The Next Generation Internet: Defining the Federal Government's Role

Scott A. Heideman

Kansas State University
Washington Internships for Students of Engineering (WISE)
The Institute of Electrical and Electronics Engineers (IEEE)

ABSTRACT

The Next Generation Internet (NGI) initiative is a federal project that was first announced in Knoxville, Tennessee on October 10, 1996 by the Clinton-Gore Administration. The primary goal of the project is to accelerate the discovery of new Internet technologies and applications. The project will help facilitate federal goals and missions.

The discussion over NGI has raised some concerns. First, lawmakers have questioned the federal government's role in creating Internet technologies. Second, the debates over NGI have made apparent the high costs that rural universities face in connecting to high speed networks. Finally, legislators believe that the NGI proposal itself needs work before it can become a federal program.

This paper addresses the key conflicts and concerns of NGI, and provides policy alternatives that will lessen the problems. It focuses especially on alternatives that will help connect rural universities to high speed networks that are vital to research at these institutions.

TABLE OF CONTENTS

EXECUTIVE SUMMARY

The Information Age began approximately 150 years ago with Alexander Graham Bell's invention of the telegraph. Since that time, the world has become continually more reliant on new technologies that improve our ability to communicate. The amount of information and knowledge that our country possesses and the ability to communicate that information bestows a great power to this nation.

With the Internet, scientists and researchers at universities and government institutions found a new form of communication. The Internet, which had its origins in the federal government, allowed them to collaborate with one another by networking their computers together. The Internet grew rapidly from its beginnings at government facilities and at universities. Recently, it has become commercialized, overcrowded and too slow.

The Next Generation Internet (NGI) initiative and the Internet2 projects have offered researchers the opportunity to achieve advanced Internet capabilities. These programs have goals of attaining speeds that are 100 to 1000 times faster than that of the current Internet. They offer researchers and scientists at universities and federal research facilities the ability to communicate at faster speeds. These projects are not intended for use by the general public. At the same time, the programs do stress the importance of developing new Internet technologies and spreading these technologies to the current Internet.

However, it is very important to realize that NGI and Internet2 are not the same project. NGI is a federal program while Internet2 is a consortia of over 100 universities and a handful of private industries. Lori Perine stated in an interview [1] that, "NGI is a program to research the tools and technologies that would make use or utilization of very high bandwidth networking technology possible." NGI has a federal agenda. Internet2, on the other hand, is a project primarily concerned with connecting universities to high speed networks and keeping universities at the cutting edge of Internet technologies.

Under the National Science Foundation's (NSF) High Performance Connections program, Internet2 schools can receive competitive grants to connect to the very high speed Backbone Network Service (vBNS). This network is sponsored by NSF through a cooperative agreement with the MCI Telecommunications Corporation.

[1] Lori Perine, Senior Policy Advisor , National Science and Technology Council (NSTC), personal interview, 23 Jul 1997

The vBNS infrastructure initially operated at speeds of 155 Mb/s (Megabits per second), compared to the Internet's top speed of 45 Mb/s. The vBNS is currently operating at 622 Mb/s. In other words, the system transmits 622 million (622,000,000) bits of information for every second it sends information. The vBNS plans to be able to operate in the Gb/s (Gigabits per second) range soon. Speeds in excess of 2.2 Gb/s are expected by the year 2000. This is a speed of over *2.2 billion* (2,200,000,000) bits of information for every second spent in transmission![2] At this high speed, the vBNS ensures state-of-the-art performance for new Internet applications as they emerge.[3]

From May to July of 1997, several concerns have surfaced with the Administration's approach to NGI. The United States Senate's primary concern is that rural universities will not successfully connect to the vBNS due to high connection costs. Rural universities face larger costs to connect to the vBNS than urban facilities do. Research at rural institutions will be at a great disadvantage if they are left to deal with the slower Internet. Several legislators contend that NGI should provide an answer to lowering the high costs of rural connectivity. The Internet2 project helped to bring the issue of rural connectivity into the spotlight. Universal access to a research-oriented, high speed Internet is a very legitimate concern for rural universities.

NGI is also viewed to unfairly favor business, and has been criticized by critics as corporate welfare.[4] NGI represents a $100 million per year increase over the next five years in the budget for the Committee on Computing, Information and Communications of the Office of Science and Technology Policy (OSTP). It is believed that industry will ultimately profit from the commercialization of the new applications and technologies. With a goal of balancing the budget, Congress would prefer to leave the responsibility of creating these new Internet technologies and applications to private industry and academia.

Finally, there is a concern that the NGI proposal was presented to Congress prematurely. The proposal, appearing in its *draft* form before Congressional Authorization Committees, lacked clear goals and objectives for the five agencies involved (described later). Without adequate coordination, duplication of research efforts and conflicts of interest between these agencies may occur. Several members of Congress believe that the NGI initiative requires more preliminary work than has been performed thus far.

Politically, there are several directions that the NGI initiative could go. First, the NGI

---

[2] United States, National Science Foundation, Fact Sheet: very high speed Backbone Network Service (vBNS), (Washington: GPO, Aug 1996) 1

[3] John Jamison and Rick Wilder, "vBNS: The Internet Fast Lane for Research and Education," IEEE Communications Magazine, (Jan 1997) : 60

[4] Sue Fedor, personal interview, 15 Jul 1997

requested funding could be approved in all of the bills that are before Congress. Another option would be to eliminate NGI. Fortunately, this probably won't happen because Congress does recognize that NGI is critical to the United States if it is to remain at the forefront of communication technology. So, it is likely that some other policy option will emerge.

An understanding of the history of the Internet will be useful in fully comprehending NGI and Internet2 and their implications to society. For NGI to succeed, it must respond to the concern that it is an underdeveloped policy. Consensus on the necessity and scope of the Federal government's role must also be reached. Particularly, NGI must address or answer the legitimate concerns of rural universities.

This paper will examine several policy alternatives concerned with rural connectivity. The Telecommunications industry plays a vital role in this issue. The Telecommunications Act of 1996 deregulated the industry and set the stage for competition in the previously monopolized market. However, there have been few visible signs of increased competition to this point. The price of telecommunications is dictating which universities are served.

The policy alternatives will examine the government's role in combating these prices. These alternatives include federal incentives to increase competition in rural areas, cost sharing between federal and state governments, increased federal aid, and the possibility for federal involvement in the construction of the Information Superhighway.

Finally, this paper provides recommendations for NGI. This section summarizes the author's views of the issues involved. The importance of NGI as a Federal program is stressed.

BACKGROUND

The Internet: Growing Pains with a Growing Audience

With the recent commercialization of the Internet, the possibilities for information transfer have greatly increased. The Internet can be used to send text to millions of people who have e-mail (electronic mail) access; retrieve software, pictures, audio files, and other information from a variety of locations worldwide; or use it to collaborate work with people from another state or even another continent.

The Internet's predecessor, the ARPANET, was the first transcontinental backbone network in the United States. Completed in 1969, the Advanced Research Projects Agency (ARPA) of the Department of Defense (DOD) felt it was necessary to ensure reliable data transfer in the event of a nuclear war. The ARPANET involved basic

research in the area of packet-switched computer networks. [5]

[5] John S. Quarterman and Smoot Carl-Mitchell, The Internet Connection: System Connectivity and Configuration, (New York: Addison-Wesley Publishing Company, 1994) 25

The Internet used today is primarily a result of the ARPANET research and the NSFNET (National Science Foundation national backbone network). The Internet is a combination of networks and individual routers, hosts and servers, and it uses packets to send information. *Packets* are discrete groups of data that are sent to a specific destination. Each packet is a few thousand bytes long and it contains a portion of the total data. A dedicated computer called a *router* sends the packets to certain destinations. *Links,* constructed of fiber optic cable, copper cable, or a microwave relay connect the routers to each other. The networked computers that people actually use are *hosts*. Links connect hosts to the networks, as well as connecting the networks to other networks. (In the ARPANET, the hosts were simply connected to one router.) Finally, the Internet's creators established a protocol in order to allow all of these different computers to communicate to each other. The Internet uses many protocols but it relies primarily on the *TCP/IP* (Transmission Control Protocol/ Internet Protocol) protocol suite as a basis.[6]

The Internet has grown beyond the expectations of the people who originally conceived it. What began as an experiment by researchers has become a commercial success. Internet experts anticipate that more than 50 percent of the population of the United States will have access to the Internet by the year 2000. In other words, within 2 ½ years, an estimated 130 million Americans will be "on-line." Information technology accounts for 30 percent of all US investment in new plant equipment.[7] Moreover, the Internet, due in part to the success of the World Wide Web (WWW), has grown at nearly 100 percent per year since 1988. Traffic on the Internet has grown at a rate of 400 percent per year recently.[8] In many instances, the Internet's technology is not meeting the demands of the general public.

Researchers encounter even more problems with the Internet. The researchers at universities and at governmental facilities that originally used the Internet now find that it cannot meet all of their needs. First, the flood of people that use it are causing traffic problems. The links carry so many packets of data that the routers have problems sending the information speedily to their next destinations. A good analogy is a large water pipe connected to a smaller pipe. The flow of water must slow once it enters the smaller pipe. Experts call this problem a bottleneck. Workstations and PCS also contribute to the slow information flow.[9]

Another problem that researchers face is bandwidth limitations. The available bandwidth of the connecting medium restricts the amount of information transmitted at

---

[6] Quarterman and Carl-Mitchell 21

[7] Henry Kelly, Acting Associate Director for Technology, OSTP, Testimony before Subcommittee on Communications of the US Senate Committee on Commerce, Science, and Transportation, Hearing, Washington, 3 Jun 1997

[8] Ken Kennedy and Bill Joy, "Letter to Dr. John Gibbons," (Arlington, VA: National Coordination Office for Computing, Information, and Communications) 1

[9] John Bluck, "NASA Holds Briefing for Industry on Next Generation Internet," World Wide Web Page, http://www.ngi.gov/pr_west_coast.html, 4 June 1997, 1

a given time. For instance, fiber optic cables provide greater bandwidth than do copper wires. The limited bandwidth has caused many problems for researchers. Quick transmission relies on great amounts of bandwidth. The high bandwidth technology exists, but it has yet to fully reach the Internet.

Additionally, applications have not kept up with the researchers' needs or desires. The research community has found it particularly difficult to do collaborative work on the Internet. They need an Internet that can transmit tremendous amounts of data. The speeds that the current Internet offers simply are not fast enough to make long distance research worthwhile.

To give an example of how a faster Internet could facilitate the flow of large amounts of information, consider scientific satellites. Some of these satellites are sending nearly a *terabyte* of information to earth per day. A *byte* is equivalent to 8 bits. A terabyte is one trillion (1,000,000,000,000) bytes. By comparison, the entire printed collection of the United States Library of Congress is equivalent to about 10 terabytes.[10] A faster Internet is needed to be able to send this large amount of data more quickly to the researchers who need access to the information.

The Next Generation Internet Initiative (NGI)

To answer these concerns, President Clinton announced the Next Generation Internet initiative in October 1996. The NGI initiative is a federal research effort that will eventually spread new network technologies and applications to the current Internet. It has three main goals:

- To promote experimentation with the next generation of network technologies,
- To develop a next generation network testbed to connect universities and federal research institutions at rates that are sufficient to demonstrate new technologies and support future research, and
- To demonstrate new applications that meet important national goals and missions.[11]

Agency Roles and Funding

The funding for NGI, as set forth by the President's FY 1998 Budget Proposal, totals $100 million per year over 5 years. It is being divided between the Defense Advanced Research Projects Agency (DARPA) of the DOD, the Department of Energy (DOE),

[10] Office of the Press Secretary, "Background on the Clinton-Gore Administration's Next Generation Internet Initiative" (Press Release),World Wide Web Page, http://www.iitf.nist.gov/documents/press/internet.html, 10 Oct 1996, 4

[11] "NGI Initiative Concept Paper," World Wide Web Page, http://www.hpcc.gov/ngi/concept-Jul97/, 23 Jul 1997, 3

NSF, the National Air and Space Administration (NASA), and the National Institute of Standards and Technology (NIST). The National Library of Medicine (NLM) and the National Institute of Health (NIH) recently became partners in the NGI initiative and are asking for an additional $5 million per year to fund NGI research in their facilities.[12] The figure on the next page indicates the total amount of funding that each agency was to receive as of July 23, 1997.

The National Coordination Office (NCO) for Computing, Information and Communications provides the interagency coordination for NGI. This office ensures that replication between agencies is at a minimum. Additionally, the President appointed Bill Joy of Sun Microsystems and Ken Kennedy of Rice University to co-chair the Presidential Advisory Committee on High Performance Computing and Communications, Information Technology, and the Next Generation Internet. The committee maintains the interests of academia and industry during the process of implementing NGI. Finally, the Large Scale Network working group, which is part of the CCIC, oversees the NGI initiative. The CCIC reports to the White House through the National Science and Technology Council (NSTC), chaired by President Clinton. The NSTC is part of OSTP.

Figure 1: Proposed division of NGI Funding

[12] "NGI Initiative Concept Paper" 22

Each federal agency (DARPA, NSF, etc.) has been involved with information technology in the past. According to the NGI Initiative Concept Paper, their "skills and experiences provide an essential base upon which the initiative is built. The strength of this base allows projection of likely success for the initiative, without which the initiative would be much more risky." It is worthwhile to consider each agency's role in the NGI initiative.[13] The table below illustrates each agency's role in NGI and their experience with network technology.

Table 1: Agencies' Previous Networks and Their Role in the Next Generation Internet[14]

Agency	Previous Networks	Role in NGI
DOD	*ARPANET,* *DREN* (Defense Research and Education Network)	long-term, general expertise in networking research, general skill in high-end network technology and testbeds, and experience in managing networks.
DOE	*ESNET* (Energy Science Network)	long-term experience in managing production and research networks, specialized skills in networking technology, great strength in mission-driven applications and in system integration
NASA	*NI* (NASA Internet), *NREN* (NASA Research and Education Network)	experience in network management and in specialized network testbeds, strength in system engineering and integration
NIST	*SMDS (Switched Multi-megabit Data Service),* *FDDI (Fiber Distributed Data Interface)*	long experience in standards development, networking research, metrology, computer systems, security, systems integration for manufacturing applications, and in testbeds involving many industrial partners
NSF	*NSFNET,* *vBNS*	special relationships with the academic community, experience in network research and in managing networks, great strength in scientific applications

Social and Economic Consequences from NGI's Technologies and Applications

The ultimate goal of the NGI research is to achieve "end-to-end, high performance" communication. The term *end-to-end* refers to the ability of a network to transmit information from a source at a certain speed and recover that information at the same speed at its destination point. To put it briefly, NGI is the next step forward in the ever-evolving Internet. The technologies and applications that will be discovered through NGI could lead the United States well ahead of foreign competitors. The Information Age would take a giant leap forward with the genesis of new networking technologies and applications envisioned by the Next Generation Internet initiative.

The NGI technology and applications are expected to revolutionize the current

[13] The table provides general information regarding the agencies' roles. For specifics regarding agency roles, please view the NGI Implementation Plan at www.hpcc.gov/ngi/implementation-Jul97/

[14] "NGI Initiative Concept Paper" 22

Internet. Digital libraries, weather modeling and biomedical imaging are among some of the emerging applications.[15] Scientists have started producing some of these applications and are simply waiting for the Next Generation Internet for them to become fully successful.[16]

Consider how a faster Internet could ultimately change the nature of health care. A heart surgeon could send real-time video of a surgery conducted in one part of the country to a physician that is training in another part of the country. The surgery could be a truly interactive educational experience. This could be performed now if the Internet had speeds capable of sending this large of an amount of data.

Several industries will eventually benefit from the applications that NGI will uncover. Distance education could be possible through two-way video to remote sites. Distance education allows working Americans to improve their skills by providing access to education that is otherwise unavailable to them. The concept of a "university-without-walls" could become a reality.[17] Similarly, health care, national security, and energy research could all benefit, just to name a few.
Additionally, several spin-off applications and technologies could result from NGI's basic research. For example, e-mail was very much an unintended, but extremely positive, spin-off from the basic research for the Internet. The World Wide Web has recently emerged as a crucial reservoir of government documents, research documents and information in general. Many new applications could also result from NGI. Given the broad scope of the initiative, it is hard to determine exactly what applications are possible.

Economic growth is possible with NGI. Just consider how the Internet itself has benefited the economy. New businesses, such as Netscape, have emerged at an astonishing rate. Also, existing business has benefited as a result of increased communication possibilities.
The proponents of NGI expect that it will spur more new business and economic growth.

Internet2

NGI is somewhat based on the goals of another project, Internet2. Internet2 is an effort undertaken by over 100 universities in collaboration with the private sector. As

---

[15] United States, National Science and Technology Council, Advancing the Frontiers of Information Technology : Supplement to the President's FY1997 Budget,(Washington: GPO, 1996) 18
[16] "NGI Concept Paper Draft: NASA Role in NGI," World Wide Web Page, http://www.hpcc.gov/ngi-concept-08Apr97/append_nasa.html, 1
[17] Position Statement "Next Generation Internet", The Institute of Electrical and Electronic Engineers, Inc. - United States Activities (9 Jul 1997 DRAFT)

explained earlier, it has the goal of connecting research universities at high speeds using the NSF-built vBNS. Appendix A of this paper contains the list of all of the current Internet2 schools (as of June 1997). Internet2 provides for interaction between private industry, government and academia.

The Internet2 project is the key player for new university networks. The goals of the project are as follows:

- To create and sustain a leading edge network capability for the national research community,
    - To direct efforts to enable a new generation of applications to exploit fully the capabilities of broadband networks-media integration, interactivity, and real time collaboration,
    - To integrate its efforts with ongoing efforts to improve production Internet services for all members of the academic community.[18]

To become an Internet2 school member, a university must first prove that it has sufficient high performance computing capability. Then, the Internet2 schools must pledge a certain amount of money towards the project. At this point, NSF grants are provided to universities that show that they have a research program that demands the capability of the vBNS. Thus far, 60 of the current 109 Internet2 schools have received these grants. By the end of 1997, Internet2 will begin functioning for the university research community.

Status of NGI Funds

It is worthwhile to explain the status of the NGI funding. Table 2, shown below, gives the amount of funding appropriated by the US House of Representatives and the US Senate to each federal agency involved with NGI. Congressional committees held hearings to determine the level of funding. The House and Senate still must meet to decide the final funding, which will ultimately be signed into law by President Clinton. The final funds for NGI will not be approved until the end of August, 1997.

[18] Douglas Van Houweling, Vice Provost for Information Technology and Dean for Academic Outreach, University of Michigan, Testimony before the Subcommittee on Communications of the US Senate Committee on Commerce, Science, and Transportation, Hearing, 3 Jun 1997

Table 2: *Preliminary* Funding for the Next Generation Internet (Millions $) [19]

Agency	NGI Proposal	US House	US Senate
DOD	40	55	40
DOE	35	**0**	**0**
NASA	10	10	10
NIST	5	5	5
NSF	10	23	10

It's interesting to see that DOE received no funding for NGI from the House of Representatives or the Senate. While DOE received a $35 million cut, the funding for DOD increased by $15 million and NSF's funding increased by $13 million in the House. NIST and NASA received the original amount allocated by the NGI proposal. In the Senate all of the agencies originally involved with NGI received full funding, except DOE.

KEY CONFLICTS AND CONCERNS

The NGI Proposal is Underdeveloped

The Clinton Administration's NGI initiative is very new, originally dating back to October 1996. The creation of the Presidential Advisory Committee in February 1997 signaled the onset of NGI as a proposal. Clearly, it is time for the United States to move forward with Internet technology. While the concept of NGI is very timely, opponents claim that the proposal itself is underdeveloped. The concern centers around NGI's multi-agency nature, its unclear language, and its lack of clear objectives and metrics.

The authorization bills for FY1998 (Fiscal Year 1998) for NIST, NASA, NSF, DOD, and DOE included funding for NGI. To add to the mix, the National Institutes of Health (NIH), realizing the applications of telemedicine, recently joined the pursuit for a role in NGI. None of the FY1998 authorization legislation for NIH included NGI funding, however. While some of the agencies received NGI funding from Congress, others, like DOE, did not.

The House Committee on Science did not support NGI in many of its Committee hearings because they believed that it is a very underdeveloped proposal. Of the five

[19] Lori Perine, personal interview, 23 Jul 1997

agencies, the Science Committee reviewed authorizations for all agencies except DOD. The legislation that left committee specifically stated that no additional money is to be used to fund the NGI initiative.

Too Many Federal Agencies are Involved

Concern has arisen regarding the number of agencies involved with NGI. Altogether, there are six federal agencies currently involved. As Sen. Wyden (D-OR) stated in a June 3 hearing, NGI "seems to be strewn around the government."[20] Primarily, Congress is concerned that replication may occur between agencies under the current NGI plan.

The NCO will be responsible for the amount of replication that occurs with NGI. The NCO has proven that it can coordinate multi-agency programs, especially in the area of high performance communications. The High Performance Computing Act of 1991 established the NCO's role as a coordinator.

Lack of Controls and Metrics

Opponents of NGI have said that there are no clear objectives, goals, or metrics stated in the NGI concept paper. By law, the government now reviews the performance of federal agencies every year to determine if the programs are working. Opponents of NGI claim that it lacks clear goals and metrics. The process of measuring NGI's performance could become a very difficult task given these unclear goals.

Government Involvement and Corporate Welfare

The House of Representatives believes that NGI is better handled in the private sector than by the federal government. Critics view NGI as a form of corporate welfare. As stated previously, private industry will be involved with commercializing the NGI research. Under NGI, the research for these technologies will occur within government and university research facilities, in much the same manner as for the Internet. The Internet created many industries, and the next Internet will be able to do the same.

The fact that an Internet industry exists now is the difference between the first Internet and the next Internet. One would tend to think that a billion dollar industry should have the capability to conduct research that is similar to that done by researchers in government and academia. According to its opponents, the research for new Internet capabilities ought to occur within business because new business and huge amounts of revenue will result from NGI.

---

[20] George Leopald, "Internet Upgrade Hits Budget, Political Obstacles," Electronic Engineering Times, (9 Jun 1997): 18

On the other hand, proponents of NGI and Internet2 both contend that government support is critical. The success of NGI will play a role in how fast the new Internet technologies and applications arrive.[21]

First, and foremost, no one firm can capture the benefits that will result from NGI.[22] The nature of Research and Development (R&D), especially basic research, implies that it is impossible to foresee the new advances that result from the research. Therefore, no business will take the lead in this instance.

The NGI Concept Paper points out that the Federal government needs NGI "because critical federal missions require a next generation Internet for their success." This statement defines the federal government's role in NGI. When the ARPANET was created in 1969, it was a federal mission to ensure communication in the event of a nuclear war. Similarly, NGI has a federal mission. Through developing new technologies and applications, NGI will facilitate the speed at which critical federal missions occur.

For an example, a national security application for NGI involves "battlefield awareness." An area of a battlefield could be surveyed for enemies. A large file results from such a survey. A commander, located at a remote site, would be able to receive the information in a matter of minutes instead of hours. Or, consider how NGI technology could assist disaster response in an event like Hurricane Andrew. Clearly, NGI funds the research that will facilitate important federal missions.

Moreover, it is traditionally the government's role to support basic R&D and spread its benefits to others. As John Gibbons, Director of the Office of Science and Technology Policy stated, "The government's primary role is to support research that is common to our heritage and to ensure that markets operate efficiently, and fairly, so that private innovation can prosper."[23] Certainly, government, industry and academia should benefit from the research for NGI. This would aid the proliferation of new technology. The best format for this to occur is probably a partnership between government, industry, and academia.

---

[21] Mike Roberts, Project Director of Internet2, personal interview, 16 Jul 1996

[22] "Background on Clinton-Gore Administration's Next Generation Internet Initiative" 4

[23] "Remarks of The Honorable John H. Gibbons, Assistant to the President for Science and Technology to the Presidential Advisory Committee for High-Performance Computing and Communications, Information Technology and the Next Generation Internet," World Wide Web Page, http://www.whitehouse.gov/WH/EOP/OSTP/director/022797speech.html, 27 Feb 1997

IEEE (The Institute of Electrical and Electronics Engineers) reports that for every federal dollar invested in the original Internet, private sectors contributed twenty dollars to complete and operate the system.[24] Nobody could have anticipated this 20:1 (20 to 1) ratio. Yet, it became possible when government, industry, and academia worked together. Federal seed money has proved vital in the past, and proponents say that the NGI seed money will prove as vital in the future.

It is important to note that the Administration does not wish to fund the construction of the Information Superhighway. Rather, they would prefer to leave it to private industry.[25] The Telecommunications Act of 1996, which deregulated the telecommunications industry, has set the stage for competition in this area to occur.

Henry Kelly, Acting Associate Director for Technology in OSTP stated a final argument in his June 3 testimony. He said that the federal government has a "critical role in undertaking programs that encourage businesses to work together in developing common communications protocols and ensure interoperability competing systems."[26] Competition cannot guarantee interoperability. Interoperability ensures that systems will be able to communicate. The TCP/IP protocol used now found its base in the federal government.

Rural Universities Face Large Connection Costs

The issue of rural connectivity was first raised in the Communications Subcommittee of the Senate Committee on Commerce, Science, and Transportation on June 3, 1997. Rural state senators, notably Sen. Conrad Burns (R- MT), Sen. Ron Wyden (D- OR), and Sen. Ted Stevens (R- AK), felt that NGI favored urban areas, such as California. They argued that NGI was not representative of the entire research community.

The vBNS is mainly being overlain on the existing infrastructure that resulted from the growth of the telecommunications industry.[27] Often times, telecommunications monopolies occurred in rural areas. These areas traditionally represent high costs to the telecommunications industry due to their low-population, remote locations. The network's *GigaPops* (connection areas to the vBNS, numbering about 20) are occurring in areas that are distant from several of the Internet2 rural universities. Just

[24] Position Statement "Next Generation Internet", The Institute of Electrical and Electronic Engineers, Inc. - United States Activities (9 Jul 1997 DRAFT)
[25] "Background on the Clinton-Gore Administration's Next Generation Internet Initiative" 5
[26] Henry C. Kelly, Acting Associate Director for OSTP, Testimony before Subcommittee on Communications of the Senate Committee on Commerce, Science and Transportation, Hearing, 3 Jun 1997
[27] Sue Fedor, personal interview, 15 Jul 1997

as before, rural areas will face high connection costs.

Bonnie Neas outlined the problem faced by North Dakota in her testimony at the June 3 hearing. North Dakota, which is a member of the EPSCoR (Experimental Program to Stimulate Competitive Research) alliance, has joined forces with 6 other EPSCoR states in the NSF-EPSCoR Great Plains Network proposal. North Dakota was hopeful that this network of 6 states would attract low prices from telecommunications carriers. However, there is a 1.6 million mile shortage of fiber optic cable. The three leading long distance carriers told the "distance disadvantaged" states that they would have to pay the high installation costs to acquire any high speed service. In addition, to meet the Internet2 and Great Plains Network obligations, their Internet connectivity prices will increase from $150,000 per year to $400,000 per year.[28]

Dr. Gwen Jacobs, an assistant biology professor at Montana State University (MSU), testified about the difficulties seen in Montana. She described the rural states' views very well, noting, "Unless steps are taken to enhance Internet connectivity to rural states, this [technological] gap will widen even further, and the researchers, students, and citizens of these states will soon find themselves shut out of the great scientific adventures, challenges and opportunities facing us as we enter the next century."[29]

She went on to note that the Internet is becoming increasingly important to researchers, and that researchers at rural facilities are disadvantaged. The Internet can allow for access to scientific databases, to colleagues engaging in similar research, and to advanced research tools located at other universities and laboratories. To make long distance research worthwhile, high speed connections must be in place. Dr. Jacobs noted that without the high speed connection "a typical sequence of movements of the specimen that would take five minutes from Cal Tech [California Institute of Technology] might require up to 150 hours at MSU!" In this case, the analysis would occur by telemicroscopy at San Diego's National Center for Microscopy and Imaging Research facility. Researchers at the California Institute of Technology would be at an obvious advantage here.

Such testimony led the rural state senators to state the following remarks regarding NGI:

- NGI represents "yet another widening of the gap between have and have-nots." (Sen. Wyden)
- "I think we need the project, but unless efforts are made...to make it more representative, Congress won't fund this project." (Sen. Wyden)

[28] Bonnie Neas, Director, Information Technology Services, North Dakota State University, Testimony before the Subcommittee on Communications of the US Senate Committee on Commerce, Science and Transportation, Hearing, 3 Jun 1997

[29] Gwen Jacobs, Assistant Professor, Department of Biology and Co- Director, Center for Computational Biology, Montana State University, Testimony before the Subcommittee on Communications of the US Senate Committee on Commerce Science and Transportation, Hearing, 3 Jun 1997

- "You ought to go back to the drawing board." (Sen. Stevens)

On May 28, a letter was sent to John Gibbons, Director of OSTP, which voiced the senators' complaint that 11 of the 20 members of the Presidential Advisory Committee hail from California.[30]

[30] Leopald 18

In the meantime, proponents of NGI have responded to the rural issue by sticking with the plan as originally stated. They believe that a lack of communication exists between them and the senators. Indeed, this seems to be the case. As Neal Lane, Director of the National Science Foundation pointed out at the June 3 meeting, NGI is not an infrastructure project, but "a work-in-progress, an experiment, a testbed."[31]

It would seem that the main problem that the rural states have with NGI is that the vBNS is being used to connect Internet2 schools. However, Internet2 is a completely separate project, sponsored by universities and industry. As Mike Roberts, Director of the Internet2 project told me, the only link Internet2 has to the federal government is through NSF's High Performance Connections program.[32] NGI is suffering as a result of the Internet2 program that has been going on for tht paend is for telecommunications companies to merge to maximize their economic efficiency. Often times, these mergers do not increase consumer choice, but limit it in much the same fashion.

[31] "Internet: 'Next Generation Internet' funding Request Meets Opposition from Rural State Senators," Daily Report for Executives, World Wide Web Page, http://www.newsstand.lotus.com/der/3c106_2ea6e.html, 4 Jun 1997, 1

[32] Mike Roberts, personal interview, 16 Jul 1997