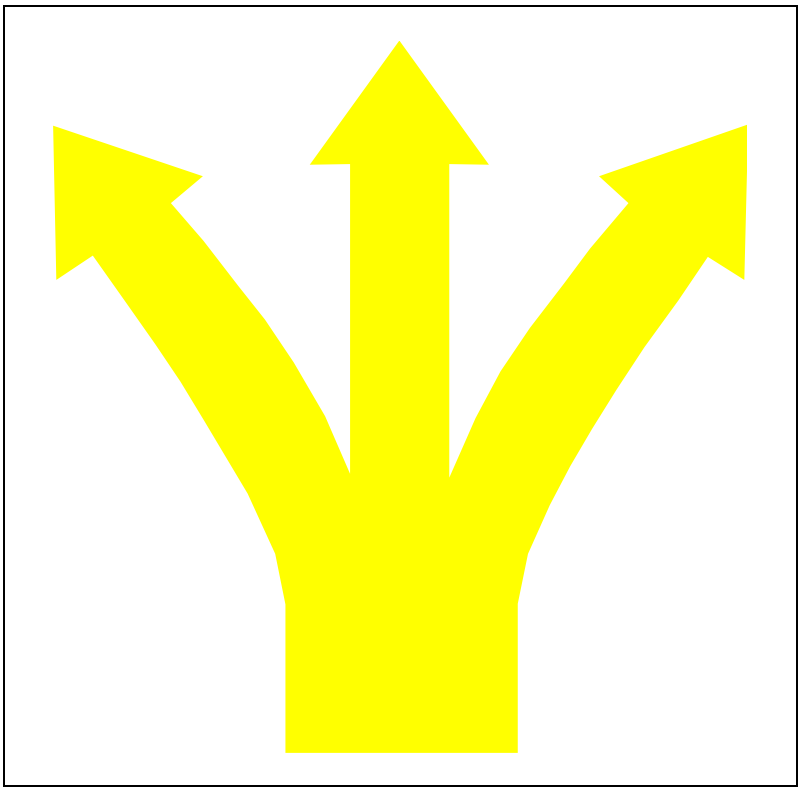

SERVING THE COMMUNITY:
A PUBLIC INTEREST VISION OF
THE NATIONAL INFORMATION INFRASTRUCTURE

COMPUTER PROFESSIONALS FOR
SOCIAL RESPONSIBILITY
(CPSR)

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However, the views expressed in this report are those of CPSR and do not necessarily reflect the views of those individuals and organizations.

EXECUTIVE SUMMARY

The National Information Infrastructure (NII) holds great promise for the future. The convergence of communications technologies and the expansion of network services will transform our society and create unparalleled opportunities. CPSR believes that the benefits of the NII, however, should not be framed solely in economic or functional terms. The nation's communications infrastructure should reflect the values of a democratic society. Ultimately, the success of the NII program will be measured by whether it empowers citizens, protects individual rights, and strengthens the democratic institutions on which this country was founded.

CPSR believes that the development of the NII must be guided by a set of principles that reflect public-interest values. CPSR endorses the principles proposed by the Telecommunications Policy Roundtable, which are discussed in detail in the body of this report. But principles alone are not enough. Despite the general agreement surrounding public aims, it remains unclear whether these goals will be realized. There are many aspects of the NII planning process that already raise concern, several of which are outlined in this report:

- The NII may fail to provide universal access.
- A small number of companies may dominate the network and exert undue influence on its design and operation.
- There is a danger that carriers will control content on the NII.
- NII services may emphasize commerce at the expense of communication.
- Public access to government information may be restricted.
- The NII may fail to provide a vital public space.
- The NII may be used to justify the elimination of other essential public services.
- The NII may fail to protect individual privacy.
- Global communication using the NII may be restricted.
- The hardware structure may be chosen without giving adequate consideration to the software implications.

To avoid these dangers, it is essential to adopt policy and design guidelines that will serve the public interest.

CPSR makes the following policy recommendations to the Information Infrastructure Task Force:

- Consider the social impact of NII development.
- Guarantee equitable and universal access to network services.
- Promote widespread economic benefits.
- Promote diversity in content markets.
- Provide access to government services over the NII.
- Protect the public spaces necessary to foster community development.
- Encourage democratic participation in the design and development of the NII.
- Think globally rather than nationally.
- Guarantee functional integrity throughout the network.

In addition, CPSR proposes the following guidelines for designers of NII services:

- Emphasize ease of use.
- Provide full service to homes, workplaces, and community centers.
- Enable all users to act as both producers and consumers.
- Address privacy and security issues from the beginning.
- Develop open and interoperable standards.

- Encourage experimentation and evolution.
- Require high reliability.

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PART 1
SUMMARY OF PRINCIPLES, CONCERNS, AND RECOMMENDATIONS

One of the central goals of the Clinton administration has been to develop new policies that strengthen U.S. communications and information technology. The administration's vision of a new National Information Infrastructure was first presented in a February 1993 white paper entitled "Technology for America's Economic Growth: A New Direction to Build Economic Strength." That vision was later refined in a report entitled "The National Information Infrastructure: Agenda for Action" issued in September 1993 by the National Telecommunications and Information Administration (NTIA).

The Clinton administration believes that the National Information Infrastructure, or NII, offers enormous potential for the nation. The Executive Summary of the NTIA report concludes that:

> The benefits of the NII for the nation are immense. An advanced information infrastructure will enable U.S. firms to compete and win in the global economy, generating good jobs for the American people and economic growth for the nation. As importantly, the NII can transform the lives of the American people—ameliorating the constraints of geography, disability, and economic status—giving all Americans a fair opportunity to go as far as their talents and ambitions will take them.

CPSR also sees great promise in the NII. At the same time, we believe that its potential benefits are not solely economic. The NII must promote the public interest along with private interests. The success of the NII program will depend on the extent to which it empowers all citizens, protects individual rights, and strengthens the democratic institutions on which this country was founded.

1.1 Fundamental principles

We believe that the design of the NII must be guided by a set of principles that reflect the importance of the public interest in communications and information technology. CPSR strongly endorses the following principles set forth by the Telecommunications Policy Roundtable in Washington, D.C., of which CPSR is a member:

1. *Universal access.* All people should have affordable access to the information infrastructure.
2. *Freedom to communicate.* The information infrastructure should enable all people to effectively exercise their fundamental right to communicate.
3. *Vital civic sector.* The information infrastructure must have a vital civic sector at its core.
4. *Diverse and competitive marketplace.* The information infrastructure should ensure competition among ideas and information providers.
5. *Equitable workplace.* New technologies should be used to enhance the quality of work and to promote equity in the workplace.
6. *Privacy.* Privacy should be carefully protected and extended.
7. *Democratic policy-making.* The public should be fully involved in policy-making for the information infrastructure.

Our experiences as both designers and users of networking systems lead us to formulate an additional principle:

8. *Functional integrity.* The functions provided by the NII must be powerful, versatile, well-documented, stable, reliable, and extensible.

Part 3 of this report elaborates on these eight principles.

1.2 Areas of concern

The principles outlined in Section 1.1 are widely accepted. In public discussions of the NII, most participants embrace a similar set of goals. For example, much the same principles are expressed in the "Agenda for Action" paper issued by the NTIA and in position papers issued by the telecommunications industry. At the level of general goals, there is broad consensus throughout the United States that the NII cannot be limited to the commercial sphere but must also serve the public interest.

As members of CPSR, we are encouraged by this consensus. We also recognize that stating a goal and achieving it are profoundly different things. Despite the general agreement regarding the public-interest principles, it is not yet clear how much those principles will influence the design of the NII. There are many other factors involved. When private interests conflict with the public interest, decisions must inevitably be made. In some cases, the decisions may make it difficult to satisfy public-interest principles, no matter how widely those principles are held.

After listening to much of the early debate concerning the NII, we have identified the following areas of concern:

- *The NII may fail to provide universal access.* The principle of universal access is much easier to articulate than to achieve. If network connections are not readily available, particularly in rural or economically disadvantaged areas, the NII will fail to serve those communities. If the pricing structure is not carefully designed, individuals and public institutions lacking the necessary resources may be frozen out. Even if the network itself is accessible at a reasonable price, the NII will remain outside the reach of most nontechnical users unless training programs and well-designed software tools are available. It is critical that the designers of the NII undertake the necessary measures to ensure full network access to people in all sectors of the United States.
- *A small number of companies may dominate the network and exert undue influence on its design and operation.* The NII is an extremely large and ambitious program that will require substantial investment on the part of private companies who undertake the task of providing the physical infrastructure. Because of the enormous scale of the project, barriers to entry into the carrier market will be high, creating a situation in which it is difficult to rely on market forces to ensure effective competition. If a small number of companies end up dominating the market, it will be harder to guard against monopolistic tendencies in that market and to ensure that the public-interest goals are met.
- *There is a danger that carriers will control content on the NII.* The enormous economic potential of the NII lies not in the network infrastructure itself but rather in the information and services that infrastructure carries. Even so, the carriers that own the network may seek to control the content that flows through it. Of serious concern, along with more traditional forms of censorship, is the danger that carriers may give preference to content that they control. The economic history of the United States provides convincing evidence that it is difficult to provide an equitable marketplace for content providers when single companies are allowed to control both carrier and content.
- *NII services may emphasize commerce at the expense of communication.* Judging from the way information networks are used today, people value being on-line primarily because it gives them new ways to communicate with other people. Much of the recent discussion of the NII focuses instead on using the network to market information services. Failure to understand what people want from the NII may adversely affect the design. Over the past two decades, for example, many companies have conducted trials of videotext systems focused on shopping and information retrieval. All have been dismal failures. Now, as we stand poised to develop the NII, telephone, cable TV, computer, and broadcast companies are again focusing on providing systems to promote electronic consumerism. Why? Part of the explanation is that, just as engineers tend to emphasize the engineering aspects of what they design, business people tend to emphasize the business aspects. Most Americans are neither engineers nor business people. The NII must be designed to meet the needs of all.

- *Public access to government information may be restricted.* In recent years, more and more public information has been turned over to private companies for distribution. In the absence of pricing regulations, much of this information has become unavailable except to the well-funded. If the trend toward privatization continues, the NII will be unable to satisfy its enormous potential as a source of public information.
- *The NII may fail to provide a vital public space.* In recent years, public participation in the political process and civic life has eroded considerably. By providing a framework for communication and community-building, the NII has the potential to reverse this trend. To achieve that potential, individuals and groups that represent the public interest must be an integral part of the NII design process. Otherwise, the NII is unlikely to meet the needs of that constituency.
- *The NII may be used to justify the elimination of other essential public services.* Although increased access to information can benefit and empower everyone in society, it is important to recognize that there are many other problems in society that the NII will not address. For example, making government documents available through the NII does not eliminate the need for reference librarians any more than providing on-line medical advice eliminates the need for local doctors.
- *The NII may fail to protect individual privacy.* As the NII develops and the amount of data accessible through the network grows, concerns about individual privacy become more pressing. Using the NII, government agencies and private companies would have unprecedented opportunities to gather and disseminate information about individuals. If no protections are built into the infrastructure to guard against abuse, such data collection threatens to erode the rights of citizens. Similarly, if the network itself does not protect the privacy of its users, they will be unable to communicate freely.
- *Global communication using the NII may be restricted.* Even more than the networks of today, the NII will be global in its scope. Moreover, by providing a common medium for international exchange of information, the NII will open up unparalleled opportunities for economic, scientific, and cultural exchange. To take full advantage of those opportunities, however, the NII must support and encourage international participation. Unfortunately, there is some danger policymakers will use economic competitiveness or national security to justify restrictions on international traffic. While imposing such restrictions may benefit a particular industry or special interest, it also runs the serious risk of isolating the United States from the international electronic marketplace, cutting us off from the enormous benefits that come from greater cooperation in this area.
- *The hardware structure may be chosen without giving adequate consideration to the software implications.* The NII requires considerable investment in physical connections, transmission lines, switching stations, and other forms of computing hardware. Even so, the most important challenges in the NII design lie elsewhere—in the software that makes it both powerful and easy to use. All too often, hardware considerations are allowed to dominate the initial design of such a project, to the point that the hardware choices end up placing severe constraints on what the software can achieve.

An imaginative view of the risks of an NII designed without sufficient attention to public-interest needs can be found in the modern genre of dystopian fiction known as "cyberpunk." Cyberpunk novelists depict a world in which a handful of multinational corporations have seized control, not only of the physical world, but of the virtual world of cyberspace. The middle-class in these stories is sedated by a constant stream of mass-market entertainment that distracts them from the drudgery and powerlessness of their lives. It doesn't take a novelist's imagination to recognize the rapid concentration of power and the potential danger in the merging of major corporations in the computer, cable, television, publishing, radio, consumer electronics, film, and other industries. We would be distressed to see an NII shaped solely by the commercial needs of the entertainment, finance, home shopping, and advertising industries.

CPSR believes that the principles outlined in Section 1.1 provide a standard by which to judge the success of the NII. If the design meets those principles, the NII will indeed serve the public interest, revitalizing our communities and the nation as a whole. On the other hand, if the potential dangers are ignored, the NII may fall short of its goals and thereby fail to bring the power of the information age into everyone's reach.

1.3 CPSR's recommendations

CPSR has developed a set of recommendations that we feel will help avoid many of the pitfalls outlined in the preceding section. Although there is some overlap, we have divided our recommendations into two groups. The first, directed primarily to the Information Infrastructure Task Force and other governmental agencies responsible for oversight and administration of the NII, consists of recommendations concerning policy. The second is directed toward designers and addresses more technical aspects of the NII.

Policy recommendations

CPSR agrees with the conclusion expressed in the NTIA document that "the government has an essential role to play" in the development of the NII. We believe that the NII cannot meet its public-policy objectives without some combination of government initiative and regulation. In particular, we recommend that the Administration seek to establish the following general policies.

P1. *Consider the social impact.* Beginning with the initial design, the Administration must evaluate the impact of the NII on the society at large. It is essential to conduct periodic reviews as the NII is implemented and used to ensure that it continues to serve the public interest.

P2. *Guarantee equitable and universal access.* To the extent that free-market principles cannot guarantee affordable access to a full range of NII services, the Administration must be publicly accountable for the achievement of this goal through some appropriate mix of legislation, regulation, taxation, and direct subsidies.

P3. *Promote widespread economic benefits.* The Administration should evaluate the NII's economic success using measures that reflect its impact on the economy as a whole, not merely the profits of NII investors and service providers.

P4. *Promote diversity in content markets.* The Administration must recognize the distinction between the *carrier* of NII information services and the *content* that is carried over that infrastructure. In economic terms, the greatest potential of the NII lies in the marketplace it will create for content services, and the Administration must take whatever steps are necessary to ensure that the content market is both fair and open.

P5. *Provide access to government services and information over the NII.* The Clinton/Gore technology announcement of February 1993 explicitly recognizes that information technology can "dramatically improve the way the Federal Government serves the people," thereby making the government "more cost-effective, efficient, and 'user-friendly.'" The Administration must continue to make provision of government services a central aspect of the NII design.

P6. *Protect public spaces.* The Administration should promote the development of a vital civic sector by ensuring resources, training, and support for public spaces within the NII where citizens can pursue noncommercial activities.

P7. *Encourage democratic participation.* Government must prevent concentrations of economic power from controlling the design of the NII and the operational "rules of the game." Decisions that affect the public's use of the NII must be conducted openly and democratically. To this end, the Administration must ensure full public disclosure and actively promote democratic decision-making. In addition, the Administration should ensure that any committees, such as the soon-to-be-appointed Advisory Council on the National Information Infrastructure, include sufficient representation from the public-interest community to ensure effective participation and to reflect the diversity of that constituency.

P8. *Think globally.* The Administration should actively facilitate the seamless connection of America's NII with the information infrastructures of other nations by working to resolve such issues as security, censorship, tariffs, and privacy. Moreover, the NII should not be limited to the United States and the highly industrialized nations of Europe and the Pacific Rim. Because communication and information are vital resources for all nations, it is in the common interest to help the developing countries become part of the global information infrastructure.

P9. *Guarantee functional integrity.* To the extent that market forces alone cannot guarantee that the design recommendations discussed in the following section will be achieved, the Administration should take

appropriate steps to ensure that the NII design satisfies these critical technical, functional, and safety requirements.

Design recommendations

Our breadth of experience with existing networks and communications technology lead us to make the following recommendations about the technical aspects of NII design:

D1. *Emphasize ease of use.* Existing computer networks have fallen short of serving the public interest because they are difficult for nonexperts to use. The most significant challenge facing NII designers is to reduce the barriers to entry into the information network that the NII provides, so that using the NII for simple inquiries becomes as easy as using the telephone.

D2. *Provide full service to homes, workplaces, and community centers.* From the beginning, NII designers must strive to provide a high level of service to users where they live and work—to private homes, libraries, community centers, and businesses. If the public at large is offered only restricted, second-class service, the NII will be unable to serve as a medium for individual and community empowerment.

D3. *Enable all users to act as both producers and consumers.* Perhaps the greatest strength of existing networks is the opportunity for all participants to act as both producers and consumers of new products and information. By making it easy for individuals and small groups to develop new on-line services, today's networks display a vitality and openness that is difficult to find in other media. Individual initiative and entrepreneurship must continue to be supported in the NII design.

D4. *Address privacy and security issues from the beginning.* As is the case with reliability, it is difficult to implement privacy and security as an afterthought. In order to provide sufficient safeguards, it is essential that privacy and security be considered throughout the NII design.

D5. *Develop open and interoperable standards.* The NII will never be a single, static entity. It will instead continue to grow, driven in part by the general progress of technology and the extension of service to developing networks throughout the world. The NII community must develop standards that facilitate the growth of the network and allow for the broadest possible participation in the process.

D6. *Encourage experimentation and evolution.* On the basis of our experience with existing networks, it is clear that the most significant source of new network services and capabilities will consist of contributions by the NII users themselves. Many of the facilities that are now considered part of the core of the network were once experimental projects. Someone using the network recognized a need, developed a new service in response to that need, and then made that service available to others. As the community of users expanded, the service was then refined and standardized to the point that it became a widely accepted tool. The NII must allow for and encourage the same sort of experimentation and evolutionary development.

D7. *Require high reliability.* As use of the network expands into more and more sectors of the economy, the need for high reliability and fault-tolerance will become increasingly important. To meet the requirements of its users, reliability must be a central theme of the design at every stage of the process.

PART 2

TODAY'S INFORMATION INFRASTRUCTURE: LESSONS FOR THE NII

Although the National Information Infrastructure will be larger, more powerful, and more widely used than current computer networks, it is important to recognize that the underpinnings of such an infrastructure already exist in the United States today. In fact, it is difficult to go through a day without using some part of the existing information infrastructure. We use a computer network every time we make a phone call, watch TV, listen to the radio, get cash from an automated teller machine, reserve an airplane ticket, or pay with a credit card.

Despite the pervasiveness of computer networks, relatively few people understand them in any detail. As computer professionals, the members of CPSR have extensive experience working with networks as both users and designers. As citizens, we recognize that technical issues are only a part of the design considerations. Public policy issues must be considered as well. To enable everyone to participate effectively in the debate over public policy, it is important for us to share our technical expertise.

The NII of tomorrow will evolve from the networks of today. It will incorporate the services currently offered by cable companies, the telephone system, and broadcast media. Yet we expect that, in many technical ways, the NII will more closely resemble existing general-purpose networks that link computers throughout the world. Transmission using the NII will be digital, not analog as many of these media are today. Data will travel in individual packets and not through the dedicated circuits that have traditionally been used for telephone communication. Information will flow in both directions, in contrast to its behavior in the broadcast media. These are all characteristics of existing computing networks, which makes them a useful model for the NII.

The closest existing analogue to our vision of the NII is the Internet, a loose confederacy of computer networks that can exchange data freely. Understanding the Internet—what it is, how it works, where it has succeeded, and what its shortcomings have been—makes it easier to comprehend the challenges that face the designers of the NII. This part of the report provides an analysis of the Internet, which serves as background for the recommendations in Part 3.

2.1 A brief history of the Internet

Although the Internet incorporates many different networks with different histories, the current system can be traced directly to the ARPANET project, which provided the first large-scale demonstration of a new digital communications technology called packet-switching. Beginning in 1968, the Advanced Research Projects Agency (ARPA) of the Department of Defense provided grants to several universities and corporations to develop a nationwide digital communications medium separate from the existing telephone system. The purpose of the ARPANET was to link researchers at different sites and allow them to share hardware and software resources. Using the ARPANET, those researchers could send electronic mail to each other, transfer files of information from one site to another, and connect directly to a system that might be hundreds or thousands of miles away.

The early ARPANET experiment was quite successful and led to a dramatic growth in network technology. When the ARPANET first became operational in late 1969, the entire network consisted of four computers. After the first ten years of operation, the number of connected computers expanded to more than 100. At that point, however, the ARPANET began to exceed the capacity permitted by its initial design. As is usually the case with large, computer-based systems, the main problems were not in the physical hardware that comprised the network, but in the software-based procedures and conventions established to facilitate communication, which are known as "protocols." The original ARPANET protocols were not flexible enough to accommodate the ongoing expansion of the ARPANET itself or permit other networks to connect easily into the ARPANET framework.

In the late 1970s, a new family of message protocols was designed to address these problems. These new protocols were formalized in 1980, and their use became an ARPANET requirement in 1983. The most basic of

the new protocols are the Transmission Control Protocol (TCP) and the Internet Protocol (IP), which together provide the facility by which computers can exchange messages. In addition to the TCP and IP protocols, the extended protocol family includes the Simple Mail Transfer Protocol (SMTP), the File Transfer Protocol (FTP), and a protocol to allow users to connect directly to and use a remote machine (TELNET).

Many computer operators quickly adopted TCP/IP as the message protocol for their systems. Those who could not convert—either because TCP/IP required faster hardware or because they did not have control over their system software—could still use TCP/IP by connecting to a "gateway" machine that converted the local protocol into the TCP/IP standard. Use of TCP/IP is now widespread in many different networks because it facilitates communication with an ever-growing community that shares this common protocol.

Meanwhile, other networks began to come into existence. Because ARPANET access was restricted to institutions with defense-related contracts, universities pushed for independent networks. To meet this need, CSNET and BITNET were created in the 1970s and 1980s to serve different segments of the academic community. As part of its own process to develop network standards, Europe began to deploy an information infrastructure of its own, based on another protocol called X.25. At the same time, several hardware vendors in the United States developed proprietary network technologies for their own internal use.

Because they used different protocols, many of these networks were initially isolated from each other. To communicate between different networks, it was necessary to have one computer linked to two or more networks so that it could serve as a gateway machine. Using these gateways to transfer data between independent networks was difficult, because doing so required a thorough understanding of all the different protocols involved. During this period in network history, gateways were developed as needed and operated with mixed results.

As the Department of Defense began to reduce ARPANET support in the mid-1980s, the National Science Foundation (NSF) stepped in and supported a new networking structure called NSFNET that was available to universities without restriction and to commercial concerns for a fee. The NSF also funded five supercomputer sites and a network of high-speed connections between them. That connection matrix, with its wide availability and its use of the TCP/IP protocols, allowed NSFNET to become the "backbone" of an entire collection of networks that is known collectively as the Internet.

By making it possible for many different networks to communicate with standard protocols over a common backbone, the deployment of NSFNET accelerated the pace of network expansion. As of 1993, the Internet has become an enormous global web linking over 1.5 million computers in more than 50 countries. Data traffic on the NSFNET backbone doubles every year.

2.2 Management and pricing structures on the Internet

Given the size and importance of the Internet, its management structure is surprisingly loose and decentralized. To a certain extent, the Internet runs itself. The community of users and institutions connected to the Internet has such a strong interest in keeping the network running that they perform much of the management themselves. Even so, a certain amount of additional coordination is required.

The diverse assemblage of over 2000 individual networks is held together by the Internet Activities Board (IAB). This group serves as the coordinating committee for Internet design, engineering, and management. The committee has several functions, including

- Defining Internet standards and organizing the process by which standards are set
- Acting as the Internet's international technical policy liaison
- Undertaking strategic planning for the network
- Taking advantage of long-range opportunities
- Solving problems as they arise

Much of the work of the IAB is done through two subcommittees: the Internet Engineering Task Force, which manages the evolution of Internet protocols, and the Internet Research Task Force, which fosters research into new network technologies.

The administration of the NSFNET backbone is managed by Merit Inc., which is the parent organization of the mid-level network connecting state-supported universities in Michigan. The physical network that forms the backbone—the wires and routing hardware—is administered by Advanced Network Services (ANS), which is a not-for-profit consortium funded jointly by Merit, IBM, and MCI. Commercial organizations use the Internet through a for-profit subsidiary of ANS called CO+RE Inc. Access to the NSFNET backbone is given to mid-level networks for a fee. Universities, corporations, and commercial service providers then buy access to the mid-level networks on an ability-to-pay basis.

Funding for the Internet is as piecemeal and diverse as the networks it comprises. Within the NSFNET itself and the regional subnetworks, institutions generally pay a flat monthly or annual fee based on the speed of the connection. For universities, some of these costs are met through federal subsidies that pay for connections to mid-level networks and by federal subsidy of the NSFNET itself. Commercial users must pay their own way. Because the fee structure is not based on the volume of traffic, however, institutions do not need to pass the marginal costs of additional use back to individuals. As a result, the costs of network services are completely hidden from individual users who use the Internet through their university or company.

The pricing strategy has a profound effect on the Internet. The fact that individual users are not normally charged for service encourages use of the network and promotes the development of a more inclusive Internet community. Moreover, the pricing structure encourages experimentation, which in turn leads to the development of new software tools that increase the value of the Internet itself.

In certain foreign countries, individual users are charged based on connect time and traffic volume. This policy has had a noticeably chilling effect on use abroad. Increasingly, Internet users who obtain access to the network through commercial services in the United States are charged for that service in a similar way. If “metered service” becomes the norm, individuals and public institutions may be disenfranchised. Moreover, the network may lose the sense of openness and free experimentation that have driven much of its development in the past.

2.3 Successes of the Internet

The Internet has had many profound successes, which must be kept in mind when designing future networks. The following are among its successes:

- *The Internet has proven valuable to a large number of users.* For any computer system, one of the best measures of success is the satisfaction of the user community. By this measure, the Internet has clearly been successful. Individual users have found the Internet an extraordinarily valuable tool for many different purposes: communicating with friends and colleagues, sharing data and software, obtaining access to information, and participating in the development of new on-line communities. The explosive growth of Internet use is a clear indication that people find it worthwhile. Since computers all over the world can instantly store and deliver information at minimal cost, the potential of the network can only increase.
- *The structure of the Internet encourages participation and involvement.* The value of the Internet comes primarily from the knowledge and creativity its users bring to it. Many services, such as bulletin boards and user-generated archives, are successful only when people contribute to them. By making individual contribution easy, the Internet has enabled those services to develop and grow.
- *The pricing strategy of the encourages experimentation and growth.* For users in universities or companies, access to the Internet usually seems free and unlimited. Costs of the network are paid by institutions for which individual researchers and developers work. Because the Internet pricing structure charges a fixed fee for the institutional connection, most users are not charged for individual

use. This policy, which allows users to peruse the network casually, has generated forms of interaction that could not flourish in an environment of usage or connect-time charges.

- *The Internet is run democratically.* Even though the Internet requires some central coordination, its loose management structure has demonstrated the value of allowing widespread participation in the process of running the network. Because each site derives considerable benefit from being a part of the Internet, individual users and their institutions often feel a strong investment in its success. This sense of investment on the part of users encourages them to participate more actively in network maintenance and administration and thereby leads to more democratic involvement. Moreover, communication on the Internet is remarkably free from censorship, particularly on bulletin boards and other network services that provide space for public discussion.
- *The Internet has demonstrated the value of open, interoperable standards.* The protocols currently in use were designed to coexist with as-yet-unknown protocols and to permit evolution. The fact that the TCP/IP network protocol has enabled the Internet to sustain dramatic growth over the last few years illustrates the advantages of evolutionary standards.

2.4 Shortcomings of the Internet

Despite its considerable successes, the Internet also has certain inadequacies when viewed as a prototype for the NII. The Internet is dwarfed as a carrier of data when compared to the size and connectivity of the telephone system. A number of improvements must be made to transform the Internet into a system that can serve the whole country inexpensively at high speed. Most of the following trouble areas are already under investigation.

- *The Internet is not connected with enough services of general interest.* Although many people find the current Internet to be exciting and rewarding, it does not provide certain facilities that many people need. For many users, the facilities provided today seem esoteric and outside of the bounds of their daily lives. To make the network useful, those individuals need access to social services, to job-training programs, to better health care, and to communities of people who share their interests. Making sure that the services provided by the NII are the ones that people need is perhaps the greatest challenge in its design.
- *Individual Internet connections are too expensive and difficult to obtain.* The cost of providing an Internet connection directly to a home is too high—often as much as an automobile. Although service providers offer a compromise allowing individuals to dial in to a shared Internet connection, such connections usually offer only a minimum form of interaction. The price of home connection needs to compare move favorably with telephone or cable TV service.
- *Human-computer interfaces for the Internet are not yet very sophisticated.* A large development effort needs to take place if extremely sophisticated services are to be offered to unsophisticated users. The Internet does not yet allow widespread, easy-to-use multimedia interaction. It is generally aimed at people who are technically very experienced and knowledgeable. Adding new services often requires a high level of sophistication that many people do not have.
- *Information overload is a significant problem.* As a network grows, the volume of information and services available on it also expands. Making use of that information, however, requires that users be able to find what they need, without being overwhelmed by massive amounts of data. On the Internet today, the proliferation of new bulletin boards, discussion lists, information sources, and tools for retrieving information makes it harder for any user to locate a specific piece of information and represents a significant barrier to new users. It is crucial to provide better mechanisms for both finding and limiting information, especially for the NII, which will be much larger in scale than the Internet.
- *The Internet offers no adequate mechanism for controlling antisocial behavior.* Although free interchange is what makes the Internet valuable, it can sometimes be annoying. Individuals often abuse the privilege of global communication by posting silly, trivial, or redundant questions or comments. Commercial concerns are now contemplating the fact that, at no additional charge over basic Internet service, they can post electronic mail to absolutely everyone. The low fixed-price structure will not cope with an influx of advertising, or individuals capriciously broadcasting

messages for their personal amusement to Internet mailboxes worldwide. Mechanisms need to be evolved to balance, and enforce, as-yet-unmade policies concerning both freedom of speech and the cost of speech.

- *The Internet lacks sufficient mechanisms to guarantee privacy and security.* The Internet does not provide adequate safeguards to ensure privacy and security. In today's Internet, it is impossible to ensure that individual communication is kept confidential. In addition, well-publicized attacks on the network by malicious individuals intent on gaining unauthorized access underscores the failure of current network security policies.
- *The current Internet design suffers from several technical problems.* Although the TCP/IP protocols have been extremely successful, there is concern that these protocols cannot easily be adapted for extremely high-speed machines. Moreover, the Internet protocols used for routing—the process of deciding how to send data from one network to another—are still experimental. Several competing routing protocols are in use, which can lead to complicated failures of network routing as a whole. In addition, several of the existing protocols, including those used for sending mail and identifying individual machines on the network, are likely to become unworkable as the network grows. Growth also presents a challenge to the protocol design, because the number of available IP addresses is too small for a large global system.

2.5 Further lessons from the Internet experience

Although the Internet has been an enormous success, the computer science community is still in the process of discovering how networking can best be done. Along the way, we have learned many useful lessons that will apply to the design of the NII as well. These lessons include the following:

- *The technical development of a network is not an easy process.* Particularly in the early days, researchers were surprised at how difficult network technology turned out to be, and all the problems are not yet resolved.
- *Network design and development must be evolutionary.* In the process of getting to the current design, many alternative strategies were attempted and then discarded. The right answers emerged slowly through experimentation. That experimentation continues today and must certainly continue into the future, if the NII is to respond to evolving needs.
- *Substantial research and development funding is required to develop the technology.* Over the years, the Internet and its predecessor networks have required significant investment of both public and private resources to overcome the difficult problems that arise in network design. New technologies and new uses for the network will require additional research and development on an ongoing basis.
- *An open, cooperative environment is critical to network success.* By combining the efforts of many researchers and building up a shared technological base, the network was able to grow and develop much more successfully than would have been possible using a less cooperative approach.
- *Users tend to engage in communication rather than information retrieval.* The most popular services on the Internet include electronic mail, bulletin boards, and programs to mediate on-line conversations. People enjoy the opportunity to communicate with other people and to build new communities that share interests or concerns. As an example of such community-building, the Internet is home to a discussion group for women who work with computers. The participants often find that they are the only women in their work group—sometimes, the only women in their company. The on-line group allows them to discuss problems they have encountered and to get advice on how to work through difficult situations. At the very least, they find sympathy and assurance that they are not alone. The NII ought to provide the mechanism for the formation of many such distributed communities.

The stakes are clear. The NII has the potential to introduce a uniform, centralized, oppressive viewpoint that further stratifies and polarizes society. With thoughtful design, however, the NII could provide universal access, support developing communities, and nurture true democracy.

PART 3

BACKGROUND ON THE PRINCIPLES AND RECOMMENDATIONS

The recommendations summarized in Part 1 of this document arise from the principles established in its first section. Part 3 expands on these principles and recommendations, highlighting their interrelationship.

3.1 Public-interest principles

CPSR equates the public interest with a strong and unequivocal commitment to democratic principles. By most objective evidence, the practice of democracy in America has been eroding steadily in recent years. Voter participation continues to decline, citizens are uninformed about political and social issues, and there is widespread public cynicism about the entire process of government. More than any other public-policy initiative, the National Information Infrastructure (NII) has the potential to reverse this erosion and give new life to our democratic principles. We believe that the design and structure of the NII will have a profound effect on the future of democracy in America.

CPSR believes that the seven principles for the NII outlined by the Telecommunications Policy Roundtable are essential to the realization of a democratic society. Those principles, therefore, must occupy a privileged and protected status in the development of NII policy. In order to serve the public interest, the NII must be both designed and operated according to those principles.

Much of the current debate over the NII has focused on who will build the carrier hardware and what levels of regulation need to be provided. CPSR believes that the questions are important primarily to the extent that they influence the principles and goals of democratic practice. The public interest depends upon the rules of the game—how the NII will be designed and operated—and the necessity of preventing concentrations of political or economic power from dictating those rules at the expense of democratic principles. For this reason, our primary concern is that debate on other issues be framed so as to preserve the unique and irreplaceable status of the public-interest principles, which are expanded in the sections that follow.

Universal access

Universal access to the NII is a necessary and basic condition of citizenship in our information-driven society. Guaranteeing such access is therefore an absolute requirement for any degree of equity. At a minimum, universal access requires the following conditions:

- Everyone in the country must have a place they can go to gain access to the NII.
- Hardware and software for the NII must be easy to use and fit the needs of all users, including the disabled.
- Simple training in the effective use of these tools must be available.
- Pricing for the NII must be structured so that service is affordable by everyone.
- Access to the full range of features supported by the NII must be available to all.

Freedom to communicate

Freedom of speech and of the press are fundamental characteristics of a democratic society. In the 18th century, when these freedoms were encoded in the Bill of Rights, human speech, the printing press, and postal delivery were the most sophisticated means of communication available. These tools, and the guarantees that everyone would have access to using them, were seen as vital to economic, social, and especially political life. Today, the need for expression is increasingly met through electronic communication.

Protecting every citizen's right to freedom of expression must be a fundamental goal of the NII. The freedom to communicate has two essential aspects. On the one hand, those who speak must be able to do so without fear of censorship. On the other, it is essential that all people have the opportunity to be heard in the first place. While these two aspects are closely linked, their realization often requires separate and distinct policies.

In seeking to ensure freedom from censorship, a clear line must be drawn between those domains of the NII dedicated to private interests, which are largely free to determine their own operating policies, and domains available for public use. The constitutional protections on freedom of expression must be protected in all public spaces within the NII. Moreover, it is important to ensure that such public spaces continue to exist in the NII, just as they do in today's Internet.

Our collective experience with network communication has shown that a certain level of civility enhances the quality of service for all users. To this end, CPSR believes that it is important for network communities themselves to formulate ethical principles and standards for appropriate behavior that can serve as guideposts for those who choose to participate in those communities. We believe that censorship based on the content of expression must not be imposed from the top down. Citizens must feel as free to express themselves over the NII as they do today over the telephone.

At the same time, it is essential to protect the rights of citizens to be heard in the first place. As A. J. Liebling observed when he wrote that "freedom of the press belongs to those who own one," the high costs of entry into traditional print and broadcast media have formed a barrier to individual expression throughout this century. By lowering the economic barrier, computer networks make it possible for individuals to express their ideas much more widely through electronic mail, on-line publications, mailing lists, and bulletin boards. In the Internet today, people use these tools extensively as a means of expression, and it is important to retain these capabilities in the NII.

The NII requires two kinds of resources to allow individuals to publish their own contributions using the NII. First, it must provide a physical connection that can carry information in both directions. Second, it must offer software tools that facilitate the posting of messages so that others can find them easily. Without two-way communication, citizens at the receiving end of the wire are not merely passive but mute. In a society linked together by the NII, the capability of every individual to post messages will be the functional equivalent of the freedom in the world before electronic media to stand on a corner and speak one's mind.

Freedom to communicate, however, does not mean freedom to intrude. The right to free speech must be balanced by the right not to listen. Given that many people now find unsolicited mail and telephone calls intrusive, it is easy to imagine that the NII might enable the production of an overwhelming amount of electronic "junk mail." It must not fall as a burden to the individual to sift through all such material to find the nuggets of desired communication. There must be ways for people to choose classes of messages they do and do not wish to receive.

Vital civic sector

The American democratic system is designed to provide the opportunity for thoughtful, informed decision-making. To make that system work, citizens and public officials must have opportunities to understand each other's needs and desires. As it becomes our central communications mechanism, the NII must be designed to support this system of governance. The NII must provide service capabilities that encourage the spontaneous development of communities of all kinds. The primary requirement is a set of software tools specifically designed to facilitate the creation of self-defining groups of users. These groups will consist of people who want to discuss issues concerning their neighborhood, state, nation, or planet.

Individuals and groups must be enabled to participate in governmental decision-making at national, state, and local levels. To do so, they will need timely access to government information and pending policy decisions. They will also need the opportunity to participate directly in hearings and other public proceedings. With universal access and usability, the NII has the potential to reduce the distance between citizens and their government as nothing else can. Civic participation will enable citizens to help design regulation and legislation, not merely to appeal it or vote on it.

Schools and libraries play key roles in nurturing the civic sector. Not only should people be able to reach out into the NII from schools and libraries, but people should be able to reach into them from the NII. Classes and teachers at all levels from elementary schools to colleges should be reachable through the NII. Not just library catalogs but eventually the contents of the libraries should be accessible through this medium.

Making schools and libraries accessible from the NII serves two purposes. First, it enables life-long learning, not just for those of traditional student age, but for workers in need of retraining, for immigrants, for all who want to improve themselves. Second, it helps provide people with the information they need to be informed citizens.

Diverse and competitive marketplace

An open market for content is even more important than an open market for its carriers. The NII should ensure competition among ideas, products, and information providers. They should be able to compete because of their quality and not merely the marketing resources behind them. This means that individuals and small publishers must be enabled to be as visible in the marketplace as the large commercial institutions. The NII can allow individuals to act as their own publishers. The public can then decide whose program to watch, which software to run, and which databases to scan.

The NII has the opportunity of providing a level playing field where small businesses can more readily compete with large concerns. More diverse offerings allow for market innovations, experimentation, and the customization of products that economies of scale prohibit.

Referring to the NII as a marketplace of ideas does not, however, mean that providers must charge for their offerings. Publishers may decide that having their idea widely accepted is more important than making a profit. This happens often in the computer research community: much of the most popular software is the result of donated labor. Software publishers benefit by being able to share ideas with a wider community, by proving the validity of their research, or by satisfying their altruistic tendencies. The competition of their offerings with commercial products can only improve both.

Equitable workplace

Although computers have become relatively common in the home, most people in the United States today are more directly affected by computing technology at work. For example, the widespread use of word processing has profoundly transformed the character of office work in the last fifteen years. During a similar period, the development of new techniques for factory automation has changed not only the nature of manufacturing jobs but also the availability and importance of such jobs in the national economy.

The NII, while it offers extraordinary opportunities for economic growth in global information, will also continue to transform the nature of work in our society. In sectors of the economy that generate and distribute information resources, job growth is likely. Other sectors, however, may continue to suffer job losses and the associated economic dislocation. For example, as the NII reduces the cost of international communication, it will become easier for companies to export certain jobs formerly done in the United States to countries with a lower wage rate. Similarly, the availability of new services on the NII may reduce the need for workers who now provide those services locally.

Too often in the past, new technologies have been introduced into the workplace with little concern for their effects on workers. In many cases, the introduction of computers has required workers to acquire new expertise and knowledge, raising the skill level needed for the job. In other cases, computers have had the opposite effect, reducing the level of job skill needed to such an extent that workers become merely agents of the machine. Without planning and foresight, such changes can have a negative effect on total productivity. Workers whose jobs suddenly require enhanced skills may not receive the additional training they need or any recognition to compensate for the increased responsibilities. At the other end of the spectrum, workers whose jobs have been deskilled lose a sense of personal investment in the process.

Since the NII will further change the nature of work in the United States in profound ways, its policies must be designed to address those changes. CPSR believes that workplace technology is best used to enhance, not replace, the skills of workers. Moreover, workplace systems themselves are more effective when workers participate actively in the design process.

Privacy

Privacy protection is a fundamental human right. The protection of privacy is all the more important in advanced communication networks where enormous amounts of personal information are generated and transferred. The ever-increasing capability of both existing and new technologies to accumulate and cross-reference personally identifying information constitutes a grave threat to personal privacy.

Proposed NII services should be carefully examined. New network services, if not properly designed, may easily diminish user privacy. Caller ID, for example, reduced the privacy of telephone customers and was opposed by consumers and state regulators. Users of the NII should also be permitted to use strong cryptography to protect communications. It is inappropriate and potentially dangerous for the integrity of the NII for the government to encourage communications services that facilitate wire surveillance.

CPSR believes that an NII privacy code should be developed and enforced. We have already recommended a set of principles that could help address many of the privacy concerns the NII will raise. These principles are:

1. The confidentiality of electronic communications should be protected.
2. Privacy considerations must be recognized explicitly in the provision, use and regulation of telecommunication services.
3. The collection of personal data for telecommunication services should be limited to the extent necessary to provide the service.
4. Service providers should not disclose information without the explicit consent of service users. Service providers should be required to make known their data collection practices to service users.
5. Users should not be required to pay for routine privacy protection. Additional costs for privacy should only be imposed for extraordinary protection.
6. Service providers should be encouraged to explore technical means to protect privacy.
7. Appropriate security polices should be developed to protect network communications.
8. A mechanism should be established to ensure the observance of these principles.

CPSR acknowledges the interest of corporate marketing and recognizes the public interest in both law enforcement and national security. However, we assert on principle the necessity of an NII policy that effectively resists the otherwise endless demands for personal information. Although privacy cannot always supersede other concerns, it is often possible to find a way to meet those other needs with a minimum of infringement.

Democratic policy-making

If the NII is to serve the needs of the public, the public must have input into its design. The public must help establish both the policy by which it is guided and the design through which it is implemented. Experience has shown that such involvement has been critical to the design of the most popular existing electronic systems. Effective participation is as important to computer systems as it is to government.

Traditionally, technologists have argued that only a strong central vision can produce elegant, consistent, complete designs. Citing examples of the failure of design by committee, they argue that technical design must be left to those who understand its complexities. Unfortunately, this approach tends to create complex systems that can be understood and used only by the technical elite.

New approaches, however, combine the centralized and decentralized models, obtaining the benefits of each while avoiding their deficiencies. These approaches can be applied to the design of a system and to the adoption of a standard.

In participatory design, the people who are expected to use the final product are involved from the early design stages through several iterations of testing the implementation. The system is implemented by a small team that works with a central design. Those who use the system contribute their own knowledge to the design by commenting on the goals and features to make sure the system is widely usable.

Just as participatory design allows systems to emerge after cycles of user input and testing, the same approach can be used to define new standards. The process begins with the formulation of an experimental standard. After a period of testing in its intended environment, comments are obtained and another iteration of design and testing begins. When the system is stable and both architects and users are satisfied, the standard is adopted. This approach has been used with great success by the Internet Society and the X Consortium, which has developed a window system used today by most of the major workstation vendors.

Both participatory design and the experimental approach to standardization achieve the benefits of democratic input to design and policy-making without sacrificing the technical advantages of consistency and elegance of design.

Functional integrity

The NII must be engineered to high standards of reliability, functional capability, and extendibility. In time, the NII will encompass all the nation's telecommunications. As it becomes the primary conduit for economic transactions and long-distance medicine, businesses and people will trust the NII with their economic livelihood and, perhaps, their lives. We will demand a system that works under heavy loads and in natural disasters. Failures will occur, but they should be localized, not system-wide. Recovery must be swift—a matter of minutes or hours, not days or weeks. We will not be able afford to turn off the whole system to maintain or upgrade it, but we will not tolerate it becoming antiquated. Infrastructure must be there when you need it.

Anyone who has worked with today's computer systems knows that they have not achieved this level of dependability. Their limitations are partly the result of economic priorities. It costs a lot of money to design a highly reliable system. That cost must be balanced against the cost of system failure. But the major reason computer systems, particularly software systems, are unreliable is that we do not know how to design them to be more reliable. A large software systems is so complicated that no one person can understand it all. Yet the system is often so fragile that one programming flaw, one misplaced comma, can bring the whole system crashing down, or send a satellite flying out of control.

Setting high standards for the engineering will push us, as designers and implementers, to find new ways to improve the quality of computer software. That we have failed to do better to date shows that the task will not be easy. But when we understand that the NII is vital to the economic and perhaps the physical health of the nation, it becomes clear that we must challenge ourselves to do our best.

3.2 Policy recommendations

Government is the institution through which we come together to set collective priorities, to organize our resources for the common good, to set the rules under which we wish to live. For all its problems, government is essential. If the NII is left entirely to private enterprise, it may become nothing more than a vehicle for entertainment, finance, shopping, and advertising—to paraphrase Bruce Springsteen, "500 channels with nothing on." It is only through government action that we will preserve a public-interest component of the NII beyond these commercial interests.

P1. Consider the social impact

We agree with the Administration that implementation of the NII will have far-reaching effects. The infrastructure will change society both in ways we can predict and in ways we cannot. Unless we understand these

changes, we cannot hope to control them. Therefore, we recommend that a portion of both the initial funding and the maintenance funding be set aside for research into the social impact of the NII.

P2. Guarantee equitable and universal access

Universal access to the NII is required to ensure that society does not become divided into the information-poor and the information-rich. Because access to information is critical in the modern world, we believe that the NII will become the primary medium for political and economic participation. To limit people's access because they are physical disabled, economically disadvantaged, or geographically remote is unacceptable in a democracy. We anticipate that a network implemented solely on free-market principles would not reach all citizens. No single commercial institution finds it financially worthwhile to provide service to the marginal users. Today's telecommunication system fails to support all citizens adequately, and the NII will be built from much the same technology. Yet all will benefit, both economically and politically, by universal service.

Access will require not merely a connection to the NII, but the hardware to use that connection. A telephone wire to one's house is useless if one cannot afford a telephone. What the user's equipment will look like remains to be determined: it may be a computer terminal or some completely new device, but we must find a way to offer access to everyone at an affordable, perhaps subsidized, price.

P3. Promote widespread economic benefits

From the two major position papers the Administration has released concerning the NII, it is clear that they intend it to benefit all sectors of the U.S. economy. We are concerned that in estimating and measuring the impact of policy alternatives, there will be a tendency to consider only the most readily quantifiable aspects, such as the effect on the telecommunications and information industries. There are likely to be cases, such as the establishment of rate structures, in which the interests of these two industries is not precisely aligned with the interests of the nation as a whole. We call for the foresight and breadth of vision to see beyond short-term, narrow interests to enduring national needs.

In considering the structure of the NII, one of the crucial public-policy issues is how its construction and operation will be financed. In the current debate, the prevailing assumption is that as much of the service as possible should be privatized in the interests of economic efficiency. Economists, however, have long recognized that certain conditions are necessary for a free market. When those conditions do not exist, market failures can occur. In the case of the NII, several factors—its status as a public good, the high cost of entry into the carrier market, the existence of both positive and negative externalities in its operation—are predictors of market failure. Speaking at a conference on "Public Access to the Internet" at Harvard's Kennedy School of Government in May 1993, economist Sandra Schickele pointed out that "the assumptions which must hold if the free market is to be efficient are fundamentally violated by the nature of the Internet and any likely successor to it, and that market prices cannot by themselves efficiently allocate resources for the production and use of the Internet." Government planners must be sensitive to this danger and intervene as necessary.

P4. Promote diversity in content markets

The public benefits from exposure to a diverse marketplace of ideas. Can market forces alone foster this diversity of content on the NII, or will it need a champion? As long as information providers are able to reach their public, they have no further interest in diversity. In fact, they have an economic motivation to raise barriers that keep others from entering the market. Moreover, as long as their networks are saturated, carriers are indifferent to the number of content providers. If no one has an economic motivation to ensure diversity, market forces alone cannot suffice.

The early history of the railroads offers an instructive parallel. Even though the railway expansion greatly benefited the nation by the end of the 1800s, the economic process of achieving those benefits was hardly smooth. For many years, railroads operated in an environment with no regulations against monopolies or discriminatory pricing. Through an extensive network of trusts and discriminatory tariff structures mandating higher rates for short hauls than longer ones, railroad companies enriched themselves at the expense of the economy as a whole. Outrage against them led to the formation of the Independent Farmers' Association and the Grange movement,

which in turn led Congress to establish the Interstate Commerce Commission in 1887 and to enact the Sherman Anti-Trust Act in 1890.

P5. Provide access to government services and information over the NII

We applaud the Administration's intention to use the NII to create a government that is "more cost-effective, efficient, and 'user-friendly.'" While technology is not a quick fix for social problems, it can enable the flow of information and democratic empowerment needed to address these problems. For example, individuals need access to social services, public information, legal records, census and agricultural data; the ability to inspect and correct government records about themselves; and information on pending public-policy decisions and the ability to comment on them. Moreover, to be equitable, we must not only provide these services through the NII, but also guarantee universal access to them.

P6. Protect public spaces

We mean many things when we speak of public space on the NII. There must be areas that are publicly owned. Anyone must be able to post messages, confident that the content of those messages are protected by First Amendment guarantees of free speech. The NII should offer an arena for public discussion. Public spaces may also be the venue for interchange with local, state, and federal government agencies. Pending legislation and regulations could be posted there along with people's comments. Public spaces also allow developers to offer free noncommercial software to a wide audience.

It will take funding to maintain these public spaces. Possible models for funding include surcharges on profits for information providers, royalty fees for the use of publicly collected data, profits for carriers, or tax abatement to donators of public space. Recommending a particular model is beyond the scope of this report, but we strongly urge the Administration to consider the various possibilities.

P7. Encourage democratic participation

For reasons of both principle and expedience, we believe that decisions affecting the public's use of the NII must be made openly and democratically. The principle of government for, of, and by the people demands public involvement in the design of so vital an infrastructure. Anything that will have such an impact on our lives and the social structure of our nation should be a matter for public consideration. Further, we believe that the infrastructure will be easier to use and more beneficial if the intended users, the public at large, have input into its design.

P8. Think globally

An information infrastructure will obtain its maximum economic, social, and cultural benefits when it is world-wide in scope. We cannot, of course, mandate the global adoption of the U.S. infrastructure. We cannot control other nations, and choices that meet our cultural needs may be inappropriate elsewhere. Nonetheless, we can design the NII so that it does not create barriers to global communication. Currently, our national standards set a lower threshold for the protection of individual privacy than do the laws of other countries. These countries consequently restrict the flow of data records into our country. If we work to establish comparable standards, both individual privacy and global communication will be enhanced. Similar issues exist in the areas of security, censorship, and tariffs.

P9. Guarantee functional integrity

The government has a compelling interest in making sure that the NII meets its design goals. As with other parts of the national infrastructure, the government must at times establish regulatory mechanisms to ensure that basic standards are upheld. Government intervention is particularly critical when market forces act to favor individual companies rather than the public good. For example, regulation may be required to ensure that standards remain open, that basic service is available to all at reasonable cost, that privacy is protected, and that citizens have access to public information.

In most cases, the areas in which government may need to take action correspond to those for which CPSR has developed design recommendations. The specific challenges that may arise are discussed in more detail in the sections that follow. Our purpose in including this recommendation in the policy section is to emphasize that the process of guaranteeing that technical requirements are met is an issue of public policy as well as of design.

3.3 Design recommendations

As computer professionals, the members of CPSR have considerable experience in systems design and the use of network technology. This experience leads us to make several recommendations to the designers of the NII, who must ensure that the system is technically capable of meeting its intended goals. These recommendations, briefly articulated in Part 1, are expanded in the sections that follow.

D1. Emphasize ease of use

The single most important failing of the Internet today is that it is extremely hard to use for those lacking a certain level of technical expertise. The Internet was designed by computer programmers for themselves and their colleagues; its style of use reflects that history. New users are faced with an overwhelming collection of network resources and tools for getting at them. Only in the last several years have service providers begun to tackle the problem of reducing the complexity of using the network.

Building a system that is simple for users and yet gives them access to the full range of data and services available on the NII is an extremely difficult challenge. Moreover, it is a challenge too important, complex, and open-ended to be left in the hands of a small group of technical experts. Millions of people will use the NII. Millions more will be affected by its presence. That constituency needs to be brought into the design process. Doing so will require rethinking the traditional approach to setting policy and designing systems. In addition, it will require finding ways to ensure that people of different levels of technical expertise can participate in a meaningful way. We believe that the NII must be easier to use than a VCR, possibly as simple as the telephone.

D2. Provide full service to homes, workplaces, and community centers

The NII is often described as a superhighway for data. For most people in the United States, however, that superhighway will only be useful if they can reach it from where they live and work. In designing an NII that serves the public interest, it is not enough to consider only the network "backbone"—the high-speed data channels that serve as an analogue to the Interstate highway system. It will also be necessary to focus as well on the connections between the superhighways and the individual user—the secondary roadways and streets that form the "last mile" of the information infrastructure. Completing the last mile of the NII is a significant undertaking that will require considerable investment from both the public and private sectors. Moreover, the goal of universal connection will not happen overnight. Even so, it is important to make such connection a national priority and to design the NII itself on that basis.

Unfortunately, it is easy to imagine that early designs of the NII could fail to place sufficient emphasis on the problem of bringing connections directly to the home. Carrier companies may focus instead on the data superhighway, which is certain to offer a higher return on their investment. The U.S. Post Office and the Regional Bell Operating Companies (RBOCs) have found that they lose money on home delivery. Concentrating on high-volume services is more cost-effective. Unfortunately, such a strategy does not support the principle of universal access and would be unacceptable in the NII. The planners of the NII must recognize the importance of reaching the individual user and design the system accordingly, even though establishing those connections will certainly take time.

Beyond guaranteeing that the NII will reach into the home, it is also important that residential connections provide the full range of network functions. A design that offers a high level of service to companies that can afford a direct connection to the network backbone and a restricted, second-class form of service to individual residences is unacceptable. Such a system increases the disparity of power between the information-poor and the information-rich and runs counter to the principles of universal access, freedom to communicate, and democratic policy-making. The definition of full-function service will necessarily evolve with time. We realize that the bandwidth of the connections used for residential customers will certainly place some limits on what can be done

initially, but it is nonetheless important to make high-quality, full-function, residential service a priority in the NII design.

To provide full-function service to all NII users, it is essential that

- The provision of high-level service to individual homes be made a priority
- The NII be designed to incorporate technological advances as they occur
- No arbitrary restrictions be placed on individual users that put them at a disadvantage in comparison to corporate users

D3. Enable all users to act as both producers and consumers

One of the central requirements for full-function service is a two-way channel for communication. It is not enough to design a network that allows individual users to act only as passive consumers of information or entertainment. As is the case with today's Internet, every user of the NII must also have the option to generate new information and to publish that information through the network. Allowing users to act as producers as well as consumers has significant implications for the design of both the hardware and software for the NII.

To an extent, the desire to ensure that all users can become contributors flows from the principle of freedom to communicate. The network must not become like radio and television, where the few broadcast to the many. Individual voices must be heard on the NII, just as they are on the Internet today.

The desire to support individual contribution is also founded on the principle of a diverse and competitive marketplace. The evolution of the Internet in recent years has made it clear that the most valuable new ideas and technologies often come from individuals. The Internet of today is a community that sustains itself technologically. Because individual users feel invested in that community, they seek to make it better. They create their own information services, develop their own software tools, and build on the work of others to create a dynamic and evolving technology unlike any other. The individual initiative and entrepreneurship that characterize the Internet today must remain an essential element in the NII. Those contributions will drive the evolution of the NII itself and provide new value-added services.

D4. Address privacy and security issues from the beginning

Privacy of communication is a fundamental precept that must guide the development of the NII. While the responsibility for ensuring privacy lies partly in the domain of policy, it also has technical ramifications. As is true for reliability, a computer system can ensure privacy only if the designers of that system make privacy a fundamental goal of the initial design.

D5. Develop open and interoperable standards

At one time in U.S. history, different railroads used tracks of different sizes. Doing so preserved corporate autonomy, but retarded the development of a national transportation system. In more recent times, computer manufacturers have also sought to retain a competitive advantage by developing and maintaining proprietary standards. Over the last decade, however, such tactics have backfired in the computing industry. Private standards make it difficult to connect computer systems supplied by different vendors and complicate the process of creating network software. Because clients today insist on being able to perform these functions, private standards drive those clients away. By adopting a public standard and encouraging its use, on the other hand, computer manufacturers can take rely on the broader computing community to create new tools based on the open standard.

The same effect is certain to apply in the design of the NII. The Internet today has been successful in large measure because it provides an open standard that permits systems of different types to communicate. By providing an open and interoperable standard, the Internet makes it easy for new machines and networks to become part of an ever-expanding webs. Moreover, as the Internet grows, the incentive to conform to its standards increases. Since the NII will be much larger than today's Internet, the importance of using open standards for equipment and protocols will be even greater than it is today.

Open standards are also essential to maintain a diverse and competitive marketplace. In an environment as large and as distributed as the NII, proprietary standards can only increase the pressure toward monopolistic concentration, which would work against both competition and diversity.

D6. Encourage experimentation and evolution

Although open standards are essential to the success of the NII, it is also important to recognize the dangers of premature standardization. Because no one can predict with certainty how network usage will evolve, standards must not simply be imposed but instead allowed to evolve. Designers of the NII must not rush to adopt a single transmission medium or software model as a standard. They should instead experiment with trial approaches to find out what does and does not work.

Such experimentation must continue throughout the evolution of the NII. The NII is far too important for us to wait until the perfect solution has been developed. It is critical to begin with what is possible, make those capabilities available to the American people, and then build on that foundation. Throughout the process, the design must be flexible enough to accommodate new technologies and changing patterns of use.

D7. Require high reliability

As a crucial part of the nation's infrastructure, the NII must be reliable. We expect, for example, bridges, roadways, and the other familiar parts of the national infrastructure to be kept in working order through periodic maintenance and to serve reliably when needed.

The NII, however, is different in many respects from the other parts of the infrastructure. More than any other product of engineering, computer systems are susceptible to failure. Although hardware flaws certainly occur in complex systems, software errors represent a greater danger. A single software error can lead to catastrophic failure, particularly in a complex, distributed systems like the NII. Moreover, such errors can sometimes remain undetected through years of testing and use, only to arise when a particular set of conditions occurs.

In a system as large and sophisticated as the NII, it is impossible to eliminate all software errors. Moreover, because the NII must support experimentation and growth, software errors will be a recurring problem as the system evolves. Even so, good software engineering practice and careful attention to reliability in the design phase can reduce the likelihood of critical failures and minimize their effects. To keep software errors to a minimum, however, it is essential to address reliability issues early in the design process and to keep them in the foreground of the project. The history of software development shows that it is extremely difficult to introduce high reliability into a system for which it was not an initial design goal.

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The mission of CPSR is to provide the public and policymakers with realistic assessments of the power, promise, and problems of information technology. As concerned citizens, CPSR members work to direct public attention to critical choices concerning the applications of information technology and how those choices affect society.

Founded in 1981 by a group of computer scientists concerned about the use of computers in nuclear weapons systems, CPSR has grown into a national public-interest alliance of information technology professionals and others. Currently, CPSR has 22 chapters in the U.S. and affiliations with similar groups worldwide. In addition to our National Office in Palo Alto, California, we maintain an office in Washington, D.C., which is home to our Civil Liberties and Privacy program.

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- Civil Liberties and Privacy
- Computers in the Workplace
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- Reliability and Risk of Computer-Based Systems

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