Telecommunication and Computing
Technologies Program

Office of Technology Assessment
U.S. Congress

National Information Infrastructure

Initiative:

Context for the Future

103d Congress

April 1993

PREFACE

Strategic planning is based on a perception of the present and a vision of the future. It is neither precise science nor divination. It is an educated guess about what is likely to occur, based on current and expected trends. Its purpose is to guide near-term actions in order to achieve desired goals, and to minimize risks of failure, in the future.

As the Congress considers making major investment in the Nation's information infrastructure, it will face a number of major strategic decisions. This is because institutional factors, as well as technology, will weigh heavily in determining the effectiveness of America's future information infrastructure. Networks and computers alone are not enough. Many factors will affect the shape of the future information infrastructure: changes in structure of the telecommunication industry, concerns about privacy of personal information, effectiveness of intellectual property protection, the role of international agreements and standards.

A first step in making strategic decisions is to uncover the relevant issues and to ask the right questions. In this paper, the staff of OTA's Telecommunication and Computing Technology Program have attempted to outline some of the questions that should be explored early in the planning process.

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Telecommunication and Computing
Technologies Program
April 1993

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NATIONAL INFORMATION INFRASTRUCTURE INITIATIVE: CONTEXT FOR THE FUTURE

The National Information Infrastructure initiative is envisioned as a high-capacity network linking a range of institutions (schools, businesses, homes, government) to important resources (libraries, databases, laboratories) here and in other countries. Advocates of this initiative wish to use public and private resources to build an advanced "information infrastructure" that will put computer and telecommunication technologies to work for the American people. The Federal Government's role in this public-private partnership is another evolutionary step beyond the National Research and Education Network (NREN) described in the "High Performance Computing Act of 1991" passed by the 102d Congress.[1] The concept of the National Information Infrastructure initiative is outlined in the White House report on President Clinton's technology initiatives[2] and is embodied in S.4, the "Information Infrastructure and Technology Act of 1992" and H.R.1757, the "High Performance Computing and High Speed Networking Applications Act of 1993."

Advocates of NII have identified a wide range of potential benefits in areas such as health care, education, manufacturing, job creation, and government services:

(1) In 1991, health care spending totaled $738 billion (13 percent of GNP). Better use of information technology might reduce costs by improving the management of medical records and insurance claims. In addition, "telemedicine" applications using information technology might help deliver better health care services to residents of rural and remote areas.

(2) Education could be improved by giving students and teachers access to computers and to electronic libraries and by facilitating exchange of information among laboratories and researchers.

(3) Small and medium manufacturers account for 40 percent of GNP and 50 percent of all jobs created in the 1990s. Giving them access to high performance computing, communications and information resources would enable them to adopt new technologies that are expected to reduce cost, and increase productivity and efficiency.

(4) The computing and communications industries are major contributors to the economy (about 10 percent of GNP). Building and operating the NII would create new well-paying jobs in these industries. The NII could also facilitate creation of jobs using telecommuting, teleconferencing, and other techniques for streamlining organizations, cutting costs, and reducing energy use.

(5) Better use of information technology could reduce costs of government while allowing citizens -- particularly the disabled, homebound, or senior citizens -- better access to information critical to their health and welfare.

PROMISE VS. REALITY

The NII initiative is seen as developing a tool for attacking several social problems and for encouraging economic growth and competitiveness. Its supporters base their vision of the NII on the premise that the United States must have an infrastructure in place that supports competition in the "Information Age" if the Nation is to remain an economic power in the 21st Century. Such an infrastructure would be a tool for Americans to be increasingly more productive and innovative.

Information technology can play a significant role in the US economy and society, but there are dangers in uncritical acceptance of this premise or of any programs that are based on it.

While the use of information technology has transformed work in offices and factories in many ways, there is a body of evidence that suggesting that few industries that use computers have actually

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[1] NREN is the planned upgrade of the government-funded portion of the existing Internet, a "network of networks" now linking computers at many universities, agencies, and corporations. National Science Foundation is the lead agency for its development.

[2] William J. Clinton and Albert Gore, Jr., *Technology for America's Economic Growth, A New Direction to Build Economic Strength*, (Washington, D.C.: Office of the President, February 22, 1993).

experienced improved productivity through their use (although in some industries, particularly telecommunications, the productivity improvement due to computerization is clear).[3]

If this is true, then it would be unwise to expect great productivity improvements from indiscriminate investment in further applications of information technology. One critic suggests that the implications from the hyperbole surrounding these technologies are profound:

> The obvious weaknesses of utopian predictions [of how computers and telecommunications can fix myriad social problems] have distracted the public from serious consideration of more down-to-earth issues of electronic service delivery.[4]

There are five issue areas that must be seriously investigated as the Congress undertakes the beginning phases of the National Information Infrastructure initiative or any other major investment in information infrastructure development: (1) the relationship of the initiative to the existing communication and information infrastructure; (2) the role of user communities in defining system needs; (3) the costs of transition to electronic information; (4) possible negative impacts associated with success of the initiative; and (5) considerations for reducing risks of implementation. Past and current OTA work has addressed many points within these issue areas, and these studies are referenced as appropriate.

WHAT IS AN INFORMATION INFRASTRUCTURE?

An "infrastructure" is the "underlying foundation or basic framework (as of a system or organization)."[5] According to the Information Infrastructure and Technology Act of 1992 the term "information infrastructure"

> means a network of communications systems and computer systems designed to exchange information among all citizens and residents of the United States.

It is often described as a "superhighway" system for electronic information. One author envisions:

> an information infrastructure that would make it easy for the computers in every home, office, school, and factory to interconnect. Text, pictures, movies, software, designs, and much more would move easily and rapidly over this substrate.[6]

This infrastructure is expected to carry broad band digital information (for example, video) and yet have the switching capability, widespread availability, and transparent ease of use now available for (narrow band) telephone conversations. Many supporters of the NII believe that optical fiber cable must serve as the backbone for transporting information in such a network, along with some role for digital radio and new wireless technologies. Others assert that, at least in the near term, many services could be offered on the installed base of copper wires using ISDN (Integrated Services Digital Network -- a digital transmission standard).[7] (See fig. 1.)

The information infrastructure would not be built from scratch, but would evolve from the existing computer and communications infrastructure. An OTA report has noted that despite the connotation of "infrastructure" as related to "public works," most of the US communications infrastructure is privately owned. These include local and long distance telephone carriers, cable television providers, broadcast radio and television, computer network operators, computer and electronics equipment manufacturers, and more. Important characteristics of the infrastructure include:

(1) the technical characteristics of the facilities themselves;

(2) the economic interdependencies among producers, distributors and users of . . . . facilities; and;

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3 Martin Neil Baily and Alok K. Charabarti, *Innovation and the Productivity Crisis*, (Washington, DC: The Brookings Institution, 1988).

4 William H. Dutton, "Electronic Service Delivery and the Inner City: Community Workshop Summary," summary of a workshop held at the Annenberg School for Communication, Los Angeles, CA, contractor report prepared for the Office of Technology Assessment, December 1992, p.6.

5 *Webster's Ninth New Collegiate*

6 Michael L. Dertouzos, "Building the Information Marketplace," *Technology Review*, January 1991, pp. 28-40

7 Graeme Browning, "Search for Tomorrow," *National Journal*, March 20, 1993, pp. 674--679.

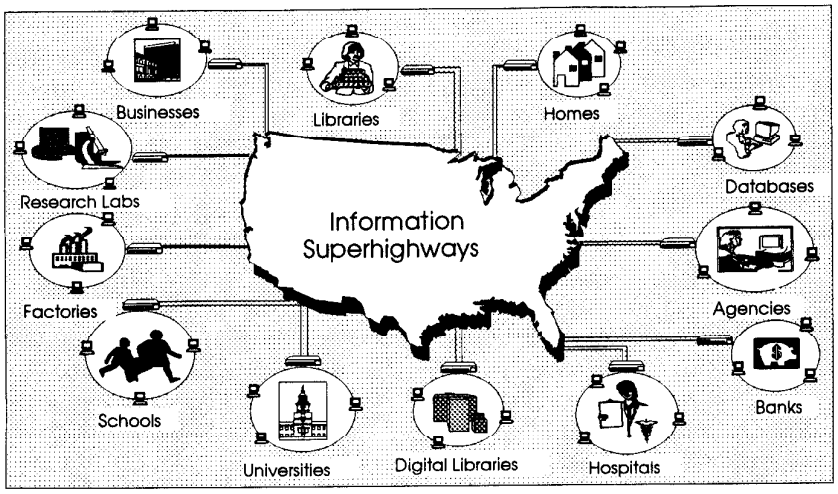

Figure 1--Concept of Information Superhighways

(3) the policy goals and rules that define and constrain these relationships.[8]

Currently, there are major changes taking place in all three of these areas. The current technological trends toward convergence of computing and communication functions, increased miniaturization and portability, and decentralization of intelligence and control in networks are among the trends that make something like an NII possible. The trends, and the new products and services that can arise from them are changing economic interdependencies as users begin to demand new services and providers scramble to protect their old markets and establish themselves in new ones.

Many of the firms that own pieces of today's communication and computer infrastructure are vitally interested in promoting NII and finding their place in its development and deployment.[9] For example, the widespread belief that fiber optics is the ideal backbone technology for transporting information on the NII is in line with the continuing trend of long distance and local telephone carriers, as well as cable TV providers, to install optical fiber cable in their systems. Meanwhile, other providers are eager to demonstrate that new digital radio technologies can deliver services more cheaply than cable.[10] The new infrastructure, like today's installed plant, will be a mix of facilities provided by a number of private firms using different technology choices, and there will be even more need to settle questions of standards and interoperability. There will be major structural changes in many of the provider firms as they seek to offer new services. There may be shakedowns in the industries that might slow development or market failures where intervention by government will have to be considered.

Policy goals and rules are continuing to change as we feel the ramifications of the AT&T divestiture and the partial deregulation of telephone service over the past decade. There is a growing trend in the literature, in popular thought, and in advertisement to characterize telephone service as a "competitive industry" rather than a "natural monopoly," even though the actual level of competition in the local loop is rather low.[11] The growth of a competitive industry in this area has profound implications for public policy. Congress and the State and Federal regulatory agencies will face a number of key policy choices over the next few years: they may have to consider new approaches to regulation.[12]

An "information infrastructure" is more than just the communication infrastructure with more broad band capability, however. Some envision the NII as supporting applications where:

> . . .advertising could be done in reverse, with consumers broadcasting needs to

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8 U.S. Congress, Office of Technology Assessment, *Critical Connections: Communication for the Future,* OTA-CIT-407 (Washington, DC: U.S. Government Printing Office, January 1990), p 3.

9 A significant industry voice for the NII is the Computer Systems Policy Project, a group of representatives from computer and communications firms and universities put together under the aegis of the Council on Competitiveness. The project is chaired by John Young, retired CEO of Hewlett Packard and Charles Vest, President of MIT.

10 U.S. Congress, Office of Technology Assessment, *The 1992 World Administrative Radio Conference: Technology and Policy Implications,* forthcoming.

11 Peter W. Huber, Michael K. Kellogg, John Thorne, *The Geodesic Network II: 1993 Report on Competition in the Telephone Industry,* (Washington, DC: The Geodesic Company, 1992), ch. 1.

12 Several OTA reports have outlined the main areas of policy choices in telecommunications, including: U.S. Congress, Office of Technology Assessment, *Critical Connections,* op. cit., footnote 8; *Rural America at the Crossroads: Networking for the Future,* OTA-TCT-471 (Washington, DC: U.S. Government Printing Office, April 1991).

> suppliers; where a retired engineer in Florida could teach high school algebra to a bunch of students in New York City; a parent can deliver office work to a distant employer while. . . at home; . . . where national treasures like the National Gallery could be explored at your own pace and with your own interests in mind; where you can tap a rich assortment of interactive, graphical how-to lessons; where a company's designers and marketers could collaborate . . . even though they may be a continent apart. . . .[13]

Such a description suggests much more than mere connectivity between computers and terminals: it implies that information delivered will be accessible, useful, and usable by people. This requires attention not only to the operating hardware and software, but also to the quality of information content, usefulness of application programs, user-friendliness of navigation tools, efficiency of search and retrieval systems, appropriateness of human interface designs, and the effectiveness of all of these in providing real-world services that people want and can afford to use.

Thus, among the stakeholders to be included in developing an NII are a wide range of the information providers (newspapers, publishers and authors, game developers, libraries and museums, movie and video program producers) and, most important, the current and potential users.

The variety of different technologies and the number of stakeholding groups involved with the information infrastructure stagger the imagination, as does the complexity of the economic, legal, and regulatory environment. Fig. 2 gives a partial summary of these components.

IMPORTANCE OF INCLUDING USER COMMUNITIES

It is now a truism that the introduction of computers and electronic information transforms the way people work, the way business enterprises are organized, and the way services are delivered. OTA studies have investigated these changes since the early 1980s,[14] and have noted the importance of focusing on users' needs and of including users themselves in the process of designing and implementing computer-based systems that affect their work. "User" in this case should be broadly defined to include all levels from the organization as a whole, to the department, to the individual worker.

In the case of the NII, the definition of "user" must be extended to whole communities -- individuals and organizations, professions and clients, regional interests, etc. Without sufficient input from user communities, the equipment deployed and the services developed are likely to respond to "technology push" rather than user needs, and they will have few real customers once the demonstration phases are over. Ultimately, communities of users will decide if services are worth their cost. For example, telemedicine services that link patients and local health professionals with remote medical experts may provide improved health care in rural areas, but they may not reduce health care costs, on net.

The design of specific services must take into account the needs, practices, ethical standards--perhaps even the folklore and irrational preferences--of the user communities. A successful "telemedicine" consultation must maximize the effectiveness, security, and comfort of the parties involved.

This means that the need for such a service, and the design for its human interfaces and other features, must be specified by health professionals and patients, not by equipment designers and telecommunication engineers. A doctor's "bedside manner" is an important professional tool, and the presence of a computer or camera may alter the way the doctor acts or the way the patient perceives the doctor's actions. Changes in work practices are inevitable, but if the service is to be successful, changes should be anticipated, understood and approved by the users.

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13 Dertouzos, op. cit., footnote 6.

14 For example, see U.S. Congress, Office of Technology Assessment, *Computerized Manufacturing Automation: Employment, Education and the Workplace*, OTA-CIT-235 (Washington, DC: U.S. Government Printing Office, April 1984); *Automation of America's Offices, 1985-2000*, OTA-CIT-287 (Washington, DC: U.S. Government Printing Office, December 1985); *The Electronic Supervisor: New Technology, New Tensions*, OTA-CIT-333 (Washington, DC: U.S. Government Printing Office, September 1987); *Hospital Information Systems at the Veterans Administration*, OTA-CIT-372 (Springfield, VA: National Technical Information Service, October 1987); *The Electronic Enterprise: Opportunities for American Business and Industry*, forthcoming.

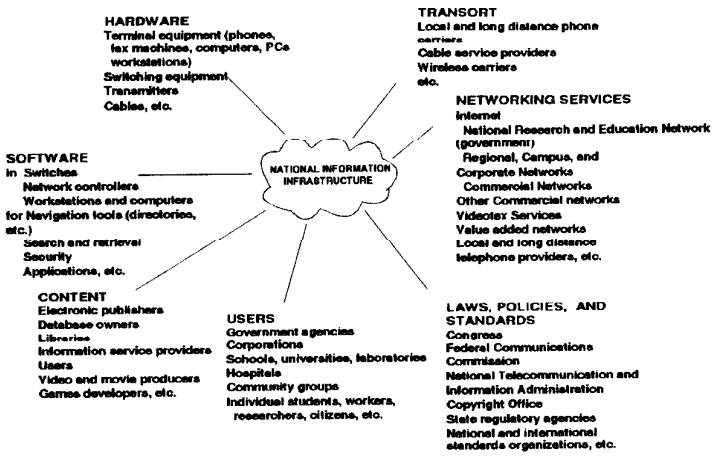

Figure 2--Components of the National Information Infrastructure

The issues will vary in different user communities. The important point is to recognize the importance of user input and the need to identify all the relevant users, and to develop structures for incorporating their input. Patients and their families will be users of medical systems, as well as doctors, nurses, technicians, records managers, hospital administrators, insurance underwriters, medical researchers, and others. Students and parents, as well as teachers and librarians, are users of educational systems. Systems for delivering government information or services must take into account the needs of individual workers, citizens seeking information or service, as well as the goals and mission of the agencies.

TRANSITION ISSUES

Another area to be considered is the cost of transition to new methods of work and the methods of paying those costs. Some costs are obvious, for example those for the purchase and installation of equipment, cable, and software. Other costs, like training, software maintenance, and redesign or replacement of workstations and furniture, are sometimes forgotten or gravely underestimated even though they often overshadow the first list as a percentage of total costs.

In addition to these, there may be other costs of transition that will be different for different industries, users, or segments of society. These costs need to be identified and evaluated so that those who have to pay are not surprised when the time comes. For example, what are the costs to libraries or to publishers of maintaining continuity between paper and electronic versions of journals. Despite the promise that computers would bring about the "paperless office," a great deal of the world's information is still in paper form, and there are costs involved in converting even a portion of it to electronic form.

SOME POSSIBLE NEGATIVES

Talk about a "paperless office" or "paperless society" leads to another set of considerations that must be explored with relation to the NII. When improvements to the information infrastructure are put into place, they may produce effects that are unforeseen, or that are at odds with the stated goals. For example, thus far, the information revolution has not lived up to early predictions about reducing the use of paper. There are applications where computerized processes have reduced the use of paper (e.g., ordering, billing, and payment through electronic data exchange[15]). However, others exist in which use of computers has increased the use of paper because of the ease of creating and printing multiple versions.[16]

In planning for any program of investment in new technology and programs, there is the danger that faulty assumptions may cloud predictions or that second order effects have not been adequately considered. A few examples spring readily to mind (this list is far from exhaustive). These and other issues identified should be explored in detail lest they result in stumbling blocks to the success of NII or unwanted results of its implementation

- The lifeblood of the NII will be software and digital information, yet our intellectual property system still has some difficulties in these areas. Both technological and institutional challenges remain in finding ways to control unauthorized copying and compensate rights holders, while at the same time making works widely available in electronic form at reasonable prices. Many of today's publishers use computer-based publishing technology, but only release their works in paper form because they fear that electronic versions will be too easily copied. The exis-

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15 For an example, see *Rural America at the Crossroads*, op cit., footnote 12, p. 12.

16 For example, see Paul A Strassman, *The Information Payoff: The Transformation of Work in the Electronic Age*, (New York, NY: The Free Press, 1985) pp. 165-177.

tence of a better infrastructure for distributing electronic copies will exacerbate those fears. If intellectual property questions are not settled, many proposed applications will be stalled,[17] and the services that are available may be less useful to users. For example, electronic access to a library may allow (as is now generally the case) only views of indexes and catalogs, not of actual documents.

- Similar considerations exist for privacy and security. It will be necessary to determine the limits of what technology can do to guarantee protection of confidential information. Even more important than technology, however, may be the legal, institutional, and even perceptual problems that must be solved if proposed applications are to have their full value.[18] For example one possible side effect of public distrust of the security of electronic medical records systems might be a "black market" of doctors who do not use the information infrastructure to serve people who do not wish to have personal information entered into data bases.
- Availability of high quality communication may facilitate creation of jobs, as expected. However, if these jobs depend on access to a widespread network rather than proximity to a particular location, they will be easier to move than are industrial jobs that are tied to a plant or facility. Workers and their communities may be constantly vulnerable to loss of these jobs to lower-wage areas in this country or abroad.[19]
- There may be inequities in people's ability to access or make use of information technology. These may lead to an increasing gulf between information "haves" and "have nots," with economic, social, cultural and other consequences.
- A society dependent on electronically stored and transported information is vulnerable in ways that a paper-based one is not. These vulnerabilities are intensified when control of the information infrastructure is the hands of many firms and individuals. Past OTA reports have identified several factors that are relevant to the security and survivability of networks.[20] It is possible that others can now be identified based on new technologies as well as new threats and changing security needs.

REDUCING RISKS IN IMPLEMENTING THE NII

One major problem in beginning a new program of major investment is anticipating what the demand for services will actually be. If the services are not what the customer wants, the investment becomes merely a loss.

Many in the provider industries advance ideas about what customers would like from the NII, but it would be unwise to put uncritical faith in their predictions for two reasons. First, they might simply be wrong; for example, one existing computer network provider anticipated that customers would want electronic shopping and configured its infrastructure to make this service efficient. After beginning operation, however, it discovered that its customers are very interested in electronic mail -- a service that is expensive to provide in that configuration.[21] Second, provider firms are motivated to make use of the technologies they have at hand, and they will tend to promote the things they can do, even if these are less important than the things they cannot do. Similarly, vocal user groups, such as universities, have also expressed predictions about the uses that would be most valuable for the NII, but their predictions must be treated with caution for the same reasons.

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17 U. S. Congress, Office of Technology Assessment, *Finding a Balance: Computer Software, Intellectual Property, and the Challenge of Technological Change,* OTA-TCT 527 (Washington, DC: U.S. Government Printing Office, May 1992), especially ch. 5.

18 OTA has explored issues related to privacy and security in a number of reports, including: *Privacy Rights in Computerized Medical Information*, forthcoming; *Defending Secrets, Sharing Data: New Locks and Keys for Electronic Information*, OTA-CIT-310 (Washington, DC: U. S. Government Printing Office, October 1987), ch. 3; *Electronic Record Systems and Individual Privacy,* OTA-CIT-296 (Washington, DC: U.S. Government Printing Office, June 1986); *Electronic Surveillance and Civil Liberties,* OTA-CIT-293 (Washington, DC: U.S. Government Printing Office, October 1985).

19 OTA has been concerned with export of information-related jobs since *Automation of America's Offices*, op. cit., footnote 14, especially ch. 8.

20 OTA, *Critical Connections,* op. cit., footnote 8, ch. 10; OTA, *Defending Secrets, Sharing Data,* op. cit. footnote 18.

21 Jim Schubiner, "Trying to Catch its Breath, Prodigy Sees Huge Growth in Surprising Areas," *High Performance Computing and Communications Week,* Vol. 2, No. 3, Thursday, January 21, 1993, p. 3, 7.

Both the provider industries and the major user groups find their risk reduced by the participation of Government as a major player in the research, development and deployment of NII. It is important that strategies be developed that also reduce Government's risk.

A first step is to identify specific social or economic problems to be solved with the help of information technology, not to create technical "solutions" first and then search for a situation where they might be useful. The proposed Acts (S.4 and H.R. 1757) identify some general areas of health care, education, manufacturing, etc., where information technology would be useful, but individual applications must be specifically refined in future planning. Demonstration projects should be driven by user community needs rather than technology push. As much as possible, all relevant user groups (not just the most vocal ones) as well as equipment and service providers should be identified and included. Gathering user input may not be easy, as many potential users and grass-roots organizations are relatively uninformed about the technology and its potential uses. Experimentation and open-mindedness are essential: it will be advisable to try several different approaches before locking on to a preferred methodology. There may be several good methods for obtaining user input as well as several different technical solutions to the needs users identify.

An important step in matching deployment to needs might be careful review of existing experiments with using information technology in health, education, government, and manufacturing and to determine the lessons learned from them. This strategy has been the basis for some past and ongoing OTA studies.[22]

It is also important to be sure that the roles of all relevant users, providers, and constituencies within the Government have been considered, and that available resources and expertise are being used in the most productive way.[23] This requires careful review of past and current activities of Government agencies with regard to use of information technology, expertise in infrastructure development and other related areas. For example, the Department of Energy has considerable expertise in network development and in ensuring the security and survivability of networks; the Department of Education has experience with development of applications of information technology for use by schools and students.

Finally, it could be useful to review lessons that the Federal Government and the Congress have learned from their own experience with computers and telecommunications. For example, in the years after the Brooks Act was passed to provide Government with better control of computer hardware costs, hardware costs went down while software became the major contributor to computer system costs. These technologies -- their capabilities, costs, and vulnerabilities -- are changing rapidly and ways must be found to flexibly accommodate these changes while maintaining a structure for effective long term planning and control.

QUESTIONS OF CONCERN TO CONGRESS

The issue areas discussed above raise a number of questions that concern the Congress. For the most part, these questions do not deal directly with the technology, but with the effects of the technology on producers and users of services, on the economy, and on policy goals and rules. Congress will find further study of these questions useful as it considers the implementation of the NII and oversees the programs that grow out of it. Below is a list of questions, each of which might generate a list of research topics.

Relationship with Existing Infrastructure

- What is the impact of the NII on the public switched telephone network ? To what extent will other firms compete directly with telephone service providers and to what extent will new

22 A number of past and ongoing OTA reports have done this, including: *The Electronic Enterprise*, forthcoming; *Information Technology and the Delivery of Government Services*, forthcoming; OTA, *Technologies for Adult Literacy*, forthcoming; OTA , *Linking for Learning: a New Course for Education*, OTA-SET-430 (Washington, DC: U.S. Government Printing Office, November 1989); *Power on! New Tools for Teaching and Learning*, OTA-SET-379 (Washington, DC: U.S. Government Printing Office, September 1988).

23 OTA has looked at Federal government information technology in: Office of Technology Assessment, *Helping America Compete: The Role of Federal Scientific and Technical Information*, OTA-CIT-454, June 1990; *Informing the Nation: Federal Information Dissemination in an Electronic Age*, OTA-CIT-396 (Washington, DC: U.S. Government Printing Office, October 1988); *Electronic Delivery of Public Assistance Benefits, Technology Options and Public Issues*, OTA-BP-CIT-47 (Washington, DC: U.S. Government Printing Office, April 1988); *Hospital Information Systems at the Veterans Administration*, op. cit., footnote 14.

technologies compete with or complement telephone service? How will these changes affect the still existing subsidy from business customers to residential customers?

- How is the US regulatory structure dealing with the convergence of computer and communication technologies and the redrawing of market niche boundaries?
- What is the optimal structure or process for developing or modifying US telecommunication, information, and intellectual property policy?
- What current or proposed experiments with alternative regulation have lessons for future changes in regulatory structure?

Users and Uses

- What is the relationship between information technology and productivity? How is productivity measured? How is improved quality taken into account? How can it be determined which investments in information technology make the greatest contributions to productivity?
- What are the greatest citizen needs for electronic information services? What are the mechanisms for enhancing citizens' ability to articulate those needs and participate in the design and implementation?
- What lessons can be learned from past and ongoing experiments with electronic delivery of services?

Transition Issues

- What will be requirements for education, training, and equipping of users? By whom will these costs be borne?
- What other transition costs can be expected within specific application areas like medical records, library services, delivery of government services, etc.?
- How will the standard setting process affect the speed of deployment of the NII? What is the role of international standards organizations? To what extent should technical standards be set by the private sector or by private agreement or contract between providers? Which may require government intervention to protect institutions or individual users?
- Are new institutions, procedures, or government roles necessary for developing standards?
- What is a satisfactory level of protection for data integrity, privacy, and intellectual property rights? What are the technological, institutional, and legal tools for providing that protection? Are different levels necessary for different users or uses, and if so, how can they be differentiated and maintained?

Assumptions, Vulnerabilities, and Side Effects

- To what extent will international intellectual property and privacy laws affect the NII?
- What are the vulnerabilities of the NII to threats such as power failures, human error, computer viruses, etc.? What new and as yet unforeseen threats are possible, given the new technologies that will be used? What measures can be taken to prevent or recover from disasters? How will these measures be institutionalized and coordinated among a diverse mix of owners and users of the NII?
- What are the potential inequalities of access that may develop with deployment of the NII (e.g., large vs. small business, residential vs. commercial customers, institutional vs. individual users, new vs. old buildings, rich vs. poor neighborhoods, etc.) Is it desirable for government to anticipate and attempt to minimize these, and if so, how?
- What adverse impacts might the expected increase in information related jobs have on the US work force (for example, stress-related illnesses and repetitive strain injuries have definitely been associated with computer work, and there are suspected health effects from exposure to electromagnetic fields such as those present around computers and radio-based communication devices)? What technologies, standards or policies can mitigate the impacts? Who will be responsible for implementing them?
- What adverse impacts could affect the US economy (for example, what is the potential for export of jobs from region to region or to other countries as the economy becomes increasingly dependent on a nationwide/international network)? What policy tools exist to deal with this?

Reducing Implementation Risk

- What effects will the NII have on Federal planning for telecommunications and computing applications?

- What lessons have been learned from previous Federal involvement in infrastructure development (e.g., rural electrification, interstate highway system) and how might they apply to NII?
- What lessons have been learned from previous Federal programs and policies related to the use of information technology, and how might they be applied to NII.

CONCLUSION

The proposed public-private partnership to develop the national information infrastructure offers both opportunities and risks. While the Congress begins the tasks of authorizing and overseeing Government's role in this endeavor, a number of existing OTA studies (listed previously in this paper) offer useful analysis of important issues.

In addition, a number of new strategic studies will be useful, including some in the areas of: 1) relationship of technology change to the structure of information and telecommunication industries; 2) Federal and state telecommunication policy structure and strategies; 3) computers, networks, and crime; 4) current and future trends in the human-computer interface; 5) information technology and health care; 6) equity of access to information services; 7) privacy, security, intellectual property, and liability rules for information networks; 8) information technology and the environment; 9) information technology and urban infrastructure; 10) managing and accessing large amounts of data in on-line libraries.

OTA REPORTS ON RELATED TOPICS

Automation of America's Offices, 1985-2000
December 1985: 348 p.

Computerized Manufacturing Automation: Employment, Education and the Workplace
April 1984: 471 p.

Critical Connections: Communication for the Future,
January 1990; 408 p.

Defending Secrets, Sharing Data: New Locks and Keys for Electronic Information
October 1987; 200 p.

Electronic Delivery of Public Assistance Benefits; Technology Options and Policy Issues
April 1988; 32 p.

The Electronic Enterprise: Opportunities for American Business and Industry
forthcoming 1993.

Electronic Record Systems and Individual Privacy
June 1986; 160 p.

The Electronic Supervisor: New Technology, New Tensions
September 1987; 150 p.

Electronic Surveillance and Civil Liberties
October 1985; 80 p.

Finding a Balance: Computer Software, Intellectual Property, and the Challenge of Technological Change
May 1992; 236 p.

Helping America Compete: The Role of Federal Scientific and Technical Information
June 1990; 80 p.

Hospital Information Systems at the Veterans Administration
October 1987; 45 p.

Information Technology and the Delivery of Government Services
forthcoming 1993.

Informing the Nation: Federal Information Dissemination in an Electronic Age
October 1988; 344 p.

Linking for Learning: a New Course for Education
November 1989; 192 p.

1992 World Administrative Radio Conference: Technology and Policy Implications
forthcoming 1993.

Power on! New Tools for Teaching and Learning
September 1988; 260 p.

Privacy Rights in Computerized Medical Information
forthcoming 1993.

Rural America at the Crossroads: Networking for the Future
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