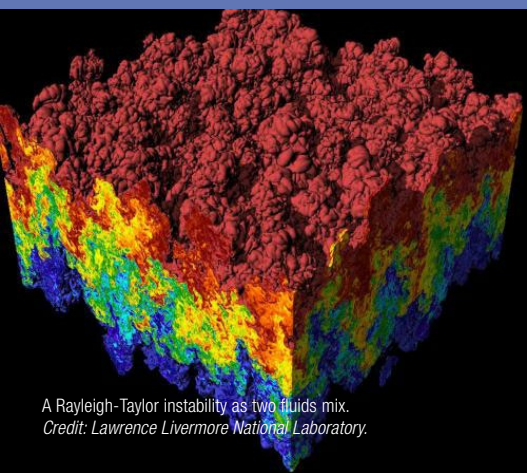
OVERCOMING SCALING CHALLENGES

Massively Parallel Processing Systems Boost Computer Power and Speed

A turbulent flow in compressed fusion plasma. *Credit: Seth Davidovits, Princeton Plasma Physics Laboratory/Lawrence Livermore National Laboratory.*

Nearly four decades ago, Department of Energy (DOE) laboratories recognized that the prevailing vector supercomputing technology would need to be replaced with systems that used many smaller microprocessors to support the ever-growing need for computational power and speed. Today these massively parallel processing (MPP) systems have become the dominant approach for building the most powerful computing systems in the world.

That successful shift was built directly on coordinated R&D investments from the Advanced Scientific Computing Research (ASCR) program. Before MPP systems could be used for scientific discovery, researchers needed to address scaling challenges at every level, from building the communication fabric needed to connect thousands of microprocessors to developing scientific applications.



A Rayleigh-Taylor instability as two fluids mix. *Credit: Lawrence Livermore National Laboratory.*

INNOVATIONS

MPI, PGAS, UPC AND SOFTWARE INFRASTRUCTURE

ASCR's R&D investments in programming models and systems, system software, and communication libraries were critical to the large-scale use of MPP in science.

- ASCR support led to several programming standards, including MPI (message passing interface), PGAS (partitioned global address space) and UPC (unified parallel C) that enabled applications to be developed for MPP systems.
- ASCR's further support of system software, message-passing libraries and underlying algorithms ensured that these applications could effectively harness MPP systems and helped researchers produce software that was portable across different systems. These technologies, adopted by industry, have formed HPC's ecosystem over the past three decades.

IMPACT

ASCR HAS CREATED AN MPP ECOSYSTEM

ASCR's investments combined with DOE's R&D investments in applications through the Scientific Discovery through Advanced Computing (SciDAC) program and partnerships with industry vendors have boosted computational capabilities for science.

- When acquiring new supercomputers, DOE viewed industry vendors as partners.
- Improvements in MPP systems support science advances, which, in turn, lead to further advances in MPP and a larger industry market for MPP systems, paving the way for tomorrow's computers and assuring U.S. leadership in the field.

TAKEAWAY

A MASSIVE RETURN ON COMPUTING INVESTMENT

ASCR R&D investments in scalable programming models, system software and communication libraries laid the foundation for today's key computational science applications.

Content provided by Department of Energy multiprogram laboratory researchers. Prepared by the Krell Institute for the ASCAC Subcommittee on the 40-year History of ASCR.