

proposed biomedical research program on small satellites, called Lifesat, was killed outright. CRAF-Casini, the long-delayed pair of robot observers that would hurtle alongside a comet and pay a visit to Saturn was saved, but at a price: Congress directed NASA to coax Germany to help finance the launch. Still, the project will be delayed. So too will the advanced x-ray telescope, or AXAF, which was given \$60 million less than requested. The Earth Observing System will go forward as part of the NASA's global climate and resources program, but its timetable will be stretched, while its ceiling of \$11 billion will remain steady through the end of the decade.

At the same time members of the House and Senate Appropriations committees enfeebled NASA's research programs, claiming lack of funds, they injected more than a dozen unsolicited projects of their own, amounting to \$137 million, into the budget bill. These earmarked pork projects were savaged in speeches by George Brown Jr, a California Democrat who heads the House Committee on Science, Space and Technology, and the committee's senior Republican, Robert Walker of Pennsylvania. The pork projects "were never requested by the Administration, never authorized and never discussed on the floor," declared Brown.

By contrast, NSF had an unexpected windfall. The research agency had

faced a loss of \$105 million if it had to pay for logistical support and environmental cleanup at its Antarctic bases. Congress proposed that the Defense Department foot the bill to cover the Navy's use and abuse of those facilities. OMB opposed the idea because it would mean removing the caps of the 1990 budget agreement, which forbids shifting funds between the defense side and the discretionary domestic side of the budget. To force the issue, the House-Senate conference committee argued that the Pentagon should pay the tab, and OMB gave in to the demand.

Congress exacted an even larger payout from the Pentagon's budget. On 23 November, with Congress impatient to end the session and go home for Thanksgiving, the Senate passed the \$291 billion defense appropriations bill. But in doing this, senators had to endure a scolding from Sam Nunn, the Georgia Democrat who heads the Armed Services Committee, and the committee's ranking Republican, John W. Warner of Virginia. Both objected to the \$3.3 billion worth of pork-barrel projects in the defense bill that had not been authorized by their committee. Nunn specifically attacked \$12 million earmarked for military museums and \$94.6 million set aside for research at universities in 12 states. He objected to members of the Senate Appropriations committee grabbing slabs of pork from defense funds in violation

of statutory requirements and informal agreements adopted in 1990 to prevent such shenanigans.

Pork also was on the menu of the DOE budget bill. Members of the House-Senate conference committee sliced nearly \$90 million in research funds from the agency's accounts—specifically, \$44.5 million from basic energy sciences, \$41.5 from health and environmental research, and another \$4.5 from other programs. Unlike Congress's earmarking practices in previous years, when DOE had to eat the pork, the lawmakers decided to add sufficient money to cover their own largess. As in most other cases of earmarking, the money went to universities and medical centers.

Congress's taste for pork appears to be increasing as universities and other institutions find fund-raising more dicey in these times of economic recession. Deploring earmarking at a press briefing on 25 October, Congressman Brown stated that "meritorious projects are going begging" because of the practice. As evidence of the magnitude of the problem, he released a report his committee had commissioned from the Congressional Research Service showing that earmarks for academe had gone up from \$270 million in fiscal 1989 to \$500 million in fiscal 1991. With the pile of pork in this year's budget, Congress will surely get into the *Guinness Book of World Records*.

—IRWIN GOODWIN

BUSH SIGNS ACT LINKING COLLEGES, LABS AND BUSINESSES BY COMPUTERS

Before signing the High Performance Computing Act of 1991 (P. L. 102-194) in the Roosevelt Room of the White House on 10 December, President Bush spoke of its "potential to transform radically the way in which all Americans will work, learn and communicate in the future. It holds the promise of changing society as much as the other great inventions of the 20th century, including the telephone, air travel, and radio and TV." Not even the hyperbole in the President's script can disguise the significance of the new legislation. The implications of the act include the acceleration of the commercial development of the next generation of supercomputers and the creation of a nationwide network that would allow them to communicate with workstations in universities, industry and national laboratories at speeds and capacities now unattainable.

The Administration, Congress, computer makers and communications carriers all believe the cost of the program will be worth the benefits. Those likely to benefit first are mathematical modelers, physicists and biochemists. Testifying on the bill before the House Science, Space and Technology Committee last year, Sheryl Handler, president of Thinking Machines Corporation, observed that supercomputers and their networks will enable researchers to "shrink oceans, zoom in on molecules and galaxies, slow down physics experiments and fast-forward global climates." The larger social and economic benefits will appear more slowly, though government and academic forecasts hold that these are sure to come when the entire data network reaches all businesses, libraries, schools and homes in the nation. That achievement should carry an imposing price tag of more

than \$200 billion, most of it from commercial firms.

Though Bush gave his Administration all the credit for the project at his signing ceremony, where he was surrounded by Cabinet officials, agency heads and computer company executives, the program owes much to Congress, which has been pushing hard to achieve what Senator Albert Gore Jr, a Tennessee Democrat and one of the first true believers in the concept, likes to call an "information superhighway." When the proposed data network is completed in 1996, says Gore, it "will be the prototype for an infrastructure that will be as ubiquitous and easy to use as the phone system is today, and probably not much more expensive."

The House and Senate passed separate bills last year for similar computer networks but disagreed with each other and with the White House on

how the system would be managed. The House wanted the project to be run by the National Science Foundation, which now operates NSFNet, a digital system that connects its four supercomputer centers with regional networks and into hundreds of universities and laboratories at speeds of 1.544 megabits per second in the US and bursts of 2.048 megabits in some European countries. The Senate Energy and Natural Resources Committee, however, fought for the Department of Energy, with its MFENet for magnetic fusion researchers, to be the lead agency. This year the House again designated NSF as the program manager, while the Senate preferred that the President decide who would run the show. Worried that Japan might succeed in supplying supercomputers, fiberoptic cables or other components to the project, some House members inserted a "buy American" proviso into their version of the bill (see box on page 55). Under the threat of a Presidential veto, both bodies agreed that the final bill would give the White House the job of overseeing the operation through its Office of Science and Technology Policy, headed by D. Allan Bromley.

The act provides for a "coordinated Federal program to ensure continued US leadership in high-performance computing... as vital to the prosperity, national and economic security, industrial productivity, engineering and scientific advancement." A key component is a high-capacity and high-speed National Research and Education Network. The act authorizes R&D funds for NREN to rise steadily over the next five years to almost \$1 billion by fiscal 1996. The goal for that year is to have more than 1 million computers linked.

The act mandates four related programs: computer hardware and systems, software technology and algorithms, NREN, and basic research and human resources. The hardware program seeks a thousandfold improvement in computing capacity, to 1 trillion operations per second—a goal considered unduly ambitious when set in 1989 but now deemed attainable with recent developments in parallel processing, electronic switching and multichannel optical interconnects. Software has usually been a limiting factor in the use of supercomputers by most researchers other than those programming maven who write elaborate codes for problems in, say, nuclear weaponry, theoretical physics, aerodynamic designs and climate modeling. So the aim of the software program is to devise "user friendly" software for

Opposed by Congress, Fujitsu Withdraws Supercomputer

Reacting quickly to opposition from Washington, Fujitsu Ltd withdrew its offer to donate a \$17 million supercomputer to an international consortium of scientists who had negotiated to use the machine at the National Center for Atmospheric Research in Boulder, Colorado. The machine would have been used to produce models and perform research on global climate problems.

The incident is the latest in a politically sensitive contretemps over how far the US government should go to protect the interests of the nation's supercomputer industry. Japan's supercomputer makers have sold few of their machines in the US, mainly because national laboratories and universities are either compelled or coaxed to "buy American." This practice has placed US officials in an awkward position in light of a 1987 US-Japan agreement that provides for more open bidding in Japan's own supercomputer market. US trade representatives demanded the accord in response to complaints from American manufacturers that they had been excluded from bidding on Japanese government contracts.

Fujitsu's fiasco was another instance in which Japan's supercomputer producers have attempted to show that their machines are faster number crunchers than Crays or Connection Machines and thereby to gain acceptance among scientists and engineers. In 1987 MIT was ready to lease an NEC supercomputer at an attractive price, but the US Commerce Department, worried that Japan was "dumping" the machine, pressured university officials to cancel the deal. Last year NEC Corporation lodged a protest with the Commerce Department after it was kept from bidding on a supercomputer contract with NASA's Ames Research Center. NEC was subsequently permitted to enter the bidding, along with Hitachi and Fujitsu. All three are also bidding for other contracts with NASA and the Department of Energy.

In the past two years some Japanese supercomputers have exceeded Crays in test runs called benchmarks. But these machines can be tuned to score high in such tests, and American experts such as Jack Dongarra of the University of Tennessee and Oak Ridge National Laboratory stress that benchmarks don't really show how a machine will work day in and day out. Moreover, US supercomputers have more sophisticated software. Although a few customers, including Lawrence Livermore and NASA's Jet Propulsion Lab, can write their own programs for specific problems, most want proven software for designing aircraft, pharmaceuticals or composite materials.

When the High Performance Computing Act was going through the House last spring, some members wanted to make sure that no Federal agency would buy a foreign supercomputer or component under the legislation. After the White House threatened to veto the measure over this provision, the House removed it. Still, the Fujitsu offer was protested by the House majority leader, Richard A. Gephardt of Missouri, who wrote both the Japanese embassy and President Bush's science adviser, D. Allan Bromley. In his letters Gephardt cited "continued trends in unfair pricing practices, including heavy discounting and outright donations," by Japan's supercomputing firms.

Asked about Fujitsu's decision to drop the offer, Richard Anthes, president of the University Corporation for Atmospheric Research, which manages NCAR, said the company "felt the political heat." He said that the scientific group for whom the machine was intended, known as the Model Evaluation Consortium for Climate Evaluation and representing organizations in the US, France, Italy and Japan, was "very disappointed" by the opposition. "Here was a donation," he said, "that would have advanced scientific understanding and collaboration in global climate change."

—IRWIN GOODWIN

researchers in other fields seeking, for instance, to understand the behavior of complex materials and organic molecules, to design new pharmaceutical compounds and to predict particle masses with lattice gauge theory.

NREN is seen as the next generation in science data networks. The mother of them all was ARPAnet, conceived in the late 1960s for use by a small community of computer whizzes and academic researchers under contract to the Defense Department. The

largest system today is Internet, consisting of more than 5000 unclassified, interconnected data networks, including NSFNet and Bitnet. When NREN is turned on it will probably operate at NSFNet's upgrade of 45 megabits per second. Considering the pace of advances in computers and networks, by the turn of the century NREN should be capable of transmitting information at speeds of between 1 and 3 gigabits per second—about 50 000 single-spaced typed pages each second.

One of the implications of NREN is that a corps of trained people will be needed to expand the base of R&D in computational science and technology as well as to maintain and operate the network.

The act provides for eight Federal agencies to develop the program under the aegis of the director of OSTP, whose primary task may be to avoid turf wars. The concept of the supercomputer network originated in 1982 at OSTP, when George Keyworth II was director. He got the Federal Coordinating Committee for Science, Education and Technology to study how the government might advance supercomputing. In 1985 FCCSET declared that government participation was essential if the US is to hold its technological supremacy in the development and use of supercomputers. Another FCCSET report, "Grand Challenges: High Performance Computing and Communications," was adopted by President Bush to justify the project as an R&D initiative for fiscal 1992.

Fearing an industrial policy

Bush's 1992 budget asked for a 30% increase in funding high-performance computing and communications—up to \$638 million from \$489 million last year. Though Bromley immediately saw the wisdom of the concept, others in the White House feared it was an attempt to create "industrial policy"—something the Bush Administration considers anathema. Bromley argued that it would be an R&D investment into generic, precompetitive technology—a policy the Administration endorses (see PHYSICS TODAY, December 1990, page 54).

The new act authorizes the eight agencies to spend \$616.5 million this year as follows: NSF gets \$201 million; NASA, \$72 million; DOE, \$92 million; the National Institute of Standards and Technology, \$3 million; the National Oceanic and Atmospheric Administration, \$10 million; the Environmental Protection Agency, \$5 million; the Department of Education, \$1.5 million; and the Defense Department, \$232 million. Unlike the other agencies, the Defense Advanced Research Projects Agency will be expected to put its money into development projects that the act now speaks about in vague terms.

Bromley, the designated point man for the operation, championed it at Supercomputing '91, a conference of government and industrial computing experts that met in Albuquerque on 19 November. He cited an independent study of the economic potential of high-performance computing

and nationwide networking that predicted these technologies would add somewhere between \$170 billion and \$500 billion to the nation's GNP over the next decade. If this growth occurs, he said, "it will be because American companies, both large and small, are able to deploy the technologies that are developed to produce quality goods and services. The Administration is not going to select winners or losers in the marketplace by choosing specific industries to support specific technologies." The project, he observed, "represents a partnership among all sectors of our society to take full advantage of this transforming technology."

In remarks in the Senate on 22 November, Ernest Hollings, an ebullient South Carolina Democrat who heads the Committee on Commerce, Science and Education, gave credit for the legislation to Gore and to Representative George E. Brown Jr of California, chairman of the House Committee on Science, Space and Technology. Hollings also lauded Paul G. Huray, senior vice president for research at the University of South Carolina, who, while working for OSTP, spearheaded the project by heading an interagency committee that sent an enthusiastic report to Congress in 1987.

Senator Malcolm Wallop, a Montana Republican who is the senior minority member of the Committee on Energy and Natural Resources, reminded his colleagues that the measure before them was important because the US preeminence in computer technology "is now being challenged by foreign competitors and it won't exist much longer if we do not take action. . . . It is important that the executive branch develop and implement, through this generic authorizing legislation, an appropriate Federal role in the promotion of high-performance computing and networking. Failure to do so would weaken our defense posture, it would weaken our competitive edge in the international marketplace, and it would weaken our ability to achieve scientific advancements ahead of our international competitors. That would clearly be unacceptable." Wallop stated that the issues are so critical that Congress decided to designate no single agency to lead the program, but to place the responsibility squarely on the President's doorstep.

Still, some in Congress caution that the OSTP director, as the program's coordinator, should not micromanage it or become a czar of a supercomputing network. "The director facilitates; he does not dictate," Hollings

informed his Senate colleagues.

The problems raised by the program have been studied by the Government Accounting Office, which has issued reports arguing that important questions need to be cleared up about NREN's technology, security, management and funding. Ken Allen, senior vice president of the Information Industry Association, says: "At the moment NREN is the apocryphal story of several blind men studying the elephant: Each one had a different vision of what the elephant really looked like."

Seeking solutions for society

It was just a matter of time before the industry made itself heard. In a report issued on 3 December, the Computer Systems Policy Project, representing the chief executives of 12 big US computer companies, urges that the program's priorities be re-ordered to achieve what it termed a "world class" high-performance computing and communications infrastructure. The companies were Apple, AT&T, Compaq, Control Data, Cray Research, Data General, Digital Equipment, Hewlett-Packard, IBM, Sun Microsystems, Tandem and Unisys. The putative aim of the business leaders is to widen the program's vision. Thus, says their report, the focus of the program's research should be on multiple hardware and software configurations across a broad performance range from high-performance workstations to parallel vector, heterogeneous and massively parallel systems. The company bosses ask for an increase in the funding for software research, which, at \$279 million this year, is already the top award for any part of the program. Their report also calls for "a balance between advancing key technologies and applying those technologies to solve complex problems affecting our society," such as delivering better health care to the poor, disabled and elderly; improving manufacturing productivity; and providing lifelong learning for all.

The executives had hoped to have an agreement worked out between their companies and DOE's national laboratories for a cooperative R&D effort in computing and communications by the time they came to Bush's signing ceremony. But they found themselves hung up on patent, copyright and product liability issues. The problems, said one CEO, may be "an omen of how hard it will be to develop a partnership of commercial and government interests in a well-intentioned, high-purpose program."

—IRWIN GOODWIN ■