Designs on a National Research Network

Major upgrading of existing computer networks urged as part of strategy on high-performance computing

RESEARCHERS using the National Science Foundation's data communication network (NSFnet) will soon have entree to data bases and supercomputers at National Aeronautics and Space Administration laboratories. The new NSF-NASA agreement marks another step toward creation of the full-blown national research network advocated by federal science agencies.

The distance to that goal remains substantial. A new report* on high-performance computing from the White House Office of Science and Technology Policy (OSTP) laments that current U.S. networks "have low capacity, are overloaded, and fail to interoperate successfully." It goes on to say that "the networks, which in the 1970s had significant impact in enabling collaboration, are now barriers." The report finds that "Europe and Japan are aggressively moving ahead of the U.S. in a variety of networking areas with the support of concentrated government and industry research and implementation programs."

Invoking the cause of national competitiveness, the report done by an interagency task force urges development of a high-speed research network as part of a broad strategy for cooperative action by government, industry, and academia on high performance computing. The report was prompted by a request from Congress for information on the needs of networks for research computers. The scope of the report was broadened, says President Reagan's science adviser William R. Graham, director of OSTP, because addressing the networking problem alone would have meant ignoring crucial, interrelated issues.

Research networks were pioneered in the 1960s by the Defense Advanced Projects Research Agency. A main function of its trailblazing ARPANET was to give researchers access to the scattered mainframes that offered high-speed computing in that day, but it also opened the way for rapid exchanges of information and for a kind of collaboration on research by scientists heretofore impossible.

The pattern has been for federal science agencies to create special-purpose networks to support their missions. The Department of Energy (DOE), for example, established the magnetic fusion energy network (MFENET) and high-energy physics network (HEPnet) to serve researchers in those two specialties.

As research networks proliferated, it became clear that the same community of users was involved and that interconnecting the networks would improve efficiency and reduce cost. The main complaints now are that the transmission speeds are too low to handle data from supercomputers.

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David B. Nelson, executive director of energy research at DOE, says that as supercomputers get bigger, the volume of data to be transmitted grows enormously and problems arise. The best way to understand what a supercomputer is doing, he says, is not to look at a flood of numerical data but at a graphical representation, a "picture" of the data. But to deliver a picture "takes a lot of bits," says Nelson, more than current networks can accommodate.

Networks open the possibility of a new dimension of research cooperation by transmission during experiments of large data sets for remote analysis. In some physics experiments, for example, it is essential to look at data as it is being produced in order to modify experiments in progress. But such interaction exceeds the current capacity of networks.

Networks today typically transmit digital information at a speed of 56,000 bits of data per second. NSF has announced a plan to expand and upgrade its NSFnet, which connects the foundation's five supercomputer centers and the National Center for Atmospheric Research with seven regional academic research networks, to 1.5 megabits a second (Mb/sec), some 20 to 30 times faster than the present system permits. The report estimates the bandwidth required to transmit a high-resolution color image routinely at 1 billion bits a second or 1 gigabit (Gb/sec). The OSTP report proposes development of a high-speed network with a 3 Gb/sec capability within 15 years.

It is agreed that such speeds can be attained only by use of optical fiber lines that employ light rather than electrical impulses in transmission. In addition to communication links, the essentials of a network are "gateways," the computers that give local and regional networks access to the larger system, and "protocols," the instructions that enable the network to operate. The leap to the high-speed network envisioned will require a sustained R&D effort on both hardware and software.

The report proposes that work toward a national network go in three stages: (i) Upgrade existing networks and establish better interconnections. (ii) Expand existing networks to give 200 to 300 U.S. research institutions access to data communications at 1.5 Mb/sec. (iii) Develop hardware and software for a national research network operating at 3 Gb/sec. within 15 years.

The federal government currently spends about $500 million a year on all aspects of high-performance computing. The bill for implementing the report would come to an additional $140 million the first year, rising to an extra $545 million in 5 years. Within the current $500 million total, funds for networking amount to $50 million a year. Additional funding to develop a national research network is estimated at $50 million in the first year rising to $95 million in the fifth. Graham says that for the fiscal year 1989 budget cycle, funding would have to be "osmotic," that is, shifted from funds already in agency budgets, with direct funding coming in later years.

In its favor, the grand design for a national research network enjoys the interest of Congress and an apparent consensus among science agencies on what should be done and how. An interagency task force, evidently convinced of the cost-effectiveness of the plan, showed a unanimity unusual when serious cost-sharing is under discussion.

For users, a full-service national research network would significantly widen scientific horizons, but their pleasure at the prospect is unlikely to be totally unalloyed. Until now, sponsoring agencies have borne the major share of creating and operating the major networks. In future, researchers will be asked to assume more of a share of the costs. ■ JOHN WALSH

*"A Research & Development Strategy for High Performance Computing"