

FOIA MARKER

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What's Special about the Internet?

Although the Internet will continue to evolve at an incredibly rapid rate, it's worth reflecting on the characteristics of the Internet that are of enduring economic and social value. I believe that it is what Mitch Kapor called the "Jeffersonian architecture" of the Internet that is worth fighting for. Therefore, an important question in the "open access" debate is whether changes in the industry structure of the telecommunications and Internet service provider industry (e.g. consolidation, vertical integration, shift from common carrier to private carrier) will undermine the Internet's Jeffersonian architecture. This (as opposed to which company controls the billing relationship with the customer) should be the focus of the public debate.

Important characteristics of the Internet include:

1. **Individuals and small institutions can be both producers as well as consumers of information.**
 - The Internet is a very important medium for freedom of expression because of the low barriers to publishing. As A.J. Liebling remarked, "Freedom of the press belongs to those who own one." With the emergence of the Internet, many people can afford to own a printing press. Some firms provide free (advertiser-supported) Web hosting services, and the cost of an entry-level personal computer has dropped to below \$500.
 - This characteristic of the Internet is also important for global electronic commerce, since a small firm can set up a Web site and immediately have access to global markets.
 - Of course, it is important to acknowledge that this characteristic of the Internet creates problems as well – if everyone can publish than everyone does – including neo-Nazis and people interested in sharing information on bomb-making.
2. **The Internet enables "many to many" communication as opposed to solely "one to one" (telephony) or "one to many" (broadcast).**
 - "Many to many" communication (e.g. a mailing list, a bulletin board) allows for the formation of communities based on shared interests as opposed to geography. For example, parents of children with a rare genetic disease called xeroderma pigmentosum (XP) – a disease which gives children severe blisters from any exposure to the Sun's UV rays – were able to find each other on the Web. They formed a virtual community, and created "Camp Sundown." Children with XP and their friends and relatives play during the night and sleep during the day.
 - "Many to many" communication is also important for political participation, since the Internet is being used by non-profits and political organizations to keep in close touch with their members.

3. The core standards of the Internet are not controlled by anyone company, and are “open.”

- Internet standards such as TCP/IP are “open” in the most robust sense of the word. They are not controlled by any one company or organization, the technical documents that describe the standards are freely available, and there are multiple, competing implementations of these standards.

4. The functionality of the Internet can evolve rapidly.

- The Internet provides a very general-purpose service (a “datagram”) – and it is possible to provide many applications on top of this service.
- Unlike the telecommunications network, where telecommunications service providers determine what services can be provided (e.g. call-waiting, caller ID) – the Internet enables anyone to introduce a new application. Anyone can write a new application (e.g. a new Web browser, Internet telephony, streaming video) – and it can be immediately downloaded by millions of Internet users and content providers.
- The Internet community has a highly effective standards process for extending the functionality of the Internet – the Internet Engineering Task Force (IETF).

OPPORTUNITY IN THE INFORMATION AGE

June 5, 1998

To ensure that all Americans have an opportunity to succeed in the Information Age, President Clinton believes that we must make universal technology literacy for our children a national goal. Technology literacy will allow students to use the latest Information Age tools for learning, research, and communication -- and compete for the high-wage, high-tech jobs the U.S. economy is creating in record numbers.

President Clinton is also committed to increasing investment in research and development to create economic growth and maintain America's leadership in science and technology. His FY99 budget includes record increases for the National Science Foundation and the National Institutes of Health. In his FY2000 budget, the President will call for significant increases in the information and communications R&D within agency budget allocations.

IN TODAY'S SPEECH, PRESIDENT CLINTON WILL:

- ✓ **Challenge States to Make Technology Literacy a Requirement for Middle School Graduation;**
- ✓ **Pledge to Provide \$180 Million over Three Years to Train a Team of Teacher Technology Experts in Each Middle School -- Who Could in Turn Help Train Other Teachers;**
- ✓ **Urge Telecommunications Companies and the Congress to Support the "E-Rate" -- Which Will Provide up to 90 Percent Discounts to Our Poorest Schools to Connect Them to the Internet;**
- ✓ **Announce the Administrations's Support for \$15 Million in Competitions to Encourage the Development of High-Quality Educational Software and Educational Web Sites by Students, University Faculty, and Commercial Software Companies; and**
- ✓ **Pledge to Increase Long-Term Computing and Communications Research in his FY2000 budget**

A NEW EFFORT TO EXPAND TECHNOLOGY LITERACY

- (1) **Technology Literacy as a Requirement for Middle School Graduation:** President Clinton is challenging states to make technology literacy a requirement for middle school graduation. Just as good schools would not allow students to graduate from middle school without being able to read and write -- all students should be technologically literate before they graduate from middle school. This is a "new basic" -- but it clearly rests on a foundation of the fundamentals. Obviously, knowing how to send e-mail or browse the Web will not help a child that can't read and write effectively.
- (2) **Technology Training for Teachers:** To reach the goal of universal technology literacy, President Clinton is pledging to provide \$180 million over three years to train a team of teacher technology experts in each middle school -- who could in turn help train other teachers. The money would go to states that agree to establish technology literacy as a requirement for middle school graduation.
- (3) **Support for the E-Rate:** The President is urging telecommunications companies and the

Congress to support the "e-rate" -- which will provide up to 90 percent discounts to our poorest schools to connect them to the Internet.

- (4) **Competition for High-Quality Educational Software:** The Administration will support \$15 million in competitions over the next three years to encourage the development of high-quality educational software and educational Web sites by students, university faculty, and commercial software companies -- and make it easier for teachers and parents to find high-quality educational resources.

THE NEED TO ACT -- ENDING THE DIGITAL DIVIDE

Although there is some evidence that we are beginning to close the gap between information "haves" and "have-nots" -- America must act if we are to avoid a digital divide.

- In 1997, high-minority enrollment schools were almost three times less likely to have Internet access in classrooms than predominantly white schools (13 percent of classrooms vs. 37 percent). [Source: Department of Education, National Center for Education Statistics, March 1998.]
- Similarly, poor schools were more than 2 ½ times less likely to have Internet access in classrooms than wealthy schools (14 percent of classrooms vs. 36 percent). [Source: Department of Education, National Center for Education Statistics, March 1998.]
- While 73 percent of white students (high school and college) own a home computer -- only 33 percent of black students do. [Source: "Bridging the Digital Divide: The Impact of Race on Computer Access and Internet Use," Thomas P. Novak and Donna L. Hoffman, Vanderbilt University, February 2, 1998]
- While 77 percent of wealthy households own a computer at home, only 19 percent of poor households own one. [Source: Forrester Research, December 1997.]

PRESIDENT CLINTON'S RECORD - MAKING ALL OF OUR CHILDREN TECHNOLOGICALLY LITERATE

Beginning in 1995, President Clinton established four goals (the "four pillars") to ensure that all of our children are technologically literate -- (1) connecting every classroom to the Internet by the year 2000; (2) expanding access to multimedia computers; (3) ensuring that teachers are as comfortable with a computer as they are with a chalkboard; (4) and promoting the development of high-quality educational software. He has:

- Proposed a 5 year, \$2 billion Technology Literacy Challenge Fund -- with \$475 million in FY99 -- to help states and local communities meet these four goals;
- Proposed \$75 million in investments in FY99 to ensure that all new teachers can use technology effectively in the classroom;
- Signed the Telecommunications Act of 1996 - which provides deep discounts to connect schools and libraries to the Internet that need it most;
- Helped jumpstart grassroots volunteer activities like NetDay and TechCorps -- which have mobilized hundreds of thousands of volunteers across America.

***MAINTAINING AMERICA'S LEADERSHIP IN THE INFORMATION AGE --
EXPANDING OUR INVESTMENTS IN RESEARCH AND DEVELOPMENT***

Government-funded basic research has led to some of the most important innovations that are driving the Information Revolution, such as the Internet, Web browsers, and many other advances in computing.

In his FY99 budget, President Clinton has called for the largest increase in history at the National Science Foundation and the National Institutes of Health -- and increases in many other areas of civilian research and development. This budget proposal would allow increased investment to help find a cure for cancer, reduce greenhouse gases with more energy-efficient technologies, explore space, and develop the Next Generation Internet.

In his FY2000 budget, President Clinton will call for significant increases in the long-term information and communications R&D within agency budget allocations. The National Science and Technology Council -- in consultation with the President's Information Technology Advisory Council -- will be responsible for developing a long-term research agenda. Some of the exciting research challenges that lie ahead include:

- Developing supercomputers that are hundreds of times faster than today's machines, and that will allow scientists and engineers to more accurately predict the impact of climate change and design more fuel-efficient engines;
- Making computers so easy to use that all Americans can use them, including the 55 million Americans with disabilities;
- Increasing our ability to design complicated information systems that are reliable; and
- Developing high-speed wireless networks that can help bring distance learning, telemedicine, and economic opportunity to every rural community in America.

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[Note: Many of the government actions proposed here should be preceded by an analysis of whether there is a “market failure” – or some other overarching policy goal such as “equity” that justifies a more activist government policy. For example, government support of R&D is justified when individual companies can’t capture the returns of the investment, the social rate of return is higher than the private rate of return, and the private rate of return is insufficient to justify private sector investment.]

I. Rights of Way

A. Background

1. Access to rights-of-way can make it much easier for telecommunications companies to deploy broadband services. Qwest, for example, was able to rapidly deploy a nationwide network by securing the rights-of-way from railroads such as Southern Pacific Rail Corporation.
2. Lack of access to rights of way can slow down competition and new entrants. In their analysis of the 3-year anniversary of the Telecommunications Act, the Association for Local Telecommunications Services (ALTS) complained that “municipalities continue to impose excessive taxes and burdensome regulations on all telecommunications carriers ... and building owners are often reluctant to allow new carriers to wire their building or put antennas on rooftops.”
3. On the other side of this debate, the National League of Cities believes that “local governments must be able to determine their own futures and ensure equity in revenues, rights-of-way, land use, and zoning.”

A. Options

1. Issue Executive Order which requires as a condition for Federal Government tenancy – that landlords permit competing telecommunications carriers in their buildings on reasonable and non-discriminatory terms
2. Convene conference on “rights of way” with industry and state and local government.
3. Look for ways to encourage states to use interstate highway system rights of way for both wired and wireless telecommunications (some states are already doing this).
4. Support legislation that would prevent landlords from establishing exclusive relationships with incumbent carriers.

II. Encourage Rural and Inner-City Deployment of Broadband Services

A. Background

1. The President and the Vice President want to ensure that these new information technologies bring America together, as opposed to creating a “digital divide.”
2. Research shows that (as of the spring of 1997) -- three quarters of the U.S. population had easy access to commercial Internet service providers. Of the 13 percent of counties that had no commercial ISP, 88 percent were rural. This lack of access may be exacerbated as we move to broadband, given the cost of deploying broadband networks to rural areas.
3. There is strong Congressional interest in rural broadband deployment. USDA and NTIA recently received a letter from the Hill asking for a study which would assess investment in advanced telecommunications services in rural areas as compared to non-rural areas, the availability of backbone networks and “last mile” facilities, the feasibility of different technological alternatives, and the effectiveness of competition and universal service support mechanisms to promote deployment of advanced services.
4. This may also be an issue in our inner cities. Groups such as the Alliance for Public Telecommunications believe that “communities across the nation are reeling from the market-driven “electronic redlining” that is frustrating their efforts to promote universal deployment of advanced telecommunications capability.” As part of its FY2000 budget proposal, the Administration is proposing an increase in the funding for Community Technology Centers from \$10 million in FY99 to \$65 million in FY2000.

B. Options

1. Identify specific ways in which universal service support mechanisms and the definition of “core services” can provide incentives for investments in the network.
2. Expand programs that provide grants and loans to rural and distressed urban communities – such as the Rural Utility Service and Telecommunications and Information Infrastructure Assistance Program.
3. Create testbeds that demonstrate potential of new wireless and satellite technologies for rural areas (see research section).
4. Expand FCC’s discounts for rural health care providers.

1. Provide tax incentives, changes in depreciation for both regulatory and tax purposes for private sector investment.

III. Broadband applications

A. Background

1. The deployment of high-speed networks may suffer from the classic “chicken-and-egg” dilemma. Without broadband networks, no one can experiment with broadband applications. However, without broadband applications, no one will deploy broadband networks.
2. The Administration is supporting the development of broadband applications for the research community as part of the Next Generation Internet initiative. Government, industry and academia are working together to connect more than 100 universities and national labs at speeds that are 100 to 1,000 times faster than today’s Internet. Scientists and engineers are developing applications such as remote access to supercomputers, tele-immersion, massive digital libraries, real-time collaboration, telemedicine, and distance learning. However, none of these testbeds or applications involve home users. The Administration should consider initiatives that are aimed at demonstrating and promoting broadband applications for residential use.
3. There may also be regulatory and other policy steps that the Administration can take to promote these applications.

A. Options

1. **Telecommuting:** Extend the same tax treatment that is currently being provided for commuting benefits to telecommuters (Price legislation).
2. **Telemedicine/home health care:** Review HCFA policy with respect to reimbursement of information technology.
3. **Broadband communities:** Expand TIIAP program to create one or more “broadband” versions of the Blacksburg Electronic Village – in which the entire community was connected to the Internet.
4. **Digital libraries:** Increase funding for digital libraries to include content such as old movies, sound recordings, and 3-D flythroughs of historic places.
5. **Demand-side management:** Look for policies that will encourage electric utility investment in broadband for demand-side management and other energy-related applications. This will

have the added benefit of encouraging investment by companies that may be more willing to resell excess capacity.

6. **Digital Government:** Increase funding for the “Innovation Fund” (or some similar mechanism) to encourage agencies to begin prototyping government services that require broadband networks.
7. **Life-long learning:** Examine whether existing support for life-long learning (loans, grants, etc.) can or should be used to support broadband connectivity – to allow “anytime, anywhere” instruction for adult learners and students.

IV. Research and development

A. Background

1. Currently, the Administration’s research agenda has focused on “long-haul” networks. As part of the Administration’s Next Generation Internet initiative, DARPA is supporting research projects to develop all-optical, terabit per second networks. However, there is very little research in improving the technology for the “last mile.”

B. Options

1. Extend NGI for 2001 and 2002 – with a new emphasis on “last mile” technologies. Examples in the wireless area might include better models for broadband radio propagation, dynamic, adaptive network protocols, fast, low-power algorithms, knowledge needed to deploy wireless systems based on the actual physical environment, low cost millimeter wave receivers and transmitters, smart antennas, and new mechanisms for mitigating interference. A group of researchers in industry and academia convened by the National Science Foundation concluded that with additional research dollars, “data rates of *tens of megabits per second* (i.e., broadband Internet access), even gigabits per second, are envisioned as a realizable goal beyond third generation (wireless systems).
2. Create “NGI Fellows” program to encourage undergraduate and graduate students to develop new applications.
3. Support research into advanced applications that require high-speed networks (e.g. telepresence – ability to get 360 degree coverage of a remote location.)

THE WHITE HOUSE
WASHINGTON

July 7, 1997

MEMORANDUM FOR GENE SPERLING, DON GIPS

FROM: TOM KALIL TAK
RE: DIGITAL "LABORATORIES OF DEMOCRACY"

"I believe we should ship decision-making responsibility and resources from bureaucracies in Washington to communities, to states and where we can, directly to individuals."

-- President Clinton, January 31, 1995

You say you want a devolution?

The President and Vice President are strong supporters of giving additional resources and responsibilities to state and local governments. This has certainly been the trend. The net growth in federal civilian employment between 1962 and 1995 was 15 percent, while state and local employment grew by 150 percent over the same period.

One of the arguments for devolution is that states can serve as "laboratories of democracy." John Donahue observes that "as states innovate, their experience informs not just their own policy choices, but those of the other states as well." Donahue identifies a number of examples where innovation in one state has spread quickly to others:

- Georgia's discovery that with respect to environmental regulations -- businesses care more about rapid processing of permit applications than the stringency or laxness of the regulations;
- State adoption of laws barring "gag rules" -- HMO rules forbidding doctors to discuss costly treatment options with patients;
- Sunset laws triggering automatic review of legislation; and
- Competency tests for teachers.

Use of Internet/Intranets for diffusion of “best practices”, formation of “virtual communities”

New technologies may enable the United States to take maximum advantage of these “laboratories of democracy” - and of all of the information and expertise that is generated by a particular community.

Within the last couple of years, companies have moved aggressively to deploy Intranets as a mechanism for sharing best practices and the accumulated knowledge and expertise of its employees. Texas Instruments, for example, found such wide disparity in the yields of their wafer fabrication sites that they launched an effort to create a “free fab” by closing the productivity gap between their world-class fabs and the manufacturing facilities that were lagging behind. Arthur Andersen (AA) has developed an intranet called KnowledgeSpace that contains:

- A taxonomy of all business processes, and information on the ways in which world-class companies accomplish a particular business process;
- Descriptions of previous client engagements;
- Studies and articles;
- Tools for performance measures and diagnostics;
- Templates for presentations to clients;
- Intranet-based training;
- Directories of AA experts in a particular subject;
- Sophisticated tools for searching and navigating through all of this information.

Internet-based companies are also forming to foster “virtual communities” or “communities of interest.” For example, ParentSoup, one of the companies highlighted in the Administration’s event on global electronic commerce, has developed an on-line community for parents. The service has discussion groups on 60 subjects - everything from bottle feeding to sibling rivalry; polls; live chat; an on-line library on parenting issues; information on 5,000 baby names; and parent’s picks on books, baby products, travel, and toys.

As McKinsey consultants John Hagel and Arthur Armstrong note in *Net Gain: Expanding Markets Through Virtual Communities*, these on-line communities often demonstrate “increasing returns.” For example, the more people participate, the more user-generated content is published, which in turn attracts more users.

Public sector applications

I believe that there are significant public sector applications for these techniques. Already, some public sector “communities of interest” (e.g. people working on acquisition reform, public financial management.) are exploring ways of using the Internet more aggressively.

Obviously, as opposed to maximizing the dissemination of information and expertise within a firm, the government’s interest is in promoting this within a particular community of interest (e.g. everyone working on welfare-to-work, community policing, the “America Reads” challenge, etc.) Participants in these on-line communities might include federal, state and local officials, practitioners, academic experts, staff of non-profit organizations, and other stakeholders in a particular issue area. A wide range of services could be provided, including:

- On-line access to a wide range of relevant information, including federal and state legislation, program evaluations, case studies of successful initiatives and “best practices”, statistics, databases, proceedings of conferences, etc.;
- An ability to conduct electronic transactions with the federal government (e.g. NSF’s submission and management of grants using a system called FastLane);
- Moderated newsgroups or mailing lists on particular topics;
- Interviews and presentations, with real-time questions from the “virtual” audience;
- Polls and surveys;
- Structured debates on hot issues of the day;
- Internet-based training; and
- Directories of participants in the community, allowing people with shared interests to find each other.

It is important to note that companies are investing heavily in tools to support these kinds of activities. A new start-up called PlaceWare, for example, has developed a product called “Auditorium” that allows presenters can show a slide show, give a space, or host a discussion, while the audience can ask questions, chat, collaborate, and even vote. A high-tech consulting firm is developing a service called “ExperNet” that allows customers to ask questions, get back answers within 24-48 hours, and query a knowledge base of previously answered questions.

Potential benefits of these communities

There are a wide range of potential benefits, including:

- Faster diffusion of innovative practices;
- Sharing of expertise that is in people's heads, and not written down anywhere;
- Broader access to information that is relevant to policy-makers and practioners in a particular issue area, which would hopefully lead to better decision-making;
- Better communication between different levels of government, and between people in government, non-profit organizations, private sector, and academia;
- Creation of a "space" for debate and public discourse on important issues.

Implementation/next steps

My view is that the development of these "digital laboratories of democracy" should be outsourced. The skills necessary to develop these include expertise in the subject matter; information management; and Internet/Web technical skills.

As these communities gain momentum, it is possible that some or all of the costs associated with maintaining them could be defrayed by subscription fees, advertising sponsorships, etc.

Funding requirements for these would be relatively modest - probably several million dollars per year per laboratory. In terms of funding:

- The Administration could issue a white paper on the subject, and encourage agencies to experiment with these concepts within existing FY98 funds.
- The Administration could provide specific funding for "digital laboratories of democracy" in its FY99 budget.

MEMORANDUM

To: Don Gips
From: Tom Kalil
Re: NII agenda for 1997 and beyond
Date: May 19, 1997

I. Overview

A cluster of technologies/industries (e.g. the Internet and intranets, mass storage, microprocessors, fiber optics, satellite and wireless, GPS, remote sensing at 1 meter, speech recognition, intelligent agents, electronic cash, data mining, smart cards, groupware, micro-electronic mechanical systems, etc.) is having a profound impact on virtually every aspect of our economic and social life.

We are still at the early stages of the Information Revolution - and can look forward to at least another 20-30 years of improvement in:

- *Price:performance* (30%-40% annual reduction in cost of storing, transmitting and processing information);
- *Ubiquity* (household and business adoption of PC's and other information appliances, Internet connectivity); and
- *Functionality* (new applications such as multicast, tele-immersion, secure transactions, etc.)

Given that the President and Vice President are "present at the creation," -- they have a unique opportunity to pursue policies that will:

- Strengthen America's leadership in the production and export of these technologies - which are arguably driving U.S. economic growth and productivity increases;
- Maximize the benefits of the Information Revolution in areas such as life-long learning, health care, delivery of government services, digital libraries, community networks, electronic commerce, environmental monitoring, digital libraries, environmental

monitoring, improving the quality of life for people with disabilities, and public safety.

- Deal responsibly with the issues raised by the Information Age, such as intellectual property, privacy, security, equity, and Internet governance.

II. Policies

A. White House priorities

The Administration needs to identify a relatively small number of priorities that it believes will (a) lead to major economic and social benefits; and (b) require White House leadership to be successful. Below is a first cut at such a list.

1. President's educational technology initiative

The President and Vice President have identified some clear goals -- now we have to meet them. 1997 action items include:

- Full funding for Technology Literacy Challenge;
- E-rate implementation;
- Event with Redstone group on 100,000 computers;
- "Content" initiatives such as digitization of Smithsonian, implementation of Presidential memorandum;
- Professional development initiative;
- Better coordination of educational technology R&D, release of PCAST report.

2. Successful implementation of the Telecommunications Act of 1996 and WTO

Making the transition from a regulated monopolies to a competitive market for local telecommunications services - with lower prices, more choice, and faster deployments of new services -- would be a huge win. The Administration also needs to ensure that the transition to a competitive marketplace does not lead to "rate shock" or an erosion of universal service.

I also think that the Administration needs to be more visible on the issue of broadband deployment. The computer industry and Internet users continue to be frustrated by the glacial pace at which telephone and cable companies are deploying affordable, multi-megabit services to homes and businesses. The U.S. will reap huge economic benefits from being the first to deploy the new products and services associated with broadband networks.

3. **Investing in R&D to sustain U.S. leadership in the information revolution, such as the Next Generation Internet**

In 1997, our major action item will be securing full funding for the Next Generation Internet initiative and the base-line high-performance computing and communications budget.

Longer-term, I think there is a strong case to be made that federal funding for computing and communications R&D should be increased. It has remained around 2 percent of federal R&D -- at a time when the private sector is substantially increasing its R&D in information and communications technology.

4. **Creating the foundation for a global electronic marketplace**

The "Framework for International Electronic Commerce" lays out an ambitious agenda that would be significant if accomplished, including:

- Ratification of the WIPO treaties;
- Resolution of Internet governance issues (e.g. domain names, Internet numbering);
- Encouragement of industry self-regulation in areas such privacy and content controls; and
- Negotiation of a "duty-free zone" in cyberspace.

5. **Promoting particular NII applications**

The Administration has identified a series of NII applications that it wishes to promote, including:

- Life-long learning;
- Delivery of government services (e.g. implementation of *Access America* report);
- Health care (telemedicine, consumer health information, computer-based patient records);
- Digital libraries;
- E-commerce and manufacturing;
- Law enforcement;
- Improving the quality of life for people with disabilities;
- Environmental monitoring and geographical information systems;
- Telecommuting;
- Public safety;
- Demand-side management; and
- Community networks.

In addition to these specific applications, the government is also trying to create “virtual” agencies that serve particular constituencies or accomplish specific tasks, such as the Business Advisor, the Trade Promotion Coordinating Committee, the National Environmental Data Index, etc. Figuring out how to efficiently create, fund, staff, and manage these virtual agencies would be a major accomplishment.

For each of these applications, there are a series of steps that the government can take to promote them, including:

- Eliminating legal and regulatory barriers (e.g. lack of HCFA re-imbursement for telemedicine, establishing a uniform national framework for privacy of medical records, making digital signatures legally binding);
- Sponsoring R&D and pilot projects (e.g. TIIAP, support for digital library projects by NSF, NASA, and DARPA)
- Setting national goals (e.g. connecting every classroom to the Internet by the year 2000);
- Making the government a better user of technology (electronic procurement, federal law enforcement use of wireless networks, electronic “self-service”);
- Creating fora for stakeholders of the application to exchange views and reach consensus;
- Collecting and sharing “best practices”;
- Sponsoring efforts to evaluate the use of information and communications technology (e.g. cost-benefit analysis);
- Supporting efforts to establish private voluntary standards; and
- Providing training for the people that will use and develop these applications (e.g. Kellogg Foundation’s support for transforming the graduate schools of library and information science to produce “digital librarians.”)

Obviously, White House staff can not manage the development and execution of national strategies in all of these applications. We can, however:

- Look for specific projects that we can help launch (e.g. for \$4.5 million/year, we could make the National Library of Medicine’s MEDLINE free to the public, for \$800,000 over 3 years, we were able to launch the Web Accessibility Initiative);
- Designate particular agencies as the “lead” for a given application;

- Expand the size of the “Innovation Fund” -- which is providing funding for many of the projects identified in “Access America.”

B. **“Have to dos”**

There are another set of policy issues that may not have a huge potential for “upside” - but could cause problems for the Administration if not managed correctly.

1. **Encryption**

Management of legislative process, export control policy.

2. **Year 2000**

Imagine core federal services not being delivered because of Year 2000 problems!

3. **Security**

Follow-up to Presidential Commission on Critical Infrastructure Protection. Imagine collapse of the Internet (a la Robert Morris “worm” of 1988), or major hacker/info-war episode before 2000!

4. **Major federal information systems**

Systems such as FAA, IRS, etc.

C. **Contribution of information technology to other Administration initiatives**

There are a number of ways in which information technology could contribute to other Administration goals - e.g. use of computer-based training to support “welfare-to-work.”

II. Process suggestions

A. White House working group

We should have a meeting once every 2 weeks with the following people.

- OVP: Don Gips, Jim Kohlenberger
- OSTP: Henry Kelly, Brian Kahin, Lori Perine
- OPD: Ira Magaziner
- NEC: Tom Kalil, Jon Kaplan
- OMB/OIRA: Bruce McConnell
- NPR: Greg Woods
- Commerce: David Lane, Larry Irving

Other people could be brought in on an “as-needed” basis.

The purpose of these meetings would be to:

- Ensure that the Administration is making progress on its top NII/GII priorities;
- Maintain a rolling calendar;
- Provide a mechanism for building Administration consensus around issues or new initiatives;
- Identify potential events for the President or Vice-President, or identify issues that need to be brought to their attention for decision;
- Identify specific assignments that need to be delegated to agencies or inter-agency working groups.

We could position this group as the successor to the IITF.

B. Greater cabinet involvement in NII/GII

We need to increase Cabinet involvement in the initiative. We should consider:

- Identifying steps that we want all agencies to take (e.g. on-line dissemination of information, on-line delivery of government services);
- Identifying specific agency actions that would promote the NII and its applications, getting agencies to “sign up” for these;

- Asking each Cabinet agency and major independent agency to identify someone at the sub-cabinet level that has the responsibility of interacting with the White House on these issues;
- Making information technology one of the focal points of the Vice President's reviews
- Conducting briefings for the chiefs of staff, and the principals of the relevant policy councils.

C. Earlier involvement in the FY99 budget

As rule, the policy offices do not get involved in the budget until late fall. At this point, it is very difficult to make any changes. In many areas, a few million dollars in the right places could make a significant difference in our ability to produce real results by the year 2000.

D. Advancing the state-of-the-debate

- The Administration should have a mechanism for encouraging government employees to publish "NII Policy Papers" as a way of advancing the state-of-the-debate. If these are well done, they can significantly enhance the Administration's reputation in the relevant communities. For example, Kevin Werbach's paper won kudos in the Internet community even though it did not formally represent the views of the FCC.
- The Administration should initiate an activity in the FY99 budget that is the information & communications equivalent of "ELSI" -- the part of the Human Genome Project that funds research on the ethical, legal, and social implications of genome research.

E. NII Agenda for Action 2.0

The Administration should consider issuing a revised "NII Agenda for Action." Much of what we said we were going to do has been completed - so it might be worthwhile pulling together a "NII Agenda for Action V 2.0"

We also need to have a web site that indicates "who is doing what."

F. Personnel

We don't have enough capable people in the White House or in the agencies working on this set of issues. This is a real bottleneck. Below are a few suggestions for dealing with it:

- Encourage agencies to use IPA authority (Intergovernmental Personnel Authority) to recruit university professors with an IT background -- possibly under the rubric of an "NII Fellows" program.

- Establish an NII program office -- similar to the HPCC National Coordination Office or the National Performance Review.
- Ask the relevant agencies to devote more people to this issue.
- Push for strong candidates for leadership positions within the federal government.
- Get permission to have "virtual" interns (grad students that work for us while remaining at their institution).

G. **Press**

Our press in the first term was not great. The "cyber" press had a tendency to focus on crypto, copyright, and censorship.

We need to have a mechanism for making the press aware of everything that the Administration is accomplishing. As a first step - it would make sense to have an "e-mail" exploder that would allow us to update the press on Administration announcements and accomplishments. Major dailies, weeklies and the trade press now have many reporters covering this beat -- we should make sure that they have a steady stream of announcements coming from the Administration.

**PROGRESS REPORT:
GROWTH AND COMPETITION IN
U.S. TELECOMMUNICATIONS
1993-1998**

February 8, 1999

The Council of Economic Advisers

THE WHITE HOUSE
WASHINGTON

August 20, 1997

MEMORANDUM FOR DON GIPS, KATHY WALLMAN

FROM:

TOM KALIL

TAK

RE:

RESIDENTIAL BROADBAND "PURCHASING CONSORTIUM"

Tom:
Seems
intriguing
you should
coordinate
with
Dave Barton
Da

In the last several months, computer and Internet companies have stepped up their complaints about the slow pace of residential broadband deployment. For example, this issue is now a top priority for the Computer Systems Policy Project - which is comprised of the top 12 U.S. computer companies. Broadband deployment is also central to achieving the Administration's vision of an advanced information infrastructure.

There will be a number of opportunities for the Administration to engage on this issue in a regulatory context - the innovation NOI, Section 706, and the continued debate over the impact of TELRIC pricing on infrastructure investment.

However, I don't think there has been enough discussion of the ways in which **consumers** could stimulate broadband. One could imagine a scenario in which a consortium of companies interested in providing their employees with high-speed data services from home (for telecommuting, remote access) could issue a joint RFP as a way of lowering costs and jump-starting the market. RBOCs and cable companies have used this technique for ADSL and cable modems.

Attached is a short paper that describes this scenario in more detail. With your permission, I would like to float this as a "trial balloon" to some high-tech companies to see if there is any interest in pursuing something like this. The primary government role would be to participate in a purchasing consortium as a user (e.g. government employees that are telecommuting).

Please let me know if you have any comments on the concept or the paper. From 8/22 - 8/26 - I will be reachable at tkalil@nist.gov.

PROPOSAL FOR A "JUMP-START" FOR BROADBAND TO THE HOME

Draft August 20, 1997

The problem

- In recent years, Internet users and computer/Internet companies have expressed concerns about the slow pace of residential broadband deployment.
- Progress in broadband deployment is certainly much slower than the progress being made in other elements of the information infrastructure:
 - The computer/semiconductor industry is continuing to move down the "Moore's law" curve - doubling the number of transistors on a semiconductor every 18 months. This is leading to both low-cost "information appliances" and personal computers capable of handling rich multimedia and 3-D applications.
 - Existing and new, venture-backed companies are investing in the "building blocks" for networked applications, such as audio and video streaming, networked virtual reality, digital signatures, electronic payments, intelligent agents, reusable software objects, tools for discovering and retrieving information, and speech recognition.
 - Applications are being developed in areas such as entertainment, information services, telecommuting, electronic commerce, delivery of government services, digital libraries, health care, life-long learning, geographical information systems, community networks, intelligent transportation systems, and access to information for people with disabilities. Many of these applications can not be widely deployed because of the lack of affordable, residential broadband service.
- The country that is the first to deploy a ubiquitous, broadband network will enjoy a competitive advantage in a wide range of products and services that enable and take advantage of networked multimedia technology, given the importance of "time-to-market" in today's global economy.

A jump-start for broadband to the home

- Clearly, there is no single "silver bullet" that will accelerate the deployment of broadband services. Creating a more stable and pro-competitive regulatory environment will certainly help. Over time, declining costs of equipment will make broadband deployment a more attractive investment for network service providers. But it is worth considering whether there is something that **consumers** can do to accelerate deployment and drive down the costs.

- For example, companies interested in providing their employees with remote access to their corporate LAN or intranet could issue a joint “request for proposals.” If this “purchasing consortium” was large enough, it might result in:
 - More attention to the residential broadband market by both incumbent and competitive telecommunications service providers; and
 - Lower prices, as both equipment and service providers are able to take advantage of economies of scale and move down the learning curve.
- An effort to aggregate purchasing power might make the residential broadband market for attractive for both incumbent and competitive network service providers. For example, CLECs (competitive local exchange carriers) are currently devoting most of their resources to the business market, given the margins that are now available in the market for services such as T1 access. A single order for thousands or tens of thousands of residential customers in a service area might provide the incentive necessary to get service providers to devote more resources to the residential market.
- It is interesting to note that cable and telecommunications companies have used consortia to get lower prices and open standards from equipment vendors. Four of the Regional Bell Operating Companies formed the Joint Procurement Consortium in an effort to get lower prices for ADSL modems. Four of the major cable companies created an organization called Multimedia Cable Network System (MCNS) Partners Ltd to develop vendor-independent specifications for cable modems.

Government role

- Any purchasing consortium should be driven by industry and consumers, with a limited, “catalytic” role for government.
- The government role might include:
 - Playing a neutral convening role to determine whether there is a “critical mass” of interest in one or more regions of the country;
 - Identifying government agencies with an interest in participating as a customer;
 - Disseminating “lessons learned” from different regional experiences;
 - Supporting the development and demonstration of specific broadband applications for research, education or public interest purposes; and

- Making progress on any regulatory issues which arise. [Some of these may be under the purview of the state Public Utility Commission or the FCC.]

Regional candidates

Such an initiative might be more likely to succeed in a region with:

- A high concentration of companies that want to provide their employees with remote access, and/or that see broadband deployment as a “strategic” issue for their industry;
- A high concentration of Internet users;
- A regulatory environment conducive to competition and new entrants (e.g. rights-of-way, interconnection, pricing of unbundled network elements);
- Aggressive network service providers; and
- A track record of successful community-wide technology initiatives and leadership from “civic entrepreneurs.”

EXECUTIVE SUMMARY

Since 1993 the U.S. telecommunications industry has prospered. Telecommunications markets in the United States have continued to open and firms have competed to meet new consumer demands, to build the infrastructure to support the growing information industry spurred by the Internet, and to provide the foundation for future innovations in communications. The benefits for the U.S. economy have been substantial:

- The telecommunications sector has created hundreds of thousands of new jobs since 1993. The telephone services and equipment sectors, long areas of declining employment as technology increased productivity, are directly responsible for the net creation of approximately 200,000 new jobs in the past 5 years.
- Hundreds of new firms have entered all sectors of the industry, with the number of publicly held telecommunications companies alone nearly doubling in the past 5 years. New competitors have been responsible for much of the growth in the local, long-distance, wireless, and equipment sectors.
- New and incumbent firms have collectively invested tens of billions of dollars in facilities, services, and research and development, leading to increased network capacity, deployment of new technology, and roll-out of advanced communications services.
- Output of services has increased and prices have declined industry-wide.

This progress has been supported by the Administration's long-standing commitment to make competition and regulatory flexibility the fundamental principles on which U.S. telecommunications policy is based. In 1993, when Vice President Gore announced those principles in the Administration's National Information Infrastructure agenda, there were predictions that the approach would lead to substantial industry growth. The above results bear those predictions out.

The benefits of a policy approach geared towards opening markets and promoting competition can be seen sector-by-sector in the telecommunications industry:

- Long-distance telephone services: Growing competition in long-distance services has eroded AT&T's market share from its former monopoly level to about 50 percent. With this competition has come increasing availability of low-cost calling plans for a broad range of consumers. As a result, average revenue per minute earned by carriers has been declining steadily for several years and long-distance usage has increased substantially. Consumers will likely reap further benefits as competition grows in the long-distance market under the Telecommunications Act of 1996.
- Local telephone services: Many new carriers have entered the wireline local services

market since the 1996 Act, providing both switched voice and high-speed data services to customers. To date they have created more than 50,000 new jobs and attracted over 30 billion dollars worth of capital investment, not counting debt or private venture financing. Recent entrants, including resellers, have so far captured between 2 and 3 percent of the local services market measured by lines and about 5 percent of the market measured by revenues. The competitive emphasis to date has been on business rather than residential customers, due partly to underlying economic and regulatory factors. As competitors establish their businesses and expand their networks, and now that the Supreme Court has affirmed the FCC's broad authority to implement the 1996 Act's market-opening provisions, local competition for residential customers is likely to increase.

- Wireless telephone service: Increased capacity and competition have led to fast growth of wireless services: over 60 million Americans now subscribe to mobile service; four times the number in 1993. Median prices per minute have fallen, depending on usage levels, between 30 and 40 percent for residential users and as much as 50 percent for business users. Wireless carriers directly created more than 100,000 new jobs from 1993 through 1998. Wireless service revenues have grown an average 24 percent annually since 1993, to \$30 billion. Capital investment by the industry has reached a cumulative \$50 billion.
- Telecommunications equipment: The telecommunications equipment industry in the U.S. has grown substantially. Total revenues in 1998 are estimated at \$120 billion, a three-fold increase since 1993. A growing proportion of manufacturing consists of innovative equipment for integrated voice and data communications over digital networks. Annual U.S. telecommunications equipment exports doubled from 1993 to 1998, to over \$25 billion.
- Telecommunications infrastructure and the information sector: The telecommunications industry provides the infrastructure for fast and reliable transport of information. With the surge in Internet usage in the past 5 years, the number of "hosts" for Internet sites grew from fewer than 3 million to over 30 million and electronic commerce has become a multi-billion dollar industry. Driven by the growing information industry, high-speed data services have spread as providers invest in facilities to provide customers with a variety of "broadband" options; deployment of high capacity fiber grew by at least 16 percent in 1997; and production of innovative data networking equipment has increased. Demand for additional lines has increased with data traffic, from about 9 million lines in 1993 to about 18 million lines in 1997.

In some of the above markets, such as long-distance, growth is the effect of more than a decade of competition. In others, like local telephone service, the regulatory and legislative changes that opened the market to entry occurred much more recently. While more remains to be done for entry to occur in parts of the local market, notably residential service, the lesson from markets with a longer history of entry is that, with time and opportunity, competition can grow and produce the expected benefits.

INTRODUCTION

This report describes developments in the U.S. telecommunications market since 1993.¹ It presents an overview of the growth of the industry, discusses key developments in the long-distance, local, wireless, and equipment sectors, and describes the dramatic rise in use of the Internet and the increasingly interdependent relationship between the information and telecommunications industries. The goal of this report is not to examine the economic issues underlying specific regulatory proceedings, nor is the purpose to analyze whether particular refinements to current laws or regulations would be useful. It is instead to discuss overall trends and to assess the broad impact of the current regulatory framework.

The evidence reviewed demonstrates that the telecommunications industry has been a substantial part of the outstanding performance of the U.S. economy—now in the longest peacetime expansion in American history. Since 1993, the telecommunications industry has created hundreds of thousands of new jobs, seen entry by hundreds of new companies, made tens of billions of dollars of new investment in infrastructure and innovation, raised exports, and fostered a revolution in the scope of communications services available to consumers.

The growth of the American telecommunications industry has been supported by a flexible, competition-oriented approach to policy and regulation. The principles of market competition and regulatory flexibility are implemented in the Omnibus Budget Reconciliation Act of 1993, through which President Clinton signed into law authorization for auctions of spectrum for wireless communications; in the National Information Infrastructure (NII) initiative developed by the Administration in 1993 and overseen by Vice President Gore; and in provisions of the Telecommunications Act of 1996. They appear also in the Administration's initiatives to ensure the successful growth of electronic commerce and to keep the Internet, a key driver of

¹This report focuses on the telephone industry, which includes related carrier services like data transport. It does not address cable, broadcast, satellites, or other mass media services.

demand for telecommunications infrastructure, free from economic regulation.

To be sure, there remain important challenges for telecommunications policy to address – for example, ensuring that competition develops further and more quickly in certain markets and that anti-consumer tactics like “slamming” and “cramming” are stopped. Moreover, innovation and change in a variety of markets, for example in the markets for satellite, cable, and fixed-wireless services, may alter the assumptions underlying some current regulations and require policies to adapt. But by any fair measure, the development of the telecommunications market in the United States must be considered a success. This success provides no basis for complacency, but neither do remaining challenges provide a reason to change the current regulatory approach. Instead, both are strong reasons to adhere more strongly to the underlying principle of open competition that is bringing great economic benefits to American workers, consumers, and businesses, and to make sure that competition has the opportunity to develop in markets where it so far has been unable to do so.

Policy Developments

Traditional market structure and regulation. For much of this century, most telecommunications service in the United States was provided by a single, regulated monopoly. Competition first arose in long-distance service. That market was fully opened to new entrants in 1984, when the Department of Justice's antitrust suit led to the break-up of the integrated Bell system into 7 separate local companies, the Regional Bell Operating Companies ("RBOCs" or "baby Bells") and one unaffiliated long-distance company, AT&T. Telecommunications markets nonetheless continued to be highly regulated. Local telephone service remained, for the most part, the province of monopolies overseen by state utilities commissions. The long-distance market became more competitive but, in order to ensure that it remained so, entry into the market was barred for the RBOCs because they controlled access to local networks and could therefore discriminate against rivals needing that access to originate or terminate long-distance calls. The nascent cellular industry started with two licenses in each service market being issued by the FCC, one to the incumbent local carrier and the other to an unaffiliated entrant. Partly due to regulatory limitations on available spectrum, the market remained a duopoly for several years.

Policy evolution. Recognizing that the telecommunications industry was changing at an increasingly rapid pace due to technological and market innovations, and that the regulatory framework needed to adapt to those changes, the Administration launched the National Information Infrastructure (NII) initiative in September 1993. To complement and advance the NII initiative, the Administration proposed in January 1994 a set of principles for overhauling the regulatory framework of telecommunications and fostering investment and competition. The NII initiative envisioned advanced networks that would make it easy and affordable to connect people to each other, to computers, and to a vast array of services and information resources. On the wireless side, the Omnibus Budget Reconciliation Act of 1993, signed by the President, authorized the FCC to increase competition in the wireless industry by auctioning major blocks of radio spectrum across the country.

Fundamental principles for regulatory reform. Along with the need for a modern, flexible regulatory framework, the Administration promoted from its earliest days the benefits of competition for both consumer choice and innovation. Vice President Gore thus set forth five fundamental principles to guide the study and formulation of legislative proposals for regulatory reform:

- Encouraging private investment in information infrastructure;
- Promoting and protecting competition;
- Providing open access to advanced telecommunications networks for consumers and service providers;
- Preserving and advancing universal service to avoid creating a society of information “haves” and “have nots”; and
- Ensuring flexibility so that the newly-adopted regulatory framework can adapt to rapid technological and market changes in the telecommunications and information industries.

The Telecommunications Act of 1996. The principles of the NII initiative are reflected in many instances in the Telecommunications Act of 1996, which Congress passed with overwhelming bipartisan support. When President Clinton signed the Act into law on February 8, 1996, he called the legislation an important step in the Administration’s commitment “to reform our telecommunications laws in a manner that leads to competition and private investment, promotes universal service and open access to information networks, and provides for flexible government regulation.” The 1996 Act eliminated legal barriers to entry and further opened the door to local phone competition by requiring incumbent local telephone companies to interconnect and exchange traffic with new entrants into the market on non-discriminatory terms,

to lease one or more parts of their networks (“unbundled network elements”) to new entrants at cost-based prices, and to provide service at wholesale rates to new competitors so they could gain a foothold in the local market through resale to customers. The Supreme Court recently upheld the FCC’s authority to implement many of the market-opening provisions of the Act after the scope of that authority was challenged by incumbent local carriers and certain states.

In addition to imposing market-opening obligations on incumbents, the 1996 Act withholds authority for the RBOCs to enter the long-distance services market until they have fully complied with those obligations. The RBOCs have been barred from that market since 1984, when an antitrust settlement caused their divestiture from AT&T. The 1996 Act lifts that restriction once the FCC finds that an RBOC has met certain market-opening requirements set forth in the statute, providing a further measure to achieve the Act’s goal of opening the local market to competition.

The FCC’s policy efforts since the Act have focused on implementation. Defining and restructuring universal services, reforming access charges, and establishing the rules under which incumbent local telephone companies can provide “advanced” services over their networks are examples of issues on which the Commission has been working. Further policy developments will follow as markets continue to change in response to the 1996 Act and to new investment and technological innovation.

Economic Growth and Competition in Telecommunications Markets

Revenue growth and contribution to the national economy. At the time the Administration announced the NII initiative in 1993, it was estimated that industries related to the NII would create \$300 billion in new sales for the telecommunications industry and contribute a comparable amount to GNP by 2007. These levels are already being achieved and even surpassed: Communications services and equipment companies had revenues of about \$250 billion in 1993, which grew to \$408 billion in 1998 (Chart 1). Telecommunications services contributed about \$25 billion to GDP growth from 1996 to 1997, and increased their share of GDP by more than 20 percent.²

Overall job creation. The telecommunications services and equipment sectors are directly responsible for the net creation of, conservatively, about 200,000 new jobs since 1993 (Chart 2).³ This increase is extremely significant: prior to 1993, telecommunications employment was decreasing, even as the production of telecommunications services was expanding. For example, from 1981 to 1992, the number of phone lines—"local loops"—in the United States increased by nearly 40 million, and the amount of long-distance calling more than doubled.⁴ But over that same time period, the number of workers in the U.S. telecommunications services industry fell by 200,000.⁵ Indeed, labor productivity in the telecommunications industry—measured as output

² Total telecommunications revenues are the sum of telecommunications equipment sales reported by MMTA and telephone communications services revenues reported by the Census, projected to year-end 1998. U.S. Census Bureau. 1998. *Annual Communications Services Survey*. Also, MultiMedia Telecommunications Association. 1998. *1998 MultiMedia Telecommunications Market Review and Forecast*.

³Bureau of Labor Statistics (BLS). 1999. *National Employment, Hours, and Earnings*. Hereafter, "BLS."

⁴ Federal Communications Commission, Industry Analysis Division. 1998. *Trends in Telephone Service*. pp. 63, 97. Hereafter, "FCC. *Trends in Telephone Service*."

⁵ BLS.

per hour—increased by 80 percent from 1981 to 1992, reducing the number of workers needed even as business grew rapidly.⁶ Labor productivity in telecommunications has continued to grow at least as fast since 1992.⁷ But lower prices, new and innovative services, dramatic growth of wireless communications, and new demand for services and infrastructure from the information sector have caused the growth of the telecommunications industry to outpace productivity increases and create large numbers of new jobs.

Telecommunications firms have been particularly important in providing crucial inputs to other industries, thereby contributing to the progress and growth of those sectors. By providing the advanced infrastructure and services essential to data processors and information providers, the telecommunications industry has contributed to the creation of an additional 600,000 new jobs since 1993 in data services, whose growth depends significantly on communications infrastructure (Chart 2).⁸ That figure does not count indirect employment effects in the software and computer hardware industries, or in the many other economic sectors that have become increasingly reliant on telecommunications and information technology.⁹

Entry by new firms. The structure of the telecommunications industry today is radically

⁶ FCC. *Trends in Telephone Service*. p. 19.

⁷ FCC. *Trends in Telephone Service*. p. 19.

⁸ BLS. Data for employment in the SIC category of “computer services and data processing,” excluding the subcategories of pre-packaged software and computer repair and servicing.

⁹ The number of jobs that would not exist today without the growth of the telecommunications industry is likely much higher, although hard to estimate with precision. An example of the broader “ripple effect” can be seen in data the Cellular Telephone Industry Association has compiled on employment effects of the wireless industry. Beyond the more than 130,000 jobs created directly by wireless carriers, as of the end of 1998 there are an estimated 260,000 sales and distribution jobs, 45,000 manufacturing jobs, and over 600,000 support service, construction and product development jobs related to wireless. Such multiplier effects exist in all sectors of the telecommunications industry.

different from that of 15 years ago. Numerous firms have entered each sector of the telecommunications market, with the number of public telecommunications companies swelling from under 100 in 1984 to over 200 in 1993 and surging to just under 400 in 1997. In critical sectors like local telephone service, the majority of entrants are private companies not counted in the above figures. The Association for Local Telephone Services (ALTS) lists 145 private companies in the local exchange market alone. Consolidation and acquisitions keep the number of companies in flux, but market data show that many of the fastest growing and most successful firms in the industry are unrelated to AT&T, its Regional Bell Operating Company progeny, or any of their subsequent spin-offs. In the long-distance, local, and equipment sectors of the telecommunications market, small, recent entrants have outpaced larger and more established firms in their rate of growth of both market capitalization and revenue.

Competition and market value. When concentrated or monopoly industries become competitive, economic theory suggests that, unless the market grows, profits decline as rival firms offer lower prices and transfer more value to consumers. What is good for customers may be viewed differently by shareholders. It is thus indicative of growth and innovation in the telecommunications market that, despite major changes in the regulatory environment, increased competition, lower prices, and some predictions to the contrary, the market value of public telecommunications firms since 1993 has kept pace with the soaring U.S. stock market and increased by over \$800 billion—more than doubling in size (Chart 3). The many private companies have created substantial, additional value and investment. More than half of this growth is from companies that did not exist prior to the breakup of AT&T's integrated monopoly in 1984.¹⁰

New infrastructure. The growth of the telecommunications industry has led to construction of more advanced infrastructure. The conversion of the wireless industry to digital technology and expanded use of fiber optic cable in wireline systems are two examples. FCC

¹⁰ Calculated using Compustat data.

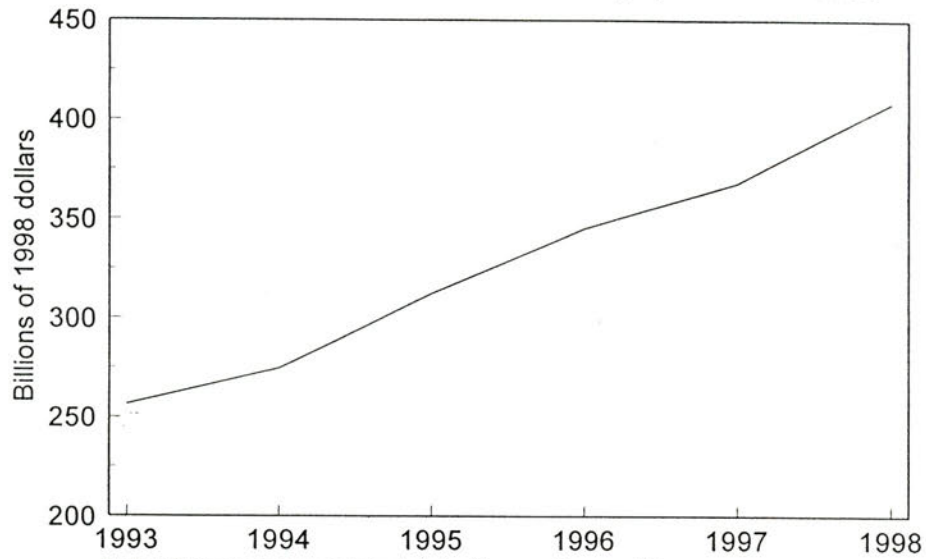
figures show that from 1993 through 1997, fiber deployment increased from 2.3 million to 3.4 million miles in long-distance networks, from 6.6 million to 12.2 million miles in incumbent local telephone networks, and from 0.2 million to 1.8 million miles in competitive local exchange networks.¹¹ Fiber mileage overall increased an estimated 16 percent in 1997 alone. The above figures are estimates based on incomplete data. Actual fiber capacity by the end of 1998 was almost certainly much higher. Moreover, the above data do not include the 800,000 fiber miles in place by the end of 1998 in systems financed by the Rural Utilities Service of the United States Department of Agriculture, or the fiber systems installed by others such as electric utility companies or state governments.¹²

Infrastructure that will advance the telecommunication sector, and the consumers and industries that increasingly rely on it, continues to develop in circuit-switched telephone networks as well as in data networks, satellite operations, and cable systems. The current emphasis is on expanding the broadband connections available to households and businesses. New entrants into all of those sectors are constructing new facilities and upgrading existing ones, and promise to provide an increasing range of services on more competitive terms for consumers.

¹¹ Federal Communications Commission. 1998. *FCC Fiber Deployment Data - End of Year 1997*.

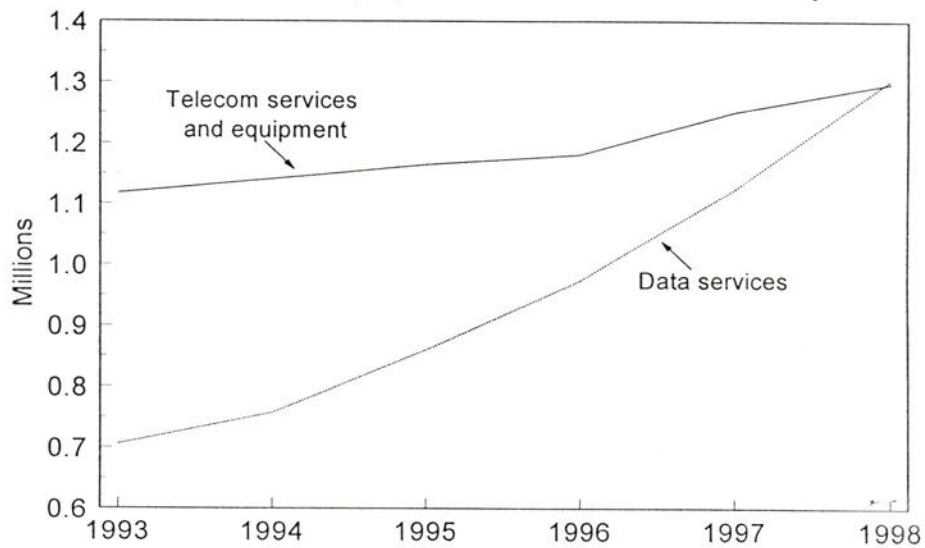
¹² United States Department of Agriculture. 1998. *1997 Statistical Report Telecommunications Borrowers*. p. 33.

Chart 1 Telecom Services and Equipment Revenue



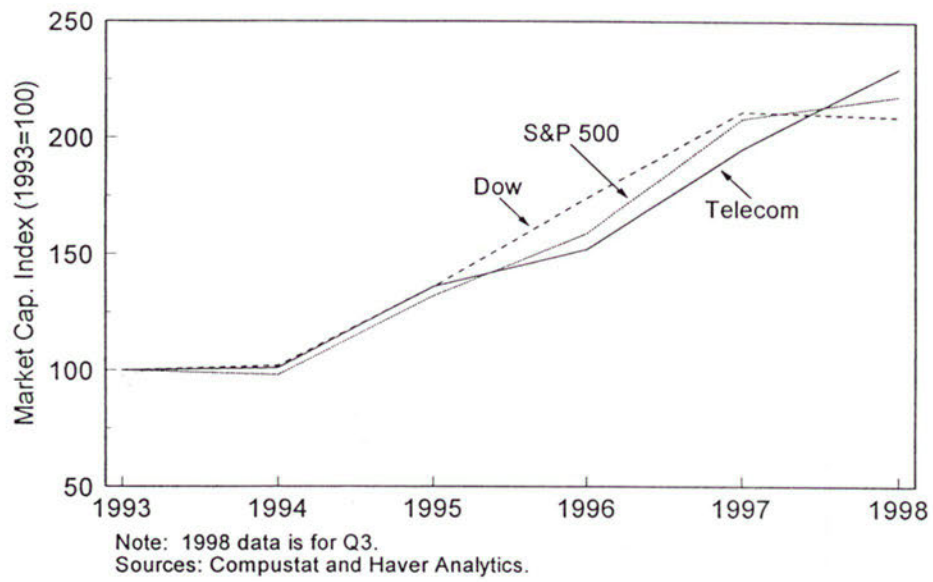
Note: Revenues do not include television, radio, or cable.
 Source: Bureau of the Census and 1997 and 1998 editions of "MultiMedia Telecommunications Market Review and Forecast."

Chart 2 Employment in the Telecom Industry



Note: Data for 1998 based on September. Telecom services include wireless and equipment includes only manufacturing.
 Source: Department of Labor (Bureau of Labor Statistics).

Chart 3 Market Capitalization of Telecom Industry
Compared to Market Indexes



Long-Distance Telephony

Long-distance telephone service was for decades a monopoly of AT&T. That monopoly was attacked at the margins in the 1970s and early 1980s and more fully after the Department of Justice's antitrust suit successfully opened the market by breaking up AT&T in 1984. While AT&T's share of long-distance revenues at first eroded slowly against competition by MCI and Sprint, it has declined from over 90 percent in 1984 to under 50 percent today.¹³

Since the 1980's, increasing numbers of residential and business customers have been offered subscription plans and incentive programs that lower their actual long-distance prices below the basic tariff rates, or posted prices. While the tariff rates fell steadily through the 1980s and then, starting in 1991, began to rise slightly, the proliferation of discount options has meant that the basic tariff rate alone overstates actual prices paid in most cases. With incentive programs and low-rate plans available not only to high volume callers, but also to customers whose monthly long-distance bills average as little as \$10, it is extremely difficult to calculate how much particular customers are paying per minute of long-distance use. But one indication of actual prices is the FCC's data on average revenue collected by long-distance companies per minute of usage. By this measure, effective rates have declined steadily over the last five years (Chart 4). Long-distance usage, meanwhile, went from about 370 billion minutes in 1993 to 500 billion minutes in 1997 (Chart 5).¹⁴ This increase is partly a function of the availability of lower rates, but also of an outward shift in long-distance demand due to increased transport of data and information.

The combination of lower long-distance prices and increased long-distance usage has been driven by competition. In the past five years, many new firms have entered the long-distance market both as resellers and by building their own facilities. According to FCC data,

¹³ FCC. *Trends in Telephone Service*. pp. 55, 58.

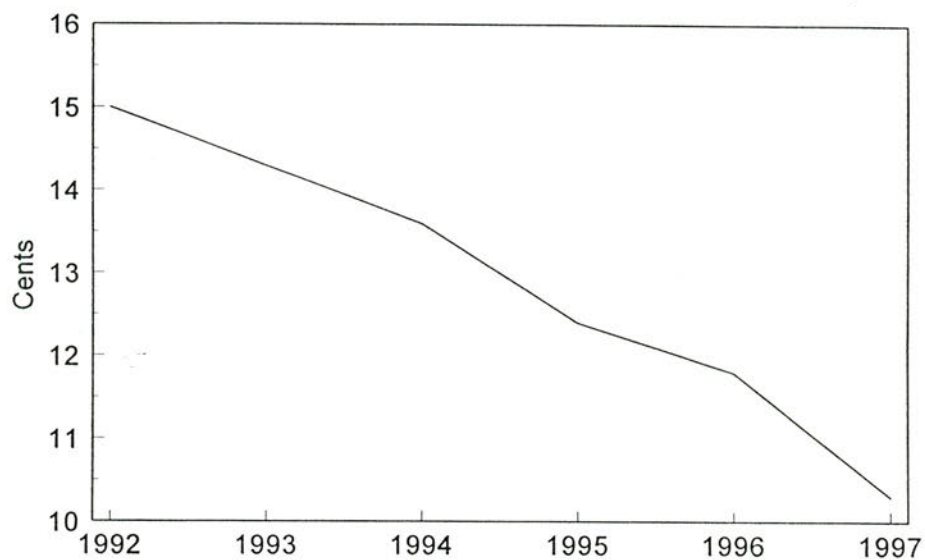
¹⁴ FCC. *Trends in Telephone Service*. p. 63.

the numerous companies with tiny individual market shares raised their collective share by 7.5 percentage points—from 12.3 to 19.8 percent of the market—from 1993 to 1997, and together have made the largest market-share gains in the long-distance market.¹⁵ That small firms have become more competitively significant both as a group and individually is indicated by the expanding list of firms whose individual shares are reported by the FCC. New carriers have continued to bring additional competition to the long-distance market, in some cases deploying substantial new facilities. There has also been entry into the market by 1010-xxx “dial-around” services and consumer substitution of the Internet for increasing amounts of data and voice traffic. Recent data show a dip in long-distance prices that corresponds to this entry.

The substantial competitive advances in the long-distance market do not preclude benefits from further entry. In addition to the possibility of even lower rates through competitive erosion of existing profit margins, one of the principal benefits of additional competition could arise from more widespread offerings of bundled local and long-distance services. Most observers have concluded that such bundled offerings would be attractive to consumers—particularly residential consumers—and may create significant cost-saving opportunities (from joint marketing, billing, etc.) for carriers that would lead to lower prices. Greater availability of such bundled offerings depends on the abilities both of long-distance carriers to be effective providers of local service, and of the Bell companies and other local carriers to offer long-distance service. Thus, completion of the local market-opening process required by the 1996 Act, which will enable such cross-entry to occur, can yield additional consumer benefits.

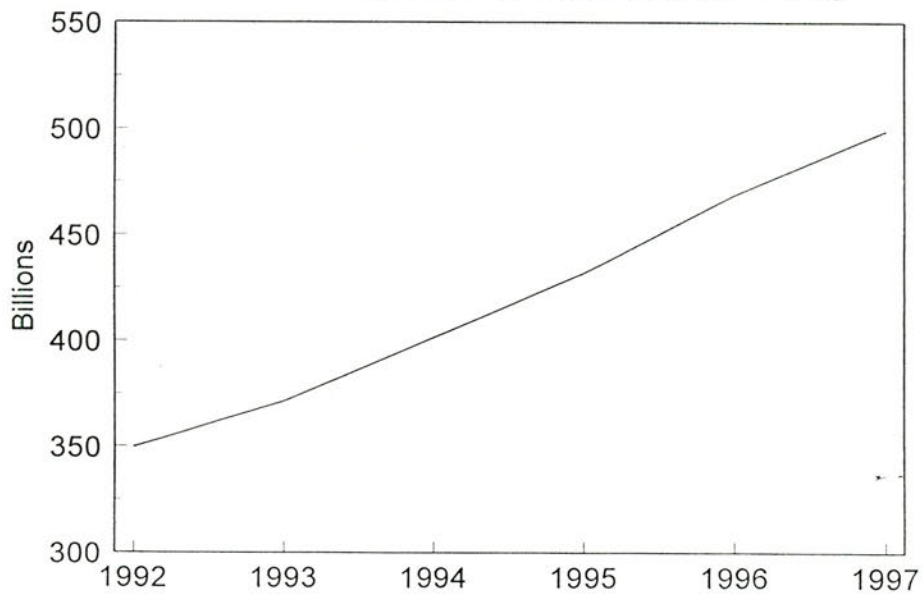
¹⁵ FCC. *Trends in Telephone Service*. p. 55.

Chart 4 Average Revenue Per Minute for Long Distance Calling (All Domestic Interstate Switched Services)



Source: FCC report "Trends in Telephone Service." July 1998.

Chart 5 Total Minutes of Long Distance Calling



Source: FCC report "Trends in Telephone Service." July 1998.

Local Telephone Service

After the 1984 divestiture of AT&T, local telephone service remained a franchise monopoly throughout the United States. The regional “baby Bells” and GTE were, and remain, the largest local-service providers, while over one thousand independent companies and cooperatives serve small, primarily rural, territories. The regulatory barriers to entry into the local market were substantial and, for the most part, within the jurisdiction of state public utilities commissions. A variety of justifications were advanced for local monopolies: the economics of “natural monopoly,” preserving geographical rate averaging or other cross-subsidies that support universal-service goals, and ensuring timely network upgrades and extensions. Competition was eventually allowed in the provision of enhanced services and access to the long-distance network, but not generally in switched, local voice service.

The 1996 Act radically changed that regulatory environment by pre-empting and prohibiting regulations that protect monopolies over local telephone service. The Act thus dismantled a legal and administrative structure that had evolved over decades and replaced it with a fundamental rule: the local telephone market must be open to competition. The Act pushes this principle beyond the regulatory agencies to the incumbent local exchange carriers (“ILECs”) themselves. It requires incumbent local companies to open their networks so competitors can “interconnect” (*i.e.* exchange traffic) with incumbent networks and lease “elements” of the incumbent networks (facilities like switches and customer lines) that the entrants lack.

Competitive entry since the Act has focused principally on full-service, local telephony for urban business customers. Residential local service has seen some competitive entry but has not developed in a manner comparable to business service. The market opening provisions of the 1996 Act have also spurred entry by firms providing high-speed data services to local exchange customers over unbundled loops leased from the incumbent carriers.

Progress by the CLECs: Competitive local exchange companies (“CLECs”) have invested billions of dollars and have come to employ over 50,000 workers since 1992.¹⁶ Several of these companies started as competitive access providers that offered business customers bypass of the local exchange and connection to the long-distance network at lower prices. Some CLECs began to acquire the numbering codes necessary to operate competing local switches as early as mid-1994,¹⁷ but little competing service actually existed. Since the 1996 Act, when CLECs began to acquire numbering codes more rapidly and, in addition, were able to enter the market for switched, local voice service through resale and use of the ILEC’s unbundled network elements, they have captured between 2 and 3 percent of local lines from the incumbents (Chart 6). Because competitors have focused on serving the largest and most profitable customers first, the business they have won represents about 5 percent of the local services market measured by revenues (Chart 7).¹⁸ Current data show local telephone revenues overall to be growing about 5 percent annually, driven by the demand for data and Internet service and for “vertical features” like voice mail and caller ID. The shares the CLECs are gaining are thus of an expanding market.

Recent data show the publicly traded CLECs to be gaining between 600,000 and 700,000 customer lines per quarter, most of them business customers (Chart 8).¹⁹ It would take the CLECs about ten years to capture half the 60 million business lines now in service if they continue to add lines at the current pace. Of course, both the number of business lines and the rate of market growth of the CLECs are likely to change, making the actual rate of market share change uncertain. But as a benchmark, it took more than a dozen years after the 1984 divestiture

¹⁶ Association for Local Telephone Service. Hereafter, “ALTS.”

¹⁷ FCC, Industry Analysis Division. 1998. *Local Competition*. p.55.

¹⁸ Merrill Lynch. 1998. *CLEC Vital Signs: Update For 3Q98 Results and Trends*. Table 11.

¹⁹ Merrill Lynch. 1998. *CLEC Update: Continued Weakness in the Sector Creates a Great Buying Opportunity*. p. 26.

for long-distance competitors to gain a 50 percent share of market revenues, and their shares of pre-subscribed lines and long-distance access minutes has not yet reached that level.²⁰

More than 70 percent of lines served by CLECs are through resale of the incumbents' services or through combination of the ILECs' unbundled network elements with the CLECs' own facilities.²¹ Competition by new entrants serving customers mostly on their own networks—"facilities-based" competition—accounts for the remainder. However, it is estimated that more than one third of the lines added by the CLECs in the third quarter of 1998 were on the CLECs' own networks. This very slightly raised the proportion of total CLEC lines that are independent of the ILECs' facilities to 27 percent, and suggests that facilities-based competition for local service is becoming more common.²² The growth of facilities-based competition relative to resale is also documented by the Telecommunications Resellers Association, which reports that, from 1995 to 1998, the proportion of its members that owned or leased facilities (as opposed to competing through pure resale) increased from 34 percent to 54 percent.²³ The FCC estimates that the number of unbundled loops leased by CLECs from large incumbents in order to provide partially facilities-based service increased by 10 percent in the third quarter of 1998.

The number of switches owned by CLECs grew from 65 before the Act to nearly 700 by the end of 1998.²⁴ As new entrants continue to build out their networks, the relative growth of facilities-based service will likely accelerate. Several sources of data show the CLECs to be building out their fiber networks at a fast clip, although the data are sketchy and incomplete.

²⁰ FCC. *Trends in Telephone Service*. pp. 45, 46, 49.

²¹ Merrill Lynch. 1998. *CLEC Vital Signs: Update For 3Q98 Results and Trends*. p. 6.

²² Merrill Lynch. *Op. Cit.*

²³ The Telecommunications Resellers Association. 1998. Report submitted to the House Commerce Committee.

²⁴ ALTS.

Merrill Lynch estimates from its survey of public CLECs that those companies added over 40,000 route miles of fiber to their networks in each of the first three quarters of 1998, and that the rate of deployment was increasing through that period.²⁵ FCC data show the amount of fiber deployed by CLECs to have tripled from 1993 to 1997, with particularly rapid deployment from 1994 to 1997.²⁶

The marketplace clearly expects local competitors to flourish. Although CLECs are still in the early stages of accumulating market share, and only one has so far posted a profit, they have created nearly 20 percent of the growth in local telecommunications market value since 1993.²⁷ The market capitalization of CLECs has gone from almost nothing to over \$30 billion since 1993.²⁸ The value of the numerous privately held CLECs is not captured by the above figure. Employment by competitive local service companies has also grown dramatically since the 1996 Act. Data from 23 small, local entrants that voluntarily reported employment figures to the Association for Local Telephone Services (ALTS) show employment increasing by over 100 percent in 1998 alone—from roughly 9,000 jobs in January 1998 to over 18,000 jobs at year's end in the sample companies alone. The ALTS sample did not include employment data for large companies like MCI WorldCom, AT&T, Sprint or others that have entered the local market, nor does it account for the vast bulk of CLECs. The growth rate, however, is indicative of the investment being committed to local competition. CLECs are plying their trade in all of the top 100 urban markets in the United States, and in 250 smaller business trading areas as well.²⁹

²⁵ Merrill Lynch. *Op. Cit.* p. 7. Data from several companies were not available to be included in that calculation.

²⁶ Federal Communications Commission. 1998. *FCC Fiber Deployment Data - End of Year 1997*. p. 40.

²⁷ Compustat data.

²⁸ ALTS data.

²⁹ ALTS data.

Residential versus business competition. Competition in the provision of local telecommunications services to residential customers has proceeded more slowly and tentatively than competition to serve business customers. Some CLECs target business customers exclusively. Comptel, an industry association representing CLECs, recently surveyed its members about local competition. Twelve of seventeen respondents reported providing residential service in at least one state. Overall, of the roughly 5 million lines estimated to be served by CLECs, less than one third probably belong to residential customers. The United States Telephone Association, the industry association for incumbent local carriers, reports that about 1.3 million residential lines are being resold by CLECs.³⁰ The FCC makes a similar estimate of 1.2 million lines.³¹

Resale remains the primary means by which CLECs are serving residential customers. The Telecommunications Resellers Association (TRA) represents numerous competitors, 175 of which provide local phone services through a combination of resale and deployment of their own facilities. Of the customers served by TRA's members, 21 percent are reported to be residential. And 94 percent of the residential business is through pure resale rather than through use of facilities that the CLECs either own or lease from the incumbent.³² The FCC finds that, while CLECs serve 1.2 million residential lines through resale, they serve about 260,000 customers through a combination of their own facilities and unbundled network elements leased from the ILECs.³³ Fully facilities-based competition by CLECs for residential customers, at least on a broad scale, seems distant. Such competing facilities may come sooner from cable entrants into local telephony. AT&T has made acquisitions and formed a joint venture to provide telephone service over cable systems that pass over 40 percent of American households. Other cable

³⁰ United States Telephone Association. 1998. *Local Market Wide Open to Competition*.

³¹ Federal Communications Commission, Industry Analysis Division data.

³² The Telecommunications Resellers Association. 1998. Report submitted to the House Commerce Committee.

³³ Federal Communications Commission, Industry Analysis Division data.

systems have slowly been upgrading their networks and marketing local phone service to their cable customers.

There are several possible explanations for why competition has been slower to develop in the residential local service market than in the business market. Some parties point to problems of compliance with the 1996 Act—the FCC has not yet found any of the incumbent carriers to have satisfied all of the Act’s market-opening requirements. But, the pace of residential competition is also strongly affected by underlying economic factors. The economics of residential local service—with its regulated rates and comparatively lower sales of profitable, vertical services—arguably do not make pursuit of the average residential customer as interesting a business prospect when there is lower-hanging fruit in the business market.

Regulation keeps rates for residential local service low, and the revenues gained from access charges that long-distance carriers pay to local networks are generally lower for residential than for business customers. But the costs of providing a phone line are about the same for residential and business customers, making the latter a source of higher profit margins. A CLEC incurring the fixed costs of entry will therefore recoup its investment more quickly by focusing on the business sector. Moreover, marketing costs per line are probably lower for business customers, which often have multiple lines, than for residential customers that typically have one, and at most two or three, lines. A reflection of the relative desirability of business customers, and of the greater geographic concentration of business customers, is that the switching centers in which CLECs have collocation arrangements serve 50 percent of ILEC business lines, but only 35 percent of residential lines. Moreover, those switching centers serve at least 57 percent of the incumbents’ high-capacity lines, which are connected to the largest and most profitable business and government customers.³⁴

Regulation also produces below-cost rates for local service in areas where the costs of

³⁴ FCC, *Local Competition*. p.38. Also, FCC Industry Analysis Division data.

providing service are high, and above-cost rates for local service in areas where the costs of providing service are low. In other words, revenues from above-cost rates implicitly subsidize below-cost rates. Entrants thus have artificial incentives to provide service to customers paying above-cost prices (*e.g.* business customers and urban residential customers) and artificial disincentives to serve those customers paying below-cost prices (*e.g.* rural customers). The FCC and state regulators are working to restructure the current system of rates for local telephone service in a way that both preserves universal service and makes serving residential and rural customers more attractive for competitors. But until regulation of residential and rural rates are made competitively neutral, entry incentives will remain skewed.

The residential market remains an area in which competition needs to develop further to meet the goals of the 1996 Act. But developments in local competition so far are not necessarily as limited or unpromising as some portray them to be. History indicates that roll-out takes time and generally starts, for sound economic reasons, with higher-revenue customers. The construction of the original Bell System itself is a lesson in the move from commercial centers to more rural areas. And Bell was merely repeating a strategy followed decades before by Western Union in building out its telegraph network. MCI's entry into the long-distance market similarly started with private business service, went to public business service, and eventually to residential offerings.

The aggressive entry by CLECs into the business market, and their construction of facilities for both voice and data, are likely to have benefits for residential customers over time. For example, CLECs have been constructing urban fiber networks that pass not only businesses, but apartment houses as well. Once the infrastructure is in place, serving residential customers in "multiple dwelling units" becomes easier and may entail only incremental cost. As the most profitable customers provide the CLECs with the revenue necessary for effective entry into the local market, competitors will be able to expand service offerings to customers from which they earn less return.

Because of the long institutional history of local monopoly and the economic complexity of entry into the local residential market, the uneven development of competition does not in itself show that the 1996 Act's market-opening provisions are a failure or should be changed. Indeed, the developments in the business market suggest otherwise. To ensure that the potential for residential benefits is realized, continued application of the proven, competitive principles of the Act is the course better supported by the economic evidence.

Data CLECs and broadband competition. A developing area of local competition has been in the market for high-speed data services. Numerous companies have taken advantage of the 1996 Act to lease customer lines ("loops") and space in the incumbents' switching centers ("collocation" space) in order to offer customers digital subscriber line (DSL) service, primarily for high-speed access to the Internet. DSL technology uses special modems to transmit digital information over existing copper lines. Most of the data CLECs are still small, privately held companies. Although there is little available data on DSL deployment, it is estimated that about 30,000 lines are so far being served. By comparison, about ten times that number of customers receive broadband service from cable companies over "cable modems."³⁵ But competition in data services over the telephone network shows promise. Data CLECs have invested heavily in facilities, pushed DSL prices down, and created thousands of new jobs in the services and manufacturing sectors. Several competitive DSL providers have entered multiple markets in which they compete against each other, the ILECs, and cable modem providers. For example, competition among broadband service providers in the San Francisco area has recently pushed DSL service prices down to about \$40 per month.

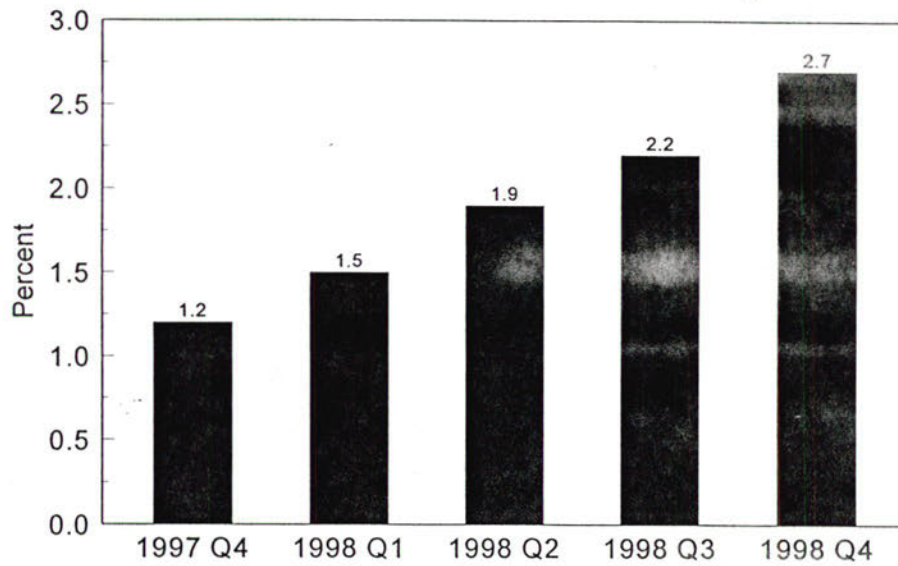
Competition in DSL service faces several challenges as it grows. First, DSL must overcome certain technological impediments. Transmission via DSL is generally most effective for customers located a short distance, for example about three miles, from the central switching

³⁵ Lawyer, Gail. 1998. "Leader of the Pack" in *X-Change*, October 1998. p.22. More formal data are not yet reported.

office. Performance of DSL transmission declines with loop length, but varies also with condition of the loop and the quality of equipment attached to the loop. Technological advances are starting to provide improvements, but for now DSL remains an option primarily in densely populated areas where loops are short.

A second challenge for DSL providers, like other CLECs, is getting collocation everywhere they need it, and therefore in gaining access to some customers lines. As more competitors have entered the market and sought collocation in central offices serving the most desirable regions, entrants have reported difficulty in negotiating collocation arrangements. Technical issues such as whether collocation at remote terminals outside of central offices is necessary to serve customers who do not have a direct copper line to the central office, is another unresolved problem for CLECs. These challenges are intensified by the fact that incumbent local service providers offer both DSL service themselves and control inputs—notably loops and collocation space—needed by their DSL competitors. Nonetheless, the DSL market is growing and, if the above challenges can be met, data CLECs could grow into a substantial competitive presence in a greater number of markets and offer a broader range of services than is the case today.

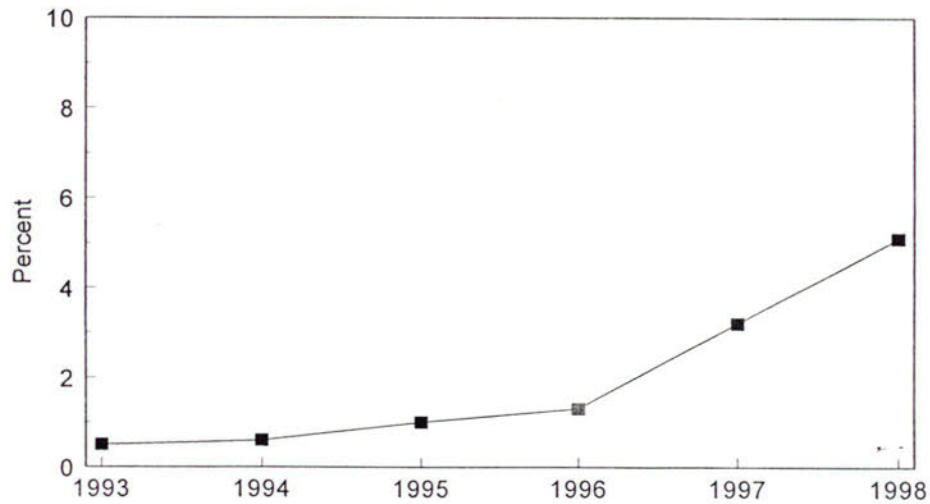
Chart 6 CLECs' Share of Local Market by Lines



Note: 1998 Q4 is estimated.

Source: Merrill Lynch industry report on local telecom services. November 1998.

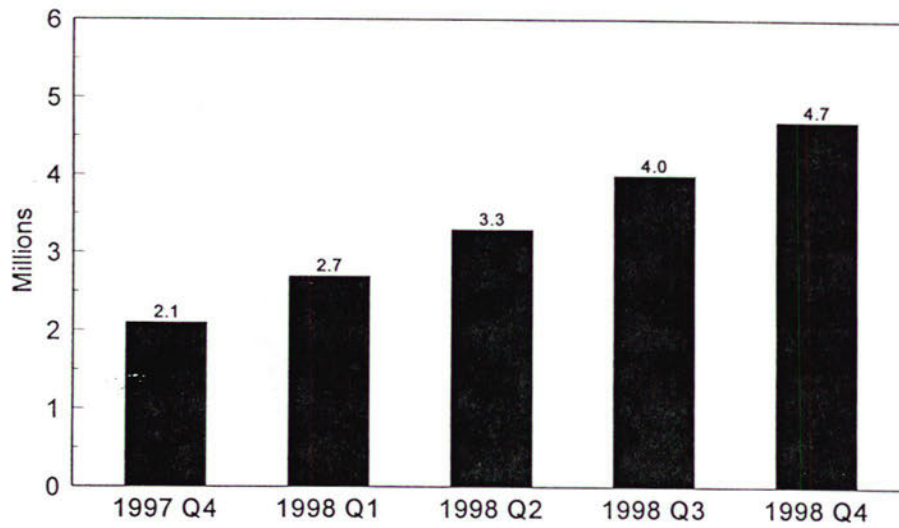
Chart 7 Share of Local Service Revenues by New Entrants



Note: The 1998 figure is an estimate for the fourth quarter.

Sources: Merrill Lynch industry report on local telecom services. November 1998.
FCC report "Trends in Telephone Service." July 1998.

Chart 8 Total Local Access Lines in Service
(New Entrants)



Note: 1998 Q4 is estimated.

Source: Merrill Lynch industry report on local telecom services. November 1998.

Wireless Telephone Service

The wireless telephone industry has experienced remarkable growth in the past 5 years. From 1993 to 1998, the number of Americans subscribing to cellular service grew from about 16 million to over 60 million (Chart 9).³⁶ Policies that set the stage for increased competition in the wireless market and fostered investment in advanced digital technology directly contributed to this growth.

The FCC assigned the first licenses to use radio spectrum for cellular telephone service in 1983, introducing competition through a “duopoly rule” under which one license in each market was given to the incumbent local telephone provider and another to an unaffiliated competitor. By June 1985, cellular companies altogether had just over 200,000 subscribers, 600 “cell sites” (each site contains the transmission equipment that serves a local cell), and 1,700 employees.³⁷ In June 1995, subscribership had climbed to 28 million, a total of 20,000 cell sites were operative, and the number of people employed by wireless service companies was 61,000.³⁸

In 1995, as authorized by the President and Congress in the Omnibus Budget Reconciliation Act of 1993, the FCC held the first auctions for broadband spectrum to be used for digital “personal communications services” (PCS), creating new wireless licensees in U.S. markets. As the successful bidders entered the market, and as subsequent licenses were auctioned, the duopoly market structure gave way to full-fledged competition among multiple providers. By the middle of 1998, there were nearly 61 million cellular subscribers and over 57,000 cell sites, and by end of 1998, over 160,000 Americans were holding jobs with wireless

³⁶ Cellular Telecommunications Industry Association. 1998. *Semi-Annual Data Survey: June 1985 to June 1998*. Hereafter, “CTIA Survey results.”

³⁷ CTIA Survey results.

³⁸ CTIA Survey results.

telephone companies (Charts 9, 10, and 11).³⁹ The average monthly bill for wireless telephone service fell by more than half from its level a decade earlier, probably reflecting both declining prices and changes in average monthly usage as more individual, as opposed to business, customers used wireless service.⁴⁰

Today, more than 200 million Americans, or over 80 percent of the population, live in wireless service areas with at least 1 new competitor to the 2 original cellular systems, and more than half of all Americans live in areas with at least 3 new competitors.⁴¹ This new competition, as well as increased investment in new technology, has caused prices to plummet while increasing the variety of available calling plans. Although reliable data on revenues per minute are unavailable, existing price and billing data indicate that wireless telephony is becoming ever more affordable. One study finds that in 1997, median prices per minute—what the typical user pays—fell as much as 30 to 40 percent for residential users and 30 to 50 percent for business users, due primarily to new PCS competition.⁴² As mentioned, the average monthly bill for mobile customers has fallen by more than half in the last decade.⁴³

Wireless telephony (cellular, PCS, and ESMR) is now a nearly \$30 billion industry, as measured by service revenues, growing an average 24 percent a year since 1993.⁴⁴ Capital investment, a leading indicator of future industry growth, has now grown to a cumulative \$50

³⁹ CTIA Survey results. Also, BLS employment data.

⁴⁰ CTIA Survey results.

⁴¹ Federal Communications Commission. 1998. *Third Annual CMRS Competition Report*. Appendix B, p. B-4. Hereafter, "FCC CMRS Report."

⁴² FCC CMRS Report. pp. 19-20.

⁴³ CTIA Survey results.

⁴⁴ CTIA Survey results, adjusted for inflation using the Consumer Price Index (CPI).

billion (Chart 12).⁴⁵ Extraordinary growth in subscribership is the cause: more than 60 million Americans, or more than 1 in 4 American adults, now subscribe to a mobile service. That is nearly 60 percent higher than in 1996 and five times the number in 1993.

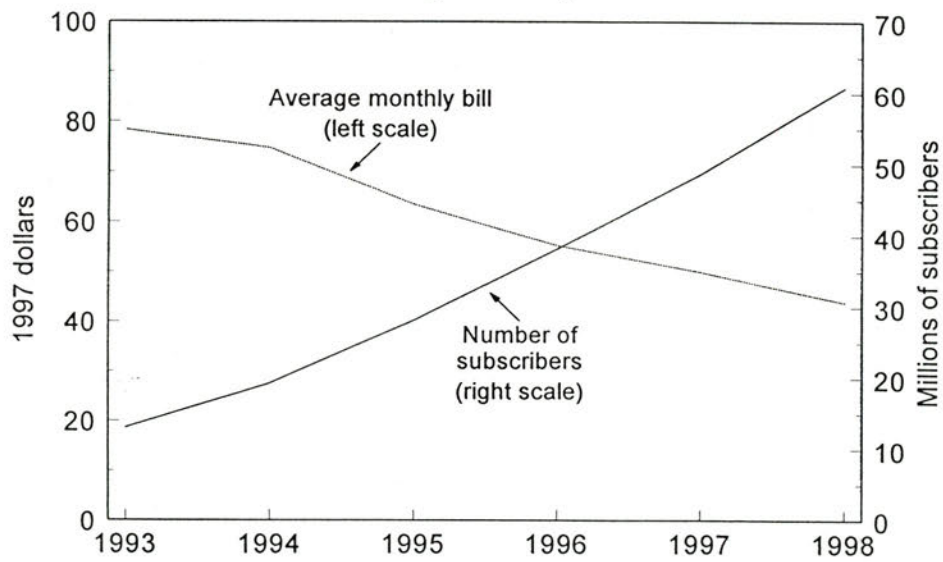
There is anecdotal evidence that wireless telephone service is beginning to substitute on the margins for traditional (wireline) telephone service; and it may do so increasingly as technology improves, competition and subscribership increase, and prices fall. Wireless companies have excess capacity on their networks and have been able to offer packages that provide a maximum number of minutes—whether local or long-distance, and from anywhere in the country—for a fixed price. In the second half of 1998, prices for these packages fell as low as \$50 for 500 “anytime, anywhere” minutes. Such low-priced packages have the possibility of making wireless service an alternative to wireline service for some users, particularly those who travel a lot or desire an additional line from home.

In addition to the main wireless telephone technologies of cellular, PCS, and ESMR discussed above, wireless communications also encompass such services as paging, SMR, and fixed point-to-point, as well as such new services as fixed wireless local loop and Third Generation mobile services. These services could have a profound effect on growth and competition in telecommunications, not just in the wireless market, but in the local, long-distance, and advanced services markets as well.

Further challenges remain for the wireless industry. As Americans increasingly demand information services and mobile access to those services, data traffic will become an increasing component of wireless telephony. As wireless use grows and services expand, technologies to manage increased traffic demands will need to be developed. But the success of the industry so far in innovating and growing to the benefit of American consumers leaves little doubt that wireless communications will be a central and growing part of telecommunications in the future.

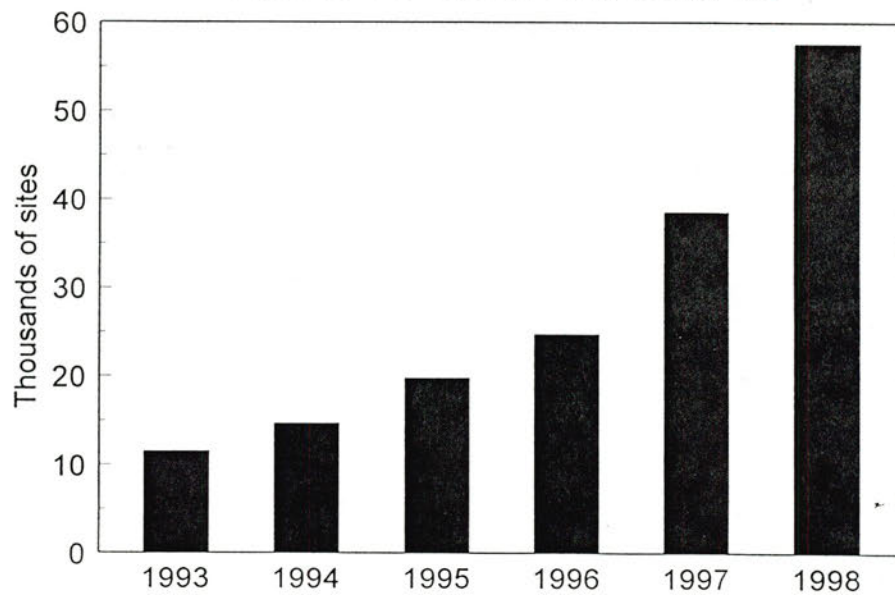
⁴⁵ CTIA Survey results.

Chart 9 Wireless Subscribership and
Average Monthly Bill



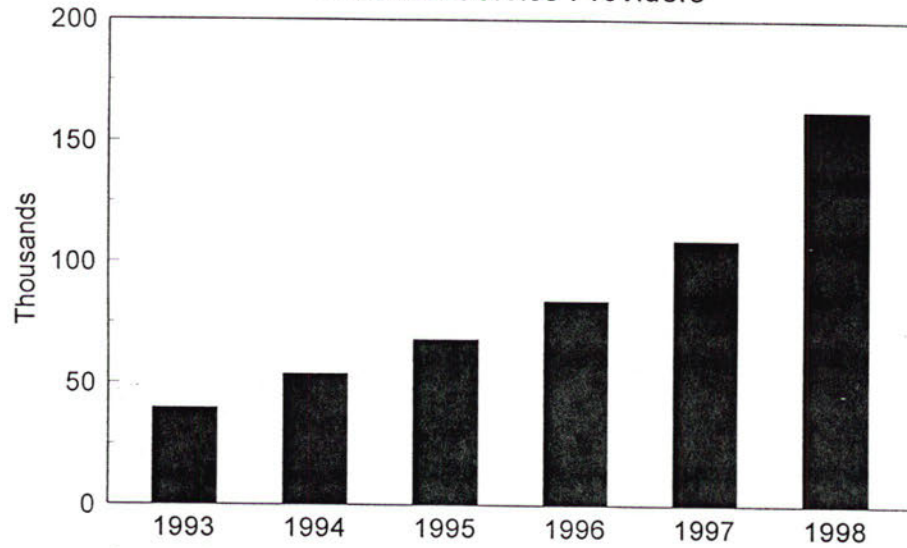
Source: Cellular Telecommunications Industry Association.

Chart 10 Cell Sites in Commercial Use



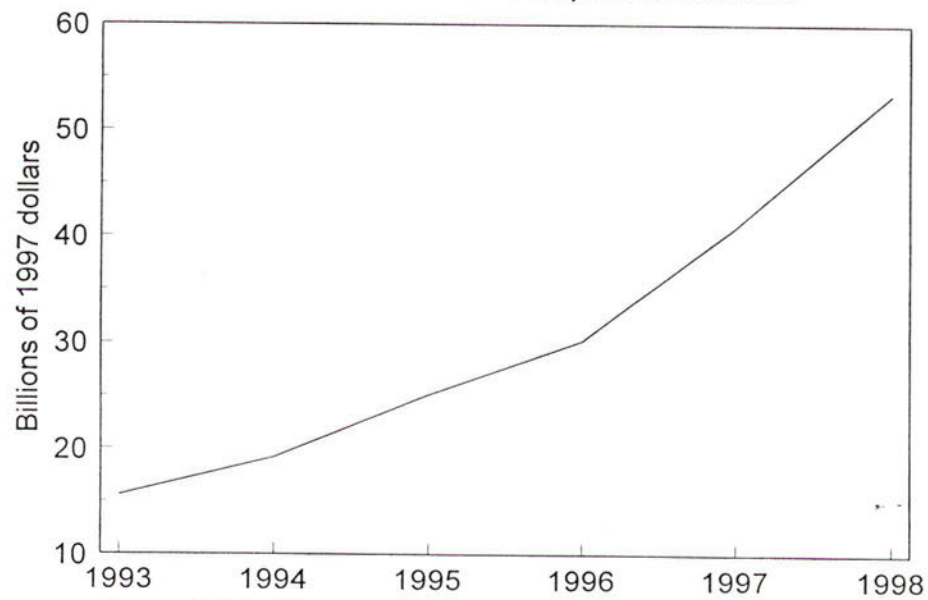
Source: Cellular Telecommunications Industry Association.

Chart 11 Direct Employment by
Wireless Service Providers



Source: Cellular Telecommunications Industry Association and Department of Labor (Bureau of Labor Statistics).

Chart 12 Cumulative Capital Investment



Source: Cellular Telecommunications Industry Association.

Telecommunications Equipment

The telecommunications equipment industry in the U.S. has grown substantially. Total production in 1997 topped \$70 billion and is estimated to have reached \$120 billion in 1998, a growth of \$80 billion since 1993 (Chart 13). New service markets created by wireless auctions, the 1996 Act, and the Internet have created a large demand for innovative telecommunications equipment. The many new entrants into equipment design and manufacturing have created thousands of jobs, invested billions in producing novel solutions to technical challenges faced by new entrants and incumbents alike in providing new services, and doubled U.S. exports of telecommunications equipment from about \$13 billion in 1993 to over \$25 billion in 1997.⁴⁶

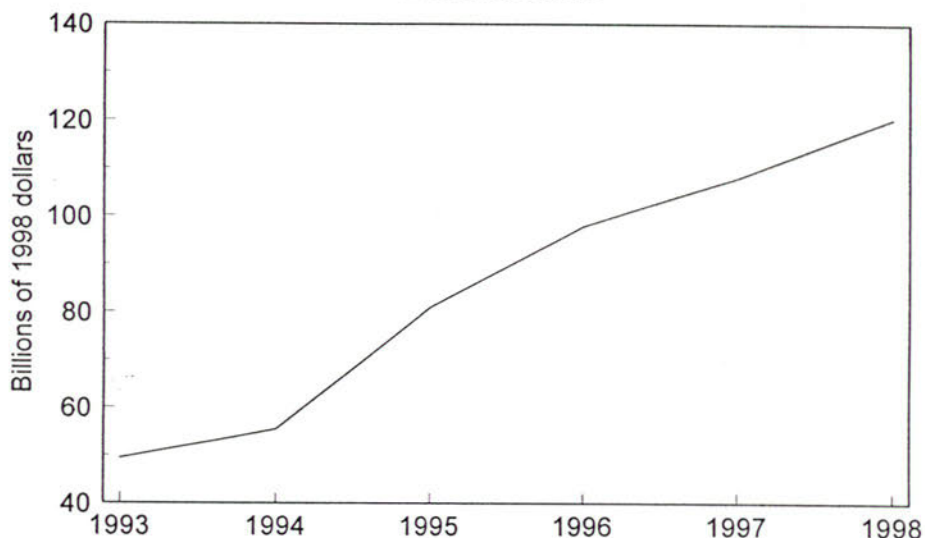
There are now more than 100 publicly traded companies that list telecommunications equipment as their primary line of business. Nearly 50 additional public companies list their primary line of business as data networking equipment. The joint market capitalization of traditional telecommunications equipment manufacturers and data networking equipment makers has more than tripled since 1993 (Chart 14). Again, numerous private companies add economic value that is not captured by the market capitalization data. The telecommunications equipment market as a whole is responsible for about one-third of the value created in the telecommunications market in recent years, with data networking equipment companies growing faster than traditional equipment companies since 1994.

The growth of data networking companies reflects the shifting demands of telecommunications consumers away from conventional voice telephony and toward fast and reliable data transport. Digitization is requiring systems to provide integrated voice and data services, and competition among conventional telecommunications equipment manufacturers and newer data network equipment makers is leading to research and development along several promising paths, both wireless and wireline.

⁴⁶ U.S. Department of Commerce.

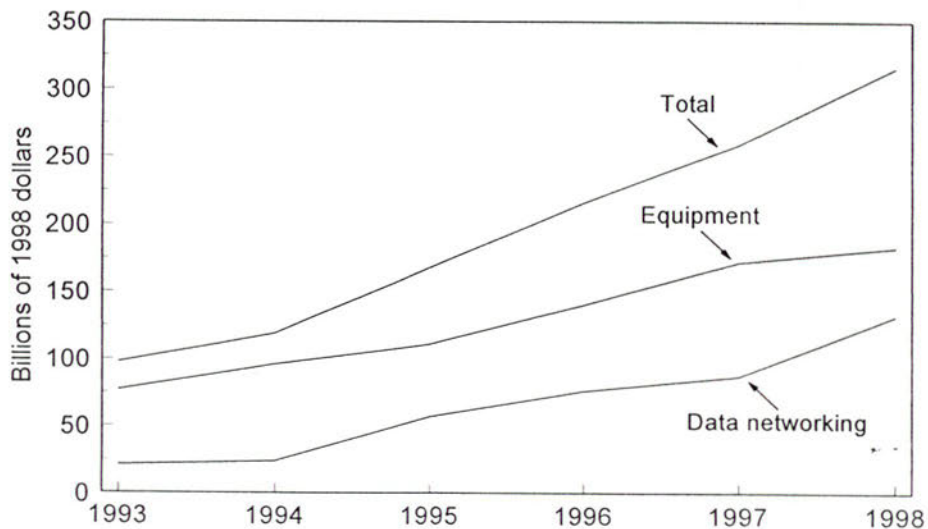
The telecommunications equipment industry will play a crucial role in solving the myriad technical problems faced by new communications service providers, whether they be cable systems, data CLECs, or full-service CLECs seeking to build out their own facilities. The equipment industry in the United States also faces substantial global competition, particularly in the area of mobile communications, and U.S. policy is working through appropriate channels to prevent harm to American manufacturers from the technical standards adopted in various international markets.

Chart 13 Revenues of Telecom Equipment Manufacturers



Source: 1997 and 1998 editions of "MultiMedia Telecommunications Market Review and Forecast."

Chart 14 Market Capitalization of Telecom Equipment and Data Networking Firms



Note: Data for 1998 based on Q3.

Source: Compustat.

The Internet

The pace of technological advance, the importance of forward-looking infrastructure, and the growing desire for information are all manifest in the rapid growth of the Internet and its associated industries. This relatively young sector of the U.S. economy has been boosted by the successful confluence of a market-oriented and non-regulatory government policy, private investment and innovation, and the public's growing demand for information services.⁴⁷ Regulatory forbearance and policies to encourage usage, as well as continuing investment in information infrastructure, have made possible unprecedented growth in both the development and adoption of this communications medium. For example, the Administration has successfully opposed taxation on Internet usage: the Internet Tax Freedom Act creates a 3-year moratorium on new taxes for electronic commerce, and the World Trade Organization has agreed to place a moratorium on customs duties for e-commerce. The Administration has also supported protection of intellectual property rights in the digital environment and has worked to establish a legal framework for electronic contracting. Furthermore, the Next Generation Internet Research Act authorizes an initiative to provide universities with the most advanced connections to the Internet and to support long-term research on Internet technologies.

The Internet's evolution from a government-sponsored research project to a global network that connects individuals, businesses, and institutions of all kinds has been propelled by increasing computing power at falling prices. The digitization of information has blurred the lines between data, video, and voice, with all these types available for transmission at ever lower cost. The cost of transmitting one bit of data over a kilometer of fiber optic cable fell by three orders of magnitude between the mid-1970s and the early 1990s.⁴⁸ The cost of processing one million

⁴⁷See the *U.S. Government Working Group on Electronic Commerce, First Annual Report*, November 1998, and *A Framework for Global Electronic Commerce* issued by President Clinton on July 1, 1997.

⁴⁸ Atkinson, Robert D., and Randolph H. Court. 1998. *New Economy Index: Understanding America's Economic Transformation*. Washington, D.C.: Progressive Policy

instructions per second (mips) was \$480 in 1978. By 1995, processing costs had tumbled to \$4 per mips.⁴⁹ And the cost of information processing continues to plummet, increasing the capability of the information industry and expanding the demand for information services.

Notwithstanding the technical advances mentioned above, the recent growth trajectory of the Internet would not have been possible without the grid of telephone lines, cables, optic fibers, signal processing and routing equipment that forms the “backbone” of the U.S. telecommunications infrastructure. The increasing public demand for—and provision of—fast and ready information has driven this “backbone” industry, motivating tremendous private investment and market capitalization as well as job creation. The growing demand for carrying capacity, or “bandwidth,” has pushed the roll-out of yet more physical equipment and wiring, as well as the deployment of such technologies as cable modems, ISDN lines, DSL services, and new methods of digital compression.

Investment in high-capacity fiber by telecommunications systems has also grown rapidly to meet new infrastructure demands. The number of “fiber miles,” calculated by multiplying the number of miles of sheathed fiber times the number of fibers in the sheathed bundle, is one measure of system capacity. As mentioned previously, the number of such fiber miles constructed by telecommunications carriers in the United States grew by about 16 percent in 1997 according to FCC estimates.⁵⁰ On the consumer end, increasing numbers of American households are purchasing additional telephone lines. Although some of these lines are probably used mostly for voice service, many are used for dedicated data lines. The number of households with additional lines grew from 8.8 million in 1993 (9.4 percent of residences) to 15.7 million in

Institute, p. 19. Hereafter *New Economy Index*.

⁴⁹ *New Economy Index*. p. 8.

⁵⁰ Federal Communications Commission. 1998. *Fiber Deployment Update*.

1996 (16.5 percent of residences).⁵¹ Those numbers have most likely grown sharply since the end of 1997 with increased use of the Internet by American consumers. Co-axial networks used by cable television systems, which increasingly now offer Internet access, are another major source of information infrastructure that will be important for bringing broadband access to residential customers.

The equipment industry has also been driven by the need for more advanced information transport. Companies engaged in manufacturing equipment for data networks are developing the advanced electronics for broadband transmission and routing of digital material—whether voice, video, or data—that innovative service providers are using to construct the networks that link users to information on the Internet and other sources.

And such advanced links are increasingly in demand. Altogether, over 35 million Internet “hosts”—computers that store sources of information on the Internet—were active world-wide by early 1998, up from 20 million only six months earlier and from fewer than 3 million in 1993 (See Chart 15). Thanks to tremendous investment in infrastructure, the United States ranks far above Japan, Germany, and the United Kingdom in public participation in the Internet, as measured by the number of hosts per capita.⁵² Only Finland has a higher concentration than the U.S. In 1993, there was roughly 1 Internet host in the United States for every 200 Americans. By 1997, the ratio had changed ten-fold, to 1 host for every 20 people—about 1 Internet host for every 4 American adults who use the Internet.⁵³ In the two years between 1995 and 1997, the number of people in the United States who used the Internet grew from about 28 million to over 73 million, or about one in four people.⁵⁴ This year, nearly one in three American adults is expected to be

⁵¹ FCC Trends. Table 19.3.

⁵² *New Economy Index*. p. 30.

⁵³ *New Economy Index*. p. 30.

⁵⁴ The estimates of adult users are from Pew survey results and the adult population of the United States. The Pew Research Center for the People and the Press. *Technology Survey 1998*

“online.” The latest Pew Center survey finds that the total number of American Internet users today is over 80 million (See Chart 16).

Recent data also show that Internet use is reaching a broader spectrum of society. In 1995 the average household income of an Internet user was over \$50,000. The latest Pew Center survey shows that the fastest growing groups of new Internet users are those with much lower income and educational levels than in the past. The survey finds that 23 percent of new users have annual household incomes below \$30,000—which is below median household income in the U.S.—and that 40 percent of new users never attended college.⁵⁵ As use expands to all economic segments of society, so too will the range of services and uses available through the Internet.

Challenges nonetheless remain. There is evidence of a “digital divide” whereby some racial and ethnic groups in the United States use the Internet disproportionately less than others. The “e-rate” program for wiring schools and public libraries, created under the Telecommunications Act of 1996, will be an important means of increasing diffusion of Internet use and ensuring that access to information is widely available. To date, the e-rate program has disbursed over \$750 million, with the goal of connecting up to 40,000 American public schools and 7,000 libraries to the Internet. Such policies ensure that an increasing spectrum of Americans will grow up with the skills to participate in an increasingly information-driven economy.

The broad reach of the Internet has made it suitable for an increasing variety of applications. “Distance learning” and telemedicine, for example, are already flourishing. Many businesses see a future in online transactions, or “e-commerce.” The volume of retail sales over the Internet more than doubled between 1997 and 1998 and electronic commerce as a whole is

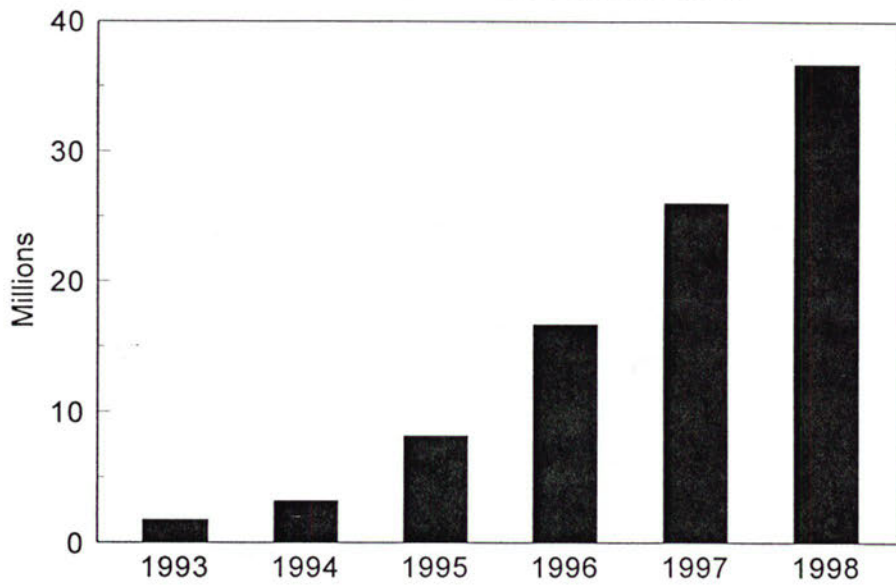
results and report, “Online Newcomers More Middle-Brow, Less Work-Oriented: The Internet Audience Goes Ordinary.” Hereafter, “Pew survey results.”

⁵⁵ *New Economy Index*. p.31.

forecast to reach \$300 billion by 2002.⁵⁶ At the same time, widespread and growing public participation in this medium heralds new possibilities for the dissemination of public interest information, whether political discourse, community news, health resources, or scientific research. The telecommunications system is the foundation upon which these possibilities will develop.

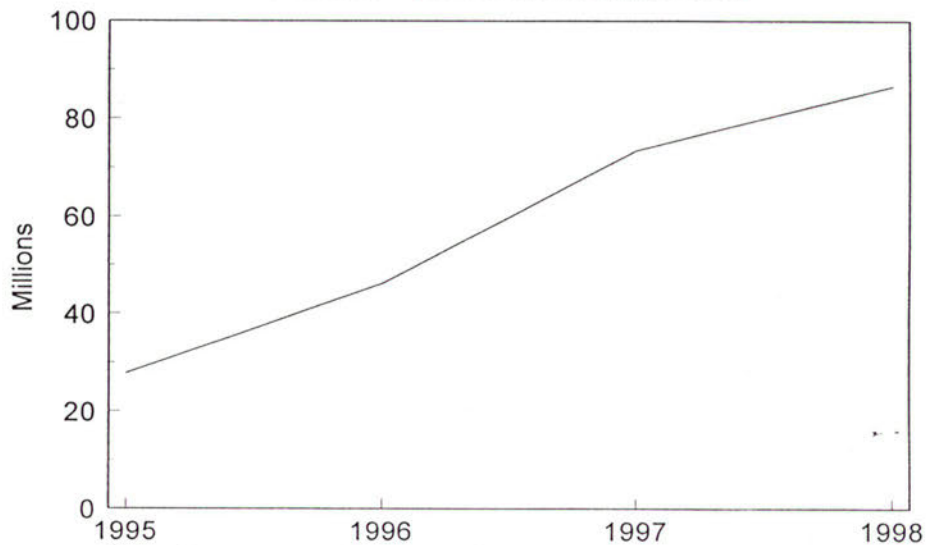
⁵⁶ Internet sales data from Boston Consulting Group and shop.org, *Online Retailer Survey*.

Chart 15 Growth in Internet Hosts



Source: Network Wizards, <http://www.nw.com>.

Chart 16 Growth in Internet Users



Note: Data represents the number of Americans who ever go online to access the Internet or World Wide Web or to send and receive email.
Source: The Pew Research Center's "1998 Technology Questionnaire."

Conclusions and Future Challenges

Competition and innovation have been vital catalysts for the growth of the U.S. telecommunications industry since 1993. Both of those forces have benefitted from a transformed regulatory approach that opens markets and rewards deployment of new services and technologies. In each of the market sectors examined, the path to increased output and lower prices has been the implementation of market opening policies, followed by investment, innovation, and competition. Fiber optics in long-distance networks, digital networks for wireless telephony, advanced services in the local network, and the equipment to support them, have all followed from the opening of those respective markets to competition. As a result, consumers pay less for larger amounts of long-distance service, wireless subscribership has soared as wireless rates have moved closer to those for conventional phone service, and households and businesses are finding the prices of high-speed, advanced services within reach as the services themselves become increasingly available.

While progress in telecommunications has been excellent, challenges remain and will continue to arise as technology and markets change. In the near term, ensuring that local markets continue to open, and that regulatory distortions on competitive incentives in those markets diminish, will be important. Moreover, unless the current system of rate averaging is restructured, the equitable goals of universal service policy—availability of essential services on fair terms for poor as well as rich, rural as well as urban—will be more difficult to achieve in an increasingly competitive telecommunications market. Specific competition issues like the pricing of interconnection and unbundled network elements, and the conditions on which ILECs may participate in the advanced services market, present challenges of opening markets while preserving efficient incentives to invest in and deploy new services, facilities, and R&D.

Although this report addresses the U.S. market only, there are also challenges on the international front of importance to American telecommunications consumers. The increasing volume of information and communications that flow globally make international

telecommunications infrastructure and interconnection vital to businesses, institutions and other consumers. The FCC, the U.S. Trade Representative, the State Department, and the Department of Commerce have all worked to obtain fair terms for U.S. carriers that need access to networks in foreign markets and to open those markets to competition. Much progress has been made and telecommunications markets in many areas of the world have moved from a structure of state-sponsored monopoly to open competition. It is important that bottlenecks that impose discriminatory terms on new competitors in global communications do not develop or persist at our borders. The infrastructure investment that has increased capacity, lowered prices, and supported the information economy domestically will also benefit the growth of electronic commerce and other information-intensive sectors world-wide. Insuring that the same competitive incentives that have developed domestically also develop for investment in facilities between the United States and other countries, and within other countries themselves, will speed the arrival of those benefits.

Finally, as innovative services and technologies affect the structure of the telecommunications market, telecommunications policy will more effectively serve the public interest if it retains sufficient flexibility to change when regulatory assumptions no longer hold. The changes that innovative systems will bring to the telecommunications market are hard to predict. New kinds of data networks, Internet-based alternatives for voice traffic, and important changes in the scope and competitive structure of the satellite industry are just a few examples of current developments. It will become increasingly important to ensure that regulation is technologically neutral, and that competition is not handicapped by disparities in the regulation of different systems that, through convergence, have come to provide the same services. The lesson from the telecommunications industry over the past 5 years is that consumers and the American economy will continue to benefit as competition has the opportunity to take hold in all markets.

INFORMATION SOCIETY

Background:

Information and communications technologies are having a pervasive impact on our economic, political, social, and cultural life. As we enter the 21st century, we should expect this trend to accelerate, as information technology becomes more powerful and widely available. For example:

- Our ability to store, process, and transmit information is continuing to improve at exponential rates. The semiconductor industry is already developing the technology that will allow them to put billions of transistors on a single integrated circuit. Fiber optics technology will eventually allow us to transmit all of the phone traffic on Mother's Day on a single strand of fiber.
- The number of transistors on an Intel microprocessor gives some indication of the continued exponential rate of this change:

1971	4004	2,300
1978	8086	29,000
1982	286	134,000
1985	386	275,000
1989	486	1.2 million
1993	Pentium	3.1 million
1995	Pentium Pro	5.5 million
1997	Pentium II	7.5 million

- The Internet, which connected 2,000 computers in 1985, now connects 19.5 million computers, and is continuing to double in size every year.
- Satellite and wireless systems will soon provide users with "anytime, anywhere" communication.
- Remote sensing systems offering 1-meter resolution imagery of the entire planet will be commercially available in 1998.
- "Building blocks" for new applications are being developed such as digital signatures, electronic payments, shared virtual environments for collaboration, intelligent agents, audio and video-on-demand, reusable software objects, tools for discovering and retrieving information, and speech recognition.

- Applications are being developed in areas such as entertainment, electronic commerce, delivery of government services, digital libraries, health care, life-long learning, environmental monitoring, geographical information systems, “collaboratories” for scientific research, community networks, intelligent transportation systems, access to information for people with disabilities, collaborative design, crisis management, etc.
- Information and communications industries have become one of the major engines of economic growth, productivity, and innovation. All companies are using information technology to cut costs, reduce the time required to develop new products, form closer relationships with customers and suppliers, and manage the “intellectual capital” of their employees:

Opportunities and Challenges

This area provides several significant opportunities for the President and Vice President.

- Information and communications technologies can be used to support virtually every important national goal they have set (e.g. life-long learning, reinventing government);
- Strategic investments in this area can have a significant impact for relatively small amount of money. Part of this has to do with the nature of digital information -- once an investment is made in creating networked information or networked services - the marginal cost of making it available to more people is almost zero. It is also possible to leverage the contributions of people outside the federal government See Tab 5.
- “Creating opportunity for all Americans in the Information Age” could be an important part of the President’s legacy.

Obviously, there are challenges as well. There is the risk that this technology could polarize American society into information “haves” and “have-nots.” Many Americans are concerned about an erosion of their personal privacy. Many computers could stop working in the year 2000 because of the millennium bug, and important elements of our infrastructure (air traffic control, financial system, electric utilities, phone network, the Internet) could become more vulnerable to a “cyber-attack.”

Potential specific initiatives

1. **Create a “Digital Globe”:** Work with universities and the private sector to create a “digital globe” -- a 3-D, digital map of the planet that has the ability to integrate imagery and geospatial data from multiple sources. This has applications in a wide variety of areas, including education, crisis management, environmental monitoring, and urban planning. See Tab 1.

Funding: FY99: \$20 - \$25 million. NASA is possible lead agency.

2. **Invest in R&D to create “knowledge” from “raw data”:** One of the biggest problems we face is information overload. We are now collecting so much data that we can’t interpret it. Many of the problems that we are facing are so complex that we need the ability to integrate data from multiple sources and disciplines. For example, planning for the recovery of the Florida Everglades requires data from long-term biological surveys, watershed flow models, land use change analyses, hydrochemical monitoring, remote sensing, economic analyses and demographic studies, etc. NSF has developed a program called “Knowledge and Distributed Intelligence” to address these challenges. See Tab 2.

Funding: FY99 ~ \$60 million. Included in NSF’s budget at “investment” level.

3. **Enhance our understanding of the economic, legal, and social implications of information and communications technology:** Despite the significant economic and social impacts of this technology, the federal government has not sponsored a great deal of social science research in this area. For example, there is no equivalent in the information technology area of the ESLI (Ethical, Legal and Social Implications) Research Program of the National Human Genome Research Institute. ELSI supports basic and applied research that identifies and analyzes ethical, legal and social issues surrounding human genetics research, such as: discrimination in insurance and employment based on genetic information; when and how new genetic tests should be integrated into health care services; and informed consent in genetics research. A program like this for information and communications technology is needed. See Tab 3.

FY99: NSF - \$10 - \$20 million.

4. **Foster Digital Laboratories of Democracy:** The President and Vice President are strong supporters of giving additional resources and responsibilities to state and local governments. One of the arguments for devolution is that states can serve as “laboratories of democracy.” John Donahue observes that “as states innovate, their experience informs not just their own policy choices, but those of the other states as well.” New technologies such as intranets may enable the United States to take maximum advantage of these laboratories of democracy - and of all of the information and expertise that is generated by a particular “community of interest” -- whether they are working on community policing, welfare to work, America Reads, local economic development, or parental involvement in education. See Tab 4.

FY99: \$1-2 million per “laboratory” - \$10 million total.

5. **Create a user-friendly online government:** Government agencies are beginning to use information and communications technologies in innovative ways that reduce costs, improve service, and make government more responsive and transparent. For example:

- People can now access the Toxic Release Inventory through the EPA web site, and find out what pollution corporations are releasing in their community. The fact that this information is readily available has caused some companies to reduce their emissions.
- Agencies are working together to create "one-stop shops" such as the Business Advisor and the Non-Profit Advisor -- that tie together all of the information and services related to a particular constituency.
- The Department of Labor has worked with the 50 state Employment Services to create "America's Job Bank" - which got 33 million "hits" in October 1997 alone.
- Law enforcement and public safety officials at the federal, state and local level are working together to create secure, interoperable networks that allow for more effective crime fighting (e.g. swat teams) and responses to emergencies.

The Administration could encourage these kinds of activities by expanding funding for the "Information Technology Innovation Fund" with a direct appropriation in the GSA budget -- or directing every agency to set aside a certain percentage of their information technology budgets for innovative projects. This is the approach that is taken for the Small Business Innovation Research (SBIR) program.

Preference would be given to those projects that:

- Implement the recommendations of the Vice President's "Access America" report;
- Cut across multiple agencies and multiple levels of government to create a user-friendly, "virtual government"; and
- Partner with researchers in industry and academia to use emerging technologies in innovative ways.

FY99: Preferred option would be to establish a \$40 million line item in the GSA budget that would be spent on inter-agency projects. Other options is to set-aside a certain percentage of government IT budgets (e.g. 0.5 - 1.0 percent).

6. **Curbcuts on the Information Highway:** President Clinton has said that "new information and communications technologies can improve the quality of life for people with disabilities, but only if such technologies are designed from the beginning so that everyone can use them." Over 50 million Americans have some form of disability. If information and communications services are designed from the beginning to be accessible, Americans with disabilities will enjoy a higher quality of life and increased

ability to participate in the workplace. Funding is required for:

- R&D in areas like speech-to-text, speech recognition, screen readers for new information appliances like palmtops and set top boxes, etc.;
- Consortia comprised of companies and representatives of the disabilities community to set standards for accessibility;
- An organization like an "Underwriter's Laboratory" that evaluates the accessibility of various products and services; and
- Testbeds that use information and communications technology in the context of "return to work" trials.

Funding: \$20 million - \$10 million for DoE - National Institute of Disabilities and Rehabilitation Research, and \$10 million for NSF.

THE WHITE HOUSE

WASHINGTON

November 12, 1997

MEMORANDUM FOR THE VICE PRESIDENT

FROM: ^{AK} TOM KALIL, ^{JK} JIM KOHLENBERGER

THROUGH: DON GIPS

RE: DIGITAL GLOBE PROJECT

After additional research, we think that the vision that you have outlined for a Digital Globe is achievable. This is particularly the case given the dramatic improvements in storage technology and the availability of one-meter resolution commercial satellite imagery. We also think that it may be possible to take advantage of the military's keen interest in acquiring high-resolution coverage of the planet from commercial sources, assuming that any national security and intellectual property issues can be worked out.

The project will need some focus if it is to achieve some near-term results. The volume of data that could conceivably be collected as part of a Digital Globe is potentially unlimited. Imagine a digital library project that set out to put "all authored works of mankind" online! We think that it would make sense to choose a few motivating applications as a way of focusing the project. We recommend (1) education; and (2) support for decision-making on one or more high-priority environmental issues, such as climate change. For an education application, for example, one might start out by having very high levels of resolution for at least one of each of the major biomes. There will also be cases where it is much easier for us to get data for the United States than for the rest of the world. Many other countries have much more restrictive policies with respect to data dissemination than we do.

We also think that it may make sense to pursue this project in a few stages:

- **Stage 1:** Integration of existing data
- **Stage 2:** A digital map of the planet at 1 meter resolution
- **Stage 3:** Full coverage of the planet with historical data and multiple thematic data sets

Our other major conclusion is that a potential big “win” from the Digital Globe is the establishment of a framework and a set of standards that allows hundreds of thousands of individuals and organizations to contribute to its development. The history of the World Wide Web, and your concept of “distributed intelligence”, is instructive. Agreement on a few standards allowed everyone to contribute to the development of a global information space. Admittedly, this will be more difficult, given that the standards associated with representing geospatial information are more complicated. But a large Digital Globe testbed could bootstrap the process - and create the “increasing returns” that Brian Arthur (Santa Fe Institute) has described.

Making this vision a reality will not happen unless you unveil your vision, and challenge government, industry, and academia to make it happen. Below are the steps we believe you should take to move this project forward:

1. **Publish a high-level vision statement:** Attached is a draft short article that spells out your vision of the Digital Globe. This could be published in either (1) a science journal e.g. (*Scientific American*, *Science*, *Nature*); (2) an industry journal on geographical information systems (*GIS World*); or (3) as an op-ed in a paper like the *San Jose Mercury News*, with a link to the full version on your Web site. Per your request, we have not circulated this vision statement to anyone within the U.S. Government or to any outside experts. We think it would make sense to do so before publishing it.
2. **Charter an inter-agency working group to develop a more detailed action plan for the Digital Globe:** After your vision piece is published, you should task an inter-agency working group to develop a more detailed action plan, engage the private sector and the university community, and identify policy issues such as privacy and intellectual property rights. We recommend Interior as the chair, given that they chair the Federal Geographic Data Committee, and given Secretary Babbitt’s personal interest in this. Secretary Babbitt is co-hosting a meeting in October with EU Commissioner Bangemann to discuss a Global Spatial Data Infrastructure. Other participants might include NASA, NIMA (National Imagery and Mapping Agency), NOAA, DARPA, NSF, and Census. You could meet with this group to lay out your vision, and participate in an annual symposium similar to the one you convene on the PNGV. You should know that you have tasked many of these same agencies to develop a Global Disaster Information Network. This group has been meeting to develop mechanisms for better sharing of both classified and unclassified information to respond to disasters. It may also be necessary to establish a high-level project office with full-time managers and technical experts.
3. **Ask the National Academy of Sciences for outside expert advice:** The National Academy of Sciences already has a working group that is interested in “geo-libraries.” This is an effort to bring together the GIS community and the digital libraries community, and could support your vision. We think that getting advice from the NAS would be very helpful, since it would provide a mechanism for getting input from both university

researchers and companies.

4. **Ensure that the Administration's budget contains some level of funding in FY99:** Unless we act during the coming budget cycle, we would not be able to request funding from Congress until FY2000. We think that even without funding, it would be possible for agencies to make some progress on this. For example, the Defense Science Board has recommended that NIMA develop "an Internet-like structure in which geospatial information services are provided by a large number of autonomous entities through a global communications network." However, we think that the project would move forward more rapidly with some targeted funding (e.g. \$20 - \$25 million).
5. **Task the National Endowment of the Humanities, the Library of Congress, and the Department of Education with the development of a "world history" application of the Digital Globe:** We think that the NEH, the Department of Education and the Library of Congress are the appropriate agencies to encourage the development of a "world history" application of the Digital Globe, and to convene leading historians to pursue this project.

The Digital Globe: Understanding our planet in the 21st Century

A new wave of technological innovation is allowing us to capture, store, process and display an unprecedented amount of information about our planet and a wide variety of environmental and cultural phenomena. Much of this information will be "georeferenced" - that is, it will refer to some specific place on the Earth's surface.

The hard part of taking advantage of this flood of geospatial information will be making sense of it - turning raw data in to understandable information. Today, we often find that we have more information than we know what to do with. The Landsat program, designed to help us understand the global environment, is a good example. The Landsat satellite is capable of taking a complete photograph of the entire Earth's surface every two weeks, and it's been doing that for more than 20 years. In spite of the great need for that information, 95% of those images have never fired a single neuron in a single human brain. Instead, they are stored in electronic silos of data. We used to have an agricultural policy where we stored grain in Midwestern silos and let it rot while millions of people starved to death. We now have an insatiable hunger for knowledge. Yet the data sits rotting away by remaining unused.

Part of the problem has to do with the way information is displayed. Someone once said that if we tried to describe the human brain in computer terms, it looks as if we have a low bit rate, but very high resolution. For example, researchers have long known that we have trouble remembering more than seven pieces of data in our short-term memory. That's a low bit-rate. On the other hand, we can absorb billions of bits of information instantly if they are arrayed in a recognizable pattern within which each is related to all the others -- a human face, or a galaxy of stars.

The user interfaces that we have used to interact with data, such as the desktop metaphor, may no longer be up to the challenges ahead. A "Digital Globe," a multi-resolution, three-dimensional representation of the planet, is just what we need.

Imagine, for example, a young child going to a Digital Globe exhibit at a local museum. After donning a head-mounted display, she sees Earth as it appears from space. Using a data glove, she zooms in, at higher and higher levels of resolution, to see continents, countries, cities, and finally, individual houses, trees, and other natural and man-made objects. Having found an area the planet she is interested in exploring, she takes the equivalent of a "magic carpet ride" through a 3-D visualization of the terrain. Of course, terrain is only one of the many kinds of data she can interact with. Using the systems' voice recognition capabilities, she is able to request information on land cover, distribution of plant and animal species, real-time weather, roads, political boundaries, and population. She can also visualize the environmental information that she and other students all over the world have collected as part of the GLOBE

project. This information can be seamlessly fused with the digital map or terrain data. She can get more information on many of the objects she sees by using her data glove to click on a hyperlink. To prepare for her family's vacation to Yellowstone National Park, for example, she plans the perfect hike to see the geysers, bison, and bighorn sheep that she has just read about.

She is not limited to moving through space, but can also travel through time. After taking a virtual field-trip to Paris to visit the Louvre, she moves backwards in time to learn about French history, perusing digitized maps, newsreel footage, oral history, newspapers, and other primary sources. She sends some of this information to her personal e-mail address to study later. The time-line, which stretches off in to the distance, can be set for days, years, centuries, or even geological epochs, for those occasions when she wants to learn more about dinosaurs.

Obviously, no one organization in government, industry or academia could undertake such a project. Like the World Wide Web, it would require the grassroots efforts of hundreds of thousands of individuals, companies, university researchers, and government organizations. Although some of the data for the Digital Globe would be in the public domain, it might also become a digital marketplace for companies selling a vast array of commercial imagery and value-added information services. It could also become a "collaboratory" -- a laboratory without walls -- for research scientists seeking to understand the complex interaction between humanity and our environment.

Technologies needed for a Digital Globe

Although this scenario may seem like science fiction, many of the technologies and capabilities that would be required to build a Digital Globe are either here or under development. Of course, the capabilities of a Digital Globe will continue to evolve over time. What we will be able to do in 2005 will look primitive compared to the Digital Globe of the year 2020. Below are just a few of the technologies that are needed:

- **Computational science:** Until the advent of computers, both experimental and theoretical ways of creating knowledge have been limited. Many of the phenomena that experimental scientists would like to study are too hard to observe - they may be too small, too far away, or occur in a billionth of a second. Pure theory, on the other hand, can not predict the outcomes of complex natural phenomena like thunderstorms or airflows over airplanes. But with high-speed computers as a new tool, we can simulate phenomena that are impossible to observe, or better understand data from observations. In this way, computational science allows us to overcome the limitations of both experimental and theoretical science. Modeling and simulation will give us new insights in to the data that we are collecting about our planet.

- **Mass storage:** The Digital Globe will require storing quadrillions of bytes of information. Already, NASA's Mission to Planet Earth program generates a terabyte of information each day. Fortunately, we are continuing to make dramatic improvements in this area.
- **Satellite imagery:** The Administration has licensed commercial satellite systems that will provide 1-meter resolution imagery beginning in late 1997. This provides a level of accuracy sufficient for detailed maps, and that was previously only available using aerial photography. This technology, originally developed for the U.S. intelligence community, is incredibly accurate. As one company put it, "It's like having a camera capable of looking from London to Paris and knowing where each object in the picture is to within the width of a car headlight."
- **Broadband networks:** The data needed for a digital globe will be maintained by thousands of different organizations, not in one monolithic database. That means that the servers that are participating in the Digital Globe will need to be connected by high-speed networks. Driven by the explosive growth of Internet traffic, telecommunications carriers are already experimenting with 10 gigabit/second networks, and terabit networking technology is one of the technical goals of the Next Generation Internet initiative. The bad news is that it will take a while before most of us have this kind of bandwidth to our home, which is why it will be necessary to have Digital Globe access points in public places like museums.
- **Interoperability:** The Internet and the World Wide Web have succeeded because of the emergence of a few, simple, widely agreed upon protocols, such as the Internet Protocol. The Digital Globe will also need some level of interoperability, so that geographical information generated by one kind of application software can be read by another. The GIS industry is seeking to address many of these issues through the Open GIS Consortium.
- **Metadata:** Metadata is "data about data." For imagery or other georeferenced information to be helpful, it might be necessary to know its name, location, author or source, date, data format, resolution, etc. The Federal Geographic Data Committee is working with industry and state and local government to develop voluntary standards for metadata.

Of course, further technological progress is needed to realize the full potential of the Digital Globe, especially in areas such as automatic interpretation of imagery, the fusion of data from multiple sources, and intelligent agents that could find and link to information on the Web about a particular spot on the planet. But enough of the pieces are in place now to warrant proceeding with this exciting initiative.

Potential applications

The applications that will be possible with broad, easy to use access to global geospatial information will be limited only by our imagination. We can get a sense of the possibilities by looking at today's applications of GIS and sensor data, some of which have been driven by industry, others by leading-edge public sector users:

- **Conducting virtual diplomacy:** To support the Bosnia peace negotiations, the Pentagon developed a virtual-reality landscape that allowed the negotiators to take a simulated aerial tour of the proposed borders. At one point in the negotiations, the Serbian President agreed to a wider corridor between Sarajevo and the Muslim enclave of Gorazde, after he saw that mountains made a narrow corridor impractical.
- **Fighting crime:** The City of Salinas, California has reduced youth handgun violence by using a GIS to detect crime patterns and gang activity. By collecting information on the distribution and frequency of criminal activities, the city has been able to quickly redeploy police resources.
- **Preserving biodiversity:** Planning agencies in the Camp Pendelton, California region predict that population will grow from 1.1 million in 1990 to 1.6 million in 2010. This region contains over 200 plants and animals that are listed by federal or state agencies as endangered, threatened, or rare. By collecting information on terrain, soil type, annual rainfall, vegetation, land use, and ownership, scientists modeled the impact on biodiversity of different regional growth plans.
- **Predicting climate change:** One of the significant unknowns in modeling climate change is the rate of deforestation. By analyzing satellite imagery, researchers at the University of New Hampshire are able to monitor changes in land cover and thus determine the rate and location of deforestation.
- **Increasing agricultural productivity:** Farmers are already beginning to use satellite imagery and Global Positioning Systems for early detection of diseases and pests, and to target the application of pesticides, fertilizer and water to those parts of their fields that need it most. This is known as precision farming, or "farming by the inch."

The Way Forward

We have an unparalleled opportunity to turn a flood of raw data into understandable information about our society and our planet. This data will include not only high-resolution satellite imagery of the planet, digital maps, and economic, social, and demographic information. If we are successful, it will have broad societal and commercial benefits in areas such as education, decision-making for a sustainable future, land-use planning, agriculture, and crisis management. We could even create a "situation room" for the Earth. This would allow us to

respond to manmade or natural disasters - or to collaborate on the long-term environmental challenges we face.

A Digital Globe could provide a mechanism for users to navigate and search for geospatial information - and for producers to publish it. The Digital Globe would be composed of both the "user interface" - a browsable, 3-D version of the planet available at various levels of resolution, a rapidly growing universe of networked geospatial information, and the mechanisms for integrating and displaying information from multiple sources.

A comparison with the World Wide Web is constructive. [In fact, it might build on several key Web and Internet standards.] Like the Web, a Digital Globe would organically evolve over time, as technology improves and the information available expands. Rather than being maintained by a single organization, it would be composed of both publicly available information and commercial products and services from thousands of different organizations. Just as interoperability was key for the Web, the ability to discover and display data contained in different formats would be essential.

I believe that the way to spark the development of a Digital Globe is to sponsor a testbed, with participation from government, industry, and academia. This testbed would focus on a few applications, such as education and the environment, as well as the tough technical issues associated with interoperability, and policy issues such as privacy. As prototypes became available, it would also be possible to interact with the Digital Globe in multiple places around the country with access to high-speed networks, and get a more limited level of access over the Internet.

Clearly, the Digital Globe will not happen over night. In the first stage, we should focus on integrating the data from multiple sources that we already have. Next, we should endeavor to develop a digital map of the world at 1 meter resolution. In the long run, we should seek to put the full range of data about our planet and our history at our fingertips.

In the months ahead, I intend to challenge experts in government, industry, academia, and non-profit organizations to help develop a strategy for realizing this vision. Working together, we can solve many of the most pressing problems facing our society, inspire our children to learn more about the world around them, and accelerate the growth of a multi-billion dollar industry. To comment, or to stay informed about the progress we're making, you can check out our web site, at <http://www.whitehouse.gov/globe/>.

THE WHITE HOUSE
WASHINGTON

October 21, 1997

MEMORANDUM FOR VICE PRESIDENT GORE

FROM: TOM KALIL ^{TAK}

THROUGH: DON GIPS

RE: KNOWLEDGE AND DISTRIBUTED INTELLIGENCE

Summary: In 1996, you gave several speeches on "distributed intelligence" - most notably your June 1996 MIT commencement address. These speeches accelerated NSF's efforts to develop a foundation-wide, multi-disciplinary research and education activity called "Knowledge and Distributed Intelligence" (KDI) in the Information Age. This memo provides a brief summary of KDI -- based on a longer NSF briefing -- and suggests some steps that you could take to learn more about it and to support it. You should know that at this point, KDI is a cross-cutting integrating "theme" at NSF as contrasted with an explicit initiative, and that the specifics of KDI are continuing to evolve. An initiative like KDI could definitely support some of the research needed for the "Digital Globe" project you have expressed an interest in - which we will be sending you a separate memo on shortly.

Budget: As part of its FY98 budget, NSF requested \$58 million in additional funding for KDI, of which \$10 million was to support NSF's involvement in the Next Generation Internet. NSF estimated that \$356 million in its \$3.4 billion base budget was supporting research in areas relevant to KDI. The House was strongly supportive of KDI, indicating that it "could have a profound impact on the research and education enterprise in this country." The Senate wanted more details on the program, so the final conference report calls on NSF to develop "appropriate milestones and guideposts" for KDI. Funding for KDI in the Administration's FY99 budget will be contingent on the overall level of funding for NSF.

Premises of KDI:

KDI is based on a number of assumptions, namely:

- The rise in computing power and connectivity has changed the face of science and engineering, just as it has generated new opportunities for all Americans.
- We are entering an era in which information is available to anyone, anywhere, at anytime, and the relationships between people and organizations are being reshaped. Since knowledge is generated by interaction between distributed individuals and communities,

this is having a profound impact on our processes of learning, exploration, cooperation, and communication.

- We have an opportunity to develop the next generation of information and communications technologies, and to use them to enhance our ability to understand and manage natural and artificial systems of greater complexity. Some of the biggest challenges will be in developing the tools and techniques to transform raw information into synthesized knowledge.

Goals and payoffs from KDI research

KDI is a highly ambitious research and education effort. NSF's goals are to:

- Revolutionize our ability to analyze, predict and influence the behavior of complex systems;
- Achieve, across a variety of scientific and engineering communities, the next generation of human capabilities to collect and model cross-disciplinary scientific data;
- Transform this data into knowledge by combining, classifying and analyzing it in new ways;
- Deepen our understanding of the cognitive, ethical, educational, legal and social implications of new information and communications technologies; and
- Promote collaboration to develop and share knowledge across space, time, disciplines, and scientific cultures.

NSF believes that KDI research will lead to increases in scientific productivity, more rapid formation of scientific communities to exploit new discoveries, enhanced understanding and performance of complex systems, improvements in science and engineering education, and the transfer of new understanding and technological innovations to society.

Components of the KDI research program

Currently, there are three components of KDI - Knowledge Networking, New Challenges in Computation, and Learning and Intelligent Systems. As mentioned above, NSF's definition of KDI continues to evolve, so these components may change. NSF also views the Next Generation Internet initiative as something that will support KDI.

1. Knowledge Networking

Knowledge Networking is designed to help bridge the gap between the ability to collect

and transmit large amounts of data -- and the construction of knowledge. Knowledge implies “consensual verification” and the ability to predict and shape outcomes. The goal of Knowledge Networking is to allow scientists and engineers to create networks to share and integrate data, analyze information, and synthesize knowledge.

Some of the specific technical objectives of Knowledge Networking include:

- Establishing effective and content-rich interaction between people, teams, and scientific instruments;
- Representing knowledge so that it can be displayed in different ways, such as text, audio, video, and simulation;
- Developing intelligent agents, or “knowbots”, that can seek specific information on behalf of individuals or teams;
- Allowing a researcher in discipline A to search a digital library in discipline B without having to learn a new vocabulary; and
- Automatically discovering patterns and relationships in data sets that are too large (millions of data elements) to use traditional database tools to analyze.

2. New Challenges in Computation

New Challenges in Computation focuses on research and tools needed to model, simulate, analyze, display, or understand complicated phenomena, to control resources and deal with massive volumes of data in real time, and to predict the behavior of complex systems. The goal is to improve our ability to:

- Analyze problems that are complex, non-linear, result in very large data sets, require high levels of resolution, and that span large scales of space and/or time;
- Provide real-time control of experiments and access to information content; and
- Visualize and represent this data in new ways - e.g. the ability to visualize data sets with many dimensions.

Many important problems require these new capabilities in computational science and engineering, such as:

- Analysis of orthopedic implants over days (determine proper placement), months (verify performance) and years (determine wear characteristics);

- Modeling phenomena (e.g. collapse of a star, global weather patterns, reliable management of communications and electric power networks) that are too complicated to understand from simple observation;
- Steering a simulation or experiment using real-time visualization of data and "smart" instruments; and
- Understanding "emergent" behavior that arises from the interactions of systems of relatively simple objects, and being able to make inferences about macro-behavior based on the properties of individual elements, and vice-versa.

3. Learning and Intelligent Systems

Learning and Intelligent Systems (LIS) will expand research in "learning about learning" in both artificial and natural systems. Some of the questions on the LIS research agenda include:

- How does learning and intelligent behavior occur in both human and artificial systems?
- What types of learning tasks are best performed by humans and artificial systems?
- How is learning impacted by different interactive environments and social contexts?
- How can we integrate insights about learning from multiple disciplines (e.g. biological, cognitive, linguistic, social, educational) with new information and communications technologies?

Next steps:

I believe that KDI is an exciting initiative with the potential for a high return on investment. It could result in an increased ability to understand and predict complex systems, increased productivity of scientific research, and improvements in the ability of scientists and engineers to collaborate across time, space and disciplines. Like the Internet, the new tools developed by researchers to create "communities of learners" could eventually have a much broader impact on our economy and our society. The economic payoffs are clear. A recent analysis of global exports by technology policy experts suggests that products are becoming more complex, in the sense that they require the "capability to integrate diverse knowledge located in many different organizations to produce previously non-existent capabilities." KDI may provide the tools that enhance our ability to do this.

As NSF moves forward with KDI, I think their most important challenges are to:

- Make some strategic investments that will create the “paradigm shifts” they are looking for;
- Obtain adequate funding for KDI;
- Foster multi-disciplinary collaboration in an academic environment that often fails to reward this; and
- Explain to the research community, the Congress, and the broader public what KDI is and why they should support it.

If this is an initiative that you are interested in learning more about and supporting, I would recommend the following as potential next steps:

1. Ask NSF to put together a briefing that would include not only NSF officials but leading researchers.
2. Ensure that NSF has adequate funding for KDI in the FY99 budget, and consider making a substantial increase in NSF funding one of the FY99 Administration investment priorities.
3. Encourage NSF to expand research in the ethical, legal, and social implications of these new information and communications technologies. This could be similar in nature to the ELSI (ethical, legal, social implications) program of the Human Genome Project. I have a longer memo on this if you are interested.
4. Publish an op-ed in *Science* that would increase awareness within the scientific community of both KDI and the Next Generation Internet initiative.

Economic and Social Impact of Information Technology: (Kalil -- Draft 11/13/97)

I. Background

Information and communications technologies are having a pervasive impact on our economic, political, social, and cultural life. As we enter the 21st century, we should expect this trend to accelerate, as information technology becomes more powerful and widely available. For example:

- Our ability to store, process, and transmit information is continuing to improve at exponential rates. The semiconductor industry is already developing the technology that will allow them to put billions of transistors on a single integrated circuit. Fiber optics technology will eventually allow us to transmit all of the phone traffic on Mother's Day on a single strand of fiber.
- The Internet, which connected 2,000 computers in 1985, now connects 19.5 million computers, and is continuing to double in size every year.
- Satellite and wireless systems will soon provide users with "anytime, anywhere" communication.
- Remote sensing systems offering 1-meter resolution imagery of the entire planet will be commercially available in 1998.
- "Building blocks" for new applications are being developed such as digital signatures, electronic payments, shared virtual environments for collaboration, intelligent agents, audio and video-on-demand, reusable software objects, tools for discovering and retrieving information, and speech recognition.
- Applications are being developed in areas such as entertainment, electronic commerce, delivery of government services, digital libraries, health care, life-long learning, environmental monitoring, geographical information systems, "collaboratories" for scientific research, community networks, intelligent transportation systems, access to information for people with disabilities, collaborative design, crisis management, etc.

Despite the significant economic and social impacts of this technology, the federal government has not sponsored a great deal of social science research in this area. For example, there is no equivalent in the information technology area of the ESLI (Ethical, Legal and Social Implications) Research Program of the National Human Genome Research Institute. ELSI supports basic and applied research that identifies and analyzes ethical, legal and social issues surrounding human genetics research, such as: discrimination in insurance and employment based on genetic information; when and how new genetic tests should be integrated into health care services; and informed consent in genetics research

Additional support for social science research on information and communications technology -- and greater interaction between social scientists and specialists in IT -- is critical for a variety of reasons:

- As discussed above, this technology will have a pervasive impact on our economy, society, culture, and political system. Although there are plenty of pundits who are willing to speculate on the impact, much of this speculation is occurring in the absence of solid, empirical data.
- Insights derived from social science research may be able to contribute to the design of information systems. The design of groupware, for example, should be informed by an understanding of how groups of people actually share information and make decisions.
- The technology is raising a series of important, complicated policy issues, such as privacy, intellectual property rights in a digital environment, the emergence of information "haves" and "have-nots", and the impact of state and national regulation on the global Internet. Social scientists may be able to make a contribution to these ongoing debates by conducting additional empirical research on the impact of IT, but also engaging in normative discussions about what "ought" to be.
- Some of the social issues raised by information technology may be partially addressed through technical solutions. For example, the World Wide Web Consortium is developing a set of technologies known as the Platform for Privacy Preferences (P3). Using the technology, a user will be able specify his or her privacy preferences. Web sites that fall within the range of a user's preference will be accessed "seamlessly," otherwise users will be notified of a site's practices and have the opportunity to agree to those terms or other terms and continue browsing if they wish. Support for these kinds of activities could solve some of the problems raised by new technology while reducing the need for legislation or regulation.
- Many of the barriers to realizing the benefits of these new information and communications technologies are not technical, but social, political or legal. For example, deployment of telemedicine is being slowed by state-by-state licensure of doctors. The use of geographical information systems is hampered by the difficulty of sharing GIS data across organizational boundaries. Widespread use of electronic commerce will require mechanisms for creating trust between parties in an online environment. Social science research could shed light on these barriers and possible solutions.

II. Examples of research topics

Clearly, there is a large number of potential research topics in this area. Below are a few examples:

1. **Diffusion of innovation:** Companies are scrambling to develop mechanisms to share “best practices” within their firm - often using groupware and intranets. Texas Instruments, for example, found such wide disparity in the yields of their wafer fabrication sites that they launched an effort to create a “free fab” by closing the productivity gap between their world-class fabs and the manufacturing facilities that were lagging behind. These same techniques could be used to promote diffusion of socially useful innovation that is occurring at the state and local level. Does the literature on diffusion of innovation (e.g. Rogers, 1995) and computer-supported collaborative work shed any light on how to design technical and social systems that will encourage diffusion of best practices, not only within a firm, but within a community of practice?
2. **Evolution of knowledge:** Drexler argues that properly designed hypertext systems can contribute to the evolution of knowledge, by, for example: enabling authors to link pithy ideas to existing content (meaningful one-sentence publications); allowing critics to attach comments directly to a target work; enabling easier formation of intellectual communities; and allowing authors to express networks of facts and relationships. How are new tools (the Web, public annotation, collaboratories, e-print archives, etc.) changing the conduct of science, scholarly debate, and public discourse? Why are they having different impacts in different fields? What are the limitations of today’s tools, and how might they be overcome?
3. **Self-regulation:** Some argue that many of the social issues associated with information and communications technology (e.g. consumer privacy) - can and should be dealt with through industry codes of conduct and self-regulation. Under what circumstances can industry self-regulation be effective?
4. **Residential broadband deployment:** Why have local telephone and cable companies curtailed their plans for deployment of broadband services to the home? What effect will current pricing and unbundling regulations have on incentives by telecommunications companies to invest in broadband networks?
5. **Network externalities:** What public and private mechanisms have proven effective in dealing with the “chicken and egg” nature of network industries?
6. **Applications:** A wide range of applications for information and communications technologies have been identified (see above). What can social science contribute to (a) evaluation of the costs and benefits of IT in these application domains; and (b) identifying barriers to the adoption of these applications?

7. **Productivity paradox:** Economists continue to argue about why increases in U.S. productivity have remained sluggish despite large private sector investments in information technology. What additional empirical research, particularly at the sectoral level - could shed light on this issue?
8. **Informed participation:** Some argue that these new information and communications technologies will allow more opportunities for “informed participation” and higher levels of transparency and disclosure in political and community affairs at the national, state and local level. For example, residents of Los Angeles were able to see 3-D visualizations of proposals for rebuilding the city after the riots before zoning changes were made. Community activists are being trained to use the Toxic Release Inventory data to discover which companies are emitting high levels of pollution in their neighborhood. More and more elected officials accept e-mail from constituents. What are the circumstances in which technology can be effective in expanding opportunities for informed participation? How will elected officials and policy-makers cope with the “information overload” problem?
9. **Changing role of key institutions:** Information and communications technologies will create both threats and opportunities for existing organizations. For example, some universities may be able to serve non-traditional students (e.g. adult students who can’t attend a university full-time) by expanding distance learning services. Others may lose students and tuition to “virtual universities” or publishers that can offer courses at a lower cost per credit hour. Some have suggested that the functions of the university (administration, degree-granting, instruction, physical facility) will be “unbundled.” How are key organizations responding to IT-related challenges and opportunities? If existing organizations are unable or unwilling to adapt, will new organizations emerge?

III. Current efforts

NSF is currently supporting some research in this area. The Social Dimensions of Engineering, Science, and Technology (SDEST) program, which has a budget of approximately \$2.3 million per year, is supporting several projects related to information and communications, such as an evaluation of whether a community network project in Minnesota is expanding access to resources and civic participation, and a study of the costs and benefits of anonymous communication online. In addition, there is another NSF program called Information Technology and Organizations which is supporting some social science research, such as a study of the impact of IT on American households, and an analysis of the development of trust among groups working online. NSF is also sponsoring a National Research Council study to develop a research agenda on the economic and social impact of information technology.

Although both the SDEST and ITO programs are supporting some worthwhile research, more needs to be done. The SDEST program, for example, only has a budget of \$2.3 million to support research on all issues related to both: the ethical and value dimensions of science,

engineering, and technology; and the management and direction of research, science, and technology.

IV. Elements of an initiative:

(1) The government should establish a program focused on information and communications similar to the ELSI (Ethical, Legal and Social Implications) Research Program of the National Human Genome Research Institute.

As noted earlier, there is no “ELSI” for information and communications. Such a program could support:

- One or more “centers” (which could be either real or virtual).
- Social science research by individual researchers.
- Inter-disciplinary teams of computer scientists and social scientists that seek to address social issues at the “protocol level” - such as the Platform for Internet Content Selection (PICS) and the Platform for Privacy Preferences (P3).
- Graduate or post-graduate fellowships for social scientists interested in exploring information and communications issues, or computer scientists interested in exploring social issues.
- Workshops and other community-building activities.

An ELSI program could also support efforts to “mediate” between policy makers and social scientists. Unfortunately, policy makers usually don’t have time to pour over scholarly journals or attend conferences. These efforts might include:

- “Headlines” of relevant social science research with links to full text.
- Regularly updated, on-line literature reviews covering key topics.
- Directories of specialists in particular areas.
- Mechanisms that allow for funding of “snap” studies if policy makers are forced to make decisions under time constraints.

(2) Certain government-supported information and communications initiatives should include a social science component.

For example:

- The Digital Libraries Initiative has convened workshops on the social aspects of digital libraries. [See <http://www.dlib.org/groups/socialaspects.html>]
- One of the foci of the Next Generation Internet initiative is “quality of service” - which will not be widely deployed without a workable economic/business model.
- The President’s Council of Advisers on Science and Technology is recommending that the Administration substantially expand its investment in evaluation of educational technology.

(3) Statistical agencies (e.g. Census Bureau, BLS) should expand their collection of data in this area.

An example of this is Census data on computer use and ownership.

(4) Companies could agree to share market-research data with a consortium, which could be made available to social scientists.

Although companies conduct market-research data for proprietary reasons, some of the data might be helpful for social scientists.

References:

K. Eric Drexler. “Hypertext Publishing and the Evolution of Knowledge,” *Social Intelligence*, Vol. 1, No. 2, pp.87-120.

NSF Workshop on Information Technology and Organizations. See <http://www.cs.colorado.edu/~laurav/workshop/itogranttees.html>. This page has pointers to the abstracts of the roughly 50 PIs whose work is being supported by the NSF ITO program.

Everett Rogers. Diffusion of Innovations. New York: The Free Press, 1995.

DIGITAL LABORATORIES OF DEMOCRACY

Draft Tom Kalil 11/13/97

"I believe we should ship decision-making responsibility and resources from bureaucracies in Washington to communities, to states and where we can, directly to individuals."

-- President Clinton, January 31, 1995

You say you want a devolution?

The President and Vice President are strong supporters of giving additional resources and responsibilities to state and local governments. This has certainly been the trend. The net growth in federal civilian employment between 1962 and 1995 was 15 percent, while state and local employment grew by 150 percent over the same period.

One of the arguments for devolution is that states can serve as "laboratories of democracy." John Donahue observes that "as states innovate, their experience informs not just their own policy choices, but those of the other states as well." Donahue identifies a number of examples where innovation in one state has spread quickly to others:

- Georgia's discovery that with respect to environmental regulations -- businesses care more about rapid processing of permit applications than the stringency or laxness of the regulations;
- State adoption of laws barring "gag rules" -- HMO rules forbidding doctors to discuss costly treatment options with patients;
- Sunset laws triggering automatic review of legislation; and
- Competency tests for teachers.

Use of Internet/Intranets for diffusion of "best practices", formation of "virtual communities"

New technologies may enable the United States to take maximum advantage of these "laboratories of democracy" - and of all of the information and expertise that is generated by a particular community.

Within the last couple of years, companies have moved aggressively to deploy Intranets as a mechanism for sharing best practices and the accumulated knowledge and expertise of its employees. Texas Instruments, for example, found such wide disparity in the yields of their wafer fabrication sites that they launched an effort to create a "free fab" by closing the

productivity gap between their world-class fabs and the manufacturing facilities that were lagging behind. Arthur Andersen (AA) has developed an intranet called KnowledgeSpace that contains:

- A taxonomy of all business processes, and information on the ways in which world-class companies accomplish a particular business process;
- Descriptions of previous client engagements;
- Studies and articles;
- Tools for performance measures and diagnostics;
- Templates for presentations to clients;
- Intranet-based training;
- Directories of AA experts in a particular subject;
- Sophisticated tools for searching and navigating through all of this information.

Internet-based companies are also forming to foster “virtual communities” or “communities of interest.” For example, ParentSoup, one of the companies highlighted in the Administration’s event on global electronic commerce, has developed an on-line community for parents. The service has discussion groups on 60 subjects - everything from bottle feeding to sibling rivalry; polls; live chat; an on-line library on parenting issues; information on 5,000 baby names; and parent’s picks on books, baby products, travel, and toys.

As McKinsey consultants John Hagel and Arthur Armstrong note in *Net Gain: Expanding Markets Through Virtual Communities*, these on-line communities often demonstrate “increasing returns.” For example, the more people participate, the more user-generated content is published, which in turn attracts more users.

Public sector applications

I believe that there are significant public sector applications for these techniques. Already, some public sector “communities of interest” (e.g. people working on acquisition reform, public financial management.) are exploring ways of using the Internet more aggressively.

Obviously, as opposed to maximizing the dissemination of information and expertise within a firm, the government’s interest is in promoting this within a particular community of interest (e.g. everyone working on welfare-to-work, community policing, the “America Reads”

challenge, etc.) Participants in these on-line communities might include federal, state and local officials, practitioners, academic experts, staff of non-profit organizations, and other stakeholders in a particular issue area. A wide range of services could be provided, including:

- On-line access to a wide range of relevant information, including federal and state legislation, program evaluations, case studies of successful initiatives and “best practices”, statistics, databases, proceedings of conferences, etc.;
- An ability to conduct electronic transactions with the federal government (e.g. NSF’s submission and management of grants using a system called FastLane);
- Moderated newsgroups or mailing lists on particular topics;
- Interviews and presentations, with real-time questions from the “virtual” audience;
- Polls and surveys;
- Structured debates on hot issues of the day;
- Internet-based training; and
- Directories of participants in the community, allowing people with shared interests to find each other.

It is important to note that companies are investing heavily in tools to support these kinds of activities. A new start-up called PlaceWare, for example, has developed a product called “Auditorium” that allows presenters can show a slide show, give a space, or host a discussion, while the audience can ask questions, chat, collaborate, and even vote. A high-tech consulting firm is developing a service called “ExperNet” that allows customers to ask questions, get back answers within 24-48 hours, and query a knowledge base of previously answered questions.

Potential benefits of these communities

There are a wide range of potential benefits, including:

- Faster diffusion of innovative practices;
- Sharing of expertise that is in people’s heads, and not written down anywhere;
- Broader access to information that is relevant to policy-makers and practioners in a particular issue area, which would hopefully lead to better decision-making;

- Better communication between different levels of government, and between people in government, non-profit organizations, private sector, and academia;
- Creation of a “space” for debate and public discourse on important issues.

Implementation/next steps

My view is that the development of these “digital laboratories of democracy” should be outsourced. The skills necessary to develop these include expertise in the subject matter; information management; and Internet/Web technical skills.

As these communities gain momentum, it is possible that some or all of the costs associated with maintaining them could be defrayed by subscription fees, advertising sponsorships, etc.

Funding requirements for these would be relatively modest - probably several million dollars per year per laboratory. In terms of funding:

- The Administration could issue a white paper on the subject, and encourage agencies to experiment with these concepts within existing FY99 funds.
- The Administration could provide specific funding for “digital laboratories of democracy” in its FY99 budget.

ABSTRACT

People with shared interests are using the Internet to solve problems, accomplish tasks, and create resources that would be well beyond the reach of any one person or organization. The Internet is being used to create virtual libraries, factor large numbers, organize massive volunteer efforts, and filter information in a collaborative fashion. The ability to leverage the efforts of large numbers of networked users has important economic, social, and political consequences. This phenomenon is important to policy makers because it can potentially be used to leverage scarce taxpayer dollars and promote applications of the information infrastructure.

Leveraging Cyberspace

Thomas A. Kalil, National Economic Council

"Give me a lever long enough and a place to stand, and I will move the Earth."

— Archimedes

The rapid growth in the ubiquity and functionality of the Internet is amazing. The Internet now connects 10 million computers, tens of millions of users, and more than 100 countries. At its current rate of growth, the Internet will connect 100 million computers by the year 2000. Because anyone with a computer and a connection to the Internet can publish, the global information space is also growing rapidly. Developers of search engines such as Altavista and Lycos believe that the Web currently contains 30–50 million pages of information, or 200 to 330 Gbytes of text. At current growth rates, the Web could surpass the 29 Tbytes of the Library of Congress in two years [1].

In addition to allowing anyone to publish, the open architecture of the Internet also allows anyone to add to its functionality. In recent years, researchers and companies have developed new applications such as audio and video streaming, multicasting, downloadable "applets" written in object-oriented languages like Java, voice over the Internet, three-dimensional virtual environments, intelligent agents, electronic payments, and new media types for rich documents. Vendors have scrambled to "Internet-enable" their existing products, such as spreadsheets, groupware, authoring tools, workflow software, and relational databases. Because the Internet serves as its own distribution channel, the diffusion of new standards, protocols, and software can occur very rapidly without the need for shelf space in retail outlets. As Tony Rutkowski, former Executive Director of the Internet Society, is fond of observing, "The Internet is its own revolution."

Although the evolution of the Internet is fascinating, the Clinton-Gore Administration does not view it as an end in itself. The Administration is interested in the Internet and the other information and communications technologies that comprise the national and global information infrastructure because of their potential to contribute to a broad range of economic and social goals. The development of the national information infrastructure (NII) is an Administration priority because of its potential to increase U.S. productivity and economic growth; improve the way teachers teach and students learn; make government more efficient, transparent, and responsive; allow individuals to make better decisions about their health care needs; allow scientists and researchers to collaborate more easily; and enable Americans with disabilities to lead more independent lives.

In my view, one of the more important applications of the Net is its ability to enable "communities of interest" to solve problems, accomplish tasks, or create resources that would be well beyond the ability of any one individual or organization to complete. Steven Whitehead refers to this phenomenon as "cyberspace leveraging," which he defines as "using computer networks to harness the power of a large population of networked users" and leveraging the "small efforts of the many" as opposed to the "big efforts of the few" [2]. Think of the Internet as a distributed, massively parallel supercomputer connecting not only microprocessors but people, information repositories, sensors, intelligent agents, and mobile code.

There are many examples of Internet users leveraging cyberspace, some of which will be described in greater detail below. Six hundred volunteers from five continents used 1600 computers to factor RSA-129 in eight months, a mathematical feat that was projected to take 40 quadrillion years. Users of multi-user dungeons (MUDs) collaborate to build elaborate text-based virtual reality environments. Archives of scientific e-prints and popular indexes of the World Wide Web (WWW) such as Yahoo are maintained primarily through the submissions of thousands of individuals and organizations. Using a bulletin board on Niftyserve (a commercial on-line service), Japanese users of the HP-100 collaborated to create a public domain library of Japanese fonts. The WWW was used to organize NetDay, a grassroots effort by more than 20,000 volunteers to deploy internal local area networks in thousands of California schools. The collective wisdom of many participants in a given newsgroup often distilled into answers to "frequently asked questions," or FAQs.

Leaders in both government and business recognize the importance of this phenomenon. Vice President Gore recently gave a speech in which he argued that "distributed intelligence" and "massive parallelism" are powerful metaphors for our age that help explain why democracy has triumphed over totalitarian and authoritarian regimes, and why "American businesses are pushing power, responsibility, and information away from the center [3]." John Gage, chief science officer of Sun Microsystems, says that companies should try to "harness the collective brainpower of the Net in the service of your product. The old idea was that the only people who could help you invent new things were people inside your company. On the Net, you can invoke the talents of people worldwide, 24 hours a day, who are doing it out of love — doing it just to do it" [4]. Similarly, in his analysis of "business ecosystems," James Moore concludes that major information technology companies no longer succeed or fail as single entities. "Central firms are joined by hundreds or even thousands of other

*Think of the Internet as a
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organizations, such as VARs [value-added resellers] or ISVs [independent software vendors] working to bring solutions of total value to customers. The end customer wants to sign up with the most robust community" [5]. Economists such as Hayek have long recognized the power of markets to harness distributed knowledge. As he explains, "every individual has some advantage over all others because he possesses unique information of which beneficial use might be made only if the decisions depending on it are left to him" [6].

Of course, not all tasks can be completed more rapidly by having more people or organizations work on them. This is certainly the case for large, complex software projects. As Fred Brooks has concluded, "The man-month as a unit for measuring the size of a job is a dangerous and deceptive myth. Men and months are interchangeable commodities only when a task can be partitioned among many workers with no communication among them" [7]. If a task cannot be partitioned because of sequential constraints, or if there are complex interrelationships between parts of the task, assigning more people to a task may not reduce the time required to complete it, and may even increase it. Writing a speech is a good example of an activity that can take longer if more people are involved. For other kinds of tasks, the tradeoffs are more complicated. Making a decision can certainly take longer if more people participate, but the decision may be of higher quality and more legitimate.

EXAMPLES OF LEVERAGING CYBERSPACE

The Seven Wonders of the Ancient World were massive construction projects like the Great Pyramid, built with 2 million blocks of stone, each weighing several tons. What future wonders of the "Wired World" might evolve from the voluntary association of people who work and play on the Net? By looking at some actual and proposed examples of cyberspace leveraging, we may be able to discern which types of problems can be solved by large numbers of networked users.

AUTO-FAQ

In a paper at the Second International WWW Conference, GTE researcher Steven Whitehead observed that the development of intelligent systems is usually constrained by a knowledge acquisition bottleneck, and that it "typically involves a small number of highly skilled knowledge engineers, is expensive and does not scale." To overcome this bottleneck, he proposes cyberspace leveraged intelligent network agents (CYLINAs). CYLINAs require:

- A widely accessible medium for information exchange, such as the WWW
- A motivated user community that is willing to contribute expertise and time
- An application that allows nonprogrammers to incrementally contribute and maintain knowledge

Whitehead has developed a prototype CYLINA that answers questions, called Auto-FAQ. Users pose questions to the Auto-FAQ system, which maintains a database of question-answer pairs. When a user asks a question that Auto-FAQ cannot answer, this question can be added to a Gap List, which is made available to a population of domain

experts who can provide the information. Depending on the application, this population of experts could be a single guru, the staff of a customer service center, or the global Internet community. Users are also given an opportunity to rate the usefulness of the answers. This user feedback is used to filter information which is incorrect, not useful, or out-of-date. In addition, Auto-FAQ is more likely to retrieve records (question-answer pairs) which have high utility scores. In short, Auto-FAQ uses "cyberspace leveraging" to identify the gaps in

its database of question-answer pairs, to allow experts to contribute answers to these gaps, and to gather feedback from its users on the utility of its information.

CRACKING RSA-129

In August 1977, three MIT professors — Ronald L. Rivest, Adi Shamir, and Leonard M. Adleman — offered a \$100 award to anyone who could decode a cipher they printed in a *Scientific American* column on mathematical games. Because of the strength of the algorithm they used, they estimated that it would take 40 quadrillion years to decode the cipher, which used a 129-digit number as their "public modulus." In April 1994, a team of four computer scientists announced that they had cracked it in only eight months. By using a mathematical attack called a "multiple polynomial quadratic sieve," the team was able to split this job, which required 100 quadrillion computer tasks, into smaller tasks. By sending messages to relevant mailing lists and newsgroups, the team recruited 600 volunteers from five continents, who collectively donated time on 1600 computers [8]. In addition to donating computer time on nights and weekends, volunteers also ported the factoring code to a variety of machines, which ran on computers that ranged from a 386SX PC to a Cray C90. Participants in a project called FAFNER (Factoring via Network-Enabled Recursion) are already working on cracking RSA-130, and intend to work on even larger numbers in the future to evaluate the security of public key cryptosystems such as RSA.

CREATING AND ORGANIZING A GLOBAL INFORMATION SPACE

The volume of information on the Internet is exploding. Finding a specific piece of information, however, can be frustrating and time-consuming. Much of the information on the Internet may be out of date or of uncertain quality. Some people have observed that the Internet is like a library without a card catalogue.

One example of a project designed to remedy this problem is the World Wide Web Virtual Library. This project was started by Tim Berners-Lee, creator of the WWW, in 1991. In 1993, the WWW project (then based at CERN, the European Laboratory for Particle Physics) began to delegate responsibility for creating and maintaining Web-based subject catalogues. As of 1996, there are over 200 virtual libraries maintained by volunteers from around the world, on subjects from aboriginal studies to zoos. Each of these virtual libraries may have hypertext links to other virtual libraries on progressively more narrowly defined subjects. This system allows the task of creating and organizing a global information space covering all subjects to be divided into more manageable pieces. For example:

- The top-level virtual library on engineering points to 23

domain-specific engineering virtual libraries (e.g., civil, electrical, mechanical).

- The Mechanical Engineering Virtual Library points to WWW servers maintained by hundreds of university departments, vendors, institutes, and research initiatives, such as the Microelectromechanical Systems (MEMS) Clearinghouse.
- The MEMS Clearinghouse maintains an archive which contains announcements of job openings, calls for papers, bibliographies, dissertation abstracts, newsletters, user contributed files, software tools, descriptions of fabrication facilities, and software tools, and points to the MEMS-related servers maintained by vendors, research initiatives, and professional societies.

In some academic disciplines, the Internet has become the primary means by which scientists communicate their research findings. The Los Alamos "e-Print Archive," started by theoretical physicist Paul Ginsparg in August 1991, now covers 17 disciplines in physics. It is used by more than 35,000 researchers around the world to distribute and archive scientific preprints, and handled 13,000 submissions in 1995. The archive allows research results to be disseminated instantaneously, eliminating the delays of months or years associated with traditional journals. As Ginsparg notes, it has also instituted a "form of democracy in research both by circumventing the boat-mail gap between continents ... and by granting access to new results without discrimination to beginning graduate students and to seasoned operators [9]." The e-Print Archive has a very low centralized overhead. It successfully leverages the "small efforts of the many" by requiring scientists to submit their own preprints. Scientists are generally willing to make their research results freely available because they are interested in communicating their findings to their peers and establishing professional reputations, not in earning royalties.

Yahoo is another high-profile effort to organize the WWW. Started in 1994 as a volunteer effort by Stanford graduate students Jerry Yang and David Filo, this high-tech start-up lists more than 200,000 Web sites under 20,000 different categories, and is used by almost 800,000 people per day. Although Yahoo! is an outgrowth of Yang's and Filo's "hotlists," the majority of the uniform resource locators (URLs) for new WWW sites are submitted from people who want their site listed. In this case, leveraging cyberspace by relying on self-submission from thousands of people each day is necessary but not sufficient. Yahoo would not be as useful if it relied solely on self-submission. Much of Yahoo's value comes from its carefully developed taxonomy of subjects, and the fact that the company has hired 20 people to categorize new sites in a consistent fashion.

NETDAY

Networks can also be used to organize and leverage the small efforts of the many in the "real world," as opposed to cyberspace. For example, on March 9, 1996, President Clinton, Vice President Gore, and more than 20,000 volunteers participated in "NetDay." NetDay was a grassroots effort to install internal wiring in thousands of schools throughout California that used the Internet in creative ways to mobilize volunteers. The President helped to kickstart NetDay, first proposed by John Gage (Sun Microsystems) and Michael Kaufman

The WWW site created by NetDay organizers included a home page for all 13,000 California public and private schools. Volunteers were able to sign up on-line, indicate their level of expertise and commitment, and see who else had agreed to help out.

(KQED), by bringing together high-tech industry leaders for a meeting on educational technology in California schools on September 21, 1995.

Hundreds of companies sponsored individual schools by paying for the NetDay wiring kits, and helping to design and test the networks. Several companies provided free authoring tools, WWW server software, and Internet access to every school in California. Organizers developed workshops, instructional videos, and online manuals to teach thousands of parents and other volunteers how to wire schools.

The WWW site created by NetDay organizers included a home page for all 13,000 California public and private schools. Volunteers were able to sign up on-line, indicate their level of expertise and commitment, and see who else had agreed to help out. An on-line clickable map allowed Californians to "zoom in" to the street level; each school was represented by a dot that was color-coded based on the number of volunteers who had signed up. This has allowed people with a shared interest in upgrading the technology in their local school to discover each other in a self-organizing, bottom-up way.

GLOBAL COOPERATIVE COMPUTING

A group of researchers at the Massachusetts Institute of Technology (MIT) Artificial Intelligence Laboratory have proposed a framework for global cooperative computing to support software evolution, including "development, distribution, execution, feedback gathering, profiling, optimization and patching" [10]. Their motivation for creating this framework is that while "fundamental computing substrate has been dramatically altered to include pervasive computer networks, a large, public programming expertise, and the World Wide Web," systems for software development have not changed much over the last decade.

Although they note that the Internet has already been used effectively for software development such as Linux and the GNU project, they believe that continued progress will require mechanisms and tools for:

- Indexing and documenting code for public reuse
- Cross-organization collaboration on code development
- Acquiring and managing user annotations on code
- Quick, easy software upgrades and bug fixes

GLOBE

Global Learning and Observation to Benefit the Environment (GLOBE) is an international environmental education and science partnership conceived of and promoted by Vice President Gore. The program is designed to heighten environmental awareness, increase scientific understanding of the Earth, and promote higher student achievement in science and math. Students conduct measurements and observations, such as atmospheric temperature, precipitation, soil moisture, species identification, and surface water Ph, and share the data with scientists and other students. The data is combined using visualization techniques. Currently 2700 schools in 32 countries have registered to participate, and 950 schools have already submitted 156,000 data reports. GLOBE demonstrates the potential of the Net to help parallelize the collection and observation of local data, while still allowing participants to understand the "big picture."

COLLABORATIVE INFORMATION FILTERING

Researchers at the MIT Media Lab have created algorithms to deal with information overload that make personalized recommendations by automating "word of mouth [11]." Ringo, for example, was a social information filtering system that made personalized music recommendations. Users of Ringo developed profiles by rating artists and albums on a scale of 1 (pass the earplugs) to 7 (One of my FAVORITE few!). Ringo used these user profiles to generate advice to individual users. It compared user profiles to determine which users have similar tastes in music. By computing an average of all of the ratings given to an album by users with similar tastes, Ringo was able to predict the likelihood that an individual user would like or dislike a given album. Users were also able to review short reviews written by other Ringo users with shared tastes, and to add albums and artists to the database.

This technology is now being commercialized by Agents Inc., whose on-line "Firefly" service asks potential customers to:

"Visualize the universe of people you know. Reduce that to the handful of those people whose tastes and opinions you trust. These are the people who you rely upon today for recommendations. Now imagine that you could have your own personal and intelligent agent whose task it is to find more people across the globe — who also share your tastes and opinions — and not only learn from their experiences (by communicating with their agents) but introduce you to these people."

UNDERSTANDING CYBERSPACE LEVERAGING

These are only a few of the existing or proposed examples of cyberspace leveraging. As the number of users, bandwidth, networked computational resources, and sophistication of software (e.g., intelligent agents) all increase, these collaborative projects will become even more complex. Artificial life expert Tom Ray wants to create a "very large, complex and inter-connected region of cyberspace that will be inoculated with digital organisms"; organisms that will increase in diversity and complexity through natural selection [12]. David Gelterner envisions "Mirror Worlds," software models representing some piece of reality (a hospital, a corporation, a city) fed by so much data that "the model can mimic the reality's every move, moment-by-moment [13]."

If distributed, cooperative problem-solving/resource creation is likely to increase in importance over time, we should try to understand what factors will determine whether these efforts will succeed or fail. Based on the case studies, below are some initial thoughts on the important success factors.

Can Dependencies between Parts of the Task Be Eliminated or Managed? If this cannot be done, recruiting more people to work on a project won't help and may even be counterproductive.

What Will Motivate People to Participate? Currently, the "gift economy" is alive and well on the Internet. Many people

If distributed, cooperative problem-solving/resource creation is likely to increase in importance over time, we should try to understand what factors will determine whether these efforts will succeed or fail.

will give away resources (papers, indexes, computer programs) that may have taken them weeks to develop. Sometimes this motivation is easy to understand. As a scientist, I want my peers to read my work. If I have already developed an index for my own use, the costs associated with sharing it with the world are very low. If I am a programmer at the beginning of my career, I may want the notoriety that comes with authoring a cool Java applet. I may derive some "psychic income" from being part of a larger community working toward a common end.

The "opportunity cost" associated with giving away compute cycles at night or during the weekend to factor RSA-129 may be very low. It will be interesting to see whether the introduction of technologies such as "micropayments" will create new markets, and encourage more people and firms to provide intellectual property or services on a commercial basis.

Is There Part of the Task that Must Be Centrally Administered? Most of the examples have at least a portion of the task that must be centrally administered. Yahoo would not work if everyone classified their own Web sites. The Los Alamos e-Print Archive is easier to search and less likely to suffer from URLs that no longer point to anything because all of the papers are centrally archived.

Does the Initiative Demonstrate Increasing Returns? Some of these efforts demonstrate virtuous circles. As more people use Yahoo, the incentive to register one's site with Yahoo increases, which in turn attracts more visitors to Yahoo. Similarly, collaborative filtering schemes increase in accuracy with the number of users. This suggests that reaching a certain "critical mass" may be important.

POLICY IMPLICATIONS OF LEVERAGING CYBERSPACE

The ability of networks to leverage the small efforts of the many has a number of important policy implications. First of all, governments need to pay attention to this phenomenon because they should always be searching for opportunities to maximize the impact of taxpayer dollars, especially in a period of tight budgets and fiscal austerity. Some federal research and development programs, for example, require that the private-sector participants pay for at least 50 percent of the cost of the project. The Net may create opportunities for leverage that go far beyond one-to-one, and policy makers should look for opportunities to take advantage of it. For example, there is a good deal of political support for shifting responsibility and authority for programs (e.g., welfare reform, training, community development) from the federal government to state and local governments. Policymakers should develop mechanisms (clearinghouses, centers of excellence) to harness the expertise that exists at the local level.

Second, many of the applications of the NII that the Administration is interested in promoting rely heavily on networked information and services. Examples include consumer health information, government information, interactive modules for life-long learning, digital libraries, framework data for geographical information systems, and networked databases for scientific collaboratories. As this article has shown, creating

and organizing a global information space is a task that can be parallelized. Individuals publish papers or other forms of networked information on the Net. Others develop indexes, meta-indexes, self-publishing archives, search engines, annotations or evaluations, and other mechanisms for adding value to the ocean of raw data and information.

As the government works with academia, the private sector, and other stakeholders to promote these NII applications, it should look for ways to leverage cyberspace. For example, the National Science Foundation has funded an effort to build a Virtual Department of Geography [14]. Over 30 geography professors will work over the next three years to develop peer-reviewed interactive course modules that cover the entire discipline. As part of President Clinton's initiative to promote the use of technology in our nation's schools, the Administration would like to see similar initiatives launched for other disciplines. The Administration is also interested in promoting "virtual office hours." Many professionals with a wide range of backgrounds could each devote several hours each week to answering questions posed by students on the Internet and, in the process, develop a useful database of FAQs.

Finally, if cyberspace leveraging is important, understanding and advancing its technical and social underpinnings are important. This suggests the need for continued investment in research in areas such as distributed computing, distributed AI, computer-supported collaborative work, coordination science, and knowledge-sharing.

REFERENCES

- [1] S. Steinberg, "Seek and Ye Shall Find (Maybe)," *Wired Mag.*, vol. 4, no. 5, May, 1996, p. 113.
- [2] S. Whitehead, "Auto-FAQ: An Experiment in Population Leveraging," *Proc. 2nd Int'l. WWW Conf.*, 1994, pp. 25-38.

Many professionals with a wide range of backgrounds could each devote several hours each week to answer questions posed by students on the Internet and, in the process, develop a useful database of frequently asked questions.

- [3] A. Gore, "The Technology Challenge: How Can America Spark Private Innovation?" Feb. 14, 1996.
- [4] R. Rapaport, "The Network Is the Company," *Fast Company*, Apr.-May 1996, p. 120.
- [5] J. Moore, "The Advent of Business Ecosystems," *Upside*, Dec. 1995.
- [6] F. A. Hayek, *The Use of Knowledge in Society*, Menlo Park, CA: Institute for Humane Studies, 1977, p. 8.
- [7] F. Brooks, *The Mythical Man-Month: Essays on Software Engineering*, Reading, MA: Addison-Wesley, 1982, p. 16.
- [8] K. Leutwyler, "Superhack," *Scientific American*, July 1994, pp. 17-20.
- [9] P. Ginsparg, "Proposal to the NSF for Support of E-Print Archives," Feb. 24, 1994, p. 4.
- [10] I. Eslick et al., "Global Cooperative Computing: A White Paper."
- [11] U. Shardanand and P. Maes, "Social Information Filetering: Algorithms for Automating Word of Mouth," *Human Factors in Comp. Sys., CHI '95 Conf. Proc.*, ACM SIGCHI, pp. 210-17.
- [12] T. S. Ray, "A Proposal to Create a Network-Wide Biodiversity Reserve for Digital Organisms," ATR Tech. Rep. TR-H-133, 1995.
- [13] D. Gelertner, *Mirror Worlds*, New York: Oxford University Press, 1992, p. 3.
- [14] K. Foote, "Building and Linking Geography Curricula Nationally Using the Internet and Worldwide Web," June 5, 1995, available at <http://www.utexas.edu/depts/grg/virtdept/about/proposals/nsf95/cover1.html>.

BIOGRAPHY

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