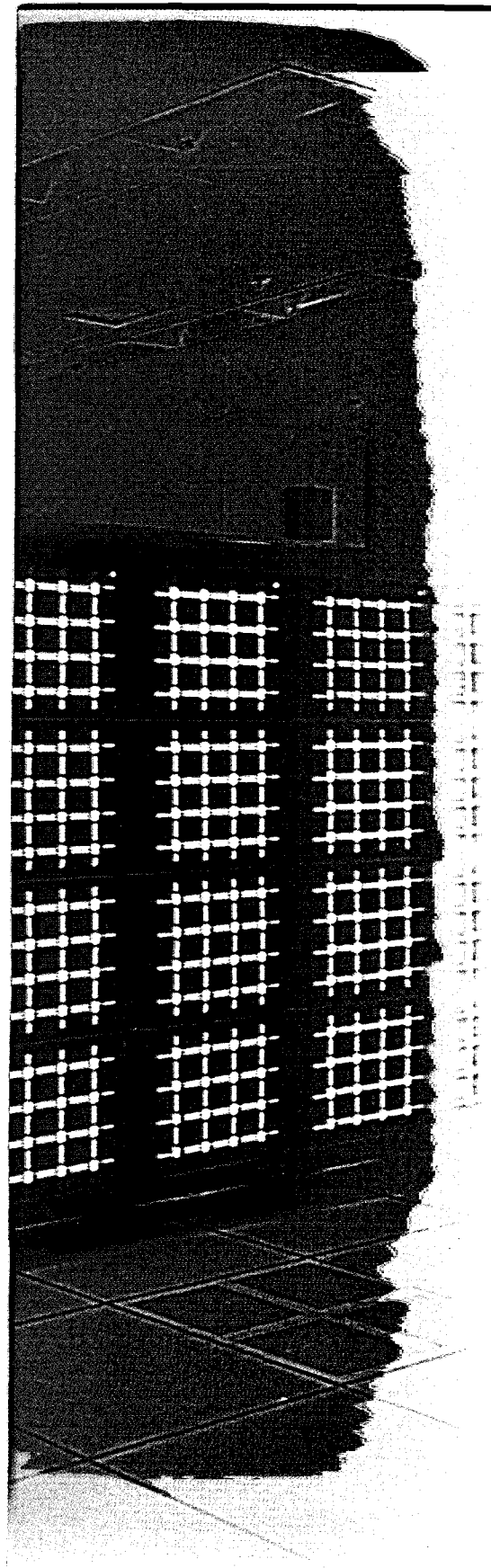

ORNL's Intel Paragon machine was the fastest supercomputer in the world in 1995.

HIGH-PERFORMANCE COMPUTING

Pushing the Limits

For 50 years ORNL has been a leader in advancing supercomputing. In 1954 an ORNL group led by Alston Householder partnered with Argonne National Laboratory to create a computer with the fastest speed and largest data storage capacity of any computer in the world. Called the Oak Ridge Automatic Computer and Logical Engine (ORACLE), this machine helped scientists solve problems in nuclear physics, radiation effects, and the development of shielding for the ill-fated nuclear aircraft project.

In the 1980s ORNL researchers made computational breakthroughs using a new "parallel computer," which harnessed several thousand processors working together to solve scientific problems. In 1995 ORNL obtained the Intel Paragon XP/S 150, a parallel supercomputer linking 3000 processors that was the fastest in the world at the time. It helped scientists predict climate change and develop groundwater movement models. Five years later, ORNL became the first Department of Energy laboratory to have a one-teraflop computer—that is, a machine capable of a trillion calculations per second. ORNL continued its progress with the purchase of an IBM system dubbed "Cheetah," the 8th fastest computer in the world at the time and now the 16th fastest machine.

In 2002 ORNL established an ultra-high-speed, real-time connection that enables the research community to tap supercomputing resources previously unavailable for general use. This feat was accomplished by bridging the gap between DOE's Esnet and Internet2.

Also in 2002 ORNL and Cray forged a partnership under the guidance of DOE and with the cooperation of other national labs. This collaboration is expected to result in supercomputers that will exceed the capabilities of Japan's 40-teraflop Earth Simulator, currently the world's fastest computer. The partnership, which will provide resources enabling unprecedented solutions to scientific problems, will advance ORNL to the forefront in supercomputing for the new millennium.

SOFTWARE SIMULATIONS

Models for Scientific Discovery

ORNL has had significant influence worldwide on the software and algorithms used for scientific discovery. In the late 1980s, Parallel Virtual Machine (PVM) software was developed at ORNL. PVM, which had more than 400,000 users in the mid-1990s, became a worldwide de facto standard for clustering computers into a virtual supercomputer.

In the mid-1990s, the Message Passing Interface (MPI) effort was begun by Jack Dongarra, who has joint appointments at ORNL and the University of Tennessee. MPI is the dominant programming paradigm used by scientific codes around the world. Dongarra also led the development of LAPACK and BLAS to solve linear algebra problems by high-performance computers. LAPACK and its parallel version ScaLAPACK are now used on all supercomputers around the world.

In the late 1990s ORNL, other national labs, and IBM developed an award-winning, ultrafast data storage system, known as the High Performance Storage System, which is used today on supercomputers across the nation. At the same time, ORNL researchers developed electronic notebook software that allows large scientific research teams to collaborate more efficiently. This software now has thousands of users in research, industry, medicine, and academia.

In 2002 a national software effort led by ORNL called OSCAR (Open Source Cluster Application Resources) became the most used cluster-computing management software in the world. It has 50,000 users.

With the help of software and simulation codes partly developed at ORNL, Laboratory researchers have used supercomputers for three-dimensional modeling of fusion plasmas and exploding stars; finding genes and predicting future climate as industrial emissions change; and simulating car crashes to aid the design of lighter, more efficient cars that better protect car-crash victims. ORNL's computer modeling of giant magnetoresistance already has influenced Seagate and IBM, leading to faster desktop computers and smaller, smarter digital cameras.

1994

"Lab on a chip" invented; now used commercially for protein analyses & drug discovery experiments

Mass spectrometry techniques devised for detecting pollutants, explosives, proteins

Codes prepared to run models of future climate on new parallel supercomputers

ALLIANCE software developed to make team of robots work cooperatively

1995

Startup of Intel Paragon XP/S 150, then the world's fastest supercomputer

RABiTS™ method devised for making high-temperature superconducting wires