OFFICE OF TECHNOLOGY ASSESSMENT ■ U.S. CONGRESS

REPORT *brief*

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The testbed program is a useful model for network research

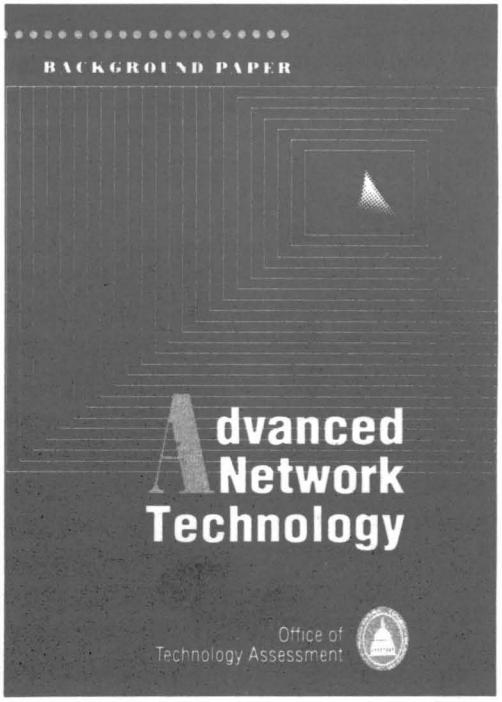
Researchers in industry and academe—with government support—are developing key technologies for tomorrow's information superhighways. These technologies are needed to realize the vision of a national network that permits high-performance communication of images, video, sound, and other kinds of information. A national network with these capabilities has the potential to change science, manufacturing, education, health care, and entertainment. The OTA background paper, **Advanced Network Technology**, describes current trends in communications technology and provides an overview of Federal programs that support communications technology research.

The most visible source of Federal funding for the development of new communications technologies is the High Performance Computing and Communications (HPCC) program. This 5-year program was authorized by the High Performance Computing Act of 1991. The HPCC program supports both research on advanced network technology and the deployment of the technology in a National Research and Education Network (NREN). In addition to its primary role as a communications infrastructure for the research and education community, the NREN will be used to test and demonstrate advanced network technologies before they are more widely deployed.

The network technology research component of the HPCC program funds the development of six testbeds—prototype networks that will be used to test new concepts in network design. These networks are to transmit data at speeds of 1 "gigabit" per second, over 20 times faster than today's most capable networks. The testbeds' research will help develop technologies that can meet the objectives of the High Performance Computing Act of 1991, which specified that the NREN should operate at gigabit speeds by 1996, to the extent technically possible. The testbed program is administered jointly by the National Science Foundation and the Advanced Research Projects Agency of the Department of Defense.

ADVANCED NETWORK RESEARCH

- Successful development of advanced networks requires that individual components such as transmission equipment be improved and that these components be effectively integrated. The testbeds are focusing on combining the newly developed



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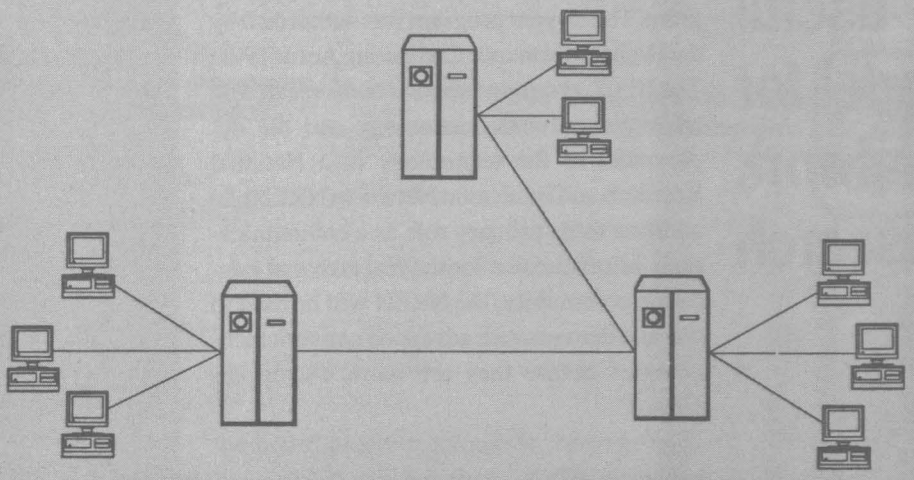
KEY NETWORK TECHNOLOGIES

- **Applications Software:** New kinds of applications will be enabled by advances in computer and network technology. High-resolution displays, increased computer processing power, and broadband network technology permit a shift to "multimedia" applications that work with images and video, not just text and numerical data. Multimedia applications have been suggested for several areas, including health care, education, and entertainment.
- **Computers:** Many different kinds of computers will be connected to the NREN, ranging from desktop personal computers to supercomputers. The testbeds are investigating a concept called "distributed supercomputing," in which a high-speed network is used to link several supercomputers. Their combined processing power can then be used to tackle scientific problems that would take too long to solve with a single supercomputer.
- **Links:** A key component of high-bandwidth networks is fiber optic transmission technology. The transmission equipment required for the "gigabit" NREN no longer presents any true research issues and is becoming available commercially. This equipment conforms to a new family of fiber optic transmission standards called Synchronous Optical Network (SONET).
- **Switches:** Switches are used to direct messages from one link to another as they travel through the network. A new technology called "fast packet switching" will allow future networks to handle voice, data, and video services. Today's switching technologies are less suited for multimedia applications because they do not handle all types of services equally well. The most prominent kind of fast packet switching technology is called Asynchronous Transfer Mode (ATM).



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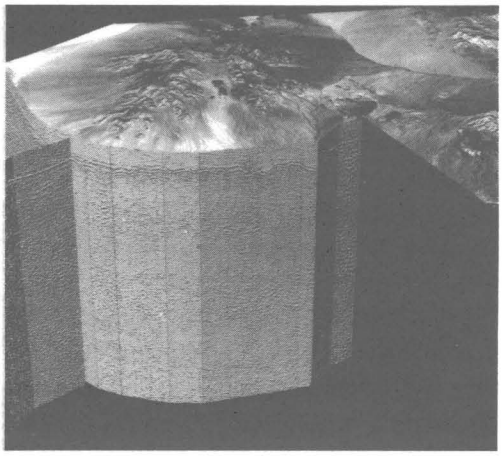
components into a working network. Several research issues can only be addressed by building a realistic test network and trying different approaches.

- Significant progress has been made toward the development of the components needed for the gigabit-speed NREN. There has been growing consensus within the technical community on many issues, such as the design of high-performance switches. The telecommunications and computer industries have made rapid progress in building advanced transmission equipment, switches, and other network components.
- The testbed networks are being constructed as a collaborative effort of industry, universities, and Federal laboratories. Most of the cost of building the networks has been borne by industry, in the form of contributions of prototype equipment and personnel. The relatively modest amount of Federal funding has been primarily used to organize the testbed program and to encourage the involvement of university researchers.
- The testbeds have established a useful model for network research. The organization of the testbeds as a collaborative effort of government, academic, and industry groups is essential, because of the many disciplines required to build and test a network. Moreover, the participants in the testbed research will be in a position to play important roles when the new technologies are deployed in production networks.
- Progress on the testbeds has been slower than expected. The networks are only now becoming operational; most of the major research results are still to come. Delays have been due in part to technical problems and in part to business decisions made by the industrial partners. The testbed research agenda overlaps with industry priorities in some areas and not in others.



Supercomputers linked by advanced networks can create three-dimensional views.

APPLICATION OF TESTBED RESEARCH

- One of the first applications of the testbed research will be in the National Research and Education Network. The NREN program will upgrade federally supported networks such as the National Science Foundation's NSFNET, the Department of Energy's Energy Sciences Network, and the National Aeronautics and Space Administration's NASA Science Internet. During 1992, DOE, NASA, and NSF published plans for the future development of their networks.
- The Federal agencies' plans for the future development of their networks are consistent with the testbed research. Initially, the agency networks will operate at lower bandwidths than the testbed networks, but they will incorporate more of the testbed

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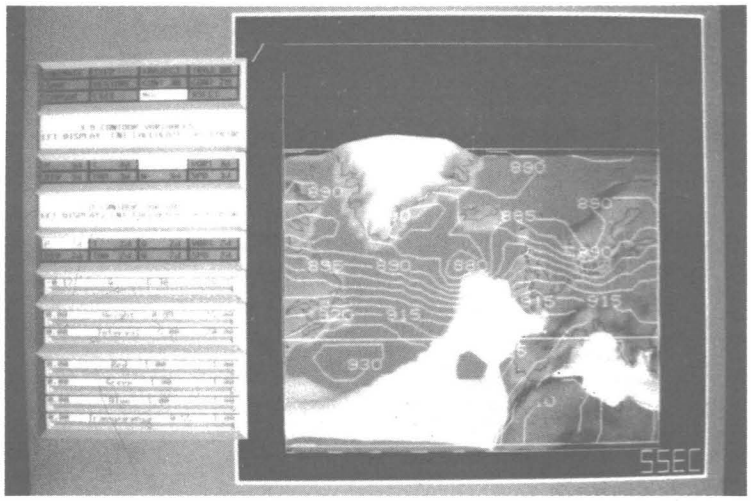

A "control panel" allows scientists to select the displayed data.

technologies as they evolve over time to meet the goal of the gigabit NREN.

- The rate of evolution of the Federal networks is less dependent on technology issues than on delays in the process by which the Federal agencies select contractors to operate their networks. Because of the commercial importance of networking, there have been several disputes over the agency plans and agency choices of suppliers.
- The testbed research will also be applied to networks other than the NREN. The testbed networks reflect ideas that figure prominently in industry plans for commercial networks and, wherever possible, use equipment that conforms to emerging standards.

Copies of the report for congressional use are available by calling 4-9241.

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