

Appendix A

Supercomputer Centers

The National Supercomputer Centers

In February 1985, National Science Foundation (NSF) selected four sites to establish national supercomputing centers: Cornell University, the University of Illinois at Urbana-Champaign, the University of California at San Diego, and the John von Neumann Center in Princeton. A fifth site, Pittsburgh, was added in early 1986. Funding for Princeton's Von Neumann Center was later dropped. The four remaining NSF centers are described briefly below.

The Cornell Theory Center

The Cornell Theory Center is located on the campus of Cornell University. Over 1,900 users from 125 institutions access the center. Although Cornell does not have a center-oriented network, 55 academic institutions are able to utilize the resources at Cornell through special nodes. A 14-member Corporate Research Institute works within the center in a variety of university-industry cost-sharing projects.

In November 1985 Cornell received a 3084 computer from IBM, which was upgraded to a four-processor 3090/400VF a year later. The 3090/400VF was replaced by a six-processor 3090/600E in May 1987. In October 1988 a second 3090/600E was added. The Cornell Center also operates several other smaller parallel systems, including an Intel iPCS/2, a Transtech NT 1000, and a Topologix T1000. Some 50 percent of the resources of Northeast Parallel Architecture Center, which include two Connection machines, an Encore, and an Alliant FX/80, are accessed by the Cornell facility.

Until October 1988, all IBM computers were "on loan" to Cornell for as long as Cornell retained its NSF funding. The second IBM 3090/600, procured in October, will be paid for by a NSF grant. Over the past 4 years, corporate support for the Cornell facility accounted for 48 percent of the operating costs. During those same years, NSF and New York State accounted for 37 percent and 5 percent, respectively, of the facility's budget. This funding has allowed the center to maintain a staff of about 100."

The National Center for Supercomputing Applications

The National Center for Supercomputing Applications (NCSA) is operated by the University of Illinois at Urbana-Champaign. The center has over 2,500 academic users from about 82 academic affiliates. Each affiliate receives a block grant of time on the Cray X-MP/48, training for the Cray, and help using the network to access the Cray.

The NCSA received a Cray X-MP/24 in October 1985. That machine was upgraded to a Cray X-MP/48 in 1987. In October 1988 a Cray-2s/4-128 was installed, giving the center two Cray machines. This computer is the only Cray-2 now at a NSF national center. The center also houses a Connection Machine 2, an Alliant FX/80 and FX/8, and over 30 graphics workstations.

In addition to NSF funding, NCSA has solicited industrial support. Amoco, Eastman Kodak Eli Lilly, FMC Corp., Dow Chemicals, and Motorola have each contributed around \$3 million over a 3-year period to the NCSA. In fiscal year 1989 corporate support amounted to 11 percent of NCSA's funding. About 32 percent of NCSA's budget came from NSF, while the State of Illinois and the University of Illinois accounted for the remaining 27 of the center's \$21.5-million budget. The center has a full-time staff of 198.

Pittsburgh Supercomputing Center

The Pittsburgh Supercomputing Center (PSC) is run jointly by the University of Pittsburgh, Carnegie-Mellon University, and Westinghouse Electric Corp. More than 1,400 users from 44 States utilize the center. Twenty-seven universities are affiliated with PSC.

The center received a Cray X-MP/48 in March 1986. In December 1988 PSC became the first non-Federal laboratory to possess a Cray Y-MP. For a short time, both machines were being used simultaneously; however the center has now phased out the Cray X-MP. The center's graphics hardware includes a Pixar image computer, an Ardent Titan, and a Silicon Graphics IRIS workstation.

The operating projection at PSC for fiscal year 1990, a "typical year," has NSF supporting 58 percent of the center's budget while industry and vendors account for 22 percent of the costs. The Commonwealth of Pennsylvania and the National Institutes of Health both support PSC, accounting for 8 percent and 4 percent of budget respectively. Excluding working students, the center has a staff of around 65.

San Diego Supercomputer Center

The San Diego Supercomputer Center (SDSC) is located on the campus of the University of California at San Diego and is operated by General Atomics. SDSC is linked to 25 consortium members but has a user base in 44 States. At the end of 1988, over 2,700 users were accessing the center. SDSC has 48 industrial partners who use the facility's hardware, software, and support staff.

A Cray X-MP/48 was installed in December 1985. SDSC's first upgrade, a Y-MP8/864, was planned for

December 1989. In addition to the Cray, SDSC has five Sun workstations, two IRIS workstations, an Evans and Sutherland terminal, five Apollo workstations, a Pixar, an Ardent Titan, an SCS-40 minisupercomputer, a Supertek S-1 minisupercomputer, and two Symbolics machines.

The University of California at San Diego spends more than \$250,000 a year on utilities and services for SDSC. For fiscal year 1990 the SDSC believes NSF will account for 47 percent of the center's operating budget. The State of California currently provides \$1.25 million per year to the center and in 1988 approved funding of \$6 million over 3 years to SDSC for research in scientific visualization. For fiscal year 1990 the State is projected to support 10 percent of the center's costs. Industrial support, which has given the center \$12.6 million in donations and in-kind services, is projected to provide 15 percent of the total costs of SDSC in fiscal year 1990.

Other High-Performance Computer Facilities

Before 1984 only three universities operated supercomputers: Purdue University, the University of Minnesota, and Colorado State University. The NSF supercomputing initiative established five new supercomputer centers that were nationally accessible. States and universities began funding their own supercomputer centers, both in response to growing needs on campus and to increased feeling on the part of State leaders that supercomputer facilities could be important stimuli to local R&D and, therefore, to economic development. Now, many State and university centers offer access to high-performance computers (HPC);¹ and the NSF centers are only part of a much larger HPC environment including nearly 70 Federal installations (see table A-1).

Supercomputer center operators perceive their roles in different ways. Some want to be a proactive force in the research community, leading the way by helping develop new applications, training users, and so on. Others are content to follow in the path that the NSF National Centers create. These differences in goals/missions lead to varied services and computer systems. Some centers are "cycle shops," offering computing time but minimal support staff. Other centers maintain a large support staff and offer consulting, training sessions, and even assistance with software development. Four representative centers are described below.

Minnesota Supercomputer Center

The Minnesota Supercomputer Center, originally part of the University of Minnesota, is a for-profit computer center owned by the University of Minnesota. Currently, several thousand researchers use the center, over 700 of which are from the University of Minnesota. The Minne-

Table A-1—Federal Unclassified Supercomputer Installations

Laboratory	Number of machines
Department of Energy:	
Los Alamos National Lab.	6
Livermore National Lab, NMFEC 4	
Livermore National Lab.	7
Sandia National Lab, Livermore 3	
Sandia National Lab, Albuquerque. 2	
Oak Ridge National Lab.	1
Idaho Falls National Engineering 1	
Argonne National Lab.	1
Knolls Atomic Power Lab.	1
Bettis Atomic Power Lab.	1
Savannah/DOE 1	
Richland/DOE	1
Schenectady Naval Reactors/DOE 2	
Pittsburgh Naval Reactors/DOE 2	
Department of Defense:	
Naval Research Lab.	1
Naval Ship R&D Center 1	
Fleet Numerical Oceanography 1	
Naval Underwater System Command 1	
Naval Weapons Center 1	
Martin Marietta/NTB 1	
Air Force Weapons Lab 2	
Air Force Global Weather 1	
Arnold Engineering and Development 1	
Wright Patterson AFB 1	
Aerospace Corp.	1
Army Ballistic Research Lab.	2
Army/Tacom 1	
Army/1-Huntsville 1	
Army/Kwajalein 1	
Army/WES (on order) 1	
Army/Warren 1	
Defense Nuclear Agency 1	
National Aeronautics and Space Administration:	
Ames 5	
Goddard 2	
Lewis 1	
Langley 1	
Marshall 1	
Department of Commerce:	
National Institute of Standards and Technology 1	
National Oceanic and Atmospheric Administration.	4
Environmental Protection Agency:	
Raleigh, North Carolina 1	
Department of Health and Human Services:	
National Institutes of Health 1	
National Cancer Institute.	1

SOURCE: Office of Technology Assessment estimate, September 1989.

sota Supercomputing Institute, an academic unit of the university, channels university usage by providing grants to the students through a peer review process.

¹The number cannot be estimated exactly. First, it depends on the definition of supercomputer one uses. Secondly, the number keeps changing as States announce new plans for centers and as large research universities purchase their own HPCs.

The Minnesota Supercomputer Center received its first machine, a Cray 1A, in September 1981. In mid-1985, it installed a Cyber 205; and in the latter part of that year, two Cray 2 computers were installed within 3 months of each other. Minnesota bought its third Cray 2, the only one in use now, at the end of 1988, just after it installed a ETA-10. The ETA-10 has recently been decommissioned due to the closure of ETA. A Cray X-MP has been added, giving the center a total of two supercomputers. The Minnesota Supercomputer Center has acquired more supercomputers than anyone outside the Federal Government.

The Minnesota State Legislature provides funds to the university for the purchasing of supercomputer time. Although the university buys a substantial portion of supercomputing time, the center has many industrial clients whose identities are proprietary, but they include representatives of the auto, aerospace, petroleum, and electronic industries. They are charged a fee for the use of the facility.

The Ohio Supercomputer Center

The Ohio Supercomputer Center (OSC) originated from a coalition of scientists in the State. The center, located on Ohio State University's campus, is connected to 20 other Ohio universities via the Ohio Academic Research Network (OARNET). As of January 1989, three private firms were using the center's resources.

In August 1987, OSC installed a Cray X-MP/24, which was upgraded to a Cray X-MP/28 a year later. In August 1989 the center replaced the X-MP with a Cray Research Y-MP. In addition to Cray hardware, there are 40 Sun Graphic workstations, a Pixar II, a Stallar Graphics machine, a Silicon Graphic workstation, and an Abekas Still Store machine. The center maintains a staff of about 35.

The Ohio General Assembly began tiding the center in the summer of 1987, appropriating \$7.5 million. In March 1988, the Assembly allocated \$22 million for the acquisition of a Cray Y-MP. Ohio State University has pledged \$8.2 million to augment the center's budget. As of February 1989 the State has spent \$37.7 million in funding.² OSC's annual budget is around \$6 million (not including the purchase/leasing of their Cray).

Center for High Performance Computing (CHPC)

The Center for High Performance Computing is located at the University of Texas at Austin. CHPC serves all 14 institutions, 8 academic institutions, and 6 health related organizations, in the University of Texas system.

The University of Texas installed a Cray X-MP/24 in March 1986, and a Cray 14se in November 1988. The

X-MP is used primarily for research. For now, the Cray 14se is being used as a vehicle for the conversion of users to the Unix system. About 40 people staff the center.

Original funding for the center and the Cray X-MP came from bonds and endowments from both the University of Texas system and the University of Texas at Austin. The annual budget of CHPC is about \$3 million. About 95 percent of the center's **operating budget** comes from State funding and endowments. Five percent of the costs are recovered from selling CPU time.

Alabama Supercomputer Network

The George C. Wallace Supercomputer Center, located in Huntsville, Alabama, serves the needs of researchers throughout Alabama. Through the Alabama Supercomputer Network, 13 Alabama institutions, university, and government sites are connected to the center. Under contract to the State, Boeing Computer Services provides the support staff and technical skills to operate the center. Support staff are located at each of the nodes to help facilitate the use of the supercomputer from remote sites.

A Cray X-MP/24 arrived in 1987 and became operational in early 1988. In 1987 the State of Alabama agreed to finance the center. The State allocated \$2.2 million for the center and \$38 million to Boeing Services for the initial 5 years. The average yearly budget is \$7 million. The center has a support staff of about 25.

Alabama universities are guaranteed 60 percent of the available time at no cost, while commercial researchers are charged a user fee. The impetus for the State to create a supercomputer center has been stated as the technical superiority a supercomputer would bring, which would draw high-tech industry to the State, enhance interaction between industry and the universities, and promote research and the associated educational programs within the university.

Commercial Labs

A few corporations, such as the Boeing Computer Corp., have been selling high performance computer time for a while. Boeing operates a Cray X-MP/14. Other commercial sellers of high performance computing time include the Houston Area Research Center (HARC). HARC operates the only Japanese supercomputer in America, the NEC SX2. The center offers remote services.

Computer Sciences Corp. (CSC), located in Falls Church, Virginia, has a 16-processor FLEX/32 from Flexible Computer Corp., a Convex 120 from Convex Computer Corp., and a DAP210 from Active Memory Technology. Federal agencies constitute two-thirds of

²Jane Ware, "Ohioans: Blazing Computer," *Ohio*, February 1989, p.12.

CSC's customers.³ Power Computing Co., located in Dallas, Texas, offers time on a Cray X-MP/24. Situated in Houston, Texas, Supercomputing Technology sells time

on its Cray X-MP/28. Opticom Corp., of San Jose California, offers time on a Cray X-MP/24, Cray I-M, Convex C220, and CI XP.

³Norris Parker Smith, "More Than Just Buying Cycles," *Supercomputer Review*, April 1989.