And it's a new learning environment for people.

But there are many barriers there. One of them is getting the access. And when you look at all the schools we have and the cost of providing all that access, you're talking about a lot of money, and that's very daunting.

And the other thing is, you need some expertise in all these schools that's able to do this and to maintain the connection and to be able to do the teaching with it. So that also is daunting.

And, furthermore, if you go beyond just the networking, and talk about educating people in their homes and distance learning and things like that, things have not worked as well as we would have hoped in many cases.

I do like many of the experiments I've heard about, just network kids together. The kids learn from other kids, from school to school. So I think there's great potential there.

The people in industry, though, if you contrast that with taking education into the homes via multimedia and stuff, industry's pretty convinced that they can't make a buck doing that. That there's not a market that could sustain that. That's very unfortunate, but that's the belief in industry.

SENATOR KERREY. But the three big areas for me where government will make an effort will be in the area of research, in the area of regulation, and in the area of direct investment, any time we're trying and accomplish some objective.

And I say, direct investment, that can be tax credits, tax incentives, or actual tax expenditures. Any time we have an objective where we're trying to move from where we are today to where we'd like to be, we use those three tools to try and accomplish it. In general, I guess I'm looking for comments.

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MR. LUCKY. Right. Well, NSF has promulgated Internet by giving subsidies to the universities to hook up to it, and for the first two or three years of connection.

SENATOR KERREY. Well, I must say, with respect to that, I've supported NSF and I support what they're doing at the universities, but the universities are institutions that are responding to the general public's need for education, not the other way around, although they sometimes act differently.

It is, it seems to me, an institution response to a general educational need. And I'd rather not have the tail of the university system wagging the dog of the people themselves.

And I'm concerned that as I look at our investment strategy, indeed, that is what's happening.

MR. LUCKY. Well, I was only suggesting that some similar program for the K through 12 might be effective. But the problem is, there's a lot of dollars involved.

SENATOR KERREY. I should draw a grid, particularly from the thought that Mr. Dertouzos gave me, as to how we should organize our government.

We have problems in the country and we're responding to them, particularly problems with children, that 35 million market that we're talking about here.

On the horizontal, just look at the Federal Government organized in a variety of ways to do something.

We have the Department of Labor working to try and find jobs for teenagers and for their parents that will impact their education. In fact, we have 22 different federal agencies that are involved in trying to do something either with the children directly or with the families.

Then, on the vertical grid, we have a variety of efforts directly focused upon this task of education, as well.

NASA's doing education in mathematics and science; the Department of Energy is doing educational efforts in mathematics and science; the National Science Foundation, as well; the Department of Defense, and so is the Department of Education.

So you have this vertical grid narrowly directing its attention, trying to figure out what to do.

I believe very much that somehow we have to break the governmental impasse. I think we're still operating in the old culture. The old culture being that in order to learn, I have to build a building, move into the building, and hire people that are actually going to have an office in the building. That's the old world where, in order to learn, I had to actually move myself to a site of learning in order to get the job done. I'm still operating in that culture.

MR. DIMMIT. I think there are two things that the government can be looking at.

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One is just as there's going to be a migration from copper to fiber—I wouldn't say from narrowband ISDN—to get to broadband. The same thing that we're seeing in schools.

I've been working with some consortiums on education and technology in the St. Louis area. First, they're starting by getting into the schools by putting in multimedia learning systems into the classrooms, into centers where they can learn, so that the students get used to it and learning in a different way. There's also programming material that's valid out there. Then you can work about getting the technology in the homes.

So one is to encourage it to get into the schools, even though that's probably not the best place to do education, as you're saying. It's a good place to start and understand how you teach with multimedia broadband systems.

I think the second issue that we've run into is a bigger problem than the technology issue, and that's the copyright issue. In trying to do a lot of these multimedia systems and getting video and text and graphics other sources, the copyright issue keeps coming up again. And when we've tried to do prototype systems in schools and for learning multimedia systems, we've had a hard time getting the information from the producers of that information because of copyright laws.

And those are two areas I think the government can be looking at; how to deal with copyright issues, as well as how to get into schools first, and then migrate, over time, into the homes.

MR. KAPOR. Let me try and address some of the areas in which I think technology can play an enabling role in providing better education and what the government can do.

The first is the Internet—and now the NREN—it has proven to be a fabulously successful experiment. We are now in a new phase. And, in fact, there is a division in the research that is going on. On the one hand, investigating even higher speed systems—the gigabit networks of the future. And on the other hand, making Internet connections more broadly available, bringing it down to K through 12 and so on.

In my view, the best thing the government can do in that area is to recognize that two different policy regimes should be applied. One is to continue to fund the fundamental research that pushes towards higher speeds. But with respect to what is now a production network that is run with off-the-shelf components, it is to gracefully let go of the system.

Don't have the government fund another subsidized backbone surface. It's not needed. With the actual functioning Internet of today, the private sector can do a better job if you allow competition. Prices are going to come down. Service is going to be available in more areas and it will be more affordable.

Take the money that would otherwise go to funding a subsidized facility and give it directly to the institutions that you want to support, whether it's K through 12 or colleges and universities, and let them

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make choices in the marketplace, just the way they buy personal computers.

There is a certain maturity of the technology that permits competition. And it is a bit frustrating that private investment in what I call the commercial Internet is being held up, and therefore consumers are being denied the benefits of more access and lower cost access because it is still not an open playing field.

The second point, if I might. This is really a question of very specific NSF policies. A very hot and current debate because those issues as to how the NSF portion of the Internet is going to be funded are being discussed actively, week by week.

You asked about the RBOCs and what government could do with respect to the role of the phone companies. I think it's very clear that if you want to provide an affordable, easy-to-use access to the Internet or NREN, there needs to be some kind of end-to-end digital service get into each home that is affordable, and that is fast enough to move something besides just text.

You can't bring this network into the home, even to a small number of homes, if there isn't a modernization or upgrade of the phone system.

Again, you've heard the analogies of muscle cars over dirt roads, skyscrapers out of bamboo, but the step to narrowband ISDN would be sufficient enough to let people have a certain amount of face-to-face contact through video telephony, and to use graphics and sound and images in the instructional materials.

So I think there is another reason to push or move the RBOCs into making ISDN broadly available and affordable sooner, rather than later. Otherwise, there is really no adequate solution to the last mile.

The last thing I want to say is that there is some good news, that another part of the problem that exists today in this regard does not, in my opinion, require government intervention.

As we speak, Apple, IBM, and lots of other computer firms, are taking their first 15 years of experience in making personal computers and finally figuring out how to eliminate the complexity, and how to even get rid of the keyboard and replace it with a pen, and how to simplify the user interface.

You will hear buzzwords about personal digital assistance and home multimedia players. All this means is that over the next few years, you will see devices that are intended for the residential market. They have a few simple buttons on them. They don't have the arbitrary complexity of dealing with some naked operating system, but yet they'll have a full computer inside them, capable of being interactive, of storing images, and full motion video.

The technology is at the point of maturity where you can do that, and firms have recognized that the only way they're going to drive the number of personal computers at home up over 20 percent of the market is if they do this.

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All you have to do is solve the distribution bottleneck, how you move the information.

SENATOR BINGAMAN. Senator Kerrey has to go open the session of the Senate.

MR. DERTOUZOS. I was going to respond to Senator Kerrey, but he's going. Anyway it will be on the record.

I'd like to suggest that the government should encourage research and experimentation on the technological links to education, the use of computers and communications for education.

The jury is still out. I mean, at MIT about 15 years ago, we invented a language widely used by children called LOGO. Professor Papezt did that. And we still are not sure what the effect of that has been.

As we all know, this nation ranks between eighth and eighteenth worldwide in literacy, numeracy, geography at the post-high school level.

Our competitors, nations like Korea and Germany and France that are scoring ahead of us, are not doing this because they have deployed high technology.

So there is a lot to be learned here about how this medium can help us.

I share Senator Kerrey's optimism, and I've listed some of the ways in my own testimony.

It's scandalous how little money is available for research in that area. I have looked at it personally, and business, as Mr. Lucky said, is absolutely disinterested. They don't see how to make a buck here.

And even agencies like NSF are putting very very little money on truly trying to find out how computers, infrastructures, communications and education can help each other.

Is it by bringing kids together, is it by bringing the retired engineers from Florida with the inner city kids, is it by doing technological innovations that are simulations, is it by wearing goggles and virtual reality.

What are the mechanisms here that are truly going to improve education? We really don't know.

SENATOR BINGAMAN. Let me just ask one other question, then we'll let everyone go here.

Professor Dertouzos has recommended that we try to establish a new agency for National Information Infrastructure Development in order to get these conventions established and do the rest of it.

Mr. Kapor, do you believe that some kind of new governmental entity is required to do what you are suggesting should be done in this promoting of a narrow ISDN?

Who should do this? Who should do what you think needs doing?

MR. KAPOR. It's a matter for legislation at the federal level and a matter for public utility commissions. We don't see the need, at this point, to create an additional agency.

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MR. BERMAN. I think it's building this consensus, and you don't need a new, big government bureaucracy to do this.

SENATOR BINGAMAN. He didn't say he wanted a big government bureaucracy. He said he wanted a little government bureaucracy.

MR. BERMAN. But implicit was the idea that you would get all of these partners in a room to agree——

SENATOR BINGAMAN. Right. I'm just wondering who should call the meeting?

MR. BERMAN. I think Congress should call the meeting.

SENATOR BINGAMAN. Congress should?

MR. BERMAN. Congress can do that by mandating that it wants modernization to take place in the near term, and setting the terms of that modernization within the structure of the current telecommunications debate.

In other words, you can take steps to legislate the deployment of ISDN more rapidly through legislative mandate, at least the interstate part. And, as I said before, you can create incentives for the telephone companies to move forward with ISDN deployment in the states.

And I think the PUCs will come along, and you will have a federal-state partnership. It's got to be dropped, plunk, right in the middle of this current debate over the future of the MFJ.

SENATOR BINGAMAN. Mr. Lucky, did you have a thought as to how we could get this done?

MR. LUCKY. I'm not sure about Mike Dertouzos' suggestion.

There has been a leadership vacuum in communications since the MFJ in 1984. There is a lack of leadership because they said, go compete. That's the way it works.

Now, the question is whether the competition results in the right kind of infrastructure forming. Sometimes it does. I think in the area of customer equipment, customer premise kinds of things, it does. Whether the national infrastructure can be run that way is another question.

But what I like in industry, for government to act as a cohesive force, at first it can act as a forum. I mean, how does AT&T get together with MCI and RBOCs and that kind of thing? We can't do it really on our own. And so government plays an important role there.

I like what's happening in NREN because government is serving not only as a forum, but even in leadership, they've set out a vision, gotten people together. And they really are leading. And if there is an information infrastructure taking shape, I think the government forum created by NREN is having a big role in that.

And the other thing that the government can do, which is unrelated to what we've been talking about before, is I think you can do a better job in promulgating U.S. standards.

As you know, the standards——

SENATOR BINGAMAN. Who should do that? I mean, what should——

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MR. LUCKY. Well, I don't understand the whole standards business. I keep trying to find someone who does.

CCITT sets standards in communication, and that's an international thing. But the United States has a position. But the U.S. position comes apart from a complicated interplay of a lot of players. And there are a lot of people asking, can't we do a better job pushing the U.S. position. Take a stronger hand in the way we represent ourselves in the international standards arena.

SENATOR BINGAMAN. Who represents us on this CCITT?

MR. LUCKY. Well, CCITT is a lot of working groups that have members. There's a U.S. position that I think, in my naive way, is the responsibility of the State Department. But I really don't know about these things. There are a lot of players.

There is ANSI, which is a private group. And then there are places like Bell Core that try to promulgate standards in communication on behalf of the RBOCs.

There are a lot of players. It's a very complicated arena. But this is where things take shape. Government does have a role in there because the United States has to have a national position on these things, which plays in the international arena.

Historically, we've not worried about that so much in the United States because when we had a monopoly, prior to 1984, we didn't worry about what anyone else did.

SENATOR BINGAMAN. Mr. Dimmit, did you have a comment on this set of questions?

MR. DIMMIT. Yes.

I'm not sure a new agency would solve this. I think Congress can do it already. I would differ from the viewpoint that was just expressed from the four gentlemen. I don't think Congress should be dictating technologies. This is the technology you should put in, because technology changes so rapidly and so frequently that you might find yourself dictated to do something that no longer makes sense.

SENATOR BINGAMAN. What about technologies in a generic sense—I guess everybody here is saying that we should go to an end-to-end digital system. That's in the country's best interest.

What if Congress were to pass a law saying, it's in the country's best interest to go to an end to end digital system here—and then you have to fill in the blank—go get it done.

MR. DIMMIT. Well, if the economic situation would encourage that, that might be fine.

I think a mandate like that, without changes in the regulated system that we're under, would just not work.

SENATOR BINGAMAN. No, there'd have to be a lot of changes, but someone has to have the job of saying, okay, if that's our goal, let's put out the steps.

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MR. DIMMIT. If it's similar to the man-on-the-moon-before-the-end-of-the-decade type of thing, I think that's what the intent of S.1200 is—the Burns Bill. Let's set a goal and go towards that.

And I think if a goal is set, that's fine, as long as the implementation to get there isn't dictated as well, because this is a business as well.

SENATOR BINGAMAN. Mr. Lucky?

MR. LUCKY. For a long time in this country, we had something called universal service, and that was the goal that was promulgated by the FCC and by our policy.

You can redefine universal service now to be ISDN 64 kilobits, whatever. You can redefine that and say that is what we consider to be the universal service, and you can base the FCC policies and regulations on that as the new concept of universal service.

SENATOR BINGAMAN. Mr. Berman?

MR. BERMAN. I think that we don't want to be specific about technologies. I think Bob Lucky is right, that you can move ahead and say that our new goal for universal service is universal digital service available to all the residences in the United States at reasonable costs over time.

That could be done by Congress. There was mention of the Burns Bill that sets a goal of a fiber optic network in the future, and talks about infrastructure investment.

And we have no quarrel with that end goal, but we believe that that legislation should be modified so that the clear near-term goal is to establish this transition ISDN platform as the first hurdle. Then establish a series of steps towards broadband network.

We think that a consensus is possible because the investment isn't great. You're dealing with embedded costs that have already been absorbed in the network, and there are a whole host of entrepreneurs who are ready to come into the market if they can get end-to-end digital.

SENATOR BINGAMAN. Professor Dertouzos?

MR. DERTOUZOS. Well, I hear everybody saying that they are afraid of government running an agency, but they think someone should do it, and it should be a commission or it should be someone who worries about standards, or it should be Congress, whatever that means.

I'd like to submit a very simpleminded observation, Senator Bingaman.

This fear of government and the great faith in the entrepreneurship is what made this country great.

However, we're entering a period in which the world is getting smaller. We're next to our Japanese and German colleagues who have a lot more support at the central and common level.

And it seems to me that when everybody is saying what we want is someone to help do this, whether it's a commission or whatever. I'd like to suggest maybe that's what government is for, to take care and help us when we need to be pulled together and have someone worry about things like a phone book for this information infrastructure.

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Thank you.

SENATOR BINGAMAN. Okay. I think this has been very useful hearing. I appreciate very much all the testimony, and we'll continue with this set of hearings in the future, and try to do something useful.

Thank you very much.

[Whereupon, at 11:45 a.m., the Committee adjourned, subject to the call of the Chair.]

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SUBMISSIONS FOR THE RECORD

PREPARED STATEMENT OF MICHAEL L. DERTOUZOS

I wish to thank the chairman, the committee members and particularly Senator Bingaman for the opportunity they have given me to testify on a matter that I consider crucial and central to this nation's future economic primacy.

My testimony reflects two streams of experience: First, as Director of the MIT Laboratory for Computer Science, I have been professionally involved in dreaming about, crafting and analyzing the systems that are at the heart of today's discussion. In particular, I published my first vision of electronic highways for the U.S. eleven years ago under the title "The Information Marketplace". More recently I have published two relevant articles on the same subject following a decade of new experiences. These are entitled "Building the Information Highway" and "Communications, Computers and Networks" and are the cover story and lead article respectively of the January 1991 issue of Technology Review and the September 1991 special issue of Scientific American. With your permission, I would like to enter all three articles into the record as part of my testimony.

The second experience behind this testimony is the MIT Commission on Industrial Productivity which I chaired and which, starting in 1986 expended some 100 person years studying weaknesses in U.S. Industrial Performance and ways in which the U.S. could regain the productive edge. The outcome of this study is the book "Made in America; Regaining the Productive Edge", which has been translated into 6 languages and has circulated widely here and abroad. In that book we recommended that the U.S. proceed forthwith with the construction of a national information infrastructure which in our view would eventually become a network of communication highways as important for tomorrow's business as the current highway network is for today's flow of goods.

As I have been asked to do, I will try to address through this testimony the kinds of activities we might pursue through a well crafted information infrastructure, steps Congress should take toward making such an infrastructure a reality; and some of the ways in which such a development would change how we work, live, learn and play.

National Information Infrastructure

Let's begin by clearing up what a national information infrastructure is:

At bottom, there must be a **telecommunications and information infrastructure** that enables the tens of millions of computers in the U.S., and their users, to become effectively interconnected with one another. This infrastructure entails a huge network of glass fibers, wires, cellular and satellite links as well as the computers and software dedicated to switching and moving signals around, protecting them from unauthorized eavesdropping, billing for communications use and so forth.

The current telephone network is a precursor of such an infrastructure. It is, however, handicapped by its principal historic goal which has been to cater to the human voice. As a result, the phone network cannot allow machines in our homes and offices to talk to each other at the highly variable levels of **speed, reliability and security** that computers require in order to be effective. For example, photographs shipped around such a network for human analysis by distant experts can tolerate small errors in transmission, since people can ex-

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tract the right meaning from noisy images. On the other hand, critical medical data, software or money transferred over the infrastructure would require error free transmission. Likewise, legal contracts should be communicated securely over such an infrastructure while advertisements of products and services would typically require no such privacy.

The telephone network is likely to evolve over the next decade toward an approach called BISDN, or Broadband Integrated Services Digital Network, from its current forms, which include the similarly-named but vastly different NISDN (N stands for Narrowband) in use at many businesses today. BISDN or something close to it is needed for the national information infrastructure to be truly effective. Accordingly, **Congress should ensure that this evolution of the underlying network toward the broadband direction is legally enabled and accelerated.**

Beyond transporting information at variable speed, reliability and security, the information infrastructure must also offer certain **basic common services** i.e. services which are common to **all** users. For example these would include the equivalent of white and yellow pages for on-line use by computers. At a more ambitious level these services may even involve access from our homes of common national treasures like the Library of Congress and the National Gallery.

A word of caution: There is a tendency among telephone companies, internationally, to try to extend their role beyond carriers of information and providers of basic common services to sellers of many more of the specialized services that people are likely to require.

It is imperative, that we resist this tendency in the U.S., letting instead the free market forces of the users and their communities determine the nature and extent of the bulk of the services that will be transacted by them over the information infrastructure. Letting the carriers control such user services is potentially as ineffective and dangerous as was the attempt by Eastern Europe and the Soviet Union to anticipate and plan their respective economies - and for the same reasons!

Information Marketplace

What we should strive for is to encourage a free-market interaction among the tens of millions of computers in the nation's offices and homes, letting their users determine what services these machines will offer to or consume from one another. I have called this aggregate of the information infrastructure together with the millions of computers that will use it the **Information Marketplace,** because it resembles an old village market ... or a modern financial market.

This approach toward computer use of an information infrastructure is entirely analogous to letting millions of vehicles use the nation's highways for their own purposes, and at their own discretion—rather than trying to provide through some central authority busses, trucks and other vehicles in anticipation of people's transportation needs. As simple and straighfforward as this point should be, especially in a free market society, it is nevertheless a source of great confusion among telephone and cable companies as they try to position themselves for increased revenues through new services.

Here then is **an important step for Congress—to ensure that the providers of the underlying infrastructure focus on transporting information effectively among the millions of computers in our homes and offices and on offering basic common services. Significantly, these carriers should not**

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be given the authority to control or in any way limit services on the information marketplace.

I expect that these carriers, be they phone or cable companies, will press for offering such enhanced services anyway, on the same free market basis as everyone else. If this is permitted, then safeguards should be provided to ensure that the privileged status of these companies as carriers does not conflict with their aspirations as sellers of special services. This brings **us to a related step that Congress should take to empower the FCC to develop and enforce a comprehensive regulatory policy for the U.S. information infrastructure.**

Communication Conventions – E Forms

The services that will emerge on this information marketplace are essentially unlimited and will flow out of the entrepreneurship that has characterized this nation's history. To blossom, however, they will require adoption of certain **common communication conventions,** a sort of language through which computers will be able to understand the information flowing over this infrastructure. One way to achieve this is through what I have called **E-Forms,** an abbreviation for Electronic Forms.

E-Forms are very much like conventional forms with blanks to be filled out that have a pre-assigned meaning. For example, an E-Form to order produce would have fields or slots for the kind of produce, its grade, quantity, asking or bid prices, seller and buyer data and so forth. Another well known E-Form is used by travel agents today to book flight reservations on airline computers, with slots for origin, destination, date of travel, number of travelers and so on. I envision that eventually, there will be a large number of different such EForms on the information marketplace for different sectors of the U.S. economy. These forms would be defined by common interest groups, professional associations and other special groups representing users.

E-Forms need not be typed. They can be filled in by speaking as they are in a research prototype recently developed by Dr. Victor Zue at the MIT Laboratory for Computer Science. Moreover, they can be easily translated from one language to another, thereby providing an easy way to conquer linguistic barriers for routine business transactions. For example, to order a few thousand pounds of coffee, a wholesaler could spell out his needs or place his order in English and the suppliers would read and fill out their corresponding EForms in Spanish, first by typing and later in time by speaking. Once again, Dr. Zue has developed such a prototype at the MIT Laboratory for Computer Science, demonstrating translation of E-forms among English, Japanese and French.

Uses of the National Information Infrastructure

Trying to anticipate the uses of such a telecommunication and information infrastructure is as silly and fruitless a task as trying to anticipate all the uses of the telephone a century ago! Inasmuch as information processing together with communications pervade all facets of our economic activity and our everyday lives and account for some 14% of the GNP today, it is fair to say that the uses of such an infrastructure would touch on everything we do, much like the telephone, the highway system and the electric power grid have done to date.

Nevertheless, I shall try to summarize some of the uses that can be seen over the horizon, so that the Joint Economic Committee may better gauge the future potential of a U.S. information infrastructure. In the interest of economy, I shall do so in tabular telegraphic form, by category. More detail can be gleaned from the accompanying articles:

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Business Mail and Mail Order

Interactive video-sound-text communication that takes 5 seconds instead of 5 days, on $40B/year of business mail.

An entirely new set of portable communication activities on board cars and on persons.

Dynamic interactive sales demos and previews of

... physical goods (cars, bikes, boats, lawn mowers...)

... software

... services (hotels, restaurants, vacation spots...) Tailoring of products to individual needs (clothes, shoes...).

Recreation

HDTV—available through the infrastructure!

Interactive video—selecting what more of the news to view. On-line rental of high-definition movies and sound recordings, out of the millions made and offered—by various entrepreneurs.

Interactive travel to prospective vacation spots.

Explorations by common interest groups. The virtual neighborhood, where you choose with whom to communicate.

Community games.

Interactions toward meeting new people.

Intra and Inter-Company Uses

Collaborative work across space and time within and across firms.

Product simulators to torture designs prior to manufacturing.

Market simulators to assess product/service adoption.

Business simulators to train employees, like aircraft simulators for pilots, e.g. by simulating employee management problems.

Instant "explosion" of complex systems like cars into subassemblies, upon placement of an order, and remote just- in-time delivery of the necessary parts to the factory floor for rapid individualized production.

Seamless continuity along the lifetime of a product, from design, through prototyping, development, production and service.

Publishing

A rich video component is added to all-text and picture publishing—a new genre of video magazines and newspapers emerges.

Tailored, dynamic, interactive news.

Anyone can put forth his (her) creations on the information marketplace—A free market samizdat.

Publishers continue to exist. They sieve through the infojunk for useful pearls, and we still go to them for quality selections.

Democratization of the media and reduction of the monopolistic hue of cable TV, broadcasters, and others.

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Education

Interactive, video-intensive Teaching Assistants that respond to queries based on prior experience.

Linking retired engineers, e.g. in Florida, to high school students, e.g. in New York.

Interactive analysis and simulation tools that can analyze student work and answer what-if type questions.

Training simulators for math, languages, repair procedures and many other skills.

Automated tutors that identify and strengthen student weaknesses.

Other

Medical: Remote examination and, maybe, manipulation.

Legal: Client-lawyer collaboration in space and time.

Governmental: On-line acc6ss and interaction with legislatures; Handling of tax returns, queries and related business.

Real Estate: Shopping interactively at a distance.

Construction: Siting, designing, ordering, implementing.

Finance and Banking: Video conferencing, simulation, inspection

Impact of a National Information Infrastructure

These and many other uses that cannot possibly be anticipated at this time will change the way we work, live and play in several ways:

First, old work will be done faster and more effectively leading to increased productivity, especially in terms of the United States' competitive posture in the international arena. Imagine, for example, the consequences on productivity of business mail taking 5 seconds instead of 5 days to reach its destination.

Second, new activities will be possible that will open new horizons. Consider, for example being able to work from home if you are a spouse with children or as a physically disadvantaged person. Imagine, too, how the nation's industrial performance would improve if a company's financiers, production specialists, designers and workers could coordinate their work even if they are thousands of miles apart and cannot meet at the same time. Ultimately, education might change in important ways if we can bring together through this information marketplace great teachers with students regardless of where they may be situated.

Embedded in the nation's fabric through its diverse and distributed uses, such an information infrastructure would be difficult to copy by other nations.

Takeoff

Other nations are not standing still: Singapore has already set a plan in motion called IT2000 and sees itself as a potential international broker of services through it's information marketplace. Sweden is beginning to have the same aspirations.

Japan is on its way to construt6t an information infrastructure. And in what used to be East Germany, a brand new phone system of the BISDN variety is likely to be installed, since they are about to rebuild their communication infrastructure.

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In the U.S. a national information infrastructure will not emerge spontaneously, or under the greatness of the free market system—any more than a national highway system, a phone network or an electric power grid would have so materialized years ago!

It is therefore imperative for Congress to undertake the biggest step of all—to seed the National Information Infrastructure. This, I believe, can be done with expenditures mostly devoted to **coordination,** and estimated very roughly to be near the 1-billion dollar a year level. Limiting government's role to coordination is essential and adequate, since the carriers will finance the capital and operating costs of the telecommunications infrastructure, and business users will pay for its effective use through electronic stamps or equivalent pay-as-you-use schemes.

In my view, what Congress should do is take the first big step by causing interested parties from the telephone companies, the cable companies, industry, government and academia to get together in a concerted way. This would be best done **by Congressional legislation that would establish a new agency for National Information Infrastructure development which through its staff would stimulate and coordinate the actions of all these agents.**

The specific goal of this new group would be to develop and set in motion a viable plan for the evolution of the U.S. information infrastructure. For example, they would agree with the carriers on a plan to lay out fiber connecting first individual businesses and then homes. They would select modest but highly effective services, such as business mail, mail order, and perhaps some people-togovernment communications for the early uses of this infrastructure. Together with business and government advisors they would also agree on a core set of E-Forms or equivalent conventions for the users of the infrastructure to conduct useful business on this medium, **starting immediately via the current communications substrate.** And they would offer paths for interconnection of the nation's thousands of existing computer networks as well as emerging ones like NREN into this larger national aggregate toward a full fledged national information infrastructure.

Mr. Chairman, let me conclude by noting that I see no major technological barriers to turning this dream into reality. The principal obstacle ahead is likely to be our inability to easily agree on a common course. Yet, agree we must, if we are to move from the steam to the jet engine age of information, and enter the 21st century with computers and information technology sustaining and enhancing the economic primacy of the United States.

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PREPARED STATEMENTS OF MICHELL KAPOR AND JERRY BERMAN

Mr. Chairman and Members of the Committee:

I want to thank you for inviting us to testify today as part of your investigation into the future of the United States telecommunications Infrastructure. For those who may not know me, I am the principal developer of the Lotus 1-2-3 spreadsheet program and served as the CEO of the Lotus Development Corporation between 1982 and 1986 during which time it grew into a $200 million dollar a year software company. Jerry Berman is the Director of the Washington Office of the Electronic Frontier Foundation (EFF). Prior to joining EFF, Mr. Berman was Chief Legislative Counsel at the American Civil Liberties Union and founder and director of ACLU Projects on Privacy and Information Technology. Mr. Berman has worked to draft and enact such legislation as the Foreign Intelligence Surveillance Act of 1978; the Electronic Communications Privacy Act of 1986; the Computer Security Act of 1987; and the Video Privacy Protection Act of 1988.

I am a founder and President of the Electronic Frontier Foundation, a public interest organization established one year ago by pioneer developers of computer software and hardware and members of the computer networking community.

We founded the EFF based on a shared conviction that a new public interest advocacy organization was needed to educate the public about the democratic potential of new computer and communications technologies and to work to develop and seek to implement public policies to maximize freedom, competitiveness, and civil liberty in the electronic social environments being created by new computer and communications technologies.

While one of EFF's objectives is to secure First and Fourth Amendment protections for computer users and electronic bulletin board operators, our primary mission is to insure that the new electronic highways emerging from the convergence of telephone, cable, broadcast, and other communications technologies are truly free and open. By building our membership base, cosponsoring the Communications Policy Forum with the Consumer Federation of America and the American Civil Liberties Union, and developing and advocating specific communications policies, we hope to play a significant ongoing role in resolving critical communications issues. In this context, Mr. Chairman and Members of the Subcommittee, we again welcome the opportunity to appear here today.

I. Introduction

Until now the nation's telecommunications policy debate has largely been perceived as a struggle among entrenched commercial interests over who will control and dominate markets such as information services, manufacturing, and long distance service. We believe it is time to refocus the debate by seeking near- term technological, economic, legislative and regulatory solutions which will encourage the rapid development of a diverse information services market and help realize the democratic potential of new information media.

In the Fall of 1991, the Electronic Frontier Foundation was invited by Representative Edward Markey to testify before the House Subcommittee on Telecommunications and Finance on the subject of Bell company entry into the information services market. To address concerns that Bell entry into this market would reduce the diversity of information through anti-competitive behavior, EFF proposed the rapid deployment of a digital information platform, using existing technology and facilities, which could be made available to all

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on a ubiquitous, affordable, equitable basis. Our testimony suggested that Integrated Services Digital Network (ISDN) could be such a platform.

Narrowband ISDN, if offered nation-wide, and tariffed at affordable, mass-market rates, can offer end-to-end digital service without major infrastructure investments. This narrowband technology can also serve as a transitional telecommunications platform until national switched broadband access options become available early in the 21st century. With an ISDN platform in place, information entrepreneurs will soon be able to reach an expanded market in which to offer text, video, and interactive multimedia services. Public agencies, private communications, computer, and publishing firms, and even individuals will be able to access an inexpensive, widely available medium in which to publish and communicate electronically. Other technologies from outside the public telephone network may also come to play an important role in providing digital access, but because of the importance of the public switched telephone network, ISDN has a key role to play.

EFF believes that ISDN deployment and other developments in the public telecommunications infrastructure should proceed with the following goals in mind:

- make end-to-end digital service widely available at affordable rates;
- promote First Amendment free expression by reaffirming the principles of common carriage;
- ensure competition in local exchange services;
- foster innovations that make networks and information services easy to use;
- protect personal privacy; and
- preserve and enhance equitable access to communications media for all segments of society.

A robust, open telecommunications infrastructure is certainly important for the international competitiveness and economic health of our nation. But also, as people become more dependent on telecommunications services in their daily lives, the character of the evolving infrastructure and the laws which govern its operation will come to have a profound impact on politics, culture, education, and entertainment. Therefore, the steps that we take at this critical moment in the development of telecommunications technologies must be carefully considered.

II. Feasibility and Benefits of Rapid Deployment of ISDN

ISDN is a platform which could stimulate innovation in information services in a way that will benefit much of the American public that currently has no access to electronic information services. Lessons from the personal computer industry can help guide telecommunications policy makers in the development of an information infrastructure. The desktop personal computer represented a revolutionary platform for innovation of the 1980's because it was affordable, and was designed according to the principle of open architecture, allowing numerous hardware and software entrepreneurs to enter the computer industry.

To bring the benefits of the information age to the American public in the 1990's, we need to build an open, ubiquitous digital communications platform for information services. Just as the personal computer brought access to computing power beyond large organizations, widely available ISDN can enable the citizen's access into the Information Age.

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A. What is ISDN?

ISDN (Integrated Digital Services Network) is a technology designed for the public switched telephone network which allows low-cost communication in data, voice, video, and graphic media over the existing copper telephone network. ISDN is not an information service, but a platform, a transmission medium, for delivering and receiving information in a variety of formats. Crude data communication is possible over standard analog telephone lines now, but the fact that the existing transmission system was designed for voice, not for data, means that transmission rates are very slow, error rates are high, and equipment (modems) are difficult to use. Basic Rate ISDN offers transmission speeds over ten times faster than most data transmission schemes now used on voice grade lines.

ISDN is not a "field of dreams" technology. It is a fully-developed international standard that has been extensively tested in the United States and has already been implemented in the public switched telephone networks of other countries. Real applications have been demonstrated over ISDN lines. AT&T has field-tested distance learning applications which allow students in classrooms all across a city to participate in multimedia presentations run by a teacher in a remote location. Inexpensive desktop and home video conferencing systems are **now** being introduced which run over ISDN lines. These applications have real value, but are only a small sample of what entrepreneurs will inevitably produce if ISDN were widely available.

B. Prospects for Near Term ISDN Deployment

EFF's Open Platform proposal for ISDN is a work-in-progress. We have received valuable comments and support from key players among the Regional Bell Operating Companies (RBOCs), interexchange carriers, information providers, and state public service commissions, all of whom believe that ISDN can play a crucial role in developing the information arena for the benefit of all today. To date, we have reached the following conclusions:

1. ISDN deserves a *second look* because it can meet many of the information needs of residential and commercial users long before a public, switched broadband network will be available.

2. ISDN can be deployed on a nationally ubiquitous basis within the next three to five years, without massive infrastructure investment or new technology development.

3. ISDN can and must be tariffed as a *basic service* at affordable rates.

4. ISDN is a critical and even necessary *transitional* technology on the path toward the future broadband national public network.

5. The benefits of other networks that are already important information distribution media can be enhanced by interconnection with ISDN.

More investigation of many issues is still required, especially the regulatory economics of deployment. Still, we are optimistic that ISDN is an important step along the path to the development of a telecommunications infrastructure that meets the diverse needs of the nation.

1. ISDN deserves a "second look" because it can meet many of the information needs of both residential and commercial users long before a broadband network could be deployed

ISDN is the only *switched, digital* technology available *today* in the public switched network that can be deployed widely in the near term. Some telecommunications cogniscenti view the promise of narrowband ISDN as quite limited, because they are aware that ISDN has languished unimplemented for over ten years, and because they know that other copper-based transmission tech-

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nologies offering much higher bandwidth are available. We are fully supportive of implementing higher capacity narrow band and broadband networks in the future, when technology and user demand make it possible.

ISDN can meet many of the critical information needs of both residential and commercial users even without broadband capacity. For text-based data users and publishers, ISDN offers a dramatic advantage over data transmission technology currently used by individuals and small organizations. One of the two 64kbits/sec data channels available in the ISDN Basic Rate Interface can fax 30 typewritten pages of text in one minute, and send a 1000-word newspaper article in less than one second. Dramatic advances in video compression make transmission of video-conference images possible today, and all indications are that new compression algorithms will allow real-time transmission of VCR-quality video images in the near future. The Massachusetts Department of Public Utilities found, in the course of its recent investigation of ISDN, that "residential customers will benefit from the availability of significant enhancements to services such as home banking, library access, work at home, home health care monitoring, home shopping, and information access."[1]

The personal computer industry shows that raw power is not all that matters in a new technology. By about 1980, corporations already had good access to massive computational facilities at the institutional level through their mainframes and minicomputers. But individual workers had no effective direct access to those facilities. In practice, all the computing power didn't directly help the white-collar worker get her job done. Personal computers made a difference in the office and in the home because they were directly under the control of the individual, despite the fact that they were anemically underpowered.

Similarly, there may be high data capacity at the institutional data network level already, but if individuals and small organizations can't connect with it, its value is limited. We must make tapping into the digital, switched network as easy as ordering a phone line for a fax. Just as PCs enhanced individual productivity, ISDN can enhance individual connectivity.

2. ISDN can be deployed ubiquitously in the near future without massive new infrastructure investment or new technology development

In sharp contrast to fiber optic-based broadband technologies, only modest infrastructure investment is required. Digital central office switches are required for ISDN[2], but with the Bell companies aggressive deployment of a fully-digital switching and signaling system (Signaling System Seven), the bulk of the infrastructure necessary to support ISDN is already installed or planned.[3] Some Bell companies such as Bell Atlantic and Ameritech plan to have roughly 75% of their subscriber lines ISDN-ready by the-end of 1994. Other companies, however, project deployment rates as low as 17%. On a national level, 56% of all lines are expected to be capable of carrying ISDN calls by 1994.[4] (See Appendix A)

Many segments of the telecommunications industry are engaged in a concerted effort to make nation-wide ISDN deployment a reality. Problems that haunted ISDN in the past, such as lack of standard hardware and software protocols and corresponding gaps in interoperability, are being addressed by National ISDN-1. This a joint effort by Bell companies, interexchange carriers, and switch manufactures, and Bellcore, is solving major outstanding standards problems. By the end of 1992, a single hardware standard will make ISDN central office switches and customer premises equipment interoperable, regardless of which vendor made the equipment. Following National ISDN-1, Na-

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tional ISDN-2 will address standards problems associated with ISDN Primary Rate Interface (PRI), a switched 1.5Mbit/sec service with 23 separate 64kbit/sec data channels and one 64kbit/sec signaling channel.

Led by Bellcore, the communications industry has a nationwide demonstration of real, off-the-shelf, ISDN services planned for November 1992, called TR1P'92. A variety of local and national ISDN services will be demonstrated on a working ISDN network covering twenty cities around the country. TRIP'92 will show that Bell companies, long distance carriers, and information providers can work together to provide the kind of ubiquitous, standards-based service that is critical to the overall success of ISDN.

Additional interconnection problems do remain to be solved before ISDN is truly ubiquitous. Among other things, business arrangements between local Bell companies and interexchange carriers must be finalized before ISDN calls can be passed seamlessly from the local exchange to long distance networks.

3. ISDN can and must be tariffed as a basic service at affordable, mass-market rates

If ISDN is to be a platform that spurs growth and innovation in the information services market, it must be priced affordably for the average home and small business user. Platform services, even if they are ubiquitous, are useless unless they are also affordable to American consumers. Just as the voice telephone network would be of little value if only a small fraction of the country could afford to have a telephone in their home, a national information platform will only achieve its full potential when a large majority of Americans can buy access to it. Therefore, the tariffs adopted by state public utility commissions are critical to the success or failure of ISDN.

Since few states have adopted single-line business and residential ISDN tariffs, there is a window of opportunity to establish pricing principles for ISDN which make it viable as a mass-market service. The Massachusetts Department of Public Utilities (DPU) recently completed proceeding should serve as a valuable example to other states. The Massachusetts regulators found that ISDN is a "monopoly, basic service that has a potentially far-reaching and significant role in the telecommunications infrastructure of the Commonwealth."[5] The DPU also recognized that the "risks of pricing the service too high are of much greater concern... [because] high rates could discourage the development of new ISDN-dependent technologies and their applications."[6]

The final tariff approved has a monthly access charge of $13.00 for single line residential service and usage sensitive fees of 2.6 cents for the first minute and 1.6 cents for each additional minute. After much dispute, New England Telephone (NET) based the usage sensitive component of the tariff on measured voice rates already in place in Massachusetts. We believe that NET's decision to link prices to existing basic voice rates is an important signal to other LECs and other state commissions that low-priced ISDN service is indeed possible.

To encourage widespread use of ISDN, it must be priced at or near the price levels already in place for basic voice services. ISDN line charges will be somewhat higher than analog voice services because there are some additional one-time capital costs associated with offering ISDN service, but basing prices on voice telephone rates is possible and rational from a regulatory stand point.

The digital switches which carry ISDN calls treat voice and data calls in exactly the same manner. A five minute data call uses no more or less switching resources than a five minute voice call, so their pricing should be equivalent. Some states may chose to tariff ISDN only with measured (usage sensitive) rates, while others may also want to adopt a flat rate scheme similar

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to that which exists for residential voice services. The economics of this issue need more study, but we believe that both options have arguments in their favor.[7]

Current prices for ISDN telephones, data links, and in-home network terminators are high. An ISDN telephone with voice and data interfaces costs roughly $1000. If these price levels persist, many small scale users will never enter the market. However, with increased demand, ISDN terminal appliance prices can be expected to follow the steep downward curve of VCRs and PCs prices. When first introduced, VCRs cost well over $1000, but now sell below $200 for a basic unit.

Ill-considered pricing policy could, alone, cripple ISDN's chances for success. We are hopeful that Bell companies with more aggressive deployment plans will file such residential tariffs and set a precedent for progressive, mass-market pricing that will make ISDN affordable. In any event, legislative or regulatory action may be necessary to establish such a rate structure for ISDN nationally.

4. ISDN is a critical transitional technology on the road to a nationwide public broadband network

ISDN is not a permanent substitute for a broadband network, but it is a necessary transitional technology on the way to public switched broadband networking. Though some might like to leap directly to a broadband network, the entire telecommunications and information industry still has much to learn about designing a broadband digital network before it can be implemented.[8] Though a first generation of broadband switches are now being introduced, many basic questions still remain about the most appropriate design for a broadband network that can replace or be built on top of the analog telephone network. These questions are impossible to answer without experience in the ways that people will use a public, digital switched network.

Some are reluctant to make any investment in ISDN because it is perceived as old technology. But this is not an either/or choice If implemented at prices that encourage diverse usage, ISDN will provide important new services to all segments of society, and offer vital perspectives on how to design the next generation of public, switched broadband networks.

5. The benefits of other networks that are already important information distribution media can be enhanced by interconnection with ISDN

The public switched telephone network is a critical, central part of the nation's telecommunications infrastructure, so ISDN has a vital role to play in the overall information infrastructure. In addition to being an information platform itself, ISDN can interconnect with other networks that offer a variety of information resources. Cable television systems, which already provide broadband connections to 60% of U.S. homes and pass by 80%, might evolve to provide a new digital data service. Using ISDN, cable systems could develop interactive video applications. The Internet, an international packet network that serves universities, government organizations, and an increasing number of commercial enterprise, has over two million users and access to vast archives of information. Wireless transmission systems such as PCS (Personal Communications Systems) could also serve as open platforms for information services.

III. Guiding Communications Policy Principles

The public switched telephone network is just one part of what we call the National Public Network, a vibrant web of information links that will come to

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serve as the main channels for commerce learning, education, politics, social welfare, and entertainment in the future. With or without ISDN, the telephone network is undergoing dramatic changes in structure, scope, and in its growing interrelationship with other communications media. These changes should be guided by a public policy vision based on the following principles.

A. Create an Open Platform for Innovation in Information Services by Speedily Deploying a Nation-wide, Affordable ISDN

To achieve the information diversity currently available in print and broadcast media in the new digital forum, we must guaranty widespread accessibility to a platform of basic services necessary for creating information services of all kinds. Such a platform offers the dual benefit of helping to creating a level playing field for competition in the information services market, and stimulating the development of new services beneficial to consumers. An open platform for information services will enable individuals and small organizations, as well as established information distributors, to be electronic publishers on a local, national, and international level.

B. Promote First Amendment Free Expression by Affirming the Principles of Common Carriage

In a society which relies more and more on electronic communications media as its primary conduit for expression, full- support for First Amendment values requires extension of the common carrier principle to all of these new media. Common carriers are companies which provide conduit services for the general public. The common carrier-s duties have evolved over hundreds of years in the common law and later in statutory provisions. (All communications carriers, however, are not necessarily common carriers.)

The rules governing their conduct can be roughly distilled in a few basic principles. Common carriers have a duty to:

- provide services in a *non-discriminatory* manner at a *fair price,*
- *interconnect* with other carriers, and
- provide adequate services.

The public must have access to digital data transport services, such as ISDN, which are regulated by the principles of common carriage.

Unlike arrangements found in many countries, our communications infrastructure is owned by private corporations instead of by the government. Therefore, a legislatively imposed expanded duty of common carriage on public switched telephone carriers is necessary to protect free expression effectively. A telecommunications provider under a common carrier obligation would have to carry any legal message regardless of its content whether it is voice, data, images, or sound. For example, if full common-carrier protections were in place for *all* of the conduit services offered by the phone company, the terminations of "controversial" 900 services such as political fundraising would not be allowed, just as the phone company is now prohibited by the Communications Act from discriminating in the provision of basic voice telephone services. As a matter of law and policy, the common carriage protections should be extended from basic voice service to cover basic data service as well.

C. Ensure Competition in Local Exchange Services

Many consumer and industry groups are concerned that as the judicially imposed line of business restrictions are lifted (MFJ), the RBOCs will come to dominate the design of the emerging National Public Network, shaping it more to accommodate their business goals than the public interest. The bottleneck

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that RBOCs have on local exchange services critical to information providers can be minimized by unbundling these services and allowing non-BOC providers to offer them in competition with BOC local exchange companies.

Some suggest that an entry level test is necessary to guarantee that alternative infrastructure is developed for information services delivery. Alternative pathways are a useful and necessary part of our telecommunications infrastructure, but we should not rely on them alone to level the information services playing field. First and foremost we must find ways to open up the existing public switched network to competition at all levels. Competition will promote innovation in the services on which information providers rely, and help guarantee equal access to all local exchange facilities.

The post-divestiture phone system offers us a valuable lesson: a telecommunications network can be managed effectively by separate companies—even including bitter opponents like AT&T and MCI—as long as they can connect equitably and seamlessly from the user's standpoint. Together with the open platform offered by ISDN, unbundling and expanded competition is a key to ensuring equitable access to local exchange services needed for information service delivery.

D. Protect Personal Privacy

As the telecommunications infrastructure evolves, there are increasing threats to both communications privacy and information privacy. Strong government intervention will, at times, be necessary to protect people's constitutional right to privacy. In addition to this, however, we believe that technological advances should be used to help people protect their own privacy and exercise more control over information about themselves.

The privacy of telephone conversations and electronic mail is already protected by the Electronic Communications Privacy Act. However, communications in other media, such a cellular phone conversations, can be intercepted using readily available technology by private third parties without the knowledge or consent of the conversants. We need to give citizens greater control over information collected, stored, and disseminated by telephone companies and information providers. As the public outcry over Caller ID demonstrates, citizens want and deserve to have adequate notice about what information is being collected and disseminated by communications firms and must be able to exercise informed consent before information collected for one purpose can be used for any other purpose.

E. Make the Network Simple to Use

One of the great virtues of today's public switched telephone network, from a user's perspective, is that it operates according to patterns and principles that are now intuitively obvious to almost everyone. As this network grows beyond just voice services, information services that become part of this network should reflect this same ease-of-use and accessibility. The development of such standards and patterns for information services is vital, not just because it helps makes the network easier to use, but also because it ensures an open platform for information providers. However, standards development will be ad hoc and even chaotic at first. Numerous standards may be tried and found inadequate by users before a mature set of standards emerges. Congress and government regulatory bodies may need to set out the ground rules for standards planning in order to ensure that all interested parties have an equal voice, and the resulting standards should be closely analyzed to make sure that they reflect public needs. But, direct government involvement in the process should be avoided if possible.

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F. Preserve and Enhance Socially Equitable Access to Communications Media

The principle of equitable access to basic services is an integral part of nation's public switched telephone network. From the early history of the telephone network, both government and commercial actors have taken steps to ensure that access to basic voice telephone services is affordable and accessible to all segments of society. Since the divestiture of AT&T, many of the internal cross- subsidies that supported the "social contract" of universal service have fallen away. Re-creation of old patterns of subsidy may no longer be possible nor necessarily desirable, but serious thought must be given to sources of funds that will guaranty that the economically disadvantaged will still have access to basic communications services.

The universal service guaranty in the Communications Act of 1934[9] has, until now, been interpreted to mean access to "plain old telephone service" (POTS). In the information age, we must extend this guaranty to include "plain old digital service." Extending this guaranty means ensuring that new basic digital services are affordable and ubiquitously available. Equity and the democratic imperative also demand that these services meet the needs of people with disabilities, the elderly, and other groups with special needs. Failure to do so is sure to create a society of "information haves and havenots."[10]

IV. Conclusion

The path toward ISDN deployment requires that cooperation of numerous public and private sector organizations and political constituencies. National policy direction is needed to ensure that the necessary ubiquity and interconnection of service providers is achieved. Federal policymakers in Congress and the Federal Communications Commission will also have to consider the appropriate regulatory role for guidance of a new national resource: the information infrastructure. State public service commissions will be at the forefront of establishing pricing policy for ISDN service. The success of residential applications for ISDN will depend heavily on the PUCs' approach to single-line ISDN pricing.

The communications industry—including the Bell Companies, the interexchange carriers, equipment manufacturers—all have cooperative roles to play in making ubiquitous ISDN a reality. The computer industry is a new, but critical player in telecommunications policy. Many of the innovative products and services to take advantage of ISDN will likely come from the computer community.

In the policy arena and in relations with industry, many public interest advocacy organizations have a vital role to play in ensuring that new technologies are implemented and regulated in a way that promotes wide-spread access to new media and preserves the fundamental guarantees of affordable, universal service.

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Appendix A: ISDN Deployment Data

Regional Bell Operating Company ISDN Deployment Plans Through 1994
(Numbers in Thousands)

Regional Bell Operating Co.	Total Lines	Lines With Access To ISDN	
		Number	Percent
Ameritech	16,410	11,400	70%
Bell Atlantic	18,600	16,200	87%
Bell South	20,000	10,500	52%
NYNEX	16,360	5,100	31%
Pacific Telesis	15,900	10,900	69%
Southwestern Bell	13,600	2,900	21%
US West	14,100	8,300	59%
TOTAL	114,970	65,300	56%

Source: Bellcore Special Report SR-NWT-002102, *ISDN Deployment Data*, Issue 2, June 1992.

Note: This table does not include deployment data for independent telephone companies.

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NOTES

[1] Mass. D.P.U. 91-63-B, p. 86-7. See Appendix B for an overview of the Massachusetts proceeding.

[2] In central offices where digital switches have not yet been installed, ISDN can still be provided at lower cost than by installation of special "switch adjuncts."

[3] Though the Bell companies are not required to install Signalling System Seven, it is the only practical way that they can meet new FCC requirements for 800 number portability. See *Memorandum Opinion and Order on Reconsideration and Second Supplemental Notice of Proposed Rulemaking,* FCC Docket 86-10, Released September 4, 1991.

[4] See FCC Docket 89-24 and Bellcore Special Report SR-NWT-00210, *ISDN Deployment Data,* Issue 1, October 1991.

[5] *ISDN Basic Service,* Mass. D.P.U. 91-63-B, p. 34 (February 7, 1992).

[6] Id. at 86.

[7] Since the average length of a data call may be longer than the average voice call, the flat rate for ISDN would have to be adjusted upward to reflect added load on central office switching systems. However, the mere fact that data lines may remain open longer does not preclude a flat rate, non-usage-sensitive tariff.

[8] The most optimistic BOC estimates on fiber deployment promise ubiquitous fiber optic cable in roughly 20 years.

[9] 47 USC 151, et seq.

[10] *Modified Final Judgment: Hearings Before the Subcommittee on Telecommunications and Finance of the House Committee on Energy and Commerce,* 101st Cong., 1st Sess. 2 (1989) (Opening Statement of Chairman Markey). Chairman Markey set the following goal for the development of new information services:

> to make [information services] available swiftly to the largest number of Americans at costs which don't divide the society into information haves and have nots and in a manner which does not compromise our adherence to the long-cherished principles of diversity, competition and common carriage.

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PREPARED STATEMENT ROBERT W. LUCKY

The Evolving Telecommunications Infrastructure

Executive Summary and Conclusion

This is an energetic time in the communications business. The vitality of the industry is causing many alternatives to reach the marketplace. It is also a time when the infrastructure itself is undergoing a fundamental revolution. There is frantic activity in many of the piece parts of the industry. If there is any gap between expectations and availabilities, it might be in the public data networking area, where widespread access and informational support have not developed as fast as some might have desired. If this is in fact the case, it is probably because there has not been sufficient market demand for this activity.

Thank you Mr. Chairman. My name is Robert W. Lucky. I am Executive Director of the Communications Sciences Research Division at AT&T Bell Laboratories. I am pleased to have this opportunity, as a technologist, to comment on the evolving telecommunications infrastructure in the United States.

Twin revolutions power the technology of communications today. They are the ever-decreasing size of the transistor and the ever-increasing rate of information transmission on optical fibers. Put together with the growing pressure of information age needs and applications, this technology portends a new era of communications that has the potential to change profoundly the way we live and work.

The rate at which the new infrastructure evolves depends on much more than just technological invention. Since the divestiture of the Bell System in 1984, telecommunications has been dominated increasingly by International standards, in whose definition the United States plays no special role. Furthermore, the privatization of telecommunications has effectively substituted market forces for what was once accomplished by top-down, integrated planning. The responsibility for these solutions has been fragmented among a number of competing vendors, who often face difficult economic and political considerations in this competition, especially in the increasingly important international arena.

As a technologist, I shall try not to stray too far outside my own view and expertise. In surveying the infrastructure evolution, I will divide the field into the traditional components of transmission, distribution, networking, and applications. In each of these domains I will try to give a concise summary of the current state of knowledge and progress.

Transmission

Of the areas I shall discuss, transmission is the easiest in which to project future progress. Every year for the past decade and a half, the capability of an optical fiber to carry information (measured in speed times distance) has been doubled by research. The current international standard rate is 2.5 gigabits (billions of bits) per second on a fiber. This is about 50,000 voice telephone channels per fiber.

This unfolding capacity of a fiber has served to fuel both desires and realities in communications. Although, only a few years ago, it was predicted that no further progress needed to be made in capacity for the remainder of the

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decade, there is now a significant demand for upgrading of the present long distance fiber transmission facilities. New systems are under development that will transmit 10 gigabits per second on a fiber, and it certainly seems feasible to double this rate without requiring any major new breakthroughs in technology.

The most important innovation in optical transmission in the last half dozen years has been the erbium-doped, fiber optic amplifier. This is an amazingly simple component that amplifies light by a factor of about one thousand, regardless of the modulation or data format being carried by the lightwave signal itself. These amplifiers are being designed into the latest generation of undersea cable by AT&T. As a consequence of their introduction, it will be possible to upgrade the capacities of future undersea systems without the necessity of laying new fiber on the ocean floor.

Fiber amplifiers will also be used in terrestrial systems, where their main purpose will be to enable the skipping of huts—the points where the present systems require regeneration of the digital signal. This will make transmission even more economical than it is now. Indeed, the impact of research in the transmission field has been to make bits ever cheaper. This has not always been good for the equipment industry, as so little equipment is needed to provide such great transmission capacities. The markets are small; yet the necessary research and development is very sizable.

To summarize: basic transmission is getting cheaper, capacities are increasing steadily, and research is quite fruitful in this area. Though it is. quite unlikely that transmission will ever be free, the cost of providing long distance channels should tend to become only weakly dependent upon distance and bandwidth. In the future we should be able to send data over very long distances just to reach a point where switching or processing might be more economical. And we should expect to get wideband channels, such as for video, at almost the same cost as we get voiceband channels today.

Distribution

It is well known that communications is a "last-mile" problem. The superhighways for communications are taking shape, but bottlenecks will likely become apparent in both access and in the networking infrastructure.

There is no magical solution to broadband, inexpensive access. The current emphasis is on two approaches—wireless, personal networks, and fiber loops. Both offer exciting new capabilities in telecommunications, and put together, they bring about what the author George Gilder has called the "Negroponte changeover"—moving the broadband, find destination television signal into cables, and the narrowband, mobile voice traffic into the air. Yet, for different reasons, each of these transitions will be difficult to bring into widespread deployment.

Wireless networking is driven by the availability of radio-frequency spectrum, and by evolving agreements on standards for the air interface. The industry is focusing on opportunities in the frequency band around 2 GHz, with the promise that spectrum will become available in this region, which is generally considered to be ideal for personal communications. In the United States two incompatible signaling formats (the time division standard, IS-54, and code division multiplex) are competing for this market.

In building a personal communications infrastructure, the trend will be toward microcells of much smaller size than the current cellular design. The microcells will permit low-power terminals, and will also increase capacity, through greater frequency reuse. There is considerable activity in indoor per-

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sonal communications systems, where room-sized cells will support both voice telephony and data transmission in PBX- or LAN-based wireless architectures.

There is also activity in technology for wireless terminals and in the network control and intelligence for personal networks, it will not be very many years before a "Dick Tracy-like" radio wristphone becomes a reality. Undoubtedly, the proliferation of such personal, portable terminals will raise social problems, involving a fundamental tradeoff between accessibility and privacy.

The problems with fiber access are quite different in character. Spectrum availability and standards are not relevant. Instead, the issues center about the economics and applications. Fiber loops are more expensive than copper loops, and this will remain true for some years to come. For business access, the larger capacity of fiber makes it the medium of choice, but, for home access, there seems to be no compelling application that is worth the extra investment.

The video that a fiber could bring into the home can also be brought through CATV, or through high speed modems (ADSL at 1.5 Mbps) operating on existing copper loops. The cable systems have an evolutionary plan to increase capacity through upgrades of their present plant, including the use of fibers in their own distribution plant. The CATV capacity upgrades will free up channels to be used for video-on-demand by individual customers. The telephone companies can also offer these services through the copper loops using the ADSL models and modern picture compression technology.

There seems to be no apparent technological winner in the home access sweepstakes. It will be an interesting economical and political battlefield.

Networking

The present network is engineered around circuit switching of voice telephone calls. It is an extraordinarily complex network. Millions of lines of computer code control the electronic switches. New features are difficult to add, and in the coming years the capacity of these switches, and of the signaling network that controls the network, will approach exhaustion. Problems of reliability and the self-healing of the network have assumed a new prominence. There is a great deal of discussion about new network architectures that will enable the creation of new services, particularly broadband and data networking.

A new standard in network philosophy has swept the engineering community in the last several years. It is called ATM—Asynchronous Transfer Mode. ATM is a standard for information transmission that encodes all information into small (48-byte) packets. Each packet of information includes a header that indicates a pre-arranged destination address. ATM is a one-size-fits-all approach to communications; it provides bandwidth-on-demand to implement both bursty and continuous data connections of either narrowband or wideband speeds.

In ATM, each user takes as many packets as desired, at whatever rate fits the particular application. For example, voice users would take regular packets at a slow rate, video users would take regular packets at a fast rate, and data users transferring computer files would take a great many packets in one burst of activity. The bit rate at which packets are transferred across the network, 155 Mbps, is very high by today's standards.

ATM represents a unique opportunity to rethink and re-engineer the telecommunications infrastructure. It is an economic gamble in the sense that a great deal of processing is required, and this must be made very inexpensive. Furthermore, its one-size-fits-all philosophy means that it will be suboptimum for many applications. A fundamental question is whether there will be one

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integrated network in the future, or many overlaid, specialized networks that are optimized for various applications and types of traffic.

In spite of these and other concerns about ATM, there is worldwide enthusiasm in the industry over its ability to provide bandwidth on demand, its integration of many traffic types, and its presumed ability to serve as a platform for the easy creation of unforeseen future services.

There is already growing activity in providing ATM local area networks (LANS), and in bridges and routers that internetwork between LANs. The customer-premises equipment industry can move very quickly into areas bike this, and therefore serves as an impetus for developments in the wide area network beyond.

ATM can also serve as a vehicle for building data networking capabilities, but the real problems here lie more in economics, software, and information. The fantastic growth of Internet shows the appeal of public networking—the fact that the value of a network to each user grows with the number of users connected to the network. But in spite of the success of Internet, the culture, history, customer expectations, and subsidies in that network make it an unattractive business for the established common carriers Put bluntly, there does not seem to be any money in it. `the majority of the data networking business is in the private networking arena.

Applications

There is continual discussion in the industry about whether the demand for new applications drives the communications infrastructure, or whether it is the other way around. I generally favor the philosophy of Say's law, that supply creates demand. Fòr most of the history of communications, the applications have only developed when the Infrastructure was put in place. In today's world, with the marketplace acting as the arbiter of development, it is difficult to make the commitment and investment to build an infrastructure, in the absence of known applications.

The recent history of communications has not given a great deal of optimism about the leading power of applications. Many people have said that ISDN has developed more slowly than expected, owing to the lack of a "killer" application, such as the spreadsheet was for the personal computer. Furthermore, there has been an unwarranted optimism for certain services whose popularity has not developed, such as home information systems.

Nevertheless, there is great enthusiasm in the industry today for video services. The time seems right, in that bandwidth is becoming inexpensive, video compression technology is now powerful, and consumer electronics has effected cheap video components. The recently announced AT&T consumer videophone is but the first of a series of videotelephony and videoconferencing products that will cover a wide range of options ill resolution and price.

It is too early to tell how popular videotelephones will become. They convey an emotional dimension that should appeal within families and among close friends, but arguably add little to the informational dimension important to business. On the other hand, video conferencing is steadily gaining acceptance in business, where its effect seems to be an increase in organizational togetherness, rather than a decrease in travel.

Another new capability that has many proponents is multimedia. In multimedia conferencing, participants share a video workspace, where they can work jointly on editing documents, collaborative design, and other group ac-

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tivities. Again, it remains to be seen how we will change the way we work in order to take advantage of this capability.

In the home, the only service that I am especially enthusiastic about is some form of video-on-demand. I say "some form" because there is a wide range of possible definitions, depending on the range of material and the speed of response. Furthermore, as I have indicated earlier, such services can be provided by copper loops, CATV, fiber, satellite, or even radio. A related service that has similar characteristics is the narrowcasting of sparsely-desired material, for example, in the educational, hobby, or sports fields.

The last service I shall mention is messaging. The telephone system does not serve us as well as it once did for the simple reason that no one is home anymore. Cellular telephones are not the answer; it is more L fundamental question of availability and scheduling. Telephone answering machines, voicemail, fax, and electronic mail are assuming an ever more important role. Certainly, some form of personal messaging will be important in the near future. Some people argue for consumer e-mail, while others say that consumers will use only voice as a messaging medium.

Thank you.

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PREPARED STATEMENT OF STEVEN R. DIMMITT

Mr. Chairman and Members of the Joint Committee:

Introduction

I am pleased to have the opportunity to appear before the Joint Committee today to present Southwestern Bell Corporation's views on the development of a strategic plan for the nation's telecommunications and information infrastructure.

As stated in the National Telecommunications and Information Administration (NTIA) Infrastructure Report released last year, the U.S. has the best, most efficient and most affordable communications system in the world. But the U.S. cannot retain this preeminent position by adhering to outmoded notions of regulation and government micromanagement.

Present regulatory policies that discourage modernization, limit ingenuity and restrict the market presence of a large portion of the domestic communications industry are damaging America's international competitiveness. State and federal regulators should be providing the incentives to encourage further domestic infrastructure and market development by all members of the U.S. communications industry.

Status of Communications Competitiveness

The communications marketplace is rapidly changing. To remain competitive, Southwestern Bell Corporation and other U.S. companies must deploy state-of-the-art technology and set strategic directions that recognize a global market place.

Digital technology is the driving force behind a worldwide convergence of information-based industries. Signals from telephones, televisions and computers are translated into digital form. Pictures, as well as voice and text, are coded as bursts of zeros and ones transmitted over traditional copper cables, through the airways and as beams of light over hair-thin glass fibers.

The communications industry is converging from three sides, forming a giant triangle. The first side consists of distribution networks, like those offered by telephone, cable television, cellular and satellite communications companies. The second side is programming, including the production of everything from movies to compact discs and computer software. The final side of the triangle is manufacturing, the mass design, development and production of everything from televisions and personal computers to telephones and switching equipment.

This convergence of digital technologies and related industries is fueling the debate before this Joint Committee and other Congressional committees looking to reshape information industry policy. How policymakers ultimately deal with these issues will greatly impact this nation's competitiveness. Of the jobs created in the U.S. during the last decade, 90 percent were related to the generation, processing and manipulation of information. Nearly half of the nation's economic output arises directly or indirectly from information related activities.

Foreign countries like Singapore, Japan and Korea have already established aggressive national policies addressing the development of their information infrastructures. Numerous foreign corporations have established aggressive strategies and are making inroads into the U.S. communications market place.

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Southwestern Bell Corporation is concerned that certain American companies are being walled off from domestic and foreign markets by government imposed barriers. Seven of this country's most capable players—the Regional Bell Operating Companies (RBOCs)—are excluded from manufacturing. And the ability of local telephone companies to develop a more efficient, competitive infrastructure is being stymied by out-dated, unnecessary restrictions and regulation.

Manufacturing

The Modification of Final Judgment (MFJ)—the court settlement that broke up the Bell System—prohibits Southwestern Bell Corporation and the other RBOCs from manufacturing telecommunications and customer premises equipment. This restriction sidelines seven of the nation's largest corporations representing nearly 60 percent of the U.S. telecommunications industry's capital assets.

The manufacturing restriction applies to the design, development and fabrication of all types of telecommunications equipment. Southwestern Bell Corporation cannot establish a plant anywhere in the U.S. to manufacture telecommunications equipment sold in this country. No Bell company can design telecommunications equipment and then contract with another company to fabricate it.

From the vantage point of U.S. competitiveness, it is difficult to imagine a public policy as ill-conceived as the MFJ manufacturing restriction. The prohibition limits corporate incentives to invest in research and development (R&D), stymies technological advancements, stunts development of new products and services, and diminishes potential exports.

In effect, when the court broke up AT&T, it insulated AT&T and foreign vendors from additional competition by closing the U.S. telecommunications equipment market to the Bell companies. The federal court effectively appointed AT&T as the "national champion" hoping it would hold its own against foreign rivals.

While the Bell companies have wanted to enter and compete in this market, AT&T has steadily downsized its domestic manufacturing operations, eliminating more than 60,000 manufacturing jobs in the U.S. At the same time, AT&T started or invested in overseas manufacturing operations in 16 different countries and has established more than 20,000 foreign-based manufacturing jobs.

In 1984, there were 15 major telecommunications equipment manufacturers in the world market, three of them American. Today there are eight top players: three from Japan, three from Europe, one from Canada and only one, AT&T, from the U.S. America's onetime $200 million telecommunications trade surplus (SIC 3661— telephone and telegraph equipment) has, since the Bell System breakup, plummeted to an estimated $1.9 billion deficit in 1991.

AT&T's annual outlays on R&D since 1984 have increased an average annual rate of only 2.3 percent. By comparison, between 1984 and 1989, R&D spending in the computer industry and all U.S. industries rose at average annual rates of 11.5 and 7.7 percent, respectively. Barring the Bell companies from telecommunications equipment manufacturing appears to have reduced AT&T's incentives to invest in R&D.

Since 1984, the Bell companies have devoted only 1.3 percent of their annual sales to R&D, or about one-sixth of what most high-tech firms routinely spend. The MFJ effectively discourages any greater commitment to R&D by the Bell companies.

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Southwestern Bell Technology Resources, Inc. (TRI) provides technological research, direction and support for Southwestern Bell Corporation and its affiliates. In my previous assignment as Executive Director-Information Technology at TRI, it was my charge to help position SBC as the quality provider of leading-edge communications products and services at competitive prices. Frankly, this was often a frustrating charge.

Through its evaluation of products and services, TRI engineers often find that what customers actually want is neither available nor on the drawing boards of suppliers. Because of limited R&D resources and SBC's inability to work with them on design and development, many suppliers are not in a position to rapidly design and develop products that SBC affiliates can deliver to customers. The whole chain of events from identifying market need to designing an appropriate product and bringing it to market is stagnated.

In evaluating consumer needs and assessing technological alternatives, TRI engineers often discover and develop ideas which could improve products and services offered to consumers. Because of the MFJ manufacturing restriction, Southwestern Bell Corporation and its affiliates may neither fabricate nor provide detailed technical information on the design and development of these ideas to outside manufacturers.

Most frustrating is determining what activities are permissible under the MFJ and what are not. Severe potential penalties preclude the RBOCs from exploring promising innovations. The MFJ manufacturing restriction even inhibits investments and funding of small manufacturers who might be able to bring new products and associated jobs to this country.

For example, the MFJ prohibits Southwestern Bell from manufacturing either directly or through an `affiliated enterprise. This term is not defined in the MFJ. Six years ago one of the RBOCs—Ameritech—sought permission to invest in a small manufacturer and share product royalties resulting from its investment. The Department of Justice (DOJ) after thorough analysis concluded the investment and royalty arrangement was permitted by the MFJ and requested the Court's concurrence. After a three-year deliberation, the Court this year rejected the DOJ's request. As a result, Southwestern Bell and the other RBOCs now are reluctant to provide "seed" money to small manufacturers or entrepreneurs with new product and service ideas.

A growing list of promising TRI projects are held captive in the labs by the MFJ. For example, while looking for a way to improve data storage capabilities of computerized communications systems, TRI researchers found promising optical storage software and devices that improve reliability, require less floor space and reduce the cost of storage 10 fold. Although laboratory tests of hardware have yielded promising results, design specifications are prohibited from leaving TRI.

Consortia R&D efforts also are difficult because of the manufacturing restriction. TRI, Southwestern Bell Telephone Company, Washington University and NEC America Inc. recently participated in a "fast-packet" switching project in St. Louis. The trial looked at improving the transmission of X-rays and other high-resolution medical images and video over the telephone network. While NEC and Washington University researchers sat side-by-side gaining valuable design and development information, the two Southwestern Bell entities were restricted to providing the link between medical facilities. Most of the immediate technology transfer research benefits went to NEC.

The NTIA's Infrastructure Report correctly states that the MFJ manufacturing restriction hampers development of the U.S. telecommunications infra-

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structure. It slows R&D of new telecommunications products and hinders deployment of the network services built upon them.

Congress must ask itself serious questions in regard to the MFJ manufacturing restriction. Does it promote innovation and low cost provision of high quality goods and services? Does it capitalize on the collective R&D capabilities of U.S. companies? Does it help to provide the necessary infrastructure and operating environment for achieving U.S. competitive advantage? Does it allow research, development and application of technology to be exploited fully for economic prosperity? The answer is a resounding no to each of these questions.

Infrastructure

Certainly no other element of the overall U.S. infrastructure is as critical to this country's future global competitiveness as its communications network. Like an electronic interstate highway system, a national digital communications network will foster economic development. Japan already has determined that its nationwide fiber optic communications network will be the foundation of its twenty-first century economy. The Ministry of International Trade and Industry projects that by the year 2020, the broadband network will generate no less than one-third of Japan's gross national product.

As stated in the NTIA Infrastructure Report, much of the current telecommunications public policy debate concerns the respective roles of competition and regulation in local exchange markets, and the rate of deployment of advanced technologies in the local networks. At the heart of this debate is fiber optics.

Cable television operators, broadcasters, newspaper publishers and others with vested interests fear the day that a hair-thin strand of glass fiber provided by the telephone company will carry a stream of digitized voice, video and text information into American homes. George Gilder, a senior fellow at the Hudson Institute, predicts that powerful "telecomputers" will be connected to that fiber. This combination telephone/television/computer will process many different forms of information, providing news, education, health care and entertainment in one interactive digital system. The current U.S. communications infrastructure simply cannot handle what the telecomputers will be dishing out.

The super highway for digital traffic is fiber optics. Tiny lasers flash digitized messages across glass fibers that resemble fishing line. A single fiber can carry more than 35,000 simultaneous telephone calls and can replace 10 copper cables four inches in diameter. Laboratory prototypes of future systems currently place more than 100,000 calls on a single fiber.

Fiber optics is becoming an increasingly integral part of Southwestern Bell Telephone's network in Arkansas, Kansas, Oklahoma, Missouri and Texas. Fiber systems carry greater amounts of information, are less likely to be affected by adverse weather and provide a higher quality signal that can travel longer distances without regeneration.

For the past eight years, fiber optics has been Southwestern Bell Telephone's technology of choice whenever it is cost competitive with copper systems. Today it is used almost exclusively in replacement and expansion projects connecting central offices. Since 1986, fiber has proven to be the cost effective technology in a majority of projects connecting central offices to residential neighborhoods and business districts.

Southwestern Bell economic studies indicate that the day is close when fiber systems will be the cost-effective choice in many new construction pro-

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jects covering the final mile to customers' homes and businesses. Once fiber extends from central offices to homes and businesses, its full benefits can begin to be realized by consumers.

Congress recognized the importance of high-speed, high-capacity fiber optic networks last year when it passed legislation providing $2.905 billion over five years for the development of the National Research and Education Network (NREN). President Bush signed the High-Performance Computing Act late last year. It's now time to consider how to extend to all Americans the same communications advantages offered universities, hospitals, libraries and research facilities on the NREN.

Many state Public Utility Commissions (PUCs) have expressed concerns about local telephone companies "gold plating" the network. These PUCs fear that investments in new technology will benefit business users at the expense of higher phone bills for residential users. However, according to Gilder, the real threat of higher phone rates comes from businesses bypassing the phone companies to reach new fiber networks provided by companies that do not have an obligation to provide universal service.

George Gilder, *Harvard Business Review*, March-April 1991:

"The United States still spends far more money per capita on its communications infrastructure than any other country and commands a far more inventive and entrepreneurial information industry. The bulk of the spending, however, is by and for businesses, not the public.

"In 1987, for example, U.S. companies spent some $14.7 billion on private networks. Between 1988 and 1993, outlays of business local-area and wide-area networks are projected to rise fourteenfold. There are now some 700,000 private networks in the United States, compared with just 14,000 in all of Europe. U.S. businesses are demanding—and getting—broadband communications.

"This business-oriented telecommunications system will ultimately be bad for U.S. business, and, ironically, is starving the ultimate distribution system for its services and products. To open new markets, business leaders need a national network, not simply a Babel of business networks."

Some state legislators and regulators are moving to improve local economies by expanding the capacity of their communications infrastructures. For example, the New Jersey Telecommunications Act (P.L. 1991, Chapter 428) signed this year allows the State Board of Regulatory Commissioners to approve alternatives to rate of return regulation and deregulate services it deems to be competitive. This regulatory change has provided New Jersey Bell the incentive to pursue long-term planning and investment without burdening rate payers.

New Jersey Bell has filed a plan for alternative regulation with the Board of Regulatory Commissioners which includes consumer safeguards and rate stability provisions. The company also has filed "Opportunity New Jersey," its plan to accelerate the deployment of advanced switching and transmission technologies. This plan is intended to culminate in a fully fiber public network by the year 2010. This increased capital expenditure will be funded through new services, new capital borrowing and new efficiencies.

Information Services

In an opinion column published in a Hackensack, N.J., newspaper, Rep. Robert Torricelli (D-NJ) endorsed the New Jersey plan. He warned, however, that potential technological advancements and economic growth would be missed if New Jersey Bell was not allowed to offer new information services.

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Rep. Robert Torricelli, *The Record*, December 3, 1991:

"Tragically, though, New Jersey Bell cannot carry through with this effort if it and other RBOCs (Regional Bell Operating Companies) cannot provide information services which make fiber-optic wiring a worthwhile investment. Congress is considering legislative action itself to restrict the RBOCs' entrance into this market. Proponents of such restrictions argue that allowing the RBOCs into this market will give them a monopoly on information services. But no one is stopping competitors from entering this market today. Cable TV companies can lay fiber right now, and several information services are available to consumers with personal computers."

Although the Courts recently lifted the MFJ ban prohibiting the RBOCs from offering information services, a 1970 Federal Communications Commission (FCC) ruling and the 1984 Cable Act still bar phone companies from owning cable operators and providing video programming to subscribers in their regions. The "legislative action" referred to by Rep. Torricelli is an attempt by newspaper publishers and cable operators to reinstate the information services ban and solidify telco/cable video programming restrictions.

The latest attempt to take away existing services and prevent the Bell companies from bringing additional products and services to market is H.R.5096, the "Antitrust Reform Act of 1992" introduced by Rep. Jack Brooks (D-TX). This legislation would remove information services freedoms and would codify the MFJ restrictions on manufacturing and interexchange services.

This bill is anti-competitive and protectionist, designed to hold the Bell companies in check while allowing others to expand unrestrained. It needlessly protects newspaper publishers, cable operators, long distance providers and other large companies capable of competing with anyone. H.R.5096 also threatens present Bell company jobs and will limit future job growth within and outside of the seven Bell companies.

Regulatory safeguards, already adopted by the FCC and state PUCs, effectively address concerns raised by H.R.5096 proponents. According to Gilder of the Hudson Institute, the emergence of an advanced telecommunications infrastructure should not be seen as giving a monopoly to the telephone companies. Rather, it will liberate and reward U.S. entrepreneurs. Today some 30 cents of the entertainment dollar goes to distribution. On the fiber network, however, Gilder estimates the share of the entertainment dollar going to distribution will drop to less than a nickel. The real financial payoff is in providing the information, not delivering it.

New and yet to be discovered technologies assure that the provision and delivery of information services will become increasingly global and competitive. Diverse delivery systems and information providers will erase geographic and regulatory boundaries. For example, domestic cable television companies like TCI and Cox are testing tele-conferencing, medical imaging, high- speed data transmission and other telephone related ventures. Together, TCI and Cox are acquiring Teleport, a company that provides local communications services. These are unregulated monopolies using advanced technology to compete against regulated telephone companies.

While the competitive landscape is rapidly changing, the regulatory landscape is languishing. Instead of binding the hands of the Bell companies, Congress should be removing outmoded regulatory practices and encouraging greater participation by the Bell companies. Southwestern Bell Corporation welcomes the prospect of working together with Congress, regulators and business entrepreneurs to bring economically sound communications solutions to education, health care, environmental and other current U.S. concerns.

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Recommendations

Southwestern Bell Corporation appreciates this Joint Committee's invitation to make recommendations on the development of a strategic plan for the nation's telecommunications and information infrastructure. Many of the following thoughts mirror recommendations endorsed by the NTIA in its Infrastructure Report:

—**Congress should adopt legislation removing the MFJ manufacturing restriction.** The manufacturing restriction hampers development of the U.S. telecommunications infrastructure. It effectively eliminates the Bell companies from participating in proprietary and consortia R&D efforts to develop new communications products and services.

—**Congress should oppose legislation aimed at reinstating the MFJ information services restriction.** The Courts lifting the information services restriction will enhance the growth of new and innovative services, and will increase incentives to invest in the communications infrastructure.

—**Congress should adopt legislation removing the current telco/cable cross-ownership restrictions in the Cable Communications Policy Act of 1984 and FCC rules.** Allowing local telephone companies to provide their own video programming over their facilities would help promote infrastructure development by increasing incentives to deploy fiber optics and other advanced network capabilities.

—**State PUCs should continue to replace rate of return regulation with appropriate forms of incentive regulation.** In addition to Congress, the states must be part of the overall plan for enhancing U.S. telecommunications competitiveness. Incentive regulation generally rewards regulated firms for operating more efficiently. This can result in regulated services being provided at lower prices and at lower cost than under rate of return regulation. At the same time, it can provide incentives for efficient levels of investment in infrastructure development.

—**Congress, as well as federal and state regulators, should refrain from attempting to direct the selection of particular technologies or the pace of infrastructure investment.** Instead of mandating investment levels and technology choices, the FCC and states should encourage further infrastructure development by removing the government-imposed barriers to efficient investment in telecommunications facilities and services.

—**The FCC and state PUCs should continue to pursue regulatory depreciation reforms.** These reforms should increase the incentives for efficient telecommunications investment. Current depreciation practices often do not take into account rapid technological change, leaving assets on regulated firms' books that, in time, may prove to be substantially overvalued. Accelerating depreciation rates for telephone companies also would boost the economy and improve the competitive landscape.

—**Congress should continue to follow policy directions that support strategic research for long-term competitiveness.** Government initiated efforts such as the NREN have resulted in technology oriented

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companies partnering at the pre-cornpetitive stage of R&D. These efforts benefit broad sections of American business.

Conclusion

In conclusion, Mr. Chairman, Southwestern Bell Corporation applauds the Joint Economic Committee's efforts to support the development of the nation's telecommunications and information infrastructure. It is our hope that during the final weeks of the 102nd Congress significant legislative relief will be granted to the Bell companies, allowing these seven companies to participate more fully in revitalizing the global competitiveness of the U.S. economy.



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